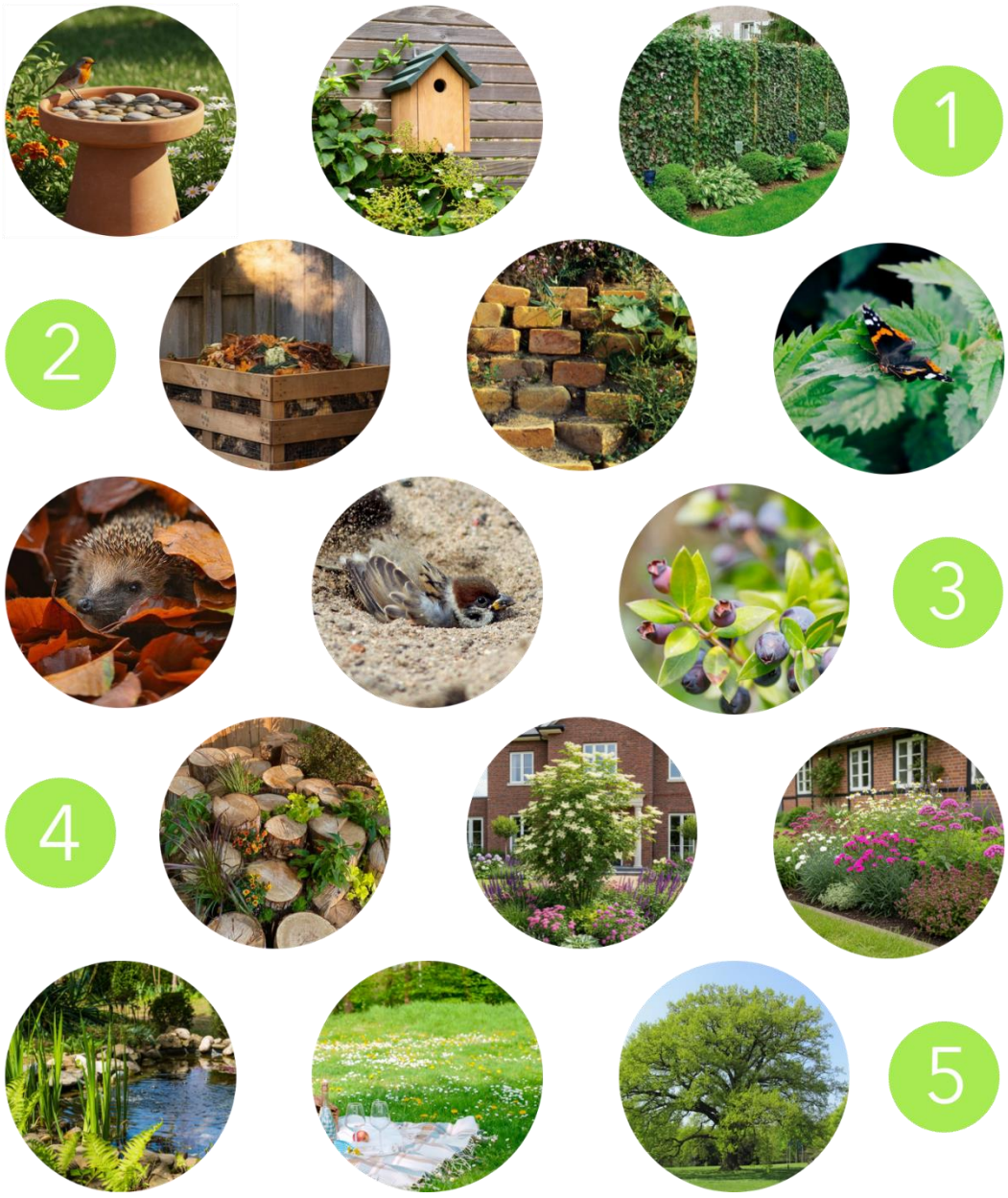
Garden Biodiversity Index (GBI) for Dutch Urban Private Gardens

Applying a Citizen Science Approach to Measuring Biodiversity Levels in Private Gardens in Arnhem (NL)



A Master Thesis by Niamh Bosch

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Garden Biodiversity Index (GBI) for Dutch Urban Private Gardens

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Applying a Citizen Science Approach to Measuring Biodiversity Levels in Private Gardens in Arnhem (NL)

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ABSTRACT

Urban private gardens play a big role in urban biodiversity, but their private ownership and the complexity of the biodiversity concept hinder data collection about the level of biodiversity in those gardens. The recently developed Garden Biodiversity Index (GBI) aims to overcome these issues by presenting a self-evaluation tool for garden owners, containing a checklist of 15 biodiversity enhancing elements. Following a citizen science methodology, this research uses the GBI, transformed to a Dutch online survey, for determining the biodiversity level of Dutch private gardens in the city of Arnhem. The 24 districts house over 37.000 private gardens, which together form a potential greening area the size of 1.000 football fields.

The survey reached 1690 respondents in total by means of snowball sampling (survey A) and *Gemeente Arnhem's* panel sampling (survey B). The results show that both the mean (29,6) and the median (27,5) of the total GBI scores obtained are relatively high, meaning that the gardens in this research are rather biodiverse. Compared to the original study where the mean and median both are around 21, this shows that either the new urban context of this research scores better or that Arnhem's garden owners are less critical. The average, minimum and maximum scores per district group were largely in sync with their Steenbreek classifications. The elements Tree, Vertical Greenery and Bed of Flowers were most frequently present in respondents' gardens while least found elements were Compost, Dry Stone Wall and Pond. The control evaluations, in most cases, had lower GBI scores than the corresponding self-evaluation. The largest difference was found for the elements Pile of Leaves and Meadow, which have a longer list of prerequisites and are harder to distinguish than the elements Tree, and Vertical Greenery for which the difference was small.

The research was limited by the wintery season in which it took place, making it harder to distinguish various elements in respondents' gardens. Another factor potentially influencing the results of this research is the selection bias, increasing the likelihood of responses from people involved either in biodiversity, gardening or the researcher herself. At the same time, most respondents were enthusiastic about the GBI as an online self-evaluation tool, with higher relative perception change compared to action change. Thus, the results show the promising application of the GBI in various academic and professional fields ranging from professional gardeners to local government.

Keywords: Garden Biodiversity Index (GBI), urban private gardens, biodiversity, Arnhem (NL), citizen science, survey

PREFACE

Dear Reader,

This thesis report dives into the topic of biodiversity in privately owned urban gardens in Arnhem, the Netherlands. With the help of the Garden Biodiversity Index (GBI) as an online self-evaluation tool for garden owners, insight is gained into the level of biodiversity in their gardens. This master thesis was written as part of the master's program Environmental Sciences at Wageningen University & Research. In a way, it is a continuation of my previous research, a master thesis in communication, into the garden experiences of hard-to-reach garden owners in Schuytgraaf, a district of Arnhem, as it dives further into the topic of greenery and urban private gardens. It also combines my two biggest interests: the environment and communication thereof. I am still a great believer in the power of environmental communication and the significance of an individual's role in achieving a world in which we live in harmony with humans, animals and the Earth. What better way than to pick a research topic that combines all three: biodiversity in the private garden. Even though this thesis report is part of my master's program, the intended audience is larger than that and encompasses everyone who is interested in green gardens. Yet I had to resort to a few field-specific terms in order to properly describe my results. That brings me to the writing part of this thesis, which was nothing but a pure joy! Not only did it build on the knowledge I had gathered during my education, but it also proved to be a very interesting topic, inspiring a great number of people I met on the way. Their enthusiasm was infectious.

I cannot end this process without paying attention to the people who made it possible for me to do this and who supported me immensely along the way. Major thanks go out to my two incredibly sweet, enthusiastic and supportive supervisors: Sophie Rickebush and Marjolein Lof. You added another layer of fun to this project for me, and I am super grateful for all the effort you put into helping me. Big thanks to Anne Luijten, Wilco Liebrand, Ria Eilander and the rest of the *Gemeente Arnhem* support team! You gave me the awesome opportunity to present my results at the town hall, an experience I will never forget. Lastly, I'd like to thank every single person that contributed to this report, either as a respondent of the surveys, as a reviewer of my work or as my personal cheerleader. It would not have been so great without your presence.

Now it is time to start reading. I wish you a lot of fun reading it, may it interest & inspire you!

Niamh Bosch
Arnhem, 20 February 2026

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LIST OF SYMBOLS


Birdbath


Nestbox


Vertical Greenery


Compost


Dry Stone Wall


Wild Corner


Pile of Leaves & Branches


Open Terrain


Berry-bearing Shrubs


Dead Wood


Shrubbery


Bed of Flowers


Pond


Meadow


Tree

1 INTRODUCTION

Urban private gardens play an important role in climate resilience in cities. As they constitute a large part of urban green, their contribution to cooling, biodiversity, water retention, and health amongst others is significant (Hanson et al., 2021). Yet, there remains uncertainty about the exact role of urban private gardens in the overall urban green infrastructure (GI) as well as their actual content and management, being privately owned (Cavan et al., 2021; Hanson et al., 2021) Knowledge about the green infrastructure types (such as trees, grass etc.) is needed to understand the influence it has on the urban microclimate. Overall, it is assumed that a greater amount of greenery in one's garden relates to a higher level of biodiversity as there is generally more space for different habitats leading to higher species richness (Murkin et al., 2023). Green connectivity is key, with more biodiverse private gardens in a row lead to higher perceived benefits for the overall level of biodiversity. In the Netherlands, there remains a large greening potential as only 36% of a private garden exists of greenery on average. Combined with the current paving trend, resulting in a 2,6% decrease in vegetation, this asks for more insight into the level of biodiversity in private gardens (Deloitte & Climate Adaptation Services (CAS), 2019).

1.1 GARDEN BIODIVERSITY INDEX

The Garden Biodiversity Index (GBI) shows great potential in not only mapping the current biodiversity situation in urban gardens but also providing different levels of advice based on this (Felgentreff et al., 2025). It is thus a useful tool for aiming to increase insight into garden biodiversity on an individual/household level, potentially leading to a change in perception or action on the longer term. It applies a bottom-up approach and a form of citizen science, in which the garden owner (or citizen) is the primary data source, collecting scientific data to advance scientific research (Fraisl, 2022).

1.2 THE CASE OF ARNHEM

The GBI being a relatively new tool, only tested on private gardens in North-western Germany, applying it to a different case is considered a useful addition. This master thesis aims to test the applicability and usefulness of the GBI in the Dutch city of Arnhem, comparing the results of garden owners in predominantly biodiverse (green) and tiled (grey) districts. Arnhem aims to be climate resilient and nature inclusive, but it seems that not every part of the city shares this goal yet. Where in the northern part of Arnhem a greater percentage of private gardens adheres to the Steenbreek guideline for the amount of greenery in the garden (25-75%), the southern part scores a lot lower (25% and less) (Stichting Steenbreek et al., 2024). This stark difference functions as a starting point for a green and grey division.

1.3 SCIENTIFIC & SOCIAL RELEVANCE

As this master thesis aims to test a newly developed tool in a different context, it is considered an important contribution to the already existing body of literature about biodiversity in private gardens. It especially benefits research in the field of improving urban green and could be beneficial for both *Gemeente Arnhem* and other municipalities that aim to incorporate this tool in their biodiversity approach. On a social level, garden owners get more insights into the significance and level of biodiversity in their gardens. When this leads

to increases in greenery in gardens, this not only affects individuals (e.g. health) but also society as a whole through for example climate regulation (Hanson et al., 2021).

1.4 PURPOSE & RESEARCH QUESTIONS

The purpose of this study is to test the recently developed Garden Biodiversity Index (GBI) in a different context. Where it is based on the situation in North-western Germany, the focus of this thesis is on an urban area in the Netherlands, specifically the city of Arnhem. The main (MRQ) and sub (SRQ) research questions this thesis aims to formulate an answer to are:

MRQ. What can GBI self-evaluations tell us about the level of biodiversity in private gardens, differentiating between district paving levels in Arnhem?

SRQ1. What is the current state of knowledge on biodiversity in urban private gardens and the associated measuring tools according to literature?
This question aims to set the GBI in a bigger context, to understand why it is relevant to use this specific index for measuring biodiversity in private gardens.

SRQ2. How do garden owners self-evaluate the level of biodiversity in their garden using the GBI?
This question is to understand the current level of biodiversity in gardens within each district separately: what is their average index and what does that mean?

SRQ3. How does paving level of districts influence the results of the GBI?
This question aims to find a difference or correlation between district categories based on their paving level, distinguishing 4 district types from relatively green to largely paved.

SRQ4. In what ways do the self-evaluations of the GBI differ from the control evaluations?
This question aims to compare the self-evaluations by the garden owners with the control evaluations by the researcher. The extent to which they differ gives an indication of the user-friendliness of the GBI as a tool and the person's self-evaluation abilities. This finally results in suggestions for improvements of the GBI as a tool used by garden owners. It is about the user-friendliness and the coverage of the biodiversity domain.

SRQ5. How are the participants influenced by the results of their individual GBI's?
This question investigates the social effects of GBI self-evaluations. Participants are asked if they can reflect on the use of the GBI and whether it influences their own perceptions or actions related to biodiversity in their garden.

2 GARDEN BIODIVERSITY

This chapter dives into the scientific literature behind the concept of biodiversity, especially aimed at private gardens in the Netherlands. It first identifies the definition, pros and cons of urban biodiversity as a concept. Then, the situation in Dutch private gardens is discussed, after which the already existing biodiversity conservation efforts are listed.

2.1 DEFINITION OF URBAN BIODIVERSITY

A clear distinction can be made between urban biodiversity and urban nature. Urban biodiversity refers to "the variety and abundance of life in a city", while urban nature encompasses all life in a city, including nature areas that support this (Guerry et al., 2021). Those nature areas stretch from larger and wild nature spaces, both blue and green, to smaller patches of urban nature such as gardens. Thus, urban nature supports urban biodiversity by providing spaces of nature for various animal species to live in urban areas.

Especially in the current society in which the natural environment is increasingly fragmented, biodiversity conservation is a more pressing item than ever (Goddard et al., 2009). With the agricultural intensification and urbanisation processes, biodiversity is generally decreased, but the presence of suitable urban gardens, both private and public, has potential to counteract this. Though, there are still upsides and downsides to urban biodiversity.

2.1.1 UPSIDES & OPPORTUNITIES TO URBAN BIODIVERSITY

The collective size and connectivity of urban private gardens and other urban nature form important interconnected systems and could provide significant benefits to biodiversity (Goddard et al., 2009). These benefits can broadly be ascribed to the ecological function and societal aspects of urban areas.

From an ecological perspective, biodiversity has the potential to increase a city's climate resilience (Mattijssen et al., 2020). More greenery in densely populated urban areas increases the soil's capacity to retain water but also provides natural cooling. More indirectly, more greenery provides regulation of air pollution, carbon sequestration and noise reduction (Puppim de Oliveira et al. 2014). The other way around, climate change affects the state of biodiversity. It is therefore important to increase and preserve biodiversity to protect ourselves against the effects of climate change and increase liveability in cities.

Beside the apparent ecological benefits, urban biodiversity also contributes to societal and personal aspects. The benefits for individuals are wide-ranging but generally relate to personal or societal factors (Davies et al., 2009). Examples include quicker recovery from illnesses and an overall better physical health, stress-relief and improved mental health, but also higher social interaction and lower crime rates. Private gardens also contribute to the transmission of knowledge on agricultural practices and therefore function as an important social and cultural space (Galluzzi et al., 2010).

2.1.2 DOWNSIDES & THREATS TO URBAN BIODIVERSITY

Increasing urban biodiversity also comes with negative consequences, however (Goddard et al., 2009). Urban areas often pose as a threat for native biodiversity due to a higher risk of transmission of wildlife diseases and the existence of cats as major predators. On top of that, the relatively great diversity in plants within urban gardens can mainly be attributed to the import of exotic species. Studies show that these non-native plant species do not support

native animal species, resulting in a mismatch between the two. Exotic plants can also cause other problems such as replacing crucial native species or even destruction.

The most important threats for urban biodiversity are development projects that replace urban green, paving or other types of conversion to impermeable materials, and smaller plot sizes (Delahay et al., 2023). Urban biodiversity thus faces competition over space (Kowarik et al., 2025). Besides, garden owner's values, attitudes, needs and resources also greatly influence garden management decisions (Ward & Evans, 2025). The declining engagement of inhabitants with nature adds another human pressure to biodiversity in the city (Kowarik et al., 2025). Less influential, but worth mentioning, constraints are social norms and aesthetics (Ward & Evans, 2025).

2.2 URBAN BIODIVERSITY IN DUTCH GARDENS

In the Netherlands, a general negative trend in biodiversity has been observed due to habitat loss, densification, reduced soil- and water quality, and increased disturbances from light and sound (Edixhoven & Hofhuis, 2025). These trends also significantly influence the quality of the living environment, health, and climate resilience. This has led to the development of the Basiskwaliteit Natuur (BKN), a framework for establishing a minimum level of biodiversity in areas outside nature reserves, essential for a healthy society (Meesters et al., 2024). It aims to collectively improve the quality of nature and maintain it sustainably so that native species can thrive again (Vogelbescherming Nederland, n.d.). At the moment, most Dutch landscapes do not meet the BKN standards.

A significant part of these Dutch landscapes are urban private gardens, which have only recently been included in attempts to increase biodiversity. For that reason, there is only limited data available on the exact role of private gardens in biodiversity (Goddard et al., 2009; Galluzzi et al., 2010). Research in the Netherlands on private gardens generally only addresses the relation between green gardens and several health benefits (De Vries et al., 2025) or garden identities of older people, influenced by gardening, garden trends, and socio-economic factors, changing over time (Lauwerijssen et al., 2024). Even though the research directions differ, all papers conclude that an increase in green space in a private garden is associated with multiple benefits to individuals. It can also be concluded that more greenery often equals more space for different habitats and thus more biodiversity, creating a link between amount of greenery and biodiversity in private gardens (Delahay et al., 2023).

A report by Deloitte and Climate Adaptation Services (CAS) (2019) shows that a Dutch garden consists of vegetation for about 36% on average, with percentages varying greatly between cities. That translates to a rather large greening potential reaching multiple billion square meters (i.e. 285.000 football fields), which could, if effectively utilized, reduce heat significantly. Every 10% increase in greenery per neighbourhood equals to a decrease of 0,6 °C. This potential increases with the current paving trend, which puts pressure on the biodiversity in private gardens with an average vegetation decline of 2,6% (Van Iersel, 2024).

2.3 DUTCH BIODIVERSITY CONSERVATION EFFORTS

Recommendations for improving the role of private gardens for biodiversity are commonly known as "wildlife gardening" or "wildlife-friendly management" (Gaston et al., 2005; Delahay et al., 2023; Goddard et al., 2009). Examples of such practices are the introduction of insect nest sites, small ponds, dead wood for fungi, and nettles for butterflies. However,

Gaston et al. (2005) justifiably point out that the appraisal for using such methods should be in line with their actual success in increasing biodiversity. Nevertheless, the focus of such practices on providing optimal conditions for biodiversity to return to the garden is a good starting point (Delahay et al., 2023).

Existing biodiversity conservation efforts generally focus on a specific aspect of biodiversity, such as the amount of greenery, soil quality, and state of certain species (e.g. bees). The most important Dutch campaigns for increasing biodiversity in private gardens are:

'EEN GROENER NEDERLAND BEGINT IN JE EIGEN TUIN' is an umbrella term for the cooperation between 29 green organizations (Plant Je Mee, n.d.-b). It was first set up in 2020 by Steenbreek, Appeltern and NL Greenlabel, starting with a spring and autumn campaign: *Maand van de Groene Tuin* and *Plant Je Mee* respectively. Besides, they also started the *NK Tegelwippen* that year, focusing on the battle between Rotterdam and Amsterdam initially but gaining popularity and support base over time.

> MAAND VAN DE GROENE TUIN is an initiative by Milieu Centraal focussed on motivating people to make their living environment (including gardens, balconies, and neighbourhoods) greener (Milieu Centraal, n.d.). In the month of April, participants are provided with useful tips and are given the opportunity to participate in various campaigns. These range from workshops about aspects of increasing biodiversity and climate resilience on garden-level and informational webinars, to local initiatives such as the tegeltaxi's (for picking up tiles from individual's gardens) and farmers markets focused on plants and cuttings. Participants can also join various competitions for prices like garden elements or garden advice. To promote this campaign, various famous Dutch people (BN'ers) also take part in it.
>
> PLANT JE MEE focuses on the autumn period (Plant Je Mee, n.d.-a). It promotes planting seeds and plants in the months of October and November, spreading information and promotion via online channels and magazines. It is based on the idea that the preparations for the spring ideally start in the autumn when seeds and plants should be planted due to perfect soil conditions and to promote instant growth in the spring season.
>
> NK TEGELWIPPEN was first introduced in 2020, starting as a rally between the rivalling cities Rotterdam and Amsterdam aimed at removing as much tiles from the urban area as possible (NK Tegelwippen, n.d.). It has since gained more attention, making it a national competition as of 2021, with an increasing number of participating municipalities. There is even a competition between the Netherlands and Belgium, known as the *Derby van de Lage Landen*. Various prices encourage people to remove the tiles in their gardens between 21 March and 31 October.

