Indicators of social acceptability of carbon-smart UGI

Deliverable report 3.1

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Authors:	Oriol García-Antúnez [1], Anton Stahl Olafsson [1], Natalie Gulsrud [1], Jussi Lampinen [4], Kayleigh Kavanagh [4], Christopher M. Raymond [2, 3, 4]
Institutions:	[1]Department of Geosciences and Natural Resource Management, Section of Landscape Architecture and Planning, University of Copenhagen, Copenhagen, Denmark. [2]Helsinki Institute for Sustainability Science (HELSUS), University of Helsinki, Helsinki, Finland. [3]Ecosystems and Environment Research Program, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland. [4]Department of Economics and Management, Faculty of Agriculture and Forestry Sciences, University of Helsinki, Helsinki, Finland

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CO-CARBON is a multidisciplinary research project aiming to quantify the carbon storage of green spaces at different urban scales using novel measurements and process-based models. In the project, atmospheric, soil and social scientists work together with landscape designers and urban planners. New solutions and knowledge for planning, implementation and maintenance of carbon smart urban green infrastructure are developed. This will be done in collaboration with project partners, citizens, businesses and city planners.

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Introduction and objectives

There is an extensive body of literature proving that urban green infrastructure (UGI) provides a long list of ecosystem services and benefits that sustain and improve human livelihood and quality of life of urbanites (TEEB, 2011; Haase et al., 2014; Cvejić et al., 2015). One of them is carbon sequestration and storage in urban vegetation and soils, which is claimed to be a cost-effective climate mitigation solution with multiple co-benefits for human and non-human residents (European Commission, 2013). The city of Helsinki has the ambition to reduce 60% of emissions by 2030, and aims to reach carbon-neutrality by 2035. To achieve these intimidating goals, the city will not only have to reduce greenhouse emissions, but also compensate for approximately 20% of the remaining emissions. Specifically, the city's action plan acknowledges the potential of urban vegetation to sequester and store carbon and calls for further examination of its compensation potential (City of Helsinki, 2018).

At the same time, urban densification, consolidation or infilling is a common strategy to mitigate climate change (EEA, 2006), since the compact and dense city is argued to have substantial sustainability benefits in terms of reduced travel distances and minimized urban sprawl. New buildings and infrastructure are being built on vacant green and brown spaces within the city borders so as to consolidate the urban fabric. Added to the urban population growth that most European cities are already experiencing, there is a growing fierce pressure exerted on UGI (Sister et al., 2010). In other words, amenity services, biodiversity and regulation services, among others, must coexist within the same green space (EEA, 2011). Consequently, maximizing carbon sequestration while not compromising other key co-benefits such as recreation and human well-being is a big challenge.

The CO-CARBON project seeks to quantify CSS at different urban scales and support the practical operations for the planning and management needs of carbon-smart UGI. Additionally, these effective practices to maximize CSS need to take into account the associated benefits of UGI, social values and preferences for carbon-smart UGI and engage multiple stakeholders in the decision-making processes. More specifically, the main task of this work package (WP3) is to find the balance between social and ecological values of urban green spaces in order to make informed and socially accepted decisions to advance carbon neutrality at the city scale. Task T3.1, consisted of an extensive literature review of social acceptability with a special focus on UGI. In this Deliverable, we start by describing what carbon-smartness stands for in the context of UGI. Further, with the help of current literature, we discuss the meaning of carbon-smartness and collect relevant indicators of social acceptability to make informed socio-ecological decisions on how to advance carbon-smartness in the context of UGI in a just, resilient and implementable way. Finally, we describe how these indicators will be used in task T3.2, which consists of a questionnaire for a sample population from Kumpula, a residential neighbourhood in the middle of Helsinki

Carbon-smart Urban Green Infrastructure

Carbon-smart Urban Green Infrastructure (CS-UGI) is a novel term that currently lacks an official definition. Taking the already-existing concept of "Climate-Smart Agriculture" (CSA) that aims to address food security issues and climate change under the same rubric (FAO, 2010), CS-UGI must include a similar multipurpose approach in its definition. Carbon-smartness clearly suggests a more specific focus on carbon, rather than climate change as a whole. This is why we approach our definition based on carbon cycling only, keeping other aspects derived from climate change such as urban air pollution or storm water management, secondary.

The term "Carbon-smartness" consists of two words: carbon and smartness. In relation to the "carbon" aspect, if we are to come up with an inclusive definition, we should first identify carbon sources and sinks in the context of UGI and the factors interplaying in carbon cycling. Therefore, "Carbon-smart" UGI suggests green spaces with either low emissions and/or high sequestration rates that simultaneously provide multiple purposes or co-benefits. In order to ease our own understanding of "carbon-smartness", we suggest a framework constituted by two dimensions, key for its definition, with examples of factors affecting their performance, which can be understood as "carbon smartness" proxies.

