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# URBAN ECOLOGICAL PRINCIPLES AS A DRIVER OF SUSTAINABLE URBAN DEVELOPMENT

AN ASSESSMENT OF FOUR EUROPEAN  
FORERUNNERS

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## Colophon

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## **Abstract**

The majority of sustainable development strategies of cities are made under the smart cities paradigm, which emphasizes socio-economic sustainability. At the same time, environmental targets related to the United Nations Agenda on Sustainable Development need scaling in order to succeed. Scholars therefore argue to integrate environmental and ecological targets within the urban environment. This raises a question about how environmental sustainability and ecology can be considered in sustainable urban development strategies, and what we can learn from successful examples. This study compares four European forerunners in order to gain insights on how key principles from the field of urban ecology can help drive sustainable urban development. The first step in this study was to formulate an assessment framework on the basis of urban ecological principles and environmental sustainability. The second step was to apply this framework to evaluate the sustainable urban development strategies of Stockholm, Vitoria-Gasteiz, Hamburg and Breda, which are considered some of the greenest cities in Europe by means of awards such as the European Green Capital of the year award.

The assessment demonstrated that referring to ecological theory in strategy documents highlights the consideration given to the local ecology of the city, with Stockholm and Vitoria-Gasteiz scoring higher compared to Breda and Hamburg. Overall, all cities adequately addressed nature and ecology and had clear strategies on integrating green infrastructure in the city by catering both to the needs of citizens and nature. However, environmental quality indicators (i.e. air quality) scored lower in the strategies of Breda, Hamburg and Vitoria-Gasteiz. In comparison with Stockholm, which did score higher, it was concluded that a misalignment of policy measures and ambitions between various levels of government halted ambition and integration on the local scale. This resulted in goals, measures and strategies not being mentioned adequately in the sustainable development strategies. The results demonstrate that integrating definitions and ecological theory within strategy documents and policy resulted in a larger scope of ambition and thoroughness of said policy or strategy. Therefore, it was recommended that other cities should integrate wider environmental goals within their sustainable development strategies and to make use of the exemplary methodologies of the four assessed cities.

**Keywords:** Environmental sustainability, urban development, urban ecology, urban sustainability, sustainable development

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# 1. Introduction

## 1.1 Background

The United Nations (UN) predicts that urbanization will increase the amount of urban dwellers from the current 3.2 billion to ca. 6.4 billion by the middle of the century (UN-Habitat, 2016). There are numerous environmental and socio-economic challenges involved with such a massive transition. If no measures are taken the environmental impacts may become detrimental (UN-Habitat, 2016). As cities become home to an increased portion of the human population, most experiences with nature become urban (Miller, 2005). Furthermore, cities are dependent on natural processes, for example to manage excess rainwater. Urban vegetation provides not only physiological but also psychological benefits such as increased productivity and well-being (Heymans et al., 2019; Tuan, 1974). As a response urban ecology has seen an increase in popularity in discussions on urban planning and sustainable development (Colding & Barthel, 2017). Colding and Barthel (2017) argue that urban planning must enable citizens to (cognitively) reconnect with the biosphere. Urban ecology highlights the importance and functions of ecosystem services (ES). ES are defined as the contributions of ecosystem structure and function (often in combination with other inputs) to human well-being (Cortinovis & Geneletti, 2018; van Eekelen & Bouw, 2021; Heymans et al., 2019). The concepts of green infrastructure, biophilic cities and socio-ecological planning have emerged as a way to provision ES into the human-dominated landscape (Ahern et al., 2014; Colding, 2011).

Contemporary social, economic, cultural and environmental challenges are fundamentally interdependent, as are opportunities for development and growth (van Eekelen & Bouw, 2021). These interdependencies determine the way people live and thrive and should also guide the way we develop cities. In recognition of this the UN developed the 2030 agenda for sustainable development, which includes 17 Sustainable Development Goals (SDGs) which are an opportunity to take decisions that address poverty, inequality and environmental challenges by 2030 (UNEP, 2020). The environment underlies each global goal, thereby demonstrating the interdependency between nature and humanity. Cities are important sites for engaging with environmental issues (Colding & Barthel, 2017; van Eekelen & Bouw, 2021), and each city is approaching its challenges differently, which are reflected in their sustainable urban development strategies. It is the first year (2021) of the 2030 Agenda for Sustainable Development's decade of action, which means we have ten years to deliver on our promise. Therefore it is important to evaluate current progress and assess how cities are doing with regard to environmental sustainability.

## 1.2 Research problem

Cities can deploy a range of strategies to integrate the environment into urban planning and management. These strategies vary with spatial scale. However, it is widely acknowledged that activities in cities affect the environment in multiple scales at the same time both in negative and positive ways (van Eekelen & Bouw, 2021). Incorporating sustainable development into urban plans is both complex and multi-scalar (van Eekelen & Bouw, 2021; Klopp & Petretta, 2017; Verma & Raghubanshi, 2018). Heymans et al. (2019) describe the importance of place-oriented cities as a means for sustainable development in cities. Klopp and Petretta (2017) argue that it is the local scale where the UN SDG framework's interpretations and meaning will be created, but most importantly where struggles will take

place in improving urban areas. van Eekelen and Bouw (2021) argue that investing in nature must be an integral part of sustainable development as both human well-being and biodiversity benefits from investments in nature. Planners already have a large set of tools and frameworks in order to incorporate the environment and ecosystem within their sustainable development plans (Cortinovis & Geneletti, 2018). Although frameworks for urban environmental and sustainability goals exist at large, most urban plans do not consider the ecosystem as a strategic point (Ahvenniemi et al., 2017; Colding & Barthel, 2017; de Jong et al., 2015). Each city faces the choice of formulating strategies in order to achieve its sustainable development goals. The choice is important as it has a direct effect on city management and decision-making (Kitchin et al., 2015). There are however, often limitations in selecting and applying indicators and frameworks due to a lack of data and examples (Klopp & Petretta, 2017; UNEP, 2019). Furthermore, the amount of methods that address the multi-functionality of urban ecological approaches is rather insufficient (Artmann et al., 2019; Cortinovis & Geneletti, 2018). This study addresses this gap by examining four European frontrunners utilizing an assessment framework based on urban ecological principles in order to provide key insights and lessons to be deployed in other cities.

### **1.3 Societal relevance**

The term of smart green cities dawns the literature the most (Colding & Barthel, 2017; de Jong et al., 2015). Smart green cities aim to preserve and (re)develop urban green infrastructure, but are focused on the perspective of humans, as opposed to the ecosystem (Artmann et al., 2017). This contradicts the values of the SDGs as defined by the UN, which identified 93 environmental related targets with its 17 goals (UNEP, 2020). 22% of these targets are likely to succeed, however 16% will not be met with current measures and 62% cannot be measured due to lack of data (UNEP, 2019). Sustainable development is critical to secure long-term community health, therefore action to protect the environment needs to increase in scale and speed (UNEP, 2020). Heymans et al. (2019) advocate to treat cities as socio-ecological systems and to utilize a holistic approach which sees urban areas as complex living systems. The holistic approach should manage human interference within the environment based on an understanding of the ecological system (Heymans et al., 2019). The UN recognizes the importance of the environment and the ecosystem in its sustainability targets. Therefore, it is important to examine how environmental sustainability and ecology can be integrated within sustainable urban development and to learn from successful examples.

### **1.4 Scientific relevance**

There are multiple studies advocating the use of smart sustainable city frameworks, which emphasize socio-economic sustainability. Therefore, the majority of cities that want to become sustainable and incorporate SDGs in their urban plans make use of smart city frameworks (Colding & Barthel, 2017; Huovila et al., 2019; Garau & Pavan, 2018). Cities such as Barcelona, Amsterdam, Manchester and Berlin have all made use of smart city frameworks for their transformation projects to enhance urban quality of life. Ahvenniemi et al. (2017) conclude that environmental indicators are underrepresented in smart city frameworks, arguing that environmental aspects may not be considered to a sufficient extent. de Jong et al. (2015) conclude that the literature on the smart city concept places little emphasis on ecological sustainability. As this discrepancy exists in sustainable urban

development frameworks and their strategies, it is relevant to assess the possibilities of including environmental goals in city strategies and which extra steps cities can take in order to succeed in the environmental global SDGs as defined by the UN. This research will therefore assess strategies from four ambitious European cities that deploy urban ecological principles and green infrastructural solutions (i.e. nature based solutions) in order to examine differences in scope, results and nature, and to identify key differences, strategies and lessons to be implemented in other cities.

### **1.5 Research questions**

To derive conclusions on how ecological considerations have been implemented in sustainable urban development strategies in European cities, it is important to dissect it into multiple components within this research. In this research, the central question was: *What lessons can be drawn from green sustainable development strategies of European cities with regard to environmental sustainability and urban ecological principles?* To support this central question, multiple sub-questions have been formulated.

The first two sub-questions will be based on theoretical information and serve as the background for the assessment in this research.

SQ1: How can the principles of urban ecology help drive sustainable urban development?

SQ2: What are the key possibilities of ecosystem services and structures within the urban realm?

The latter two sub-questions relate to the case studies that will be analyzed during this research. These will focus on the empirical part of this research, the assessment of sustainable development strategies of Stockholm, Vitoria-Gasteiz, Hamburg and Breda.

SQ3: How do the assessed cities compare in considering ecological principles in their sustainable development plans?

SQ4: Which formulated strategies from the assessed cities benefit the natural environment the most and should be exported to other cities?

### **1.6 Thesis outline**

The subsequent chapter will elaborate upon the theoretical framework, which aims to synthesize the definition of sustainable development from an environmental sustainability perspective and urban ecological principles utilizing academic literature. Chapter two will also present the assessment framework and the utilized indicators that underlie the assessment carried out in this thesis. A conceptual framework is presented that describes the structure of the research undertaken. Chapter three describes the methodology employed in this research regarding the assessment of sustainable urban development strategies. Results of the assessment of city strategy and policy documents are presented and analyzed in chapter four alongside findings from a literature review with regards to the research questions. Chapter five attempts to answer the research question and presents a conclusion. Subsequently, suggestions for future research are presented at the end of chapter five.

## **2. Theoretical framework**

In this section, the concepts of sustainable development and urban ecological principles will be defined, linked and connected. Furthermore, the assessment indicators will be defined and presented. This research will use an assessment scheme, which has a checklist as the focus of the theoretical framework.

### **2.1 Definition sustainable development**

There is a wide variety of types of sustainability in urban areas and urban sustainable development strategies. Li et al. (2009) and Verma and Raghubanshi (2018) define four types of sustainability: social, institutional, economic and environmental. As described in the introduction, most cities focus on socio-economic sustainability in their sustainable development strategies. Verma and Raghubanshi (2019) argue that socio-economic development should be based on clear considerations to the environment. van Eekelen and Bouw (2021) refer to the necessity of balancing economic demands with the environment and ecology in order to contribute to social benefits and the sustainability of urban environments. According to Ding et al. (2016) environmental sustainability forms the basis for sustainable urban development and all other forms of sustainability.

Within this research the definition of sustainable development as described by Camagni (1998) has been used: “Sustainable urban development is a process of synergetic integration and co-evolution among the great subsystems making up a city (economic, social, physical and environmental), which guarantees the local population a non-decreasing level of wellbeing in the long term, without compromising the possibilities of development of surrounding areas and contributing by this towards reducing the harmful effects of development on the biosphere.” (p. 1)

This approach differs compared to the contemporary definition of: “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UN, 2021). The definition used in this research takes a more (bio)physical stance as opposed to a socio-economic perspective as the focus will be on the ecological and environmental sustainability aspects of sustainable urban development. As stated during the UN Rio+20 conference, UN member states recognize the severity of global biodiversity loss, which has a negative impact on multiple fronts and impacts multiple SDGs (UNDESA, 2020). Therefore taking a physical stance when assessing sustainable urban development, will enlarge the scope of sustainable development within urban environments. These will not be confined to the urban area specific goal(s) of SDG 11, but also relate to the SDGs of: 3, 6, 9, 13, 15 and 16 (UN, 2021).

### **2.2 Urban ecological principles and the ecosystem services approach**

At the turn of the millennium a shift in biodiversity conservation took place in the direction of an ES lens (Pascual et al., 2021). This approach focuses on the (in)direct benefits of ecosystems for people. Green infrastructures within urban areas can provide a multitude of ES such as cooling the direct surrounding environment, reducing flood risk, filtering of the air and soil, supply food and offer recreational possibilities (Colding & Barthel, 2017; Costanza et al., 1998; McPhearson et al., 2015). The ES approach also focuses on the value people



attach to green structures, which in turn influences land value (Barthel et al., 2010; van Eekelen & Bouw, 2021; Laconte & Gossop, 2016).

Chapin et al. (2011) argue that urban development and metabolism processes threaten a multitude of ES that are in principle essential to society. Therefore, cities have to balance their choices between allocating space for nature and traditional urban development. This dilemma between allocating space for urban nature such as green infrastructure and other land uses underlies the foundation of urban ecological principles (van Bohemen, 2012). The main principles of urban ecology are defined in three steps. Firstly, consideration has to be given to the biophysical environment of urban areas and the high biodiversity and diverse habitats that can be found within it. Secondly, human-nature relationships are examined to explore the biological, health and (socio-) economic and environmental benefits that can be derived from ES. Thirdly, step one and two are linked to increase the valuation of nature within the urban environment to provoke increased attention towards, and investments in, green infrastructure within urban areas (van Bohemen, 2012).

This new approach goes further than just the sociological and biophysical benefits derived from ecosystems. It acknowledges that ecosystem functioning in urban areas (both of nature itself and the people that inhabit the city) depends on, and influences, environmental conditions. The environmental conditions of cities and their surroundings are significantly impacted by human activities (Laconte & Gossop, 2016). Furthermore, the principles of urban ecology satisfy both the biocentric (naturalization) and anthropocentric (goods and services) views towards nature development and conservation (Pascual et al., 2021). ES have historically never been valued by traditional economics (Steiner, 2014).

The main goal behind utilizing urban ecological principles is to seek a balance in the combination of artificial and natural spaces and structures in the urban environment (van Bohemen, 2012; Laconte & Gossop, 2016). Multifunctionality is key as the biophysical status, environmental quality and societal benefits need to be covered by ES (Douglas, 2012). Urban ecological principles are important drivers for sustainable urban development as it attempts to link benefits derived from green and blue infrastructure to other sustainability goals and sectors. For example, urban heat islands can be combated via green infrastructure development. Trees have the possibility to transpire 450L of water per day, equating to an energy consumption of 1000MJ of energy via the evapotranspiration process (Hough, 1989). The benefits with regards to combating urban heat stress are clear, however these benefits can also be linked with public health. For example, during the European heat wave of 2003, roughly 40000 deaths were registered, the majority of deaths were linked to elderly people living in housing units that did not have adequate cooling (Douglas, 2012). Furthermore, it can also be linked to energy (efficiency). For instance, in Chicago it has been found that an increase in tree coverage by 10% in a neighborhood had the potential of reducing energy costs by 50 to 90 US dollars per housing unit per year (McPherson et al., 1997).

### 2.3 Indicators

As described in the previous section, urban ecological principles focus on giving consideration to the biophysical environment as well as explore human-nature relationships (van Bohemen, 2012). These two steps were taken as the two focus points for the indicators. From these two focus points, four groups have been distinguished, which are the four main indicators employed in this research. Ecological considerations emphasize considerations given to nature and the ecosystem(s) within and around urban areas. Environmental quality focuses on the quality and health of the environment and can be recognized, together with ecological considerations, as step one from the urban ecological principles. Green infrastructure focuses on the integration of greenery and green structures within the urban fabric. Together with human-oriented considerations, which emphasizes benefits from and desires of green structures and nature within and around urban areas, can be recognized as step two from the urban ecological principles.

To arrive at a shortlist of sub-indicators, a set of criteria has been evaluated that are most effective for this study. Following these considerations, indicators were selected on the basis of the following criteria: accessibility (availability of data), comparability (to compare the selected case studies), representativeness (at the city level) and relevance (to the research topic). Key topics related to ES that benefit environmental sustainability in urban areas have received their own sub-indicator (i.e. microclimates). The indicators used in this research are described in table 1. See appendix I for an extensive overview of all (sub)indicators, their descriptions and sources. Each (sub)indicator refers to an important topic that requires clear goals and scopes within the sustainable development strategies of cities.

Table 1: Overview of indicators used in this research.

<i>Focus</i>	<i>Indicator</i>	<i>Sub indicator</i>					
<i>Biophysical</i>	Ecological considerations	Habitat provisioning	Protected areas	Ecosystem quality	Biodiversity	Species consideration	Forest coverage
	Environmental quality	Water quality	Soil quality	Rainwater drainage	Restoring natural processes	Sewage treatment	Air quality
	Green infrastructure	Integration	Proximity	Connectivity	Quality	Maintenance	Microclimates
<i>Socio-ecological</i>	Human-oriented considerations	Education	Protection of cultural heritage	Stewardship	Public recreation	Fostering environmental innovation	Ecosystem services

### 2.4 Conceptual model

To visualize the relationships between the concepts and the reasoning behind the assessment framework utilized in this research, a conceptual model has been composed (figure 1). Firstly, (green) sustainable development and urban ecological principles were defined based on the literature. Secondly, an assessment framework with indicators has been formulated based on these concepts and selection principles relating to the case studies that were selected. Thirdly, the assessment was carried out, from which a comparison was made and subsequent best practices were formulated, which was the main focus of this research.

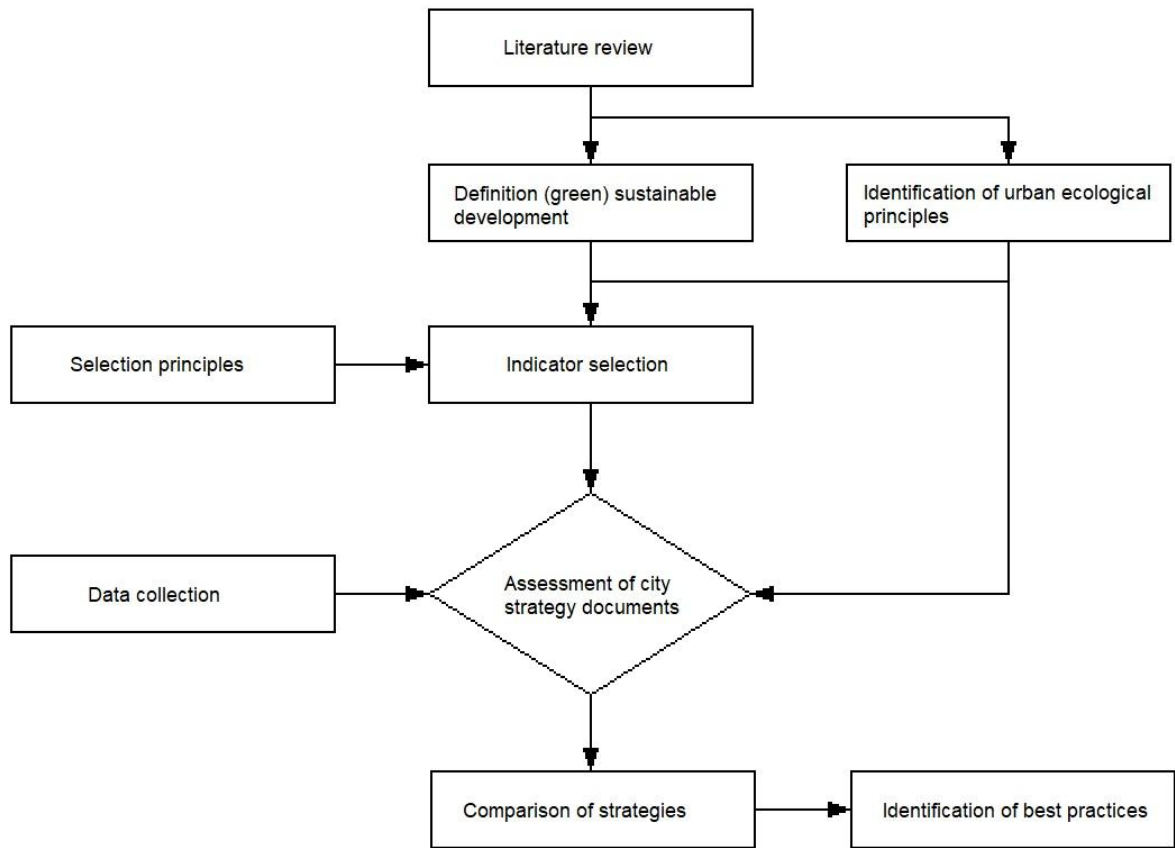


Figure 1: conceptual model in support of the theoretical framework

### **3. Methodology**

In this section, the methodology behind this research is presented and discussed. The methodology in this study synthesizes the theoretical and conceptual aspects of urban ecology under the sustainable urban development paradigm. In order to assess urban strategies a suitable indicator system has been formulated (section 2.3), which embodies the urban ecological principles synthesized beforehand (section 2.2). Subsequently, a content analysis of city strategy plans has been carried out featuring a qualitative assessment based on the (sub)indicators.

#### **3.1 Literature review**

Academic literature has been consulted in order to formulate the assessment criteria (indicators), define sustainable development and urban ecological principles and to answer the first two sub-questions. Furthermore, as the focus of this research is the (urban) ecological principles related to environmental sustainability, secondary data has been collected which serves to describe the case studies themselves and their natural environment in order to objectively assess their ecological stance. Data such as the ecosystem catalogue (Keith et al., 2020) and urban audit statistics from Eurostat (Eurostat, 2021) have been utilized to compare cities and make sense of the ambitions and goals expressed in their strategies. The secondary data is consulted in order to support the comparison between the various cities and denote the importance and targets of green infrastructure, ecology and biodiversity.

#### **3.2 Case studies**

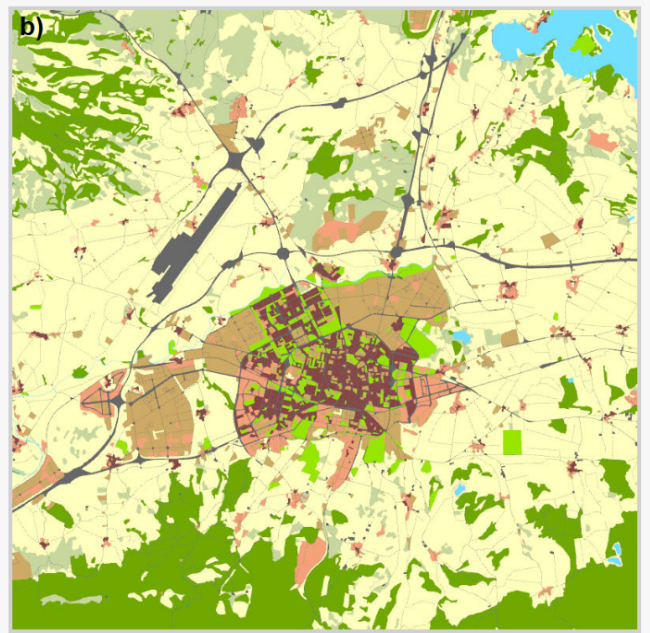
The case studies were selected on the basis of their acknowledgement of, and ambition within their strategy documents on environmental sustainability and ecology. Furthermore, a clear plan relating to environmental sustainability and/or green infrastructure had to be available within their sustainable development strategies and policy. From these cities, whitepapers, policy documents, strategy documents, government reports, as well as newspapers about these strategies have been collected from their official websites, websites of local news outlets and via the European Climate Adaptation Platform (Climate-ADAPT, 2021). As all data is gathered from official sites and platforms, the quality of the data is of sufficient quality for this research. These documents serve as the primary data in this research and are referred to in appendix II.

The cities of Stockholm, Vitoria-Gasteiz, Hamburg and Breda (figure 2) were selected as these cities have all formulated a wide and holistic strategy document which contains clear goals and strategies for the environment and local ecology. Furthermore, all cities except Breda have received the distinguished accolade of European Green Capital of the year within the last ten years, which was awarded for their ambition and efforts in sustainable and environmental development (European Union, 2010, 2011, 2012). Breda was selected as it aims to be a forerunner in integrating nature with urban development in the Netherlands (Municipality of Breda, 2016a).

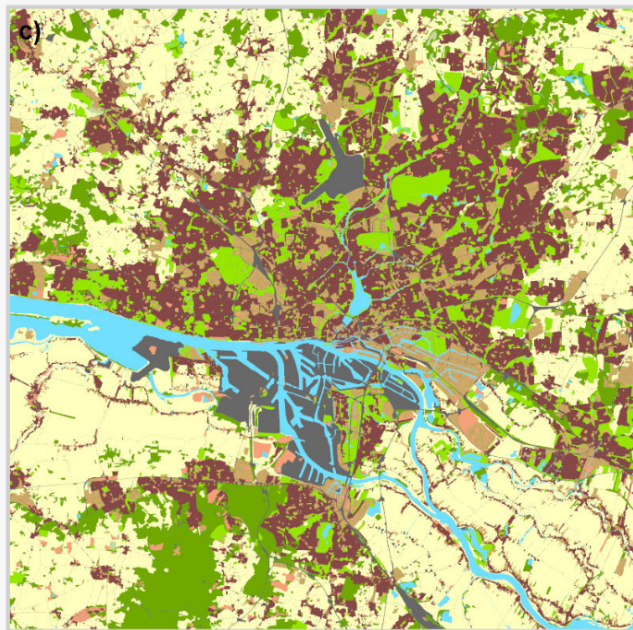




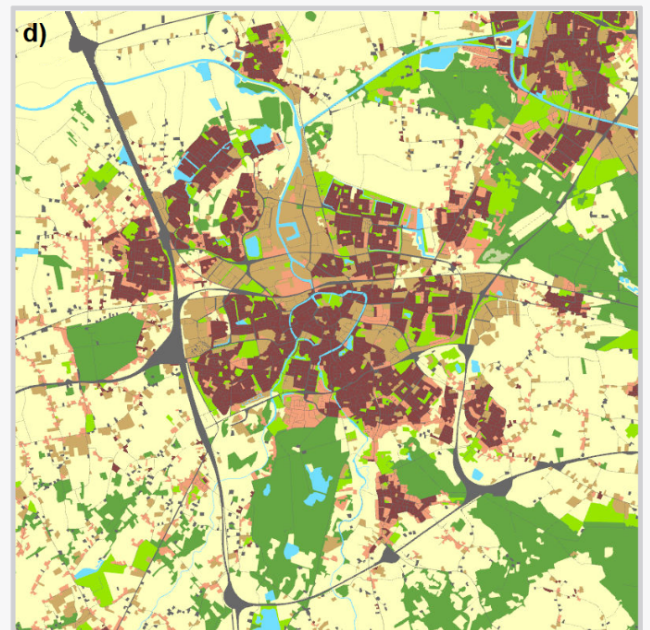
0 2 4 6 8 10 km



0 1 2 3 4 5 km



0 2 4 6 8 10 km



0 1 2 3 4 5 km



- |  |   |
|--|---|
|  Green urban areas and leisure         |  Dense urban fabric > 50 %             |
|  Forest                                |  Low density urban fabric < 50 %       |
|  Herbaceous vegetation and open spaces |  Transport                             |
|  Wetlands and water bodies             |  Industry, construction and commercial |
|  Agriculture                           |   |

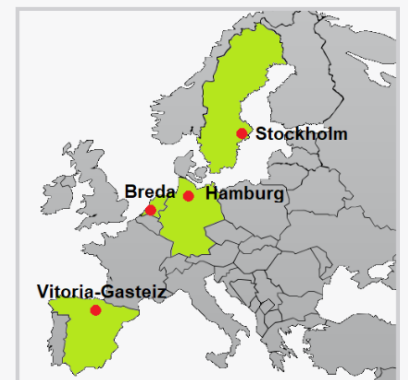


Figure 2: The land-uses and locations of Stockholm (a), Vitoria-Gasteiz (b), Hamburg (c) and Breda (d), GIS data derived from: EEA (2012).

