iSCAPE

Report on solutions at urban level

D3.4

September 2017

(Updated December 2018)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 689954.

Project Acronym and Name	iSCAPE - Improving the Smart Control of Air Pollution in Europe	
Grant Agreement Number	689954	
Document Type	Report	
Document version & WP No.	V 0.4	WP3
Document Title	Report on solutions at urban level	
Main authors	Marisa Fuchs, Felix J. Othmer, Nadine Mägdefrau, Hanna C. Schmitt, Prashant Kumar, Stefan Greiving	
Partner in charge	TU Dortmund University (TUDO)	
Contributing partners	University of Surrey (UoS)	
Release date	07/09/2017	

Document Control Page			
Short Description	*The report provides an overview of the implications of urban design for the mitigation of air pollution and the improvement of the local climate. This deliverable is an output of Task 3.3.*		
Review status	**Action**	**Person**	**Date**
	Quality Check	*Coordination Team*	20/12/2018

	Internal Review	*Andreas Nikolaos Skouloudis (JRC-IES), Muhammad Adnan (UH)*	29/8/2017
	Internal Review	*Giorgio Bagordo (T6), Athanasois Votsis (FMI)*	10/12/2018
Distribution	Public		

Revision history			
Version	**Date**	**Modified by**	**Comments**
V0.1	23/08/2017	Nadine Mägdefrau, Julia Staufenbiel, Hanna C. Schmitt, Christina Gollmann, Britta Weißer, Florian Hurth, Madeleine Kirstein, Stefan Greiving (TUDO)	The first draft
V0.2	30/08/2017	Nadine Mägdefrau, Julia Staufenbiel, Stefan Greiving (TUDO)	First review
V0.3	07/09/2017	Nadine Mägdefrau, Julia Staufenbiel (TUDO), Prashant Kumar (UoS)	Reviewed and corrected version
V0.4	17/12/2018	Marisa Fuchs, Felix Othmer (TUDO)	Reviewed and corrected version. Strategies of SWOT analysis added.

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List of abbreviations

ARL	German Academy for Spatial Research and Planning
EEA	European Environment Agency
EU	European Union
D	Deliverable
FCC	Future City Catapult
FUA	Functional Urban Areas
GIS	Geo-Information System
HSL	Helsingin Seudun Liikenne
LL	Living Lab
NUTS	Nomenclature of territorial units for statistics
S-O	Strengths-Opportunities-strategies
S-T	Strengths-Threats-strategies
SWOT	Strengths, Weaknesses, Opportunities and Threats
UHI	Urban Heat Island
UK	United Kingdom
W-O	Weaknesses-Opportunities strategies
WP	Work Package
W-T	Weaknesses-Threats strategies

1 Executive Summary

Air pollution and the urban heat island effect are consequences of climate change that affect vulnerable population groups in urban areas. To tackle these effects, adequate strategies and solutions at the urban level are required. This report outlines tailor-made solutions at the urban level by conducting a SWOT analysis (Strength-Weaknesses-Opportunities-Threats-Analysis) and a stakeholder survey for the iSCAPE Living Lab (LL) Cities of Bologna, Bottrop, Dublin, Guildford, Hasselt and Vantaa.

The report analyses the relevant urban parameters that influence, and can regulate, urban air quality and the emergence of urban heat islands such as 'urban structure', 'transport', 'industry and trade' as well as 'urban green and blue infrastructure'. Each of these parameters were equipped with specific indicators to analyse the cities' strengths, weaknesses, opportunities and threats to engage in these specific fields.

For the parameter 'urban structure', the indicators 'sealed ground', 'population density' and 'urban development model' were used. The 'transport' network was represented through the 'commuter outflow' and the 'density of motorways' for the private sector, the 'equipment rate for public transport vehicles' for the public sector, the 'number of road freight vehicles' and the presence of an airport and/or sea freight port' for the freight sector. For the parameter 'industry and trade', the indicator 'share of industrial areas' was used, while the parameter 'urban green and blue infrastructure' was analysed with the help of indicators on the 'percentages of areas covered by green or blue areas' (forests, urban green, agriculture and water bodies).

The SWOT analysis of the spatial parameters was supplemented with a SWOT analysis of the results from the stakeholder survey as well as an analysis of plans and strategies (documents) of each city. The stakeholder survey was conducted by Future City Catapult (FCC) as part of Task 1.1 in November 2016; its results are collected in the iSCAPE Deliverable 1.1 (*Report on Challenges and Opportunities in iSCAPE Cities*).

The results from the SWOT analysis were used to identify relevant strategies and possible solutions for each LL City that address the challenges of climate change and improve air quality. In addition, the city and metropolitan plans and strategies of each LL City were examined to capture strategies, goals and measures corresponding to, or working towards, the strategies identified in the SWOT analysis. This provides an overview of activities currently in line with the strategies derived from the SWOT analysis, and therefore opportunities, as well as any gaps, provided by the existing city plans/strategies in each city. The solutions identified serve as a basis for the development of draft plans at the urban level that will be discussed with local stakeholders from the LLs during one-day workshops in order to check their usefulness and feasibility. This will be done as part of Task 3.6. At the urban level, Task 3.6 works towards approaching the aim to prepare actions plans for urban level interventions that "make the interventions ready for a real implementation.

Air pollution and the urban heat island effect are consequences of the climate change that affect vulnerable population groups in urban areas. To tackle these effects, adequate interventions at the urban level are required. The report of Task 3.6 on 'potentialities of urban interventions', 'action plans', and 'of climate effectiveness of urban interventions' details the functionality and effectiveness of urban level interventions and sums up the implementation action taken in different cities on the urban level. The identified strategies and approaches, which are described in the following, will be taken up in Task 3.6 and can serve as a starting point and basis for urban interventions and action plans.

2 Introduction to the Report

2.1 Aims and Objectives

This report completes Task 3.3 of the third work package (WP) of the iSCAPE project. Below you can find a description of the aims for the WP in general and the objectives of Task 3.3 taken from the project proposal.

The proposal defines the aims of WP3 (*Planning and evaluation of PCS solutions*) as follows:

- *"To optimise and deploy high-end air quality and meteorological stations at the Living Labs locations to monitor the improvements in terms of air quality;*
- *To optimise and deploy low-cost air quality monitoring kits for citizen science initiatives at the Living Labs;*
- *To improve the performances of photocatalytic coatings used on building facades in urban environments;*
- *To develop, model and deploy a range of infrastructural solutions identified in WP1 ad-hoc for each city location to improve the air quality in current climate conditions and reduce climate change adverse effects at neighbourhood and urban levels, with particular focus on areas where vulnerable population groups are;*
- *To capitalize on the technological innovation and smart citizen approach through the Living Labs to strengthen scientific knowledge on the use of low cost sensors."*

At the urban level, Task 3.3 works towards approaching the aim to "develop, model and deploy a range of infrastructural solutions […] for each city location to improve the air quality in current climate conditions and reduce climate change adverse effects at […] urban levels". In this context, the proposal defines the objective of Task 3.3 (Matching city needs to adequate solutions at urban level) through the following actions:

- SWOT analysis of the existing settlement structure, stakeholder interviews (see Section 2.5) and planning documents by the different implementing cities
- Elaboration of urban design concepts that anticipate the impacts of climate change and the needs for mitigating air pollution
- Discussion of draft plans at a one-day workshop with local stakeholders as part of the LL activities (will be part of Task 3.6)

The final action, the discussion of the draft plans at one-day workshop with local stakeholders as part of the LL activities will be transferred to Task 3.6 and D3.9. The reasons for this decision were the restricted time frame for Task 3.3. (3 months) and the possibility to use this Deliverable (D3.4) as a basis for the development and implementation of the workshops with the local stakeholders, if the workshops are conducted a little later on.

2.2 Introduction to urban design and air pollution

Historically, air pollution was mainly linked to industrial sites, which were concentrated in specific parts of industrialized cities. Locatable air pollution like this could be controlled through the designation of industrial zones and the prohibition of industries in residential areas. With the mass production of the automobile after World War II, the approach to deal with air pollution changed rapidly. Cars could take the pollution that they caused anywhere they went. The identification of the car as a source of air pollution "altered the nature of urban air quality management in a number of important ways" (Stone, Jr., 2005, p. 14). One of these ways was the abandonment of land-use planning as an approach to deal with air pollution. Instead, policies mainly focused on a technological approach by requiring automobile manufacturers to reduce the emission of the cars they produced. This approach was also applied to industrial enterprises, which were required to lower their smoke and other emissions since the 1950s (Williams, 2004).

Urban Heat Island Effect

In comparison to a more rural surrounding, cities have an annual average elevated temperature of 1-2°C (Kuttler, 2011; Matzarakis *et al.*, 2008). This gradient results from the radiative and thermal conditions that differ between built-up and undeveloped areas, i.e. the "absorption ability, the heat capacity, the heat conductivity, and the evaporation ability of the underlying ground" (Reuter and Kapp, 2012; Section 2.3). This distinct temperature difference of surface temperatures is called 'urban heat island' (UHI) (U.S. Environmental Protection Agency, 2008)

Until today, air pollution control policies have resulted in an improvement of air quality, particularly in urban areas (Williams 2004). Nevertheless, the growing number of cars in combination with increasing travel distances result in the fact that traffic pollution today is the most significant threat to air quality in most of the larger cities (Næss, 2014; Williams, 2004). This means, that even though significant successes could be reached by reducing the emission of cars, additional approaches should also be applied to increase the effectiveness of air pollution control. In this context, the importance of urban structure for air quality in cities has been (re)discovered. There are many aspects of a city that can either decrease or increase the amount of air pollution as well as influence the emergence of heat islands, these include:

- **Urban structure:** The urban form of the city influences its air quality. Traveling distances between different urban functions (e.g. housing, working, leisure) in compact cities are usually shorter and can be reached via public transportation more conveniently than it is the case in dispersed settlements caused by urban sprawl. The European Commission declared the model of the compact city as most effective in relation to a sustainable urban development (European Commission, 1990). For instance, a dense and compact city provides better conditions for an effective transport network and lesser emissions than dispersed settlements (Legras and Cavailhès, 2016; Næss, 2014). On the other hand, dense urban structures can lead to a high degree of ground sealing, which is directly linked to temperature gradients in cities. Furthermore, the emergence of UHI is also mostly dependent on the degree of ground sealing (Buth *et al.*, 2015; Knieling *et al.*, 2012; Kuttler, 2008). Sealing increases both the average annual temperature of an area and engraves the daily temperature differences (Reuter and Kapp, 2012). Additionally, the sealed ground is air- and water-tight, which impedes rainwater infiltration and restricts gas exchange between ground and atmosphere (Umweltbundesamt, 2013). As another side effect, heavy rainfall may lead to urban flooding as densely populated and sealed urban areas do not

have sufficient rainwater storage capacities. Furthermore, a high degree of ground sealing in combination with a low proportion of vegetation leads to a higher physical stress during heat waves (Kuttler *et al.*, 2013; Steinrücke *et al.*, 2011). As a result, a compact settlement structure that has proper ventilation through appropriate green infrastructure (In terms of quantity as well as quality) is understood as an ideal spatial design concept (Kuttler, 2008).

- **Transport:** Transport is one of the main causes of air pollution in cities (Brosch *et al.*, 2016; Kuttler, 2008). The road transportation sector in Europe causes around 23% of total greenhouse gas emissions, after energy production with 55%, mainly by cars and other on-road vehicles. Though technological innovations could reduce the air pollution caused by transport (by 36% between 1990 and 2007), it is not expected that these emissions can be stabilized, especially those caused by private transport (Eurostat, 2017; Legras and Cavailhès, 2016). Urban transport networks include the following three types: private, public, and freight transport. As functional segregation of work, leisure and living areas caused longer distances, the most used form is private transport with a focus on cars as means of transport, causing high energy use for transportation (Holz-Rau and Scheiner, 2005; Næss, 2014). In contrast, public transport is far less energy consumptive per passenger kilometer, which is why a shift to public transport is often politically wished for (Holz-Rau and Scheiner, 2005). However, this shift requires a change in mobility behaviour, which can – amongst others – be enhanced through accessible and extended public transport network which should also be reasonably priced. Further emission reduction strategies can e.g. be the shift of freight transport from road to rail (Ministerium für Verkehr und Infrastruktur Baden-Württemberg, 2015). The transport network depends on the urban form (see urban structure above), suburbanization and decentralisation of for e.g. of the retail sector caused urban sprawl. This often results in an increased air pollution through private and freight transport (Holz-Rau and Scheiner, 2005).

- **Industry and trade:** Since their emergence, industrial plants have been an important source of air pollution in urban areas (Stadt Nürnberg, 2012). The effect of industrial air pollution depends on their location within a city. This location can be governed by spatial planners through land-use planning. Today, it is a common understanding in spatial planning that industrial plants should not be located upwind of sensitive land-uses such as residential areas, schools or hospitals. While this approach can reduce the impacts of industrial air pollution on a city's citizens, the location of these plants in the periphery increases the amount of traffic from and to the industrial plants (Becker *et al.*, 2011). This traffic includes private traffic (by the workers) and commercial traffic (freight transport).

- **Urban green and blue infrastructure:** Urban green and blue infrastructure has a positive impact on air quality, as it is capable of filtering CO_2, able to produce cold air and to store rainwater, so green spaces and water bodies are important for the local climate in cities. In addition, they have a cooling effect, able to mitigate potential heat loads in UHI (Aflaki *et al.*, 2017; Bruse, 2003; Kuttler, 2008). Therefore, it is necessary that a city's built structure contains an appropriate amount of water bodies and especially green spaces to positively influence the city's local climate (Yu *et al.*, 2017).

2.3 Our Approach

This report focuses on two main approaches: 1) a SWOT analysis to identify suitable strategies to reduce air pollution and mitigate the urban heat island effects, and 2) an analysis of existing city and metropolitan plans and strategies (mainly urban planning documents) to find out to what extent the LL Cities are already following the strategies derived from the SWOT analysis and identify any gaps.

2.3.1SWOT analysis

The SWOT analysis, used in this report, is a verbal-argumentative evaluation-method (Fürst and Scholles, 2008). It was originally used by companies to identify their qualities and the external influences they have to face. Since the 1990s the SWOT analysis approach is also used at a local government level as a strategic management tool (Kühn, 2008). The overall aim of the analysis is to systematically evaluate the current situation and develop integral strategies to reach a specific goal (Kallmünzer, 2010). The results of this evaluation will be validated by the stakeholder workshops which are part of 3.6.

Therefore, key factors that help to reach this goal need to be identified and put into four different categories (Fürst and Scholles, 2008):

S	= Strengths	internal qualities, helpful to reach specific goal
W	= Weaknesses	internal qualities, harmful to reach specific goal
O	= Opportunities	external conditions, helpful to reach specific goal
T	= Threats	external conditions, harmful to reach specific goal

The internal factors in relation with strengths and weaknesses are the features of the city: own resources, experiences, a city's built or green infrastructure. They can be influenced by the local government. The external factors such as opportunities and threats (e.g. politics, law, economy, culture, demographics), on the other hand, are exogenously set, and cannot be directly influenced. To address opportunities and threats, the local government has to observe and anticipate the external factors (e.g. react with an adoption of strategies) (Holt *et al.*, 2017). With this approach, SWOT analyses are able to support both, strategic planning and decision making.

To successfully implement a SWOT analysis, the following five working steps should be followed (Kühn, 2008; Fürst and Scholles, 2008):

1. Identification of the specific goal that should be achieved
2. Analysis of internal factors and categorization as strengths or weaknesses (S, W)
3. Analysis of political, economic, socio-cultural, technical, legal and ecological framework conditions and categorization as opportunities and threats (O, T)
4. Collection of analysis results in matrix table (Table 1)
5. Development of appropriate strategies

As a first step, a specific goal has to be identified. A SWOT analysis can be used for different purposes such as the selection of a location for certain land-uses or the evaluation of different projects. Steps 2 and 3 include the analysis and categorization of the internal (S, W) and external factors (O, T). Strengths and opportunities are helpful to reach the specific goal while weaknesses and threats have a negative or problematic influence. Once analysis and categorization is complete, the results are put together in a matrix (step 4). The combination of strengths and

weaknesses with opportunities and threats then enables the development of the following four different types of strategies (step 5) (Kühn, 2008; Fürst and Scholles, 2008):

- Strengths-opportunities strategies use the existing strengths to pursue opportunities,
- Strengths-threats strategies use these strengths to reduce threats,
- Weaknesses-opportunities strategies use opportunities to eliminate weaknesses, and
- Weaknesses-threats strategies have the purpose to eliminate Weaknesses and reduce threats.

The SWOT matrix and the four different types of strategies are shown below in Table 1:

		internal	
		strengths 1. … 2. … 3. …	**weaknesses** 1. … 2. … 3. …
external	**opportunities** 1. … 2. … 3. …	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 1. … 2. … 3. …	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 1: SWOT matrix (own figure based on Kallmünzer, 2010).

The goal of this specific SWOT analysis is to improve the air quality and reducing the heat island effects in the iSCAPE LL Cities. The SWOT analysis was conducted for each single LL, based on the following parameters: 'urban structure', 'transport', 'industry and trade', and 'urban green and blue infrastructure'. These parameters were elaborated in D1.2 (*Guidelines to Promote Passive Methods for Improving Urban Air Quality in Climate Change Scenarios*). In addition, planning documents and results from the stakeholder survey (D1.1: *Challenges and Opportunities in the iSCAPE Cities*) will be taken into account to develop adequate strategies for each LL.

2.3.2Analysis of local plans and stretegies

For each LL City, local strategies and plans were examined to compare what is already in place at a city level with the strategies identified in the SWOT analysis undertaken. The strategies and plans examined included overarching, sectoral or integrated planning documents, both formal and informal, dealing with policies, objectives, strategies and interventions aimed at reducing air pollution and emissions as well as mitigating the urban heat island effects. These included air

quality plans, climate mitigation concepts, climate adaptation concepts, land-use plans, green and open space concepts or transport development concepts.
Strategies, plans and documents vary from country to country and city to city, as do the terms and designations used. When relevant, objectives, strategies and/or measures/interventions already present in local strategies and plans were highlighted within the strategies developed through the SWOT analysis so as to provide an overview of the extent to which the LL Cities are already in line with the strategies being proposed.
The strategies and plans analysed for each LL City are listed in the following table:

LL City	Local plans and strategies
Bologna	Piano Strategico Metropolitano di Bologna 2.0 (2018) Piano Energetico Regionale Emilia-Romagna (2017) Piano per l'Innovazione Urbana di Bologna (2016) Programma per la Qualificazione Urbana (2015) GAIA Green Areas Inner City Agreement (2013) Piano d'azione per l'energia sostenibile (2012) Regolamento Urbanistico Edilizio (2009) Programma Energetico Comunale (2007) Piano Generale del Traffico Urbano (2006)
Bottrop	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014) Integriertes Klimaschutzkonzept der Stadt Bottrop (2011) Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord Masterplan Emscher-Zukunft (2006) Flächennutzungsplan der Stadt Bottrop (2004) Landschaftsplan der Stadt Bottrop (2004)
Dublin	Dublin City Development Plan 2016-2022 (2016) Transport Strategy for the Greater Dublin Area 2016-2035 Dublin City Sustainable Energy Action Plan 2010-2020 Dublin Regional Air Quality Management Plan 2009-2012 Climate Change Strategy for Dublin City 2008–2012
Guildford	The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting (2018) Air Quality Strategy 2017-2022 Guildford Borough Transport Strategy 2016

LL City	Local plans and strategies
	Surrey Transport Plan: Climate Change Strategy (2011)
Hasselt	Klimaatadaptatieplan Limburg 2017 Fietsactieplan Hasselt (2017) Woonplan Hasselt 2030 (2015) Mobiliteitsplan Hasselt-Genk (2014)
Vantaa	Helsinki City Air Quality Plan 2017-2024 Helsinki Metropolitan Area Climate Change Adaptation Strategy (2012) City of Vantaa´s Environmental Policy 2012-2020 (2012) Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)

Table 2: Analysed planning documents

2.4 Spatial parameters influencing air quality

As already introduced above, air quality can be affected by the following parameters: 'urban structure', 'transport', 'industry and trade', and 'urban green and blue infrastructure'. These parameters are introduced in the following paragraphs. Each parameter is equipped with several indicators, which help estimate a city's strengths and weaknesses in the context of air quality. The parameters were introduced in D1.2 and are used for the SWOT analysis as and when appropriate valuation standards could be identified.

2.4.1Parameter 'urban structure'

In the following, the indicators 'sealed ground', 'population density' and 'urban development model' are used for an approximation of the parameter 'urban structure' (see Section 2.2).

2.4.1.1 Sealed ground

The indicator 'sealed ground' contains the percentage of the sealed ground. It is derived from spatial data and based on the different degrees of ground sealing according to different land-use categories. For the SWOT analysis, a low percentage of sealed ground (< 30%) is valued as positive and a high share of the sealed ground is valued as negative (≥ 80%) (EEA, 2011).

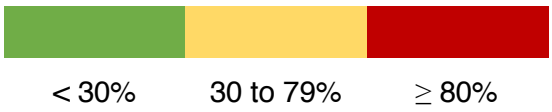

Figure 1: Rating scale for the indicator 'sealed ground' (EEA, 2011)

2.4.1.2 Population density

Additionally, the indicator 'population density' depicts the average number of inhabitants living per km² over the total urban area. These people are potentially being affected by urban heat. The values for each LL were gathered from D1.1 (*Challenges and Opportunities in the iSCAPE Cities)*,

with the exception for Bottrop where the value was taken from the city's climate protection concept (Stadt Bottrop, 2011). The values for each LL are rated positively under a population density of 2,999 people per km², whereas a population density over 5,000 is evaluated negatively.

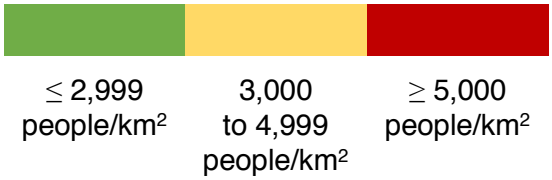

Figure 2: Rating scale for the indicator 'population density' (EEA, 2011)

2.4.1.3 Urban development models

In the following, the characteristics of the three urban development models 'compact city', 'decentralised city' and 'decentralised concentration' and their role in air quality and the local climate are assessed.

2.4.1.3.1 The compact city

The urban development model of the compact city (Figure 3) is an internationally discussed and broadly accepted spatial guiding principle in urban planning in Europe (Burton *et al.*, 2003; Tian *et al.*, 2014; Stigt *et al.*, 2013). The model describes the counteraction of urban sprawl by refocusing on the quality of inner-city districts.

