Cultural Ecosystem Services on the university campus

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A student-centered approach to assess psychological and climate-related benefits of cultural ecosystem services on the university campus.

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Abstract

With climate change being one of the largest worldwide challenges of our time, it is important to prevent the loss of natural ecosystems that can act to mitigate climate change. Moreover, ensuring that urban areas are designed for human needs in conjunction with climate change adaptation/mitigation for a sustainable environment is crucial. University campus environments serve as places for study but are also used for other purposes. It is important that a campus area is designed with multifunctionality in mind. This study assesses students' appraisals of a university campus environment with integrated climate adaptation features and evaluates the cultural ecosystem services (CES) provided by the environment as measures of Perceived Restorativeness (PRS), Quality-of-Life (QoL), and Core Affect (SCA). In this study, 21 university students individually followed a predetermined structured walk on the Lund University campus. The participants responded to a web-based questionnaire on their mobile phone with stops in four predetermined places. The four places included varying types of environmental features and values for climate change adaptation/mitigation. Important findings include that areas with water surfaces are highly restorative, which was also the case for areas with high perceived biodiversity. The study showed that CES and climate change adaptation/mitigation work well in conjunction with each other. Simultaneously, by addressing these values it could also aid biodiversity measures and by assessing students' activities serve as a good basis for achieving multifunctionality in the environment. Careful design of urban green spaces including a diversity of features can thus preserve and improve CES, while contributing both to climate change adaptation/mitigation strategies and biodiversity.

Keywords: cultural ecosystem services, environmental appraisal, university campus, green areas, climate change adaptation, climate change mitigation, urban heat island effect, perceived biodiversity, perceived restorativeness, NCP, multifunctionality.

Populärvetenskaplig sammanfattning

Vad ser du som de viktigaste värdena som kan naturen ge dig?

Nu tänker du kanske, att naturen får oss att må bra och att den har ett egenvärde i sig. Men vad händer när dessa värden, som oftast inte är mätbara, ska konkurrera med andra värden? Stora delar av vår urbana miljö är överexploaterad, vi behöver platser att vila på, arbeta på och mycket mycket mer. De immateriella värden som naturen ger oss, kallade kulturella ekosystemtjänster, är beroende av levande naturmiljöer. Vill gärna ha dem nära oss och vi vill använda dem till såväl rekreation som vila eller till andra saker. Vi mår bra av naturmiljöer!

De är dock svåra att mäta, eftersom det inte riktigt går att sätta pris på dessa värden som så mycket annat. De är ovärderliga! Men tänk om det skulle vara möjligt att mäta, vore det inte då fiffigt om man behandlade flera värden från naturmiljön samtidigt? Så att utforma en studie som undersökte just detta vore väl en bra läsning? Jag hoppas det, låt mig berätta mer om studien! Vi börjar med det kanske största hotet för såväl människa som natur.

Klimatförändringarna.

De är en av vår tids största utmaningar, lägg därtill att flertalet av jordens ekosystem riskerar kollaps och vi kan konstatera att det är bråttom. Det är av yttersta vikt att hitta en väg framåt som förhindrar klimatförändringar och ekosystemkollaps, samtidigt som den dystra verkligheten är att vi till viss del måste anpassa oss till denna problematik. Den urbana miljön kan användas för att hitta synergieffekter mellan lösningar som samtidigt bidrar med andra värden. För denna studien är universitetsområden särskilt intressanta, där såväl klimatanpassningar som ekosystemtjänster kan skapa dessa synergieffekter. Av särskilt intresse är de kulturella ekosystemtjänster som grönområden kan bidra med, så som återhämtning och rekreation. Genom att 21 studenter fick skatta utemiljön genom psykometriska instrument på universitetscampus, Lunds universitet, kunde det konstateras att mångfunktionella grönområden med fördel kan implementeras för att skapa synergieffekter; genom att ta hänsyn till klimatanpassning och kulturella ekosystemtjänster men även biologisk mångfald i planeringen av utemiljöer.

Att skapa mångfunktionella grönområden stödjer inte bara en åtgärd utan flera samtidigt som exempelvis att individers aktiviteter tenderar att gå hand i hand med vilka kulturella ekosystemtjänster området kan erbjuda. Detta visar på en hållbar väg framåt för urban utveckling som kan stödja flertalet värden för såväl människa som natur, restaurera ekosystem samt en möjlighet att anpassa sig till den verklighet och möjliga framtid som klimatförändringarna för med sig. Om vi arbetar med naturen, så arbetar naturen med oss och det är nog det som de flesta av oss vill, för att vi ska kunna fortsätta känna glädje över dessa immateriella värden som naturen ger oss!

Läs gärna mer om studien och bär gärna med dig detta i läsningen; hur skulle du jämföra olika grönområden och förmåga att ge återhämtning – *och hur övertygar du beslutsfattare om att detta är viktigt?*

Dedication

Still, after nine years since you departed on your next journey, you are still my greatest inspiration, mother. You departed all too soon, but left us with your spirit, courage and everlasting kindness. For my dad, I will never fully grasp just how much adversity you have overcome over the years, but you always were and are still are, my rock in the storm.

Contents

Introduction

Climate change is one of the most pressing environmental challenges of human history. The Intergovernmental Panel on Climate Change (IPCC, 2013, 2018), emphasizes the urgency to prevent the global average temperature levels from rising above 1.5 degrees Celsius from pre-industrial levels by the year 2100. Current projections provided by IPCC (2018) states that extreme weather conditions and climatic events will be increasingly intense and frequent with the consequences of climate change in the future. Including prolonged, and intermittent, drought spells and heavy rainfall periods, extreme heat and cold periods, with consequences for both nature and society. The temperature is projected, for the foreseeable future, to increase 0.2 degrees Celsius per decade. Even at the current increase of 1-degree Celsius from pre-industrial levels, extreme weather changes, rising sea levels, and diminished Arctic sea ice are noticeable (IPBES, 2019b; IPCC, 2018). Furthermore, as the CO_2 emissions are increasing it has implications in other areas as well such as acidification of the oceans and other open water surfaces due to impact on the carbon cycle (IPCC, 2013) and non-anthropogenic species struggling to adapt to the new climate conditions. In addition, there are indirect effects of climate change such as the well-being of humans.

Climate change adaptation/mitigation

To halt the temperature increase, considerable efforts to limit greenhouse gas emissions in the atmosphere are needed. Climate change mitigation initiatives (CCM) in order to limit emissions, include retrofitting old buildings to increase energy-efficiency and decarbonizing the energy supply (IPCC, 2014b). The other option for mitigation is to remove existing greenhouse gases (GHG) from the atmosphere through carbon capture and storage technologies, and carbon sequestration from trees (IPCC, 2014b). However, IPCC (2018) concludes that CCM will not be enough to address the issue of climate change, human society also needs to adapt to future conditions. Climate change adaptation measures (CCA) varies depending on context but intends to reduce the consequences of climate change, for example; through storm water drainage, preserving wetlands to handle heavy rainfall/water surges or relocating buildings at risk of climate hazards e.g. homes close to the sea (Brink et al., 2018; Wamsler et al., 2013). As climate change also impacts nature (IPBES, 2019b; Pörtner et al., 2021), assessing measures to preserve and protect ecosystems from the effects of climate change is vital. Not least considering that marine and terrestrial ecosystems accounts for a gross carbon sequestration equivalent to 60 percent of global emissions (IPBES, 2019b). It is therefore apparent that we need to work alongside nature.

The importance of ecosystem preservation and restoration also applies to urban and peri-urban environments, as symbolized by United Nations Environmental Programme initiative The UN Decade on Ecosystem Restoration (United Nations, n.d.) which started 2021. Interspersed green spaces and ecosystems within urban and peri-urban areas can assist in CCA, reducing the urban heat island effect by improving wind-flow (Debbage & Shepherd, 2015; Hsieh et al., 2010; Krüger et al., 2011; Morakinyo et al., 2013; Ward et al., 2016), provide cooling opportunities during heatwaves by implementing water bodies in the environment (Ghosh & Das, 2018; Ketzler et al., 2021; Manteghi et al., 2015; Steeneveld et al., 2014; Wu & Zhang, 2019), handle storm-water and preventing flooding (Thoni, 2017; Voskamp & Van de Ven, 2015; Zimmermann et al., 2016) or through vegetation that provides shade during heatwaves (Trimmel et al., 2021). Such an ecosystem-based approach can also aid CCM by enhancing carbon storage and sequestration from planted trees (IPCC, 2012, 2014a) and preserve values important to other species e.g. biodiversity.

Ecosystem-based approaches, or similarly Nature-based solutions (NBS), in an urban setting provide multifunctional values (Andersson et al., 2019). For instance, water surfaces are generally appreciated by people and promote human well-being (Du et al., 2021; Karmanov & Hamel, 2008; Ulrich et al., 1991; Völker & Kistemann, 2011) while at the same time serving as storm-water management and providing cooling opportunities. Water surfaces can also benefit a variety of plants and animals (IPBES, 2019b; Manteghi et al., 2015). An ecosystem-based approach thereby enables a holistic application for climate change adaptation and mitigation (CCA/M).

Ecosystem services and Cultural ecosystem services

An ecosystem can be defined as *"A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit"* (IPBES, 2019a). The services provided for human benefit are called ecosystem services (IPBES, 2019a). Ecosystem services (ES) can be divided into supporting (e.g. habitat for species, biodiversity), regulating (e.g. carbon sequestration, countering extreme weather events), provisional (e.g. food, energy), and cultural (e.g. learning, well-being) (Andersson et al., 2019; IPBES, 2019b; Millennium Ecosystem Assessment, 2005). In the context of CCA/M, the regulating ecosystem services are important both in undeveloped natural environments and as restored ecosystems in urban settings.

The traditional ecosystem services concept provides a framework of understanding the human benefits of environments with nature-like elements. However, it does oversimplify certain dimensions and does not fully grasp nor explain the complexity of services nature provides to people. Nature's contribution to people (NCP) was therefore conceptualized by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) to include all the contributions to humanity deriving from nature, including ecosystem goods and services that together provides good human quality of life i.e. QoL (IPBES, 2019b). In this framework, the previously mentioned cultural ecosystem services (CES) are recognized as the non-material benefits that humanity draws from nature through recreation, mental and physical health, social interactions, learning, tourism, as well as aesthetics and spiritual experiences.

The concept of CES is not as easily quantifiable or monetized as other ES (Stålhammar & Pedersen, 2017), and in order to make the human-nature interaction tangible, and to assess CES for the maintenance of sustainable ecosystem-based approaches, recent environmental psychology publications have addressed CES from the individual's perspective (Johansson et al., 2019; Liu et al., 2021; Nghiem et al., 2021; Pedersen et al., 2019; Simkin et al., 2021; Stålhammar & Pedersen, 2017). The individual's valuation draws from the appraisal of the place. This approach has been applied for assessing CES and the benefits to QoL provided by restored wetlands and other environments with natural features (e.g. Johansson et al., 2019), for identifying nature's healing and aesthetically pleasing properties (Stålhammar & Pedersen, 2017), and for assessing how wetlands contribute to QoL aspects in the urban and peri-urban setting compared to parks and urban forests (Pedersen et al. 2019).

Previous research has identified areas that include water surfaces are rated higher in regard to well-being and QoL than green environments without water, while the spatial level is also important to bear in mind (Pedersen et al., 2019). As suggested by Stålhammar and Pedersen (2017), the benefits of a place is often based on the actual place and its unique characteristics and the services provided from a place cannot be generalized to what a certain type of place (e.g. urban forest, green area with water surfaces) can provide. Previous experiences play a role in the individual's perception of a place (Stålhammar & Pedersen, 2017) and the perceived benefits that the place provides can be both recreational and provisional (in terms of ES). Individual appraisals of the place therefore influence the environment's value in terms of CES and QoL benefits provided for the individual (Johansson et al., 2019; Stålhammar & Pedersen, 2017).

Appraisals of Cultural Ecosystem Services

In this study I take a broad approach to evaluate aspects within the framework of CES in campus environments; including dimensions of perceived restorativeness, affective response, and Quality-of-Life. The appraisals of CES have previously been linked with constructs that relate to how the environment is appraised at a direct level (Johansson et al., 2019) such as the perception of biodiversity (Gyllin & Grahn, 2005), olfactory and auditory senses (Johansson et al., 2019), and the perceived pleasantness of the environment (Grahn & Stigsdotter, 2010; Johansson et al., 2019; Kaplan, 1995; Küller, 1972). The visual, olfactory and auditory environmental stimuli are experienced in two dimensions i.e. valence which varies along the unpleasantness and pleasantness dimension and arousal along deactivation and activation dimension (Mehrabian & Russell, 1974; Russell et al., 1989). As Johansson et al. (2016) shows, these affective experiences can vary between specific contexts and in geographical scope, such as environments and specific places.