### 3.3 Content analysis

This research deployed a content analysis of four sustainable urban development strategies from four European cities. A content analysis was selected as it offers a means of objective and systematic analysis of documents (Krippendorff, 1980). According to Paisley (1969), a content analysis allows for data processing by means of an objective and methodical application of categorization (such as the assessment framework synthesized in chapter 2.3 and appendix II). The resulting data interpretation can then be summarized and compared. As the key objective of this research is to assess and compare the ecological considerations and environmental sustainability of sustainable urban development strategies from four cities in Europe, it was concluded that this method of analysis is best suitable for this research.

### 3.4 Method of assessment

In order to assess the consideration towards each theme, indicators were defined for the four themes central to this research (ecological considerations, environmental quality, green infrastructure and human-oriented considerations), each indicator was subdivided into sub-indicators, each of which is described in appendix I. The tool for assessment within this research was the information form presented in table 2, which was filled for each sub-indicator and each city assessed. It was filled with general descriptions of all goals, strategies and programmes within the strategy documents relating to that particular sub-indicator in order to reduce subjectivity in the assessment process. The results of the assessment are presented in appendices IV to VII.

Secondary data was also consulted to assess the strategy documents as objectively as possible. For example, a city that already has a significant amount of green space, will focus in its strategies more on retaining what is there and improving existing spaces rather than investing in new green spaces. In that case, this city would still score decently in the perspective of urban ecological principles. Each element relating to the sub-indicator was evaluated and given a numeric value, which was then summed to an average value for each sub-indicator. All scores for the sub-indicators were summed to a value for each indicator (i.e.  $I_{\text{ecological considerations}}$ ) and all indicator scores were summed to a city overall score ( $I_{\text{tot}}$ ).

$$I_{\text{tot}} = I_{\text{ecological considerations}} + I_{\text{environmental quality}} + I_{\text{green infrastructure}} + I_{\text{human-oriented considerations}}$$

$$\text{with } I_{\text{ecological considerations}} = I_{\text{habitat provisioning}} + I_{\text{protected areas}} + \dots + I_{\text{forest coverage}}$$

The sum of values ( $I_{\text{tot}}$ ) is based on the various indicators and thus sub-indicators. The resulting overall value is therefore an indicative parameter for the ecological considerations and environmental sustainability of sustainable development strategies of cities. Furthermore, this method can be used to analyse city strategies from different perspectives as each variable (indicator) relates to a specific focus point of urban ecological principles, and comprises a set of sub-indicators which relate to important topics within each respective focus point.

The point system that was used to rate all elements in the content analysis is based on The point system of Garau & Pavan (2018). Their point system was developed to qualitatively assess urban sustainability and urban quality. The adopted 5 point scale was used as follows: 0 points were given when strategies did not include any goals or mentioning of the assessed sub-indicator or strategies were in place that did more harm than good for the applicable sub-indicator. 1 point was given when strategies mentioned the goal but had no or inadequate strategies and goals attached to them. 2 points were given when the sub-indicator was mentioned, combined with limited goals and strategies. 3 points were given for sub-indicators that had an adequate description combined with a variety of goals and strategies attached. 4 points were given when there were clear and concise goals and strategies alongside a detailed description of the issue at hand. 5 points were given when the strategy was ambitious, innovative, and provided a benchmark for other cities to follow. Thus, the score reflects the ambition, consideration and extensiveness of city strategies with regard to urban ecological principles and environmental sustainability. The final output consists of a number of scores corresponding to each category, indicator and sub indicator. A total of 120 points were available, which represents the maximum value of  $I_{tot}$ .

Table 2: evaluation sheet for the (sub)indicators

Indicator			
Sub-indicator			
Evaluation parameters: Insufficient (0); inadequate (1); sufficient (2); adequate (3); good (4); excellent (5)			
Object:	Score	Note	
	Average score		

### 3.5 Data analysis scheme

Firstly, whitepapers, policy documents, strategy documents and government reports have been collected from each case study. These serve as the primary data in this research and can be found in appendix I. Alongside this, secondary data is collected in order to describe and grasp the context of each city, these include statistics from Eurostat, newspaper reports and scientific literature. Secondly, these are analyzed and sorted based on the main indicators and subsequent sub-indicators utilizing ATLAS.ti (see appendix III for the coding scheme utilized in this research). Each sub-indicator was then assessed according to the evaluation sheet in table 2 (see section 3.4). A comparison was made between the cities based on their scores. Finally, best practices have been formulated based on the assessment of the indicators, and analyzation of the strategies. Finally, an analysis was done on the core elements within the strategies that are most progressive and innovative. The results from the assessment and subsequent comparison are discussed in chapter four of this thesis.

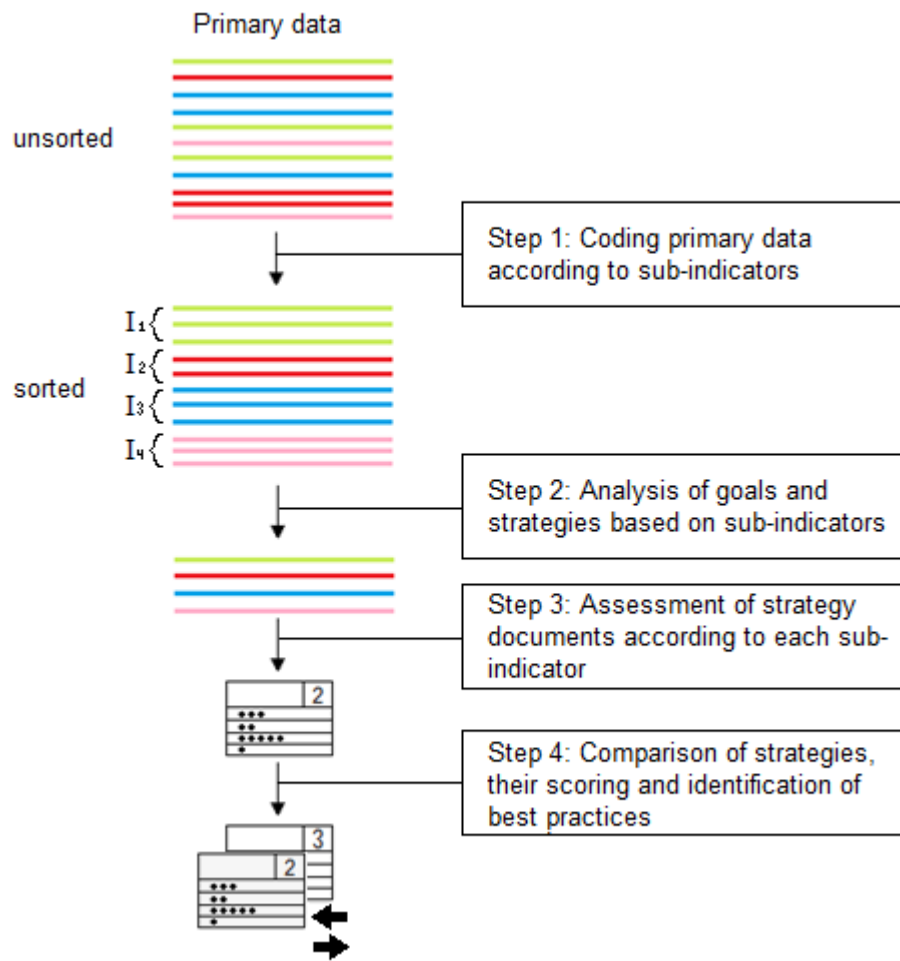


Figure 3: data analysis scheme



## 4. Results

This section summarizes and discusses the results of the assessment of the sustainable development strategies of the four case studies. The chapter is structured according to the themes relating to the subquestions, which will be covered and answered respectively.

### 4.1 Urban ecology and sustainable development

To answer the sub-question '*How can the principles of urban ecology help drive sustainable urban development?*' a literature review was carried out. The UN recognizes the importance of an integral approach to its SDGs, as a majority of goals are not likely to succeed by 2030 (UNEP, 2019). Therefore it is important to increase the scale and speed of actions to protect the environment (UNEP, 2020). Urban ecological principles provide a solution by integrating more SDGs with the urban environment and urban development, driving investments and devoting more attention toward the biophysical status of urban environments. It does so by firstly, reflecting on the ecological impacts of urban areas (Artmann et al., 2019), which results in considerations given to the biophysical status and environmental quality of urban areas. This approach also aims to emphasize the importance and functions of ES within the urban environment (Colding & Barthel, 2017; McPhearson et al., 2015). Cities can affect the environment through its metabolic processes in negative and positive ways (Chapin et al., 2011; van Eekelen & Bouw, 2021). Therefore, it is important to give consideration to the impacts of urban areas on the environment and its ecology (Heymans et al., 2019) and to balance economic needs with ES that contribute to social benefits (Douglas, 2021; Camagni, 1998; van Eekelen & Bouw, 2021). Urban ecological principles and its ES approach allow for more value creation, which can drive investments in sustainable development (Costanza et al., 1998; Steiner, 2014). van Eekelen and Bouw (2021) argue that nature development can be a useful tool for sustainable development, as cities can offset their environmental impact through habitat creation, restoring natural processes and integrating greenery. With UN member states recognizing the severity of the current global biodiversity loss (UNDESA, 2020), urban ecology can act as a driver for nature conservation and development (Apfelbeck et al., 2019; Laconte & Gossop, 2016; Pascual et al., 2021). Lastly, urban ecological principles can drive sustainable development by linking benefits from ES with other sustainability goals and sectors (Laconte & Gossop, 2016). This makes urban ecology an proficient solution to the integral approach as advocated by the UN.

#### 4.1.1 Integration within the urban realm

To further understand the benefits of urban ecology toward SDGs, a second sub-question was formulated: *What are the key possibilities of ecosystem services and structures within the urban realm?* Bolund and Hunhammar (1999) provide an inventorisation of ES within the urban realm with an emphasis on urban quality of life. Costanza et al. (1997) identify 17 categories of ES. McPhearson et al. (2015) inventarise benefits with a focus on (climate) resiliency, as contemporary sustainable development emphasizes resiliency building (van Eekelen & Bouw, 2021). All these inventarisations demonstrate the multitude of ES that exist within the urban realm and their wide range of applications. MEA (2005) distinguishes four groups of urban ES. Firstly, regulating, which is defined as benefits derived from the regulation of ecosystems (i.e. rainwater retention). Secondly, supporting, which is classified as the services needed for further ecosystem functioning and other ecosystem service

provision (i.e. nutrient cycling). Thirdly, cultural, which refers to all non-material ES (i.e. cultural heritage). Finally, supplying, which are products derived from ES (i.e. food and water).

Artmann et al. (2019) argue that planning can be done on the basis of ES. The spatial outcome is the integration of green infrastructure in the urban environment. The literature unanimously refers to blue and green infrastructure as the ecological structure and ES provider within the urban environment. The EPA states that green infrastructure is an essential method to support sustainable communities, maintain and to support a healthy environment (EPA, 2021). The EPA emphasizes the multifunctionality of green infrastructure. For example, the utilization of vegetation to manage rainwater at the local scale not only benefits rainwater storage and retention but also benefits air quality, urban heat islands and biodiversity. As a response, landscape urbanism has presented itself as a new theory that incorporates and applies ES into the design of urban environments (Steiner, 2014). It takes inspiration from landscape ecology and design theory, which is applied to urban planning and design practices. Examples include the Sustainable Sites Initiative (Calkins, 2012) and the Freshkills Park development (FPA, 2021).

To answer the sub-question, There is great variability in the application of ES in the urban environment (Douglas, 2012). The most sought after applications are climate change mitigation (Gill et al., 2007), providing recreational opportunities in densely built-up areas (Oberndorfer et al., 2007) and promoting biodiversity in urban areas (Tratalos et al., 2007). It is in the nature of planning itself that choices are made on what is needed, desired and possible at the area under planning. Methodology and theory from the newly established paradigm of landscape urbanism provide a solution to integrate ES into the urban realm.

#### **4.2 Comparison between city strategies**

This section elaborates upon the results of the assessment. An analysis is made on the trends in the data. Subsequently, this section will go deeper into the ecological considerations to answer the sub-question: How do the assessed cities compare in considering ecological principles in their sustainable development plans?

To visualize the scoring of all the indicators and their sub-indicators, a table was formulated (table 3). To help visualize the distribution of points per case study a clustered bar chart (figure 4) was drawn. When looking at figure 4 we can see that all cities have a roughly similar distribution of points among the four main indicators. Overall, Vitoria-Gasteiz scored the highest with 88 out of 120 points. Similarly, Vitoria-Gasteiz also scored the highest on the indicators: ecological considerations and human oriented considerations. On the other hand, the indicator environmental quality is scored lower among three city strategies.

Table 3: table with the results of the case study assessment

		Stockholm	85	Vitoria-Gasteiz	88	Hamburg	71	Breda	77
Indicator	Sub indicator	Score		Score		Score		Score	
Ecological considerations	Habitat provisioning	3		5		2		4	
	Protected areas	4		4		3		3	
	Ecosystem quality	4		5		3		4	
	Biodiversity	4		4		4		3	
	Species consideration	4		5		4		3	
	Forest coverage	3		3		3		3	
	Indicator total	22/30		26/30		19/30		20/30	
Environmental quality	Water quality	5		2		3		3	
	Soil quality	3		3		1		2	
	Rainwater drainage	5		4		5		4	
	Restoring natural processes	4		2		3		0	
	Sewage treatment	3		0		0		3	
	Air quality	4		3		2		1	
	Indicator total	21/30		14/30		14/30		13/30	
Green infrastructure	Integration	4		4		2		4	
	Proximity	4		4		2		4	
	Connectivity	4		4		3		4	
	Quality	3		4		3		4	
	Maintenance	4		4		4		4	
	Microclimates	4		3		4		3	
	Indicator total	23/30		23/30		18/30		23/30	
Human-oriented considerations	Education	3		5		4		1	
	Protection of cultural heritage	3		5		0		4	
	Biosphere stewardship	1		4		3		4	
	Public recreation	4		4		4		4	
	Fostering environmental innovation	4		3		5		4	
	Ecosystem services	4		4		4		4	
	Indicator total	19/30		25/30		20/30		21/30	
Total		84/120		88/120		71/120		77/120	

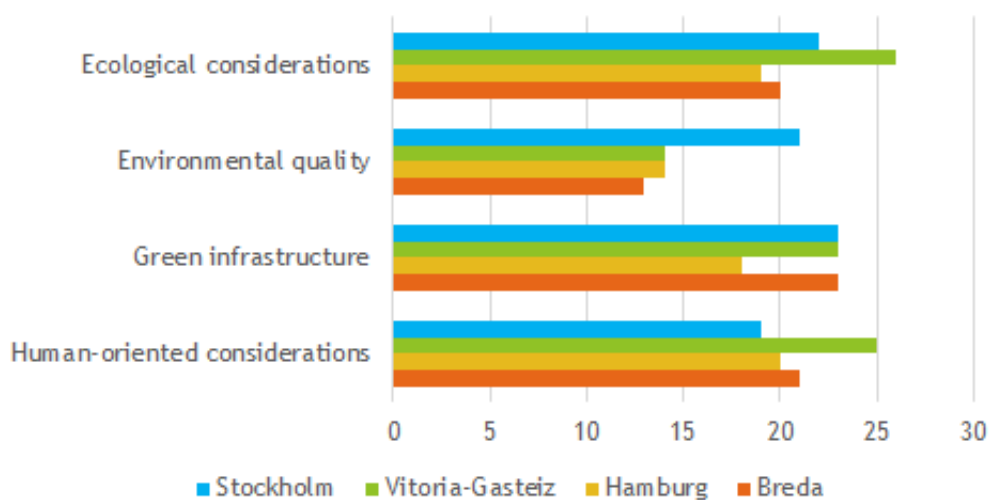


Figure 4: Clustered bar chart depicting the score per indicator

#### **4.2.1 Ecological considerations**

This section aims to answer the sub-question: *How do the assessed cities compare in considering ecological principles in their sustainable development plans?* The results (table 3) suggest that all cities scored adequately on ecological considerations. All city strategies featured concrete policy plans, measures or ambitions towards improving the quality and functioning of the ecosystem within and around each respective city. With increasing the amount of habitats and improving and/or expanding the amount of protected areas as key components. Surprisingly, all cities demonstrate clear consideration to important (native) target species, which were either important parts of the city and regional identity or were placed on a local to national vulnerability list. The city of Vitoria-Gasteiz went one step further by carefully constructing habitats for different types of species (for example, the placing of dry stone structures for invertebrates and lizards, piling dead wood for xylophagous species and the placing of nesting boxes for birds and bats). An important question when assessing the strategies was how is ecology defined and perceived amongst the case studies. Stockholm and Vitoria-Gasteiz provided clear definitions within their strategies and made active use of landscape ecology theory as a way to substantiate their policy measures and goals. From this, biodiversity was the most important morale and indicator within each city strategy. According to van Eekelen and Bouw (2021) biodiversity is an important indicator for a healthy ecosystem, thus also an urban ecosystem. All city strategies followed this argumentation line within their strategies. All other sub-indicators directed towards the overall goal of each city, to maintain current levels of biodiversity and/or to increase the level of biodiversity by creating more connections between green and blue areas, improving ecosystem quality and functioning, providing more habitats and to increase the amount of vegetation within and around the city. All city strategies had goals to increase the amount of vegetation, especially trees within the city in the short term, with Vitoria-Gasteiz presenting the most ambitious goal of increasing vegetation within the urban environment as much as possible by redeveloping city districts with the new superblock model and street reform programme, alongside integrating green infrastructure with buildings in the most densely built parts of the city (Vitoria-Gasteiz City Council, 2014, 2015).

#### **4.2.2 Environmental quality**

When looking at table 3 and figure 4, the city strategies score in general lower on the indicator environmental quality compared to the other indicators, therefore this section attempts to investigate the reasoning behind this phenomenon. The cities of Breda, Hamburg and Vitoria-Gasteiz did not formulate concrete strategies with regards to air, soil and water quality. Hamburg and Vitoria-Gasteiz were not ambitious with their sewage treatment as they did not formulate any goals to alter their water treatment practices and/or standards such as Stockholm which aims to reduce nutrient loading via recycling nutrients such as phosphorus and to capture heat from wastewater to reduce thermal loading on waterways and ecosystems (City of Stockholm, 2018, 2020a). Similarly, Breda has invested in methods of integrating natural drainage basins in the city that further clean treated waste water before draining into the local water system. Restoring natural processes did not receive much attention in the strategies of Breda and Vitoria-Gasteiz, with both stating that having control on for example, local water management, outweighs the impacts that this control has on local ecosystems. All strategies did have concise, expansive and thorough strategies with regards to the sub indicator rainwater drainage which scored high among all cities in this analysis. The dominant theme amongst the three lower scoring cities was the

differentiation between levels of government. They all acknowledge their responsibility with regards to rainwater retention, as it occurs on the local scale, but delegate the responsibilities of water quality of larger fluvial systems and water bodies to higher levels of government. Pascual et al. (2021) reflect on a similar instance with regards to nature development and policy. They conclude that the perspectives and rationality between levels of governments often misalign. A similar phenomenon occurs within the case studies, where environmental standards from the central government are complied with or delegated to the respective higher levels of government. Giles-Corti et al. (2020) argue that integrated policy between levels of government and policy sectors is an absolute prerequisite for sustainable development. This integration occurs within the strategy of Stockholm, which aims to take the lead in regional cooperation and collaboration on the regional ecological structure and water bodies and natural areas that share municipal borders. Furthermore, the city of Stockholm refers to the environmental standards from the central government and is even more ambitious in some instances, where it aims to go even further by slashing more emissions from the transport and energy sector within the city.

### **4.3 Best practices**

To answer the sub-question: *'Which formulated strategies benefit the natural environment the most and should be exported to other cities?'*, a reflection is made on the most innovative aspect of each city's strategy. This aspect is a recurring aspect that continuously returns within the strategy documents and also forms a major component of the strategy itself. All in all, these best practices demonstrate perspectives upon, and methods toward, sustainable urban development.

#### **4.3.1 Stockholm**

The methodology of Stockholm is to utilize urban (re)development as a tool for sustainable development. New development not only has to assess the environmental status on which it occurs, but also needs to support the local ecology. This is achieved by exploring methods to integrate green infrastructure at the new development site. The city mandates that consideration is given to improve air and soil quality, help combat stormwater stress and build upon the identity of the city of an interconnected web of green and blue spaces (City of Stockholm, 2015; City of Stockholm, 2020a; City of Stockholm, 2020b). The city utilizes planning instruments such as the green space factor tool (City of Stockholm, 2020a), which aims to support system solutions that integrate green infrastructure, alongside information systems such as the biotope database, which aims to provide detailed landscape analyses so urban planners can facilitate local ecology more effectively.

#### **4.3.2 Vitoria-Gasteiz**

The city of Vitoria-Gasteiz is the only city part of the case studies that actively identifies itself as a green city. It has formulated a specific green infrastructure strategy to comply with this status which aims to naturalize the city as much as possible through redeveloping vacant plots, city districts with the new superblock model and streets through the reform programme. These measures aim to decrease the amount of (paved) surface devoted to roads, to subsequently transform them into low traffic paths and green public spaces. It also aims to renaturalize and reconstruct some of the (extinct) waterways and streams within the city. The city has also formulated a master plan that foresees green corridors that connect the city with the green belt, which the city describes as a gateway between the city and the

natural environment outside the city (Vitoria-Gasteiz City Council, 2014, 2020). This strategy is actively supported by landscape ecology theory within the strategy documents. The city also formulated the green acupuncture approach that aims to integrate as much greenery as possible in highly built-up areas by integrating green infrastructure in and around buildings in areas that are unsuitable for the superblock model and street reform programme (Vitoria-Gasteiz City Council, 2020).

#### **4.3.3 Hamburg**

The city of Hamburg has an active monitoring policy on ecosystem functioning within its administrative area and aims to be proactive in ushering measures to safeguard ecosystem functioning. It does so by heavily investing in research that supplies innovative smart maps that monitor parameters such as soil permeability, the condition of its tree stock and the performance of green roofs to aid in planning measures and green space management practices. To secure continued development and knowledge building, the city has set itself the task to continuously collect and share data (Free Hanseatic City of Hamburg, 2014, 2015). Throughout its strategy document, smart maps are mentioned as a planning tool to inform future sustainable development and to manage and safeguard ecosystem quality throughout the city.

#### **4.3.4 Breda**

The municipality of Breda provides clear targets to increase the amount of green infrastructure within the urban environment, but most importantly calculates these investments on the basis of efficiency in other policy sectors. This is achieved by constructing innovative cost benefit models that work on the basis of urban ecological principles by denoting economic value to ES. These models demonstrate the long term benefits of blue and green infrastructure. For example, investments in greenery improve urban quality of life, which in turn improves economic productivity as citizens are not only happier, but also healthier (Municipality of Breda, 2013). The city states that as productivity increases, economic output improves leading to growth. Secondly, it states that as people become healthier, public health spending decreases in the long term (Municipality of Breda, 2013). The city of Breda actively utilizes these models throughout its strategy document(s) with regards to arguing on behalf of its policy and goals, as well as investments. These cost benefit models will become publicly available in the near future for other cities to use and help direct funds towards green infrastructure and sustainable urban development.

## 5. Conclusion and discussion

The aim of this thesis has been to assess the sustainable development strategies of four selected European cities with regards to urban ecological principles and environmental sustainability. Central to this thesis was the question: *What lessons can be drawn from green sustainable development strategies of European cities with regard to environmental sustainability and urban ecological principles?* Based on the literature, urban ecological principles can both drive and aid sustainable urban development as it links ecosystem benefits with other sustainable development sectors such as energy and public health (van Bohemen, 2012; Laconte & Gossop, 2016). It emphasizes the importance of nature and their ES, resulting in more ecological considerations given to nature within urban environments (Colding & Barthel, 2017; McPhearson et al., 2015). The strategies from the case studies demonstrated the potential of urban ecological principles as they actively referred within their strategies to the importance of ES within their cities for urban quality of life and towards their environmental sustainability goals. Overall, all city strategies assessed and catered to the ecology of the city and its periphery in an adequate manner, however strategies and goals relating to environmental quality scored lower in the assessment amongst all cities except Stockholm. It was found that a differentiation and misalignment between levels of government resulted in cities inadequately mentioning and formulating environmental policy measures within their sustainable development strategies. This may be due to the fact that Stockholm is a capital city while the other cases were regional capitals or generic cities, which would indicate that a shorter distance to the central government, which in all cases devises environmental policy, benefits integration and alignment. On the other hand, Stockholm's longstanding history in environmental policy and nature protection might also have prompted its city government to be more ambitious and integral in its environmental quality strategies and goals.

Pascual et al. (2021) conclude a similar pattern with regards to the misalignment between levels of government on nature conservation and development policy. The city strategies assessed in this case study did focus on the regional ecological structure but not on regional measures in place. The city of Stockholm aims to take the lead in regional municipal collaboration on regional nature conservation and management, as well as water quality and recycling goals. Similarly, the city of Vitoria-Gasteiz works with the Basque Autonomous community on biodiversity and nature development strategies, as well as an environmental education platform. Giles-Corti et al. (2020) argues that an integrated policy between levels of government and policy sectors, such as demonstrated in the strategies of Stockholm and Vitoria-Gasteiz, is an absolute prerequisite for sustainable development. The results of this study demonstrate that policy integration benefits environmental sustainability targets and could, in line with the definition of sustainable development synthesized in chapter two, be indeed a prerequisite for sustainable development. Therefore, it is recommended that other cities should integrate wider environmental goals within their sustainable development strategies. Furthermore, the strategies from these cities can serve as an example, especially in their methodology as it allows for integrating environmental targets with sustainable development, whether it is using new development as a method for sustainable urban development (Stockholm), utilizing smart maps (Hamburg), innovative cost benefit models (Breda) or formulazing a specific green infrastructure strategy (Vitoria-Gasteiz). All in all, these four European made careful use of the ES approach as advocated by urban ecological principles. They demonstrate that the principles of urban ecology alongside their own

methodologies are suitable methods to drive environmental sustainable targets with sustainable urban development.

### **5.1 Reflection**

This study synthesized the theoretical and conceptual aspects of urban ecology under the sustainable urban development paradigm in order to assess the ecological considerations of sustainable urban development strategies from four European cities. A critical reflection is given on the possibilities of urban ecological principles and on the strategies analyzed. However, this study only assessed four city strategies that are constrained in their context and location. The best practices formalized in this research are therefore possibly not suitable for every type of city. Secondly, these cities are not representative of Europe as a whole or the world with regards to how cities formalize sustainable urban development strategies and goals. Furthermore, as data had to be collected online, there is a possibility that not all policy papers have been analyzed if they were not publicly available (in English), which might have resulted in a non-sampling error during the assessment. Additionally, research into urban ecology is at its forefront of maturation, which presents gaps within the current database of literature. In order to improve the incorporation of urban ecology into planning practices, a better understanding of the benefits derived from nature and ecological potential within urban environments is required (Steiner, 2014). Pascual et al. (2021) argue that the definition of biodiversity is very misaligned between different cities and governments. During the content analysis of the four city strategies, the most successful and highest scoring cities were those that had clear definitions of their ecology and actively referred to landscape ecology theory. Future research can look into how the valuation and definition of nature, biodiversity and green infrastructure by city governments influences their policy and strategies on these respected topics. Subsequently, it can then look at the impacts of this policy on the ecology and environment, ultimately to improve the quality of urban environments.