Figure 3: The urban model of compact city, not to scale (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006, p. 27)

The model of the compact city is characterised by a concentrated and resource-efficient settlement development. Accordingly, the different land uses within a city (residential areas, business districts, industry and trade, urban green etc.) are in direct proximity, promoting a functional mix. In a compact city, vehicle kilometres travelled per inhabitant are generally lower than in the other urban models due to rather short distances and well-developed public transport. As a result, pollutant emission from private transport is reduced. Additionally, compact cities have a favourable environmental balance due to their concentrated surface sealing (protection of the countryside, low urban sprawl) and a good modal split (BMVBS/BBSR, 2009; Mitchell *et al.*, 2011). This model is also known as "new urbanism" and "smart growth". In summary, the urban development model of the compact city is characterised by the following aspects (BMVBS/BBSR, 2009; Mitchell *et al.*, 2011):

- High-density settlement development within existing urban areas (reduction of land usage)
- Functional mix of land uses instead of mono-functional areas
- Attractive and efficient public transport systems, strong local connections

These advantages of a compact city can be exemplified with the cities Bologna and Dublin. According to the European Commission, more than 20% of the respondents to the 'Survey on perceptions of quality of life in 75 European cities' in both cities use public transport on a daily basis (European Commission, 2010).

Nevertheless, there also are disadvantages to the urban development model of compact cities. Compact cities are at risk of becoming too compact if an ongoing settlement development puts pressure on urban green spaces and results in the restriction of local recreation areas. Eventually, this can lead to the necessity for citizens to commute to the periphery for recreational purposes, creating transport emissions (BMVBS/BBSR, 2009). Furthermore, the structure of compact cities with high rise building along streets can restrict the ventilation, increasing the risk of concentrated air pollution in the city centre and an increased UHI potential if large amounts of the surface are sealed (BMVBS/BBSR, 2009).

From a spatial perspective, the following guidelines can be summarised for cities that apply to the urban development model of a compact city:

- Positive characteristics as e.g. a sophisticated public transport network and operation should be preserved.
- Further settlement development should take place with respect to the preservation of urban green spaces.
- Possibilities for settlement pressure need to be weighed carefully against the opportunity for green space development and should consider ventilation and UHI potential.
- Existing green and blue spaces should be interlinked in order to enable fresh air transport.
- Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions (Cohen and Potchter, 2010).
- Especially in dense structures, space-saving solutions of urban green need to be developed, e.g. façade greening and green roofs. Both types of urban green are able to reduce urban heat, especially in core cities (Leal Filho, 2016). Furthermore, extensive green roof systems are able to filter fine dust particles (Steyn and Trini Castelli, 2012)
- Roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors (Steinrücke *et al.*, 2011).
- Measures aiming at a reduction of private transport can actively be implemented e.g. through a reduction of parking spaces in the core city centre, the introduction of vehicle tolls, the closure of roads for motorised vehicles or an increase of parking fees (Onursal and Gautam, 1997).

A good practice example can be taken from the city of Bologna. In Bologna, the threats of a compact city have been recognised and measures have been set up: "Bologna, like many Southern European cities, is facing drought, extreme temperatures and water scarcity as a result of climate change. With no national or regional adaptation action plan still in place, the city of Bologna took it upon them to draft an Adaptation Plan to Climate Change. The plan, which was approved by the City Council on October 2015, focuses on the development of innovative, concrete measures that could be tested locally" (EEA, 2016). The measures such as the inclusion of adaptation measures in the City's Building Code to envisage incentives for adaptation to a more efficient management of climate change effects or the definition of guidelines for infrastructures at risk, so that infrastructural reactions during extreme meteorological events can be improved were developed as part of the LIFE+ project BLUE AP (Bologna Local Urban Environment Adaptation Plan for a Resilient City) (BlueAp, 2017).

2.4.1.3.2 The decentralised city

The urban development model of a decentralised city (Figure 4) evolved in the 1980s as a reaction to the continuous urban sprawl, resulting from suburbanization processes. Suburbanisation describes the outward migration of population and compact cities' function to the suburbs and beyond.

Figure 4: The urban model of decentralised city, not to scale (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006, p. 27)

The urban development model draws on the diffusion of the compact city and promotes a revaluation of disperse settlement structures by focusing on a spatial development outside the core city (Knieling *et al.*, 2012). Characteristics of decentralisation can also be found in other models such as "Edge City" or "Postsuburbia" (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006). The urban development model of a decentralised city is characterised by the following aspects:

- Population and core city functions are spread across a complex network of central and less central places instead of being concentrated in a dominant core city
- Nodal points are less concentrated and not bound by hierarchical centralization patterns. Instead, these networks of nodal points are significantly more finely woven
- No clear distinction between open spaces and densely populated settlement areas is possible. In contrast, open spaces and loosely built-up areas form a mosaic structure (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006).

Decentralised cities have the advantage that ventilation usually is well as they have a high share of green spaces and no highly condensed core centre. The city of Vantaa is a suitable example for a decentralised city with over 60% of its area being green and blue spaces contrasting only 18% sealed surface. A decentralised settlement structure generally offers the opportunity for high-quality design of settlement and green structures (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006).

Nevertheless, the urban development model of a decentralised city is highly criticised due to the urban sprawl, the fragmentation of landscape and the accompanying impairment of eco functions such as loss of biodiversity and arable land (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006). Moreover, disperse settlement structures hold the risk of encouraging private transport and consequently trigger traffic-induced CO2 emissions. This is often the case when public transport is underdeveloped due to high maintenance costs and the various directions of travel that make public transport quite inefficient.

From a spatial perspective, the following guidelines can be summarised for cities that apply to the urban development model of a decentralised city:

- On-going decentralisation tendencies should be picked up in development concepts, which focus on a concentration of jobs and public functions (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006).
- Further settlement development should be conducted in line with the urban development model of decentralised concentration, i.e. along existing axes and with a local focus on concentration.
- In order to reduce distances, mixed land-uses should be aspired.
- Public transport, especially between cities, should be improved to become an alternative to private transportation.
- Other private transport reduction measures, like car sharing, should be fostered.
- Environmental functions like the production of ground water, cool air or valuable habitats need to be protected either by land-use planning or environmental planning in order to mitigate the negative effects of the further expansion of settlements and infrastructure.

A good practice example can be taken from the city of Vantaa. Vantaa is actively working on a reduction of private transport emissions and a shift to public transport. The local public transport provider Helsingin seudun liikenne (HSL) is promoting sustainable mobility: ”The aim is to encourage people to reduce driving alone in their cars and increase walking, cycling, use of public transport, car sharing, ride sharing and economic driving. Good public transport services, town planning and locating services and jobs close to housing reduce the need to use a car on a daily basis“ (HSL, 2017).

2.4.1.3.3 Decentralised concentration

The spatial model of decentralised concentration (Figure 5) has evolved in reaction to the two spatial models described above and may be described as a combination of both. It combines large-scale decentralisation and small-scale compact settlement structures with high density and high amounts of open spaces. This means spatial decentralisation and concentration are being applied on different scale levels (BMVBS/BBSR, 2009).

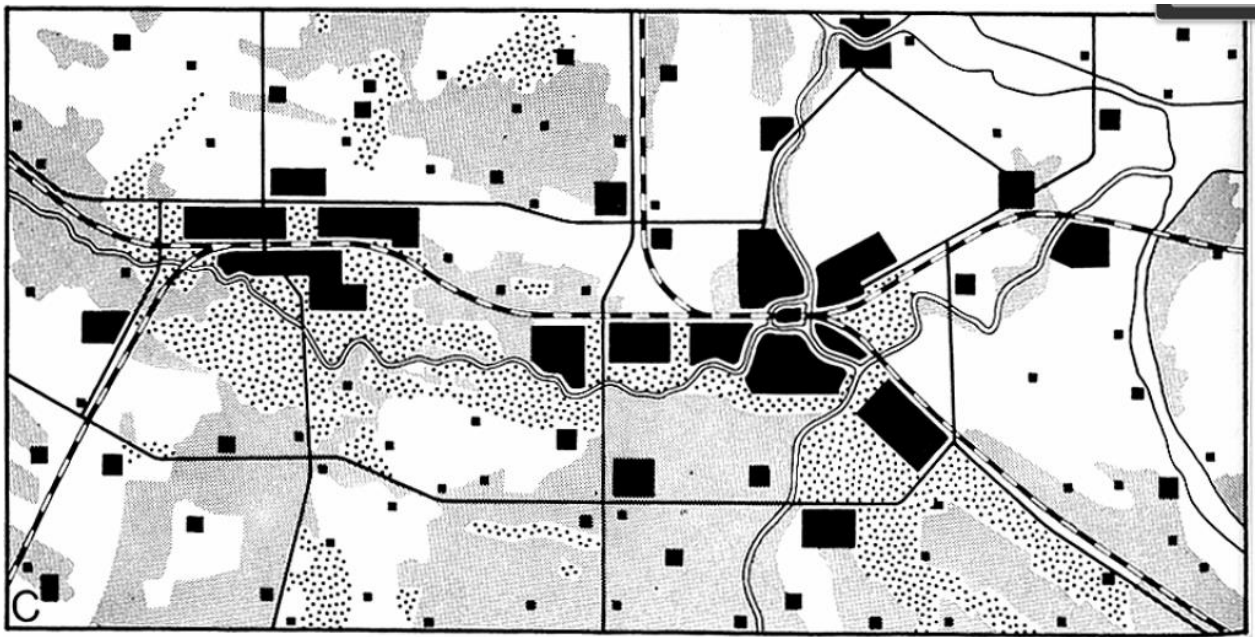

Figure 5: The urban model of decentralised concentration, not to scale (Kooperationsgemeinschaft Landesentwicklungsplan Berlin-Brandenburg LEP B-B, 2006, p. 27)

The urban model of decentralised concentration focuses at counteracting disperse settlement development in favour of a balanced spatial development. The model roots from various other urban development models. The model of decentralised concentration originates from Ebenezer Howard's Garden City model (Knieling *et al.*, 2012) . The German Academy for Spatial Research and Planning (ARL) states the model's evolution from the Central Place Theory by Walther Christaller (ARL, 2017). In summary, the urban development model of decentralised concentration is characterised by the following aspects:

- Development of decentralised centres and small-scale networks through the concentration of settlement development and infrastructures in centres along the main transportation axes (BMVBS/BBSR, 2009).
- The small decentralised centres are being developed following the principles of the compact city (BMVBS/BBSR, 2009; Knieling *et al.*, 2012).
- Prevention of spatial disparities and congestion in growth regions and strengthening of existing regional potential (ARL, 2017).

The model of decentralised concentration reduces the stress on the core centre by distributing settlement to various smaller centres. Furthermore, spatial disparities are reduced and agglomerated regions are strengthened (ARL, 2017). At the same time, suburbanization processes are prevented due to a point-axial development. In the ideal realisation of the urban development model, there is less settlement pressure than in the compact city, green spaces can be preserved and even connected so that eco functions remain high and the UHI potential is lowered (BMVBS/BBSR, 2009; Knieling *et al.*, 2012).

Nevertheless, the sophisticated supply infrastructure that exists within cities associated with the model of decentralised concentration can also be seen as its greatest threat. If the infrastructure is well developed until wide in the periphery, further land consumption may become an option (BMVBS/BBSR, 2009).

From a spatial perspective, the following guidelines can be summarised for cities that apply to the urban development model of a decentralised concentration:

- Positive characteristics such as an adequate mix of functions and sophisticated public transport should be preserved.
- Further settlement development should take place with respect to the preservation of urban green spaces with special consideration of the maintenance of ventilation channels and other ecologic functions such as groundwater production, habitats, etc.
- Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions (Cohen and Potchter, 2010).
- In denser settlement structures, space-saving solutions of urban green can be enhanced, as e.g. façade greening and green roofs. Additionally, roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors (Steinrücke *et al.*, 2011).
- Measures aiming at a further reduction of private transport can actively be implemented, for example, through a reduction of parking spaces in the core city centre, the introduction of vehicle tolls, closure of roads for motorised vehicles or an increase of parking fees (Onursal and Gautam, 1997). Other interventions could be the introduction of bike renting with nominal fees, car sharing and schemes to encourage modal shift from private to public transportation systems. Some of these interventions are discussed in detail in D1.3 (*Report on Behavioural Interventions*).

Table 3 gives an overview of the described indicators and their data basis.

	Indicator	**Description**	***Data Basis***
Urban Structure	Sealed ground	*Percentage of sealed ground on the basis of total city area (in Percent)*	*Spatial data: Urban Atlas Data / CORINE Data*
	Population density	The number of inhabitants living per km^2	*D1.1 (Challenges and Opportunities in the iSCAPE Cities).*
	Urban development model	Analysis based on a city's affiliation to the urban development model 'compact city', decentralised city' or 'decentralised concentration'	*Spatial data: Urban Atlas Data / CORINE Data*

Table 3: Indicators of parameter 'settlement structure'

2.4.2Parameter ‘’transport’

Transport has the most important share of urban air pollution (see Section 2.2), which makes it an important parameter to include in the SWOT analysis. Transport can be subdivided into public, private and commercial sector. Of these three, the public transport sector is far less energy consumptive than the private and commercial (see Section 2.2). The parameter ‘transport’ is scrutinised through the following indicators.

2.4.2.1 Private transport

The indicator ‘private transport’ is approximated through ‘commuter outflows’ and ‘density of motorways’. Both are drawn from the regional yearbook of Eurostat, a database from a Directorate-General of the European Commission. ‘Commuter outflows’ means the percentage of the employed population commuting out of the LL for work purposes. The higher the commuter outflow rate, the higher the private transport emissions. To evaluate the ‘commuter outflows’ of the LL, they have to be classified by the following three classes (share of commuters in percent of total employment) (Eurostat, 2016a).

Figure 6: Percentage of employed population commuting outwards for work purposes (Eurostat, 2016a)

The ‘density of motorways’ illustrates long-distance transport and gives reference to a city’s integration into the regional traffic network. The indicator describes the amount of km motorway per 1,000 km² of total area (Eurostat, 2016b). The higher the indicator, the higher the emissions:

Figure 7: Amount of km per 1,000 km² of total area (Eurostat, 2016b)

2.4.2.2 Public transport

The third indicator ‘public transport’ is investigated by the ‘equipment rate for public transport vehicles’, measured in a number of public transport vehicles (such as buses) per 1,000 inhabitants. This indicator visualises the availability and attractiveness of public transportation services (Eurostat, 2016b). Additionally, qualitative statements are gathered e.g. from local public transport providers, in order to better estimate the on-site use of public transportation.

Figure 8: Number of public transport vehicles (buses etc.) per 1,000 inhabitants (Eurostat, 2016b)

2.4.2.3 Freight transport

Regarding 'freight transport', the local situation of the LL will be analysed through two different aspects. The indicators 'road freight vehicles' is gained from the Eurostat regional yearbooks. The number of 'road freight vehicles' gives reference to the road freight pollution load in the LL (Eurostat, 2016b; Kotzeva *et al.*, 2014).

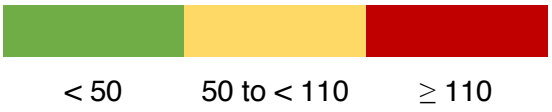

Figure 9: Number of road freight vehicles (in 1,000) (Kotzeva et al., 2014)

The existence of either an airport or a sea freight port (or both) within or close to the LL City is additionally identified to gain knowledge about the additional emission loads that are caused by airports and sea freight ports. The emissions are not solely dependent on the presence of the airport or sea ports but also on the number of passengers or ships handled per year. The handling vehicles are the airports produce emissions that are execrated during landing and take-off by planes. The issues of sea ports are different as they produce emissions on ground levels, especially during idling and in loading times.

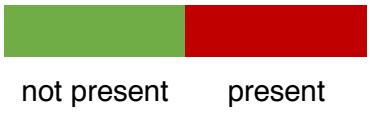

Figure 10: Presence of airport and/or sea freight port

Table 4 summarises the indicators used for the parameter 'transport' and gives both a short description as well as the data basis.

	Indicator	Description	*Data Basis*
Transport	Private Transport		
	commuter outflows	Percentage of employed population commuting outwards for work purposes	*Eurostat Regional Yearbook 2016; NUTS2*
	density of motorways	Amount of km per 1,000 km² of total area	*Eurostat Regional Yearbook 2015; NUTS2*
	Public Transport		
	equipment rate for public transport vehicles	Number of public transport vehicles (buses etc.) per 1,000 inhabitants	*Eurostat Regional Yearbook 2016; NUTS2*
	qualitative statements	Quotes illustrating the local public transport situation	
	Freight Transport		

	Indicator	Description	*Data Basis*
	road freight vehicles	Number of road freight vehicles (in 1,000)	*Eurostat Regional Yearbook 2013; NUTS2*
	presence of airport and/or sea freight port	Presence of airport and/or sea freight port as major sources of air pollution	*Google maps*

Table 4: Indicators of parameter 'transport'

2.4.3Parameter 'industry and trade'

In the SWOT analysis, the effects of industry will be considered based on their share of the city's surface area (percentage of area covered by industrial or commercial units or port areas). This approach is a simplification of the complex local situation, but enables the approximation of the emission load from the sectors of industry and trade.

	Indicator	Description	*Data Basis*
Industry and trade	Industrial area (%)	*Percentage of area covered by industrial or commercial units or port areas*	*Spatial data: Urban Atlas Data / CORINE Data*

Table 5: Indicators of parameter 'industry and trade'

2.4.4Parameter 'urban green and blue infrastructure'

The parameter 'urban green and blue infrastructure' is composed of all types of green and blue spaces within an urban area, e.g. parks, cemeteries, sports grounds, but also nature conservation areas, forests or water bodies (BMUB, 2015).

As 'urban green and blue infrastructure' positively influence both air quality and local climate, it is an important and strong parameter for the SWOT analysis. The parameter embraces five separate indicators. At first 'green and blue areas (%)' sums up the individual land-use categories and shows the share of climate-comforting green and blue spaces. Furthermore, the indicators 'forest', 'urban green', 'agriculture' and 'water bodies' are all measured and evaluated in percentages of area covered by these land uses.

An amount of green area below 20% of a city's area can be considered as a weakness, while a share of above 60% can be considered as a strength.

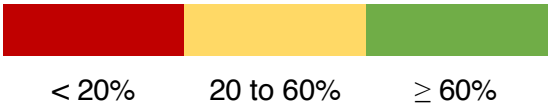

Figure 11: Percentage of area covered by urban green (parks etc.) (EEA, 2010)

The evaluation of agricultural land-use is conducted accordingly (see figure 12).

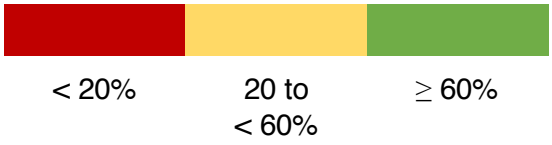

Figure 12: Percentage of area covered by agricultural land use (EEA, 2010)

Table 6 gives an overview of the indicators used for the parameter 'urban green and blue infrastructure' and gives a short description and information about the data basis used.

	Indicator	Description	*Data Basis*
Urban green and blue infrastructure	green and blue areas (%)	*Percentage of area covered by green of blue areas (sum of forests, urban green, agriculture and water bodies)*	*Spatial data: Urban Atlas Data / CORINE Data*
	forest (%)	*Percentage of area covered by various types of forests*	*Spatial data: Urban Atlas Data / CORINE Data*
	urban green (%)	*Percentage of area covered by urban green (parks etc.)*	*Spatial data: Urban Atlas Data / CORINE Data*
	agriculture (%)	*Percentage of area covered by agricultural land use*	*Spatial data: Urban Atlas Data / CORINE Data*
	water bodies (%)	*Percentage of area covered by water bodies*	*Spatial data: Urban Atlas Data / CORINE Data*

Table 6: Indicators of parameter 'urban green and blue infrastructure

2.4.5Data basis

The map for each city is the outcome of a geo-information system (GIS) analysis of the current land uses and provides a first overview of the spatial proportions (built-up area vs. undeveloped land) within the LL Cities. The database for all LL Cities except Hasselt is the Urban Atlas Data of the European Environment Agency (EEA) (EEA, 2014). For Hasselt, CORINE Land Cover Data, also of the EEA, are used (EEA, 2017).

The presented parameters are assessed through land use information taken from GIS datasets. The prevailing data set is the EEA Urban Atlas data (the reference year 2006) (EEA, 2014). The data set contains high-resolution land use and land cover data for functional urban areas (FUA) above 100,000 inhabitants. Urban Atlas data are vector data (point surface) with a resolution of 1:10,000. Land-use information gained from Urban Atlas data are marked bold and provided with a star (*). As Hasselt, has less than 100,000 inhabitants, EEA CORINE land cover data (the reference year 2006) are used for the Belgian city (EEA, 2017). CORINE data are raster data (grid cell surface, the reference year 2006) derived from satellite images with a lesser spatial resolution compared to Urban Atlas data. Land-use information gained from CORINE data are not printed in bold and provided with two stars (**). In order to provide maximum comparability, land-use information is provided from both datasets, where possible (Bologna, Bottrop, Dublin, Guildford, and Vantaa).

Statistical information is used for the parameters private transport, public transport, freight transport and population density. All four parameters are mainly extracted from the Eurostat website, the online appearance of the European Commission's statistical office. Additionally, further information, e.g. from the European Commission's 'Survey on perceptions of quality of life

in 75 European cities' (2010), are given. The largest limitation to most of the statistical data from Eurostat is its broad spatial resolution. An example is the indicator 'commuter outflows' within the air quality parameter 'private transport'. While, generally speaking, the commuter rate is a valid indicator for the approximation of work-related traffic, Eurostat data are solely available for NUTS2[1] regions, which is why this scale was chosen. In the case of Bologna, this e.g. means that commuter outflows are averaged for all of Emilia-Romagna region or in Dublin for all of Southern and Eastern Ireland. Despite the broad resolution, the indicator is still a reasonable choice for the parameter 'private transport', as a great share of traffic takes place at a regional scale. And, however, the regions show great differences in their commuter outflow rates. While in the region around Dublin commuter outflows are very low (1.3), the regions around Bottrop (16), Guildford (18.2) and Hasselt (19.1) have a more than ten times higher rate. Accordingly, work-related traffic is more focused on the region or an urban centre in the regions around Bologna and Dublin than it is in the other LL Cities.

It must be considered that the indicators used for the SWOT analysis can only imply but never conclusively capture local conditions. Furthermore, the spatial indicators are only indicating quantities; statements on the quality of e.g. urban green spaces, their interconnection or local climatic function would have to be investigated in separate analyses (e.g. site visits).

2.5 Stakeholder survey

In addition to the analysis of the spatial characteristics based on data and planning documents, the SWOT analysis also includes the results from the stakeholder survey conducted by FCC as part of Task 1.1 in November 2016. The survey was sent to various stakeholders in the LL Cities, including government bodies responsible for environmental policies. Urban planning and transport as well as researchers from corresponding universities. The results from the survey are collected in D1.1 (*Report on Challenges and Opportunities in iSCAPE Cities*) and were used to identify strengths, weaknesses, opportunities and threats for this report.

3 Analysis of the Living Lab Cities

The following sections present the analysis of the LL Cities based of the parameters presented above and the results from the stakeholder survey. At the end of each section, the SWOT matrix summarizes the results and also gives examples for strategies that can be applied in order to improve the local air quality and reduce the risk of UHI.