The natural setting seems to support restorative qualities and help individuals cope with stress (Abdelaal, 2019; Hartig et al., 1997; Kaplan, 1995). Two theories dominate the field regarding restorativeness; the Psycho-evolutionary (Ulrich et al., 1991) which proposes that restoration occurs when no threat is present and when the landscape is considered ideal for survival, for instance by including water sources and vegetation. The second theory, Attention restoration theory (Kaplan, 1995), proposes that restoration is achieved when individuals experience psychological distance from demands by being away or when engaging with environmental features that hold attention without effort and generating fascination. Hartig et al. (1997) proposes that the compatibility of the environment and the individual's intended activity facilitates the perceived restorativeness. Perceived restorative qualities is considered being a reflective appraisal and an affective experience (Johansson et al., 2019). IPBES (IPBES, 2019b) considers NCP or similarly, ES as essential for QoL and well-being. The World Health Organization (World Health Organization, 1995) defines it similarly, they state that an individual perceives her/his position in life in six domains: physical, psychological, independence, social relationships, environment, and personal spiritual/religious beliefs. This in turn suggests that cognitive, affective and psychological aspects are well within the concept. A good soundscape contributes to QoL by facilitating psycho-physiological recovery, while a poor soundscape can induce stress (Van Kamp et al., 2015).

University campus environments

University campuses are working environments, research facilities, and teaching environments while they simultaneously provide green areas with potential for addressing climate change and added values to nearby residents, students, and employees. In order to address the global sustainability challenges, there is a need to not only address the issue of ecological sustainability but also other dimensions of sustainability such as social sustainability, and it is key to take these into consideration along with the ecological values (Bergquist et al., 2019).

Within a university campus, both CCA/M are possible, although the ability to provide either or both is limited by the landscape and general location of the university. Still, designing in accordance with a regenerative approach is applicable on all areas. A regenerative design is the thought of re-designing the interaction between human and nature which will heal and amplify ecosystems (Pedersen Zari, 2015). For a regenerative landscape, there is a need to prioritize certain elements such as green areas with or without water features, photosynthesizing plants and water bodies which in turn contribute to recreational values (Bergquist et al., 2019). Promoting CCA/M in this regard could be through implementing NBS (Bergquist et al., 2019) i.e. creating/restoring green surfaces such as trees, water surfaces such as creating/restoring a stream or other surface of water. NBS can provide ecosystem services such as water filtration, storm-water management, along with carbon sequestration (Bergquist et al., 2019) which provide measures for both adaptation and mitigation. As it can provide access to human-nature interaction it also provides recreation opportunities, knowledge-gathering and place-attachment (Bergquist et al., 2019).

Another important aspect to consider is that the design of the outdoor environment has implications for the indoor environment, with tree canopies providing shade to reduce the need of cooling for buildings in warm weather and by providing a barrier to prevent excessive cooling through wind flow in cold weather (Bergquist et al., 2019). As of now, emissions from cooling buildings account for 10 percent of the global electricity demand (Birol, 2018) which is roughly estimated to 3 percent of the global GHG emissions (K. Östman (The Swedish Society for Nature Conservation), personal communication, June 9, 2021). With climate change, the use of air-conditioning (AC) has been increasing as the climate has gotten increasingly warmer (Birol, 2018), where vegetation has the ability to lower the need for AC. Abdelaal (2019) points out that within the discourse of the sustainable campus it is often implied that in order to achieve sustainability goals, the focus needs to be on material utilization and GHG emissions, while other dimensions are neglected e.g. societal, psychological and cognitive health effects for individuals utilizing the campus area. This refers mainly to the grey infrastructure such as buildings or other facilities. The general well-being of individuals and the benefits for levels of stress, productivity and employment longevity is well established (Abdelaal, 2019) which include findings that the outdoor environment influences the experience of the indoor environment. Thus, in the sustainable campus both the indoor and outdoor environment are interlinked.

As Bergquist et al. (2019) suggest, it is possible to find connections and synergies for a regeneration of both human and ecological resources by applying a holistic approach in the design of the physical environment. As previously stated, there is a need to apply methods such as NBS in order to achieve a regenerative and sustainable landscape (Bergquist et al., 2019) for the benefit of the environment, the climate, and for humans. The added human-centered values can be on a multi-level scale as the individuals who spend time on campus can benefit from the QoL aspects provided by the campus environment. The close connection with the education and research environment that the university offers can provide unique research opportunities (Bergquist et al., 2019). Not least for investigating the effects that CCA/M features can have for perceived cultural ecosystem services.

Aim

This study aims to contribute to a deeper understanding of the CES that green areas within campus environments with integrated CCA/M values can provide for students. Student activities are assessed in order to evaluate the multifunctionality of campus green areas and their potential for CCA/M. In addition, the study aims to contribute to narrowing the gap between implemented CCA/M measures and the concept of cultural ecosystem services in planning the university campus environment.

Research questions

- Can campus green areas with incorporated climate change adaptation/mitigation values support cultural ecosystem services for university students?

- Do certain characteristics of the selected green areas (e.g. vegetation, water surfaces) provide distinct aspects of cultural ecosystem services?
    - *H_1 suggests that areas with water surfaces support CES to a higher degree than green areas without.*
    - *H_2 suggests that areas with high perceived biodiversity support CES to a higher degree than those with low perceived biodiversity.*
    - *H_0 suggests that there are no differences in regard to CES and certain characteristics.*

- Do certain student groups obtain different CES from the selected areas?

- How are the selected areas used by students?

- What functionality is desired by the students within the selected areas and how can it be incorporated with the existing environment?

Method

Study areas

Landscape analysis

In accordance with the aim of this study, the geographical scope was set to evaluate the *LTH Norra campus area* at Lund University, Sweden. The first step was to survey the surrounding landscape through a landscape analysis (Bergquist et al., 2019) conducted 26-29 January 2021 and repeated on 31 March 2021 to account for seasonal variations. The landscape analysis was applied to identify distinct features, spatial scales and the organization of landscape elements on the university campus green areas such as vegetation and water surfaces. Of particular interest was to identify places for study with values for CCA/M. Places with elements of interest were then mapped out and compiled to provide an overview of areas in order to compare their relative value in regard to CCA/M.

The landscape analysis conducted at the *Norra campus area* revealed a landscape with a variety of physical characteristics e.g. water surfaces, trees, vegetation. The analysis further concluded that there were few variations when it came to spatial scale and spatial density, as the analysis revealed mainly large areas with few objects in relation to the space, large water features and tall trees. Therefore, the geographical scope was extended to include areas with small-scaled objects, such as smaller areas of vegetation or other features of smaller scale. The neighboring campus area *Universitetsplatån* offered settings that could complement the variety lacking in the *Norra campus area*. The extended analysis that included *Universitetsplatån* concluded that there was a satisfying variation of spatial scale (e.g. water streams, vegetation, grass fields and meadows) making the extended geographical scope suitable for the study.

Figure 1. Overview map.
The area of Universitetsplatån and Norra Campus highlighted in green, Lund University. *Source:* Lantmäteriet 2021.

Supporting material, basis for selection of places

With the landscape analysis concluded and the geographical scope set, it was possible to identify general areas for the places of study. As part of this process, supporting documents were gathered from Akademiska hus (personal communication, February 18, 2021) which included site layout plans for the areas *Norra campus* and *Universitetsplatån*. This material made it possible to foresee any potential physical changes in the landscape which could impact the study, such as seasonal variations. Insight on which values are considered important by individuals using the campus area was gathered from an evaluation made by Akademiska hus and Lund University (Jonson et al., 2020), though this was limited to the *Norra campus area*.

To further identify areas of interest, questions were asked to three students (Anonymous, personal communication, February 19, 2021) by showing them the map covering the area of Norra Campus and Universitetsplatån, and with the questions: *"From what areas on the map have you experienced non-material gains from the physical environment. And how?"* along with *"What areas on the map do you usually visit?"*. Furthermore, an on-site interview was done with staff at Peab (Person in charge of groundskeeping, Peab, personal communication, February 24, 2021) where the maintenance of the campus green areas was explained, what the future plans were and what collaborations with Lund University were in place regarding the maintenance of the physical environments.

Places identified

The places for study were chosen with the criteria that; 1) for the basis of multifunctionality in the environment, that departing from the IPBES framework of Nature's contribution to people (see *Appendix A.*) at least five categories of ES were considered present, 2) that the place had characteristics important for CCA/M, 3) that the places needed to be separated by at least 5 minutes of walking distance in order to avoid cross-contamination of appraisals between the places (adapted from Johansson et al., 2019).

As categories 15-17 are strictly CES (see *Appendix A.*) and CES being the object of study and therefore assessed through participants appraisals, these categories were disregarded as criteria for selection. From the 11 places identified in the landscape analysis, 8 places fulfilled the criteria of having five categories of NCP present. The criteria (and indicators) of the categories from the NCP framework that were identified in the 8 areas are presented below.

For *Habitat creation and maintenance*; nesting grounds, growing sites for plants, mating sites for animals were found in the areas.

Dispersal of seeds by birds and facilitation of pollination flowers and bees were identified to fulfill the criteria *Pollination and dispersal of seeds and other propagules.*

The criteria *Regulation of air quality, Regulation of climate, Regulation of ocean acidification* were all fulfilled similarly; by photosynthesizing plants i.e. flowers, bushes, trees and by water features. *Regulation of climate* was further fulfilled by carbon sequestration through soil formation processes and the area providing evapotranspiration through mixed water features and photosynthesizing plants.

Regulation of freshwater quantity, location and timing was fulfilled through water features by regulating the timing of storm-water and having floodable areas such as a reedbed.

Regulation of freshwater and coastal water quality was fulfilled by filtration in water features e.g. meandering brook.

Regulation of hazards and extreme events was fulfilled by ground-and water surfaces that can regulate storm water and by providing cooling during heatwaves, either through foliage or water surfaces.

Maintenance of options was fulfilled by the area having a wide variety of plant-life that makes it resilient and able to adapt to future changes to the environment or by ensuring the continued existence of species important to the environment as a whole.

The 8 places all had values for CCA/M. For climate change adaptation (CCA) the areas countered the urban heat island effect by providing cooling opportunities for both humans and infrastructure. To a varying degree, the areas offered storm water management through floodable areas and water features. The areas offered CCM through soil formation and photosynthesizing plants, mainly trees in varying size.

As the places for assessing CES needed to be separate from each other, in order to avoid cross-contamination of appraisals, four different general areas (with a total of 8 places) were identified which between them is a distance of 5 minutes of walking distance. Four places within these areas were chosen for the study, with disparate characteristics in accordance with the spatial scale of vegetation e.g. large or small trees, layers of vegetation, and if the places had water features. As water features are known to affect how green areas are experienced; two places with water features were chosen, one with a lake and one with a brook. Two places with no water features were chosen for comparison; one which had large grass fields and meadows, and one that had large trees. Thus, the final selection of four places were chosen for the study. For each place correspondence to the NCP categories along with a description, see the following section.

Description of places for study

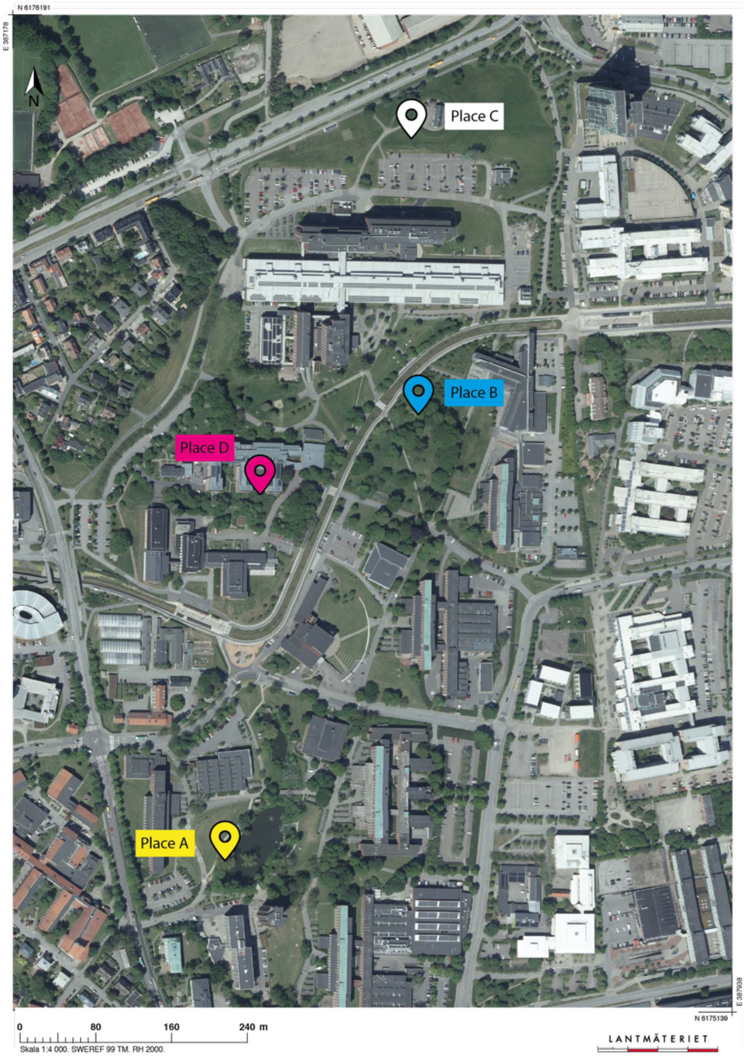

Figure 2. Overview of places.
Overview map with the Places A,B,C,D marked in separate colors. *Illustrations:* Maria Border. *Source:* Lantmäteriet 2021.

