D2.1 Report on the exploratory analysis of all the case studies

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EXECUTIVE SUMMARY

This report is the main outcome of Task 2.1 of work package 2 (WP2). Overall, this WP aims to analyze and compare the implementation of UF-NBS in selected cities and city regions in view of their impacts on urban ecosystems and societies, their cost effectiveness, and their replicability in distinct contents. In this context, Task 2.1 consisted of an exploratory analysis of all selected case studies, useful to provide the context for a comparative, in-depth analysis of ongoing cooperative efforts toward the enhancement of UF-NBS (T2.2) in the second phase of CLEARING HOUSE.

The report includes a wide Europe-wide perspective to UF-NBS potential in urban areas via a spatial quantitative analysis (Chapter 2), and five in depth case study analyses on the governance arrangements, planning approaches and socio-ecological situation of the CLEARING HOUSE urban areas (Chapters 3, 4, 5, 6, and 7).

The initial proposal for D2.1 was to conduct an exploratory analysis of not only the five case studies in Europe included in this report but also of five case studies in China; Beijing, the Hong Kong, Guangzhou, Shenzhen metropolis, Hangzhou, Huaibei and Xiamen. It became clear that a combination of data availability and obstacles presented by COVID-19 which prevented international travel and field work would make achieving this with the original timeframe impossible. Since D2.1 is an input to task 2.2 it was concluded that to avoid delay the exploratory analysis of the Chinese cities would be moved into task 2.2 (the in-depth analysis of the case study cities and city regions). A further advantage being to allow the case histories from D1.4 to be inputted directly into task 2.2 as well as the results from local co-design workshops.

Using the most recent available and comparable data provided by the Copernicus programme, a first assessment of mapping the UF-NBS potential in European urban areas is provided based on a selected set of indicators. The use of indicators which display respectively the availability of forest areas (forest share); the potential per-capita supply with forest areas and trees (forest area per resident); and the biophysical benchmark of canopy cover (tree cover density) was instrumental in showing the broad variety characterising European urban areas and in positioning the five case study localities. Analysing the relation between certain indicators allows a first but descriptive conclusion on influencing factors such as built-up structure or city size.

On the basis of the screening tool developed as part of Work Package 1, five case study analyses of five European localities were performed. These took the form of "locality profiles", each including elements of general context, information on the current state of UF-NBS in the locality, analysis of UF-NBS governance and finally an outlook on the strategic objectives for the locality, and on the existing challenges and barriers. The case studies were based on data collected through desk research, review of scientific and policy literature, and key informant interviews, and have also benefited from the discussion and exchange that took place during the project workshops (WP3).

The information presented in this report will populate the repository developed in WP1 with spatial and other information from the case study cities. It will feed into the development of the analytical framework to be used as a basis for the in-depth analysis of the case study cities and city regions. The findings from the exploratory analysis will be discussed in a workshop.

KEYWORDS

GIS, urban forests, case studies, governance, urban forests, environmental policy, participation

REFERENCE

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1   INTRODUCTION

This report is the main outcome of Task 2.1 of work package 2 (WP2).

The main objective of WP2 is to analyse and compare the implementation of UF-NBS in selected cities and city regions in view of their impacts on urban ecosystems and societies, their cost effectiveness, and their replicability in distinct contents. In this context, Task 2.1 aimed to undertake an exploratory analysis of all selected case studies which will feed into the co-design process (T3.1) and provide a necessary background for a more in-depth and targeted comparative analysis of UF-NBS-related challenges and research questions, which will be conducted as part of T2.2. During this second stage of WP2, specific questions identified as critical will be addressed by the project team with a comparative angle. In the transition from the exploratory stage (T2.1) to the in-depth research stage (T2.2), specific UF-NBS challenges described and research questions will be further elaborated in view of enabling the most insightful comparative analysis of the co-design process.

The report consists of two parts. In Part I we conducted a cross-European quantitative assessment of the potential of tree-based/forest-based nature-based solutions (UF-NBS) in urban and peri urban areas, inquiring the differences between areas in different countries and between urban and peri-urban forests. The assessment was useful to position, within the broader European landscape, the five localities to be scrutinised in depth in Part II. Part II is divided in five chapters: one for each of the project localities. The analysis includes elements of general context, information on the current state of UF-NBS in the locality, a perspective on the governance of UF-NBS and finally an outlook on the strategic objectives for the locality, and on the existing challenges and barriers.

The five areas analysed in this report cover a range of biogeographical regions, socio-economic and demographic settings, governance arrangements, and urban development and planning approaches (e.g., shrinking cities, cities in transition as well as booming cities). The areas covered by the case studies do not always correspond to given cities and/or existing administrative units. Their delineation, conversely, is the outcome of a trade-off between considerations on existing administrative and morphological boundaries on one hand (e.g. as in demarcating municipalities, metropolitan area, ecological areas...), and project-related considerations on the other, i.e. taking a geographic scale that would be relevant for the next steps of the project, considering the project partners, their administrative competence, and their priorities.

Figure 1: Five focus areas

Gelsenkirchen, Germany

Gelsenkirchen is located in North Rhine-Westphalia in the middle of the largest polycentric conurbation in Germany, the Ruhr metropolis (Ruhr area) with over 5 million inhabitants and has 264,710 inhabitants (September 25, 2020). Around 31% of the people living in Gelsenkirchen are German citizens with a migration background and / or foreign citizens. As a result of decades of economic and social change (Gelsenkirchen was previously characterized by the coal and steel industry - "City of Thousand Fires"), the city now has one of the highest unemployment rates in Germany (2019: 12.8%). Due to the highest immigration rate of all NRW municipalities, special efforts are required in Gelsenkirchen to shape the future of urban society. In recent years, Gelsenkirchen has renovated and rebuilt numerous former mining sites (coal mines, coking plants, steel works) and given them new uses. Some of these fallow areas were converted into smaller inner-city parks or integrated into urban and regional green and forest areas ("Emscher Landscape Park" of the Ruhr Metropolis) and fulfill functions as "urban wilderness areas", "nature discovery areas", "places for extracurricular learning"; ("Biomass Park, Rheinelbe Forest Station") and "Green Laboratories" with a focus on nature experience, community gardening, urban forest and (environmental) education.
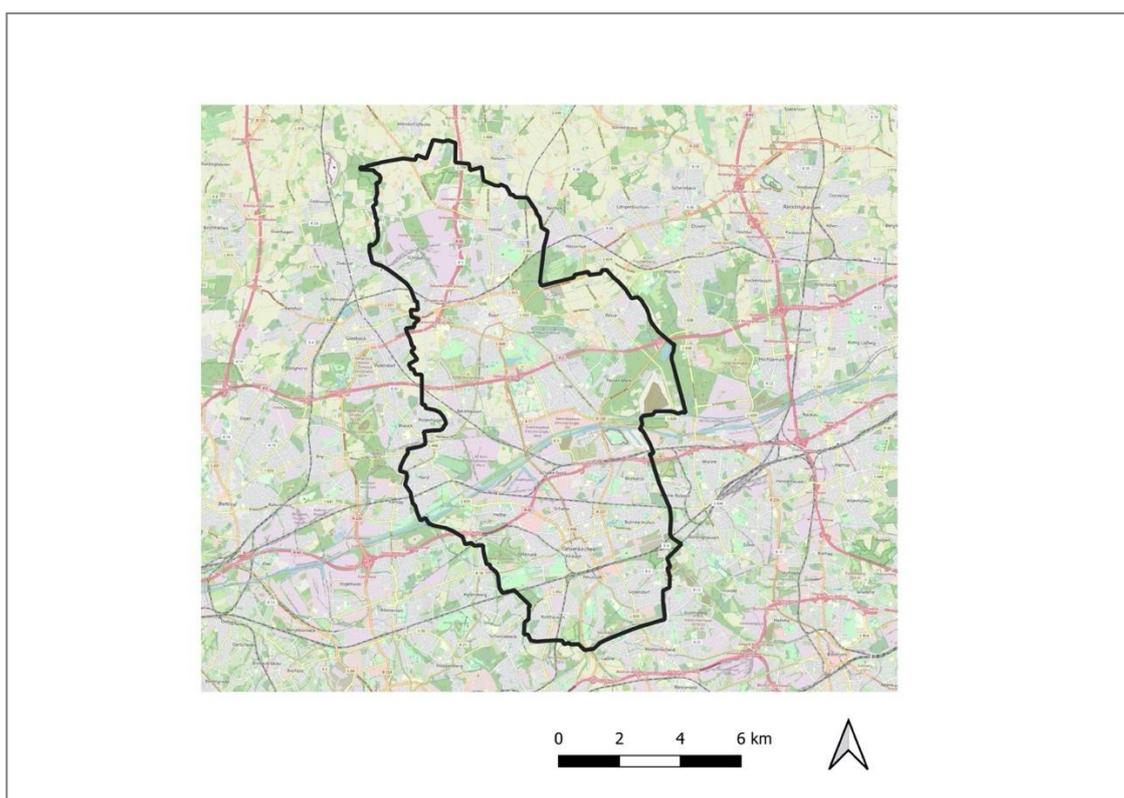
Municipalities	NUTS3 ID(s)	
Gelsenkirchen	Gelsenkirchen, kreisfreie Stadt	DEA32
	Gelsenkirchen	OECD Functional urban area: DE503

Figure 2: Gelsenkirchen

Krakow, Germany

Kraków is a strong urban unit with a population of over 800,000 and a cultural, academic, industrial and touristic center of national significance. It is a part of Metropolia Krakowska - an institutionalized platform of cooperation for Kraków and 14 surrounding municipalities, which main task is to implement Integrated Territorial Investments in the Kraków Functional Area. Kraków benefits from its size, importance, its cultural, creative and social capital as well as from its natural heritage and surroundings. Among the biggest challenges are considerable air pollution, uncontrolled urban sprawl and housing development, shrinking area of the green spaces (often connected to the previous point) and turistification (slowed down by the COVID-19).
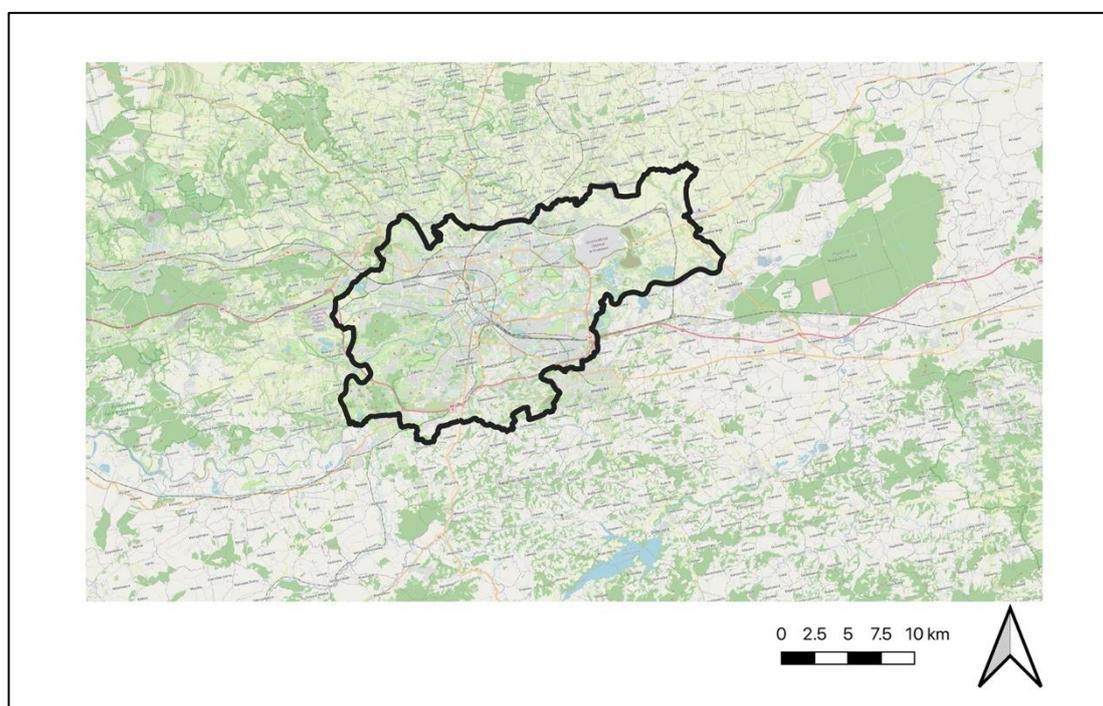
Municipalities	NUTS3 ID(s)	
Kraków	Miasto Kraków	PL213
		OECD Functional urban area: PL003

Figure 3: Krakow

Leipzig, Germany

Leipzig is the largest city (a municipality with city status due to its size) in Saxony, Germany, with an area of about 30,000 ha and currently almost 600,000 inhabitants benefiting also from protected riparian forests, stretching from the south towards the north. The city was affected by massive population loss, increasing vacancy numbers and unused brownfields after 1990. Population losses slowed down by the turn of the millennium. Since 2012 Leipzig re-grows by around 10,000 citizens (2%) per year. Consequently, pressures on the city's remaining open spaces are strongly increasing. Former industrial sites or residential buildings have now become opportunities for residential and commercial development but also support urban biodiversity and provide recreational services.
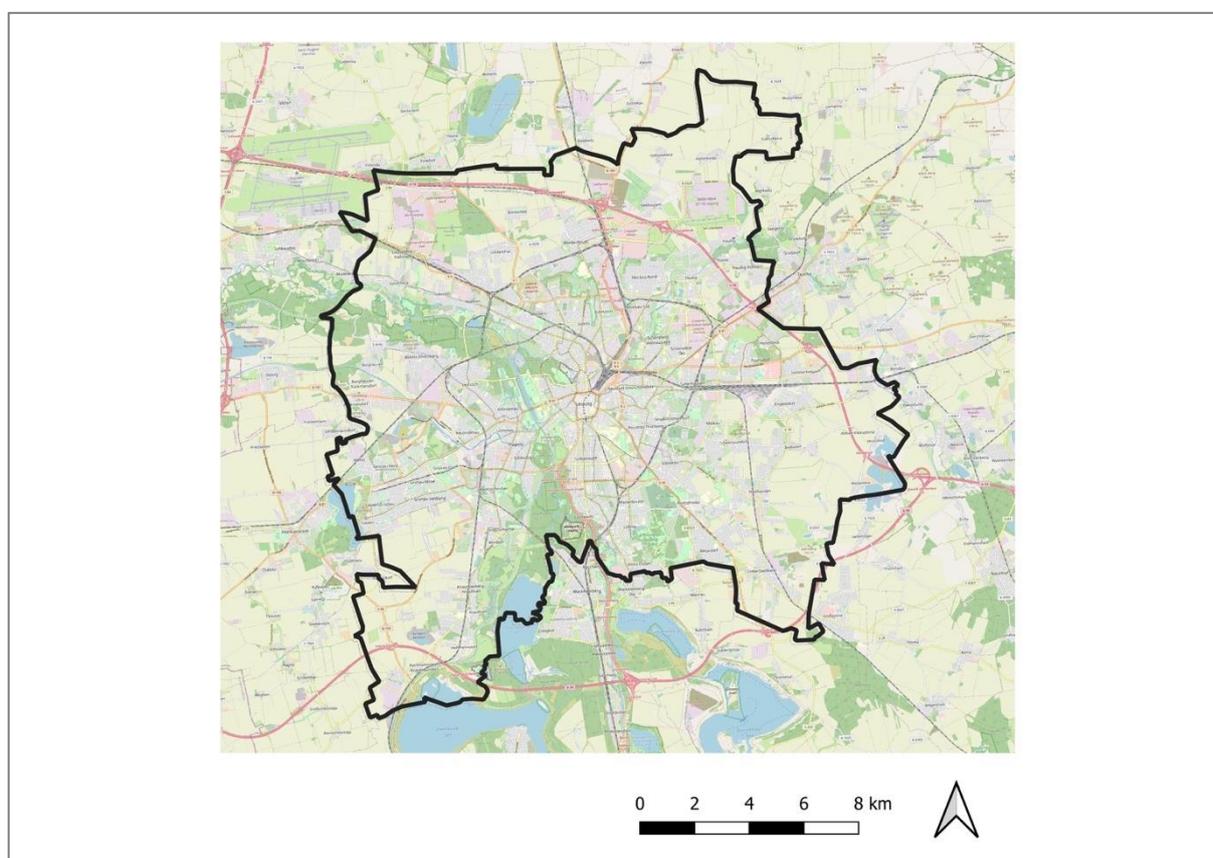
Municipalities	NUTS3 ID(s)	
Leipzig (and surrounding municipalities covered by the surrounding two NUTS3 regions, for a list see here https://ec.europa.eu/ eurostat/web/nuts/local-administrative-units	Leipzig, Kreisfreie Stadt	DED51
	Leipzig, Kreis	DED52
	Nordsachsen, Kreis	DED53
		OECD Functional urban area: DE008

Figure 4: Leipzig

Lower Llobregat Valley (in the Barcelona wider region), Spain

The Llobregat river is a strategic corridor of the first magnitude in the metropolitan area of Barcelona. It is also one of the most important river systems in Catalonia, in a territory dominated by intense land-use changes in the last decades. The total river longitude spreads over 30,78 km and it encompasses a rich diversity of fauna and flora. The first Framework Project for the Recovery of Llobregat River Area dates back to 2003. The document, whose area of action was the comarca of Baix Llobregat, was a basic instrument for controlling the environmental impacts arising from the construction of the high speed train and other transport infrastructures. In 2006 an agreement opened the way to the Barcelona Metropolitan Area to establish a series of measures, to recover the river´s social function, ecology and landscape. The Consortium for the Recovery and Conservation of the Llobregat River was established, responsible for monitoring and coordinating investments in the area. The Llobregat River Park is the result of an open regional transformation, that reveals the river as a multifunctional space in which ecological and socio-economics aspect converge. One concern of the projects developed around the river has been their synergies and adaptation to the dynamic metropolitan context. Special interest has been taken over the connectivity of the river, linking and strengthening the historical values, but also the biodiversity and ecological processes. Social aspects were represented through measures targeting the accessibility of the river area. Areas with important ecosystems services are the crops included in the Agricultural Park, which also acts as an ecological and landscape connection within the network of natural spaces of the Metropolitan Area of Barcelona. Since its creation in 2006, the Llobregat River Park has been a great success. The riverside parks of El Prat and Sant Boi of Llobregat were consolidated and became very popular.

Municipalities	NUTS3 ID(s)	
There are 13 municipalities encompassed within the landscape of Lower Llobregat Valley: El Prat de Llobregat, Sant Boi de Llobregat, Cornella de Llobregat, Sant Joan Despi, Sant Just Desvern, Sant Feliu de Llobregat, Sant Vicents dels Horts, Molins de Rei, Palleja, El Papiol, Corbera de Llobregat, Sant Andreu de la Barca, Castellbisbal.	Catalonia	ES 51
		OECD Functional urban area: ES002

Figure 5: Lower Llobregat Valley

The Sonian City (Brussels and neighbouring areas), Belgium

The Sonian City is the area including and surrounding the Sonian Forest in Belgium. It is located at the south-eastern periphery of the country's capital city, Brussels, and its territory spans across three regions (the Brussels Capital Region (BCR), Flanders, and Wallonia). While the Sonian Forest (FR Forêt de Soignes, NL Zoniënwoud) is a forest widely studied and with defined boundaries, the Sonian City is an operational concept to be developed and researched within the CLEARING HOUSE project. It consists of the Sonian Forest, at its core (i.e., non-urbanised, protected by several decrees as Natura 2000, Forest and natural reserve and regional planning tools), and the neighbouring areas where the forest ecosystem stretches toward and intertwines with the urban areas.

Within the area, the Sonian Forest covers 4,383 hectares divided between the three regions of the country: 56% in the Flemish region, 38% in the BCR, and 6% in Wallonia. It's ecosystem is dominated by the beechwood ("Kathedraal beukenhout - Hêtraie cathédrale - *Beechwood Cathedral*") hosting an exceptional fauna and flora. Since the largest part of the forest has never been cleared, it has preserved a relief and soils that have not been modified by agriculture for more than 10,000 years. To delineate the neighbouring areas, we considered the boundaries of the forest and include in this analysis all municipalities completely or partially overlapping with these boundaries (something that could be called: "the administrative Sonian city"). Given the framework of the project, emphasis was put on the territory in Flanders and in the Brussels Capital region. The text included in the various sections below but juggles between different delimitations depending on the various considerations we just mentioned.
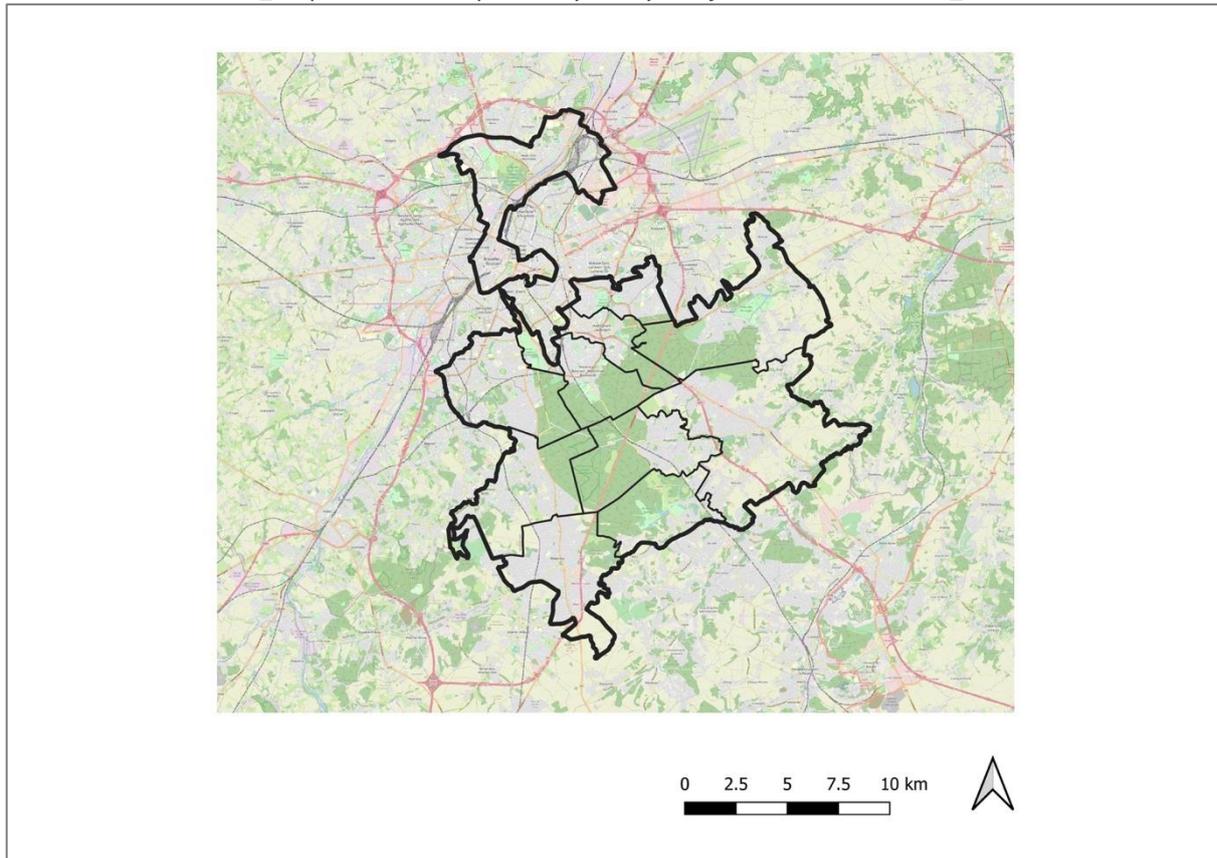
Municipalities	NUTS3 ID(s)	
In the Brussels Capital Region Uccle; Watermael-Boitsfort; Auderghem; Woluwe-Saint-Pierre; Ville de Bruxelles; in Flanders Sint-Genesius-Rode; Hoeilaart; Overijse; Tervuren in Wallonia La Hulpe; Waterloo	Arrondissement of Brussels-Capital (part of)	BE100
	Arrondissement of Halle-Vilvoorde (part of)	BE241
	Arrondissement of Leuven (part of)	BE242
	Arrondissement of Nivelles (part of)	BE310
	Brussels functional area (part of)	OECD Functional area BE001

Figure 6: The Sonian City

Localities										
	The Sonian City		**Gelsenkirchen**		**Krakow**		**Leipzig**		**Llobregat Valley**	
Name of the corresponding ecoregion	European Atlantic mixed forests		European Atlantic mixed forests		Central European mixed forests		Central European mixed forests		Mediterranean	
	value	*ref. year*	*value*	*ref. year*	*value*	*ref. year*	*value*	*ref. year*	*value*	*ref. year*
Surface area (km²)	245,48	2020	104,94	2020	327	2018	298	2016		
Total resident population (residents)	485,910	2020	264 710	2020	771 069	2018	587,857	2019	275.569	2020
Population density (pop/km²)	1979,42	2020	2522	2020	2 358	2018	1970 pop/ha	2019		
Population change rate (% per annum)	NA		-0,03	2019	+ 0,43%	2015-2018	2.02% p.a.	2015-2019	NA	
Total GDP (EUR)	NA		7 750 000 000	2017	15 926 000 000	2016	20 540 840 000	2017		
GDP per capita (EUR)	NA		29 648	2017	20 088	2016	35,600	2017	NA	
Existing public green space per capita (e.g. public parks, scenic green spaces, in m²/capita).	NA		na		8.31 (public green spaces with the recreation function)	2014	254	2012 (Urban Atlas)		
Policy goal for public green space per capita (m²/capita), if applicable	For Brussels: every inhabitant has an accessible green space of >1ha within 400 m of their home and <1 ha within 200 m For Vlaamse Rand + 1000 ha by 2022 (year to be confirmed).		na		10 m2/capita (public green spaces)	2030	1,000 new street trees per year ("Leipzig 2030 Street Tree Concept")	2030		

Table 1:1 - Comparative facts sheet

	The Sonian City	Gelsenkirchen	Krakow	Leipzig	Llobregat Valley
Assessment, maintenance or improvement of the quality of life (including attractiveness of place)		X		X	
Assessment, maintenance or improvement of public/human health and well-being (physical and mental)	X	X		X	
Assessment, maintenance or improvement of environmental justice		X			
Nature/Landscape conservation	X			X	
Assessment, maintenance or improvement of ecosystem health (Ecosystem restoration/rehabilitation)	X				
River catchment restoration	X			X	
Restoration of post-mining areas		X		X	
Assessment, maintenance or improvement of ecosystem management	X			X	
Assessment of technologies for forest management	X			X	
Assessment, maintenance or improvement of biodiversity	X				
Assessment, maintenance or improvement of forest patterns (spatial distribution of urban forests)					X
Assessment, maintenance or improvement of forest composition	X				
Hazard mitigation		X			X
Climate change adaptation	X				
Sustainability	X			X	
Assessment, maintenance or improvement of food security/food system resilience (including productivity enhancements)	X			X	
Assessment, maintenance or improvement of water security/water system resilience					X
Funding of (UF-)NBS		X		X	
Governance of (UF-)NBS		X		X	
Urban/Landscape planning	X				X
Cost/Cost-effectiveness				X	X
Other		Assessment of ecosystem services and consideration in urban planning			Risk assessment (flood risk)

Table 1:2 - UF-NBS related strategic objectives for the locality

Methods

The research underlying this report also builds on past work and reflections. The structuring framework of the report, in particular, was developed as part of the CLEARING HOUSE screening tool (D1.5). This provided the analytical entry points for the guidance of the exploratory case study analysis in the case study cities and regions. It consisted of different sections:

- o Section 1 about introducing the general context of the locality under scrutiny (without specific reference to urban forests as nature-based solutions, UF-NBS);
- o Section 2 included information on the current state of UF-NBS in the locality;
- o Section 3 about UF-NBS governance, with references to the different relevant scales;
- o and Section 4 to illustrate the UF-NBS-related strategic objectives for the locality and to provide a direction to CLEARING HOUSE work.

The screening tool provided the analytical entry points for both the GIS analysis and for the exploratory case study analyses. The former was performed 'centrally' by the task team, and more details about the methodological strategy are included in the chapter itself. The latter were conducted by the teams of each case study city and brought together in this report. The bulk of data collection, there, was based on desk research, review of scientific and policy literature, and request of information from informants directly or indirectly connected to the CLEARING HOUSE consortium. In addition, the discussion and exchange that took place during the CLEARING HOUSE project workshops (i.e. WP3) were also useful to collect key information on the different questions. In one case (i.e. the Sonian City), the project team conducted a stakeholders consultation via an open questionnaire.

While filling out the screening tool, the authors were encouraged to identify the right balance between local specificity and comparative potential. On one hand, information was to be provided that was specific to each locality and useful to guide the further research work of CLEARING HOUSE at the level of each case study. On the other, the information provided in the screening tool was also to be so 'general' to be understandable outside of the specific case study context, and hence useful for these cross-city comparisons. The case study reports resulting from completing the screening tools in every case study city were reviewed and analysed individually and in comparison, with the others, and they represent the bulk of this deliverable. It should also be noted, however, that this report is only the most tangible part of the research: completing the screening tool was critical for every city-team to acquire comprehensive knowledge about the city, learn about the existing situation, and identify venues of concrete intervention.

As a final methodological consideration, it should be noted that the bulk of the research for this report was conducted at the time when the COVID19 pandemic impacted the countries where the project was conducted. This had an impact at different levels, that we can at least introduce. The public health crisis reshuffled individual and institutional priorities, and working capabilities. The sanitary restrictions also changed drastically our way of working, making it more common to work from home, sharing time and space with other -more or less independent- household members; and more difficult to meet colleagues and informants, to organise group activities, conduct field research. They also had an impact on the object of this research, which we can today comprehend only to a limited extent. Overall, while the pandemic did not prevent us to deliver a high-quality report, it limited -at least partially- the potential that was inherent in the design of task 2.1. the collective and comparative dimension of the task was probably the one that was impacted the most, resulting probably in reduced coherence among the different chapters and in a global perspective to the five localities that is only

introduced. Our commitment as researchers, now and in the future, is to deal with this challenge by mitigating its negative impacts and by actively reflecting on its implications.

Part I

2 Mapping UF-NBS potential in European urban areas

2.1 Objectives and conceptualization

A robust quantitative assessment of the potential of tree-based/forest-based nature-based solutions (UF-NBS) in cities is of essential use for all WP's within the CLEARING HOUSE (CH) project. Based on a European wide mapping of this potential several questions can be deduced:

- What are differences between urban and peri-urban forests in Europe?
- Which significant differences emerge from the national or macro-regional variation of UF-NBS potential?
- What are influencing factors for the provided UF-NBS such as city size or built-up area?
- How are the CH case studies performing among their national, regional, or city-size-class counterparts?

Answering these and other similar question in line with the overall objectives in CH is confronted with an important trade-off: the more suitable criteria are considered, the lower is the number of cases that can be covered, and vice versa (Figure 7, Wolff and Haase, 2019). Consequently, the mapping exercise is approached from two sides: from the data suitability perspective and the data availability perspective. While the first serves the purpose of determining indicators relevant for sufficiently describing UF-NBS covering several describing contents, the second perspective seeks for a high spatial coverage in order to detect overall patterns or identify aberrations or representative cases (Table 2:1).

Perspective	Purpose
Content coverage	- Several indicators considered - Allows for mapping the variety of different facets of UF-NBS - Multi-variate statistics possible - Intersection with more qualitative and data-rich results possible (e.g. participatory mapping, PP-GIS)
Spatial coverage	- Allows analytical and statistical generalization - Overarching pattern detection and their comparison possible (nations and regions) - Identification of critical/ extreme, representative/typical, or revelatory case - Contextualization of individual cases, transfer of findings / concepts between similar cases (Yin, 2017)

Table 2:1 Purpose of two perspectives for mapping tasks

It is important to note that UF-NBS *per se* can be mapped on a case-study level while a large-scale mapping maps the potential of UF-NBS – a result of the trade-off between the two perspectives. In order to find a solution for this trade-off, this mapping exercise introduces a two-level analysis in order to combine the advantages of both perspectives: European and the case-study level of analysis (Figure 7). The two levels of analysis are interlinked via analytical generalization and contextualization techniques as well as nested data-driven approaches with a complementary degree of details.
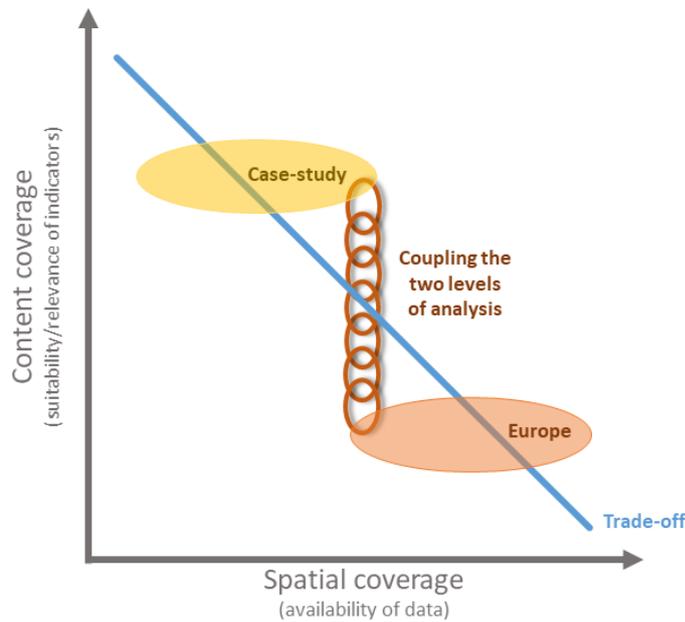
Figure 7 - Trade-off and two-level approach of the mapping analysis

2.2 Materials and methods

2.2.1 Spatial scale and coverage

For the European level of analysis, we delineate urban areas using the Urban Audit classification of spatial units (Dijkstra and Poelman, 2012). ***Cities*** are defined as local administrative unit (LAU1 or LAU2) where the majority of the population lives in an urban centre of at least 50 000 inhabitants. At least half of their population live inside an urban centre which is defined by a cluster of grid cells with >1500 inhabitants per km² (which in sum have a minimum population of 50 000 inhabitants). Around each city a commuting zone is delineated by identifying all municipalities with at least 15 % of their employed residents working in a city – the so-called commuting zone. As Figure 8 shows, both city and commuting area constitute the ***functional urban area (FUA)***.
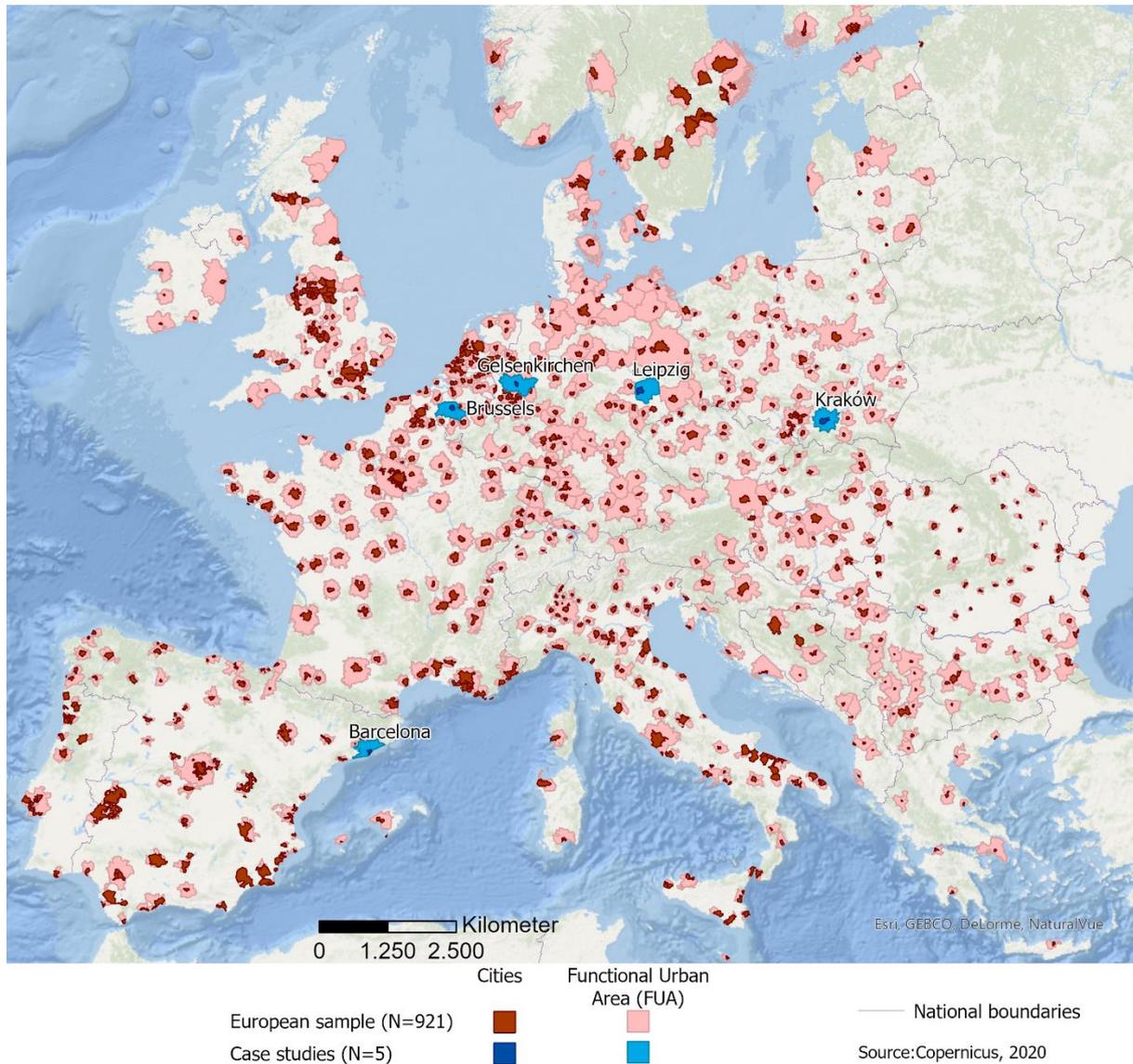
Figure 8 - Cities and functional urban areas (FUA) in Europe based on Urban Audit

2.2.2   *Data availability*

Without question the European level of analysis relies on comparable data, which is either available for the European continent, or at least for the urban areas under consideration (see point 2.1). A second criteria is that the data has to be available for free (open data portals) in order to allow other project partners or third parties to reproduce or update the performed analysis. In order to analyse patterns of demand such as population, or urbanization trends and drivers such as GDP, several databases can be considered:

- Urban Audit database of the European Union: provides a rich data source on socio-economic or environmental data for the Urban Audit cities and their FUA (Eurostat, 2020).