3.1 Bologna

As discussed above in Section 2.4.1.3 as an example of a compact-type of city, Bologna is one of the several densely inhabited cores along with San Marino, Modena and others located close to the Apennine Mountains. This unique location makes it not only an important railway hub of the national railroad network but also a traffic hot-spot for car traffic. Bologna's characteristic as a transportation hub is enhanced through the city's important international airport. As a university

[1] NUTS stands for Nomenclature of territorial units for statistics and is a hierarchical system for spatial compartmentalization of the EU for statistical means. Therein NUTS1 reflects socio-economic greater regions (e.g. Federal States in Germany) NUTS2 reflects base regions for regional policy (e.g. Regioni in Italy) and NUTS3 smaller statistical regions like provinces or cities. (European Union, 2015)

town, Bologna has a strong education market. Due to its education and labour market, workforces from surrounding municipalities commute to Bologna (OECD, 2016).

Figure 13: Land use in Bologna (©F. Hurth, Urban Atlas Data), scale: 1:125,000, reference year 2006, total area: 76.88 km²,see annex for key

3.1.1 Analysis of spatial parameters

The following table (Table 7) gives an overview of the parameters 'urban structure', 'transport', 'industry and trade' and 'urban green and blue infrastructure' analysed in this section:

Parameter	Indicator	Value	Data Basis
Urban Structure	Sealed ground (%)	***40.99**/29.23***	*Spatial data:* *Urban Atlas Data / CORINE Data*

Parameter	Indicator	Value	Data Basis
	Population density	7,134 people/km²	*D1.1 (Challenges and Opportunities in the iSCAPE Cities).*
	Urban development model	Compact city	*Spatial data:* *Urban Atlas Data / CORINE Data*
Transport	Private Transport		
	Commuter outflows	Region: Emilia-Romagna 2.8	*Eurostat Regional Yearbook 2016; NUTS2*
	Density of motorways	Region: Emilia-Romagna 25	*Eurostat Regional Yearbook 2015; NUTS2*
	Qualitative statement	"Due to its education and labour market, workforces from surrounding municipalities commute to Bologna, making it a metropolitan area."	*OECD, 2016*
	Public Transport		
	Equipment rate for public transport vehicles	Region: Emilia-Romagna 1.4	*Eurostat Regional Yearbook 2015; NUTS2*
	Qualitative statement	"Everyday more than 340,000 passengers use buses and more than 30,000 regional rail transport."	*Trasporto Passeggeri Emilia-Romagna, 2017*
	Freight Transport		
	Road freight vehicles	No data available	*Eurostat Regional Yearbook 2015; NUTS2*
	Presence of airport and/or sea freight port	Aeroporto di *Bologna* - Borgo Panigale "Guglielmo Marconi"	Google Maps

Parameter	Indicator	Value	Data Basis
Industry and Trade	Industrial area (%)	***22.55**/15.11***	*Spatial data: Urban Atlas Data / CORINE Data*
Urban green and blue infrastructure	Urban green (incl. forests) (%)	***8.24**/2.66***	*Spatial data: Urban Atlas Data / CORINE Data*
	Agriculture (%)	***19.43**/25.26***	*Spatial data: Urban Atlas Data / CORINE Data*

Table 7: Indicators for Bologna

3.1.1.1 Strengths

Spatial concentration of industrial area

The location of land used for industrial and trade purposes are concentrated in the northern and eastern part of the city's area, close to the city centre and the airport in the east (Figure 13). This indicates a lower pollution for Bologna's inhabitants because the industrial area is close to, but not directly located next to residential areas.

Public transport

Although the number of public transport vehicles used by population is located in the middle range, there is still a high use of public transport: More than 340,000 people (roundly 87,5% of the total population) per day use the local public transport and around 30,000 people use the regional transport system (Trasporto Passeggeri Emilia-Romagna, 2017). This fact positively influences the local air quality as public transport causes less emissions than private transport.

Urban development model: compact city

Based on the description of the characteristics of the urban development models presented in Section 2.4.1.3 the City of Bologna can be predominantly assigned to the model of the compact city. The reason for this is the high population density (2,720 inhabitants per km^2) and the relatively large area of sealed ground (40.99%). In addition to this, Bologna also has an attractive and efficient public transport system.

3.1.1.2 Weaknesses

High population density

With 2,720 people per km², Bologna has a significantly high population density meaning that a huge number of inhabitants is possibly exposed to UHI.

Low percentage of urban green and agriculture

In addition to this, the city contains a low percentage of urban green infrastructure (8.24%) and a low amount of land used for agricultural purposes. These facts increase the UHI effects and therefore the well-being of the city's population.

3.1.1.3 Threats

The city is close to the airport

The airport Aeroporto di Bologna - Borgo Panigale “Guglielmo Marconi” is located in the east of Bologna (Figure 13) and causes emissions by air traffic affecting the city’s air quality. As the location of airports is out of the influence of local government, the airport can be seen as a threat.

3.1.2Analysis of local Stakeholders

The following paragraphs summarise the SWOT analysis of the results from the stakeholder survey (see D1.1).

3.1.2.1 Weaknesses

The city is designed for the car

Even though the city centre of Bologna is widely pedestrianised, the entire city is designed for car drivers. This might be related to the car and motorcycle manufacturers which have their headquarters in or around Bologna (e.g. Lamborghini, Ferrari and Maserati). The high amount of car usage results in strong traffic congestion. The preference of cars as the main source of transportation is enhanced by a slow bus system and small amount of cycling lanes.

A culture of car users

Directly linked to the urban design of the city for car users is the "big attachment to cars" (D1.1, p.16), which results in the fact that many citizens are not interested to use other modes of transportation. This means, that according to the stakeholder survey, the citizens of Bologna are reluctant to change their commuting behaviour in order to improve air quality, even if they are informed about air quality and climate change issues.

Innovating within a historic city can be difficult

Bologna is fortunate to have many historic landmarks and buildings, including the oldest university in the world. While the city's historic structure can be considered a strength from an urban building point of view, it is also a threat to the city's infrastructure development. Because any future urban development needs to follow the existing urban structure, large scale interventions into the city's structure are complicated and require precise considerations.

3.1.2.2 Threats

The city's location can make air pollution worse

The geographic location of Bologna in a wide valley with low winds and a high humidity prevents a dispersion of air pollution – the pollution gets trapped within the city, causing the transgression of EU ambient concentration limits of pollutants, especially during winter time.

3.1.3Results of the SWOT analysis

All of the results from the SWOT analysis were incorporated into the following matrix (Table 8). The matrix gives a good overview of the strengths, weaknesses, opportunities and threats identified for Bologna. Based on this analysis, the opportunities for the iSCAPE cities (see D1.1) as well as the strategies for the urban development models in Section 2.4.1.3 were reviewed for their usefulness. The result is a list of strategies that Bologna could use in order to improve its

local air quality and vulnerability to UHI building (see below). Each LL City includes the participation in the iSCAPE project as an opportunity.

		internal	
		strengths 1. Spatial concentration of industrial area 2. Public transport 3. Compact city	**weaknesses** 1. High population density 2. Low percentage of urban green and agriculture 3. The city is designed for the car 4. A culture of car users 5. Innovating within a historic city can be difficult
external	**opportunities** 1. Participation in the iSCAPE project	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 1. City close to airport 2. The city's location can make air pollution worse	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 8: SWOT matrix for Bologna

3.1.3.1 Strengths-opportunities-strategies (S-O)

The following strategies can be selected in order to use strengths to pursue opportunities:

- Positive characteristics such as a user-friendly and sophisticated transport network and its easy accessibility and reliable operation should be preserved.

No concrete goals, interventions and/or measures are currently present within relevant local plans and strategy documents in line with the above mentioned strategy. Due to the general formulation of the strength-opportunities-strategy, however, it should be noted that objectives and measures can be found and assigned to other strategies that relate to the transport network, accessibility and operation.

3.1.3.2 Weaknesses-opportunities strategies (W-O)

The following strategies have been identified to use opportunities to eliminate weaknesses:

- Further settlement development should take into consideration the preservation of urban green spaces;
- Possibilities for settlement pressure need to be weighed carefully against the opportunity for green space development and should consider ventilation and UHI potential;
- Existing green and blue spaces should be interlinked in order to enable fresh air supply and ventilation;
- Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions.

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Further settlement development should take into consideration the preservation of urban green spaces	Grant the continuity of ecological networks in organising green areas	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic goal	continuously implemented
	Enhance local landscapes and resources in organising green areas	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic goal	continuously implemented
	Exploitation and protection of natural habitats and landscape integrating urban green space	Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Protection and recovery of environment and landscape	Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Care of green areas, permeability and urban microclimate	Programma per la	informal/not binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
		Qualificazione Urbana (2015)	strategic development goal	

Table 9: Weaknesses-opportunity strategy Bologna A

The *Regolamento Urbanistico Edilizio* ('Urban Building Regulations', 2009) for the City of Bologna contains the rules for interventions on the existing building stock as well as urban and environmental spread for improving the quality of the territory. According to the 'Urban Building Regulations', ecological networks as well as the preservation of ecologically significant landscape elements and the maximum possible permeability of building structures must be taken into account when structuring green spaces. The *Piano d'azione per l'energia sostenibile* ('Action Plan for Sustainable Energy', 2012) for the City of Bologna complements the importance of conserving natural resources and protecting natural habitats and landscape, including urban green spaces, parks and protected areas in the metropolitan regional system. The protection and restoration of the environment and landscape is also important, especially for the protection of hills and agricultural wedges. The binding nature of the two documents mentioned ensures the preservation of urban green spaces including some of their functions is protected in a binding manner when designating future settlements.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Possibilities for settlement pressure need to be weighed carefully against the opportunity for green space development and should consider ventilation and UHI potential	Green spaces should be utilised to regulate microclimate	Programma Energetico Comunale (2007)	formal/binding strategic goal	continuously implemented
	Urban development should consider adequate conditions of environmental comfort and mitigation of pollution	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic goal	continuously implemented
	Increase of green spaces to contrast climate change (UHI), for better air quality and urban environment	GAIA Green Areas Inner City Agreement (2013)	informal/not binding strategic development goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Control thermal inertia	Programma per la Qualificazione Urbana (2015)	informal/not binding strategic development goal	continuously implemented

Table 10: Weaknesses-opportunity strategy Bologna B

Various formal and informal plans and strategies of the City of Bologna contain a number of statements on objectives and measures for settlement development, taking into account the development of open spaces and their functions. The preservation and development of green spaces are of great importance in the context of climate change, improving air quality and urban space as a whole. For example, the GAIA project (*Green Area Inner City Agreement*) was developed between 2010 and 2013 as a contribution of the LIFE+ programme of the European Commission in the urban area of Bologna. The aim of the project was to enlarge the green areas of Bologna by planting new trees in order to combat climate change, improve air quality and the urban environment.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions	Conservation and protection of regional green areas/corridors	Programma per la Qualificazione Urbana (2015)	informal/not binding strategic development goal	continuously implemented

Table 11: Weaknesses-opportunity strategy Bologna C

The *Programma per la Qualificazione Urbana* ('Urban Qualification Programme', 2015) for the City of Bologna emphasises the importance of maintaining and developing regional green spaces and corridors. The landscape is of particular importance in the design of urban and regional green spaces. This is also reflected in formulated objectives for strengthening the ecological network and the natural functions of green spaces. Due to its informal character, the 'Urban Qualification Programme' has no legal basis, but is subject to the principle of self-commitment by the municipality.

No concrete goals, interventions and/or measures currently in place are in line with the strategy 'Existing green and blue spaces should be interlinked in order to enable fresh air supply and ventialtion'.

3.1.3.3 Strengths-threats-strategies (S-T)

There were no strengths-threats-strategies identified.

3.1.3.4 Weaknesses-threats strategies (W-T)

The following strategies have been identified to eliminate weaknesses and/or reduce threats:

- Reduce the appeal of driving in a city;
- Increase the appeal of cycling and walking;
- Improve public transport;
- Move to electric vehicles;
- Pedestrianise and provide cycle infrastructure in narrow streets;
- Create shared use public spaces;
- Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre;
- Introduce new urban models of mobility such as the 'superblock' - where existing gridded streets within a city are grouped together in small clusters. Traffic is then restricted to outside of this area while the streets inside the superblock become repurposed as community spaces;
- Better incentives from government to move to more sustainable transport options;
- Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature;
- Mandatory solar panels on all public buildings to take advantage of the sun – this energy can then be used in various ways to mitigate the effects of air pollution;
- Roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors.

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Reduce the appeal of driving in a city	Extension of low-emission zones	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Introduction of tolls to increase the use of greener commercial vehicles	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Parking pricing	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented

Table 12: Weakness-threat strategy Bologna A

The formal and biding *Piano Generale del Traffico Urbano* ('Urban Traffic Plan', 2006) as well as the *Piano d'azione per l'energia sostenibile* ('Action Plan for Sustainable Energy', 2012) for the City of Bologna set out the strategic goal of improving and extend low-emission zones, where access for particularly polluting vehicles will be restricted in order to improve air quality. At the same time, the use of environmentally friendly vehicles and means of transport is to be promoted, e.g. through toll charges or parking pricing.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Increase the appeal of cycling and walking	Increase of cycle lanes	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Realisation of new pedestrian zones	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented
	Regulate the use of mopeds and motorcycles in low-emission zones	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Protect the accessibility and the security of pedestrians and cyclists, e.g. roundabouts, pedestrian zones	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented
	Promote the mobility of pedestrians and cyclists, also as a tool for better public spaces and urban regeneration	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented
	Consideration of traffic flow and necessary stops in urban areas.	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	If not possible to build roads with a continuous network of cycle paths, at least footpaths should be provided at these points.	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Increase trips by bicycle and foot, to at least 37% by 2030 in the metropolitan area	Piano Strategico Metropolitano di Bologna 2.0 (2018)	informal/not binding strategic development goal	continuously implemented

Table 13: Weakness-threat strategy Bologna B

The City of Bologna has a general strategic objective around the development of cycle paths. This objective is addressed in both formal and informal planning documents. The mobility of pedestrians and cyclists will also be promoted at regional level as a tool for improving public spaces and urban regeneration. These objectives should also lead to an improvement of the accessibility and safety for pedestrians and cyclists, e.g. through more roundabouts or pedestrian zones. When it is not possible to integrate roads with a continuous network of cycle lanes or foreseeing spaces for the exchange of bike to car, a coherent and comfortable network of paths for pedestrians should be implemented. The integrated design of urban spaces in Bologna should be strongly adapted to the needs of pedestrians. This includes, for example, the design of

pedestrian zones (also to promote the location of shops), additional stops and meeting points as urban squares or the exclusion of uses that promote car traffic or thereby hinder other environmentally friendly means of transport. The goal is to sensibly increase trips by bicycle and foot to 37% by 2030 in the metropolitan city, therefore 440,000 trips per day using cars and private motorcycles should shift to other sustainable options (public transport, bicycles, foot).

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Improve public transport	City regeneration also includes a mobility model to be spread over the territory favoring the use and improving the efficiency of public transport	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Integrated interventions aimed at increasing public transport and the protection of zones with higher environmental and architectural value	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Dedicated lanes for taxis and buses	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Traffic light adjustments to improve traffic flow and favour buses	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented
	Improving public transport in order to increase its competitiveness	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Management of mobility requirements for travel from home to school and work	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented
	In order to increase the use of public transport, it is necessary to ensure road safety for different users, promote modal shift, improve accessibility and safety of stops	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Identify and create dedicated public transport lanes through appropriate design of sections	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Public transport stops must be located in such a way that pedestrians and cyclists can easily reach them	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Multimodal traffic junctions between private and public transport must be designed, parking spaces and taxi stops must be provided	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Promote measures favoring public transport in urban development plans for sustainable mobility	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Promote urban infrastructures for public local transport, primarily electric	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented

Table 14: Weakness-threat strategy Bologna C

In general, all formal and informal planning documents listed above formulate objectives for improving public transport including general objectives as well as concrete measures concerning the qualification and improvement of the supply and usability of public transport. These are, for example, measures that favour public transport over mobile private transport by promoting bus and taxi lanes as well as improving bus stops and their safety, mobility stations with parking facilities for taxis, cars and bicycles or charging infrastructure for e-mobility.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Move to electric vehicles	Support measures aimed at spreading electric vehicles	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Incentives towards the renovation of private vehicular transport towards higher efficiency-lower polluting vehicles	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Encouraging substitution of public and private vehicle stocks with eco-sustainable technology	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Promotion of measures to achieve the objectives of sustainable mobility and the dissemination of vehicles powered by alternative drive systems and fuels	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented
	Promote measures favoring the use of sustainable vehicles (e.g., electric vehicles) in urban development plans for sustainable mobility	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented
	Ease tax system (e.g., exemption from car tax) and other incentives to help the transition to the use of some vehicle categories (e.g., electric vehicles)	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented

Table 15: Weakness-threat strategy Bologna D

For the City of Bologna, both goals and measures for the expansion of e-mobility are mentioned in different formal and informal planning documents. These initially concern the promotion of sustainable transport, which also includes alternative drive systems and fuels (e.g., electric, hybrid, natural gas and liquefied petroleum gas). In addition, the conversion of public and private vehicle fleets is mentioned as an important goal of a traffic turnaround. Financial incentives are also to be created for this purpose, e.g. through tax concessions, in order to promote the transition to environmentally friendly means of transport.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Pedestrianise and provide cycle infrastructure in narrow streets	City regeneration also includes a mobility model which improves and actuates pedestrianisation all over the city	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Integrated interventions aimed at increasing cycle routes and protection of zones with higher environmental and architectural value	Piano Generale del Traffico Urbano (2006) Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Connect and extend cycle lanes, strengthen and develop complementary services	Piano Generale del Traffico Urbano (2006)	formal/binding strategic measure	continuously implemented
	Development of active pedestrians and cyclist active mobility	Piano per l'Innovazione Urbana di Bologna (2016)	formal/binding strategic goal	continuously implemented
	Hubs of changing modality transport	Piano per l'Innovazione Urbana di Bologna (2016)	formal/binding strategic goal	continuously implemented
	Promote measures favoring the mobility of cyclists and pedestrians in urban development plans for sustainable mobility	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented

Table 16: Weakness-threat strategy Bologna E

For the strategy mentioned, the statements and contents of the analysed plans and strategy documents largely coincide with objectives and measures for the promotion of walking and cycling in the City of Bologna. Therefore, synergy effects can be exploited here.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Better incentives from government to move to more sustainable transport options	Favour technological change of public and private transport towards more sustainable options	Piano Generale del Traffico Urbano (2006)	formal/binding strategic goal	continuously implemented
	Promote infrastructures for alternative sustainable mobility, especially in the sector of public transport	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented
	Promote innovative services of shared mobility (e.g., car sharing, corporate car sharing, ride sharing, etc.) and related information	Piano Energetico Regionale Emilia-Romagna (2017)	informal/not binding strategic development goal	continuously implemented

Table 17: Weakness-threat strategy Bologna F

The formal and informal objectives for the implementation of this strategy at a local level currently relate to the general promotion of sustainable mobility. This includes the development of infrastructures which are particularly needed in public transport for sustainable mobility (e.g., electric, biogas etc.). But also the promotion of alternative mobility concepts (such as car sharing, corporate car sharing or car pools) and corresponding information on different types of mobility are mentioned.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Mandatory solar panels on all public buildings to take advantage	It is intended to intervene consistently in existing urban structures.	Programma Energetico Comunale (2007)	formal/binding strategic goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
of the sun – this energy can then be used in various ways to mitigate the effects of air pollution	Roof coverings made of asbestos are replaced with photovoltaic modules	Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Extend the experience of photovoltaic communities	Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	After 2020 all new buildings should be zero consumption, and the majority of remaining consumption will be from renewable sources	Piano d'azione per l'energia sostenibile (2012)	formal/binding strategic goal	continuously implemented
	Control and use of solar energy	Programma per la Qualificazione Urbana (2015)	informal/not binding strategic development goal	continuously implemented
	Coordinated use of renewable energy, long-distance heating and cogeneration	Programma per la Qualificazione Urbana (2015)	informal/not binding strategic development goal	continuously implemented
	Save energy in public buildings	Piano per l'Innovazione Urbana di Bologna (2016)	formal/binding strategic goal	continuously implemented

Table 18: Weakness-threat strategy Bologna G

As part of this strategy it is considered essential to intervene consistently in existing structures, in the thermal insulation of buildings, in the installation of thermal solar and photovoltaic modules, in the reduction of electricity consumption and traffic development. Formal and informal documents currently address this strategy at a local level. The promotion of areas and mechanisms to enhance the experience of photovoltaic communities, i.e. opportunities for the integrated purchase of photovoltaic modules to be installed on public land and roofs, is considered important.

According to the formal 'Action Plan for Sustainable Energy' (2012), by 2020 all new buildings should meet the highest energy standards (low-energy or zero-energy houses) and their remaining energy consumption should come from renewable sources. The use of renewable energies must also be coordinated and various supply options (e.g., district heating or cogeneration) must be combined.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors	Planting of vegetative species that can integrate into and complete local nature and landscape, in order to mitigate negative impacts on the environment	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Urban transport planning taking into account the city's hinterland relations and the environmental contribution of greenery	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented
	Reducing the impacts caused by means of transport through measures to reduce noise, pollution and light, in particular greening measures	Regolamento Urbanistico Edilizio (2009)	formal/binding strategic measure	continuously implemented

Table 19: Weakness-threat strategy Bologna H

The 'Urban Building Regulations' (2009) of the City of Bologna contain some statements about street greening to reduce emissions. Urban transport planning in general must take into account the importance of the city's hinterland relationships and attach particular importance to landscape and green structures. In particular, the importance of vegetation and its contribution to the environment must be considered. Negative environmental impacts on nature and landscape can also be mitigated by planting vegetative species, possibly autochthonous ones. In addition, the effects of traffic are to be reduced by measures to reduce noise, pollutants and light, in particular greening measures.

No concrete goals, interventions and/or measures from plans and strategy documents are currently in place and can be linked to the remaining strategies ‘Create shared use public spaces’, ‘Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature’, ‘Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre’, and ‘Introduce new urban models of mobility such as the ‘superblock’ - where existing gridded streets within a city are grouped together in small clusters. Traffic is then restricted to outside of this area while the streets inside the superblock become repurposed as community spaces’.

3.2 Bottrop

Bottrop is part of a polycentric system in the Ruhr Area; therefore, a lot of urban cores of similar or bigger size are located close to the city. It is well connected with the regional transport system and easily accessible from surrounding cities. Compared to other cities in the Ruhr Area, Bottrop offers lesser workplaces and no university; hence more people from Bottrop commute to other cores than the other way around (OECD, 2016).

