GREEN SURGE

BCD: LINKAGES BETWEEN PEOPLE AND NATURE – DATABASE, TYPOLOGY AND INDICATORS

WP2: **Assessment of urban biocultural diversity (BCD)**

Partners: **University of Helsinki (UH), Wageningen University (WU),**

MS22: **Internal project report that outlines biocultural diversity (BCD) database, typology and indicators in urban context as a part of the EU FP7 (ENV.2013.6.2-5-603567) GREEN SURGE project (2013-2017)**

SEVENTH FRAMEWORK PROGRAMME

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1 INTRODUCTION

1.1 Objectives and outline of the report MS22

According to the Project Annex I "Description of Work" (DoW, p. 3) the objectives of Green Surge are to identify, develop and test ways of connecting green spaces, biodiversity, people and the green economy, in order to meet the major urban challenges related to land use conflicts, climate change adaptation, demographic changes, and human health and wellbeing. The Green Surge programme has identified biocultural diversity (BCD) as a key concept for (1) understanding the integration between biological variety in the urban green infrastructure (UGI) and the cultural specificities of the UGI's users and (2) developing innovative approaches to planning and governance of UGI. The concept was introduced for denoting the 'inextricable link' between biodiversity and cultural diversity (Posey 1999). Work Package 2 (WP2) aims to apply the BCD in the context of Western urban societies, which is an innovative and novel approach to the use of the concept requiring further operationalisation in respect of its relevance for Urban Green Infrastructure (UGI) planning and governance. To realise these aims, WP2 is divided into three different tasks:

- ***2.1. Development of a conceptual framework for addressing how residents value and interact with biodiversity (BD) and each other in urban regions***
- ***2.2. Use the conceptual framework to assess components of UGI and how residents with different cultural backgrounds and socio-economic situations value and use UGI across European cities***
- ***2.3. Development of a database and typology of BCD of UGI components as grounding knowledge for other parts of the project (WP4-7).***

This milestone is result of Task 2.3, which is led by UH. FFCUL, UBER, WU, TUB and SRC have contributed to MS22. In addition, ULOD reviewed and commented the outcome during the writing process (Table 1). MS22 is an analytical step for Green Surge researchers in producing final analyses for Deliverable 2.3. This report will work as basis for D2.3 and present a BCD database, typology, indicators and next steps for finishing Task 2.3.

Table 1. List of partners and their contribution to the task 2.3.

No.	Contributing partner	Role	Task/ contribution
2	University of Helsinki (UH)	Lead	Writing MS22 and D2.3. Case analyses in Helsinki. Organizing meetings and workshops
3	Humboldt Universität zu Berlin (UBER)	Core team	Testing BCD indicators, writing short parts to the MS22/ D2.3
5	Wageningen University (WU)	Core team	Developing typology and content of MS22 and D2.3, commenting and reviewing
6	Stockholms Universitet (SRC)	Core team	Writing short parts of MS22 and D2.3
12	Uniwersytet Łódzki (ULOD)	Reviewer	Reviewing and commenting
14	Fundação da Faculdade de Ciências Da Universidade de Lisboa (FFCUL)	Core team	Writing MS22 and D2.3. Development of BCD indicators; cases analyses in Lisbon
16	Techniche Universität Berlin (TUB)	Contributor	Analysing BCD in ULL cities; commenting and short contributions to MS22 and contribute analyses to D2.3

1.2 BCD research in the Green Surge

In the D2.1 a research framework for BCD were introduced (Vierikko et al. 2015, p. 21-23). The concept of BCD was divided into three different research pillars: manifestations, maintenance and creations of BCD. Three pillars drew attention to the ***multiple relationships*** between culture(s) and nature by studying how i) physical manifestations in urban settings, ii) different policy goals and management practices, iii) people interact with biodiversity and with each other in different green spaces and place-making situation.

BCD research in the Green Surge project was simultaneously carried out in five different phases at multiple scales from the local and context-dependent scale (ULL cities) to European level analyses of interlinkages between biodiversity and cultural diversity in European cities. Main research phases were 1) conceptual, 2) policy, 3) governance, 4) people-biodiversity interactions, 5) biophysical environment, and finally 6) synthesis of all research (Fig. 1). Methodological approaches of different research phases are introduced in the D2.1, and the MS22 gives an overview of BCD studies conducted in the WP2 and other WPs. There are some clarifications of methodological approaches and development of the BCD research framework made after D2.1. The conceptual framework introduced in the D2.1 was a starting point for BCD research in urban context and the aim was to develop the BCD concept further. The MS22 will present the final research phase: synthesis with BCD database, typology and indicators.

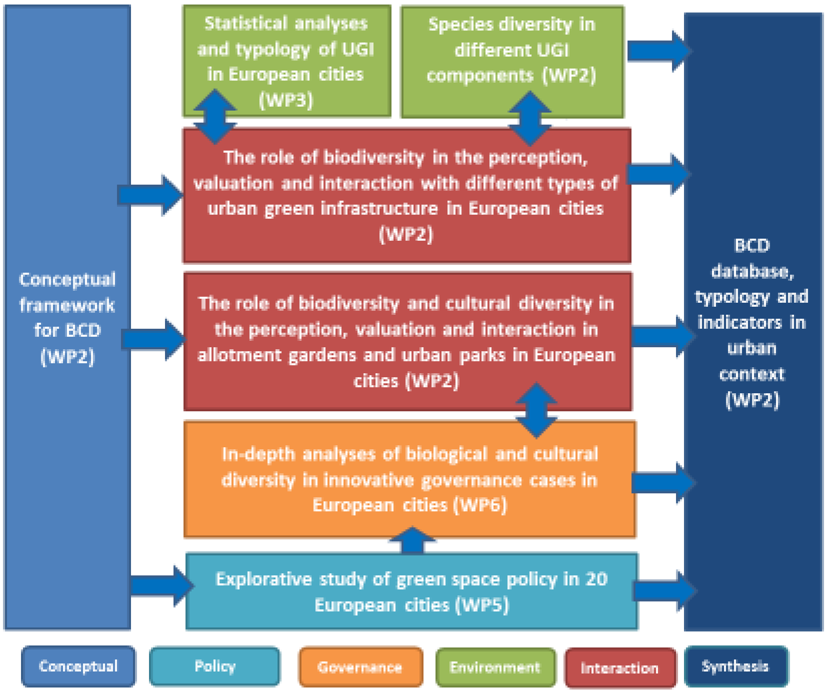

Figure 1. Different research phases for multi-scale BCD studies in the Green Surge project. Close collaboration between partners and stakeholders has been crucial to develop typology and indicators for BCD in the urban context.

1.3 BCD database developed in the Green Surge

As framework above shows most of the BCD research was carried out within the WP2, but the studies on the identification of BCD features or UGI components as biophysical objects were carried out as part of the research activities in WP3 (functional linkages of UGI), explorative studies of policy interpretations were carried out together with WP5 (advanced planning of UGI) and in-depth analyses of biological and cultural diversity within different cases were made as a part of WP6 (innovative governance of UGI) (Davies et al. 2015, Buijs et al. 2016a, Hansen et al. 2016). These studies form a basis for the development of the BCD database (see Table 2). In the Green Surge project, a BCD database is formed from two data sources: (1) primary data from explorative and empirical studies, and (2) secondary textual or digitized data from published documents, GIS-data etc. Primary BCD data has been managed and stored by the respective leading project partners (UH, FFCUL, TUB and UBER). The BCD database is presented in Appendix I with detailed information about contributing authors, the cities in which the BCD research was conducted, and the main UGI considered. In addition, table 2 presents objectives of the study, methods used and by whom the primary data is stored and managed.

Table 2. Overview of BCD research within the Green Surge. Studies are presented in more detailed in the separate table in the Appendix 1.

Research phase	Main considerations	References
Conceptual	Conceptual exploration and initial identification of analytical framework for research	Vierikko et al. 2015
	Introducing of BCD concept as a reflexive and transdisciplinary approach	Buizer et al. 2015
Policy	Explorative study of BCD in UGI policy and planning in 20 European cities	Elands et al. 2015, Davies et al. 2015, Vierikko et al. 2015
Governance	In-depth analyses of people-biodiversity interactions in different cases of innovative governance	Buijs et al. 2016a, Buijs et al. 2016b, Vierikko et al. 2016
	Ecological and social memory carriers in metropolitan landscape	Andersson and Barthel 2016
Environment	Identification of UGI components as biophysical objects, access and health benefits of UGI in European cities	Haase et al. 2015, Cvejić et al. 2015, Fischer et al. 2016
	Identification of biodiversity values in different UGI components	Fischer et al. 2015, Fischer et al. 2016, Eler et al.2016
Interaction	Ex-situ survey on people's perceptions, values and use of different UGI and BD in five (ULL) European cities	Fischer et al. 2015, Fischer et al. 2016, Botzat et al. 2016, General insights were integrated in the German TEEB report on urban ecosystem services, see Kowarik et al. 2016b, and in Kowarik et al. 2016a
	Literature review on the perception and valuation of urban biodiversity; a global perspective.	Botzat et al. 2016
	Hedonic pricing of BCD significant places	Czembrowski et al. 2016
	In-situ survey on people's perceptions, values, interactions and use of different UGI and BD in European cities	Not yet published
	Perceptions and values about BD held by allotment gardeners	Not yet published
Synthesis	Identification of typology and concept for characterizing emergent features of BCD in an urban context	MS22
	Development of BCD indicators at the local scale	MS22

1.4 Ongoing WP2 research activities and publications

This section describes ongoing research activities as well as outputs of these activities until February 2017. Between November 2013 and December 2016, Green Surge project's WP2 has been successful in collecting a primary data through field observations, multi-taxa inventories, face-to-face interviews, internet surveys — much more than was anticipated in the research plan and in the DoW. Two WP2 meetings were organized during the annual PGA meeting in Ljubljana and Wageningen during 2016. The core team has regularly organized Skype meetings (2016: February 6th, March 3rd, April 29th, November 11th, November 24th). WP2 has been very active in conceptual framing and the development of analytical tools and approaches. Many of these BCD related studies were finished in 2016:

- A study on urban dwellers' perceptions and values towards urban parks, and associated cultural and biological diversity was finished in Helsinki in summer 2016. The study in Helsinki consisted of a multi-taxa assessment of biological diversity: vegetation, epiphytic lichens and birds in 12 urban parks, and face-to-face interviews of park users (600 in total), based on the questionnaire developed for the field survey that was conducted in task 2.2 in the five ULL cities (see Fischer et al. 2015 and D2.2, Fischer et al. 2016).
- In Lisbon, a study of urban dwellers' perceptions and values towards green spaces, associated biodiversity and ESS was finished in summer 2016. The study included four typologies of UGI: parks older than 50 years in three urban matrix types (urban fabric, close to other UGI, green embedded), allotment gardens, forests and derelict lands. Multi-taxa assessment of biological and functional diversity: soil invertebrates, lichens, vascular plants, bees and butterflies, birds, and face-to-face interviews of park users (611 total) and gardeners (60 total) were conducted.
- The BCD research of urban parks developed by UH and FFCUL, was adopted in two other cities: Berlin (160 interviews) and Leipzig by the UBER. In addition, researchers at the University of Bucharest used the same approach in their park studies. We have not yet performed any analyses, but based on data we presume that the research brings new information about why and how different cultural groups uses parks, what they consider about place specific biodiversity and cultural diversity.
- Exchange between university students: Master student Joana Viera visited the University of Helsinki. Associated with the study presented above, she studied epiphytic lichen diversity in 18 urban parks of Helsinki in August 2016. The aim was to test air quality modelling developed in Lisbon in different geographical and urban context in Helsinki (Cristina: could you check this one?). The contributing partner is FFCUL. Researcher Kati Vierikko visited Lisbon with two master students in May 2016.
- At TUB, analyses of the database on valuation, perception and use of urban green spaces (task 2.2, see MS22, Fischer et al. 2015 and D2.2, Fischer et al. 2016) progressed well. General outcomes of the field survey in task 2.2 were integrated in the German TEEB report on urban ecosystem services (Kowarik et al. 2016) and presented at various international workshops and conferences. A comprehensive manuscript was finalized for submission to a scientific journal with the ULL partners in this task. Results of task 2.2 were integrated in the work

within the Berlin ULL (WP7) at a very practical level: Hereby, TUB cooperated with a secondary school to create a biodiversity-friendly school garden and undertook environmental education about edible wild plants in the school's surrounding. During summer 2016 the TUB undertook extensive vegetation and bird surveys on a wasteland site next to the school garden and conducted a survey on urban foraging. The results will be integrated into a management concept for the area that is momentarily developed by TUB students and the Berlin Focal LA. This work is primarily listed as an activity within WP7 but the working group used the knowledge gathered by the WP2, task 2.2 field survey in the previous year.

- The ULOD team used hedonic pricing to check if green spaces characterized by high biocultural diversity increase prices of nearby apartments more than other green spaces (Czembrowski et al. 2016). The study was carried out in Łódź, Poland. This study indicated that while there is a general desire to live close to the green space, biocultural diversity does not translate into any positive impact on property prices.

