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ECOLOGY

City love and place quality assessment in livable neighborhoods in cities

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Keywords: urban ecology, life quality, well-beeing index

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After the worldwide interest in global sustainability and climate change challenges, an increasing concern is voiced on local quality of life and neighbourhood livability. In recent urban social-ecological studies, human well-being, environmental satisfaction and citizen happiness studies are gaining muchpopularity in a local context (the 'microcosmic city').

The present study seeks to identify the determinants of the residents' appreciation for their daily environment, called here 'city love'. The The latter concept captures both tangible or material aspects of city life ('body') and immaterial and emotional dimensions of local quality of life ('soul'). The present paper seeks to develop and test a new quantitative 'city love' concept, inspired by the soul and body conceptualisation of urban attractiveness for residents and visitors – based on a novel 'feelgood' index (FGI) and a 'human habitat' index (HHI), with a view to map out the citizens' contentment or appreciation (called neighbourhood love index – NLI) at a district or neighbourhood scale in the city of Rotterdam. ur study utilizes data from a quantitative survey among thousands of residents located in 63 neighbourhoods in this city. In addition, the Rotterdam dataset contains not only survey data, but also register data on these neighbourhoods, e.g., urban green, bike lanes, real-estate values, crime statistics, and socio-demographics, while a wealth of geographical information from OpenStreetMap (OSM) is added as a complement. In addition to a multivariate analysis of the rich data set, the paper employs also a quantile regression analysis extended with fixed effects.

The results show that the coefficients of the feelgood index (FGI) and the human habitat index (HHI) are both important, but decrease slightly as we move up the distribution of the neighbourhood love index (NLI). This means that environmental and functional aspects of neighbourhoods, e.g., access to such amenities as green space, public transportation, sport facilities, and also streets with diverse attractions or bikeable and walkable road networks, become more important for the lower end of the distribution of the neighbourhood love index (NLI). Our neighbourhood-specific analyses show that the Rotterdam districts and neighbourhoods differ substantially in many physical and social-emotional attributes, which calls for place-based policies and sub-local well-being initiatives in the context of local livability initiatives.

Cities as shared habitats of people, plants and animals: key challenges for urban biodiversity conservation

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Keywords: biodiversity conservation, ecosystem services, urban habitats, urban design for people-plants-animals

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In the Urban Millennium, sustainable urban development is key to livable cities and, at the same time, to the future of biodiversity. Accelerated urban growth is a major threat to biodiversity outside cities. At the same time, urban areas can host a surprisingly high number of animal and plant species, including many endangered species – within and beyond protected areas. However, recent studies also show that the loss of nature experiences is an increasing challenge in human societies. Conceptualizing cities as shared habitats of people, plants, and animals involves multiple opportunities to address the global biodiversity crisis and strengthen diverse ecosystem services for the benefit of urban populations. However, urbanization is not generally associated with positive benefits for biodiversity, and not in all urban land uses. Therefore, we need to better understand the social and ecological mechanisms that determine which animal and plant species can not only occur in urban structures, but also survive there. Based on insights from recent studies, policies to conserve and promote biodiversity in all urban land uses can be improved. Designing cities as shared habitats for people, plants and animals is a promising approach to reconciling cities and the natural world.

The ecosystem promise: guidelines for its implementation in policy and practice

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Keywords: ecosystem services, social-ecological system, policy

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The concept of ecosystem services was introduced in the 1980's with as underlying assumption that it could help to move the world in a more sustainable direction. It took more than 20 years before it really became acknowledged as a tool that could 'bridge' the divide between ecology and economics, and harmonize conservation with development, with the release of the Millennium Ecosystem Assessment (2005) and the TEEB-study (2010), and more recent the creation of the IPBES.

Yet in spite of, or maybe because of this long history, there is still discussion about the definition, classification and valuation-approaches.

After a brief reflection on the main discussion points I would like focus on how the concept, finally, can live up to its promise and can be used in practice to support better informed decision making, and help bring about the much needed fundamental change in the economic system. Two encouraging signs that things are finally changing are the release of the Dasgupta report in February this year, and the approval of the UN Statistical Commission in March to expand the System of Environmental Accounting (SEEA) with ecosystem services.

[1] Dasgupta, P. 2021. The Economics of Biodiversity. The Dasgupta Review. HM Treasury, London (610 pp). The review can be downloaded at www.gov.uk/official-documents

[2] UN Statistical Commission 2021. Report of the Commission on its fifty-second session. 5 March 2021 (16 pp). Further information can be found at https://seea.un.org/content/seea-experimental-ecosystem-accounting-revision

PLENARY SESSION

K.4

Listening to the trees: A recent narrative about the power of urban forests as nature-based social-ecological solutions in cities and the risks they face

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Keywords: Urban trees, urban forest, drought, taxa, nature-based solutions

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This plenary talk will focus on the effects of recent droughts and periods of intense insolation in spring and summer seasons in Central Europe on urban forests, in particular on mature and young trees and different tree taxa. Trees and urban forests are excellent and effective nature-based solutions to counteract heat, low air quality and illbeing of people in the city and therefore, urban forest nature-based solutions are among the most frequently implemented greening strategies in our cities.

Climate change challenges the strategy to implement trees for urban wellbeing as it sets urban trees and forests under novel stress next to the existing stress factors cities, their soil sealing and their soil pollution, usually mean for trees. Exceptionell surface and mostimportantly subsoil water shortage endangers the treescapes in our cities and let mature trees die and young trees suffer from the beginning of their urban life. In Central Europe, urban foresters usually do not irrigate trees, maximum in their first years. But this management bases on climate experiences from past decades and needs revision as well as the idea what taxa should/can populate our streets and parks in the future. Local—native—trees species and old alien trees species might not be able to adapt to new dry and hot conditions and thus large tree-testing programmes and tree-replacement lists have been created in the last decade to find a new optimum in trees/urban forest taxa distributions for our Central European cities. Another challenge related to the new drought and tree stress situation are a growing number of pests affecting single trees species and the destiny of many insects, birds and beetle which are hosted by mature local trees in and of urban forests.

The paper will discuss the abovementioned challenges and possible solutions using the city of Leipzig in Central Germany (511 mm annual water budget) as a case in point.

The abstracts should be uploaded in the ABSTRACTS section of the conference site www.sure2020.org

Acknowledgments: This work was supported by the CLEARING HOUSE project which has received funding from the European H2020 Research and Innovation programme under the Grant Agreement n° 821242. The content of this document reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

Quantifying spatial heterogeneity of urban landscapes and its effects on urban climate

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Keywords: Urban sustainability, Urban heat island, Green infrastructure, Climate change, Urban ecosystem

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Spatial heterogeneity has myriad influences on ecosystem processes, ecosystem services, and thus the sustainability of urban areas. It acts as a medium for urban design, planning, and management to determine how processes affecting sustainability can operate and interact. Therefore, how spatial heterogeneity is conceptualized and measured in cities is crucial for ecological understanding of urban ecosystems, and for enhancing sustainability. Here I first discuss the different ways in which ecology IN versus ecology OF and ecology FOR the city affect how to conceptualize, model and map urban spatial heterogeneity.

I present a new framework to guide the comparisons of spatial heterogeneity under the three paradigms, and an approach that explicitly recognizes the patchiness of hybrid social and biophysical nature of heterogeneity in urban ecosystems. Using the effects of spatial configuration of landscape features on surface temperatures as an example, I then exemplify how the hybrid approach under the ecology OF/FOR the city paradigm helps better understand the effects of spatial heterogeneity on ecological processes. The analyses were conducted in four cities, Baltimore and Sacramento in the USA, and Beijing and Shenzhen in China.

The results showed that spatial configuration of landscape features significantly affected surface temperatures, but the magnitude of impacts and its relative importance to landscape composition varied by cities, highlighting the importance and benefits of cross-city comparisons. Additionally, using an integrated social-ecological approach, tree planting programs in cities worldwide can achieve social and ecological win-wins when using trees to adapt to urban extreme heat and climate change.

ORAL SESSION

K.6

Seven imperatives for ecological urbanism

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Keywords: ecological urbanism, nature-based solutions, green recovery

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The International Union for Conservation of Nature (IUCN) is increasingly concerned with urban dimensions of nature conservation. IUCN comprehends that "residential and commercial development" is now the third most frequently cited threat to species on the IUCN Red List; that in the three decades leading 2030, an area of natural habitat larger than the United Kingdom may be consumed by urbanisation;[1] that by 2030, some 40 % of strictly protected areas will likely lie within 50 km of a city;[1] that, as centres of consumption and production, cities have ecological footprints orders of magnitude larger than their physical urban areas;[2] and that for the surging majority of humanity, cities are home.

However, IUCN also recognises the opportunity that urbanisation presents to reset humanity's relationship with nature; to reign-in bloated economies to within planetary boundaries; to reimagine built environments as regenerative systems; and to create a truly ecological civilisation. As centres of social, financial and political capital and as hubs of innovation, cities are clearly central to the success of the 2030 Agenda for Sustainable Development.

In pursuit of a "just world that values and conserves nature," IUCN is committed to partnering with city governments and their partners. Several recent IUCN Resolutions and the new Nature 2030 IUCN Programme provide a clear political mandate for this work. At the best of its 1,400 Members, IUCN has established the IUCN Urban Alliance, a coalition of IUCN constituents working to create greener cities. The IUCN Urban Alliance is developing a tool for evaluating the ecological performance of cities, the Urban Nature Index, and jointly coordinates the PANORAMA Solutions Thematic Community on Sustainable Urban Development and Resilience, a knowledge-sharing platform. However, within IUCN and the broader conservation community, there is still much debate over how best to influence forms and patterns of urbanisation; over how to take ecological urbanism to scale. The IUCN Urban Alliance has contributed to this debate by identifying and promoting seven imperatives:

1. Educate city shapers. Fostering ecological literacy among architects, engineers, planners, designers, investors, developers, policymakers and citizens can help ensure that the the value of nature is properly recognised and incorporated into urban decision-making processes.
2. Empower communities. Participatory planning, co-design, and other forms of deliberative democracy can bring popular demand for nature to bear on urban development.
3. Adopt a rights-based approach. Advancing the human right to a safe, clean and wildlife-rich environment, can improve urban planning regulations and design codes.
4. Ally with culture-makers. Partnering with creatives—musicians, writers, poets and artists—is vital for reaching the scale of audience required to bring about 'whole-of-society' transformative change in cities.
5. Fix market failures. Targeted policy solutions (e.g., urban planning and zoning) and market-based instruments (e.g., taxes and subsidies) are needed to address the environmental shortcomings of the free market.
6. Share knowledge liberally. Gathering and disseminating urban experiences and lessons can help inspire and inform the replication and scaling of best practices.
7. Measure performance. By monitoring urban ecological performance, cities can better understand their impacts on nature, set science-based targets for improvement and track progress.

With reference to a number of practical examples, the author presents the rationale and evidence for these imperatives and critically evaluates the extent to which IUCN is acting on them. Notwithstanding progress in a number of areas, he identifies a clear need for IUCN and the broader conservation community to take a more systematic, concerted and proactive approach to advancing ecological urbanism and influencing urban futures.

Acknowledgments: This work was supported by Arcadia, a charitable fund of Lisbet Rausing and Peter Baldwin.

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Oral Sessions

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Green infrastructure operationalisation: A systematic review on the procedural aspects from a decade of research

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Keywords: planning processes; mainstreaming; summary

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Green Infrastructure (GI) has received much attention as a strategic approach for the ecological, social and economic regeneration of urban and peri-urban landscapes. Many cities integrate GI into their planning practice by developing new and retrofitting degraded sites to improve health and wellbeing of citizens, promote economy, and not least adapt to climate change [1].

Yet, looking at the recent state of practice, operationalising GI as a strategic planning approach still seems scarce and scattered. Different barriers hamper the proper implementation of and governance for GI [2,3]. GI is defined by the principles addressing green structures (multifunctionality, connectivity, green-grey integrity) and the principles addressing planning processes (social inclusivity, multiscale and inter- and trans-disciplinary planning) that underline its strategic character [4]. A careful consideration of the concurrent social, administrative and political planning processes is especially important for successful GI operationalisation [5,6], as it requires inclusion of a multitude of actors, interests and approaches on different levels and in long-term perspective [1]. In our study, the described planning processes are referred to as *procedural aspects* that represent modes of courses or actions in which the GI is operationalised, implemented or governed for. This study aims to provide more insight on how and whether procedural knowledge on GI has been addressed in GI research and practice.

We conducted a systematic literature review of peer-reviewed articles published in the SCOPUS and Web of Science databases between years 2010-2020. The combination of keywords "green infrastructure" and "urban OR rural" in title, abstract or keywords resulted in a collection of 1728 publications, after duplications and non-refereed pieces were filtered out. We developed an analytical framework to study the list of publications on various aspects in relation to GI operationalisation in planning processes. The analysis was structured to determine (1) whether the research focus is of a procedural (socio-cultural, planning, governance or policy) or a substantive nature (physical and spatial GI assets, benefits, design, modelling or assessment). Next, we studied (2) the methodological approach(es), (3) the spatial level of analysis, and (4) the level of disciplinary and/ or transdisciplinary approaches.

Then, we proceeded to analyse those articles addressing procedural aspects with an emphasis on participatory and governance processes in planning. This phase included studying (5) the participatory approaches, (6) the level of participation and/ or collaboration, and (7) the governance or planning approaches.

We are currently processing the preliminary results. Based on the findings, we aim to identify which procedural aspects to operationalise the strategic GI approach have been addressed in research. An analysis of empirical studies provides insight on how these aspects are taken up in practice. We conclude with clarifying existing knowledge gaps and recommendations for further research to promote GI operationalisation, implementation and inclusive governance.

Acknowledgments: This work was supported by the Scientific Grant Agency of the Ministry of Education of the Slovak Republic (VEGA No. 1/0706/20 "Sustainable urban development in the 21 st century - Assessment of key factors, planning approaches and environmental relationships").

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ORAL SESSION

A.1.2

Ecological network analysis of a metabolic urban system based on input–output tables: Model development and case study for the city of Vienna

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Keywords: Emergy, urban metabolic system, ecological network analysis, indirect effects, Vienna.

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The rapid economic growth accompanied by health concerns and other global environmental problems in cities and regions has boosted the popularity of the 'urban metabolism' topic among academics and policy makers. As a major city with a strong reputation for environmental stewardship and liveability, Vienna plays a key role in promoting efficient and sustainable resource production and consumption including how it interacts with other regions. Combining emergy input-output with ecological network analysis allows researchers to study hierarchy of sectors and functional relationships along all possible metabolic paths of ecological and socio-economic flows exchange in urban economy and between urban economy and environment. In this study, we introduced a model that combines emergy input-output tables with ecological network analysis to investigate the structure and functions of Vienna's urban metabolic system.

The following research methods were utilized. The flow analysis was applied to account for emergy flows along direct (emergy inputs from environment and exchange between sectors) and indirect pathways (emergy invested in production and transfer of products between sectors) and to estimate total emergy consumption of each sector in Vienna Region [1]. Then, contribution analysis was used to estimate the status of each sector based on total control over all other sectors and dependence of each sector on all other sectors [2].

Consequently, pairwise controls and dependences between each pair of sectors were determined using control analysis [2]. Finally, utility analyses allowed to assess the pairwise positive utilities (benefits) and negative utilities (costs) between sectors [3]. The last two analyses revealed sectors responsible for the status (distribution structure of each industry) and emergy consumption of the other sectors.

The analysis of system-level hierarchy of sectors revealed that producing sectors (AGR and MIN) are unsupported by consuming sectors (i.e., tertiary) in an indirect way and, therefore, cannot satisfy demand of consuming sectors for their production. Moreover, there are many problems within tertiary industries preventing them from supporting producers. Some downstream industries consume the most of emergy in the system (ADS and HS), while other sectors rely on imports (EC and TS), leading to the low delivering abilities of these sectors. In addition, few sectors have low importance in the system (WR and CON) due to their capacities to receive and to provide investments being the lowest.