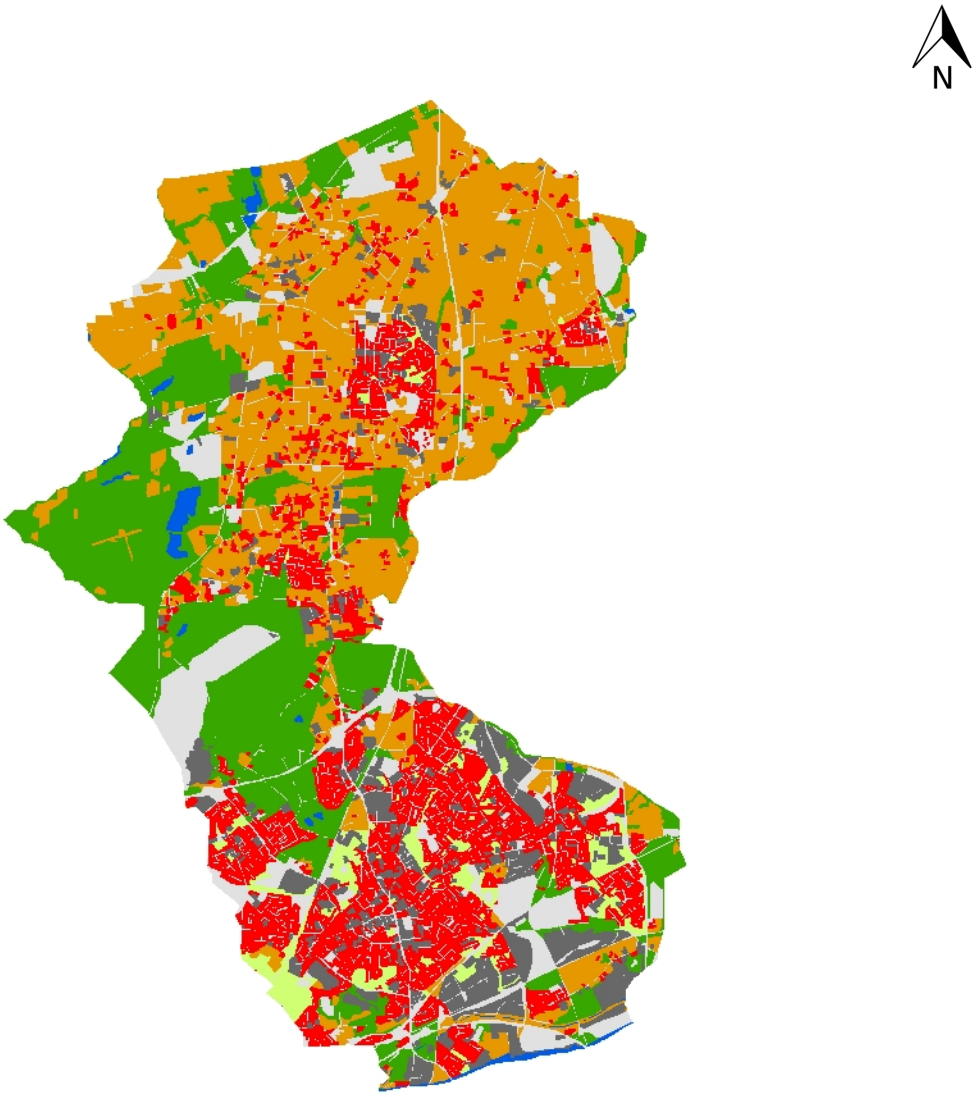

Figure 14: Land use in Bottrop (©F. Hurth, Urban Atlas Data), scale: 1:125,000, reference year 2006, total area: 100.27 km², see annex for key

3.2.1 Analysis of spatial parameters

The following table (Table 20) gives an overview of the parameters 'urban structure', 'transport', 'industry and trade' and 'urban green and blue infrastructure' analysed in this section:

Parameter	Indicator	Value	Data Basis
Urban Structure	Sealed ground (%)	***24.23**/11.06***	*Spatial data: Urban Atlas Data / CORINE Data*
	Population density	1,168 people/km²	*Stadt Bottrop, 2011*
	Urban development model	Decentralised concentration	*Spatial data: Urban Atlas Data / CORINE Data*
Transport	Private Transport		
	Commuter outflows	Region: Münster 16	*Eurostat Regional Yearbook 2016; NUTS2*
	Density of motorways	Federal State: North-Rhine Westphalia 65	*Eurostat Regional Yearbook 2015; NUTS2*
	Public Transport		
	Equipment rate for public transport vehicles	Region: Münster 1	*Eurostat Regional Yearbook 2015; NUTS2*
	Qualitative statement	"The 'Vestische' is one of the largest traffic enterprises in Europe with about 976 km². Every year about 63 million people travel with 'Vestrische'."	*Vestrische, 2016, p.4-5*
	Freight Transport		
	Road freight vehicles	Region: Münster: 122	*Eurostat Regional Yearbook 2015; NUTS2*
	Presence of airport and/or sea freight port	No	*Google Maps*
Industry and Trade	Industrial area (%)	***9.08**/6.69***	*Spatial data: Urban Atlas Data / CORINE Data*

Parameter	Indicator	Value	Data Basis
Urban green and blue infrastructure	Urban green (incl. forests) (%)	***26.43**/19,33***	*Spatial data: Urban Atlas Data / CORINE Data*
	Agriculture (%)	***30.60**/43.92***	*Spatial data: Urban Atlas Data / CORINE Data*

Table 20: Indicators for Bottrop

3.2.1.1 Strengths

Low value of sealed ground

With 24.23 Percent the overall amount of sealed ground low and Bottrop has a decentralised structure. There are two settlement centres including Bottrop's city centre in the southern part and another centre in the northern part (Bottrop-Kirchhellen) (Figure 14). The settlement developed along transport axes and in the north of the city's area there is green and agricultural infrastructure that increases the general local climate and air quality.

Low population density

Overall, Bottrop has a low population density with 1,168 people per km². This means, that not many people are strongly exposed to UHI effects. Nevertheless. The two-part structure of the city with a very dense South and a rural North leads to the fact, that the people in the densely populated city centre are still exposed to UHI.

3.2.1.2 Weaknesses

Urban development model: decentralised concentration

Based on the description of the characteristics of the urban development models presented in Section 2.4.1.3 the City of Bottrop can be predominantly assigned to the model of decentralised concentration. The reason for this is the existence of two settlement centres instead of one core city. Furthermore, the settlement development in Bottrop occurred along the transport axes of the city.

Concentration on private transport

As the Ruhr Region accommodates a car-affine society, Bottrop's structure is also focused on private transport and the equipment rate for public transport vehicles is very low (1 for Region Münster). As a result, the high amount of public transport produces high emissions and greenhouse gases.

High amount of road freight transport

There is a high rate of road freight transport (total amount of 122,000 road vehicles in region Münster), which can be a source of high emission of hazardous substances.

3.2.1.3 Opportunities

No airport close to the city

The fact that there is no airport in the vicinity of the City of Bottrop can be evaluated as positive because air traffic does not additionally decrease the air quality in the city.

3.2.1.4 Threats

Density of motorways

Regarding the car-affinity the federal state, North Rhine-Westphalia contains a dense motorway network with 65 km per 1,000 km², creating a constant exposure of the population towards emissions. The high density of motorways has to be seen as a threat because motorways are out of local government's influence.

3.2.2Analysis of local Stakeholders

The following paragraphs consist the SWOT analysis of the results from the stakeholder survey (see D1.1).

3.2.2.1 Weaknesses

The city has an industrial heritage

The city of Bottrop developed on the basis of the coal mining industry. Today, there remains one coking plant close to the city centre, which leads to increased air pollution in the area surrounding the plant.

The city is designed for the car

Like the rest of the cities in the Ruhr Region, Bottrop's transport system mainly relies on car usage. The reason for this is the dense motorway system of the Ruhr Region, which makes the car the fastest way to travel. Bottrop's urban structure with a very dense city centre and very rural suburbs enhance the citizens' reliance on their car. Although the city centre is well accessible by public transportation (trains and buses), the public transportation system in the suburbs could use improvements.

A culture of car users

Linked to the layout of the City of Bottrop for car users is the citizens' attraction to use this mode of transportation. The relatively low taxes for the purchase and maintenance of cars in combination with high costs for public transportation enhances this focus on car usage even more.

The city structure is dense

The city centre of Bottrop is very dense, with a ground sealing over 90%. This high amount of sealed ground leads to the build-up of urban heat islands during the summer months. In addition to this, flash floods can cause huge damages, because the water has nowhere to go if the entire urban area is sealed.

3.2.2.2 Opportunities

Increasing support from central government

Even though the importance of air quality in context with transportation policies is still in need of improvement (see threats below), a slow change of thinking can be determined (e.g. through the establishment of the "Air Pollution Control Plan" and the extension of funding options). This can be considered as an opportunity.

3.2.2.3 Threats

Lack of support from central government

The importance of transportation policies in context with public health is only slowly developing. Until recently the need for personal transportation seemed to be valued higher than the health of citizens. However, the "Air Pollution Control Plan", which introduced "Climate Adaptation Measures" to deal with this topic, helps to reconsider the former approaches. In relation to this, there is also an increase in funding opportunities to approach projects in this context (also see opportunities above).

Disagreement and lack of coordination among government bodies

The Ruhr Region in constituted of various bigger and smaller cities, which are all required to work together in order to achieve the best results for the region. In reality, this cooperation does not always work out the way it is intended to. One result of this is the region's public transport system, which is not everywhere interlinked as well as it should be.

3.2.3Results of the SWOT analysis

The following matrix combines all of the results from the SWOT analysis and gives an overview of the identified strengths, weaknesses, opportunities and threats in Bottrop (Table 9). On the basis of this matrix, strategies – on the basis of the opportunities for the iSCAPE cities (see D1.1) and the urban development models in Section 2.4.1.3 – for the city were identified and are presented below. Each LL City has the participation in the iSCAPE project as an opportunity.

		internal	
		strengths 1. Low value of sealed ground 2. Low population density	**weaknesses** 1. Decentralised concentration 2. concentration on private transport 3. road freight transport 4. The city has an industrial heritage 5. The city is designed for the car 6. A culture of car users 7. The city structure is dense
external	**opportunities** 1. Participation in the iSCAPE project 2. No airport close to the city 3. Increasing support from central government	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 1. Density of motorways 2. Lack of support from central government 3. Disagreement and lack of coordination among government bodies	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 21: SWOT matrix for Bottrop

3.2.3.1 Strengths-opportunities-strategies (S-O)

The following strategies can be taken forward in order to use strengths to pursue opportunities:

- Positive characteristics like an adequate mix of functions and sophisticated public transport should be preserved
- Further settlement development should take place with respect to the preservation of urban green spaces with special consideration of the maintenance of ventilation channels and other ecologic functions such as groundwater production, habitats, etc.
- Existing green and blue spaces should be qualitatively developed and re-valuated in order to explicitly foster climatic and air quality functions

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Positive characteristics like an adequate mix of functions and sophisticated public transport should be preserved	Development and implementation of an integrated overall transport concept	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	implemented and will be continued
	Promoting public transport	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	partly implemented and will be continued
	Promoting mixed use and functional diversity	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented

Table 22: Strength-opportunity-strategy Bottrop A

Strategic local measures for traffic development and air pollution control are relevant to the first strategy. Nevertheless, the wording of the *Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord* ('Air Quality Action Plan Ruhr Area', 2011) remains rather general and the individual local measures for the City of Bottrop must be concretised in the course of their implementation. According to the *Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord* within the development of transport, priority will be given to promoting local public transport and other environmentally friendly means of transport (eco-mobility and transport shift).The *Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop* ('Masterplan Climate-Suitable Urban Redevelopment

InnovationCity Ruhr', 2014) formulates various field-specific urban development goals and strategies for an existing inner-city area, which may be transferred to the city as a whole. References to strength-opportunities-strategies arise initially in the course of promoting mixed use and functional diversity. Through the mixture of uses, a traffic-reducing and space-saving settlement structure can be achieved, making a considerable positive contribution to climate protection and sustainable urban development.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Further settlement development should take place with respect to the preservation of urban green spaces with special consideration of the maintenance of ventilation channels and other ecologic functions such as groundwater production, habitats, etc.	Preservation and protection of regional green areas/corridors	Flächennutzungs-plan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented
	Conservation and protection of air exchange via ventilation channels	Flächennutzungs-plan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented
	Illustration of ventilation channels, cold-air production areas and other areas to be kept free from development	Flächennutzungs-plan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented
	The current landscape structure must be preserved, improved and developed. Recreation space must be secured.	Landschaftsplan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented

Table 23: Strength-opportunity-strategy Bottrop B

The *Flächennutzungsplan der Stadt Bottrop* ('Land-Use Plan for the City of Bottrop', 2004) concretises the guiding principles and objectives for the city development. An essential task of land use planning is to ensure that sufficient land is available for foreseeable future needs. However, it is not only a matter of designating new land uses, but also of securing and maintaining the existing urban structure and the green and open spaces. The 'Land-Use Plan' is only binding on authorities in the course of the subsequent binding urban land-use planning and only becomes legally binding for the citizen through a binding land-use plan (*Bebauungsplan*, 'development plan'), a building permit or a plan approval. In general, the urban development goals of the 'Land-Use Plan' are of importance for the strength-opportunities-strategies. The goals mentioned refer to the economical use of building land, the preservation and expansion of inner-city open space systems and the relationships between urban and landscape space. Despite policies to give

preference to consolidating inner-city development over development on the urban fringes, inner-city open spaces must be secured and developed. The open building structures with open spaces and ecologically high-quality vegetation are an essential basis for a high quality of living. In addition, the existing potentials must be secured from an urban and landscape design perspective and in terms of ecologically sustainable development. The *Landschaftsplan der Stadt Bottrop* ('Landscape Plan for the City of Bottrop', 2004) supplements the framework of action for the intended settlement development in accordance with the objectives and principles of nature conservation and landscape management, in particular for the undeveloped meadow as well as the forest and nature conservation areas.

Strategy	**Corresponding Interventions/goals**	**Local plans and strategies**	**Character and context**	**Implementation status**
Existing green and blue spaces should be qualitatively developed and re-valuated in order to explicitly foster climatic and air quality functions	Redevelopment (renaturation) of the Emscher	Masterplan Emscher-Zukunft (2006)	informal/not binding regional intervention of neighbouring cities	continuously implemented
	Maintaining and developing free spaces. Activate open space potentials	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic goal	continuously implemented
	Developing and implementing water-sensitive urban development	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic goal	continuously implemented
	Enhancement of green areas (e.g. along railway lines)	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Reactivation of original watercourses, use of water as design element	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic goal	continuously implemented
	Creation of the framework plan 'green and water' for the inner city core	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic goal	continuously implemented
	Landscape equipment for the purpose of pollution control and soil protection or to improve the climate	Landschaftsplan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented
	Plants for pollution control	Landschaftsplan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented
	Protection and development of landscape structures in populated areas: to secure living space for animals and plants, ventilation channels as well as a climatic and filter function for pollutants and serve the soil and groundwater protection.	Landschaftsplan der Stadt Bottrop (2004)	formal/binding strategic goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Promotion of greening measures	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented

Table 24: Strength-opportunity-strategy Bottrop C

The informal 'Masterplan Climate-Suitable Urban Redevelopment InnovationCity Ruhr' (2014) formulates numerous development goals and strategies concerning the development of attractive and multifunctional green and blue infrastructures. These objectives and strategies are initially only subject to a self-commitment and need to be implemented through appropriate measures and lead projects. The existing green structures and unsealed open spaces must be preserved and strengthened because they form the basic framework for the functioning of the natural balance, the biodiversity as well as for a good living environment and quality of life. The preservation of urban green spaces and unsealed open spaces (e.g., agricultural areas) is also of central importance in the context of climate adaptation. Due to the possible effects of climate change public and private green are of particular importance, especially in highly sealed areas such as the city centre, since urban green structures provide a variety of positive climatic and ecological relief effects. The unsealing of areas, the creation of new green spaces and the preservation and expansion of existing green structures lead to an improvement in soil functions, soil water balance and microclimatic conditions. The 'Landscape Plan' (2004) also emphasise the importance of the landscape and open spaces with their climate characteristics and climate functions. In addition, the 'Air Quality Action Plan Ruhr Area 2011' also specifies further greening measures that concern road space greening, dust filtering vegetation or roof and facade greening for climate adaptation.

3.2.3.2 Weaknesses-opportunities strategies (W-O)

The following strategies can be taken forward in order to use opportunities to eliminate weaknesses:

- Better incentives from government to move to more sustainable transport options
- Use the iSCAPE LL Cities as a place to coordinate and bring together different government bodies
- Encourage stakeholders to work together in a 'round-table' approach

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Use the iSCAPE LL Cities as a	Networking of economic areas,	Integriertes Klimaschutzkonzept	informal/ not binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
place to coordinate and bring together different government bodies	associations and institutions	der Stadt Bottrop (2011)	strategic field of action	

Table 25: Weakness-opportunity strategy Bottrop

Networking and public relations work for the networking of economic areas, associations and institutions are an essential point for the success of strategic decisions in the City of Bottrop. Many local, regional and supra-regional networks have been established in Bottrop in recent years, which have an influence on action within the city and beyond its borders. The City of Bottrop has set itself the goal of bundling regional and supra-regional competences, using synergy effects, strengthening regional economic structures, promoting the exchange of experience and know-how and strengthening economic and political influence.

No concrete goals, interventions and/or measures from planning documents are currently in place and in line with the strategies 'Better incentives from government to move to more sustainable transport options' as well as 'Encourage stakeholders to work together in a 'round-table' approach'.

3.2.3.3 Strengths-threats-strategies (S-T)

There were no strengths-threats-strategies identified.

3.2.3.4 Weaknesses-threats strategies (W-T)

The following strategies/activities have been identified and could be taken forward to eliminate weaknesses and/or reduce threats:

- Reduce the appeal of driving in a city
- Increase the appeal of cycling and walking
- Improve public transport
- Move to electric vehicles
- Better incentives from government to move to more sustainable transport options
- Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Reduce the appeal of driving in a city	Setting up a low-emission zone (= defined area in which motor vehicles may only be driven that have a certain comply with emission standards)	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	implemented
	Restriction of transit traffic in the inner city area	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	informal/ not binding strategic measure	continuously implemented
	Following the guiding principle 'the city of short distances' in order to avoid motorized individual traffic and to encourage pedestrian and cycle traffic	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	informal/ not binding strategic measure	continuously implemented
	Development of traffic-avoiding settlement structures	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding strategic goal	continuously implemented
	Reduction of car parking spaces, establishment of a parking facility management	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented

Table 26: Weakness-threat strategy Bottrop A

Goals and measures for traffic reduction in the City of Bottrop are consistently taken up in various planning documents. These include the more traffic-related measures of the 'Air Quality Action Plan Ruhr Area 2011' for the City of Bottrop, the field of action 'Bottrop.mobile' of the *Integriertes*

Klimaschutzkonzept der Stadt Bottrop ('Climate Protection Concept', 2011) as well as the development goal of environmentally friendly and city-compatible traffic management of the 'Masterplan Climate-Suitable Urban Redevelopment' (2014). The focus is on avoiding traffic and shifting journeys to environmentally friendly means of transport. In the future, a climate protection sub-concept for mobility will serve to update the 'Transport Development Plan for the City of Bottrop'.

Strategy	**Corresponding Interventions/goals**	**Local plans and strategies**	**Character and context**	**Implementation status**
Increase the appeal of cycling and walking	A targeted promotion of cycling	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	implemented
	Creation of further Park & Ride and Bike & Ride facilities	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	informal/ not binding strategic measure	continuously implemented
	Ensuring more safety and quality for cycling on main routes	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/ not binding strategic measure	continuously implemented
	Creation of a North-South connection for cycling for better accessibility to the city centre	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding	continuously implemented
	Restructuring of multi-lane roads by implementing cycle paths	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding strategic development goal	continuously implemented
	Promotion of pedestrian traffic	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Optimised street space design	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Planning and construction of connecting routes. Testing the concept of shared-space on neighbourhood level	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented
	Routes away from main roads	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented
	Adequate seating facilities in public spaces	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented
	Reduction of fear-causing public spaces/ spaces of anxiety through suitable lighting concept	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented
	Complaint management for pedestrians	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented
	Expansion and revaluation of the pedestrian area	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic development goal	continuously implemented

Table 27: Weakness-threat strategy Bottrop B

The 'Air Quality Action Plan Ruhr Area 2011' and the 'Climate Protection Concept' (2011) specify targeted measures to promote pedestrian and cycle traffic in the City of Bottrop. Furthermore one-way streets in the opposite direction are to be opened for bicycle traffic. In addition, further cycle routes are to be examined and, if necessary, set up, and connecting roads planned and built, also to create a coherent cycle traffic network. This also includes the expansion of the rental bicycle station network (*Metropolradruhr*), the addition of parking facilities, signposts or the preparation of a bicycle city map. The planning documents also specify additional measures for the promotion of pedestrian traffic in the City of Bottrop. These include traffic-calmed areas, pedestrian crossings and crossing aids, signposts, pedestrian-friendly street space design, planning and construction of connecting paths and generally increased attractiveness and safety for pedestrians. The City of Bottrop is also a member of the working group of pedestrian and bicycle-friendly cities, municipalities and districts in North Rhine-Westphalia.