Place A – Lake Sjön

An area with low density vegetation e.g. sparsely located objects such as deciduous trees (approximately 0.5-1.0m in width, 8-12m tall), shrubbery, reed and water surfaces e.g. an approximately 3,800 m^2 large lake. Identified by students as especially appreciated (Anonymous, personal communication, February 19, 2021). Sequestrates carbon through the soil, the large water body and large trees, provides storm water management and cooling opportunities for heat waves.

Place B – Grove with an adjacent larger green surface

An area with high density vegetation e.g. densely located objects such as deciduous trees (approximately 0.5-1.0m in width, 10-20m tall), bushes, flowers and large green surfaces e.g. grass. The area was identified by students as especially appreciated (Anonymous, personal communication, February 19, 2021) and sequestrates carbon through trees and soil as well as provide shade during heatwaves.

Place C- Large meadows and grass fields

An area by the building *Kemicentrum* with large green surfaces e.g. grass and restored meadows. Identified as being a particularly unpleasant environment in the Norra campus evaluation (Jonson et al., 2020). Offers carbon sequestration through soil and can limit the urban heat island effect as it is possible for wind to flow unobstructed into the other campus areas.

Place D – Brook

An area by the building *Ekologihuset* with high density vegetation e.g. densely located, mainly deciduous trees with occasional evergreen trees (approximately 0.1-0.5m in width, 5-6m tall) and bushes. The area consists of features such as interconnected waterspouts, iris marsh and an artificial meandering brook that supports storm water management and run-off water.

Figure 3. Places A, B, C, D (in order). Showing standing plates, signs and representative elements of environmental features. Photos were taken from afar to illustrate features in the surrounding environment. *Source:* Christoffer Hahn

NCP Criteria for places

The place's ability to fulfill a category of NCP is described in *Table 1*. For *Habitat creation and maintenance*; nesting grounds and mating sites for animals were found in Place A, B, D. While growing sites for plants were found in Place A, B, C, D.

Dispersal of seeds by birds; spreading seeds when consuming, harvesting and gathered feed for nesting-place, were identified to fulfil the criteria *Pollination and dispersal of seeds and other propagules* in Place A, B, C, D. The criteria were further fulfilled through facilitation of pollination through deadwood, insect hotels, flowers or meadows that were identified in Place B, C, D.

The criteria *Regulation of air quality, Regulation of climate, Regulation of ocean acidification* were all fulfilled similarly; by photosynthesizing plants i.e. flowers, bushes, trees in Place A, B, D. And by water features in Place A and D.

For *Regulation of climate* was further fulfilled by carbon sequestration through the soil for Places A, B, C, D. Photosynthesizing plants sequestering carbon was found in Place A, B, D. The water features with nearby vegetation in Place A and D provides evapotranspiration.

Regulation of freshwater quantity, location and timing was fulfilled through water features by regulating the timing of storm-water and having floodable areas such as a reedbed. Provided by Place A, B and D.

Regulation of freshwater and coastal water quality was fulfilled by filtration in water features e.g. the large lake and meandering brook for Place A and D.

Regulation of hazards and extreme events was fulfilled by ground and water surfaces that can regulate storm water and by providing cooling during heatwaves, either through foliage or water surfaces for Place A, B, C and D.

Maintenance of options was fulfilled by the area having a wide variety of plant-life or meadows that makes it resilient and able to adapt to future changes to the environment or by ensuring the continued existence of species important to the environment as a whole for Place A, B, C and D.

Table 1. Categories of NCP's and the place's ability to fulfill them.

	Reporting categories of nature's contributions to people	**Place A**	**Place B**	**Place C**	**Place D**
1	Habitat creation and maintenance	Yes	Yes	Yes	Yes
2	Pollination and dispersal of seeds and other propagules	Yes	Yes	Yes	Yes
3	Regulation of air quality	Yes	Yes	-	Yes
4	Regulation of climate	Yes	Yes	Yes	Yes
5	Regulation of ocean acidification	Yes	Yes	-	Yes
6	Regulation of freshwater quantity, location and timing	Yes	Yes	-	Yes
7	Regulation of freshwater and coastal water quality	Yes	-	-	Yes
8	Formation, protection and decontamination of soils	-	-	-	-

	and sediments				
9	Regulation of hazards and extreme events	Yes	Yes	Yes	Yes
10	Regulation of detrimental organisms and biological processes	-	-	-	-
11	Energy	-	-	-	-
12	Food and feed	-	-	-	-
13	Materials, companionship and labor	-	-	-	-
14	Medicinal, biochemical and genetic resources	-	-	-	-
15	Learning and inspiration*	-	-	-	-
16	Physical and psychological experiences*	-	-	-	-
17	Supporting identities*	-	-	-	-
18	Maintenance of options	Yes	Yes	Yes	Yes

* category not part of criteria due to object of study through participant's appraisals.

Participants

The study included *n*=21 students at Lund university from several faculties and fields of study (see *Table 2.*). The majority of the students were studying Environmental Sciences.

Table 2. Descriptives of participants.

Mean age, years	27
Age range, years	24-34
Gender/Stated identity (n)	Female (16) Male (5)
Field of study (%)	Environmental Sciences (67%) Social Sciences (14%) Engineering (10%) Medicine (5%) Humanities (5%)

Recruitment proceeded in four steps; first, student unions with students that have their lectures in the Norra campus/Universitetsplatån area were contacted. Two unions were able to pass on information to their members. Second, student organizations with housing in close proximity to the area was contacted. Two were able to pass on information to their members. Third, a selection of student councilors for fields of study that are located in the campus area were contacted (selected from where unions were not able to pass on information). One was able to pass on information about the study to students. Fourth step was a convenience selection, contacting earlier and present classmates and contacts of the author studying at Lund University.

For all the steps mentioned above, recruitment information was given with the aim of the study, length and requirements to participate. For steps 1-3, flyers were distributed digitally either through a mailing list or through a student newspaper. For these initial three steps 2 participants were recruited while for the fourth step (convenience sample), 19 participants were recruited.

Instruments

The assessments used in this study were based mainly on the method and instruments used by Johansson et al. (2019). Established and validated instruments were used (internal reliability reported in *Appendix B.*), with the exception of the items used for qualitative analyses.

Environmental description was assessed through asking participants to rate several aspects of what they see, hear and smell in the environment. The visual perception of the four places was assessed by using a revised version of Biodiversity Experience Index i.e. BEI (Gyllin & Grahn, 2005; Johansson et al., 2014). Semantic Environment Description i.e. SED (Küller, 1972) dimension pleasantness (8 items) was used for the overarching visual perception assessed on 7-point scales. Soundscape perception (Axelsson et al., 2010; Johansson et al., 2019) was assessed with the question *"To what extent do you agree with each of the following statements about how you experience the surrounding sound environment right now?"* on two dimensions, i.e. pleasantness (4 items) and eventfulness (4 items) with 5-point scales and later converted to -2 to +2 scales. Scent perception (Johansson et al., 2019) was assessed with the question *"How do you perceive the smell of this place?"* using two 7-point polar scales, i.e. unpleasant–comfortable and weak–strong, representing the two dimensions pleasantness and strength.

For perceived CES, the affective experience in the place-assessments was rated by the participants by using an affect grid measuring valence and arousal for experimental situations was adopted. Originally developed by Russel et al. (1989) and further developed by translating into Swedish, modified into a 5 x 5 grid, and adapted to field experiments (Johansson et al., 2016). This lets participants assess their affective experience vertically ranging from low to high arousal (passive to active) and horizontally ranging from low to high valence (negative to positive). For the purpose of this study, this was adapted onto the online survey by the feature Heat Map in Qualtrics XM (n.d.) where participants were asked to assess their affective experience by marking a certain square on an image of the 5 x 5 grid constructed by Johansson et al. (2016). As a second step in the assessment of affective experience, the Swedish short measurement of core affect was used, comprised of two composite rating scales (Västfjäll & Gärling, 2007). This ranges from low valence (sad, depressed, displeased) to high valence (glad, happy, pleased) and from low arousal (dull, passive, sleepy) to high arousal (peppy, active, awake). As both measures for affective experience were satisfactory in regard to internal reliability (see *Appendix B.*) averaged indices were created for both dimensions.

Reflected appraisal was assessed as perceived restorativeness using a short version of the Perceived Restorativeness Scale i.e. PRS (Hartig et al., 1997; Lindal & Hartig, 2013; Nordh et al., 2009) which consisted of 11-point scales on three dimensions i.e. being away (two items: *"Spending time here gives me a break from my everyday routines"* and *"In this place, I get away from what usually requires my attention"*), fascination (two items: *"There is a lot to discover and investigate here"* and *"This place is fascinating"*) and environmental preference (one item: *"I like this place"*) was measured with the question on a 11-point scale ranging from 0="do not agree at all" to 10="agree completely". The measurements of the subjective QoL for each place are based on 3 of originally 22 items (Poortinga et al., 2004), translated into Swedish and adapted to Swedish context by Johansson et al. (2019). Participants rated how the places contributed to selected subjective QoL aspects Aesthetic beauty, Environmental Quality, Nature/Biodiversity on 5-points scales ranging from 1="not at all" to 5="extremely much", which related to aspects of nature and its contribution to QoL.

The qualitative section of the questionnaire consisted of three items with free text response. To assess how students currently use each area, the item *"How do you use this area?"* was used. The item *"What activities can you imagine yourself doing in this area?"* was used in order to assess what students would like to use the area for. The item *"How can the area be improved in order for you to use it to a higher degree?"* was used to evaluate potential improvements to the area in order to facilitate utilization and multifunctionality in the areas. In addition, the evaluation of the Norra campus area made by Akademiska hus and Lund University (Jonson et al., 2020) was used to provide a wider perspective in regard to multifunctionality in the areas.

Procedure

Environmental assessments by students were done individually and without supervision through a Qualtrics web-based survey adapted for responding on a mobile phone. Prior to the study, participants were given the starting location, instructions on how to start the survey, a personal link to the survey, and a time slot for when to start the survey. On arrival, participants entered the provided password, signed a consent form and were provided with directions and a map to the next location. A mobile phone number was provided to call if any questions arose during the study. Upon arriving to a new location, participants were asked to enter the 4-digit location ID-number provided by the standing plate on the ground. After the location ID-number was entered they were instructed to stand on the plate, on the marked footprints, assess the environment with a 180-degree viewpoint (which was illustrated on the standing plate, along with a directional arrow) when answering the questionnaire. Upon finishing a place-specific questionnaire, the participants were given directions for the next location along with a map. These steps were repeated for all locations (Place A, B, C, D). When finishing the questionnaire for Place D, participants were directed to a nearby location to complete the survey and receive a quick debriefing explaining the study and what was measured. A mobile phone number was provided in case any questions arose or if participants wanted more information.

Analyses

As normality could not be observed in parts of the quantitative data, to err on the side of caution, non-parametric tests were conducted. Statistical analyses were conducted with Wilcoxon Signed-rank tests, in order to compare related samples, when comparing Place A, B, C and D for each instrument. The analyses tested for how participants' appraisals differed between the places for environmental description and CES.

To test the differences between places that shared characteristics; first, comparisons were made for CES in areas with (Place A, D) and without water surfaces (Place B, C). For perceived level of vegetation, comparisons were made for CES in areas with high levels of perceived biodiversity and those with low levels of perceived biodiversity. Categorization was made in a similar manner as for testing H_1 where high levels of biodiversity was operationalized through Perceived Biodiversity (BEI) being rated above M=4.0 for a place, while low levels of biodiversity was operationalized through Perceived Biodiversity being below M=4.0. Place A, B and D were all rated above M=4.0 and formed the category High Perceived Biodiversity. Only Place C was rated below M=4.0 and formed the category Low Perceived Biodiversity.

Mann-Whitney U tests for independent samples, were used to identify differences between students' groups for perceived CES from the places of study. As participants mainly were students from environmental sciences, their appraisal of perceived CES were compared to a second group consisting of students from other fields of study.

For all statistical tests the significance level $p < .05$ was used. Free text responses provided items relating to activities and improvements for each area assessed by participants were analyzed through inductive thematic analyses (Braun & Clarke, 2006). Overarching themes were identified through responses and categories while keeping distinct activities and improvements separate. Similar activities were merged and reported as one activity.

In order to eliminate potential data validity errors and account for differences in weather conditions; raw-data was analyzed to identify straight-liners and examining variations across the raw-data. Although the weather conditions, in part differed between participants, the analyses of the raw-data concluded that the validity of the data-set was intact as the raw scores did not vary significantly when assessing differences in raw scores between participants.