The results of pairwise control and utility analyses showed that the emergy dependence of WR on MIN sector was the main reason behind the low emergy cosumption of the MIN sector. In addition, the MIN and EC's control over energy and monetary delivery to AGR sector hindered AGR's production capacity. Finally, the competition for investments between AGR and EC sectors contributed the most to the low delivering capacity of AGR sector to consuming sectors. The low values of system-level indicators (mutualism and synergism) reflected the dominance of pairwise competitive indirect relationships in the system. The establishment of numerous eco-industrial parks can improve the overall level of mutualism and synergism in Vienna's metabolic system in long-term perspective.

Future studies could identify the key sectors limiting the system's efficiency by applying information indices to the network analysis. Another possible direction would be to add the time data for monitoring the system stability and efficiency in terms of emergy utilization. Those directions could contribute to the healthier state of Vienna's metabolic system.

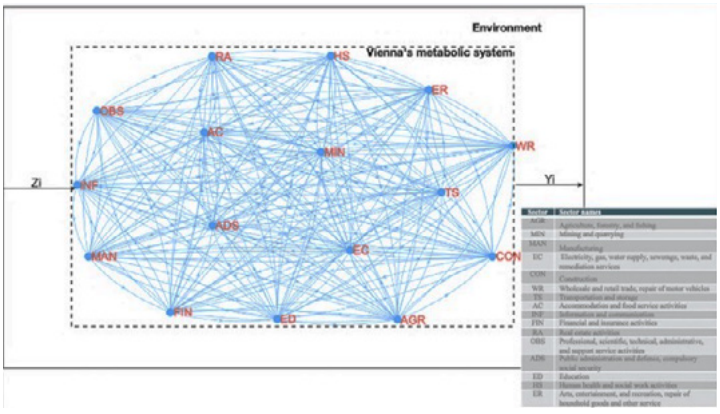

Figure 1. Network model of Vienna's metabolic system. Names and abbreviations of sectors shown in right corner. Zi and Yi represent inputs from and to the external environment of the urban metabolic system, respectively

Acknowledgments: This work was supported by Assoc. Prof. Dominik Weidenhofer, BOKU, Vienna

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Is the green infrastructure considered as the development asset of Polish municipalities? Five medium-sized cities case study

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Keywords: spatial development, socio-economic development, public policy

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The greatest number of theoretical considerations and analysis of practical applications of green infrastructure (GI) concepts have been devoted to large cities [e.g. 1,2,3]. Researchers seem to be less interested in smaller cities. However, in the case of Poland, according to the political declaration, small and medium-sized cities are to play an increasingly important role as significant elements of the national settlement network [4]. Among smaller cities, the concept of the GI is still poorly known. Though, a belief of growing importance of green spaces for improving environmental and social conditions of the cities is being observed. So, the question arises if the local authorities appreciate these areas as an social and economic development asset.

The aim of this study was to determine to what extent green infrastructure is positioned in local public policy in medium-sized cities. The research was conducted in five urban municipalities, selected on the basis of two criteria: the direction of economic development and the potential to provide green infrastructure.

The starting point of the research was identifications of the natural resources for the creation of a well-functioning GI, which depend primarily on the types and spatial arrangement of areas covered with vegetation and water. The following types of spatial arrangement were identified (on the basis of analysis of 264 urban municipalities): enveloping, sectoral, archipelago, perforated, ribbons.

Taking into account the analysis performed by the Polish Economic Institute [5] the medium-sized cities are anticipated the following development trajectories: cities with the need of new strategies and ideas for development, cities with potential however without strong differentiators, cities - the development engines of local markets. In our analysis we concentrated on the medium-sized cities considered as approaching the most promising development trajectory (the third type of development scenario).

In our study, we analyzed to what extent cities, selected according to: 1) different open spaces' spatial arrangements models; 2) the most promising development trajectory, use the concept of GI (or green open spaces) as a development assets. The following medium-sized cities was used as the research areas: Chełm (GI type: archipelago), Działdowo (GI type: ribbons), Jasło (GI type: perforated), Przemyśl (GI type: enveloping), Ząbki (GI type: sectoral). The analysis was carried out on the basis of available strategic and planning documents.

The conducted research showed that there is no visible correlation between the ambitious vision of social and economic development and the perception of the importance of a multifunctional, coherent structure of green open spaces, conceived according to GI rules. However, in some cities the approach which can be interpreted as being in line with the GI rules was identified.

Acknowledgments: This work was supported by the National Science Cente, Poland (research project No. 2019/35/B/HS4/04221)

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ORAL SESSION

A.1.4

Built environment factors effecting urban biodiversity and its planning strategies: case study in blocks along Century Avenue, Pudong New District, Shanghai,China

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Keywords: Urban Biodiversity, Built Environment Factors, Avian Diversity

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Urban biodiversity is one of the key indicators to assess urban ecosystem services. With ecological urbanization becoming hot topic in China recently, there has been increasing concern about urban biodiversity in the eco city development. However, for urban planners, knowledge on what role urban built environment plays in terms of biodiversity is still in its infancy, constituting a black box in urban planning and design, especially in the high-density urban areas, which are common living environment for city-dwellers in Chinese metropolitan.

This study seeks to contribute to a more complete understanding of how urban built environment influences biodiversity in high-density urban areas. We choose 54 blockes along Century Avenue, Pudong New District in centre area of Shanghai, China-from Lujiazui CBD to Century Park-an area with 4.06km^2 including diverse land use and diverse biotopes.

Taking empirical analysis of avian diversity in blocks along Century Avenue, Pudong New District, Shanghai as case study, we explore the relationship between avian diversity variables and urban built environment variables including ecological land, vegetation and development intensity with correlative and regression analysis.

The study results indicate that 14 urban built environment variables are important to impact avian diversity, of which 4 have a greater negative impact, including: Perimeter area ratio of green space, Largest perimeter area ratio of green space, FAR, building density. The negative impact of building density is the largest, which reflects that reducing the proportion of building area and reserving more available space for habitat might be the most effective way to conserve biodiversity in high-density urban areas.

There are 10 factors with great positive impact, including: Total class area of green space, Largest patch area of green space, Mean proximity index of green space, Patch aggregation index of green space, Patch cohesion index of green space, Tree coverage area, Ground cover coverage area, Vegetation (tree, ground cover, shrub) species, Average height of trees, Green space ratio.Among them, the average height of trees has the most significant effect, which reflects the adaptability of birds for the off-ground habitat in high-density urban areas.

Corresponding planning strategies to protect and enhance biodiversity are proposed as followed: (1) Establish "sink-corridor-stepping stone" habitat chain system; (2) Optimize the shape and configuration of the concentrated green space; (3) Encourage compound planting structure.

The research results have been used in the practical planning projects in Shanghai such as the ecological Planning Guidelines for Waterfront Area of Huangpu River and Suzhou creek

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Planning for cultural Ecosystem Services in socialist and post-socialist Zagreb, Croatia

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Keywords: cultural ecosystem services, urban green and blue spaces, urban planning

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Although conceptualised as cultural ecosystem services (CES) only at the beginning of the 21st century, socio-cultural contributions of nature to human well-being have long been considered in urban planning. Proliferating research on both CES and urban green and blue spaces (UGBS), as their main supplier in cities, is still mostly limited to western societies, despite studies that show that socialist regimes might have had a favourable influence on the amount of UGBS in cities [1]. Particularly, we examine how CES were considered in socialist and post-socialist urban plans of Zagreb, Croatia. We believe that Zagreb's case may provide a novel perspective on valuing and planning for urban CES in different socio-political settings.

We analyse three socialist (1953/1971/1986) and two post-socialist (2003/2016) general urban plans of Zagreb. Using Tandarić et al.'s 5P framework [2], we investigate to what measure place, people, practices, purpose and past were considered in UGBS planning to determine the level of provided opportunities for the generation of CES. The level is determined on the scale 0-1 for each factor and has an indicative rather than absolute value. The plan analysis results were combined with interviews with ten socialist and post-socialist urban planners and academics from various disciplines and with relevant scientific and professional literature from both periods.

The analysis showed that place and purpose factors were considered the most in both socialist and post-socialist plans, while people and practices were rarely addressed (Fig. 1). Place (locational factors) and purpose (planned function of UGBS) are traditional dimensions in planning, so it does not surprise that they were consi-dered the most. Nonetheless, a decrease in values for both factors can be observed in the post-socialist period, which can be linked with the re-introduction of private property and free market, according to interviewed planners and academics. Moreover, ecological benefits of UGBS seem to be neglected after 1990 as well. On the other hand, people (UGBS users' preferences, wishes and needs) and practices (preferred activities in UGBS) were considered low in both periods which is connected with ostensible public participation in planning and obser-vation of residents' preferences. Past (observing history of place) was somewhat considered in socialist plans, primarily by observing historical physiographic features of space and rarely the historical land use patterns.

The two ideologies have influenced the provision of opportunities for the CES generation differently in terms of (i) the supply of substrate for the creation of spatial opportunities for CES generation, (ii) the planning pro-cesses that enable such opportunities, (iii) the physical forms that operationalise such opportunities, (iv) the plan implementation and management. During the socialist period, most urban land in Zagreb was nationalised, giving planners the freedom in planning, which was only limited by the available funding for realisation. In such conditions, socialist neighbourhoods were planned as self-sufficient residential units of buildings nested in a green matrix (functionalist Corbusian approach). How-ever, the lack of funds often left UGBS unrealised as authorities prioritised housing and traffic over other functions. Nonetheless, the land for UGBS was reserved. With the reintroduction of free market and private property in 1991, a new influential player (private inve-stors) entered the planning area, and planning gave place to location-oriented urbanism, in which city is planned plot by plot rather than comprehensively and systemati-cally, and no new large UGBS have been planned, while some parklands were converted into construction plots.

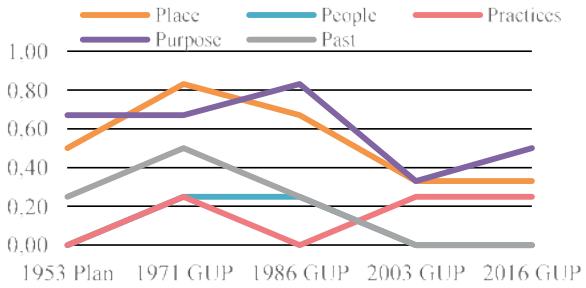

Fig. 1. The 5P assessment of five urban plans of Zagreb

There are several insights for urban planning to provide more and better opportunities for CES generation. Interconnected green spaces in the Corbusian style would provide opportunities for both intentional and incidental encounters with nature, whereas combined quantitative and qualitative standards for UGBS provision might improve the living environment. These spaces should be planned as multifunctional to enable various other ecosystem services. Finally, including users directly in UGBS planning and management might enable the provision of more adjusted and diverse CES.

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ORAL SESSION

A.1.6

Side effects of instruments for land value capture on urban densification and expansion

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Urban land has immense market value in comparison with agricultural land or natural environment, especially in cities facing high development pressure. The value of urban land is fully reflected by the market, whereas the benefits of non-urbanised landscape are often external to the owner. High land values of urban land are by many scholars considered as undeserved to private landowners, as land values do not rise as a result of the efforts of landowners, but thanks to external factors, such as the overall urban economic success. Land values of urban land often skyrocket after planning permissions are granted on them by public authorities [2].

Local governments worldwide are under fiscal stress and seek for ways how to cover the costs of public infrastructure connected to urban development by private resources. Municipal authorities start in this respect to be more and more aware of the presence of high land prices of urban land and seek for ways how to utilize these land values for public good. A considerable amount of planners and researchers studying planning law takes part in research on instruments for land value capture, in other words instruments which redirect a part of the land value uplift resulting from planning and other activities of public authorities from landowners to public sector [e.g. 1, 3].

Some countries or cities already use the phase of granting planning permissions to tap a part of the increased land value by imposing certain obligations to landowners or developers as a condition for granting the planning permission. This type of value capture instrument is called developer obligations [3], or developer contributions [2]. These conditions may have the form of an in-kind provision of public infrastructure or a monetary contribution to the municipality.

The theoretical effect of developer contributions on urban development might be twofold. On the one hand, it may incentivize municipalities to allow higher density development, as land values rise with the intensity of development and high land values allow municipalities to get even higher contributions from developers for their needs. On the other hand, municipalities may perceive capturing of land value as an interesting business model to expand their municipal budgets, incentivising them to allow more development on the outskirts of the city in comparison without such an instruments for disposal.

This paper assesses the effects of developer contributions on urban densification and expansion on the case study of the city of Prague, where no established policy takes place currently, but where political representatives are keen to introduce such a scheme in near future. The research method builds on the analysis of institutional background of shaping the urban structure of the city of Prague together with content analysis of in-depth interviews with key stakeholders.

Results show that the instrument of developer contributions brings incentives in both ways – for urban densification helping to prevent land take by urban land, as well as urban expansion accelerating land take. Currently, municipal district representatives who are potent players in the game, tend to prefer less intense development or no development at all. They seem to be more inclined to allow more development under the condition that it would pay off. A similar story can be drawn about the representatives of the central city government of Prague.

The primary purpose of instruments for land value capture is to allow municipalities to financially cover necessary public infrastructure investments as well as their other needs. They have side effects as well by incentivizing in-fill development and densification and bringing an additional incentive for development outside urban boundaries. Other complementary instruments directly aiming at land preservation are needed to prevent excessive urban expansion at the expense of agricultural and forest land.

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The hellenic garden. A worldwide brand of climate wise cultural landscaping approach in urban spaces

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Keywords: Hellenic Flora, Pikionic Example, Artful Ecology, Amplified Nature, Healing Places, Gardens against Pandemic.

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There are several factors that make the argument for integrating native plants into parks, gardens, and suburban greenery compelling [1]. There has been a growing demand in recent years for the use of native plants following the trend for a more ecological approach to landscape management. The idea of creating spaces (gardens, parks, etc.) was gradually developed by selecting species that aim to create landscapes that simulates the natural ones.

The naturalistic style creates landscapes with great biodiversity.

The "Hortus Theory" about the Hellenic Garden is a wide talk about branding the Hellenic Flora as thematic part of modern urban landscaping not only in Greece (Hellas) but throughout areas with similar climate all over the World. There are several references about this especially in Ancient Texts (e.g Homer Odyssey, the Garden of Alcinous) [2]. This brand described as designed Nature in several Landscape Expos worldwide brings wildlife as much as rural habitat in difficult places in modern cities and brought an alternative interest during pandemic (Covid-19) period to people of all ages.

The approach is based on "Pikionic Example" of using native Flora in Greece to all kind of design and constructed areas that he worked on during his creative period (1934-1965), by establishing the "designed plant communities" like Hellenic Nature. The most popular work on this example is the planting around the worldwide cultural heritage of Acropolis (Athens). The outdoor formations on the rock of the Acropolis and the hill of Philopappos is probably the most important architectural work done in Greece in the 20th century and presents the works as a proposal and a legacy that Pikionis left in modern Athens and humanity. Far from the romantic idea of parks which in distinct areas of the city undertake to represent the nature that exists outside of them, Pikionis proposed the emergence of the already existing land formation within the city, imposing on it a demarcation that could maintain the topological and historical-natural environment visible and alive in the city (Picture 1), [3].

Picture 1: Pikionic Example in worldwide heritage "Garden for Kids" (Athens, Greece).

The planting puzzle is a result of mixed plant teams with similar needs and aesthetic structure. The microclimatic variability develops the opportunity to use in different planting pattern several plants of the Hellenic Flora that adopted to different areas in the World.

The designed plant communities with Hellenic Flora plants, gives an Artistic, Cultural and Rural approach of the Hellenic Garden in the urban landscape. As a result of this are the high visual appeal, the low inputs, the easy and simple maintenance, the high ecological function, and the climate adopted practices. There was a special interest about this in communities that this kind of design approach was applied, and several environmental awareness activities were held due to this. The result was that the immersion of people of all ages in these green areas (Hellenic Garden type) make them want the "experience" of living in Nature or to get closer to plants and trees that are useful to everyday diet or have healing properties.