PIENTERE TUINEN is a citizen science project in which garden owners help measure the soil quality in their garden using a soil sensor they receive at participation (Kennisportaal Klimaatadaptatie, n.d.). Every participant also gains access to data, advice, and research results. This is an effort to increase awareness amongst garden owners about the importance of green gardens. *Pientere Tuinen* is aimed at collecting as much data as possible from private individual sources. The first measurements started in April 2023, but the number of participants has grown to 1300 in 2025, making it the largest participation project in the Netherlands (RIVM, n.d.). The first measurements have led to the conclusion that temperatures are on average lower in greener gardens, and smaller gardens warm up faster.

Pientere Tuinen is derived from the Belgian project *Curieuze Neuzen* which collected data on soil temperature and moisture with 5000 devices. A derivative of the *Pientere Tuinen* project is *Pientere Schooltuinen*, a project focused on measuring schoolyards and involving pupils in their own school environment and accompanying themes such as climate adaptation (IVN, n.d.-a).

TUINY FOREST is a campaign designed by IVN to create small forests the size of 6 m^2 in an urban private garden (IVN, n.d.-b). It provides packages filled with native plants as a starting point for a small wilderness area aimed at survival of species, which is expected to grow in 2 years. Tuiny Forest is a derivative of the Tiny Forest campaign, focused on increasing biodiversity in cities through the implementation of small forest areas the size of a tennis field within the urban area (Kennisportaal Klimaatadaptatie, n.d.). Besides Tuiny Forests, IVN also offers a variety of other packages aimed at increasing biodiversity: Tuiny Poel (for ponds), Tuiny Haag (for hedges), Tuiny Dak (for green roofs), Tuiny Bloeipakket (for flowers), and Tuiny Gevel (for green façade gardens) (IVN Natuureducatie, n.d.).

An important player in the campaigns surrounding biodiversity (or greenery) in private gardens is Stichting Steenbreek (Kennisportaal Klimaatadaptatie, n.d.). They not only set up campaigns themselves but also support municipalities and other important players in their efforts to make their surroundings greener and more sustainable.

2.4 BIODIVERSITY INDICES FOR PRIVATE GARDENS

Basiskwaliteit Natuur (BKN) emphasises the need for monitoring tools for assessing the state of biodiversity (Naturalis Biodiversity Center, 2025). In recent years, several indices have been created to measure biodiversity in private gardens, but there remains uncertainty about the scale (local (garden) vs landscape (city)) at which factors determining biodiversity are measured (Goddard et al., 2009). For this, conclusions have only been drawn from urban parks, which are not comparable to the area of a private garden. Yet there have been developed a few indices over the years that are able to measure different aspects of biodiversity on such a small scale. Some of them, however, are not user-friendly enough to be put in practice as they require complex in-person or expert-performed assessments (Felgentreff et al., 2025). Simpler and more effective indices include:

- the Environmental Gardening Index (EGI), which measures the number of ecological gardening practices (e.g. lawn-mowing frequency and use of pesticides) applied in a private garden and the presence of ecologically important elements (e.g. a pond and nesting sites) (Lindemann-Matthies & Marty, 2013). During their research, Lindemann-Matthies & Marty combined the result of this index with a Species Richness Index (i.e. a flora and fauna species count) and an Aesthetic-rating Index (i.e. rating photographs of gardens) to find out if ecologically important or biodiverse gardens are in line with the perspective of people on aesthetically pleasing gardens.
- the Wildlife Resources Index (WGI), which counts the presence of certain wildlife-friendly elements within a private garden (Goddard et al., 2012). This index was used to determine the factors that influence wildlife-friendly garden management.
- the Habitat Heterogeneity Index (HHI), which adds up the number of different land-use types and features observed in a private garden (Young et al., 2019).
- the Habitat Richness Index (HRI), which shows the frequency of occurrence of nine land cover types in private gardens (Braschler et al., 2020).

These indices are generally not conclusive and need to be combined with other indices to present the full picture. The latest addition to this list is the Garden Biodiversity Index (GBI), which is only recently developed, but is more user-friendly and encompasses all important elements of biodiversity in a private garden in a relatively short questionnaire (Felgentreff et al., 2025).

2.4.1 GARDEN BIODIVERSITY INDEX

The Garden Biodiversity Index (GBI) was developed in 2025 by Felgentreff et al. to help garden owners self-assess the biodiversity level in their gardens (Felgentreff et al., 2025). It makes use of a survey for determining the presence of certain biodiversity enhancing elements. The GBI exists of 15 elements: a bird bath, nesting box, vertical greenery, compost, dry stone wall, wild corner, pile of leaves and branches, open terrain, berry-bearing shrubs, dead wood, shrubbery, flowerbed, pond, meadow, and tree. Each element has a specific number of points ranging from 1 to 5, based on its contribution to biodiversity. This was initially calculated using the mean positive change in plant species richness between gardens with and without the different elements. The higher the plant species richness change, the higher the points for that element. The points add up to a biodiversity score, which can vary between 0 and 45. The list is shown in Table x. The higher the score, the higher the biodiversity level. Based on this GBI score, gardens are categorised in three main groups: 0-15 points, 16-30 points, and 31-45 points. Each score category then receives its own advice to further improve the garden's situation.

Table 2-1: The Garden Biodiversity Index (GBI) checklist with the 15 elements on the left and their respective points on the right.

Element	Present?	Points
Birdbath	☐	**1**
Nestbox	☐	**1**
Vertical Greenery	☐	**1**
Open Compost	☐	**2**
Dry Stone Wall	☐	**2**
Wild Corner	☐	**2**
Pile of Leaves & Branches	☐	**3**
Open Terrain	☐	**3**
Berry-bearing Shrubs	☐	**3**
Dead Wood	☐	**4**
Shrubbery	☐	**4**
Perennial Border	☒	**4**
Pond	☐	**5**
Flower or Herb Meadow	☐	**5**
Tree	☐	**5**
GBI score		**0-45**

3 CASE-STUDY: ARNHEM

Arnhem is the capital of the province of Gelderland in the Eastern part of the Netherlands as shown in Figure 3-1 (Mijn Gelderland, n.d.). It is currently home to about 169 thousand inhabitants and 37.6 thousand private gardens (AlleCijfers, n.d.; Stichting Steenbreek et al., n.d.). The city is divided into 24 districts, which in their turn host various neighbourhoods (CBS, 2025). A map of the city's districts is shown in figure 3-2 below (AlleCijfers, n.d.).

Figure 3-1: The location of Arnhem within the Netherlands.

Arnhem holds a double identity due to the two different parts of the city, separated by the river Rhine, where the Southern part has only been added 80 years ago (De Vries, n.d.). Back then, the mayor decided to expand southwards rather than up north because he strongly believed the nature reserve in the north should be protected. He has been honoured for his efforts, which shows that nature is an important part of this city's identity. Figure 3-2 also clearly shows the distinction between Arnhem-Noord (northern part) and Arnhem-Zuid (southern part), crossed by the Rhine.

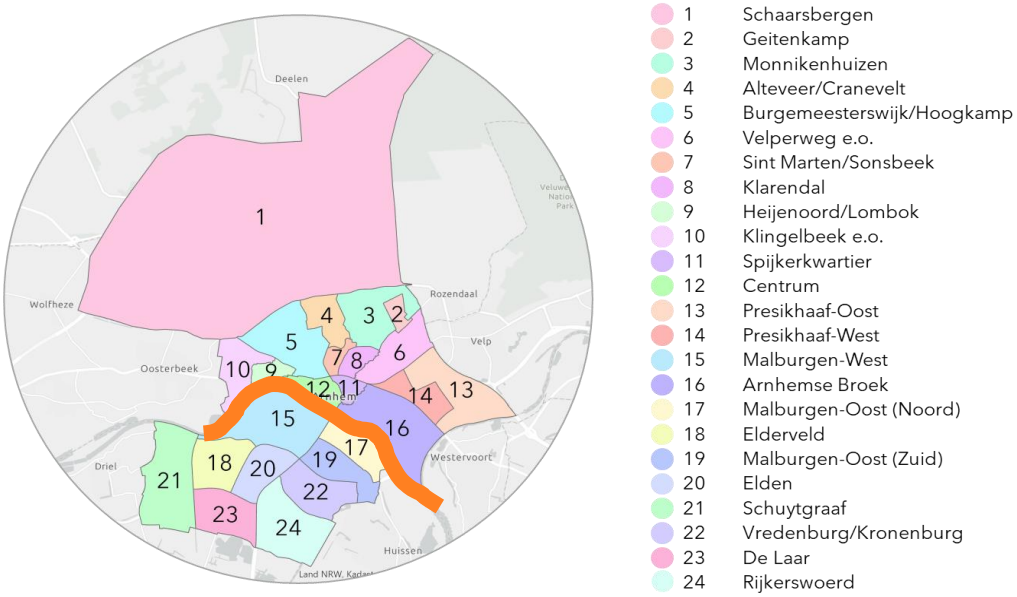

Figure 3-2: A map of Arnhem, showing the 24 districts with different colours and numbers. The thick orange line shows the Rhine, splitting the city in North and South. The map was created in ArcGIS Pro.

Arnhem-Noord and Arnhem-Zuid also differ when it comes to their characteristics. Where the Northern part holds more tree-like vegetation in a sandy soil, the Southern is characterized by a wetter landscape including more swamp-like vegetation in a clay soil (Bodemdata, n.d.). This translates to different types of vegetation amongst others.

3.1 ARNHEM & TACKLING CLIMATE ISSUES

Arnhem is very involved in tackling issues related to climate change on a city-level. Just like the *Klimaatplan* at the national level, Arnhem has set up a *Klimaatplan* too, in which it documented its goals for CO_2-reduction on city-level (Gemeente Arnhem, 2025-a). In its *Klimaatadaptatieplan* strategy that was developed in 2021, it has assigned different levels of priority to different districts, depending on their proneness to heat, droughts, and flooding (Gemeente Arnhem, 2025-b). Within these categories, different goals and strategies to tackle these issues are described. Arnhem also focuses on greening the city through setting up measures to make it easier for people to participate (Partij voor de Dieren, 2022). An example is Arnhem's frequent participation in campaigns such as *NK Tegelwippen*.

3.2 ARNHEM'S LEVEL OF BIODIVERSITY

Arnhem's general biodiversity level is estimated to be acceptable but still with greening potential. On the Steenbreek Atlas, Arnhem scores an "average" on a scale from least to most promising cities to green (Stichting Steenbreek et al., n.d.). Relating it to neighbouring cities, Nijmegen is considered less promising and Barneveld is considered promising (Figure 3-3).

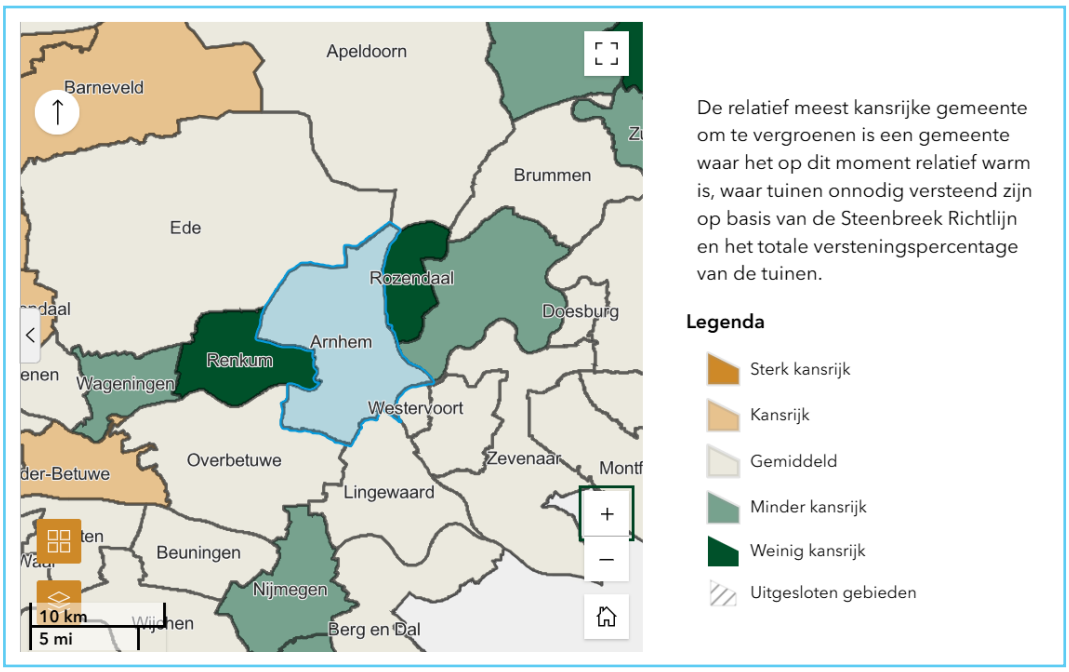

Figure 3-3: One of the Steenbreek Atlas maps showing how promising Arnhem and its neighbouring cities and villages are when it comes to its greening potential. Arnhem scores "Average", as shown by the beige colour.

The Steenbreek Atlas also shows that there are about 37.6 thousand gardens in Arnhem, with a total size of 948 hectares. Of these gardens, 356 hectares is paved, resulting in a paving percentage of 38%. This translates to Steenbreek's goal for Arnhem: improving 174 hectares in total, turning pavement into greenery.

3.2.1 DISTRICTS & BIODIVERSITY SCORES

Zooming in to district-level provides more insight into the variety of gardens and their paving percentage within Arnhem. Steenbreek has therefore created a guideline suggesting that an average Dutch garden should consist of greenery for at least 60% (Steenbreek, 2024). Considering that the gardens in a big city are relatively small, the guideline describes an

ideal small garden to have a seating area or other functional paved space of 15 m^2, as shown in Figure 3-4. The remaining part of the garden should have a 20/80% balance between paved area (20%) and greenery (80%).

Based on this guideline, the Steenbreek Atlas provides insight into the adherence to this guideline on average for all gardens in one district. It assigns a 4-step scale to each district, showing in red low adherence and in green high adherence. For Arnhem, this is shown in the coloured column in Table 3-1. For reference and the interpretation of results in this research, the number of residents is added to the table as well.

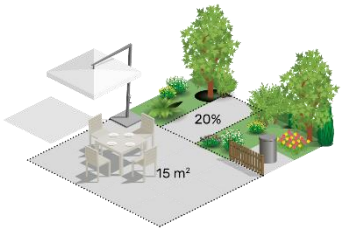

Figure 3-4: Visualisation of the Steenbreek Guideline for smaller or bigger gardens than average. A garden should have 15m^2 paved plus 20%.

Table 3-1: Analysis of Arnhem's districts, categorising them based on their Steenbreek Atlas adherence scores. The last column shows the Living Environment scores, which are not prioritised as they contain more elements than are related to biodiversity. The middle column contain the number of residents in 2025 (AlleCijfers, 2026).

Number	District	Number of residents	Steenbreek Guideline	NDTL Score
1	**Schaarsbergen**	2.390	Green	B
2	**Geitenkamp**	3.805	Orange	C
3	**Monnikenhuizen**	4.435	Yellow	B
4	**Alteveer/Cranevelt**	3.505	Green	B
5	**Burgemeesterswijk/Hoogkamp**	7.845	Yellow	B
6	**Velperweg e.o.**	9.325	Yellow	C
7	**Sint Marten/Sonsbeek**	5.720	Yellow	C
8	**Klarendal**	7.235	Yellow	C
9	**Heijenoord/Lombok**	3.835	Green	C
10	**Klingelbeek e.o.**	1.430	Yellow	B
11	**Spijkerkwartier**	6.840	Yellow	C
12	**Centrum**	7.520	Yellow	C
13	**Presikhaaf-Oost**	7.710	Orange	C
14	**Presikhaaf-West**	8.895	Orange	C
15	**Malburgen-West**	4.825	Orange	B
16	**Arnhemse Broek**	7.205	Orange	C
17	**Malburgen-Oost (Noord)**	6.400	Orange	C
18	**Elderveld**	8.720	Orange	B
19	**Malburgen-Oost (Zuid)**	9.265	Orange	C
20	**Elden**	2.985	Orange	C
21	**Schuytgraaf**	16.335	Red	C
22	**Vredenburg/Kronenburg**	8.765	Orange	B
23	**De Laar**	12.100	Orange	B
24	**Rijkerswoerd**	12.275	Red	B

Table 3-1 also shows the NDTL scores per district. Nationaal Dashboard Toekomstbestendige Leefomgeving (NDTL) (NDTL, 2024) has measured and visualised the state of the living environment, rewarding it with a score from A (excellent) to G (insufficient). They calculated, amongst others, the vegetation score, share of paving, heat stress score and NL Omgevingsscan Label for all districts in Arnhem. Taken altogether, this leads to the categorisation as shown in the right column in Table 3-1.

For the purpose of this research, the Steenbreek guideline categorisation of districts in Arnhem is prioritized above the NDTL-scores as these provide a direct insight into the pavement situation in gardens solely.

4 METHODOLOGY

This master thesis followed a sequence of steps, leading to the formulation of an answer to the main research question **"What can GBI self-evaluations tell us about the level of biodiversity in private gardens, differentiating between district paving level categories in Arnhem?"**. This chapter therefore gives a step-by-step explanation of the methods that were applied in the exploration, analysis and interpretation phases of this thesis. It is structured chronologically. The data was handled according to the data management plan (see Appendix II). This thesis applies both quantitative and qualitative methods, which is reflected in the survey questions that are a mix of closed (yes/no) multiple choice and open-ended questions. The closed questions were analysed with Excel, applying statistical analysis amongst others. The non-numerical data was analysed according to a thematic analysis approach.

4.1 LITERATURE REVIEW

As an introductory step in the research, a literature review was performed to determine the importance and relevance of the GBI and its implications and to place it in a wider context. It shows the current state of knowledge about biodiversity in urban private gardens and the corresponding measuring tools used to determine this, thereby answering SRQ1.

Relevant articles were selected based on several criteria. First, a list of queries was used to filter out articles regarding biodiversity and private gardens (Table 4-1). Second, articles were selected from 2020 onwards to include only the most relevant information. However, several exceptions were included for articles not prone to ageing.

Table 4-1: Overview of the queries used in the selection process for scientific literature about biodiversity in private gardens. The list is not in chronological order.

Queries Literature Review	#	References
Urban Biodiversity	1	(Guerry et al., 2021)
Urban Biodiversity Benefits	5	(Goddard et al., 2009), (Davies et al., 2009), (Galluzzi et al., 2010), (Delahay et al., 2023), (Kowarik et al., 2025)
Wildlife Friendly Gardening	2	(Ward & Evans, 2025), (Gaston et al., 2005)
Biodiversiteit Nederland	3	(Edixhoven & Hofhuis, 2025), (Meesters et al., 2024), (Naturalis Biodiversity Center, 2025)
Basiskwaliteit Natuur	1	(Vogelbescherming Nederland, n.d.)
Dutch Private Gardens	2	(De Vries et al., 2025), (Lauwerijssen et al., 2024)
Nederlandse Tuinen Groenpercentage	2	(Deloitte and Climate Adaptation Services (CAS), 2019), (Van Iersel, 2024)
Campagne Biodiversiteit	10	(Plant Je Mee, n.d.-b), (Milieu Centraal, n.d.), (Plant Je Mee, n.d.-a), (NK Tegelwippen, n.d.), (ANP, 2021), (Kennisportaal Klimaatadaptatie, n.d.), (RIVM, n.d.), (IVN, n.d.-a), (IVN, n.d.-b), (IVN Natuureducatie, n.d.)
Biodiversity Indices	4	(Felgentreff et al., 2025), (Lindemann-Matthies & Marty, 2013), (Young et al., 2019), (Braschler et al., 2020)
Citizen Science	1	(Fraisl, 2022)

4.1.1 CASE-STUDY

Arnhem was chosen as the case-study for this thesis due to its double character. It is a city of high contrasts regarding its landscape and structure amongst others. The case-study aimed to provide an overview of Arnhem and its position regarding greening initiatives. The 24 different districts of Arnhem were analysed and categorized in groups based on their

performance regarding the Steenbreek guideline (Steenbreek, 2024), differentiating between green, yellow, orange and red districts. This distinction in its turn was based on the number of gardens that adhere to the Steenbreek guideline suggesting that a garden should have a maximum size of paved area, where green refers to great adherence and red to almost no adherence.

4.2 SURVEY CREATION & DISTRIBUTION

The survey was based on the original GBI checklist, which for the purpose of this research was translated from German to Dutch with the help of a native German speaker. This was also shared with Felgentreff et al. It was created and spread by the researcher herself, referring to it as Survey A. The involvement of *Gemeente Arnhem* has led to the creation of a similar survey to be able to use their panel: survey B. The data of survey A and B combined thus resulted in a total of 1690 responses.

4.2.1 SURVEY A - QUALTRICS

Survey A was created by means of the Qualtrics software. It had 7 main components: introductory explanation, introduction questions, GBI questions, GBI score with an advice / explanation, reflection questions, and concluding questions and information. In the introductory explanation, participants were made aware of the topic, type of questions, structure, goal and duration of the test in general. At the start of the introduction (district, type of garden), reflection (review of the survey and look into the future) and concluding questions (willingness to cooperate in this study in the future or receive results), respondents were reminded of the way their data was handled. It was also clearly stated that the information that was gathered contained no personal information that could trace the answers back to the respondent. In this case, the Dutch AVG law states that is not obligatory to add a privacy statement (Autoriteit Persoonsgegevens, 2025). At the end, however, respondents were asked to leave their name and email address for future contact, but they had to state their interest in this in a previous question, asking for permission for this. If they answered "no" the question on personal information was skipped.