Strategy	**Corresponding Interventions/goals**	**Local plans and strategies**	**Character and context**	**Implementation status**
Improve public transport	Promotion of public transport	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	implemented
	Improving the attractiveness of public transport	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding strategic measure	-
	Real-time information on delays and alternative connections	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic goal	-

Table 28: Weakness-threat strategy Bottrop C

The 'Air Quality Action Plan Ruhr Area 2011' and the 'Climate Protection Concept' (2011) name various measures to promote public transport in the City of Bottrop. These include, in particular, acceleration measures to increase travel speed and the harmonisation of driving procedures which goes hand in hand with an increase in comfort and services. In addition, bus stops are to be modernised and dynamic passenger information expanded. A marketing concept and demand-oriented adaptation of the range of services are also mentioned. The 'Masterplan Climate-Suitable Urban Redevelopment' (2014) outlines a project to improve customer information in local public transport by displaying current timetable and connection information in vehicles.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Move to electric vehicles	Expansion of e-mobility	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Retrofitting of vehicles of public administrations	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Use of regenerative energies in motorised individual transport and public transport	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding strategic measure	-

Table 29: Weakness-threat strategy Bottrop D

As part of the expansion of e-mobility, innovative utilisation concepts such as CarSharing or the expansion of alternative vehicle drives in public transport are to be tested. In the context of mobility management, a successive conversion of the vehicles of the public administrations and of the public transport system to gas/bioethanol/hydrogen/electricity/hybrid shall take place.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Better incentives from government to move to more sustainable transport options	Mobility management as a contribution to air pollution control	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Further development of public transport, including financial support	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Tickets for special user groups with high discounts	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Development of a mobility management system	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
			strategic measure	
	Increase the attractiveness and reliability of regional public transport	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding strategic measure	continuously implemented

Table 30: Weakness-threat strategy Bottrop E

In order to implement further measures, the *Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord* specifies that cities should be granted additional financial support for infrastructure measures to comply with limit values under the EU Air Quality Directive. In the course of setting up a mobility management system, a contact/advice centre is to be set up. Other measures include courses on energy-saving driving and the combination of awareness-raising measures. In general, further incentives for public transport use are to be created. This also includes special tickets for user groups such as schoolchildren, companies or elderly people. In general, further incentives for public transport use and environmentally friendly mobility behaviour should be created. This also includes special tickets for user groups such as schoolchildren, companies or elderly people.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature	Successive remodelling of street spaces to be examined during conversion measures	Luftreinhalteplan Ruhrgebiet 2011 - Teilplan Nord	formal/binding strategic measure	continuously implemented
	Promotion of greening measures	Luftreinhalteplan Ruhrgebiet 2011 – Teilplan Nord	formal/binding strategic measure	continuously implemented
	Establishment and implementation of a climate protection concept	Integriertes Klimaschutzkonzept der Stadt Bottrop (2011)	informal/not binding	
	Establishment and implementation of a	Integriertes Klimaschutzkonzept	informal/not binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	climate adaptation concept	der Stadt Bottrop (2011)		
	Climate-friendly and functional upgrading of the green area (e.g., pocket-parks)	Masterplan Klimagerechter Stadtumbau für die InnovationCity Ruhr, Modellstadt Bottrop (2014)	informal/not binding	continuously implemented

Table 31: Weakness-threat strategy Bottrop F

The 'Air Quality Action Plan Ruhr Area 2011' specifies additional greening measures. In the case of conversion measures, the redesign of road spaces is to be successively examined, including, for example, deconstruction, greening concepts or wider ancillary facilities. As part of the promotion of greening measures, a road space greening concept is to be developed in order to increase the greening of road spaces. In addition, the programme for tree-lined avenues is to be intensified and the planting of dust-filtering vegetation as well as roof and facade greening for climate adaptation are to be promoted. In general, green spaces in Bottrop are to be upgraded in a climate-friendly and functional way. The development and implementation of a climate protection concept and a concept for adaptation to the impacts of climate change also contribute to this strategy.

3.3 Dublin

As the capital of the Republic of Ireland, Dublin is the biggest and most densely inhabited core in the region. It has a strong influence on the commuting workforce from the surrounding and even distant municipalities due to the city's strong labour and education markets. Dublin not only holds many jobs but also universities. In addition, the city is one of the most important national and international transport nodal points, due to the fact that it has one of the biggest international airports in Europe (OECD, 2016).

Figure 15: Land use in Dublin (©F. Hurth, Urban Atlas Data), scale: 1:125,000, reference year 2006, total area: 117.52 km², see annex for key

3.3.1Analysis of spatial parameters

The following table (table 32) gives an overview of the parameters 'urban structure', 'transport', 'industry and trade' and urban green and blue infrastructure' analysed in this section:

Parameter	Indicator	Value	Data Basis
Urban Structure	Sealed ground (%)	***50.20**/34.02***	*Spatial data: Urban Atlas Data / CORINE Data*
	Population density	9,412 people/km²	*D1.1*
	Urban development model	Compact city	*Spatial data: Urban Atlas Data / CORINE Data*
Transport	Private Transport		
	Commuter outflows	Region: Southern and Eastern Ireland 1.3	*Eurostat Regional Yearbook 2016; NUTS2*
	Density of motorways	Region: Southern and Eastern Ireland 18	*Eurostat Regional Yearbook 2015; NUTS2*
	Public Transport		
	Equipment rate for public transport vehicles	Region: Southern and Eastern Ireland 2.2	*Eurostat Regional Yearbook 2015; NUTS2*
	Freight Transport		
	Road freight vehicles	Region: Southern and Eastern Ireland 241	*Eurostat Regional Yearbook 2015; NUTS2*
	Presence of airport and/or sea freight port	Dublin Airport Dublin Connolly	*Google Maps*
Industry and Trade	Industrial area (%)	***11.39**/10.86***	*Spatial data: Urban Atlas Data / CORINE Data*
Urban green and blue infrastructure	Urban green (incl. forests) (%)	***12.17**/10.42***	*Spatial data: Urban Atlas Data / CORINE Data*
	Agriculture (%)	***3.15**/2.65***	*Spatial data: Urban Atlas Data / CORINE Data*

Table 32: Indicators for Dublin

3.3.1.1 Strengths

Urban development model: compact city

Based on the description of the characteristics of the urban development models presented in Section 2.4.1.3 the City of Dublin can be predominantly assigned to the model of compact city. The reason for this is the high population density (4,526 inhabitants per km^2) and the relatively large area of sealed ground (50.20%). In addition to this, Bologna also has an attractive and efficient public transport system.

Low commuter outflows

With a value of 1.3 (Region: Southern and Eastern Ireland) Dublin's commuter outflow is very low compared to other cities and regions. Low commuter outflow means that there is less emission caused by commuting population.

3.3.1.2 Weaknesses

High population density

Dublin contains a high population density with 9,412 persons per km². This means a larger amount of people living in the city centre are exposed to the effects of UHI.

High value of road freight vehicles

There is a significant amount of road freight vehicles (241,000) traveling through Southern and Eastern Ireland (the region Dublin is located in). The hazardous substances emitted by these vehicles deteriorate the urban air quality.

Industrial area next to residential use

As shown in figure 15, industrial areas in Dublin are directly located next to residential sites. This means that the citizens in these areas have a high exposure a high exposure to emissions.

Low value of urban green and agricultural area

The low percentage (12.17%) of green infrastructure in Dublin's urban area suggests an increase of the UHI effects in these areas. In addition to this, there is a low value of agricultural land (3.15%) which intensifies the effect even more.

3.3.1.3 Threats

City close to airport and sea freight port

The Dublin Airport in the north of Dublin, as well as the sea freight port (Dublin Connolly) east of the city centre, have negative impacts on the city's air quality due to emissions caused by air traffic and freight traffic.

3.3.2Analysis of local Stakeholders

The following paragraphs consist the SWOT analysis of the results from the stakeholder survey (see D1.1).

3.3.2.1 Weaknesses

The city is designed for the car

Dublin does not have a well-developed public transportation network. The city is also lacking an adequate cycling infrastructure. This means, that many people rely on their car for their commute to work.

A culture of car users

The urban structure that supports the car usage of the citizens directly links to the people's choice to use cars instead of other transportation sources. People also do not see a link between their car usage and air pollution until they are directly asked about it.

Innovating within a historic city can be difficult

The City of Dublin possesses a historic city centre with narrow streets and many buildings under monumental protection. These old urban structures increase traffic congestion and restrict the possibilities for urban reconstruction in order to improve the city's general infrastructure, its public transportation system and its cycling network. Any development will have to consider and follow the existing historic structures.

3.3.2.2 Threats

Disagreement and a lack of co-ordination among government bodies

The complexity of the topics air quality and climate change can lead to misunderstandings and misconceptions between different government bodies. This includes the general knowledge about these topics but also the responsibilities to address these issues, which are not always clearly distributed.

Lack of support from central government

Even though transportation is the main cause for air pollution in Dublin, this topic is not addressed sufficiently. In this context, a greater support from the central government's transport authorities could help to forward air quality initiatives.

3.3.3Results of the SWOT analysis

The matrix below gives an overview of the strengths, weaknesses, opportunities and threats identified for Dublin (Table 11). With the help of this matrix and on the basis of the opportunities for the iSCAPE cities (see D1.1) and the urban development models in Section 2.4.1.3, strategies were identified and are presented in the sections below. Each LL City has the participation in the iSCAPE project as an opportunity.

		internal	
		strengths 1. Compact City 2. Low commuter outflows	**weaknesses** 1. High population density 2. High value of road freight vehicles 3. Industrial area next to residential use 4. Low value of urban green and agricultural area 5. The city is designed for the car 6. A culture of car users 7. Innovating within a historic city can be difficult
external	**opportunities** 1. Participation in the iSCAPE project	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 1. Presence of airport and sea freight port 2. Disagreement and a lack of co-ordination among government bodies 3. Lack of support from central government	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 33: SWOT matrix for Dublin

3.3.3.1 Strengths-opportunities-strategies (S-O)

The following strategies have been identified to use strengths to pursue opportunities:

- Positive characteristics as e.g. a sophisticated public transport network and operation should be preserved

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Positive characteristics as e.g. a sophisticated public transport network and operation should be preserved	In the past 20 years Dublin's air quality has shown significant improvement	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding -	Implemented (prior to plan)
	Gas grid is widespread throughout the greater Dublin region	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding -	Implemented (prior to plan)
	The use of the city centre by heavy goods vehicles (HGVs) has been restricted with the opening of the Dublin Port Tunnel and the introduction of the ban on 5+ axle vehicles	Climate Change Strategy for Dublin City 2008–2012	informal/not binding strategic measure	Implemented (prior to plan)
	160 kilometres of bicycle lanes have been constructed in Dublin.	Climate Change Strategy for Dublin City 2008–2012	informal/not binding strategic measure	Implemented (prior to plan)

Table 34: Strength-opportunity-strategy Dublin

In the past 20 years Dublin's air quality has shown significant improvement in the levels of black smoke, lead, sulphur dioxide (SO_2), benzene, and carbon monoxide (CO). This is mainly due to the success of the regulatory ban on the sale of bituminous coal in the Dublin region and the elimination/reduction of other substances in vehicle fuels. The large natural gas finds off the Cork coast were also a vital contributor in providing an alternative fuel source and in the subsequent reduction of smoke levels, as the gas grid is now widespread throughout the greater Dublin region. The use of the city centre by heavy goods vehicles (HGVs) has been restricted with the opening of the Dublin Port Tunnel and the introduction of the ban on 5+ axle vehicles, which has resulted in a reduction in HGVs of between 85 and 94% in the city. Before the Dublin Port tunnel was opened Dublin experienced 9,000 HGV journeys daily. The tunnel has resulted in cleaner air, an

improvement for public transport and pedestrian and cycle facilities, reduced congestion, safer streets etc.

3.3.3.2 Weaknesses-opportunities strategies (W-O)

The following strategies have been identified to use opportunities to eliminate weaknesses:

- Positive characteristics as e.g. a sophisticated public transport network and operation should be preserved
- Further settlement development should take place with respect to the preservation of urban green spaces
- Possibilities for settlement pressure need to be weighed carefully against the opportunity for green space development and should consider ventilation and UHI potential
- Existing green and blue spaces should be interlinked in order to enable fresh air transport.
- Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions.
- Use the iSCAPE LL as a place to coordinate and bring together different government bodies
- Encourage stakeholders to work together in a 'round-table' approach

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Further settlement development should take place with respect to the preservation of urban green spaces	Develop a more consolidated city as far as possible	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic development goal	plan expired
	Establish, where feasible, river corridors, free from development, along all significant watercourses in the city	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Table 35: Weakness-opportunity strategy Dublin A

The binding *Dublin City Development Plan 2016-2022* (2016) provides an integrated, coherent spatial framework to ensure Dublin is developed in an inclusive way which improves the quality of life for the citizens, whilst also being a more attractive place to visit and work. The plan will have a key influence on the future of City of Dublin as it provides the agreed framework which gives

spatial expression to the economic, social, housing and cultural development. The plan will also have a crucial role in protecting the environment, heritage and amenities of the city and in mitigating the impacts of climate change.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Possibilities for settlement pressure need to be weighed carefully against the opportunity for green space development and should consider ventilation and UHI potential	Recognise and promote green infrastructure and landscape	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Balancing complex sets of economic, environmental or social goals in planning decisions	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Ensure that public open space is provided in new residential developments	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Table 36: Weakness-opportunity strategy Dublin B

According to the formal *Dublin City Development Plan 2016-2022* (2016), Dublin City Council will promote sustainable development by balancing complex sets of economic, environmental or social goals in planning decisions. For the above mentioned strategy, it is important to recognise and promote green infrastructure and landscape as an integral part of the form and structure of the city, including streets and public spaces. It is also necessary to ensure that in new residential developments, public open space is provided which is sufficient in quantity and distribution to meet the requirements of the projected population, including play facilities for children.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Existing green and blue spaces should be interlinked in order to enable fresh air transport	Create a network of corridors linking Natura 2000 sites to each other, to green areas and to Dublin City conservation areas	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic development goal	plan expired

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Open up culverted streams and rivers	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired
	Development of a green infrastructure network through the city, thereby interconnecting strategic natural and semi-natural areas with other environmental features	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Develop linear parks, particularly along waterways, and link existing parks and open spaces in order to provide green chains throughout the city	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Table 37: Weakness-opportunity strategy Dublin C

The development of a green infrastructure network through the City of Dublin can contribute significantly to the implementation of the above mentioned strategy. This includes the interlinking of existing green and blue spaces and interconnecting strategic natural and semi-natural areas with other environmental features including green spaces, rivers, canals and other physical features in terrestrial (including coastal) and marine areas. Moreover, a network of corridors will be established linking Natura 2000 sites with each other, with green areas and Dublin City conservation areas. These corridors must be appropriate, for example native Irish hedgerows/tree corridors, canal/river, wetland area, and parks. Another goal is to develop linear parks, particularly along waterways, and to link existing parks and open spaces in order to provide green chains throughout the city. Where lands along the waterways are in private ownership, it shall be policy in any development proposal to secure public access along the waterway.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Encourage stakeholders to work together in a 'round-table' approach	Establish an Air Quality Steering Committee comprising of managerial and technical members of each of the local authorities	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired
	The Air Quality Steering Committee will appraise major existing sectoral plans with a view to ensuring elements of air quality are addressed	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired
	Develop a system to share and pool of air quality monitoring data between the local authorities	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired
	Develop a common pool of knowledge on emission sources within the Dublin region	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired
	Develop a partnership programme on research activities with other bodies	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired

Table 38: Weakness-threat strategy Dublin A

The informal *Dublin Regional Air Quality Management Plan 2009-2012* aimed at encouraging stakeholder to work together. Therefore, an Air Quality Steering Committee should be established, comprising of managerial and technical members of each of the local authorities to periodically review and report on the implementation of the *Dublin Regional Air Quality Management Plan*. The Air Quality Steering Committee should appraise major existing sectoral plans (e.g. Waste Management Plans, Traffic Strategy) with a view to ensuring elements of air quality are addressed. In addition, a system should be established to share and pool monitoring data on air quality

between the local authorities. In this way, a common pool of knowledge on emission sources within the Dublin region can be created. A first step in this process would require the development of an emission inventory for the region.

Furthermore, the development of a partnership programme on research activities with other bodies (such as third level institutions) can improve the evidence base for informed decisions on air quality.

No concrete goals, interventions and/or measures from plan and strategy documents have been identified to be in line with the remaining strategies 'Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions' and 'Use the iSCAPE LL as a place to coordinate and bring together different government bodies'.

3.3.3.3 Strengths-threats-strategies (S-T)

There were no strengths-threats-strategies identified.

3.3.3.4 Weaknesses-threats strategies (W-T)

The following strategies have been identified to eliminate weaknesses and/or reduce threats:

- Reduce the appeal of driving in a city;
- Increase the appeal of cycling and walking;
- Improve public transport;
- Move to electric vehicles;
- Pedestrianise and provide cycle infrastructure in narrow streets;
- Create shared use public spaces;
- Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre;
- Introduce new urban models of mobility such as the 'superblock' - where existing gridded streets within a city are grouped together in small clusters. Traffic is then restricted to outside of this area while the streets inside the superblock become repurposed as community spaces;
- Better incentives from government to move to more sustainable transport options;
- Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature;
- Roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors.

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Reduce the appeal of driving in a city	Investigate the possibilities of further restricting car traffic in the city centre and giving higher priority to pedestrians at traffic lights	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired
	Congestion charges: The costs, benefits and effects of congestion charging may be assessed, especially in terms of greenhouse gas emissions	Dublin City Sustainable Energy Action Plan 2010-2020	informal/not binding strategic measure	not implemented
	Progressively eliminate all 'free' on street parking	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Renew restrictions on the use and cost of on-street parking and change them, if necessary	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic measure	continuously implemented
	Control the supply and price of all parking in the city in order to achieve sustainable transportation policy objectives	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Set maximum parking standards for all new developments	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented
	Reduce the availability of workplace parking in	Transport Strategy for the	formal/binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	urban centres to discourage car commuting	Greater Dublin Area 2016-2035	strategic development goal	
	Secure the introduction or expansion of on-street parking controls, and charging structures	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented

Table 39: Weakness-threat strategy Dublin B

For the strategy to reduce the appeal of driving in the City of Dublin, different informal and formal strategies and plans contain various strategic goals and measures. For example, possibilities are to be investigated to what extent further restrictions on car traffic in the city centre and a higher priority for pedestrians at traffic lights can be implemented. Moreover, the costs, benefits and effects of congestion charging may be assessed, especially in terms of greenhouse gas emissions. All the 'free' on street parking space should be progressively eliminated, both within the canals and in adjacent areas where there is evidence of 'all day' commuter parking, through the imposition of appropriate parking controls, including disc parking. Measures will also be taken to renew and change restrictions on the use and cost of parking on the street, in order to discourage commuter parking, and to facilitate short-term parking for shopping, business and leisure purposes at appropriate locations. For all new developments, maximum parking standards should be set. The availability of workplace parking spaces in urban centres should be reduced to prevent cars from commuting when alternative means of transport are available. A further measure is the introduction or expansion of on-street parking controls, and charging structures, that seek to reduce commuter parking and which contribute to greater parking turnover for non-commuting purposes.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Increase the appeal of cycling and walking	Extend and improve the cycling and walking network	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired
	Increase the number of secure cycle parking spaces across the city and in the car park or outside locations of	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Council offices/property			
	Improve connectivity of the cycle lane network	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired
	Expand pedestrianisation where possible	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired
	Improve the pedestrian environment and promote the development of a network of pedestrian routes	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Improve existing cycleways and bicycle priority measures throughout the city	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Implement in full the Greater Dublin Area Cycle Network Plan	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented
	Develop and expand off street and on street public cycle parking, the Dublin Bikes share scheme, and cycle route signage	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented
	Improve facilities for pedestrians	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented

Table 40: Weakness-threat strategy Dublin C

To increase the appeal of cycling and walking in the City of Dublin, the pedestrian and bicycle infrastructure should be improved and expanded. For this purpose, the pedestrian environment should be improved to promote the development of a network of pedestrian routes which link residential areas with recreational, educational and employment destinations to create a pedestrian environment that is safe and accessible to all. For bicycle traffic, the existing cycleways and bicycle priority measures throughout the city should be improved. This includes the creation of guarded cycle lanes where appropriate and feasible. In general, the *Greater Dublin Area Cycle Network Plan* should be fully implemented, delivering 1,485 kilometres of safe, high quality cycle facilities. The improvement and expansion of pedestrians' facilities include widening footpaths, providing better surfacing, improving junctions and reducing wait times at crossings, better permeability and pedestrianisation schemes.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Improve public transport	Influence the improvement of the public transportation network	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired continuously implemented
	Continue discussions with the bus companies of the possibility of real time information	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired implemented
	Investigate the possibility of introducing a uniform ticket system for all public transport	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired implemented
	Support and facilitate the development of an integrated public transport network with efficient interchange between transport modes	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Promote and facilitate the provision of Metro, all heavy elements	Dublin City Development Plan 2016-2022 (2016)	formal/binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	of the Dublin Area Rapid Transit (DART) Expansion Programme		strategic development goal	
	Various infrastructure improvements, including new rail stations, station upgrades, bus stops and shelters, replacement and upgrading of bus and train fleets, and better travel information	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented
	Various infrastructure projects, including Phoenix Park Tunnel Link, City Centre Re-Signalling, and Luas Cross City	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented
	Various infrastructure projects, including DART Expansion Programme, Train Control Building, Metro North, Metro South, Luas Line Extensions, Core Radial, Orbital and Regional Bus Networks, and Bus Rapid Transit	Transport Strategy for the Greater Dublin Area 2016-2035	formal/binding strategic measure	continuously implemented

Table 41: Weakness-threat strategy Dublin D

Both formal and informal planning documents set out general strategic objectives and measures for the City of Dublin to improve and expand public transport. Strategic measures have already been implemented in the course of implementing the *Climate Change Strategy for Dublin City 2008-2012*. These include the possibility of real time information of bus companies, which provide

timely and accurate data such as route number, final destination, waiting time and service disruptions etc. and which can increase the use of public transport by 6%. The Real Time Passenger Information was introduced in 2011 and is available through a website, apps and electronic displays at busier bus stops. Moreover, a uniform ticket system for all public transport was introduced in 2011 (Leap Card). The *Dublin City Development Plan 2016-2022* (2016) continuously aims at supporting and facilitating the development of an integrated public transport network with efficient interchange between transport modes, serving the existing and future needs of the City of Dublin in association with relevant transport providers, agencies and stakeholders. The *Transport Strategy for the Greater Dublin Area 2016-2035* concretises various infrastructure improvements, including new rail stations, station upgrades, bus stops and shelters, replacement and upgrading of bus and train fleets to low- or zero emission vehicles, and better travel information. In addition, concrete infrastructure projects are mentioned, including Train, Metro, and Bus. One example is the so called *DART Expansion Programme* (Dublin Area Rapid Transit), a series of projects which would develop and expand the DART network in the Greater Dublin Area. To promote and facilitate the provision of Metro, all heavy elements of the *DART Expansion Programme* including *DART Underground* (rail interconnector), the electrification of existing lines, the expansion of Luas, and improvements to the bus network in order to achieve strategic transport objectives.