Ethical considerations

The results of the study were not expected to have any ethical implications per se, though some considerations were made regarding data collection and information provided by participants. Participants were granted confidentiality, with only the author and supervisor having access to the data. Participation was only granted with confirmed consent, with information and purpose of the study and how the data is stored (locally on a computer and in the survey tool). Participants were informed that citations could be made of their answers, with anonymity. After participation, they were provided with a debriefing text in the survey in addition to a phone number if they had any questions. Ethical considerations in this study complied to the American Psychological Association's (2017) ethical principles for conducting psychological research and codes of conduct. Furthermore, the study complied to the research principles established by ALL European Academies (ALLEA, 2017) regarding reliability, honesty, respect and accountability. The methodology, descriptive sample data and collected data are disclosed transparently in order to assess these principles. The data collection was constructed with the current Covid-19 pandemic in mind, which was done individually and fully digitally through a web-based survey on the participants own phone in order comply to Covid-19 restrictions and for participants own safety. In conclusion, the ethical implications of the study were deemed small with these precautions.

Results

Green areas with climate change adaptation/mitigation values and their contribution to perceived CES

In order to assess university green areas contribution to students perceived CES, and the first research question *"Can campus green areas with incorporated climate change adaptation/mitigation values support cultural ecosystem services for university students?"* Wilcoxon signed-rank tests were conducted across Places A, B, C, D.

For students' appraisals of the environment; *Perceived Biodiversity, Semantic Environment Description, Soundscape perception, Scent perception* were assessed. For CES; *Affective response, Perceived Restorativeness, Environmental preference, Perceived contribution to Quality-of-Life aspects* were assessed.

Table 3. Descriptive statistics.

Constructs are in bold and dimensions in italic in the left column. Means with standard deviation (SD), for Places A, B, C, D .

	Place A	Place B	Place C	Place D
Biodiversity Experience Index, BEI (scale 1–7)				
Perceived biodiversity	4.56 (SD=1.12)	5.00 (SD=1.18)	2.01 (SD=0.79)	5.23 (SD=0.93)
Semantic Environment Description, SED (scale 1–7)				
Pleasantness	5.50 (SD=0.74)	5.90 (SD=0.67)	3.30 (SD=0.70)	5.89 (SD=0.69)

Soundscape perception (scale –2 to 2)				
Pleasantness	1.06 (SD=0.72)	1.22 (SD=0.59)	-0.36 (SD=0.51)	1.11 (SD=0.85)
Eventfulness	0.69 (SD=0.69)	0.32 (SD=0.73)	-0.40 (SD=0.56)	0.41 (SD=0.64)
Scent perception (scale 1–7)				
Pleasantness	5.00 (SD=1.45)	5.24 (SD=2.02)	4.14 (SD=1.65)	5.10 (SD=1.58)
Strength	2.38 (SD=1.24)	3.24 (SD=1.87)	2.86 (SD=1.65)	2.33 (SD=1.49)
Affective response (scale 1–5)				
Valence	4.29 (SD=0.66)	4.40 (SD=0.62)	3.43 (SD=0.98)	4.42 (SD=0.56)
Arousal	3.77 (SD=0.77)	3.75 (SD=1.05)	3.69 (SD=0.90)	3.52 (SD=0.85)
Perceived Restorativeness Scale, PRS (scale 0–10)				
Being away	6.67 (SD=1.63)	7.10 (SD=1.59)	3.38 (SD=1.80)	6.90 (SD=1.82)
Fascination	6.42 (SD=2.03)	5.33 (SD=1.93)	2.33 (SD=3.40)	7.05 (SD=1.63)
Environmental preference	7.14 (SD=1.77)	7.57 (SD=1.81)	3.10 (SD=1.67)	8.24 (SD=2.02)
Perceived contribution to Quality-of-Life aspects, QoL (scale 1–5)				
Aesthetic beauty	3.05 (SD=1.07)	3.52 (SD=0.87)	1.71 (SD=0.56)	3.10 (SD=0.89)
Environmental Quality	2.81 (SD=1.08)	3.33 (SD=1.11)	1.71 (SD=0.64)	3.33 (SD=1.02)
Nature/Biodiversity	2.95 (SD=1.24)	2.95 (SD=0.87)	1.52 (SD= 0.51)	3.38 (SD=0.92)

Wilcoxon signed-ranks were applied to compare each of the places for each of the variables for student's perceived CES (see *Table 4*.).

Table 4. Z-values across Place A, B, C, D.
Z- values for Affective response, Perceived Restorativeness Scale dimensions Being Away and Pleasantness, Environmental preference, Perceived contributions to Quality-of-Life aspects Aesthetic beauty, Environmental Quality and Nature/Biodiversity.

	Affective response		
	Valence		
	Place B	**Place C**	**Place D**
Place A	z=-1.03, p= .305	z=3.32, p< .01**	z=-0.54, p= .590
Place B	-	z=3.32, p< .01**	z=-0.32, p= .750
Place C	-	-	z=-3.44, p< .01**
Place D	-	-	-
	Arousal		
	Place B	**Place C**	**Place D**
Place A	z=0.14, p= .892	z=0.56, p= .575	z=0.91, p= .365
Place B	-	z=0.14, p= .886	z=1.08, p= .281
Place C	-	-	z=1.20, p= .230
Place D	-	-	-
	Perceived Restorativeness		
	Being Away		
	Place B	**Place C**	**Place D**
Place A	z=-1.34, p= .181	z=3.81, p< .001***	z=-0.63, p= .531
Place B	-	z=3.99, p< .001***	z=0.83, p= .404
Place C	-	-	z=-3.73, p< .001***
Place D	-	-	-
	Fascination		
	Place B	**Place C**	**Place D**
Place A	z=2.16, p< .05*	z=4.02, p< .001***	z=-1.16, p= .244
Place B	-	z=4.02, p< .001***	z=-2.82, p< .01**
Place C	-	-	z=-3.99, p< .001***
Place D	-	-	-

Environmental preference			
	Place B	**Place C**	**Place D**
Place A	z=-1.08, p= .281	z=3.92, p< .001***	z=-2.18, p< .05*
Place B	-	z=3.94, p< .001***	z=-1.03, p= .303
Place C	-	-	z=-3.92, p< .001***
Place D	-	-	-
Perceived contributions to Quality-of-Life aspects			
Aesthetic beauty			
	Place B	**Place C**	**Place D**
Place A	z=-1.69, p= .092	z=3.71, p< .001***	z=-0.19, p= .846
Place B	-	z=3.99, p< .001***	z=1.65, p= .099
Place C	-	-	z=-3.70, p< .001***
Place D	-	-	-
Environmental Quality			
	Place B	**Place C**	**Place D**
Place A	z=-1.40, p= .163	z=3.21, p< .01**	z=-1.25, p= .213
Place B	-	z=3.70, p< .001***	z=0.00, p=1.000
Place C	-	-	z=-3.75, p< .001***
Place D	-	-	-
Nature/Biodiversity			
	Place B	**Place C**	**Place D**
Place A	z=0.33, p= .740	z=3.57, p< .001***	z=-1.16, p= .248
Place B	-	z=3.92, p< .001***	z=-1.86, p< .063
Place C	-	-	z=-3.97, p< .001***
Place D	-	-	-

* Significant values at p < 0.05.
** Significant values at p < 0.01.
*** Significant values at p < .001.

The conducted tests showed statistically significant values, mainly related to Place C (see *Table 4.)*. For the affective experience; the only significant differences found were on one dimension, where Valence was rated significantly lower for Place C (meadows) compared to all other places. No significant differences were identified for the dimension Arousal. Perceived restorativeness values were rated significantly lower for Place C than for all other places on all three dimensions. For the dimension Being away, no significant differences were found between Place A, B, D.

For the dimension Fascination, Place B (grove) was rated significantly lower than areas with water surfaces – Place A and D, as well as Place C. For the dimension Environmental preference, Place A (lake) was rated significantly lower compared to Place D (brook). Perceived contribution to Quality-of-Life were rated significantly lower on all aspects measured for Place C compared to the other areas i.e. Aesthetic beauty, Environmental Quality, Nature/Biodiversity.

Wilcoxon signed-ranks tests were applied with comparisons between each of the places for each of the variables for students' appraisals of the environment (see *Table 5*.).

***Table 5.* Z-values across Place A, B, C, D.**
Z- values for Perceived Biodiversity, Semantic Environment Description dimension Pleasantness, Soundscape perception dimensions Pleasantness and Eventfulness, Scent perception dimensions Pleasantness and Strength.

	Perceived Biodiversity		
	Place B	**Place C**	**Place D**
Place A	z=-1.27, p= .204	z=3.95, p< .001***	z=-2.14, p< .05*
Place B	-	z=4.02, p< .001***	z=-0.85, p= .397
Place C	-	-	z=-4.02, p< .001***
Place D	-	-	-
	Semantic Environment Description *Pleasantness*		
	Place B	**Place C**	**Place D**
Place A	z=-2.13, p< .05*	z=4.02, p< .001***	z=-1.45, p= .147
Place B	-	z=4.02, p< .001***	z=0.06, p= .952
Place C	-	-	z=-4.016, p< .001***
Place D	-	-	-
	Soundscape perception *Pleasantness*		
	Place B	**Place C**	**Place D**
Place A	z=-0.46, p= .646	z=3.98, p< .001***	z=-0.28, p= .777
Place B	-	z=3.99, p< .001***	z=0.26, p= .793
Place C	-	-	z=-3.78, p< .001***
Place D	-	-	-

	Eventfulness		
	Place B	**Place C**	**Place D**
Place A	z=2.04, p< .05*	z=3.37, p< .01**	z=1.07, p= .283
Place B	-	z=3.26, p< .01**	z=-0.79, p= .431
Place C	-	-	z=-3.35, p< .01**
Place D	-	-	-
	Scent perception		
	Pleasantness		
	Place B	**Place C**	**Place D**
Place A	z=-0.52, p= .605	z=2.40, p< .05*	z=-0.28, p= .776
Place B	-	z=2.38, p< .05*	z=0.32, p= .752
Place C	-	-	z=-2.78, p< .01**
Place D	-	-	-
	Strength		
	Place B	**Place C**	**Place D**
Place A	z=-1.88, p= .060	z=-1.79, p= .074	z=0.04, p= .967
Place B	-	z=0.76, p= .449	z=2.19, p< .05*
Place C	-	-	z=1.27, p= .206
Place D	-	-	-

** Significant values at $p < .05$.*

*** Significant values at $p < .01$.*

**** Significant values at $p < .001$.*

As in the previous tests for students' perceived CES, statistically significant differences were found, mainly related to Place C *(*see *Table 5.).* Perceived Biodiversity values were rated significantly lower for Place C (meadows) than for all other places while Place D (brook) was rated significantly higher than Place A (lake). For the SED dimension Pleasantness, Place C was rated significantly lower in comparison to all the other areas. SED Pleasantness was also rated significantly lower for Place A compared to Place B (grove). Soundscape perception was rated significantly lower for Place C than for all other places on both dimensions. For the dimension Pleasantness, no significant differences were found between Place A, B, D. For the dimension Eventfulness, Place A showed a significantly lower rating compared to Place B. Scent perception was rated significantly lower for Place C compared to the other areas for the dimension Pleasantness. For the dimension Strength, Place B was rated significantly higher than Place D.

Characteristics of green areas and distinct aspects of CES

To answer the second research question "*Do certain characteristics of the selected green areas (e.g. vegetation, water surfaces) provide distinct aspects of cultural ecosystem services?*" it was possible to compare the areas CES in regard to whether or not they contain water surfaces and/or high levels of vegetation.

For the first hypothesis, H_1, the gathered data showed that the only significant difference between Place B and those with water features lies in the PRS dimension fascination (see *Table 4*.). Furthermore, it was possible to see that Place C was significantly lower on all aspects of CES except for arousal. Which means that it is possible to conclude that H_1 is partly true: Green areas with water surfaces support CES to a higher degree than those without.

For the second hypothesis, H_2, green areas with a high level of perceived biodiversity were rated significantly higher than green areas with a low level of perceived biodiversity on all aspects of CES except for the Affective response dimension Arousal. This indicates that it is possible to conclude that H_2 is true: Green areas with high perceived biodiversity support CES to a higher degree than those with low perceived biodiversity. For both tests, the null hypothesis H_0, was rejected. Significant differences were found in both comparisons.

Do certain student groups obtain different CES from the selected areas?

In order to address the research question on how certain student groups obtain different CES from the selected areas, a Mann-Whitney U-test was used to observe differences between Environmental Sciences students (n=14) and students from other fields of study (n=7).

Table 6. Descriptive statistics on how students within different fields of study assess Places A,B,C,D. Means with standard deviation (SD), for Places A, B, C, D.