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ORAL SESSION

A.2.1

Impact assessment of nature-based solutions upscaling strategies at the city scale: a case study

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Keywords: nature-based solutions, upscaling, impact assessment

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The provision of ecosystem services by the urban green infrastructure contributes substantially to the quality of life in cities. The restoration and creation of new green spaces as part of the urban green infrastructure are considered nature-based solutions (NbS) that help alleviates several social and environmental challenges [1]. In this study, we used the term NbS to refer to a wide range of green spaces such as urban forests, urban parks, community gardens, street trees, green roofs, green walls, constructed wetlands, rain gardens, ponds, etc.

Considering the multiple benefits that NbS provide locally, it is crucial to understand the impacts (in terms of enhanced supply of ecosystem services) of scaling up such solutions at broader spatial scales. For example, there can be a proportional increment of recreational opportunities and beneficiaries in relation to the size and number of new urban parks [2]. However, this relationship is not comprehensively addressed for other types of ecosystem services (e.g., regulating ecosystem services), making necessary a more profound analysis on how ecosystem services accumulate as NbS are increasingly spread to other parts of the city [3].

The costs of implementing a punctual NbS can be summarized as capital costs including investments for land acquisition, design and construction, and operating costs related to the operation and maintenance of the green space during its life span. Understanding how these costs are related to the supply of ecosystem service at different spatial scales is essential to build a robust evidence base that guides the upscaling of NbS within cities [4].

This study aims to develop spatial upscaling strategies by assessing the impacts of the progressive conversion of open spaces into NbS. To this purpose, we used the case study of Las Palmas de Gran Canarias, Spain. This is a densely populated city in an insular context where land is a highly valuable resource, making challenging the upscaling of certain types of NbS that require large spaces at the ground level. To address this issue, our assessment focused on the following NbS types: urban parks, urban forests, infiltration ponds, and community gardens.

Impacts were evaluated as the enhanced supply of ecosystem services supply, construction costs, and their relationship at different spatial levels. More specifically, we mapped available open spaces and assess their suitability for each NbS type based on specific space requirements regarding size, shape, and slope. This resulted in a map that shows the spatial opportunities to scale up the assessed NbS. We then simulated the progressive conversion of suitable spaces into each NbS type. To guide this conversion, we assigned to each space a score based on the aggregated demand of a bundle of ecosystem services relevant for the case study, including runoff mitigation, water purification, soil erosion control, recreation, and food supply. The order of conversion prioritizes spaces with high to low scores in order to use a more just approach for developing the upscaling strategies. We quantified ecosystem service supply and construction costs for different levels of conversion. These levels were defined by incrementing constantly the number of converted spaces. For runoff mitigation, water purification, and soil erosion control, we used process-based models such as InVEST and the Universal Soil Loss Equation. For recreation and food supply, we used distance-based proxies to quantify potential beneficiaries living near the NbS. The assessment of costs focused on estimating the increment of baseline costs of construction due to current land cover types and other biophysical conditions of the converted spaces. The final step of our approach consists of developing upscaling strategies that maximize the supply of services and minimize the costs of construction. To this purpose, we compared the relative increment of services and costs for each NbS type and conversion level, to ultimately identify the most efficient NbS types, their location, spatial scale, and order of conversion.

This approach addresses the spatial upscaling from a comprehensive perspective by combining information regarding the biophysical capacity of NbS to provide ecosystem services, the mechanisms by which citizens benefit from these services, the urban areas exposed to a risk or deprived of ecosystem services, and the capital costs for implementing NbS. In this sense, it helps construct the technical basis for upscaling NbS that are economically viable to address urban challenges at the required scale. Finally, it contributes to building the evidence for mainstreaming NbS at multi-governance levels beyond the city boundaries.

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Let´s make our cities greener: integration of participation approaches in strategies and concepts for urban green infrastructure in the federal system of Germany

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Global warming, loss of biodiversity and urbanization processes are major drivers to urban development in Germany [1,2]. Urban green infrastructure (UGI) plays a considerable role in adapting cities to future threats and to make them sustainable and livable [3].

The German government has recognized its importance and encourages local authorities to implement UGI into processes of urban development. This process is encouraged by European directives that let „trickle down" urban green policy from a supranational to a national level. In the federal system of Germany, these urban green policy is refined over the three levels „Bund" (federal level), „Länder" (state level) and „Kommunen" (community level).

Purpose of this research is to analyse participation in policy for UGI across federal levels by document analysis. The degree of participational integration and the interdependencies between the levels are structurally and systematically analysed.

Examining recent environmental policy in urban areas, following results can be made: participative processes are integrated and UGI governance organized by communication, transfer and implementation tools.

- Communication tools occur in the process policy design as workshops, meetings, conferences, strategies, and steering committees in research projects where experts from different areas meet to accompany and shape processeses for UGI enhancement. The process of designing concepts and strategies for more urban green infrastructure is led by governance approaches. Rather than in a strict top-down governmental rule, different stakeholders aim to find contextual solutions in an open and transparent dialogue. Other measures to influence the process include commenting drafts of working papers and agreements. On this communicational level, ideas for further implementation are gathered, following the mandate to develop concepts for municipal implementation [4,5].
- Transfer tools compose of directives, brochures, research and development projects, and funding programmes: the federal level gives a framework paying attention to the pecualiarities: local conditions (e.g. population density, climate, history) within the "Länder" need local solutions.
- Implementation tools guarantee the execution of proposed measures, e.g. in informal planning instruments, like open-space concepts. Local authories again participatively implement „top down translated" policy guideline for UGI. [3] concludes, that "communication with all concerned actors is an essential basis so that participatory and cooperative planning of urban green infrastructure is possible."

UGI infrastructure policy is coined by interdependencies between the local and federal government: the federal government's role mainly is focussed on offering general policy guidelines. The „Länder" and local communities then act upon by means of detailed legislation. All major strategies are therefore passed at federal and implemented at local level. Throughout all these levels, participative processes are integrated into strategies for more urban green.

Findings of this structural analysis of German environmental policy in urban areas then are highlighted in three recent activities, that differ in the extent and implementation of participation due to their purpose and address, but always integrate it.

Communication tools can be explained by the national biodiversity strategy that lists measures to stop the loss of urban bioversity and the "alliance of communities for biodiversity". The latter forms a bottom-up group of local communities that collaborate to enhance urban biodiversity. Example for transfer tools are research projects that offer a toolbox for UGI and aim to adapt orientation values for sufficient supply with UGI. Examples for implementation tools are "Masterplan Green Leipzig" and "Offensive Green Infrastructure 2030" by the Ruhr Regional Association (RVR). Both open-space concepts (funded by federal and Länder level) are exemplarily applying the idea of UGI, paying attention to the most important driver of UGI policy: urban population and its participation.

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ORAL SESSION

A.2.3

Integration of climate adaptation measures in planning processes – A practice-oriented research approach

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Keywords: living labs, transdisciplinary approaches, mainstreaming formal and informel instruments

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In view of the predicted climate changes, the creation of climate-resilient cities is an absolute necessity. In particular, the extent and quality of green and blue infrastructure play a decisive role here. The instruments of urban and landscape planning offer control options to adapt new development areas to the climate at an early stage, to initiate transformations of bioclimatically unfavourable neighbourhoods or to preserve valuable areas. These range from informal planning processes such as urban planning and landscape planning competitions, to formally established development plans, to legislation that regulates the framework for individual building projects that require approval.

The research project "Green City of the Future - Climate-Resilient Neighbourhoods in a Growing City" has taken on the task of examining these instruments and processes for possible integration windows for climate adaptation measures and analysing obstacles. For this purpose, experts from different disciplines and institutions were interviewed and the methodological procedure of the real laboratory approach was followed. The selected real laboratories are urban neighbourhoods of the City of Munich that differ in their urban location, building structure and density, type of use and socio-demographic cross-section. For the work focus of the instrument analysis, it was important that the neighbourhoods were in the process of planning. In this way, the planning steps could be accompanied scientifically and the newly acquired knowledge could be used to carry out the first implementations. The topic area was worked on by a transdisciplinary team of administration and science. The interlinking of practice and theory enabled synergies to be gained that facilitated integration into ongoing processes.

In the course of the surveys conducted, two important principles became clear that apply equally to all planning tools: The holistic and the early consideration of climate-relevant concerns. By holistic, it is meant that all aspects at the different levels should be taken into account. For example, the requirements of green in planning, implementation and maintenance, as well as the services that green infrastructure (GI) can provide for people, climate and nature. The aspect of time aims to take climate-relevant concerns into account as early as possible in all urban planning considerations. The earlier concerns are integrated into planning, the greater the impact and the likelihood that they will also be considered consistently in further planning steps. Depending on the planning instrument, there are different potential integration windows for GI in the further course. When distinguishing between formal and informal planning instruments, it was found that although a high degree of bindingness is an advantage, there is little scope for new content due to the strict and legally prescribed procedure. In addition, a high expenditure of time and human resources was criticised.

Obstacles at various levels mean that climate adaptation measures are not sufficiently taken into account by GI. It should be noted, however, that the greatest obstacles to the expansion, maintenance or qualification of green and blue infrastructure are less evident in the planning tools available. According to Brasche [1], the instruments are available, but the potentials have not yet been used. It is more often the case that priorities are set in the planning process when weighing urban planning concerns that counteract or contradict climate concerns. At present, the politically ambitious goals of creating more (affordable) living space are given priority, which leads to tensions and conflicts of goals.

As an example of the integration of GI into planning processes, this paper presents a real-life laboratory, which first presents the challenges of planning practice and then goes into approaches to solutions that have been tested in our transdisciplinary approach. The linking of practical experience and science in transdisciplinary research projects generates interactions that not only have a positive effect on the knowledge base of the parties, but can also accelerate transformation processes.

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On a path to urban green infrastructure? Changes in green space planning approaches in selected European cities between 2014 and 2020

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Urban green infrastructure has emerged as a concept to valorise the multiple benefits of urban greenery for city dwellers. In the European context, the concept has been discussed since a decade in the pursuit for innovative green space planning and governance. The European research project GREEN SURGE started in 2013 and gathered data on green space planning and governance in cities across Europe and developed concepts, recommendations and guidelines for using green infrastructure as an innovative concept for urban greening [1]. In 2014, the state of affairs in green space planning and governance was studied in 20 European cities within the frame of GREEN SURGE, revealing the diversity of European cities and their activities but also commonalities such as struggles to protect green spaces from densification, to combat the effects of climate change or for more inclusive and just decision-making processes [2].

Today, public awareness of environmental challenges such as climate change or biodiversity loss has risen, increasing the popularity of urban greening and giving tailwind to concepts such as green infrastructure. Against this background, it could be assumed that green space planning and management is also gaining in importance within the municipal system. However, path dependencies, budget and staff shortages, competing spatial claims, and other constraints may prevent stakeholders responsible for urban greening to gain sufficient public support for translating into real changes on the ground.

By reinvestigating eleven of the twenty GREEN SURGE case study cities, we aim to shed light on the question if and how green space planning and governance have changed. The results from the GREEN SURGE project provide a unique opportunity for such a comparison as this study provides the most comprehensive and in-depth information on green space planning and governance of European urban areas to date. Moreover, there is a great deficit of longitudinal studies in planning research that would allow to assess the capacity of planning approaches to respond to changing contexts.

Urban development is an on-going process that is not only shaped by higher-level planning laws and policies but also, as part of municipal planning sovereignty, by responses to changes of local conditions and other local decisions. For this study, we hypothesise that green space planning and governance are reflexive practices which are continuously adjusted in an incremental manner to changes in contextual factors. However, municipalities might greatly vary in flexibility and responsiveness as well as supporting framing conditions to allow for more rapid and/or profound transitions. We aim to identify factors that helped to adopt new approaches for green space planning and governance and also those that hinder transformation of green space planning and governance. Consequently, our study will help to identify patterns and variations of reflexive green space planning and governance in Europe.

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ORAL SESSION

A.2.5

Proposal of planning standards for green public spaces as a tool supporting sustainable development of housing estates. The example of Wrocław, Poland.

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Keywords: green public spaces; housing estates; standards; urban planning and development

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The implementation of the idea of a compact city must be combined with a very rational management of space and provide a sufficiently attractive housing environment to prevent the escape of residents from the city and excessive development of buildings in peri urban areas. Therefore, one of the key aspects of sustainable planning of urban settlements should be the provision of accesibility to green public spaces. Many studies in recent years indicate that the opportunity to make use of green spaces affects both human well-being and encourages a variety of physical activity and social contact behaviours [1, 2]. The frequency of using green public spaces is determined by many aspects, e.g., amenities, security and the proximity defined by the distance from the place of residence.

Adoption and proper use of standards can be an effective tool supporting the planning of green public spaces in urban landscape. They define the hierarchy of green public spaces, their basic program and the service radius / the catchment area [3].

The standards of green public spaces were used in Poland in the planning of housing estates from the 1970s and 1980s. Since the change of the planning system, Polish regulations have no longer defined the issue of public green spaces in residential areas. The type, distribution and area of green public spaces are specified in spatial development plans. Polish scientists and practitioners, however, emphasize the need to create standards as tools supporting local planning and sustainable development of housing estates [4, 5].

The aim of the research is to analyze public green spaces – parks and squares – in the context of the building development in selected housing estates in Wrocław and to assess their pedestrian accessibility.

The studies were conducted using: publicly accessible database of topographic objects BDOT10k updated for 2018, orthophoto map 2020 made on the basis of digital images acquired in the 2nd – 3rd quarter of 2020, with field resolution of 25 cm/pixel, planing documents (local spatial devemlopment plans and a study of conditions and spatial development).

The research was carried out using GIS applications and network analyzes [6]. The following ranges of pedestrian access have been adopted: for areas up to 2 ha – 400 m and for areas from 2 ha to 5 ha – 800 m and over 5 ha – 1200 m.

The study revealed a non-uniform distribution of public green spaces within the surveyed areas, as well as a scarcity of developed green spaces. The development of buildings and infrastructure is ahead of the development of green infrastructure. Local spatial development plans provide for an increase in public green spaces – parks and squares, but their distribution does not ensure equal accessibility to all residents.

The research results offer guidelines for planning and spatial development and justify the need to introduce a standard for planning public green spaces in Wrocław. This will allow for a more effective implementation of the policy of planning sustainable housing estates adopted in Wrocław – equipped with public services and spaces, as well as green public spaces.

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Public's concerns about zonal urban plans: a focus on urban green spaces

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Keywords: public participation, SOM, urban green spaces

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Public participation is an essential process in urban planning initiatives in order to reach a consensus between urban planners, policy makers and the public on issues linked to local urban development. This study aims to better understand the public needs in terms of planning the urban space by exploring the content of online public comments. We identify the general, most frequent and most related topics, along with their distribution through time using Bucharest's zonal urban plans as a case study. We assessed 2696 online public comments (2005-2020) submitted for 228 out of 1148 zonal urban plans. We used the Self-Organizing Maps (SOM), an unsupervised artificial neural network to visualize and cluster the online public comments based on their content. Using these method, thirteen clusters show the general landscape of topics in the online public comments for Bucharest's zonal urban plans. These reveal three frequently discussed issues among the public: urban green spaces (i.e., developing new green spaces), administrative (i.e., lack of confidence in the decision-making process) and cultural issues (i.e., preserving the cultural heritage of the city and protecting spaces with historical importance). When assessing the distribution over time of the main topics in the online public comments we noticed a more involvement of citizens in the past years along with an increasing interest on issues related to urban green management of the city. We further discuss the importance of urban green spaces for people's wellbeing and sustainable urban development and advocate for integrating such visualization methods as SOMs into urban management.

Acknowledgments: This work was supported by the Romanian National Authority for Scientific Research UEFISCDI grant number PN-III-P1-1.1-TE-2019-1009.

ORAL SESSION

A.2.7

A ride through four landscapes. Creating urban green infrastructure by regenerating the old Piacenza railway route

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Keywords: green corridor, nature based solutions, territorial regeneration

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The paper is about the creation of a green infrastructure that crosses 4 different landscapes thanks to the reconversion of an old railway route in the Piacenza province [1]. The Piacenza-Bettola, a former and dismissed railway path, is recovered, restoring its historical value in a modern key, in the wake of the growing phenomenon of greenways. The old path, that is long 35 km, crosses part of the territory of the Piacenza province that is called Val Nure, which takes the name from the river Nure.