Published and submitted papers in 2016:

- Andersson, E. and Barthel, S. 2016. Memory carriers and stewardship of metropolitan landscapes. Ecological Indicators 70, 606-614.
- Buizer, M., Elands, B. and Vierikko, K. 2016. Governing cities reflexively – The biocultural diversity concept as an alternative for ecosystem services. Environmental Science & Policy 62, 7-13.
- Botzat, A., Fischer, L.K. and Kowarik, I. 2016. Unexploited opportunities in understanding liveable and biodiverse cities. A review on urban biodiversity perception and valuation. Global Environmental Change 39, 220–233.
- Czembrowski, P., Laszkiewicz, E. and Kronenberg, J. 2016. Bioculturally valuable but not necessary worth the price: integrating different dimensions of value of urban green spaces. Urban Forestry & Urban Greening 20, 89–96
- Kowarik, I., Fischer, L.K. and Honold, J. 2016. Beeinflusst Artenvielfalt die Wertschätzung der Stadtnatur? In: Kowarik, I., Bartz, R. and Brenck, M. (Eds.) Naturkapital Deutschland – TEEB DE (2016): Ökosystemleistungen in der Stadt – Gesundheit schützen und Lebensqualität erhöhen. Technische Universität Berlin, Helmholtz-Zentrum für Umweltforschung – UFZ. Berlin, Leipzig.
- Kowarik, I., Bartz, R. and Fischer, L.K. 2016. Stadtgrün pflegen, Ökosystemleistungen stärken, Wildnis wagen! Informationen zur Raumentwicklung 6, 731-738.
- Vierikko, K., Elands, B., Niemelä, J., Andersson, E., Buijs, A., Fischer, L.K., Haase, D., Kabisch, N., Kowarik, I., Luz, A. C., Olafsson Stahl, A., Száraz, L., Van der Jagt, A. and Konijnendijk van den Bosch, C. 2016: Considering the ways biocultural diversity helps enforce the urban green infrastructure in times of urban transformation. Current Opinion in Environmental Sustainability 22, 7-12.
- Vierikko, K. and Niemelä, J. 2016. Bottom-up thinking— Identifying socio-cultural values of ecosystem services in local blue–green infrastructure planning in Helsinki, Finland. Land Use Policy 50, 537-547.

2 TOWARDS A BCD TYPOLOGY

The second main goal of the Task 2.3, based on DoW (p. 9), was to develop a typology BCD of UGI. In Green Surge the UGI is defined, in line with Benedict and McMahon (2006), as an interconnected network of green space embodying the principles of multifunctionality and connectivity, which conserve natural ecosystem values and functions, and provides associated benefits to human populations. Very often in the literature, authors use the term **urban green space (UGS)**. In the Green Surge, UGS is understood as any vegetation found in the urban environment including different **UGS elements** (also called here as **UGI components**) such as parks, community or allotments gardens, residential gardens, urban forests or street trees, lawns or cemeteries, water bodies and coastal areas (Breuste et al. 2013, Kabisch and Haase 2014). It is worth mentioning that some biotopes such as forests, agricultural land or sand dunes are usually not considered urban. Furthermore UGS have a different meaning as a land cover type in Urban Atlas dataset including only certain types of green spaces such as constructed parks and leaving original ecosystems such as forests or wetlands out from the category. However, as these landscapes have historically sometimes been incorporated in expanding cities, they may be conceived as components of UGI (Fig. 2).

Figure 2. Urban green space (UGS) can be characterised based on its structural complexity and vegetation management type (Photos FFCUL). UGS, by definition, is any vegetation found including different UGS elements ranging from natural biotopes less modified by humans (e.g. forests) towards human-regulated or created UGS elements (e.g. green roofs).

In order to further characterise the differencin UGS a typology was developed within the work of Green Surge WP3 for describing connectivity with the built environment or other green spaces and primary functions of UGS (Cvejić et al. 2015). 44 different UGS elements i.e. UGI components were identified in the D3.2 (Table 3). They were classified under eight categories based on a) their integration with buildings/grey infrastructure; b) ownership, and c) primary function and use. The categories are: 1) building greens, 2) private, commercial, industrial, institutional UGS and UGS connected to grey infrastructure; 3) riverbank green; 4) parks and recreation; 5) allotments and community gardens, 6) agricultural land; 7) natural, semi-natural and feral areas and 8) blue spaces.

Table 3. Eight UGS categories and 44 elements (UGI components) identified by the authors in WP3 (Cvejić et al. 2015).

UGS category	UGS elements
1. Building greens	Balcony green, ground based green wall, façade based green wall, extensive green roof, intensive green roof, atrium
2. Private, commercial, industrial, institutional UGS and UGS connected to grey infrastructure	Bioswale, tree alley and street tree, hedge, street green, green verge, house garden, railroad bank, green playground, school ground
3. Riverbank green	Riverbank green
4. Parks and recreation	Large urban park, historical park/garden, pocket park, botanical garden/arboreta, zoological garden, neighbourhood green space, institutional green space, cemetery, churchyard, green sport facility, camping area
5. Allotments and community gardens	Allotment garden, community garden
6. Agricultural land	Arable land, grassland, tree meadow, orchard, biofuel production, agroforestry, horticulture
7. Natural, semi-natural and feral areas	Forest (remnant woodland, managed forests, mixed forms), shrubland, abandoned, ruderal, derelict land, rocks, sand dunes, sand pit, quarry, open cast mine, wetland, bog, fen, marsh
8. Blue spaces	Lake, pond, river stream, dry riverbed, rambla, canal, estuary, delta, sea coast

Another way of typifying UGS is to look at relationships between culture(s) and nature. For example, Botzat et al. (2016) distinguished studies of human-nature interactions according to how biodiversity were identified. Many studies assessed "biodiversity" primarily focused on either structural complexity of vegetation or "green vs. gray" level when analysing perceptions, valuation or human-nature interactions (Botzat et al. 2016). The explorative study on BCD manifestation as a part of UGI planning in WP2 aimed to identify how biological and cultural diversity was interpreted and assessed by city managers, and what kinds of BCD manifestations could be identified in 20 European cities (Elands et al. 2015, Vierikko et al. 2015). Two spatial scales for BCD manifestations (e.g. human-nature interaction) were identified: at the level of the city or at the local level of UGS element. At the city level, the human-nature interactions in UGI were more either focused on natural or cultural capital and transferred between recreation and conservation (Fig. 3). At the local level, UGS element was characterised by either incorporation of biodiversity in the human domain or the incorporation of culture in the ecological domain, and transferred between people using/ consuming area without engagement or stewardship towards nature and people actively (co)managing the biodiversity. These results elucidated the multiple dimension of human-nature relationships as characterised by manifestations along a nature-culture continuum (Elands et al. 2015, Vierikko et al. 2015).

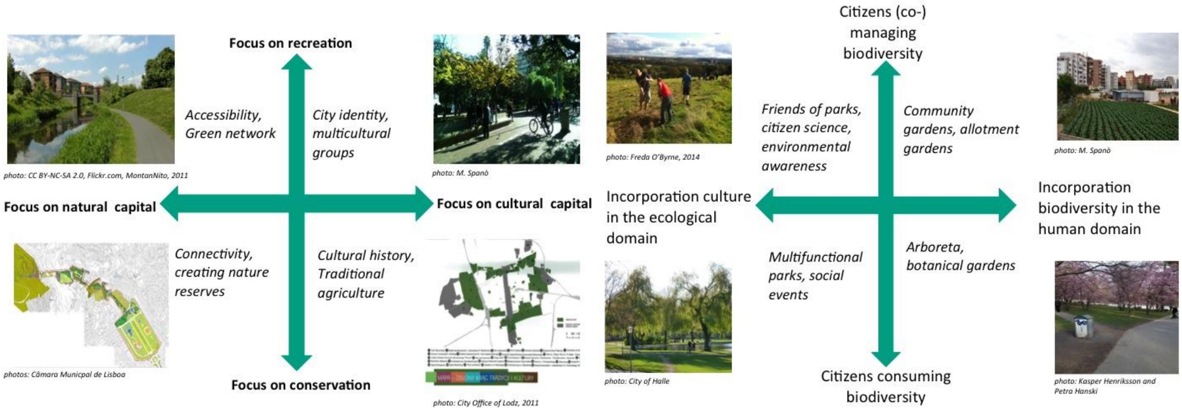

Figure 3. Four dimensions of BCD manifestations (e.g. relationships between culture(s) and nature at the city (GI) and the local (UGI composition) level (Vierikko et al. 2015).

2.1 Relationships between culture(s) and nature is a key essence in BCD

Today there is a desire among scientists to better acknowledge the value pluralism and value integration in research and policy making processes (e.g. Jacobs et al. 2016, Kenter 2016, Pascual et al. 2017). However, we should not only consider values as economic, social and ecological, but we need to acknowledge contextual and individually held values, and identify socially shared values and those transcendental values that guide our life choices (Irvine et al. 2016, Raymond and Kentar 2016). For instance, the fifth plenary meeting (March 2017) of Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) decided that instead of using the term "nature's benefits" to people we should talk about "nature's contributions" that reflect more pluralistic approach on values (IISD 2017, p.4). As Pascual et al. (2017) argued "*we should be more aware of diversity of value of nature and its contributions to people's good quality of life are associated with different cultural and institutional contexts*". The BCD concept can respond to these epistemological and ontological challenges related to valuation of UGI or ecosystem services. In addition, we should also acknowledge the plurality of relationships between culture(s) and nature, to better understand synergies and conflicts between values. In the MS22, we identified four main paths that relationships can be formed between culture(s) and nature (Fig. 4).

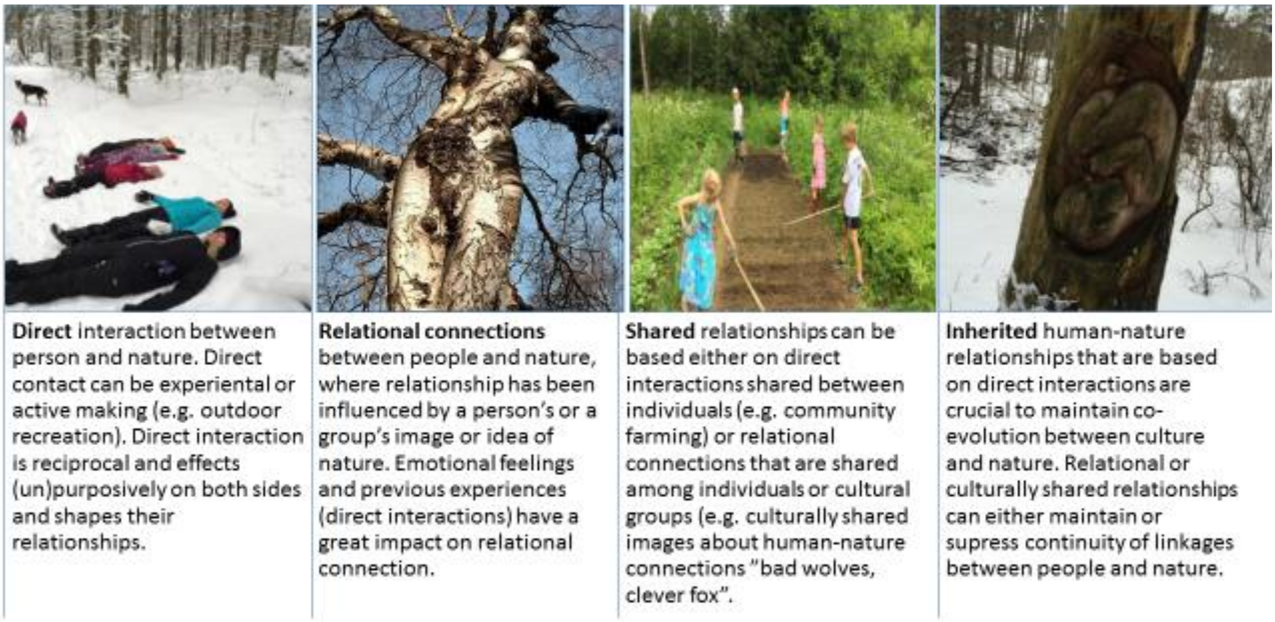

Figure 4. Examples of four relationships between people and nature: direct, relational, shared and inherited (photos: Kati Vierikko, www.facebook.com).

The Fig. 4 illustrates four main types of relationships between culture(s) and nature. Firstly, there is a place-based relationship between the individual and the environment, i.e. in situations when a person has ***direct contact with nature***. Dose-response e.g. in human health (blood pressure, decrease in stress hormones) is generally dependent on the exposure time and exposure route of direct contact, but the complexity of biological systems makes it usually difficult to define the single exposure causing response in humans (Tyrväinen et al. 2014). According to the "biodiversity hypothesis," reduced contact of people with natural environmental features and biodiversity may adversely affect the human commensal microbiota and its immunomodulatory capacity. Compared with healthy individuals, atopic individuals had lower biodiversity in the surroundings of their homes and significantly lower generic diversity of gammaproteobacteria on their skin (Hanski et al. 2012). The second type of relationship is ***relational connections*** that is influenced by cultural and personal values and can emerge in different social or spatial context. Lack of existence of direct connection to nature has a great impact (Soga and Gaston 2016), as well as other relationships – partnerships, family, work, power – on relational connections. The third type of relationship – ***shared relationships*** – is culturally or community shared people-nature relationships that can be based on direct (e.g. managing nature/ bird-watching) or relational contacts (e.g. emotional feelings towards nature). The fourth type of relationship - ***inherited relationships*** – is needed to maintain continuity of relationships between generations and co-evolution between people and nature, i.e. maintenance of social-ecological memory carriers (Andersson and Barthel 2016). Social memory carriers guide human practices and they are repositories and transmitters of experiences, knowledge and meaning are key actors in inherited relationships (Andersson and Barthel 2016).