The *carbon* dimension

The first "carbon" dimension makes reference to carbon fluxes and stocks in UGS. Despite the special complexity of urban ecosystem functioning, we propose two main components encompassed in this dimension; a) carbon stored in plants and soils, and b) management Hiding Carbon Costs (HCC). The amount of carbon stored in urban vegetation depends on multiple factors, including above, below and dead plant biomass (Gratinni et al., 2016), whereas soil properties such as bulk density (Trammell & Carreiro, 2012), and the quality of entering litter (Setälä et al., 2016), among others, control carbon storage in urban soils. These two components are directly affected by the management intensity and direction by means of maintenance tasks such as irrigation, fertilization (Quian & Follett, 2002), and direct removal of biomass via pruning and mowing (Lerman & Contosta, 2019). The other component of this dimension, "Management HCC", makes reference to the emissions produced by green spaces maintenance tasks *per se* (e.g. Gu et al., 2015), which are not negligible, and should hence be taken into account when assessing the net carbon storage of UGS (Selhorst & Lal, 2013).

The *smartness* dimension

On the other hand, the "smartness" dimension represents the co-benefits provided by UGS other than carbon sequestration, such as recreation amenity, biodiversity support and other regulating services. The extent to which these co-benefits can be enjoyed by residents depend on the psychological and physical accessibility (Nesbit et al., 2018; Shanahan et al., 2015; Kronenberg et al., 2020). Not all user groups coexisting in the city have the same recreational needs and landscape preferences, and this diversity must to be taken into account when deciding the design and management of UGS (Kronenberg *et.al.*, 2020; O'Brien et al., 2017), even if they are justified by sustainability governmental targets such as carbon-neutrality (Harper, 2020). More related to the physical accessibility, the distribution of UGS is not homogenous within the urban fabric, preventing certain sectors of the society (generally disadvantaged socio demographic minorities) from enjoying these so-called co-benefits (Wolch et al.,2014). Under the -sometimes arguable- aim of improving access to green spaces and fostering a sustainable city structure, the creation of green spaces in traditionally disadvantaged areas has been a typical planning solution, yet bringing disastrous results for local residents, referred to as the *green space paradox* (Curran & Hamilton, 2012). Due to systematic urban design formulae and ecological restoration approaches failing to meet the needs, concerns and desires of local communities, the increased attractiveness of these retrofitted areas draw the attention of investors and the high-income class. Further, because of the inflation of property values caused by affluent newcomers, local disadvantaged communities, which were the primary target of these actuations, are ultimately excluded and forced to relocate. This paradoxical effect is termed under green, ecological or eco-gentrification. Similarly, although not directly related to UGI, improvements in grey infrastructure, namely building energy efficiency, form of transportation possibilities, walkability and multi-use and dense building models, are also carbon-smart policies that can promote gentrification, specifically known as (low-) carbon gentrification (Bouzarovski et al., 2018; Rice et al., 2019).

It is in this context where procedural and recognitional justice instruments play a vital role in urban planning and policy-making processes. By hearing the voices of local people directly affected by these decisions, and of those whose needs for access to green are more acute, adverse exacerbating effects such as gentrification and social opposition to sustainability policies can be prevented (Curran & Hamilton, 2012). It would therefore be a no-sense not to integrate the distributional, procedural and recognitional justice aspects under the "smartness" dimension. In other words, any urban sustainability model that seeks to simultaneously promote ecologically and socially responsible urban planning needs to take into account justice issues (Anguelovski et al., 2018) as, decisions seeking carbon-neutrality or carbon-smartness would not be fully "smart" if they were not just (Bulkeley & Fuller, 2012).

Decisions seeking carbon-neutrality or carbon-smartness would not be fully "smart" if they were not *just*

What is social acceptability?

Any attempt to plan, design and manage CS-UGI to maximise carbon sequestration and storage needs to be socially accepted by urbanites. But, what is social acceptability? There is an extensive collection of literature around social acceptability of technological projects that can have an impact on the living quality of residents. These include mining activities (Kuisma & Suopajärvi 2017), wind farming (Westerlund, 2020), Carbon Capture and Storage (CCS) projects (Huijts et al., 2007; Boyd, 2017), forest fuel management for wildfire risk prevention (Mylek & Schirmer, 2020), rangeland management for carbon sequestration (Cook & Ma, 2014) and even urban farming projects (Specht et.al., 2017; Sanyé-Mengual et al., 2018). Another important layer of studies have looked into social acceptability of biodiversity-friendly management in the context of natural, semi-natural and urban environments such as grasslands (Lampinen et al., 2021; Unterweger et al., 2017; Ramer et.al., 2019), road verges (Lampinen & Anttila, 2020), and private gardens (Lindemann-Matthies & Marty, 2015).