Strategy	**Corresponding Interventions/goals**	**Local plans and strategies**	**Character and context**	**Implementation status**
Move to electric vehicles	Report on the feasibility of the conversion of local authority fleet to alternative fuels	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired -
	Promote the use of renewable fuels within the bus fleet	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired continuously implemented
	Promote the use of renewable fuels within the Council's vehicle fleet	Climate Change Strategy for Dublin City 2008-2012	informal/not binding strategic measure	plan expired continuously implemented
	Free parking for electric vehicles	Dublin City Sustainable Energy Action Plan 2010-2020	informal/not binding strategic measure	continuously implemented
	Facilitate the provision of electricity charging	Dublin City Development	formal/binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	infrastructure for electric vehicles	Plan 2016-2022 (2016)	strategic development goal	

Table 42: Weakness-threat strategy Dublin E

For the expansion and promotion of e-mobility in the City of Dublin, different measures are mentioned in the examined plans and strategies. The measures initially relate to the retrofitting of the vehicle fleets of public transport and the council's vehicle fleet, these measures could support a future move to electric vehicles. Other measures relate to creating the infrastructure to ensure the take up of electric vehicles such as setting free parking for electric vehicles and the provision and extension of charging infrastructure.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Pedestrianise and provide cycle infrastructure in narrow streets	Develop a sustainable network of safe, clean, attractive pedestrian routes, lanes and cycleways	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Table 43: Weakness-threat strategy Dublin F

The formal *Dublin City Development Plan 2016-2022* (2016) contains approaches for the development of a car-free, pedestrian- and cycle-friendly city. The plan forsees the development of a sustainable network of safe, clean, attractive pedestrian routes, lanes and cycleways in order to make the city more coherent and navigable.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Create shared use public spaces	Promote traffic calming in existing residential neighbourhoods	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Table 44: Weakness-threat strategy Dublin G

For the design and implementation of shared public spaces the *Dublin City Development Plan 2016-2022* (2016) aims at promoting traffic calming in existing residential neighbourhoods through innovative street design and layout such as home zones.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Better incentives from government to move to more sustainable transport options	Encourage measures to introduce benefit in kind schemes for public transport, car-pooling and improved facilities for cyclists	Dublin Regional Air Quality Management Plan 2009-2012	informal/not binding strategic measure	plan expired -

Table 45: Weakness-threat strategy Dublin H

To move towards more sustainable transport and environmentally friendly transport modes in the city, the *Dublin Regional Air Quality Management Plan 2009-2012* should have contributed and encouraged measures to allow private or public companies introduce benefit in kind schemes for public transport, car-pooling and improved facilities for cyclists.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature	Promote the concept of carbon-neutral sustainable communities throughout the city	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Encourage the use of internal ducting/ staircores within all new mixed-use developments, where appropriate	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Support the development of energy efficient initiatives	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Integrate green Infrastructure solutions into new developments and as part of the development of a	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Green Infrastructure Strategy for the city			

Table 46: Weakness-threat strategy Dublin I

The *Dublin City Development Plan 2016-2022* (2016) formulates some initial development goals for promotion and build development that reduce air pollution. In general, the City of Dublin should promote the concept of carbon-neutral sustainable communities throughout the city and should seek to initiate and support carbon-neutral demonstration projects in conjunction with local communities. Moreover, the city should support the development of energy efficient initiatives such as use of District Heating and Combined Heat and Power, and promote the use of cogeneration systems large developments. The encouragement of the use of internal ducting/staircores within all new mixed-use developments, where appropriate, to facilitate air extraction/ventilation units and other associated plant and services, is a further development goal. To improve the cities air quality and temperature level, integrated green infrastructure solutions should be implemented into new developments and as part of the development of a green infrastructure strategy for the city.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors	Incorporate open space into the green infrastructure network for the city, providing a multi-functional role	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented
	Encourage and promote tree planting in the planning and development of urban spaces, streets, roads and infrastructure projects	Dublin City Development Plan 2016-2022 (2016)	formal/binding strategic development goal	continuously implemented

Table 47: Weakness-threat strategy Dublin J

To further promote urban greening in the City of Dublin, the incorporation of open spaces into the city's green infrastructure network should be taken into account. This involves providing a multi-functional role including urban drainage, flood management, biodiversity, outdoor recreation and carbon absorption. The urban development should also encourage and promote tree planting in the planning and development of urban spaces, streets, roads and infrastructure projects.

No concrete goals, interventions and/or measures from plans or strategy documents have been identified for the other strategies 'Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre' and 'Introduce new urban models of mobility such as the 'superblock' - where existing gridded streets within a city are grouped together in small clusters. Traffic is then restricted to outside of this area while the streets inside the superblock become repurposed as community spaces'.

3.4 Guildford

Guildford is located close to the economically strong capital London, which influences swaths of its region offering great labour and education markets. Nevertheless, Guildford is the core of a functional urban area itself, because it holds (amongst others) a university and many jobs in the technological field, so people of surrounding municipalities commute to Guildford (IGEAT *et al.*, 2007).

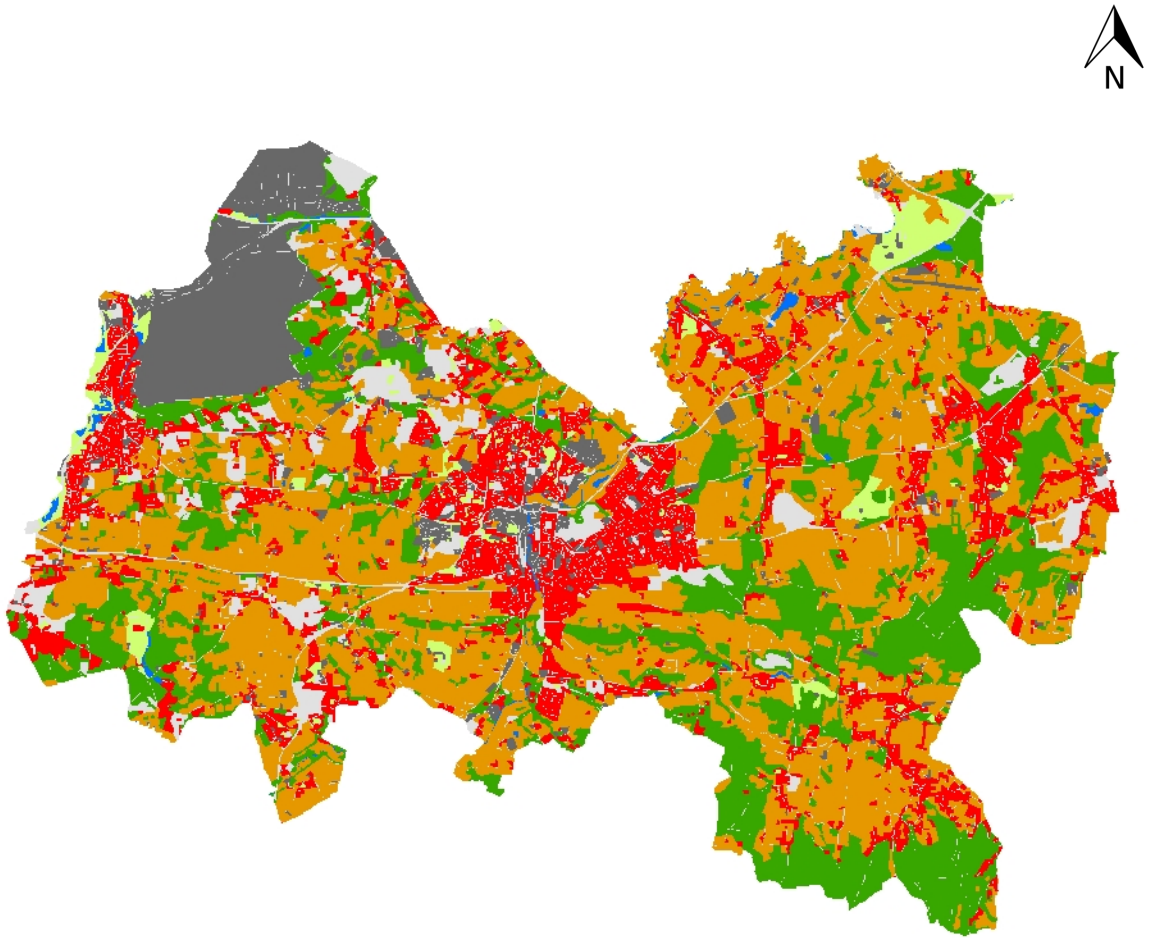

Figure 16: Land use in Guildford (©F. Hurth, Urban Atlas Data), scale: 1:175,000, reference year 2006, total area: 270.80 km², see annex for key

3.4.1 Analysis of spatial parameters

The following table (Table 48) gives an overview of the parameters 'urban structure', 'transport', 'industry and trade' and urban green and blue infrastructure' analysed in this section:

Parameter	Indicator	Value	Data Basis
Urban Structure	Sealed ground (%)	***13.70**/5.32***	*Spatial data:* *Urban Atlas Data / CORINE Data*
	Population density	506 people/km²	*D1.1 (Challenges and Opportunities in the iSCAPE Cities).*
	Urban development model	Decentralised concentration	*Spatial data:* *Urban Atlas Data / CORINE Data*
Transport	Private Transport		
	Commuter outflows	Region: South East England 18.2	*Eurostat Regional Yearbook 2016; NUTS2*
	Density of motorways	Region: Surrey, East and West Sussex 21	*Eurostat Regional Yearbook 2015; NUTS2*
	Public Transport		
	Equipment rate for public transport vehicles	Region: Surrey, East and West Sussex 2.2	*Eurostat Regional Yearbook 2015; NUTS2*
	Qualitative statement	"Guildford offers a range of transport services in order to guarantee that everyone can use public transport. Guildford offers community transport services for those who can't easily use public transport, e.g. senior citizens, citizens with a physical disability or mobility problem, citizens with learning difficulties or citizens	*Website Guildford Borough 2017*

Parameter	Indicator	Value	Data Basis
		who are suffering short or long term ill health. Furthermore, the city offers "Dial-a-ride" which is a door-to-door service, providing transport to a range of locations, appointments and social activities in Guildford and key towns in the surrounding area. Also, Door to Store services, transport to centres for older people, a library service and social trips are offered."	
	Freight Transport		
	Road freight vehicles	Region: Surrey, East and West Sussex 161	*Eurostat Regional Yearbook 2015; NUTS2*
	Presence of airport and/or sea freight port	London Airports Heathrow and Gatwick	*D1.1, p.32*
Industry and Trade	Industrial area (%)	***8.98**/1.02***	*Spatial data: Urban Atlas Data / CORINE Data*
Urban green and blue infrastructure	Urban green (incl. forests) (%)	***24.32**/24.40***	*Spatial data: Urban Atlas Data / CORINE Data*
	Agriculture (%)	***40.84**/56.91***	*Spatial data: Urban Atlas Data / CORINE Data*

Table 48: Indicators for Guildford

3.4.1.1 Strengths

Low value of sealed ground

With about 13% the amount of sealed ground in Guildford is low and the city has a decentralised structure. This means there is a low risk for UHI in this city. The core part of Guildford can be identified. However, there are several smaller centres around the core city. These smaller centres are interconnected by axes. (Figure 16). The settlement developed along axes and around the

core city, there is green and agricultural infrastructure that increases the general local climate and air quality.

Low population density

Guildford has a low population density with 506 people per km² so that generally speaking people living in Guildford are not strongly exposed to UHI effects.

Good public transport system

The city offers a range variety of transport services in order to guarantee access to public transport for everyone, e.g. community transport services for those who cannot easily use public transport or a dial-a-ride service, providing transport to nearly all locations in the urban area.

Low percentage of industrial area

The land used for industry and trade is very low in Guildford and is concentrated in the centre and in the western part of the urban area. Consequently, the emissions caused by industrial area have no big influence on the residential sites and the population.

3.4.1.2 Weaknesses

High value of road freight vehicles

In Guildford, there is a high rate of road freight transport (total amount of 161,000 road vehicles in Region of Surrey, East and West Sussex) causing high emissions.

Urban development model: decentralised concentration

Based on the description of the characteristics of the urban development models presented in Section 2.4.1.3, Guildford can be predominantly assigned to the model of decentralised concentration. The reason for this is that the centre part of Guildford is surrounded by several smaller centres. These smaller centres are interconnected by transport axes.

3.4.2Analysis of local Stakeholders

The following paragraphs consist the SWOT analysis of the results from the stakeholder survey (see D1.1).

3.4.2.1 Weaknesses

The city is designed for the car

In Guildford, the car is the main mode for people to travel and Surrey includes some of the busiest roads in the United Kingdom (UK). Because of the region's closeness to London, many people use their private cars to commute to London on a daily basis. The stakeholders assess that road traffic is a dominant reason for a large amount of air pollution. In combination with high buildings along very busy roads, the traffic emissions create a 'pollution tunnel'.

The city structure is dense or overcrowded

Guildford's location within commuting distance to London, makes the city suffer from similar issues like the capital city: Increased population growth and overcrowded public transportation systems.

3.4.2.2 Threats

The city is close to the airport

Guildford is close to the London Airports Heathrow and Gatwick, which may contribute to the background concentration of the city. Because of the vicinity of Heathrow Airport, Guildford was declared to be a "hot spot for air pollution within the UK" (D1.1, p.32).

Disagreement and a lack of co-ordination among government bodies

The responsibilities for Guildford's road network is split between the Surrey County Council (responsible for local roads) and Highways England (responsible for motorways). This means that the implementation of policies by the local government always requires a third party agreement - which may not always be reached.

Lack of support from central government

Even though the interest of the central government for air quality has recently increased, there is still not enough funding related to this topic.

3.4.3Results of the SWOT analysis

The results from the SWOT analysis are collected in the following matrix (Table 49). The matrix gives an overview of the strengths, weaknesses, opportunities and threats identified for Guildford. Based on the SWOT analysis, the opportunities for the iSCAPE LL Cities (see D1.1), as well as the strategies for the urban development models in Section 2.4.1.3, were reviewed for their usefulness. The result is the below list of strategies that Guildford could use in order to improve its local air quality and vulnerability to UHI building. Each LL City has the participation in the iSCAPE project as an opportunity.

		internal	
		strengths 1. Low value of sealed ground 2. Low population density 3. Good public transport system 4. Low percentage of industrial area	**weaknesses** 1. High value of road freight vehicles 2. Decentralised concentration 3. The city is designed for the car 4. The city structure is dense or overcrowded
external	**Opportunities** 1. Participation in the iSCAPE project	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 1. Presence of airport and sea freight port 2. Disagreement and a lack of co-ordination among government bodies 3. Lack of support from central government	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 49: SWOT matrix for Guildford

3.4.3.1 Strengths-opportunities-strategies (S-O)

The following strategies have been identified to use strengths to pursue opportunities:

- Positive characteristics such as an adequate mix of functions and sophisticated public transport should be preserved.

No concrete goals, interventions and/or measures from plans or strategy documents currently in place at a local level are in line with the strategy mentioned.

3.4.3.2 Weaknesses-opportunities strategies (W-O)

The following strategies can be selected in order to use opportunities to eliminate weaknesses:

- Further settlement development should take place with respect to the preservation of urban green spaces with special consideration of the maintenance of ventilation channels and other ecologic functions such as groundwater production, habitats, etc.
- Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions
- Use the iSCAPE LL Cities as a place to coordinate and bring together different government bodies
- Encourage stakeholders to work together in a 'round-table' approach

No concrete goals, interventions and/or measures from plans or strategy documents currently in place are in line with the strategy mentioned.

3.4.3.3 Strengths-threats-strategies (S-T)

There were no strengths-threats-strategies identified.

3.4.3.4 Weaknesses-threats strategies (W-T)

The following strategies can be selected in order to eliminate weaknesses and/or reduce threats:

- Reduce the appeal of driving in a city
- Increase the appeal of cycling and walking
- Improve public transport
- Move towards electric vehicles
- Better incentives from government to move towards sustainable transport options
- Build developments that reduce air pollution such as use green walls, rooves and urban farming to improve air quality and ambient temperature
- Encourage green barriers around open busy roads to reduce air pollution exposure of people walking and cycling nearby (Abhijith *et al.*, 2017)

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Increase the appeal of cycling and walking	New developments should take place in the close proximity of existing transport infrastructures and new roads should be designed to support pedestrian and cycle paths as well as charging	Surrey Transport Plan: Climate Change Strategy (2011)	informal/not binding strategic development goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	infrastructure for e-mobility			
	Improvement of River Wey towpath	Guildford Borough Transport Strategy 2016	informal/not binding strategic development goal	implemented
	Improvements in cycle network and signage	Guildford Borough Transport Strategy 2016	informal/not binding strategic development goal	continuously implemented
	Expand the public realm through significantly extended pedestrian-priority areas	Guildford Borough Transport Strategy 2016	informal/not binding strategic development goal	continuously implemented

Table 50: Weakness-threat strategy Guildford A

The existing road network in Guildford is to be improved and expanded in order to promote walking and cycling. This includes both pedestrian zones and new infrastructure elements for sustainable mobility in general. The River Wey towpath as a green route for pedestrians and cyclists is a good example. The *Surrey Transport Plan: Climate Change Strategy* (2011) recommends that new development should be located in close proximity to existing transport infrastructure and new streets are designed to support walking, cycling as well as charging infrastructure for e-mobility.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Improve public transport	Improvements in rail and station capacity	Guildford Borough Transport Strategy 2016	informal/not binding strategic development goal	continuously implemented
	Expansions of Park & Ride	Guildford Borough	informal/not binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
		Transport Strategy 2016	strategic development goal	
	Improvements in bus networks	Guildford Borough Transport Strategy 2016	informal/not binding strategic development goal	continuously implemented
	Bid of the Department for Environment, Food and Rural Affairs for grant from the 'low emission bus scheme'	Air Quality Strategy 2017-2022	informal/not binding strategic measure	continuously implemented

Table 51: Weakness-threat strategy Guildford B

Both the formal *Guildford Borough Transport Strategy 2016* and the informal *Air Quality Strategy 2017-2022* mention general strategic objectives and measures for the City of Guildford for the improvement and expansion of public transport. These include public funding for a low-emissions bus scheme and cooperation with bus companies to increase the number of low- and ultra-low emission buses in Guildford over the period 2018 to 2021. In addition, the bus network and the efficiency of railways and railway stations should be expanded. This also includes improving accessibility and encouraging participants of motorised individual transport to switch to public transport (e.g., through Park & Ride).

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Move towards electric vehicles	Proposals and financing offers for electric vehicle charging stations should be developed.	Surrey Transport Plan: Climate Change Strategy (2011)	informal/not binding strategic development goal	continuously implemented
	Green scheme parking fees for electric vehicles in car parks	Guildford Borough Transport Strategy 2016	informal/not binding	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
			strategic development goal	
	Increase in charging points for electric vehicles to 30 charging points	Guildford Borough Transport Strategy 2016	informal/not binding strategic development goal	continuously implemented

Table 52: Weakness-threat strategy Guildford C

The Surrey Transport Plan: Climate Change Strategy (2011) highlights the need, to support electric vehicles and that proposals and funding bids for electric vehicle recharging points be developed. Therefore, appropriate locations should be determined, e.g., workplaces, public car parks and on-street. In order to secure the future of these infrastructures, acceptance is to be promoted through demonstration programmes and advertising campaigns. Moreover, owners of electric vehicles can apply for a parking permit to obtain reduced fees. The City of Guildford has already installed four charging stations at car parkings in town centre during 2017 and a feasibility study was developed for the provision of additional charging stations in residential streets in the city centre as well as publicly accessible electric vehicle charging stations in the district.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Build developments that reduce air pollution such as use green walls, rooves and urban farming to improve air quality and ambient temperature	Towns and cities will be greened by the creation of Green Infrastructure	The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting (2018)	informal/not binding strategic development goal	continuously implemented
	A set of Green Infrastructure standards will be developed to help deliver good quality green infrastructure	The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting (2018)	informal/not binding strategic development goal	continuously implemented

Table 53: Weakness-threat strategy Guildford D

The *National Adaptation Programme and the Third Strategy for Climate Adaptation* (2018) defines that UK towns and cities will be greened by the creation of green infrastructure and planting of one million urban trees and create more, better quality and well maintained green infrastructure. A set of green infrastructure standards will be developed to help local green infrastructure planners, designers, managers and communities deliver good quality green infrastructure. This includes: undertaking an evidence review and consulting stakeholders; developing a draft model framework of green infrastructure standards; test draft framework through pilots; producing guidance on planning and delivering green infrastructure, including applying the framework of green infrastructure standards; launching mainstreaming and support to local authorities, developers and others monitoring and evaluation.

No concrete goals, interventions and/or measures from plans and strategy documents are in line with the remaining strategies 'Reduce the appeal of driving in a city', 'Better incentives from government to move to more sustainable transport options' as well as 'Encourage green barriers around open busy roads to reduce air pollution exposure of people walking and cycling nearby'.

3.5 Hasselt

Hasselt is a small urban area surrounded by further smaller municipalities, from which labour force parties commute to Hasselt. Bigger cities nearby are Brussels or foreign cities like Aachen (Germany) and Maastricht (Netherlands). The city is well connected in the regional transport network. Hasselt holds a university as well as an administrative and trading centre with regional influence. The city is also located at the Albert-Canal, which connects various inland cities to the North Sea (IGEAT *et al.*, 2007).

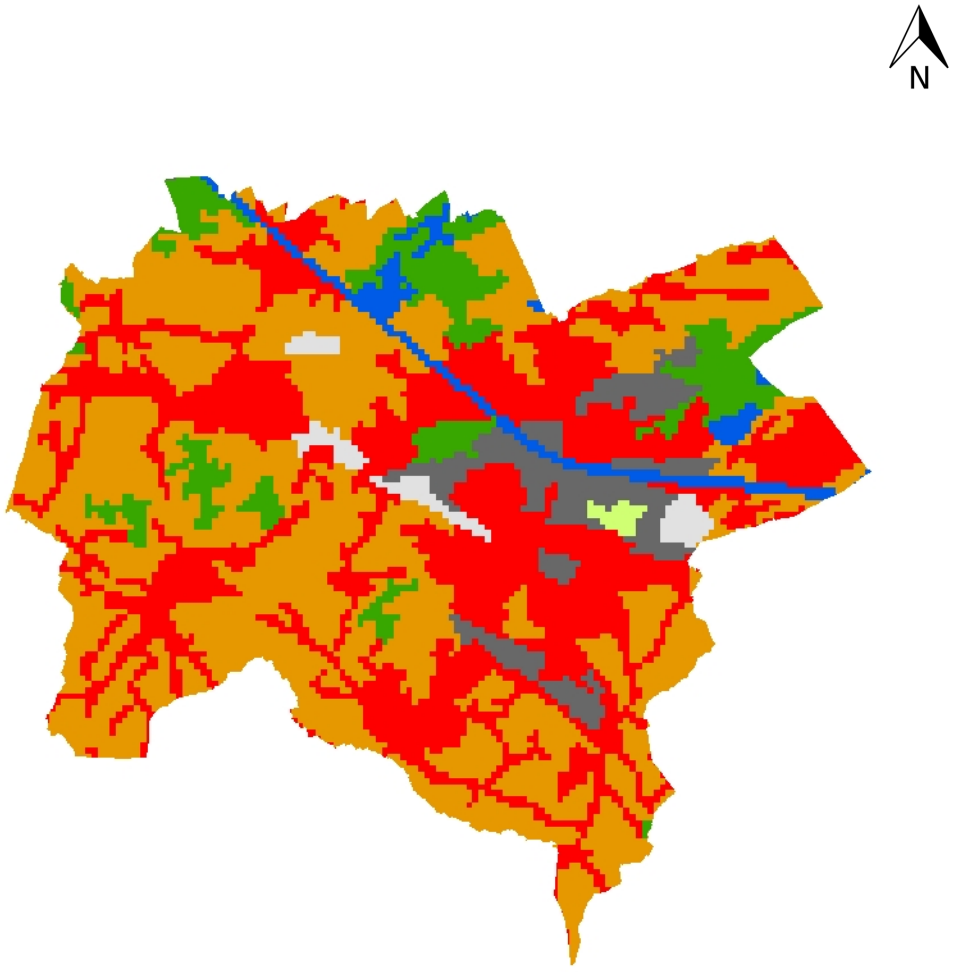

Figure 17: Land use in Hasselt (©F. Hurth, CORINE Data), scale: 1:125,000, reference year 2006, total area: 102,70 km², see annex for key

3.5.1 Analysis of spatial parameters

The following table (Table 54) gives an overview of the parameters 'urban structure', 'transport', 'industry and trade' and urban green and blue infrastructure' analysed in this section:

Parameter	Indicator	Value	Data Basis
Urban Structure	Sealed ground (%)	*14.63***	*Spatial data: CORINE Data*
	Population density	752 people/km²	*D1.1 (Challenges and Opportunities in the iSCAPE Cities).*
	Urban development model	Decentralised concentration	*Spatial data: CORINE Data*
Transport	Private Transport		
	Commuter outflows	Region: Province Limburg 19.1	*Eurostat Regional Yearbook 2016; NUTS2*
	Density of motorways	Region: Province Limburg 44	*Eurostat Regional Yearbook 2015; NUTS2*
	Public Transport		
	Equipment rate for public transport vehicles	Region: Province Limburg 1.4	*Eurostat Regional Yearbook 2015; NUTS2*
	Qualitative statement	"The city of Hasselt abolished public transport fares in 1997 within the city range. For many years, this decision was the flagship of the 'politics of free'. This will now come to an end and only young people under 19 years will still travel for free. Because of the free public transport, Hasselt got worldwide media attention and has become a success story."	*ELTIS, 2014*
	Freight Transport		

Parameter	Indicator	Value	Data Basis
	Road freight vehicles	Region: Province Limburg 73	*Eurostat Regional Yearbook 2015; NUTS2*
	Presence of airport and/or sea freight port	no	*D1.1, p.32*
Industry and Trade	Industrial area (%)	*6.20***	*Spatial data: CORINE Data*
Urban green and blue infrastructure	Urban green (incl. forests) (%)	*8.15***	*Spatial data: CORINE Data*
	Agriculture (%)	*46.05***	*Spatial data: CORINE Data*

Table 54: Indicators for Hasselt

3.5.1.1 Strengths

Low value of sealed ground

With 14.63% the amount of sealed ground is low and Hasselt has a decentralised structure. The core city of Hasselt can be identified. However, there are several smaller centres around the core city. These smaller centres are interconnected by axes (Figure 17). The green and agricultural infrastructure increases the general local climate and air quality.