- OECD metropolitan database: as some data is not available in the Urban Audit database OECD data could be used (e.g. GDP, government form etc.). The spatial units are comparable due to a joint spatial definition of urban areas (OECD, 2020).

- National Statistical Offices: in order to fill some gaps comparable data could be derived from national statistics and project partners after carefully checking the comparability to existing values (e.g. time series on population counts).

For the supply side usually data for geoinformation systems (GIS) is used. Among the open data portals, in particular the Copernicus program is of relevance for the mapping exercise as it provides a rich open data source with data constantly being updated or new data becoming available:

- Urban Atlas: provides pan-European **land cover and land use** data covering a number of FUA for the reference years 2006, 2012, and 2018. In 2012, an additional layer (**Street Tree Layer** - STL) was produced for a selection of FUAs as well as a **building height dataset** covering currently the capital cities. The latest update (ongoing) refers to the 2018 reference year and accounts for the update of the land cover and land use product (including a revision of the 2012 reference year) as well as an update of the Street Tree Layer (Copernicus, 2020a).

- High Resolution Layers: provide information on specific land cover characteristics i.e. the level of sealed soil (imperviousness), tree cover density and forest type, grasslands, wetness and water, and small woody features. The HRL Forests consists of 3 types of (status) products, and additional change products. The status products are available for 2012 (20m resolution), 2015 (20m resolution), and 2018 (10m resolution based on Sentinel satellite) reference years: **Tree cover density** (level of tree cover density in a range from 0-100%), **dominant leaf type** (broadleaved or coniferous majority), **forest type** (according to FAO forest definition).

- Additional open data portals: other portals than Copernicus could also be of relevance when compiling GIS data. The Global Forest Watch (2020) provides rich data on **forest gain and loss** between 2001-2019 (based on Landsat data). Protected Planet (2020) provides a worldwide and recent GIS data for the different types of **protected areas**. Finally, ESRI (2020) provides a compilation of different data (mostly for the USA, but also worldwide) e.g. **intact forest landscape** usually derived from other portals. **Open Street Map** data provides information on information on public green spaces with, however, varying data quality between countries.

For the case studies additional data specific to a certain purpose such as ecosystem services or socio-demographic differentiation of residents might be needed. For instance, some cities such as Brussels provide data portals with statistical and geoinformation data. We thereby inserted a first example for the case study of Leipzig into this document. At a later stage of the project (e.g. as part of WP2.2), we will conduct a more detailed analysis, based on the needs and data availability of case studies.

2.2.3 Indicators and data processing

Figure 9 - Workflow of European and case study level of analysis together with derived indicators and typologiesmirrors the applied workflow of this deliverable (work in progress) distinguishing between the European and the Case study level of analysis.
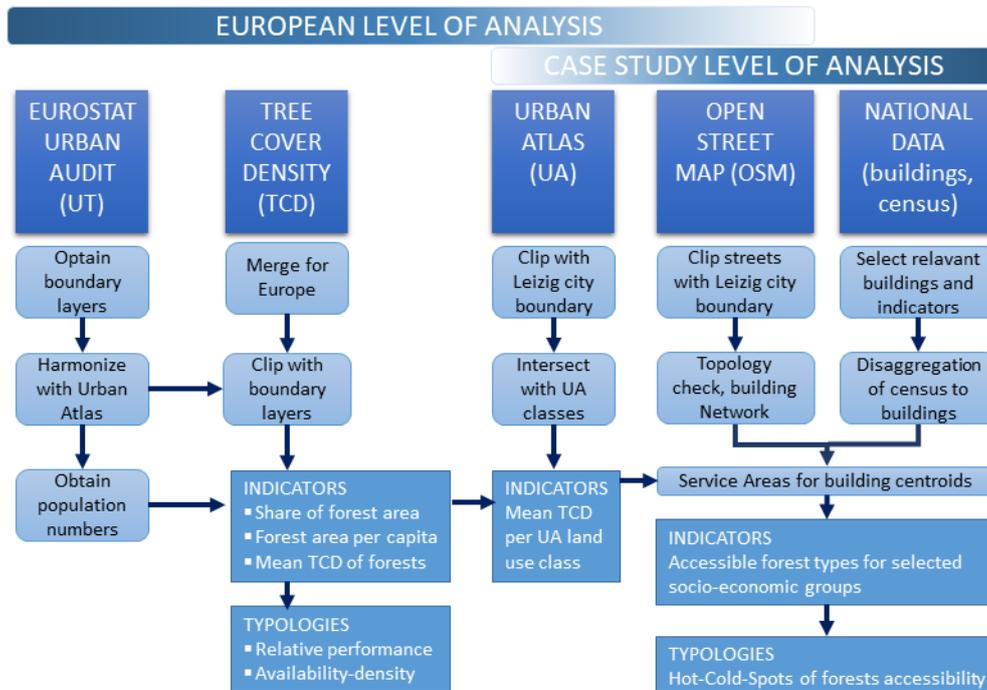
Figure 9 - Workflow of European and case study level of analysis together with derived indicators and typologies

The recent availability of the Urban Atlas (UA) 2018 dataset allows a European wide comparison of green spaces in general and forest areas in particular. As the example of the city of Leipzig shows the city is equipped with large green urban areas in its centre, particularly along the Elster-Luppe river system from north to south (Figure 10a). According to the UA, forest areas are rather located at the fringe of the city boundaries. This picture, however, somehow distorts the actual availability of forest areas within the city as many urban green space areas as covered by trees. Consequently, a second layer - Tree Cover Density TCD - details the availability of tree areas based on a 10-meter resolution (Figure 10b). According to this dataset, trees can be detected on almost all UA land use classes. A second advantage of this dataset is that it further displays the tree cover density of the reference year 2018.
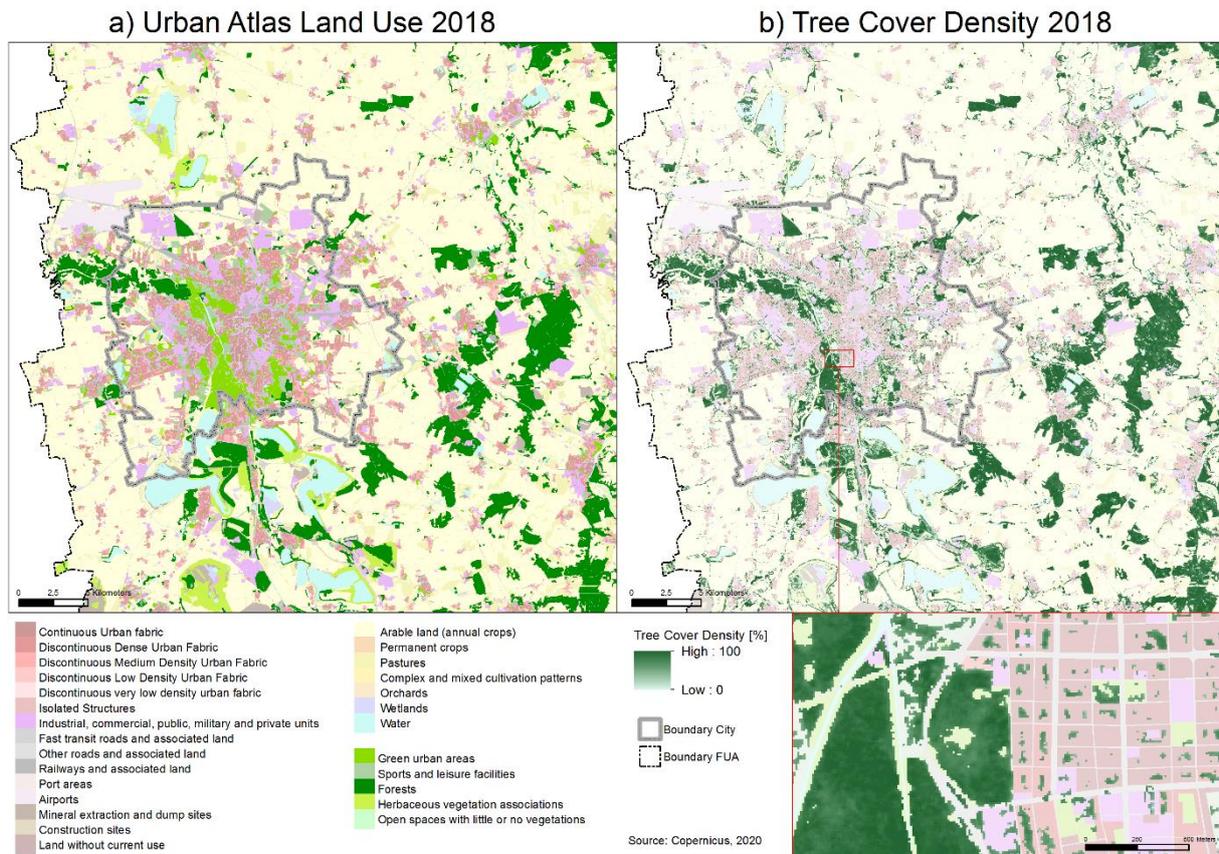
Figure 10 - Urban Atlas land use and tree cover density 2018 for the city of Leipzig.

Against this background, we used the TCD dataset with reference year 2018 for the ***European level of analysis***. We used the harmonized boundary layer for cities (n=926) and FUA (n=709) covering 37 countries for the intersection calculating the share of forest area, the per capita provision with forest area, and the mean tree cover density of the forest area (Table 2:2).

We checked for ***bivariate relations*** between the selected indicators using scatterplots and R² statistics. On the one hand, we related the selected forest indicators to indicators of population demand and urban structure such as population size or population and built-up density of the corresponding city (please note that population and built-up density will be calculated in a later stage after data will be available for all cities).

On the other hand, we are interested in the density of the corresponding forest areas, indicated by forest share on total area, in terms of potential number of users (per capita forest area) and vegetation density (tree cover density). While the first set of relations allow conclusions on the characteristics and impacts of urban structure and size of a city, the second set of relations allow conclusions on the pressure on forest areas in terms of human use and climate impacts.

Level of analysis	Indicator	Calculation [unit]	Spatial / temp. scale	Explanation power of indicator	Source
Europe	Forest share	Forest area / total area [%]	City, FUA 2018	Describes the availability of forest area in city/FUA	Tree Cover density
	Forest provision	Forest area / residents [m²/capita]	City, FUA 2018	Describes the available forest area per capita and the potential demand	Tree Cover density, EUROSTAT
	Tree Cover Density (TCD)	Mean Tree Cover Density per spatial unit [%]	City, FUA 2018	Describes the average canopy cover of forests	Tree Cover density
Case study	Forest share per land use class	Forest area / UA land use class [%]	City Leipzig 2018	Describes the equipment of land use classes with trees	Urban Atlas and Tree Cover density
	TCD per land use class	Mean TCD per UA land use class [%]	City Leipzig 2018	Describes the average canopy density of land uses	Urban Atlas and Tree Cover density
	Forest type accessibility	Green areas with trees / socio-demographic groups [m²/capita]	City Leipzig 2018	Describes the accessible trees for selected groups together with over- and undersupplied households	Urban Atlas and Tree Cover density, OSM, National buildings and census data

Table 2:2 - Indicators used for the European and case study level of analysis

As a European analysis usually brings about a big variety of observations and possible indicator expressions, we introduce **two typologies** in order to distinguish between cities with different performance of selected indicators (Figure 3).

A first typology contrasts the per capita forest area provision of a city with the national as well as European average. This relative typology allows a quick comparison and contextualization of the forest area provision relative to the national context and in relation to the European sample without introducing average values for larger regions e.g. Scandinavian vs. Southern-European cities assuming a certain regional dependency of the indicator performance. In addition, we analysed the difference in per capita forest area provision between the core city and the corresponding hinterland. This allows to analyse to what extend a low per capita value can perhaps be compensated by a high forest area provision in the surrounding hinterland.

A second typology focuses on the forest area within a city and questions to what extent a larger share of forest area is associated with a higher density of the canopy cover of the corresponding forest. Similar to the relative typology explained above we distinguish between four different types contrasting the share of forest area to the median tree cover density TCD. In addition, we used the share of a city's forest area on the total forest area of the FUA in which the corresponding city is nested in order to show the relative importance of a city's forest for the entire urban region, as well as the forest area of the urban region which could potentially compensate for a lack of forests within a city.

For the **case-study level of analysis** we compiled the indicators for the cities Leipzig, Kraków, Gelsenkirchen, Barcelona, Brussels. With this overview, we discuss the way these case studies are embedded and performing within the larger sample of European cities (note that this chapter focuses on the existing FUA that somewhat correspond to the five project localities, in the following chapters

we outlined more exactly the boundaries of the localities which is not always overlapping with thee FUA boundaries).

Finally, we demonstrate the added value of linking comparable European and national or local datasets (Figure 3). We will demonstrate this with the ***case study of Leipzig*** as at the moment of writing UA data for 2018 is still missing for Gelsenkirchen and Brussels while for Barcelona, Kraków, and Leipzig the data is available. First, we intersected the already described European datasets Urban Atlas UA and Tree Cover Density TCD for the reference year 2018 and calculated the share of trees over the corresponding UA land use classes together with the mean tree cover density. The added value is, first, that with this analysis we can detect different types of forests and trees (e.g. trees in parks or street trees) which could also be used to further distinguish between public accessible forest areas (e.g. public parks), and areas with rather limited accessibility options (e.g. trees on sport fields or in backyards). Second, the variation of the canopy cover using tree cover density allows to conclude on the effectiveness and robustness of different tree and forest types e.g. against heat, droughts, use pressure, pollution etc.

Furthermore, we performed an accessibility analysis in order to demonstrate the unequal provision of socio-demographic groups with forest and trees in Leipzig. Therefore, we used a dataset with more than 70,000 buildings and with disaggregated and updated data for three socio-demographic groups: households with children, households with only senior citizens, and households with people born abroad. We created a 5-minutes service area (400 meter) around each building centroid using OSM street data using network analysis as implemented in ArcGIS (Figure 3). The resulting service areas have than be intersected with a selected green space type (Urban Atlas classes forests, green urban areas, herbaceous vegetation association, sport and leisure facilities) which are covered by trees (derived from Tree Cover Density data). With the resulting per capita values we performed a Hot-Cold-Spot analysis in order to detect significant high and low values which emerge due to the spatial configuration of the buildings in relation to each other, and to green spaces.

2.3   Results

2.3.1   *European analysis of forest area provision*

Figure 11 displays the forest area provision (m²/capita, indicated by the colour of the circles) as well as the share of forest area (percentage, indicated by the size of the circle) for 926 cities covering 37 countries. Large green circles indicate the most desirable situation, with high forest share , and high level of per capita forest provision. Large red circles indicate that the forest share is high, but under the pressure of high population densities. Small circles, conversely, indicate reduced forest surfaces, in some cases (i.e. the red circles) the scarcity is exacerbated by high population density. Larger share of forest area (i.e. large circles) can be detected for several Scandinavian countries, Central European countries like Germany or France, as well as Southern European countries such as several parts in Italy or Spain. The provision of forest areas, measured by per capita forest area, is in particular low at the

Balkans, in several parts of Eastern Europe but also in dense agglomerations of Central Europe and the UK (i.e. red and light red circles).
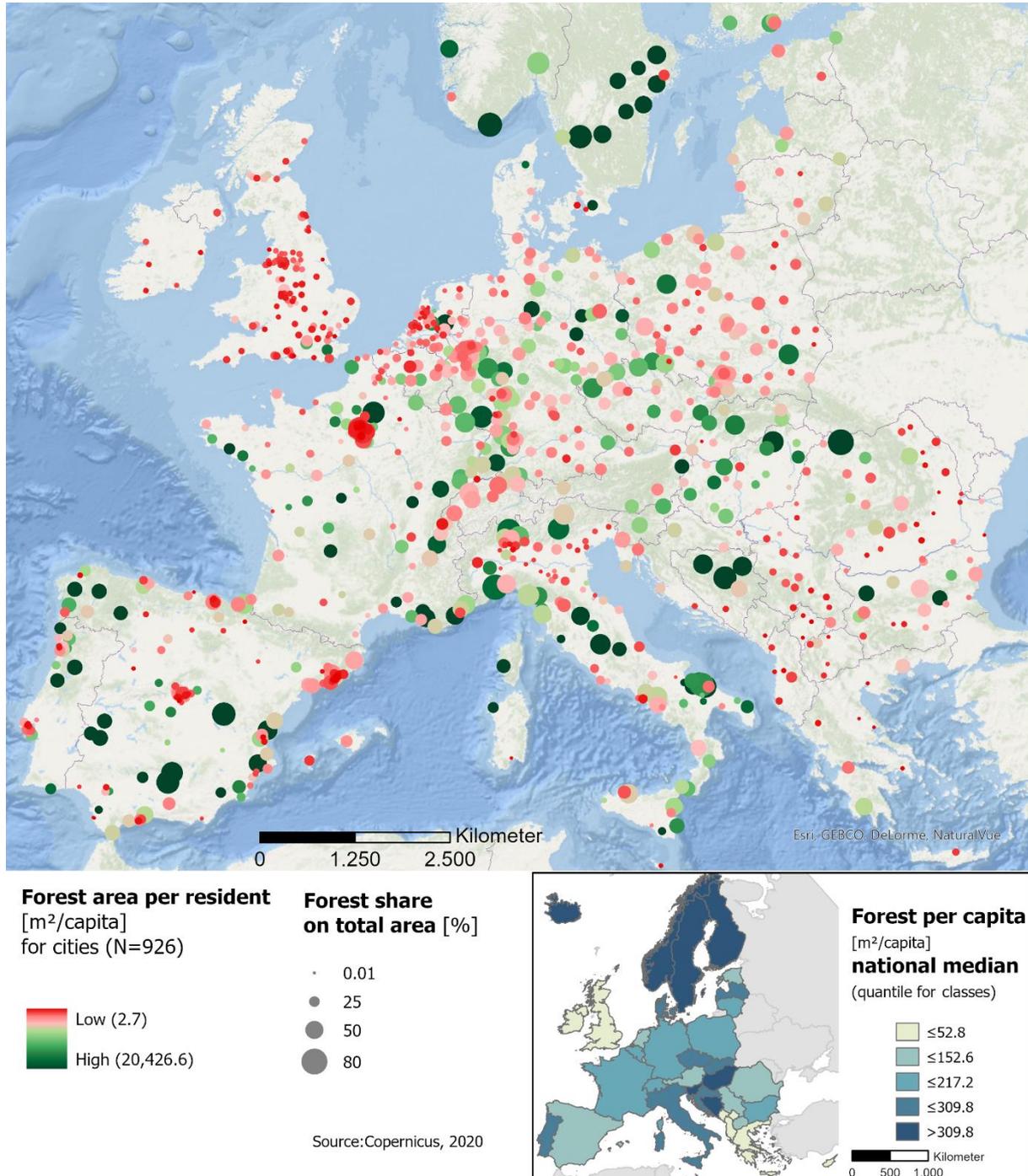
Figure 11 -Forest provision per resident in cities and national median 2018

Studying the relation of selected city characteristics such as location, density, population size, and selected forest area indicators allows to illuminate framing conditions such as built-up structure or population demand on forest area availability and per capita forest area provision.

Figure 12A mirrors a weak inverse relation between population size of a city and per capita forest area provision: the larger a city is the lower is the provision of forest areas per capita with small and medium-sized cities reaching the highest values for forest area provision. As this relation is somehow obvious, the reasons behind are diverse. From the perspective of the indicators used Figure 12b shows that the performance of cities in terms of per capita forest area provision is less an issue of the forest area available: the more forest area – measured by the share of forest area – a city has available the higher is the per capita provision of forest area. In contrast, the final low, average or high per capita forest area provision is basically an outcome of the high population pressure in cities (Figure 12C): There are also larger cities which provide comparable high forest shares such as Brussels, Berlin or Warszawa but which, however, have a very low per capita provision of forest areas due to the high population demand. In contrast, also cities with a low forest share can provide a high per capita forest area provision as population numbers are low e.g. Aalborg or Helsingborg. For instance, Leipzig has, among the case studies, the lowest forest share – but can provide a comparable high per capita provision of forest area.

Furthermore, there is also a big variation, and a resulting weak relation, between the availability of forest areas and the density of the corresponding forest – a necessary indicator for estimating the biophysical impact by climate conditions: The majority of cities follows the relation: the more forest area is available, the dense the corresponding forest areas is. However, there is a big variation of cities which will be further elaborated with a corresponding typology.
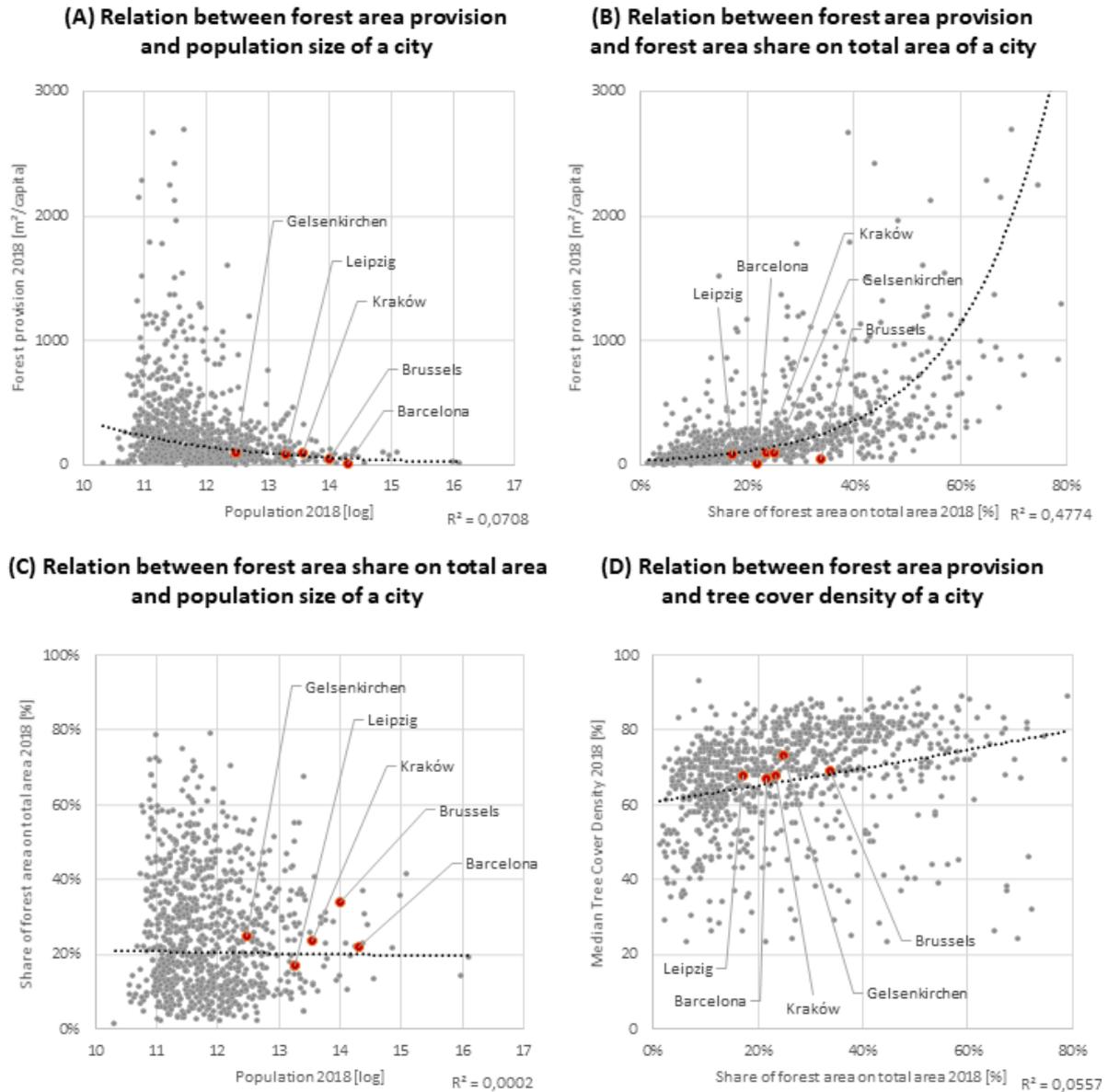
Figure 12 - Bivariate relations between selected forest area indicators for cities 2018

2.3.2 European typologies

Relative typology of spatial scales

This typology compares the difference of the individual per capita forest area values of cities with the corresponding national and European average. Following this, 41% of all cities are of type "Low performer" as their per capita forest area provision is both below the national and the European average. As the lower map in Figure 7 displays, this type of cities can be found in particular in the dense agglomerations from the UK towards the Benelux and Germany, to Northern Italy – but can also be found in Eastern Poland, at the Balkan, or the Iberian Peninsula. All of the five case studies are of this

30

type. In contrast, 41% of all cities show a provision above the European and national average ("Double champions"). These cities can be found all around the continent in almost every country. Cities for which a provision above the national but below the European average can be detected ("National champions" 8%) are located in the UK, Spain or South-Eastern Europe, while cities above the European but below the national median can be found on the British islands or the Balkan region ("European champions" 10%).

Of course, the performance of a city in terms of per capita forest area provision can be compensated by a comparable higher forest area share which needs to supply a lower number of residents in the surrounding hinterland. The upper map in Figure 13 displays the degree of this hinterland reserve. The closer the value gets to -100%, the higher is the reserve in the hinterland compared to the provision within the city. This is in particular the case for cities at the Balkans and in the Baltic countries, but also for cities in Poland, and for cities along the French-Spanish coastline including also the case study Barcelona. In contrast, for several cities the potential of the hinterland is comparably low what means that either the forest area in the hinterland is low like in the Netherlands, it already experiences an equal population demand like for cities in the UK, or the city is already showing a very high per capita forest area provision like for many Scandinavian cities (Figure 13).

Typology of forest shares and tree cover density

A second typology contrasts the share of forest area with the median tree cover density TCD of the corresponding forest area. Similar to the typology above Figure 8 presents a bipolar picture. While 34% of all cities have a below-average forest share as well as a below-average TCD ("Little and low density") – in particular located in the UK, the Benelux (Belgium, Netherlands, Luxemburg), and Southern as well as South-Eastern Europe – another 34% saw an inverse performance ("Much and high density"). The latter is in particular located north of a line Porto-Varna (see lower map in Figure 8), cities with a comparable high share but a below-average TCD are located basically below this line ("Much and low density" 16%). Finally, 16% of all cities have a comparable low share of forest area – but this forest is comparable dense ("Little and high density") characteristic for cities scattered around the continent – but above the described line Porto-Varna (see lower map in Figure 13).

Comparing the share of forest areas of a city to the forest area of the entire FUA (Figure 8) shows that several cities in Southern Europe already have a comparable high forest share – the hinterland does not necessarily provide additional forest area. A similar picture is drawn by the Benelux and UK cities which have, in turn, also a very low forest share within the FUA. In contrast, cities e.g. in the Paris agglomeration have a very low share of the FUA's forest areas highlighting their low forest area availability.

Difference between forest area per resident in urban core city and hinterland [%] for cities (N=926)

Additional demand in hinterland
Low reserve in hinterland

- >0.0 (N=81)
- 0.0 to ≤-68.0 (N=105)
- -68.0 to ≤-86.0 (N=186)
- -86.0 to ≤-93.0 (N=184)
- -93.0 to ≤ -96.0 (N=186)

High reserve in hinterland
- <-97.0 (N=184)

Forest share in Functional Urban Area FUA on total area [%]

- · 10
- 20
- 40
- 60

Source: Copernicus, 2020
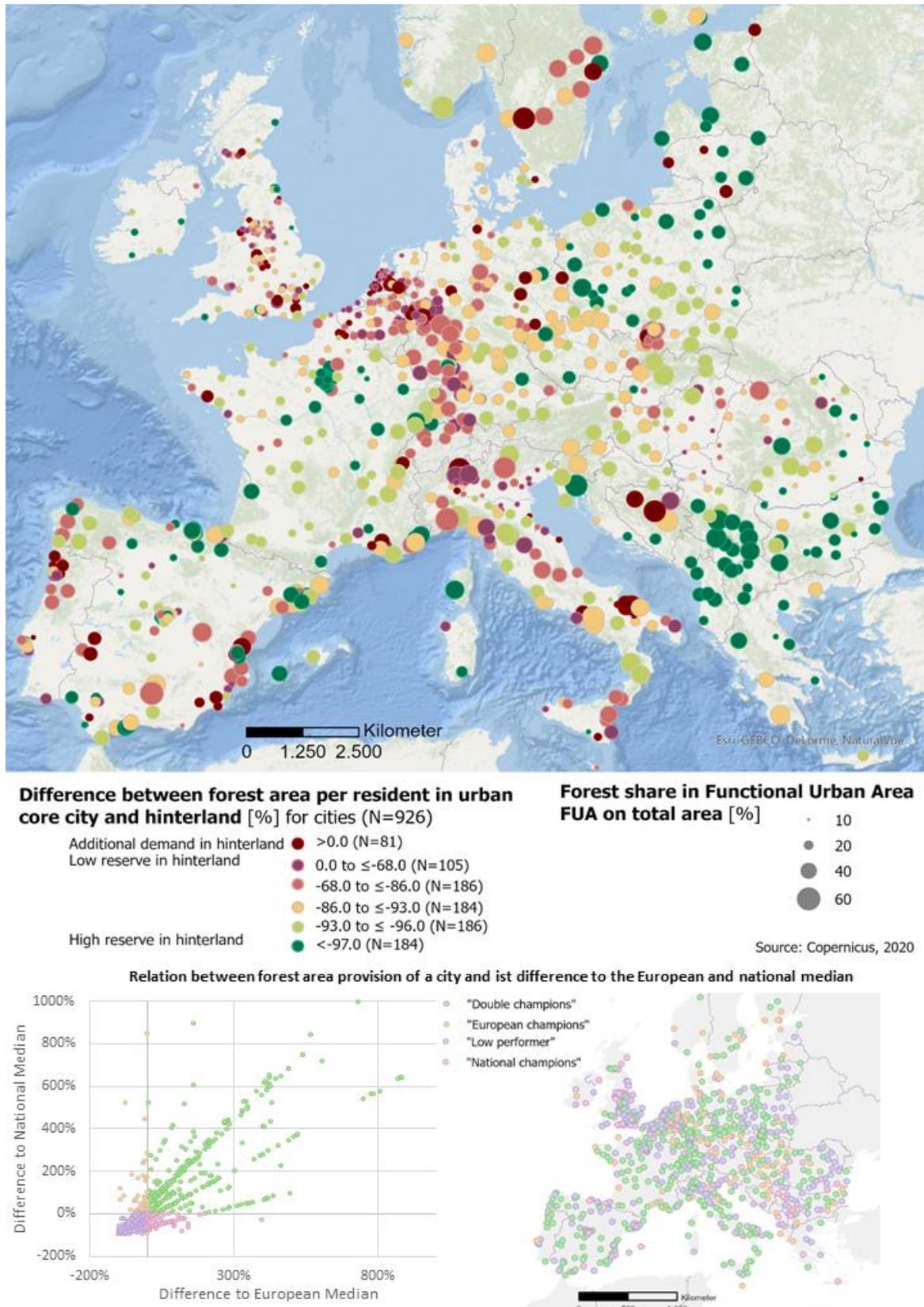
Figure 13 - Relation between spatial scales for per capita forest area provision in 2018 for cities
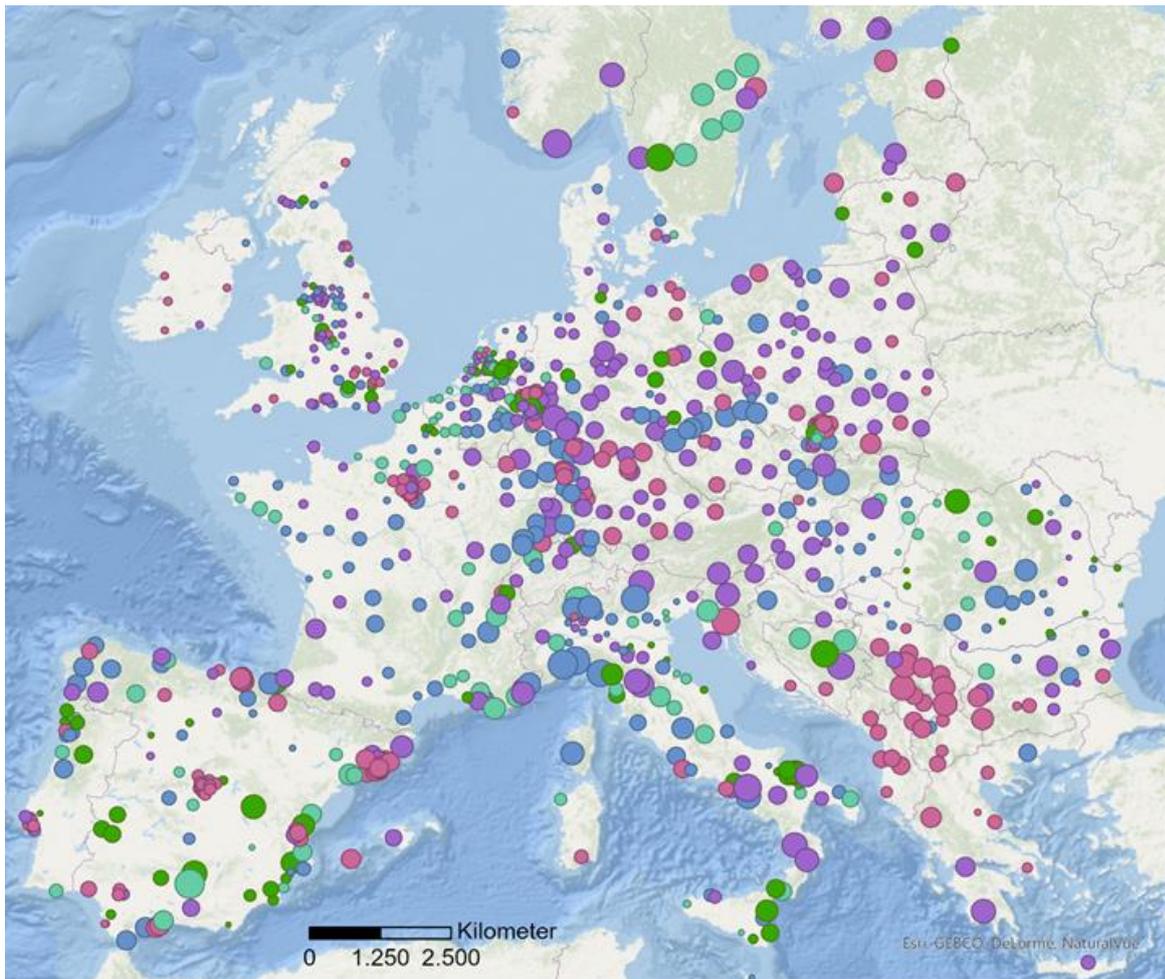
Share of forest area of city over on the forest area of the corresponding FUA [%] for cities (N=926)

- 0.0 to ≤ 2.5
- 2.5 to ≤ 10.0
- 10.0 to ≤ 25
- 25 to ≤ 50
- >50

Forest share in Functional Urban Area FUA on total area [%]

- 10
- 20
- 40
- 60

Source: Copernicus, 2020

Relation between tree cover density and forest area share on total area

- "Little and low density"
- "Little and high density"
- "Much and low density"
- "Much and high density"
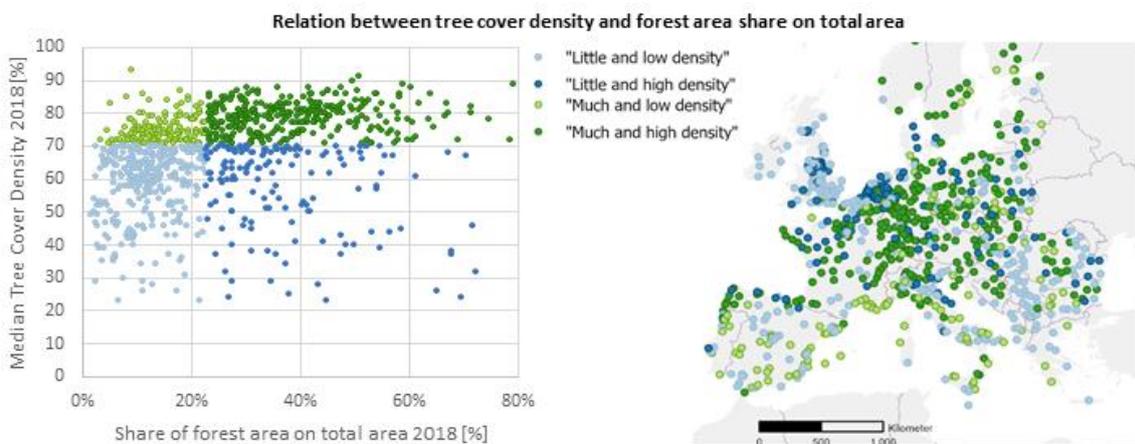
Figure 14 - Relation between forest shares with hinterland and tree cover density

2.3.3 Case study comparison

Spread all over the continent, the five case studies represent different contexts ranging between different European planning families, national contexts, and locational differences such as coastal and inland locations. When comparing the per capita forest area provision of the cities to the individual European and national median, all cities range below the national and European average – so all cities share some similar performance compared to the European and national context in terms of low provision and – as the inverse perspective – high pressure on forest areas in terms of potential forest users. As Table 3 shows, Brussels and Barcelona have a tremendous difference to the European average (46 and 13 m²/capita versus 161 m²/capita average in Europe) while Kraków and Gelsenkirchen show a per capita provision (101 m²/capita each) close to the European average. Similar, although Leipzig is a comparable green city, the coverage with forest areas is quite below the European and even national average. With a share of 17% forest area and a population of 581,980 the city provided a per capita forest area provision of 88 m²/capita ranging thereby below both the European as well as the national average in terms of forest area provision.