Reconverting this old path, the project aims to create a new infrastructure for slow mobility capable of connecting the historic centre of Piacenza with the mountain system of which Bettola is the gateway, inserting itself into an existing system of pilgrimage routes, cycle paths and gastronomic and trekking itineraries. This new corridor not only represents an alternative route to the conventional road system but constitutes the backbone that crosses the Val Nure and leads the visitor to get to know the territory by discovering points of interest and particularities. This new greenway will boost a new form of slow tourism thanks to the reconversion of the old railway path in a new rail trail that will assume a regional importance because it connects trasversally three main systems represented by the po river and its ciclovia del po and Via del Pellegrino, the hills and their gastronomic itineraries and the mountains and their trekking itineraries (figure 1).

However, the project works as a green and vibrant ecological corridor that provides an opportunity to regenerate the surrounding areas thanks to the implementation of nature based solutions [2] that will help in creating a multi-scope, multi-functional, multi-benefit and multi-scale urban green infrastructure. Since the territory crossed is very rich and varied both in term of land use, naturalistic elements and cultural heritage, is possible to identify four different landscape. The different landscapes of the Val Nure crossed by the new corridor, to be precise urban landscape, rural landscape, cultural landscape and wet landscape, which are now fragmented, will be "mended" thanks to an urban area in order to support the urban ecosystem service and to solve some challenges related to water treatment management, on site infiltration, reduction of air and noise pollution and the enhancement of sociability. ecological approach that respects their vocations and their different habitats. Different actions are implemented in the Regarding the rural landscape, where the main isuues are related to the intensive agricultural activities, the actions are mainly aimed to improve soil quality and food production quality while providing ecological continuity and reducing agricultural pollution. In the cultural landscape instead, since there are not particular environmental issue and its strenghts stay in the amount of naturalistic and cultural elements that are present, are provided some actions to improve knowledge and boost people engagement.

The idea takes its first step from a growing fenomenon, the greenways, and become an occasion to develop a model of territorial regeneration both in terms of environment and economy, thanks to the creation of a proper green infrastructure that sees the landscape and the cultural identity at the centre. This new urban green infrastructure has the aim of reviving historical memory, enhancing the landscapes and rebuilding the relationship between man and nature by celebrating biodiversity and historical heritage.

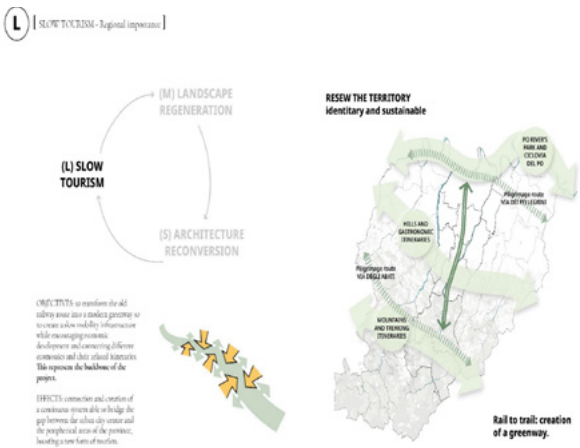

Figure 1. Connections of ecosystems thanks to the reconversion of the Piacenza-Bettola former railway line into a greenway, inside Piacenza province's territory

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Park availability, accessibility, and attractiveness in relation to the least and most vulnerable inhabitants

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Keywords: urban parks, barriers, environmental justice

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The main goal of this paper is to investigate which groups of inhabitants (the most or the least vulnerable) live around parks depending on the availability, accessibility, and attractiveness of those parks. The novelty of our approach to studying environmental justice resides in explicitly distinguishing between the above three levels of urban green space provision. After all, parks may be available to urban residents (they may live close to parks), but for various reasons these parks may not be accessible to them, or the parks which are available may not be attractive enough to meet the nearby inhabitants' needs.

The paper deepens the ongoing debate on urban environmental justice by proposing and testing a novel research approach to study urban green space provision. We explicitly distinguish between three levels of park supply: availability, accessibility, and attractiveness to capture related more nuanced picture of unequal park provision in the city (compared to the approaches followed so far). We focus on socioeconomic differences between different groups of inhabitants, and specifically on the supply side of park provision.

Following a large body of environmental justice literature, our research hypothesis is that the most vulnerable groups of inhabitants (typically with lower socioeconomic status, children and youth, older adults and seniors) concentrate around parks (if they live nearby at all) whose provision is affected by the largest number of barriers at each of the three levels (availability, accessibility, and attractiveness). That is, the most vulnerable inhabitants live around parks endangered at the first level (availability), their accessibility to parks is relatively worse (e.g., they live in less safe neighbourhood of parks), and also live close to the less attractive parks (in terms of park size, infrastructure, leisure equipment and water reservoirs, as well as due to noise and air pollution). Meanwhile, the least vulnerable (those with higher socioeconomic status) benefit from parks rated better on all three levels – availability, accessibility, and attractiveness.

We studied correlation between the indicators of three levels of UGS provision (availability, accessibility, and attractiveness) and the indicators representing the most economically vulnerable, the least economically vulnerable, and age groups of residents (children and youth, adults, older adults and seniors) using Pearson's coefficient. Correlations were calculated for all parks and all SA variants, respectively: SA 200 m for small green squares; SA 400 m for medium parks; SA 800 m for large parks, and SA 1200 m for very large parks. Moreover, we analysed the sensitivity of the results by performing additional correlation analyses for different variants of park size and SA ranges. Apart from the statistical analysis covering all parks and the whole city area, we analysed three case studies: Mickiewicz Park, Poniatowski Park, and the combined complex of 3rd May and Baden Powell Parks.

In Lodz, even the most vulnerable groups (recipients of welfare benefits, unemployed) are quite well represented around parks and enjoy good park availability, but the most vulnerable groups have access to parks with a large number of barriers affecting their attractiveness. Moreover, availability of parks for older adults and seniors is limited. However, the results do not indicate large inequalities among the extreme socioeconomic groups of inhabitants in our case study city, which seems to be due to the specificity of the postsocialist and postindustrial legacy of our case study city, with chaotic spatial planning, unequal distribution of parks, and with no clear socioeconomic segregation. To provide more straightforward results, our research approach should be tested in more explicit city contexts that are typically studied in the context of urban environmental justice (with higher segregation, and stable and developed planning contexts).

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ORAL SESSION

A.3.2

The value of urban nature for health and well-being: An empirical study in three Central European cities

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Keywords: ecosystem service; recreation; urban green; green infrastructure; interviews

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The quality of life in our cities depends critically on the planning and shaping of urban living space. Health is one of the most important constituents of human welfare in this context and a key factor of sustainable development. Urban nature contributes essentially to the wellbeing of city dwellers and plays a major role in the avoidance of frequent diseases since it makes a good impact on physical and mental health. Because it is not possible to directly observe or measure in particular the psychological well-being, it was necessary to ask the concerned persons for a self-assessment. We obtained opinions on and ratings of different greenspace types by face-to-face interviews. These interviews have been conducted in 2018.

Surveys among more than 700 people were carried out in Dresden (Germany), Liberec and Děčin (Czech Republic) in order to find out and compare how the respondents experience and value the effects of urban green spaces to their wellbeing/health status. The questionnaire has been applied respectively in German or Czech language. It consists of three parts: first, an introduction part with information about the area where the interviews took part; second, to inquire the people's perception and appreciation of urban green in general; third, to ask for additional socio-demographical indications. The results prove the high valuation of urban green for preventative health care. The majority of 235 respondents in Dresden stated among others that they feel more relaxed (81 %), happier (70 %), physically better (68 %), more energetic (51 %), and able to concentrate (44 %) after spending time in urban green. The interviews in Liberec took place in seven green spaces and reached 275 persons, the survey in Děčín was performed in seven green spaces with 209 respondents. Prime differences between the cities occurred regarding the preference of green space types, which are forest in Liberec, but park sites in Dresden and Děčín.

The results show a high appreciation of urban green space for well-being and mental health, confirming a positive beneficial impact on physical health as it is perceived by the people who use urban green spaces. Time spent in urban green space helps them to relax, enhances their well-being, enables rest and recuperation while refreshing and promoting social contacts. Near-natural (i.e. less intensively maintained) green space with safe, clean and accessible pathways as well as water bodies is the most preferred type. Frequent maintenance measures are viewed rather critically. In addition, we found some specific differences in the appreciation of other forms of green spaces depending on the country and city.

It is particularly important if urban green is in close proximity to residential areas. Distant green spaces which are very well-known and offer diverse features may also be preferred. However, the length of stay and frequency of visits are not directly related to the level of appreciation, but rather to the location, size and facilities of green spaces as well as the aim of the visit, i.e. for some specific purpose (relaxation, fitness, etc.) or merely as a pathway to somewhere else.

The most popular types of green space are urban forests, public parks and water bodies. The inhabitants particularly like those green elements that are characteristic of their city. Further, the repair of broken equipment could significantly improve the urban quality of life. The appreciation of urban green varies depending on the age or typical habits of residents. Thus public parks are particularly important to the elderly as well as young people and families. For middle-aged individuals, urban forests are the most popular form of green space. Water bodies are highly rated by almost all age groups, with a slight drop in appreciation by the elderly. On the other hand, older people, who may be unable to travel to more distant parks or forests, enjoy street trees, street greenery and fountains. Young parents appreciate the availability of playgrounds and complain when such play or sports facilities are lacking. Urban planners and politicians are urged to enhance and connect green space in their cities rather than develop these valuable areas for residential, commercial or transport purposes.

Acknowledgments: The research was funded by EU project BIDELIN. Thanks go to the numerous student assistants who helped us with the surveys, and of course to the citizens in Dresden, Liberec and Děčín who made the effort to patiently answer our questions. Many thanks for assistance with the layout of the maps and illustrations to Sabine Witschas and Ulrike Schinke.

Green areas use during a lockdown in Croatia caused by a Covid-19 pandemic.

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Keywords: citizen perception, urban green space, lockdown

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Over the last year we have witnessed a COVID-19 pandemic caused by the SARS-CoV2 virus that has spread around the world unexpectedly fast. Beside the health aspect of the human population a pandemic also affected the entire social and economic situation and relations around the world [1], [2]. The temporary closure of educational institutions and many service industries almost all over the world marked the first wave of the COVID-19 pandemic. In Croatia first wave started on March 16, 2020, when the Government of the Republic of Croatia issued the decision on suspension of teaching in higher education institutions, secondary and primary schools and the regular operation of pre-school education institutions and the establishment of distance learning. Physical distancing was among the most promoted measures aiming to slow down the spread of the virus [3].

The intensity of daily migrations has decreased, and many citizens have spent their days inside private housing. We were interested in whether the citizens used green urban areas in that period. The reasons, motivation, categories of green areas and the frequency of visits during the lockdown were examined and the obtained results were compared with the use of green areas by the same citizens in the period before the pandemic. The research was conducted through a web questionnaire in Croatia. City parks are the most visited category of green spaces before and during the lockdown. In order to avoid meeting other people there was an increase in the use of green areas outside the city and the use of riverbanks.

Beside use of green areas before and during lockdown, we assessed general thoughts on urban green areas, they showed that maintenance of existing as well as planning of future urban green areas are very important to respondents regardless of them living in village, small or big cities. Most respondents emphasized the importance of having the nearest green area within a radius of 300 m from home. Respondents from villages were more content with the aesthetic side of green areas they are visiting, than city residents. City residents stress the importance of having accessible public green space, as village dwellers prefere presence of private green areas. Both would like to improve waste collection in the green areas they frequently use. Frequently suggested improvements that respondents shared included a wish of more green areas, more trees, better maintenance, more care for older trees and better facility infrastructure inside the green areas (dog parks, children's playgrounds, sports equipment benches, tables and waste bins). Respondents also shared dissatisfaction with tree topping, frequently used pruning technique, which shows deeper understanding of urban green spaces.

The research showed the importance of urban greenery in the everyday life of citizens, as well as in times of crisis. Interestingly, the number of green area users increased during the lockdown, which also confirms to us the importance of urban green spaces. The collected data enabled a better understanding of the use of green areas in general and the perception of the same by citizens.

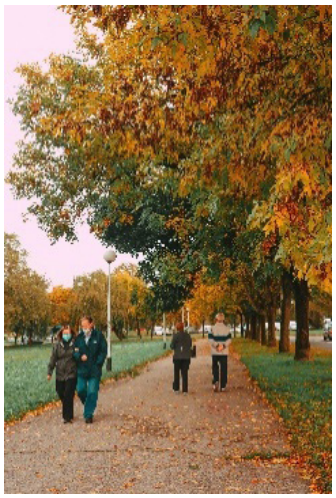

Figure 1. Use of urban park in Zagreb, Croatia

Acknowledgments: This work was supported by Croatian Science Foundation, project „Improving green infrastructure planning and management through participatory mapping of cultural ecosystem services" (CULTUR-ES), grant number UIP-2017-05-1986, and project „Career development for young researchers – training of new doctors of science" (DOK-2020-01-6490)

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ORAL SESSION

A.3.4

Urban informal parks. Attractiveness of Warsaw wastelands in their user's eyes

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Keywords: urban greenery, photovoice, bottom-up facilities

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Informal green areas are valuable both for natural and social reasons. The aesthetic attractiveness of undeveloped areas in cities in the eyes of their users has not been studied so far. The Warsaw wastelands studied by us extend the typology proposed by researchers [1] with an additional type that could be described as bottom-up recreational areas, informal parks.

Researching the aesthetics of greenery and wastelands, with particular emphasis on the objectified, pre-reflective choice by users of the preferred aesthetics of recreational areas, one can recall the works concerning city parks (designed and arranged greenery). Wastelands used informally and bottom-up organised sites, similar to parks, are rarely studied [2], [3]. The results of the presented research allow us to expand the knowledge about the aesthetic attractiveness of wastelands, which so far focused on the assessment of individual aspects: general ecological values [4], the stage of natural succession [5], biodiversity [6] uses [7], role of microinterwentions [8] and the comparison of preferences between formal and informal greenery [9].

Figure 1. The scenery of an informal meeting place in a wasteland by the Vistula river in Warsaw (B.J. Gawryszewska)

The research question is how the inhabitants of Warsaw prioritise individual elements of informal greenery. The research results show that there are regularities in the way such spaces are perceived. Combining several preferred landscape features, we also identified places considered beautiful and desirable (hotspots).

The study was carried out on 25 undeveloped green areas located in 9 districts of Warsaw. The data received using the photovoice method (Visitors Employed Photography [10]) were interpreted both qualitatively and quantitatively: based on the pool, preferred phototypes were determined, and the structure of aesthetic preferences was developed; a quantitative heatmap analysis was performed to determine the selected phototypes' spatial dispersion and cluster analysis.

The results show the preference of scenery with bottom-up recreation areas and various forms of vegetation and panoramas with a deep view.

Acknowledgements: This work was a part of the project "Inventory and valorisation of selected degraded and polluted areas in Warsaw - natural and social potential of wastelands", co-financed under the Operational Program Infrastructure and Environment 2014-2020, a project commissioned by the Department of Urban Greenery, Municipality of Warsaw.

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Socio-cultural assessment of importance of ecosystem services around greenspaces in rural-urban gradient of Bengaluru, India

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Keywords: green infrastructure, photo-elicitation, socio-cultural preferences

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Urbanization is a major anthropogenic process with often irreversible impacts on wellbeing of a society. With the increasing trend of urbanization globally, there are ongoing discussions on roles of green infrastructure to solve societal challenges. Though existence of greenspaces mostly decreases with increase of degree of urbanity, and the intensity is even worse in megacities of Global South such as in Bengaluru, Bengaluru is still relatively 'greener' than many other cities in the Global South. Tree species in Bengaluru have a specific local purpose and meaning that are shaped by cultural backgrounds and livelihood of the residents. However, dynamics of multiple ecosystem services or disservices (ES/ED) provided by the greenspaces and their synergies or trade-offs along rural-urban gradients are less explored.