One of the introduction questions also aimed at gaining insight into how people view their garden. For this purpose, 5 pre-defined garden categories were used. These were based on the researcher's previous research, sorting them based on their contribution to biodiversity. The garden types are shown in Table 4-2 below.

Table 4-2: Explanation of 5 pre-defined garden types, designed to gain more insight into how people view their garden and to compare it with the GBI score results. They are sorted based on their contribution to biodiversity.

Nr.	Garden Type	Biodiversity	Description
1	Tiled Garden	Low	This type of garden is characterized by the abundance of impermeable materials such as tiles, artificial grass and gravel. It is focused on practical use, prioritizing access and low maintenance. A tiled garden is expected to score low on the GBI as it does not contain much greenery. Yet there are elements within the GBI that are suitable for this garden.
2	Neat Garden	Low to Medium	This type of garden is focused on keeping it as tidy and neat as possible. It generally has a frequently mowed lawn and carefully taken care of borders. Eco-consciousness is not the top priority as fertilizers, pesticides, weeding and mowing techniques are used to keep the garden in good condition. It is hypothesized that this type of garden only scores a little higher than the tiled garden due to the greater amount of green elements present.

3	Flower Garden	Medium	This type of garden prioritises aesthetics more than anything else. Flowers, such as roses, tulips, chrysanthemums, lilies, oleanders, laburnum and hydrangeas, are carefully picked out based on their appearance and colours to make the garden look beautiful. These flowers are often non-native and require unsustainable amounts of chemicals. A flower garden is therefore expected to score medium high (in the second GBI category), with the exact score depending on the type of flowers.
4	Lively Garden	High	This type of garden is focused on the ecology of the garden, harbouring various biodiversity-enhancing elements such as a pond, flowers, trees and plants, and food- and nesting places for animals. It is partly left to nature's course and partly maintained to make sure it is manageable and effective for flora and fauna. This attracts a great variety of life to the garden, amongst which butterflies, bees, birds, frogs and insects. When in line with the GBI classification, this garden can reach the highest score possible. It is thus hypothesized to end up in the highest GBI category.
5	Wild Garden	Unclear	This type of garden is characterized by the lack of maintenance. It is completely left to nature's course, no attention is paid to its design, leading to an overgrown garden. Therefore, this garden looks neglected and in time returns to the original state: a forest. It is an extreme interpretation of wild gardening, which is why it could score high on the GBI, depending on the elements present.

The survey included multiple choice, multiple response, drop-down, ranking, and open-ended questions. For the latter, answers were optional. A full overview of all questions can be found in Appendix III. Survey A was distributed by means of snowball sampling. The link to the survey questions was shared with acquaintances in Arnhem for them to spread it in their circles. In total, 449 people started the survey and 357 completed it.

4.2.2 SURVEY B - GEMEENTE ARNHEM

Survey B was created using the *Gemeente Arnhem*'s own software system, operated by one of their employees. A consultation was held beforehand to make sure the goal and questions of *Gemeente Arnhem* were in line with those of the researcher. A total of 10 extra questions were added to also serve *Gemeente Arnhem*'s objective with this research. Survey B was distributed using the panel of *Gemeente Arnhem*, which exists of about 4200 panel members living in Arnhem (*Arnhemmers*), with an expected response rate of 35%. In total, 1652 panel members started the survey, of which 1333 completed it. This translates to a response rate of 31,7%. For privacy reasons, personal data of the respondents was not shared with the researcher but kept in *Gemeente Arnhem*'s database for the duration of the research. The full survey questions are listed in Appendix IV.

4.3 SURVEY ANALYSIS

The data of each survey was exported to a separate excel file. The data common to both datasets was transferred to a third Excel file and merged into one table using the Power Query tool. The remaining data was analysed separately as it only applied to either Survey A or B. Survey A contained additional reflection questions, while Survey B was supplemented with questions relevant for *Gemeente Arnhem*'s own research purposes. A detailed description of the analysis of the 4 different parts in the survey (e.g. introduction, GBI, reflection and municipality-relevant) is given below, including in brackets the survey (A or B) the data belonged to.

4.3.1 INTRODUCTORY QUESTIONS (A&B)

Most introductory questions were asked in both survey A and B. Only in case of survey B, the question "*Do you own a garden in Arnhem?*" was left out. The questions concerned the district participants come from and how they perceive their garden and were analysed using frequency tables.

4.3.2 GBI CHECKLIST (A&B)

The GBI checklist questions were the main objective of the survey. Therefore, these questions were embedded in both survey A and B. In survey A, participants were shown one question at a time, giving them the option to answer "yes" or "no" to the presence of each element in their garden. In survey B, the participants were shown a table with 5 elements at the same time, giving answer options in the form "yes" or "no" too. The GBI scores each element of a garden on a scale of 1 to 5, as shown in Table 4-3. The total score is the sum of all these elements.

Table 4-3: The number of points assigned to all 15 elements of the GBI.

Number of Points	Elements
1	Bird bath, nesting box, vertical greenery
2	Open compost, dry stone wall, wild corner
3	Pile of leaves & branches, open terrain, berry-bearing shrubs
4	Dead wood, shrubbery, flower border
5	Pond, flower or herb meadow, tree

4.3.3 MUNICIPALITY-RELEVANT QUESTIONS (B)

In survey B, the *Gemeente Arnhem* added a set of questions - 10 in total - relevant to their own interests regarding green in gardens. These questions were mainly explorative in nature and covered building type (rent/buy), an estimation of the green/grey distribution in the garden, the importance of green gardens and reasons why or why not to green, recent changes in garden design, the interest in green measures and the ones already taken or planned, and familiarity with the green-blue subsidy. The data was partly numerical and partly non-numerical and analysed using frequency tables.

4.3.4 REFLECTION (A)

At the end of survey A, a few reflection questions were asked to gain insight into how participants experienced the survey. These were analysed separately. The questions were mainly based on a ranking scale, giving the participants the opportunity to assign 0-5 stars to different aspects of the survey: Clarity, Image use, Purpose, Outcome, and Explanation. The last two questions also made use of a raking scale, but these were categories: yes (4), probably yes (5), maybe (6), probably not (7), no (8). Again, frequency tables were created to show the occurrence of each category.

4.3.5 THEMATIC ANALYSIS OF NON-NUMERICAL DATA

Lastly, open-ended questions were analysed, were relevant, based on the recurring themes in the answers (Thematic Analysis). This was done in excel, applying a colour coding method, after which the categories and their occurrence was turned into a word cloud using AhaSlides' online converter tool.

4.3.6 VISUALISATION

The data was visualised using Excel's built-in Graph and Table styles. Additionally, to visualise the results spatially, maps were made using ArcGIS Pro.

4.4 CONTROL EVALUATIONS

To gain more insights into the real-life application of the GBI checklist and to increase the research's reliability, control evaluations were conducted in addition to the self-evaluations. Participants who agreed to participate in follow-up steps in Survey A were contacted to arrange a meeting for the researcher to visit the gardens. Beforehand, the 62 interested respondents were analysed based on their GBI score category (Light, Middle, Dark Green) and the Steenbreek classification of their district. Combined, this led to 12 groups of participants, which would all ideally be represented at least twice in the control evaluations (a minimum of 24 control evaluations in total).

However, due to time constraints and practical limitations (e.g. an extensive period of snow), only 5 control evaluations were physically conducted. Other participants were asked to share photos of their garden so that the researcher could evaluate them as desk research. This resulted in a total of 18 control evaluations. The control evaluations were analysed by hand, calculating a GBI score and comparing it with the self-evaluation in Excel.

4.5 VALIDITY & RELIABILITY

The data's reliability is ensured by the topic of the survey. It is relatively time consistent as the presence of various elements in a garden is not expected to change vastly, unless a person decides to do a garden makeover. The test-retest reliability is thus considered high (Middleton, 2025). The addition of control evaluations also increases the interrater reliability, showing how different perceivers (e.g. the garden owner and the researcher) view and score the garden.

All relevant elements of the GBI are included and measured, thus ensuring a high content validity (Middleton, 2023). The construct that was measured, biodiversity in private gardens, is represented by the GBI. It covers the most important aspects of biodiversity but might lack other aspects. Still, the GBI can be considered the best academic tool to accurately measure biodiversity. Therefore, the construct validity is considered adequate. As the questions are presented with an eye on the target group, the face validity is also considered good. Lastly, the survey measured what it was supposed to measure and gives good insight into the situation in Arnhem where the data is spread over the entire city and amongst the different score groups, thus showing high criterion validity. This is emphasised by the large number of respondents - more than 1600.

5 SURVEY RESULTS

This chapter dives into the results of the survey. It is structured according to the overarching themes of the survey questions: general characteristics of the data and data units, GBI scores, and GBI elements. Besides, the questions from *Gemeente Arnhem*, which were only present in Survey B, are added as a separate part. Not all questions are analysed due to time constraints and the alignment with the scope of this research. The results are interpreted in the Discussion. The superscript in the subheadings relate the question to Survey A or B.

5.1 GENERAL CHARACTERISTICS

A few exploratory questions served to find out the general characteristics of both the participant and the corresponding garden. These contain the spreading of all survey data, the participant's perception on garden type, the housing type, and the types of recent garden adjustments.

5.1.1 SPREADING OF DATA A&B

To gain insight into the spreading of the survey data, the number of entries per district are shown in Figure 5-1. The category "Other" (0) shows the most entries (161), which are either participants who live elsewhere (not in Arnhem) or who were not able to pick a district from the list. Apart from 0, the most participants are from district 5, followed by 6, 21 and 18. Lowest number of entries are in districts 12, 14, 16, 10, and 2.

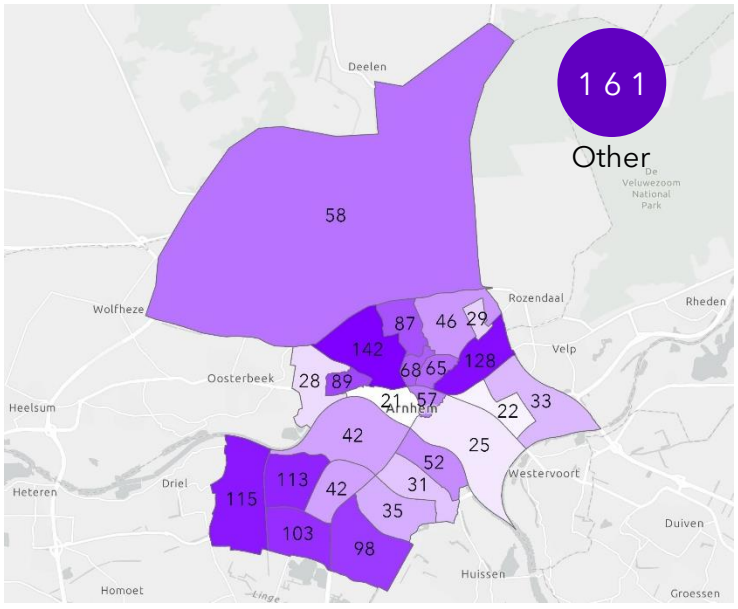

Figure 5-1: A map of Arnhem showing the spreading of the survey data. A darker colour refers to more respondents. The map was made in ArcGIS Pro.

Table 5-1: The absolute (Part.) and relative (%) response rate per district.

	Part.	Res.	%
0	161		
1	58	2.390	1,5%
2	29	3.805	0,7%
3	46	4.435	1,3%
4	87	3.505	1,1%
5	142	7.845	1,5%
6	128	9.325	2,2%
7	68	5.720	0,9%
8	65	7.235	1,7%
9	89	3.835	6,2%
10	28	1.430	0,4%
11	57	6.840	0,8%
12	21	7.520	0,3%
13	33	7.710	0,4%
14	22	8.895	0,5%
15	42	4.825	0,6%
16	25	7.205	0,4%
17	52	6.400	0,6%
18	113	8.720	1,2%
19	31	9.265	1,0%
20	42	2.985	0,3%
21	115	16.335	1,3%
22	35	8.765	0,3%
23	103	12.100	0,8%
24	98	12.275	0,8%

Figure 5-1 shows this distribution of data in a map, highlighting the districts with high responses in a darker purple. The three districts with the most responses coincide with the sources of distribution of survey A: the snowballing method. The map also shows that a few districts, amongst which the city centre (12. Centrum) have a rather low number of responses, which might have consequences for drawing conclusions based on these specific districts. Overall, the data appears to be spread to all districts with a varying number of responses amongst the districts. Table 5-1 shows the districts and their absolute (Par.) and relative response rate (%) to the number of residents (Res.) per district, showing a different pattern.

5.1.2 PERCEPTION ON GARDEN TYPE [A&B]

Before the GBI questions, participants were asked how they perceived their garden, giving them 5 pre-defined options to choose from. This resulted in the number of entries per garden type as shown in Table 5-2. Conditional formatting shows that option 4, a Lively Garden, was most popular amongst respondents. The Wild Garden (option 5), on the other hand, was least abundant. Overall, there appears to be a slight orientation towards the greener garden types (option 2, 3 and 4). The 50 respondents that did not agree with the 5 pre-defined options choose "Other".

Table 5-2: The number of entries per garden type. Conditional formatting is applied to show the highest number of entries in green and the lowest in red.

Garden Type	Other	**Tiled**	**Neat**	**Flower**	**Lively**	**Wild**
Code	0	1	2	3	4	5
# entries	50	259	383	378	486	134

Combining this data with the spreading shown in paragraph 5.1.1 results in Figure 5-2 below, which shows the perceived garden types sorted by district. The Lively Garden (4) is the greatest category for more than half the districts, namely 1 to 13 and 17. Thus, mostly in the northern part of Arnhem. The southern part shows a less clear pattern, with higher occurrences of the Tiled (1) and Neat Garden (2) generally.

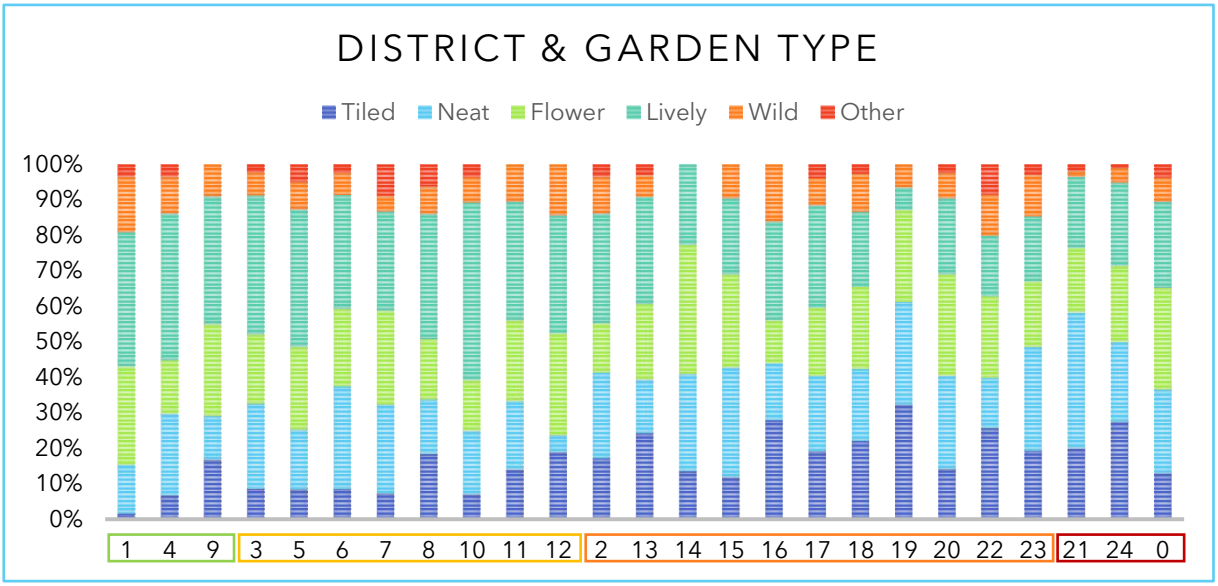

Figure 5-2: Occurrence of garden types (coloured bars) per district (x-axis) in percentages of the total. The x-axis is ordered based on the Steenbreek categorization of the districts in Green – Red.

5.1.3 OWNERSHIP & HOUSING TYPE [B]

As the type of ownership (rent or buy) and housing are likely to influence the garden design, these characteristics were embedded in the survey in 2 separate questions. This results in the two graphs in Figure 5-3 and 5-4. Figure 5-3 shows that more than half of the respondents are house owners, which makes it private property. A relatively small percentage rented their house and are thus subject to their rental companies. Figure 5-4 shows that about a quarter of respondents lives in an apartment, the largest proportion in a terraced house, and smaller proportions in a corner or semi-detached house. Stand-alone houses were only represented in 116 cases and bungalows in 13.

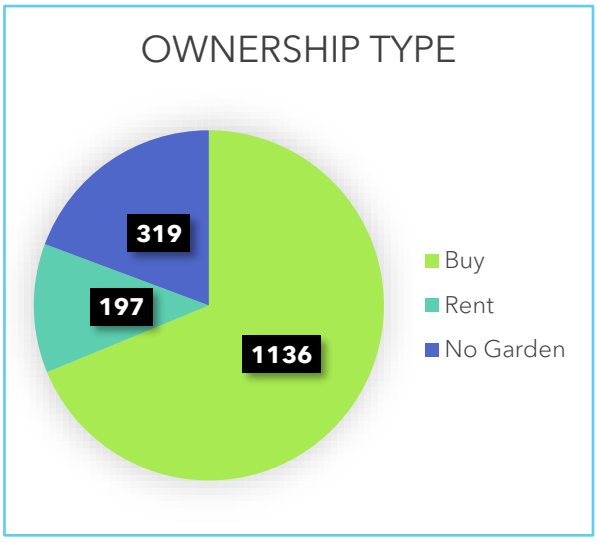

Figure 5-4: Pie graph showing the proportion of respondents buying their house (lightgreen), renting their house (bluegreen) and without a garden (darkblue).

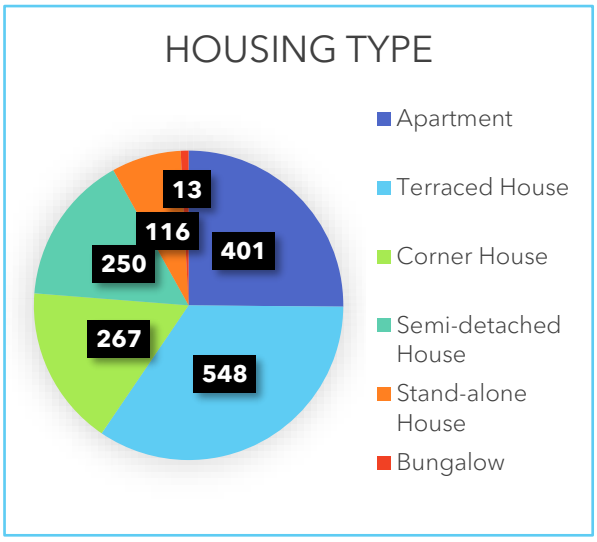

Figure 5-4: Pie graph showing the housing types of the respondents. The colours refer to the pre-defined categories as shown in the legend.

For a comparison between the ownership type and the score go to paragraph 5.2.4.

5.1.4 RECENT GARDEN ADJUSTMENTS A & B

Another general characteristic of the respondents' gardens is the garden makeovers that took place recently. Figure 5-5 shows the proportion of respondents that had recently adjusted their garden, totalling around 1000 respondents. Figure 5-6 shows how often all pre-defined options were chosen, keeping in mind that respondents were able to choose all that apply to them. Though this does not show the exact direction of the change, it does give insight into the general tendency towards implementation of more greenery in the garden.

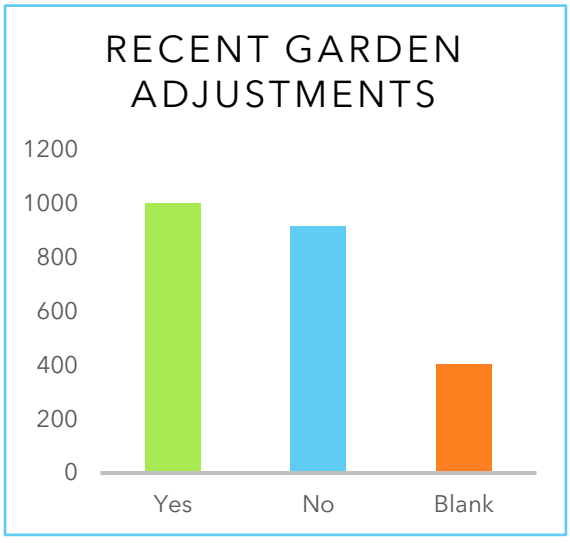

Figure 5-5: Results to the question: "Did you recently make changes to your garden?". The "yes" options redirects to the question in the next figure.