It is important to note that all case studies have a big potential of forest area provision in their hinterland. Measured by the difference between the per capita value of the core city and the corresponding hinterland, Barcelona shows the highest reserve of forest are which could supply residents with forest area e.g. for recreation, followed by Leipzig and Kraków (Table 3). In contrast, for Brussels and particular the Gelsenkirchen FUA the difference between core and hinterland is still significant above the European average, but low compared to the other case studies.

As Table 2:3 details, Kraków, Gelsenkirchen and Brussels have a share of forest areas above the European median (23%, 25%, 34% versus 22.6% average in Europe) while only Gelsenkirchen shows an average tree cover density higher than the European median.

|	Forest area provision 2018				Forest area share and tree cover density 2018		
	Forest area / residents [m²/capita]	Difference to hinterland [%]	Difference to national median [%]	Difference to European median [%]	Forest area [ha]	Forest area / total area [%]	Median tree cover density [%]
Europe (Median)	161	-90,1%	Does not apply	0%	241,723	22.6	70
Leipzig	87.8	-94,7%	-59.6%	-45.5%	5,113	17.1%	68
Kraków	100.8	-92,9%	-37.8%	-37.5%	7,770	23.4%	68
Gelsenkirchen	100.8	-78,8%	-53.6%	-37.5%	2,624	24.9%	73
Barcelona	13.3	-98,3%	-89.1%	-91.8%	2,149	21.7%	67
Brussels	45.5	-88,9%	-70.5%	-71.8%	5,486	33.7%	69

Table 2:3 - Characteristics of case studies

2.3.4 Leipzig as an example for further data processing

This chapter exemplifies the advantage of intersecting both datasets – Urban Atlas (UA) and Tree Cover Density (TCD) – using the case study of Leipzig. In Leipzig, the high resolution of the TCD allows to detect forest areas and trees on land use classes of UA which are not predominantly indicate a forest-related land use class. While 92% of all green space areas in Leipzig (forests, urban green areas, herbaceous vegetation) are somehow covered by trees, the share is 80% for residential areas (continuous and discontinuous urban fabric, isolated structures), 78% for agricultural areas (arable land, pastures), and 64% for transportation and industrial areas (see Figure 15). Figure 15 shows that on average 63% of green urban areas are covered by forests which, in turn, have a comparable TCD compared to forest (73% and 79, respectively). In addition, also other land uses classes also show a forest share of almost 20% and more: pastures, discontinuous urban fabric (except with very low density), sports and leisure facilities, or land without current use. Figure 16 displays the distribution of forest areas and their TCD per UA classes in Leipzig. This intersection displays, for instance, inner court and backyard trees among residential areas, pasture woodland or small orchards among agricultural areas, or larger street tree alleys, squares with trees, as well as trees on brownfields, industrial or larger railway areas.
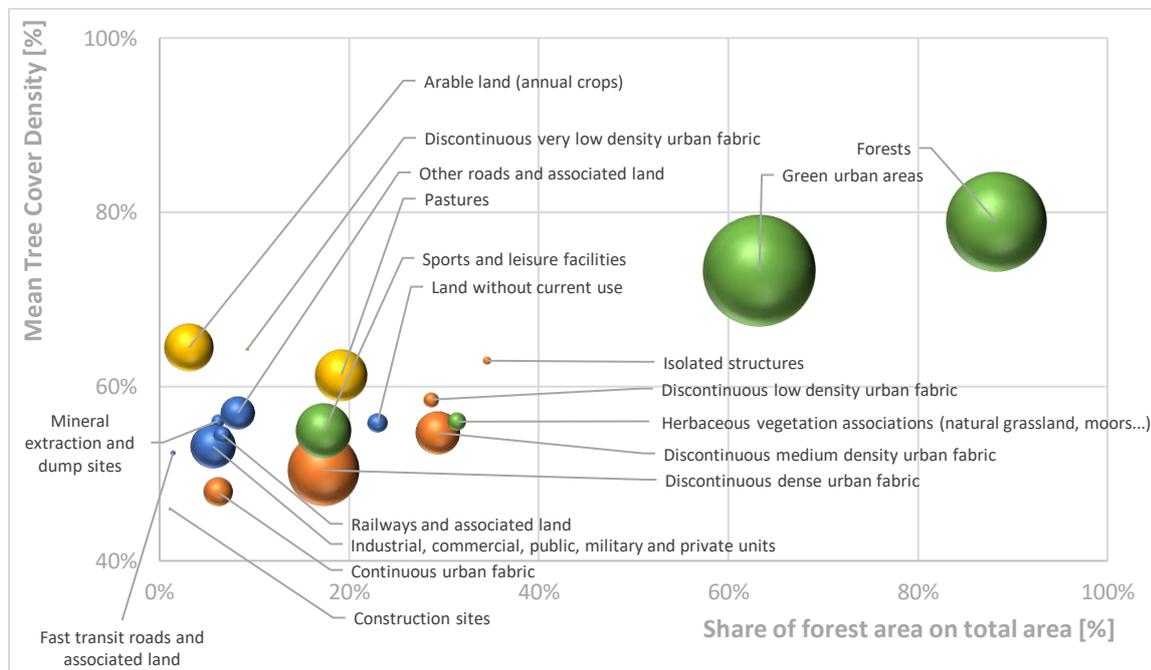
Figure 15 - Tree Cover Density and share of forest area for land use classes of Urban Atlas in Leipzig 2018

(green area classes, yellow = agricultural area classes, orange = residential area classes, blue = transportation and industrial area classes) size of points indicate the total forest area.

Land Use Classes 2018

Tree Cover Density 2018 [%]

Green areas[1)]   Agricultural areas[2)]   Residential areas[3)]   Transportation and industrial areas[4)]

Leipzig administrative boundary

20
40
60
80

Source: Copernicus, 2020

1) Forests, Green urban areas, Herbaceous vegetation associations, Sports and leisure facilities
2) Arable land, Pastures
3) Continuous urban fabric, Discontinuous urban fabric, Isolated structures
4) Fast transit roads and associated land, Other roads and associated land, Railways and associated land, Industrial, commercial, public, military and private units, Construction sites, Land without current use, Mineral extraction and dump sites

Figure 16 - Tree Cover Density and by major land use classes of Urban Atlas in Leipzig 2018

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While the previous analysis has shown the diversity and location of types of trees, the following example of analysis elaborates on the relevance of green areas with trees based on a network analysis. Based on a walkability of 5 minutes from residents' home, Figure 17 maps significant high and low values for forest area per capita for three socio-demographic groups in Leipzig. With this analysis we can map areas which ask for planning intervention due to low forest area provision. While low forest area provision for people born abroad is characteristic for whole districts in particular in the city centre, the central northern and southern district, households with senior citizens with very low forest area provision are scattered all over the city's territory characterising in particular the inner-dense parts of districts. In contrast, for households with children the picture is in particular dichotomous with larger areas with significant low per capita values interrupted by areas with high provision values.

Figure 17 - Accessibility green areas with trees for selected socio-demographic groups in Leipzig 2018

Part II

3 Gelsenkirchen, Germany

3.1 General information

3.1.1 Institutional framework and planning system

Gelsenkirchen is located in the state of North Rhine-Westphalia (NRW) in the middle of the largest polycentric conurbation in Germany, the Ruhr metropolis.

In NRW, regional planning falls under the responsibility of one of the districts in which the state is subdivided. The district are "state authorities, i.e. they derive their democratic legitimacy from the state elections. There is an exception for the Ruhr Metropolitan area: since October 2009 responsibility for regional planning in the area have been assigned to the Regionalverband Ruhr, RVR (Ruhr Regional Association), and are no longer included in the regional plans of the district governments that affect the Ruhr area. The RVR is the amalgamation of the 11 "independent" cities (These are cities which are not assigned to any sub-district and therefore have to perform certain tasks otherwise performed by the sub-district) and four sub- districts (=circles) in the Ruhr Metropolis. The RVR is not only responsible for state regional planning in the region, but is also responsible for important infrastructure projects such as the Route of Industrial Culture and the Emscher Landscape Park (ELP). Municipal land-use planning is located below regional planning; it covers the area of a municipality in the form of land use planning. As the lowest level of spatial planning, there is the binding land-use planning in the form of the development plan at the district and neighbourhood level.

The six independent cities of Bochum, Essen, Gelsenkirchen, Herne, Mülheim an der Ruhr and Oberhausen joined forces in 2005 to form the "Planning Community Urban Region Ruhr" and for the first time set up a regional land use plan (RFNP) nationwide, which simultaneously fulfils the function of a regional plan and a joint land use plan.

The new planning instrument RFNP was included in the federal spatial planning law in 1998. The planning area of the RFNP covers around 680 km² with around 1.8 million inhabitants and is the responsibility of three district governments. The RFNP thus replaces the sections of three regional plans as well as the six previous communal land use plans and combines them into a new set of plans.

The RVR is currently preparing a regional plan for the entire Ruhr Metropolis. As soon as this regional plan comes into force, it will replace the RFNP in its function as a regional plan for the six member municipalities. A joint land use plan (GFNP) will then be continued in the six cities, which will comply with local regulations (https://www.rvr.ruhr/themen/regionalplanung-regionalentwicklung/regionalplan-ruhr/planentwurf/)

Spatially, Gelsenkirchen is assigned to the administrative district of Münster at the level of the district government = state administration), a state funds authority that also performs tasks in the field of nature and species protection (higher nature conservation authority).

Map of Ruhr metropolis

Map of North Rhine-Westphalia (NRW)

Ruhr metropolis (11 independent cities and four sub- districts (=circles = Kreis; Kreis Recklinghausen, Kreis Unna, Ennepe-Ruhr-Kreis, Kreis Wesel))

North Rhine-Westphalia (NRW) – five district government (Düsseldorf, Münster; Arnsberg, Detmold, Köln); two regional associations (LVR und LWL)

In North Rhine-Westphalia there are two regional associations, the Rhineland Regional Association (LVR) and the Westphalia-Lippe Regional Association (LWL). They perform important public tasks that go beyond the capabilities of the individual municipalities. This administrative approach has its historical roots in the tasks of the former Prussian provinces of Rhineland and Westphalia.

In the social area, the LVR and LWL take on the responsibility for supra-local social, handicapped and youth welfare and they are responsible for the preservation of culture and monuments. Gelsenkirchen is a member of the LWL.

The city of Gelsenkirchen has had a legally binding landscape plan since 2000 ("Landschaftsplan Gelsenkirchen")

The landscape plan implements the goals and measures of nature conservation in the area of the city of Gelsenkirchen. It specifies and supplements the nature conservation content of the regional plan as a landscape framework plan. The landscape plan is drawn up by the districts and independent cities, which adopt it as a generally binding municipal statute. Landscape plans are drawn up across the board for all areas that are outside the contiguous built-up districts and the scope of the development plans (outside area). The landscape plan records and evaluates the natural balance in the planning area, develops goals and measures for the sustainable protection and development of the protected assets. The protected assets include the plants, animals and biotopes to be preserved in their biological diversity, as well as the landscape. Soil, water, air and climate should be protected as far as possible through measures of nature conservation and landscape management. When drawing up the landscape plan, the specifications of the superordinate regional plan must be observed. Existing plans from other areas - zoning and development plans - as well as the stipulations of other specialist plans must also be taken into account.

The Emscher Landscape Park (ELP)

The ELP is a regional cooperation project in the northern Ruhr area to create the world's largest connected park system (450 km²). Due to the industrial and montane past of the region, the natural landscape is heavily populated, changed many times and structured like a mosaic. The aim of the landscape park is to create a new type of park that combines different open spaces: preserved pre-industrial cultural landscape, areas of the regional green corridors that have been created since 1920, industrial landscape and post-industrial landscape.

The concept of the ELP was developed during the International Building Exhibition Emscher Park (IBA 1989 - 1999). The more recent development of the ELP is documented in the ELP 2010 master plan, which has been drawn up by the 20 participating cities and regional institutions since 2002. It defines the area of the park and names the main themes of development (New Emschertal, ecology, infrastructure, culture, urban agriculture and forestry, development and vegetation management).

Approx. 70% of Gelsenkirchen urban area is in the catchment area of the Emscher; the northern parts of Gelsenkirchen drain into the Lippe.

As a water management association, the **Emschergenossenschaft** is responsible for water maintenance, sewage drainage and purification, groundwater management and regulation of mining consequences (subsidence) in the Emscher catchment area with around 2.2 million inhabitants. With the end of hard coal mining, the subsidence has come to a standstill. Therefore, the Emschergenossenschaft can "rebuild" the natural drainage system and the streams will be renatured.

The natural reconstruction of the Emscher system is the main task of the present and future. This generation project was initiated with the IBA. Within the planned and budgeted time frame 1992–2021, the entire Emscher system is to be rebuilt with € 5.38 billion. The consequences of mining are irreversible, so that the need to pump - that means to keep the settlement areas in the Emschertal dry - remains permanently.

3.1.2   Experiences with participatory governance and citizen science

In order to meet the major global and local challenges, long-term strategies based on the principles of sustainable development are required.

In recent years, Gelsenkirchen's strategy has focused on **prevention, education and participation** as well as the idea of "learning city" - the combination of integrative, equal opportunity and good education with "Education for Sustainable Development (ESD)".

The city of Gelsenkirchen has joined the United Nations' Agenda 2030. In 2016 the City Council unanimously passed the Agenda 2030 resolution: "Shaping sustainability at the municipal level", making of Gelsenkirchen the first municipality in Germany to do so. The city of Gelsenkirchen has received several awards for this:

- o   UNESCO Learning City Award (2017)
- o   Award of Gelsenkirchen at level 3, the highest level, within the framework of the UNESCO world action program "Education for Sustainable Development (ESD) (2016)
- o   Nomination of the city of Gelsenkirchen for the German Sustainability Award (2016)
- o   City of the UN Decade "Education for Sustainable Development" (2014, 2013, 2012, 2010)
- o   German Sustainability Award / Special Award "Education for Sustainable Development" (2012)

"City of the Future 2030" - What will the city of tomorrow look like? This is the question that is at stake in the competition launched by the Federal Ministry of Education and Research (BMBF) in the 2015 Science Year. Gelsenkirchen emerged from a three-stage competition process - as one of seven winning municipalities.

A wide range of actors in urban society will implement the vision "Learning City of Gelsenkirchen - Education and Participation as Strategies for Socio-Spatial Development" with a total of 16 modules in four research pillars. Urban society and science work hand in hand in specialist groups in the four real-world laboratories "Learning locations and learning laboratories", "Participation in the neighbourhood", "Digital city" and "City and science". It is about extracurricular learning locations and new educational approaches, about acquisition and participation processes in the neighbourhood, about digitization and collaboration with science.

As a joint project with the FU Berlin and the FH Dortmund, new educational approaches are being tried out, new instruments are being tested and concepts are being developed - in short: experimenting. In addition to the concrete real laboratory research on site, the Institut Futur of the FU Berlin accompanies the entire process with a view to a further development of the participation approach for cooperation between the city administration and the city society and the development of an instrument "transfer of effective participation approaches" that can be used by the city of Gelsenkirchen.

Gelsenkirchen has been working with the dynamic "coexistence integration concept" since 2015, which is constantly being further developed as required in the participatory process with citizens. Accordingly, for the multi-ethnic city of Gelsenkirchen, actively shaping integration work and living together is a self-binding, permanent and future-proof task. New challenges arise, particularly in light of current backgrounds such as flight, immigration, tendencies towards radicalization, etc. Encounters at eye level and mutual respect are of particular relevance. With regard to the integration of new immigrants, there are two other target group-specific concepts in addition to the "integration concept living together", one for new EU immigrants (action concept "Immigration within the framework of the EU's eastward expansion: Bulgaria and Romania") and the other for refugees ("action concept for the reception of refugees ")

Dialogue format "GELSENKIRCHEN - LET'S TALK!" - With this format, which is deliberately open to results and designed as a laboratory, since June 2019 people in the city have been able to better engage with each other and with politics and administration. Listening, understanding, learning from one another, on an equal footing and without the hysteria of the discourse in social media - that is what this format should achieve. 2.000 Gelsenkirchen residents selected at random will be invited by letter to three-hour themed events (Previous topics "respect, tolerance and cultural curiosity", "money", "mobility and climate protection"). The results of the discussion are then followed up and the city administration examines implementation options for the citizens' suggestions.

3.1.3   Socio-economic profile

The city of Gelsenkirchen lies on the northern edge of the Ruhr area, the "Metropole Ruhr". As a former centre of the coal, iron and steel industry with almost 400,000 inhabitants, 14 mines and the location of steel, glass and textile industries, the city experienced a population decline of around 150,000 inhabitants in the 1970s due to the decline of coal and steel and severe slumps in other areas of the coal, iron and steel industry. This was accompanied by a sharp rise in unemployment figures - particularly among the group of people of Turkish origin. Following the accession of Bulgaria and Romania to the EU and the subsequent influx from these countries, the tendency towards segregation increased, GDP fell and Gelsenkirchen regularly occupied the last places nationwide in terms of growth, unemployment and income.

The loss of image associated with the lack of jobs intensified the trend of emigration - especially among the young, well (educated) population group.

At the same time, efforts were made to find new uses for the industrial and commercial sites which had fallen into disuse as a result of structural change. The International Building Exhibition and the 1997 Federal Horticultural Show were important impulses for a fundamental change of direction - economically, ecologically and socially.

The course was set for a move away from large industrial structures towards smaller and more flexible companies, company start-ups were promoted, as was the linking of R&D (research and development) with the economy. In the course of a changed ecological awareness, Gelsenkirchen became a "solar city", green spaces, parks and forests were created at former mining and steel sites, regional green corridors were created with regional cooperation projects, and the network of cycle paths was expanded on former railway lines.

By intensifying contacts with the "Westfälische Hochschule" and linking up with the regional higher education landscape with offers for students with a migrant background, the current "brain drain" is

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to be slowed down and, by setting up companies out of the university, promoted into sustainable, innovative business areas of structural change.

Gelsenkirchen, as part of a polycentric metropolitan region, is itself bi-central with a (historically grown) administrative centre in the area north of the Rhine-Herne Canal and the southern centre.

Here we tend to find a lower level of education and income, neighbourhoods with precarious housing situations, combined with a high proportion of inhabitants with a migrant background. Both areas are separated by the Rhine-Herne-Canal, the logistic "lifeline" of the coal and steel industry, adjacent commercial and industrial areas and in the direct vicinity of the Emscher, a river course which canalised to receive all kinds of wastewater.

The Emscher is currently being renaturalised, and the resulting wastewater is collected and treated by a parallel pipe system.

The area between the canal and the Emscher, the so-called "island", is part of a regional green belt and, in the area of the former Nordstern colliery, part of the Nordsternpark (built during the 1997 Federal Horticultural Show). Further to the east, in the area of the former harbour of the Graf Bismark power station, a new urban quarter on the water's edge has been created with attractive residential uses, supplemented by restaurants, a marina and commercial areas on the periphery.

The development of the south of Gelsenkirchen into a "creative quarter" is another building block in the city's development. Attractive living and working opportunities for young, creative entrepreneurs and companies are created here, which not only enhance a district with unfavourable socio-economic conditions, but also become important partners in municipal economic and environmental policy by participating in innovative urban development.

Due to its industrial history and the current demographic situation, the city is also facing major challenges in the education sector. Nevertheless, Gelsenkirchen has managed to become a "learning city" in a project funded by the Federal Ministry of Education and Research. School and extracurricular actors as well as children, young people and adults are networked here. The 2030 Agenda is a priority, and the city has set itself the goal of implementing the SDGs relevant to it and integrating them into the target systems of the city's administrative sectors.

3.2   Geography of UF-NBS

3.2.1   *State of (peri)urban forests, green infrastructure and urban greenspace*

(Peri)urban forests

With 64.8%, North Rhine-Westphalia has the largest share of private forests in Germany; The proportion of the state forest is the lowest in Germany at 13.0% (State Forest Report 2012).

- Forest in the territory of the Ruhr Regional Forestry Office: 70,000 ha (total area: 340,000 ha)
- Share of forest cover: 21% (NRW 27%); Forest area per inhabitant: 143 m² (NRW 508 m²);
- Distribution of ownership: 67% private forest, 32% communal / state forest
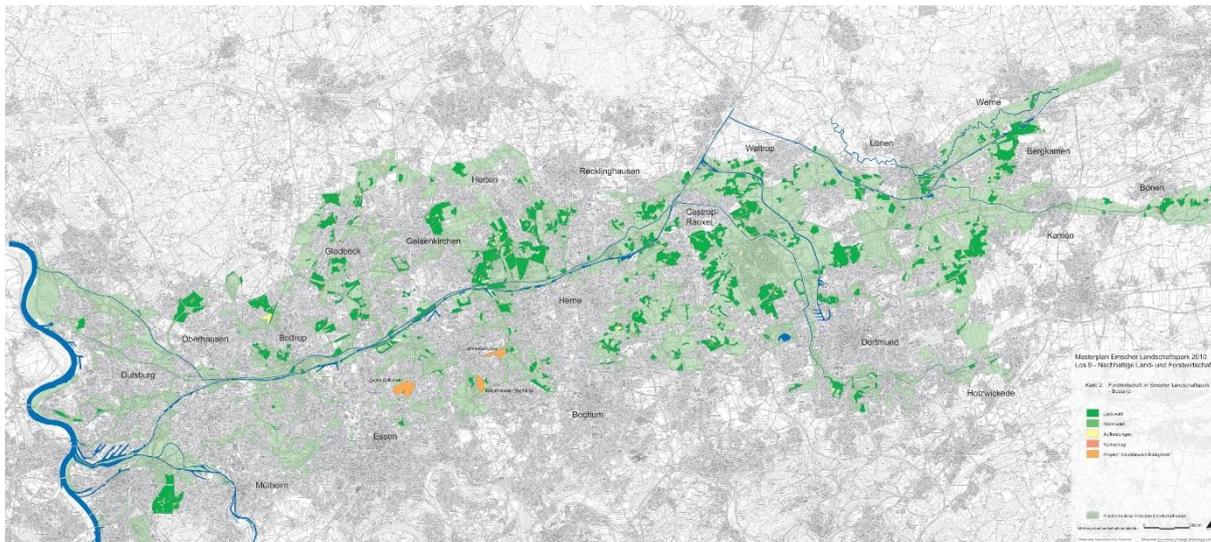
Map 1 Forest areas in the Emscher Landscape Park

The Ruhr area is shaped and reshaped in many parts by anthropogenic influences. Therefore, depending on their origin, the forest images range from old forest relics with remnants of potentially natural vegetation to planted forests to pioneer forests on post-industrial areas that have emerged from succession. They form a significant part of the green infrastructure in the Ruhr area. The socio-economic and ecological services of the forest represent an irreplaceable social value.

Here, regulatory ecosystem services (CO_2 sink function, fresh air formation, fine dust filtering, flood protection, cooling effect) of the forests are just as important as their function as an important recreational area. At the same time, the biodiversity of these forests is impaired by heavy pollution, eutrophication and a high level of disturbance, which contributes to a certain homogenization of flora and fauna and the promotion of neobiota.

In Gelsenkirchen there are around 1,430 hectares of land with a forest-like character (total area of the city: 10,494 hectares) From that:

- 100 hectares of forest in parks.
- 270 hectares of industrial forest and forest areas on slagheaps

The **industrial nature or the industrial forest** is a specialty in the Ruhr area. The term industrial nature refers to nature that has developed independently on the areas of the former mining industry, on derelict railway tracks, train stations and commercial areas. Industrial nature is an expression of the decline in industry and at the same time a signpost for new open spaces. The common feature is the anthropogenic overprinting of the surfaces, with the predominance of technogenic substrates such as slag, ash, dust, sludge, building rubble or tailings. A special case are tailings piles, in particular tailings piles, which, depending on the preparation of the surface tailings, can also represent locations of industrial nature. As a result, a "new type of ecosystem" has established itself which did not exist in pre-industrial nature.

Large and structurally rich industrial wastelands are hot spots for biodiversity, as they are often home to many endangered animal and plant species. In addition to the ecological networking of living spaces,

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they make a significant contribution to urban biodiversity and are at the same time places for relaxation, nature experience and environmental education.

In the course of the succession, the former open land biotopes develop into forest in the long term.

As the examples of the Hugo Green Laboratory and the Rheinelbe Forest Laboratory show, the links and synergies to the subject areas of "history", "social" and "environmental education" are very pronounced.

Forest ownership in Gelsenkirchen divided by owners:

- 500 hectares of the city of Gelsenkirchen
- 306 ha regional association RVR
- 261 ha Ruhrkohle AG (RAG)
- 133 ha of Graf von Westerholt
- Other public and private forest owners (forest and wood NRW, EON, EGLV, BP etc.)

In Gelsenkirchen, the majority of these are mixed deciduous forests. The proportion of softwood is less than 1%.. 500 hectares of the forest areas owned by the city of Gelsenkirchen are looked after and maintained in accordance with a forest management plant.

A forest management plant is available for 400 hectares; another 100 hectares of urban forest areas are not yet included; these should also be included in the next revision.

The tree species are distributed here:

- English oak 24.9%,
- sycamore 18.3%,
- European beech 15.6%,
- ash 10.3%,
- Red alder 8.9%,
- hornbeam 5.9%,
- red oak 3.3%,
- birch 2.8%,
- pasture 2.5%,
- Gray and white poplar 1.6%, bird cherry 1.5%;
- Field maple 1.0%
- winter linden 0.9%
- norway maple 0.6%
- other deciduous tree species with a longer rotation time 0.3%
- summer linden 0.1%
- robinia 0.5%
- white alder 0.2%
- mountain ash 0.2 %
- Black poplar hybrids 0.1%
- and Japanese larch 0.3%

(Source: Forsteinrichtungswerk Stadtwald Gelsenkirchen, reference date 1.1.2012).

Due to the last 3 dry years (2028-2020), the trees in the Ruhr area suffer from the consequences of the drought. In addition, there are further impairments from the storms ELA in 2014 (June) and Friederike 2018 (January), the ash shoot death, the soot bark disease of the maple, the beech complex disease as well as the small beech bark beetle and the oak processionary moth, which, due to the conditions favoured by the warmth, also the Midsummer shoot of many oaks in 2018 and thus led to a significant loss of vitality of the trees. In addition, the caterpillar hairs of the oak processionary moth contain a toxin that is poisonous for humans and other animals and represents a health hazard. The pedunculate oaks in the Gelsenkirchen city area were infested with oak processionary moths across the board in 2019. The fungal spores of the maple soot bark also pose a health risk. The removal requires a not inconsiderable financial and human effort.

Green infrastructure and urban green space

The development of the Ruhr area is reflected in its open space and garden culture. As early as the 16th century, several gardens and parks were built in Gelsenkirchen around moated castles and palaces, which are still preserved today. With industrialization, numerous public gardens and parks were developed in the city districts from 1890 to 1910, followed in the 1920s by the system of regional green corridors, which connect the northern Ruhr area with the southern Ruhr area. These emerged from the need to increase people's quality of life and, last but not least, work productivity. Between 1922 and 1927, during the term of office of Gelsenkirchen's horticultural director Ernst Max-Gey, the "Buersche Green Belt" was developed as a semi-circular inner-city green corridor along the residential areas for local recreation.

In the 1970s, combined leisure facilities with parks, swimming baths and event centres such as the "Revierpark Nienhausen" were built in the regional green corridors.

In the course of the International Building Exhibition Emscher Park, the idea of an east-west corridor along the Emscher and the Rhine-Herne Canal was developed, which connects these green corridors to form an open space system. A central component of an integrated renewal strategy of the Emscher Landscape Park is the development of a high urban landscape quality, among other things through the maintenance and development of open spaces and their addition to a supra-regional network system.
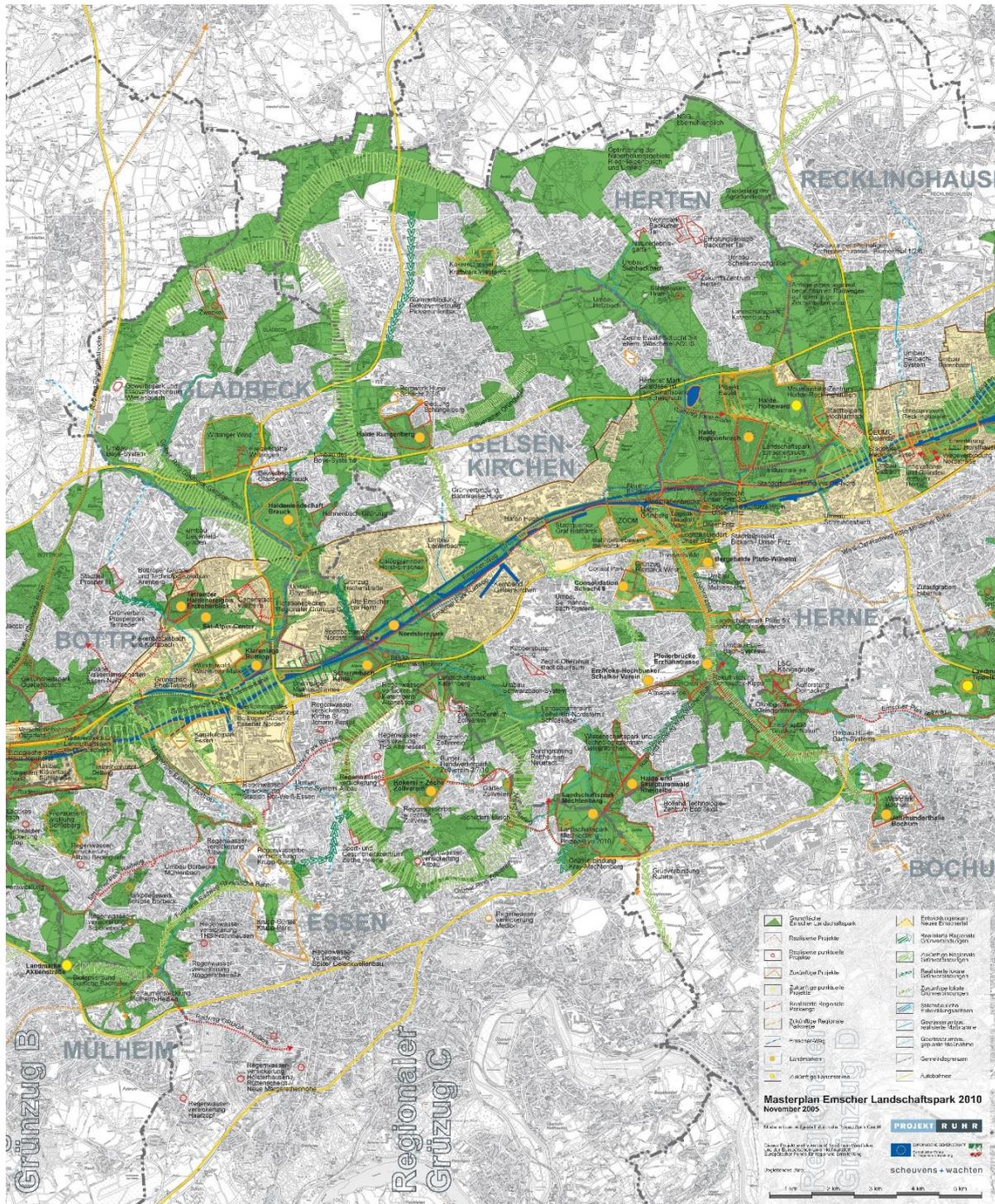
Map 2 - Emscher Landscape Park in Gelsenkirchen

As part of the natural remodelling of the Emscher system, Gelsenkirchen and the entire region have the unique opportunity to restore what has already been lost. Because before the mining industry completely reshaped the Emscher region, the area was strongly characterized by the meandering Emscher. The region was largely swampy, with swamp forests dominating the picture. These old forest images can be easily restored on sites that have been soaked through mountain subsidence - while at the same time remodelling the Emscher and its tributaries in a natural way.