Using the five most common types of greenspaces in Bengaluru (domestic greenspace, farm greenspace, street greenspace, platform greenspace and temple greenspace), and considering three tree species that are commonly chosen for its design locally, we carried out a photo-elicitation survey to assess the relative importance of the different greenspaces for ES/ED supply as perceived by the local community. To do so, we used different sets of photographs depicting those greenspaces with different tree species, and surveyed 648 residents from 61 villages across two transects along the rural-urban gradient. We explored the association of perceived importance of ES/ED for the different greenspaces based on socio-demographics factors (e.g., gender, age, caste, migration origin, income sources, religion and education levels) and assessed the potential influence of tree species choice for the greenspace in its importance for the local community. To do so, we employed ordinal regression models. Our results contribute to a better understanding of the use of greenspaces in rural-urban dynamics and inform relevant policies. Understanding the association of the differences in the uses the greenspaces by different groups of people would facilitate inclusive management, policy making and governance of the greenspaces.

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ORAL SESSION

A.3.6

Socio-spatial analysis of distribution and accessibility of Vienna's Municipal Parks

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Keywords: urban green spaces, parks, equity, environmental justice

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Introduction and research objectives

Throughout the past four decades, research in the field of Environmental Justice has shown various socio-environmental inequities. Among others, urban green was identified as unequally distributed and accessible public good. Multiple factors such as social class, ethnicity, and age proved decisive. By providing ecosystem services, the so-called green infrastructure is a crucial component for human well-being in urban areas, though. Especially municipal parks offer a broad range of urban ecosystem services to the general public. To enjoy and benefit from such services, individuals predominantly have to frequent green spaces personally. Therefore, the uneven spatial distribution and accessibility of green spaces in general and parks in particular poses a major challenge for urban planning and the management of sustainable green cities worldwide.

The proposed talk discusses the revealed socio-spatial inequities in municipal park access between the 23 districts of Vienna. Being repeatedly elected the most liveable and greenest city in the world, the capital of Austria is known for its excellent green infrastructure. In the light of former findings [1], however, the question arises: Which social groups actually benefit from it?

Apart from an extensive mixed-methods enquiry, which uncovered the spatial accessibility of all public green spaces in 2013-15 [2], research on Vienna's municipal parks is still limited. Placing the present study at the interface between Urban Ecology and Environmental Justice, its objective is to address this research gap by conducting a network buffer analysis that includes the socio-spatial accessibility of municipal parks. The following research questions are addressed:

RQ1: How equitable is the distribution and accessibility of Vienna's municipal parks?

RQ2: Which districts and social groups suffer most from their lacking supply and accessibility?

Materials and methods

All relevant parks i.e. public green spaces were identified. All public park entry points were located and mapped with Esri ArcGIS Online. The resulting data provided the basis for the subsequent examination of the spatial park distribution and accessibility. A network buffer analysis was carried out in combination with the ArcGIS Online Walking distance tool which bases upon the footpath and road network and thus depicts the spatial catchment area of each park realistically. In accordance with empirical findings and recommended accessibility standards for larger parks in Western Europe, three buffer zones were determined for an overlay analysis that intersected the seven socio-spatial clusters from the Vienna Social Demographic Atlas.

Results

Results indicate that the uneven spatial distribution of municipal parks correlates with Vienna's social structure. The socio-spatial catchment areas, illustrated in Figure 1, suggest that Cluster III households – above all single-person households, childless families, and young adults – benefit most from a close proximity to parks. Whilst this particularly affects the inner districts, peripheral parks predominately supply the elderly population without a migration background (Cluster I) and well-off families with children (Cluster II). The economically disadvantaged clusters IV to VII are not excluded from proper park access either. Quite the contrary, some of them benefit from short walking distances to municipal parks. Therefore, no socio-spatial park access gradient became apparent within the catchment areas. Likewise, nationality and ethnical background proved to be insignificant variables.

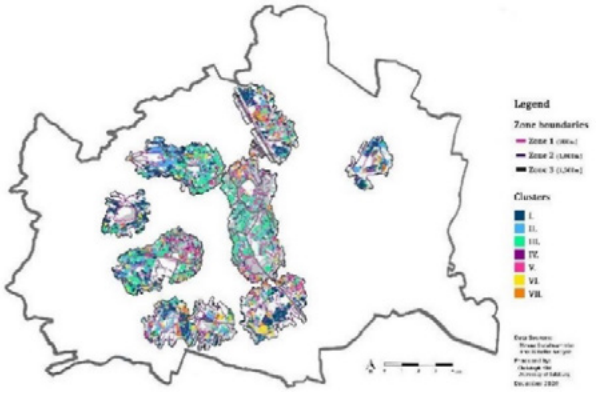

Figure 1. Socio-spatial catchment areas of Vienna's municipal parks

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10 years of green infrastructure research: a review on strategies and tools to suppport its operationalisation

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Keywords: instruments, guidance, mainstreaming

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Green Infrastructure (GI) has been identified as a promising concept for the ecological, social and economic regeneration or urban and peri-urban areas by creating open spaces for recreation, cultural activities and urban farming, which in turn promote health, social cohesion, new green jobs and climate change adaptation [1]. In the last 10 years, this concept has gained increasing attention in research as research publications on GI have grown steadily in this time (see Fig. 1).

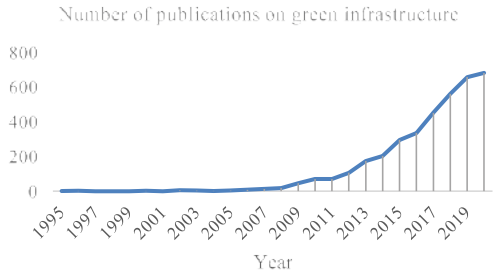

Figure 1. Number of publications on green infrastructure from 1995 (first mentioning of GI) until 2010 (Source: Scopus)

European research projects, such as GREEN SURGE, and the European Strategy on GI [2,3] promoted the uptake of the concept in research and practice by defining the concept, affirming its benefits and providing guidance. Many European cities apply in their planning practice the GI concept or its underlying principles: multifunctionality, connectivity, green-grey integration and social inclusion. Yet, GI development requires a strategic process, which involves a variety of actors and agencies representing a multitude of interests, often competing and conflicting, on different scales [4]. Therefore, it is specifically in the operationalization of GI, where social, administrative and political structures need to be considered, and where many barriers hamper the process [5,6]. Despite the increasing body of knowledge on GI, knowledge on the process of GI operationalization still seems underrepresented in research, while guidance for supporting the process seems scarce, scattered and one-sided and lacks attention on social and relational aspects [7].

With this study, we look into the strategies and tools, as these aim to provide concrete guidance for GI operationalization. Next to gaining insight in how well strategies and tools are considered in GI research, we want to identify the type of strategies and tools that are suggested and applied as well as which barriers they address. In addition, we intend to examine how the use of these strategies and tools links to different governance contexts.

As part of a larger review, we conducted a search on peer-reviewed research and review articles in the SCOPUS and Web of Science databases by using the combination of keywords "green infrastructure" and "planning OR approach" in title, abstract or keywords for publications in English for 2010-2020. We filtered out duplications and non-refereed publications. From the resulting list of publications, we selected those focusing on the operationalisation of GI in planning processes. From these publications, we extracted strategies and tools for GI operationalisation. The publications were further analysed for the barrier(s) these strategies and tools address as well as the scale and further indicators of the procedural context such as type of planning approach (e.g. bottom-up, top-down, strategic, ad-hoc) and level of inter- or transdisciplinarity. The review results were critically examined through comparison with existing strategy and tool classifications [e.g. 8,9].and with literature on the needs for GI implementation and governance in practice.

Based on the review, we could identify that strategies and tools are only recently received attention as important steps in GI operationalisation. We propose a classification for strategies and tools for GI operationalisation, which includes strategies and tools supporting social and relational approaches and links them to barriers to GI operationalisation. Such a classification can support researchers and practitioners in considering the full perspective of strategies and tools to select the adequate instruments in relation to their needs. We conclude with recommendations for further research to promote strategies and tools in GI research, practice and different governance contexts.

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ORAL SESSION

A.4.1

Patterns of green infrastructure use in cities using Social Media

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Keywords: Urban green spaces, green infrastructure, parks, use, social media

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Urban green spaces such as parks provide ecosystem services which are particularly important in the context of challenges from climate change and urbanisation. Accordingly, many studies exist that show park visitation patterns using observations or questionnaire surveys. These studies are often case specific and address a particular point in time. To provide a more holistic picture on what park visitors enjoy in particular park settings and what they potentially miss, social media data are recently used as a new tool to provide more in depth data.

The main objective of this research is to review how social media data have been applied for the assessment of green space/park use. Using the Prisma method as a structured way of literature reviews, we analyze (See Figure 1) the existing literature on park use in cities using social media data. ScienceDirect and Web Of Science databases are used as search engines with the keywords: „urban green infrastructure", „urban parks", „social media", „Twitter", „Google reviews", and others. The initial screening identified 290 records that matched the searched keywords. After reducing duplicates, further in-depth screening, and full article analysis, 25 papers were left for final analysis. The results show that the topic is still relatively new, but the attention is increasing.

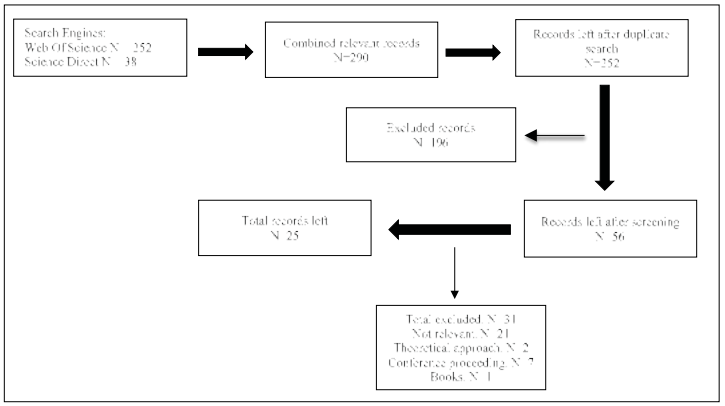

Figure 1. Prisma method scheme

Initial findings show that social media data include more "honest answers" about park use and perception. Data is provided over entire years and is not restricted to particular seasonal periods. Still, a number of limitations appear such as lacking socio-demographic information, potential biased data on social media use by age groups.

We conclude that social media data may be used to evaluate holistic visistors perceptions of different parks, e.g. which factors are essencial for park use.

Investigating park visitors' perception and vegetation preferences with the help of a photo-based mobile application survey method

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Through their ecosystem services, public urban green spaces - especially urban parks - largely contribute to the quality of life and well-being of city dwellers [1]. While many of the positive effects provided by these green spaces (e.g. dust removal, climate mitigation or shading) prevail regardless of human attitudes, certain values (e.g the various types of cultural ecosystem services) are largely dependent from human perception and preferences, thus their proper assessment in many cases can require social scientific approach.

As one of the three major components of green space provision (besides availability and accessibility) [2] [3], the attractiveness of green spaces is also influenced by human demands shaped by the local communities' green space preferences. In the interest of increasing the attractiveness of urban parks or other types of urban green spaces, understanding human attitudes towards green spaces with different vegetation structures, as well as the common perception of other attributes connected to vegetation (e.g. heterogeneity, safety, openness or naturalness) is a highly important issue in the fields of landscape ecology and landscape planning.

In this present study, a photo-based field survey method in the form of a mobile application called Park Survey [4] was used to assess vegetation preferences of university students in Elizabeth Park, one of the biggest and structurally most diverse urban parks in Szeged, Hungary. The same survey was carried out in both 2017 and 2019. Both statistical and geoinformatic assessment methods were applied to the survey results to analyse connections between respondents' scores, ass well as the content and geographic location of their photos.

According to the results, the most preferred structural vegetation type within Elizabeth Park is the dense forest-like vegetation. Further analyses of the data imply significant statistical connection between overall preference and perceived heterogeneity, as well as between perceived safety and perceived openness.

Acknowledgments: This research was supported by grant NK-FIH-1279-2/2020 of the Ministry for Innovation and Technology.

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ORAL SESSION

A.4.3

Planning and governance for sustainable climate-resilient public open urban spaces and streetscape

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Keywords: green infrastructure, public spaces, urban planning, Vienna

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Hotter summers and frequently recurring hot spells are prompting changes in the demands placed on the design and infrastructure of public spaces in cities. The necessary adaptations include unsealing, greening, providing water elements and (structural) shade.

Drawing on the city of Vienna as a case study, this paper examines the opportunities and potential of strategies, tools and measures used to create climate-conform urban places and streets through the use of green and blue infrastructure.

Important strategies have been defined in various planning concepts. The "Public Space" concept was adopted in 2018. This set out a plan of action such as the planting of 10,000 trees by 2025 to ensure that people can still use streets and squares, even on hot days. Another key framework is the Urban Heat Island Strategy Plan (MA 22, 2015), which provides a good practical overview of the effectiveness of green and blue measures to make open urban spaces more adaptable to climate conditions.

As a vehicle for implementation, the "InKA - Infrastructural Measures for Climate Change Adaptation" programme was launched in 2018 in the Competence Centre for Green and Environmental Infrastructure (under the city council directorate of Buildings and Technology). A number of funding streams, namely "Cool Streets Plus" and "Cool Districts", created an increased incentive for urban district policy to incorporate the implementation of cooling measures in public spaces from early 2020 onwards.

This paper will introduce the different planning scales (strategic to implementation level) which are important for sustainable implementation of green infrastructure planning.

It will show the importance of the knowledge and competences of the different stakeholders involved on strategic and implementation scale (Ring et al. 2021).

This contribution aims to explore the potential of transdisciplinary approaches and tools to plan and design climate-resilient public spaces as important amenities for climate just city.

Acknowledgements: This work was supported by the City of Vienna.

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Assessing urban ecological space's resilience based on ecosystem service supply and demand matching: taking Shanghai as an example

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Keywords: urban ecological space's resilience, ecosystem service, supply and demand matching

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Urban ecological space plays an important role in urban comprehensive resilience building, as the multiple kinds of ecosystem service which provided. However, academic community have pointed out that ongoing policies and planning practices pays not enough attentions to the resilience of urban ecological space itself.

This study firstly defining the concept of urban ecological space's resilience and discusses its significance on urban social-ecological system. Considering the bridge role ecosystem service playing between urban social subsystem and ecological sub-system, this study proposed a method to measure urban ecological space's resilience through the supply and demand spatial matching of ecosystem service. It puts forward the urban ecological space resilience grade comparison table based on the ecosystem service supply and the matching separately on type and quantity. This study, comprehensively adopting InVEST model, evaluation matrix and other methods, combined with multi-source data such as land cover data, mobile phone signaling data and satellite imagery under the platform of ArcGIS, measures the indicators of Shanghai's ecosystem services supply and demand, indicating the urban ecological space with resilience in grades of high, low and to be further observed based on the result of ecosystem service supply and demand matching.

This study will contribute to provide reference for optimizing the distribution of urban ecological space in the city, making balance between meeting the demand of citizens and maintaining ecological security and ecosystem conservation to achieve a final social-ecological resilience of the city.

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[2] The Shanghai Municipal Science and Technology Commission Project fudning, Grant Number 17DZ1203200.

ORAL SESSION

A.4.5

Green and blue infrastructure as part of a landscape strategy for innovating the municipal spatial planning in Portugal

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Keywords: Green and blue infrastructure, Landscape Strategy, Innovative spatial planning

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In Portugal it is recognised that spatial planning and governance need to be reviewed and updated to respond efficiently to challenges such as those of territorial cohesion, technological, economic and social transformations, loss of biodiversity and the environmental and pandemic crisis.

From the work of revising the National Programme for Spatial Planning Policy, approved by Law No. 99/2019 of 5 September, which constitutes the reference framework for the other territorial programmes and plans and as a guiding instrument for strategies with territorial incidence, the need to adopt new approaches to sustainability, capable of responding to current territorial challenges, has become evident.

The Municipal Master Plan, as a mandatory instrument that establishes the municipal territorial development strategy and the land use and occupation regimes, is a fundamental piece of the territorial management system, providing the reference framework for planning at the municipal level. Recently guidelines have been published for the integration of innovative themes that respond to climate change adaptation, valuation of ecosystem services, landscape quality, flexible transport in low density territories, circular economy, sustainable use of rural land and, finally, economic-financial sustainability (1).