	Field of study	Place A	Place B	Place C	Place D
Affective response (scale 1–5)					
Valence	*Environmental studies*	4.18 (SD=0.72)	4.32 (SD=0.70)	3.04 (SD=0.93)**	4.30 (SD=0.57)
	Other subject	4.50 (SD=0.50)	4.57 (SD=0.45)	4.21 (SD=0.49)**	4.64 (SD=0.48)
Arousal	*Environmental studies*	3.68 (SD=0.89)	3.63 (SD=1.21)	3.57 (SD=0.94)	3.41 (SD=0.76)
	Other subject	3.93 (SD=0.45)	4.00 (SD=0.65)	3.93 (SD=0.84)	3.75 (SD=1.03)
Perceived Restorativeness Scale. PRS (scale 0–10)					
Being away	*Environmental studies*	6.71 (SD=1.78)	7.14 (SD=1.20)	3.11 (SD=1.42)	6.32 (SD=1.74)*
	Other subject	6.57 (SD=1.40)	7.00 (SD=2.29)	3.93 (SD=2.44)	8.07 (SD=1.46)*
Fascination	*Environmental studies*	6.57 (SD=1.95)	5.61 (SD=1.78)	2.39 (SD=1.43)	7.00 (SD=1.72)
	Other subject	6.14 (SD=2.30)	4.79 (SD=2.23)	2.21 (SD=1.44)	7.14 (SD=1.55)
Environmental preference	*Environmental studies*	6.71 (SD=1.77)	7.79 (SD=1.37)	2.93 (SD=1.44)	7.71 (SD=2.23)
	Other subject	8.00 (SD=1.53)	7.14 (SD=2.54)	3.43 (SD=2.15)	9.29 (SD=0.95)
Perceived contribution to Quality-of-Life aspects, QoL (scale 1–5)					
Aesthetic beauty	*Environmental studies*	3.14 (SD=0.95)	3.71 (SD=0.73)	1.79 (SD=0.58)	3.07 (SD=0.83)
	Other subject	2.86 (SD=1.35)	3.14 (SD=1.07	1.57 (SD=0.53)	3.14 (SD=1.07)

Environmental Quality	*Environmental studies*	2.71 (SD=1.07)	3.21 (SD=0.97)	1.71 (SD=0.73)	3.21 (SD=0.97)
	Other subject	3.00 (SD=1.15)	3.57 (SD=1.40)	1.71 (SD=0.49)	3.57 (SD=1.13)
Nature/Biodiversity	*Environmental studies*	2.93 (SD=1.14)	3.07 (SD=0.83)	1.50 (SD=0.52)	3.36 (SD=0.93)
	Other subject	3.00 (SD=1.53)	2.71 (SD=0.95)	1.57 (SD=0.53)	3.43 (SD=0.98)

* Significant values at $p < .05$.

Few differences were found between the two groups (see *Table 6*.). For the affective experience, on the Valence dimension, students in environmental sciences rated Place C (meadows) significantly lower than did students from other faculties ($U=14.0$, $p<.01$). Similarly, these students also scored significantly lower on the perceived restorativeness dimension Being away in Place D, the brook ($U=21.0$, $p<.05$).

How selected areas are used by students

In general, the areas are reported as underutilized by the students (see *Table 7*.), assessed with the question *"Do you normally use this area?"*.

Table 7. Percentage of students utilizing an area (number of students).

	Place A	Place B	Place C	Place D
Students using area	19% (4)	14% (3)	5% (1)	43% (9)
Students not using area	81% (17)	86% (18)	95% (20)	57% (12)

In order to assess how the selected places for study are utilized by students, an inductive thematic analysis (Braun & Clarke, 2006) was conducted based on the responses to the question *"How do you utilize the area?"*. The analysis revealed several themes which in part differed across the different places. Six overarching themes were identified; *Recreation, Social activities, Rest, Food-related activities, Studying, Other.*

While these themes provide an overview of what activities students consider suitable for the specific place in general terms, it does not account for overlapping activities that fit into several themes. Therefore, the results of the thematic analysis should be interpreted as activities not being exclusive for one category but rather an indicator for how well the areas fulfill a certain theme. For example, both meeting friends and eating lunch can be seen as the same activity and can both be regarded as a food-related activity and a social activity. The separate activities reported have been translated from Swedish to English and have in part been clustered together when similar terms have been used i.e. walking, stroll. While some similar activities have been kept as is i.e. taking a break from studies, relax. As these, although similar, could have a specific function in restoration. Where similar activities have been reported by three or more participants for an area, this has been recorded as a frequent answer (see *Table 8*.).

Table 8. Themes identified regarding activities for a specific place interpreted from the question "How do you utilize the area?".

	Place A	Place B	Place C	Place D
Recreation	Walking†	Working out at the outdoor gym†		Walking†
	Running†			
Social activities	Group activities	Social events		Meeting friends†
	Novisch-activities††	Novisch-activities††		
	Meeting friends†	Meeting friends†		
	Student-related activities†	Student-related activities		
Rest	Relax			Taking break from studies†
Food-related activities	Having lunch†			Lunch†
	Fika†, †††			Fika†,†††
Learning				Study
Other			Transport	

† Frequently occurring answer at the specific place.
†† Novisch activities are activities carried out for introducing new students.
††† Fika is the Swedish word for coffee break or similar activity but has different cultural connotations in Sweden and thus has not been translated.

The thematic analysis shows that all but Place C are used by the students and the themes uncovered show that the places are utilized in a variety of ways e.g. for social activities, recreation etc. Most common uses for the areas are walking, fika, having lunch, meeting friends which could be interrelated and span across the themes identified. Place C is underutilized and the only report from the data collected is from one respondent which utilized the area by: *"…biking through in order to get to class"*.

In order to see in what ways students can imagine themselves utilizing the area without taking into consideration what they are currently using the area for, they were asked *"What activities can you imagine yourself doing in this area?"*. The question revealed more responses than the previous, which in part can be explained by some students not using the area prior to the study (*see Tables 7,8,9.*). The themes identified in the previous question was used for analysis, while keeping in mind that new activities can arise. No new themes were identified, but new activities e.g. playing games, reading a book, barbecuing, sunbathing arose.

Table 9. Themes identified regarding envisioned activities for a specific place, interpreted from the question "What activities can you imagine yourself doing in this area?".

	Place A	**Place B**	**Place C**	**Place D**
Recreation	Walking with a dog	Walking	Walking	Walking
	Working out†	Working out†	Working out	
	Reading a book†	Reading a book†		Reading a book†
	Playing games	Playing games†		
	Appreciate nature	Appreciate nature		
Social activities	Meeting friends†	Meeting friends†	The building Lophtet is important for social gatherings††	Meeting friends†
	Student-related activities	Student-related activities	Student-related activities	Social activities
	Spending time with family	Social activities		
	Pre-party	Teambuilding		

Rest	Rest†	Rest†	Rest	Rest†
	Sunbathing	Get peace of mind†	Sunbathing	Being alone
	Relaxing walk	Getting a break from city life		Rejuvenate energy
	Taking a break†	Relax†		Taking a break
	To just be†	Contemplate		
		Cope with stress		
Food-related activities	Having lunch†	Having lunch†		Having lunch†
	Fika†, †††	Picnic		Fika†, †††
	Picnic			
	Barbecuing†			
Learning	Study†	Study†		Study†
				Learning about nature
Other	-	-	-	-

† Frequently occurring answer at the specific place.

†† Although activities within the building Lophtet are not assessed in this study, its function in the outdoor environment is identified by students.

††† Fika is the Swedish word for coffee break or similar activity but has different cultural connotations in Sweden and thus has not been translated.

The results display a wider variety of activities when students are asked to reflect on what they can envision themselves doing in the areas (see *Table 9.)*. Similar to the previous question; activities such as lunch, fika, taking a break, walking and meeting with friends are prominent. New patterns in activities that arose were studying, barbecuing, working out. More reflective activities are also more prominent when students are asked to envision activities e.g. learning about nature, studying, coping with stress, relaxing, reading a book.

Functionality students desire within the selected areas and improvements

Participants were asked *"How can the area be improved in order for you to utilize it to a higher degree?"*. Themes from previous questions were not applicable to the same degree on the improvements suggested and mainly consisted of suggestions regarding the physical environment (see *Table 10.*). However, the uncovered themes Social activities, Learning and Food-related activities were also present in the previous questions. New themes that arose from the material were Maintenance, Changes to green spaces, Changes to grey spaces.

Table 10. Themes identified regarding envisioned activities for a specific place, interpreted from the question "How can the area be improved in order for you to utilize it to a higher degree?".

	Place A	Place B	Place C	Place D
Maintenance	Clean up water†			Maintenance of the brook
	Clean up litter†			Better care of trees
	Restore worn down green areas			
Changes to green spaces	More vegetation†	More vegetation†	More vegetation†	More vegetation†
	More flowers	More flowers	More flowers†	More flowers
	More trees	More defined and enclosed spaces	More trees†	Expanding the area
	Less steep hillsides	More shrubbery	More shrubbery	The reedbed considered misplaced
	More variation in the landscape	More variation in the green spaces†	More variation in the green spaces†	More defined spaces
	More animal life	More meadows	More biodiversity	

			Flowerbeds/vegetable patch	
			Vertical planters	
Changes to grey spaces	Make buildings less dull		Less dull buildings	The building is considered smothering in regard to the scale of the place
	Remove features that are not used		Less parking spots	
	Improve the use of natural materials			
	Remove the phonebooth			
	Lessen the number of roads for cars			
Social activities	More seating arrangements	More seating arrangements†	More seating arrangements†	More seating arrangements†
			Places for outdoor activities	Make seating arrangements more accessible
Food-related activities	More places for lunch			
	More barbecue areas			
Learning			Wind shelter would help for using the area for studying	
Other	Less noise†	Less noise	Less noise†	Less noise
			Ability to shield off from the road and surrounding buildings	

† Frequently occurring answer at the specific place.

Results show that in general, participants seem to focus mainly on alterations to the physical environment as opposed to reporting certain activities they would like to use the area for. The majority of the participants stated that more vegetation is needed for them to utilize the area more. This includes more vegetation in general and more specific alterations to green spaces, such as more flowers, more trees, more shrubbery. More specific but less frequent answers in regard to vegetation include: more biodiversity, flowerbeds/vegetable patches and vertical planters. What was common across all areas was that more seating arrangements and less noise would increase usage. For Place D, the accessibility of the seating arrangements were found in need of improvement along with a participant stating that *"… while increased number of seating arrangements would be good, but it can also impact the sense of nature"*. Having more defined and enclosed areas to close off from surrounding roads and buildings were stated as preferable for Place B, C and D. For Place C, features that would shield the area from wind, road and surrounding buildings was stated as something that would increase the utilization of the area for studying. While many improvements were suggested, several of the participants stated that Place A, B, and D is good as it is. For Place C, one participant stated that *"…while it would be good with more shrubbery and trees it can also give a sense of insecurity"*.

Discussion

Can campus green areas support both climate change adaptation/mitigation and CES?

In response to the first research question; all but one area, the meadows, are considered to be supportive of CES. However, the aspects did differ to some extent across the areas. The affective response was generally high for valence (e.g. positive, negative) for all areas, while for the area with the meadows it was experienced as average. Participants perceived medium to high arousal for all areas, with little differences between them. Drawing from previous studies (Russell et al., 1989; Västfjäll & Gärling, 2007), this suggests that most areas offer pleasant activation of affect (e.g. happiness, elation) while the meadows seemingly offer unpleasant activation of affect (e.g. anger, being upset).

Conversely, in comparison to the findings on the dimensions of affect, it seems as though restorativeness is not based on deactivation. There are however signs, primarily for the area with the meadows, that valence affects restorative properties. This would suggest that the restorative potential is not dependent on the area being still or evoking arousal but is instead likely to be dependent on whether it is perceived as evoking positive or negative affect. With increasing urbanization and the increased intensity of our daily lives, designing (or restoring) the outdoor environment from a human point of view requires a focus on restorative benefits. Previous research indicates, that the incompatibility between the individual's intended activity and the environment's ability to accommodate the activity results in an increasing need to restore psychological resources (Hartig et al., 1997; Kaplan, 1995). As Hartig et al. (1997) suggests, the environment often lacks these restorative qualities, which in turn suggests that it is particularly important to address this upon design decisions. Similarly, by assessing existing environments prior to design interventions, it is possible to pinpoint alterations that could be made to promote restorative qualities (Hartig et al., 1997). The restorative qualities between the areas differ, but not substantially. The meadows were perceived as being less restorative than the lake, grove and brook. The latter three areas were perceived as above average in regard to restoration, with the exception of the grove which was considered as being less fascinating. Fascination is considered to be effortless and without capacity limitations which contemporary environments often does not offer

(Hartig et al., 1997; Kaplan, 1995). The grove offers above average fascination while the lake and brook were both highly fascinating. Similarities are found in previous research, which indicates that urban forests, water surfaces and wetland areas acts restorative through fascination (Johansson et al., 2019; Pedersen et al., 2019). Areas such as these offer climate change adaptation/mitigation (CCA/M) by alleviating the effects of heat waves, handle storm-water drainage as well as offer carbon sequestration (Debbage & Shepherd, 2015; Ketzler et al., 2021; Krüger et al., 2011; Pörtner et al., 2021; Ward et al., 2016; Wu & Zhang, 2019). This in turn shows the importance of the green areas, as they can provide multifunctionality and ensure that CCA/M values are kept intact (Andersson et al., 2019).