The initial efforts to develop a typology in D3.2 (Cvejić et al. 2015) is based on the conceptualization of UGS as a definite concept. UGS is characterized based on connections to gray infrastructure, ownership or primary function and use. However, little attention has been given dynamic human-nature relationships and issues of equal access or opportunities to use UGS, social cohesion of places or ecological sustainability. The BCD typology as a sensitizing concept could support UGI planning and governance to become ecologically and socially more inclusive, as well as to elucidate the various types of interaction between the biological variety in UGI and the cultural orientations of the users. Instead of giving “a final type” for UGS could we typify UGS based on its dynamic and constantly evolving relationships between people and nature?

3 BCD TYPOLOGY AS A SENSITIZING CONCEPT

As discussed in the 2nd chapter, a further conceptualisation of BCD typology is needed, and BCD concept should be sensitive and reflexive rather than definitive when analysing relationships between culture and biodiversity. Buizer et al. (2016) argued that BCD concept can account for the many ways in which modern people live with green areas in urbanized landscapes and acknowledge the different kinds of cultural orientations this involves. The BCD concept should acknowledge the dynamics in biological and cultural diversity, and their relationships, in response to the ongoing processes of ***urban transformation***. We identified four challenges related to urban transformations in the sense of a co-evolution between biodiversity and cultural diversity:

- ***Past dynamics between human-nature relationships*** that have resulted in specific human-nature interactions and that can be found in a landscape or in components in UGI. During the past decade, much attention has been given to identifying how the historic processes of co-evolution between biodiversity and cultural diversity have resulted in specific constellations of UGI. An example of such dynamism might be the Green Circle of Tradition and Culture (GCTC), which was designated in Łódź to underline the special biological and cultural value of certain areas in the city. The GCTC is an irregular ring around the city center and consists of green spaces as well as post-industrial areas and other historically important locations. The GCTC is also the effect of the cultural diversity which was a trademark of Łódź in the 19th century and which shaped the character of the city (Elands et al. 2015, Czembrowski et al. 2016).
- ***Present dynamics between human-nature relationships***. Changes in urban lifestyles or trends can reconnect people with nature or deepen the loss of biodiversity experiences (Andersson et al. 2014, Pett et al. 2016, Soga et al. 2016). Kowarik found (2015) that the acceptance of novel wild nature at urban wastelands conspicuously increased during the last decades and facilitated the integration of such novel wilderness areas into the urban green infrastructure. Today, an important part of urban residents assign environmental values also to wild growing plants (”weeds”) in streetscapes (Weber et al. 2014). Increased interest of urban people on rewilding the urban green space gives more space for autonomous ecological processes (Diemer et al. 2003) as well as conservation of threatened natural biodiversity (Goddard et al. 2010, Puppim de Oliveira et al. 2011). However, what is at present novel, might be a heritage for a next generation, if the relationships or values are inherited.
- ***Present dynamics in urban biodiversity***. Loss of local green spaces and associated biodiversity due to densification; homogenisation of UGI and species pools (green spaces and species sets are becoming more similar everywhere) in cities restricts people’s daily interaction with a specific local, diverse nature. Limited ability of individuals to perceive biodiversity will influence a person’s experiences, emotions and understanding about local biodiversity i.e. increase of people-biodiversity paradox (Pett et al. 2016, Soga et al. 2016).
- ***Present dynamics in cultural diversification***. Cultural diversification can happen through the influx of migrants with different cultural orientations on the use of UGS (Jay et al. 2012, Kloek et al. 2013, Leikkilä et al. 2013), or among different socio-demographic groups or through differentiation in urban lifestyles (trends). Increasing cultural diversity will have effect on meanings, values or perceptions assigned to UGI, which can cause conflicts, inequity of use/access/values related to UGI. Some groups can be stronger or more empowered than others and

notions of equal access, environmental justice and power issues become important (Paloniemi et al. submitted).

Diversity is a focal concept of the BCD concept. By its emphasis on diversity, the BCD concept acknowledges the different knowledges (e.g. expert, tacit, traditional), meanings and values this involves, and can reveal conflicts and ambivalence that may be at stake. Therefore, the BCD approach calls for a genuine transdisciplinary thinking in research to cross borders between disciplines or scholars, and to give way to new, “intermediate” research. Research itself should also maintain methodological and epistemological diversity. However, diversity (e.g., in values, interests, uses) can also cause problems and conflicts, and therefore the BCD approach is critical on how far research should go towards supporting specific values (Lang et al. 2012). During the Green Surge project, researchers within WP2 agreed on some general requirement and objectives for the BCD concept:

1. The BCD typology should not be considered a static system to classify UGI. BCD typology is more about identifying dimensions and parameters than classes.
2. The BCD typology need to consider cultural values, meanings, perceptions, actions and ongoing relations as well as understanding of the biophysical reality and ecosystem services (ESS).
3. BCD allows us to illustrate how cultural understanding about UGI is created, and how different UGI types have been transmitted and captured into cultural realities. Cultural reality includes expressions, stories, narratives, historical archives, cultural artefacts and also the values that are held or certain meanings that an individual or a group conveys about biodiversity.
4. In addition to biophysical and cultural reality, the BCD typology should also consider intangible aspects and values, such as interactions between culture(s) and nature or power relations and equity/justice.

Based on previous discussions and main findings presented above we developed a conceptual model for BCD typology. Figure 5 depicts three different aspects: tangible, lived and stewardship, being departure points from which BCD can be studied. A focus on one aspect does not exclude the existence of the other two, rather, they should be considered as interdependent. The concept of BCD typology does not separate humans and nature as a counterbalance system as the ESS approach does (Buizer et al. 2016). The core idea of the BCD concept is that there is an innate connection between biological and cultural diversity. (Fig. 5). Changes in lived BCD (e.g. use of a UGI) will have an impact on tangible/materialised BCD (e.g. facilities, trails, species composition).

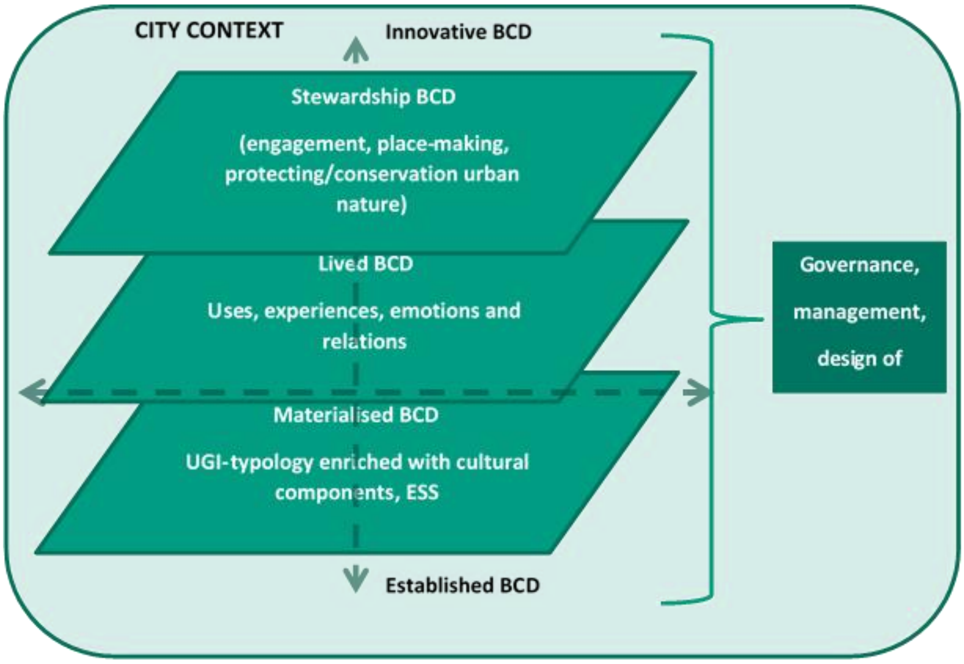

Figure 5. Conceptualizing of BCD typology into three interlinked aspects: tangible, lived and stewardship to study relationships between culture(s) and nature at different spatial and social context. The model present three aspects that can be used as a starting point in studying complexity and multidimensional human-nature relationships of urban green spaces.

3.1 Tangible and materialised BCD

Tangible BCD identifies *components and composition of diversity* in an urban landscape and at different spatial and temporal scales. This dimension explores how BCD manifests itself through either material elements in the UGI or through historical documents, visual maps or policy documents (e.g. land-use planning documents, nature conservation programs, green management plans). When studying tangible BCD the focus is on the first hand on direct human-nature interactions and linkages that can be identified in a landscape, or within a single UGI space. On the other hand, by analyzing present UGI components, species composition or policy documents we can reveal previous shared human-nature connections, e.g. past actions made in policy-making and landscape planning. Tangible BCD can also identify presence of ecological and/or social memory, i.e. inherited human-nature connections (Schaefer 2011, Andersson and Barthel 2016). These can be signs about caring or "cues to care" i.e. cultural symbols that make places more meaningful for residents (Nassauer 1995). Next we give two examples of how tangible BCD can be measured or identified.

Examples of tangible BCD

Every city has a unique spatial structure. By classifying and studying urban morphology, we can analyze how previous human-nature relationships and decisions to 'build a park' or 'keep an area wild' manifest themselves in the current UGI (Pungetti 2013). Recognizing different types of urban green spaces or present-day vegetation structure in urban landscape reflects not only materialised elements of BCD, but also legacies of past human-nature relationship (Boone et al. 2010, Pungetti 2013, Agnoletti and Emanueli 2016, Andersson and Barthel 2016). There are plenty of classification systems and typologies developed for UGS. These systems are on the one hand examples of how we construct a material dimension of UGI and on the other hand examples of how we interpret urban landscapes by using the developed UGI typology. Unique combinations of UGI types and neighbor associations with other land uses are never complete, and manifestations of tangible BCD changes constantly in different spatial or compositional scales – from local (species composition/ facilities of a park) to city scale (land-use planning). In D2.2 authors analysed UGI by mapping and measuring proximity of green spaces with the total population in 300 European cities with special focus on five ULL cities (Bari, Berlin, Edinburgh, Ljubljana and Malmö). Figures give a rather rough overview on distribution and proximity of UGI in the five ULL cities (Figure 6). For analysing complexity or diversity of UGI, more detailed information about tangible characteristics are needed.

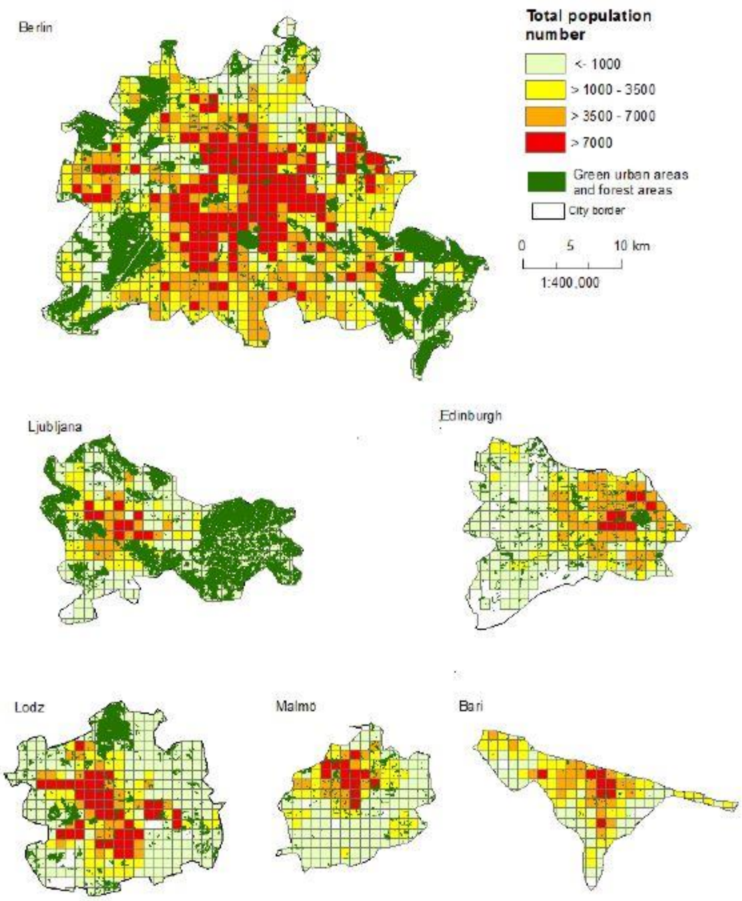

Figure 6. Using GIS-based data for spatial analyses of UGI can increase our knowledge on distribution and proximity of green spaces for citizens, but it does not reveal how people interact with nature, and what kind of relational human-nature linkages there exist in different cities or city districts (Fischer et al. 2016).