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Within the Emscher Landscape Park, the open spaces are made up of the large parks and cemeteries, the allotment gardens and grave borders, the flowing waters with their embankments / dykes, the dumps and the still preserved agricultural areas and forests. This shows their multifunctionality and makes it clear that the open spaces, beyond biotope and species protection, also perform other indispensable ecological functions in climate, soil and water protection as well as under air hygiene aspects.

As part of the urban development program "Socially Integrative City" of the Ministry of Urban Development in North Rhine-Westphalia, residential buildings in need of renovation in dense and disadvantaged districts have been acquired and demolished by the city of Gelsenkirchen since 2015. "Pocket parks" were created on these areas, which are maintained and designed by the residents.

Street trees

There are 26.150 street trees in Gelsenkirchen.

The main genera are:

Maple:	19.1%	(5006),
Linden:	18.0%	(4708),
Sycamore:	17.4%	(4543),
Oak:	14.0%	(3652).

There are a total of 105 tree species on the streets. the main tree species are:

Sycamore:	17.4%	(4543),
Dutch Linden:	11.4%	(2985),
Norway maple:	10.9%	(2839),
English oak:	10.0%	(2618),
Sycamore maple:	5.9%	(1534).

3.2.2   Projects and initiatives

Name	Description
Grünlabor Biomassepark Hugo	**Grünlabor Biomassepark Hugo** - a "green laboratory" and a "learning place for education for sustainable development" - and its neighboring city quarters. (Duration: since 2016) https://www.gelsenkirchen.de/de/Infektur/Umwelt/Kli ma / Klimaschutz / Erneuerbare_Energien / Biomassepark_Hugo.aspx

With innovative forest types and forest combinations, answers to climate change and the energy transition in the biomass park are sought, taking into account social and nature conservation aspects. Refers to T2.1, T2.2, T4.4

This area (250,000 m²) is divided into three areas:

1. Area "Biomass Park" - economic, ecological, social: On the site of the Biomass Park, energy is generated from renewable raw materials (biomass). The area is also used as a recreation area and as a play area for children
2. Urban wilderness area; - Ecological: areas for endangered and protected species such as "natterjack toad" (Bufo calamita)
3. "Community gardens / urban gardening" area - participation, relaxation and ESD Actors: citizens, neighbors, associations and organizations, schools and day-care centers, city administration, forestry office, Ruhrkohle AG, foundations

A concept was developed here with many actors in which the experience of nature, joint action and (environmental) education find a suitable place. In this way a new city park could be won, which incurs lower maintenance costs than usual in terms of maintenance and at the same time develops new qualities through civic engagement. |
| **Industrial forest Ruhr area (Industriewald Ruhrgebiet)** | "Learning place for education for sustainable development" and succession research – forest of the future. |

(Duration: since 1996)
https://www.wald-und-holz.nrw.de/ueber-uns/einrichtungen/regionalforstaemter/ruhrgebiet/industriewald-ruhrgebiet

The aim of the project is to maintain the industrial wasteland of the Emscher Landscape Park through natural development processes and to make it accessible to people in a targeted manner as nature experience, nature experience spaces, places of environmental education and recreation close to home. The result is a completely new, authentic type of open space in the Ruhr aerea, which combines aspects of the past as a production location with those of the present (fallow land) and future (forest). The developments are accompanied by natural and social sciences. The change process on the industrial wasteland is also taken up in landscape art, accentuated by design measures and taken into account in a special way. This is the reason for including the case study and linking it to T2.1, T2.2, T4.4, T5.1, T5.2

Wald und Holz NRW operates the industrial forest project on its own and contracted areas of the municipalities and industrial successor organizations.

The project currently comprises 13 sub-areas with a total area of around 200 hectares. The potential of such areas in the Ruhr area is far beyond that. In the "Rheinelbe" project area there is the "Waldstation Rheinelbe", where two foresters deal with the local maintenance of the areas and local public relations.

Relevant for T2.1, T2.2, T4.4

The program focuses on five subject areas:

1. Biotope and species protection on the very different development soils and stages of development
2. Contribution to the development of a "green" cultural landscape in the metropolitan area
3. Accessibility of formerly fenced industrial wastelands in the immediate living environment of the population
4. Artistic design in the field of tension between industry and open space
5. Ecological, sociological and use-oriented primary forest accompanying research

	After a long period of natural development from industrially polluted raw soil to closed high forest, special functions emerge in many cases that this pioneering forest is able to fulfill. In these special cases, the succession can then be steered. This applies, for example, to recreation and cultural landscape, nature, water or soil protection functions.

Some reflections on the combined impact of the projects and initiatives listed above

Through the cooperation between the City of Gelsenkirchen and Wald und Holz NRW considerations on the municipal and state level are made to correspond. A year-long trustworthy collaboration with a steady knowledge and information exchange and different joint project in the field of forests, in particular urban forests and Education for Sustainable Development (ESD) was developed.

3.3 Government and governance of UF-NBS

3.3.1 Policy instruments for enhancement and protection of UF-NBS

National - Federal Republic of Germany

1. Federal Forest Act

The Federal Forest Act dates from 1975.

§ 1: "The purpose of this law is, in particular, to protect the forest because of its economic use (utility function) and because of its importance for the environment, in particular for the permanent efficiency of the natural balance, the climate, the water balance, keeping the air clean, the soil fertility, the To preserve the landscape, the agricultural and infrastructure and the recreation of the population (protective and recreational function), if necessary to increase and to ensure its proper management in the long term, to promote forestry and a balance between the interests of the general public and the interests of the forest owners bring about. "

This basic paragraph is still undisputed today. All forest laws in the federal states are based on this and, accordingly, the objectives of regional planning. The described requirements for forest management lead to a multifunctional forest management in which all three basic functions (useful, protective and recreational functions are promoted in the same area, albeit with different priorities depending on the region.

2. Federal Nature Conservation Act

In the Federal Republic of Germany, the Federal Nature Conservation Act (BNatSchG, 2020) forms the legal basis for nature and landscape as protected assets and for nature conservation and landscape management measures

§ 5 Agriculture, Forestry and Fishing

(1) In the case of nature conservation and landscape management measures, the special importance of agriculture, forestry and fishing that is compatible with nature and the landscape must be taken into account for the maintenance of the cultural and recreational landscape.

(3) When using the forest for forestry purposes, the aim is to build up near-natural forests and to manage them sustainably without clear-cutting. A sufficient proportion of local forest plants must be observed.

State of North Rhine-Westphalia

1. State Forestry Law of North Rhine-Westphalia (April 24, 1980, last amended in March 2019)

§ 1a Sustainable forestry

A characteristic of sustainable forestry is that forest areas are looked after and used in such a way that biological diversity, productivity, regeneration capacity, vitality and the ability to fulfil important ecological, economic and social functions now and in the future, is preserved and no harm is done to other ecosystems.

§ 1b Proper forest management

In particular, proper forest management is characterized by:

1. Longevity of forest production;

2. Securing sustainable wood production and preservation of forest ecosystems as a habitat for a species-rich flora and fauna (by working towards healthy, stable and diverse forests);

3. Avoidance of large-scale blows;

4. Choice of tree species appropriate to the location using suitable seeds and planting material and utilization of natural regeneration while maintaining genetic diversity;

5. Needs-based forest development with the greatest possible protection of landscape, soil and stock;

6. Careful approach, especially with rejuvenation measures, wood use and wood transport;

7. Use of existing and soil-conserving techniques;

8. Site-specific use of plant nutrients to maintain or improve soil fertility;

9. Extensive avoidance of pesticides, use of the possibilities of integrated pest management;

10. Working towards game densities that are adapted to forest stands and their regeneration, as well as measures to prevent game damage;

11. Sufficient amount of old and dead wood to secure the habitats of wild animals, plants and other organisms.

2. Law for the protection of nature in North Rhine-Westphalia (State Nature Conservation Act - LNatSchG NRW)

§ 4 Agriculture, Forestry

(4) In addition to Section 5 (3) of the Federal Nature Conservation Act, the aim of using the forest for forest purposes is to leave standing thick-trunked dead wood from deciduous trees in the forest. To implement this goal, the ministry responsible for nature conservation and forestry can conclude a framework agreement with the forest owner associations.

3. Intervention regulation in North Rhine-Westphalia

The term "Eingriffsregelung" includes provisions of the Federal Nature Conservation Act (§§ 13 ff.) And the State Nature Conservation Act of North Rhine-Westphalia (§§ 30 ff.) go hand in hand with nature and landscape.

With the help of the intervention regulation, negative consequences of interventions in nature and the landscape are to be avoided or minimized and unavoidable negative consequences are compensated for by nature conservation measures The provisions of the Building Code apply to the requirements of the intervention regulation within the framework of municipal land-use planning.

Regionalverband Ruhr - regional planning

Regional planning is the intermediate stage between state development planning and municipal land-use planning. The Ruhr Regional Association (RVR) is currently preparing a regional plan for the entire Ruhr Metropolis (https://www.rvr.ruhr/themen/regionalplanung-regionalentwicklung/regionalplan-ruhr/planentwurf/)

Regional plan

The Ruhr regional plan specifies the goals and principles of the NRW state development plan for the Ruhr region. He lays down the desired spatial development and order of the region as goals and principles of spatial planning in text and drawings. The regional plan takes into account changed framework conditions of spatial development such as demographic change, structural and climate change as well as equal opportunities.

Chapter 2: Open space development

The open space is to be protected by overarching open space, settlement and other specialist planning and a large-scale, ecologically effective open space network is to be created. The further fragmentation of the open landscape and forest areas is to be avoided as far as possible.

2.7. Forest and forestry Determinations in the regional plan Ruhr - objectives:

Z 2.7-1 Maintain and develop forest areas

Z 2.7-5 received special uses in the forest

Principles:

G 2.7-2 Develop location-appropriate, ecologically stable forest stands taking climate change into account

G 2.7-3 Preserve and increase near-natural forest stands

G 2.7-4 Maintain and develop small forests

G 2.7-6 Spatially direct forest reproduction

G 2.7-7 Compensate for interventions in the forest

City of Gelsenkirchen

Municipal land-use planning

The municipal land-use planning is located below the regional planning, which covers the area of a municipality in the form of land use planning. As the lowest level of spatial planning, there is the binding land-use planning in the form of the development plan at the district and neighborhood level. The six cities of Bochum, Essen, Gelsenkirchen, Herne, Mülheim an der Ruhr and Oberhausen joined forces in 2005 to form the "Planning Community Urban Region Ruhr" and for the first time set up a regional land use plan (RFNP) nationwide, which simultaneously fulfills the function of a regional plan and a joint land use plan. (since 2010)

Städteregion Ruhr 2030 (staedteregion-ruhr-2030.de)

As soon as the Ruhr regional plan becomes legally binding, it will replace the RFNP in its function as a regional plan. A Joint Land Use Plan (GFNP) will then be continued in the six cities, which will meet local regulations.

Landscape plan Gelsenkirchen

The landscape plan implements the goals and measures of nature conservation in the area of the city of Gelsenkirchen. It specifies and supplements the nature conservation content of the regional plan as a landscape framework plan. Landscape plans are drawn up across the board for all areas that are outside the contiguous built-up areas and the scope of the development plans (= outside area).

The landscape plan of the city of Gelsenkirchen (since 2000) covers approx. 50% of the city area and includes 19 nature reserves with a total area of 333 ha. These consist mostly of forest and wetland areas with near-natural stream meadows. Another 2,431 hectares have the status of landscape protection areas. It contains a catalogue of development, maintenance and access measures, such as the creation, restoration or maintenance of near-natural habitats. The implementation of measures in the landscape plan takes place within the framework of implementation plans. Changes to the plan are necessary if, for example, additional areas are to be included in the landscape plan or if urban planning objectives have changed and e.g. a new building areas should arise.

Tree protection statute of the city of Gelsenkirchen

It is a legal instrument that is located alongside the intervention compensation regulation and binding land-use planning (development plan) and must be viewed separately from these. The tree protection statute defines the protection criteria for the trees and is the basis for the establishment of replacement plantings in the case of necessary felling on private property. The statute applies to trees within the built-up districts and the scope of development plans. The tree protection statutes of the city of Gelsenkirchen include all trees with a trunk circumference of at least 80 cm (50 cm for multi-trunk trees), measured at a height of one meter above the ground. bylaws for the protection of trees in the urban area of Gelsenkirchen. (source: satzung_zum_schutz_des_baumbestandes_im_stadtgebiet_von_gelsenkirchen.pdf (gelsendienste.de)

Trees in the open countryside In the area of application of the landscape plan of the city of Gelsenkirchen, it is generally forbidden to remove, damage or otherwise endanger the growth of trees outside the forest.

Open space development concept (FREK)

In 2005, the city of Gelsenkirchen created a city-wide open space development concept that shows the development prospects for all open spaces in the city. It makes an important contribution to sustainable ecological urban development and thus to improving the living conditions of the people living in the city. The model for the development of open spaces in Gelsenkirchen is symbolically represented as the "green ring" of the open spaces around Gelsenkirchen with the east-west connectors "Buerscher Grüngürtel" and "Emscher Canal Belt" and the north-south connecting axis "Inner World". Based on this, a target concept with the most important free space links was developed. For further differentiation, the open spaces were delimited into 30 sub-areas, for which essential potentials, deficits and priority measures were named. The results of the open space development concept serve as an informal guideline for the development and networking of open spaces in

Gelsenkirchen. The proposed measures have been taken into account in urban and regional planning since 2005. (source: www.gelsenkirchen.de - Freiflächenentwicklung)
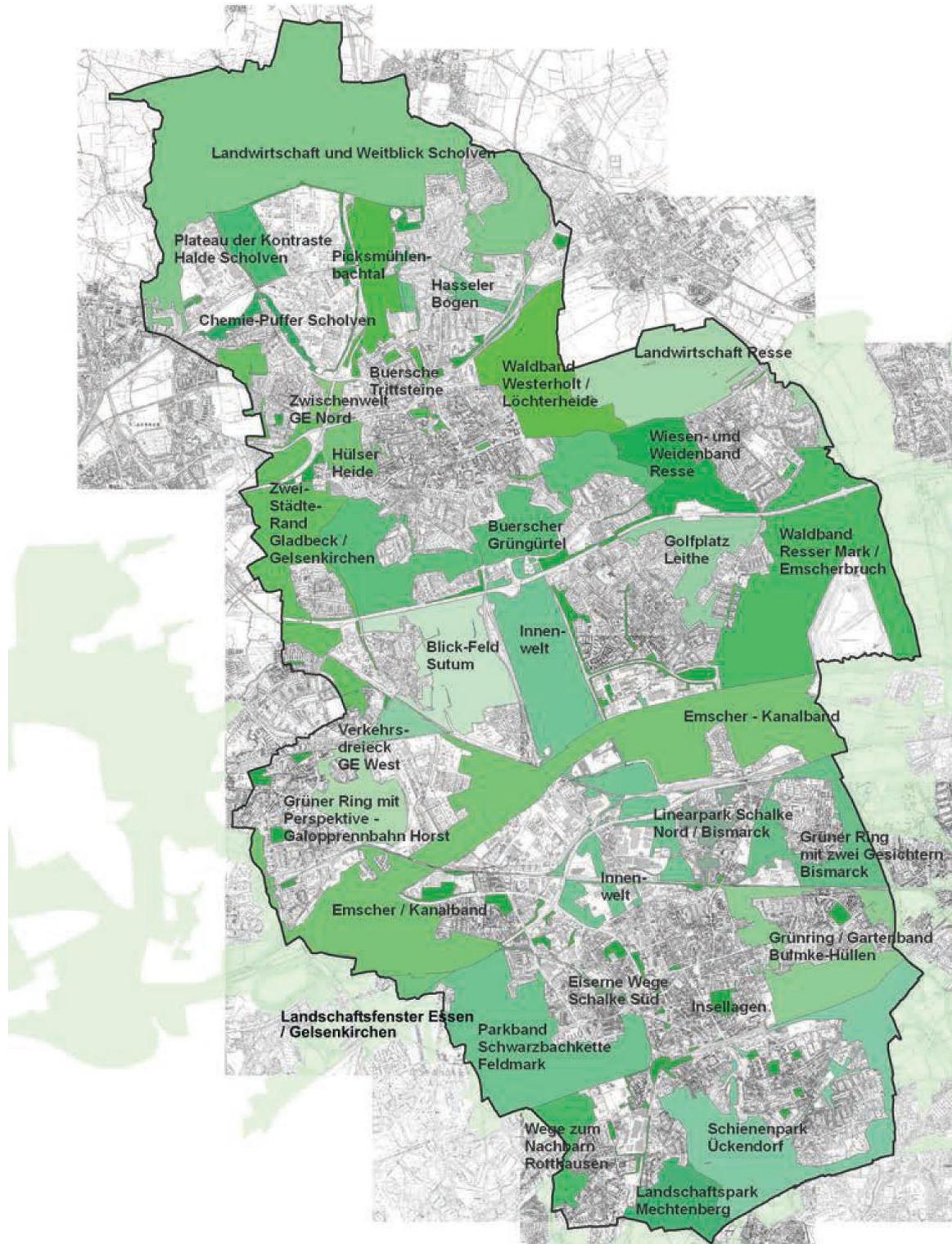
ARGE R.W. Architekten Stadtplaner

Open space development concept (FREK 2005)

Spatial structure concept (RSK, 2018)

Spatial structure concept (RSK)

The contents of the concept include the topics of settlement structure, housing, open space, environment and climate, transport, economy, leisure and building culture. The RSK bundles already existing urban specialist concepts, coordinates them and in some cases develops them further. This creates strategic guidelines for the future spatial development of the city. The RSK shows which development ideas and needs for action arise for specific areas and properties. It also identifies goals and priorities for action for structural and spatial planning (e.g. urban planning, traffic, environment). Effect and implementation of the RSK: The concept represents an orientation framework for urban planning and serves as a basis for action and decision-making for administration and politics. The concept was developed with the participation of politicians and citizens. The City Council of Gelsenkirchen decided on the RSK in 2018 as an urban development concept within the meaning of Paragraph 1, Section 6, No. 11 of the Building Code. Thus, the RSK is to be formally taken into account in the urban land-use planning. As a planning basis, it also flows into other formal and informal spatial planning and concepts of the city. A number of priority tasks and measures / priorities for future urban action are derived from the concept. (source: www.gelsenkirchen.de - Räumliches Strukturkonzept (RSK))

3.3.2 Experiences with participatory governance and citizen science (focus on UF-NBS)

In Gelsenkirchen, the Agenda 21 office has been working for more than 20 years in the sense of Agenda 21 of the United Nations, focusing on Education for Sustainable Development (ESD) and participation. Conferences, workshops and working groups have resulted in over 100 projects, various networks and, ultimately, structures.

In the competition entry "City of the Future 2030+ - Learning City", Gelsenkirchen also focuses on education and participation. In addition to the concept of future education, research into Citizen Science 2.0, a further development of the well-known Citizen Science concept, is central to the research project.

Urban society, science, administration and business work together on an equal footing on the conception and implementation of concrete measures. This learning by doing process researches what is needed to enable work on equal terms at the interface between science and practice.

The outcome so far include:

1. First scientific concept Citizen Science 2.0 (https://opus.bsz-bw.de/fhdo/frontdoor/index/index/searchtype/authorsearch/author/Kira+Fink/docId/2877/start/0/rows/10 2.
2. Working paper on the joint work of the actors in the area of the City of the Future 2030 (https://opus.bsz-bw.de/fhdo/frontdoor/index/index/searchtype/authorsearch/author/Kira+Fink/start/1/rows/10/nav/next/docId/2878)

On this basis, the Citizen Science 2.0 concept will be outlined, researched and sharpened.

One measure deals with the implementation of a partnership exchange between science and urban society. Offers and needs from science and urban society are to come together on this platform and be matched with one another. This creates collaborations between universities and actors in urban society, ranging from expertise and theses to jointly conceived projects. Here, too, we work together under the concept of Citizen Science 2.0 and at the same time research and refine it.

Both the green laboratory and the forest laboratory work on a participatory basis. Experiences with nature are an integral part of the work in the surrounding kindergartens and schools and the people in the neighboring districts. All children in Gelsenkirchen should have this opportunity to experience nature and to be able to move freely, play, learn to romp and develop. Future ambitions: Environmental education for our children and future generations is an important task and at the same time one of the great challenges of the future.

3.3.3 Stakeholder mapping

Stakeholder name	Type of stakeholder	Description and website (ca. 100 words per actor)
City of Gelsenkirchen (public)	public	Municipality in charge https://www.gelsenkirchen.de Different departments: • Environmental, • European Affairs, • Team Zukunftsstadt 2030+/aGEnda 21, • Gelsendienste, • Stabsstelle Vernetzte Stadt • GeKita
Wald und Holz NRW	public	Forestry administration NRW https://www.wald-und-holz.nrw.de/
Wald und Holz NRW / Regionalforstamt Ruhrgebiet	public	Forestry administration NRW – Regional forest office Ruhrgebiet (Residence: Gelsenkirchen) Ruhrgebiet	Wald & Holz – regionalforstamt Ruhr)
Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen	public	Ministry of Environment, Agriculture, Nature and consumer protection Department III - Forests and Nature Conservation Department *Umweltministerium NRW: Startseite* *Organisationsplan MULNV (nrw.de)*
Regionalverband Ruhr (RVR)	public	Regional planning / regional development *Regionalplanung & Regionalentwicklung (rvr.ruhr)*
Emschergenossenschaft / Lippeverband	public	River basin management The Emschergenossenschaft is a water management association for water maintenance, sewage discharge and purification, groundwater management and regulation of mining consequences in the Emscher catchment area EGLV - EMSCHERGENOSSENSCHAFT und LIPPEVERBAND
NRW Urban	public	Area development for residential, industrial and commercial as well as for complex urban planning projects NRW URBAN: Partner für Kommunen bei der Stadtentwicklung (nrw-urban.de)
RAG Montan	private	Revitalization and development of former coal mining areas and industrial fallow land RAG Montan Immobilien - RAG Montan Immobilien (rag-montan-immobilien.de)
Landschaftagentur Plus	third sector	
European Forest Institute (EFI)	academia	EFi *We conduct research and provide policy support on issues related to forests.*

		EFI Bonn coordinates two of the European Forest Institute's main initiatives: the Resilience Programme and the Governance Programme EFI Bonn | European Forest Institute
Landschaftagentur Plus		
Regionalverband Ruhr (RVR)	public	Regional planning / regional development Regionalplanung & Regionalentwicklung (rvr.ruhr)
Emschergenossenschaft / Lippeverband		
Waldjugend Gelsenkirchen	NGO	*Deutsche Waldjugend GElsenkirchen - Startseite | Facebook*
Förderverein Grünlabor im Biomassepark Hugo e.V.	NGO	Förderverein Grünlabor Hugo (gruenlabor-biomassepark.de)
Förderverein agenda21 Gelsenkirchen e.V.	NGO	Homepage der aGEnda 21 - Zukunft in Gelsenkirchen gestalten

3.4 Looking forward

3.4.1 Strategic objectives in relation to UF-NBS

Objective	Detailed description
O1 Assessment, maintenance or improvement of public/human health and well-being (physical and mental)	Answers to the question: How can parks and urban forests become places of social balance / compensation?
O2 Funding of (UF-)NBS / Cost/Cost-effectiveness	Cost-effective maintenance of urban forests and parcs
O3 Assessment of ecosystem services and consideration in urban planning	Operational or economic consideration, which goes far beyond ecosystem services

3.4.2 Major barriers

- Strategic conflicts in relation to land use (green areas vs. commercial and residential areas; UFNBS vs. economic forest use).

- The last green island locations in city districts / quarters are often built over as part of the so-called "densification" and thus withdrawn from green use for people. The use of these open spaces for construction purposes (especially with existing tree and forest structures) results in compensation obligations such as replacement afforestation, for which available areas must also be found.

- Nature-based solutions are not yet in the consciousness of politics and administration; usually technical solutions are the focus.

- The funds made available are not sufficient to guarantee sustainable financing of the life cycle costs for the maintenance / upkeep of green infrastructure and UFNBS in times of climate change. Recommendations for action for comparable cost optimization are required.

- The monetary profit generated by UFNBS measures in the long term or the benefits from ecosystem services (society, health, environment, economy) are not sufficiently qualified and quantified.

- Although several best practice examples already exist in Gelsenkirchen: A rollout of measures of education on UFNBS is necessary

3.4.3 Knowledge gaps

- The monetary profit generated by UFNBS measures in the long term or the benefits from ecosystem services (society, health, environment, economy) are not sufficiently qualified and quantified.

The aim is to present the diverse ecosystem services of the forest and in particular of the urban forest as comprehensively as possible, in order to point out their importance for all people, but also for the future design of a sustainable forest policy that does justice to all social interests.

The representation, qualification and qualification of the ecosystem services

- Can promote awareness of a more sensitive handling and more sustainable use of natural resources.

- It is an important basis for information and discussion in order to address the importance of these services for humans (interplay between services provided by nature, the added value of the economy and human well-being); To bring the services of forest ecosystems more into the public interest and thereby better bring them to bear;
- To initiate a broad social discussion - including politics and administration with regard to the value of nature, the preservation of biological diversity, sustainability, more careful resource management, improved acceptance of environmental and resource policy and integration into planning processes .

The EU's biodiversity strategy for 2020 already called for the mapping and assessment of ecosystem services by the member states on their national territory. This is intended to serve as a measure to improve knowledge of ecosystems and ecosystem services in the EU.

4   Krakow, Poland

4.1   General information

4.1.1   Institutional framework and planning system

City and local level spatial planning in Poland has to be compatible with regional and country level programmes. Country level documents - e.g. **The National Spatial Development Concept 2030** - are created by the government and proper ministries. Regional level documents are created by the voivodeship office - **Voivodeship Spatial Development Plan**. On the local level the most important spatial planning documents are **Study of Conditions and Directions of Spatial Planning**, which is obligatory to do, but unrequired to follow - and based on the previous one, **Local Plan of Spatial Development**, which is not obligatory to do, but requires every investment to be compliant. It is also possible to receive **Building Conditions** for the investment, when Local Plan is not available, which is often used to develop the space in the way not available with the plans.

At the city and local level, the main executive is the city president, who might set his deputies and proxies for specific cases. One of the president's deputies is focused on sustainable development of the city. The main legislative power is the city council, who approves every decision, plan or strategy of the city. Additionally, every district (18) has its own council who supports the city level government and works on quality of life and needs of their neighbourhoods' citizens. City is further divided into faculties (27), referees and independent positions, which prepare plans and programmes. Another element of the city government are managements who focus on specific parts of the cities' infrastructure. The one most important considering blue-green infrastructure is **Green Spaces Management**, which received competences to govern all the parks, forests and generally - green spaces in the city. Before creation of this unit, responsibility for cities' green spaces was divided between multiple faculties.

Both **Study of Conditions and Directions of Spatial Planning** and **Local Plan of Spatial Development** contain information, requirements and programme of green spaces. Kraków, as well as 43 other cities in Poland, has passed the **Local Plan of Adaptation**, consisting of study of climate change impact on the city and ways to mitigate and adapt. It mentions greenery on multiple occasions. Every other decision in the city should be compliant with the document, there is no, however, way to execute this fact. There is also the **"Powiat Programme to Increase Afforestation in the City of Kraków for the years 2018-2040"**, which aims to increase forests area in the city by at least 8%.

The most notable planning document and initiative in Kraków is the "**Development and Management of Greenery in Kraków, 2017-2030"** (mentioned also in point 3.3.1.). It took the form of a wide cooperation between various city units (which usually have their own strict competencies and do not work together), experts and with use of the social participation methods - workshops with the citizens were organised in every district. The document covers various aspects of blue-green infrastructure in the city - spatial planning, land property, cultural heritage, social necessity of green spaces and their accessibility. It also highlights necessary actions in real estate management, spatial planning and cultural heritage management. The main aims of the document are:

- creation of a consistent and long-term strategy for green spaces development.
- integration of scattered elements of green infrastructure.
- protection, development and creation of new green spaces;

- cultivation of a natural heritage and spatial, environmental, economical sustainability of the city;
- improving a green spaces administration in the city.

4.1.2 Experiences with participatory governance and citizen science

Participatory governance in Poland has lots of obstacles and it is hard to say that administrators and decision makers are accustomed to conversate with their citizens. The authorities are usually hierarchy based, with strictly divided competences which does not help in involving inhabitants to projects. Social participation is often reduced to limited groups of active inhabitants, projects' meetings and consultations.

There are some initiatives, however, which certainly will help building a cooperation between the city and its citizens. Those connected to NBS are started by Zarząd Zieleni Miejskiej in Kraków (ZZM - Krakow Green Management Board) and often focused on activation and education. Some of them are:

- "Kraków w zieleni" and its projects (eg. "zatrać się w zieleni", "co w trawie piszczy") - a programme of ZZM focusing on cooperation with the citizens, fun and education. Consists of events, workshops, meetings and activation of the inhabitants. https://krakowwzieleni.pl/en/
- "Re:URBAN", coordinated by ZZM in partnership with european organisations focusing on creation and finding solutions of community gardens and urban farms. It is based on cooperation between citizens, specialists and local administration.
- "Zielony Budżet Obywatelski" in which inhabitants may propose and vote for realisation of their projects.
- "Zasadź się na ZIELEŃ" is an action of planting trees and plants together with the inhabitants.

Another example of social participation in Kraków are consultations of "**Development and Management of Greenery in Kraków, 2017-2030**" with the citizens. The first part was coordinated by Fundacja Sendzimira, during which citizens of every district (18 in total) had a chance to participate in open workshops. During them participants worked with use of maps and plans creating postulates, choosing priorities for development of the green spaces. Second part of the consultations was undertaken by Cities' Dialogue Centre (Miejskie Centrum Dialogu UMK) which opened a point where during one week citizens could learn about, discuss and comment.

Kraków also saw many informal movements and actions. They are usually initiated by a local NGO (there are many concerned about nature, public space and pollution) or a group of citizens, who see lacks in their surroundings, or believe the formal paths are too long.

- Informal group "ADaSie" (which is a plural of the name "Andrew", but might also mean "Yes, it's possible") organised planting public spaces and started the tradition of "Cracovians' Parks" where Cracovians might plant a tree as a memorial to birth of their children, which is now continued by ZZM.

There are also activists' groups, NGOs and other organisations involved in public debate about the public and green spaces for example:

- Autoportret magazine,

- Stowarzyszenie Przestrzeń-Ludzie-Miasto,

- ADaSie,

- Fundacja Krowoderska.pl,

- Akcja Ratunkowa dla Krakowa,

- Strajk dla Ziemi,

- Stop Ogradzaniu Krzemionek.

It is also worth mentioning that ZZM is searching for more efficient ways to communicate with the citizens and started using the "Collectively" platform, which might be used to highlight the elements of cities' infrastructure needing repair or change. However, it is used in about 1% received reports.

4.1.3 Socio-economic profile

- Circumstances:

  - turistification and gentrification of Old Town and Kazimierz (Jewish District),

  - uncontrolled urban sprawl and new developments on green spaces,

  - plenty of surrounding family housing towns/estates adding do urban sprawl,

  - lack of green spaces in new developments,

  - reduction of public green spaces in the city centre for developments,

  - Cracow is strongly based on its universities and student life (which with every year goes further from the centre - direction old town-kazimierz-pogórze-further)

- Quantitive:

  - population: c. 771,069 (2018), growing slowly

  - area: 326.85 km2

  - pop. density: 2359 in/km2 (2018)

  - natural growth (per 1k in.): 2.02 (2018)

  - migration: 5.37 (2018)

  - woman/man ratio: 1.14 (2018)

  - demography (2018):

    - 0-18 y.o. 130 336 (16.9%)

    - 18-64 y.o. 459 543 (59.6%)

    - 64+ y.o. 181 160 (23.5%)

  - GDP: c. 65.09 bn PLN

  - unemployment (2020): 2.7%

- pollution: every indicator above the safety limit

- budget 5,945,404,971 PLN (2018)

- budget division (2018):

  - education 24,58%

  - social 17,84%

  - transportation and communication 17,03%

  - nature protection and urban engineering 10,24%

  - public administration 6,53%

  - culture and heritage 4,97%

  - housing 4,09%

4.2 Geography of UF-NBS

4.2.1 State of (peri)urban forests, green infrastructure and urban greenspace

Green spaces and green infrastructure in Kraków were most extensively described in "**Development and Management of Greenery in Kraków, 2017-2030**". Cities' forests are mostly covered by the **"Powiat Programme to Increase Afforestation in the City of Kraków for the years 2018-2040"**. The first one defines cities' natural system as "consisting of not only arranged green spaces, but also those intended for agriculture, or ones staying unused - post-industrial, post-agricultural or natural and semi-natural landscapes. It also accepts the concept of "third nature" by admitting nature is developing in various locations - housing estates, industrial zones etc, even though the name itself is not used. It also divides cities' green spaces into two categories - public green spaces and contributing green spaces. The first one being at least partially designed, open for inhabitants and covered in greenery by at least 50%, the second consists of other spaces e.g., cemeteries, gardens, allotment gardens, agricultural lands etc. Forests might be divided into two types - regular ones and forest parks and fall in both categories of green spaces, depending on their landscaping and infrastructure.

Main green spaces of the city include:

- Planty (former fortifications surrounding the old town),

- waterfront of Wisła and multiple smaller rivers,

- Błonia (a large meadow in the centre of the city),

- Park Jordana, Park Krakowski, Park Strzelecki, Park Decjusza, Park Bednarskiego, Park Lotników Polskich and UJ Botanical Garden - main parks of the city,

- church gardens and cemeteries,

- allotment gardens,

- Bielany-Tyniec Landscape Park (a large terrain of protected nature in the western part of the city borders),

- urban forests (mainly concentrated in the above mentioned Landscape park - eg. Wolski and Tyniec forests, as well as in other parts of the city - eg. Borkowski, Mogilski forest).

There are also multiple protected areas, including Nature 2000 programme, smaller parks and green, unused spaces, which also support the local ecosystem. "**Development and Management of Greenery in Kraków, 2017-2030**" suggest creation of many new areas of protection in Kraków. It also plans to create new forests in the eastern (close to Nowa Huta district), northern and southern parts of the city by changing the function of unused and agricultural lands.

Area of green spaces and forests in Kraków seem to be expanding, they however are exposed to increasing pressure from developers and investors. It is also worth mentioning, that Kraków, as one of the oldest cities in Poland, former capital and the city of tradition and science, has a rich history of green spaces development and natural heritage. Even the earliest plans of Kraków consider public green spaces (eg. Planty and Błonia) as one of the most important places in the city - environmentally and functionally.

Urban forests, which should include those planned in the aforementioned documents, but not restricted to them, should be considered an important part of the city. They might help with the multiple problems of Kraków - giant pollution, changing climate and unregulated urban sprawl, as well as creating new places of recreation and building wider social awareness of the environment. New urban forests would also strengthen the ecological network of the city and increase biodiversity by connecting various, separated green spaces.