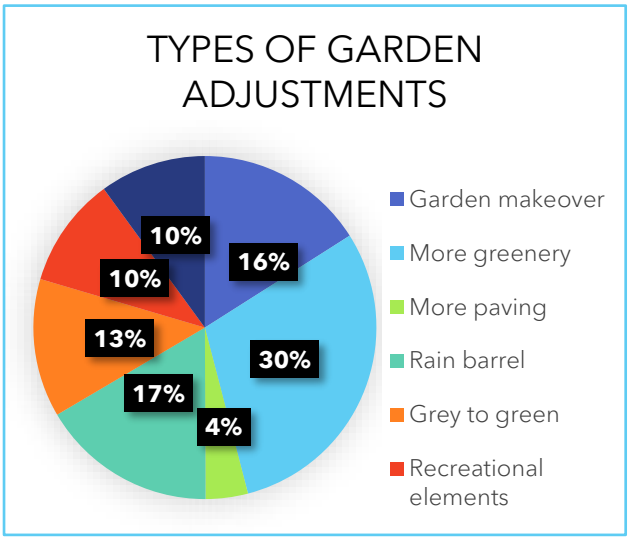

Figure 5-6: The types of adjustments respondents made to their garden, choosing from pre-defined options, with an "all that apply" concept.

5.2 GBI SCORES

The core of the survey consists of 15 questions that together constitute the GBI. These are yes/no questions in the form "Do you have a [element] in your garden?". Taken altogether, the presence of elements results in a score.

5.2.1 TOTAL GBI SCORES A&B

The distribution of gardens over the 45 possible scores is shown in Figure 5-7, which distinguishes between the three GBI garden categories: Light Green (0-15 points), Green (16-30 points), and Dark Green (31-45 points). It can be observed that each possible score occurs at least twice. The data shows a Gaussian pattern, with the weight around the higher Green category scores. This is emphasised by the calculated median and mean as shown in Table 5-3.

Table 5-3: The calculated median and mean of the GBI total scores data.

Median	Mean
27,5	29,6

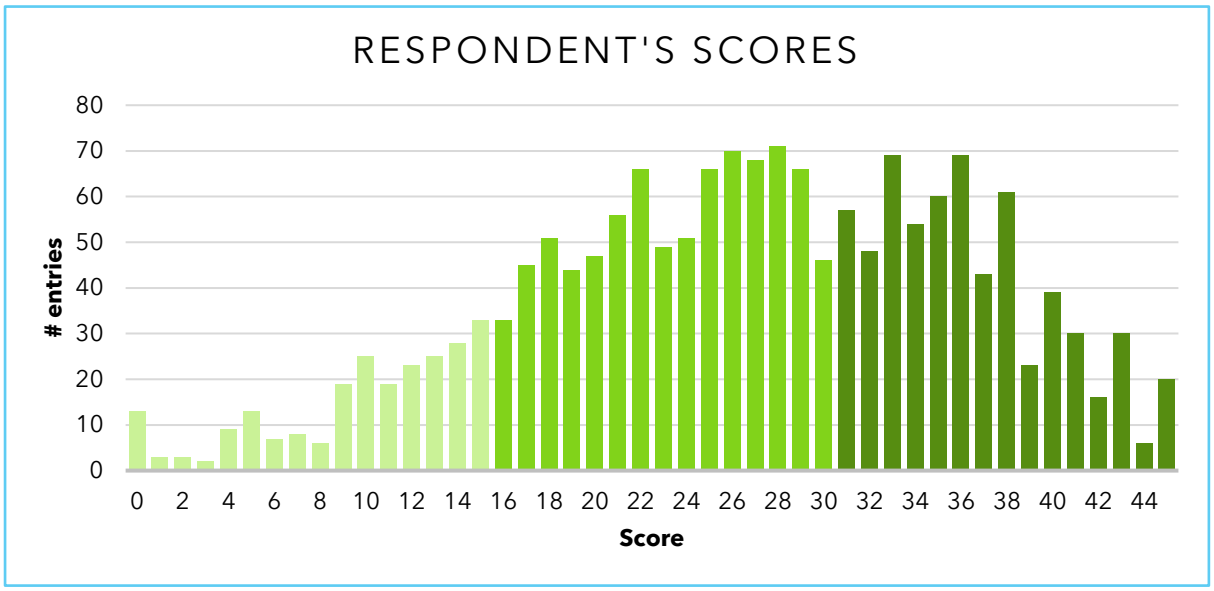

Figure 5-7: Distribution of scores. All possible scores are listed on the x-axis while the y-axis shows how often that score was achieved by respondents. The three different colours refer to the three categories: Light Green (0-15 points), Green (16-30 points), and Dark Green (31-45 points).

5.2.2 GBI SCORE DISTRIBUTION A&B

The average GBI score per district gives insight into the distribution of the data. This is shown in Table 5-4 below. Conditional formatting points to district 1 having the highest score on average, followed by 11 and 20. The lowest scores are present in district 17 and 19.

Table 5-4: The average scores per district. Conditional formatting is applied to show the highest average score in green and the lowest in red.

District	1	2	3	4	5	6	7	8	9	10	11	12
Average Score	34	26	30	30	29	27	28	25	28	32	27	26

District	13	14	15	16	17	18	19	20	21	22	23	24
Average Score	25	25	25	25	22	24	22	26	23	24	24	24

Visualising spatially, Figure 5-8 shows the average GBI scores per district. The greener the colour, the higher the average score. It shows that the highest scores are reached in the Northern part of the city, while the Southern part scores lower average GBI scores. Comparing it with the number of respondents as listed in Table 5-1, it is no surprise that Schaarsbergen, the upper North district scores highest. It is the district with one of the lower number of residents and the largest area.

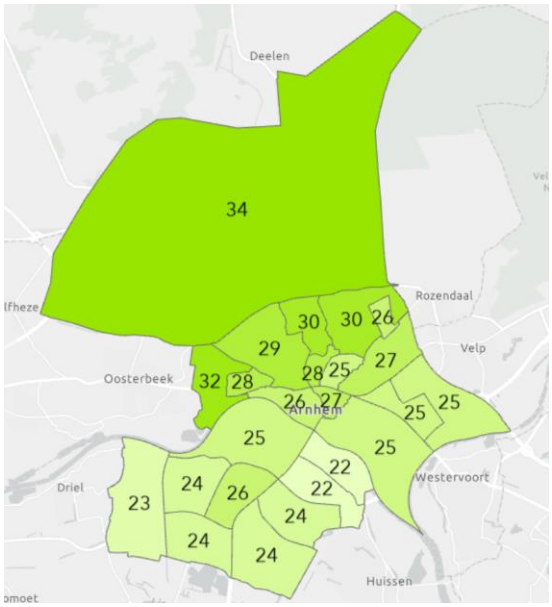

Figure 5-8: A map of Arnhem showing the average GBI scores per district. A darker colour refers to a higher GBI score for that district. The map was made in ArcGIS Pro.

5.2.3 GBI SCORES & GARDEN TYPE A&B

Placing the Garden Type data and the scores side-by-side shows to what extent the respondents' perception differs from the real situation. The result of this comparison is shown in figure x. Overall, Figure 5-9 shows a declining trend when it comes to the occurrence of the Tiled Garden in higher GBI categories. The other way around, the occurrence of the Lively Garden increases with a higher GBI. Other garden types show a less clear trend.

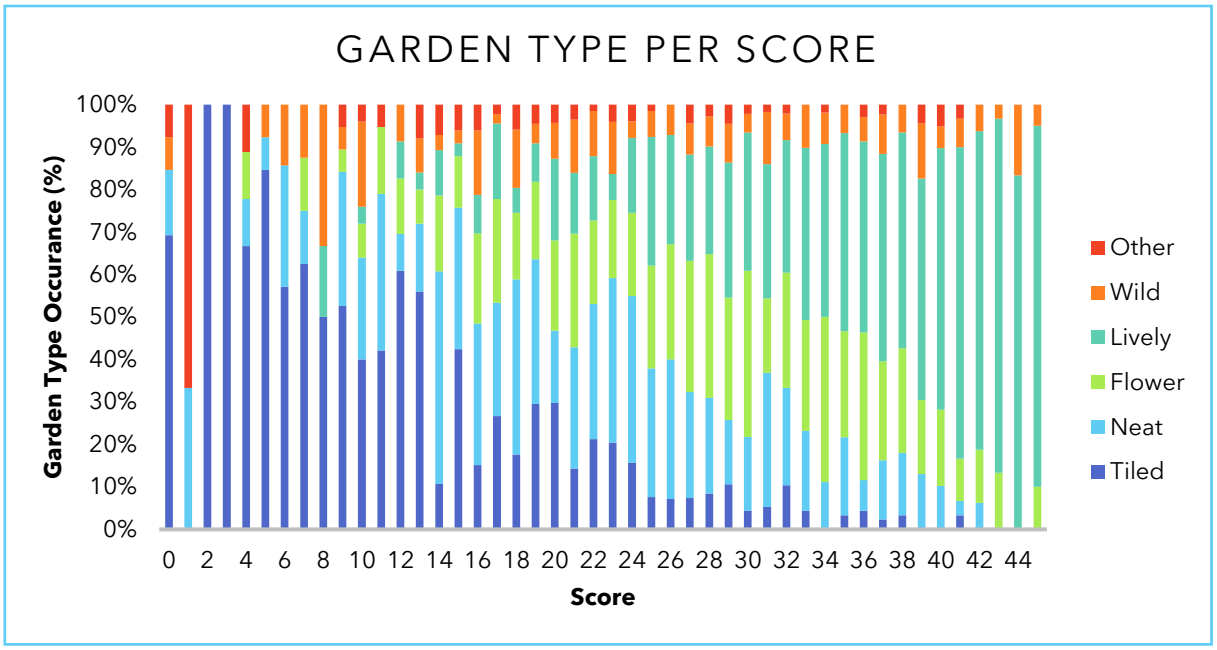

Figure 5-9: Occurrence of Garden Types per Score category. The colours in the bars refer to the type of garden chosen.

Translated to garden type per score category, this comes down to Table 5-5. It shows that the largest number of entries relates to the combination of a Lively Garden and a Dark Green garden (high GBI). Above that, by far the greatest proportion of respondents falls into the Middle category, scoring highest on the Neat and Flower Garden types. The Light Green category mainly consists of Tiled Gardens and is the smallest GBI garden category represented in the table. The averages in the second column from the right show that the highest average score is associated with the Lively Garden while the lowest average score is achieved in the Tiled Garden. In total, the greatest proportion of respondents estimated their garden to be a Lively Garden.

Table 5-5 GBI categories of garden (Light, Middle and Dark Green) sorted per Garden Type.

		GBI Category								
		Light		Middle		Dark		Average	Amount	
Garden Type	Tiled	102	6%	123	7%	20	1%	17,1	245	15%
	Neat	47	3%	237	14%	88	5%	23,9	372	22%
	Flower	18	1%	208	13%	148	9%	28,0	374	23%
	Lively	8	0%	166	10%	311	19%	32,8	485	29%
	Wild	17	1%	68	4%	48	3%	25,8	133	8%
	Other	11	1%	27	2%	10	1%	22,1	48	3%
		203	12%	829	50%	625	38%		1657	1

5.2.4 GBI SCORES PER OWNERSHIP TYPE A&B

The type of ownership – rent or buy – is hypothesised to influence the GBI scores. Figures 5-10 and 5-11 below show the distribution of scores for bought and rental houses respectively. It can be observed that the bought houses show a smoother Gaussian distribution than the rental houses. The top of the parabola is around a score of 28, slightly higher than the average. The graph for the rental houses does not show a clear pattern, with alternating peaks and throughs.

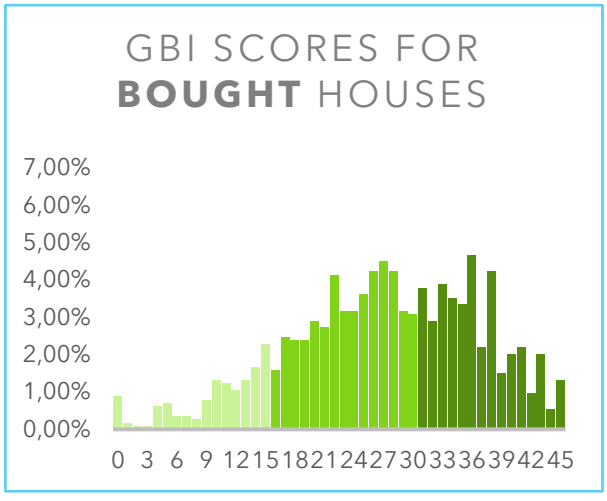

Figure 5-10: Distribution of GBI scores for bought houses. All potential GBI scores are shown on the x-axis and the occurrence of each score in percentage on the y-axis. The green colours refer to the three GBI garden categories.

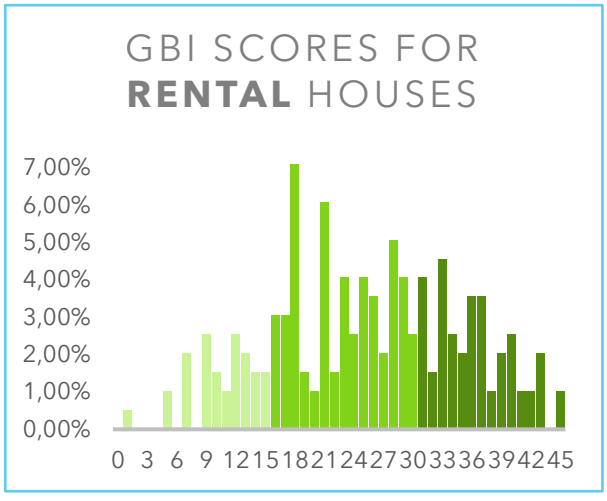

Figure 5-11: Distribution of GBI scores for rental houses. All potential GBI scores are shown on the x-axis and the occurrence of each score in percentage on the y-axis. The green colours refer to the three GBI garden categories.

5.3 GBI ELEMENTS

The GBI scores are a sum of the points assigned to the separate elements - out of the list of 15 potential elements - that are present in a garden. This was embedded in the survey with yes/no questions.

5.3.1 TOTAL ELEMENT SCORES & ELEMENTS PER DISTRICT [A&B]

Table 5-6 shows the frequency of occurrence of all elements per district. Conditional formatting reveals that the red columns are the least chosen categories, relating to compost (apple), dry stone wall (wall), and pond (lotus). At the same time, the black bordered cells show the most often chosen elements are vertical greenery (bamboo), bed of flowers (sunflower), and tree (tree). Table 5-6 also shows that districts 2, 10, 12 – 16, 19, and 22 have relatively low element scores, which can be explained by the low number of respondents in those districts or by the general low biodiversity in those districts.

Table 5-6: The spreading of all 15 GBI-elements per district. Conditional formatting is applied to the entire table, showing in red the least chosen element & district combinations and in green the most. The black bordered cells indicate, per district, the most popular element.

0	104	121	124	34	37	120	96	112	92	79	107	144	42	115	146
1	50	41	50	22	15	50	49	50	39	45	52	49	24	47	55
2	21	22	23	6	10	20	18	17	16	16	19	24	6	16	23
3	32	35	41	7	14	38	35	33	26	33	28	44	15	35	42
4	69	65	78	16	27	72	60	61	61	50	61	76	28	69	80
5	90	98	120	24	41	110	106	87	89	88	107	124	44	99	129
6	78	91	114	15	22	83	84	73	75	66	78	115	36	79	117
7	36	42	55	10	24	49	45	44	36	40	40	63	17	45	63
8	31	36	54	9	16	45	44	37	39	41	38	46	16	29	53
9	65	59	75	13	29	69	65	50	57	55	44	77	28	63	78
10	19	22	19	5	7	24	19	20	17	17	22	27	13	25	28
11	33	41	48	10	17	46	38	36	25	34	37	47	18	35	48
12	11	13	18	5	7	15	13	13	14	8	15	16	6	13	17
13	15	22	28	4	9	21	21	19	17	12	17	30	6	21	27
14	11	11	17	2	2	15	15	12	8	11	17	20	4	15	18
15	21	33	36	5	3	29	30	26	26	24	20	37	8	22	37
16	7	13	14	2	7	17	12	18	12	12	17	21	6	17	20
17	28	32	40	7	6	27	35	18	24	21	21	41	8	30	42
18	70	63	82	8	13	69	59	67	57	46	65	99	26	62	94
19	17	18	23	5	4	19	17	14	16	13	14	23	6	18	21
20	27	30	31	1	8	26	22	26	28	21	19	37	12	32	37
21	54	76	96	5	14	60	65	61	54	40	44	96	15	81	94
22	21	20	26	3	8	22	18	21	17	12	19	29	11	21	26
23	62	61	75	6	22	61	57	70	49	47	56	89	30	58	81
24	61	66	72	14	12	57	54	59	50	38	51	83	21	64	77
	1033	1010	1235	204	337	1044	981	932	852	790	901	1313	404	996	1307

5.3.2 ELEMENTS PER SCORE CATEGORY A&B

To find out if certain elements occur more in a certain GBI category, Figure 5-12 is created. It shows how often each element is present (bars) in the three GBI categories of gardens (colours of bars). There seems to be a more significant trend in the high category (green) as most bars reach similar heights. For the other categories, this is less clear. Gardens in the Green category score higher than the other 2 garden types on tree, bed, vertical greenery, and nest box. For all other elements, the High category garden scores the highest.

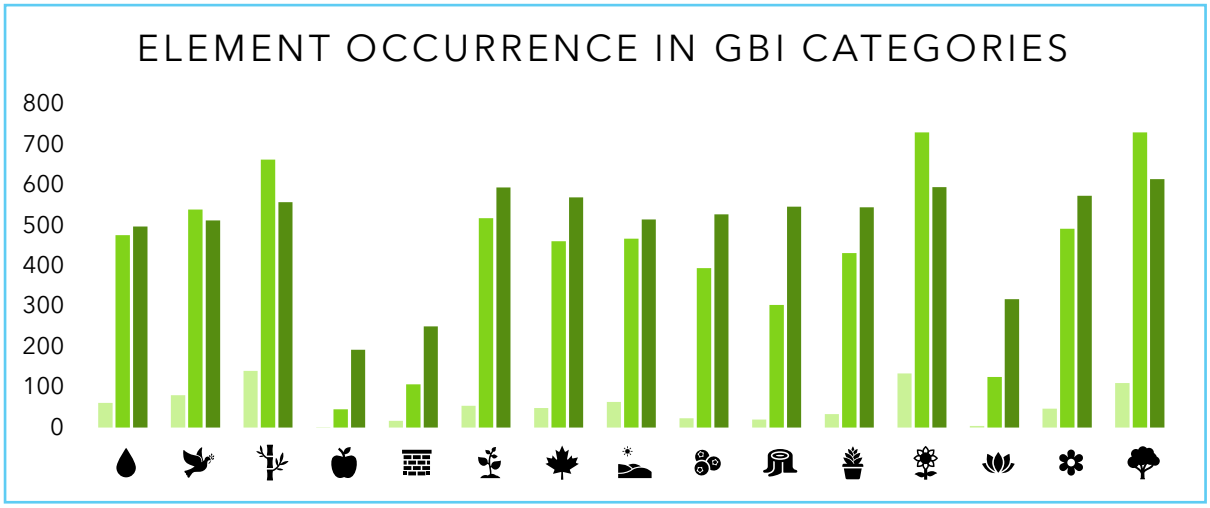

Figure 5-12: The absolute occurrence of the 15 elements (x-axis) for all three GBI categories (colours).

5.3.3 RELATION BETWEEN ELEMENTS A&B

Table 5-7 shows the correlation matrix for all 15 elements of the GBI. The conditional formatting indicates that there are no negative relations between elements as these would colour red. At the same time, there are not very strong positive relations, with the highest being 0,4. Yet, this does suggest a slight link between Dead Wood and a Pile of Leaves, and between a Pile of Leaves and a Wild Corner as the strongest ones in this case.

Table 5-7: Correlation matrix for the 15 elements of the GBI. Conditional formatting is applied to show negative correlations in red, neutral correlations in white and positive correlations in green.

	1	0,30	0,09	0,12	0,16	0,18	0,15	0,11	0,20	0,17	0,16	0,15	0,25	0,18	0,13
	0,30	1	0,16	0,12	0,14	0,16	0,12	0,08	0,22	0,13	0,14	0,16	0,19	0,19	0,15
	0,09	0,16	1	0,08	0,07	0,11	0,14	0,04	0,12	0,15	0,11	0,13	0,08	0,07	0,12
	0,12	0,12	0,08	1	0,17	0,20	0,23	0,13	0,20	0,27	0,16	0,02	0,17	0,12	0,11
	0,16	0,14	0,07	0,17	1	0,16	0,17	0,10	0,18	0,20	0,15	0,04	0,18	0,11	0,06
	0,18	0,16	0,11	0,20	0,16	1	0,40	0,27	0,22	0,39	0,29	0,06	0,20	0,20	0,18
	0,15	0,12	0,14	0,23	0,17	0,40	1	0,19	0,24	0,40	0,20	0,03	0,12	0,13	0,17
	0,11	0,08	0,04	0,13	0,10	0,27	0,19	1	0,14	0,19	0,13	0,10	0,10	0,15	0,13
	0,20	0,22	0,12	0,20	0,18	0,22	0,24	0,14	1	0,33	0,26	0,10	0,17	0,19	0,18
	0,17	0,13	0,15	0,27	0,20	0,39	0,40	0,19	0,33	1	0,27	0,03	0,19	0,15	0,19
	0,16	0,14	0,11	0,16	0,15	0,29	0,20	0,13	0,26	0,27	1	0,13	0,16	0,16	0,16
	0,15	0,16	0,13	0,02	0,04	0,06	0,03	0,10	0,10	0,03	0,13	1	0,07	0,31	0,18
	0,25	0,19	0,08	0,17	0,18	0,20	0,12	0,10	0,17	0,19	0,16	0,07	1	0,13	0,11
	0,18	0,19	0,07	0,12	0,11	0,20	0,13	0,15	0,19	0,15	0,16	0,31	0,13	1	0,17
	0,13	0,15	0,12	0,11	0,06	0,18	0,17	0,13	0,18	0,19	0,16	0,18	0,11	0,17	1

5.4 DISTRICT PAVING LEVELS

As described in the Methodology, Arnhem's 24 districts were, prior to the data analysis step, divided into 4 groups based on their paving levels. Now, they are placed next to each other to find out if there are noticeable differences between them.