In 2017, the Municipality of Braga adopted the methodology contained in this guidance regarding the landscape qualification in the review of its Municipal Master Plan, in accordance with the legislative changes that require a revision to adopt the new concepts of rustic and urban soil.

The municipality of Braga, is located in northern Portugal, with a population of 182,299 inhabitants, a density of 994 hab/Km^2 and an average of GDP growth rate of 4.1% (1% higher than the average growth rate of the Iberian Peninsula), being the 3rd largest exporting municipality in the country, and with average annual employment generation of over 2000 jobs since 2014, very much on the basis of R&D.

One of its problems results from the fragmentation of the landscape due to the inconsistent urban and industrial expansion along with a forest simplification process that implies a high fire risk. Due to its morphological and climate condition the urban area is exposed to significant hot waves, which implies efective strategies on climate change adaptation. On the other hand, historical and cultural heritage is one of the rich components of built and religious patrimony that has been recently by UNESCO.

A Landscape Strategy seemed to be a consistent tool to respond to this weaknesses and strengths in an integrated perspective, as a basis for the identification of new solutions for the PDM Territorial Development Strategy, in order to respond to a new urban agenda where the quality of the landscape is determinant for the quality of life of all those who live or visit the municipality of Braga, especially in a framework of climate change and natural and anthropic risks that threaten health and well-being.

This framework accomplishes with a set of trends and guidelines at European level, namely the Urban Agenda 2030 and the UN SDGs, using examples of processes that are underway in numerous cities where natural-based solutions are constituted as efficient measures in urban management, allowing to achieve results at controlled costs.

As such, this article describes the principles that were at the basis of the definition of the Landscape Strategy and of a green and blue infrastructure as a way of operationalizing the strategic objectives of territorial management. The articulation between the Landscape Strategy and the Territorial Development Strategy in the framework of the revision of a PDM in a mostly urban context is an innovative initiative, insofar as it allows a differentiated perspective of the territory, making compatible a strategic vision of the whole with specific objectives for each of the Landscape Units with their own characteristics and identities. This method facilitates both the adequacy of the regulation of space categories to each of these units, the strengthening of their identity and the development of priorities that will provide a place-based approach towards a more consistent territorial model for the municipality.

Acknowledgments: This work was supported by the Municipality of Braga.

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Where is the forest core area? Gradient of flora in the ecotone of the urban forests

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Keywords: plants, forest habitat transformation, threshold, city, Warsaw

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Forests are very important ecosystems in cities. They perform very important cultural services and have very important regulatory functions, including lifecycle maintenance, habitat and gene pool protection. Unfortunately, despite various activities aimed at preserving biological diversity at various scales, naturally valuable areas in cities continue to decline or undergo irreversible transformations. Hence, it is very important to determine the extent of human influence on forest ecosystems in a highly urbanized environment. In our studies, the level of transformation of flora in different study areas, gradients of changes from edge to core area and threshold distance and threshold straightness between edge and core area were examined on the basis of various indicators of flora. Also the impact of the number of inhabitants, the degree of protection and the area and shape of the forests on above mentioned features were analyzed. The gradients of changes were proven to be rarely linear and showed logarithmic or polynomial shape and the most regular gradients were observed for lability and naturalness of flora. The most regular shape of the threshold was observed for the naturalness index and the least regular shape for the lability index. Threshold distance depends heavily on human influence, the more inhabitants, the greater the level of flora transformation and the border between edge and core zones is deeper. Also the shape and area of the forest is of great importance. The studies have shown that in the case of strong human penetration of the forest, protection in the form of a reserve has no effect. The results of the study are expected to be useful to determine suitable indicators in order to define threshold values, i.e. to define size of forest edge and core zones of urban forests in the context of the potential to protect the plant species pool.

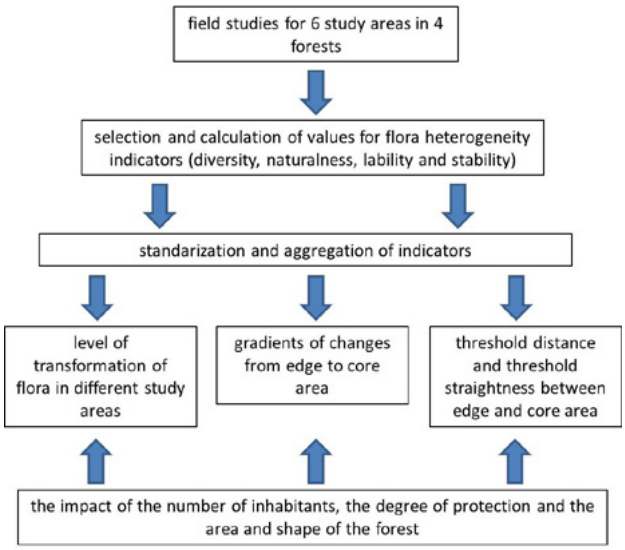

Figure 1. Research procedure

ORAL SESSION

A.4.7

Ecosystem services provided by urban forests in the Southern Caucasus region: a modeling study in Tbilisi, Georgia

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Keywords: urban forests; ecosystem services; Southern Caucasus

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All cities globally are growing considerably as they are experiencing an intensive urbanization process resulting in significant economic, social, and environmental challenges[1]. One of the major risks is the deterioration of living environment in urban areas due to the high soil consumption and pollution of environmental components[2].

For this reason, cities are required to adopt measures to reduce air pollution concentration and CO2 emissions, preserve biodiversity and mitigate the urban heat island effect. In this context, tree planting has been suggested as one cost-effective strategy because green infrastructures can provide important environmental and social functions which contribute to the quality of life and health of city dwellers[3].

Tbilisi is the largest city in Georgia, with a population of over 1,100,000 inhabitants (about 30% of total population of Georgia). Due to its size, the air pollution in Tbilisi is considerable, caused by the large number and percentage of outdated vehicle fleet[4] and the massive construction activities that produce various polluting gases and particulates. The green space availability in Tbilisi (5-6 m^2 per inhabitant) is low compared to other European cities, and in recent years the need to increase the amount of urban vegetation has been underlined at planning level[5].

In our study, we implemented for the first time in an Eastern European city the i-Tree Eco model to quantify the main ecosystem services from common tree species in Southern Caucasus. Two parks, Expo Park (694 trees) and Red Park (1,027 trees) in the city of Tbilisi have been measured and a model simulation was performed for the year 2018.

These urban forests store large amounts of carbon in their woody tissues (198.4 t for Expo Park and 126.5 t for Red Park) and each year they remove 4.6 and 4.7 t of CO_2 for Expo Park and Red Park. They also positively contribute to the air quality by removing 119.6 and 90.3 kg of pollutants (CO, NO2, O3, PM2.5, SO2), and reducing water runoff of 269.5 and 200.5 m^3, respectively.

This analysis highlighted the key role of urban forests in improving the environmental sustainability of the city of Tbilisi and provides important decision support for the tree species selection in this geographic area with the aim of maximizing the benefits trees can supply to cities.

Acknowledgments: This work was supported by Shota Rustaveli Scientific Foundation of Georgia for the research grant provided for carrying out this research. Authors thank Drs Stephan Pauleit, Ruediger Grote, Antonio Castelbranco and Joseph Salukvadze for their valuable advice in research design, Alexis Ellis and Alejandro Zelaya for their support in model data input and analysis; Mr. Grigol Deisadze and Mamuka Mirtskhulava for their input in the field study and the research process; the students of Human Geography at Tbilisi State University for helping in data collection during fieldwork in Tbilisi urban parks.

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Urban green in densifiying cities: joint assessment of microclimate regulation on district and block level

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Keywords: outdoor thermal comfort, green infrastructure, climate responsive design

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Green spaces fulfill an important role in regulating the urban microclimate, however they are under high pressure in growing cities [1]. As much as densification is a threat towards existing green spaces, it also offers the possibility to redesign residential areas in a climate-responsive way [2]. To do so, urban green infrastructure needs to be incorporated from the outset of a planning process and the urban context and mutual influences between different scales have to be considered.

To assess whether densification can be compensated by introducing new green in a real planning case, we compare microclimatological modelling outcomes on city quarter and block level for different densification and green intervention scenarios. We differentiate between increasing building heights and adding additional buildings and distinguish between optimistic and realistic green interventions regarding amount of tree replacement, green roof substrate thickness and green façade employment. On block scale, the focus is set on outdoor thermal comfort while for the district scale, the focus is set on ventilation. For the block scale, microclimate modelling is performed with ENVI-met while for the district scale the meso- and microscale model FITNAH is used. The assessment was carried out for a residential district in Munich for a hot summer day with elevated heat stress.

Our results suggest that green infrastructure can compensate for negative effects of building densification on daytime thermal comfort, but not for impacts on cold air volume flow (CAVF). CAVF is mainly affected by densification – especially by increasing building heights – and not the greening situation. By increasing the building height of existing buildings for additional storeys the impacts on the CAVF reach up to reductions of 37% compared to the status quo. Moreover densification lead to a decrease in the CAVF in neighbouring areas. Strategical placement of trees prevents worsening the nighttime ventilation, while providing effective cooling during daytime. For mature trees PET was reduced by 7.5-7.9°C compared to newly planted tree scenarios. Thus we highly recommend to avoid removal of old trees in densification projects. Adding green roofs and green façades did not result into decreased heat stress levels for pedestrians, but significantly reduced surface temperature of roofs and walls. Besides energy savings, these interventions can provide further ecosystem services such as stormwater retention and air purification.

Based on our results we suggest that the ventilation situation at district scale should be assessed as a prerequisite for microclimate optimisation by green infrastructure to ensure a strategic placement for the implementation of green measures. Our study furthermore highlights that future research should consider coupling of microclimate models operating on different scales and with different spatial resolutions by nesting for holistic microclimate optimisation.

Figure 1. Investigation area on district and block level with exemplary optimistic green intervention setup

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ORAL SESSION

A.5.2

Identifying suitable policy instruments to promote nature-based solutions in cities: a decision tree approach

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The availability, capacity, and distribution of green and blue infrastructure in cities strongly depend on urban planning decisions that regulate spatial arrangement of land uses and functions [1], and are formalised in urban plans and policies, together with the actions, instruments, and rules for implementation. To actually uptake NbS, several options of policy instruments have already been specifically crafted and incorporated in the city's plans and policies, such as incentives for green roofs or requirements for in-site stormwater retention (e.g., [2, 3]). However, urban plans continue to be almost exclusively based on land use zoning prescriptions that have limited capacity to promote NbS implementation. One of the main barriers that have prevented wider uptake is the lack of relevant experience with and knowledge of NbS planning and implementation instruments that could support mainstreaming [4]. Several opportunities to incorporate NbS into the existing urban fabric (e.g., buildings, public spaces, and transport infrastructures) and transformation areas (e.g., development and redevelopment sites), as well as in non-urbanized land (e.g., periurban farmland), exist and can be addressed by appropriate policies and instruments (e.g., [5, 6]).

This study aims to provide a structured guidance for the identification and selection of suitable policy instruments that can be used alongside land use regulations to promote NbS implementation in urban plans. Objectives of the study are: i) to develop a decision tree to guide the identification and selection of suitable instruments to promote NbS implementation in different contexts of application in cities; and ii) to apply the proposed decision tree categories to analyse and identify options of policy instrument applications in two real-life urban plans, while exploring further opportunities for implementing NbS that contribute to mitigate climate-related hazards.

First, background information that support the development of the decision tree approach is described, namely an overview of policy instruments that can be used to promote NbS implementation in cities and the different options of NbS implementation based on the contexts of application in cities. We then present the decision tree that is designed so that users can identify what policy instruments can be used for promoting the implementation of different typologies of NbS interventions in different urban contexts, showing what instruments among the different categories (e.g., regulatory, financial, and information instruments) are suited to be adopted. We further apply the decision tree categories to analyse the content of two urban plans covering a high-density urban case study with the aim to identify what and where policy instruments are currently deployed to promote the implementation of different typologies of NbS against the full range of available options. We finally discuss the usefulness of, and the opportunities offered by the decision tree approach in the light of supporting decision-making and widening the options of policy instrument applications to promote and mainstream NbS in urban plans, with a specific focus on NbS to address the case study's climate-related challenges.

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Assessment of the multiple benefits of nature-based solutions – an approach. Green infrastructure in the urban areas

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Urban stormwater has become an important aspect of the safety and functionality of urban areas. Heavy rain events cause many problems in densely built areas, including flooding and deterioration of water quality. Nature-based solutions (NBS) have gained popularity as potential solutions for stormwater related problems in cities. Apart from direct water management benefits, they can bring multiple societal and biodiversity benefits as well. Although there is a rich literature regarding NBS in urban environments, there are surprisingly few articles where their effectiveness, costs and benefits have been assessed. This type of knowledge would be of utmost importance for mainstreaming NBS and to facilitate the integration of NBS with conventional urban infrastructure.

We have developed an approach that can be used in the identification, assessment and inclusion of the multiple benefits related to NBS in stormwater management. The approach is based on multi-criteria decision analysis (MCDA) and a surface runoff model developed in Finnish Environment Institute SYKE. The methods have been applied in two urban cases in Finland.

In the first case (City of Pori), we organised a workshop to identify potential NBS to control urban flooding and evaluate the impacts of these solutions. In the workshop, a preliminary multi-criteria framework to evaluate benefits and costs of NBS was presented, discussed and further developed. After the workshop, the feasibility of presented measures was assessed, and the most feasible ones were selected for the surface runoff model calculations. In the second case (City of Jyväskylä), our aim was to test how the developed multi-criteria evaluation framework suits for the planning of a new residential area. A workshop was arranged with local planners and the framework was utilised for two purposes. First, the importance of different benefits in the planning of the area were evaluated and second, the different stormwater and green area options were assessed against each other.

The NBS recognised in the Pori workshop were modelled with the surface runoff model to evaluate the hydrological impact of the measures. The model was originally developed for the preliminary assessment of pluvial flood risk in Finnish cities. In this project we tested its use for impact assessment of NBS. The model uses 2x2 m resolution digital elevation model (DEM) and land use data (CORINE) as input data [1]. The modelled NBS included stream network measures, such as retention pools and natural streams, as well as green roofs or similar pervious areas that retain runoff. Stream network measures were modelled by modifying the input DEM. Green roofs were modelled by modifying the runoff coefficient within the building polygon area. Three different scenarios were modelled and compared to the current situation. The scenarios were: 1. extensive green roofs (all the buildings in great Pori area modelled as green roofs), 2. stream network modifications, and 3. extensive green roofs.

The modelling results showed that extensive green roofs or similar runoff retaining pavements were efficient in reducing runoff and water depth as well as flood risk to roads and buildings especially in densely built areas where the proportional area of modifications to catchment is large. However, the impact of green roofs could only be approximated on a general level, because the runoff coefficient used in the model was time-constant. The impacts of stream network modifications were smaller because of the way the modelling of the measures was implemented. The 2 m DEM resolution used could not describe the measures with sufficient accuracy to provide reliable information on their effectiveness. Also, the modelling was done with relatively severe rain event and NBS work better with less heavy rain events. However, the surface runoff model was efficient in detecting the pressure areas where stormwaters gather and which should be left unbuilt, and where NBS could be focused.

Based on the results and feedback from the Pori workshops and Jyväskylä case, making the multiple benefits of NBS visible was considered very important to accelerate the implementation of NBS in the urban environment. MCDA was considered an approach that can help to identify, structure and illustrate impacts, as well as facilitate dialogue both within organisations and with stakeholders and citizens. The applied evaluation framework was identified as a useful tool for larger and strategic projects, such as master plans, development programs and strategic programs. The framework could be utilised e.g. as a check list when recognising important objectives, when looking for solutions that answer many simultaneous objectives, in the impact assessment of alternative plans, and in post-evaluation of the impact of realised projects.

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ORAL SESSION

A.5.4

Integrating heat waves vulnerability modelling and participatory scenario building in support of green infrastructure planning and urban sustainability

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Increased risk of heat waves has been identified as one of the most severe climate change impacts in cities. Urban plannings should consider approaches and tools allowing for strategic thinking based on both scientific and stakeholders' knowledge in order to gain abilities to respond to climate impacts and enhance the current praxis in green infrastructure planning and implementation.