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## Appendix I Assessment framework

This appendix contains an extensive table of the indicators used in the assessment of sustainable development strategies. Each indicator contains six sub-indicators, followed by an explanation of each indicator (their criteria within the analysis) as well as a reference from which the sub-indicator is derived.

Indicator	Sub indicator	Criteria/unit	Monitoring/reference
Ecological considerations	Habitat provisioning	<p>Ambition, goals and plans to provide and create necessary (useful) habitat structures in and around the built environment.</p> <p>This includes not only large green spaces but also small parks, vacant lots, residential yards or physical structures such as nesting boxes</p>	<p>Ahern et al. (2014)</p> <p>Apfelbeck et al. 2019</p> <p>Blair (2004)</p> <p>van Eekelen &amp; Bouw (2021)</p>
	Protected areas	Protect and conserve the natural environment and/or (threatened) flora and fauna that are present within and around the urban environment and within future project sites.	Giles-Corti et al. (2020)
	Ecosystem quality	<p>The biological condition of the natural environment. In other words, how much has the ecosystem been altered to human specifications. Undisturbed natural environments score high on ecosystem quality.</p> <p>Examples of measures include the re-naturalization of green areas.</p>	Deng & Du (2011)
	Biodiversity	The variability in species, genetics and ecosystems. Measures to ensure and improve the migration of species between sites are important to secure and improve biodiversity.	<p>Heymans et al. (2019)</p> <p>Tratalos et al. (2007)</p>
	Species consideration	How is flora and fauna integrated in urban (re)development? Are considerations given to key (target) or native species?	Apfelbeck et al. (2019)
	Forest coverage	<p>How much of the land in the city is devoted to (urban) forests?</p> <p>Measures and ambitions to improve and protect the tree stock.</p>	Giles-Corti et al. (2020)

Environmental quality	Water quality	Improving the quality of urban water bodies. Measures to improve the biological status of water bodies by combating eutrophication.  Indicators: Total N, Total P, BOD, Turbidity, pH	Ahern et al. (2014)
	Soil quality	Retention of soil within an ecosystem and the prevention of losses and inhibition of soil formation processes.	Costanza et al. (1998)
	Rainwater drainage	Capacity of blue/green infrastructure to store and drain rainwater. Improvements in climate resiliency.	Ahern et al. (2014) Bolund & Hunhammar (1999)
	Sewage treatment	Assimilation of nutrients by wetland plants and animals to decrease nutrient deposition into the environment.  Ambitions and measures to improve sewage treatment practices to reduce nutrient loading on water bodies.	Bolund & Hunhammar (1999)
	Restoring natural processes	Enable ecosystem (natural) processes such as sedimentation (i.e. not disturbed by hard engineering measures).	van Eekelen & Bouw (2021)
	Air quality	Filtering of air through green infrastructure and forested areas.  Limiting polluting sources.	Ahern et al. (2014) Bolund & Hunhammar (1999) Giles-Corti et al. (2020)
Green infrastructure	Integration	Integration of greening of built-up areas with other uses such as water management, recreation and aesthetic quality.	Artmann et al. (2019)
	Proximity	Residents' proximity to parks, natural areas and water bodies.	Artmann et al. (2019)

		Accessibility of green areas within and around urban environments.	
	Connectivity	Connectivity through wildlife corridors / habitat networks. (includes green corridors/belts, blue-green networks and salt/fresh water gradients.  Increasing connectivity is important to create a richer continuum of habitats.	Artmann et al. (2019)  van Eekelen & Bouw (2021)
	Quality	The amount of green space available within the urban environment.  Measures and ambitions to increase the amount of green space within the urban environment.	Artmann et al. (2019)
	Maintenance	Management of green (and blue) infrastructure and spaces.	Apfelbeck et al. (2019)  Holden & Liversedge (2014)
	Microclimates	Reducing heat stress to create a safe and healthy living environment.  Facilitate healthy microclimates by taking the thermodynamics of the urban system into account.	Ahern et al. (2014)  van Eekelen & Bouw (2021)  Duffy & Chown (2016)  Lehmann et al. (2014)
Human oriented considerations	Education	Building capacity and knowledge amongst residents on environmental sustainability and ecosystem services.	van Eekelen & Bouw (2021)
	Protection of cultural heritage	Strengthening of cultural and symbolic values of natural sites (natural heritage). Thereby, reinforcing the cultural identity of natural areas.	Costanza et al. (1998)  Bolund & Hunhammar (1999)



	Biosphere Stewardship	Connecting citizens with nature experiences, thereby facilitating the building of socio-ecological memory.	Barthel et al. (2010) Colding & Barthel (2017)
	Public recreation	Providing opportunities for recreational activities.  Recreational values also include the appearance of certain fauna, birds and fish.	Bolund & Hunhammar (1999) Costanza et al. (1998)
	Foster social and environment innovation	Facilitate transdisciplinary cooperation in environmental sustainability and taking advantage of environmental opportunities.	Artmann et al. (2019)
	Ecosystem services	Interlinking greening of the environment with benefits for human health and well-being and (socio-)economical development.	Artmann (2013) Artmann et al. (2019)

## Appendix II Collected primary data

This appendix contains the bibliography of the primary data collected for the content analysis of four European sustainable urban development strategies.

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## Appendix III Coding scheme

This appendix describes the coding scheme utilized in the content analysis and the subsequent occurrence of each code per city assessed.

Illustration of the codes used in the content analysis and their occurrence in the case studies

Ecological considerations	EC	Stockholm	Vitoria-Gasteiz	Hamburg	Breda
EC: Habitat provisioning	EC-HAPR	5	14	2	5
EC: Protected areas	EC-PRAR	17	10	18	1
EC: Ecosystem quality	EC-ECOQ	8	23	8	4
EC: Biodiversity	EC-BIOD	18	12	9	9
EC: Species consideration	EC-SPEC	8	12	4	2
EC: Forest coverage	EC-FORC	2	6	3	0
<b>Environmental quality</b>	<b>EQ</b>				
EQ: Water quality	EQ-WATQ	14	3	3	4
EQ: Soil quality	EQ-SOIQ	3	2	4	4
EQ: Rainwater drainage	EQ-RAID	14	18	24	16
EQ: Restoring natural processes	EQ-REST	1	2	1	1
EQ: Sewage treatment	EQ-SEWT	3	0	2	1
EQ: Air quality	EQ-AIRQ	14	7	4	2
<b>Green infrastructure</b>	<b>GI</b>				
GI: Integration	GI-INTR	25	16	13	17
GI: Proximity	GI-PROX	14	8	5	4
GI: Connectivity	GI-CONN	15	22	7	11
GI: Quality	GI-QUAL	8	11	12	10
GI: Maintenance	GI-MAIN	11	10	13	4
GI: Microclimates	GI-MICL	9	5	11	13
<b>Human-oriented considerations</b>	<b>HC</b>				
HC: Education	HC-EDUC	8	19	11	1
HC: Protection of cultural heritage	HC-HERI	12	6	0	10
HC: Biosphere stewardship	HC-BIOS	3	12	3	3
HC: Public recreation	HC-PUBL	26	18	16	16
HC: Fostering innovation	HC-INNO	14	10	11	4
HC: Ecosystem services	HC-SERV	7	9	1	13

## Appendix IV Assessment forms Stockholm

**City assessed:** Stockholm

**Date of assessment:** April 10th, 2021

### Ecological considerations

Indicator	Ecological considerations		
Sub-indicator	Habitat provisioning		
Object:	Score	Note	
The Stockholm sustainable growth strategy	2	<p>New urban development has to Provide good conditions for urban habitats by interconnecting and integrating green (infrastructure) within the city.</p> <p>The environment programme provides possible neighborhood designs which minimizes its impact on the ecosystem and its functions for flora and fauna.</p> <p>New urban development consumes space otherwise relegated to nature or agriculture which offers more habitat capacity. However, within the city this scheme can provide beneficial outcomes, delegating more space for habitats within the built environment.</p>	
Strategic planning	4	<p>Strategic planning to build in higher densities, to achieve a more efficient use of space. This results in more space available for green infrastructure and thus habitats within the urban environment.</p>	
Maintain ecological functions and connections	4	<p>The municipality of Stockholm aims to create new green and blue environments that contribute to the resilience and robustness of the ecosystem.</p> <p>This is achieved by constructing new connections and strengthening weak connections between natural and park areas and water bodies.</p>	

Improved water quality of the Stockholm water bodies		4	<p>The aquatic environment has to become more suitable as a functional ecosystem which provides good quality habitats for aquatic organisms.</p> <p>The city formulates vegetated shorelines, wetlands and watercourses as important natural habitats that have important functions for Stockholm's ecosystem.</p> <p>Structural measures are taken to improve water quality. For example, reducing polluting substances and the purification of stormwater.</p> <p>Ecosystem goals are part of the legally binding water quality goals and standards. These apply to all authorities and municipalities that share water bodies within and around Stockholm.</p>
Stockholm stormwater strategy		3	Exploration of areas to retain stormwater, These areas can also support habitats and recreation.
	Total	3	The municipality of Stockholm aims to make the aquatic environment a functional aquatic ecosystem. It also aims to give consideration to nature with new urban development and aims to strengthen the interconnectedness of green and blue spaces within the city. It has clear goals to improve the ecosystem within the built environment and surroundings.
Indicator	Ecological considerations		
Sub-indicator	Protected areas		
Object:		Score	Note
Biotop protective status		2	Tree lines within the landscape and along roads are protected under biotope protection areas (c7 environmental code)
Exploration key ecological corridors		5	There is currently an investigation in place to

		determine the most regionally significant ecological corridors. These would then receive the same protection status as the large natural areas they interconnect.
The Stockholm biotope database	2	<p>The city of Stockholm maintains data and records of all core natural areas, transition zones and corridors as well as important habitats that are all necessary to protect Stockholm's flora and fauna.</p> <p>The city acknowledges the learning process of nature conservation within the city. It aims to build knowledge on nature conservation within the urban environment.</p> <p>The Stockholm biotope database provides landscape analyses which are utilized in planning processes.</p>
Ecosystem functions	5	Ecosystem functions from green areas have to be protected and maintained. Therefore, changes that affect green infrastructure need to be analyzed in order to formulate measures that minimize impacts and or to implement compensation measures for deteriorated ecosystem functions.
Protection of blue infrastructure	4	<p>The city of Stockholm aims to protect and conserve more aquatic areas such as its watercourses, wetlands and lakes.</p> <p>Furthermore it aims to explore possibilities to reinstate drained wetlands and culverted watercourses to re-naturalize its blue infrastructure.</p> <p>Additionally, it aims to make shorelines more suitable as terrestrial ecological corridors and as a transfer from aquatic to</p>



		<p>terrestrial areas. These shorelines are then protected.</p> <p>However, these shorelines and blue infrastructures have to be made more accessible for recreational activities. They are then not fully protected from human disturbances. However, the city is designating ecological sensitive shore zones where disturbances are avoided as much as possible.</p>
Ecological compensation and conservation	4	The city of Stockholm is increasing the amount of reinforcements measures with regard to ecological compensation and conservation.
Ecological conservation	3	The city of Stockholm is analyzing the needs of ecosystems to provide better conservation approaches for individual blue and green spaces.
Minimize fragmentation	4	<p>The fragmentation of habitats within and around Stockholm has to be minimized. This is achieved with strategic and sensible city planning and adapted conservation management.</p> <p>Greater protection is given to strategically located green spaces within the city by giving it protection in the form of nature reserves. The strategy document has planned five areas to receive such protection status. (Hagsatra, Ragsved, Arsta, Arsta Holmar, Hasselby).</p>
Protection against disruptive activities	4	<p>The city of Stockholm aims to protect natural areas from activities that could have detrimental impacts.</p> <p>Additionally, it aims to protect areas that are a fundamental part of the blue-green network.</p>

	Total	4	The city of Stockholm has a multitude of strategies that aim to protect and conserve blue and green spaces within its administrative area. Furthermore, monitoring programmes as well as compensation measures are a structural part of active planning policy.
Indicator	Ecological considerations		
Sub-indicator	Ecosystem quality		
Object:	Score	Note	
Increase vegetation within the city	2	The city of Stockholm wants to increase vegetation in open (green) spaces and shorelines. It aims to plant trees on grasslands, streets and squares.	
Water quantity management for ecosystem functioning	4	Water conservation measures are drawn to support the ecosystems in and around the city during periods of droughts. The city is seeking innovative ways to retain water in periods of drought. Sufficient water supply during periods of drought are necessary to preserve soil stability, biodiversity and ecosystem functioning.	
The green space factor tool	4	<p>The city wants to implement more reinforcement measures for ecosystems.</p> <p>As a result it has formulated a tool to support system solutions which integrate urban green spaces and stormwater management. The goal is to strengthen the ecosystem and to compensate for negative effects of climate changes. Furthermore, these areas have to become attractive outdoor environments.</p>	
The aquatic environment	5	The city of Stockholm has formulated strategies and measures with regards to the ecosystem quality of its blue infrastructures.	

		<p>It aims to improve conditions for aquatic species by removing barriers to migration and to increase aquatic vegetation in shoreline environments.</p> <p>Furthermore it aims to explore measures to return aquatic environments to their natural rhythm of water levels and flows.</p> <p>Additionally, it aims to explore possibilities to reinstate drained wetlands and culverted watercourses to re-naturalize its blue infrastructure.</p> <p>Structural measures are taken to improve water quality. For example, reducing polluting substances and the purification of stormwater.</p> <p>One example of water quality measures is the city's action plan for reducing the spread of microplastics. This includes upstream measures such as procurement requirements and downstream measures such as (storm)water purification.</p>	
	Total	4	<p>The city of Stockholm has focused its ecosystem quality improvements on its aquatic environment, which entails a multitude of measures and strategies. Furthermore measures are also in place to safeguard ecosystem functioning during periods of drought and innovative ways are explored for periods during high precipitation.</p>
Indicator	Ecological considerations		
Sub-indicator	Biodiversity		
Object:	Score	Note	

Biodiversity and cohesive ecosystems	4	<p>The city of Stockholm acknowledges the importance of biodiversity and the challenges that it faces. It has formulated the definitions and importance of biodiversity at the top of its environment programme.</p>
District council park plans	4	<p>District council park plans contain an overview of all the ecological infrastructures within the district. The plans formulate management guidelines to conserve biodiversity. Each park and natural area has its own strategy and management plan.</p> <p>The management of natural areas is adapted to conservation measures of biodiversity.</p> <p>The city itself will formulate a city-wide action plan to develop Stockholm's biodiversity. It will facilitate connections between natural areas and the overall strategy of the entire city. It aims to work together with residents and commercial parties to develop blue and green infrastructures within the city.</p>
Strengthening ecological corridors	4	<p>The city of Stockholm is strengthening ecological corridors. This is done by removing or bridging barriers to migration, or to construct new connections.</p> <p>It aims to improve the overall quality of and the interconnection between green and blue spaces. If measures are not possible, compensation measures of deteriorated ecological functions are implemented as part of its continuous efforts in conservation of green and blue areas within the city.</p>

		<p>The city of Stockholm states that a robust network is important to biodiversity and ecosystem functioning.</p> <p>Therefore, attention should be given to important ecosystem functions that are important for biodiversity.</p>
climate-smart food	5	<p>The city of Stockholm acknowledges the influence of food consumption on ecosystems due to the spread of harmful substances and waste production.</p> <p>Therefore it wants to increase the proportion of consumed food and goods in the city that benefits biodiversity.</p> <p>The city itself as well as commercial parties and residents should choose food that has climate and environmental considerations.</p> <p><b>Measures include:</b>  Increase the proportion of ecologically produced foods and goods consumed within the city.</p> <p>Utilize the WWF consumer guide to contribute to biodiversity and global fish stocks, when purchasing goods and foods.</p> <p>Increase the (internal) knowledge and awareness with regard to waste reduction and the importance of locally produced goods.</p> <p>Support natural agricultural practices.</p> <p>Reduce consumption of products that contain harmful substances.</p>

			For example, organically produced food benefits the biodiversity of pollinating species, due to the reduced amount of pesticides used.
The green space factor tool		4	<p>The city wants to implement more reinforcement measures for ecosystems that contribute to biodiversity.</p> <p>The green space factor tool is utilized to deploy these multifunctional solutions. The tool is aimed at strengthening the ecosystem and compensating for negative effects of climate changes.</p>
	Total	4	<p>The city of Stockholm has extensive measures and strategies with regards to biodiversity. It goes beyond its own limits (this also benefits biodiversity elsewhere) by introducing awareness schemes and measures to increase the consumption of climate-smart foods that are less detrimental on the environment.</p> <p>Furthermore, it aims to strengthen its network of blue and green spaces and it gives clear considerations to nature within its planning and maintenance practices.</p>
Indicator	Ecological considerations		
Sub-indicator	Species considerations		
Object:		Score	Note
Smart and strategic planning		4	<p>The environment programme of the city of Stockholm provides guidelines on urban design to minimize the intervention and impact of the urban environment on ecosystem functioning.</p> <p>The Stockholm green space factor tool is utilized in planning practices to analyze ecosystem functioning and to implement</p>

		<p>suitable measures and designs. This is done through Biotope surveys and landscape analyses.</p> <p>The tool is aimed at strengthening the ecosystem and compensating for negative effects of climate changes. The tool makes use of the biotope database.</p> <p>The city aims to further develop this database to provide better landscape analyses.</p> <p>The biotope database is also utilized when (re)developing green or blue spaces. Careful consideration is given to (priority) species that inhabit areas, or adjacent areas and the necessary ecosystem functions that these species need.</p>
Implementation of ecological compensation and conservation measures	4	Restoration, maintenance and reinforcements of green and blue infrastructures takes specific considerations for priority species.
The aquatic environment	4	<p>Careful consideration is given to aquatic species in conservation and landscape quality measures. The city has clear aims for its water bodies (as described in the assessment of the aquatic environment under sub indicator 'ecosystem quality').</p> <p>Measures include improving the breeding and spawning grounds for fish species.</p> <p>Secondly, the action plan for reducing the spread of microplastics has been made according to careful considerations and studies on the influence of microplastics on aquatic organisms.</p>

	Total	4	The city of Stockholm makes careful considerations to species in its planning practices and strategies. However, consideration is of course given to most species in the ecosystem and a line has to be drawn. Some species are weighted above others if they are priority species.
Indicator	Ecological considerations		
Sub-indicator	Forest coverage		
Object:		Score	Note
Protective status 'natural area'		3	The city of Stockholm sees its woodlands as important natural assets. They are all protected as natural areas.
Biotope database entry		3	The municipal green ecological structure includes a network of habitats specific to oak woodland species, coniferous woodland species and wetland species. Woodlands and their unique ecosystem assemblages are taken into account in the Biotope database.
Exploration important ecological corridors		4	The city is analyzing the importance of corridors between woodlands to designate them a protected status, similar to the woodlands themselves, which are protected under natural areas.
			.
	Total	3	The city of Stockholm is proud of its woodlands and actively protects them. Furthermore their unique ecosystems are monitored with the biotope database and important key links between woodlands will receive a similar protected status in the near future.



## Environmental quality

Indicator	Environmental quality		
Sub-indicator	Water quality		
Object:	Score	Note	
Water quality as a key identity for Stockholm	4	<p>Water quality is part of Stockholm's branding strategy. Targeted measures have been in place for years with the result of swim safe and fishing safe water bodies in and around Stockholm. Water quality is positioned high on the political agenda.</p> <p>Therefore, improving the water quality of all water bodies in and around Stockholm is one of the primary milestones in the environment programme.</p>	
Local action plans	5	<p>The majority of water bodies in the Stockholm capital area are required to achieve an adequate ecological status , as laid out by the EU water framework directive. This is to be achieved within the upcoming decade, with significant advances made by 2023. Limits on chemical water status such as phosphorus, nitrogen and biological oxygen demand are determined within the plans and are legally binding</p> <p>Local action plans are formulated for each water body. Plans describe the measures taken to comply with standards. Additionally, measures have to be taken when urban development occurs as urban development may not negatively affect water quality. Municipal coordination provides a foundation for regional cooperation. all authorities and municipalities that share bodies of water are responsible.</p>	

Lake Malaren	4	<p>Lake Malaren has an vulnerable status due to its functioning as a source of drinking water. The city goes further by also considering the effects of pollution from the city and aims to reduce these. These relate to the treated wastewater and untreated stormwater being released into this lake. For stormwater, the city has formulated stormwater strategies, for waste water the city has aimed sewage strategies.</p>
Circular flow of sewage	5	<p>The city is investing in the recirculation of material resources. One measure is aimed at reducing phosphorus deposition into water bodies through treated wastewater.</p> <p>The goal has been set to triple the amount of phosphorus returned back to the agricultural sector in this decade.</p> <p>Phosphorus in wastewater (sludge) is returned to arable land in the upstream regions, where it is utilized as plant nutrients.</p>
Action plan for reducing the spread of microplastics	5	<p>Microplastics are seen as potential detrimental pollutants for aquatic organisms and citizens. Therefore the city has aimed measures with regards to consumption patterns within the city and the treatment of water.</p> <p>Measures include: Promoting the consumption of climate sensible goods and food will also improve water quality by reducing pesticide use and microplastics from packaging.</p>

			Upstream measures such as procurement requirements and downstream measures such as (storm)water purification are utilized to reduce microplastic deposition into lake Malaren.
Improved water quality of the Stockholm water bodies		4	<p>The aquatic environment has to become more suitable as a functional ecosystem which provides good quality habitats for aquatic organisms.</p> <p>Structural measures are taken to improve water quality. For example, reducing polluting substances and the purification of stormwater. But also addressing historical discharges and polluted areas within the catchment area to reduce deposition within the catchment area.</p>
	Total	5	<p>The city of Stockholm has clear measures in place to improve water quality, it aims to collaborate on a regional level to include all responsible authorities and municipalities that share water bodies. Secondly, it is focusing on the circulation of phosphorus to reduce deposition through waste water. Thirdly, it is highly innovative by considering the issue with microplastics and actively tackling these as one of the few cities in the world.</p>
Indicator	Environmental quality		
Sub-indicator	Soil quality		
Object:		Score	Note
Soil remediation with urban redevelopment		3	The city of Stockholm wants to redevelop areas previously used for industrial activities. Soil remediation measures are deployed with redevelopment.
Risk assessment		4	The city acknowledges the risk of soil contamination as a result of excess rainfall, flooding. Soil erosion, and subsidence.

			<p>A risk assessment has to be made of soil contamination with each urban (re)development. Additionally, an overview of the situation has to be presented to the municipality.</p> <p>Effective and sustainable urban development can be utilized to improve soil quality by analyzing risks and problems and implementing soil remediation measures, which go further than just pollution as it can also include measures to strengthen the underlying soil.</p>
climate-smart food programme		3	The city aims to promote the consumption of climate-sensitive locally grown food in order to improve soil quality by reducing pesticide use in the region.
	Total	3	Soil quality is an integral part of the environment programme. The city has made assessing the quality of the soil an mandatory part for each urban development and sees urban development as a means to improve soil quality by soil remediation measures. Soil quality is not only limited to pollutants in the soil, but also includes the stability of soil, its infiltration rates, groundwater and erosion rates.
Indicator	Environmental quality		
Sub-indicator	Rainwater drainage		
Object:		Score	Note
Local stormwater management plans		5	<p>The city has formulated guidelines for stormwater management structures that also includes measures on water quality that have to be met with new urban development.</p> <p>These are then utilized in the implementation of local stormwater management plans.</p>

		<p>It aims at tailored spatial design with climate adaptation measures. This can include green roofs, permeable coverage measures or green infrastructure implementation or integration.</p> <p>New urban development and/or public spaces have to retain water and filter rainwater to reduce pollutant deposition.</p> <p>Retaining rainwater is seen as important ecosystem service of green infrastructure. Therefore, public spaces have to become multifunctional spaces, part of a network of green and blue spaces that can retain rainwater.</p> <p>The city is expanding its natural water basins to increase storage capacity.</p>
Stormwater strategy	5	<p>The long-term stormwater strategy promotes the construction of multifunctional areas that support biodiversity, recreation alongside providing water storage and filtration capacity.</p> <p>Investments in these climate adaptation measures are weighed with additional benefits to recreation, the economy and nature.</p>
Building codes in flood-prone areas	4	<p>Newly constructed buildings in flood prone areas have a minimum foundation height, which is based on future precipitation patterns and seawater level projections, in order to reduce flooding.</p>
Risk analysis	4	<p>Detailed risk and vulnerability analysis of City property and operations which are at risk during high precipitation events are undertaken. On the basis of</p>

		<p>each analysis, a preventive action plan has been constructed.</p> <p>The city has made the goal to safeguard the operation of stormwater installations.</p>
	5	The risk of flooding as a result of a 1in100year high precipitation event is assessed in zoning plans and protective measures are presented and implemented.
Separate rainwater from the sewage system	4	The city is aiming to construct separate sewerage systems in order to transport rainwater directly into the city's water bodies as opposed to the sewage system, to prevent the overflowing of polluted wastewater.
Sustainable stormwater management / strategy	5	<p>Stormwater management is one of the key milestones in the climate adaptation strategy.</p> <p>A sustainable approach is deployed that replicates natural processes of processing precipitation. Stockholm has made clear additional goals with regards to water quality of stormwater alongside the management and processing of stormwater.</p>
Water quantity management to safeguard ecosystem functioning	4	Innovative solutions to collect and retain water for periods of drought are sought after. This is done to safeguard ecosystem functioning and environmental quality within the city.
	Total	5
		<p>The city of Stockholm has a large encompassing strategy with regards to rainwater drainage. It goes beyond just stormwater management, but also aims to reduce pollutant deposition, reduce flooding risks and emphasize a local strategy formulation and implementation. All city properties and operations have undertaken a risk assessment</p>

			and risk assessment are a mandatory part of future zoning plans.
Indicator	Environmental quality		
Sub-indicator	Sewage treatment		
Object:		Score	Note
Water treatment plant upgrades		4	<p>The wastewater treatment plant will be expanded and upgraded in order to make treatment more efficient but most importantly to comply with higher environmental standards. The treatment plants will utilize modern membrane technology to increase the quality of treated water.</p> <p>This technology enables the separation of pharmaceutical residues, which has adverse effects on the ecosystem and fish stocks.</p>
Nature-based filtration		4	<p>The city aims to explore locations where it can construct green infrastructures that can filter (contaminated) stormwater to reduce its impacts on the environment.</p>
Circular flow of sewage		5	<p>The city is investing in the recirculation of material resources. One measure is aimed at reducing phosphorus deposition into water bodies through treated wastewater.</p> <p>The goal has been set to triple the amount of phosphorus returned back to the agricultural sector in this decade.</p> <p>Phosphorus in wastewater (sludge) is returned to arable land in the upstream regions, where it is utilized as plant nutrients.</p>
	Total	4	The city of Stockholm has important strategies to improve the quality of treated

			wastewater to reduce its impact on the (aquatic) ecosystem.
Indicator	Environmental quality		
Sub-indicator	Restoring natural processes		
Object:		Score	Note
Synchronisation of the natural aquatic rhythm			<p>The city of Stockholm aims to explore measures to return aquatic environments to their natural rhythm of water levels and flows. Thereby, restoring tidal fluctuations and sedimentation processes.</p> <p>Additionally, it aims to explore possibilities to reinstate drained wetlands and culverted watercourses to re-naturalize its blue infrastructure and restore the natural processes that occur within and between them.</p>
			.
	Total	3	The city of Stockholm has formulated some goals to restore natural processes within its aquatic environments. It is however limited to an exploration study in the near future.
Indicator	Environmental quality		
Sub-indicator	Air quality		
Object:		Score	Note
Vehicle management and subsidization		4	<p>The majority of emissions are derived from private car traffic. Therefore, the city aims to reduce vehicle growth and to change the drivetrains of vehicles on the road (e.g. EVs and hydrogen fueled vehicles).</p> <p>In 2019 the Swedish bonus-malus system went into effect which implements a vehicle tax bonus for cleaner vehicles (i.e. higher emissions result in higher vehicle tax).</p> <p>A reduction of vehicular traffic emissions is necessary to</p>



		<p>comply with air quality standards. The bulk of measures are focused on reducing emissions, but a few measures include the promotion of green infrastructure.</p> <p>The congestion tax has been successful in the city of Stockholm and can be expanded in the future to make distinctions based on type of car and drivetrain. The central Swedish government has to approve and change legislation for this to go into effect.</p> <p>Expansion of cycling lanes and cycling measures have been undertaken and will be continued.</p> <p>The city aims to electrify public transport (however this is not possible in the short term, due to contract leases)</p>
Ecosystem services as smart solution	4	<p>Ecosystem services are acknowledged to improve air quality. Therefore smart solutions are utilized within the dense urban environments that integrate green infrastructure with the built environment. Furthermore, these green infrastructures need to be resilient and protected in the long term.</p> <p>The city acknowledges that greenery only works in open spaces as in narrow streets it can reduce air circulation which has negative consequences on air quality.</p>
Air quality tool	2	<p>Environmental quality standards for air quality cannot be exceeded as a result of spatial planning measures.</p> <p>Therefore, the city of Stockholm has implemented an air quality</p>

		<p>tool which aims at reducing private motorized transportation and promotes cycling, walking and public transport.</p>
<p>Action programme for nitrogen dioxide and particulate matter in Stockholm county</p>	<p>4</p>	<p>The city of Stockholm aims to reduce the exposure of residents to nitrogen dioxide and particulate matter in residential areas.</p> <p>It does so by a wide variety of measures and policy instruments:</p> <p>Promote the renewal of the municipal and national vehicle fleet with emission free drivetrains.</p> <p>Enforce compliance with environmental zones within the city.</p> <p>Optimize construction traffic logistics to reduce traffic load and nuisance within the city and reduce the emission load during rush hour.</p> <p>Promote the reduction of studded tires, which increase particulate matter values.</p> <p>Utilize dust-binding measures with street cleaning procedures.</p> <p>The city aims to continue its monitoring utilizing environmental sensors and the evaluation of this data in order to implement policy measures such as:</p> <p>Dynamic traffic management on the basis of air quality (reduce traffic load in areas with lower air quality)</p>

			Implement dynamic environmental zones on the street level in areas where air quality levels are exceeded.
	Total	4	The city of Stockholm focuses on reducing emissions which are mostly due to private motorized traffic. Its aims however go beyond its capabilities therefore it aims to lobby with the central Swedish government. Green infrastructure is part of the strategy but only for a minor part, the bulk is focused on reducing emissions by promoting cycling, walking and public transport, modernizing fleets. Furthermore the city is innovative in dust-binding street cleaning procedures and the utilization of dynamic traffic management and environmental zone implementation on the basis of real time air quality monitoring.