5.4.1 DISTRICT PAVING LEVELS & SCORES

Comparing the average results per district with the Steenbreek category gives insight into the spreading of data and the accuracy of the Steenbreek categories. Figure 5-13 shows this spatial distribution in a graph. The district scores are sorted from high (left) to low (right) and the district numbers are on the x axis. Overall, the Green and Yellow districts are on the left-hand side, with higher scores than the Orange and Red districts on the right-hand side, except for district 8. This suggests that, on average, the Steenbreek categorization is in line with the average district scores, but with variation between districts in the same category.

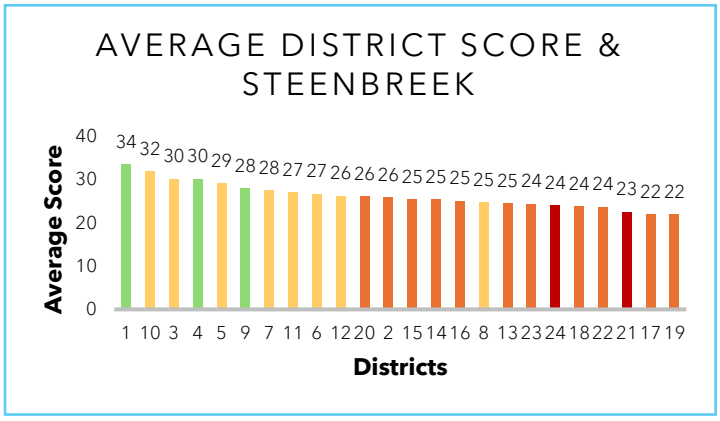

Figure 5-13: Average district GBI scores (bar height & numbers) and the Steenbreek category (bar colour).

Table 5-8: The average, minimum and maximum scores per district group based on Steenbreek's guide (colours in the left column).

	Av.	Min	Max
Green	30,5	8,0	45,0
Yellow	27,9	5,0	43,5
Orange	24,4	2,4	42,2
Red	23,3	0,0	45,0

Table 5-8 shows the average, lowest and highest scores achieved in the districts that belong to the Green, Yellow, Orange, and Red Steenbreek groups. It shows that the scores do on average go down the lower the Steenbreek category. The same counts for the lowest achieved scores (column Min). The only number that is not in line with the expectations is the highest score in the Red category, which is higher than the Yellow and Orange category.

5.4.2 DISTRICT PAVING LEVELS & ELEMENTS

Diving into the elements chosen per Steenbreek district category, Table 5-9 shows the sum of the number of times an element was chosen for all districts belonging to Green, Yellow, Orange, and Red respectively. Conditional formatting is applied per row, showing that there is no significant difference between the Steenbreek groups when it comes to which elements are present in the garden.

Table 5-9: The frequency of element choice by a participant belonging to the Green, Yellow, Orange, or Red group based on their district, summed up. Conditional formatting was applied per row.

G	197	197	242	53	64	205	193	184	175	161	191	240	88	195	252
Y	301	327	401	76	148	372	344	306	292	302	315	426	145	329	436
O	393	448	543	67	113	426	409	407	352	302	362	595	154	433	572
R	38	38	49	8	12	41	35	35	33	25	33	52	17	39	47

5.5 MUNICIPALITY-RELEVANT QUESTIONS

The collaboration with *Gemeente Arnhem* involved the addition of municipality-relevant questions. These cover a wide range of aspects as can be seen in Appendix IV: Survey B. The questions that have not been analysed yet as part of the GBI but are considered supplementary to this research are analysed in this subchapter.

5.5.1 GREY/GREEN DISTRIBUTION [B]

Gemeente Arnhem showed interest in the perceived green/grey distribution in participant's gardens. Therefore, in survey B, participants were asked to make an estimate of this based on 4 pre-defined categories: predominantly grey, more grey than green, more green than grey, and predominantly green. This results in the estimation in Figure 5-14 below.

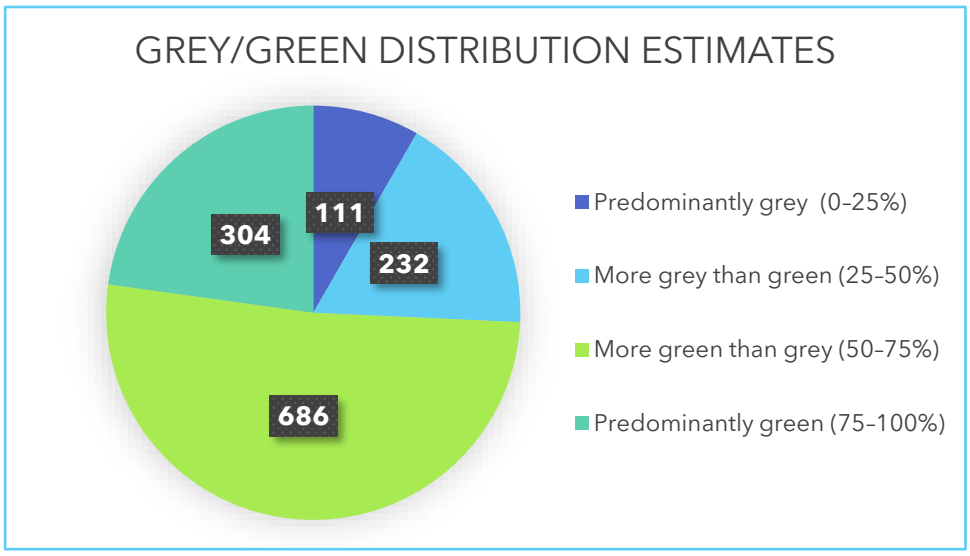

Figure 5-14: Green/grey ratio in private gardens of survey B participants.

The graph in Figure 5-14 shows that most participants of survey B perceive their garden as relatively green, where 50-75% of the garden is made up of greenery. It also shows that the data is a bit skewed towards the greener gardens as the two highest categories together constitute 990 entries, 60% of the total number and 74% of all entries that were filled in. In total, 319 participants did not answer this question and are thus not incorporated in the chart.

5.5.2 GREEN GARDEN PERCEPTION & MOTIVES [B]

Besides the estimation of the ratio of greenery and impermeable surfaces, *Gemeente Arnhem* is also interested in the perception of garden owners on the importance of a green garden. This translates into 3 questions in the survey. First, participants were asked how important they think a green garden is, on a 5-point scale from very unimportant to very important. Table 5-10 shows the results.

Table 5-10: The perception of participants in survey B on the importance of having a green garden, on a 5-point scale. Conditional formatting is applied to show the most chosen in green and the least chosen in red.

Very Important	Important	Indifferent	Unimportant	Very Unimportant	No opinion
811	404	89	15	11	3

The category "very important" is by far the most chosen option, suggesting that either most participants care deeply about a lot of greenery in the garden (sometimes even in contradiction with the actual garden design) or that the data is skewed towards the greener gardens. Nevertheless, table 4 shows that a very large proportion of the participants (91%) thinks a green garden is important. The two follow-up questions dive into the motives for (not) having a green garden. Table 5-11 shows the reasons why people would green their garden on the left and the reasons why they don't on the right.

Table 5-11: The reasons why (not) participants in survey B would want a green garden. Conditional formatting is applied to show the main reason (green) and the least important reasons (red) according to participants.

Reasons TO GREEN garden	
Changing climate	520
More biodiversity	826
More aesthetically pleasing	774
Cooler in summer	713
Water infiltration	644
Other	125
None of the above, I don't want to green my garden.	107

Reasons NOT TO GREEN garden	
No time	136
Too much effort	76
Don't know how	90
Too expensive	148
Don't feel like it	46
Maintenance	251
I have trouble with potential setbacks (e.g. weather, soil, allergies)	27
I rent so I can't	17
Not necessary, the garden is fine	539
I don't think I can	47
Children	30
Other	357
Don't know	0

The three main reasons for greening a garden are biodiversity, aesthetics, and cooling capacity respectively. Out of 1333 there are only 107 participants who do not want to green their garden and 125 who had other motives like children, the maximum level of greenery has been reached, and private produce, relaxation and privacy. Apart from the large amount of people (539) who do not think greening their garden is necessary, the biggest barrier seems to be maintenance, distantly followed by money and time. Yet there are 357 other barriers, including physical abilities (due to age), accessibility, practical situation (e.g. location of necessities, moving), and the small size of the garden. A full list can be found in the Municipality Analysis Excel file in the supplementary material.

5.5.3 MOTIVES FOR GREENING MEASURES

The block of questions right after the GBI questions are aimed to find out if participants were interested in taking greening measures, what measures they have already taken and which they are planning to take in the future.

Table 5-12: Answer to the question "Are you interested in taking measures to green your garden?". Conditional formatting is applied to show the most chosen category in green and the least in red.

Yes & I already took measures recently	645
Yes, I haven't taken measures, but I am interested!	535
No, I have no interest in green measures	472

Table 5-12 shows that the largest proportion of participants are interested in taking measures to green their garden and have already done so. The smallest proportion is not interested in taking measures at all. The kind of measures people have already taken or are planning to take in the future are shown in Table 5-13, which is based on a multiple response question.

Table 5-13: Measures already taken to green a garden (left) and measures planned for the future (right). Conditional formatting is applied to show the most applied measure in green and the least in red.

Already taken measures	
Green roof	130
Green facade	132
Replace paving with green	281
Allotment garden	116
Rain barrel	328
(Fruit)tree	312
Other	129
-99	1007

Future (planned) measures	
Green roof	363
Green facade	168
Replace paving with green	234
Allotment garden	123
Rain barrel	411
(Fruit)tree	134
Other	146
No plans / don't know	305
-99	472

Thus, the most applied measure is the addition of a rain barrel to the garden, followed by planting a (fruit)tree, and replacing grey with green respectively. "Other" options include disconnecting the drainpipe, adding potted plants and participating in governmental campaigns. The least applied measure is an allotment garden. Listed in the "other" category are more attention for insects, more water elements (pond, wadi), and a green roof amongst others. Participants who answered "No" or "Yes, but I haven't done that yet" to the previous question about whether they are interested in greening measures are not asked the question of what measures they have already taken, thus resulting in 1007 "-99" answers.

Interestingly, measures planned for the future also mostly cover the addition of a rain barrel, supplemented by plans for a green roof. An allotment garden is again the least chosen option. In addition, there are 146 participants who added extra options using the "Other" option and 305 participants who did not know the answer to the question. For this question, only the people who answered "No" to the question whether they were interested in greening measures were excluded, totalling 472 skipped entries ("-99").

5.5.4 SUBSIDY GREEN-BLUE INITIATIVES

One of the last questions in survey B is an orientation question regarding the awareness of the existence of the Subsidy Green-Blue Initiatives by *Gemeente Arnhem*. This is mainly for *Gemeente Arnhem* to get insight into how well their subsidy is promoted and to give participants a heads up of its existence. The results are shown in Table 5-14.

Table 5-14: Answer to the question "Have you heard of the Subsidy Green-Blue Initiatives by Gemeente Arnhem?". Conditional formatting is applied to show the category with the most answers (green) and the one with the least (red). The number at the bottom shows the sum, to check for missing answers.

Yes, I have heard of the subsidy	381
No, does not sound familiar	1201
No opinion	70

Thus, the largest proportion of participants are not familiar with the subsidy.

5.6 COMPARISON BETWEEN STUDIES

As this study aimed to test the GBI in a different context, comparing the results with those of the original study by Felgentreff et al. provides useful information. Figure 5-15 below shows the graph created in their study with the distribution of achieved scores. Even though there appears to be a difference between the expert-visited and owner-reported garden scores, the overall shape follows a Gaussian pattern. The same goes for Figure 5-16, showing a similar Gaussian pattern in the graph created for this master thesis. The main difference between the two is the location of the mean. Where in Figure 5-15 this is centred around 21, Figure 5-16 indicates a mean around 29. This large difference can potentially be attributed to the difference in situations between the samples of German and Dutch gardens.

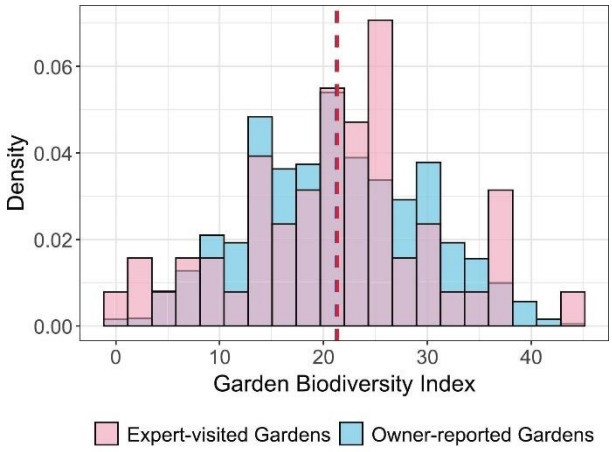

Figure 5-15: Graph from the study by Felgentreff et al. (2025) showing all possible scores on the x axis and the density of achieved scores in their study on the y axis. The red dotted line indicates the mean score.

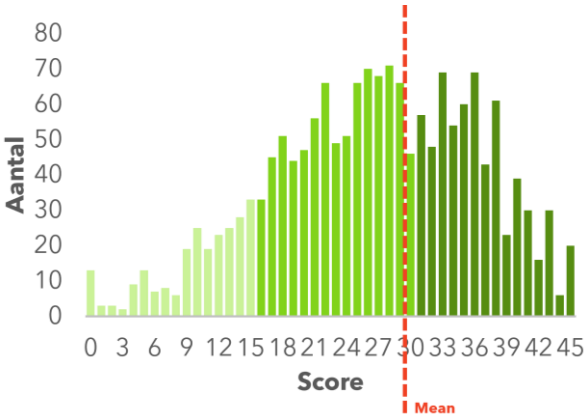

Figure 5-16: Graph showing the number of times each possible score was achieved by the participants of this master thesis. The red dotted line indicates the location of the mean. The different shades of green coincide with the GBI garden categories.

5.7 REFLECTION

The last part of survey A consisted of reflection questions to give the participants of the survey the possibility to share their thoughts concerning the GBI checklist. Participants were asked to rate several aspects of the GBI checklist. The results are shown in Table 5-15.

Table 5-15: Valuation of various aspects of survey A. On the left are the different aspects, on the right how they were valued. The last column shows the average score for each aspect on a range from 0 to 5. Conditional formatting is applied to show the most chosen number of stars in green and the least in red.

	0	1	2	3	4	5	Average
General	0	1	5	24	141	121	4,3
1. Clarity	0	0	2	10	88	188	4,6
2. Images	0	1	1	17	74	195	4,6
3. Purpose	0	5	4	39	85	155	4,3
4. Outcome	0	5	12	38	97	136	4,2
5. Explanation	1	4	13	33	95	142	4,2

This shows that, on average, participants of survey A were relatively satisfied with all 5 aspects of the survey, where most participants assigned a 5-star reward. Overall, the survey receives mostly a 4-star reward, with a 4,3 on average.

5.7.1 FUTURE OUTLOOK

The effect the survey had on the participants was measured with two 4-choice questions, asking about the influence of the survey on the participant's garden perception and their likelihood of adjusting their garden design or management. The answer options were yes, probably yes (yes?), maybe, probably not (no?), no. The result is shown in Figure 5-17.

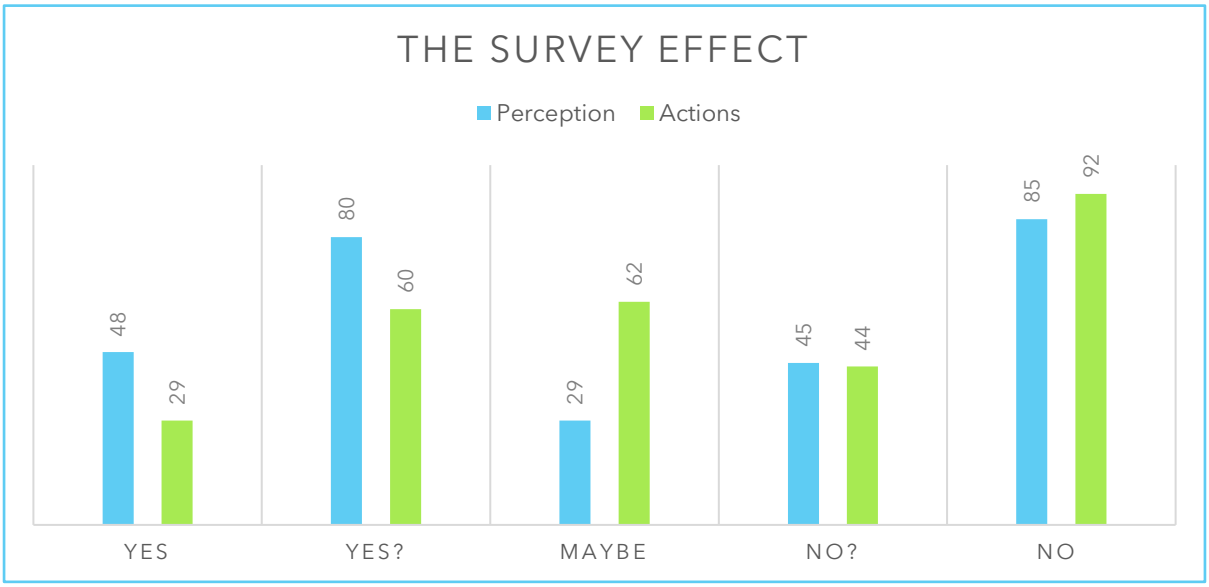

Figure 5-17: The effect the survey had on participants' perception (left) and their likelihood to adjust their garden actions (right). The coloured bars show how often one of the 5 answer options is given, where darker is less influence and lighter is more influence.

Figure 5-15 shows that to both questions the most dominant answer is "no", which means that participants do not perceive it likely that the survey changes their perception or actions in the garden. For adjusting actions, this pattern is most visible. The figure also shows that the yes categories score higher on perception, suggesting that the GBI more strongly influences the respondents' perception than it does the action.

5.7.2 REMARKS

Lastly, participants had the opportunity to leave a remark about the survey in general or aspects of it. These were analysed by hand using a shortened version of a thematic analysis. Remarks based on the practicalities of the online survey are left out as the format is not definitive for future use. The results are shown in Figure 5-18.

Figure 5-18: Word cloud of all remarks of Survey A participants.

Remarks that show potential for improvement of the GBI are divided into either practical or content relevant. On a practical level, some participants indicate that the concepts and descriptions used in the survey were not clear enough for everyone. Besides, the survey being yes/no style can feel a bit judgemental, pushing people to a "right" answer. It was also unclear whether the survey covers only the back garden or also the front one.

More content-related, some garden types such as roof gardens, balconies, allotment and ornamental gardens, sedum roofs are currently not represented in the GBI. The same goes for garden characteristics such as sunlight, soil type, fence, and particularly garden size. One participant also pointed out the relevance of darkness in a garden. Furthermore, the type of owner (e.g. a rental company or a new owner) is also viewed as a great influence in the garden design. More specifically, certain species such as bast and insects were not accommodated by the GBI.

These remarks should be taken into consideration when designing a new version of the GBI.

6 CONTROL EVALUATION RESULTS

This chapter dives into the results of the control evaluations. These were performed in gardens of participants who agreed to be contacted after the survey has reached its due date, 18 control group participants in total.

6.1 SURVEY VS CONTROL EVALUATIONS

The main aim of the control evaluations was to be able to compare them with self-evaluations and look for differences and similarities between expert and layperson judgement. At the same time, it gained insight into the practical application of a theoretical index.

6.1.1 OVERVIEW OF CONTROL GROUP DATA

An overview of the respondents and their general characteristics in terms of the district they live in, its corresponding district category, their GBI score, and the corresponding score category is given in Table 6-1 below. It shows that every district category is present, represented with the green, yellow, orange and red colours of the district numbers. The same goes for the GBI categories although Dark Green is most present and Light Green least.

Table 6-1: An overview of the participants (upper rows), their district category (middle rows) and their GBI score category (lower rows).

Participant	1	2	3	4	5	6	7	8	9
District	20	21	1	4	8	7	6	9	3
Score	40	32	38	35	45	29	11	25	35

Participant	10	11	12	13	14	15	16	17	18
District	6	24	24	9	12	23	6	21	2
Score	36	19	14	36	24	33	28	34	30

Table 6-2 shows the number of respondents per district. It can be concluded that not every district is represented and the districts that are represented do not have equal representation. It shows that the data is more evenly spread in the Northern part of Arnhem (districts 1-13) and less available in the Southern part. Besides, the highest number of control evaluations was performed in district 6, while 11 districts do not contain any control data. Districts 9,21 and 24 are the only districts that meet the criteria set out in the Methodology of having at least two control evaluations per district.