4.2.2 Projects and initiatives

Name	Description
INTERNATIONAL PROJECTS	
INTERLACE: International Cooperation to Restore and Connect Urban Environments in Latin America and Europe -	H2020 project, which main goal is to empower and equip European and CELAC cities to effectively restore and rehabilitate (peri)urban ecosystems towards more liveable, resilient and inclusive cities. The project applies an integrative, city-driven approach to address urban challenges through the restoration, rehabilitation and (re)connection of natural and social processes between places. A three-tiered mechanism for city and wider stakeholder exchange and learning – the City Network Accelerator – will strengthen cooperation and peer-to-peer interactions on the local
LIFE Urbangreen	
LIFE MonitAir	
SPATIAL AND URBAN PLANNING	
POWIATOWY PROGRAM ZWIĘKSZENIA LESISTOŚCI MIASTA KRAKOWA (Powiat Programme to Increase Afforestation in the City of Kraków for the years 2018-2040)	Strategic document aiming to increase forests area by 8% in the administrative borders of the city.
KIERUNKI ROZWOJU I ZARZĄDZANIA TERENAMI ZIELENI W KRAKOWIE NA LATA 2017-2030 (Development and Management of Greenery in Kraków, 2017-2030),	This also includes the comprehensive GIS data-base (QGIS) with information on natural ecosystems, green-blue infrastructure and many other related layers (~30 GIS maps);
LOCAL PROJECTS	

"Kraków w zieleni" and its projects (eg. "zatrać się w zieleni", "co w trawie piszczy")	a programme of ZZM focusing on cooperation with the citizens, fun and education. Consists of events, workshops, meetings and activation of the inhabitants. https://krakowwzieleni.pl/en/
Re:URBAN",	coordinated by ZZM in partnership with european organisations focusing on creation and finding solutions of community gardens and urban farms. It is based on cooperation between citizens, specialists and local administration.
"Zielony Budżet Obywatelski"	A project in which inhabitants may propose and vote for realisation of their projects.
"Zasadź się na ZIELEŃ"	The project " is an action of planting trees and plants together with the inhabitants
<u>GRASSROOTS PROJECTS</u>	
Cracovians' Parks"	A project where Cracovians might plant a tree as a memorial to birth of their children, started by an informal group "ADaSie" and continued by ZZM.

Some reflections on the combined impact of the projects and initiatives listed above

Kraków's natural heritage, involvement of the city in international projects and many local programmes including general strategy for the green spaces and an afforestation programme show great potential of the city to improve their green spaces and especially UF-NBS. The cities' Green Management gives innovative ideas into the city structure and hierarchy, by cooperating with multiple city units and with the citizens. Especially when it comes to the last ones, Green Management has an outstanding history of activation and cooperation, in opposition to other faculties in the city structure.

Also, citizens of Kraków show great interest in their surrounding and environment. Activist-like planting, protest, workshop and multiple NGOs are connected to the topic of Green Spaces. They stand, however, against pressure from the investors, developers and tourists, who generate considerable part of the cities' income.

Possible areas of conflict might include:

- unregulated urban sprawl and investors' pressure on green spaces,
- hierarchical and non-elastic administration structure,
- strong dependance on cars and struggle for parking spaces,
- despite many activists and NGOs there is a visible lack of education and understanding about importance of environment and nature,
- lack of tradition of social participation in the society,

- diverse property possession and stakeholders - multiple private and corporate owners, low percent of cities' plots.

4.3 Government and governance of UF-NBS

4.3.1 Policy instruments for enhancement and protection of UF-NBS

The most important document organizing the protection and management of urban green areas in Krakow is "**Directions for the development and management of green areas in Krakow for 2017-2030**" (*„Kierunki rozwoju i zarządzania terenami zieleni w Krakowie na lata 2017-2030"*). Its primary goal is to define a coherent, planned and long-term development policy for green areas in Krakow. The document assumes the integration of a dispersed green structure into a continuous system of areas connected by walking and cycling paths and green areas; preservation, development and creation of new public green areas that meet social needs; protection of historic green areas important for the quality of the cultural landscape; protection of valuable natural areas, i.e. spatial and ecological sustainability of the city's development and rational management of environmental resources, including water resources; raising the standards of maintenance and establishment of green areas; improving the management of green areas in Krakow. In addition to a comprehensive, extensive basic study, "Directions..." includes four thematic appendixes and 24 maps (https://www.bip.krakow.pl/?dok_id=115410). The document was adopted by the Order of the Mayor of the City of Krakow No. 2282/2019 from the 9th September 2019 and is currently an element of local law.

"Directions..." includes the comprehensive inventory of the existing public greenery (1,514 ha) and also assumes the creation of new areas of this type (>400 ha). It also determines that currently 75% of residents of Kraków have access to green areas within walking distance, and by 2030 it will be 86%. On average, there are 8.3 m2 of green areas per capita in Kraków, and it is assumed in "Directions..." it will be at least 10 m2 per capita (which will be achieved in the first stage of implementation). It also assumes that new areas of the highest natural and landscape values will be protected as ecological lands and nature and landscape complexes. Together with the currently protected areas (existing landscape parks, reserves, ecological sites and Natura 2000 sites), they will cover 17.5% of the city's area (currently approx. 15%).

In "Directions…" a great emphasis is placed on the preservation and development of the Krakow River Parks system, which is an extremely important element of the Krakow urban greenery and NBS system, developed since 1996. The concept is based on the city's hydrographic system – it assumes that the Vistula River and its tributaries, together with neighboring green zones of different widths, are actually an existing, legible system of public greenery. In addition to connections within the administrative boundaries of the city of Krakow, the system also provides excellent external connections, in the east-west direction between the Jura Landscape Parks and the Niepołomicka Forest, and numerous ecological ranges in the north-south direction.

Many elements of the protection and maintenance of the urban greenery of Krakow are also included in subsequent editions (2000-2014) of "Study of the conditions and directions of spatial development of the city of Krakow" (*Studium uwarunkowań i kierunków zagospodarowania przestrzennego miasta Krakowa*), as well as in local spatial development plans (*miejscowe plany zagospodarowania przestrzennego*). These documents contain provisions assuming the shaping of publicly accessible open areas in the form of gardens and city parks. It is also important to maintain the spatial connectivity of pedestrian and bicycle paths, with particular emphasis on River Parks, and to shape water recreation complexes on the basis of water reservoirs in post-mining areas.

"**Diagnosis of the state of the environment of the city of Krakow**" (*Diagnoza stanu środowiska miasta Krakowa)* (2012) emphasizes the potential of the River Parks, which results from their spatial distribution (radial arrangement). These Parks – directed to the city center – cross all districts, connecting them with each other, and they also connect many protected green areas. It was assumed that the hydrological system together with the adjacent areas constitute the skeleton of the green city system that requires protection. The protection zones and the development zones have been developed for the River Parks.

"**Environmental Protection Program for the City of Krakow for 2012-2015**" (*Program ochrony środowiska dla miasta Krakowa na lata 2012-2015*) emphasizes that the concept of green areas development must employ the city's hydrological system to integrate the areas by creating a system of River Parks. It was stated that the River Parks should be made available by creating pedestrian paths and bicycle paths and including them into the existing and planned urban system. River Parks are natural ecological corridors. After a careful analysis of the natural capacity of the habitats, they can be used for recreational purposes. Apart from their natural values, their potential is not colliding with the city infrastructure.

In addition to the documents described above, there are other local strategic documents that contain some elements of urban greenery management, such as:

- "Krakow's tourism development strategy for 2014–2020" (*Strategia rozwoju turystyki w Krakowie na lata 2014 –2020*);
- "The Municipal Program for the Revitalization of Krakow" (*Miejski Program Rewitalizacji Krakowa*);
- "Krakow's Small Retention Program" (*Program Małej Retencji Krakowa*);
- "Concept of drainage and improvement of flood safety of the City of Krakow" (*Koncepcja odwodnienia i poprawy bezpieczeństwa powodziowego Miasta Krakowa*).

There is also the Uniform Ranking List in Krakow (*Jednolita Lista Rankingowa*), developed and updated by the Department of Environmental Management (Krakow City Hall), it includes a list of planned urban investments in the field of green areas. It is a set of investment needs in this field and serves as an auxiliary tool, especially in creating the new facilities.

An important tool in shaping urban greenery and NBS is the Krakow civic budget (since 2014), in which a high percentage of submitted and financed projects relates to the green areas, which is systematically growing (from ~5 million PLN in 2015 to almost 10 million PLN in 2018).

4.3.2 Experiences with participatory governance and citizen science (focus on UF-NBS)

See Section 2.4.

4.3.3 Stakeholder mapping

Stakeholder name	Type of stakeholder	Description and website	Role in relation to green infrastructure/UF-NBS
Krakow Municipal Greenspace Authority (Zarząd Zieleni Miejskiej w Krakowie)	Public, municipality level	The municipal unit responsible for public green areas in Kraków. It was established the 1st of July 2015 (Resolution of Krakow City Council). The green areas under their jurisdiction: parks, urban forests, lawns and squares; housing estate greenery, road lanes, the Wisła River Boulevards https://zzm.krakow.pl/	The most important stakeholder regarding green areas protection and management. The dynamic, 'young' municipal unit, creating the innovative forms of greenery (parklets, pocket parks, etc.). Responsible for blue-green infrastructure in Kraków. Very active in education of Kraków's inhabitants and other stakeholders. Actively cooperating with other municipal units, business, academia and NGOs. The partner in CH consortium.
Regional Directorate for Environmental	Public, regional level	The institution responsible for the implementation of the environmental protection policy in the Małopolskie Voivodeship (Małopolska Region, including Kraków) in the field of nature protection, including Natura 2000 areas and nature reserves; control of the investment process (e.g. environmental impact assessments);	It has a significant impact on the methods of conducting constructions

Protection in Krakow (*Regionalna Dyrekcja Ochrony Środowiska w Krakowie*)		preventing and repairing environmental damage. http://krakow.rdos.gov.pl/	and other investments carried out in Krakow (especially in valuable natural areas, including River Parks). Analyzes the impact of investments on the environment and water relations.
Environmental Protection Department, Krakow City Hall (*Wydział Ochrony Środowiska, Urząd Miasta Krakowa*)	Public, municipality level	Range of interest and activity: environmental protection and management, including water and greenery protection, agriculture, forestry, animals and geology. https://www.bip.krakow.pl/?id=32&sub=struktura&query=id%3D10955%26pz%3D1	Responsible for strategic documents and tools to support the environmental protection in Kraków, which is connected and interlinked with Kraków's green areas, urban forests and NBS.
Spatial Planning Department, Krakow City Hall (*Wydział Planowania Przestrzennego, Urząd Miasta Krakowa*)	Public, municipality level	The department responsible for spatial planning, development of local law and relevant strategic documents in this regard. https://www.bip.krakow.pl/?id=412	Effective and integrated regulations related to urban spatial planning are of great importance for the effective protection and sustainable management of urban green areas in Kraków, including River Parks.

Civil Dialogue Commission for the Environment (*Komisja Dialogu Obywatelskiego ds. Środowiska)*	NGO	The representation of the most important and active Krakow's NGOs related to environmental protection, established at the Krakow City Hall for advisory purposes. https://www.bip.krakow.pl/?dok_id=83587	The body is very active and visible in Kraków, in regards of the protection of urban ecosystems and green areas. They have the strong influence on the politics and activity of the municipality.
Regional Office for the Protection of Monuments (*Wojewódzki Urząd Ochrony Zabytków*)	Public, government, regional level	The area of responsibilities: the protection of cultural heritage, especially the historic buildings, their conservation and proper use; the protection of cultural property; the cooperation with the central administration, local government and NGOs; inventory, documentation and scientific studies of cultural goods. https://www.wuoz.malopolska.pl/	As the large areas of Krakow are part of cultural heritage (e.g. Planty Park), all works on old parks and areas close to monuments are strictly supervised by the unit.
Foundation "Children in Nature" (*Fundacja Dzieci w Naturę*)	NGO	The Foundation conducts innovative forms of education for children (including the youngest), directly in nature. https://www.dzieciwnature.pl/	They actively lobby for the protection of urban ecosystems, emphasize the value of wild areas, including fallow lands.
Aeris Futuro Foundation (*Fundacja Aeris Futuro*)	NGO	The goal of the foundation is to mitigate the global climate change, protect and increase biodiversity and natural landscape, support the development of local communities and promote responsible business. https://aerisfuturo.pl/	They conduct various actions of planting trees and creating urban forests (also in Krakow), and actively participate in discussions about green

			areas and valuable natural areas in Krakow.
Association "Drwinka" (*Stowarzyszenie Drwinka*)	NGO	A group of local activists working to protect and expand the Drwinka River Park.	A lot of activities and actions aimed at enriching and extending the urban forest, functioning in the valley of the Drwinika River.
Universities in Kraków	Academia	AGH University of Science and Technology; Jagiellonian University; Technical University of Kraków; University of Agriculture in Kraków	The universities active in scientific research and/or education on green areas and NBS
Landscape Parks of Małopolska Region (*Zespół Parków Krajobrazowych Województwa Małopolskiego*)	Public, government, regional level	The institution managing 11 landscape parks in the Małopolska region, 6 of which are located in the vicinity of Krakow. https://zpkwm.pl/	
State Forests National Holding, Regional District (*Państwowe Gospodarstwo Lasy Państwowe,*	Public, government, regional and national level	State Forests National Holding is responsible for public forests in Poland (which is almost one third of Poland's territory). One of the biggest organization in Poland. https://myslenice.krakow.lasy.gov.pl/ https://www.lasy.gov.pl/en	

Odział Regionalny)			
Polish State Waters (Państwowe Gospodarstwo Wodne Wody Polskie RZGW w Krakowie)	Public, government, regional and national level	Polish State Waters manage rivers and all kinds of water bodies in Poland, calculate and charge fees for water services, issue administrative decisions (water law approvals). https://wody.gov.pl/	

4.4 Strategic objectives in relation to UF-NBS

4.4.1 What are UF-NBS related strategic objectives for the locality?

☐ Assessment, maintenance or improvement of the quality of life (including attractiveness of place)

☒ Assessment, maintenance or improvement of public/human health and well-being (physical and mental)

☐ Assessment, maintenance or improvement of environmental justice

☐ Nature/Landscape conservation

☐ Assessment, maintenance or improvement of ecosystem health (Ecosystem restoration/rehabilitation)

☐ River catchment restoration

☐ Restoration of post-mining areas

☐ Assessment, maintenance or improvement of ecosystem management

☐ Assessment of technologies for forest management

☐ Assessment, maintenance or improvement of biodiversity

☐ Assessment, maintenance or improvement of forest patterns (spatial distribution of urban forests)

☐ Assessment, maintenance or improvement of forest composition

☐ Hazard mitigation

☒ Climate change adaptation

☐ Sustainability

☐ Assessment, maintenance or improvement of food security/food system resilience (including productivity enhancements)

☒ Assessment, maintenance or improvement of water security/water system resilience

☐ Funding of (UF-)NBS

☒ Governance of (UF-)NBS

☒ Urban/Landscape planning

☐ Cost/Cost-effectiveness

☐ Other (please specify in the box below)

4.4.2 Detailed information on strategic objectives

From the objectives identified in section 4.1, provide up to three objectives that you consider the as being the most important, and describe them further **(ca. 100 words per objective).**

Objective	*Detailed description*
O1. Climate change adaptation	
O2. Assessment, maintenance or improvement of water security/water system resilience	
O3. Assessment, maintenance or improvement of public/human health and well-being (physical and mental)	
O4. Urban/Landscape planning	
05. Governance of (UF-)NBS	

4.4.3   Major barriers

The conflicts of interest, both humans-humans and nature-humans. The strong conflicts between different stakeholders with opposing interests. The most important and visible: the groups of stakeholders actively using green areas (caring for urban nature) versus residential and commercial developers (fragmentation of ecological corridors, degradation of ecosystems). The current and future investments in green areas (especially River Parks) and making them available to users create the risk of their degradation (noise, light pollution, littering, scaring animals, destroying plants, introducing invasive species, etc.).

The problems with the enforcement of local law, especially municipal spatial development plans; 'creative' activities of investors, resulting in too intensive development and a lack of biologically active areas (chaotic housing processes; urban concrete "deserts" in new residential districts).

"Silosity" of city management; too many institutions responsible for the of urban green areas and the protection of urban ecosystems, their dispersed and unclear responsibilities, lack of coordination and a coherent strategy. Limited cooperation between the municipality and stakeholders, as well as between various social groups.

The degradation of environment in Kraków, low quality of surface water, very low quality of air (smog), some strongly degraded brown-fields.

The lack of tradition and models of involving business and private owners in the protection of urban green areas; high resistance to comprehensive regulations ensuring effective protection of trees and plants in private lands; problems with making certain green areas available (e.g. monasteries and churches, housing estates, schools and universities).

4.4.4   Knowledge gaps

The methods of creating and maintaining the protected green areas (e.g. the River Parks) to balance their ability to be used by citizens (as open public areas) and their effective protection, without losing biodiversity. The rules of making them available and using them.

How to build the public awareness on the value of green areas and ecosystem services, how to influence and create reasonable needs and expectations of various groups of stakeholders (citizens, local government and administration, business and privatesectors, etc.). The interesting and inclusive methods of initiating the public dialogue in this regard.

The complex and efficient tools and regulations of spatial planning (see Line 2 in Section 5.3).

The methods of precise evaluation and determination of ecological continuity; taking into account and balancing all types of continuity (needs of various species of plants and animals, hydrological, city ventilation, alternative forms of transport, etc.)

5 Leipzig, Germany

5.1 General information

5.1.1 Institutional framework and planning system

The key features of the German planning system are a central legal framework and a decentralised decision-making structure. The full responsibility for development and land use control is at the local level, derived from the established self-government of communities. The supra-local level, the districts, usually have limited, more executive functions in the field of infrastructure planning and public service provision. In the larger German federal states, such as Saxony, an intermediate level of regional planning administration also exists (Raumordnungsregionen). These administrations set out spatially explicit planning aims for sub-regions within regional plans. The main instruments at the federal state (Land) level are state-wide spatial structure plans and programmes, in German, the Landesentwicklungspläne or Landesentwicklungsprogramme. They contain broad statements on spatial development intentions with the exception of more specific targets for large retail services and the protection of river banks. Furthermore, settlement hierarchies and priority areas are defined based on population projections. Plans have to be sufficiently detailed to serve as a baseline for the next levels in the hierarchy, regional and municipal planning. Local and regional planning is controlled by the federal states (Länder). The implementation of spatial structure plans and regional plans is supported by a number of legal instruments. One example is the state's option not to approve development deemed detrimental to regional and state plans (§ 12, Raumordnungsgesetz (ROG 2005)). Spatial planning at the different levels is interlinked vertically. State-wide development plans and regional plans set the frame for municipal planning as noted above. However, the diversity of local contexts should also be considered in planning at the state and regional level (the so called "feedback principle"). Consequently, land use planning is organised along the hierarchy but the levels of government are interrelated. A comparison of European planning systems shows that spatial planning in Germany allows for a medium level of public control over land use change. This is due firstly to a limited degree of spatial planning control attributed to the supra-local level, the districts and regions, which are considered most appropriate for effectively steering land use and secondly to limited administrative fragmentation of urban regions.

At the regional level (city plus suburban hinterland), land-use planning (and monitoring) is the responsibility of the Regional Planning Association. The Regional Development Plan for the Leipzig Region (REP) was introduced in 2008 and is the most important legally binding framework for regional development establishing the planning principles, goals, and designates areas for environmental protection and nature conservation. The regional and city-wide land-use goals and requirements need to be coordinated with each other based on Federal Law. At the city level enhancement and protection of urban green space is ensured by the City Hall, specifically the Planning Department, Section for Urban Development and Open Space Planning as well as the Local Nature Conservation Authority. The Land Use Plan (FNP) is the legally binding instrument for land-use planning at the municipal level, which includes a chapter on environmental protection and landscape planning, and determines for example green and blue areas with specific purposes. The FNP defines which land uses are designated for which areas. To cope with the city's challenges after the German reunification, Leipzig made use of funding for urban redevelopment (Stadtumbau Ost), including demolition of vacant housing areas. The urban redevelopment and modernisation process is based on cooperation among the city administration,

city council and non-governmental stakeholders, especially from the housing sector. Building on the Integrated Urban Development Strategy (SEKo) from 2008, the redevelopment process was adjusted according to the population stabilization of the city. Currently, the city has defined priorities for further development within the Integrated Urban Development Strategy (INSEK) 2018.

5.1.2 Experiences with participatory governance and citizen science

We refer here to the INSEK Leipzig 2030 as the latest and most important planning concept of the city. The INSEK is the result of an intensive multidisciplinary, multi-stakeholder process supported by the high level of dedication and cooperation of all the participants. From mid-2015 until the end of 2017, the Urban Development Concept was updated by various inter-departmental working groups within the local administration. Debate regarding the Strategic Goals was shaped by the Mayor, Deputy Mayors and Heads of Offices. Overall coordination rested with the City Planning Office, which was supported by specialist offices, particularly when it came to producing the Sectoral Concepts. At important points in the proceedings, there were various opportunities for residents of Leipzig to get involved, including the public launch, thematic workshops, local debates, and the public presentation of the draft. Depending on the format, either the community at large or alternatively local politicians, representatives of business and research, and other stakeholders were invited to attend. After each participatory event, the findings were examined and incorporated into the latest version of the Urban Development Concept by the various working groups. Public participation was structured by Leipzig Thinking Ahead, the City of Leipzig's coordination centre for public participation.

Assessment phase (2015)

Starting in summer 2015, the Urban Development Concept adopted in 2009 was reviewed with regard to its impact and need for revision. This was partly done during workshops in the relevant administrative departments. Furthermore, interviews were conducted with representatives of the top tier of the local administration, all the political groups on Leipzig City Council, the direct service companies and the community. The resulting conclusions were summarized, and the City Council was notified of them in early 2016. These conclusions also formed the basis for the structuring and content of the INSEK 2030. It was at this time that the section Background was drafted, which sets out the main developments for the various thematic areas of the Urban Development Concept.

Core work phase (2016 – 2017)

The core work phase began with a public kick-off event. The aim was to poll the opinions and wishes of residents for Leipzig's development over the next fifteen years before the concept was drafted. The 260 participants of all ages declared the following topics to be especially important: transport and mobility, the preservation of open spaces in contrast to the need for new buildings, integration, equity of opportunities and social mobility, as well as a functioning economy with an attractive jobs market. One visible result was the production of an 'image of the future'. From early 2016 to May 2017, those involved worked hard on the individual sections of the Urban Development Concept. This involved continuous strategic coordination with the direct service companies. The results and status of the Sectoral Plans were publicly discussed in 2016 at various events. Five workshops were held where important future issues were examined with invited representatives and actors. In November and December 2016, four district forums provided an opportunity to discuss what the city's growth implied for individual districts of Leipzig and what Priority Fields of Action should accordingly be defined.

Draft phase (2017–2018)

After the results of work and public debate had been collated to create the draft Urban Development Concept, intensive political and public discussion of the draft began. Parallel to this, two exhibitions were held setting out the main aspects of the draft Urban Development Concept at Leipzig Central Station and in the public library, and information was also published online. Neighbouring municipalities and public agencies were invited to give written statements regarding the Urban Development Concept. In addition, the draft was presented on request at events hosted by various groups of stakeholders and in the plan's Priority Areas. As far as Leipzig City Council was concerned, readings of the draft took place in the relevant specialist committees. It was also discussed by committees in local districts and neighbourhoods. Moreover, the draft Urban Development Concept was discussed by a temporary working group made up of representatives of each political group on the city council. Although most of the proposals and discussion results addressed mobility issues, action responding to Leipzig's growth was also questioned. Attention was paid to the environmental angle of sustainability and, given the uncertainty affecting growth, the adaptability of urban structures. The INSEK Integrated Urban Development Concept for Leipzig 2030 was adopted by Leipzig City Council on 31 May 2018.

5.1.3   Socio-economic profile

The strong and fast demographic regrowth of the city of Leipzig after years of shrinkage is primarily driven by strong in-migration. In the 2000s, the city experienced a net influx, especially of young people. The in-migration surplus increased over the last 15 years and reached the level of >10,000 net immigrants from 2011 onwards. The most mobile migration groups are those commencing higher education or employment. Although the share of people between 18 and 25 years decreased slightly as these people moved to other cities or abroad, the group of immigrants aged 18 to 30 remains high and is increasing. On the one hand, this is accompanied by an increase in the number of births, as more and more people of child-bearing age consider staying in Leipzig. On the other hand, it is also due to the increasing attractiveness of the city for job starters from the rural surroundings and increasingly from other larger cities and regions in Germany. Moreover, whereas the number of immigrants has remained at a consistently high level since 2011, the number of people arriving from abroad has increased significantly since then. The share of foreigners immigrating to the city increased. In terms of relative and absolute numbers of migrants, Leipzig currently ranks today second, after Berlin, among eastern German cities, with a share of about 14.7% (2019) of the total population with a migration background. International immigration is contributing to Leipzig's rejuvenation because of the age structure of migrants. The average age of Germans without a migration background was 45 years in 2015, that of migrants was 31 years.

After reunification in the 1990s, Leipzig experienced a profound process of deindustrialisation on top of a severe loss of population, which led to rapidly increasing unemployment rates and rapidly increasing inequalities. During recent years, Leipzig's labour market stabilised and improved slightly. We have thus observed a constant decline of the unemployment rate from 14% in 2005 to 5.9% in 2019. Clearly related to this tendency, the rate of welfare recipients also decreased steadily to a share of 17% of the total employable population. Even though the total number of older and long-term unemployed persons remains stable, their relative proportion is increasing. These numbers reveal that access to the labour market is not possible for everyone, even though the city is growing strongly.

Today, Leipzig is one of the large cities in Germany with the highest shares of people living in, or at risk of poverty. In 2012, 30% of Leipzig's population was at risk of poverty, 11% above the national level in Germany. Among Germany's largest cities, Leipzig has the largest share of low-income households (more than 62% with incomes below €25,000 per annum) whereas other large German cities range between 48% (Munich) and 60% (Berlin). One in three children lives below the poverty threshold. Moreover, during the last few years, an increasing number of refugees have been assigned to the city, which will have an impact on the city's ethnic make-up and on processes of diversification, as well as on patterns of residential segregation. Access to Leipzig's labour market is more difficult for migrants than for Germans. Although the unemployment rate of migrants is declining – 23.5 % in 2015 – it is still twice as high as the rate of the total unemployed. Moreover, employed migrants often work in precarious conditions and only 17% of all migrants are covered by social insurance. However, compared to the total share of migrants in the population, the share of ethnic entrepreneurs (8%) is relatively high. Today, Leipzig adorns itself with the economic development of the last decades. Since 2008, around 63,500 jobs have been newly created. Although many jobs have been created, a substantial proportion was to a large extent characterised by low wages and precarious contracts, especially in the secondary sector. This characterises the city's labour market until today. Leipzig managed to attract larger western German companies, such as BMW, Porsche, Amazon or DHL. Today, the major share of jobs in Leipzig can be found in construction firms, public health, social, and educational services, public administration, and infrastructure suppliers. Additionally, the automotive supply industry and the logistics sector are important parts of Leipzig's economy. Since a couple of years, the growing touristic sector has become a further economic foothold. The trade tax revenue increased continuously - in 2006 it was just under €190 million; in 2016 it will already reach €300 million. The revenues from the municipal share of income tax rose from € 54 million to € 147 million.

5.2 Geography of UF-NBS

5.2.1 State of (peri)urban forests, green infrastructure and urban greenspace

In 2013, about 45% of the settlement and transport areas (excluding recreational areas) were sealed with buildings and traffic areas. As a result of the structural change, Leipzig still has a large amount of fallow land (approx. 1,051 ha, 3.4% of the city area). Within the framework of revitalisation in recent years, commercial and industrial wastelands have mainly been used for construction purposes, partly also renaturalised (2014 in a ratio of approx. 5:1). In 2015, agricultural land accounted for 34.3% of the total area of the city of Leipzig or approx. 10,200 ha. Through industrial settlements and compensatory measures since 2009, the agricultural area has decreased by about 714 ha or 7%. For about 23 % of the urban population (as of 2015) there is no public green space (min. 2,000 m²) at a distance of 250 m (approx. 5 min walk) accessible. For 32%, such green spaces are accessible, but they are not sufficient for minimum supply of 6 m² per inhabitant to be aimed at (the goal of the local authority). In the individual urban districts, the supply of public green spaces is quite diverse. The location and size of the green spaces as well as the building structure and the population density plays a major role. In the inner-city quarters with perimeter block development there is already a shortage of green space. The high density in the neighbourhoods reinforces the competition for use and reduces the scope for green actions. Even allotment gardens and wooded areas close to residential areas cannot compensate for the deficit. They do not meet all the requirements, especially for sport and play in public green areas, fulfil other nature conservation and forestry functions (forest), or are only open for specific groups

(allotment garden). The population growth will result in a decline of the open space supply of public green spaces per inhabitant in most inner-city neighbourhoods what requires a corresponding protection of existing and expansion of new public green spaces.

The total stock of Leipzig's street trees consists of plantations, some of which date back to 1900. The distribution of street trees of different ages is relative balanced. By far the largest share of trees is the result of the planting period 1996 to 2005. The number of felling is compensated by plantations, in most cases even significantly more street trees are planted than felled. Despite this effect, Leipzig's street tree stock only increases slightly. The target of the Clean Air Plan of planting 1,000 additional trees per year has not been reached since the mid-2000s. The city centre and the Wilhelminian style quarters are formed by the predominant perimeter block development and urban heat islands due to the comprehensive sealing with little greening. Within the urban heat islands, brownfields, allotment gardens, sports fields, cemeteries, parks and green spaces and large green inner courtyards are indispensable cold air areas, which additionally have a special role for air-hygienic due to their filter function. To reduce the heat during the day as much as possible to be able to move away from residential areas, public green spaces with sufficient shade and evaporation areas ("comfort islands") for the recreation and health of the people will continue to gain in importance. In low-wind weather conditions, ventilation can only be achieved by thermal compensating flows (corridor wind) e.g. along the Pleiße, Parthe, Elster flood bed, Elster basin and along railway lines, e.g. in the direction Bayerischer Bahnhof. Apart from the small-scale pattern of inner-city open spaces, the most important climate-ecological compensation area and fresh air producer is the alluvial forest of Leipzig. The loss of green spaces and the densification of inner block areas lead to a significant increase in thermal load. Compensatory Measures can hardly mitigate this. An increase in the number of hot days (≥ 30 °C) in the Leipzig region from the current average of 9 to 13 in 2030 is predicted. An increase in extreme weather events such as heavy rainfall or dry periods is also forecasted. Since the beginning of the 1990s, a trend towards heavy precipitation with increasing precipitation in the Leipzig area can be observed, which has further increased since 2002. Consequently, the frequency of flooding - also due to the increasing degree of sealing of the catchment area - has increased in recent years.

The alluvial forest with the associated water network of the Elster-Pleiße-Luppe floodplain is the most important area for biodiversity. Moreover, also other floodplains with mainly near-natural areas are designated as protected. Supplementary areas with buffer functions for the core habitat areas can be found in the agricultural landscape, in the area of recultivation areas of post-mining landscapes in the southern region, and in the area of renaturalised urban wasteland (Plagwitz railway station). In the settlement area, ecological stepping stones can be found in nature conservation-oriented parks and green spaces as well as in allotment gardens and cemeteries, or in the form of dry biotopes along tracks. Since 1990, the water quality of the watercourses has improved, mainly as a result of wastewater engineering measures. The overall quality of Leipzig's standing waters has also improved. Since 1990, almost 55 % of the standing waters have been restored in terms of water management and ecologically upgraded. However, 94% of rivers and lakes had not achieved good ecological status by 2015.

5.2.2 Projects and initiatives

Name	Description
"Baumstarke Stadt" fundraising campaign and political instrument	In the following we focus on one UF-NBS project as it is a highly complex and long-term initiative and political/planning instrument at the same time with various ecological and social implications. In 1996, Leipzig launched the fundraising campaign "Baumstarke Stadt" as a political instrument. The project has two goals: On the one hand, the money is used for the planting of new trees. On the other hand, the city seeks to establish a long-term engagement of citizens with the city greenery. A location for the plantations is determined by the Office for City Greenery and Water. The Office is also responsible for the implementation of the planting. The donor can currently choose the tree species from a current planting catalogue. Those who also take on a sponsorship can choose a sponsored tree between these specified locations and young trees that have already been planted. The city takes care of the sponsored trees. The sponsored tree is maintained by the City, but the sponsor can provide additional support, e.g. by watering the trees extensively in dry periods, keeping the tree disc free from weeds, loosening the soil surface of the tree disc (if not overgrown) to aerate the soil, checking the attachment of the tree-supporting post, cleaning the tree disc of debris such as paper etc., or simply informing the department of urban greenery in case of larger waste deposits, damage to the tree or its holding device etc. This all contributes to identification of residents with their "green city". In fact, for many citizens the signs at the trees have emerged as the most important thing. The first part of the sign inscription indicates the name of the tree species, the second part the name and dedication by the sponsor. Consequently, the trees are given a designation for the sponsor or pedestrians in terms of being a memorial or for inspiration. Others than that, there is an increasing problem awareness of direct climate change impacts e.g. in case of dry

trees – so people see the need to take responsibility which then fosters social cohesion, supported by the city.

The location for the plantations is determined by Planning Office. Sponsors can choose between these specified locations and already planted young trees. The city provides a web-based public list of planed plantations of trees indicating street name, house number and time of planting. This list corresponds to the planting programme of the city of Leipzig for the current and previous year. The city suggests concrete individual locations that best meet the requirements of interested parties in a mutual agreement. By providing the necessary resources, the stock of street trees can not only be maintained, but also specifically developed and extended. New plantings of trees are particularly focussed on previously treeless streets, especially in the densely populated urban districts, but also on district connecting roads. In this vein, street trees are an integral part of a connected green network for the sustainable city of Leipzig. The continuity of the program allows its implementation within a strategic framework for action up to the year 2030 taking into account the objectives of the sustainably growing city formulated in the Integrated Urban Development Concept (INSEK) 2030 and the open space strategy of the City of Leipzig.

Currently, and based on Leipzig's open space strategy "Liveable green city by the water" (2017), a debate on the future handling of green-blue infrastructure is run aiming to develop a Green Master Plan. With the sectoral concept for open space and environment, the corresponding objectives and priorities for action have also been incorporated into the Integrated Urban Development Concept (INSEK) 2030. The Green Master Plan intends to provide concrete spatial support for these objectives and priorities with the participation of the public. The associated participation concept was approved by the city council in June 2018 and will accompany the development process of the

Some reflections on the combined impact of the projects and initiatives listed above

The long-term character of the project "Baumstarke Stadt" is a success factor. However, it needs to be questioned how sustainable the plantings of new city trees in Leipzig is planned and implemented, and which ecological, the social and the economic challenges are related to this program. The future depends on the common will of politicians, administration and citizens to carry out such a tree planting program together, because it is all about the money. Maintaining the long-term character of the program (e.g. maintain continuous contact with long-standing sponsors and interested parties) is challenging. The support of interested parties, donors and tree sponsors including consultation and documentation is realized with the support of staff from the employment promotion (Arbeitsförderung) and, in the future, maybe by the Federal Voluntary Service. In the future the program might be extended towards surrounding municipalities. Despite many years of experience, the participative design process and maintenance of green spaces is lacking in Leipzig, especially in inner-city areas. The pure availability and accessibility of and to green spaces is still not equally distributed or even taken into account. The criterion of biodiversity also plays a rather subordinate role in the official planning concepts of urban trees. In addition, there is an increasing shift of responsibilities crucial for UF-NBS in the city. The maintenance of the public green spaces is largely taken over by city-owned companies. They are responsible, among other things, for pruning, watering and planting the trees. The city cannot take care of the whole green spaces alone, but increasingly needs to rely on the help of volunteers from the civil society. The increasing frequency of heat summers and persistent periods of drought leads to a situation in which the city cannot maintain or replace dead trees at the same vein thus leading to spatial inequalities in the provision of trees in the city.