## Green infrastructure

Indicator	Green infrastructure		
Sub-indicator	Integration		
Object:	Score	Note	
Stockholm stormwater guidelines	4	<p>The Stockholm stormwater guidelines promote multifunctional spaces that integrate water management with recreational green spaces.</p> <p>Stormwater management is focused on areas that retain and filter the rainwater. These areas are also used as habitat to support biodiversity and recreational areas.</p> <p>Furthermore, it is seeking innovative solutions to store water in periods of drought</p>	

<p data-bbox="188 232 405 264">multifunctionality</p>	<p data-bbox="887 232 906 264">5</p>	<p data-bbox="1023 232 1412 517">The city of Stockholm wants to construct multifunctional outdoor environments, which cool the surrounding environment, retain stormwater during high precipitation and offer attractive recreational activities for citizens.</p> <p data-bbox="1023 555 1385 728">The city mentions that multifunctional spaces can strengthen urban ecosystem services and provide an attractive urban environment.</p> <p data-bbox="1023 766 1401 909">Furthermore, the city wishes to utilize these spaces to contribute to the identity of a borough within the city.</p> <p data-bbox="1023 947 1409 1229">Guidelines have been set out in which each urban project has to contribute to the surrounding area and interact with its environment. The contact with green and blue spaces have to be safeguarded with new urban development.</p> <p data-bbox="1023 1267 1412 1514">The existing green spaces have to become more flexible in their multifunctionality. Multifunctional spaces are important for a sustainable city as they can respond to (societal) changes.</p>
<p data-bbox="188 1525 632 1556">Ecosystem services as smart solution</p>	<p data-bbox="887 1525 906 1556">4</p>	<p data-bbox="1023 1525 1409 1731">Ecosystem services are acknowledged. Therefore smart solutions are utilized within the dense urban environments that integrate green infrastructure with the built environment.</p> <p data-bbox="1023 1769 1374 1912">Furthermore, these green infrastructures need to be resilient and protected in the long term.</p> <p data-bbox="1023 1951 1398 2013">Examples from Stockholm include the planting on streets,</p>

		<p>on walls and roofs, the construction of more green and blue spaces, and attractive gardens.</p>
Identity	2	<p>New green spaces have to contribute to the identity of the area.</p> <p>The identity of boroughs and neighborhoods have to be strengthened. Careful considerations has to be given to the heritage (natural) environment.</p>
Green space factor tool	4	<p>The city of Stockholm has developed a tool to support system solutions which integrate urban green spaces and stormwater management. The goal is to strengthen the ecosystem and to compensate for negative effects of climate changes. Furthermore, these areas have to become attractive outdoor environments.</p> <p>The city wishes to create multifunctional spaces with a high concentration of natural assets within the dense built environment.</p>
Waterfronts	5	<p>The city of Stockholm is constructing attractive waterfronts that serve as ecological corridors and as transition areas between the aquatic and terrestrial and recreational space. Furthermore these spaces also serve as important recreational areas.</p> <p>The city is designating ecological sensitive shore zones where disturbances are avoided as much as possible. These areas are not utilized as recreational areas.</p>

Integration of ecosystem services		4	<p>Ecosystem services have to be integrated in part of new urban development. New urban areas need to consider existing ecological corridors.</p> <p>In order to achieve this, the ecosystem structure of green and blue structures is included early on in the planning process. This is done to make sure that ecosystem services are integrated in the new urban development.</p> <p>The city of Stockholm wants to give vegetation the chance to become established in the built environment.</p>
	Total	4	The city of Stockholm is pushing integration forwards with its emphasis on multifunctionality and ecosystem and stormwater management considerations in new urban development.
Indicator	Green infrastructure		
Sub-indicator	Proximity		
Object:	Score	Note	
Public spaces strategy	5	<p>Many areas already have good accessibility to natural assets. Assets are classified as parks, the green corridors within the city and blue spaces such as waterfronts.</p> <p>The proximity to attractive green and blue environments is a key asset for the city of Stockholm it therefore aims to protect and maintain these.</p> <p>The city aims to reinforce these. Measures include maintenance and operations to make areas more inviting and accessible to the public, especially vulnerable citizens.</p> <p>Furthermore, measures have to be taken to increase physical capacity, as a result of pollution</p>	

		<p>growth, to prevent overcrowding.</p> <p>Stockholm corridors are a network of well-maintained green links with cycling and walking routes. These have a multifunctional purpose: they are municipal ecological corridors that allow for the migration of species. They also serve as the backbone of the cohesive function of the city.</p> <p>The city aims to protect and further develop these corridors. Furthermore, the city wants to promote daily contact with the countryside by developing and maintaining the green links within this corridor structure. Corridors also feature bike and walking paths from the city towards the countryside.</p>
<p>Improve accessibility by making spaces more inviting and accessible.</p>	<p>2</p>	<p>The city's existing green and blue spaces have to become more inviting and accessible. They have to become attractive features.</p> <p>This is achieved by well-designed public spaces.</p> <p>The city therefore aims to develop the recreational asset of parks, green and blue spaces and the green corridors.</p>
<p>Integration of greenery</p>	<p>4</p>	<p>Many green spaces are difficult to access due to unclear entrances or due to buildings that cover the green space, exuberating privatization.</p> <p>In these instances, the city aims to improve the integration of greenery with buildings to promote invitation.</p>

		Measures include new paths, entrances or new functions.
Improve the distribution of green spaces within the city	4	<p>The city acknowledges that proximity to green and blue spaces promotes a healthy lifestyle. Walking, cycling and relaxing are positive for public health and the former two also for climate and traffic.</p> <p>Therefore the city aims to invest in more green spaces, especially in underserved areas to improve the equal distribution of green and blue spaces.</p>
Social sustainable Stockholm	4	<p>Public spaces have to be inviting. Access to inviting and space places for vulnerable citizens, fundamental in and equal society.</p> <p>Invest in assets to increase the perceived accessibility of green and blue spaces.</p> <p>For waterfronts the city is improving accessibility to blue spaces by making more inclusive banks instead of quays.</p>
Analyzation of public needs	3	The city of Stockholm analyzes shortcomings with regards to its public and natural assets and subsequent needs of citizens to improve the accessibility of green and blue spaces within the city.
Guide to silence	2	<p>The city of Stockholm has produced guides for paths and trails for 65 natural spaces within and around Stockholm. The goal was to improve accessibility of calm green spaces by means of informing citizens on how to get there safely and quickly.</p> <p>Accessibility can still be poor due to large distances that need to be covered.</p>



	Total	4	The accessibility of Stockholm's green and blue spaces is already at a very high level. The city acknowledges that and aims to maintain that. The accessibility to natural features is a key asset of the city. The city is focusing on making spaces more inviting, accessible to vulnerable citizens and increasing their capacity.
Indicator	Green infrastructure		
Sub-indicator	Connectivity		
Object:		Score	Note
Maintain ecological functions and connections		4	<p>The municipality of Stockholm aims to create new green and blue environments that contribute to the resilience and robustness of the ecosystem.</p> <p>New spaces need to be interconnected as much as possible by creating corridors to other natural areas and green and blue spaces within the city. Or expanding the existing blue and green spaces.</p>
Nature reserves and corridors		2	<p>The city of Stockholm sees its nature reserves as wildlife corridors that lead into the city.</p> <p>The regional authority is currently identifying the key ecological corridors. These will receive a similar protection status as the natural areas they connect to.</p>
A cohesive city both socially and ecologically		4	<p>The city of Stockholm identified ecological corridors that have to be strengthened or developed within the (local) urban development plans presented within the strategy document.</p> <p>The strengthening of links is achieved by either expanding the corridor or by planting more vegetation along the corridor.</p>

			<p>Barriers to migration have to be removed or bridged.</p> <p>It is an integral approach as the corridors are also used to promote the social connection between different parts of the city. Corridors also feature bike paths.</p>
	Total	4	<p>The city of Stockholm aims to develop and maintain an interconnected structure of green and blue spaces. This benefits ecology as species can migrate between habitats (islands of nature within the built environment) and the inhabitants of Stockholm as these corridors serve as paths between different parts of the city.</p>
Indicator	Green infrastructure		
Sub-indicator	Quality		
Object:		Score	Note
Create new blue and green structures		2	<p>The municipality of Stockholm aims to create new green and blue environments that contribute to the resilience and robustness of the ecosystem. These spaces also have to contribute to the recreational capacity of neighborhoods.</p> <p>Ecosystem services are acknowledged. Therefore smart solutions are utilized within the dense urban environments that integrate green infrastructure with the built environment.</p>
Investments in quality improvements		3	<p>The city of Stockholm is aiming to create new assets within public spaces such as public gardens. But also increasing the concentration of natural assets within existing green spaces, by planting more vegetation on open grasslands in parks.</p>

Waterfronts		4	<p>The city of Stockholm is constructing attractive waterfronts that serve as ecological corridors and as transition areas between the aquatic and terrestrial and recreational space. Furthermore these spaces also serve as important recreational areas.</p> <p>The city is designating ecological sensitive shore zones where disturbances are avoided as much as possible. These areas are not utilized as recreational areas.</p> <p>Additionally, the city is planting vegetation in shorelines to provide habitats for aquatic species and filter the water to improve water quality.</p>
Local urban opportunities		2	New parks and green spaces are proposed within the local urban opportunity strategies.
	Total	3	The city of Stockholm has set clear goals to increase the amount of green and blue spaces within the city. This is however difficult in the dense urban environment where space is scarce. There the city is investing in integrating greenery with the built environment and increasing the amount of natural assets in public spaces such as squares, parks and streets by planting vegetation.
Indicator	Green infrastructure		
Sub-indicator	Maintenance		
Object:	Score	Note	
Conservation and ecologically adapted maintenance	4	The city of Stockholm is promoting conservation adapted maintenance to its natural areas and certain green spaces. This means to let certain spaces grow wild with minimal human intervention.	

		<p>Furthermore, the city is also promoting ecologically adapted management, which sets requirements for biodiversity in the management of blue and green infrastructures.</p> <p>Conservation adapted focusing on keeping spaces 'wild' while ecologically adapted maintenance focuses on promoting and maintaining biodiversity. It is possible that for certain spaces a similar approach is sought after, for example let a space show its wild side in order to promote biodiversity.</p>
Community engagement	2	The city of Stockholm is continuing the dialogue with citizens on the maintenance of future and current green spaces.
Regional collaboration	4	<p>The city of Stockholm is continuing and further increasing its regional collaboration with authorities that share the same water bodies and natural areas.</p> <p>With regards to water bodies, each body respectively has its own plan which is adhered by each responsible authority that shares that body of water.</p>
District council plans	5	<p>District council park plans contain a description of the ecological infrastructures within the district and management guidelines that give consideration to biodiversity conservation measures.</p> <p>The city itself will formulate a city-wide action plan to develop Stockholm's biodiversity. It will facilitate connections between natural areas and the overall strategy of the entire city. It aims to work together with</p>

			residents and commercial parties to develop blue and green infrastructures within the city
Knowledge building		2	The city of Stockholm acknowledges that is a learning process with maintaining natural, green and blue spaces. It aims to continue building knowledge on nature conservation within the urban environment with conservation adapted and ecologically adapted maintenance.
	Total	4	The city of Stockholm is a forerunner in the maintenance of green spaces. It aims to further develop knowledge on conservation adapted and ecologically adapted maintenance. It has made plans for each of its green and blue spaces to maintain and promote biodiversity and ecosystem functions.
Indicator	Green infrastructure		
Sub-indicator	Microclimates		
Object:		Score	Note
Energy efficiency strategy		2	As part of its energy efficiency strategy, it aims to make the built environment 'climate-smart'. The strategy specifically refers to reducing the effects of urban heat islands.
Green and blue network		4	The city of Stockholm is developing a network of green and blue spaces to combat heat stress. This also refers to creating multifunctional spaces that can retain water during high precipitation events, cool during heat waves, act as habitats for the local ecosystem and act as recreational areas for its citizens.
Climate adapted urban development		4	The city of Stockholm has expressed the goal to add

		<p>microclimate consideration into urban development.</p> <p>Future development has to take microclimates into account by looking at the effect of buildings on their vicinity .</p> <p>Buildings can be designed to screen the sun or to make use of cooler nighttime air in order to cool the building down.</p> <p>The city wants to integrate greening with buildings in dense urban environments and create a coherent network of blue and green spaces.</p>
Stockholm climate adaptation strategy	4	<p>One of the main milestones of the Stockholm climate adaptation strategy is adaptation to urban heat stress.</p> <p>Cooling as a result of evapotranspiration is acknowledged as an important ecosystem service in the Stockholm Environment Programme.</p> <p>The city of Stockholm is performing risk assessments for the entire city.</p> <p>Then measures will be formulated to reduce the (potential) impact of heat stress.</p> <p><b>Measures include:</b></p> <p>Cooling measures on and next to buildings (i.e. create more green spaces on and around buildings)</p> <p>Create cool rooms within residential units.</p> <p>Construct cooling outdoor environments where people can escape the heat.</p>

			Furthermore, the city of Stockholm is actively investing in solutions that store water for periods of drought. This is done in order to safeguard ecosystem functioning during heatwaves.
	Total	4	The city of Stockholm has made urban heat stress one of its main points of attention in the environment programme. It is currently doing a risk assessment for the entire city. A multitude of measures have been formulated to be deployed to reduce the impacts of heat stress. Furthermore, the city mainly expressed the goal to integrate greenery within the built environment to combat heat stress.

### Human oriented considerations

Indicator	Human-oriented considerations		
Sub-indicator	Education		
Object:	Score	Note	
Exemplary position	2	The city of Stockholm will set good examples, inspire citizens and commercial parties and most importantly share best practices with regard to sustainable urban development.	
Knowledge building	4	The city of Stockholm acknowledges in its environment programme that knowledge about Stockholm's climate and environment and subsequent activities or innovative solutions needs to be increased. The city aims to create more interest into Stockholm's efforts such as the city plan and environment programme. The city also states that this is important to improve collaboration and commitment of partners and citizens.	

		<p>Food conscience is tackled with the climate-smart food programme, which focuses on knowledge building internally with regards to investments and its own consumption. Furthermore, the programme informs and motivates citizens to consume food with a smaller environmental footprint.</p> <p>The city aims to increase acceptance of physical measures of the city with regards to environmental sustainability, through informing citizens.</p> <p>The city is reducing the environmental impact of target groups through information sharing and knowledge building efforts.</p>	
Environment programme	4	<p>Knowledge building is acknowledged as a key management aspect of Stockholm's biodiversity strategy.</p> <p>A city wide action plan with strategies on green and blue space management will be formulated that works together with residents and property owners in the city. The city of Stockholm aims to actively include these actors in the development of blue and green spaces.</p>	
	2	<p>Communication of nature conservation measures will increase.</p>	
	Total	3	<p>The city of Stockholm acknowledges the need to inform citizens, partners and commercial parties. It does so through a wide variety of programmes and pilot projects. It aims to share best practices with regard to sustainable urban</p>



			development and increase knowledge building amongst residents and target groups.
Indicator	Human-oriented considerations		
Sub-indicator	Protection of cultural heritage		
Object:	Score	Note	
Socially cohesive city strategy	4	<p>New urban development has to acknowledge cultural assets and take careful consideration of them.</p> <p>The city's aim is to protect the cityscape which includes sightlines onto blue and green spaces and (ecological) corridors. The green structure of Stockholm is seen as an integral part of the historic landscape and therefore the city aims to conserve the structure.</p>	
Identity and cultural heritage	4	<p>Future green spaces should contribute to the identity of the city, borough or neighborhood. This identity is directly linked to the cultural heritage and nature heritage of said area.</p>	
District council plans	2	<p>District council park plans contain an overview of all the ecological infrastructures within the district. The plans formulate management guidelines to conserve biodiversity. Each park and natural area has its own strategy and management plan.</p> <p>These also include management plans for culture reserves, which are historic green spaces within the city of Stockholm.</p>	
Preservation of natural assets	2	<p>The natural features of the city are included alongside the built historical features in the Stockholm cultural heritage planning document. Guidelines will be presented to preserve these natural assets.</p> <p>This document aims to identify, protect and conserve natural heritage environments.</p>	

	Total	3	The city of Stockholm describes its important natural features as culture reserves. New urban development has to harmonize with these assets and add new assets to the city. The city's green and blue spaces and their structures need to be conserved, as well as the sightlines upon them for citizens.
Indicator	Human-oriented considerations		
Sub-indicator	Biosphere stewardship		
Evaluation parameters: Insufficient (0); sufficient (2); good (4); excellent (5)			
Object:	Score	Note	
Child development	2	The city of Stockholm has expressed its desire to provide quality outdoor environments for (pre)schools. The city states that discovering the natural environment is an integral part of child development (city plan pp 53). It is important for children to interact with natural surroundings for their mental and physical development.	
Design of blue and green spaces	0	Stockholm's blue and green spaces are further designed to facilitate human encounters as opposed to encounters with nature.	
	Total	1	The city of Stockholm did not formulate any concise measures to stimulate the interaction between citizens and nature. It does however have measures in place to improve the accessibility of green and blue spaces where citizens can interact. However, the focus is not on interaction with nature specifically.
Indicator	Human-oriented considerations		
Sub-indicator	Public recreation		
Evaluation parameters: Insufficient (0); sufficient (2); good (4); excellent (5)			
Object:	Score	Note	
Capacity	2	The city of Stockholm aims to guarantee the sufficient capacity of public spaces. It is described as a major focus point	

		<p>due to the projected population growth.</p> <p>Measures include:  Urban (re)development should draw on existing assets and in the case of redevelopment enable more people to enjoy these assets.</p>
Dynamic Stockholm	4	<p>The city aims to develop new assets such as public spaces to enrich the city. It has formulated this a clear city planning goal. Future planning will focus on maintaining and creating a wealth of attractive features within and around the city.</p> <p>These spaces will include new aesthetic and social assets (assets that facilitate human encounters), but also offer more ways to recreate within the city.</p>
Stockholm corridors	4	<p>The green corridor structure of parks is a major public recreational area. The city aims to strengthen this network in order to allow citizens to utilize an alternative landscape for transport around the city. The city aims to maintain and include more walking routes to popular assets such as parks.</p> <p>The green structure encourages integration. Barriers to movement of species and also citizens need to be removed or bridged with the structure.</p> <p>Strengthen connections, especially on the local scale. Improve public recreational capacity of existing stock of blue and green spaces.</p> <p>Construct unbroken waterfronts and make these assets more</p>

		accessible by redeveloping quays into ecologically friendly banks and staircases.
Pop-up parks	2	<p>The city of Stockholm is exploring pop-up parks as a measure for its goal on a vibrant Stockholm.</p> <p>No further clear information is presented in the strategy document.</p>
Multifunctionality	4	<p>The city of Stockholm is focusing on multifunctional spaces.</p> <p>On the one hand this is focused on facilitating a wider variety of uses for a wider variety of users throughout the day.</p> <p>On the other hand this is focused on making public spaces, for example, multifunctional with regards to rainwater retainment.</p>
Waterfronts	4	<p>The city wants to encourage water bound recreation such as boating, fishing and swimming.</p> <p>Furthermore, it is determined to protect blue spaces such as canals and waterfronts and make these more accessible for recreation to facilitate this goal.</p>
Incorporate public health perspectives into urban planning.	4	<p>The city of Stockholm is incorporating public health goals and perspectives into its planning process. Measures entail considerations to sports facilities and green spaces.</p> <p>Recreational capacity is seen as a major component of this strategy.</p>
Equal, inclusive and safe public spaces	4	<p>The city of Stockholm has formulated a concise strategy with regards to the inclusiveness of its assets. It aims to distribute its assets equally in the city to combat segregation.</p>

			<p>It also aims to make public spaces such as parks and waterfront more accessible for vulnerable citizens in order to serve all parts of society.</p> <p>The local development exploration within the city plan identifies neighborhoods which should (and can) be enriched with new green spaces.</p>
	Total	4	<p>The city of Stockholm aims to explore opportunities to create more public recreational assets within its city through future urban development. It has made concise strategies that focus on the inclusiveness of the city. The green structure and waterfronts are seen as the backbone for the city.</p>
Indicator	Human-oriented considerations		
Sub-indicator	Foster social and environmental innovation		
Object:		Score	Note
Collaboration		4	<p>The city of Stockholm acknowledges that it cannot achieve sustainable urban development on its own. Therefore it aims to continue its collaborations with academia and businesses to develop Stockholm sustainably. The city will facilitate innovation, development, collaboration and co-creation.</p> <p>The city will participate in innovative collaborations and research initiatives in which Stockholm's green areas can represent test beds in various pilot projects.</p> <p>The Stockholm environment programme has been designed specifically to allow for collaboration and innovation.</p> <p>The City has also formulated its innovation strategy that</p>

		describes its focuses, works and partnerships. It also contains options the city wishes to explore.
Climate action plan	3	<p>The Stockholm climate plan emphasizes the city's efforts on promoting new technology through pilot projects.</p> <p>The environment programme states the city's desire to explore collaborations on innovative tests to improve air quality and the urban acoustic environment.</p>
Exemplary function	4	The city of Stockholm is a global example in public and green space design. It aims to retain this position in the future by investing in improving existing public spaces and developing new green infrastructure.
Green IT	5	<p>The city of Stockholm is prioritizing Green IT solutions as part of its sustainable society strategy. Green IT aims to improve the environment through climate impact reduction and energy efficiency strategies.</p> <p>The environment programme sets out clear strategies and goals with regard to Green IT.</p>
Stockholm biotope database	5	<p>The city of Stockholm maintains data and records of all core natural areas, transition zones and corridors as well as important habitats that are all necessary to protect Stockholm's flora and fauna.</p> <p>The city acknowledges the learning process of nature conservation within the city. It aims to build knowledge on nature conservation within the urban environment.</p>

			<p>The Stockholm biotope database provides landscape analyses which are utilized in planning processes.</p> <p>The city aims to further develop its biotope database in order to provide detailed landscape analyses that can advise future planning processes.</p>
Eco-development		4	<p>The city of Stockholm acts as a testbed for sustainable urban development. It employs state of the art environmental technology in energy production, waste reduction and management and climate adaptation measures. It aims to make widespread use of these technologies and measures by 2030.</p> <p>Testbeds are done for both research initiatives and climate-smart solutions from the industry such as climate smart production and consumption.</p>
	Total	4	<p>The city of Stockholm is a global leader on environmental innovation. It aims to retain this position through clear considerations in writing its strategies, providing testbeds and collaborating with industry, businesses and academia.</p>
Indicator	Human-oriented considerations		
Sub-indicator	Ecosystem services		
Object:	Score	Note	
Integration	4	<p>New green environments and the built environment have to be in harmony with each other. Therefore ecosystems have to be integrated into the urban environment. This is achieved by including the green and blue structure as a framework early in the planning process.</p>	

		<p>The green and blue spaces of the city and their structure are the backbone of the city. The city states that its ecosystem services contribute to the healthiness of the urban environment.</p>
Multifunctionality	4	<p>Multifunctional green spaces are an important strategy to the city of Stockholm. It acknowledges the fundamental ecosystem services these spaces offer with regards to stormwater management, urban heat stress, air quality, water quality, urban acoustics and public health.</p> <p>The city aims to develop multifunctional solutions that integrate ecosystem services with urban development.</p>
Safeguard ecosystem functioning		<p>In order to safeguard the multitude of ecosystem services offered by the city's natural, green and blue spaces, the city is focusing on the quality of its green spaces and their ecosystems. Biodiversity is seen as an indicator for a healthy ecosystem.</p> <p>Stockholm is actively investing in solutions that store water for periods of drought. This is done in order to safeguard ecosystem functioning during heatwaves</p>
Incorporation	4	<p>In the dense urban environment space is limited for traditional green and blue space development. In these areas the needs for ecosystem services are the highest. In these instances the city is focusing on incorporating more greenery in the built environment to increase and improve the amount of ecosystem services in the urban environment.</p>



	Total	4	The city of Stockholm acknowledges the importance of ecosystem services in its strategies and planning goals. It aims to safeguard these services, improve and increase their amount within the dense urban environment and incorporate them early on in the planning process.