The above presented example of studying tangible BCD by identifying, mapping and analysing existing urban landscape is made by experts. Pretty (2013) speaks about analytical landscape aspects as part of a holistic landscape approach. Expert-oriented measures and ex-situ analyses of distribution or proximity of green spaces needs another aspect to study BCD manifestations to deepen our knowledge on how people interact with biodiversity in cities. For example, who has the opportunity or access for daily interactions with nature-associated biodiversity? Tangible BCD dimension can help us to find indications of different human-nature relationships e.g. by observing signs of cultural engagement with a place or signs of management or caring (e.g. trails, trashes, facilities, feeding boxes for animals). These signs can be easily identified in UGI (Fig. 7), but revealing salient meanings or complex values beyond tangible BCD, we need to move on from tangible dimension towards intangible dimension of BCD, and search evidence on how people in cities interact with nature and with each other in different context (relational relationships within lived BCD). In addition, we might be interested if direct human-nature interactions are reconnecting people with nature and unpacking the people-biodiversity paradox in cities (Elands and van Koppen 2013, Kronenberg 2014, Pretty et al. 2014, Shwartz et al. 2016). Or is it more likely consumptive way of fulfilling human needs and using services and benefits of nature without caring?

Figure 7. Example of tangible BCD manifestations in UGI as signs of engagement and caring for nature. Signs of engagement or caring are sometimes easy to observe (left hand), but leaving decaying wood or enhancing biodiversity do not necessarily gives a clue of caring (middle). Labelling and giving a story (right hand) why certain pieces of nature are saved enhances people's understanding and gives a meaning for caring (e.g. Caula et al. 2009).

3.2 Lived BCD

The second aspect of BCD concept identifies diversity in use of UGI and users, people's meanings, perceptions and values towards nature and associated biodiversity. Opposite to the ontological paradigm in ES approach the concept of BCD inherently presumes that nature is not a separate biophysical system from social system providing different services for people or society. Rather, the BCD concept underlines that social-ecological system include interactions between people and their worldviews, value systems, understandings, preferences, management and ecological preconditions and human mediated novelty. UGI per se does not have independent features that are unrelated to how people interact with it. By analysing lived BCD in different spatial or social contexts helps us identify current direct, relational and shared relationships between culture(s) and nature, and *place-based values* that different groups and individuals assign for UGI and associated biodiversity (Horlings 2014, Martín-López and Mortes 2014, Chan et al. 2016). Here we give two examples how we can study lived BCD by analysing personal and culturally shared values.

Examples of lived BCD

Lived BCD refers to personal perceptions, interactions and values, e.g. direct and relational relationships (Fig. 4). Emotional involvement with nature will influence an individual's relationship to the natural world (Kollmus and Agyeman 2002). Direct connections are an important factor shaping beliefs, values and attitudes towards the environment, as well as to participate or promote planning, management and care for the place. People directly interact with different biodiversity (BD) components in a variety ways. Sometimes interaction between a person and nature is direct and easy to observe (e.g. bird-watching, picking edible fruits or berries), but there are also other kinds of direct interactions (e.g. enjoying bird signing) that are more difficult to observe by researchers or practitioners (Pallidowa et al. 2017). People can use and value BD through different elements: landscape characteristics, genetic variation (colour of flowers) in addition to a species point of view (Muratet et al. 2015, Voigt and Wurster 2015). Some elements of biodiversity are more recognised and appreciated by people than others, and these elements tend to be the more actively promoted. For example, direct ecosystem goods like edible plants play a central role in place making and cultural identity and spending time in certain landscape types can provide directly experienced increases in well-being.

Figure 8. Direct contact with nature affect our relational human-nature relationships. Loss of daily contact with diverse nature can reverse our relationships to become more negative (e.g. increase in allergy, fear of nature, negative feelings towards nature).

In Task 2.2 Fischer et al. (2016) studied people's (n=3,800) perception, valuation, and uses of different UGI elements and biodiversity levels in five European cities (Bari, Berlin, Edinburgh, Ljubljana and Malmö). People were asked to mention their main activities in different UGI types and, score their valuations towards different UGI types (forest, park, street green and wasteland), and perceptions and valuation on vascular plant diversity in different UGI types by using photo-manipulations. Citizens valued forests and other green spaces positively, regardless of city or migration background, but valuations of different levels of plant diversity varied significantly between cities, suggesting that the regional context and, moreover, some cultural factors, influence preferences for different types of urban nature (Fischer et al. 2016). Explorations of how different social groups interact with, use and value UGI, or specific components of biodiversity (e.g. plant or animal species, decaying wood, ecosystem functions), are an essential ingredient of BCD research (Vierikko et al. 2016). However, these kinds of studies do not reveal how socially and ecologically inclusive different UGI places are (Ernstson 2013, Campbell et al. 2016). Changes in use or values of UGI, as well as in place-making activities, may lead to shifts in the relationship between culture(s) and nature(s), where some societal groups, individuals or biological features gain while others lose (Buizer et al. 2015). Therefore, place-based and contextualized, transdisciplinary research of lived BCD is necessary (Demsey and Smith 2014).

Lived BCD refers also to cultural perceptions, interactions and values e.g. culturally shared relationships (Fig. 4). In WP5 and in Task 2.1. Green Surge researchers studied BCD manifestations and bioculturally significant places in the UGI planning in 20 European cities (Davies et al. 2015, Vierikko et al. 2015, Hansen and Rall 2014). Studies on bioculturally significant places revealed how European citizens live with urban biodiversity. Those culturally shared biodiversity components, that are meaningful for the different cultural groups, can be called as "cultural keystone biodiversity". Original definition referred to a cultural keystone species emerged from studies of indigenous people, and identifying species that have a key role in defining cultural identity (Garibaldy and Turner 2004). Cultural keystone species can vary over temporal, geographic, and social scales. They are dependent on context and what is a keystone species to one group may not be keystone to another. For example, in Romania, every year, when the new generation of mayflies (*Palingenia longicauda*) swim on the surface of the river for a short period of time, many people come to Szeged to watch and experience this "blooming of Tisza" (Davies et al. 2015). Analysing keystone BD elements as a part of lived BCD dimension can help us reveal shifts in relational relationships between culture(s) and nature in cities.

3.3 Stewardship BCD

Stewardship is the third aspect of the BCD concept. A growing body of literature on different forms of stewardship and engagement in nature or sustainability issues clearly show how people engage actively in shaping biodiversity to align with ideas about what is 'desirable' or 'valuable'. This desire to manage, improve or promote certain aspects of the natural world we live in is constantly changing both nature and biodiversity itself and how we understand and make meaning of it. Novelty, the break from business as usual, either through the arrival of new perspectives or new ecological features may provide windows for re-evaluation and opening up new fields of meaningful biocultural diversity. However, BCD is not only created by the intentional interaction between engaged stewards and a local ecology. Various human interests and pursuits come with indirect, if often profound, consequences. Land transformations or sheer human presence influence ecological processes and dynamics, as well as species communities. Thus, actively or passively, directly or indirectly, we co-produce and are influenced by the nature we are embedded in. The third dimension of the BCD concept tries to capture this inherent agency and some of the complex factors that shape human-nature relationships over time. This includes the various activities aimed at maintaining or promoting biodiversity as well as those altering biophysical conditions for other reasons. Stewardship can emerge from three social context: institutional/public (municipality, government, research institution taking care of nature), communal (group of people, NGOs, organizations taking care of nature) and private (individuals or entrepreneur taking care of nature). We give an example how communal stewardship of BCD can be analysed.

Example of stewardship BCD

Communal stewardship of private people towards environment is example when citizens or private actors are taking responsibility for the maintenance or creation of UGI. These can be individual people, local NGOs, community groups, private companies. People might be engaged with the environment through volunteering in management activities, on an ad hoc base or in a more structural form through participation in e.g. a "Friends of" group, self-governance of urban green spaces, citizens science activities (Buijs et al. 2016a). They can contribute to more established forms of BCD or contribute to new, innovative forms. The activities of these 'biocultural creatives' (Elands and Van Koppen, 2013) are a learning-lab to identify novel approaches to both conserving and developing BCD in urban areas. They can also act as memory carriers and to carry out that relationships between culture(s) and people are inherited to next generations or other groups.

Innovative UGI governance practices were studied in-depth via 18 cases in European cities as part of the Green Surge WP6 (Buijs et al 2016a). Examples of community garden were established recently on derelict land by either local people (Edinburgh and Ljubljana), communities (Szeged), or municipalities (Malmö and Lisbon) or have a longer history as traditional allotment gardens (Stockholm) (Buijs et al. 2016a) (Fig. 8). BCD assessments of case narratives and documents were carried out. The aim was to identify to what extent BCD is being manifested in urban farming practices (Vierikko et al. 2017). Cultural diversity (CD) was assessed by means of investigating (i) the heterogeneity of involved societal groups, (ii) the knowledge exchange between groups, and (iii) whether a socially shared bonding to the place has evolved (Stokowski 2002). We analysed biodiversity (BD) by investigating how it is expressed and acknowledged by the actors in each case. BD was assessed through (i) the way it was articulated, (ii) the extent to which BD was acknowledged and (iii) whether a strong bonding with nature has evolved, i.e. living together with biodiversity. Involvement of different groups varied between cases.

The group diversity (in terms of socio-economic characteristics, age, ethnicity) differ between cases, and in one case increasing multiculturalism was regarded by some participants as a threat to the involvement of autochthonous residents (Buijs et al. 2016a). Knowledge exchange appeared to be important in all cases to share and maintain social memories and practices, being especially relevant for newcomers and subsequent generations (Andersson and Barthel 2016). Sometimes external facilitators (government actors, institutions or organizations) have a focal role to play in offering solutions for internal cultural or ecological problems (Kabisch et al. 2016). Initiators and established boards organized events for strengthening the dialogue between gardeners and other actors. Those cases that were initiated by local people showed strong bonding. Joint place-making increases social bonds among participants and strengthens community identity (Stokowski 2002, Dinnie et al. 2013). Although our analysis did not reveal to what extent the cases were open for heterogeneous societal groups, it is important to mention that in cases of a homogeneous group composition, which often coincides with a high sense of community, there is a potential pitfall that the social cohesion of the green space decreases, because the community becomes protective of the place (Raymond et al. 2010). Biodiversity in urban farming is shaped by initiators and gardeners, and controlled by shared rules and norms. Management activities and norms (e.g. organic farming) can increase or decrease species, biotope or functional diversity. Participants in the urban farming cases (Edinburgh and Ljubljana), for which the aim was to diversify derelict land by creating gardens for both people and nature, embodied strong bonding with nature; they perceived themselves as living within nature and, because of that, they feel they needed to respect biodiversity. In cases that show strong manifestations of both cultural and biological diversity, urban farming was inclusive, the place was made together, learning from each other and respecting biodiversity. “Social gathering, learning, engagement with nature, sense of ownership” were common BCD manifestations in these cases.

Figure 9. Six urban farming cases analysed as a part of WP2.

4 DEVELOPMENT OF BCD INDICATORS

Above we presented the conceptualisation of BCD typology with three interlinked dimensions: tangible, lived and stewardship, and next we will discuss how the BCD concept and its assessment can be useful for UGI planning and research. Due to limited resources (in money, time or allocation of working hours) neither science nor practice can take all possible components and factors into account when planning, managing or studying "real life situations". Although the original aim of WP2 was not to provide indicators, we realized that introducing some proxies and practical measures could help policy-makers, researchers or practitioners to make sense of BCD. Therefore, we ended up developing a list of potential BCD indicators. These can help us to typify UGI components (forests, parks, allotment gardens…) based in their multi-dimensional relationships between culture(s) and nature (Fig. 10).

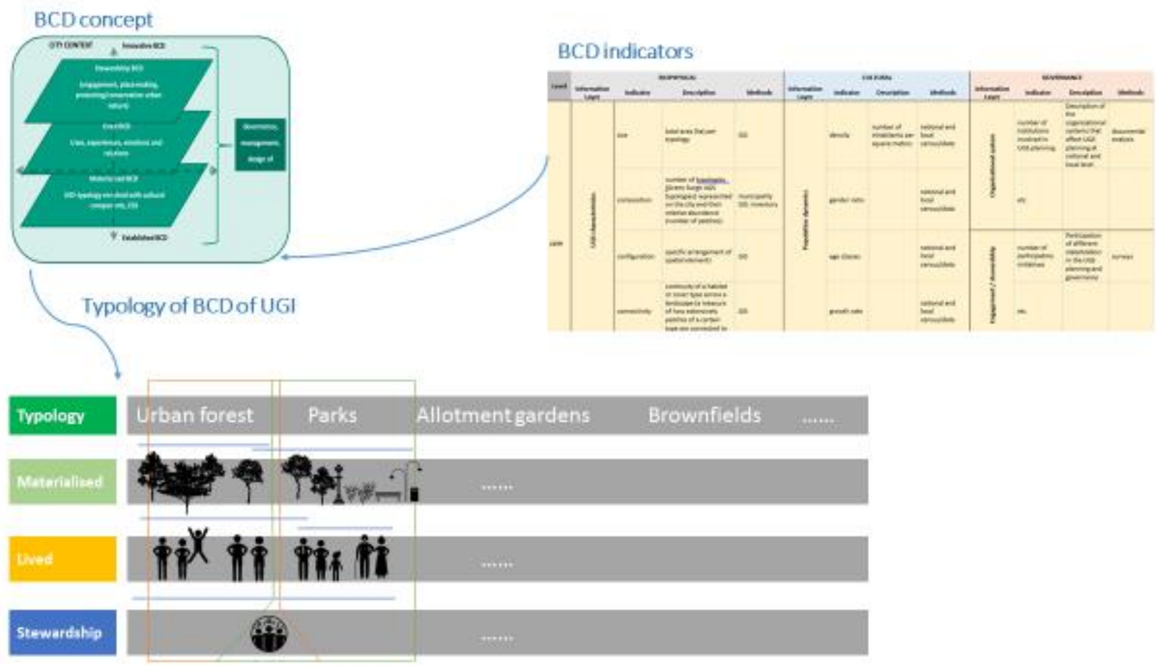

Figure 10. Illustration of how BCD indicators can be implemented as a tool for typifying human-nature relationships in different UGS elements, i.e. UGI compositions (developed by FFCUL).