Table 6-2: The number of control group participants (lower rows) for all 24 districts (upper row). Conditional formatting shows the highest number of respondents in darker green shades and lower ones in white.

District	1	2	3	4	5	6	7	8	9	10	11	12
# control	1	1	1	1	0	3	1	1	2	0	0	1

District	13	14	15	16	17	18	19	20	21	22	23	24
# control	0	0	0	0	0	0	0	1	2	0	1	2

6.1.2 DIFFERENCE BETWEEN CONTROL & SELF EVALUATIONS

The result of the comparison between the self-evaluations and the control evaluations of the same participants is shown in Table 6-3. It shows the participant number in the upper row (#), the self-evaluation score in the second row (S), and the control evaluation in the third row (C). The lower row gives a calculated difference of both scores, subtracting S from C. Four out of 18 participants score higher or equal on the control evaluation compared to their self-evaluation, while the other, larger proportion, generally scores lower.

Table 6-3: Comparison of self-evaluation scores (S) and control evaluation scores (C). Conditional formatting is applied to the difference (Δ) in the lower row to show negative differences in red and positive in green.

#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S	40	32	38	35	45	29	11	25	35	36	19	14	36	24	33	28	34	30
C	23	29	28	22	37	26	21	14	17	26	11	19	22	19	33	32	24	27
Δ	-17	-3	-10	-13	-8	-3	10	-11	-18	-10	-8	5	-14	-5	0	4	-10	-3

Table 6-4 shows the result of the comparison on an element-level. The numbers represent the number of times there was a mismatch between the elements assigned to that participant's garden by the participant itself and by the researcher. For the elements Berry-bearing shrubs and Compost, it turned out to be too difficult to distinguish them in wintery gardens. Therefore, the self-evaluation scores of these elements were also used in the control evaluation, which explains the zeros. This assumes that most people know what plants they own. The biggest difference is found for the Pile of Leaves and the Meadow. The smallest difference - apart from the berry-bearing shrubs and composts - is found for Vertical Greenery and Trees.

Table 6-4: The number of times a mismatch occurred between an element assigned by the researcher and by the participant, per element. Conditional formatting shows the largest differences (red) and the smallest (green).

7	5	2	0	4	9	11	3	0	6	8	9	4	10	2

6.2 CONTROL EVALUATION OBSERVATIONS

The control evaluations did not only serve as a method to compare judgement of an expert with that of a layperson, but it also aimed to critically analyse the first version of the GBI based on the observations during the control evaluations. This subparagraph sums up the most significant observations.

Firstly, the control evaluations pointed at concepts too vague or complex for everyone to understand. This was the case for the words "native" and "wild". Such **jargon words** receive different interpretations from an expert in the field and a layperson. Even when the concept was interpreted correctly, it is hard to properly apply it to a real-life situation, not specifically knowing which plants are native or wild from the top of your head. Underlying this issue is the lack of knowledge of common plant species, making it even more difficult to assess them. Besides, in the Netherlands it is more common to use words such as "organic" (NL: biologisch) to describe how plants are grown.

Secondly, the GBI does not thoroughly describe what **part of a garden** is used in the analysis and how those parts contribute to the overall biodiversity. It is only focused on the garden as one whole patch of nature. This is especially important when it comes to Dutch gardens where fragmentation of front, back and side garden is not uncommon. As these do not have to be connected it is hard to determine which part of the garden to analyse with the GBI: all garden patches together or each separately?

Thirdly, a few elements in the GBI checklist seem to **miss information** about some factors that possibly influence the element's effect on biodiversity in the garden. A list of questions that arose during the control evaluations are shown in Table 6-5.

Table 6-5: List of questions regarding inclusivity of factors not yet mentioned in the GBI, sorted per element.

	Inclusivity Questions
	- Do cats (and their liveliness) influence the use of the bird bath by birds? - Does size matter? - Does height matter (e.g. on a pillar or on the ground), specifically with cats? - Are bird baths still necessary with the presence of a pond? - Is a shallow bird bath without wood or pebbles also sufficient? - Does it matter whether the water is moving (e.g. small waterfall) or still?

	- What about nesting boxes for other fauna, such as:
	  o Insect Hotels
	  o Butterfly Boxes
	  o Hedgehog Houses
	- Are combination nest boxes (of e.g. insects and birds) useful?
	- Why are feed boxes not part of the GBI? Especially in winter.
	- Are there specifications that are important, like open/closed, size and material?
	- Does the location matter e.g. relative to plants/trees/house?
	- What if we know for certain it is not being used?

	- The GBI only mentions climbing plants as vertical greenery, what about:
	  o Hedge or hedgerow
	  o Shrubs as fence type
	- Does height matter?
	- Is there a difference between plant species (e.g. hedera vs flower plant)?
	- Nativeness of plant species is not mentioned here, does it not matter?
	- Does it have to be in one piece, or can it be small patches?
	- What if they are not luscious and green in winter?

	- What if they are closed composts instead of open? Especially when there is clearly small fauna present.
	- Why does it have to be a certain size? Does a small wall not count? - What does "untreated" mean in this case?
	- What does a Wild Corner mean in small urban Dutch gardens? - What if the elements are there but they are clearly separated? - In case of overlap with Pile of Leaves, count both? - If the herbs are used for consumption, do they still contribute to biodiversity? - What if it is smaller than $2m^2$ or does not contain all factors listed?
	- Do leaves spread over a larger area (e.g. whole garden or flower bed) count? - If there are branches present, can it coincide with Dead Wood?
	- Difference in winter and summer, does it need to be present in both? - Are small patches in between plants enough? - Are dirt patches in grass or moss also considered Open Terrain?

	- Do they have to carry berries throughout all seasons?
	- What types of berry-bearing shrubs count? I encountered the following:
	  o Blackberry, strawberry, raspberry, bramble, cranberries
	  o Ribes varieties, rosehip

	○ Guelder Rose, holly ○ Cherry, plum, grape, fig, apple ○ Various climbing plants ○ Firethorn, cotoneaster - There might be overlap with Shrubbery, count both? - Do they also count if in the shape of a tree? - Could non-native berries count for half the points?
	- Does size or amount matter? Are branches also part of it? - Do bark pieces on the ground also count?
	- Does amount matter? A garden full of shrubs vs one small shrub? - When do you know a shrub is "wild"? No guidance on that. - In small gardens pruning is necessary, is there a biodiversity maintaining type? - What if some are wild or native and some are pruned or non-native?
	- Are "wild" plants possible in the Netherlands? Reportedly difficult to find. - How do you know a plant is a perennial? - Does it have to be around the edges of the garden? - Do ground cover also count as perennials? - Overlap with Shrubbery and Border possible, count both?
	- A lot of requirements, what if not all are met? Especially when there is fauna present (e.g. small pond tub with frogs). ○ Planted banks not always possible in small gardens - Does size matter? - Are maintenance and management of oxygen supply allowed? - Can it also have a current?
	- Shouldn't these be separate elements? Or their differences and similarities be well described, with pictures. - Do potted plants or herb gardens also count? - What if the border is not in touch with the Earth, but instead in a large pot? - What if the herbs or flowers unintentionally grow without being sewn? - What about alternatives to grass such as moss? - What if there's grass and a biodiverse meadow, does it still count?
	- Amount and variety affect the influence of trees on biodiversity, include that? - Don't they have to be native? - What if it is officially the neighbours' but it spreads over your garden too? - Which tree management practices are biodiversity enhancing? (pollard willow?) - What if it is more shrub-like or intended for consumption (e.g. apple tree)? - Does a small, young tree count?

The long list presented in Table 6-5 also points out that the **requirements** of some elements are too restrictive. Sometimes, though, the existing element without the list of requirements harboured biodiversity already. It is also unclear why some elements specifically require native and wild plants while others do not. The question arises whether all elements should inherently be native and wild, making it one of the pillars of the GBI.

The table also emphasises the importance of **combinations** of elements, where one can complement (or substitute) the other. For example, a Nest Box generally needs greenery in its proximity for birds to use it. Combinations also occur outside the garden when attention is paid to the creation of wildlife corridors. This can be done by creating holes in Vertical Greenery for example, adding another layer to this element in the GBI.

Lastly, **management practices** are generally not taken into account in the GBI. Only in case of the Meadow, it is mentioned how often it should be mown and for Shrubbery that it should not be pruned. Yet it might be useful to add the use of chemical fertilizers and pesticides as a negative influence on the GBI.

7 DISCUSSION

This chapter aims to put the results of this thesis in perspective. It interprets the results, discusses the potential limitations and dives into the implications. Finally, three suggestions for future research are elaborated upon.

7.1 INTERPRETATION OF RESULTS

The results of this study show that the GBI is an adequate tool for quantifying and visualizing the concept of biodiversity at the scale of urban private gardens in one of the larger cities in the Netherlands. Contradictory to the expectation based on the literature review in Chapter 2, it proved easy to collect data of a great share of citizens of Arnhem about biodiversity on their private property due to the cooperation with *Gemeente Arnhem* and the numerous acquaintances. The clarity and usefulness of the GBI also greatly contributed to this, it being a simple, online, self-evaluation form. This study proves that it is possible to reach a big audience on a complicated topic concerning private property. Another expectation based on literature was that the GBI scores in the analysis are average or lower than average based on Steenbreek's labelling of Arnhem as "average" when it comes to greening potential. Especially considering Arnhem is a rather big, urbanized city. However, the data suggests otherwise: Arnhem's respondents show a higher-than-average score in general. This can have two possible explanations: either gardens in Arnhem are already more biodiverse than expected or the share of biodiverse garden owners is relatively large amongst respondents.

Comparing the results of this study with existing scientific literature emphasises its relevance. Börger et al. (2026), for example, looked into the likelihood of garden owners applying biodiversity enhancing elements in their garden of a sample of 2000 German private garden owners. Of all 14 elements (inspired by the GBI) possible in their study, most participants had between 6 and 10 elements in their garden. Of these, trees were most abundant (87,5%), while drywalls, ponds and open spaces were least present. This is in line with the results of this thesis which concludes that trees, borders and vertical greenery are most often present, and ponds, dry stone walls, and composts the least. The only difference is the open spaces, which scored relatively high in this thesis but low in the study by Börger et al. (2026). The total biodiversity scores are hard to compare to scientific literature as this concept is new.

In contrast, Hanson et al. (2021) points out that garden biodiversity is not only dependent on the presence of biodiversity enhancing elements but also on general garden characteristics, management and other outside factors. Besides, the location of a garden also has potential to influence its biodiversity. For example, living next to a forest area increases the chances of housing various species as the garden functions as a corridor for them to move through (Goddard et al., 2009).

In addition, Hu & Lima (2024) correctly point out that currently the available knowledge on garden biodiversity and its benefits - in relation to the actions to get there - does not always reach the garden owners that need it. The GBI is an important first step and could play a significant role in this, providing information to the garden owners about their garden situation and the importance of the elements. Still, the selection bias remains, making people with a natural interest in biodiverse gardens more likely to contribute and cooperate in biodiversity enhancement programs, as was found by Norton et al. (2025). That also means

that there remains a rather large share of people with no interest in biodiversity or wildlife-friendly gardening, about a quarter of Dutch inhabitants (Groene Ruimte, 2026).

7.1.1 DIFFERENCES CONTROL & SELF-EVALUATIONS

The results also exposed the stark differences between the control and self-evaluation, which can have two reasons. The on average lower GBI scores for the control evaluations can indicate that the questions are too field-specific, talking in jargon that is not understandable for lay people. It can thus be a difference in interpretation between an expert who understands the exact meaning of the concepts and someone from outside the field who thinks the concepts have a slightly different meaning. It can also mean that garden owners are not capable enough to self-evaluate their garden as they are biased towards the positive.

7.1.2 DIFFERENCES STEENBREEK & SCORES

The difference between Steenbreek's categorization of Arnhem's district based on the share of paved area and the achieved GBI scores in those districts shows a discrepancy. Even though the general trend remains comparable - the better the Steenbreek category, the higher the average score – the individual situations do not always add up. For example, districts 4 and 9 are categorized as Green according to Steenbreek, but their mean GBI results are listed between the mean GBI results of the Yellow Steenbreek districts, suggesting that the average scores of this district are below expectations. This can either be explained by a greater share of less biodiverse gardens, a difficulty to properly assess one's own garden, or the general inconsistency between a paving and biodiversity measurement.

7.2 LIMITATIONS

Even though proper care was taken to diminish the potential limitations of this research, some biases are inevitable. In this case, a selection bias likely occurred during the distribution of the survey as people with a naturally higher interest in garden biodiversity are more likely to fill it in. This was connected to the snowball sampling method that was used for survey A, where acquaintances of the researcher helped to spread the survey, knowing the aim of the research. Some of these acquaintances reported later that they had only shared the survey with people with green gardens, making the sampling biased. At the same time, some enthusiasts reported having filled in both survey A and B, minimally influencing the results.

Secondly, nonresponse bias could have led to more positive results than in reality. To account for this potential bias, the researcher has carefully chosen the words and images in her communication as to incorporate a range of gardens. Survey questions were phrased as neutral and non-judgemental as possible. For that matter, the English GBI texts were kept as close to the original as possible except the advice at the end. This was considered rather steering and judgemental and was therefore rewritten as to not demotivate respondents with their scores and encourage them to take more action. Besides, it was focused on German initiatives that are not relevant in the Netherlands. Yet, after the rewriting of these parts, there might still have been hidden clues about the goal of the project.

Thirdly, the GBI method served as a basis for this research to find out, amongst others, what contribution this could make to research on Dutch gardens. During the research, however, questions arose regarding how fitting the GBI was for this new case-study. Therefore, the GBI might not have measured the biodiversity level in gardens in Arnhem as well as was hypothesised. Tailoring this to the Netherlands might remove this bias in the future.

Triangulation was applied to account for this, where a sample of 18 gardens served as an extra step in determining the suitability of the GBI in this research.

Lastly, the wintery season in which this research was conducted proved not to be beneficial for its findings. It was harder for the researcher to distinguish plant species and whether they were native or carry berries, or if the barren spots were meant to be bare. To account for this, the answer to the element "berry bearing shrubs" was taken from the respondent's own answer. Nativeness was considered, but only in cases with clearly non-native species (such as palm trees) points were not assigned to the item that requires nativeness. Baren spots were estimated to what extent they would be bare in summer. Connected to this, due to time limitations, the researcher could not physically visit all gardens for control evaluations. Instead, garden owners were asked to send photos of their garden, which were analysed from a distance. This made it difficult to fully understand and see all the garden elements present, which might have accidentally clouded the results. This was dealt with by performing a double evaluation: first the non-biased control evaluation and then placing it next to the self-evaluation and going over the differences. The answer to the element "compost" was taken from the respondent's own answer.

7.3 RESEARCH IMPLICATIONS: GBI IMPROVEMENTS

The GBI proved a good starting point for measuring and analysing biodiversity in urban private gardens. Since the GBI was originally created to promote a "broad applicability by lay people" (Felgentreff et al., 2025), this paragraph discusses some improvements to increase the GBI's application. It should be noted though that the authors of the original GBI intentionally left some elements out as they considered them not relevant or not simple enough for a self-assessment tool. The list below is therefore an indication of the aspects that could be implemented once all pros and cons are considered.

7.3.1 FROM POINTS TO SCALE

In the GBI as is, the 15 elements only score a certain number of points if all criteria in that category are met. From a theoretical point of view, this is a valid method, but from a more practical point of view this does not always add up. Especially when taking biodiversity as a goal, where the increase in number of species is prioritized above the elements that cause this. Although there might be a direct link between elements (that adhere to the defined guidelines) and an increase in biodiversity, it is also dependent on outside factors and has levels. In this line of thought, it is more intuitive to change the set number of points to a scale in which points are assigned to every single criterion that is met. This way, a pond can get the points it deserves for housing frogs without having a planted bank for example. A scale could make the survey more dynamic and adds more detail to the obtained score. It could also provide greater insight and a motive for improving the situation as is.

7.3.2 ADDITION OF ELEMENTS

The self and control evaluations pointed at some missing elements and aspects of the GBI. One of the main elements is shelter opportunities for other species than birds and bats, like bees, butterflies, insects, hedgehogs and other animals. Although some of them are already accounted for in other elements (e.g. a pile of leaves for hedgehogs), it might be beneficial to direct more focus towards this topic as gardening for biodiversity is in essence about creating enough food, water and shelter for a great variety in species, especially the endangered ones (Bradbury, 2019). Connected to this, food provision in winter is an important element for survival of certain species. This can either be in the form of naturally

present plants, but during winter times and in case of a lack of plants, it might prove worthwhile to help feeding various species (Golawski et al., 2025). This can therefore become a sub question under for example "berry bearing shrubs", a natural food type. Furthermore, the GBI now only contains a flower or herb lawn as substitute for grass, but other permeable material options such as moss are not discussed. The same goes for wadis, which are a type of pond that do not always meet the requirements set out in the GBI under "pond". Clarification of the elements that are similar to the proposed elements in the GBI might help eliminate these confusions. Elements could, above that, also be differentiated between different sized gardens, where in very small gardens the presence of alternative food provision might be more realistic than having plants that provide food naturally.

Secondly, the characteristics of the garden, other than its biodiversity enhancing elements, also play a role in the opportunities for biodiversity and the presence thereof. These include garden size, sunlight, fence type, lights (i.e. potential for darkness at night), and the garden's surroundings. Although it does not necessarily mean that a bigger garden hosts more biodiversity, the likelihood of multiple landforms being present in a garden does increase with a bigger garden (Van Heezik et al., 2013). Combining that with the finding that a larger potential habitat size carries more support for individuals and thus more survival, it is most likely that bigger gardens generally lead to more biodiversity, or at least that owners of bigger gardens are more eager to implement larger biodiversity enhancing elements (Ziv, 1998; Börger et al., 2026). Still, the possibility remains that a small patch of a large garden contains all GBI elements, scoring the garden high, while the rest of the garden does not necessarily contain biodiversity enhancing elements.

In addition, biodiversity is strongly rooted in the availability of sunlight, which is the largest source of energy in the biosphere (Clarke & Gaston, 2006). Increased sunlight exposure generally results in greater pollinator diversity (Watson et al., 2022). Plant diversity, however, cannot only be explained by the presence of sunlight, but relates more to water availability in the form of precipitation and evapotranspiration. Proper darkness at night combined with suitable plant species, on the other hand, also has the potential to increase biodiversity as it attracts and provides a safe space for nocturnal pollinators (Macgregor & Scott-Brown, 2020).

Fences generally obstruct biodiversity as they form literal obstacles for wildlife to pass, with varying degrees of permeability (Jakes et al., 2018). At the same time, if designed with an eye on biodiversity conservation, a fence can create safe connections between ecosystems by guiding species to move through corridors. Artificial lights at night can equally thwart biodiversity as it alters behaviours, breeding and navigation, which can lead to higher mortality rates amongst various species and contributes to fragmentation (Chepesiuk, 2009). The surroundings of a garden also have two sides: they can either increase biodiversity through habitat connectivity of heterogenous surrounding landscapes or decrease it by locking it in with barren isolated spaces (Goddard et al., 2009).

Thirdly, the GBI is not ready yet to be implemented in other garden types, such as balconies and roof gardens. These types of gardens might not contribute as much to biodiversity as a back garden does, but they do have an influence on its connectivity. Green roofs can form crucial connections for wildlife while decreasing the effects of fragmentation (Köhler, & Ksiazek-Mikenas, 2018). They not only provide both feeding and nesting habitats for a range of species but also serve as part of important migration routes. If the management of such roofs focuses on all important details of the ecosystem, it can even offer habitats for a wider range of species. That is, if the green roof is surrounded by other urban green spaces (Wang

et al., 2022). Balcony gardens, on the other hand, are much less investigated, but are hypothesised to contribute to biodiversity by providing food and shelter in the form of plants mainly (Talhouk et al., 2025). Especially with a variety in wildlife-friendly plant species present on the balcony. Other garden types or parts that require more investigation in relation to the GBI are front (and side) gardens and allotment gardens. Both take up space and have potential to contribute to biodiversity but are generally intended for different purposes like accessibility and storage space for front gardens and food production (for the garden owner, not other fauna) for allotment gardens.

Taken altogether, concrete items that should be considered for a new version of the GBI are: nestboxes for other species than birds and bats, food provision in winter, other permeable alternatives to grass, a wadi, the general characteristics of the garden (size, amount of sunlight, location with respect to nature areas), fence type, and potential for darkness at night.

7.3.3 REMOVE VALUE JUDGEMENT

As the original GBI in German contained a form of judgement at the end of the survey and people are generally inclined to oppose judgement, shifting the focus from improving the situation to gaining insight might pay off. This could increase the likelihood that a person changes their mind or starts taking action.

7.3.4 IMPROVE WORDING

An important part of reaching a big audience is communicating in easily understandable language. Field-specific jargon can be interpreted differently by laypeople compared to experts, especially when there are no images present (Venhuizen et al., 2019). The higher GBI scores in the self-evaluations as compared to the control evaluations by the researcher shows that in the GBI, this problem also occurs, with difficult words explaining the elements. The photos do, however, support the clarification of most concepts, but they do not explain frequently used words like "native" and "wild". Taking it one step further, the plant species listed to help people assess whether they own native species could also cause confusion as it lacks photos.