## Appendix V Assessment forms Vitoria-Gasteiz

**City assessed:** Vitoria-Gasteiz

**Date of assessment:** April 15th, 2021

### Ecological considerations

Indicator	Ecological considerations		
Sub-indicator	Habitat provisioning		
Object:	Score	Note	
Urban master plan	4	<p>The city of Vitoria-Gasteiz is planning to integrate the urban green infrastructure system and the goals from its green infrastructure strategy into its urban master plan and subsequent planning instruments.</p> <p>One of the aims of the urban green infrastructure strategy is to create habitats for both flora and fauna within the city and connect these with the peri-urban environment.</p>	
Green space functionality	5	<p>The city of Vitoria Gasteiz facilitates habitats in its administrative area by creating additional green spaces and making them more suitable as habitat through the planting of shrubs and flower meadows and through the installment of artificial shelters and nests for local fauna.</p> <p><b>Measures include:</b></p> <ul style="list-style-type: none"> <li>- the creation of small ponds for amphibians</li> <li>- the placing of dry stone structures for invertebrates and lizards</li> <li>- piling dead wood for xylophagous insects</li> <li>- the placing of nesting boxes for bats and birds.</li> </ul>	
Nature-inclusive agriculture in the peri-urban environment.	4	Vitoria-Gasteiz aims to promote the development of	

		nature inclusive agricultural practices that are based upon natural processes in order to promote biodiversity. The plan refers to making the periurban agricultural belt more suitable as habitat.
Multifunctional spaces	5	<p>The city of Vitoria-Gasteiz aims to draw lessons from its green belt development, with regard to management and urban redevelopment. One of the main lessons is the importance of multifunctionality of public spaces, as these spaces can provide a habitat for valuable species.</p> <p>Furthermore, the city aims to replicate measures it took within the green belt project in the city.</p> <p>The green belt projects redeveloped, recovered and restored areas around the city perimeter. Measures included the redevelopment of gravel pits into parks and the restoration of wetlands.</p>
The naturalization of green areas and vacant plots	5	The city of Vitoria-Gasteiz aims to re-naturalize vacant plots. It does so through planting small urban forests, shrubs, fruit orchards and flower meadows or through the creation of lagoons or allotment gardens in vacant plots within the city. These areas can then serve as a suitable habitat for local flora and fauna, as well as store rainwater. The allotments have to follow sustainable management (gardening) techniques that enhance biodiversity.
	Total	5
		The city of Vitoria-Gasteiz has set clear strategies with

			regards to habitat provisioning. It does so for a wide variety of species ranging from water bound species to birds. It aims to formalize these strategies into its urban master plan. Additionally it seeks to make its peri-urban agricultural belt more nature inclusive.
Indicator	Ecological considerations		
Sub-indicator	Protected areas		
Object:		Score	Note
Green belt project		4	The green belt project instigated in the 90s has resulted in a continuous ring of green and natural spaces around the core city of the Vitoria-Gasteiz administrative area. In the past there was no legal structure to contain urban sprawl in the future. The city has now formalized its ambition to contain urban sprawl within the limits of the green belt as much as possible and to subsequently conserve its green belt.
Green infrastructure strategy		4	The city of Vitoria-Gasteiz is actively seeking to protect spaces that still contain native relic flora species. These areas will be preserved and receive a protective status.
Green belt project		5	The larger green spaces and wetlands created in its green belt programme have been given a natura 2000 status or RAMSAR status.
Urban master plan & green infrastructure strategy		4	The city aims to safeguard the green infrastructure within and around the city. It does so by integrating the urban green infrastructure system and the goals from its green infrastructure strategy into its urban master plan and subsequent planning instruments.

Green belt project		4	The city of Vitoria-Gasteiz has strategized the formalization of conserving green and natural spaces in its periphery. This is achieved by conserving natural areas that have survived until now, and by recovering them through careful maintenance and connecting and integrating these with the green structure.
Ecological corridors		4	Vitoria-Gasteiz aims to safeguard the ecological connections (corridors) between its green belt and natural areas such as the Vitoria mountains and the river Zadorra.
	Total	4	The city of Vitoria-Gasteiz has formalized strategies to protect its green infrastructure and natural areas. It does so through conservation efforts and integrating within the urban planning process. Furthermore, some of its created and restored green spaces have been given the highest accolade, a natura 2000 status.
Indicator	Ecological considerations		
Sub-indicator	Ecosystem quality		
Object:	Score	Note	
Urban green infrastructure strategy	5	<p>The urban green infrastructure strategy aims to naturalize the urban environment.</p> <p>The city does so through the planting of vegetation and trees in green spaces, squares, avenues and vacant plots. Furthermore, it states that all spaces that are able to be naturalized, should be naturalized as much as possible. The city refers to every roundabout, car park</p>	

		and vacant plot specifically in this strategy.
Naturalization of urban axes	4	The city aims to naturalize urban axes such as avenues, streets and railways as well as streams. Examples include the restructuring of an avenue with the inclusion of a linear green park planted with vegetation alongside a new smaller street.
Restoring fluvial ecosystems	4	The city has formalized the strategy to restore fluvial ecosystems within the city. This involves the construction of ponds in green spaces and vacant plots and the reconstruction of streams and river bypasses.  Additionally, the city is re-naturalizing streams within and around the city.  Furthermore, the river Zadorra has been restored and the river Avendaño is planned to be reconstructed in the city.
Site specific planning and maintenance	4	Vitoria-Gasteiz aims to safeguard the functionality of ecosystems within and around the city. It does so through careful management of each space with site specific planning and maintenance.
Green belt project	5	The city of Vitoria-Gasteiz has formalized the goal to make its green belt an integral part of the regional ecological system. It does so through making the green belt as naturalized as possible, while also catering for recreational needs.
Maintenance techniques	5	The management and maintenance of restored or developed green spaces in the green belt and periphery

			<p>are based upon methods from 'wild' natural spaces. The emphasis is on recreating the local natural environment as much as possible through the use of native species. Furthermore, the maintenance is aimed at minimal intervention to promote the utmost functionality of the green space.</p> <p>Furthermore, the city acknowledges the drop in biodiversity as a result of intensive city green space management. It therefore aims to replicate the management techniques from its peripheral spaces within the city.</p>
	Total	5	The city of Vitoria-Gasteiz has made re-naturalization of its peripheral and urban spaces a key strategy, with the ultimate goal being biodiversity and urban quality of life.
Indicator	Ecological considerations		
Sub-indicator	Biodiversity		
Object:	Score	Note	
Urban green infrastructure strategy	4	<p>Vitoria-Gasteiz aims to promote urban biodiversity through the interconnection between urban green spaces, the green belt and natural areas in its periphery.</p> <p>The green belt acts as a natural area itself and as the interplay between the interregional and urban ecological structure. Urban green spaces will connect to the green belt through green corridors along streets or streams.</p> <p>The city aims to extend the urban green belt by</p>	

		redeveloping and incorporating adjacent agricultural plots.
Naturalized management techniques	5	The city aims to promote biodiversity through the conservation led maintenance of green and natural spaces based upon methods from 'wild' natural spaces. The maintenance is aimed at minimal intervention to promote the utmost functionality of the green space and its ecosystem.
Urban green infrastructure strategy	5	The city aims to utilize functional landscape planning and design practices for the (re)development of green spaces in the future.  Measures include: the recreation of the natural environment by including only native species and through the creation of habitat structures for a wide variety of native species.
Biodiversity informed gardening	2	The city aims to promote biodiversity informed gardening methods amongst its citizens, that at the same time also promote the consumption of locally grown food.
Urban green infrastructure strategy	5	The city aims to create more habitat structures within the city and its periphery for a variety of native species. For example, the city aims to create wildlife refuges in the periphery of the city and within the green belt. Additionally, the city aims to increase the amount of vegetation on green spaces and vacant plots through the planting of urban forests,



			flower meadows and tree lines. Furthermore, the city aims to create ponds and restore streams for aquatic species and rainwater retention.
	Total	4	The city of Vitoria-Gasteiz has a clear strategy to promote biodiversity within and around the city. Measures are aimed to facilitate native species as much as possible through careful planning and management.
Indicator	Ecological considerations		
Sub-indicator	Species consideration		
Object:		Score	Note
Naturalization as key informer		5	The recreation of the natural environment by including only native species is leading with the (re)development of green spaces. The aim is to facilitate native species as much as possible through careful planning and management.
Green belt project		4	The city of Vitoria-Gasteiz has introduced a herd of deer in its green belt to control vegetation growth and prevent eutrophication of the wetlands.
Pollinating species considerations		4	The city of Vitoria-Gasteiz strategized the creation of flower meadows to promote pollinating species within its city and the agricultural belt that surrounds it.
Green infrastructure strategy		4	The city of Vitoria-Gasteiz is actively seeking to protect spaces that still contain native relic flora species. These areas will be preserved and receive a protective status.
Xylophagous species considerations		5	The city of Vitoria-Gasteiz has renaturalized and restored its Alegria river to

			facilitate the migration of the endangered European mink and otter species. Additionally, the management of green spaces mandates the collection and provision of small stacks of dead wood to favor these species, especially during critical time frames in the reproductive cycle.
Habitat provisioning for native species		5	<p>The city of Vitoria Gasteiz aims to create habitat structures for a wide variety of native species through the planting of shrubs and flower meadows and through the installment of artificial shelters and nests for local fauna.</p> <p><b>Measures include:</b></p> <ul style="list-style-type: none"> <li>- the creation of small ponds for amphibians such as the newt and natterjack toad (the latter is a threatened species in the region)</li> <li>- the placing of dry stone structures for invertebrates and lizards</li> <li>- piling dead wood for xylophagous insects</li> <li>- the placing of nesting boxes for bats and birds.</li> </ul>
	Total	5	The city of Vitoria-Gasteiz focuses on its local flora and fauna as a guiding narrative with the planning and management of green and natural spaces. It aims to facilitate these species through habitat provisioning and careful consideration.
Indicator	Ecological considerations		
Sub-indicator	Forest coverage		
Object:		Score	Note
Green infrastructure strategy		3	The city aims to strengthen the ecological network by planting more vegetation,

		<p>especially trees and shrubs along key corridors.</p> <p>The city is especially opting for the construction of urban forests on roundabouts, green lanes between or alongside avenues and on vacant plots.</p>
Raíces del mañana: 250.000 árboles para el Anillo Verde	4	The city of Vitoria-Gasteiz has successfully implemented a campaign to plant 250000 trees in its city, green belt and periphery.
	Total	3
		<p>The city has made good progress in the previous decade in its efforts to increase the coverage of trees within and around the city. The city still aims to construct small urban forests and plant more trees in the city, especially along its ecological corridors and on vacant plots. However, the scope with regard to tree coverage for this decade is less ambitious compared to the previous one.</p>

## Environmental quality

Indicator	Environmental quality		
Sub-indicator	Water quality		
Object:	Score	Note	
Wetlands management	2	<p>The city of Vitoria-Gasteiz has introduced a herd of deer in its green belt to control vegetation growth and prevent eutrophication of the wetlands. This is an example of passive water quality management through fauna.</p>	
Water retention	2	<p>The city aims to prevent untreated sewage outflow</p>	

			during high precipitation events through the construction of stormwater tank storage, small ponds within the urban environment and green infrastructure.
Acknowledgement		1	The city acknowledges the influence of changing climate and precipitation patterns on the water quality of the city's water bodies. This is a result of a loss in pollution dilution capacity which depends on water supply. The city has labeled this problem as less serious in the short term and is therefore working on a long term strategy.
Efficiency and quality controls		2	The city aims to improve its water quality controls with careful emphasis on guaranteeing drinking water quality. Furthermore, the city has formulated its goal to continue investing in the efficiency of the water cycle to promote quality and environmental sustainability.
	Total	2	The city of Vitoria does acknowledge issues with regards to water quality but does not present concrete strategies to conserve or improve current water quality levels. It states that current levels are adequate thus the issue is not stressing, subsequently it has been delegated to a long-term strategy to be developed. It does however aim to prevent eutrophication of its wetlands through the introduction of grazing deer to control the amount of vegetation.
Indicator	Environmental quality		
Sub-indicator	Soil quality		
Object:	Score	Note	
Green city approach	2	The city aims to improve soil quality through soil restoration	

			processes in (re)developed green spaces and new urban (re)development. Examples include the gravel-pit restoration project undertaken
Nature inclusive agriculture		3	Vitoria-Gasteiz aims to promote the development of nature inclusive agricultural practices that are based upon natural processes in order to promote biodiversity and soil conservation efforts. The plan refers to making the peri-urban agricultural belt into agro-ecological parks that conserve soil quality.
The naturalization of green areas and vacant plots		4	<p>The city of Vitoria-Gasteiz aims to re-naturalize vacant plots. It does so through planting small urban forests, shrubs, fruit orchards and flower meadows or through the creation of lagoons or allotment gardens in vacant plots within the city. These areas most often have degraded soils.</p> <p>The city sees agro-ecological initiatives (urban allotment gardens) and naturalization as ways to tackle plots with degraded soil quality. It therefore aims to construct urban allotment gardens in vacant plots to stimulate the consumption of locally grown produce, as well as the remediation of soil through the redevelopment into green spaces.</p>
	Total	3	The city of Vitoria-Gasteiz has a few strategies with regards to soil quality. The main emphasis is on the naturalization of (vacant) plots that have degraded soils. Additionally, the stimulation of nature inclusive agricultural practices and soil remediation measures with new

			urban development, provide opportunities to improve the soil quality within and around the city of Vitoria-Gasteiz.
Indicator	Environmental quality		
Sub-indicator	Rainwater drainage		
Object:	Score	Note	
Water retention capacity	4	<p>The city aims to prevent untreated sewage outflow during high precipitation events through the construction of stormwater tank storage, small ponds and ditches within the urban environment and green infrastructure such as vegetated strips.</p> <p>The city is also exploring water separation systems in dense parts of the city where other measures are difficult to implement.</p>	
Restoring fluvial ecosystems	4	<p>The city has formalized the strategy to restore fluvial ecosystems within the city. This involves the construction of ponds in green spaces and vacant plots and the reconstruction of streams and river bypasses.</p> <p>Furthermore, the river Zadorra has been restored and the river Avendaño is planned to be reconstructed in the city.</p> <p>Additionally, the city is creating river bypass channels that can also act as cycling and pedestrian paths and ecological corridors. Furthermore, the city is constructing retention basins that can also act as public recreational areas and habitat.</p> <p>This strategy also links with the flood defense plan between the city of Vitoria-Gasteiz and the Basque water agency.</p>	

Green infrastructure strategy	4	<p>The city is implementing green solutions that integrate with the hydrological system to improve soil permeability.</p> <p><b>Measures include:</b>  Replace the tiles of streets and parking spaces with permeable tiles. Additionally, these will be accompanied by vegetated strips with bushes and/or trees. Secondly, the city is constructing ponds and ditches, urban allotment gardens and urban forests in vacant plots around the city.</p> <p>Thirdly, the city aims to promote the integration of vegetation on buildings such as vegetated facades and green roofs.</p> <p>The green infrastructure strategy specifically mentions the goal to recharge local groundwater aquifer through restoring hydrological processes, additionally the city wants to safeguard sufficient base flow in the city's rivers and streams for ecosystem functioning.</p>
	Total	<p>4</p> <p>The city of Vitoria-Gasteiz has an elaborate strategy with regards to rainwater retention. It is one of its main target points and it has made an extensive plan that focuses on restoring natural hydrological regimes through improving permeability rates of the soil and reconstructing and improving fluvial systems. Additionally, physical measures in the sewerage system are proposed in the dense urban environment where the aforementioned measures are difficult to implement.</p>

Indicator	Environmental quality		
Sub-indicator	Sewage treatment		
Object:		Score	Note
	Total	0	The city of Vitoria-Gasteiz has not formulated any strategies with regards to improving their sewage treatment either actively through investments, goals or strategies with regards to their treatment plant or through passive treatment via vegetation.
Indicator	Environmental quality		
Sub-indicator	Restoring natural processes		
Object:		Score	Note
Green infrastructure strategy		2	The city of Vitoria-Gasteiz aims to improve the amount of ecosystem services and ecosystem functioning by lining urban metabolism processes with natural processes. The emphasis is on greening the built environment, restoring hydrological cycles (i.e. aquifer recharge by improving permeability of the soil) and reducing the consumption of environment resources.
	Total	2	The city of Vitoria-Gasteiz has formulated one encompassing strategy with regards to restoring natural processes. The city aims to tune its urban metabolism processes with natural processes. Measures have been taken to renaturalize the urban environment, reinforce and restore the hydrological system and to reduce the consumption of environmental resources.
Indicator	Environmental quality		
Sub-indicator	Air quality		



Object:	Score	Note
Sustainable mobility	2	The city aims to continue its efforts of reducing motorized traffic within the city through street reforms, parking schemes and vehicle restrictions. The city invests in pedestrianizing the city and promoting cycling and public transport connectivity at the same time by constructing more cycling and walking paths and expanding tram and electric bus lines.
Street reforms	2	The city is planning to further reform streets and avenues in the city by facilitating more space for vegetated strips or ecological corridors at the expense of parking space and traffic lanes. Additionally the city is planning to implement traffic calming measures of reducing speed limits to 30kph or lower to almost all streets within the city.
Green infrastructure strategy	4	<p>The city is aiming to increase the amount of vegetation on streets (and squares) as part of its street reformation scheme. Trees are used to improve air quality and local city climate, while at the same time acting as a functional urban corridor. Trees are planted along vegetated strips as opposed to on paved areas.</p> <p>The city aims to construct more urban forests on roundabouts and increase the amount of vegetated facades and roofs within the city.</p>
Superblock structure	2	A key part of the sustainable development strategy of Vitoria-Gasteiz is the superblock scheme. This scheme aims to restore public spaces consumed by car traffic. This is achieved by turning a block within a

			neighborhood into a superblock. The outer streets remain while the inner streets are turned into pedestrianized streets that incorporate green infrastructures. Cars can still enter the block only to park but at a highly decreased speed (10 to 20kph). The superblock structure aims to reduce noise and air pollution within residential areas and to promote cycling and walking (safety) within the city, while also increasing the amount of greenery within the city.
	Total	3	The city of Vitoria-Gasteiz presents some innovative solutions to improve air quality. It does so by reforming the streets by implementing superblocks and constructing vegetated strips. Additionally, it aims to promote cycling and walking alongside the overall investments into greening the built environment.

## Green infrastructure

Indicator	Green infrastructure		
Sub-indicator	Integration		
Object:	Score	Note	
Nature-based solutions	5	<p>The city of Vitoria-Gasteiz actively promotes the usage of nature-based solutions in its area.</p> <p>These solutions are aimed to increase the amount of green space and infrastructure within the city. The city acknowledges that these interventions benefit urban quality of life, water management, urban microclimates, ecology and the</p>	

		<p>local economy through the creation of attractive places for tourism.</p> <p>Measures include: The construction of urban forests, urban allotment gardens, ponds, vegetated strips, rainwater retention gardens and integrating vegetation in and on buildings.</p>
Integration ecological and hydrological processes	4	<p>The city aims to integrate ecological and hydrological processes within the built environment through careful planning. Therefore, the urban green infrastructure strategy has been integrated in the urban master plan and its planning instruments.</p> <p>This strategy aims to naturalize the city, improve soil permeability rates, increase ecosystem services and facilitate nature within the city to improve urban quality of life. The strategy also lays out a framework for the creation of a green system that runs throughout the city.</p>
Green acupuncture approach	4	<p>The city wishes to integrate vegetation with buildings in dense parts of the city that have insufficient space for traditional green space development. The city refers to this as the green acupuncture approach, in which dense parts are pinpointed and subsequently naturalized by integrating as much vegetation as possible.</p>
Multifunctional spaces	4	<p>The city of Vitoria-Gasteiz aims to draw lessons from its green belt development, with regard to management and urban redevelopment. One of the main lessons is the importance of multifunctionality of public spaces, as these spaces can provide a habitat for valuable</p>

			species, act as water retention areas, combat urban heat stress and provide recreational opportunities for citizens.  Furthermore, the city aims to replicate measures it took within the green belt project in the city.
Superblock concept and street reforms		2	The superblock concept and subsequent street reformations call for the integration of greenery alongside redeveloped streets and pathways. This is achieved by planting trees and shrubs and creating vegetated strips.  There are however no clear targets and design guidelines presented for the superblock other than its goals to reduce motorized traffic within the superblock (and subsequently, the city) and allocating more space for public recreation.
	Total	4	The city of Vitoria-Gasteiz actively promotes the integration of greenery within the built environment through nature based solutions. It acknowledges the multifunctional possibilities of green infrastructure and aims to improve and increase the amount of ecosystem services within the city.
Indicator	Green infrastructure		
Sub-indicator	Proximity		
Object:		Score	Note
Green infrastructure strategy		5	The current distribution of green spaces within and around the city of Vitoria-Gasteiz is excellent. The city strives to reach and subsequently maintain access to green spaces within 250m from residential areas.
Green infrastructure strategy		5	The city aims to connect people with nature by making natural and green spaces in the city and the periphery more accessible

		<p>and traversable for its citizens. This is achieved by constructing paths (for example bridges over wetlands) and removing or bridging barriers.</p> <p><b>Measures include:</b></p> <ul style="list-style-type: none"> <li>- Removing walls and or buildings that block green spaces.</li> <li>- Constructing new pedestrian and cycling paths alongside and towards the green belt and urban green spaces.</li> </ul> <p>The city also aims to increase the accessibility of natural areas in its periphery through the construction of connections between the city and the periphery. These act as both ecological corridors as well as paths for citizens to traverse by bike or on foot.</p>
Urban paths network	4	<p>The city aims to create a network of paths and green corridors that connect green spaces, public spaces, educational establishments and community centers with each other. The goal is to make these spaces more accessible through the creation of safe corridors with a high environmental quality that promote walking and cycling.</p>
Superblock concept and street reforms	3	<p>The superblock concept and subsequent street reformations call for the integration of greenery alongside redeveloped streets and pathways. This is achieved by planting trees and shrubs and creating vegetated strips.</p> <p>The superblock concept and subsequent street reforms have the potential to increase the proximity of green spaces, nature and public recreational areas for citizens.</p>

	Total	4	The city of Vitoria-Gasteiz has a good proximity and accessibility of its green spaces and infrastructure. It therefore aims to maintain this, however the city has enlarged its scope by focusing on bringing greenery and nature closer to people's doorsteps and through improving the accessibility of natural spaces in the periphery of the city.
Indicator	Green infrastructure		
Sub-indicator	Connectivity		
Object:	Score	Note	
The city green infrastructure system	4	<p>The city aims to create a network of interconnected green spaces through the city. Each small ecosystem (individual space) has to reinforce the other through its ecosystem services.</p> <p>It is planning to resolve disconnected green spaces through a variety of measures indicated in the object listed below.</p>	
Vitoria-Gasteiz regional green structure	4	<p>The city aims to connect the green spaces within the city with the city green belt. Subsequently, it aims to connect the green belt with the periphery, through corridors between large natural spaces in the region and the mountains around the city. The city is annexing agricultural plots and naturalizing them to create ecological corridors.</p> <p>Furthermore, the city in collaboration with the province is planning to integrate the municipal green structure with the regional structure of Alava.</p>	
Urban paths network	2	The city aims to create a network of paths and green corridors that connect green spaces, public spaces,	

		<p>educational establishments and community centers with each other. The goal is to make these spaces more accessible through the creation of safe corridors with a high environmental quality that promote walking and cycling.</p> <p>The network also acts as a corridor for species to traverse between green spaces and the green belt.</p>	
Naturalization of urban axes	4	<p>The city aims to naturalize urban axes such as avenues, streets and railways as well as streams. Examples include the restructuring of an avenue with the inclusion of a linear green park planted with vegetation alongside a new smaller street, the planting of vegetation alongside medians, planting tree lines alongside roads.</p>	
Restoring fluvial ecosystems	4	<p>The city has formalized the strategy to restore fluvial ecosystems within the city. This involves the construction of ponds in green spaces and vacant plots and the reconstruction of streams and river bypasses.</p> <p>Additionally, the city is re-naturalizing streams within and around the city.</p> <p>Furthermore, the river Zadorra has been restored and the river Avendaño is planned to be reconstructed in the city.</p>	
	Total	4	<p>The city of Vitoria-Gasteiz has strategized a wide variety of goals and measures that facilitate the creation of ecological corridors within the city. It aims to create a robust network within the city and between the city and the region.</p>
Indicator	Green infrastructure		
Sub-indicator	Quality		

Object:	Score	Note
Urban green infrastructure strategy	4	<p>The urban green infrastructure strategy aims to naturalize the urban environment.</p> <p>The city does so through the planting of vegetation and trees in green spaces, squares, avenues and vacant plots. Furthermore, it states that all spaces that are able to be naturalized, should be naturalized as much as possible. The city refers to every roundabout, car park and vacant plot specifically in this strategy.</p>
Naturalization of urban axes	4	<p>The city aims to naturalize urban axes such as avenues, streets and railways as well as streams. Examples include the restructuring of an avenue with the inclusion of a linear green park planted with vegetation alongside a new smaller street.</p>
Superblock concept and street reforms	3	<p>The superblock concept and subsequent street reformations call for the integration of greenery alongside redeveloped streets and pathways. This is achieved by planting trees and shrubs and creating vegetated strips.</p> <p>The superblock concept and subsequent street reforms have the potential to significantly increase the amount of green space within the city.</p>
Restoring fluvial ecosystems	4	<p>The city has formalized the strategy to restore fluvial ecosystems within the city. This involves the construction of ponds in green spaces and vacant plots and the reconstruction of streams and river bypasses.</p> <p>Additionally, the city is re-naturalizing streams within and around the city.</p>



			Furthermore, the river Zadorra has been restored and the river Avendaño is planned to be reconstructed in the city.
Green acupuncture approach		4	The city wishes to integrate vegetation with buildings in dense parts of the city that have insufficient space for traditional green space development. The city refers to this as the green acupuncture approach, in which dense parts are pinpointed and subsequently naturalized by integrating as much vegetation as possible. Dense urban environments with significant heat stress will be tackled utilizing this approach.
The naturalization of green areas and vacant plots		4	The city of Vitoria-Gasteiz aims to re-naturalize vacant plots. It does so through planting small urban forests, shrubs, fruit orchards and flower meadows or through the creation of lagoons or allotment gardens in vacant plots within the city. These areas can then serve as a suitable habitat for local flora and fauna, as well as store rainwater. The allotments have to follow sustainable management (gardening) techniques that enhance biodiversity.
Greening of municipal property		2	The city has expressed its desire to invest in green roofs and vegetated facades for municipal buildings. Additionally, municipal property such as parking lots, storage buildings have to become naturalized as much as possible.
	Total	4	The city of Vitoria-Gasteiz has formulated strategies that focus on increasing the amount of greenery within the city. It is looking to naturalize the city as much as possible.
Indicator	Green infrastructure		
Sub-indicator	Maintenance		
Object:		Score	Note