Yet, because of the novelty of the CS-UGI, there are no studies looking into social acceptability of CS-UGI. Drawing inspiration from these previous studies, we understand social acceptability as "the lack of noticeable opposition and active resistance, and the abundance of passive tolerance and positive attitudes steaming from a comparison judgment of different alternatives, which leads to support of CS-UGI and policies in a community" (building on Westerlund, 2020; Brunson, 1996). Social acceptability can be measured in multiple ways. In this Deliverable, we collect relevant indicators from existing studies that have assessed social acceptability of CS-UGI at different levels. Very much inspired by the framework to understand social acceptability suggested by Stankey (1996), we collected potential indicators for social acceptability of CS-UGI, and organized them in two dimensions (Table 1). The first dimension is the *attributes* to which acceptability refers. These could be practices, conditions or policies related to advancing carbon-smartness in the context of UGI or even at a larger city scale. The *context*, which includes the role of technical knowledge in modulating these acceptance judgements, is the second dimension we propose for social acceptability.

But acceptability to whom? Do acceptability judgments vary among different stakeholders? Equally important, is to assess how acceptability judgments are distributed among the population and where the cost and benefits of certain decisions are and will be allocated (Stankey, 1996). Decision-making processes must ensure to represent and recognise the differences in social acceptability of people from different backgrounds and ages to make sure these are just from the social, environmental and intergenerational perspectives.

Dimension	Key indicators	Question example	Element of study	Reference
Attributes	Assigned values	What are your first impressions when looking at this photograph?	Urban grasslands	Unterweger et al., 2017
		Map the following perceived problems and unpleasant experiences (PPUE)	Blue infrastructure	Raymond et al., 2016
		Assign the adjectives of this list to these images (use as many as you want)	Vegetation compositions	Lindemann-Matthies & Marty, 2013
		Stick the marker dots denoting specific values on green spaces on the map	Values of UGS	Ives et al., 2017
	Public attitudes & Preferences	Would you approve of having the following landscape components in your city parks?	Urban agriculture	Specht et al., 2017
		Attitudes towards having wind turbines in the city if they are built within the city's harbour area	Wind energy	Westerlund, 2020
		What are your attitudes towards the following production systems and orientations in urban agriculture?	Urban agriculture	Specht et al., 2016
		I will show you a set of two pictures. Which picture do you prefer?	Urban grasslands	Lampinen et al., 2021
	Economic valuation	How much are you willing to pay to enter a park with the following features?	Urban parks	Dwyer et.al., 1989
Context	Local vs. general acceptability	To what extent will you accept wind power if it was built within your community or village?	Wind power	Guo et al., 2016
	Trust in actors	Trust in the intentions to take into regard the interests of the citizens and the environment (1–no trust at all/5–high trust)	CCS	Huijts et al., 2007
		The environmental authorities are trustworthy in monitoring the impacts of the mining activities in Sodankylä	Mining	Kuisma & Suopajärvi, 2017
	Knowledge possession and level of awareness	User's self-reported level of awareness of CSS with a preface description using a slider	Rangelands	Cook & Ma, 2014
		How much, if anything, would you say you know about the following terms: CO_2/carbon dioxide emissions; carbon footprint?	Carbon capability among population	Whitmarsh et al., 2011
		Which are the benefits of flowering lawns and bees?	Urban grasslands	Ramer et al., 2019
		"The species richness of plants in a given road verge increases if the mown hay and woody debris are removed from the verge following the mowing." ("I was unfamiliar with this" (0) to "I was already familiar with this" (100)	Road verge management	Lampinen & Anttila, 2020
	Knowledge Integrity Complexity	List as many arguments for and against each fuel management strategy, and rate how strongly you feel about each argument	fuel management to reduce wildfire risk	Mylek & Schirmer, 2020

Planning of the survey and future steps of WP3

In our first attempt to assess the social acceptability of CS-UGI, we developed a pilot survey for Kumpula, a residential neighbourhood in the centre of Helsinki. Taking inspiration from the table and the example questions, the survey included elements assessing social acceptability from different angles. Open-ended, multiple choice, Likert scale and mapping questions were used to look into assigned values, attitudes, level of awareness and understanding, perceptions, policy preferences and perceived environmental justice aspects related to CS-UGI. In addition, socio-demographic and filtering questions were key to further identify trends and differences in social acceptability as well as possible unjust distribution of the costs and benefits of CS-UGI.

Having learned from our pilot survey in Kumpula, WP3 we will produce and deliver a second survey that will be targeted to residents in the whole city of Helsinki. Using data from both the Kumpula and Helsinki scale surveys, outcome manuscript from the data analysis will intend to cover some of the following objectives:

- Identify how values assigned to green spaces differ between youth and adults.
- Spatially identify which values (and whose values) are lost and maintained through existing development plans for the neighbourhood.
- Explore policy approaches that can be taken to manage for intergenerational use in light of potential loss of values.
- Understand the meanings of carbon-smartness as a feature of urban green spaces for urban residents on a conceptual and on a grass-roots level.
- Identify the co-benefits or trade-offs related to carbon-smartness.
- Asses whose values are incompatible or compatible with perceptions of carbon-smartness.
- Assess the level of public awareness around climate change and the role of UGI to mitigate it, and whether or not this links to social acceptance of CS-UGI.
- Unveil the situated and spatial meanings of carbon-smartness in the context of UGI.
- Identify differences between youth and adult in the understandings of CS-UGI.

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