While developing the BCD indicators at the local UGI level we tried to address all the above considerations on the interlinkage between biological and cultural diversity and its outcomes, and also to build a tool that could provide an in-depth look at those nuances. The objective of using these indicators is not definitive, acting as a benchmark of what should be an ideal or maximum BCD value of an UGS element, but rather to uncover missing or underrepresented components to take into consideration in UGI planning and/or management. They are, therefore, designed to be used as a support decision tool for policy and decision-makers and, thus, mostly based on easily understandable and measurable criteria.

Dealing with such a complex and multidimensional *indicandum*, the number of indicators comes to be quite extensive (n=61) and grouping them in information layers, draws attention to the main questions to be addressed when dealing with the three dimensions of BCD: i) materialized manifestations, ii) lived, and iii) governance and stewardship. The BCD indicators are presented in separate Tables, with (1) description and rationale to the real world situations, (2) what the indicator is measuring/implying; (3) suggested methods and potential data sources; linkages with (4) BCD concept, (5) ES assessment (CICES 4.3) and (6) UGI planning principles and challenges, (7) special need for qualitative analyses and finally (8) key references related to each indicator. As such indicators are not static and impervious, but rather dynamic and pervasive, data gathered can sometimes inform layers (or dimensions) other than the ones to which they were allocated for practical reasons.

Below we provide a short description of each information layer. As many authors have argued (e.g. Chan et al. 2012, Turnhout et al. 2013, Lele et al. 2014, Buizer et al. 2016), ES assessment fails to identify engagement of social and cultural beyond ecosystem services. Therefore, we highlight if BCD indicators are sensitive for human-nature relationships and cultural engagement (in the table we use not applicable N.A. if there are no links with ES assessment). In addition, we want to emphasise how BCD indicators could help to support innovative UGI planning (Hansen et al. 2016), and provide information about success of planning in terms of principles and challenges.

URBAN GREEN INFRASTRUCTURE (UGI) PLANNING – Definition and Principles

UGI planning is understood as a strategic planning approach that aims at developing networks of green and blue spaces in urban areas designed and managed to deliver a wide range of ecosystem services (Hansen et al. 2016). UGI planning aims at creating multifunctional networks on different spatial levels, from urban regional to city and neighbourhood planning. In the WP5 four UGI **planning principles** were identified. They are ***integration of green and grey infrastructures, connectivity, multifunctionality and social inclusion*.** In the D5.2 authors present several targets related to principles. For example, ***grey-green integration*** targets not only primary infrastructural needs but also seeks to provide wider environmental, social and economic benefits. Green space network can support ecological and social ***connectivity***, with benefits for wildlife and humans, and includes physical and functional connections. ***Multifunctionality*** aims at securing and increasing the multiple ecological, socio-cultural, and economic benefits of UGI – or in other words the provision of ecosystem services, while avoiding conflicts and trade-offs. ***Social inclusion*** aims at enabling all social groups to participate in the process of UGI planning, while putting a special emphasis on the most vulnerable ones.

According to Hansen et al. (2016) four main **challenges** related to UGI planning were identified: ***Social cohesion*** – Increasing social cohesion has many advantages. It can ease tensions between different ethnic groups and people of different classes and religions, reduce crime, vandalism and associated costs, improve the image of neighbourhoods, improve social relations and social capital, and increase place attachment. UGI planning can improve ***green economy***: competitiveness with other cities by increasing the attractiveness and quality of life via investment in UGI, provide business opportunities and increase economic benefits. In addition, UGI planning can promote ***biodiversity protection*** and ***climate change adaptation*** in cities. BCD indicators have many links with UGI planning principles and challenges, and therefore we wanted to point out how BCD assessment in UGI places, can also support socially inclusive and ecologically sound UGI planning that takes diverse local, contextual and surrounding (f)actors into account.

4.1 Tangible BCD manifestations

- ***Biodiversity and biophysical structure of UGS***
- ***Welcomeness of the UGS***
- ***Signs of memory carriers and cultural symbols***
- ***Neighbourhood characteristics***

Biodiversity and biophysical characteristics of the UGS refer to the physical components or functions of biodiversity, ecosystems and UGS assessed by standard measurements of biological, functional and landscape diversity. These are not only the foundations for ecological quality, adaptation capacity and ecological resilience but also the base for interactions between people and nature. Data for measuring biodiversity are mainly provided by experts (researchers, managers, planners), but also active citizens can have a central role in collecting information about e.g. distribution of species. This information layer linked strongly with all sections of ecosystem services: provision, regulation and cultural (CICES 4.3). These BCD indicators compromise especially with multifunctionality, biodiversity protection and climate change adaptation.

To have an opportunity to visit a green space, people must have a feel of welcome and not feeling excluded, which is translated as ***Welcomeness of the UGS***. An inclusive green space welcomes people of all ages, socio-economic condition or persuasion, without any kind of barriers: physical, cultural or emotional. Welcomeness as an indicator of materialized BCD focus on tangible and visible characteristics for accessible, inclusive and comfortable environment with an adequate layout for whatever people pursue when visiting the space. Welcomeness is not consistent with cultural ecosystem services (CES), because it also focuses on human constructions (traffic, roads, fees, facilities, signs of cultural actions) and not for immaterial services provided by green space. Indicators for welcomeness measure, at certain extent, multifunctionality and especially social cohesion of the place – if it's accessible to all and provide space for social interactions (Hansen et al. 2016). It also shows if integration of green and grey infrastructure do not cause limitations to access (e.g. green roofs are not necessarily open and they do not invite all equally). In addition, green space that is welcoming can also attract green economy and vice versa.

The signs of previous use or human-nature interactions, inherently influenced by the cultural context, are embodied in the environment and carry memories from the past that influence the way people construct their identity towards the environment. In urban green spaces the signs of cultural use can range from the complex architecture and design of a park, or the composition of ornamental species, to a simple desire path or a carved tree, all of them representing a close and consistent interaction with nature which is drawn in ***Signs of social memory carriers and cultural symbols***. Indicators in this layer link with CES: physical and intellectual interactions with ecosystems (CICES 4.3). They can help reveal if a green space has been and still is multifunctional and socially cohesive. Some signs (biological, cultural or biocultural) or symbols can tell us if biodiversity has been protected – and what kind of biodiversity has been culturally meaningful. They also give indication of engagement and stewardship towards nature (e.g. nest boxes or labels for culturally valued biotopes/species/elements), which will be further discussed in lived and governance & stewardship. Spaces that have many signs of memory carriers or cultural symbols, will be most likely be also welcoming and supporting green economy.

But neither biological nor cultural diversity in a green space can be dissociated from its surrounding matrix and an information layer of ***Neighbourhood characterization*** is crucial. The type and proportion of green in the matrix, which refers to two UGI planning principles: connectivity and integration of green and grey infrastructure, influences the movements and dispersion of people and species between green spaces, with higher levels of greenery in matrix promoting ecological connectivity and walkability. The built matrix, grey infrastructure, play an important role with the level of urbanization being sometimes more influential for species compositions than the size of green space or vegetation structure (Ref.). For residents, the physical characteristics of the built environment strongly influence the perception of safety, willingness to walk or bike, which can promote or hinder the opportunity to visit a green space. The existence of other green spaces in the neighbourhood with other distinct facilities or layouts, may offer alternative and/or more interesting attractions for some users and diverge them by providing complementary uses. It also decreases use pressure towards a green space. Neighbourhood characterisation, as long as the focus is on the green components, can be linked with regulation and cultural ecosystem services. Indicators of this layer provides valuable information for UGI planning related to connectivity, multifunctionality, integration of green and grey infrastructure, and how neighbourhoods influence UGI planning challenges of social cohesion, climate change adaptation and biodiversity protection.

4.2 Lived biocultural diversity

- ***User group diversity***
- ***Neighbourhood cultural and economic characteristics***
- ***Space usage***
- ***Interactions***
- ***Meanings, perceptions and values***

User group diversity and ***Neighbourhood cultural characteristics*** directly assess the cultural diversity of users in terms of their origin, the socio-demographic and economic status, and visible patterns of allegiance to any kind of subculture or urban tribe, and evaluate how they use the greenspace, and if this diversity is a reflection of the neighbourhood. ES assessment do not aim identify if (im)material benefits of UGS are equally distributed to residents living nearby the UGS. Actual access and use of a UGS is determined more by experiential barriers associated with the level of perceived integration than by the UGS resources or physical qualities. One way of trying to capture the existence of such barriers is to determine if the cultural diversity of the neighbourhood is fully represented in the greenspace users and in the diversity of uses. These information layers provides information if planning is working and supporting social cohesions and multifunctionality of UGI, and indications for eco-gentrifications in the neighbourhoods. ***Usage diversity*** of UGS indicates if UGS is supporting different recreational uses, and points out potential conflicts with increasing use diversity (Raymond et al. 2016). Observing and analysing usage diversity of UGS links with CES: physical interactions with UGS and it also shows if the place is multifunctional or not. Analysing user diversity implies that the UGS is providing CES. Social activities, events are also supporting green economy and therefore proxies measuring potential economic benefits of UGS.

Interaction, interacting with someone or something, is the foundation to develop an emotional connection, positive or negative, towards the object of interaction. Casual interaction with other people, even if coincidental, affords opportunities to face and acknowledge distinct realities, ways of living and attitudes, fostering tolerance and integration. In a regular basis, social interactions are the base for social cohesiveness by creating bonds and promoting the sense of community. The same is valid for interactions with nature, with emotional experiences with the natural world inducing empathy for the environment and the desire to protect and conserve nature. Yet, people perceive and enjoy nature in many different ways, conditioned by the meaning and value they attribute to a greenspace and what it has to offer. Some may appreciate the space solely for its aesthetic properties or the useful amenities and infrastructures it provides, while others can develop a more emotional or affective relationship building a sense of belonging and attachment to place. Perceptions of safety, inclusiveness and integration are some of the most important factors for people to feel welcome and comfortable in the space and, when different ***meanings, values and perceptions*** are at stake, conflict can arise and lead to self-exclusion or to space-time segregation. Self-exclusion may also be potentiated by the perceived reputation of the place, either true, built upon real facts as crime rate of the neighbourhood, or false, based in rumours or legends. Each place has its own and unique history that shaped not only the biophysical characteristics of the space itself, but also the way people relate with it and construct their meanings and perceptions about it. Interactions with nature links it with CES, but BCD indicators provides much deeper information about interactions among people – conflicts – which ES assessment often fails to identify. These two information layers are important for analysing social cohesion, social inclusion and multifunctionality of UGS.

Places' history is engraved in people's memories, and represent an informal repository of information, here designated by ***Memory carriers of place***, which perpetuate in time through knowledge transfer. Local ecological knowledge can represent a very useful tool for planners and managers but only if opportunity is granted to users to fully participate in decision processes. Memory carriers have a central role to support biodiversity protection, social cohesion, social inclusion and multifunctionality of UGS.

4.3 Governance and stewardship

- ***Governance system and***
- ***Stewardship***

The ***Governance system***, which includes property-right regime, actors and roles, network structure, opportunities and barriers, governance shifts, management and specific norms and rules, determines which and how actors can take part in decision processes and if they really have an active voice and power to influence decisions. To fully participate in decision processes concerning a greenspace is one of the many ways of engaging with the space. The other is environmental ***stewardship***. Environmental stewards take care of the environment by protecting, conserving, managing, monitoring, advocating and educating about environmental issues. Such stewardship practices contribute directly for ecological knowledge but also for social resilience by enhancing the emotional bonds towards nature and the place itself. These information layers have no link with ES assessment, but it offers important information if UGI planning have met one of its main challenges: social inclusion.

5 TOWARDS THE FINAL REPORT OF WP2 (D2.3.)

The MS22 has introduced the BCD database, conceptualisation of BCD typology and BCD indicators. This report will be a practical tool for WP2 researchers to conduct final analyses and prepare D2.3 that will be a handbook for planners, designers, managers, place-makers and -keepers to understand different biocultural dimensions of UGSs and why we need a BCD approach in governing or managing UGSs or greening cities. In the following we will present shortly the content of D2.3 and list the responsible contributors. The D2.3 will include:

- ***Discussion about why the BCD approach is needed in the urban context***
- ***Case narratives on materialised, lived and stewardship BCD***
- ***Methodological suggestions to assess BCD studies in different context/situations***

5.1 Some points why BCD approach is needed in the urban context

Within this chapter of D2.3 we will highlight some important issues and challenges that need to be discussed when assessing BCD approach and making BCD studies in cities. The aim is to stimulate readers to consider context-dependence and relationality of any kind of approaches (UGI, ESS, BCD…).