Maintenance techniques	4	<p>The management and maintenance of restored or developed green spaces in the green belt and periphery are based upon methods from 'wild' natural spaces. The emphasis is on recreating the local natural environment as much as possible through the use of native species. Furthermore, the maintenance is aimed at minimal intervention to promote the utmost functionality of the green space.</p> <p>Furthermore, the city acknowledges the drop in biodiversity as a result of intensive city green space management. It therefore aims to replicate the management techniques from its peripheral spaces within the city.</p>
Site specific planning and maintenance	4	<p>Vitoria-Gasteiz aims to safeguard the functionality of ecosystems within and around the city. It does so through careful management of each space with site specific planning and maintenance. Actions taken may differ between spaces and within each space itself. For example, differentiated mowing schedules are utilized to reduce the amount of mowing alongside dense vegetated structures and streams in order to increase biodiversity, but also to reduce maintenance costs.</p>
Sustainable maintenance	2	<p>The city of Vitoria-Gasteiz aims to improve the efficiency of its green space maintenance, as well as to reduce its environmental resource consumption. The maintenance (and design) of green spaces aims to reduce irrigation needs. Additionally, the compost generated from municipal waste</p>

			has to be re-utilized as fertilizer in the city's green spaces and allotment gardens.
	Total	4	The city of Vitoria-Gasteiz deploys a conservation-led maintenance approach towards its green and natural spaces. It also aims to reutilize waste streams such as through piling dead wood for xylophagous insects and utilizing generated compost from municipal waste as fertilizer. Additionally, the main focus is to re-naturalize the city as much as possible through utilizing management techniques from natural spaces and focusing on native species assemblages.
Indicator	Green infrastructure		
Sub-indicator	Microclimates		
Object:		Score	Note
Green infrastructure strategy		4	The city has formalized its goal to reduce urban heat stress as part of the main seven goals of the green infrastructure strategy. This goal is aimed at improving the resiliency of the city through climate adaptation via nature based solutions.
Impact assessment		2	The city has made an impact analysis of urban heat stress during heat waves to identify risks. The results will be used to inform future planning processes.
Superblock concept		3	The superblock concept and subsequent street reformations call for the integration of greenery alongside redeveloped streets and pathways. This is achieved by planting trees and shrubs and creating vegetated strips.  This process allows for urban heat stress reduction within these superblocks.
Multifunctional spaces		4	The city of Vitoria-Gasteiz aims to draw lessons from its green

			<p>belt development, with regard to management and urban redevelopment. One of the main lessons is the importance of multifunctionality of public spaces, as these spaces can provide a habitat for valuable species, act as water retention areas, combat urban heat stress and provide recreational opportunities for citizens.</p> <p>Furthermore, the city aims to replicate measures it took within the green belt project in the city.</p>
Green acupuncture approach		4	<p>The city wishes to integrate vegetation with buildings in dense parts of the city that have insufficient space for traditional green space development. The city refers to this as the green acupuncture approach, in which dense parts are pinpointed and subsequently naturalized by integrating as much vegetation as possible. Dense urban environments with significant heat stress will be tackled utilizing this approach.</p>
	Total	3	<p>The city of Vitoria-Gasteiz acknowledges the impact of urban heat stress and actively incorporates the results of its impact assessment into its planning practices. Measures will be taken utilizing the green infrastructure strategy, acupuncture approach or superblock concept. The main strategy is to incorporate as much greenery into the built environment as possible in a given space.</p>

## Human oriented considerations

Indicator	Human oriented considerations		
Sub-indicator	Education		
Object:	Score	Note	
Awareness campaigns	5	<p>The city aims to inform citizens about, and generate concerns with, the significant loss of biodiversity globally and locally, water consumption, ecosystem services and the influence of environmental resource consumption.</p> <p>The city aims to further develop the educational aspect of green spaces through informing citizens, awareness campaigns and activities in green spaces.</p>	
Communication platform	5	<p>The city actively involves society with its green infrastructure projects and conservation efforts. Citizens are involved with the design and implementation of measures within the city.</p> <p>Furthermore, the city is creating a communication platform aimed at generating awareness amongst citizens, as well as acceptance for the transformation projects planned for the city.</p>	
Regional cooperation	4	<p>The city together with the Basque autonomous community aim to create environmental education establishments, which inform citizens about (urban) biodiversity, policy measures and environmental sustainable practices.</p>	
Agro-ecological parks and allotment gardens	5	<p>The city has created two successful education facilities in the form of orchards and urban allotments gardens. It aims to expand this by creating more allotment gardens, especially on vacant plots, which stimulate the consumption of locally</p>	

		<p>grown foods and healthy foods. These areas also inform citizens about biodiversity led gardening methods (organic horticulture).</p> <p>Additionally, the city aims to create an agro-ecological park that focuses on displaying organic farming techniques.</p>	
Educational activities	4	The city hosts educational activities about urban biodiversity, conservation efforts and socio-ecological interaction in the city and green belt.	
The Olarizu Botanical Garden	4	The Olarizu Botanical Garden has been constructed to inform visitors to learn about vegetation and conservation efforts. It hosts and conserves elements of local, regional and continental ecosystem(s), has a seed bank and a wide variety of plants on exposition.	
Naturalized playgrounds	5	<p>The city aims to create naturalized playgrounds in new neighborhoods that allow children to experience the natural environment. The city states the importance of this for the mental and physical development of children.</p> <p>Additionally, the city is promoting allotment gardens for schools which can teach and practice agroecological practices on school property.</p>	
	Total	5	<p>The city of Vitoria-Gasteiz actively educates and informs citizens on its efforts with regards to the naturalization of the urban environment. Additionally, it aims to educate its citizens on urban biodiversity, conservation measures and organic horticulture. The city focuses on both children and adults with its measures to serve all portions of the population.</p>

Indicator	Human oriented considerations		
Sub-indicator	Protection of cultural heritage		
Object:		Score	Note
Protective status		5	The city deploys natural heritage management instruments as laid out by the Basque Autonomous Community biodiversity strategy. As a result the larger green spaces and wetlands created in its green belt programme have been given a natura 2000 or RAMSAR status.
Green infrastructure strategy		5	The city aims to promote affiliation with the natural heritage of the city and its environment through awareness campaigns and educational activities, but most important through identity building via green infrastructure development. The city aims to replicate the identity building capacity of its green belt with the green infrastructure strategy within the city.  Green infrastructure development has to create micro landscapes.
Protection of relic fauna species		4	The city of Vitoria-Gasteiz is actively seeking to protect spaces that still contain native relic flora species. These areas will be preserved and receive a protective status. The city classifies these areas as important natural heritage sites.
	Total	5	The city of Vitoria-Gasteiz has set impressive strategies and goals with regards to the protection of cultural heritage. The emphasis is on creating new cultural natural heritage environments with green infrastructure development and subsequently protecting these, which it has recently with its green belt development.
Indicator	Human oriented considerations		

Sub-indicator	Biosphere stewardship	
Object:	Score	Note
Agro-ecological parks	4	<p>The city promotes organic horticultural practices, the consumption of locally grown foods and the importance of a healthy diet through the creation of organic orchards and allotment gardens. These spaces are created on vacant plots and open green spaces within neighborhoods. The aim is to connect people with the origin of their food and the ecosystem they are fundamentally a part of.</p>
Promotion	3	<p>The city aims to promote affiliation with the natural heritage of the city and its environment through awareness campaigns and educational activities, but most importantly through identity building via green infrastructure development. The city aims to replicate the identity building capacity of its green belt with the green infrastructure strategy within the city. The city specifies its desire to consolidate a relationship between nature and citizens in this strategy.</p> <p>Furthermore, the city is facilitating citizen initiatives aimed at conservation of green spaces or species. Additionally, it is actively including citizens in the management and conservation of green spaces. The city wants to make citizens a partner of nature, creating more biosphere stewardship.</p>
Naturalized playgrounds	2	<p>The city aims to create naturalized playgrounds in new neighborhoods that allow children to experience the natural environment. The city states the importance of this for</p>



		<p>the mental and physical development of children.</p> <p>Additionally, the city is promoting allotment gardens for schools which can teach and practice agroecological practices on school property.</p>	
Green infrastructure strategy	4	<p>The city aims to connect people with nature by making natural and green spaces in the city and the periphery more accessible and traversable for its citizens. This is achieved by constructing paths (for example bridges over wetlands) and removing or bridging barriers.</p> <p><b>Measures include:</b></p> <ul style="list-style-type: none"> <li>- Removing walls and or buildings that block green spaces.</li> <li>- Constructing new pedestrian and cycling paths alongside and towards the green belt and urban green spaces.</li> </ul> <p>The city also aims to increase the accessibility of natural areas in its periphery through the construction of connections between the city and the periphery. These act as both ecological corridors as well as paths for citizens to traverse by bike or on foot.</p>	
	Total	4	<p>The city of Vitoria-Gasteiz deploys various methods of facilitating biosphere stewardship. It focuses on creating interactions between nature and its citizens via promotion, improving accessibility of green spaces and by constructing green corridors that lead nature into the city. Most importantly, the city aims to include citizens actively in conservation efforts and promote the affiliation with nature.</p>

Indicator	Human oriented considerations		
Sub-indicator	Public recreation		
Object:	Score	Note	
Multifunctional spaces	4	<p>The city of Vitoria-Gasteiz aims to draw lessons from its green belt development, with regard to management and urban redevelopment. One of the main lessons is the importance of multifunctionality of public spaces, as these spaces can provide a habitat for valuable species, act as water retention areas, combat urban heat stress and provide recreational opportunities for citizens.</p> <p>For example, the city is creating river bypass channels that can also act as cycling and pedestrian paths and ecological corridors. Furthermore, the city is constructing retention basins that can also act as public recreational areas and habitat.</p>	
Compatibility	2	<p>The city aims to promote the compatibility with public recreation of green spaces. The municipality stresses its desire to offer sufficient leisure opportunities in the city. This is achieved by improving existing public spaces, meeting public demand for recreational activities and through improving and spreading capacity amongst its green spaces. The latter is also focused on decreasing the pressure on natural spaces in the green belt.</p>	
Green infrastructure strategy	4	<p>The city aims to improve the amount of public recreational space within the city, and subsequently increase capacity of existing green spaces by making natural and green spaces in the city and the periphery more accessible and traversable for its citizens. This is achieved by constructing paths (for example bridges over</p>	

		<p>wetlands) and removing or bridging barriers.</p> <p><b>Measures include:</b></p> <ul style="list-style-type: none"> <li>- Removing walls and or buildings that block green spaces.</li> <li>- Constructing new pedestrian and cycling paths alongside and towards the green belt and urban green spaces.</li> </ul> <p>The city also aims to increase the accessibility of natural areas in its periphery through the construction of connections between the city and the periphery. These act as both ecological corridors as well as paths for citizens to traverse by bike or on foot.</p>
Urban paths network	4	<p>The city aims to create a network of paths and green corridors that connect green spaces, public spaces, educational establishments and community centers with each other. The goal is to make these spaces more accessible through the creation of safe corridors with a high environmental quality that promote walking and cycling.</p> <p>The cycling network has rapidly grown in the previous decade and the city aims to further expand this with the urban paths network strategy.</p>
The naturalization of green areas and vacant plots	4	<p>The city of Vitoria-Gasteiz aims to re-naturalize vacant plots. It does so through planting small urban forests, shrubs, fruit orchards and flower meadows or through the creation of lagoons or allotment gardens in vacant plots within the city. These areas offer public recreational capacity within the urban environment, as well as</p>

			provide habitats for local flora and fauna.
	Total	4	The city of Vitoria-Gasteiz has made public recreational capacity a top priority in its sustainable development strategy. Green spaces not only benefit local flora and fauna, but also the citizens of the city through improving urban quality of life.
Indicator	Human oriented considerations		
Sub-indicator	Foster social and environmental innovation		
Object:		Score	Note
Monitoring		2	The city is establishing a monitoring system on the ecosystem benefits, as well as the ecological, hydrological, economical and sociological effectiveness of its green infrastructure and sustainable development measures.
Nature inclusive agriculture in the peri-urban environment		3	Vitoria-Gasteiz aims to promote the development of nature inclusive agricultural practices that are based upon natural processes in order to promote biodiversity. The plan refers to making the peri-urban agricultural belt more suitable as habitat. Support young agricultural entrepreneurs  Facilitate the creation of a marketing and distribution channel for local products
Agro-ecological parks and allotment gardens		3	The city has created two successful education facilities in the form of orchards and urban allotment gardens. It aims to expand this by creating more allotment gardens, especially on vacant plots, which stimulate the consumption of locally grown foods and healthy foods. These areas also inform citizens about biodiversity led gardening methods (organic horticulture).

		<p>Additionally, the city aims to create an agro-ecological park that focuses on displaying organic farming techniques.</p> <p>These initiatives are highly innovative as they focus on connecting citizens with nature, their food and promoting a healthy and sustainable lifestyle.</p>	
Partnerships	2	Vitoria-Gasteiz wants to form partnerships with local businesses and research institutes to further its progress in nature based solutions, naturalization and sustainable development.	
	Total	3	The city of Vitoria-Gasteiz aims to safeguard its globally leading position in green sustainable urban development. It actively participates in EU funded programmes. However, its pilot projects and measures are not new to the world.
Indicator	Human oriented considerations		
Sub-indicator	Ecosystem services		
Object:	Score	Note	
Urban green infrastructure strategy	5	<p>The urban green infrastructure strategy aims to naturalize the urban environment.</p> <p>The city does so through naturalizing urban axes, integrating vegetation with buildings and by developing green spaces wherever possible. The goal is to increase the amount of ecosystem services in the city through increasing the amount of greenery in the city overall.</p>	
Maintenance techniques	4	<p>The management and maintenance of restored or developed green spaces in the green belt and periphery are based upon methods from 'wild' natural spaces. The emphasis is on recreating the local natural environment as much as</p>	

		<p>possible through the use of native species. Furthermore, the maintenance is aimed at minimal intervention to promote the utmost functionality of the green space.</p> <p>This management method aims to improve the effectiveness of the urban ecosystem, thereby maximizing the ecosystem services it provides.</p>
Acknowledgement	2	The city acknowledges the wide variety of ecosystem services and the city's dependence on them. Green infrastructure is utilized to benefit water management, combating urban heat stress, urban quality of life, the touristic attractiveness of the city, public health and public recreation.
Tourism	4	The city has utilized its green belt development as a driver for tourism. The city specifies its desire to stimulate green employment by developing green spaces that are attractive for tourists as well as citizens.
Local food production: Agro-ecological parks and allotment gardens	4	<p>The city has created two successful education facilities in the form of orchards and urban allotment gardens. It aims to expand this by creating more allotment gardens, especially on vacant plots, which stimulate the consumption of locally grown foods and healthy foods. These areas also inform citizens about biodiversity led gardening methods (organic horticulture).</p> <p>Additionally, the city aims to create an agro-ecological park that focuses on displaying organic farming techniques.</p> <p>The main goal of this strategy is to highlight the physical products that ecosystems bring, and to promote and facilitate</p>

			citizens to get an affiliation with nature and the local ecosystem.
	Total	4	The city of Vitoria-Gasteiz frequently refers to ecosystem services in its strategy documents. It argues that the city physically needs them. It therefore promotes ecosystem services through stimulating interaction, awareness campaigns and fostering affiliation.

## Appendix VI Assessment forms Hamburg

**City assessed:** Hamburg

**Date of assessment:** March 30th, 2021

### Ecological considerations

Indicator	Ecological considerations		
Sub-indicator	Habitat provisioning		
Object:	Score	Note	
Improve the functional capacity of habitats	1	The city of Hamburg recognizes the scarcity of space and therefore does not primarily focus on allocating more space as habitat for local flora and fauna. It however aims to enhance the quality and functional capacity of existing natural areas and green spaces within and around the city. This measure aims to increase the habitat capacity of existing natural and green spaces.	
Hamburg green roof strategy	3	<p>The city of Hamburg aims to increase its amount of green roof coverage within the coming decade. The strategy mentions the applicability of green roofs and façades as potential habitats for flora and fauna.</p> <p>The city deploys an active green roof strategy that includes green roof grants, which can be made for voluntary roof greening measures for roofs above 20 m<sup>2</sup>, with at least a soil depth of 8cm. The grant is applicable to private and commercial parties.</p> <p>Green roofs are limited to insects and birds, and therefore provide limited habitat space.</p> <p>The city aims to make green roofs mandatory by law in the near future.</p>	
	Total	2	The city of Hamburg has a limited strategy on creating new habitats within its



			administrative area. It however recognizes the importance of habitual space and therefore aims to enhance the functional capacity of existing green spaces. Additionally, the active green roof strategy also facilitates new habitat spaces within the urban environment.
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Indicator	Ecological considerations		
Sub-indicator	Protected areas		
Object:	Score	Note	
Compact city approach: More City in the City strategy	3	<p>The city wishes to reduce space consumption at its fringes due to exurban development, as a measure to conserve landscape and natural areas. Therefore, urban development will prioritize densification and reorganization within the urbanized zone (the current built environment).</p> <p>This approach is however not mandatory as urban sprawl is still possible. However in those cases a strategic land management plan has to be constructed.</p>	
Strategic land management	2	<p>Few cases when internal growth is not possible:</p> <p>Future development has to conserve its land resource. This is done by balancing and integrating the needs and functions of the natural environment and citizens, such as good quality green spaces and recreational areas. Integrate demands of ecology and citizens.</p> <p>Measures include constructing strategic land management plans. These show the balance between the desired protection and development of green spaces and landscape areas with</p>	

		<p>the need for housing and workplaces.</p> <p>This plan denotes attention and consideration given to the (bio)physical environment, there are however no mandatory standards and indicators. It is therefore possible for new suburban development to have few investments made which are beneficial to the natural environment.</p>
Protected areas	5	Hamburg's nature reserves, landscape conservation areas, open fields and cultural landscapes are protected under the 'not classified as building land' designation.
Master Plan Lower Elbe	3	This plan builds upon the "Integrated Elbe Estuary Management Plan". The goal is to manage future (industrial) development with nature protection and recreational uses in the Lower Elbe area. The natural and recreational areas along the Elbe have to be conserved as much as possible and a balance has to be made between urban development and the desire for quality landscapes and green spaces.
Climate Smart City	4	<p>The strategy plan of Hamburg includes guidelines for city development. One guideline is described as the conservation and sustainable development of environmental quality.</p> <p>Measures include the conservation of green spaces, public spaces and natural areas. Furthermore, nature conservation is one of the four action areas of the 2020-2030 action plan.</p> <p>The city also wishes to expand the type of areas that deserve a protected status. Not just all</p>

		<p>woodlands and forested areas, but also the semi-natural landscapes that have an adequate size and connection. These semi-natural areas contribute to the ecological matrix and safeguard the survival of existing species and enable the migration of new species.</p> <p>No clear quantified goals are specified.</p>
Biotope network	5	The city is developing and subsequently conserving a coherent network of biotopes. It aims to safeguard this network of habitats and corridors that are home to native species and plants.
Water management (climate adaptation)	4	The city aims to safeguard existing green and open spaces classified as 'urban climate compensation areas'. These include spaces that serve to absorb and store rainwater, as well as cool air corridors which aim to reduce urban heat stress.
Rewilding schemes	4	The city deploys Rewilding schemes and aims to develop areas and structures that benefit the ecosystem quality. Subsequently, it aims to protect and conserve structures and spaces part of this scheme. For example, fish ladders are constructed which allow animal and plant species to pass along rivers and streams. These structures are then protected.
Hamburg landscape programme (HLP)	3	The HLP is an instrument that takes into account the functions of natural and open spaces within the built-environment. This instrument is used in the planning process in order to safeguard natural processes and functions as much as possible and potentially enhance them

			through urban planning and design.  The instrument also includes targets on species conservation and climate adaptation.
	Total	3	The city has active policies and strategies that conserve the landscape and urban green spaces. It aims to increase the amount of protected areas but certain policies are not strong enough in protecting the physical environment.

Indicator	Ecological considerations		
Sub-indicator	Ecosystem quality		
Object:	Score	Note	
Rewilding schemes	4	<p>The city deploys Rewilding schemes and aims to develop areas and structures that benefit the ecosystem quality. Subsequently, it aims to protect and conserve structures and spaces part of this scheme. For example, fish ladders are constructed which allow animal and plant species to pass along rivers and streams. These structures are then protected</p> <p>The strategy document describes the goal to have the city show its wild side by allowing nature into the city. Furthermore, green spaces need to be in tune with their natural rhythms.</p> <p>This would offer a varied experience of nature in the city and bring more aesthetic qualities to existing parks and green spaces.</p> <p>Furthermore, rewilding produces a high level of biodiversity which benefits the urban community.</p>	

<p>Campaign for better quality open spaces</p>	<p>0</p>	<p>The city deploys measures to improve the quality of public and private open spaces to gear them to the interests and wishes of local residents.</p> <p>Furthermore, the city aims for more improvements in parts of the city which are currently inadequately served by open spaces.</p> <p>However with these measures no clear considerations are given to the ecological needs and functions of these open spaces. Measures can therefore deteriorate the ecosystem quality of these open spaces.</p>
<p>Enhance the quality of green rings and axes</p>	<p>3</p>	<p>The city wishes to improve the quality of the spaces part of its interconnected network of green open spaces from the city center to the edges of the city.</p> <p>The goal is to enhance the amenity value and quality of these green spaces to make it more robust and climate adaptive.</p> <p>One aim is to restore the natural water cycle of these areas. Furthermore, the city wishes to make these areas more accessible to migrating species to enhance biodiversity.</p>
<p>Functional natural environments</p>	<p>5</p>	<p>The city wishes to ensure productive and functional natural environments.</p> <p>Current measures include: The promotion of stable forest ecosystems. Protection of the functions of woodlands. The city is investing in monitoring and protecting the woodlands which might be negatively impacted by climate change. For example, pests are</p>

			expected to increase which could harm the forest ecosystems in and around Hamburg.
	Total	3	The city of Hamburg aims to improve the quality of its ecosystems by rewilding measures, improving connection for species migration and restoring water cycles. Secondly, the city wishes to protect its native species by monitoring the effect of climate change and formulating conservation measures. However, some measures can potentially deteriorate ecosystem quality due to the overemphasis on human needs and desires.

Indicator	Ecological considerations		
Sub-indicator	Biodiversity		
Object:	Score	Note	
Hamburg green roof strategy	2	<p>Hamburg greener on top. Green roofs provide habitats for species and therefore improves the biodiversity within the city.</p> <p>Short term actions include the planting of 100Ha of green roof surface.</p> <p>It is uncertain if green roofs, which are limited to insects and birds, improve the biodiversity of the city overall in the long term. However it does make the city more attractive to species and improves the biophysical nature of the built environment.</p>	
Biotope network	4	<p>The city is developing and subsequently conserving a coherent network of biotopes. It aims to safeguard this network of habitats and corridors that are home to native species and plants.</p>	

		<p>The biotope network aims to maintain diversity, uniqueness and beauty, but also promotes biodiversity through corridors. The city aims to improve the quality of corridors and the amount of corridors.</p>
Enhance the quality of green rings and axes	4	<p>The city wishes to improve the quality of the spaces part of its interconnected network of green open spaces from the city center to the edges of the city.</p> <p>The goal is to enhance the amenity value and quality of these green spaces to make it more robust and climate adaptive.</p> <p>One aim is to restore the natural water cycle of these areas. Furthermore, the city wishes to make these areas more accessible to migrating species to enhance biodiversity.</p>
Rewilding schemes	5	<p>The city deploys Rewilding schemes and aims to develop areas and structures that benefit the ecosystem quality. Subsequently, it aims to protect and conserve structures and spaces part of this scheme. For example, fish ladders are constructed which allow animal and plant species to pass along rivers and streams. These structures are then protected</p> <p>The strategy document describes the goal to have the city show its wild side by allowing nature into the city. Furthermore, green spaces need to be in tune with their natural rhythms.</p> <p>This would offer a varied experience of nature in the city and bring more aesthetic</p>

			<p>qualities to existing parks and green spaces.</p> <p>Furthermore, rewilding produces a high level of biodiversity which benefits the urban community.</p>
	Total	4	<p>The city has policies in place and future strategies that aim to enhance biodiversity alongside the protection of said level of biodiversity. The green roof programme is rather optimistic in its ecological possibilities, but it does however add to the amount of habitual space within the cities and would enhance the amount of nature within the city.</p>

Indicator	Ecological considerations		
Sub-indicator	Species consideration		
Object:	Score	Note	
Hamburg landscape programme (HLP)	3	<p>The HLP is an instrument that takes into account the functions of natural and open spaces within the built-environment. This instrument is used in the planning process in order to safeguard natural processes and functions as much as possible and potentially enhance them through urban planning and design.</p> <p>The instrument includes targets on species conservation and climate adaptation measures. Some of which are species specific.</p> <p>The HLP also features climate/ecosystem thematic maps that show native species and species necessities within the environment (i.e. biophysical parameters such as soil nutrition level or pH).</p>	



Urban trees and climate change project		5	<p>The city is currently studying the vulnerability of trees which might be negatively impacted by climate change. For example, pests are expected to increase which could harm the forest ecosystems in and around Hamburg.</p> <p>The city aims to monitor and subsequently formulate conservation and adaptation measures.</p> <p>Measures are taken for individual species. Similarly, target (native) species are monitored. Currently, the programme is limited to trees and woodlands within the Hamburg administrative area.</p>
	Total	4	<p>The city of Hamburg maps the various species within its administrative area. It subsequently details the needs of these species and uses that inform future planning decisions. Subsequently, it studies and monitors trees with regard to climate change in order to formulate conservation and adaptation measures in order to protect its woodlands.</p>

Indicator	Ecological considerations		
Sub-indicator	Forest coverage		
Object:	Score	Note	
Urban trees and climate change project	5	<p>The city is currently studying the vulnerability of trees which might be negatively impacted by climate change. For example, pests are expected to increase which could harm the forest ecosystems in and around Hamburg.</p> <p>The city aims to monitor and subsequently formulate conservation and adaptation measures.</p>	

		<p>Measures are taken for individual species. Similarly, target (native) species are monitored. Currently, the programme is limited to trees and woodlands within the Hamburg administrative area.</p> <p>Risks to various species and forest communities Modification of site conditions</p>	
Active preservation	5	<p>Existing forested areas are preserved at all costs. 'Unavoidable exploitation' is still possible in extraordinary circumstances. These however have to be compensated.</p>	
Forest management	4	<p>The city is evaluating forest management plans. These plans include plans to create stable multi-layered structures in order to stabilize the forest ecosystem and safeguard the functions of woodland ecosystems.</p> <p>Measures include utilizing suitable mixtures of tree species and early silvicultural intervention.</p>	
	0	<p>The city has no plans to increase the amount of woodland within its administrative areas. Few ecological connections are planned.</p>	
	Total	3	<p>The city of Hamburg aims to protect and conserve its woodlands and trees. It does so by designating them as protected areas, but also through studying and monitoring the effects of climate change on individual tree species. However, it does not aim to increase the forest coverage within the administrative area or add natural spaces to existing woodlands.</p>

## Environmental quality

Indicator	Environmental quality		
Sub-indicator	Water quality		
Object:	Score	Note	
Removal of pollutants from the Elbe estuary and river	3	<p>Hamburg initiated the Remediation of contaminated Elbe sediments programme in 2010 and aims to continue the project.</p> <p>Agricultural areas and natural areas in the floodplains are exposed to pollution from the Elbe river system, which could harm the Wadden Sea. Fish from the Elbe estuary are unsafe for human consumption.</p> <p>This programme deploys a sediment management scheme. Which aims at removing pollutants at their source, such as the industrial areas of Hamburg and the harbor.</p> <p>There are no elements that try to remove existing pollutants in sediments.</p>	
Water management and inland flood protection	2	<p>The city of Hamburg aims to guarantee the water quality of Hamburg's terrestrial water bodies in the long term.</p> <p>Subsequently it aims to increase the amount of places where it is safe to bathe, allowing more water bounded recreational possibilities.</p> <p>No clear measures presented</p>	
Structural plan rainwater 2030	4	<p>Aim of the project is to keep rainwater out of the sewers to prevent future incidents where untreated sewage is leaked.</p> <p>The precipitation should be returned directly into the</p>	

		<p>natural water cycle, allowing groundwater recharge.</p> <p>Measures include: (re)construction projects have to take measures to promote Infiltration and evaporation as much as possible</p> <p>Construction of water-sensitive roads</p>	
Continuation of the Elbe, Alster and Bille programmes	4	<p>Ensure the quality of water bodies that have been tackled in the past.</p> <p>The Elbe, Alster and Bille programmes are continued which preserve these water bodies at target levels as determined by the EU Water Framework Directive (2000/60/EC).</p>	
Landscape Programme and Rain infra Structure Adaptation project (RISA)	3	<p>The Landscape Programme and RISA project include measures for implementing the EU water framework directive, aimed at improving and conserving water quality of terrestrial water and groundwater bodies. These projects utilize specialist maps on urban climate, water and soils.</p>	
	Total	3	<p>The city of Hamburg has clear visions and goals regarding water quality, it however does not always present clear measures in order to achieve so.</p>

Indicator	Environmental quality		
Sub-indicator	Soil quality		
Object:	Score	Note	
Brownfield development	0	<p>The city aims to redevelop brownfield sites. The strategy does not mention soil remediation plans nor soil quality agreements.</p>	

Action plan 2020/2030	0	<p>Nature and soil conservation is one of the 14 actions areas in the action plan 2020/2030.</p> <p>No clear measures are presented.</p>	
Landscape programme	2	<p>The city aims to protect soils important to the climate development plans. Goals include the promotion of seepage, evaporation and other measures to stabilize the water regime.</p> <p>The goals are included in the landscape programme, which also aims to guarantee a uniform soil moisture for vegetation, groundwater recharge and increased evapotranspiration rates.</p> <p>Measures include the evaluation and monitoring of soil performances with regard to microclimates and conservation measures to protect soils from development and coverage.</p>	
	Total	1	<p>The city of Hamburg has some soil quality strategies, however these are limited to water retention and groundwater goals. However, this is only a piece of the system. Therefore, current measures are inadequate.</p>

Indicator	Environmental quality		
Sub-indicator	Rainwater drainage		
Object:	Score	Note	
RegenInfraStrukturAnpassung - Rain Infrastructure Adaptation 2030 (RISA2030)	5	<p>City strategy for sustainable management of rainwater. Less water can be drained away. Main goal is to prevent sewage system overloads.</p> <p><b>Measures:</b></p>	

		<p>Water sensitive urban and building design. Integrate water management in planning, with the emphasis on proactive planning.</p> <p>Complementation of the centralized drainage system</p> <p>Increase storage capacity in basins.</p> <p>Construction of a legal framework for water management in new building areas.</p> <p>Urban development policies on environmentally friendly buildings that maximize infiltration and evapotranspiration.</p> <p>Remove paving in certain districts to improve infiltration rates.</p> <p>Decentralized rainwater management utilizing a separate network for rainwater, which is directed towards nearby water bodies.</p>
Hamburg green roof strategy	4	<p>The city of Hamburg aims to increase its amount of green roof coverage within the coming decade.</p> <p>The city deploys an active green roof strategy that includes green roof grants, which can be made for voluntary roof greening measures for roofs above 20 m<sup>2</sup>. The grant is applicable to private and commercial parties.</p> <p>The city aims to make green roofs mandatory by law in the near future.</p>

			The green roof strategy complements the RISA2030 programme and aims to increase green space in heavily urbanized areas.
Landscape programme		4	<p>The city aims to protect soils important to the climate development plans. Goals include the promotion of seepage, evaporation and other measures to stabilize the water regime.</p> <p>The goals are included in the landscape programme, which also aims to guarantee a uniform soil moisture for vegetation, groundwater recharge and increased evapotranspiration rates.</p> <p>Measures include the evaluation and monitoring of soil performances with regard to microclimates and conservation measures to protect soils from development and coverage.</p>
RISA tools & instruments		5	<p>RISA2030 also mandates the construction and utilization of smart maps. These smart maps are focused on groundwater tables, contours, infiltration potential. These maps provide the planning guidelines .</p> <p>RISA also mandates the continued evaluation of infiltration rates.</p>
	Total	5	Rainwater drainage and climate resiliency are top priorities for the city of Hamburg. It has made an extensive list of measures with the RISA programme, which also sets examples and facilitates innovation in the form of tools and instruments, as well as planning practices.