5.3   Government and governance of UF-NBS

5.3.1   Policy instruments for enhancement and protection of UF-NBS

The most important instrument is the Regional Development Plan which establishes the planning principles, goals, and designates areas for environmental protection and nature conservation. At the city level enhancement and protection of urban green space is ensured by the Planning Department, Section for Urban Development and Open Space Planning as well as the Local Nature Conservation Authority. One of the most important plans is the FNP, which includes a chapter on environmental protection and landscape planning, and determines for example green and blue areas with specific purposes. Additionally, legally required impact mitigation and compensation is an important instrument in regard to green space on the project level. This means that loss of green spaces and their functionality, such as providing habitat or regulation, must be avoided or, if not possible, compensated. The preservation of the European natural heritage in Leipzig's alluvial forest, with its extensive European protected areas in accordance with the Flora-Fauna-Habitat (FFH) and Bird Protection Directive, is essential. Besides their formal responsibilities, spatial planning authorities also fulfil diverse facilitating tasks, ranging from local tourism development to regional landscape management and strategic planning. For such facilitating, optional tasks, spatial planning authorities cooperate with the private sector and civil society organisations or other authorities. To give an impression of these differences, the following three spatial planning strategies with varying statutory support were selected.

1) The protection of green corridors of unsealed land in the vicinity of settlements is an important regional planning aim in western Saxony. Green corridors link urban and peri-urban open spaces. The Saxon Green Corridors perform a range of ecological and recreational functions; they cover natural landscapes, in particular rivers, floodplains and forests, as well as "corridors" of unsealed land with various land cover types in-between. The aim of the strategy is that these areas should be kept free of development and disruptive land uses. While the Green Corridors serve ecological and recreational functions, the green space network also explicitly connects otherwise isolated ecosystems or biotopes in both natural and cultural landscapes. According to the strategy, land use conflicts within these areas should be resolved with particular attention to the requirements of environmental protection, landscape management and nature forestry. Regional planning aims are set out through a multi-stage procedure including stakeholder participation and public comment. The participants of the stakeholder group belonged to local authorities, inter-municipal cooperation organisations affected by the plan and nature conservation associations. The final version is prepared by regional planning associations and authorised by its general assembly and the Saxon Ministry of the Interior. Regional planning aims, such as the Green Corridors, have exerted an indirect influence on land use. Because regional plans are legally binding, municipalities implement the Green Corridors by considering them in preparatory land use and development planning. This is aggravated by the fact that many municipal land use plans often predate the regional plan. Furthermore, developers seem to be capable of applying pressure against the maintenance of Green Corridors. A frequently cited example is the case of an industrial investor who was granted a building permit in a Northern Leipzig Green Corridor by a municipality.

2) The regional development concept "Green Ring of Leipzig" has been implemented in the area of the Leipzig urban fringe. Initiated in 1996 by Leipzig planning officials, the Green Ring predominantly focused on the restoration of disused open-cast lignite mines and derelict industrial estates. Further areas of responsibility were the management of the remaining cultural landscapes and development of educational activities. More than 30 key projects have been implemented. Regarding land use change, the project "Inter-municipal pool of compensation areas" is particularly interesting. The participants in this project manage the legal requirement for compensation in the process of land development. This is realised by directing compensation measures towards land which belongs to the "Green Ring". Furthermore, a series of projects aim to encourage residents to get to know their nearby natural and cultural landscapes. To this end, infrastructure for local recreation and tourism is constructed and leisure activities are organised, e.g. guided walks. The Leipzig-based constituent members of the Green Ring are 14 municipalities, including the city of Leipzig, two rural districts and a number of civil society organisations, private firms and individual citizens. It is considered to be an important cooperation arena for urban and peri-urban as well as northern and southern municipalities of Leipzig. The decision-making body is a regional conference composed of delegates of member organisations. The strategy's main weakness is that tough decisions are deferred or not taken at all; there is no preference or prioritisation of projects, for example. This, it is argued, is a future risk because of the Green Ring's potentially conflicting aims regarding nature protection and tourism development. Furthermore, not all municipalities are equally committed and free-riding behaviour by some is seen as a problem.

3) The aim to protect the floodplain of the River Parthe and its riparian forests led to cooperation between the municipalities of Leipzig, Taucha and Borsdorf, two medium-sized towns, are located in the peri-urban area north and north-east of the centre of Leipzig. The Parthe Floodplain Cooperation or Zweckverband is legally constituted; its members form a contractual agreement. It receives its main financial support from the member municipalities, although other sources, such as state-wide funding programmes, are also used. The three municipalities, aided by a general assembly and a chairperson, synchronise preparatory landscape planning for the River Parthe which crosses the area. Since 1992, the cooperation increased its influence by degrees, taking over new responsibilities such as the management of a nature station and a local pool of compensation areas. Their personnel increased by hiring former volunteers. Apart from the three core members, neighbouring municipalities also participate in the protection and management of floodplains and water bodies. The Parthe Cooperation also collaborates with other regional development strategy organisations, such as the Green Ring, for specific projects. Furthermore, farmers, tourism associations and the German Association for Environmental Protection are involved in the project. Short-term cooperation may also take place with civil society organisations, e.g. village councils and sports clubs, and the local economy, e.g. inns, for specific projects.

5.3.2 *Experiences with participatory governance and citizen science (focus on UF-NBS)*

The program "Baumstarke Stadt" offers sponsorships for urban trees within the responsibility of the city authority. The donor can choose an already planted young tree or a tree which is intended to be planted on one of these specified locations. The sponsored tree is maintained by the City, but the sponsor can provide additional support, e.g. by watering the trees extensively in dry periods, keeping the tree disc free from weeds, loosening the soil surface of the tree disc (if not overgrown) to aerate

the soil, checking the attachment of the tree-supporting post, cleaning the tree disc of debris such as paper etc., or simply informing the department of urban greenery in case of larger waste deposits, damage to the tree or its holding device etc. Information about the program "Baumstarke Stadt" is publicly available to interested citizens accompanied special offers for various anniversaries, press releases and a leaflet. This all contributes to identification of residents with their "green city". In fact, for many citizens the signs at the trees have emerged as the most important thing. The first part of the sign inscription indicates the name of the tree species, the second part the name and dedication by the sponsor. Consequently, the trees are given a designation for the sponsor or pedestrians in terms of being a memorial or for inspiration. The administration is responsible for dealing with cases requiring clarification, such as vandalism on the tree or for example theft of the oak stele. The Office for Urban Greenery and water body that serves as the contact point for the tree sponsors has not enough staff to deal with all the concerns of the tree sponsors in a satisfactory way. The communication between the committed citizen and the city administration needs improvement to prevent conflicts which emerge from communication.

Additionally, citizens have also been involved in the development of the street tree concept Leipzig 2030 within an extensive participation and coordination process. The street tree concept Leipzig 2030 was developed by a working group involving all relevant actors from the city administration and municipal companies (e.g. cleaning company). At the same time, citizens were able to actively contribute to the planning in an extensive participation and coordination process. In a public event, about 50 visitors were introduced to the key points of the street tree concept with their main statements. The concept is to be understood as a strategy paper for the maintenance and expansion of the street tree stock. The visitors of the event were often involved in the discussion. They were asked about concrete possibilities for participation, as many of them were confident enough to tackle the issue but were not well versed in the subject. Further discussions were held about ways of enlarging tree discs and protecting them from traffic. Strong tree pruning, removal of leaves and the preservation of valuable old trees were further topics. For several participants it was important to replant the old avenues of fruit trees between the Leipzig villages to strengthen the cultural landscape and the biotope network. To this end, the participants alternated between a walk through the district with active experimentation, joint work in the plenum, and group work to develop and discuss solutions to concrete issues such as possibilities for greening previously treeless streets and tree care. Thus, different interests with regard to street trees were bundled, which finally resulted in a coordinated, comprehensible and implementation-oriented action instrument

5.3.3   *Stakeholder mapping*

Stakeholder name	Type of stakeholder	Description and website (ca. 100 words per actor)
Office for urban greenery and waters	Public (administration)	The office tasks are various but crucial for the whole green and blue infrastructure of the city: space management and maintenance, registration and management of compensation areas, recording and management of brownfields. Focussing on trees, the aim is to preserve and develop species-rich and long-lived forest communities which, under the conditions of climate change, provide their diverse services as stable ecosystems and make an active contribution to climate protection. Through various instruments, the forest management serves to implement the management plan drawn up for trees and thus clearly serves the objectives of nature conservation. https://www.leipzig.de/buergerservice-und-verwaltung/aemter-und-behoerdengaenge/behoerden-und-dienstleistungen/dienststelle/amt-fuer-stadtgruen-und-gewaesser-67/
Office for Environmental Protection	Public (administration)	The Office for Environmental Protection is responsible for continuing environmental and nature conservation with its two specialist departments, in which the lower nature conservation authority, the lower waste and soil protection authority, the lower emission control authority and the lower water authority are located. A not insignificant contribution is made by preventive environmental protection with the tasks of urban ecology and environmental planning. This also includes the Environmental Information Centre with its wide range of information on all aspects of environmental and nature conservation. The active cooperation of citizens, companies, associations and institutions has also contributed to this. https://www.leipzig.de/buergerservice-und-verwaltung/aemter-und-behoerdengaenge/behoerden-und-dienstleistungen/dienststelle/amt-fuer-umweltschutz-36/
Urban planning office	Public (administration)	The tasks and services of the urban planning office are manifold and range from the preparation of urban land-use plans and urban development plans to green space planning and urban design. Urban planning and urban development take place with the active participation of the citizens. Public participation also includes interpretations of plans of other authorities. The decision to take the comments into account is taken by the Council Assembly with a final decision. The result will be communicated to the parties concerned. The office is, among other tasks, responsible for the development of the Integrated Urban Development Concept (INSEK), spatial observation/monitoring, Land use plans, or Urban-Rural Relations.

		https://www.leipzig.de/buergerservice-und-verwaltung/aemter-und-behoerdengaenge/behoerden-und-dienstleistungen/dienststelle/stadtplanungsamt-61/
Ökolöwe Leipzig	Public (nature protection association)	Ökolöwe is a politically independent non-profit organisation and a transparent advocate of nature. This association represent green interests in politics, administration and the public, and develop alternative ideas and concepts, advise politicians and administration and mobilise with appeals, campaigns and petitions. The topics are: ecological flowering areas and near-natural green, new street trees, more facade greenery, species-rich and healthy alluvial forest, better and more affordable local transport, more safe cycle and footpaths. https://www.oekoloewe.de/
BUND Leipzig	Public (nature protection association)	As an important part of the worldwide largest environmental network Friends of the Earth, BUND is committed to the preservation of biodiversity, the protection of the climate and the rights of consumers* locally and worldwide. Their topics range from environmental public relations work (e.g. on the preservation of the alluvial forest), practical nature and species protection and biodiversity, climate & energy, traffic sustainable transport concepts for the city, organic farming and healthy food, and environmental education (in the form of an extensive programme of events, as well as special offers for children). https://www.bund-leipzig.de/
NABU	Public (nature protection association)	The NABU regional association in Leipzig is committed to nature and species conservation, maintains ecologically valuable biotopes and is active in environmental education. With exhibitions, excursions and lectures, NABU Leipzig informs young and old about the local nature and the necessity to protect it. NABU is also active in the practical protection of species, for example, it takes care of the protection of amphibians in a variety of ways and runs more than 1,000 bird nesting aids in the Leipzig urban area. One particular focus of its work is the protection of Leipzig's floodplain ecosystem, which is a green lung and recreational area but also a habitat for a wide range of animals and plants. Some ecologically particularly valuable areas around the Papitzer Lehmlachen are maintained by NABU to preserve them as habitats for endangered species. https://www.nabu-leipzig.de/
StadtLabor	Private (planning office)	This is a planning office for urban, regional and transport planning and consulting operating since 1997. The spectrum of tasks ranges from the moderation of planning processes to the creation of concepts and implementation planning. All projects are based on the desire to illuminate the task from different professional perspectives to achieve optimal solutions. In addition to the fulfilment of technical parameters, questions of user-friendliness and sustainability of the planning play an important role. The

		work follows the model of a human and environmentally friendly city, seeking to contribute to exploit the potentials of urban space and thus counteract the further urban sprawl of the landscape. Through cooperation within the office community, it is possible to offer a complex spectrum of planning services. The fields of activity include architecture, design, landscape architecture, urban, regional and transport planning, building services and solar planning as well as energy consulting. The network combines interdisciplinary competences of these different service areas with a flexible organisational structure. https://www.stadtlabor.de/
Helmholtz Centre for Environmental Research GmbH – UFZ	Public (academia)	The UFZ works towards a better understanding of the human-environment processes as basis for proposed action and strategies for the development of a sustainable society and to support their practical realization. UFZ builds on a rich tradition of scholarship in human ecological research in sociology. The research is highly interdisciplinary and focuses on different spatial-temporal scales. Besides sociology, the department offers expertise from geography, urban planning and the environmental sciences. UFZ works closely with the natural and engineering sciences, with numerous research partners across Germany and in other countries, and with policy makers and implementation partners on research projects with a focus on achieving greater sustainability. https://www.ufz.de

5.1 Looking forward

5.1.1 Strategic objectives in relation to UF-NBS

O1: Multifunctional use of space	Through spatial overlapping or delayed use, especially the pressure to use open spaces close to residential areas can be minimised. This applies in particular to the opening of areas that have so far only been available to a specific user group (allotment gardens, sports fields, open spaces on public buildings or in industrial estates) and/or also not completely be used (sports fields, schoolyards). This is also beneficial for social gathering and cohesion. The possibility of overlapping functions is limited if protection is affected (nature conservation, monument protection, noise protection, etc.). Traffic areas, or they accompanying surfaces, just like facades and roofs, can in many cases also provide additional green structures and at least contribute to increasing the volume of green space in Leipzig. Also for storage of rainwater, certain areas can be used temporarily.
O2: Green-blue infrastructure for climate adaptation	Heat islands are created in the inner city structures in summer. Global warming and redensification will increase the number and character of urban heat islands. Consequently, all possibilities of temperature minimisation need to be addressed. Also, effects of extreme events such as drought and heavy rainfall can be avoided through strategic planning and design, as well as appropriate maintenance of open spaces and water bodies. Especially in the case of heavy rainfall events, the sewerage system can become overloaded, which can be targeted flooding of less sensitive areas, usually used for other purposes, for temporary storage can be achieved.
O3: Open space-related, preventive real estate policy and sustainable land management	Open spaces, urban greenery/nature and water bodies are important location factors for the city and essential components of services of general interest. The owner of an area decides on the use of the land. This is particularly true in built-up areas, where development is subject to building law and must be approved by that. In order to improve the quality of life also against the background of redensification and climate change, it is necessary to ensure that urban real estate with open space functions is kept within the portfolio of the city authority, and to purchase new areas for this purpose. Therefore, a sustainable, continuous space management is required, which also includes cycles of maintenance and refurbishment.

5.1.2 Major barriers

Due to a lack of financial and human resources, green space maintenance cannot achieve its full performance in terms of intensity of care. The scope for action of local authorities is limited, so that the maintenance cannot meet the demands of use. In addition, there are institutional barriers due to non-transparent communication of responsibilities within the city administration. For instance, the tasks of maintenance are divided between the responsible office and a city cleaning company. This can lead to problems of unclarified responsibilities within the administration as an institutional barrier, due to the scattered division of responsibilities for green space management tasks, and further to complications of the target-oriented coordination and control in the city administration. In consequence, the care and design of the urban green spaces by actors* in the field of green space

management cannot be sufficiently achieved. The main challenges are therefore the lack of a long-term financial basis and institutional structures that are difficult to change, which may make implementation more difficult. Also, the poor equipment or design, especially of public parks and meadows, can be regarded as institutional barriers in planning and design. Besides the lack of infrastructure such as poor road connections within the green area, this covers also legal reasons as institutional barriers. Private green spaces are therefore subject to the obligation to ensure safety on roads. The owner must therefore be liable if someone on the private property suffers damage comes. As a result, private green spaces are usually fenced and not available to the public. The situation is similar with brownfield sites, especially in the inner-city, with high land potential to be revitalised and public open spaces to be developed. Unresolved ownership structures or inheritance disputes may affect the development of these inhibit potential open spaces. Private ownership restricts the development of urban green spaces. Certain restrictions are also imposed on protected areas. Restrictions on access arise here, due to the nature conservation law. In favour of the nature, this results in various restrictions on use depending on the status of the protected area. Due to the strict provisions and unclear cooperation structures within responsibilities, protected areas can be regarded as institutional barriers. For instance, the respective protected areas can either prohibit or significantly restrict the development of road systems. The differing interests of the municipal administration on the one hand and the nature conservation authority on the other hand, also constitute an institutional barrier to access to the protected areas. This requires a coordinated cooperation of all parties involved actors within the administration, but also with other actors at city level. Other barriers can be summarized as follows:

- Political: Impeding interests (economic development, investments, industries, commercial activities) between the city and local residents and green initiatives,
- Financial: Lack of financial resources; sometimes problems to allocate specified funds or low investments from private actors and business,
- Planning: Planning instruments are well defined and elaborated. The main problem is the (ongoing) cuts in the personal staff in the municipality and, respectively, the austerity and neoliberal savings policy in Germany,
- Information: planners and other governance actors would benefit from better evidence data of the impact of green and blue infrastructure on health and recreation,
- Technical: It is mainly manpower missing, neither technical knowledge nor infrastructure. Another obstacle might be the legal barriers and data protection (Datenschutz) in German administration in general,
- Institutional: Legal barriers and options, Austerity policy, landownership and housing market, Government and politics.

5.1.3   Knowledge gaps

Increasing densification, rising climate change risks and declining biodiversity are key challenges in cities. Nature-based solutions can help to develop more resilient and liveable cities. Urban trees are an essential nature-based solution that strengthens the resilience of tree-based urban ecosystems and their biodiversity and provides ecosystem services that are essential for both humans and nature. These include urban forests, wooded parks, small forests in neighbourhoods, street trees and trees in public and private spaces. The potential of urban trees as a nature-based solution has been largely neglected and underestimated both in science and in urban planning. At the same time, trees are

particularly affected by current climate change, drought and heat as well as emerging pests - new species inventories for our cities are under discussion. So, we might raise the questions:

- What is the future of different urban tree species in fast growing cities and under warmer and drier climatic conditions?

- In times of changing climate including hotter days and dehydrated soils, how can tree-based solutions be implemented sustainably so that their advantages can be used and experienced by everyone?

- What are the requirements of a climate-adaptive reforestation in terms of management and costs, policy and planning options, and monitoring?

Not produce new but manage existing knowledge. Communication or information on the use of green spaces is an important task, which is also attributed to green space management. The lack of information on behaviour or poor marketing of green spaces often prevent access to potentially usable green spaces in the city. In particular, the (non-)knowledge of what is happening in different locations to be expected or how to use them is an important barrier. Measures to provide information on the use of urban green spaces are therefore of great importance to ensure that urban green spaces of different population groups.

6 Llobregat Valley (Lower Llobregat Valley), Spain

6.1 General information

6.1.1 Institutional framework and planning system

This area has a complex institutional framework, with multiple levels of government. The metropolitan total length of Llobregat river consists of 30 km, along 16 municipalities, from Martorell to Prat de Llobregat. However, there are 13 municipalities encompassed within the landscape of Lower Llobregat Valley, which corresponds to our study area: El Prat de Llobregat, Sant Boi de Llobregat, Cornellà de Llobregat, Sant Joan Despi, Sant Just Desvern, Sant Feliu de Llobregat, Sant Vicenç dels Horts, Molins de Rei, Pallejà, El Papiol, Corbera de Llobregat, Sant Andreu de la Barca, Castellbisbal.

The main administrations with territorial planning competences are the Generalitat (The Government of Catalonia), municipalities (The City Councils corresponding to the mentioned municipalities) and special urban organizations and the Metropolitan Area of Barcelona. Institutional framework is also completed by the two public consortia in this area, belonging to the City Councils, the Metropolitan Area of Barcelona, Generalitat or Diputació de Barcelona (Barcelona Provincial Council). These are represented by the Consortium of Agrarian Park of Baix Llobregat and the Consortium of Natural Area of Llobregat Delta, corresponding to the network of protected areas. The Agricultural Park is an important reservoir of ecosystem services in the metropolitan area (i.e. food provision). The landscape of Llobregat Delta represents a hotspot of biodiversity and ecosystems services in the Metropolitan Area of Barcelona.

The AMB became the metropolitan public administration on the 27th July 2010, when the Parliament of Catalonia voted unanimously the Law 31/2010. The AMB has the function of providing public services in the metropolitan area of Barcelona and supports the management of the municipalities forming it. The constitution of the AMB governing bodies takes place after the municipal elections with a mandate lasting four years. The administration of the Metropolitan Area of Barcelona is organized through two different bodies integrated by the mayors and councilors of the 36 metropolitan municipalities, the Metropolitan Council and the Governing Board.

The main planning documents acting in the area are The General Metropolitan Plan of Urban Planning (Pla General Metropolità d'Ordenació Urbana, PGM, approved in 1976) and The Special Plan of Protection and Improvement of Agrarian park of Baix Llobregat. Most of the municipalities are led by PGM for general territorial planning, while the municipalities of Sant Andreu de la Barca, Corbera de Llobregat and Castellbisbal have other urban planning documents.

However, the future Planning document at metropolitan level will be the metropolitan PDU (*Pla Director Urbanistic Metropolità*; Urban Master Plan; AMB, BR, 2019), which will replace the old PGM. It will be also applicable in the municipalities along the Llobregat river, as they are part of the metropolitan area. PDU has been shaped in 2015, and now it is an ongoing document, that it will be shortly approved. The actual document of the PDU is focussing on defining the objectives, the general

principles and provides a complex territorial assessment. At this stage, the document allows public information, but also enhances the participatory processes (institutions, citizens). Important contributions are also made by the metropolitan councils and other institutions that collaborate to the elaboration of the documents for their initial approval.

In this sense, the initial stage not only serves as a reference for the mandatory public information procedure that enables the participation of institutions, citizens and all agents involved in the metropolitan area, but also becomes the basic document for the environmental assessment process in the Metropolitan Area of Barcelona.

6.1.2   Experiences with participatory governance and citizen science

The main tool of territorial planning in this area will be the PDU Urban Master Plan, led by the AMB. It already involved 500 experts and a complex participatory process, with more than 10.500 participants along the metropolitan area. One of the main objectives of this participatory process was to disseminate and explain the PDU process to the participants, assure stakeholders engagement and define territorial challenges. It is the first process involving participatory process from the first stages of document elaboration at this scale, however, citizen participation doesn´t have a strong influence on decision making process. Their involvement in the process depend on the limitation of the Law of Urbanism 305/2006, mainly focussing on the citizens right of being informed by the new urban plans.

At municipal level, the City Councils designed a participatory process (i.e. Decidim El Prat, Decidim Sant Just Desvern) to decide the main investments of the city, including, for instance actions related to a better management of urban parks and gardens or public space rehabilitation. Specific actions envisage enhancing city connectivity with the cropland and natural landscapes (such as the Plan of Municipal Action 2020-2023 in El Prat de Llobregat).

Other participatory actions were led by Generalitat, especially related to the Strategy of natural heritage and biodiversity in Catalonia. This participatory process targeted a broad territory (the whole Catalonia).

Among the citizen science activities focussed on creating indicators of urban diversity in the area, it is worth mentioning the Observatory related to the urban butterfly monitor scheme (uBMS). The Observatory is based on a collaborative network of volunteers to obtain data on butterfly populations. It was initially developed in Barcelona and Madrid (http://ubms.creaf.cat/en/the-observatory/), then it was expanded to the Metropolitan Area (http://mbms.creaf.cat/). To date, the Observatory include butterfly observations from Parc de la Muntanyeta (Sant Boi de Llobregat) and Parc de la Fontsanta (Sant Joan Despí), belonging to urban green areas of the study area.

Other previous and current activities include informative online tools, visualisation tools, citizen engagement activities connected to planning process in the metropolitan parks. For more information, please check the following examples:

New participatory and informative tools: "EFUF Atlas, Urban Forest Boundaries" (https://amb1.maps.arcgis.com/apps/StoryMapCrowdsourc

e/index.html?appid=f6a48090a7734a21855ec53f8f346784). The Atlas is a tool to share international experiences of different working groups to reflect the urban forest solutions applied in different territories.

"New Wildlife Visualisation Tool", more than 1.500 each day (http://amb.ico-apps.org/amb). The Wildlife Visualisation Tool of the AMB shows, in real time, fauna observations carried out in the park and beaches of the AMB through ornitho.cat and ocellsdelsjardins.cat, two projects of citizen science of the Institut Català d'Ornitologia.

6.1.3   Socio-economic profile

The study area belongs to the Metropolitan Area of Barcelona, which is responsible of 52% of GDP in Catalonia. The Metropolitan Area of Barcelona is a complex territory dealing with important socio-economic pressures. Population aging increased by 8% and 54% of its population have problems accessing a house. Recent simulations which analyse COVID socio-economic impact in the Metropolitan Area (Cruz et al. 2020) estimate that the average annual net income of Barcelona's metropolitan households have shrunk between 7% and 8% in 2020 (between € 32,330 and € 32,036). Extreme poverty is also increasing (50,000 more people, resulting in a total of 221,000), and there is a slight increase in the intensity of poverty. According to the same study, the most affected social profiles by the current post-COVID economic crisis are children, the young population, the population of migrant origin and the working classes.The 12 municipalities belonging to the study area have a total of 275.569 inhabitants in 2020. Cornellà de Llobegat is the densest municipality in the study area (12.866 inhabitants/km^2, data corresponding to 2020). GDP/capita corresponding to the Baix Llobregat county is 33.000 euros. Population growth with migration background has a gross rate per 1,000 inhabitants of 11.6 in 2019, according to IDESCAT data (Statistical Institute of Catalonia).

From the socio-residential point of view, the municipalities corresponding to the Lower Valley of Llobregat are mainly included in the typology of zones with population aging and medium income families, with few residential areas inhabited by upper classes.

Some municipalities of the study area present important disequilibrium between their employed inhabitants and available jobs (i.e. high population and lower jobs availability), which result in increased population mobility to adjacent municipalities (especially Barcelona). Only the municipalities of El Prat and Castellbisbal have higher number of available jobs than resident population.

6.2   Geography of UF-NBS

6.2.1   State of (peri)urban forests, green infrastructure and urban greenspace

Approximately 52% of the Metropolitan Area of Barcelona comprises agro-forestry mosaics, with 37 critical points of ecological connectivity.

Most of the area belonging to the Lower Valley of Llobregat river corresponds to non-urbanisable soil and it is part of various protected areas (especially belonging to *Parc Agrari del Baix Llobregat*). Only a smaller part of Llobregat Delta (belonging to red Natura 2000) corresponds to the study area.

As for the riparian forests, the Llobregat river, in its metropolitan section, follows a mostly rectilinear route, practically channelled for the most part and without a meandering trace or a consolidated "natural" riparian forest. There are only a few patches of Populus, Salix, Fraxinus, Alnus, Ulmus or Tamarix that are largely the result of recent plantations, but which in no case form the characteristic plant communities and the structure of these forests. Only small, well-preserved pieces of riparian forest have been identified in some of the courses that come from the coastal mountains and flow into the Llobregat, such as the Canyars stream. In the case of the streams that cross the deltaic plain from the coastal mountains to flow directly into the sea, the situation is the most artificial, with some streams fully channeled and with their flow historically derived through numerous canals that they form the complex supply network of the agricultural plain.

The strip that can potentially support hygrophytic vegetation, is constrained to a width of 10-20 meters. This is due both to the mobility infrastructures that enclose the river on both sides, and to the agricultural and industrial uses that occupy a large part of the river area, and to the need to guarantee safety in the face of the risks associated with the river. However, due in part to planting work, there are a few areas with vegetation typical of these environments. In general, plantations located between the first slope and the river bank have prospered, while those located from the foot of the slope have been less successful, although they sometimes have supporting irrigation. Thus, the Llobregat river offers the possibility of studying potential riparian areas, restored areas, such as the patches that would correspond to the existing hygrophytic vegetation. The area to be considered would be, as far as security allows, the riverbank and the first infrastructural slope.

6.2.2   Projects and initiatives

Name	Description
Environmental recovery of Llobregat River http://www.amb.cat/es/web/territori/espai-public/espais-fluvials/parc-riu-llobregat/el-parc/projectes-i-actuacions/detall/-/projecte/recuperacion-del-rio-llobregat--tramo-2/430359/11656	The recent renaturing of Llobregat river was led by the Metropolitan Area of Barcelona (AMB). It consist of enhancing biodiversity in urban Parks in the municipalities of Metropolitan Area of Barcelona Some of the ongoing activities led by AMB and related to small-scale NBS in Parks are: - Biodiversity refuges - Butterflies gardens - Insects hotels - Ponds renaturing Consolidation of river side parks El Prat and Sant Boi de Llobregat was an important part of environmental recovery along Llobregat river. Attention to the dynamic aspects of the river landscape, not only focussing on the high-water regimes, but also on the treatment of low-water regimes in the form of maintenance of the ecological volume and the landscape configuration associated with his regime. Creation of walkable path and bike trams, i.e. Sant Boi de Llobregat. Multiple functions of green spaces are combined (enhancing ecological processes and biodiversity recovery, with the needs of the community (recreation). Routes through natural areas of large size and high scenic quality along Llobregat river
Agrarian park of Baix Llobregat (Parc Agrari del Baix Llobregat)	It comprises agricultural fields, of major importance for food production and provision in the area. Springtime in the lower Llobregat valley is a spectacle of nature as the fruit trees blossom (peach, plum, pear trees, and cherry trees). The initiative "Producte fresc del Parc Agrari" is a special label to promote local agriculture and market.
Environmental recovery of humid areas with small patches of riparian forests - Aiguamolls de Molins de Rei	The Molins de Rei wetlands consist of a layer of freshwater spanning 6.2 ha with a depth of 30-150 cm. Amid a rich variety of riverside (including small patches of riparian forests) and aquatic vegetation, the wetlands' reeds and bulrushes provide a habitat for many species of birds. Small natural oasis where a wide variety of birds (more than 120 different species) nest in the midst of the urban area.

Some reflections on the combined impact of the projects and initiatives listed above

The Llobregat river basin, with an area of 4,930 km2 and a total length of 175 km, is the largest inland basin in Catalonia. The course of this river has been widely exploited for various uses: agricultural, industrial and consumption, among others, for many decades. The part of the Llobregat basin that belongs to the metropolitan area represents only 4.74% of the total and corresponds to an intensely humanized space. However, this area plays a key role in the ecological and social connectivity of the metropolitan area. We are facing a space with different demands, with great potential in terms of the contribution of ecosystem services, which coincides with a fundamental corridor of infrastructures and in the main gate of Barcelona, as both the port and the airport are located in their delta. But despite this pressure, which has resulted in a dramatic reduction in the river area and its quality in recent decades, the river space still offers opportunities to promote ecological and social connectivity, as well as to ecosystem maintain and improve metropolitan biodiversity and its role as an ecosystem service provider in the metropolitan area. It is for this reason that the AMB has invested and continues to concentrate many efforts that have significantly improved the quality of this space.

Many of the main challenges are shared with other key areas of the metropolitan green infrastructure, such as the balance between the preservation of ecological values and the provision of other ecosystem services, especially with regard to public use of these spaces. Another relevant aspect is the state of this ecosystem, as we find ourselves in an environment where historical biological and abiotic characteristics have been profoundly and irreversibly altered. Three key aspects of this phenomenon would be the irreversibility of certain thresholds that prevent restoration to a historical state, the presence of non-native species, and a hybrid state that includes elements of new and historical ecosystems.

6.3   Government and governance of UF-NBS

6.3.1   Policy instruments for enhancement and protection of UF-NBS

There is no specific planning instrument mentioning the UF-NBS. However, various plans include biodiversity conservation, ecosystem services and ecological connectivity assessment, urban metabolism, territorial sustainability or climate change mitigation.

The Urban Master Plan (PDU) has broad competences, granted by the Law of the Barcelona Metropolitan Area itself. Some of these powers are: the definition of reserves for general urban communication systems and other infrastructures, community facilities and open spaces; the classification of land and the delimitation of urban land; the setting of criteria for classifying urban and urbanizable land in terms of buildability, uses, densities and reserves of systems, or the definition and delimitation of areas of urban transformation of metropolitan interest. In addition, however, the same article recognizes the PDU's ability to classify, qualify, and even develop the land needed to achieve its housing and economic activity goals, and may also specify determinations that can be executed directly. Finally, the PDU has also assigned as its objective the definition of "metropolitan land and housing policies, and also economic activity, to ensure inter-municipal solidarity in the implementation of affordable housing policies and public protection".

The PDU has 10 main objectives (AMB, BR, 2019), specified bellow:

1. Enforcing the metropolitan solidarity
2. Enhancing the metropolitan centrality
3. Re-naturing the territory, enhancing the values of the biophysical matrix
4. Improving the efficiency of urban metabolism and minimizing the environmental impacts
5. Assembling the territory from a polycentric structure
6. Enhancing an active and sustainable mobility, remodelling the metropolitan infrastructures
7. Enhancing the social cohesion through improving housing access, public space, equipment and public transport
8. Restoring and recycling urban tissue
9. Guarantee the urban complexity and liveability
10. Promoting the competitiveness and sustainability of metropolitan economy.

Related to the Llobregat study area, the plan considers the importance of the ecological structure within the metropolitan territory. The ecological structure is seen as an important axis related to water and includes the main hydrographic axes, water canals and the coastal line, but also the other areas related to hydrology: aquifers, wetlands, lagoons, coastal areas and beeches. These elements belong to the blue structure, but they are intrinsically related to the green infrastructure planning.

In order to assure the ecological functions and climate change adaptation, PDU considers as a priority the preservation of elements related to hydrological cycle and the natural coastal areas. Protecting these territorial resources, the quality and ecological connectivity of green areas will be also assured, together with its related biodiversity.

In the case of the two protected parks in the study area, there are various bodies and instruments of biodiversity conservation. For instance, the consortia of The Agrarian Park and Llobregat Delta are the Park's government and management bodies. Each consortium include Barcelona Provincial Council, Generalitat, various City Councils and other associations.

6.3.2 Experiences with participatory governance and citizen science (focus on UF-NBS)

PDU is, for now, the most advanced planning instrument which considered participatory processes at the metropolitan scale. Even if NBS are not specifically mentioned, various strategic points are related to this concept (i.e. ecological connectivity or urban metabolism).

Citizen science projects are not specifically related to the NBS concept in this study area, but they cover the Metropolitan Area or Catalonia. These specific research projects are mainly related to biodiversity, invasive species or phenology and they do not capture specific UF-NBS, participatory governance or influence on decision making process.

The citizen science project *Ritme natura* contains phenological observations (i.e. flowering) of various species (including trees), to help scientists studying the impact of climate changes on plants and animals (https://www.ritmenatura.cat/index-eng.htm). Other citizen science projects with important data on biodiversity are *Ornitho* (www.ornitho.cat) and *Ocells dels Jardins (Birds in the gardens)*, a citizen science project where the participants can learn how to identify and regularly count the birds in gardens, public parks, or even balconies (www.ocellsdelsjardins.cat).

At the scale of Catalonia, the future *Observatory of Natural Heritage* will generate and transfer knowledge and it will include complex data on the natural heritage in order to enhance or prioritise the management of natural areas.

With specific focus on the study area, it is expected that future collective data on new planning and governance approaches and on possible UF-NBS in the Lower Valley of Llobregat river to be collected by the **Living Lab Llobregat&Co** the participatory mapping created by AMB and CREAF in CLEARING HOUSE. The core of Llobregat&Co is the participatory process across a detailed map of the study area, with data related to ecosystem services, initiatives, barriers and opportunities for NBS, from various typology of stakeholders (research, administration, citizens or schools). The data are then geolocalized and introduced in a GIS. The map will show a complex landscape picture containing opportunities and challenges related to UF-NBS and other NBS over the territory. Llobregat&Co creates in this way a useful tool to visualise NBS for planners, researchers, but also for citizens. More information can be consulted here: https://blogs.amb.cat/metropolisbarcelona/ca/2020/10/19/clearing-house-i-llobregatco/.