7.4 SOCIETAL IMPLICATIONS

The purpose of this study is to gain insight into the current level of biodiversity in private gardens in an urban setting, specifically one of the larger cities in the Netherlands. Although the results are subject to cultural interpretations, such as the perception on what a garden should look like and are thus not necessarily applicable to non-Dutch cultures, it does give an idea of what the biodiversity level of private gardens is in a city. It shows that it does not have to be near zero but can even be higher than average. Besides, the GBI gives insight into the most easily applicable elements, which have generally already been implemented, and deduces knowledge gaps: the elements that are least present but have high biodiversity impacts.

This study also shows that there is broad support for biodiversity enhancement in private gardens, but this is often limited to a small group with a natural interest in green gardens. Still, they can form a powerful group. This connects to the notion that neighbouring gardens influence the garden design and decisions thereof. Nassauer et al. (2009) found that the preference of a front yard design was strongly linked to the neighbours' designs, concluding that the neighbourhood level is important to consider for success when introducing

ecological designs. They also discuss that individuals are likely to influence their neighbours by starting innovations and involving their neighbours, creating so-called cultural sustainability. Therefore, reaching and involving this initial support base provides an opportunity for future change.

Linked to this, the potential application of a citizen science approach to a topic concerning private property has been established. The primary issue is no longer privacy but rather reaching a large audience. Yet, as this approach allows for inclusion of citizens in a research project, involvement and interest in the topic are likely increased. The number of people responding to this research emphasizes this, showing that, with the right tools and connections, many people can be reached.

7.4.1 PRACTICAL VALUE & RECOMMENDATIONS

The successful test of the GBI as a self-evaluation tool proved that the GBI has potential for future uses by a variety of stakeholders. Based on this thesis' results, this translates to the following recommendations concretely:

1. For scientists, the results of the GBI are a starting point for further research into the level of biodiversity in urban private gardens. It already gives a glimpse of what is expected from scientists to focus on to further improve the situation in the future. The ultimate goal of improving biodiversity in urban settings can only be reached once everyone's noses are in the right direction, working on the aspects that are proven to be knowledge gaps. An important part is improving the GBI so that it can be used to create a baseline of biodiversity levels in Dutch urban private gardens. Afterwards, attention can be paid to what is needed to increase this level.
2. For policy makers, especially on the municipal level, the results show that it has paid off to focus biodiversity campaigns on a single element in the garden, as was the case for trees and rain barrels promoted by *Gemeente Arnhem*. In the future, it would especially be beneficial to focus on increasing awareness and knowledge about ponds - which have a high GBI score but are not often present in gardens - and to make them accessible through a subsidy for example. The GBI might also provide a stepping stone for change in municipal green management and for involving parties such as professional gardeners and landlords in biodiversity enhancement efforts. This would benefit both garden owners and the municipality as their goals regarding urban green spaces become achievable.
3. For garden owners, the GBI not only provides insight into their garden from an outsider perspective, showing what is appreciated and what not by other "inhabitants" of the garden (e.g. birds, bats), but is also gives tips as to how to make the garden even more attractive to various species. Therefore, the GBI is an information and awareness tool in one.

7.5 FUTURE RESEARCH SUGGESTIONS

This research has opened up numerous opportunities for future research into biodiversity in urban private gardens. As summing up the entire list is too much, this paragraph will dive into the three main suggestions.

7.5.1 GBI EXTENSION

After the GBI has been upgraded to contain a greater number of relevant questions to determine the biodiversity level of private gardens, it can be scaled up to reach an even larger audience. To do so, research should first focus on making a comprehensive and easy

to understand list of elements, an extension of the GBI. Then, differentiating between vegetation zones and the respective native vegetation, the GBI as an online tool can be scaled up to match (urban) environments in the whole of Europe. It can remain in its current form, an online clickable survey, but with additional options for different regions in Europe. Once this is achieved, the GBI can both function as a tool for engagement as well as a citizen science method of data collection. Research after this can then focus on interpreting this data and supplementing it with action steps.

7.5.2 COOPERATION FOR ACTION

Another research opportunity lies in the socio-political dimension: how can cooperation between the parties in society linked to urban greenery lead to more action for increasing biodiversity in urban areas? The GBI then functions as the monitoring tool for setting a baseline and measuring changes after implementation of cooperative initiatives. The research can focus both on how such cooperations should be formed and structured as well as on ways to empower individuals to take action in their own garden. Important parties to include in this research are municipalities, universities, garden centres, gardeners or other green management, garden owners, landlords, local initiatives, and other governmental organizations such as waterboards. This research could then follow up on the hypothesis that the right circumstances lead to increased action, using the current GBI scores as a starting point and aiming for higher scores.

7.5.3 GARDEN CULTURE AROUND THE WORLD

Lastly, this researched showed that what a garden looks like or should look like differs per region, where in Germany a garden has a slightly different definition than it does in the Netherlands. It is therefore interesting to look into garden culture to find out what a garden means in different regions or cultures. It could also dive into the fragmentation, taking the Dutch garden with a fragmented front, side and back garden as the starting point.

8 CONCLUSION

This thesis formulates an answer to the main research question **"What can GBI self-evaluations tell us about the level of biodiversity in private gardens, differentiating between district paving levels in Arnhem?"** by applying a (quantitative) survey method.

Literature review showed that biodiversity in urban private gardens is difficult to measure for two reasons: the biodiversity concept is too complex to quantify, and urban private gardens are private properties, making data collection difficult. The Garden Biodiversity Index (GBI) as a tool is able to deal with both issues, breaking down the concept and making it accessible for people to self-assess their garden. This is a breakthrough as former biodiversity measuring tools proved to have problems with either one of the two issues. This study therefore focused on testing the GBI in a new, Dutch, context: the private gardens of citizens of Arnhem.

The self-evaluations of gardens by their owners in Arnhem vary greatly but show a slight lean towards higher GBI scores, meaning that those gardens are greener than average. This could have two explanations: either private gardens in Arnhem are already relatively green or the number of participants with greener gardens is relatively high. No clear correlation other than a variation in pattern was found for bought and rental houses considering their GBI score. The pre-defined garden types do show a clear pattern: the higher the GBI score, the more Lively Gardens (most biodiverse) and the less Tiled Gardens. Elements most frequently chosen are a Tree, Border and Vertical Greenery, while a Pond, Compost and Dry-Stone Wall were least popular. No clear relationship was found between the elements.

The categorisation of districts based on Steenbreek's guidelines gives a good indication of the district paving levels. When put next to the data of the survey, the same general trend can be found yet with nuances per district. The same conclusion can be drawn for the GBI elements, with no differences in pattern between the four categories.

Control evaluations made comparison between an expert opinion (researcher) and those of the participants possible, while it also added triangulation. In most cases, the GBI assigned by the researcher was lower than the one self-assessed. The greatest difference lies in the elements Meadow and Bed of Flowers, while the smallest difference is in Tree, Open Terrain, and Vertical Greenery. This can be attributed to the ease of determination of the elements.

Lastly, the reflection questions in survey A show that respondents are in general pleased with the GBI survey as it is, where the images and the clarity of the survey were most praised. The future outlook suggests that the GBI has a greater influence on respondent's perception of their garden than on their actions of changing the garden.

In conclusion, the GBI provides a good starting point to determine the level of biodiversity in a private garden in Arnhem. It shows that gardens in Arnhem have a higher-than-average biodiversity level with varying scores between 0 to 45. The difference between green and grey districts follows the expectations as shown by Steenbreek's categorization. However, some adjustments need to be made to get the GBI in line with the Dutch situation and to make it even more accessible. These include changing points to scale, adding missing elements, removing value judgement and improve wording.

Taken altogether, the GBI has great potential to gain insight into urban private garden biodiversity levels and forms a starting point for increasing it, striving towards green cities.

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APPENDIX I: AI STATEMENT

For the preparation, writing and analysis of this thesis report was in no case any AI tool used, nor will it be in the future. All statements, conclusion or other writing are, unless otherwise stated in the form of citations, only a product of the research as performed by the researcher herself. Following methods as taught at Wageningen University and Research (WUR).

APPENDIX II: DATA MANAGEMENT PLAN

ORGANIZATIONAL CONTEXT

Name	Niamh Bosch
Date	03-10-2025
Chair Group	Environmental Systems Analysis (ESA)
Supervisors	Marjolein Lof & Sophie Rickebusch
Start date of project	11-9-2025
File name of this DMP	1192025_DMP_MScthesis_Bosch.docx

DESCRIPTION RESEARCH PROJECT

Title	Garden Biodiversity Index for Dutch Private Gardens
Abstract	This Master Thesis looks into the effectiveness of the newly developed Garden Biodiveristy Index (GBI) through a citizen science project in the Dutch city of Arnhem. It aims to test the ease of use, applicability and difference between two types of gardens. To do so, a survey is spread to those who own a garden in two specific districts of Arnhem: a "green" and a "grey" one. The results are then analyzed based on a variety of criteria and recommendations for the GBI are given.

DATA MANAGEMENT ROLES

Data collection

Name Researcher: Niamh Bosch

Role Researcher:

- Collects and processes the data in an organized way. She is responsible for the quality and authenticity of the data and ensures that they are safely stored during the project (i.e. short-term storage). The researcher will allow the supervisor and others involved in the research access upon request.
- Responsible for documentation and submission of the data files for long-term storage according to ESA guidelines (after finishing the publication, thesis or completion of the project).

Data Analysis

Name Researcher: Niamh Bosch

Role Researcher:

- Analyses the data in an organized way. She is responsible for the quality and authenticity of the results and ensures that they are safely stored during the project (i.e. short-term storage). The

researcher will allow the supervisor and others involved in the research access upon request.
- Responsible for documentation and submission of the result data files for long-term storage after finishing the thesis.

Other	Not applicable
Role Supervisors	Names: Marjolein Lof & Sophie Rickebusch Roles: The supervisor checks the data files before long-term storage. The supervisor is responsible for the data quality, clarity and completeness.

OVERVIEW OF DATA

Data stage	Type	Software	Data size
Raw data	Notes from control group evaluations	Offline / Word	>1MB
	Survey results	MS Forms	~1MB-1GB
Processed data	Processed survey data	MS Forms	~1MB-1GB
Models/code	Comparison survey results	Excel & MS Forms	~1-10MB
Other	--	--	--

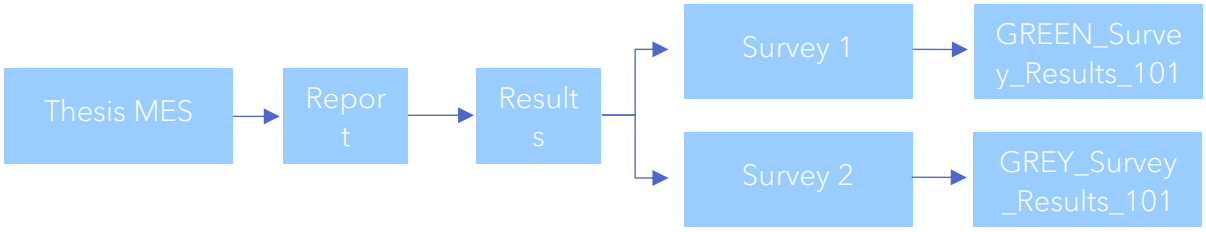
SHORT-TERM STORAGE SOLUTIONS

Data stage	Storage Location	Backup Procedures
Raw data	M-drive / Teams	IT Daily
Processed data	M-drive / Teams	IT Daily
Models/code	M-drive / Teams	IT Daily
Other	M-drive / Teams	IT Daily

The data will be saved on the personal M drive of the researcher, to ensure daily back up by ICT-WUR. If storage capacity is too limited the D drive could be used for storage, but the researcher is responsible for sufficient back-up.

STRUCTURING DATA

The data is stored both in a Teams structure as well as on a private laptop. The structure incorporates draft versions, which are differentiated based on the date at the beginning of the file name (with the format MMDD_Name, e.g. 1003_Proposal). This way facilitates sorting the files according to the version's date and previous versions are not overwritten.



The map structure also resembles the steps in the process. Thus, the survey data is stored in the map "Report" under "Results" in the corresponding category:

DOCUMENTATION & METADATA

The data is documented in a readme file, summarizing the content, context and process of the data storage. The data is organized according to the structure of the report to ensure efficient analysis. However, it is expected that this part is relatively small as the only data will be survey and processed data.

SHARING & OWNERSHIP

Data Sharing	• Who: interested parties within the university or outside (e.g. Gemeente Arnhem) • What: results of the surveys & overall results of the thesis • How: via email
Data Ownership	• Who: student & supervisors • What: all outcomes of the thesis process The project supervisors are: Marjolein Lof & Sophie Rickebusch. The project leader or supervisor (permanent staff member), in consultation with other researchers involved in the data collection, is responsible for long term data storage and access/use by others, unless stated otherwise in the individual RDMP.
Privacy	Not applicable

LONG-TERM STORAGE

The code of conduct for scientific practice requires that you retain your data for five years after you have published your article/thesis and that you make it available upon request for verification purposes.

After completion of the thesis/papers/project, data files will be submitted to the secretary for long term storage (at least 5 years). For ESA data will be stored in a dedicated central location for ESA data storage on the server of ICT.

APPENDIX III: SURVEY A

Start van blok: Standaard vragenblok

Intro **Tuinen in Arnhem** Hey! Mijn naam is Niamh (24) en voor mijn afstudeerproject aan de WUR doe ik onderzoek naar de **inrichting van privétuinen in Arnhem**. Deze vragenlijst bestaat uit **ja/nee vragen** over de aanwezigheid van verschillende elementen in je tuin. Daarbij wordt er rekening mee gehouden dat achtertuinen vaak klein zijn en is het dus niet gek als er iets niet aanwezig is. Het doel van de vragenlijst is voor mij om inzicht te krijgen in hoe vaak en welke elementen voorkomen in achtertuinen. Daarna volgt een puntentelling en een paar reflectievragen voor het verbeteren van de vragenlijst. Het invullen duurt ongeveer **10 minuutjes**.

Einde blok: Standaard vragenblok

Start van blok: Introductie

Q3 **INTRODUCTIE** Voor mijn onderzoek heb ik wat gegevens over je tuin nodig (ligging en uiterlijk). Deze gegevens worden alleen groepsgewijs gebruikt en zijn niet naar één persoon te herleiden.

Q4 **Ben jij eigenaar van een (gedeelde) tuin in Arnhem?**

- Ja, als koper (3)
- Ja, als huurder (4)
- Nee (5)

Deze vraag weergeven:
If Q4 = Nee

Q5 **Ben jij eigenaar van een tuin buiten Arnhem?**

- Ja (1)
- Nee (2)

Ga naar: Einde enquête Als Q5 = Nee

Deze vraag weergeven:
If Q4 != Nee

Q6 **In welke wijk in Arnhem woon je?** Dit is belangrijk vanwege de fysieke karakteristieken van de wijk zoals grondsoort, ligging etc.

▼ 1. Schaarsbergen (1) ... 24. Rijkerswoerd (24)

Deze vraag weergeven:

If Q5 = Ja

Q40 In welke woonplaats (evt. met wijk) buiten Arnhem woon je?

_____

Q41 Op welke foto lijkt jouw tuin het meest?

- Praktische tegeltuin Het grootste deel van de tuin is bedekt met tegels en hier en daar zijn plantenbakken aanwezig. Vaak aangevuld met kunstgras, grint en soortgelijke materialen. Het belangrijkste aan de tuin is dat het goed begaanbaar en praktisch is. (1)
- Strakke tuin De tuin heeft een strak, vaak gemaaid gazon met nette borders en een strakke inrichting. Er wordt veel aandacht besteed aan het uiterlijk, wat regelmatig onderhoud vraagt (denk aan mesten, snoeien, maaien, wieden etc.). LET OP: deze optie alleen kiezen als het natuurlijk gras (geen kunstgras) betreft. (2)
- Bloementuin In de tuin zijn veel verschillende bloemensoorten aanwezig (zoals lelies, chrysanten, rozen, tulpen, forsythia's, hortensia's, oleanders en gouden regen), waardoor de tuin er heel mooi en kleurrijk uitziet. (3)
- Levendige tuin De tuin wordt deels vrijgelaten maar ook af en toe onderhouden zodat het een goede plek biedt voor verschillende plant- en diersoorten. Het bestaat uit veel verschillende elementen (vijver, planten, bloemen, bomen, voeding- en nestplekken voor dieren etc.). Er is veel leven in de tuin zoals bijtjes, vogels, kikkers, vlinders en insecten. (4)
- Wilde tuin De tuin wordt (vrijwel) compleet vrijgelaten, zonder onderhoud. De planten die er groeien zijn grotendeels wild (niet of heel lang geleden geplant en daarna vrijgelaten) en nemen de tuin langzaam over. (5)

Q38 Heb je de afgelopen tijd (ca. 5 jaar) een (grote) verandering aangebracht aan je tuin?
Kruis alle opties aan die van toepassing zijn.

- ☐ Ja, ik heb een grote tuinverbouwing gedaan met een heel nieuw tuinontwerp (1)
- ☐ Ja, ik heb meer planten, bloemen en/of bomen geplant (2)
- ☐ Ja, ik heb meer tegels, kunstgras en/of grint gelegd (3)
- ☐ Ja, ik heb een regenton (of vergelijkbare elementen) geplaatst (4)
- ☐ Ja, ik heb tegels vervangen door grint of groen (5)
- ☐ Ja, ik heb recreatieve elementen toegevoegd (bbq, tv, overkapping, zwembad, zitje etc.) (6)
- ☐ Ja, ik heb iets anders veranderd (7)
- ☐ Nee, ik heb behalve hier en daar wat kleine dingetjes niet veel veranderd aan mijn tuin (8)

Einde blok: Introductie

Start van blok: GBI vragen - mobiel

Q46 TUININRICHTING De komende 15 vragen gaan over de elementen die in je tuin kunnen voorkomen, van klein naar groot. Je kunt alleen met "ja" of "nee" antwoorden. Dit levert een puntentelling op van het aantal groenvoorzieningen in je tuin. Aan het eind lees je wat dit betekent.

Q47 Heb je een vogelbad in je tuin?
Een waterbak kan nuttig zijn voor dorstige vogels, maar ook voor andere dieren. TIP: kleine steentjes of hout in de bak bieden insecten een hulpmiddel om uit het water te komen.

- Ja (1)
- Nee (2)

Q48 Heb je een nestkast in je tuin?
In vogelhuisjes of een vleermuiskast zullen zeker snel nieuwe bewoners intrekken.
TIP: als er in de buurt van de nestkasten ook hagen als schuilplaats, bomen, bloeiende vaste planten en veel insecten zijn.

- Ja (1)
- Nee (2)

Q49 Heb je verticaal groen in je tuin?
Klimplanten die tegen een muur, schutting of gebouw klimmen, kunnen nestplaatsen en voedsel bieden voor vogels en insecten. Tel dit alleen mee als het groen zo dicht of dik is dat een vogel erin kan verstoppen.

- Ja (1)
- Nee (2)

Q50 Heb je een open composthoop in je tuin?
Een open composthoop biedt een leefgebied voor veel dieren. Om dit te bereiken, moeten er rondom en aan de onderkant een aantal openingen zijn.

- Ja (1)
- Nee (2)

Q51 Heb je een stapelmuur in je tuin?
In en op een onbehandelde muur vestigen zich planten. Hagedissen, wilde bijen en andere kleine dieren vinden er een leefgebied.
Tel de muur alleen mee als deze minimaal een meter lang en 30 centimeter hoog is en als

er planten tussen de kieren groeien. TIP: er mag geen vlies tussen de muur en de bedding of aarde zitten – dit voorkomt dat dieren zich in de muur kunnen vestigen.

- Ja (1)
- Nee (2)

Q52 Heb je een verwilderd plekje in je tuin?
Een plekje/hoekje in de tuin van minimaal twee vierkante meter, waar wilde kruiden zoals brandnetels vrij mogen groeien en waar ook hout en stenen liggen, is een toevluchtsoord voor veel dieren. Je wordt ervoor beloond met bijvoorbeeld veel vlinders, aangezien brandnetels een voedselplant voor rupsen zijn.

- Ja (1)
- Nee (2)

Q53 Heb je een bladeren- en/of takkenhoop in je tuin?
Een hoop van bladeren en/of takken is een goede schuilplaats voor egels, lieveheersbeestjes en andere nuttige insecten. Het is belangrijk dat ze zo lang mogelijk ongestoord kunnen blijven.

- Ja (1)
- Nee (2)

Q54 Heb je een stukje open terrein in je tuin?
Veel wilde bijensoorten nestelen in zand of klei op de grond. Ook mussen gebruiken graag zand voor zandbaden. Het is voldoende om een klein gebied vrij te houden van planten. Een oude, niet meer gebruikte zandbak is ook geschikt als er wat kleigrond aan wordt toegevoegd.

- Ja (1)
- Nee (2)

Q55 Heb je bessenstruiken in je tuin?
Minimaal twee struiken die bessen dragen. Want niet alleen mensen, maar ook veel dieren, houden van heerlijke bessen. Zelfs bessen die voor ons mensen niet eetbaar zijn, dienen als voedsel voor dieren. TIP: het is beter wanneer het vrijgroeiende, inheemse (origineel Nederlandse) struiken zijn, zoals duindoorn, gelderse roos, aalbes, gewone vlier, wilde lijsterbes en kornoelje o.a.

- Ja (1)
- Nee (2)

Q56 Heb je dood hout in je tuin?
Onbehandeld dood hout is een prima habitat voor veel soorten – liggend of staand, in

stapels, stammen of wortels. Het kan ook uitstekend als decoratief element worden gebruikt.