Indicator	Environmental quality		
Sub-indicator	Air quality		
Object:	Score	Note	
Hamburg green roof strategy	0	<p>The city of Hamburg aims to increase its amount of green roof coverage within the coming decade.</p> <p>The city deploys an active green roof strategy that includes green roof grants, which can be made for voluntary roof greening measures for roofs above 20 m<sup>2</sup>. The grant is applicable to private and commercial parties.</p> <p>The city aims to make green roofs mandatory by law in the near future.</p> <p>One of the goals of the green roof strategy is to improve air quality. The strategy mentions that green roofs are able to clean the air by absorbing dust and harmful substances. This is, however, highly uncertain as it requires large substances of green roofs to have significant effects.</p>	
Traffic measures	4	<p>The city of Hamburg is enforcing emission control regimes in urban districts, allowing vehicles with certain emissions levels to enter.</p> <p>The city also aims to promote alternative drive trains which have no emissions (EVs and hydrogen fueled vehicles).</p>	
The partnership for air quality and low-emission mobility	1	<p>This partnership is between the city, the chamber of commerce and local commercial parties. It aims to raise awareness, formulate and communicate best practices and aid in mobility management of companies. Companies that join the partnership have to make a commitment to improving the</p>	



			city's air quality with their mobility policy.  It is however not very stringent in enforcing company commitments, nor is it enticing companies to join the partnership.
	Total	2	The city aims to improve air quality in its city by emission control, green roofs and partnering with companies to make their mobility policy more sustainable. The green roof strategy is rather optimistic, while the partnership can be more stringent. Its emission control and promotion of alternative drive trains is successful and state of the art.

Indicator	Environmental quality		
Sub-indicator	Sewage treatment		
Object:	Score	Note	
	Total	0	The city of Hamburg has no strategies that aim to improve sewage treatment by investments in facilities and/or wetland construction.

Indicator	Environmental quality		
Sub-indicator	Restoring natural processes		
Object:	Score	Note	
Structural Plan Rainwater 2030	4	The primary objective of this plan is to restore the urban environment to a near natural water regime. This is done by developing future-oriented solutions, active monitoring and mapping utilizing smart maps and water management.	

			Provide water storage for drought periods and dealing with high intensity precipitation events. Measures are laid out in the RISA 2030 programme.
Rewilding schemes		2	<p>The city aims to stabilize the sediment load in the Elbe estuary to reduce dredging necessities for its port. It aims to improve sediment quality and relieve the upper area of the tidal Elbe of fine materials by river engineering measures and organizes sediment management.</p> <p>Spatial measures include the formation of more shallow areas which would provide valuable habitats and where sediments can deposit.</p>
	Total	3	The city of Hamburg wishes to restore its hydrogeological system to a near nature regime. It however aims to disrupt the natural sedimentation cycle of the tidal Elbe estuary in order to reduce dredging quantities for its harbor. However, it aims to construct more shallow areas upstream where sedimentation processes can take place ahead and around the harbor, which would create valuable habitats.

## Green infrastructure

Indicator	Green infrastructure		
Sub-indicator	Integration		
Object:	Score	Note	
No integration policy in the periphery	0	The city has a large strategy on agriculture, however no considerations are given to nature development and integrating goals from the nature conservation strategy with its agricultural strategy.	

		Examples from other cities include the planting of flowers for pollination and establishing corridors between plots of land.
Integrating economy and ecology	1	The city aims at linking economy and ecology by developing solutions which benefit both spheres simultaneously.
Recreation	0	Improve the quality of open spaces to the interest and wishes of local residents and make these more suitable for public recreation.
Green roof strategy	4	<p>The green roof strategy aims to provide habitats, provide temporary water retention and evapotranspiration to reduce heat stress.</p> <p>Furthermore, green roofs are also designated as meeting space and recreational spaces within the densely urbanized environment. Therefore 20% of green roofs of new urban development in the city has to be publicly accessible.</p>
Water management	4	Flood defense structures within the city also serve as public parks and green corridors.
Strategic land management	4	<p>Few cases when internal growth is not possible:</p> <p>Future development has to conserve its land resource. This is done by balancing and integrating the needs and functions of the natural environment and citizens, such as good quality green spaces and recreational areas. Integrate demands of ecology and citizens.</p> <p>Measures include constructing strategic land management plans. These show the balance between the desired protection</p>

		and development of green spaces and landscape areas with the need for housing and workplaces.  This plan denotes attention and consideration given to the (bio)physical environment, there are however no mandatory standards and indicators. It is therefore possible for new suburban development to have few investments made which are beneficial to the natural environment.	
Action plan 2020/2030	2	Green spaces part of the green finger connections and Hamburg's green network also function as air corridors which provide cooling air to compensate for the urban climate during hot summer days.  This designation provides an additional protective status for green spaces within the city.	
	Total	2	The city of Hamburg deploys a wide variety of integration measures regarding green spaces and other uses. However, there are still gaps within the measures and some might deteriorate the quality of green spaces such as the strategic land management, which denotes no mandatory investments or quality agreements with regard to the ecosystem.

Indicator	Green infrastructure		
Sub-indicator	Proximity		
Object:	Score	Note	
Green roof strategy	2	The city has formulated the goal to make 20% of green roofs of new urban development accessible to the public. These green roofs act as meeting	

		spaces, public recreational areas and spaces where citizens can get rest.
Temporary green spaces	2	<p>The city of Hamburg wants to explore potential new open spaces that go beyond the traditional structure.</p> <p>Part of this scheme includes the temporary construction of green spaces when ground is not in use.</p> <p>Furthermore, the city aims to construct an island within the Hafencity district to provide green space and room for leisure activities.</p> <p>Additionally, the city is exploring community garden projects on both public and private land for apartment blocks and city districts.</p>
Accessibility by design	2	<p>Future design of green and open spaces have to be freely accessible to the public .</p> <p>Hamburg wants to guarantee accessibility to nature in the city.</p>
Integrate the community in designing public spaces	2	<p>The city wants to preserve the accessibility and experience value of public spaces. Furthermore, it wants to guarantee the accessible of disadvantaged portions of the population</p> <p>Secondly, it set itself the goal of integrating the community with the design of public spaces.</p>
	Total	2
		<p>The city acknowledges the scarcity of open and green spaces within the built environment. It therefore aims to preserve its current spaces, guarantee accessibility to everyone and subsequently provide temporary spaces when possible, when lots are</p>

			temporarily unused. However, no clear quantified goals such as access to an open or green space within one kilometer are formulated within the strategy.
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Indicator	Green infrastructure		
Sub-indicator	Connectivity		
Object:	Score	Note	
Green network	4	<p>The Green finger connections are a major component of Hamburg's green network. The green network is a key to the connectivity of wildlife habits, as it allows animals to move freely from one space to another.</p> <p>The main goal is to have an interconnected network of green open spaces from the center to the periphery.</p> <p>The city aims to expand and fund new parts of its green corridors.</p> <p>Steps will be taken to increase the amenity value and quality of these spaces.</p>	
Agricultural policy	0	<p>Hamburg's extensive agricultural policy and strategy does not include nature conservation goals such as the construction of corridors between plots of land.</p>	
Landscape policy	4	<p>The current landscape policy aims to link parks, leisure and sports areas with each other in order to allow people and fauna to travel from the city center to the outskirts without coming into contact with traffic.</p> <p>In its effort to minimize traffic contact and increase the landscape quality, the city is</p>	

			planning a large ecoduct over the A7 motorway in Altona.
Action plan 2020/2030		2	<p>Green spaces part of the green finger connections and Hamburg's green network also function as air corridors which provide cooling during hot summer days.</p> <p>The city aims to improve the air corridors by creating and connecting more open spaces with each other.</p>
Biotope network		5	<p>The city is developing and subsequently conserving a coherent network of biotopes. It aims to safeguard this network of habitats and corridors that are home to native species and plants.</p> <p>This network allows species to move freely in order to preserve and improve the level of biodiversity. Furthermore, it aims to develop functional ecological interactions.</p>
	Total	3	<p>The city has clear ambitions to maintain, preserve and improve its green network consisting of interconnected green and open spaces. It also aims to allow citizens and fauna to move freely along these corridors with minimizing traffic contact. Therefore it is constructing an ecoduct over the A7 motorway.</p>

Indicator	Green infrastructure		
Sub-indicator	Quality		
Object:	Score	Note	
Green roof strategy	4	Hamburg is going green on top. Hamburg is already implementing 44Ha of green roof space by new residential development and 66ha by commercial development in the short term. It had the goal of	

		<p>100Ha by 2020, the next goal (2030) has not yet been presented.</p> <p>Planted roof gardens offer additional spaces for nature, recreational space and water retention and microclimate control due to evapotranspiration.</p>	
Sustainable development of environmental quality	3	<p>The city aims to promote urban greenery and natural areas with The sustainable development of environmental quality. This includes the green roof strategy, investments in the existing green spaces and green structure.</p> <p>Furthermore, it aims to refine its systems and enrich the network by also serving areas occupied by trade and industry activities.</p>	
New aesthetic qualities	2	<p>The city of Hamburg aims to create new aesthetic qualities to its existing network of parks, open spaces and green spaces.</p> <p>This is achieved by offering a varied experience of nature and bringing natural spaces into tune with natural rhythms.</p>	
Better quality open spaces	3	<p>The city aims to attain improvements in parts of the city which are inadequately served by open spaces.</p>	
	Total	3	<p>The city of Hamburg aims to conserve and improve its current network of green spaces, this is done by investing in the green network, its green and open spaces and the green roof strategy. It also aims to create new aesthetic values to its natural capital.</p>

Indicator	Green infrastructure		
Sub-indicator	Maintenance		
Object:	Score	Note	



My Tree My City	2	The 'My Tree My City' project was an enormous success as it showed the willingness of citizens to help nature within the city. Therefore citizens are included in the city's contribution to replenish its stock of trees.
Green roof strategy	2	The green roof strategy actively monitors the capabilities of its green roofs. It aims to update green roof regulations in order to improve ecological standards.
Giving nature space in the city	5	<p>The city aims to allow nature to show its wild side in the city. This is achieved by careful maintenance that guarantees the productive and functional capacity of the environment, which in turn produces a high level of biodiversity.</p> <p>Measures are included in the Hamburg landscape programme and the Biotope network and are described as the maintenance, restoration and development of functional ecological interactions within the city of Hamburg.</p>
Urban trees and climate change	5	<p>The city is currently studying the vulnerability of trees which might be negatively impacted by climate change. For example, pests are expected to increase which could harm the forest ecosystems in and around Hamburg.</p> <p>The city aims to monitor and subsequently formulate conservation and adaptation measures.</p> <p>Measures are taken for individual species. Similarly, target (native) species are monitored. Currently, the programme is limited to trees</p>

			and woodlands within the Hamburg administrative area.  This ties into the city goal on maintain a vigorous stock of trees, which is embedded in the Hamburg landscape programme. The Urban trees and climate change programme is a proactive approach to achieve this goal.
Forest management		4	The city is evaluating forest management plans. These plans include plans to create stable multi-layered structures in order to stabilize the forest ecosystem and safeguard the functions of woodland ecosystems.  Measures include utilizing suitable mixtures of tree species and early silvicultural intervention.
	Total	4	The city of Hamburg has active strategies and measures to allow nature to thrive within its administrative borders. It deploys a proactive approach to its tree stock by monitoring and evaluating its tree stock and forest management plans to improve its conservation measures and to safeguard the ecosystem and its ecosystem services.

Indicator	Green infrastructure		
Sub-indicator	Microclimates		
Object:	Score	Note	
Green roof strategy	5	The city of Hamburg deploys an active green roof strategy which seeks to climate proof buildings against excessive heat by constructing green roofs. These structures provide evapotranspiration, which ultimately cools down the direct environment.	

		<p>The green roof strategy also actively monitors the capabilities of its green roofs with regards to evapotranspiration.</p> <p>The city aims to make green roofs mandatory by law in the near future.</p>	
Acknowledgement effects urban heat stress	4	<p>The city acknowledges the problems related to urban heat stress and its negative effects on public health, such as listing heat related illnesses.</p> <p>The city has made heat stress one of the greatest challenges of climate change and as a response has authorized an urban climate survey. The result was a smart map visualizing urban heat islands which are used to consult future urban planning processes.</p>	
Transformation of urban spaces	3	<p>The city of Hamburg aims to invest in its green open spaces to enhance visitor value such as cooling spaces during hot summer days.</p> <p>This is done by constructing new forms of water storage within these spaces.</p>	
Action plan 2020/2030	4	<p>Green spaces part of the green finger connections and Hamburg's green network also function as air corridors which provide cooling air during hot summer days.</p> <p>Areas part of this air corridor are protected and optimized to ensure air exchange.</p> <p>The city aims to improve the air corridors by creating and connecting more open spaces with each other.</p>	
	Total	4	<p>The city of Hamburg sees urban heat stress as a major threat to the built environment. It has</p>

			active policy measures and strategies in order to adapt the urban environment as much as possible. These include air corridors, green roofs and also turning green spaces into cooling spaces by utilizing innovative and creative water storage methods.
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## Human oriented considerations

Indicator	Human oriented considerations		
Sub-indicator	Education		
Object:	Score	Note	
Green roof strategy	4	<p>The city of Hamburg deploys awareness campaigns and economic incentives for behavioral change with regard to sustainability.</p> <p>This also includes a major component of the green roof strategy, which actively monitors the capabilities of its green roofs. It aims to update green roof regulations in order to improve ecological standards.</p> <p>Subsequent actions are taken to generate awareness and educate citizens how to maintain maximum utilization of their green roofs.</p> <p>Furthermore it also aims to generate more awareness for green roofs in order to have more individuals and commercial parties opting for the green roof strategy Grants.</p>	
Motivate and include citizens	4	<p>A key topic area within the strategy document is the continued action in informing, educating and motivating the urban society with regard to urban sustainability.</p>	

		<p>The city of Hamburg wants to generate enthusiasm for environmental action by including citizens in green maintenance such as through the 'My Tree My City' project.</p> <p>Measures include educating citizens how to manage their gardens and/or green roofs, but also to generate new aesthetic values to public green spaces.</p> <p>The awareness raising and education are an important pillar of Hamburg's climate activities.</p> <p>The city aims to continue organizing events on a regular basis which inform citizens about environmental challenges.</p> <p>Additionally, the Hamburg planetarium also functions as the climate change information and education center, which on average draws 500k visitors a year.</p>
Hamburg climate campus	4	<p>Hamburg has set itself the goal to become a climate research hub. It wants to facilitate and increase the amount of climate related education and training possibilities and institutions. The goal is to invest in the research and science sector in the sphere of climate research. Furthermore, this sector will organize regular events to showcase new research and findings to everyone interested.</p>
	Total	<p>4</p> <p>Hamburg wants to actively educate and generate awareness amongst its citizens with regard to urban sustainability. This also includes measures with regard to environmental sustainability</p>

			such as improving the ecological standards of green roofs, but also investing in climate research such as through the urban trees and climate change programme. The science sector will organize regular events to everyone interested to learn more about advancements in sustainability research.
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Indicator	Human oriented considerations		
Sub-indicator	Protection of (natural) cultural heritage		
Object:		Score	Note
	Total	0	The city of Hamburg does not describe the cultural values of certain natural areas in its administrative area. It does include conservation measures for its woodlands some of which have cultural values, but they are not mentioned within the strategy, nor used for a form of protective status.

Indicator	Human oriented considerations		
Sub-indicator	Biosphere stewardship		
Object:		Score	Note
Rewilding schemes and the Hamburg green roof strategy		4	The city of Hamburg wants to allow citizens to experience nature. This is done by offering a varied experience of nature and bringing natural spaces into tune with natural rhythms.  Additionally, the city's green spaces are allowed to show its wild side through careful maintenance. This guarantees the productive and functional capacity of the environment,

		<p>which in turn produces a high level of biodiversity.</p> <p>The rewilding measures also facilitate the development of functional ecological interactions within the city of Hamburg.</p> <p>These measures all aim to build the socio-ecological memory of citizens.</p>
Integrate ecological demands of citizens	2	<p>The city of Hamburg wants to have a high degree of biodiversity in its green spaces, as these spaces are important as recreational and educational spaces where urban society can experience nature. Therefore quality improvements are necessary for its green spaces.</p> <p>It therefore aims to integrate demands of urban ecology, the citizens (which yearn to experience nature) and the economy (which aims to capitalize on nearby green spaces).</p> <p>No clear concessions and standards are mentioned with this strategy, therefore it is possible that recreational and economic demands are favored over ecological demands.</p>
	Total	<p>3</p> <p>The city of Hamburg has some measures in place to improve biosphere stewardship amongst its urban population. It does so by improving the quality of existing green spaces, green management schemes, conservation efforts and rewilding measures. However, the amount of action points is rather small and some don't include clear goals and</p>

			measures that benefit the environment in the long term.
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Indicator	Human oriented considerations		
Sub-indicator	Public recreation		
Object:	Score	Note	
Landscape policy	5	The city is planning to link public recreation spaces (parks, leisure, sports areas, playgrounds and cemeteries) with each other. The goal is to allow citizens (and fauna) to travel from the city center to the outskirts without encountering traffic.	
Green roof strategy	4	20% of new green spaces have to be publicly accessible for recreation. Green roofs can serve as meeting places, gardens and leisure areas within the densely populated city center.	
Open up waterfront	4	Existing waterfront sites must be preserved and opened up As these locations have special landscape quality. Hamburg is a maritime city and sees its waterfront as an attractive place where people can relax.  Measures: Redevelop parts of the Elbe river banks into a new urban waterfront location, such as new dykes or flood defense structures, which are built as a design element of the public space.  Additionally, the Hafencity district will feature an island development in the port basin for leisure activities as this densely built part of the city does not offer enough space for recreational activities.	



Maintenance and management	4	<p>The city of Hamburg aims to improve its recreational areas by collaborating with residents and commercial parties.</p> <p>It plans to interact with residents that want to help shape their open spaces, for example by constructing community gardens on public and private land.</p> <p>Furthermore, it aims to create synergies with the private sector with regard to designing and maintaining public spaces.</p> <p>With the main goal of maintaining well kept private and public open spaces.</p>	
Accessibility	4	<p>The city guarantees the accessibility and inclusion of disadvantaged portions of the urban population with regards to open green spaces in the city.</p> <p>Valued and accessible green spaces and recreational areas are a valuable element of democratic urban culture, according to the city of Hamburg.</p> <p>The city also aims to attain improvements in parts of the city which are inadequately served by open spaces.</p>	
	Total	4	<p>The city of Hamburg has made public recreation an important and integral part of its sustainable development strategies. It aims to conserve, maintain and improve its current recreational areas, while also facilitating the construction of new recreational areas.</p>

Indicator	Human oriented considerations		
Sub-indicator	Foster social and environmental innovation		
Object:	Score	Note	
Hamburg ECO-partnership	5	<p>The city of Hamburg is establishing a joint venture between the local government and the commercial sector, named the ECO-partnership.</p> <p>Its tasks include: encouraging companies to go beyond local sustainability and environmental requirements to take additional measures to improve sustainability.</p> <p>It also serves as a large platform for information and networking for the commercial sector and relevant local government bodies.</p> <p>The partnership also offers free consultation and supports commercial parties with planning and implementing projects on climate adaptation and environmental management.</p>	
Hamburg climate campus	4	<p>Hamburg has set itself the goal to become a climate research hub. It wants to facilitate and increase the amount of climate related education and training possibilities and institutions. The goal is to invest in the research and science sector in the sphere of climate research.</p> <p>The campus will also serve as an incubator for startups in the environmental sector.</p>	
Active monitoring and Smart maps	5	<p>The city of Hamburg actively invests in monitoring its geo-hydrological systems, tree stock and green roofs.</p>	

		It aims to provide better conservation and guidance measures to improve the ecosystem or infiltration system of its green infrastructure. The lessons learned can then be utilized by other cities.	
Pioneering climate mitigation and adaptation	4	Hamburg wants to become a pioneer in climate mitigation and adaptation and aims to set examples for other cities. Therefore it engages with other maritime cities, for example waterfront development, to share knowledge and insights.	
City laboratory	5	Hamburg has made its city a laboratory for new experiments. The 2030 strategy notes that residents are willing to cooperate when relevant schemes are utilized. For example, schemes on green management or cycling.  Therefore the city aims to engage in relevant research and construct relevant environmental schemes to be tested within the city.	
	Total	5	The city of Hamburg is a major facilitator of social and environmental innovation. It wants to actively promote its city as a laboratory, invests in relevant research and engages with other cities and the commercial sector to improve environmental sustainability and quality.

Indicator	Human oriented considerations		
Sub-indicator	Ecosystem services		
Object:	Score	Note	
Green roof strategy	4	The green roof strategy mentioned a wide variety of ecosystem services that are underlying principles of the	

			strategy. These include combating heat stress through evapotranspiration, rain water retention, providing recreational possibilities and their effects on air quality.
Increase the valuation of open green spaces			<p>The city of Hamburg aims to invest in its green open spaces to enhance visitor value. It acknowledges the importance of ecosystem services with regards to its parks.</p> <p>For example, constructing new forms of water storage within these spaces to make them cooling spaces during hot summer days.</p>
	Total	4	Green infrastructure is an integral part of the climate adaptation, urban quality of life, recreational facilities and nature conservation within Hamburg. Green spaces are utilized to combat heat stress, pluvial flooding (and subsequent overloading of the sewage system), provide recreational areas, benefit public health and urban quality of life. The city makes careful considerations of ecosystem services with quality improvement investments .