Database: all
Responsible partners: UH
Supporting partners: FFCUL, SRC, TUB, UBER, WU
Deadline: June 2017

5.2 Case narrative on materialized BCD

The chapter will present how multi-taxa assessment and lichen inventories can contribute for studying human-nature interactions in cities.

Database: Multi-taxa assessment in Helsinki and Lisbon, lichen inventories in Lisbon
Responsible partners: FFCUL
Supporting partners: UH
Deadline: July 2017

5.3 Case narrative on lived BCD in European cities

The chapter will introduce how we can analyse diversity of UGI uses and users, and how these kinds of analyses can support socially sustainable (*cohesion, diversity, intergration*) planning and management of UGI. TUB will provide descriptive analyses on use diversity in different UGI types (forests, parks, wasteland) in five ULL cities. FFCUL, UBER and UH will analyse use, user and value diversity in parks in Berlin, Bucharest, Helsinki and Lisbon.

Database: D2.2, onsite interviews in parks in Berlin, Bucharest, Helsinki, Lisbon
Responsible partners: TUB and UH

Supporting partners: UBER, SRC, WU
Deadline: June 2017

5.4 Case narrative on lived BCD in Helsinki and Lisbon

The chapter will give some in-depth examples on how people the city of Helsinki and Lisbon interact with the biodiversity and with each other, and what is their relationship to the park. Two master students (Mari and Jasmina) will write a shortly about their main findings on biodiversity perceptions and park relationships of visitors.
Database: Interviews of park visitors in Helsinki and Lisbon
Responsible partners: UH
Supporting partners: FFCUL
Deadline: June 2017

5.5 Case narrative on stewardship BCD

Based on allotment gardeners' interviews in Berlin, Lodz and Lisbon the chapter discuss how engagement and stewardship of gardeners will differ in three cities. Within some specific examples the aim is to give example how BCD approach can help identify local and culturally embedded different in values and management practises.
Database: Allotment garden studies in Berlin, Lodz, Lisbon
Responsible partners: FFCUL and UBER
Supporting partners: FFCUL, SCR, UBER, WU, UH

5.6 Conclusions: suggestions to assess BCD study in different situation

In this chapter, summary of methods used in the Green Surge will be presented with some methodological suggestions how to study and analyse BCD in different context (establishing new green → greening projects, maintenance of current UGI, redesigning UGI, developing BD programmes, etch). The chapter will highlight "tested" methods, but also identify "gaps" in knowledge production.
Database: all
Responsible partners: SCR
Supporting partners: FFCUL, SRC, TUB, UBER, WU
Deadline: June 2017

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PHASE	RESEARCHER Partner(s) involved	CITY and UGI in which city/cities and UGI type the research is based on	OBJECTIVES What were the objectives of the research?	RESEARCH METHODOLOGY what kind of research is performed (mention main methods and what has been measured per method)	DATA What kind of data is collected (respons/sample), what kind of analyses, how is data stored and in which language	DATA SOURCE Where the data is stored and who is managing the data?
Policy	UH, WU and MRI	20 European cities (UGI is not specified here)	The objective was ro find answers to following research questions: How is BCD interpreted by policy makers? What kind of manifestations of BCD related biological and cultural diversity can be identified in current UGI policy? How have planning policies and management practices in European cities influenced biological and cultural diversity? What kinds of relationships exist between manifestations of BCD?	To compare BCD manifestations and policy actions for biological and cultural diversity between 20 European and planning families, statics from coded questionnaire matrices were presented. The raw interview data and BCD portraits provided by local researchers were analysed using content analyses. To recognize BCD manifestations and policy patterns in the data and to make comparisons between cities contents of texts were transcribed into binary codes (1= content identified in the text, 0= variable not identified).	A semi-structured interview of municipality officials. The interview included specific questions on green space planning, BCD and governance. In each of the 20 cities, local researchers have used a similar multimethod approach to data collection. A desk study of relevant literature and documents was conducted to verify and supplement results from the questionnaire. The analysis of two central planning documents by local partners focusing on two most important plans or policies related to UGI to provide insight on if or how different policy themes and UGI principles were considered in planning and how the plans were implemented.	The primary interview data is stored by partner who made interviews. Data analyses with comparative data tables are managed by WU. BCD analyse tables are managed by UH.
Governance	WU and UH	Aarhus, Amsterdam, Berlin, Bristol, Copenhagen, Edinburgh, Helsinki, Ljubljana, Lisbon, Lodz, Malmö, Milan, Oradea, Stockholm, Szeged, Utrecht	The objective was to analyse 18 case narratives of innovative governance as a part of D.6.2. The special focus was to identify people-biodiversity interactions and to what extent BCD is being manifested in different cases.	Qualitative analyzes of 18 case narratives of WP6. The cases covered five different clusters: (i) public participation, (i) urban farming, (iii) community-led management, (iv) business adopt the green space, and (v) e-governance. We developed three-step criteria for CD and BD, and finally analyzed the orientations of BCD of each case.	As collaborating with WP6 we performed qualitative analyzes of BCD in 18 cases of Tier2 studies. We used content analyzes to identify main expressions/manifestations for CD/BD and fixed criteria to interpret the magnitude of diversity.	The primary interview data is stored by partner who made interviews. Data analyses with comparative data tables are managed by WU. BCD analyse tables are managed by UH.
Environment	FFCUL	Lisbon and Almada (to be done)	In what extent do green spaces contribute to improve air quality in urban areas? How do lichens respond to different green spaces characteristics (size, tree density, surrounding urban density…) ?	Epiphytic lichen sampling following the standard European method, in the centroid of urban green spaces. Analyses of green spaces features such as size, medium altitude and slope. Information on Lisbon population was collected by residence area and age.	Lichen species frequency collected (from 4 trees in each 40 green spaces sampled in Lisbon). Lichen species were classified according to different response traits. Data on Lisbon population was retrieved from last Census in the city. Data stored in an excel database.	The primary inventory data is stored and managed by FFCUL.
Environment	FFCUL	Almada	How functional diversity of forest fragments respond to the urbanization gradient?	Field research with multi-taxa field inventories (lichens, butterflies and other-arthropods, birds and mammals)	Species richness and diversity of lichens, butterflies and other-arthropods, birds and mammals in 31 urban forests stratified by size and location in the municipality. Functional diversity of lichens, butterflies and birds. Data stored in Excel datafiles.	The primary inventory data is stored and managed by FFCUL.
Interaction	TUB (lead) with ULL partners	Bari, Berlin, Edinburgh, Ljubljana, Malmö	The objective was to find out if varying species richness affects human perception, valuation and use of green spaces (a) between UGI types, (b) between ULL cities, (c) among various human population groups?	We conducted a field survey that combined techniques of both the natural sciences (biodiversity/vegetation assessment) and social sciences (quantitative interviews).	In total, 3,814 valid questionnaires were included in the data base for the creation of a combined data set of all ULL cities. The data base includes the assessment of (a) valuation, (b) perception of different standardized but local-context stimuli material regarding four UGIs and three biodiversity levels; (c) use of three UGI; (d) demographic, social and cultural data of the respondents.	The primary survey data is stored and managed by TUB.
Interaction	TUB	general	The objective was to find out (a) how the studies on perception and valuation of urban biodiversity are distributed geographically across Europe; (b) which types of UGI are examined; (c) which levels of biodiversity are researched and (d) how the cultural diversity of the European urban population is represented in the studies.	We conducted a comprehensive and quantitative literature review and systematically analysed 85 papers that represent the current state of the academic literature on perception and valuation of biodiversity in European cities.	These 85 papers were analysed using assessment criteria in the form of questions such as “In which European country was the study located?” in order to extract information on the (1) geographic study location, (2) UGI type, (3) BD level (from ecosystems to genes) and (4) cultural diversity.	The primary survey data is stored and managed by TUB.

Interaction	UH	Helsinki	What is perceived and measured BCD in urban public parks? What factors (cultural, social, biophysical, ecological) influence on BCD?	Onsite field research of BCD of urban parks by using mixed-method approach (observation and semi-structured interviews of park visitor, field inventories of taxa, analyzing additional environmental and social data (GIS-data, social, economic and environmental resports etch).	Face-to-face interviews of 600 residents in 12 different parks (50 in each) around the city. Open-ended questions about use, meaning of place, favorite places, perceived biodiversity and cultural diversity values. Closed questions (scoring) of CD and BD, specific characteristics and wellbeing contributed by the park. Bacground information about education, age, mother language, country born, health condition. Field inventories of species richness of epiphytic lichens and vascular plant inventories.	The primary interview data is stored and managed by UH.
Interaction	FFCUL	Lisbon (in progress) and Almada (to be done)	What is perceived and measured BCD in urban public parks? What factors (cultural, social, biophysical, ecological) influence on BCD?	Onsite field research of BCD of urban parks by using mixed-method approach (observation and semi-structured interviews of park visitor, multi-taxa field inventories (lichens, vegetation, soil invertebrates, bees and butterflies, birds) analyzing additional environmental and social data (GIS-data, social, economic and environmental reports etc).	Face-to-face interviews of 600 residents in 12 different parks (50 in each) around the city. Open-ended questions about: i) motivation for visit and use, ii) attachment to the place and perceived benefits, iii) perception, valuation and interaction with biodiversity and ecosystem services provided, iv) health and well-being. Closed questions (scoring) of CD and BD, specific characteristics and well being contributed by the park, and socio-economic background information. Field inventories of species richness. Raw data (in portuguese) and coded data (in english) stored in excel databases.	The primary interview data is stored and managed by FFCUL.
Interaction	UBER, FFCUL and ULOD	Berlin, Lisbon and Lotzd	Allotment gardens as sites of food production and well-being	Onsite field research of allotment gardens by using mixed-method approach (observation and semi-structured interviews of gardeners, multi-taxa field inventories (bees and butterflies, birds) analyzing additional environmental and social data (GIS-data, social, economic and environmental resports etc).	Face-to-face interviews of 60 gardeners, in 60 different allotments parks around the city. Open-ended questions about: i) motivation for cultivating and intensity of use, ii) type of prodution and cultivated goods, iii) prodution determinants, iv) health and well-being perception, v) biodiversity perception, and vi) socio-economic background information. Field inventories of species richness. Location of city markets and supermarkets, and prices of cultivated goods. Raw data in progress (in portuguese), stored in an excel database.	The primary interview data is stored by partner who made interviews (FFCUL, UBER and ULOD). Data analyses with comparative data tables are managed by UBER.
Interaction	ULOD	Lodz (Poland)	We use hedonic pricing method in the case study city of Lodz to check whether green spaces representing the highest biocultural value have a stronger impact on property prices than those the biocultural value of which is lower	Hedonic pricing is an econometric method of dividing the price of a good into the prices of its components. By analyzing the price of a car one can determine how much car buyers value its components – by analyzing the price of a real estate one can find the perceived value of proximity to a green space of different types.	Data on real estate in the case study city of Lodz - information on 5018 apartments sold in years 2011–2013 in the centre of Lodz.	The data is stored and managed by ULOD.