Participants felt a high sense of being away for the three areas that were average to highly fascinating. This suggests that these areas both offer a distance to participants' everyday lives while offering features that are perceived as effortless in regard to attention (Hartig et al., 1997). The grove and brook both offer a variety of species in vegetation and the scale thereof, which could be perceived as seclusion from the surroundings which in turn could further increase the sense of being away. The area with the lake is less dense in terms of vegetation and was rated slightly lower for being away. This could suggest that green areas need to offer more seclusion to promote the sense of being away. This supports previous research (Hartig et al., 1997; Kaplan, 1995), that in order to experience a sense of being away, in terms of restorativeness, unwanted distractions need to be limited in the surroundings. Indeed, as the results seem to suggest, the perceived soundscape is more positive in the areas that offer a higher sense of being away. Hartig et al. (1997) also states that solely geographical distance is not sufficient in order to support the experience of being away, where psychological aspects are just as important. This implies that designing areas for restoration is a complex apparatus and that having recreational areas which are situated far from our usual activities does not guarantee restoration. Indeed, previous research indicates that the green area and its ability to provide restoration could be impaired by surrounding buildings and façade details (Lindal & Hartig, 2013) as in the case of the adjacent buildings nearby the meadows and brook. The findings on the sense of being away suggest that the areas with water surfaces or trees are regarded as being more restorative than the meadows which contained none of these features. This in part could be explained by the areas offering more of a secluded character and that the geographical and psychological distance for participants felt further away from what is expected from them in their daily lives. While the meadows lie further away from most university buildings, the lacking environmental features does not offer distraction to the same extent as the other areas (Kaplan, 1995).

The assessments of perceived contribution to QoL can be regarded as inconclusive for all areas except one, the meadows, as the other areas were rated similarly and averagely. The meadows contribution to QoL is however comparable to perceived CES and in how it differs compared to the other areas. However, the differences between QoL was marginal for all areas which could suggest that perceived contribution to QoL is hard to assess. As suggested by Poortinga et al. (2004), the contribution to perceived QoL is dependent on an individual's values i.e. important life goals, standards. That is, what an individual value as important to their lives. As the present study did not include pre-test conditions (as in Johansson et al. (2019)), it is not possible to conclude whether or not this impacts the results. However, the participants' most frequent answers to improve the area did include to improve vegetation. Therefore, it is likely that the participants value green spaces and vegetational features. Furthermore, previous research suggests that areas containing water surfaces e.g. wetlands (Johansson et al., 2019) supports the selected QoL-aspects that are included in the present study.

The results in the present study suggest that campus green areas with incorporated CCA/M values can support CES for university students with the exception of one location (meadows). This suggests that visits to areas with CCA/M values do not inherently promote CES but could well be addressed through design interventions based on CES research. For restoration of ecosystems in the urban environment this suggests that the characteristics of the area need to be addressed and that they could need altering to address the specific needs of the individual to promote QoL.

Green areas' characteristics and related CES

The second research question, which examined if certain characteristics (e.g. vegetation, water surfaces) provide distinct aspects of CES, suggests that areas that contain high levels of vegetation and/or water surfaces promote CES as a whole. This supports previous research (Grahn & Stigsdotter, 2010; Johansson et al., 2019; Nordh et al., 2009; Pedersen et al., 2019; Ulrich et al., 1991) which suggests that areas containing water surfaces and urban forests tend to be regarded as restorative. The assessment was based on the participants' appraisals, both in terms of CES but also in regard to what constitutes a high level of vegetation. As previous studies suggest (Gyllin & Grahn, 2005), the assessment of biodiversity can be made sufficiently by a bottom-up approach by non-experts, if provided with the tools. Although, there might be some uncertainty in regard to the meadows as it is likely to be the most species-rich area in the study (IPBES, 2019a, 2019b). At the point of the study, the meadows were not fully grown or in bloom which could explain why it was not regarded as a high-level vegetation area. Simultaneously, this signifies issues that can arise when implementing NBS or similar for the multifunctional environment, that the area and its characteristics change over a year depending on seasonal variations and over the course of time in general. While an area could support CES at one point of the year, seasonal variations could change the characteristics of the green area which alters how and what aspects of CES is being supported. From the results in the present study, it is clear that the areas containing water surfaces are more supportive of CES than the meadows. Furthermore, the hypothesis that green areas with water surfaces promote CES to a higher degree than those without was found partly true. Similarities were found in how the lake and brook were perceived in terms of CES compared to the grove. The three areas are regarded as more restorative and provide a more positive affective experience.

The brook was considered more restorative than the other areas both in terms of fascination but also environmental preference, which suggests differences in characteristics compared to the two other areas that was also restorative. As the brook in part is supported by greywater through storm water drainage, this presents a particularly interesting opportunity for future design decisions in regard to CCA. By designing green areas that are supported by greywater it can serve as a measure that both addresses CES (restorativeness in particular) and handle heavy and sudden rainfall, that will increase in the future (IPCC, 2018; Pörtner et al., 2021). Indeed, previous research suggests that the impact of CES is not based on the source of water (Johansson et al., 2019). This in turn suggests that waterbodies need not only be limited to ground- or freshwater to be supportive of CES, which could address the future issue of water-scarcity that is an indirect effect of climate change, and is becoming increasingly important to address (IPCC, 2018).

When comparing areas with high- and low-level vegetation areas, using BEI as an indicator, similar results arose as for areas with water surfaces. This could suggest that areas containing water surfaces while also being regarded as having high perceived biodiversity are the most supportive of CES, particularly in terms of restorativeness. This in turn, supports the hypothesis that areas with high levels of vegetation promotes CES to a higher extent than areas with low levels of vegetation. As stated earlier, the areas' CCA/M values are further improved when these two characteristics are combined as they alleviate heatwaves through shade from foliage and provide cooling opportunities (Debbage & Shepherd, 2015; Ketzler et al., 2021; Krüger et al., 2011; Ward et al., 2016; Wu & Zhang, 2019). Furthermore, the waterbodies sequestrate carbon (the brook leads to a larger waterbody down the stream) which makes them ample assets for climate change mitigation (CCM)(IPCC, 2014a; Johansson et al., 2019; Pedersen et al., 2019; Pörtner et al., 2021). Combined they provide evapotranspiration through deciduous trees and other layers of vegetation such as bushes. For further development in developing the areas in regard to CCM an assessment of the tree population could be needed. This is also the case for the urban environment in general. Mainly due to younger trees sequestering limited amount of carbon, while mature trees sequester most. However, as the trees ability to sequester carbon decline after a certain age (depending on species), an assessment/inventory of trees can help optimize carbon sequestration and designing green areas with the help of plantation rotation. To further advance CCA/M values in green areas, careful consideration needs to be taken when planting new trees, selecting species with good potential for carbon sequestration and also provides shade through foliage.

The green area with meadows in the present study cannot be regarded as supportive of CES, which in part can be explained by it being situated near an occasionally congested road and partly due to less vegetational features except for the meadows. It does however have an important function for CCA/M as it serves as an inlet for wind-flow into the campus area and can thereby reduce the urban heat island effect (Debbage & Shepherd, 2015; Hsieh et al., 2010; Krüger et al., 2011; Morakinyo et al., 2013; Ward et al., 2016). Although this can be regarded as a function mainly for CCA, it has implications for climate change mitigation (CCM). If the areas on campus cool down, or rather let heat escape from the areas, this affects the need for cooling down buildings which in turn reduces carbon emissions (Birol, 2018; Morakinyo et al., 2013).

The findings suggest using NBS or other comparable method for developing or restoring green areas, as it can support CES and other important functions such as biodiversity and CCA/M measures simultaneously. This also shows promise in regard to multifunctionality in the urban environment (Andersson et al., 2019; Pörtner et al., 2021; Voskamp & Van de Ven, 2015) as it can provide several functions. Meadows can provide important values for biodiversity, CCA and indirectly CCM. By implementing a measure such as NBS it can be further advanced in order for the meadows in the present study to be more supportive of CES. This could be done through implementing other layers of plant-life such as trees, bushes or even water surfaces to some degree if connected to storm-water drainage. Though certain care needs to be taken when introducing new plant-life, as meadows are dependent on low-nutrient soils (Person in charge of groundskeeping, Peab, personal communication, February 24, 2021; Swedish Environmental Protection Agency, 2011) it would promote CES to a wider degree while keeping the existing values of the area for CCA/M. This would further support the UN decade of restoration (n.d.) as it could provide restored ecosystems in the urban environment that provide multifunctionality and ensure its longevity.

How selected green areas support CES for different student groups

For the third research question, two different student groups were compared in regard to what CES they obtain from an area. Though few differences were identified between students from the environmental sciences and other disciplines, some interesting observations were made. Environmental sciences students regarded the meadows as less positive than the other group, in terms of the affective experience. The other difference between the groups lies in the area with the brook, where in the adjacent building, the environmental sciences students usually have their lectures. The aforementioned group experienced less restorativeness from the surrounding environment in the sense of being away than other students. Considering that the area is close to their usual study-environment, this is likely to be a factor. As research states, both the mental and physical distance to the work environment is what favors the sense of being away in terms of restorativeness (Hartig et al., 1997; Kaplan, 1995). This could be interpreted as it being hard for students to find the sense of being away in the campus environment, as most areas are in close vicinity of each other or close to their usual working environment. Although, the results indicate that the lake, brook and grove were all highly rated in terms of being away. The brook in particular is rated high by the non-environmental sciences students.

In order for environmental sciences students to feel a sense of being away, it could be that other areas need to be used for this particular purpose. This suggests that when developing green areas with the aim of restoration; certain considerations need to be made in regard to establishing a mental and physical distance from the target groups' everyday lives (Hartig et al., 1997; Kaplan, 1995). Indeed, the other students regarded the brook as being more restorative than any other area, in terms of being away, fascination and environmental preference. As the majority of the students in this group have their lectures elsewhere, it is likely to be a factor in the sense of being away while the areas with water surfaces seem to affect fascination the most. The results in the present study shows that green areas with water surfaces tend to be rated higher in terms of fascination. A possible relationship could be between that of fascination and that of preference in environments, as studies suggest that environments with water is often preferred (Dou et al., 2017; Johansson et al., 2019; Pedersen et al., 2019). As areas with more vegetation that encloses an area seems to promote restorativeness to a higher degree, it is possible that the sense of being away is affected by the clear view of the adjacent building in which environmental sciences students have most of their lectures (Lindal & Hartig, 2013). It could well be that the students need something to break the view of the building, such as with surrounding vegetation with foliage or green vertical planters. By doing so, the students would enter a new room in the environment and thus might address the mental distance to their place of work.

What students use the green areas on campus for

In response to the fourth research question; of the six overarching themes that were identified in the inductive analysis the lake corresponded to four of them: Recreation, Social Activities, Rest and Food-related activities. This further supports what was drawn from the quantitative analyses; that the area can support CES. Mainly social activities were reported as being carried out at the location, which can be regarded as being restorative, and being supportive of CES (Andersson et al., 2019; Millennium Ecosystem Assessment, 2005). The food-related activities that were reported can also be regarded as having social elements, which supports the idea that the same activity can support several aspects of ES i.e. cultural and provisional (Andersson et al., 2019; IPBES, 2019a; Stålhammar & Pedersen, 2017). The reported recreational activities such as walking or running are supportive of CES (Andersson et al., 2019; IPBES, 2019a). While the previously discussed quantitative analyses do not specifically point at activities, it is possible to interpret some of the results in conjunction with the thematic analysis on activities. For example, the activity category Rest being present for the same areas which was simultaneously rated as restorative through the quantitative analyses (Hartig et al., 1997). Indeed, for restorativeness (Hartig et al., 1997) the lake was rated well above average in all aspects. Based on the results on the more reflective parts of the thematic analysis, it seems as though most of the responses are in line with what they are already using the lake for. What was added for this section was the theme Learning, which relevance for the campus environment and for CES is self-evident (Abdelaal, 2019; Andersson et al., 2019; Bergquist et al., 2019).

Only two of the six overarching themes were identified at the grove i.e. Recreation and Social activities. Of the identified themes and categories, all can be related to CES (Andersson et al., 2019; IPBES, 2019a) which is in line with what was drawn from the quantitative analyses; that the area supports CES for students. However, none of the responses supports the idea of the location being restorative, which the quantitative analyses seem to suggest. This could imply that in order to assess restorativeness in green areas, it is not sufficient to only rely solely on free-text responses or by asking participants of their opinion regarding the restorativeness of a green area. This in turn supports that CES is hard to measure without the proper tools. It does however, possess restorative potential through recreational and social activities by interpretation of previous studies (Andersson et al., 2019; IPBES, 2019a; Millennium Ecosystem Assessment, 2005). Interestingly, it has above average ratings of CES, and is regarded as being highly restorative (Hartig et al., 1997) with the only exception of the aspect fascination which is just above average.

The only response for the meadows was the person cycling across the area. This supports the other material in this study which identified the area as in need of improvement (Jonson et al., 2020). The lack of activity in the area also supports that the area does not currently support CES. This suggests that the area needs development, in particular for CES, while the area could also be improved in order to further support CCA/M. The meadows could benefit from planted trees to provide wind-shelter and shade from foliage, while simultaneously addressing the common reported issue of noise. While certain care needs to be taken in order to not impact the wind-flow inlet into the campus area, or the nutrient-poor soil needed for the meadows, this could be designed with interspersed planting of trees or by framing part of the area.