## Appendix VII Assessment forms Breda

**City assessed:** Breda

**Date of assessment:** March 25th, 2021

### Ecological considerations

Indicator	Ecological considerations		
Sub-indicator	Habitat provisioning		
Object:	Score	Note	
Completion of the municipal ecological network	5	<p>New habitats are created within the urban fabric that connect existing ecological connections as part of the regional ecological corridor structure.</p> <p>The municipality has set a clear goal to complete the structure by 2027.</p> <p>Outside natural areas and future expansions are connected to the municipal and regional ecological main structure. This is done both to support the ecology of the region as well as to provide recreational space for its inhabitants.</p>	
Expansion of the Markdal area	4	<p>Structural investments are made within the 'Markdal' area. More ecological connections are made and more space is devoted to nature, thereby facilitating more space for habitats. The goal is set at increasing the amount of natural areas with 102 ha in the periphery of the city. This is a goal of devoting an additional 0.8% of the total administrative area towards nature on top of the existing 1347Ha (natural areas) + 249Ha (water), which is 12.8% of the total administrative area.</p>	
Construction of water retention areas	4	<p>Water retention areas are constructed within and around the city of Breda. These will serve as water storage and filtration areas, as well as</p>	

		provide habitats for aquatic organisms and birds
Investments in landscape improvements	4	The municipality is investing in the quality of the landscape in its periphery. Key goals include: increase the number of diversity in plant and animal species, provide habitat structures, noninvasive green management and providing calm spots where animals can reproduce. Furthermore, more trees and plants will be planted and the amount of space devoted to nature will increase. (this is an ongoing project and therefore no clear goals have been set, such as with the Markdal project).
Mark river improvements	2	The municipality of Breda is reconstructing historic inner city canals. Furthermore, the river Mark will get bypasses, green (re-naturalized) banks and will become stretched through the inner city.  The municipality has set clear goals to improve the river Mark's functions and water quality. This benefits both inhabitants of the city as well as flora and fauna, as it becomes a suitable habitat again for aquatic species and birds.  However, as the river Mark projects aim to make it more suitable for recreation it will also be rather disturbed and therefore less suitable as habitat.
	Total	4
		The municipality has clear goals to make the city more attractive to fauna as well as increase the number of natural areas in its periphery, thereby providing more space for habitats.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Ecological considerations
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Sub-indicator	Protected areas		
Object:	Score	Note	
Compact city approach	4	<p>The periphery of the city is designated for nature and agriculture. Future urban development should take place within the core.</p> <p>All natural areas in the periphery are protected from future urban development.</p>	
Green management plan	3	<p>The municipality has divided its administrative area into three zones based on the species assemblages and degree of urbanization. Each zone includes species goals (both for flora and fauna) and green management protocols (varying from intensive in urban areas to minimal in natural areas).</p> <p>The management approach for natural areas conserves and protects it from large scale human intervention.</p>	
Recreational focus of existing and future natural areas.	0	<p>The municipality focuses on an integral approach to its green infrastructure and natural environments. Investments are done both for the ecology of the area and to provide recreational areas for its inhabitants. Therefore no protected areas are solely designated for nature.</p> <p>The municipality aims to create green resting areas for its inhabitants where humans and animals can interact, as opposed to resting areas for fauna.</p>	
Investments in landscape improvements	4	<p>The municipality is investing in the quality of the landscape in its periphery. Key goals include: increase the number of diversity in plant and animal species, provide habitat structures, noninvasive green management and providing calm spots where animals can reproduce. Furthermore, more trees and plants will be planted and the</p>	

			amount of space devoted to nature will also increase in the future.
	Total	3	The municipality wants to protect and conserve the natural environment of its periphery. However, it doesn't go the extra step to provide nature reserves as every green space and natural area has to provide recreational opportunities.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Ecological considerations		
Sub-indicator	Ecosystem quality		
Object:	Score	Note	
Re-naturalization of the Mark river corridor	4	<p>Lengths of the Mark river will be altered to feature nature friendly banks as opposed to quays, allowing organisms such as water fowl to easily enter and leave the Mark river.</p> <p>Furthermore, large parts of the Mark river will feature green banks opposed to grey infrastructure such as concrete and tiles.</p>	
Green management plan	4	<p>The municipality has divided its administrative area into three zones based on the species assemblages and degree of urbanization. Each zone includes species goals (both for flora and fauna) and green management protocols (varying from intensive in urban areas to minimal in natural areas).</p> <p>The management approach for natural areas promotes nature to flourish on its own with minimal human intervention, thereby increasing ecosystem quality as it is left to grow on its own.</p>	
	Total	4	The municipality has a concrete plan with regard to green management that allows natural areas in the periphery to



			flourish with minimal human intervention. Furthermore, the river Mark (the backbone of the area) will become re-naturalized along a majority of its trajectory. The quality of the ecosystem will therefore increase by 2030.
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Table 3: evaluation sheet for the (sub)indicators

Indicator	Ecological considerations		
Sub-indicator	Biodiversity		
Object:	Score	Note	
Protect and hold the current biodiversity of the area	1	<p>The municipality expresses the clear goal to protect and keep the current level of biodiversity in the city and its periphery.</p> <p>This main goal does not express the wish to increase the level of biodiversity.</p>	
Create more ecological connections	4	<p>The city has clear goals to construct more ecological connections within its city and periphery. These include the re-construction of the inner city canals, new water retention areas and the expansion of the municipal ecological main structure. The municipality arguments on the basis of the theory of island biogeography. Ecological corridors allow the current level of biodiversity to survive and potentially grow.</p> <p>Natural areas outside the city will get better connections with each other.</p> <p>Clear goals have been set to finish the ecological structure by 2027.</p>	
Investments in landscape improvements	4	<p>The municipality is investing in the quality of the landscape in its periphery. Key goals include: increase the number of diversity in plant and animal species, provide habitat structures, noninvasive green management and providing calm spots where animals can reproduce.</p> <p>Furthermore, more trees and plants will be planted and the</p>	

		amount of space devoted to nature will increase.
Ecology as one of the key points of attention of municipal governance	4	<p>The municipality has made ecology and biodiversity one of its main focus points with regards to its policy.</p> <p>The main goal of the municipality entices: making Breda a livable, safe and attractive area for both humans and nature.</p>
Green management plan	4	The municipality has divided its administrative area into three zones based on the species assemblages and degree of urbanization. Each zone includes species goals (both for flora and fauna) and green management protocols (varying from intensive in urban areas to minimal in natural areas). This allows nature to flourish in the periphery with minimal human intervention.
Agrarian landscape management	3	The municipality is investing in the agricultural areas around the city in order to combat biodiversity loss. This includes increasing the number of flowers and the creation of small corridors between agricultural plots. However, no clear concessions , investments and goals have been made.
The municipal green plan	4	The municipality wants to make the urban environment more suitable as habitat for flora and fauna. Therefore, future development will first and foremost densify the city but also devote space and attention to blue and green space. The municipality has a green plan which includes the municipal ecological corridor structure as well as every tree and green space within the city. The goal is increase the coverage of green

			space within the city, especially along the ecological corridors.
	Total	3	The municipality actively acknowledges the decrease in biodiversity in its city and region. There are multiple plans and strategies that take this into account, but these try to maintain the current level of biodiversity, rather than increase it. The policy of the municipality can be described as maintaining rather than improving.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Ecological considerations		
Sub-indicator	Species consideration		
Object:	Score	Note	
Green management plan	4	<p>The municipality has divided its administrative area into three zones based on the species assemblages and degree of urbanization. Each zone includes species goals (both for flora and fauna) and green management protocols (varying from intensive in urban areas to minimal in natural areas).</p> <p>This plan includes clear considerations to certain indicator species, which the municipality wants to protect and facilitate in its administrative area.</p>	
Alter ecological corridors to better suit certain (indicator) species	3	<p>The municipality will develop an different ecological corridor for the European tree frog (<i>Hyla arborea</i>), to better suit this species.</p> <p>This demonstrates the consideration given to important species within planning practices of the municipality.</p>	
Investments in landscape improvements	4	<p>The municipality is investing in the quality of the landscape in its periphery. Key goals include: increase the number of diversity</p>	

		<p>in plant and animal species, provide habitat structures, noninvasive green management and providing calm spots where animals can reproduce.</p> <p>Part of this plan includes making certain landscapes more suitable for the existing flora and fauna, thereby demonstrating the careful consideration of species.</p>	
Agrarian landscape management	3	The municipality expressed the goal to increase the number of pollinating insects by careful landscape management and partnerships with agrarian businesses. This includes creating ecological corridors between agricultural plots, increasing the number of flowers in and around agricultural plots and educating farmers on how to operate nature inclusively.	
	Total	3	The municipality has given some considerations to specific species in certain parts of its plans, however these are not leading principles in the strategies.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Ecological considerations		
Sub-indicator	Forest coverage		
Object:	Score	Note	
No expansion plans for forests within the municipality	0	No plans are made to increase the number of forest coverage in the municipality even though the municipality contains a decent coverage of (cultural-historically important) forests. Furthermore, the focus on increasing the green space within the cities does not include tiny forests.	
Protection of forests	4	The municipality wants to protect the forests in its administrative area. This includes protecting its size as well as its quality by tackling the large nitrogen depositions.	

			All forests in the municipality are protected under the natura 2000 regulations.
Ecological connections between forests		4	The municipality has stated its ambition in constructing larger ecological connections between forests as part of its municipal ecological corridor structure.
	Total	3	Although the municipality actively wants to protect its green capital and culturally-historically important forests from excessive nitrogen deposition and future land development. It does not however express the ambition to increase forest coverage within its administrative area. It does however aim to improve connectivity between forests for species migration to ensure productive forest ecosystems.

## Environmental quality

Indicator	Environmental quality		
Sub-indicator	Water quality		
Object:	Score	Note	
Investments in water quality	2	The municipality has a clear vision on improving the surface water quality to standard in European directive 2000/60/EG.  No clear plans on how to achieve it have been presented in its policy documents.	
Water retention areas	4	The municipality wants to create water retention areas to prevent sewage outflow during high precipitation events, which would deteriorate water quality. Furthermore, water retention areas will be planted with indicator species that further	

		enhance water quality through filtration.	
Waterakkers project	5	<p>The waterakkers neighborhood consists of a large water retention area that filters treated wastewater at rates of 5000m<sup>3</sup> per day.</p> <p>This project is highly innovative as it is a pilot that is closely monitored if it is feasible, reliable and impactful.</p> <p>Furthermore, this project serves as an example for other cities.</p>	
Reduce nitrogen deposition	2	<p>The municipality wants to reduce nitrogen deposition in its surface and groundwater systems. This is done by working together with the agriculture sector on developing management strategies and policy under the theme of the biobased economy.</p> <p>Although mentioned as a strategy point, no clear goals and plans have been formulated.</p>	
	Total	3	<p>The municipality has made water and water quality important parts of its strategy document. Clear goals are presented that improve water quality to European standards. Furthermore, the municipality actively innovates by instigating the waterakkers project. However, the municipality is lacking in terms of working together with polluting sources on reducing pollutant deposition into its water sources.</p>

Table 3: evaluation sheet for the (sub)indicators

Indicator	Environmental quality		
Sub-indicator	Soil quality		
Object:	Score	Note	
Retain current soil and groundwater quality	1	The strategy document includes the goal to preserve the current soil and groundwater quality,	

			rather than to improve it to a certain standard.
Soil quality		2	The municipality wishes to intensify its use of the subsurface with regards to infrastructure development and the energy transition. The strategy document includes a clear procedure that future construction in the subsurface will include soil quality and groundwater quality improvements.
	Total	2	Although it is recognized that as a result of past activities and contemporary intensive farming procedures soil quality has decreased, the municipality wishes to preserve the current status rather than improving it. The only structural improvements are done in the form of ground clean-up work with new urban development.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Environmental quality		
Sub-indicator	Rainwater drainage		
Object:	Score	Note	
Water retention areas	4	<p>The municipality wants to create water retention areas to store and buffer water, thus in turn to prevent sewage outflow during high precipitation events, which would deteriorate water quality.</p> <p>Furthermore, water retention areas will be planted with indicator species that further enhance water quality through filtration</p>	
Re-naturalization of the Mark river and subsequent improvements	4	The Mark river will be upgraded to increase its drainage capacity. This is done by widening it and constructing floodplains and bypasses.	
Re-construction inner city canals	4	The inner city canals are being reconstructed, which allow water to be stored and moved downstream in the dense inner city.	

Climate adaptation measures within the built environment	4	Climate adaptation measures such as constructing blue or green infrastructure are integral parts of (re)development within the city.	
Multi-functional use of natural areas	3	New nature areas can serve as water retention areas in case of emergency. These areas are also part of the ecological corridor structure of the region and municipality.	
Decrease the amount of paved area	3	The municipality wants to improve soil infiltration rates by decreasing the amount of paved surfaces in dense urban environments. This includes measures to include blue or green infrastructure in future development. For the latter the municipality can set a quota for the percentage of green roof coverage for each new development.  No clear statistics and goals are presented within the strategy.	
Environmental impact assessment	4	Climate adaptation measures are a mandatory part of future environmental impact assessments within the city.	
	Total	4	The municipality has clear ambitions and strategies with regard to water retention and management. The municipality is tackling it integrally by looking at different measures for different environments. Blue infrastructure is seen as a must in the urban environment, if that is not possible green infrastructure is placed, for example green roofs. Furthermore, the municipality is investing in water retention areas that simultaneously serve as natural areas.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Environmental quality		
Sub-indicator	Sewage treatment		
Object:	Score	Note	



Construction of water retention areas		3	The municipality wants to create water retention areas to store and buffer water, thus in turn to prevent sewage outflow during high precipitation events, which would deteriorate water quality.
'Waterakkers' development		5	The waterakkers project includes a water retention area that is paired with planned aquatic plants in order to filter 5000m <sup>3</sup> water per day. The area is part of an ecological connection in the northeastern part of the city and provides a habitat to aquatic and bird species, as well as recreational activities for inhabitants. It is highly innovative as it serves as a pilot that is closely monitored.
		0	No strategies and goals are present to improve the sewage treatment procedures and standards to improve water quality.
	Total	3	The municipality has invested in the highly innovative waterakkers project to see if treated sewage can be further filtered through water retention areas with certain indicator species. Furthermore, more water retention areas are constructed in order to prevent outflow during high precipitation events. However, it is scale and scope is rather limited given the size of the city. Furthermore, the city does not wish to improve its sewage treatment standards to improve water quality.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Environmental quality		
Sub-indicator	Restoring natural processes		
Object:	Score	Note	
Recognition of natural processes	0	The municipality recognizes the natural processes such as sedimentation from the river Mark, however it wishes to remain in control. Water levels	

			and retention areas are managed and will remain managed.
	Total	0	The municipality has no goals and strategies to allow and facilitate natural processes such as sedimentation. However, it does recognize its position as an outflow area of the Mark river and its close proximity to the Meuse / Schelde delta.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Environmental quality		
Sub-indicator	Air quality		
Object:		Score	Note
Air quality targets		1	<p>The municipality has declared the goal to improve air quality, however it does not present clear measures on how it is going to achieve it.</p> <p>The municipality expects and anticipates that car usage will remain the same in 2030.</p> <p>However, the city aims to reduce car traffic in the inner city and increase the amount of green space to improve air quality.</p>
	Total	1	Although it is recognized, no concise goals and plans are formulated in the strategy document. It is however recognized that green space will improve air quality and urban quality of life.

## Green infrastructure

Indicator	Green infrastructure
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Sub-indicator	Integration	
Object:	Score	Note
Recreation		
Water as connecting element	4	Water is used as the identity and backbone of the city and its surrounding region. The Mark river and its tributaries such as the city canals and subsequent future blue infrastructure is used as: ecological corridor, water retention area, to combat urban heat stress and to improve urban quality of life.
Re-naturalization of the Mark river	5	This project has multiple goals and approaches attached to it. First and foremost it has ecological goals, as it is a major ecological corridor as it connects to multiple natural areas, secondly it is a large habitat for aquatic species and birds. Furthermore, there are cultural historical goals attached, as it is returned to its former glory, this also includes the re-construction of the inner city canals. This goal also aims to preserve and improve the aesthetic quality of the river and its banks. Lastly, it is seen as a major boost to recreation in the city that improves urban quality of life and the number of incoming tourists which is a major economic sector. To summarize, an integral approach is utilized for this blue/green development.
Connect with existing nature and provide recreation	3	New nature development will have to connect to the existing ecological structures. However, recreation has to be facilitated in these areas, to allow citizens to escape the city and experience nature.
Green infrastructure as long term investment	4	Nature development and blue-green infrastructure development within the city is seen as a long term investment

		for green based hospitalization (tourism) and public health.
Climate resiliency	4	Future urban green and blue infrastructure and the Mark river project can function as a water retention area and help combat urban heat stress. Climate adaptation in the form of blue or green infrastructure is an integral part of new urban (re)development.
	Total	4
		Nature and urban green space development is an integral component of public health, economy and environmental investments.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Green infrastructure		
Sub-indicator	Proximity		
Object:	Score	Note	
Parks have to be in walking distance	4	The municipality has set itself the clear goal: In 2030 every citizen has to be able to reach a green space within 200m of their front door. To achieve it the municipality is investing in new green and blue infrastructure within the city.	
Attractive periphery has to be in biking distance	4	Secondly, the municipality wants to facilitate every citizen in experiencing nature and having access to open green space. The goal is to have access to an open green space within 3km (cycling distance).	
Open up more green spaces for recreation	4	The municipality wants to open up more green spaces which are inaccessible due to inadequate infrastructure or ownership issues.	
The Mark river project	4	The Mark river and the reconstructed inner city canals will become easily accessible for fauna and citizens. Water recreation is considered an important element for the future of Breda.	

	Total	4	
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Table 3: evaluation sheet for the (sub)indicators

Indicator	Green infrastructure		
Sub-indicator	Connectivity		
Object:	Score	Note	
Water as connecting element			
Ecological main structure	5	<p>The municipality has set itself the clear target of: the network of ecological connections both municipal and regional has to be completed by 2027.</p> <p>Natural areas will get connected with each other and existing connections will be expanded.</p> <p>Species have to be able to migrate between all major natural areas and large green spaces within the city.</p>	
Connect with existing nature and provide recreation	4	<p>New nature development will have to connect to the existing ecological structures. However, recreation has to be facilitated in these areas, to allow citizens to escape the city and experience nature.</p>	
Re-naturalization of the Mark river and subsequent improvements	4	<p>The Mark river is seen as the ecological highway through the city and major habitat. This project includes making the banks 'ecologically friendly' allowing for better accessibility for species.</p>	
Expansion of the railway ecological corridor	2	<p>The railway ecological corridor is seen as one of the two major ecological corridors. Which will see structural improvements to its quality and size.</p>	
Connect the green infrastructure within the city with natural areas outside the city.	4	<p>The municipality wants to connect the municipal ecological structure with the regional structure.</p>	
	Total	4	<p>Ecological connections are seen as vital measures to improve biodiversity and the quality of the ecosystem. The municipality builds upon the island biogeography theory on its policy.</p>

Table 3: evaluation sheet for the (sub)indicators

Indicator	Green infrastructure		
Sub-indicator	Quality		
Object:		Score	Note
Increase green and/or blue coverage		4	The municipality recognizes that it has insufficient urban green and blue spaces. It however heavily invests in blue infrastructure due to its multi-functionality. Where there is no space for blue infrastructure or green spaces, the city will focus on green roofs. Its goal is to decrease the amount of paved surface and provide adequate green spaces within 200m of each citizen's front door.
Water as key element		4	Water is seen as an integral element which has positive effects on city climate, public health, citizen happiness, biodiversity and energy efficiency.  It is a main focus point through the strategy document.  The Mark river project, Waterakkers and water retention areas / nature areas are integral parts of this.
Green/blue infrastructure investments		4	New policy from the municipality and (re)developments will feature a structural investment in urban green infrastructure, natural areas or landscape quality (the latter includes making the landscape more suitable as habitat and improving ecological connections.
	Total	4	The city recognizes that the current quality is low and therefore it has set up numerous projects and measures to increase the amount of green / blue coverage in its administrative area.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Green infrastructure		
Sub-indicator	Maintenance		
Object:	Score	Note	
Green management plan	5	<p>The municipality has divided its administrative area into three zones based on the species assemblages and degree of urbanization. Each zone includes species goals (both for flora and fauna) and green management protocols (varying from intensive in urban areas to minimal in natural areas).</p> <p>The management approach for natural areas conserves and protects it from large scale human intervention. It is also highly innovative as it includes species considerations and nature conservation and biodiversity goals.</p>	
Investments in landscape improvements	4	<p>The municipality is investing in the quality of the landscape in its periphery. Key goals include: increase the number of diversity in plant and animal species, provide habitat structures, noninvasive green management and providing calm spots where animals can reproduce. Furthermore, more trees and plants will be planted and the amount of space devoted to nature will increase.</p>	
Agrarian landscape management	4	<p>The municipality expressed the goal to increase the number of pollinating insects by careful landscape management and partnerships with agrarian businesses. This includes creating ecological corridors between agricultural plots, increasing the number of flowers in and around agricultural plots.</p>	
Intensification of green maintenance within the city.	1	<p>The municipality wants to intensify its maintenance of urban and green infrastructure within the city. This is good for</p>	

			the urban quality of life but deteriorates the possibility of flora and fauna to thrive within the dense urban environment.
	Total	4	The municipality has made plans with regard to the maintenance and management of its green spaces. Inner city maintenance is intensified to improve urban quality of life, while the periphery will have less maintenance to let nature flourish.

Table 3: evaluation sheet for the (sub)indicators

Indicator	Green infrastructure		
Sub-indicator	Microclimates		
Object:	Score	Note	
Recognition	4	<p>Urban heat stress is seen as a major issue against public health and urban quality of life.</p> <p>The city has done extensive research to map the urban heat island effect in the city and uses it to inform future urban planning.</p>	
Water retention areas	2	<p>The municipality wants to construct water retention areas also to utilize them to provide cooling.</p> <p>Heat stress is tackled utilizing blue and green infrastructure within the city.</p> <p>Examples include the reconstruction of the inner city canals.</p>	
Part of the energy strategy	2	<p>Bluegreen infrastructure results in cooling and will reduce the energy use of nearby buildings. Heat stress and investments in blue and green infrastructure is also seen as an integral part of the energy transition.</p> <p>However it is only a part as the energy transition focuses more on reducing the need for heating.</p>	



Climate adaptation		4	Climate adaptation in the form of blue or green infrastructure is an integral part of new urban (re)development.
	Total	3	The city actively recognizes the implications of heat stress. It has conducted extensive research to map the urban heat island effect within its administrative area. Investments in green / blue infrastructure are seen as potential solutions and are argued on the basis of nature development, the energy transition, public health and urban quality of life.

### Human oriented considerations

Indicator	Human oriented considerations		
Sub-indicator	Education		
Object:	Score	Note	
Management	0	The municipality wishes to take full control and manage the city's efforts with regard to nature, biodiversity, climate adaptation and resilience. Instead of educating citizens and empowering them.	
Agrarian landscape management	2	The municipality expressed the goal to increase the number of pollinating insects by careful landscape management and partnerships with agrarian businesses. This includes creating ecological corridors between agricultural plots, increasing the number of flowers in and around agricultural plots and educating farmers on how to operate nature inclusively.	
	Total	1	The municipality does not express the goals and visions to educate its citizens with regard

			to environmental sustainability. It does however wish to partner with agrarian companies to innovate and educate how they can operate more nature-inclusively.
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Table 3: evaluation sheet for the (sub)indicators

Indicator	Human oriented considerations		
Sub-indicator	Protection of cultural heritage		
Object:	Score	Note	
Restore previous conditions (Mark) inner city canals			
Compact city approach	4	Protection of the periphery and the cultural historical character of its landscapes and natural areas. Only developments that add to this character are allowed such as nature development and agricultural plots that add to the current structure, which contains corridors between the plots.	
Project: Make historic water connections visible	4	The municipality is reconstructing its former city canals and former tributaries of the Mark river to bring out the cultural-historical character, as well as to provide better water drainage, combat heat stress, provide habitats and ecological connections and facilitate more recreation within its administrative borders.	
Culture historical green	4	<p>Most green spaces in and around Breda have ecological and cultural historical value. The municipality aims to protect these structures. For example, the medieval plot structure in the rural areas.</p> <p>The municipality is also investing in the replacement of authentic wooden quays along the sandy banks of the Mark river.</p>	
Water as identity	4	Water is seen as the key identity of the city and its region and forms the binding element in nature development, climate	

			adaptation and urban quality of life.
	Total	4	The municipality sees green as an integral part of its cultural-historical policy and identity. Therefore plans include to re-naturalize and reconstructing parts of former waterways. Furthermore, future development has to add to these structures and help protect this identity.

Indicator	Human oriented considerations		
Sub-indicator	Biosphere stewardship		
Object:	Score	Note	
Green as a major component of the local economy	3	<p>The municipality has made blue green infrastructure a key component of its investments in the local economy. The municipality notes that green and blue infrastructure are getting more appreciation amongst tourists and inhabitants.</p> <p>Green based leisure is seen as a growing sector and will receive more attention and investments. This in turn will increase the number of incoming tourists.</p>	
	4	<p>The municipality aims to create green resting areas where inhabitants are likely to interact with and encounter local fauna. The goal is to have every citizen experiencing nature and having access to open green space within 3km (cycling distance).</p>	
Make the city more attractive for local fauna	4	<p>The municipality aims to make the city more attractive to local fauna in order to facilitate more interaction between its inhabitants and nature.</p> <p>Plans include the connection of the municipal ecological structure and the regional</p>	

		structure, expansion of each structure respectively and creating more green and blue infrastructure in the city.
	Total	4
		There are clear goals to facilitate and foster more interaction between citizens and local fauna. Furthermore, it sees this as an lucrative opportunity for future economic development in the green leisure sector.

Indicator	Human oriented considerations		
Sub-indicator	Public recreation		
Object:	Score	Note	
Vital green 2030	4	<p>Public recreation is seen as vital just as blue and green infrastructure for public health. Therefore all new blue and green infrastructure has to allow public recreation possibilities by making them more accessible and frequent.</p> <p>For example, the new planned ecological connections also feature recreational/ mobility capabilities to allow citizens to travel between natural areas and the city.</p>	
Landscape quality improvements	5	<p>The municipality is investing in landscape quality to benefit both nature (as it makes areas more suitable as habitat and increases biodiversity through green management) and public recreation by making attractive walking and cycling routes and calm spots to relax.</p>	
More water born recreational activities	4	<p>The municipality wants to offer more water born recreational activities along the reconstructed inner city canals and in the Mark river re-naturalization project.</p>	
More sports facilities and public spaces	2	<p>The municipality wants to invest in more green spaces and sports facilities within the municipality.</p>	

			No clear goals and concessions are described for this goal/strategy.
	Total	4	There is clear consideration given to public recreation as it is a vital part of each green/blue development within the municipality. Recreation is linked to better urban quality of life, increased economic activity in the city and better public health.

Indicator	Human oriented considerations		
Sub-indicator	Foster social and environmental innovation		
Object:	Score	Note	
Foster innovation in agriculture	4	<p>The municipality is working on partnerships with agrarian businesses to make agricultural areas more biodiverse and to create ecological corridors between agricultural plots.</p> <p>Additionally, the municipality wishes to set policy into place to increase the number of flowers in and around agricultural plots in order to support pollinating insects.</p> <p>The municipality also educates farmers on how to operate nature inclusively and how green leisure can be utilized as an external source of income.</p> <p>However no clear goals are formulated and policy measures</p>	
Nature on doctor's prescription	5	<p>The municipality is working on formulating innovative cost benefit models that demonstrate the long term benefits of blue-green infrastructure (Energy transition: less cooling costs, public health: less healthcare costs).</p>	

			These models can be utilized by other cities to help support funding towards green and environmental development.
Waterakkers project		4	<p>The waterakkers neighborhood consists of a large water retention area that filters treated wastewater at rates of 5000m<sup>3</sup> per day.</p> <p>This project is highly innovative as it is a pilot that is closely monitored if it is feasible, reliable and impactful.</p> <p>The results from this project can be utilized by other cities.</p>
	Total	4	The municipality has a handful of constructive innovative projects. These include the Waterakkers project, the cost benefit models for green infrastructure investments and to an extent the farmers partnerships. The former two set the municipality and city as an example which can benefit other urban environments alike, the latter is decent in approach but lacks any clear goals and strategies.

Indicator	Human oriented considerations		
Sub-indicator	Ecosystem services		
Object:	Score	Note	
Nature on doctor's prescription	5	<p>The municipality is working on formulating innovative cost benefit models that work on the basis of ecosystem services. These models demonstrate the long term benefits of these services from blue-green infrastructure (Energy transition: less cooling costs, public health: less healthcare costs).</p> <p>The municipality recognizes the importance of green and blue infrastructure on urban quality</p>	

		of life, productivity and public health.
Green as a major component of the local economy	4	<p>The municipality has made blue green infrastructure a key component of its investments in the local economy. The municipality notes that green and blue infrastructure is getting more appreciation amongst tourists and inhabitants.</p> <p>Green based leisure is seen as a growing sector and will receive more attention and investments. This in turn will increase the number of incoming tourists.</p>
Water as key element	4	<p>Water is seen as an integral element whose ecosystem services have positive effects on city climate, public health, citizen happiness, biodiversity and energy efficiency.</p> <p>It is a main focus point through the strategy document.</p> <p>The Mark river project, Waterakkers and water retention areas / nature areas are integral parts of this.</p>
	Total	4
		<p>The strategy document actively acknowledges the wide range of ecosystem services. They are actively involved in strategies and policies on economy, climate adaptation, public health and the environment.</p>