Low population density

Hasselt has a low population density with 752 people per km² so that generally speaking people living in Hasselt are not strongly exposed to UHI effects.

Good public transport system

Hasselt got worldwide media attention due to its free public transport and has become a success story. Both the number of travellers and the number of routes and buses has increased with time (from 1,000 passengers per day in June 1997 up to an average of 12,600 in 2007).

Low percentage of industrial area

The land used for industry and trade is very low in Hasselt and is concentrated in the core city and in the western part of the urban area. Due to this the emissions caused by industrial area have no big influence on the residential sites and the population.

3.5.1.2 Weaknesses

Urban development model: decentralised concentration

Based on the description of the characteristics of the urban development models presented in Section 2.4.1.3 the City of Hasselt can be predominantly assigned to the model of decentralised concentration. The reason for this is that the core city is surrounded by several smaller centres around the core city. These smaller centres are interconnected by transport axes.

3.5.1.3 Opportunities

City not close to the airport

The fact that there is no airport next to Hasselt has to be valued positive, because air traffic does not additionally decrease the air quality in the city.

3.5.1.4 Threats

Density of motorways

The province Limburg, wherein Hasselt is located, contains a dense motorway network with 44km per 1,000km² creating a constant exposure of the population towards emissions. Because motorways are out of local government's influence, the high density of motorways has to be seen as a threat.

3.5.2Analysis of local Stakeholders

The following paragraphs presents the SWOT analysis of the results from the stakeholder survey (see D1.1).

3.5.2.1 Strengths

Government Policy

Hasselt already has a citizen focused air pollution strategy in place which includes an active campaign to inform people about the relations between their behaviour and air pollution and promotes environmentally friendly behaviours. It is possible to build future actions onto these efforts.

3.5.2.2 Weaknesses

The city is designed for the car

Even though the city centre of Hasselt is mainly car free, the city has to deal with a large amount of car traffic and as a result traffic congestion. The reason for this is the city's vicinity to two major highways and an increase of car ownerships over the past years.

People don't see air quality as something they can (or are willing) to change

Even though Hasselt's citizens are aware of the relation between traffic and air pollution, they are not willing to change their travel behaviour in order to improve the city's air quality.

Innovation within a historic city can be difficult

The historic city centre of Hasselt requires spatial planners to maintain existing structures when planning new infrastructure. This can complicate the improvement of urban infrastructure and can result in traffic bottlenecks that create traffic congestion.

3.5.3Results of the SWOT analysis

The strengths, weaknesses, opportunities and threats identified for Hasselt were collected in the matrix below (Table 15). With the help of the matrix and on the basis of the opportunities for the iSCAPE cities (see D1.1) and the urban development models in Section 2.4.1.3, strategies to improve Hasselt's air quality and reduce the emergence of UHI were identified. Each LL City has the participation in the iSCAPE project as an opportunity.

		internal	
		strengths 1. Low value of sealed ground 2. Low population density 3. Good public transport system 4. Low percentage of industrial area 5. Government policy	**weaknesses** 1. Decentralised concentration 2. The city is designed for the car 3. People don't see air quality as something they can (or are willing) to change 4. Innovation within a historic city can be difficult
external	**opportunities** 1. Participation in the iSCAPE project 2. No airport close to the city	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 4. Density of motorways	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 55: SWOT matrix for Hasselt

3.5.3.1 Strengths-opportunities-strategies (S-O)

The following strategies can be selected in order to use strengths to pursue opportunities:

- Positive characteristics like an adequate mix of functions and sophisticated public transport should be preserved.

No concrete goals, interventions and/or measures from plans or strategy documents currently in place are in line with the strategy mentioned.

3.5.3.2 Weaknesses-opportunities strategies (W-O)

The following strategies have been identified to use opportunities to eliminate weaknesses:

- Further settlement development should take place with respect to the preservation of urban green spaces with special consideration of the maintenance of ventilation channels and other ecologic functions such as groundwater production, habitats, etc.
- Existing green and blue spaces should be qualitatively developed and re-valuated in order to explicitly foster climatic and air quality functions.
- Use the iSCAPE LL Cities labs as a place to co-ordinate and bring together different government bodies
- Encourage stakeholders to work together in a 'round-table' approach

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Further settlement development should take place with respect to the preservation of urban green spaces […]	City of Hasselt provides a 'reward system' in the form of e-points, for individuals who adapt their home to new sustainability standards	Woonplan Hasselt 2030 (2015)	informal/not binding strategic development goal	continuously implemented
	Promotion of greening, green space per inhabitant and distance to this green space area	Woonplan Hasselt 2030 (2015)	informal/not binding strategic development goal	continuously implemented

Table 56: Weakness-opportunity strategy Hasselt A

The informal *Woonplan Hasselt 2030* ('Housing Concept 2030 of the City of Hasselt', 2015) contains general statements on the importance of urban green spaces. The promotion of urban greening, the proportion of green spaces per inhabitant as well as the accessibility and distance to green spaces are seen as important fields of action.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Existing green and blue spaces should be qualitatively developed and re-evaluated in order to explicitly foster climatic and air quality functions	Project initiated by City of Hasselt to promote and expand public green in Hasselt	Klimaatadaptatieplan Limburg 2017	formal/binding project	continuously implemented

Table 57: Weakness-opportunity strategy Hasselt B

In order to develop the existing urban structures within the City of Hasselt a project was initiated. According to the *Klimaataptatieplan Limburg* ('Climate Adaptation Plan Limburg', 2017), various streets will be transformed into so called flower districts. The flowers are provided completely free of charge. In return, the neighbourhood takes over the planting and maintenance.

No concrete goals, interventions and/or measures from plans or strategy documents currently in place are in line with the strategy to 'Use the iSCAPE LL Cities labs as a place to co-ordinate and bring together different government bodies'.

3.5.3.3 Strengths-threats-strategies (S-T)

There were no strengths-threats-strategies identified.

3.5.3.4 Weaknesses-threats strategies (W-T)

The following strategies can be selected in order to eliminate weaknesses and/or reduce threats:

- Reduce the appeal of driving in a city
- Increase the appeal of cycling and walking
- Improve public transport
- Move to electric vehicles
- Pedestrianise and provide cycle infrastructure in narrow streets
- Create shared use public spaces
- Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre

- Introduce new urban models of mobility such as the 'superblock' - where existing gridded streets within a city are grouped together in small clusters. Traffic is then restricted to outside of this area while the streets inside the superblock become repurposed as community spaces
- Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities above.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Reduce the appeal of driving in a city	Carpool parking (was opened in 2011 with a capacity of 250 cars)	Klimaatadaptatieplan Limburg 2017	formal/binding project	continuously implemented
	Eco delivery and collection	Klimaatadaptatieplan Limburg 2017	formal/binding project	continuously implemented
	Free public transport for students	Klimaatadaptatieplan Limburg 2017	formal/binding strategic measure	continuously implemented
	Car-free Sundays every year	Mobiliteitsplan Hasselt-Genk (2014)	formal/binding strategic measure	continuously implemented

Table 58: Weakness-threat strategy Hasselt A

To reduce the appeal of driving in the City of Hasselt different goals and related projects were implemented on the basis of the formal 'Climate Adaptation Plan Limburg' and the formal *Mobiliteitsplan Hasselt Genk* ('Mobility Plan Hasselt-Genk', 2014). In 2011, a carpool parking was opened, with a capacity of 250 cars, to promote carpooling in the city. Another approach deals with eco delivery and collection to receive goods on the outskirts of Hasselt and deliver goods efficiently and eco-friendly to the final recipient in the city centre. Furthermore, public transport is free for students up to 19 years of age. There are also car-free Sundays in the City of Hasselt every year. The city ring and centre are transformed into car-free spaces, where cyclists, hikers, athletes and children have free space between 1 and 5 pm.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Increase the appeal of cycling and walking	Awareness-raising communication activities	Klimaatadaptatieplan Limburg 2017	formal/binding strategic measure	continuously implemented
	Expand infrastructure for cyclists and pedestrians and make it more user-friendly	Klimaatadaptatieplan Limburg 2017	formal/binding strategic measure	continuously implemented
	Bicycle premium: residents who hand in the number plate of their car, motorcycle or moped receive a premium/bonus from the city to buy a bicycle.	Fietsactieplan Hasselt (2017)	informal/not binding strategic measure	continuously implemented

Table 59: Weakness-threat strategy Hasselt B

To increase the appeal of cycling and walking in the City of Hasselt, communication measures to raise awareness are being implemented through the Klimaatadaptatieplan Limburg (2017), to enable the working population to implement car-free workdays or use active mobility initiatives. Moreover, the infrastructure for cyclists and pedestrians should be designed to be user-friendly. According to the informal *Fietsactieplan Hasselt* ('Bicycle Action Plan Hasselt', 2017), the bicycle premium project provides support for residents who hand in the number plate of their car, motorcycle or moped, they then receive a premium/bonus from the city to buy a bicycle.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Move to electric vehicles	Providing electric vehicle charging systems at major parking plots	Klimaatadaptatieplan Limburg 2017	formal/binding strategic measure	continuously implemented

Table 60: Weakness-threat strategy Hasselt C

In order to promote e-mobility in Hasselt, appropriate charging infrastructure is to be made available at all major parking plots in the city.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Pedestrianise and provide cycle infrastructure in narrow streets	Cycle Route Green Boulevard (2018): Construction of an uninterrupted bicycle loop	Klimaatadaptatie-plan Limburg 2017	formal/binding project	continuously implemented
	Cycle Streets: All streets in the inner city, with the exception of the pedestrian zone, are transformed into bicycle streets.	Fietsactieplan Hasselt (2017)	informal/not binding strategic measure	continuously implemented

Table 61: Weakness-threat strategy Hasselt D

In addition to the strategy to increase the appeal of cycling and walking, the City of Hasselt has set further strategic goals and measures to promote cycling in its 'Climate Adaptation Plan' (2017) and 'Bicycle Plan Hasselt' (2017). First of all, the inner ring road should be improved by removing barriers and implement pedestrian and cycle crossing. Moreover, all streets in the inner city, with the exception of the pedestrian zone, are transformed into bicycle streets. In a bicycle street, motor vehicles are not allowed to overtake cyclists and their maximum speed is limited to 30 kilometres per hour.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Introduce new urban models of mobility such as the 'superblock' - where existing gridded streets within a city are grouped together in small clusters […]	Green Deal Shared Mobility	Klimaatadaptatie-plan Limburg 2017	formal/ binding strategic development goal	continuously implemented
	Parking space information in major parking plots/plazas on the road network	Mobiliteitsplan Hasselt-Genk (2014)	informal/ not binding strategic measure	continuously implemented

Table 62: Weakness-threat strategy Hasselt E

The Green Deal Shared Mobility is a collaboration between more than 80 partners. The concrete targets of this Green Deal are increasing numbers of car sharers, carpooling companies, bicycle dividers and electric cars by 2020.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature	The implementation of regulations in the construction of new residential buildings that help decrease the energy requirements.	Vlaams energiebeleid (n.d.)	formal/binding project	continuously implemented
	Subsidies for the energetic renovation of houses	Vlaams energiebeleid (n.d.)	informal/not binding strategic measure	continuously implemented

Table 63: Weakness-threat strategy Hasselt F

Vlaams energiebeleid ('Flemish energy policy', n.d.) is intended to contribute to the implementation of specifications and new standards for energy-efficient renovation. For this purpose, subsidies for house construction and renovation should be implemented.

No concrete goals, interventions and/or measures from plans or strategy documents currently in place are in line with the remaining strategies 'Improve public transport', 'Create shared use public spaces', and 'Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre'.

3.6 Vantaa

The municipality of Vantaa, together with those of Helsinki, Espoo and Kaunianien, form the Finnish Capital Region, which in turn is part of a much larger urban region called Greater Helsinki. Many people from Vantaa, Espoo, and Kauniainen commute to Helsinki. Simultaneously, Vantaa itself offers a diverse labour market (e.g. headquarter of Finland's main airlines and of several Finnish and international companies) as well as a university, resulting in commuter flows from surrounding municipalities to Vantaa (IGEAT *et al.*, 2007).

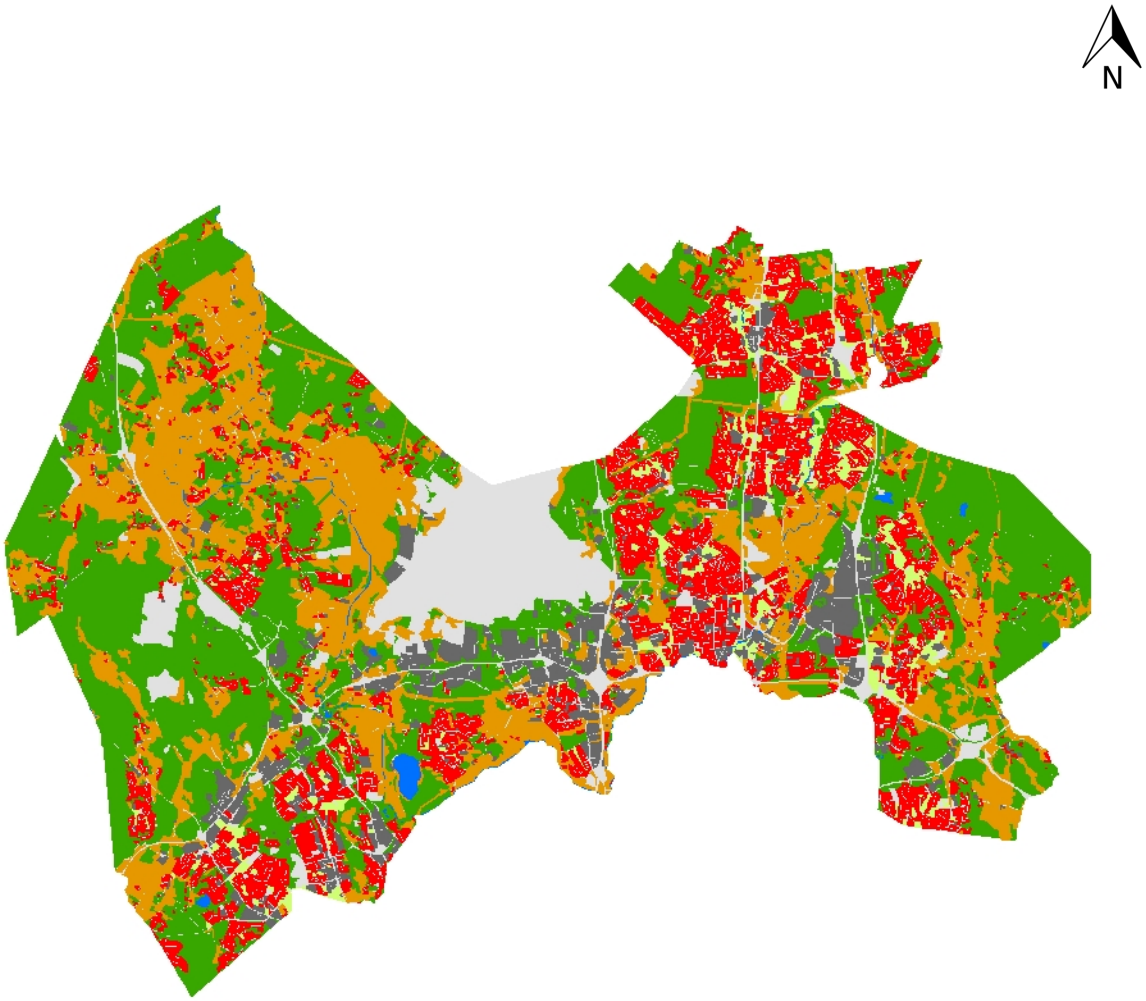

Figure 18: Land use in Vantaa (©F. Hurth, Urban Atlas Data), scale: 1:175,000, reference year 2006, total area: 240.33 km², see annex for key

3.6.1 Analysis of spatial parameters

The following table (Table 64) gives an overview of the parameters 'urban structure', 'transport', 'industry and trade' and 'urban green and blue infrastructure' analysed in this section.

Parameter	Indicator	Value	Data Basis
Urban Structure	Sealed ground (%)	***17.71**/18.52***	*Spatial data:* *Urban Atlas Data / CORINE Data*
	Population density	899 people/km²	*D1.1 (Challenges and Opportunities in the iSCAPE Cities).*
	Urban development model	Decentralised city	*Spatial data:* *Urban Atlas Data / CORINE Data*
Transport	Private Transport		
	Commuter outflows	Region: Manner-Suomi 4.2	*Eurostat Regional Yearbook 2016; NUTS2*
	Density of motorways	Region: Helsinki-Uusimaa 31	*Eurostat Regional Yearbook 2015; NUTS2*
	Public Transport		
	Equipment rate for public transport vehicles	Region: Helsinki-Uusimaa 3	*Eurostat Regional Yearbook 2015; NUTS2*
	Qualitative statement	"42% [of respondents from Helsinki Metropolitan Area] are very satisfied with public transport, 51% are rather satisfied, only 4% are rather unsatisfied and 1% not at all satisfied"	*EU, 2010, p. 67*
	Qualitative statement	"The aim is to encourage people to reduce driving alone in their cars and increase walking, cycling, use of public transport, car sharing, ride sharing and economic driving. Good public transport services, town planning and locating	*HSL, 2017*

Parameter	Indicator	Value	Data Basis
		services and jobs close to housing reduce the need to use a car on a daily basis.“	
	Freight Transport		
	Road freight vehicles	No data available	*Eurostat Regional Yearbook 2015; NUTS2*
	Presence of airport and/or sea freight port	Helsinki Airport	*Google Maps*
Industry and Trade	Industrial area (%)	***7.10**/8.66***	*Spatial data: Urban Atlas Data / CORINE Data*
Urban green and blue infrastructure	Urban green (incl. forests) (%)	***39.16**/34.28***	*Spatial data: Urban Atlas Data / CORINE Data*
	Agriculture (%)	***22.76**/20.59***	*Spatial data: Urban Atlas Data / CORINE Data*

Table 64: Indicators for Vantaa

3.6.1.1 Strengths

Low value of sealed ground

In Vantaa, the amount of sealed ground is low (17.71%). In addition, Vantaa is a decentralised city and has no dominant core i.e. a concentration of sealed ground (Figure 18). The green and agricultural infrastructure contributes to the regulation of the local climate and air quality.

Low population density

Vantaa has a low population density with 899 people per km² so that generally speaking people living in Vantaa are not strongly exposed to UHI effects.

Good public transport system

Vantaa has a high value of public transport vehicles (3.0 public vehicles per 1,000 inhabitants) and most of the population is content with the public transport in the city. In addition, there are different aims to reduce private transport. The use of public transport increases the local air quality and emits less pollutants.

Low percentage of industrial area

The industrial area is located along transport axes and – with a few execptions - is not located next to residential sites, so emissions caused by industrial areas have no big influence on residential sites and the population (see figure 24).

3.6.1.2 Weaknesses

Urban development model: decentralised city

Based on the description of the characteristics of the urban development models presented in Section 2.4.1.3 the City of Vantaa can be predominantly assigned to the model of the decentralised city. The reason for this is that no dominant core urban area can be identified and no clear distinction between open spaces and built-up areas can be made. The map shows a mosaic settlement structure that is characteristic for decentralised cities.

3.6.1.3 Threats

The city is close to the airport

The Helsinki Airport is located in the middle of the city's area and has negative impacts on the city's air quality due to emissions caused by airport ground vehicles and air traffic during landing and take-off.

3.6.2Analysis of local Stakeholders

The following paragraphs consist the SWOT analysis of the results from the stakeholder survey (see D1.1).

3.6.2.1 Strengths

Government Policy

With the establishment of Vantaa's Air Protection Policy in 2008, the city improved the cooperation between the Centre for Environment, Land Use Planning, Traffic Planning and Street Maintenance. Even though there are still disagreements about certain aspects that need to be worked out, this approach helped to bring together relevant stakeholders to work together on the topic of air quality. The city also actively follows research, strategy development, and planning performed by the Helsinki Region Environmental Services Authority (HSY) and Helsinki Regional Transport Authority (HSL), which serves as an additional resource for integration with respect to air quality.

3.6.2.2 Weaknesses

The city is designed for the car

Vantaa is crossed by several highways that lead to Finland's capital Helsinki. This means, a large amount of the city's area is located close to highways, which results in high levels of noise and air pollution. Even though investments into other modes of transportation were undertaken in recent years and planned for the coming years, the car remains the most popular mode of transportation.

A culture of car users

Because of the city's structure, Vantaa's citizens consider cars to be the fastest and easiest way to get around the city. This results in the fact that most people use their cars to commute to work.

Gap between scientific research and government

There needs to be a closer collaboration between the government bodies and the universities or other research institutes in order to ensure that the government follows the latest scientific knowledge.