6.3.3 Stakeholder mapping

Stakeholder name	Type of stakeholder	Description and website	Role in relation to green infrastructure/UF-NBS
AMB	Public (administration)	The Barcelona Metropolitan Area (AMB) is the public administration of the metropolitan area of Barcelona, which occupies 636 km² and encompasses 36 municipalities with more than 3.2 million inhabitants. https://www.amb.cat/s/home.html	The 636 km² that make up the metropolitan region are occupied by many urban settlements of various types, and a dense network of infrastructure and services. However, there is still a system of natural and agricultural spaces in this densely occupied territory, which covers more than 52% of its area and is full of environmental, productive and social values that benefit all its citizens. The AMB has influence in relation to the planning, design, maintenance and management of green infrastructure/UF-NBS. Stakeholders from various departments (Public Space, Infrastructures, Sustainability), including the actors responsible with shaping the PDU, were actively involved in CLEARING HOUSE co-design sessions.
CREAF	Public (research)	CREAF is a public research centre dedicated to terrestrial ecology, territorial analysis and global change, pursuing excellence in the production and dissemination of knowledge, in addition to the innovation, development, and transfer of methodologies.	CREAF research is involved in mapping, analysing and assessing the green infrastructure at various scales. Its focus is on biodiversity monitoring, ecosystem services and NBS. Various CREAF researchers are actively engaged in designing and planning various strategies at urban or metropolitan scale.
Metropolitan Laboratory of Ecology and	Public (research)	The Metropolitan Laboratory of Ecology and Territory of Barcelona (LET) is a project that seeks to contribute to develop new criteria, concepts, cartography, databases, models and indicators for the functional analysis of the	LET research is focused on urban planning, socio-economy and geography, with special focus on the Metropolitan Area of Barcelona. Researchers collaborate to the development of territorial

Territory of Barcelona (LET)		metropolitan system from a socio-ecological perspective, in order to influence public policies and land use planning. https://iermb.uab.cat/en/let-bcn-en/	indicators or to the design of policies and metropolitan governance (i.e. as members of Agenda urbana Catalana (Urban Agenda in Catalonia, which will implement the New Urban Agenda) or PDU.
URBAG (Integrated System Analysis of Urban Vegetation and Agriculture)	Public (research)	URBAG aims to determine to what degree green infrastructures can be a source of sustainable food, reduce environmental impacts, and promote a more efficient use of resources in urban regions. Funded by the Horizon 2020 European Research Council and hosted by ICTA-UAB. https://urbag.eu/	URBAG will take urban sustainability research into a new direction, aiming for a more integrated, systems-approach assessment than has been done up to now. The investigation will connect processes between the natural, socio-institutional, and the built environment, and is innovative in its multidisciplinary approach linking atmosphere science, agronomy, industrial ecology, and urban planning and policy.
Diputació de Barcelona (Barcelona Provincial Council)	Public (administration)	Local administration of the Province of Barcelona (with 311 municipalities); it has various competences over the territory. Barcelona Provincial Council´s Natural Parks Networks consists of 12 protected natural areas of significant scenic, ecological and cultural values. https://www.diba.cat/en/	Special interests in green infrastructure planning (see SITXELL https://www.sitxell.eu/en/default.asp, containing a complex information system on biodiversity and ecosystem services at provincial scale). It also contains a categorization and assessment of non-urban land based on the analysis of its ecological and socio-economic characteristics. Based on SITXELL data and cartography, Barcelona Province Council offers various resources and proposals of planning and management to the municipalities, to enhance projects of green infrastructure, biodiversity conservation and ecosystems restauration.
Generalitat of Catalonia	Public (Administration)	The Generalitat (Government of Catalonia) is the institutional system around which Catalonia's self-government is politically organised. https://web.gencat.cat/en/generalitat/	The Department of Natural heritage and Biodiversity is responsible of the management of 184 protected areas over Catalonia. Various plans begin to consider and include the assessment of the ecosystem services of various protected areas (i.e. Llobregat Delta).

Consortium of Llobregat Delta	Public (administration)	LLobregat Delta is part of the Natural Park Network of Barcelona Provincial Council, being a reservoir a biodiversity (especially birds) and ecosystem services in the Metropolitan Area of Barcelona. The Consortium is the park´s management and governance body. www.deltallobregat.cat	Llobregat Delta includes areas of huge natural values, such as Pineda de la Ricarda or Pineda de Can Camins (both important coastal pinewoods). It´s close to the El Prat Airport and Barcelona´s main urban nuclei. The area has different natural environments, while the end of Llobregat river is characterised by lagoons and wetlands, dunes and unspoiled beaches with dune vegetation.
Consortium of Baix Llobregat Agrarian Park	Public (Administration)	El Baix Llobregat Agrarian park is part of the Natural Park Network of Barcelona Provincial Council. The Agrarian Park Consortium is the park´s management and governance body and it was created in 1998. It aims to enhance agricultural activity through specific programmes that preserve the productive values of agricultural lands and promote the area´s high quality. The Park covers an area including 14 municipalities from Baix Llobregat county and spreads over more than 3.000 ha. https://parcs.diba.cat/es/web/baixllobregat	In the midst of the metropolitan area, the Agrarian Park is an economic hub for the production of fresh, local and seasonal food. It protects and enhance agricultural activity in the alluvial plains of the Llobregat Delta and the lower Llobregat valley.
City Councils	Public (administration)	City Councils belonging to the 13 municipalities of the study area (El Prat de Llobregat, Sant Boi de Llobregat, Cornellà de Llobregat, Sant Joan Despi, Sant Just Desvern, Sant Feliu de Llobregat, Sant Vicenç dels Horts, Molins de Rei, Pallejà, El Papiol, Corbera de Llobregat, Sant Andreu de la Barca, Castellbisbal)	Territorial (municipal) planning, management and governance of urban green areas. Some municipalities are also part of the Consortia of Llobregat Delta and Baix Llobregat Agrarian park.
*other stakeholders will include in the future local organizations related to territorial planning, biodiversity conservation, naturalists, citizen associations and schools, according to the co-design guidelines (De Vreese et al. 2020). *Social transformation* and *Gender perspective* in urban plans will be also tackled, as future stakeholders will include cooperative of architects, sociologists and urban planners. In case of *schools*, the methodologies will be differently designed and focused on disseminating CLEARING HOUSE educational material. Special emphasis will be given to synergies between the local schools and the City Councils. If possible, actions related to greening your schoolyard, especially related to trees or fruit trees planting will be considered.			

6.4 Looking forward

6.4.1 Strategic objectives in relation to UF-NBS

O1 **Increasing ecological connectivity**	It is necessary to strengthen the integrity of the main structuring elements of the green infrastructure and to guarantee, above all, that the territory achieves a good connectivity. Key points need to be improved, who are currently critical for connectivity, as well as places they can act as a passing space. Critical areas of ecological connectivity that threaten the green infrastructure in the area are already defined by PDU. With regard to the different streams and tributary torrents of the Llobregat the notable exception is the Riera de Vallvidrera, within the Serra de Collserola Natural Park, which, for the most part because it is located within a protected natural space, it reaches a good ecological status upstream with a very good riparian forest. In general, the streams are channelled in their last sections and have a significant difference in elevation in relation to the current elevation of the river due to its channelling. Intervention in these areas would improve ecological connectivity, and to a lesser extent, also social connectivity, as many of them are part of historical population centers and coincide with consolidated street layouts and routes. The work would focus on all these streams broadly, from their birth to their incorporation into the river. Other few patches of riparian forests are situated close to Molins del Rei or Sant Andreu de la Barca. Preserving and connecting these patches with other green typologies would increase landscape connectivity and favour biodiversity.
O2 **Enhancing knowledge on biodiversity and preserving the landscape values (i.e. cultural landscapes, agricultural landscapes, water related landscapes)**	The remnant cultural landscapes should be part of recovering the territory "cultural memory" and the associated biodiversity. This includes preserving food provision and increasing UF-NBS in the area. The agricultural activity of the Agrarian Park metropolitan area has a strategic value in the metropolitan area, and not only because it provides local food production, but also because it has play an important role in the water cycle, increase the complexity of the landscape, guarantee ecological functionality, increase biodiversity, order open spaces, reduces the danger of flooding and the danger of fire and helps to take advantage of the territory's own resources with a logic of green and circular economy. It will be necessary to preserve dryland agricultural landscapes and give relevance to the landscape related to water, rivers, wetlands and the coast. It will also be important to encourage the treatment of edges between urban tissues and open spaces, through the recovery of agriculture, restoring degraded contact strips, managing intensities of use or ordering peri-urban uses, among others.

	UF-NBS can be also related to preserving or recovering territorial "cultural memory" or past landscapes. The shrub fringes with Mediterranean species (i.e. Pistacia lentiscus) which limit the crops (in the Agrarian Park of Llobregat), are reservoirs of biodiversity (i.e. fauna) and have an important role in biological control of pests. Another possible UF-NBS related to agricultural landscape can be related to the recovery of certain Mediterranean species for croplands.
O3 **Better governance model**	There are many consortia and administrations involved in planning and governance of Llobregat river area. To achieve a better governance model, several crucial gaps should be tackled: How to enable institutional collaboration, connectivity and networks; How to include NBS in planning and policy frameworks at metropolitan level

6.4.2   Major barriers

One of the major barriers in this area is the lack of a well-defined governance model, which translates into an added difficulty in the planning, design and management of these spaces. In particular, a governance model shared by the main actors involved (multiple administrations, public operators and service companies) needs to be defined. Finally, the danger posed by river floods, the foreseeable scenarios of climate change that require specific planning and management, and the need to consider both high and low water regimes must also be taken into account.

On the other hand, with regard to the river exclusively, it was found an alteration of the ecological processes, such as the recharging capacity of the aquifer or the ecological connectivity. Other important barriers are: the urbanisation of the landscape and the river environment, the low phreatic level, the quality and the availability to water the vegetation, the management challenge posted by exotic species, landscape fragmentation and agricultural intensification, the lack of riparian forests (as potential river vegetation), and tree-related landscapes in general, insufficient conservation measures for coastal pinewoods outside the protected areas.

The insufficient knowledge weaving (Tengö et al. 2017, Basnou et a. 2020) related to certain concepts (i.e. NBS), especially when dealing with multidisciplinary actors, requires careful definitions and pedagogy related to the concept and its possible related actions in planning and governance.

6.4.3   Knowledge gaps

Co-design process has identified, so far, the following knowledge gaps, mainly related to research, planning and governance. Insufficient knowledge of biodiversity (certain groups) and data on key ES in the area , but also the need for a common ground for prioritization of biodiversity, ES and NBS at various administrative levels were identified in the first phases of co-design. Other knowledge gaps in this complex area are how to enable institutional collaboration, connectivity and networks at various levels; how to assess knowledge and better share information on NBS and related initiatives; how to include NBS in planning and policy frameworks at metropolitan level.

- Insufficient knowledge of biodiversity and data on key ES in the area

7 The Sonian City, Belgium

7.1 General information

7.1.1 Institutional framework and planning system

Belgium is a double federation of regions and communities (see Delwit and Deschouwer 2009) organized on a three-level institutional framework. At the top of the structure stands the Federal State, the Linguistic Communities, i.e. the Flemish-, French- and German-speaking communities; and the Regions, i.e. Brussels Capital Region-BCR, Flanders and Wallonia. These institutions have equal legal status, and different and exclusive competences. Broadly speaking the Federal State has competence over everything connected with the public interest, throughout the country. The Regions are competent within the respective regional boundaries for matters related to the territory (e.g. urbanism, mobility, development, environment...). The Communities are competent within the respective linguistic areas for people-related matters (e.g. culture, education, health...). It should be emphasized that the national government does not play a steering/coordination role, which is left to subnational (e.g. interregional) instances (i.e. this is referred to as "cooperation federalism"). The next institutional level consists of the provinces. The last level consists of the communes, which have extensive competences in directly providing services to the inhabitants.

The division of power between the different levels is based on the principle of subsidiarity and proportionality: the local level is to be considered as the level of principle for the allocation of powers and the higher authority which intends to take them away has to justify the increased efficiency (i.e. because of the subsidiarity principle) and the extent (i.e. because of the proportionality principle) of this restriction (Lagasse 2012, 1). The different (and possibly conflicting) driving forces and visions behind the process of federalization of the country, as well as the concurrent presence of two sorts of federated units with intersecting territorial jurisdictions has resulted in an asymmetrical institutional organization (see Swenden and Jans 2006, 884). In short, the country consists today of four territories characterized different institutional frameworks, namely Flanders, Wallonia, the German speaking zone, and the Brussels Capital Region (BCR).

The territory of the Sonian City spans different administrative boundaries. Relevant authorities include the local government of 11 municipalities; the provincial governments of the Flemish Brabant and the Walloon Brabant, and the regional governments of the Brussels Capital Region, Flanders and Wallonia. The federal government, and the Communities have certain competences in this territory, but play a rather indirect role considering that urban forestry is a matter of 'regional' competence in the Belgian Federal System. This administrative fragmentation implies that the planning approach is not uniform throughout the territory.

As already mentioned, the core of the Sonian City is the Sonian Forest. Since it spans across three regions, and because of its exceptional ecological status (e.g. it is not just urban greenspace but fully recognised as Natura 2000 area), its management framework is not directly integrated with other planning instruments but can be considered, as such, a policy instruments for enhancement and protection of UF-NBS.

In Brussels

In the BCR portion of the Sonian city, planning responsibilities fall under the jurisdiction of the Regional Government, and in particular of Brussels Planning Agency (perspective.brussels). The main role of the

agency is to act as a centre of expertise and the initiator of Brussels' regional development strategy. It is responsible for statistics, socio-economic information and strategic and regulatory planning in the Brussels Capital Region. In addition, it also brings together various strategic 'services' to ensure regional development. Key planning instruments & legislation include the following (https://perspective.brussels/fr/plans-et-reglements) :

<u>Strategic plans</u>

The strategic plans deal with various themes relating to spatial planning but also to economic, social, cultural, mobility and environmental development. They have an indicative value. This means that they constitute the framework to be respected by the public authorities but that they are not binding on third parties by themselves.

- the Regional Plan for Sustainable Development – PRDD (Fr: Plan Régional de Développement Durable)

- The Municipal Development Plan (Plan Communal de Développement- PCD).

<u>Regulatory plans</u>

- Regional Land Use Plan (Plan Régional d'Affectation du Sol -PRAS).

- The Master Plan (Plan d'Aménagement Directeur PAD)

- The Specific Land Use Plan (Plan Particulier d'Affectation du Sol - PPAS)

- The Municipal Development Plans (Plans de développement communaux PCD).

<u>Urban legislation</u>

- The Brussels Town and Country Planning Code (Code Bruxellois de l'Aménagement du Territoire CoBAT)

- The Regional Town Planning Regulations (Règlements Régionaux d'Urbanisme RRU)

- The Communal Town Planning Regulations (<u>Règlements Communaux d'Urbanisme</u> RCU).

In the Flemish part

<u>Regulatory plans</u>

- the Flemish Spatial Structure Plan (RSV, Ruimtelijk Structuurplan Vlaanderen)

- the provincial Strategic Spatial Plan for the Flemish Brabant (Povinciaal Ruimtelijk Structuurplan Vlaams Brabant (prspVB)

- The "Flemish Strategic area surrounding Brussels" (for parts of Sint-Genesius-Rode, Linkebeek, Tervuren)

- "Built-up peripheral landscape" (For Overijse, Hoeilaart, and other parts of Sint-Genesius-Rode)

- Gewestelijke RUPs (Regional Spatial Development Plan)

- Provinciale RUPs (Provincial Spatial Developmenbt Plans)

- Municipal RUP (only few exist, so not sure that there are in the Sonian City Perimeter)

- Gewestplan (Land Use Plan)

<u>Urban legislation in Flanders</u>

- Flemish level: Vlaamse Codex Ruimtelijke Ordening (Flemisch Codex Spatial Planning)

- Communal level – Municipal Building Regulation

7.1.2 *Experiences with participatory governance and citizen science*

Albeit not new, the concept of participatory governance, as an institutionalised process of citizen involvement in policy making is in its infancy . While different policies on the environment and support for citizen initiatives, both on a day-to-day basis and through structured programs such as local Agenda 21s or Sustainable Neighbourhood Contracts have been developed, these seem to be still at the trial and error stage in terms of how they interact and collaborate with new forms of citizen engagement. According to the declarations of the current Brussels regional government, elected in 2019, participation should be streamlined. The government intends to create a participation department, in charge of piloting the processes of citizen participation, particularly with regard to the PADs, major urban developments, Urban Renewal Contracts and in support, if necessary, of the municipalities concerning the Neighbourhood Contracts. This department will develop methodologies adapted to the projects and will be in charge of organising the places and times of exchanges between the different stakeholders in the participation process (Déclaration de politique générale commune au Gouvernement de la Région de Bruxelles-Capitale et au Collège réuni de la Commission communautaire commune 2019-2024)

Today, it is mainly at the communal level that the new forms of participatory governance seemingly take place. Most communes in the areas have a deputy mayor charged with participation, and different initiatives. A recent action-research project (VILCO, from ville collaborative, collaborative city) has been working precisely on the interaction between public authorities and collective citizen initiatives, observing local dynamics and testing new modes of governance characterised by the fact of being 'with the citizens', rather than just 'for the citizens'. Overall, the project aimed to highlight the levers that promote and improve collaboration between their different actors. Hence the idea of the "collaborative city" (VILCO). Different new models were tested. For instance the neighbourhood advisory councils, a gathering of 30 citizens per neighbourhood with a one year mandate, serving as an interlocutor between the residents of a neighbourhood and local elected officials (and vice versa). In other cases it was a matter of improving communication between the city and the citizens, for instance through the organisation of inclusive neighbourhood workshop where the deputy mayors would meet a neighbourhood's residents, or through a 'guided tour' in the administration, by means of following a practical case of request addressed to the municipality. In other cases, simple ad hoc collaboration process for the use of public buildings, or for the organisation of events in the public space where organised (https://www.cocreate.brussels/projet/vilco/,

http://vilco.brussels/wp-content/uploads/2020/07/2020-05_VILCO_RapportRecherche_Web.pdf)

Citizen science, as a specific form of citizen participation, is becoming increasingly popular in the area. In the last years there has been a wealth of Citizen Science projects initiated – or supported – by public authorities wishing to inform and monitor their actions. For example, with the ExpAIR project, Brussels Environment conducted, with the support of the NGO BRAL, campaigns for participatory measurements of black carbon pollution. The "Observatoire du vélo" based on the counting by the citizens was launched by the association Pro Velo and financed by Brussels Mobility. Other projects concern for instance the identification of vulnerable species conducted by various governmental actors, in collaboration with environmental NGOs like Natagora and Natuurpunt (see for instance Chemin et al., 2019). At the level of the Brussels Capital region, an important venue to promote citizen science the Co-Create funding scheme of Brussels agency for research and innovation (Innoviris). Created in 2015, the scheme, in particular, brings together actors from academia, civil society (including established NGOs as well as citizen movement and informal networks), with the explicit objective to co-create knowledge and social innovation. Issued from a research agency, the primary objective of the scheme remains scientific research, that is: generating new knowledge. At the same time, the broad theme that the scheme has been funding in the last years (i.e. urban resilience), the explicit call for experimentation and co-creation make it so that the projects funded have been aiming at changing the city. Other financial schemes such as JPI-Urban Europe, the Flemish EWI Oproep Citizen Science among others also foster the development of Citizen Science by financing projects covering a wide range of thematic foci, from entomology (e.g. ValueBugs, SPIN-CITY), to meteorology (e.g. Knappe k(n)open, VLINDER), agro-food practices (e.g. SPIN-coop, UltraTree, Cozy Food), air pollution (e.g. AirCasting Brussels, CurieuzeNeuze, AirBezen), traffic safety (e.g. Looper, fiets-STEM) and many others.

7.1.3 Socio-economic profile

The analysis of the socio-economic profile of the Sonian City is critically hampered by the fact that data collection and availability is dispersed through three regions, resulting in reduced comparability. Scientific and policy literature that takes cross-regional geographical scale is also rare, making difficult to deconstruct existing boundaries and create new ones. For the purpose of this document, thus, we build on the research that has been carried out at different scales that overlap with the area under scrutiny and which can provide interesting insights: the "zone RER" (e.g 135 municipalities that will be directly affected by the new rail service offered by the regional express network) the functional urban area as defined by the OECD (99 municipalities linked around brussels by significant commuting flows), the Brussels Capital Region (19 municipalities within the regional territory)...

The Sonian City and the Sonian Forest are located in the south-eastern part of a metropolitan area of about 2.5 - 3 mio inhabitant, gravitating around Brussels (the number differ depending on the boundaries considered (e.g. OECD functional area, RER zone are considered). The morphology of the agglomeration is determined by the historical development which proceeds in concentric circles, from Brussels city centre to the first and second ring roads and then to the suburbs, characterised by urbanisation around small, closely spaced cores.

From a social and demographic perspective, the area is characterised by a strong duality between the urban core (the Brussels Capital Region) and the periphery, which again follows different paths in the Flemish and in the Walloon parts of the zone. In terms of population density, the centre of gravity of the metropolitan areas is located in the very heart of the BCR. High values are also achieved in areas

of secondary cities. Overall, the densities are lower in Wallonia, as opposed to the Flemish part of the area characterised by scattered housing.

Population growth in the metropolitan core (i.e. Brussels region) has been faster than in other regions, especially in the early 2000s: almost three times that of the Walloon region and more than twice that of the Flemish region (albeit still positive, the population growth rate has now decreased, even below expectations). The metropolitan fringes remain relatively dynamic. For example, Walloon Brabant is growing at almost twice the rate of the Walloon region. There is also a clear difference in terms of age structure, with the BCR presenting a relatively young population.

Jobs seem to be relatively evenly distributed, half in the core, half in the rest of the area. The nature of the Brussels socio-economy is expressed by the fact that more than a half of the 730.000 jobs present in the capital is taken by people living in the rest of the country, with a large share of them in the provinces of Flemish Brabant and Walloon Brabant. In recent years, though, absolute numbers of jobs are increasing in the fringes, though, as a result of an expansion of the metropolitan area. In terms of unemployment, this is particularly high in Brussels (up to 30% of unemployed jobseekers in some areas). A strong contrast can be observed between Flanders and Wallonia, with neighbourhoods with 10 to 20% unemployed jobseekers are much more common in Wallonia than in Flanders.

Concerning the wealth index (average tax income per inhabitant, standardised according to the Belgian average=100), the municipalities in the centre of the BCR and some other peripheral municipalities in the RER zone register figures below the national average. The very high ratio of commuters within the employed population, makes it possible for Brussels to be the national economy powerhouse (17.7% of the GDP, but only 10.5% of the population), and yet a relatively poor region. The average income is lower than in the other regions (14.372 euros per capita, vs 18.331 euros at the national level). 32.6% of Brussels residents live below the at-risk-of-poverty line. The rest of the RER zone scores better than the Belgian average, with the provinces of Flemish Brabant and of Walloon Brabant presenting the highest average income in the country (21.963 and 21.576 euros per person, respectively). The area **around the Sonian fores**t, stands out in the map as one of the most affluent. The population is highly qualified with a very high average taxable income, the housing market is the most expensive, there is little unemployment and little share of blue-collar workers (And this is probably an underestimation, as international civil servants that live in Belgium do not have to pay taxes to Belgium, and as such are not included in the statistics. Quite some of them live in the Sonian City perimeter.

7.2 Geography of UF-NBS

7.2.1 State of (peri)urban forests, green infrastructure and urban greenspace

Understanding the Sonian City, in fact, requires a combined analysis of both the state of the forest (e.g. the urbanisation pressure on forest ecosystems) and of the state of the city (e.g. the place of trees ecosystems within the urban-socioecology).

The Sonian forest is located in the area of influence of the Brussels urban area, as well as occupying a central position with respect to the North Western Metropolitan Area (an elliptic configuration delimited by cities such as Antwerp, Ghent, Kortrijk, Lille, Mons, Charleroi, Namur, Liège, Maastricht...). The forest is the only large-scale wooded area between the Belgian coast and the Sambre and Meuse valley, with no large-scale ecological relay of similar proportions within 60 km of its edge (the only one being the Meerdaalwoud-Heverleebos, 25 km east andabout half of the size). As opposed to other

forest in rural or mountain settings, the Sonian Forest is thus characterised by ecosystemic linkages whose continuity is strongly influenced by the surrounding developed land – buildings as well as many mobility networks.

In the context of the preparation of the 2008 structural framework for the management of the Sonian forest, an in depth study of the ecological structure of the forest has brought to light the main threats to the forest. The first threat was found to be related to the mobility infrastructure that crosses and passes nearby. Some of these roads are expressways where traffic passes day and night, resulting in light and sound nuisances and high animal mortality. The ecological structure is fragmented and loses its indispensable coherence. The numerous roads crossing the forest also have an impact on the quality of surface and ground water. The second is related to recreative pressure. The forest is the green lung of the capital, located only ten kilometres from the city centre. While this a chance for its inhabitants and people living in the outskirts to get in touch with nature, it also means that the forest suffers from recreational over-pressure and significant disturbance. Albeit critical to fully understand the current conditions of the forest, it is less relevant here, for it is more a global problem, rather than an issue related to the city-forest interface.

At the same time, the embeddedness of the Sonian forest in the urban fabric, implies that it is not sufficient to look into how urbanisation represents a pressure onto the forest but look into how the forest stretches into the city. This analysis requires a discursive shift and an effort to broaden the categories of analysis, where virtually all urban trees and urban green spaces (and not only the remnants of the millenary forest) become the dots to be linked to draw the portray of the Sonian city.

According to the most recent Brussels's State of the Environment report (State of the Environnement report 2016), one of the major challenges facing the Region is to preserve the supply of accessible green spaces per inhabitant and improve their distribution by developing new parks in the dense and poorly green areas of the Pentagon (within the 1st ring road) and the inner suburbs. The creation of green corridors linking green spaces together also increases the presence of nature in the city and strengthens the resilience of ecosystems. Research based on remote sensing (Van de Voorde et al 2010, data of 2008), indicates that vegetation covers 54% of the regional territory, making Brussels a rather green city. At the same time, important inequalities are present throughout the regional territory: this number drops to 30% in the first belt (premiere couronne), and even to 10% in the city centre. In addition, it should be noted that a large share of these green areas are inaccessible to the public (private gardens or estates, spaces associated with roads, railway embankments, housing complexes, etc.). A 2009 inventory (BRAT 2009) calculates that only 19% of the regional territory could be considered as green public space, which means a regional average of 28 m2/habitant, a number that drops to 13 m2/habitant, if the Brussels parts of the Sonian forest are excluded.

In addition to the sheer scarcity of the green spaces in the city, an important challenge is constituted by their fragmentation within the urban landscape. When measured in terms of proximity (i.e. >10m) to green spaces of similar features, lacking connectivity is a problem for the central areas of the city as well as for the green spaces of the type "open" (e.g. lawns, meadows, farmland). For "closed" green spaces (e.g. woods, parks and gardens with trees and bushes) the problem is minor, and only concerns about 30% of the green spaces. For those kind of green spaces, the problem is not much the lack of proximity, but to the change of natural habitat type, as well as to the presence of physical barriers such as roads and fences.

7.2.2   Projects and initiatives

From the mapping we conducted, we observe different types of actions, including projects (Defined with a beginning and an end), as well as ongoing initiatives. In most of the initiatives listed here, trees and tree-ecosystems are explicitly present in the action (Directly managing park-based green spaces, directly managing green spaces & trees in public spaces non classified as parks, managing urban greenery / taking a broad approach to a city-region). In some cases the enhancement of tree-ecosystems is not an explicit/direct objective of the initiative, but a side effect or it is instrumental to another objective.

Name	Description
Green infrastructure / Maillage Vert & Bleu https://environnement.brussels/thematiques/espaces-verts-et-biodiversite/action-de-la-region/les-maillages	It has been established since the years 2000 and has benefited from a Life-Nature programme (LIFE/NAT /B/5167 1998-2001) (Bruxelles Environnement, undated; IBGE, 2000). A green path 'Promenade Verte' rehabilitates an abandoned railway as a connection between urban parks, semi-natural sites, nature reserves and woodlands in a circle of about 60 km around Brussels. Additional measures include developing a public access strategy for the urban green space; strengthening the presence of nature in public spaces, buildings and their surroundings; development of the ecological network; multifunctional management of green spaces; ecological management of areas linked to transport infrastructure; improve connectivity for fauna.
LIFE OZONE	From July 2013 to June 2018, the Life+ OZON project worked thoroughly on the ecological fragmentation of the Sonian Forest. With the support of the European structural fund Life+, in a broad partnership across powers, levels of government and regions. The OZON project aimed to reconnect ecological hotspots and habitats of different target species by creating infrastructure (ecoduct, ecotunnels and ecorasters) that includes the development from study to construction. In addition attention was also paid to the nature-friendly redevelopment of the forest edges with extra open zones and mantle and zoom vegetation, in combination with the construction of ecorasters and wildlife sanctuaries. Given the increasing disruptive effect of recreation on the Sonian Forest, the project has been looking at how recreation can be shifted to less disruptive zones and thus away from fragmented infrastructure. Through monitoring and communication, the project will be monitored before, during and after.
Strategic project Horizon+ https://www.vlaamsbrabant.be/wonen-milieu/wonen-en-ruimtelijke-ordening/projecten/gebiedsgerichte-projectwerking/horizonplus/index.jsp	Large strategic project of the Flemish region the Vlaams Brabant. The Horizon+ strategic project aims to robust and coherent open space network in the Sonian Forest region. Connectivity with the Forêt de Soignes (Sonian Forest) within the strongly built-up landscape is of paramount importance. This connectivity will take shape through the development of the gates to the Sonian Forest, through the realization of open space connections and through the coordination of the built-up offer. On the one hand, the gates serve to streamline the recreational pressure on the nature reserve and, on the other hand, the gates form levers for core reinforcement. The open space connections

	are provided between the Sonian Forest and the blue-green network of the Molenbeek, the Ijse and the Voer. These connections form the carriers of a robust, cohesive open space network in which recreational co-use and other ecosystem services are embedded.
Renforcement du Réseau Ecologique Bruxellois https://www.21solutions.eu/renforcement-du-reseau-ecologique-bruxellois-reb/	Exploratory project of the region to map, and pilot test projects to reinforce the Brussels ecological network. A first phase of the project brings together different actors (public, private, associations...) in predefined neighborhoods in order to highlight the different issues related to the socio-urbanistic context and to identify potential unoccupied and/or neglected sites that can contribute to the networking of the ecological network. A second phase concerns the concrete implementation of projects allowing the development of biodiversity and a possible opening of the site to the public, in priority on the basis of the feasibility studies carried out during the first phase. A separate work package aims to improve knowledge of Brussels' private gardens, to identify the brakes and levers of action, in order to formulate recommendations and ways of working to optimize their integration into the Brussels ecological network, while aiming at the regional objective of abandoning pesticides (two separate streams, focusing respectively on amateur "gardeners", and on landscape professionals who maintain this type of space.
Des parcs faits pour leurs utilisateurs https://environnement.brussels/thematiques/espaces-verts-et-biodiversite/les-parcs-et-jardins/des-parcs-faits-pour-leurs	To contribute to the revitalization of vulnerable and difficult neighbourhoods in the city and to improve the quality of life, Brussels Environment has started to create new neighbourhood green spaces in these highly urbanised and densely populated areas. .In order for the local population to feel comfortable in these parks, to make them the seat of social life, to make them their own and take care of them, they were involved in their design, realization and management. Examples of coproduced parks, with different approach include: le parc Bonnevie, le parc de la Rosée, le square des Ursulines, le parc Gaucheret, les jardins du Carré Tillens and le parc de la Porte de Hal
Tour & taxis parc http://www.parckfarm.be/	9 ha green area established in 2015 on a previous brown site (former railway terminus station). A good example of multi purposes and participative green spaces (buildings integration with green areas and social activities (urban agriculture) managed by citizens and a local association. Park design has been granted as best management initiative in 2015-
Scheutbos http://www.scheutbos.be/	The Scheutbos is a green space of 50ha located in Molenbeek. The site has been classified for its landscape qualities and its great biodiversity. The Friends of the Scheutbos (not for profit association) organize numerous thematic guided tours, maintain biological inventories and share management activities with the Commune.
Drohme - House of the Forest http://www.drohme.be/	Managing a multifunctional portal to the Sonian Forest (Natura 2000 site) combining leisure activities, nature awareness and conservation, scientific activities, cultural activities. (very contested!)
Plan Vliegend hert	Project description: 'Plan Stag Beetle' is an alliance of various local actors. The main objective of the partnership is the qualitative connection and strengthening of the remaining nature and open space in the Sonian municipalities on Flemish territory (Overijse,

|	
	Hoeilaart, Tervuren, Sint-Genesius-Rode). The focus is also strongly on increasing support for nature and landscape development, both among residents and recreational users. The ambition is to make people more aware of the value of the nature around them and to use this awareness as a lever to realise more nature.
Week van het Bos www.weekvanhetbos.be	Week van het Bos (Forest Week, 1979 - ...) is a week of activities for children and youngsters in and around parks and green spaces. This is initiative is mainly active in the Flemish Region (as it is run by the Flemish Agency for Nature and Forest and the Flemish NGO BOS+). The local ngo Nature Group Sonian Forest is organising lots of activities yearly during October for school children.

CO-NATURE
https://www.co-nature.org/
	This 4-year research project is a collaboration between the ULB and VUB and works with Bruxelles Environnement and BMA bouwmeester maître architecte for feedback and support. The project will pursue three principle objectives, and their interactions, as building blocks of the project.
	   − An inventory, classification and suitability mapping of Nature-Based Solutions for urban regeneration
	   − An understanding of urban green space use and valuation from the perspective of cultural ecosystem services
	   − Co-producing alternative scenarios through participatory research-by-design workshops for developing Nature based Urban Design and policy guidelines

Strategic Project WALDEN	The project aims to create a national park. This would correspond to an area of approximately 10,000 hectares from the Dijle valley, the Meerdaal forest and the Heverlee forest across the Sonian Forest to the Hallerbos. In this way, we are creating a gigantic green lung for Flemish Brabant and Brussels.
Bomencharter https://www.bomencharter.be/	Through the Tree Charter, cities and municipalities undertake to obtain a certain number of additional trees ('the target') on the territory of the city/municipality. The Tree Charter is therefore an instrument to obtain more trees in Flanders. In this way, the Tree Charter symbolises the collective fight we are waging against global warming. Counting the number of planted trees is an essential part of the Tree Charter. The Tree Charter covers the period 2019 - 2024.
Strategisch project Zennevallei https://www.vlaamsbrabant.be/nl/ruimtelijke-planning/projecten/strategisch-project-zennevallei	The project works to prepare the Zenne Valley between Lembeek (Halle) and Ruisbroek (Sint-Pieters-Leeuw) for the future by bringing nature, housing and the economy closer together. In particular, it takes into account: Climate change, demographic growth, spatial fragmentation of space, economical use of space. This takes place through maximising the Zennebeem path and making connections between the centre of Ruisbroek and Drogenbos for slow traffic; creating more space for the Zenne, with a landscape of dry and wet zones, running and stagnant water and tall and longitudinal trunk vegetation; create opportunities for short-chain agriculture; making natural areas around the Zenne more visible; use the landscape for water storage where possible and necessary, to soften the noise of the ring road.

Sonian Wood Coop	The Sonian Wood Coop works with forest owners, sawmills, carpenters and other partners to keep the wood from the Sonian Forest as local as possible. The SWC makes a point to consider the Sonian Forest as a common good that needs to be managed with respect and responsibility. To create a local alternative to the export of Sonian wood to Asia, the cooperative was launched in 2019. The mission of the Sonian Wood Coop is to relocate the transformation of the wood from the Sonian Forest.

Some reflections on the combined impact of the projects and initiatives listed above

The Sonian City is characterised by a wealth of projects related to the urban forest, each characterised by a different actual impact. Given the fragmentation of these projects, and the difference in their nature, make the combined impact very difficult to fully comprehend (if it is possible to speak of combined impact at all).