Recently, several cities in the Czech Republic have adopted or are preparing a climate adaptation strategy with an emphasis on green infrastructure. Although the scope of these strategies is to prepare urban territories for the future, among other impacts, in the light of extreme heat events, the use of integrated heat waves vulnerability analysis based on future scenarios has not proliferated into urban planning practice yet. This is caused by three factors. Firstly, modelling of future scenarios of vulnerability to heat waves represents a complex research issue that requires extensive, and often non-existent, data inputs. Secondly, decision-makers mostly rely on more traditional approaches to strategic thinking despite their lesser suitability for climate adaptation planning. Hence, the use of foresight methods and of future scenarios is an emerging practice in the Czech Republic only recently. Thirdly, utilization of future scenarios in urban planning requires complex collaboration among a wide range of stakeholders, including decision-makers, and scientists, that has not been properly established yet.

In this respect, our interdisciplinary research aims to address all three above-mentioned underlying factors in order to enhance green infrastructure planning for sustainable cities. Drawing on the case studies from Czech three major cities – Prague, Brno and Ostrava, we aim to introduce a process of future scenarios of heat waves vulnerability modelling for years 2030 and 2050, that is based on integrated methodology combining both, scientific approaches and stakeholders' knowledge co-production.

The first part of our contribution elaborates on data required for the modelling of future scenarios of vulnerability to heat waves for case study cities, i.e. micro-scale climate models, future scenarios of land use and land cover (LULC), and future scenarios of socio-economic development. We pay explicit attention to the development of future LULC scenarios that are a showcase of the integrated approach to spatial modelling used within our research. Hence, the second part of the contribution discusses our approach to spatial modelling that is based on land use plans of case study cities, UrbanPlanner model and Urban Atlas database, in combination with Shared socioeconomic pathways (SSPs) and participatory workshops carried out in fall 2019 and winter 2021. The main purpose of participatory scenario building and SSPs downscaling is to enrich spatial model for contextual information and for refining the first set of LULC scenarios. In the third part, we provide insights into the integration of the different types of data that are used for the development of future scenarios of vulnerability to heat waves for case study cities.

The study shows that the integration of participatory approaches with spatial modelling offer numerous potentials as well as pitfalls. While participatory scenario building allows for the inclusion of stakeholders' perspectives on the future directions of urban planning in their city, spatial modelling of future vulnerability to heat waves enables to target areas under different heat pressures. The interplay of the two approaches creates a space for co-development of shared knowledge that is respectful to both, stakeholders' viewpoints and scientific research. However, ensuring the viability of this collaborative process requires close cooperation between stakeholders and scientists which is difficult to sustain over longer time periods. Yet, the outcomes produced evidence that such an approach is a viable tool for supporting long-term strategic (not only) green infrastructure planning and implementation.

Mapping urban pervious surfaces and tree canopy cover by using high-resolution airborne imagery to support urban planning

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Keywords: surface permeability; urban tree canopy cover; urban planning

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The nature in cities has a key role in a variety of ecological questions and drives the provision of several ecosystem services. For example, multifunctional green areas influence the hydrologic cycle, microclimate regulation and biodiversity, as well as they contribute to improve health and wellbeing of the inhabitants [1]. Considering some urban societal challenges, such as the impacts of climate change and growing population, an approach towards conservation and enhancement of green areas in the urban environment is foreseen to preserve liveability and resilience.

This contribution investigates the use of Normalized Difference Vegetation Index (NDVI) in the urban environment to estimate green elements distribution and to map pervious surfaces and urban tree canopy (UTC) cover. This process provides a supporting tool to plan and manage urban green infrastructure's development, by controlling the indicators' status and by driving maintenance and enhancement of green elements in the urban environment.

The study has been carried out in Trento, an alpine city in northern Italy. Despite the rich landscape and large ecologically functioning green areas, its inner urban areas are strongly urbanized, with soil sealing affecting stormwater management and the presence of the urban heat island effect [2], reducing liveability and safety.

The proposed GIS-based methodology relies on the combination of high-resolution airborne imagery, Digital Elevation Models (DEMs) and vector datasets, and it constitutes a simple approach based on publicly available resources. The base of the method is the vegetation classification by NDVI calculation from airborne imagery with a spatial resolution of 20cm. To map pervious surfaces, the NDVI calculation is combined with vector data to superimpose surfaces that have been providing uncertainties, such as crop lands. While, to map the UTC cover, the NDVI calculation is combined with the DEMs, to ensure the selection of trees.

To assess the data, the particularly challenging areas to analyse are identified and discussed, and a binary classification (e.g. pervious or impervious) has been applied to validate the results of the classification [3].

Finally, the results are presented as a degree of perviousness and canopy cover on the block level, to provide a tool that compares the level of the indicators in the urban fabric and to drive transformations in the most challenging areas.

The advantages of the model consist of its accuracy and high spatial resolution, allowing to detect both small green elements (e.g. hedges, bushes) and private green areas, which are normally not present in the publicly produced urban green infrastructure maps. One more advantage is given by a semi-automated process which makes it easy to be updated.

The proposed method provides understanding of quantity and distribution of vegetation in Trento. Moreover, it constitutes the baseline for management and governance of green infrastructure and integration of climate adaptation policies in urban planning: for example, by setting and promoting expected performances (e.g. perviousness, presence of trees) in the built environment [4].

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ORAL SESSION

A.5.6

Public perception of outdoor thermal comfort and urban green infrastructure in a humid sub-tropical city

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Keywords: perceived thermal comfort, environmental psychology, vegetation dynamics

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Increasing heat stress in strongly developing cities of humid sub-tropical countries has reduced the liveability and usability of outdoor spaces. Thermal comfort assessment and understanding the spatial characteristics of urban green infrastructure (UGI) can support strategic planning of outdoor spaces for optimised usability. Studies in recent years have highlighted the difference in measured and perceived thermal comfort. This implies that multiple factors other than the thermal environment have a role in the overall thermal comfort perception (TCP) of the outdoor spaces.

TCP is influenced by multiple factors broadly classified as physical, physiological, psychological, behavioural or social. Very few studies have investigated outdoor thermal comfort with a holistic lens. Moreover, there is a dearth of such studies in the Indian context. In addition, none of the previous studies has analysed perception and preferences in relation to both outdoor thermal comfort (OTC) and vegetation dynamics. We adopt a unique approach in this study to examine multiple factors that influence TCP along with the perception and preferences of UGI. Taking cues from the advancements in outdoor thermal comfort assessment, this study is embedded in the theoretical framework of environmental psychology.

We conducted social surveys in five residential neighbourhoods in the north Indian city of Dehradun over a period of three months (July-September) in 2019. A total of 468 surveys were selected finally for the purpose of analysis. A semi-structured questionnaire with few open-ended questions was designed with two main sections regarding the perception and preferences of OTC and UGI respectively. The open-ended questions were categorised into more legible keywords and all the results were analysed using SPSS version 27.0.

Our results showed that apart from the physical factors i.e. the exogenous micrometeorological factors there are several other factors that influenced the thermal comfort perception of people. Physiological factors like personal characteristics i.e demographic and cultural variables had a varied influence on the thermal comfort perception of the residents. For instance, gender and education had no significant relation with TCP whereas age and momentary clothing level showed a variation with TCP. The climatic background and period of residency also indicated variation with TCP. People who belonged to a hotter climatic context felt more comfortable and vice-versa, often termed as climate habituation or acclimatisation. With respect to the kinetic state, we found that people who were more physically active felt more uncomfortable.

Psychological factors that could influence the TCP by perpetual and emotional assessment of outdoor space were also assessed. We found that 45.9% of respondents felt moderately uncomfortable, and generally perceived 59.2% solar radiation to be very high on a typical summer day. TCP was in turn reflected in the transient exposure of people i.e. duration and time of using outdoor spaces. It was found that only 1.3% of people used outdoor spaces in afternoons whereas a high 77.4% of people preferred being outside in evenings after the direct sun exposure had reduced. We also assessed the awareness related to the amount of greenery on site and if it had changed over time. The awareness of one's spatial or thermal environment is related to the concerns and relevance of ambient influences which in turn affect the thermal expectations and perception of a person. It was shown that 65.8% of people felt there was much greenery on the site and only 19.9% felt it had decreased over time. The awareness related to change in outdoor temperature had a significant negative correlation with a feeling of comfort. With respect to specific preferences related to different vegetation dynamics, we found that shade of a tree was undisputedly preferred by 97.4% of people over the shade of a building or shade through external devices. 54.1% of respondents preferred medium density of plantation followed by the combination of the open, medium and dense plantation. This choice is influenced by the aspect of perceived control where people feel more comfortable in part sun and shade than in complete sun or complete shade.

Lastly, we asked residents about their common adaptive strategies for overcoming overall thermal discomfort in summers along with the reasons i.e. spatial, physical or environmental stimuli associated with it. 23.0% of residents said they move to a shaded space and 20.6% change the time of their visit to adapt to the discomfort outside. Overall, heat stress (55.6%) and lack of shade (23.4%) were accounted for the most common reasons for different behavioural adaptations.

In conclusion, our study provides unique insights into perception studies related to outdoor thermal comfort and parametric preferences of vegetation that influence TCP.

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Greening the space – designing with the citizens the post-socialist cities towards increasing the availability and attractiveness of greenery outside urban parks

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Keywords: co-designing, informal green spaces, social awareness and perception

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As a typical post-socialist European city, Łódź is facing environmental (heat waves, flash floods, smog), social (aging, depopulation) and spatial (neglected and dense city center) problems. These issues coexist with underprovided, unavailable and poor quality urban green spaces (UGS). This has a significant impact on the residents' leisure and recreation opportunities, and thus on their health and well-being. In many places this limitation of access can be complemented by the availability of various informal green spaces (IGS). The direct use of these spaces depends on their accessibility, but also on their attractiveness for users. Consultation with end users during the design process ensures better planning and meeting public needs.

Due to the limited space available for the establishment of a new formal UGS, efforts to improve the quality of life of residents can be based on small local interventions that will support the provision of ecosystem services. Therefore, we asked citizens how they perceive space in their neighborhood (buildings, streets, backyards, abandoned/ruderal area) and benefits it should provide. To find answers, we conducted surveys and asked citizens to join the participatory design of urban spaces. Additionally we traced ongoing discussion about city greenery to check public involvement and attitudes.

The results provided a lot of information, including the general need for more greenery, and the need for specific solutions to improve public space. All suggestions can be grouped and assigned to one of three aspects of urban green spaces provision (availability, accessibility and attractiveness) [1]. For the existing but informal greenery in the city, the main proposals include small design interventions related to improving the attractiveness of place: improvement of active and passive possibilities of rest, increasing the aesthetic value of the area by improving its neatness or/and cleanliness, and implementation of new green measures. Much less attention was paid to the changes in accessibility that will ensure the safety of users and availability of these places by formalizing their status. A small percentage wanted to liquidate these places for the service and residential development. In the case of grey infrastructure such as streets and buildings, respondents expressed a desire to add more greenery like trees, flower meadows, green walls and roofs and consequently increase its availability for citizens. However, greening of backyards was less popular due to their parking function. The possibility of creating green backyards was not rooted in the consciousness of the residents. Newly designed by the respondents backyards, combine the parking function with new social and recreational functions, rarely based on greenery.

The presentation will show the possibility of urban green spaces provision beyond formal UGS, the citizens needs and views of residents in this regard, and lessons learned from the process of citizens engagement in designing of urban public green space towards a sustainable city.

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ORAL SESSION

A.6.2

Developing an Environmental Justice Index in urban areas to prioritise the implementation of nature-based solutions: a case study in Las Palmas de Gran Canaria

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Environmental Justice (EJ) has raised critical concerns about how citizens should be treated and what constitutes a just allocation of collective environmental goods and harms [1]. In this regard, the concept has become an important topic that redefined the sustainability agenda in urban areas [2]

Even if the EJ discourse has expanded to include issues of misrecognition and lack of societal participation in the environmental decision-making process, the spatial and temporal nature of environmental risks and social polarisation has derived in an emphasis on its distributional consequences [3]. As such, distributive EJ illustrates the environmental disparities that pose adverse outcomes for disadvantaged population groups that suffer from uneven income and wealth, housing segregation, unfair allocation of public goods and services, and lack of political rights [4].

Recently, new forms for understanding distributional environmental injustices have emerged to highlight both the disproportionate spreading of environmental risks and the inequitable sharing of benefits offered by strategies such as Nature-based solutions (NbS) or green infrastructure [5]. However, these approaches have treated the potential provision of such benefits in terms of the relative proximity to parks, community gardens, urban forest, etc [6]. In this regard, existing tools do not explore the complex pathways that allow for a just distribution of benefits ranging from risk mitigation or air pollution control to recreation and aesthetic enjoyment. Therefore, it is necessary to broaden the conception and language adopted for distributive EJ analysis and complement current mapping techniques to account for the dynamic provision of urban ecosystem services that are transformed into positive contributions for citizens. In turn, this approach could inform a just allocation of diverse strategies so that the least advantaged communities or individuals receive the greatest increment of environmental resources and ecosystem services.

This research aims to propose a spatial EJ composite index for urban areas based on three fundamental EJ issues: the distribution of environmental risks, the uneven provision of green space benefits, and the allocation of socially disadvantaged communities. Our approach focuses on exploring a broader range of benefit indicators to complement geographical accessibility and biophysical analyses. In this regard, we hypothesised that benefit indicators could better picture the scarcity of ecosystem services, the availability of complementary features that allow for benefits delivery, and the general urban landscape. Moreover, this approach could also result in a more nuanced analysis of EJ that recognises that injustices arise not only from unevenness in the spatial distribution of environmental risks but also from how these interact with the uneven socio-spatial distribution of green space benefit provision.

For the testing of this index, we selected Las Palmas de Gran Canaria (Spain) as a case study to understand the justice challenges faced in insular areas. Relevant EJ issues and goals were identified through a content analysis of 17 planning and policy documents. Likewise, this methodology allowed us to compile relevant data sources and identify 11 indicators that were weighted according to the public agenda's preferences from the documents analysed. After individual indicators were selected and calculated at the census tract level, input variables were normalised and aggregated into three cumulative scores for final aggregation in the EJ index.

The preliminary evaluation of planning and policy objectives indicates the existence of central themes such as "improving social cohesion", "consolidate a green space network", and "recognise the existence of vulnerable groups", even if these are not explicitly framed in the EJ theory. Furthermore, we also discuss how urban planners could use the index by testing the potential EJ implications of greening strategies based on the mapping results and focusing on areas where the greatest justice concerns have been identified. We argue that, through a compensatory-based allocation, strategies such as NbS could target the reduction and prevention of environmental risks and improve access to essential ecosystem services that depend on the capacity of current urban green spaces to be transformed into landscape-driven benefits. This final method is important to illustrate how the proposed EJ index could guide the type of solutions needed for more just and sustainable cities that respond to specific planning goals.

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Quantifying the quality and detecting social Inequality in the prosperous and deprived zones urban parks of Tabriz, Iran

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Keywords: Urban Parks, Subjective Quality, Perception, Inequality

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High quality urban parks within urban built environment help creating a healthy society. This study examines and compares the quality of two urban parks located at deprived and prosperous zones of Tabriz city, Iran. The study merely explored user's perceived quality, considering sub-factors such as sense of place, satisfaction, security, comfort, and perceived attractiveness using a subjective method. So, public perception was explored through a questionnaire. According to the findings, prosperous zone urban park (PZUP) has significantly better status in terms of public satisfaction (P = .00), security (P = .00), comfort (P = .00), perceived attractiveness (P = .00), and sense of belonging to place (P = .00), indicating inequalities in the quality of the urban parks. Despite the significant higher values, the quality of PZUP needs to be improved in terms of security and sense of place. Security impact other quality indicators in prosperous areas where security status is in the middle range. However, security in deprived zone urban park (DZUP) is not correlated with other quality factors due to its extremely low values. Security serves to increase the overall quality of PZUP.