The brook corresponds to five out of the six overarching themes in the thematic analysis of activities. Thus, it is the area which covers most of the themes for activities. Simultaneously, it supports what was drawn from the quantitative analyses; that the area can support CES. Social activities were reported as being carried out at the location, which can be regarded as being restorative and being supportive of CES (Andersson et al., 2019; IPBES, 2019a; Millennium Ecosystem Assessment, 2005). The food-related activities can also be regarded as having social elements, which supports the idea that the same activity can support several aspects of ES i.e. cultural and provisional (Andersson et al., 2019; Stålhammar & Pedersen, 2017) as the lake. Recreational activities such as walking are supportive of CES (Andersson et al., 2019; IPBES, 2019a). The location was the only area in which studying was reported as an activity, which further supports CES (Andersson et al., 2019; IPBES, 2019a). As a university campus, it is interesting that only one of the areas corresponds to the theme Learning, indicating that this could be a potential for improvement for the other areas that is both positive for studying (Abdelaal, 2019; Bergquist et al., 2019) and for CES (Andersson et al., 2019). The theme Rest was identified at the brook, which supports the findings in the quantitative analyses for CES, which found the area to be restorative (Hartig et al., 1997) while being especially restorative for students not studying environmental sciences. When interpreting the results across all areas it seems where the quantitative analyses suggested support for CES, activities are also more frequent. This could suggest that that in order for green areas to be used and ensure its longevity in the urban environment, they need to be supportive of CES.

The functionality of campus green areas desired by students

In the results regarding the fifth research question it is possible to identify a gap; between what activity is carried out, what students can envision themselves doing and what could be improved in order for students to use the area more. Most of the improvements involve changes to green spaces i.e. more vegetation, more trees, along with general maintenance. Likely, improvements such as these would further support perceived CES of the areas, as previous findings in the present study found that high levels of vegetation seem to promote CES. What was also frequently suggested were more seating arrangements, which could be a pragmatic approach to promote studying, recreation and thus CES. Moreover, reducing noise could improve perceived CES of all areas (Andersson et al., 2019; Van Kamp et al., 2015) and an improvement that is closely related to promote studying. Addressing this issue while simultaneously improving CCA/M could include planting trees and introducing new layers of vegetation (e.g. bushes). Such an approach could be used to further increase biodiversity, while at the same time increase restorativeness and CES.

In general, the results on the reflective parts of the thematic analysis are similar to those of what students already are using the area for (with the exception of the meadows). A majority of the responses indicate that the areas can be used for restoration and contemplation which are in line with the quantitative analyses that showed the restorative capabilities (Hartig et al., 1997) of the areas and further supports that the areas promotes CES (Andersson et al., 2019). Learning (i.e. studying, learning from nature) was stated as something that students could envision themselves doing in these areas, which is especially important to the campus environment (Abdelaal, 2019; Bergquist et al., 2019). Observations made by the author during data collection (before and after participants) indicated that the areas are used for research purposes, where on one occasion a research team was having a training session to set up nets for a research project that is planned for later in the summer (personal communication, April 27, 2021). On another occasion an arborist student was practicing climbing techniques that are needed for his future profession (personal communication, April 26, 2021). Both of these are in line with what Bergquist et al. (2019) suggests are important aspects of the campus environment. On a third occasion, groups of children were observed playing in the green areas as part of a field trip (personal communication, April 24, 2021) which showcases that the campus environment is not used exclusively by students or staff of the university. While these observations were not part of the set methodology for the present study, it is worth mentioning as part of the discussion, as all observations are in line with CES (Andersson et al., 2019; IPBES, 2019a) and showcases the variety of activities that the campus environment can bring (Bergquist et al., 2019). Improvements that could promote studying, rest and CES in general are identified as more vegetation and variation thereof, more seating arrangements and less noise (Andersson et al., 2019; Van Kamp et al., 2015). As previously stated, increased perceived biodiversity seems to promote CES, which similarly seems to increase student's tendency to use green areas.

While few activities are carried out at the meadows, students seem to imagine themselves doing activities in this area. This shows that it has potential for development that can support CES, which is important due to the meadows function for biodiversity (IPBES, 2019b, 2019a; Pörtner et al., 2021) and the recent developments regarding ecosystem restoration (United Nations, n.d.). With increasing urbanization, it is important that areas such as the meadows exist (Andersson et al., 2019; IPBES, 2019b, 2019a; Pörtner et al., 2021) while its existence can be reliant on how well used it is. By implementing a multifunctional environment, an area like the meadows can continue to exist, without risk of being developed for other purposes that is in conflict with biodiversity if considered underutilized. The activities are indeed fewer than in the other areas assessed; Recreation, Social activities and Rest are all relevant themes for the area and related to CES (Andersson et al., 2019). This seems to suggest that students see potential in the area that are unfulfilled by the current conditions. Indeed, participants had several suggestions for the meadows that relate to changes to green spaces. This mainly included introducing more vegetation, which the results seem to suggest have a positive impact on CES. Further improvements that could promote CES in the area are more seating areas and wind shelter in order to increase possibilities for studying (Andersson et al., 2019). Similarly, the ability to shield off from the road and reduce noise and thus promote CES could be improved (Andersson et al., 2019; Van Kamp et al., 2015).

The brook covers most of the themes in the thematic analyses, however new activities envisioned for the place are few. This could suggest that this area satisfies what students would like from green areas. It does seem like recreational activities such as reading a book and different variations within the theme Rest are more prevalent, which in turn suggests that CES is supported (Andersson et al., 2019). This is in line with previous analyses, in particular for restorativeness (Hartig et al., 1997). Studying and learning about nature are both activities that are reported and that is in line with CES (Andersson et al., 2019; IPBES, 2019a). For improvement, like most areas, more vegetation is desired by students in the area. This, as previously stated, seems to support CES and that the responses seem to indicate that CES could be promoted further in this regard.

The different green areas provide different values and while restorative properties seem to be desirable for all areas, it could well be that other adjoining areas offers what these areas do not. Further examination is needed in this regard. However, for the basis of CCA/M and CES, the areas that were selected are deemed suitable for the study. For the multifunctional environment; what is of most importance is how different areas interact and together provide a multitude of functions. The present study does not examine these interactions and the multifunctional properties a green area should be further examined in relation to other close-by areas. Similarly, while the multifunctional environment does provide a multitude of functions there are still limitations regarding the amount of functions it can support and to what degree they are supported.

Implications for the campus environment

In general, it seems as though students prefer environments with a variation of environmental features, such as a combination of large deciduous trees, bushes and water surfaces. While most students seem to want to use the areas for roughly the same activities, the most frequent improvements suggested include more vegetation, more variation in the green spaces, more trees.

This is especially important for the meadows, which did not support CES. The low growing vegetation in the restored meadows, would at least during the pre-flowering season provide an environment of low complexity and thereby provide less beneficial CES for the students. To ensure continued benefits for biodiversity from restored meadows, while increasing the perceived CES; a measure to incorporate interspersed with seating arrangements, bushes and trees or by framing the area with these features could be implemented. Preferably with concern to the soundscape and reduction of noise (Van Kamp et al., 2015). Other options include closely located flowerbeds and vegetable patches that could create a sense of attachment which could be implemented through on-campus community measures such as in the case of Uppsala University Campus Garden (Sthyr, 2021) or Ultuna Permakultur (n.d.). Although, careful consideration is required as to not impact the low-nutrient soil that the meadows need to thrive (Person in charge of groundskeeping, Peab, personal communication, February 24, 2021). The area is important for both biodiversity and for CCA/M and if CES is not improved to some extent, the restored meadows could end up being removed and the area becomes overdeveloped. To ensure multifunctionality, a better option is to improve it while keeping the meadows intact.

More vegetation can improve CES that could be implemented in regard to the need for more secluded, defined rooms in the landscape. With less noise asked for in all places these defined rooms in the landscape can help in this regard. Although these defined rooms need to be designed in a manner that does not create the feeling of unsafety in the environment (Ulrich et al., 1991). Defined rooms in the landscape could be addressed through grey infrastructure (e.g. walls, noise barriers). It is however, evident from the results that implementation of noise barriers should be done through green infrastructure (e.g. green walls, planting trees or bushes). This would provide the vegetational aspects that is sought after, while simultaneously addressing the issue of noise and thus achieving synergies in the implementation. Furthermore, by defining rooms in this manner, it would be possible to design studying rooms outdoors. As opportunities for studying is something that seems lacking in the green areas, seating arrangements with permeable surfaces should be further implemented to further achieve address the needs of students. Furthermore, it would allow for several activities simultaneously. Many student activities consist of larger social gatherings which could be in conflict with the need of less noise and more seclusion in the environment. Consequently, by offering these defined rooms the green areas could provide increased functionality for several needs. It is possible however, to take the perspective that certain areas should be used for certain activities and that the areas should complement each other. However, offering options for activities within separate green areas provides freedom of choice to a higher degree for activities. The campus environment requires opportunities for restoration, activities and research for students, staff as well as for residents with no ties to the university. In the grander scheme of things, the campus environment can provide CCA/M and biodiversity while also offering ample opportunities for applied research on the key challenges that we will face in the future.

Implications for the urban environment

The urban environment does not differ substantially to the campus environment; indeed, they are usually intertwined. This sets the results from this study in a broader context. Priorities might differ, as in the case of studying or learning, which could be seen as less important in other urban areas. This is however the case for most areas, that different needs are met with different measures; still it is important to take CES and CCA/M into consideration in all areas. For example, as evidenced in this study; water features can be implemented to support CES and CCA/M simultaneously.

Furthermore, there is a need to move away from the discourse of nature's axiomatic value in order to make sustainable changes in the urban or peri-urban environment in policy-making. While the axiomatic discourse is not inherently problematic, identifying and measuring tangible values provides policymakers with a good basis for decisions regarding sustainable environmental- and climatic solutions. The usual practice of identifying tangible values consist of monetized appraisals which cannot be applied to CES. The methodology used in the present study can provide tangible values on that monetized appraisals cannot, that could address several issues related to the environment e.g. environmental impact, climate related impact, biodiversity and anthropogenic benefits such as safety or quality of life.

Consequently, by using tangible values as a basis for intervention, NBS can further address multifunctionality of green areas and be used as a measure to restore ecosystems in the urban environment. Increased vegetation, implementing open storm-water management and biodiversity can be used in a similar manner, supporting both CES and CCA/M. Generally speaking, it might prove easier to implement vegetation in the urban environment than water features as it is usually more cost-efficient, both in regard to time and resources. Though both would be ideal as stated in the present study, supporting several values and supporting the multifunctional environment.

However, even though the tangible values in the present study offers a basis for interventions, it is of importance to not rely solely on these values for planning green areas. For instance, while restoration is preferable in general in green areas, it can be in conflict to other desired values. Therefore, striving for highest restorative properties possible in all areas might not be preferable. For example, areas which main function is for transportation (e.g. walking, cycling, bus stop) are required in the urban environment and might simultaneously prove hard to provide restoration while maintaining this function. The tangible values in the study should not be seen as values that every green area need to provide but rather as an indicator of how restorative an area is and how it relates to CCA/M. The general area needs to have specific areas within them that provide disparate values, and that these areas work well together and do not limit each other in any regard. The tangible values do however provide an indication on where improvements are needed, even though restorative properties are not explicitly needed for a specific area. Therefore, methodology such as in the present study should be applied on a per-case basis with the specific needs of the general area.

Limitations and future research

As the study was conducted in spring, there are limitations as to how these results are applicable in other seasons or over the course of time. Furthermore, with a changing climate it could well be that certain species of plant-life adapts to a higher degree than others, and as such the present study should be seen as examining green areas under a certain time frame. Similarly, the present study does not consider specific species' capability to either adapt to or mitigate climate change. Future studies could include how specific species promotes CCA/M.

Furthermore, there are concerns about the number of participants which affects what conclusions can be drawn from the results. As the study was conducted during the Covid-19 pandemic, recruitment proved to be difficult. Therefore, the aim of 30 participants was not met, and non-parametric tests were used instead of parametric tests. While this does not affect the significant differences identified, there could be differences that a parametric test would identify that were not found in this study. As the number of participants were low, and mainly consistent of Environmental Sciences students it is hard to draw conclusions based on what was significantly different between the groups apart from what is stated above. The mean scores across the different places give no clear indication if this could be the case. Results show that the areas are rarely utilized by students, with the brook being the only place that is utilized to a higher degree. As the study was conducted during the Covid-19 pandemic, this is likely a factor as to why the areas are underutilized. Several of the participants reported that they usually are not on the campus area at all and mostly have their lectures digitally, which most likely impacts the degree of utilization of the areas.