3.6.2.3 Threats

The city is close to the airport

Finland's most important airport is located in Vantaa. 90% of Finland's international air traffic pass through this transportation hub, which results in large amounts of air pollution in the city.

3.6.3Results of the SWOT analysis

The matrix below gives an overview of the identified strengths, weaknesses, opportunities and threats in Vantaa (Table 65). As the next step, this information was used to evaluate the opportunities for the iSCAPE cities (see D1.1) and the urban development models in Section 2.4.1.3 for their usefulness in this city. The result is presented below. Each LL City has the participation in the iSCAPE project as an opportunity.

		internal	
		strengths 1. Low value of sealed ground 2. Low population density: 3. Good public transport system 4. Low percentage of industrial area 5. Government Policy	**weaknesses** 1. Decentralised city 2. The city is designed for the car 3. A culture of car users 4. Gap between scientific research and government
external	**Opportunities** 1. Participation in the iSCAPE project	strengths-opportunities-strategies (S-O) using Strengths to pursue Opportunities	weaknesses-opportunities strategies (W-O) using Opportunities to eliminate Weaknesses
	threats 1. Presence of airport	strengths-threats-strategies (S-T) using strengths to reduce threats	weaknesses-threats strategies (W-T) eliminating weaknesses and reducing threats

Table 65: SWOT matrix for Vantaa

3.6.3.1 Strengths-opportunities-strategies (S-O)

The following strategies have been identified to use strengths to pursue opportunities:

- Environmental functions like the production of ground water, cool air or valuable habitats need to be protected either by land-use planning or environmental planning in order to mitigate the negative effects of the further expansion of settlements and infrastructure.

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Environmental functions like the production of ground water, cool air or valuable habitats need to be protected either by land-use planning or environmental planning in order to mitigate the negative effects of the further expansion of settlements and infrastructure.	Less destruction of natural land in urban development, measured as floorspace-to-land ratio	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented
	Condensing the urban structure, promoting mass transport and cycling, and energy-efficient building in new construction and renovation	City of Vantaa´s Environmental Policy 2012-2020 (2012)	formal/binding strategic development goal	continuously implemented
	Ensure sustainability of biodiversity in planning and implementation, and secure functional ecosystem services and ecological connection	City of Vantaa´s Environmental Policy 2012-2020 (2012)	formal/binding strategic development goal	continuously implemented
	Recognise the value of small inland water habitats and enhance their ecological state	City of Vantaa´s Environmental Policy 2012-2020 (2012)	formal/binding strategic development goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	Promote sustainable recreational use of green areas	City of Vantaa´s Environmental Policy 2012-2020 (2012)	formal/binding strategic development goal	continuously implemented
	Take care of the efficiency of ecosystem services and the preservation of biodiversity	Helsinki Metropolitan Area Climate Change Adaptation Strategy (2012)	informal/not binding strategic development goal	continuously implemented
	Creating a common land use agenda based on climate change risks	Helsinki Metropolitan Area Climate Change Adaptation Strategy (2012)	informal/not binding strategic development goal	continuously implemented

Table 66: Strength-opportunity-strategy Vantaa

Future urban development in the City of Vantaa should take place without further destruction of natural spaces and land as well as their environmental functions. The environmental policy of the city (see *City of Vantaa´s Environmental Policy 2012-2020*) responds to the efficiency of ecosystem services and the preservation of biodiversity. It aims at developing ecological contacts and a greenbelt network, to ensure sustainability of biodiversity in planning and implementation, and secure functional ecosystem services and ecological connections. Condensing the urban structure, promoting public transport and cycling, and energy-efficient building in new construction and renovation help mitigate climate change. Parks and green spaces help to cool urban spaces and improve the adaptability of the urban environment. In addition, a common land-use agenda based on the risks of climate change and a common policy for building on coastal areas should be formulated.

3.6.3.2 Weaknesses-opportunities strategies (W-O)

The following strategies have been identified to use opportunities to eliminate weaknesses:

- On-going decentralisation tendencies should be picked up in development concepts, which focus on a concentration of jobs and public functions
- Further settlement development should be conducted in line with the urban development model of decentralised concentration, i.e. along existing axes and with a local focus on concentration.
- In order to reduce distances, mixed land-uses should be aspired.
- Use the LL Cities to develop new ways to disseminate scientific/academic knowledge – both to citizens and government stakeholders

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Further settlement development should be conducted in line with the urban development model of decentralised concentration, i.e. along existing axes and with a local focus on concentration	Joint memorandum of understanding on regional land-use and transport	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented

Table 67: Weakness-opportunity strategy Vantaa

The *Helsinki Metropolitan Area Climate Strategy to the Year 2030* (2008) and the Environmental Policy of the City of Vantaa contain statements on the promotion of compact settlement structures and sustainable urban densification. For example, the *Helsinki Metropolitan Area Climate Strategy to the Year 2030* (2008) recommends a joint memorandum of understanding on regional land-use and transport (*Helsinki Metropolitan Area Transport System Plan*, PLJ). Nevertheless, both advantages and disadvantages must be weighed against each other in the course of inner-city densification and more efficient use of space. Thus, the focus of decentralised concentration is on compact and mixed settlement development with differentiated specifications for the individual rings of the metropolitan region. By maintaining a decentralised settlement structure of the entire area with its large number of efficient centres and urban regions, strong spatial disparities and congestion in growth regions can be prevented.

No concrete goals, interventions and/or measures from planning documents can be assigned to the strategies 'On-going decentralisation tendencies should be picked up in development concepts, which focus on a concentration of jobs and public functions', 'In order to reduce distances, mixed land-uses should be aspired.', and 'Use the LL Cities to develop new ways to disseminate scientific/academic knowledge – both to citizens and government stakeholders'.

3.6.3.3 Strengths-threats-strategies (S-T)

There were no strengths-threats-strategies identified.

3.6.3.4 Weaknesses-threats strategies (W-T)

The following strategies have been identified to eliminate weaknesses and/or reduce threats:

- Reduce the appeal of driving in a city
- Increase the appeal of cycling and walking
- Improve public transport
- Move to electric vehicles
- Better incentives from government to move to more sustainable transport options
- Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature

In line with the above, a number of strategies and plans are already in place at a local level. The tables below summarises the city strategies and plans taking forward interventions and goals in line with the identified strategies/activities.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Reduce the appeal of driving in a city	Transport prices, infrastructure and service standards favour public transport, walking and cycling	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic measure	continuously implemented
	Transport pricing to provide incentives for using public transport	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented
	Discontinuing free motor vehicle parking arrangements for city employees	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented
	Implementation of vehicle traffic pricing is being investigated and promoted	Helsinki City Air Quality Plan 2017-2024	informal/not binding (for Vantaa) strategic development goal	continuously implemented

Table 68: Weakness-threat strategy Vantaa A

Different strategic measures of the *Helsinki Metropolitan Area Climate Strategy to the Year 2030* (2008) are aimed at influencing the volume of traffic and patterns of mobility by improving the status and service standards of public transport, walking and cycling. These measures range from infrastructure and service standards to parking space management and public transport pricing. The implementation of vehicle traffic pricing is being investigated and promoted. In many cities this has proved effective in reducing the amount of traffic and streamlining the remaining traffic, which improves air quality. Reducing the amount of vehicle traffic effectively reduces climate emissions and noise too. parking pricing is also used to reduce the amount of traffic in the inner city, particularly during rush hours.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Increase the appeal of cycling and walking	Direct and agreeable connections for pedestrians and cyclists to stations, stops and services	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic measure	continuously implemented
	Routes for non-motorised transport are constructed, managed and maintained in winter to a high standard	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented
	Construction of adequate and secure cycle parking space stipulated for public transport stops	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented
	Creating conditions for enlarging pleasant pedestrian precincts in city centres	Helsinki City Air Quality Plan 2017-2024	informal/not binding (for Vantaa) strategic development goal	continuously implemented
	Condensing the urban structure, promoting mass transport and cycling, and energy-efficient building in	City of Vantaa´s Environmental policy 2012-2020 (2012)	formal/ binding strategic development goal	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	new construction and renovation			

Table 69: Weakness-threat strategy Vantaa B

To increase the appeal of cycling and walking within the City of Vantaa different goals and measure to improve and develop related infrastructure are mentioned in the examined planning documents. These include direct and pleasant connections for pedestrians and cyclists to railway stations, stops and services. The measures range from the construction of adequate and secure cycle parking space to the creation of conditions for enlarging pleasant pedestrian precincts in city centres.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Move to electric vehicles	Economic guidance favouring low-emission vehicles	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic measure	continuously implemented
	The electric car charging network is being expanded and utilised for the needs of commercial vehicles and working machines.	Helsinki City Air Quality Plan 2017-2024	informal/not binding (for Vantaa) strategic development goal	continuously implemented
	Numbers of vehicles running on alternative fuels, such as electricity, gas, ethanol and second generation waste-based biofuels will be increased	Helsinki City Air Quality Plan 2017-2024	informal/not binding (for Vantaa) strategic development goal	continuously implemented
	Helsinki Region Transport's (HSL) bus fleet is being developed to become more	Helsinki City Air Quality Plan 2017-2024	informal/not binding (for Vantaa) strategic measure	continuously implemented

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
	environmentally friendly			

Table 70: Weakness-threat strategy Vantaa C

In order to achieve more environmentally friendly traffic as well as to expand and promote e-mobility in the City of Vantaa, the *Helsinki Metropolitan Area Climate Strategy to the Year 2030* (2008) and *Helsinki City Air Quality Plan 2017-2024* mention different strategic goals and measures. These include the expansion of charging infrastructure as well as increase the number of vehicles running on alternative fuels, such as electricity, gas, ethanol and second generation waste-based biofuels in the fleets of the city and its contracting parties. In addition, the Helsinki Region Transport's (HSL) bus fleet is being developed to become more environmentally friendly, by investing e.g. in hybrid and electric buses.

Strategy	Corresponding Interventions/goals	Local plans and strategies	Character and context	Implementation status
Build developments that reduce air pollution, e.g. use green walls, roofs and urban farming to improve air quality and temperature	Improving energy efficiency in new buildings and the existing building stock	Helsinki Metropolitan Area Climate Strategy to the Year 2030 (2008)	informal/not binding strategic development goal	continuously implemented

Table 71: Weakness-threat strategy Vantaa D

The *Helsinki Metropolitan Area Climate Strategy to the Year 2030* (2008) aims at improving energy efficiency in new buildings as well as in the existing building stock. Financial incentives will be created for energy efficient building, for example through pricing of planning permission or site rents. In addition, planning and building regulations will be revised to support energy efficient renovation construction that respects whole life cycle costs. Energy reviews of city buildings will continue and improve, together with implementation of other energy saving measures.

No concrete goals, interventions and/or measures have been identified within current plans and strategies that can be assigned to the strategy 'Better incentives from government to move to more sustainable transport options'.

4 Conclusion and Outlook

In the chapters above we have presented specific strategies for each LL City, based on SWOT analyses, and to what extent these cities are already pursuing these strategies in their plans and strategy papers today.

According to the SWOT analyses, comparison shows that the indicators 'ground sealing' and 'density' in the iSCAPE cities are directly linked to the cities' urban form. As expected, the compact cities Bologna and Dublin have a high amount of sealed area. In addition to this, their high population density can be considered as a weakness especially regarding the UHI phenomenon. More decentralised cities, on the other hand, are strong in these two areas (Table 72).[2]

[2] However, the indicators of dense and sparse cannot be strongly evaluated as *good* and *bad* due to many interactions. Usually thorough empirical studies and modelling are needed to support such evaluations considering short- and long-term effects as well as direct and indirect effects.

Parameter	Indicator	Bologna	Bottrop	Dublin	Guildford	Hasselt	Vantaa
Urban Structure	Sealed Ground (%)	***40.99**/29.23***	***24.23**/11.06***	***50.20**/34.02***	***13.70**/5.32***	*14.63***	***17.71**/18.52***
	Population Density	7,134 people/km²	1,168 people/km²	9,412 people/km²	506 people/km²	752 people/km²	899 people/km²
	Urban development model	Compact city	Decentralised concentration	Compact city	Decentralised concentration	Decentralised concentration	Decentralised city
Transport	Private Transport						
	Commuter outflows	Region: Emilia-Romagna 2.8	Region: Münster 16	Region: Southern and Eastern Ireland 1.3	Region: South East England 18.2	Region: Province Limburg 19.1	Region: Manner-Suomi 4.2
	Density of motorways	Region: Emilia-Romagna 25	Federal State: North-Rhine Westphalia 65	Region: Southern and Eastern Ireland 18	Region: Surrey, East and West Sussex 21	Region: Province Limburg 44	Region: Helsinki-Uusimaa 31
	Public Transport						
	Equipment rate for public transport vehicles	Region: Emilia-Romagna 1.4	Region: Münster 1	Region: Southern and Eastern Ireland 2.2	Region: Surrey, East and West Sussex 2.2	Region: Province Limburg 1.4	Region: Helsinki-Uusimaa 3
	Freight transport						
	Road freight vehicles	No data available	Region: Münster: 122	Region: Southern and Eastern Ireland 241	Region: Surrey, East and West Sussex 161	Region: Province Limburg	No data available
	Presence of airport and/or freight port	Aeroporto di *Bologna* - Borgo Panigale "Guglielmo Marconi"	No	Dublin Airport Dublin Conolly	London Airports Heathrow and Gatwick	No	Helsinki Airport
Industry and trade	**Industrial** area (%)	***22.55**/15.11***	***9.08**/6.69***	***11.39**/10.86***	***8.98**/1.02***	*6.20***	***7.10**/8.66***

Urban green and blue infrastructure	Urban green (incl. Forests) (%)	***8,24**/2.66***	***26.43**/19,33***	***12.17**/10.42***	***24.32**/24.40***	*8.15***	***39.16**/34.28***
	Agriculture (%)	***19.43**/25.26***	***30.60**/43.92***	***3.15**/2.65***	***40.84**/56.91***	*46.05***	***22.76**/20.59***

Table 72: Overview of the urban parameters by city

According to the stakeholder survey, all LL Cities have an urban structure that is focused on cars. The analysis of the urban parameters however shows that the amount of this focus differs between the cities. While Dublin's commuter outflow can be considered as positive, Bottrop and Hasselt both have to struggle with very dense motorways and a related high amount of private traffic.

Even though compact cities are usually linked with a good public transport system, this connection cannot be seen in the iSCAPE LL Cities. With 3.0 vehicles per 1,000 inhabitants, the decentralised city of Vantaa is the only city with a strength for this indicator.

Three of the six iSCAPE cities (Bottrop, Dublin and Guildford) have to deal with a high amount of road freight vehicles - which is considered as a weakness.

Four of the iSCAPE cities (Bologna, Dublin, Guildford and Vantaa) are additionally tainted with their vicinity to international airports, which results in a decrease of the cities' air quality.

The share of industrial area varies significantly between the six cities. In this context, however, it is also important to consider the location of the industrial sites. While the amount and location of industrial sites can be considered as a strength in Guildford, Hasselt and Vantaa, Bologna, Bottrop and Dublin have to deal with their location in the neighbourhood of residential land-uses, which leads to the classification of this aspect as a weakness.

Finally, the amount of urban green and agricultural land is also linked to the cities' urban forms. The compact cities Bologna and Dublin both have a weakness in these areas while the other four – with the exception of Hasselt's share of urban green – have an average amount of these types of land.

Even though the strategies presented in this deliverable were selected to match the specific needs of each city, the following list gives an overall collection of all solutions presented in the sections above:

Urban structure

- Environmental functions like the production of ground water, cool air or valuable habitats need to be protected either by land-use planning or environmental planning in order to mitigate the negative effects of the further expansion of settlements and infrastructure.
- Further settlement development of decentralised cities should be conducted in line with the urban development model of decentralised concentration, i.e. along existing axes and with a local focus on concentration.
- Further settlement development of compact cities should take place with respect to the preservation of urban green spaces with special consideration of the maintenance of ventilation channels and other ecologic functions such as groundwater production, habitats, etc.
- In order to reduce distances, mixed land-uses should be aspired.

- On-going decentralisation tendencies should be picked up in development concepts, which focus on a concentration of jobs and public functions
- Positive characteristics like an adequate mix of functions and sophisticated public transport should be preserved
- Possibilities for settlement pressure need to be weighed carefully against the opportunity for green space development and should consider ventilation and UHI potential

Transport

- Better incentives from government to move to more sustainable transport options
- Create shared use public spaces
- Help businesses to understand the positive impact pedestrianisation and shared public space schemes can have in order to reduce fears of a drop in customers if people are unable to drive into the city centre
- Improve public transport
- Increase the appeal of cycling and walking
- Introduce new urban models of mobility such as the 'superblock' - where existing gridded streets within a city are grouped together in small clusters. Traffic is then restricted to outside of this area while the streets inside the superblock become repurposed as community spaces
- Move to electric vehicles
- Pedestrianise and provide cycle infrastructure in narrow streets
- Reduce the appeal of driving in a city

Urban Green and blue infrastructure

- Build developments that reduce air pollution, e.g. use green walls, rooves and urban farming to improve air quality and temperature
- Existing green and blue spaces should be interlinked in order to enable fresh air transport.
- Existing green and blue spaces should be qualitatively developed and re-valuated in order to explicitly foster climatic and air quality functions.
- Roadside greenery can help to filter transport emissions if planted and maintained with respect to ventilation and fresh air corridors
- Encourage green barriers around open busy roads to reduce air pollution exposure of people walking and cycling nearby

Others

- Encourage stakeholders to work together in a 'round-table' approach
- Mandatory solar panels on all public buildings to take advantage of the sun – this energy can then be used in various ways to mitigate the effects of air pollution
- Use the iSCAPE LL Cities as a place to coordinate and bring together different government bodies
- Use the iSCAPE LL Cities to develop new ways to disseminate scientific/academic knowledge – both to citizens and government stakeholders

As identified through the analysis of local plans and strategy documents of the LL Cities, it becomes apparent that the LL Cities are already to some extent pursuing many aspects of the

strategies identified through the SWOT analysis in their local urban plans and strategies. For a large number of SWOT strategies, implementation-oriented strategic goals and concrete measures already exist in the plans and strategies of the LL Cities examined. Further potentials and in particular the effectiveness of urban level interventions will be examined and explained in more detail in the course of D3.9 (*Report on potentialities of urban interventions and action plans*). Challenges for the LL Cities arise above all in the development of new, not yet existing goals and interventions that can be assigned to the identified SWOT strategies. This is particularly important for those SWOT strategies for which no explicit content from existing urban strategies and plans could be identified so far. However, this does not mean that the documents examined are evaluated in terms of their general usefulness or quality.

Through the SWOT analysis and the analysis of local plans and strategy documents, this deliverable collected strategies and solutions at the urban level to improve air quality. In the following Task 3.6, these will be further elaborated for their applicability and usefulness and integrated with the findings and outputs from other iSCAPE project activities. This will be done via desktop research and the implementation of planning games/ one-day workshops with local spatial planners (and other interested stakeholders) in the LL Cities that are interested to discuss these solutions. In this context, this deliverable will serve as a source and working document that will be updated as the evaluation of the solutions continues. It will also form the basis for the development of action plans for LL Cities. Finally, the results from this document will be included into D3.9 (*Report on potentialities of urban interventions and action plans*).

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6 Annex

Land use class	Key for calculation of basic information for each town							Map
For further information on which land use is contained in which land use class look at: **http://www.eea.europa.eu/data-and-maps/data/urban-atlas/** for Urban Atlas data and **http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-2/** for CORINE data	Degree of soil sealing assumed for each land use	industrial and commercial area	traffic area	water area	forest area	agricultural area	green urban area	legend
Urban Atlas								
Agricultural + Semi-natural areas + Wetlands	0%	No	No	No	No	Yes	No	
Airports	100%	No	Yes	No	No	No	No	
Construction sites	50%	No	No	No	No	No	No	
Continuous Urban Fabric (S.L. > 80%)	90%	No	No	No	No	No	No	
Discontinuous Dense Urban Fabric (S.L. : 50% - 80%)	65%	No	No	No	No	No	No	
Discontinuous Low Density Urban Fabric (S.L. : 10% - 30%)	20%	No	No	No	No	No	No	
Discontinuous Medium Density Urban Fabric (S.L. : 30% - 50%)	40%	No	No	No	No	No	No	
Discontinuous Very Low Density Urban Fabric (S.L. < 10%)	5%	No	No	No	No	No	No	
Fast transit roads and associated land	100%	No	Yes	No	No	No	No	
Forests	0%	No	No	No	Yes	No	No	
Green urban areas	0%	No	No	No	No	No	Yes	
Industrial, commercial, public, military and private units	50%	Yes	No	No	No	No	No	
Isolated Structures	15%	No	No	No	No	No	No	
Land without current use	0%	No	No	No	No	No	No	
Mineral extraction and dump sites	10%	No	No	No	No	No	No	
Other roads and associated land	100%	No	Yes	No	No	No	No	
Port areas	100%	Yes	No	No	No	No	No	
Railways and associated land	50%	No	Yes	No	No	No	No	
Sports and leisure facilities	10%	No	No	No	No	No	No	
Water bodies	0%	no	No	Yes	No	No	No	
CORINE								
Continuous urban fabric	90%	No	No	No	No	No	No	
Continuous urban fabric	30%	No	No	No	No	No	No	
Industrial or commercial units	50%	Yes	No	No	No	No	No	
Road and rail networks and associated land	75%	No	Yes	No	No	No	No	
Port areas	100%	Yes	No	No	No	No	No	
Airports	100%	No	Yes	No	No	No	No	
Mineral extraction sites	10%	No	No	No	No	No	No	
Dump sites	10%	No	No	No	No	No	No	
Construction sites	50%	No	No	No	No	No	No	
Green urban areas	0%	No	No	No	No	No	Yes	
Sport and leisure facilities	10%	No	No	No	No	No	No	
Non-irrigated arable land	0%	No	No	No	No	Yes	No	
Fruit trees and berry plantations	0%	No	No	No	No	Yes	No	
Pastures	0%	No	No	No	No	Yes	No	
Complex cultivation patterns	0%	No	No	No	No	Yes	No	
Land principally occupied by agriculture, with significant areas of natural vegetation	0%	No	No	No	No	Yes	No	
Broad-leaved forest	0%	No	No	No	Yes	No	No	
Coniferous forest	0%	No	No	No	Yes	No	No	
Mixed forest	0%	No	No	No	Yes	No	No	
Natural grasslands	0%	No	No	No	No	Yes	No	
Moors and heathland	0%	No	No	No	No	Yes	No	
Transitional woodland-shrub	0%	No	No	No	Yes	No	No	

Beaches, dunes, sands	0%	No	No	No	No	Yes	No	
Salt marshes	0%	No	No	No	No	No	No	
Intertidal flats	0%	No	No	No	No	No	No	
Water courses	0%	No	No	Yes	No	No	No	
Water bodies	0%	No	No	Yes	No	No	No	
Estuaries	0%	No	No	Yes	No	No	No	
Sea and ocean	0%	No	No	Yes	No	No	No	