LIVED									
Information Layer	**Indicator**	**Description / Rationale**	**Measuring**	**Methods and data sources**	**Link with BCD framework/theory (introduced earlier)**	**Link with ESS (WP3) according to CICES v4.3**	**Link with Planning principles and challenges (WP5)**	**Need for qualitative methods and in-depth analyses:**	**References**
User group diversity (social identities)	Socio-demographic and other characterization	Nature means different things to different people in different places and times. How people experience a greenspace, use and value its biodiversity or perceive its inherent benefits, is closely linked to their socio-cultural background. Belonging to a group, either a broad one (based on e.g. nationality, gender or age), or a restrict one (e.g. urban tribes or working mates) provides a sense of identity by sharing common interests, attitudes, beliefs or expectations.	Nationality, age, gender, education level, professional situation	survey	intercultural and intracultural diversity / surrogate for inclusiveness and social cohesion (residence also acts as a surrogate for attractiveness and esthetical value)	N.A.	Multifunctionality; social cohesion	no	Maffesoli, 1988; Peters, 2010; Dinnie, 2013; Morton 2016
	Ethnicity/urban tribes (subcultures?)		Different ethnic groups (muslim, afro, turkish) or urban tribes using the space	Field observations		N.A.	Multifunctionality; social cohesion	no	
	Residence	Users' residence and date of moving provide information on the effort spent to reach the greenspace, on the socio-economic background or on potential place attachment, while their origins can be more informative on their identity construction or sense of belonging .	Residence and date of moving	survey		N.A.	Multifunctionality; social cohesion	no	Smaldone, 2006; Brown, 2015; Cassidy, 2015
	Origin		Parents and grand parents birth place	survey		N.A.	Multifunctionality; social cohesion	no	
Neighbourhood cultural characteristics	Socio-demographic and economic characterization	An inclusive greenspace is open and welcoming, and usually their users' composition reflect the neighbourhood, as people tend to use the spaces at shorter distance. The underrepresentation of some groups may reveal the existence of some non-physical barrier leading to self-exclusion.	Nationality, age classes, gender ratio, edication level, employment ratio, professional situation	local census data	Intercultural and intracultural diversity. Is the greenspace a reflection of the neighbourhood or there is self exclusion?	N.A.	Social cohesion; multifunctionality	no	Gilles-Corti, 2005; Seaman, 2010; Soga, 2105
	Local economy	Culture and economy are mutually influential and local economic development intertwine with social processes that shape place meaning as good or bad. Changes in neighbourhood economy can drive to changes in the relationship of people with it.	Number and type of economic sectors. Evolution over time	local census data		N.A.	Social cohesion; multifunctionality; green economy	no	McCann, 2002; Pinkster, 2016
	Household prices	Household prices can be positively influenced by the close vicinity of greenspaces and are informative on the social-economic status of the neighbourhood, and its variation can inform on degradation or gentrification processes	Household prices and its variation on time	local census data		N.A.	Social cohesion; multifunctionality; green economy	no	
	Socio-demographic and economic changes	Changes in socio-demographic and economic strata can reveal processes of gentrification or impoverishment and degradation that can lead to the loss of sense of belonging and exclusion	Variation in socio-demographic groups, education level, origins; variation in in household prices, improvement or degradation of building conservation	local census data	Social cohesion, place making, sense of belonging; inclusiveness	N.A.	Social cohesion; multifunctionality; green economy	no	Persic, 2008; Pinkster, 2016; Wolch, 2014
	Crime rate	Neighbourhoods with higher levels of trust and cohesion tend to have lower crime rates	Reported complaints at local police	local census data		N.A.	Social cohesion	no	Sampson, 1997
Space usage	Number of users	The presence of people increases the perception of safety and attractiveness of a greenspace, and, even if not engaging in direct interaction, people enjoy the presence of others and to observe their activities. The diversity of activities and their actors may reveal the extent of usefulness and inclusiveness of the space and a regular use of it favours social encounters, promotes the sense of community and attachment to place	Number of users, percentage of groups, pairs and singles.	survey; direct observation	passive social interaction; social inclusion/cohesion	Cultural: Physical and intellectual interactions	Social cohesion; multifunctionality	no	(Newman, 1972; Giles-Corti, 2005; Cattell, 2008; Peters, 2010; Lin, 2014; Mehta, 2014;
	Uses		Different uses in the UGS	survey; direct observation	intracultural diversity; inclusiveness; use value	Cultural: Physical and intellectual interactions	Social cohesion; multifunctionality	no	
	Duration		Time spent in the UGS (passing by, mean time spent)	survey; direct observation	place attachment; use value	Cultural: Physical and intellectual interactions	Social cohesion	no	
	Frequency		Regular, sporadic, seasonal or year round use	survey; direct observation		Cultural: Physical and intellectual interactions	Social cohesion	no	
	Effort		Distance/time to home/work	survey	Equity; place attachment; attractiveness; living with BD	Cultural: Physical and intellectual interactions	Connectivity; social cohesion	no	
	Social activities	Socio-cultural events are often used by managers and stakeholders to encourage the visiting and use of greenspaces by offering extra attraction (Greenhalgh, 2006).	Number, type and promoter (government, organization, local people) of social-cultural events in UGS	Field observations; local data; social media	Appropriation value; passive interaction with nature; social interaction	N.A.	Green economy; social cohesion	no	Greenhalgh, 2006
	Interaction with other users		Users activily engaged with other user(s), e.g. greeting, talking,, running, playing	direct observation		N.A.	Social cohesion	no	

Interactions	Interaction with users of different subcultural group	Social interactions, even if incidental, foster tolerance, build bonds and promote the sense of community and social cohesion.	Users activily engaged with users from different ethnicity/tribe e.g. greeting, talking	direct observation	Active social interaction; social cohesion; living together	N.A.	Social cohesion	no	Cattel, 2008; Peters, 2010
	Shared activities		Users making/joining to the same activity (not having contact with each other e.g. sport)	direct observation		N.A.	Social cohesion	no	
	Interaction with nature	Active use of natural elements, besides representing a direct interaction between culture and biodiversity, contributes to avoid the “extinction of experience”, or the ongoing separation between people and nature, observed in urban settings.	People actively engaging with/or making use of biodiversity elements (e.g. feeding or watching birds, collecting plants, managing, gardening). Environmentally harmful behaviors or practices (e.g. use of chemicals, unauthorized vegetation cuttings, release of invasive species)	direct observation	BCD in action, living with BD	Cultural: Physical and intellectual interaction with biota/ecosystems	Biodiversity protection; multifunctionality	no	Soga, 2016
	Digital interactions	Digital techologies have the potential to motivate, mainly younger generations, to experience interactions with natural environments	Pokemons, geocaches, videos	internet search	Indirect interaction with nature	Cultural: Physical and intellectual interaction with ecosystems	N.A.	no	Cumbo, 2014
Meanings, perceptions and values of users	Perceived UGS qualities	The quality of a space is often more important than its availability in terms of quantity and is closely linked to its welcomeness and perceived safety, the convenience for the purpose of visit and the comfort and pleasure of the place. Perceptions have a major influence on determining how safe a place is, with unsafe places being closely associated with incivilities and neglect.	Peoples’ likes and dislikes regarding UGS qualities: space, nature, atmosphere, comfort, safety, maintenance, amenities	survey; interviews; participatory methods	Use, esthetic/amenities, narrative value; welcomeness, sense of place	Cultural: Physical and intellectual interaction with ecosystems	Social cohesion; multifunctionality	**yes**	van Herzele, 2003; Francis, 2012b; Mehta, 2014; Bertram, 2015;
	Safety		Reference of lack of safety or freedom	survey; interviews; participatory methods	Welcomeness; social cohesion; sense of refuge; place making	N.A.	Social cohesion	**yes**	
	Inclusiveness		Reference to the presence of different user groups and uses	survey; interviews	Welcomeness; social cohesion; living together	N.A.	Social cohesion	**yes**	
	Biodiversity and ecosystem services	Altough laypeople may use the term ‘diversity’ to reflect rather a subjective quality of the site that express their feeling of well-being , they can correctly perceive differences in biodiversity and recognize its importance in providing services	People’s perception on the biodiversity of the UGS (BD assessment, number of species) and ES provided	survey; interviews	Living with BD	Perceived ESs	Multifunctionality	**yes**	Martin-Lopez, 2012; Qiu, 2013; Voigt, 2015
	Conflict	Different users have different needs and experience the same place in diverse manners which can collide with the interests and well-being of others. Conflict can also arise with managing institutions by constraining certain behaviours or activities, or by the mananging options or even with nature itself through ecosystem disservices, e.g. allergies and diseases.	Reference to misconduct or conflicts with other users, with legal institutions regarding planning/management/governance GS or with nature (ES disservices)	survey; interviews; social media; participatory methods	Living together; Living with BD	Ecosystem disservices	Social cohesion; social inclusion	**yes**	Lyytimäki, 2009; Dinnie, 2013; Soulsbury 2015; von Döhren, 2015
	Sense of place	Place attachment and the sense of belonging, play crucial roles in social inclusion and sustainable communities by inspiring people to take action to protect and participate in collective decision concerning the places that are meaningful for them	Reference to place attachment/identity feelings	survey; interviews	Appropriation value; place attachment	Cultural: Physical and intellectual interaction with ecosystems; Spiritual, symbolic and other interactions with ecosystems	Social cohesion	**yes**	Stedman, 1999; Manzo, 2006; Peters, 2010; Horlings, 2015; Peters, 2016
	Wellbeing	Rural and urban livelihoods and well-being are closely connected to the status and trends in biological and cultural diversity - Florence declaration on the links between biological and cultural diversity. Leisure and environment are two essential domains contributing for both individual and community wellbeing.	Reference of emotional, psychological, spiritual wellbeing related feelings	survey; interviews	Feeling welcome and safe;	Cultural: Physical and intellectual interaction with ecosystems; Spiritual, symbolic and other interactions with ecosystems	Social cohesion	**yes**	Smale, 2017

Memory carriers of place	Place memory	Experiences and stories play an important role in assigning value to a place and keep record of past events, changes on the biophysical or social structure of the place.	Reference of memories associated to the place (either personal or related with GS biophysical characteristics)	survey; interviews	Memory carriers; place attachment; sense of belonging; narrative value	Cultural: Spiritual, symbolic and other interactions with ecosystems	Social cohesion; social inclusion	**yes**	Cilliers, 2015
	local ecological knowledge	Local ecological knowledge is one of the key areas of interdependence between biodiversity and cultural diversity and its transfer is essential to keep a memory repository for future use.	Users' knowledge regarding biodiversity and species present in green spaces, and their uses.	survey; social network analysis; participatory methods	BCD in action, living with BD; memory carriers	Cultural: Physical and intellectual interaction with ecosystems;	Biodiversity protection; multifunctionality	**yes**	Persic, 2008; Andersson, 2016; Martin-Lopez, 2015
	Local ecological knowledge exchange		Number, type and promoter (government, organization, local people) of nature-based events/experiences in UGS (e.g. Natural Skills Programme - Traditional basket making in Hyde Park).	Local data; social media; observation	Memory carriers; active interaction with nature	Cultural: Physical and intellectual interaction with ecosystems;	Biodiversity protection; social inclusion	**yes**	
	Reputation	Spaces acquire reputations, either real or built upon the imaginary, that persist in time and can attract or deter people from using those spaces	Reputation built upon e.g. rumours, urban myths, awards, touristic recommendations	Local data; social media; inetrent search; touristic guides/sites	Place identity; narrative value; attractiveness; self-exclusion	N.A.	Social cohesion; green economy	**yes**	Holland, 2007; Greenhalgh, 2006
	Digital external memory	Digital records provide easy access to information, potentiate knowledge dissemination and sharing of experiences, while keeping a memory of place that lasts in time for future generations	Records in social media (pictures in instagram, hits in Google search, videos in Youtube)	Internet search	Appropriation value; BCD creation	N.A.	Social cohesion; social inclusion	no	Andersson, 2016

GOVERNANCE AND STEWARDSHIP									
Information Layer	**Indicator**	**Description / rationale**	**Measuring**	**Methods**	**Link with BCD framework/theory (introduced earlier)**	**Link with ESS according to CICES v4.3 (WP3)**	**Link with Planning principles (WP5)**	**Need for qualitative methodsand in-depth analyses:**	**References**
Governance system	Property-right regime	Land tenure and property rights is a key dimension in determining how people access, use and participate in management of greenspaces	Ownership, access (subjected or not to a fee or a timetable) and management: public, private, common			N.A.	Social inclusion	**yes**	Muñoz-Erikson, 2016; Bac, 1998
	Actors and roles	Governance is a system of decision-making processes in which actors other than legal institutions can take part, but the way these actors, either formal or informal, can actually have an active voice in the process depend on the way they relate with each other and with legal institutions, on their position and role in the actors network. The opportunities and barriers to actors fully participate in the process, in terms of having access to information, sharing responsibilities and having real power to influence the decision, can be legally imposed or simply determined by informal rules-in-use. This is a dynamic process, both in space and time, with constant redefinition of the network, their relations and interactions, but acute shifts in governance processes can lead to conflict with impact in community cohesiveness.	Entities/users involved in UGS planning, management and maintenance. Type of activities developed (e.g. conservation, monitoring, advocate, education)	local census data; social network analysis; institutional analysis; interviews; partcipatory methods	Living together; engagement; sharing experiences and information	N.A.	Social inclusion	**yes**	Ostrom, 2007; Persic, 2008; Bodin, 2009; Biggs, 2012; Eizaguirre, 2012; Martin-Lopez, 2015; McMillen, 2016; Muñoz-Erikson, 2016; Pinkster 2016; Svendsen, 2016
	Network structure		Actors interactions and participation in the network, including centrality, influence, and cooperation. Communication channels and information exchange. Type of governance (self-governance; co-governance; governmental regulation) bottom-up; user promoted activities. Formal. Informal under LEK	local census data; institutional and document analysis; social network analysis; interviews; partcipatory methods		N.A.	Social inclusion	**yes**	
	Opportunities and barriers		Formal and informal rules-in-use			N.A.	Social inclusion	**yes**	
	Governance shifts		Recent changes in governance processes.			N.A.	Social inclusion	**yes**	
	Management	Green space management has for major purpose to provide a clean, welcoming place with multiple choice of activities or relaxation, but it also has the responsability to incorporate the best practices to conserve, protect and promote biodiversity and ecosystem services provisioning.	Type of management. Inclusion or not of eco-friendly practices envisaging biodiversity conservation/protection/promotion (BCD creation) and other environmental sustainability practices; Membership of associations for exchange of good practices (e.g. World Urban Parks), parks twinning	Local authorities; institutional and document analysis; interviews; partcipatory methods	Living with BD; promoting BD; BCD creation	Regulation: Maintenance of physical, chemical, biological conditions; Cultural: Physical and intellectual interaction with ecosystems	Biodiversity protection; social inclusion	**yes**	Manzo, 2006; Stedman, 1999; Peters, 2016; Grennhalg, 2006
	Specific rules and norms	Formal or informal rules, specifically issued or aknowledged for a certain space, can shape the way people interact with it, by promoting or deterring certain uses or activities.	Existence of site-specific formal and/or informal set of rules and/or norms (e.g. conditioned access, keep off the grass)	Local authorities; survey; interviews; partcipatory methods	Memory carriers, cultural diversity, social relations	N.A.	Social inclusion	**yes**	Ostrom, 2011
Stewardship	Citizen science	Biodiversity observations denote a direct engagement with nature and promote pro-conservation attitudes and behaviour	Observations collected in the UGS (biodiversity, meteorological data, etc)	Public databases	Living with BD; engagement	Cultural: Physical and intellectual interaction with ecosystems	Biodiversity protection	**yes**	Cooper, 2007; Cosquer, 2012
	Civic ecologic practices	Taking care of a greenspace creates a connection with place, a sense of belonging and ownership, while shaping nature itself	Users gardening, watering, repairing, volunteering, foraging, weeding, etc	Observations; survey; interviews; partcipatory methods	Living with BD, BCD creation	Cultural: Physical and intellectual interaction with ecosystems	Biodiversity protection	**yes**	Bramston, 2011; Romolini, 2012; McMillen, 2016
	Engagement	Place attachment and sense of ownership motivate active participation in decision-making processes concerning planning and/or management of the place	Collected suggestions/complaints regarding management, maintenance, planning of the UGS. Knowledge, membership and/or active participation in associations, action groups etc.	Local data; survey; interviews; partcipatory methods	Living with BD, appropriation value; place making; engagement with	Cultural: Physical and intellectual interaction with ecosystems	Social inclusion; biodiversity protection	**yes**	Manzo, 2006; McMillen, 2016