From an analysis of the project, and from the results of a consultation with stakeholders, different considerations can be made in relation to what these projects do not deliver:

- A coherent vision for the urban and metropolitan forest: a fragmentation among projects is a problem in itself. While many of them might be successful in changing a neighbourhood (or preserving it), the lack of coherence makes it difficult not only to understand, but also to exploit the full regulating, provisioning, cultural and supporting potential of the urban forest.

Related to this, is the fact that there is still a certain separation between green spaces and the city. While trees ecosystems in green spaces are managed and enhanced by the regional environment protection agency as an environmental question, those outside of the green space parcels are not (e.g. on streets and in private gardens).

7.3 Government and governance of UF-NBS

7.3.1 Policy instruments for enhancement and protection of UF-NBS

As far as the core area is concerned, one of the most important policy instrument is the "Natura 2000" network, in which the 'core' part of the forest and some neighbouring green areas are registered. Natura 2000 is a European network of natural or semi-natural sites important for both the fauna and flora that live there. In Brussels, these sites are also called "Special Areas of Conservation (Zones Spéciales de Conservation ZSC) . Unlike many nature reserves, Natura 2000 areas are not "closed" reserves. Human activities are still allowed as long as they do not compromise the "objectives for nature" in the area. The whole of the Sonian Forest core is part of the Natura 2000 network, as well as a a series of green areas around.

Map3. Natura 2000 sites and the CLEARING HOUSE boundaries

Legend:
- Natura 2000 sites in Belgium
- NATURA 2000 sites
- CLEARING HOUSE focus area
- Municipal boundaries

0   2.5   5 km
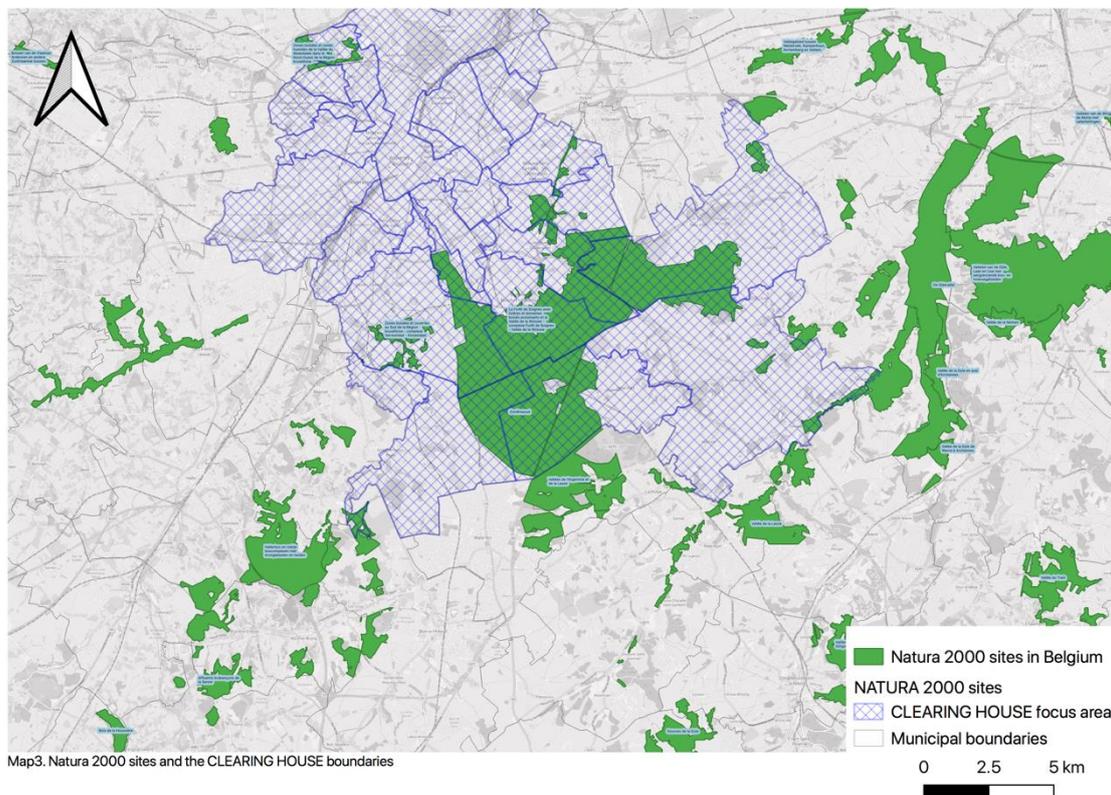
Similarly to other sections of this document, also in the context of the policy instruments for enhancement and protection of UF-NBS, there is an important demarcation between the Sonian Forest, as officially demarcated ("the core"), and the neighbouring of the area.

For the Sonian Forest, different policy instruments are relevant, both at the level of the individual regions, and a both at the interregional level. From an institutional perspective, 56% of the area of the Sonian Forest is administered by the Flemish Region (Agentschap voor Natuur en Bos), 38% by the Brussels-Capital Region (Brussels Environment) and 6% by the Walloon Region (Nature and Forests Division). In addition to these three administrations, there are properties on the periphery managed

by the Royal Donation (the Tervuren Park) and the Solvay Foundation (Solvay Park at La Hulpe), as well as various private estates partly forested.

Accordingly, the Sonian Forest is treated in the planning documents of the three regions (see also section 5.1.1 above). Every region also has a management plan for the portion of forest under their jurisdiction. In addition, to foster cooperation between the different regions, the "Structural vision for the Sonian Forest ("Schéma de structure de la forêt de Soignes") has been drawn up. Even if the Regions remain fully competent for the management and execution of initiatives on their respective territories, the Structural Plan develops a common framework for combating the threats to the Forêt de Soignes. To coordinate the implementation of the Structural Plan, in addition, the Regional Authorities have decided to establish a permanent cooperation platform, in the form of the Sonian Forest foundation.

In Brussels

For the city/forest areas surrounding this forest core, the landscape of policies and regulations impacting UF-NBS is much more fragmented. In addition to the broader planning instruments introduced above, a number of policies are specifically relevant in the context of the enhancement of UF-NBS.

Within more general policy tools (i.e. not immediately targeting the environment).

- **Regional Land Use Plan (Plan Régional d'Affectation du Sol - PRAS)**

The PRAS makes it possible to define the zones of forest affectation. Its limit is the possibility of having it modified rather easily (see for instance the case of the Boistfort Hyppodrome, where it was rather easy to change land use destination, to justify the presence of a car park).

- **The Regional Town Planning Regulations (RRU)**

A number of provisions are relevant for ecological connectivity. For instance, by preventing further development inside of building blocks, which is important to enhance the ecological continuity throughout the city. Its limitation is that numerous derogations are made. Other provisions include the obligation to make green roofs on all flat roofs (new or in case of major renovation) of more than 100 sqm; as well as the obligation to leave permeable at least 25 % of a parcels under construction.

- **Regional Plan for Sustainable Development (PRDD)**

PRDD/ GPDO: divides spatial planning and regional projects into four major themes. Pillar 2 is particularly important for this study: Deploying the territory for the development of a pleasant, sustainable and attractive living environment.

Specifically in relation to nature

- **Municipal Climate Plan**

The communes within the Brussels Capital Region are eligible to receive regional funding to develop their own municipality-specific climate plan, which includes a 'Tree strategy' . Two municipalities have already obtained a budget for this.

- **Ordonnance nature** (1er MARS 2012. -Ordonnance relative à la conservation de la nature).

The purpose of this Ordinance is to contribute to the conservation and sustainable use of the components of biological diversity through measures to protect, manage, enhance and restore populations of species of wild flora and fauna and their habitats, natural habitats and terrestrial and aquatic ecosystems, and to maintain or restore the quality of the environment required for this purpose. (art.1)

- **Ordonnance pesticides**

Ordinance of 20 June 2013 on the use of pesticides compatible with sustainable development in the Brussels-Capital Region

- **Plan Nature**

Adopted by the Government on 14 April 2016, the Nature Plan proposes a vision for the development of nature and biodiversity in the Brussels Region by 2050. It uses maps and other information to illustrate the desired evolution of nature and biodiversity in the Brussels-Capital Region. In order to make progress in this direction, objectives for 2020 have also been defined, supported by concrete measures.

- **The Green network strategy**

In this context, the concept of "maillage vert" (the green network) used by the Brussels Capital Region to protect and enhance green spaces in the city is particularly relevant. The concept refer to a strategy to improve the supply and quality of green spaces, for an enhanced environment and quality of life in the Brussels Region

- **Coalition Agreement Brussels Government (Déclaration de politique générale commune au Gouvernement de la Région de Bruxelles-Capitale et au Collège réuni de la Commission communautaire commune 2019-2024)**

Practically, speaking this is the political programme of the current regional government. UF-NBS are included in different parts of it: Axe 1.a, for instance, pledges to make sure that every BCR residents is able to access, within a ten-minute walk from his home, a green space. Axe 2 makes the connection between mobility & green networks a priority to achieve economic, social and environmental transition (with a 2050 horizon).

In Flanders

There is extensive legislation that has an impact on nature, forests and spatial planning in Flanders (VEN/IVON/SBZ, AGNAS afbakeningsprocessen, etc.) European legislation on land use, land-use change, and forestry (see for instance https://www.ecopedia.be/node/40546 and https://www.natuurenbos.be/beleid-wetgeving/natuurbeheer/beheerplan/wetgeving)

- **Flemish coalition agreement**

The political programme of the Flemish Government elected in 2019 includes a pledge to plant 4.000 ha of additional forests in Flanders by 2024, and 10.000 ha by 2030. It also include a pledge to plant 1.000.000 additional trees in Flemish Brabant by 2024.

- **Vision statement Spatial Development Province Flemish Brabant (Visienota Ruimte Vlaams-Brabant)**

It includes policies concerning open space, with the objective of protecting and strengthening large natural spaces, enhancing the green-blue networks crossing the territory, and the clearance of agricultural land. According to this policy note, the high-dynamic corridors, which accommodate growth in terms of housing and work, are the hard backbone. The network of river and stream valleys, forests and agricultural areas are considered to be the soft backbone for spatial developments in which ecosystemic links are strengthened.

- **Urban planning regulations**

In urban planning regulations, there are a number of subdivision rules and similar provisions, e.g. for residential parks, which prescribe a certain minimum level of 'high-density greenery'. One of the stakeholders we interviewed, however, noted how these are widely interpretable and hardly ever checked.

7.3.2 *Experiences with participatory governance and citizen science (focus on UF-NBS)*

The natural environment has been long be a place an area of inquiry for citizen science. In the area under scrutiny a number projects are worth attention.

Renforcement du Réseau Ecologique Bruxellois

The project was already introduced above. It is worth to further illustrate the element of participation that is included in the project. The objective of this pilot project is the definition of a nature development strategy for each district that is integrated into the Brussels Ecological Network. At the level of the neighbourhood, these strategies will lead to the development of concrete projects through the development of green spaces.

Observations.be

One of the flagship projects in Belgium are the portals www.waarnemingen.be in Dutch, and www.observations.be in french, developed in 2008 on the initiative of Natuurpunt, Stichting Natuurinformatie and Aves-Natagora. In these portals, everyone can encode their own observations about local flora and fauna).

Woodwide web

Another interesting project, launched by the civil society, is the Wood Wide Web. The project consists of an dynamic, interactive, crossmedia inventory of remarkable trees across the regional territory. While the inventory has been partially fed by existing databases, it is also open for contribution by citizens and associations, which can contribute in completing it with their "story" and images.

Citizens mobilisations

In addition to "projects" and institutionally-backed activities to enhance ecological connectivity it is also worth introducing a series of examples of citizens mobilisation to protect tree ecosystems in Brussels, from land speculations and urban development plans. A recent article by the local magazine BRUZZ has listed the most important ones (https://www.bruzz.be/milieu/groen-maar-hoe-lang-nog-negen-bedreigde-plekken-brussel-2020-02-19)

- Citizen mobilisation at Engelandplateau (Ukkel)
- Citizen mobilisation at Witte vrouwen (Sint- Pieters-Woluwe)
- Citizen mobilisation at Josaphat (Schaarbeek-Evere)
- Citizen mobilisation at Schaarbeek-Vorming (Brussel)
- Citizen mobilisation at Donderberg (Laken)
- Citizen mobilisation at the Plaine green area (Elsene)
- Citizen mobilisation at Georginbos (Schaarbeek)
- Citizen mobilisation for the Wiels Swamps (Vorst)
- Reclaim the park / Bois de la Cambre

Places of contestation (source: BRUZZ, author: N. da Schio)

7.3.3 Stakeholder mapping

Stakeholder name	Type of stakeholder	Description and website (ca. 100 words per actor)
Brussels Environment (environment protection agency of the Brussels Region)	Public	The Brussels Institute for Environmental Protection is the environmental protection agency of the Brussels Capital Region. Since 1989, Brussels Environment (IBGE) is the official environmental managing authority for the Brussels region and is responsible for implementing and supporting all environmental policies for a sustainable development of the region. IBGE's field of activity covers the urban environment in its widest sense: air quality; climate change; energy; soil; noise pollution; electromagnetic wave; waste management planning; production, construction and sustainable consumption; nature and biodiversity: animal well-being; management of non-navigable watercourses. It is also responsible for all the regional services dealing with the design and management of green spaces (i.e. almost 70% of the region's public green spaces). In Brussels it acts as the focal point for the management of UF-NBS, as well as for the direct management of the Sonian Forest. https://www.natuurenbos.be/
Perspective Brussels (urban planning agency of the Brussels Region)	Public	Perspective Brussels (official name: Bureau bruxellois de la planification) is a regional multidisciplinary agency and the centre of expertise and initiator of Brussels' regional development strategy. It is responsible for statistics, socio-economic information and strategic and regulatory planning in the Brussels-Capital Region. In addition to these roles, the institution also brings together various strategic 'services' to ensure regional development: the team of the Brussels chief architect (bMa), the Schools Facilitator and his team and the new Housing Officer. The combination of different forms of expertise at perspective.brussels helps ensure a coherent process for the development of urban projects.
Horizon +	Public	Horizon+ is not an institution as such, but a project to establish a partnership between the province of Vlaams-Brabant, the Flemish government, Regional Landscape Dijleland and the municipalities of Overijse, Hoeilaart, Sint-Genesius-Rode and Tervuren. Within Horizon+, these actors work intensively together to improve connectivity with the Sonian Forest. The Horizon+ project team consists of employees of the Vlaams Brabant province, Natuurinvest in the name of ANB and Regional Landscape Dijleland. The province of Flemish Brabant is the legal representative of the partnership.
Agentschap voor Natuur en Bos (ANB) of the Flemish region	Public	ANB is responsible for the policy, sustainable management, and the conservation, protection and development of nature in Flanders. Together with many different partners, the agency works to create greater support for nature. ANB is the largest owner of green spaces in Flanders. It manages 42,300 hectares of its own forests, nature reserves and domains. Since it also helps others to manage their domains, ANB manages a total of some 80,000 hectares of forest and nature reserves.
Department Omgeving, of the Flemish region	Public	The Department Omgeving (Environment Department) of the Flemish region was created in April 2017, from a merger of the Environment, Nature and Energy, and the Flemish Spatial Department. It is responsible for the realisation of a high-quality living environment; the development of an integrated environmental policy (space, environment, nature and energy) aimed at policy preparation and implementation, broadening support, enforcement of regulations and policy evaluation; cooperation with cities, municipalities and provinces for local environmental policy. https://omgeving.vlaanderen.be/
Natuurinvest	Public/private	Natuurinvest is a service provider that works to exploit financially nature in Flanders, on behalf of ANB. Using the resources such as from selling wood from regional forests, Natuurinvest invests in knowledge programmes and nature experiences. In this way, we contribute to a greener Flanders. https://www.natuurinvest.be/

Municipal governments	Public	In the context of UF-NBS (As well as for other themes), municipalities are the smallest administrative unit in the Belgian institutional framework, and the first point of contact for citizens. In particular, municipal governments (communes) are responsible for the municipal green spaces. In some cases it is municipal staff directly maintaining them, while in other the regional agency is asked to do so. The area under scrutiny includes Hoeilaart, Overijse, Tervuren, Sint-Genesius-Rode (in Flanders); Uccle, Watermael-Boitsfort, Auderghem, Woluwe-Saint-Pierre, Bruxelles (for the Brussels Capital Region); La Hulpe et Waterloo (for Wallonia)
Sonian Forest Foundation	Public	The Sonian Forest Foundation was established as a permanent platform to coordinate the implementation of the Structural Plan for the Sonian Forest. Its mission consists of: to coordinate of the implementation of the Structure Scheme (and its implementation), including public participation and communication aspects; to monitor projects, both technically and in terms of content, and to seek (co)financing; the creation and management of a public visitor centre; the creation and management of a documentation service on the Sonian Forest.
The Civil Society	non profit	There is a wide range of civil society actors directly and indirectly involved in the implementation of UF-NBS in the study area: in some cases they are collaborating with other public and private actors to implement projects, in other cases they make the link between citizens and institutions, in other cases yet they mobilise in defence of UF-NBS and they do so against governmental institutions or private actors. Also thanks to the support of the EU LIFE fund, some forms of cooperation were established at the level of the Sonian Forest (e.g. the meetings on management plans, establishment of a participatory platform, improved public information, etc.). The NGO Brussels Nature (« Bruxelles Nature - Brussel Natuur ») is another example of networking effort, among the neighbourhood associations and committees active in the field of nature protection in Brussels. The NGO has the objective to make both residents and public authorities aware of the need to preserve the last remaining open spaces in the Brussels conurbation. A (possibly non-exhaustive) list is below. It includes NGOs, informal networks and citizen movements; planning and urban design offices. De Rand; 21 Solutions; ACQU; Action et Défense de l'Environnement de la vallée de la Senne et de ses Affluents; ARAU; Association Protectrice des Arbres en Forêt de Soignes (APAFS); Bond Beter leefmilieu; BOS+; BRAL; Bruxelles Nature; Buumplanters; BUUR; Centre d'écologie urbaine; Cercle des Guides-Nature du Brabant; Collectif Abbaye de foret; Collectif pour les Arbres, la biodiversité et la santé; Comité "Sauver la Plaine"; comité de quartier Mediapark; Commission Ornithologique de Watermael-Boitsfort; Coördinatie Zenne; Dr Forest project; Écorce; Entente nationale pour la protection de la nature; Environnement Waterloo; Inter Environnement Bruxelles; Inter Environnement Wallonie; La Hulpe Environnement; La Hulpe Nature; Le BRAT; Les Amis de la Forêt de Soignes; Les amis du bois de Verrewinkel; Less béton ASBL; Ligue Royale Belge pour la Protection des Oiseaux; Natagora; NATURA Zoniën; Natuurgidsen Zoniënwoud/'Natuurgroepering Zoniënwoud VZW; Natuurpunt Brussel; Plant En Houtgoed; Plateau Engeland-Puits; Regionaal Landschap Dijleland; Regionaal Landschap Pajottenland en Zennevalleiet; Réseau d'échanges de savoirs; Réseau IDée asbl (Information et Diffusion en éducation à l'environnement); Société Belge de Dendrologie; Sonian Wood coop; SOS Kauwberg Uccla Natura; Streekvereniging Zenne en Zoniën vzw; Team Vlaams; Tournesol ASBL; Wood Wide Web

7.4 Looking forward

7.4.1 Strategic objectives in relation to UF-NBS

O1 Improve the forest connectivity (and accessibility)	The Brussels capital region is widely covered by forest ecosystem area (16,7 sqm – 10% of the Brussels region area) but this is mostly located on the southeast part of the city. Historically, the forest has a larger sprawl and this remaining landscape can still be observed in more urbanized context (public space, private garden, streets…). Brussels Environment aims to reinforce the connectivity between the major tree-planted area by : working on awareness with citizens and local municipalities, following urban permits, developing tree-based ecosystem projects on public space with a focus on the strategic zones of the Brussels ecological network.
O2 Tackle the urban heat issue	Regarding global warming, urban heat became an important issue especially for the very dense districts and during summer heatwave. A mean difference up to 2°C can be observed between forest area and the city center. Planting trees can provide a powerful cooling service in sensitive area. Brussels Environment has set up a cartography of the urban heat island which can be used as a useful tool for administrative and politics in order to target the critical neighborhood in a public health and living environment goal.
O3 Include UF-NBS in urban planning legislation	Brussels Environment wants to review the Brussels regional policy regarding the development and the protection of trees and urban forest. More precisely, the project will aim to adapt the legal framework and will prepare targeted questions on regulatory and economic mechanisms that would allow a better protection in tree heritage, especially in private land. From this perspective, Brussels Environment will work on two administrative levels (municipality and region) and will use different levers of urban planning.

7.4.2 Major barriers

This part of the screening tool is completed on the basis of a the discussion held during the first CLEARING HOUSE workshop, and on the basis of a stakeholder consultation conducted in the fall of 2020. Given the thematic angle that was adopted in the case of the Sonian city, the focus is mainly on the major barriers to ecological connectivity, and more broadly to the challenges or points of attention to realise greater connectivity. Considering that reflection about these challenges has been conducted at the level of brainstorming, we can only provide a qualitative assessment of the order between them. A more detail exploration (also in the context of trying to address them) is part of WP2.2

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Urban development

One of the biggest problems for ecological connectivity indicated by those who participated in the consultation concerns the urbanisation process: the development of land (as in: land clearance and construction of buildings), by reducing the sheer amount of green areas of all kinds, but also inasmuch as it is done with little consideration of the translocal ecological landscape, critically hampers ecological connectivity. "It is very very hard to leave a parcel unbuilt", noted one of the respondents. A crucial dilemma is sometimes referred to: that is on whether it is preferable to densify the urban core (e.g. second raw constructions, inside of the building blocks), thereby reducing green spaces and connectivity there where is already scarce; or in the periphery, encroaching on existing open spaces and natural areas. The latter is a particularly relevant challenge at the edges of the Sonian forest, where return to land development can be extremely high. Some of the participants, however, put emphasis on another question that should precede this dilemma, i.e. whether urban development is necessary at all considering the current demographic trends. Others underline how the issue is that today it is easier and cheaper to build in a green space than it is to demolish and clean up industrial or commercial wasteland or to renovate old or dilapidated housing. In parallel to this, respondents have also pointed at the opportunities that are too often missed in terms of "re-greening" new projects to redesign and redevelop large quasi-public spaces (e.g. squares, sport facilities...) are still very "mineral", i.e. characterised by large paved surfaces and little presence of trees and green.

Roads & mobility

An critical component of urbanisation-related challenges to ecological connectivity concerns the development of mobility infrastructures. Roads (and to a lesser extent railroad) represent a source of fragmentation and destruction of tree ecosystems, especially -but not only- in the core part of the forest. In urbanised areas many streets, it was noted, are oversized: the drive way is to large, and the side spaces for parking are unnecessary (in the areas under scrutiny, most residences seemingly have enough space in the private terrain). Overall, it was noted how mobility priorities are deemed more important than environmental ones, in a context where when abating trees can be helpful to fluidify traffic, this would be done without much hesitation. The same concerns parking, which is too often considered to be more important than vegetation. One of the respondents made an example from a contract of neighbourhood redevelopment, where citizens mobilised against the plans of the developer to eliminate some parking spots to increase soil permeability.

Private properties & gardens

Private properties & gardens represent a large amount of the urban green. In some neighbourhoods, in particular, the unbuilt inside part of the building blocks has sometimes the size of public parks. In those areas, the questions of fencing is particularly worth attention is: large plots often fenced out of a sense of security or privacy, and yet, much will be gained if they were opened up to animals, but also to pedestrians. Another important question concerns the abatement of trees in private gardens, and the challenges of maintaining them (to preserve biodiversity, but also the character of a neighbourhood). If inventories are rather popular to deal with the issue (possibly because they are relatively easy and politically non-controversial), what matters is actual control that trees are taken down only for legitimate reasons, and that replanting takes place as regulated.

Agricultural areas

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Agricultural lands are a minor issue in the area under scrutiny. But their two-sided nature is still worth mentioning. Agricultural land offers great potential of afforestation given that it is not built-up, and can be an asset inasmuch as the soil remain is permeable. At the same time it often represents a biodiversity desert (organic agriculture is only partially addressing this).

Limits of the current legislation & governance of ecological connectivity.

Overall, the current legislation is deemed insufficient to protect, and in any case to foster ecological connectivity. One of the respondents put it acutely in terms of "Absence of juridical value for the regional ecological network". Existing urban planning regulations (see section 4.1 Policy instruments for enhancement and protection of UF-NBS) are often breached, also because of the little monitoring efforts, derogated on, and modified to allow for new developments. There is virtually no regulation to preserve greenfield, with the only one concerning the preservation of large ponds.

Issue related to the governance and the management of tree spaces in the city are related to the maintenance costs of trees on public land (e.g. municipalities often look for trees that have little maintenance, for instance trees that do not have too many leaves to collect, to the expenses of biodiversity and indigenous species conservation), but also the training of staff, which includes little (or no) attention to biodiversity and eco-connectivity questions. Often the necessary expertise is simply missing at the relevant decision-making level. In addition, it was noted how the good governance of a complex and articulated field such as the protection and enhancement of ecological connectivity is also hampered by the institutional fragmentation and the lack of cooperation between different levels of governance and policy sectors.

7.4.3   Knowledge gaps

Much like section7.4.2 - Major barriers, this part of the screening tool is completed on the basis of a the discussion held during the first CLEARING HOUSE workshop, and on the basis of a stakeholder consultation conducted in the fall of 2020. Both among staff from governmental agencies and institutions there was a rather widespread consensus that already a lot of knowledge is available for the area, and that the emphasis should be placed in identifying venues for translating that knowledge into policy action (e.g. knowledge-based policy tools, inventories of relevant academic literature, inventories of existing laws and regulations, methods for effective awareness raising ...), and to bridge the gap between expertise on urban planning and biodiversity conservations expertise.

Many respondents pointed at the need to shed light (and "activate" the knowledge) about the impact of trees and urbanisation, and with attention on both sides. This includes both the impact of trees on the city (e.g. the wide range of ecosystem services of all kinds...), but also the impact of the city on trees, such as the sources of vulnerability, the impact of pollution on tree ecosystems, problems of impediments (cables and pipes under roads, electric cables...).

One type of knowledge that has been mentioned both for the better and for the worse, are tree inventories (which are either inexistent, outdated, partial, or unknown to the relevant decision makers...). While some consider them as an important piece of knowledge to support regulation monitoring and enforcement, as well as a correct diagnostic of the given situation, other emphasise how developing and maintaining good inventories can be extremely resource intensive, but at the

same time remain like unloaded gun and can even be detrimental if used as a justification to ignore other problems.

An interesting aspect also concerns the cartography of the area. The institutional fragmentation, in fact, implies that most maps are limited by the regional boundaries , making it difficult to frame and even to conceive the Sonian City as a geographic entity, and thus as an object of policy intervention. In this context, designing maps and conducting geographic analysis that deconstruct and reconstruct ecosystemic, functional and administrative boundaries can be helpful to "think" the Sonian City, and to devise adequate intervention.

In addition, very specific questions include:

- Research on the impact of urban pollution on tree ecosystems (e.g . What is the impact of traffic in and around Brussels on nitrogen levels in the Sonian Forest?)

- Research on the link between the presence of the ecological network and the presence of certain species

- Research on the state of the soils in the city and the necessities for them to contribute to diversified plant development

- Research on empty housing and price differences between building restoration vs. construction

CONCLUSION & OUTLOOK

This report illustrates the results of an exploratory analysis of five case studies in Europe. By performing a GIS analysis of UF-NBS potential in European urban areas and by analysing five case studies we achieved two important goals that are relevant per se and for the next steps of CLEARING HOUSE: we provided the context for the comparative in-depth analysis of the five localities where the nextn phase of the CLEARINGH HOUSE project will take place, and at the same time we provided all the partners involved in the consortium with the tools to learn about the five cities. While the objective of the task was not to conduct a comparative analysis of the five different localities, we deem important to bring together the main messages of the different chapters, with a focus on the geography and the state of the urban forest in the five localities, and on the barriers to enhance and them further.

Part I of this report (i.e., Chapter 2) made the case for and performed a **two-level comparative analysis**, which reflects the presence of the trade-off between maps content and spatial coverage.

Using the most recent available and comparable data provided by the Copernicus program, a first assessment of mapping the UF-NBS potential in European urban areas was provided. The analysis of forest areas availability (i.e., forest share), the potential per-capita supply with forest areas and the use intensity (forest area per resident), as well as the biophysical benchmark of canopy cover (tree cover density) have made emerge the huge variety of city performance in Europe, and positioned the CLEARING HOUSE localities in the European landscape. Analysing the relation between certain indicators allowed a preliminary but illustrative conclusion on the influencing factors such as built-up structure or city size. A more tailored-based analysis can be added which both requires the availability of additional data (e.g. the Urban Atlas 2018 is still incomplete by the time of writing and, thus, data for built-up are cannot be derived for calculating population density).

The preliminary analysis that resulted in this report was instrumental to confirm a number of previous studies and, at the same time, to provide new insights (Poelman, 2016; Kabisch et al., 2016; Wolff and Haase, 2019). First, two applied typologies extended the spatial focus towards the functional urban area and details the relative performance of forest area provision of a city relative to its national and European context. Using these relative values, specific to each city, maintains the variety of city performance e.g. when compared to average values calculated for pre-defined spatial units such as larger European regions (e.g. Eastern vs. Southern Europe). Nevertheless, an overview of selected indicators aggregated to the so-called European planning families allows to quickly grasp basic differences. For the first time traditional indicators such as the forest share have been combined, thanks to recent data availability, with canopy cover and tree cover density which allows to deduce further biophysical questions e.g., on the impact of heat or droughts on forest areas in particular cities and urban hinterlands – and emerging differences.

Finally, the pilot analysis that we performed for the case of Leipzig, showed how the intersection of recent pan-European data such as Urban Atlas and high-resolution layers (e.g. tree cover density) allows a finer-tuned analysis and potential detection of types of forest areas and trees. With this, we might account for the diversity of different types as well as their functionality (e.g. private vs. public, larger forest areas vs. backyard trees etc.). This could be an ideal basis for adding a socio-demographic perspective going one step further than a mere forest area per capita assessment. This report has demonstrated that, based on national census data, the supply of forest areas and trees is unequal both

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across the city and across different socio-demographic groups. A further contextualization, framed by arguments from the environmental justice debate, could illuminate the potential of citizens engaging with trees.

The qualitative and in-depth approach that was used for Part II of the report (i.e. Chapters 3, **Fout! Verwijzingsbron niet gevonden.**, 5, 6 and 7) allowed to draw a more detailed picture of the five localities under scrutiny, and in particular in terms of UF-NBS . Despite their diverse geographical, socio-economic, environmental or institutional contexts, all case studies have been shaped by a long history of human management which has resulted in complex (urban) social-ecological systems. The concepts of silvan city (in the Sonian city) or industrial nature (in Gelsenkirchen) are clear examples of the strong links between social and ecological (also technological) aspects in these areas. Because of its embedding in highly urbanised and dynamic environments, all of the analysed (peri)urban forests (and other types of urban green infrastructure) were found to be subject to different threats. Fragmentation due to transport infrastructure, pressure from urbanisation processes (both densification and urban sprawl), or congestion due to (massive) recreational use are some of the challenges faced by several case studies. Only Gelsenkrichen (and its larger Ruhr region) reports impacts related to droughts, severe storms and forest diseases and plagues, although other cases are probably also affected by these problems.

All the case study (peri) urban forests are subject to some degree of management and protection to ensure its conservation against the above-mentioned threats. In many cases, strategies and plans have been enforced to enhance their ecological state, biodiversity or connectivity with other green areas, although the level of implementation and effectiveness is generally uncertain. Ecological restoration and re-naturing of post-industrial areas are also a clear trend in the German cases of Leipzig and Gelsenkrichen. Improving access to green spaces for all residents is also a common goal in most urban areas (e.g., through the creation of pocket parks or green corridors linked to larger periurban forests). Most cases are also part of or affected by other projects and initiatives (e.g., scientific or educational projects related to urban nature), but usually a coherent and shared vision for the (peri-)urban forest is lacking.

The identification of the existing barriers relating to the progress and implementation of UF-NBS, and to their governance and management, as well as of the knowledge gaps was fully embedded in the processes inherent to the CLEARING HOUSE projects. The research teams of every city, in particular, focused on the issues that had arisen among project partners and relevant stakeholders, and in the context of the project objectives: the choice was strategic (i.e., this report must be instrumental in the advancement of the project), but also rooted in an epistemological approach that considers knowledge as an ongoing effort to make sense of the word and while actively engaging with it.

Barriers of different nature have emerged from the analysis. One of the biggest issues concerns the very nature of urbanisation: both in Gelsenkirchen and in the Sonian city, it was emphasised, for instance, how the choices about preserving green areas and developing land are virtually always conflictual, with the latter typically having the upper hand. It is not only a matter of divergence between priorities and agendas, but also in terms of their implementation. A dilemma that was referred to concerned the approach to densification: that is on whether it is preferable to densify the urban core (e.g. second raw constructions, inside of the building blocks), thereby reducing green spaces and connectivity there where is already scarce; or in the periphery, encroaching on existing

open spaces and natural areas. The development of mobility infrastructures also revealed double-edged: if in Leipzig the lack of adequate mobility infrastructure (among other equipment) was indicated as a barrier for the enjoyment of green areas, in the Sonian city, the presence of mobility infrastructures was indicated as a critical problem for ecological connectivity.

Other barriers concern the inadequate institutional setting, a problem raised in three of the case study localities. The inherent ecosystemic nature of the urban forest was found to be at odds with the often compartmentalised governance structure. This was both a question of unclear distribution of responsibilities in one single level of governance. In Leipzig, for instance, maintenance tasks are unclearly divided between the municipal environmental office and the urban cleaning company. In the cases of the Llobregat valley and the Sonian city, the problem of the institutional setting was related to the mismatch between ecosystemic and administrative boundaries, and thus to the unmet need to combine and 'jump' governance scales.

Finally, a set of resources was found to be critical and yet being lacking or anyway scarce. The question of financial resources was touched upon both in terms of absolute lack of thereof - even to cover the maintenance costs (e.g., as in the case of Leipzig and of the Sonian city); but also in terms of mismatch among the short-term necessity to pay for preservation and enhancement of UF-NBS, and the long term benefits provided by ecosystem services (e.g. the case of Gelsenkirchen). Human resources (e.g. sheer availability of dedicated staff, knowledge about UF-NBS, and expertise in managing them properly) were also found to be often insufficient, pointing at the need for training and awareness raising among governmental staff. In one case (i.e. the Sonian city), it was pointed out how also the legal resources are insufficient to protect, and in any case to foster UF-NBS, a problem acutely framed in terms of "Absence of juridical value for the regional ecological network".

Given the context and the ambition of the project, specific attention was given to knowledge gaps, framed both as existing barriers to the implementation of UF-NBS and as indications for CLEARING HOUSE research. Overall, the need for an ambitious research agenda to better understand the relation between trees ecosystem and urbanization at the level of specific locations was confirmed by our analysis. Research questions concern the services provided by nature to cities, their broad societal impact and sometimes even the monetary value; but also, the impact that urbanization has on nature, and the actual resilience of trees and ecosystems to pressure such as pollution, land development and temperature change. In addition, the analysis also pointed at the gaps in terms of applied knowledge and know-how , i.e. in terms of how to address institutional fragmentation, or how to ensure that the implementation of UF-NBS is sustainable and realizes benefits enjoyable by everyone.

At the same time, our analysis put emphasis on the fact that a lot of knowledge and know-how is already available. The matter, thus, is to manage such knowledge, and translate knowledge into policy action (e.g., knowledge-based policy tools, inventories of relevant academic literature, inventories of existing laws and regulations, methods for effective awareness raising ...). In some cases, it is also a matter of connecting those who have the expertise with those who have the responsibility to act, jumping governance scales, or breaking the walls of institutional silos. One of the most telling examples concerns the Sonian city, where detailed data is available, but its usability is hampered by the fact that databases and maps are limited to the area of administrative competence, and cartography of the urban forest as a whole is barely available.

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