- Ja (1)
- Nee (2)

Q57 Heb je wilde struiken (heesters) in je tuin?
Inheemse wilde struiken (ook wel heesters genoemd) kunnen dienen als nest- en schuilplaats voor veel soorten. De struiken worden niet gesnoeid, maar mogen bloeien en vruchten dragen, waardoor ze voedsel vormen voor insecten en andere dieren.
Struiken/heesters zijn er in veel soorten en maten. Geschikte inheemse soorten zijn onder andere kornoelje, meidoorn, (ongevulde) hondsroos en kardinaalsmuts. Thuja, laurierkers en forsythia zijn daarentegen exoten die geen dieren voeden.

- Ja (1)
- Nee (2)

Q58 Heb je een vasteplantenperk in je tuin?
Een perk met vaste planten. Het is belangrijk om ervoor te zorgen dat ze inheems zijn, dus uit Nederland komen. Bij voorkeur niet gekweekt, maar wild.

- Ja (1)
- Nee (2)

Q59 Heb je een vijver in je tuin?
Een vijver biedt een habitat en toevluchtsoord voor veel verschillende dieren.
Tel alleen mee als er een beplante oever en onderwaterplanten zijn, en als de vijver geen siervissen bevat, aangezien deze helaas kikkervisjes, salamanders en kikkers eten en veel nadelige voedingsstoffen aanleveren.

- Ja (1)
- Nee (2)

Q60 **Heb je een bloemenweide, bloemen- of kruidengazon of bloeiende border in je tuin?**
Beantwoord "ja" als de tuin ten minste één van deze drie opties bevat:

- Een **bloemenweide** bestaat uit een mengsel van inheemse (oorspronkelijk Nederlandse) grassen en meerjarige bloeiende wilde planten. De weide wordt maximaal twee keer per jaar gemaaid, de tweede keer in de herfst.
- Een **bloemen- of kruidengazon** is een natuurvriendelijker alternatief voor een grasveld. Wilde kruiden zijn hier welkom en mogen bloeien. De weide is toegankelijk, wordt niet bemest en wordt slechts af en toe gemaaid.
- Een **border** is meestal een grotere, strookvormige overgang tussen twee tuingedeelten met een grote verscheidenheid aan wilde planten.

- Ja (1)
- Nee (2)

Q61 **Heb je een boom in je tuin?**
Minimaal één boom, hoeft niet volgroeid te zijn. De dieren in de tuin zijn nog gelukkiger als de soort inheems (Nederlands) is, zoals de eik, beuk, berk, populier, wilg, linde en es o.a.

- Ja (1)
- Nee (2)

Einde blok: GBI vragen - mobiel

Start van blok: Uitslag

Q15 Je tuin scoort ${gr://SC_1TXqeHml9etlEmO/Score} punten. Goed gedaan! Op de volgende pagina staat meer uitleg hierover.

Deze vraag weergeven:
If Score <= 15

Q11 **0-15 punten!** Je bent op weg naar een aantrekkelijke tuin voor mens én dier! Als je meer vogels, bijen, egels, vlinders en andere soorten wil aantrekken zou je eens kunnen kijken naar de tips van IVN, Natuurmonumenten en WNF. Heb je daarnaast al eens gehoord van de groenblauwe subsidieregeling van Gemeente Arnhem? Je kunt dan maximaal €5000,- per jaar krijgen van de Gemeente wanneer je van plan bent tegels te vervangen door groen, een moestuin te beginnen, je gevel of dak te vergroenen of regenwater op te slaan. Ook leuk voor jouw tuin: doe van maart t/m oktober 2026 mee aan het NK Tegelwippen en zorg ervoor dat Nederland wint van België! Voor hulp bij het vervangen van tegels, kijk op de site van MilieuCentraal. Heb je vragen? Laat aan het eind van de vragenlijst een opmerking achter met je contactgegevens en ik neem contact met je op!

Deze vraag weergeven:

If Score > 15

And Score <= 30

Q12 16-30 punten! Je bent al goed bezig een aantrekkelijke tuin voor mens én dier te creëren! Als je meer vogels, bijen, egels, vlinders en andere soorten wil aantrekken zou je eens kunnen kijken naar de tips van IVN, Natuurmonumenten en WNF. Heb je daarnaast al eens gehoord van de groenblauwe subsidieregeling van Gemeente Arnhem? Je kunt dan maximaal €5000,- per jaar krijgen van de Gemeente wanneer je van plan bent tegels te vervangen door groen, een moestuin te beginnen, je gevel of dak te vergroenen of regenwater op te slaan. Ook leuk voor jouw tuin: doe van maart t/m oktober 2026 mee aan het NK Tegelwippen en zorg ervoor dat Nederland wint van België! Heb je vragen? Laat aan het eind van de vragenlijst een opmerking achter met je contactgegevens en ik neem contact met je op!

Deze vraag weergeven:

If Score > 30

Q13 31-45 punten! Geweldig! Deze tuin bevat veel verschillende elementen waardoor het een thuis is voor veel verschillende soorten! Als je nóg meer vogels, bijen, egels, vlinders en andere soorten wil aantrekken zou je eens kunnen kijken naar de tips van IVN, Natuurmonumenten en WNF. Heb je daarnaast al eens gehoord van de groenblauwe subsidieregeling van Gemeente Arnhem? Je kunt dan maximaal €5000,- per jaar krijgen van de Gemeente wanneer je van plan bent tegels te vervangen door groen, een moestuin te beginnen, je gevel of dak te vergroenen of regenwater op te slaan. Ben je op zoek naar iets gevorderde tips voor het klimaatvriendelijk maken van je tuin? Kijk dan naar natuurlijk tuinonderhoud, regenwateropvang, een gezonde bodem, en natuurlijke verkoeling. Hou daarbij altijd rekening met de herkomst van alle elementen (planten, tegels, aarde, mest etc.) in je tuin. Kijk ook eens op Arnhem Klimaatbestendig voor tips en het aanmelden van goede ideeën. Heb je vragen? Laat aan het eind van de vragenlijst een opmerking achter met je contactgegevens en ik neem contact met je op!

Einde blok: Uitslag

Start van blok: Reflectie

Q28 REFLECTIE Nu je de vragenlijst hebt ingevuld en je een puntentelling hebt ontvangen stel ik je graag nog wat vragen over het invullen van de vragenlijst zelf. Deze vragen zijn voor mij om de kwaliteit van de vragenlijst te beoordelen en te kijken of het een effectieve manier is om een beeld te krijgen van de inrichting van achtertuinen in Arnhem.

Q30 Wat vond je in het algemeen van de vragenlijst?

Ik geef de vragenlijst: (1)	☆	☆	☆	☆	☆

Q31 Wat vond je van deze onderdelen van de vragenlijst?

De vragen zijn duidelijk en goed te begrijpen (1)	☆	☆	☆	☆	☆
De afbeeldingen helpen bij het begrijpen van de vraag (2)	☆	☆	☆	☆	☆
Het doel van de vragenlijst was duidelijk (3)	☆	☆	☆	☆	☆
De uitkomst / puntentelling was duidelijk en logisch (4)	☆	☆	☆	☆	☆
De uitleg bij de puntentelling was nuttig en handig (5)	☆	☆	☆	☆	☆

Q33 Denk je dat de vragenlijst invloed heeft gehad of gaat hebben op hoe je naar je tuin kijkt?

- Ja (4)
- Waarschijnlijk (5)
- Onzeker (6)
- Onwaarschijnlijk (7)
- Nee (8)

Q54 Denk je dat je dingen aan je tuin gaat aanpassen na deze vragenlijst?

- Ja (4)
- Waarschijnlijk (5)
- Onzeker (6)
- Onwaarschijnlijk (7)
- Nee (8)

Q34 Heb je nog op- of aanmerkingen voor mij?

_____

Einde blok: Reflectie

Start van blok: Einde

Q36 DANKJEWEL! Heel fijn dat je de tijd hebt genomen om mijn vragenlijst in te vullen! Ik ga met jouw antwoorden (anoniem natuurlijk) aan de slag. Nog twee laatste vragen voor je over het vervolg van mijn onderzoek.

Q37 Wil je op de hoogte gehouden worden van het onderzoek en de uitkomsten? Je krijgt dan een update als de vragenlijst is gesloten (na 7 december) en een samenvatting van de resultaten wanneer ik mijn onderzoek rond heb (wordt verwacht in maart). Als je "ja" antwoord kun je hierna aangeven hoe ik je het beste kan bereiken.

- Ja (1)
- Nee (2)

Q38 Sta je open voor vervolgcontact? Nadat de resultaten van de vragenlijst binnen zijn wil ik graag de vragenlijst zelf invullen voor jouw tuin. Op die manier kan ik zelf ervaren hoe gebruiksvriendelijk / praktisch de vragenlijst is en of er verschillende interpretaties mogelijk zijn of dingen missen bijvoorbeeld. Dit kan via een foto/video van de tuin of een fysieke afspraak.

- Ja (1)
- Nee (2)

Deze vraag weergeven:

If Q37 = Ja

Or Q38 = Ja

Q39 Hoe kan ik je het beste bereiken? Laat hieronder je naam en een e-mailadres en/of telefoonnummer achter. Dit wordt eenmalig gebruikt om contact met je op te nemen. De gegevens worden (buiten het contact) niet opgeslagen en meteen na gebruik verwijderd.

- Naam (1) _____
- Email (2) _____
- Telefoon (3) _____

Einde blok: Einde

APPENDIX IV: SURVEY B

1	In welke wijk woont u?	*Single-response*

- ◯ Centrum
- ◯ Spijkerkwartier
- ◯ Arnhemse Broek
- ◯ Presikhaaf-West
- ◯ Presikhaaf-Oost
- ◯ Sint Marten / Sonsbeek-Zuid
- ◯ Klarendal
- ◯ Velperweg e.o.
- ◯ Alteveer / Cranevelt
- ◯ Monnikenhuizen
- ◯ Geitenkamp
- ◯ Burgemeesterswijk / Hoogkamp
- ◯ Schaarsbergen
- ◯ Heijenoord / Lombok
- ◯ Klingelbeek
- ◯ Malburgen - West
- ◯ Malburgen - Oost (Noord)
- ◯ Malburgen - Oost (Zuid)
- ◯ Vredenburg / Kronenburg
- ◯ Elden
- ◯ De Laar
- ◯ Elderveld
- ◯ Rijkerswoerd
- ◯ Schuytgraaf
- ◯ Anders, namelijk
- ◯ Weet ik niet

2	In welk type woning woont u?	*Single-response*

- ◯ Appartement / Flat
- ◯ Tussenwoning
- ◯ Hoekwoning
- ◯ Twee onder één kap
- ◯ Vrijstaande woning

- ○ Bungalow
- ○ Anders, namelijk
- ○ Weet niet / geen mening

3 TUIN *Single-response*

Bent u eigenaar van een (gedeelde) tuin in Arnhem?

- ○ Ja, als koper
- ○ Ja, als huurder
- ○ nee, ik heb geen tuin **[>> Vraag 14]**

4 **Op welke foto lijkt uw tuin het meest?** *Single-response*

Als u geen keuze kunt maken, mag u deze vraag overslaan. Kijk bij het 'i-tje' voor meer informatie

- ○ Praktische tegeltuin
- ○ Strakke tuin
- ○ Bloementuin
- ○ Levendige tuin
- ○ Wilde tuin

5 **Kun je een inschatting maken van de grijs/groen verdeling in je tuin?** *Single-response*

Met 'groen' bedoelen we: gras, kruiden, bloemen, struiken, hagen en bomen. Verharding zoals tegels, grind, hout of kunstgras telt niet mee. Indien de schuur of het terras het grootste deel van uw tuin inneemt, dan dient u dat mee te nemen in uw beoordeling.

- ○ Meer grijs dan groen (0–25%)
- ○ Een beetje groen (25–50%)
- ○ Veel groen (50–75%)
- ○ Bijna helemaal groen (75–100%)

6 **Hoe belangrijk vindt u zelf een groene tuin?** *Single-response*

- ○ Heel belangrijk
- ○ Belangrijk
- ○ Niet belangrijk / niet onbelangrijk
- ○ Onbelangrijk
- ○ Heel onbelangrijk
- ○ Weet niet / geen mening

7 **Wat zouden voor u redenen kunnen zijn om uw tuin groen(er) te maken?** *Multi-response*
Meerdere antwoorden mogelijk

[Minimaal aantal vinkjes: 1]

- ☐ Vanwege het veranderende klimaat
- ☐ Meer biodiversiteit
- ☐ Mooier uiterlijk
- ☐ Koelere tuin in de zomer
- ☐ Waterafvoer
- ☐ Anders, namelijk
- ☐ Geen van bovenstaande redenen. Ik wil niet vergroenen

8 **Wat zou u tegen kunnen houden om uw tuin groener te maken?** *Multi-response*
Meerdere antwoorden mogelijk

[Toon antwoorden in willekeurige volgorde]

[Minimaal aantal vinkjes: 1]

- ☐ Ik heb er geen tijd voor
- ☐ Ik vind het teveel moeite
- ☐ Ik weet niet hoe ik het aan moet pakken
- ☐ Ik vind het te duur
- ☐ Ik heb er geen zin in
- ☐ Ik kijk op tegen het onderhoud
- ☐ Ik denk dat ik het niet kan
- ☐ Ik mag het niet omdat ik huur
- ☐ Ik vind het niet nodig, de tuin is goed zoals die is
- ☐ Ik heb moeite met het weer, allergien, grondsoort en andere mogelijke
- ☐ Ik doe het niet vanwege mijn kinderen
- ☐ Anders, namelijk [Antwoord positie vastgezet]
- ☐ Weet niet / geen mening [Antwoord positie vastgezet]

9 **Heeft u de afgelopen tijd (ca. 5 jaar) een (grote) verandering aangebracht aan uw tuin?** *Single-response*

- ○ Ja
- ○ Nee

10	Welke grote verandering(en) heeft u aangebracht aan de tuin? Ik heb:	*Multi-response*

[Minimaal aantal vinkjes: 1]

Vraag 10 alleen tonen als aan de onderstaande voorwaarden wordt voldaan, indien niet voldaan spring naar: >> Volgende vraag

Vraag 9. **Heeft u de afgelopen tijd (ca. 5 jaar) een (grote) verandering aangebracht aan uw tuin?** Antwoord **Ja** Is gegeven

- ☐ Een grote tuinverbouwing gedaan met een heel nieuw tuinontwerp
- ☐ Meer planten, bloemen en/of bomen geplant
- ☐ Meer tegels, kunstgras en/of grint gelegd
- ☐ Een regenton (of vergelijkbare elementen) geplaatst
- ☐ Tegels vervangen door grint of groen
- ☐ Recreatieve elementen toegevoegd (bbq, tv, overkapping, zwembad, zitje etc.)
- ☐ Iets anders, namelijk

11	TUININRICHTING De komende 15 vragen gaan over de elementen die in je tuin kunnen voorkomen, van klein naar groot. Je kunt alleen met "ja" of "nee" antwoorden. In het i'tje staat meer info over het onderdeel, "het liefst" betekent dat dit en pre is maar niet verplicht om ja te kunnen antwoorden op dat onderdeel. Geef aan of onderstaande elementen in uw tuin voorkomen:	*Tabel(single response)*

	Ja	Nee
Een vogelbad	○	○
Een nestkast	○	○
Verticaal groen	○	○
Een open composthoop	○	○
Een stapelmuur	○	○

12	TUININRICHTING Geef aan of onderstaande elementen in uw tuin voorkomen:	*Tabel(single response)*

	Ja	Nee

Een verwilderd plekje	○	○
Een bladeren- en/of takkenhoop	○	○
Een stukje open terrein	○	○
Bessenstruiken	○	○
Dood hout	○	○

13 TUININRICHTING *Tabel (single response)*

Geef aan of onderstaande elementen in uw tuin voorkomen:

	Ja	Nee
Wilde struiken (heesters)	○	○
Een vasteplantenperk	○	○
Een vijver	○	○
Een bloemenweide, bloemen- of	○	○
Een boom	○	○

14 MAATREGELEN EIGEN WONING *Single-response*

Bent u geïnteresseerd in het nemen van maatregelen aan of om uw woning die bijdragen aan meer groen, minder hitte en minder wateroverlast?
Bijvoorbeeld groene daken, weghalen van verharding en opvullen met groen, moestuinbakken, regentonnen of (fruit)bomen.

- ○ Ja, en ik heb in het afgelopen jaar ook al maatregelen genomen
- ○ Ja, dat heb ik nog niet gedaan maar daar heb ik wel interesse in
- ○ Nee, daar heb ik geen interesse in

15 **Welke maatregelen heeft u al genomen?** *Multi-response*
Meerdere antwoorden mogelijk

[Minimaal aantal vinkjes: 1]

Vraag 15 alleen tonen als aan de onderstaande voorwaarden wordt voldaan, indien niet voldaan spring naar: >> Volgende vraag

Vraag 14. MAATREGELEN EIGEN WONING
Bent u geïnteresseerd in het nemen van maatregelen aan of om uw woning die bijdragen aan meer groen, minder hitte en minder wateroverlast? Antwoord **Ja, en ik heb in het afgelopen jaar ook al maatregelen genomen** Is gegeven

- [ ] Groen dak
- [ ] Gevelgroen / geveltuintje
- [ ] Weghalen van verharding en opvullen met groen
- [ ] Moestuin
- [ ] Regenton
- [ ] (Fruit)boom
- [ ] Anders, namelijk

16 Wilt u uw antwoord nog toelichten? *Open (groot)*

Vraag 16 alleen tonen als aan de onderstaande voorwaarden wordt voldaan, indien niet voldaan spring naar: >> Volgende vraag

Vraag 14. MAATREGELEN EIGEN WONING
Bent u geïnteresseerd in het nemen van maatregelen aan of om uw woning die bijdragen aan meer groen, minder hitte en minder wateroverlast? Antwoord Ja, en ik heb in het afgelopen jaar ook al maatregelen genomen Is gegeven

17 Welke maatrelen zou u (nog) willen nemen? *Multi-response*
Meerdere antwoorden mogelijk

[Minimaal aantal vinkjes: 1]

Vraag 17 alleen tonen als aan de onderstaande voorwaarden wordt voldaan, indien niet voldaan spring naar: >> Volgende vraag

Vraag 14. MAATREGELEN EIGEN WONING
Bent u geïnteresseerd in het nemen van maatregelen aan of om uw woning die bijdragen aan meer groen, minder hitte en minder wateroverlast? Antwoord Ja, en ik heb in het afgelopen jaar ook al maatregelen genomen Is gegeven of Vraag 14. MAATREGELEN EIGEN WONING
Bent u geïnteresseerd in het nemen van maatregelen aan of om uw woning die bijdragen aan meer groen, minder hitte en minder wateroverlast? Antwoord Ja, dat heb ik nog niet gedaan maar daar heb ik wel interesse in Is gegeven

- [ ] Groen dak
- [ ] Gevelgroen / geveltuintje
- [ ] Weghalen van verharding en opvullen met groen
- [ ] Moestuin
- [ ] Regenton
- [ ] (Fruit)boom
- [ ] Anders, namelijk

☐ Geen / weet niet

18	**Heeft u wel eens gehoord van de Subsidie Groenblauwe Initiatieven van de Gemeente Arnhem? Die kan u namelijk aanvragen, onder voorwaardes, om meer groene en blauwe maatregelen aan uw woning te nemen.** Aan het einde van de vragenlijst komt een link te staan naar de website Groen Blauw Subsidie als u geïnteresseerd bent	*Single-response*

○ Ja, wel eens van gehoord
○ Nee, ik was er niet bekend mee
○ Weet niet / geen mening

19	<u>PRESENTATIE</u> **Dankjewel voor het invullen van de vragenlijst! Als alle data verwerkt is zullen de resultaten van deze studie worden gedeeld in de vorm van een presentatie verzorgd door een student van de WUR. Dit vindt plaats bij de Gemeente Arnhem en zal naar schatting niet langer dan een uur duren. Er is een beperkt aantal plaatsen beschikbaar, dus er zal een loting plaatsvinden bij te veel aanmeldingen.** **Zou u deze presentatie willen bijwonen?**	*Single-response*

○ Ja
○ Nee

20	**Hoe kunnen we u het beste bereiken?** Laat hieronder uw naam en een e-mailadres en/of telefoonnummer achter. Dit wordt eenmalig gebruikt om contact met u op te nemen. De gegevens worden (buiten het contact) niet opgeslagen en meteen na gebruik verwijderd.	*Invulvelden*

Vraag 20 alleen tonen als aan de onderstaande voorwaarden wordt voldaan, indien niet voldaan spring naar: >> Volgende vraag

Vraag 19. PRESENTATIE
Dankjewel voor het invullen van de vragenlijst! Als alle data verwerkt is zullen de resultaten van deze studie worden gedeeld in de vorm van een presentatie verzorgd door een student van de WUR. Dit vindt plaats bij de Gemeente Arnhem en zal naar schatting niet langer dan een uur duren. Er is een beperkt aantal plaatsen beschikbaar, dus er zal een loting plaatsvinden bij te veel aanmeldingen.

Zou u deze presentatie willen bijwonen? Antwoord **Ja** Is gegeven

Naam	
E-mailadres	
Teelefoonnummer	

21	**Wilt u naar aanleiding van deze vragenlijst nog ergens op terugkomen?**	*Open (groot)*