MATERIALISED BCD							
Level	**Information Layer**	**Indicator**	**Description / rationale**	**Measuring**	**Methods and data source**	**Link with BCD framework/theory (introduced earlier)**	**Link with ESS (WP3) according to CICES v4.3**
UGS	Biological diversity and UGS biophysical structure	UGS typology	Urban green spaces are culturally constructed biotopes. Even the more natural ones such as forests or derelict lands are remants of the human intervention in the landscape. The typology of the green space acts as a label of its underlying concept/design/structure.	Definition of UGS type: forest, park, allotment garden, brownfield, wetlands, etc.	GIS, field inventories, aerial photos	BCD creation	All ESs: Provisioning; Regulation and maintenance, Cultural
		Structural diversity	Spatial heterogeneity plays a crucial role in promoting biodiversity by providing habitat complementation and niche availability, increasing ecosystem function and resilience, and therefore being responsible for multiple ecosystem services. At the socio-cultural level diverse landscape elements provide opportunity for different uses , but also for restoration and place-making.	Micro-scale landscape characteristics: Number and/or amount and configuration of different biotopes, amount/proportion of impervious soil (inclui core habitat)	GIS; landscape metrics,	Ecological quality, perceived diversity ; multifunctionality; environmental/landscape preferences and attractiveness; place making; human-nature interaction; ecological resilience	Regulation: maintenance of physical, chemical and biological conditions Cultural: Physical and intllectual interaction with biome
		Biodiversity	Biodiversity in urban green spaces are the support of a wide range of ecosystem services and represent, for much of the population, one of the few opportunities for direct contact with the natural environment, with correspondent benefits in physical health, cognitive performance and psychological well-being	BD elements e.g. number of species, ecological key species, proportion of exotic species, amount of decaying wood, species with conservation status.	Field inventories; databases of the city or National History Museums; residents' own observations	Biological diversity; shaping nature; resilience	All ESs: Provisioning; Regulation and maintenance, Cultural
		NDVI	NDVI is an indicator derived from multi-spectral remotely sensed data which can be used to assess vegetation vigour. Also its variation is positively correlated with measured species richness providing a reliable tool to assess biodiversity.	Vegetation biodiversity and vigour	Remote sensing	Biodiversity; ecological quality	
		Vegetation structure	The vegetation vertical structure, composition and cover are prime determinants of habitat quality , presenting direct relationships with the levels of biodiversity, namely species richness of various taxa.	Vertical diversity of vegetation (number and heigth of large trees, small trees, shrubs and herbaceous plants)	Inventory, modelling, laser scanning; VAST	Surrogate for wildlife diversity; landscape preferences; place making; affordances of uses; ecological resilience	Regulation: maintenance of physical, chemical and biological conditions Cultural: Physical and intellectual interaction with biome
		Regeneration status	Age classes and growth stages are important criteria when assessing the regenerative capacity of the vegetation. The existence of young specimens is critical to maintain habitat quality but also to assure the future replacement of old trees	Natural regeneration - presence and density of growth stages (seedlings, saplings and young specimens). Artificial regeneration - presence and density of planted specimens	Field inventories; remote sensing	ecological quality; adaptive capacity; ecological resilience; ecological memory carriers	
		Functional diversity	More than the number and diversity of species, the number and type of functional traits and its dissimilarity/redundancy, determine the functioning and resilience of the ecosystem. Also, functional traits are closely linked to ecosystem services provided, including cultural by offering a better way to explore and appreciate biodiversity	Functional diversity indexes based on species functional traits	Functional diversity indices; functional traits databases	Diversity; Ecological quality; ecological resilience	Regulation: maintenance of physical, chemical and biological conditions Cultural: Physical and intellectual interaction with biome
	Welcomeness	Physical accessibility (physical barriers)	Equity in access to greenspaces involves an access without natural (e.g. slopes) or artificial (e.g. high traffic roads) physical barriers or transportation difficulties to reach them. Fees for use/ entry fees can hider the use of space for poor people.	Accessibility without car: bus/train/tram stops, bicycle parking's. Number of entrances, pedestrian crossings and accesses for disabled users. Existence of high trafic streets/roads/railways in the vicinity	Municipality GIS; inventory; service area analysis	Equity of access; inclusiveness	N.A.
		Infrastructure and Amenities	Recreational facilities, goods and services, along with its design, makes a green space useful and meaningful (fit-for-purpose), encouraging regular visiting.	Type and number of different equipments (e.g., benches, sport equipment, playground, lighting, formal bike and pedestrian trails) Type and number of businesses within UGI (Cafeteria, restaurant, Kiosk, library)	Field inventory	Use/amenity value; inclusiveness; purpose for visit; affordances	N.A.
		Cleanliness/Neglect	Neatness is one of the most valued characteristics of green spaces, with litter and incivilities being associated with the perception of lack of safety	Presence (or not) of litter and damaged property (benches, drinkers)/incivilities	Field observations, records from municipality reports	feeling welcome, inclusiveness, esthetical and spiritual value, place making	N.A.
		Security	Safety is often cited as the first concern in public spaces and though its perception (to be addressed in the lived dimension) being highly influenced by a number of factors, the presence of lighting and municipality/security staff provide an immediate sense of safety.	Presence of security/municipality staff. Number of reported incidences.	Local data	Welcomeness; social cohesion; sense of refuge; place making	N.A.

	Signs of memory carriers and cultural symbols	UGS origin and evolution	Green spaces have an associated history, they were created and designed according to the political, social and economic conditions at the time. These ideas and values still dominate and determine their present design and how people perceive and use the space. Major rearrangements can, on one hand, improve welcomeness but, on the other, also lead to eco-gentrification processes.	Origin and development of UGS; original biotope and design; recent major rearrangements and BD trends (native vs exotic, number/diversity of species); degree of naturalness; Association with historical/cultural/sacred/ritual events (e.g.european sites of remembrance; Open air museums)	Historical aerial photos, local data, municipality archives; phyto-toponyms	Social memory carriers; place making; human-nature interaction; shaping nature	Cultural: Physical and intellectual interaction with ecosystems, Spiritual, symbolic and other interactions with biome
		Biological salient features	Biophysical objects and other 'things' that structure human movement in space, and brings past meanings and experiences into the present. Creating and perpetuating cultural value for key-stone species, umbrella species, long-lived organisms, and slowly changing variables, adding time markers and reference frames	Biodiversity elements with historical, cultural, aesthetic or educational value. E.g., symbolic trees, cave, water spring, etc. Presence of salient biological features originally from different culture, country (e.g.cherry trees in Helsinki)	Municipality GIS; inventories; records from municipality reports	Memory carriers; sense of belonging; place making	Cultural: Physical and intellectual interaction with ecosystems, Spiritual, symbolic and other interactions with biome
		Cultural artefacts	Cultural artefacts provide information on the society that made it, how it used to live and express. In a green space, artefacts offer meaning and identity, create a sense of belonging and help preserving cultural heritage	Constructed elements with historical, cultural, aesthetic, or educational value. E.g., statue, fountain, wall graffiti, etc. Presence of cultural features originally from different culture, country (e.g. Thai pavillons in Lisbon)	Field inventories; local data	Memory carriers; sense of belonging; place making	N.A.
		Biocultural artefacts	Biocultural artefacts represent dynamic relationships between people and nature, by making use of natural elements or representing them.	Artefacts created from and/ or representing biodiversity/natural elements (e.g. graffiti representing animals in Lisbon, tree with baby carved in Helsinki);	Municipality GIS; field inventories	BCD creation	Cultural: Physical and intellectual interaction with ecosystems; Spiritual, symbolic and other interactions with biome
		Sign of prior use	Consistent patterns of users' engagement with a space create uses and functions, other than those provided by the infrastructure itself, leaving spatially explicit traces of their interaction with it.	Presence of signs of interaction with the space (informal desire paths, seats or playgrounds (some of these can be also identified as biocultural artefacts)	Survey; field observations	BCD creation; appropriation value; making place	Cultural: Physical and intellectual interaction with biome
	Neighbourhood characteristics	Green/grey proportion and characteristics	The type and density of green in the grey matrix influences the degree of permeability for animals and plants and hence the ecological connectivity, but also the human dynamics by promoting walkability, accessibility and the use of greenspaces, while contributing for stress reduction along the path. The built matrix itself can also hinder walkability trough negative perception of safety derived from poorly maintained buildings or evidence of incivilities.	Green/Grey proportion; Cover and type of green in the matrix; Density, type of urban fabric, (apartment blocks, small buildings, residential, business or shopping areas, etc, standing institutional buildings), age, origin and conservation status	GIS, aerial photos; space syntax analysis	Ecological connectivity and habitat fragmentation; landscape heterogeneity; habitat complementation; walkability; environmental justice; equity; place making; Intracultural diversity; environmental justice; equity	Regulation: Maintenance of physical, chemical and biological conditions; Cultural: Physical and intellectual interactions with biome
		Complementarity	Different users have different needs and no single space is likely to meet all desired facilities or activities. A multifunctional network of greenspaces is thus preferable to a network of multifunctional one-size-fits-all greenspaces, as a wider variety of greenspaces in a close vicinity can meet diverse needs, promoting its use more often.	Existence of GS with complementary features/facilities in the neighbourhood	GIS; local data; observation	environmental justice; equity; place making; multifunctionality	Regulation: maintenance of physical, chemical and biological conditions Cultural: Physical and intellectual interaction with biome
		Park pressure	Park pressure is defined as the number of people per park service area, assuming that each person were to use the nearest park. High levels of park pressure denotes a shortness of greenspace availability in the area, and induces greater pressure on the park itself	Number of people per park service area - potential number of users	GIS; local census	environmental justice; equity	N.A.

Link with Planning principles and/or challenges (WP5)	Need for qualitative methods and in-depth analyses:	References: Here we introduce most important literature, methodological books
Multifunctionality	no	
Multifunctionality; biodiversity protection; climate change	no	Tews, 2003; Fischer, 2006; Lovell, 2009; Dobbs, 2014; Hunter, 2015
Multifunctionality; biodiversity protection; climate change	no	Biggs, 2012; Elmqvist, 2013; Keniger, 2013; Coutts, 2015
biodiversity protection; multifunctionality	no	Gould, 2000; Bailey, 2004
Multifunctionality; biodiversity protection; climate change	no	Beninde, 2015
Biodiversity protection; climate change	no	Thackway, 2006; Greenberg, 2011; Le Roux, 2016
Multifunctionality; biodiversity protection; climate change	no	Peterson, 1998; Diaz, 2001; Tilman, 2001; Hooper, 2002; Cornelissen, 2003; de Bello, 2010;Biggs, 2012; Goodness, 2016
Green-gray infrastructure integration; multifunctionality; connectivity; green economy, social cohesion	no	Holland, 2007; Mehta, 2014; Ngom, 2015
Multifunctionality; green economy; social cohesion	no	Francis, 2012a; Kazmierczak,2013; Mehta, 2014
Multifunctionality; social cohesion	no	Bertram, 2015; Mehta, 2014
Multifunctionality; social cohesion	no	Dunnet, 2002; Holland, 2007; Mehta, 2014; Bertram, 2015;

Social cohesion; biodiversity protection; multifunctionality; climate change	**yes**	Loukaitou-Sideris, 1995; Byrne, 2009; Wolch, 2014
Biodiversity protection; multifunctionality; social cohesion	no	Andersson, 2016
Multifunctionality; social cohesion; green economy	no	Andersson, 2016; Petersen, 2013; Axelsson, 2013
Multifunctionality; (biodiversity protection)	no	Salick, 2014
Multifunctionality; social cohesion	no	Campbell, 2016
Connectivity; green-grey integration; climate change; biodiversity protection; multifunctionality; social cohesion	no	Werner, 2011; Biggs, 2012; Ellaway *in* Cooper (ed) 2014; Mehta, 2014; Beninde, 2015; Figueiredo, 2016; Sarkar, 2015; Soga, 2015; Marcus, 2016; Ward Thompson, 2016
Multifunctionality; green-gray infrastructure integration; connectivity; social cohesion	no	Loukaitou-Sideris, 1995; Cattell, 2008; Dobson, 2012; Soga, 2015
Social inclusion	no	Sister, 2007; Tan, 2016