However, the pandemic also opens up unique opportunities in understanding how society responds in crises, what needs of the population are met and what is lacking in urban green areas. From this point of view, this study provides a unique perspective of the importance of CES during a crisis and simultaneously offers ample opportunity to replicate the study post-pandemic in order to identify what needs and values might change. Furthermore, the method that this study applies can easily be replicated and expanded to other areas, as it offers a bottom-up approach through a digital platform which could hold innovative potential. It is therefore plausible that it can be used in conjunction with GIS to map out areas that provide CES and those that do not, thus providing a tool-kit for working strategically with social and ecological sustainability for several sectors. It could further be applied to testbeds within the campus areas, for designing interventions and for data collection all year around. The method in the present study could also be further developed by applying a regression analysis in order to see what variables predict an outcome, thereby further pinpointing what CCA/M measures can work in synergy with CES. For the university campus environment specifically, there is an interesting opportunity in evaluating how CES provided by green areas can affect the self-efficacy of students. Plausibly, as campus green environments can provide restorativeness; they affect emotional states, and thereby also build resilience to stress and possibly even strengthen an individual's self-efficacy (Bandura, 1977, 1982).

Furthermore, results from the study suggest that there could be an interaction between the indoor and outdoor environment primarily in terms of restorativeness. It could prove interesting to further investigate if there is in fact an interaction in terms of perceived CES, along with directionality. Policy-makers and urban planners can draw benefits by investigating this further, as it has implications for how to plan both the indoor and the outdoor environment to promote CES.

Additionally, the present study does not examine in detail what functions the green areas is supposed to support or to what degree they would be supported. But rather what participants gather from the surroundings based on their appraisals, further studies could benefit from applying a theoretical framework including affordances (Gibson, 2014) in order to assess the multifunctional environment further. The present study does not examine planning materials for the green areas, as this would go outside the scope of the study. It would however provide further details and basis of understanding how well the green areas purpose fits the activities carried out and identify key points of how further development could be carried out.

Conclusions

This study illustrates that urban green areas, with integrated climate change adaptation/mitigation features, in a university campus environment can provide cultural ecosystem services for university students from a psychological point of view, including benefits for restoration and affective response. In addition, they can offer opportunities for learning, while they simultaneously support recreational- and social activities. Moreover, they can provide values for biodiversity. This serves as the basis for what the multifunctional environment can entail in the context of university campuses, which importance is signified by biodiversity and climate change being inextricably connected to each other and human futures (Pörtner et al., 2021).

The selected areas in the study can all contribute to climate change adaptation/mitigation, while they support perceived CES to a varying degree. Areas that contain water surfaces tend to be highly restorative, as well as areas that contain high levels of perceived biodiversity (lake, brook, grove). The meadows in the present study cannot be regarded to support CES, which in turn suggests that these types of green areas could need improvement to ensure their longevity and continued contribution to biodiversity. The present study also shows how further restoration of ecosystems can work in line with the UN decade of restoration (United Nations, n.d.) while preserving values for both humans, nature and the climate.

Furthermore, the study supports previous research which suggests that in order for an area to be restorative, there needs to be a psychological and geographical distance from the participants' usual working environment in order for it to be restorative (Hartig et al., 1997; Kaplan, 1995). The findings also suggest that there could be an interaction between the indoor- and outdoor environment, which could be manipulated by the use of vegetation.

The campus environment is used for several purposes, such as social gatherings, recreational purposes, research, studying or for restoration. This shows that the campus environment can support a variety of activities, and that it has potential for further strengthening of CES. It also shows that students in general, are well-inclined to more vegetation on the campus area which could advance the efforts of biodiversity and climate change adaptation/mitigation. The campus environment offers ample opportunity for research on how to develop and aid CES, biodiversity and climate change adaptation/mitigation in conjunction with each other, which this study shows. The present study also shows that including students in assessing the environment can provide values that might otherwise be lost. Several interventions have been suggested by students and further interpreted by the author and should serve as a useful tool for further development and aid restoration of ecosystems in the campus area. However, the results also apply to the urban environment in general. Like the urban environment, campuses contain green areas, key transportation nodes, work environments and housing.

In conclusion, the present study shows that it is possible to preserve and restore green areas and ecosystems in the urban environment, while also providing important benefits for human quality of life. To ensure a sustainable future for human and non-human life on earth, policy-makers need to be provided with knowledge on the benefits of multifunctional environments that facilitates prioritizing such environments in urban development. Thereby, addressing several issues simultaneously, including one of the most pressing environmental challenges of human history, the effects of climate change.

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Appendix A.

Table 11.
Criteria for selection of areas based on the IPBES NCP framework (IPBES, 2019b).

	Reporting categories of nature's contributions to people	Brief explanation and some examples
1	Habitat creation and maintenance	The formation and continued production, by ecosystems or organisms within them, of ecological conditions necessary or favorable for living beings of direct or indirect importance to humans. E.g. growing sites for plants., nesting, feeding, and mating sites for animals, resting and overwintering areas for migratory mammals, birds and butterflies.,
2	Pollination and dispersal of seeds and other propagules	Facilitation by animals of movement of pollen among flowers, and dispersal of seeds, larvae or spores of organisms beneficial or harmful to humans.
3	Regulation of air quality	Regulation (by impediment or facilitation) by ecosystems, of CO2/O2 balance, O3, sulphur oxide, nitrogen oxides (NOx), volatile organic compounds (VOC), particulates, aerosols, allergens. Filtration, fixation, degradation or storage of pollutants that directly affect human health or infrastructure.
4	Regulation of climate	Climate regulation by ecosystems (including regulation of global warming) through: • Positive or negative effects on emissions of greenhouse gases (e.g. biological carbon storage and sequestration; methane emissions from wetlands). • Positive or negative effects on biophysical feedbacks from vegetation cover to atmosphere, such as those involving albedo, surface roughness, long-wave radiation, evapotranspiration (including moisture-recycling) and cloud formation. • Direct and indirect processes involving biogenic volatile organic compounds (BVOC), and regulation of aerosols and aerosol precursors by terrestrial plants and phytoplankton .
5	Regulation of ocean	Regulation, by photosynthetic organisms (on land or in

	acidification	water), of atmospheric CO_2 concentrations and so seawater pH, which affects associated calcification processes by many marine organisms important to humans (such as corals).
6	Regulation of freshwater quantity, location and timing	Regulation, by ecosystems, of the quantity, location and timing of the flow of surface and groundwater used for drinking, irrigation, transport, hydropower, and as the support of non-material contributions. Regulation of flow to water-dependent natural habitats that in turn positively or negatively affect people downstream, including via flooding (wetlands including ponds, rivers, lakes, swamps). Modification of groundwater levels, which can ameliorate dryland salinization in unirrigated landscapes.
7	Regulation of freshwater and coastal water quality	Regulation – through filtration of particles, pathogens, excess nutrients, and other chemicals – by ecosystems or particular organisms, of the quality of water used directly (e.g. drinking, swimming) or indirectly (e.g. aquatic foods, irrigated food and fiber crops, freshwater and coastal habitats of heritage value).
8	Formation, protection and decontamination of soils and sediments	Formation and long-term maintenance of soil structure and processes by plants and soil organisms. Includes: physical protection of soil and sediments from erosion., and supply of organic matter and nutrients by vegetation; processes that underlie the continued fertility of soils important to humans (e.g. decomposition and nutrient cycling).; filtration, fixation, attenuation or storage of chemical and biological pollutants (pathogens, toxics, excess nutrients) in soils and sediments.
9	Regulation of hazards and extreme events	Amelioration, by ecosystems, of the impacts on humans or their infrastructure caused by e.g. floods, wind, storms, hurricanes, heat waves, tsunamis, high noise levels, fires, seawater intrusion, tidal waves. Reduction or increase, by ecosystems or particular organisms, of hazards like landslides, avalanches.
10	Regulation of detrimental organisms and biological processes	Regulation, by organisms, of pests, pathogens, predators or competitors that affect humans (materially and non-materially), or plants or animals of importance for humans. Also, the direct detrimental effect of organisms on humans or their plants, animals or infrastructure. These include e.g.:• Control by predators or parasites of the population size of animals important to humans, such as attacks by large carnivores, or infestation by liver fluke, on game or livestock). • Regulation (by impediment or facilitation) of the abundance or distribution of potentially harmful organisms (e.g. venomous, toxic, allergenic, predators, parasites, competitors, pathogens, agricultural weeds and pests, disease vectors and reservoirs) over the landscape or seascape.

		• Removal, by scavengers, of animal carcasses and human corpses (e.g. vultures in Zoroastrian and some Tibetan Buddhist traditions). • Biological impairment and degradation of infrastructure (e.g. damage by pigeons, bats, termites, strangling figs to buildings). • Direct physical damage to crops, forest plantations, livestock, poultry and fisheries by mammals, birds and reptiles. • Damage caused by invertebrates as pests of agriculture, horticulture, forest, and stored products, and by affecting health of domestic animals. • Direct damage caused by organisms to humans by e.g. frightening, hurting, killing, or transmitting diseases. • Regulation of the human immune system by a diverse environmental microbiota.
11	Energy	Production of biomass-based fuels, such as biofuel crops, animal waste, fuelwood, agricultural residue pellets, peat.
12	Food and feed	Production of food from wild , managed, or domesticated organisms, such as fish, bushmeat and edible invertebrates, beef, poultry, game, dairy products, edible crops, wild plants, mushrooms, honey. Production of feed (forage and fodder) for domesticated animals (e.g. livestock, work and support animals, pets) or for aquaculture, from the same sources.
13	Materials, companionship and labor	Production of materials derived from organisms in cultivated or wild ecosystems, for construction, clothing, printing, ornamental purposes (e.g. wood, peat, fibers, waxes, paper, resins, dyes, pearls, shells, coral branches). Live organisms being directly used for decoration (i.e. ornamental plants, birds, fish in households and public spaces), company (e.g. pets), transport, and labor (including herding, searching, guidance, guarding).
14	Medicinal, biochemical and genetic resources	Production of materials derived from organisms (plants, animals, fungi, microbes) used for medicinal, veterinary and pharmacological (e.g. poisonous, psychoactive) purposes. Production of genes and genetic information used for plant and animal breeding and biotechnology.
15	Learning and inspiration*	Provision, by landscapes, seascapes, habitats or organisms, of opportunities for the development of the capabilities that allow humans to prosper through education, acquisition of knowledge and development of skills for well-being, information, and inspiration for art and technological design (e.g. biomimicry).
16	Physical and psychological experiences*	Provision, by landscapes, seascapes, habitats or organisms, of opportunities for physically and psychologically beneficial

		activities, healing, relaxation, recreation, leisure, tourism and aesthetic enjoyment based on the close contact with nature (e.g. hiking, recreational hunting and fishing, birdwatching, snorkeling, diving, gardening).
17	Supporting identities*	Landscapes, seascapes, habitats or organisms being the basis for religious, spiritual, and social-cohesion experiences: • Provisioning of opportunities by nature for people to develop a sense of place, belonging, rootedness or connectedness, associated with different entities of the living world (e. g. cultural, sacred and heritage landscapes, sounds, scents and sights associated with childhood experiences, iconic animals, trees or flowers). • Basis for narratives, rituals and celebrations provided by landscapes, seascapes, habitats, species or organisms. • Source of satisfaction derived from knowing that a particular landscape, seascape, habitat or species exists.
18	Maintenance of options	Capacity of ecosystems, habitats, species or genotypes to keep options open in order to support a good quality of life. Examples include: • Benefits (including those of future generations) associated with the continued existence of a wide variety of species, populations and genotypes. This includes their contributions to the resilience and resistance of ecosystem properties in the face of environmental change and variability. • Future benefits (or threats) derived from keeping options open for yet unknown discoveries and unanticipated uses of particular organisms or ecosystems that already exist (e.g. new medicines or materials). • Future benefits (or threats) that may be anticipated from on-going biological evolution (e.g. adaptation to a warmer climate, to emergent diseases, development of resistance to antibiotics and other control agents by pathogens and weeds).

* category not part of selection criteria due to object of study through participant's appraisals.

Appendix B.

Table 12. Internal reliability for instruments.

Reported in Cronbach's α.

	Cronbach's α
Biodiversity Experience Index, BEI (scale 1–7)	
Perceived biodiversity (4 items)	0.63 - 0.83
Semantic Environment Description, SED (scale 1–7)	
Pleasantness (8 items)	0.65 - 0.83
Soundscape perception (scale –2 to 2)	
Pleasantness (4 items)	0.61 - 0.86
Eventfulness (4 items)	0.56 - 0.74
Scent perception (scale 1–7)	
Pleasantness (1 item)	N/A**
Strength (1 item)	N/A**
Affective response (scale 1-5)	
Valence (2 items)	0.61 - 0.90*
Arousal (2 items)	0.78 - 0.86*
Perceived Restorativeness Scale, PRS (scale 0–10)	

Being away (2 items)	0.37 - 0.91
Fascination (2 items)	0.78 - 0.82
Environmental preference (1 item)	N/A**
Perceived contribution to Quality-of-Life aspects, QoL (scale 1–5)	
Aesthetic beauty (1 item)	N/A**
Environmental Quality (1 item)	N/A**
Nature/Biodiversity (1 item)	N/A**

*For affective response, the dimensions were compared between the Affect-grid and Swedish Core Affect.
**Instruments or dimensions with a single item are marked as N/A.

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