ORAL SESSION

A.6.4

School greening: Right or privilege? Assessing urban nature within and around primary schools of Barcelona from an environmental justice lens

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A mounting body of research evidence shows strong positive associations between urban nature and child overall well-being, including mental and physical health, cognitive development and behavioral benefits. However, most part of this research focuses on residential access, while school access, also an essential part of children's daily environment is still understudied. Moreover, the quality and structure of urban nature within the school compounds and their surroundings and its potential to provide benefits to children are generally not considered, nor are their distributional environmental justice implications at the city level.

In this research, we assessed the amount and main components of the urban green infrastructure (UGI) located within and around 324 primary schools (both publicly and privately owned) of the city of Barcelona, Spain (93% of the total number of primary schools), using high resolution aerial photo imagery and GIS data. Associations between school UGI indicators and socioeconomic variables (low household income, low educational attainment, and Global South residents) at the neighborhood level were explored using bivariate and cluster analyses in order to identify potential environmental inequities. Additionally, 89 schools responded an online questionnaire addressing the type and frequency of "contact with nature" activities carried out within school compounds or in outdoor locations (e.g., protected natural areas).

Results show that school compounds located in the wealthiest neighborhoods are generally greener (e.g., in terms of tree canopy cover), but inequities are not observed for school surrounding UGI indicators (e.g., street trees or access to parks). Survey results also indicate that greener schools generally organize more nature-based outdoor activities than those with less access to urban nature, further compounding school inequities. Our findings can be used to increase the fairness of priority-setting decision processes related to re-naturing programs of school playgrounds and school environments currently being implemented in Barcelona and other cities.

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Methodological framework for assessing the equity in planning urban parks

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Keywords: equity, planning, urban parks, vulnerable groups

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Habitat Agenda and Sustinable Development Goals Framework promote the idea of sustainable urban settements as key for a healthy, resilient and inclusive development. In this context, concepts as equity and environmental justice gain in importance and become fundamentals in public policies and national and local level.

Urban green infrastructure represents a key element for urban sustainable development providing a great variery of services which contribute in improving the environmental quality, creating healhier cities and increasing the social cohesion at city level. Urban parks are one of the most important components of green infrastructure considering the number and diversity of functions and benefits they provide. They are places where a great diversity of users converges in order to fulfil very specific needs. Categories of users differentiate by age, gender, education, ethnicity, lifestyle, health, or mobility, while uses range from recreation and leisure, sports and physical activities, culture and education to social life, community activities, and alleviating health problems.

Studies in the field have mainly concentrated on the characteristics of urban green spaces in relation with one of the above-mentioned categories and on designing elements to fulffilt its needs. Our study aims to develop a methodological framework usefull in assessing the inclusivity of urban green infrastructures considenring one or more categories of users. We focused our study on the different age groups, takeing into consideration children, adolescents, adults and elderly people.

We started by assessing the needs and desires of different age groups using two methods: a literature review for establishing the general framework at international level and a survey applied in urban parks in Bucharest to identify cultural similarities and differences with the Romanian context. Taking this information into account we created a spatial database containing 4 categories of elements – general elements, endowments, utilities and problems. The database was filled in the field using ArcCollector mobile application by ESRI. We selected a sample of 15 urban parks in Bucharest for the field observations. Using the information from the spatial database and the Open Stret Map database we performed spatial and statistical analysis and calculated indicators for each case study park. The results were integrated in a multicriteria analysis which used criteria as accessibility, diversity of endowments and share of endowmens used by vulnerable groups, security, characteristics of vegetation

The analysis highlights the parks which can serve a high diversity of age groups, including vulnerable ones and can provide insights related to the directions in which planning actions should concentrate.

Our analysis has a high applicability and can be used as basis for planning strategies and action plans aiming to develop inclusive green areas since studies have already showed that better planning of parks cand facilitate social cohesion.

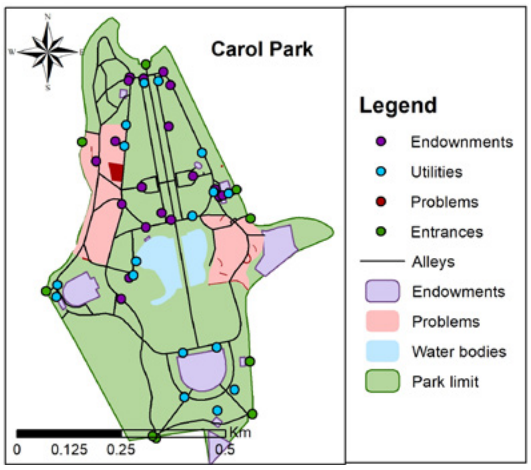

Figure 1. Plnning elements in a case study park

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ORAL SESSION

A.7.1

Insights of the relation between urban green infrastructure and self-perceived health of residents

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Green infrastructure is a key component of urban areas in the pursuit of creating sustainable, resilient, inclusive and healthy cities. Many studies have already showed that greener cities have a better environmentl quality but there is a gap related with the assessment of the direct influence green areas have on the health of the urban population. In this context, our study aims to assess the relation between the surface and characteristics of urban green infrastructure and population's health.

The Romanian urban system is organized in four categories of cities – category 0 (Bucharest – the capital city of Romania), category 1 (11 cities of national and potentially european importance), category 2 (81 cities of regional importance) and category 3 (227 towns). For our analysis we selected a sample of 40 Romanian cities belonging to categories 1, 2 and 3 and having different characteristics in terms of location, economic profile and the establishment period. We didn't include Bucharest since the capital represents an outlier in the Romanian urban system being almost ten times larger then the second most important city in the country.

We built a spatial database containing the categories of urban green infrastructure in the sample cities and we integrated the residential areas as derived from the Open Street Map Database. We performed spatial analysis wirh and calculated for each city the residential areas with high, medium, low and no accessibility to different categories of urban green spaces. In order to assess the population's health, we developed a questionnaire which was applied on-line through social media groups of the targeted cities. The survey included questions related with the behaviour of the respondents regarding the use of green spaces, their heath, their perception related with the investments in urban green and the solutions they see fit for improving urban environmental quality. Our database contained around 600 questinnaires which were analysed using statistical analysis (differences tests and regression). We tested different hypothesis to assess which are the main determinants for the perceived health of urban residents.

Our results showed the amount and accessibility of urban green spaces is negatively correlated with the perceived health of the residents. Furthermore, the residents are rarely aware of the impact different characteristics of the urbana areas, like the surface and accessibility of green spaces or the proximity of polluting activities, have on their statea of health. As other studies before, our study highlighted the importance of the level of education for the degree of awareness in relation with the urban environmental quality.

Our results can be used as basis for developing best practices for urban green space planning in the context of sustainable urban settlements and can provide insights regarding the population's demands and desires related with green areas which could be integrated in planning strategies and environmental action plans in order to be financed.

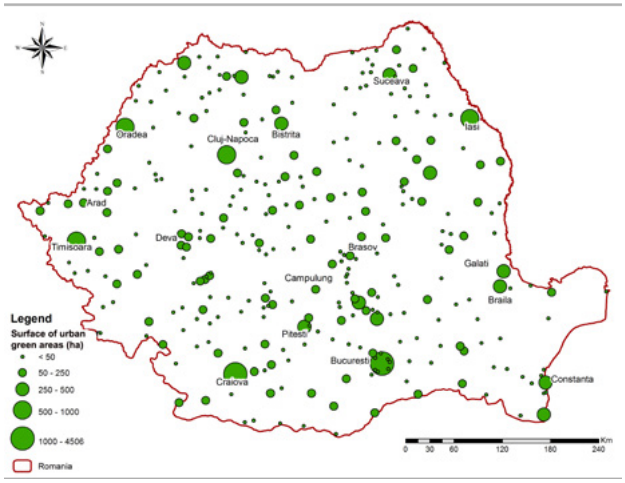

Figure 1. Surface of urban green areas in Romania

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Visitor's perceptions of Eynali Urban Woodland Park in the Mountain Steppe of Tabriz, Iran

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Keywords: Urban woodland parks, Park visitor's perceptions, Park visitor's behavior, Urban nature perceptions, Park access, equipment and infrastructure, diversity and function.

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Eynali Urban Woodland Park (EWP) in Tabriz is the largest urban woodland park in Iran. It was developed to increase urban green space in the growing city of Tabriz. The planted and irrigated hilly woodland is located in a naturally mountain. The aim to develop this woodland park was to extend the very fast shrinking urban green space for recreation, air purification, temperature reduction, biodiversity development, and ecological connection between city and surrounding landscape[1,2].

By questioning of 277 randomly selected park visitor's frequency of visits, activities, accessibility, preferences, and especially nature preferences were analyzed using photographs of different nature types. The management targets were compared to visitors' perceptions, preferences and acceptances.

The results show, visitors want to be in a natural surroundings. Expectations of visitors for specific natural design attractions were lower than the actual status offers, higher for social security, quality of infrastructure, accessibility and utilization. Especially important are security by monitoring and guarding, enhancing picnic sites, improving the lighting system for evening visits, continuing forestry, public transport, and providing natural risk protection (see to Fig 1).

Most visitors prefer nature-near vegetation, dry grassland with shrubs partly planted with trees and bushes, followed by planted forest. Their mental nature imagination matches quite good with the nature experience they have from the surrounding mountain steppe and forest patches and they prefer natural elements in designed combinations "e.g. rocks with vegetation". Also, the "Stairs made" was the most frequency from lack of natural sense and finally "Vegetation with a combination of trees and shrubs", was their choice as a scene similar to the natural forests in Eynali. the open mountain steppe without bush and tree vegetation inartificially designed vegetation-free promenades were not much valued as attractive by visitors. This shows also the preferences of a "green" tree and bush dominated vegetation against the natural vegetation (grassland) of the area

Conclusions: The park management can use the results improve the park management and to better distribute management costs.

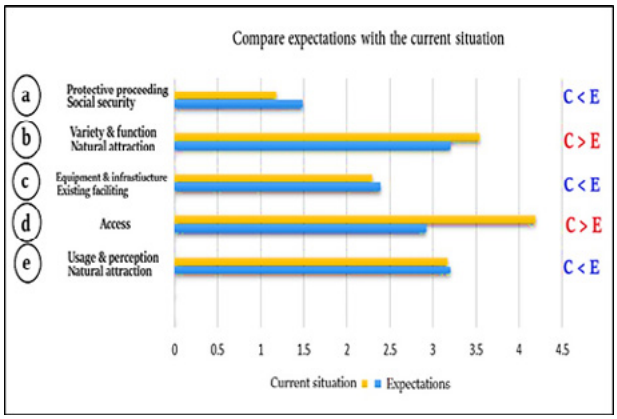

Figure 1: Expectations of visitors with current situation of Eynali

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ORAL SESSION

A.7.3

Defining biodiveristy: What do urban gardeners think?

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Keywords: biodiversity, communication, conservation

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The majority of the world's human population now lives in urban environments [1]. Living in urban environments is associated with reduced daily experiences of nature [2] and an increasing disconnect from the natural world, a major barrier to taking action to halt biodiversity loss [3]. Residential gardens occupy large proportions (up to 47% [4]) of greenspace in UK urban environments and can be important havens for biodiversity [e.g. 5]. Gardeners, therefore, collectively have responsibility for managing significant areas of greenspace. Critically, however, areas of residential gardens are subdivided into small units, each managed by different people. Understanding the views and knowledge of garden owners is therefore important for landscape-scale greenspace management.

The release of the UN's global assessment of biodiversity and ecosystem services [6], alongside increasing recognition of the sixth mass extinction, have put the term 'biodiversity' back on the public stage. The term was introduced in the late 1980s and has grown in use since then. Biodiveristy can be a difficult term for members of the public to grasp, not least because in scientific circles the term is used, understood and measured in a variety of ways. We aimed to understand how urban residents, specifically garden owners, understand the term 'biodiversity'.

We surveyed garden owners in Derby, a city of more than 250,000 residents in the UK midlands. Residents in 20 areas spanning a socioeconomic spectrum (Index of Multiple Deprivation [7]) received a hand-delivered letter inviting them to participate in a survey about garden management either online or on paper. As part of this larger, cross-sectional survey, residents were asked to explain what their understanding of 'biodiversity' is in a short definition format. Responses were classified using thematic and word frequency analyses.

Of 255 respondents, approximately one third were unable to provide a definition of biodviersity. Of the definitions provided, the most frequent theme described biodiversity in terms of the variety of species or environments and used the term 'variety' often. The next most frequent theme concerned coexistence of organisms. Participants used various synonyms to describe biodiversity in terms of either passive (e.g. coexisting) or active (e.g. interdependent) connections between elements of the natural world. Three additional themes were identified with fewer respondents: descriptions of biodiversity in terms of nature conservation or people's relationship with nature; equating biodiversity with a habitat; and uncommon answers that were not clearly related to biodiversity. All responses were also assessed for the level of taxonomic detail described and any reference to scale included.

Most respondents actively managed their outdoor space and we found no relationship between garden management and biodiversity definitions. Only 37 respondents were members of garden or wildlife organisations or charities and members were more likely than non-members to say they could define biodiversity and to use specific taxonomic terms.

These short-form responses captured many of the themes longer and/or qualitative assessments have drawn out about people's understanding of biodiversity. The proportion of people in this survey able to provide a definition of biodiversity was higher than in some other large studies, but many people did not provide a definition. Amongst people who provided definitions, understanding of biodiversity was mixed and not related to garden management. At this critical period for global and local biodiversity, technical terms, even common ones, should be used with caution. Effective communication of concepts and active engagement with members of the public to encourage biodiverse approaches to garden management is key.

Acknowledgments: This work was undertaken with support from the Derbyshire Wildlife Trust and the Environmental Sustainability Research Centre and the On Campus Internship Scheme at the University of Derby. Thanks to the volunteers who assisted in distributing the surveys.

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From invasion to resilience: Social perceptions of neobiota in urban ecosystems in the context of sustainability transitions

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Keywords: neobiota, novel ecosystems, sustainability transformation

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Neobiota are a highly contested boundary object in ecological as well in socio-ecological research: On the one hand, invasive neobiota are identified as one of the major threats for global biodiversity loss, especially in native ecosystems [1]. On the other hand, neobiota are accepted as an integral part of urban ecosystems and even contribute to an increase in biodiversity, especially in cities [2]. With regard to current social ecological crises, e.g. global climate crises, the analysis of urban ecosystems and particularly of neobiota shows high relevance for social-ecological research on sustainability transitions: Urban and novel ecosystems can be conceptualized as real world laboratories and experimenting spaces for adaptation to climate change [3], neobiota may analogously be analyzed as drivers for such transition processes. The aim of the present study is to analyze and discuss to what extent neobiota and urban ecosystems can contribute to social-ecological sustainability transitions. Analysis is conducted from the perspective of Frankfurt Social Ecology [4] and gender-oriented sustainability research [5].

Current research has emphasized the necessity to understand and analyze the ocurrance of neobiota as social-ecological phenomenon and thus to include social perspectives into the research on neobiota [6]. The present study draws on this findings and analyses social perceptions, i.e. the understanding, conceptualization and evaluation as well as the management of neobiota in novel and urban ecosystems. The main question is how social perceptions of neobiota might change in the context of novel and urban ecosystems – compared to perceptions of neobiota in more conservative contexts of nature conservation.

Research draws on a qualitative case study conducted in two novel/urban ecosystems in Germany. A total of 22 guideline-based interviews were carried out with decision-makers, practitioners and scientists. The interviews were analyzed based on a reconstruction analysis [7]. Results show that social perceptions of neobiota in novel/urban ecosystems fundamentally change: Neobiota are not (or no longer) devaluated because of their foreignness, but rather accepted as integral part of urban nature or novel ecosystems. Interestingly, those properties of neobiota that were previously devalued as 'invasive'- including high adaptability, reproductive capacity, competitiveness and resilience - are positively valued in the context of urban and novel ecosystems. Against this background, the empirical results of this study are discussed with current literature regarding resilience, adaptive cycles and sustainability transitions.

This study complements the social-ecological research on neobiota by analyzing social perceptions of neobiota in novel/urban ecosystems. Furthermore it interlinks research on novel/urban ecosystem and neobiota with the discourse of sustainability transitions and resilience.

Acknowledgments: The case study was part of the research project „Caring for natures? – Gender perspectives on (re)production in association with ‚Nature/s'", funded by the Lower Saxony Ministry for Science and Culture as part of the funding priority "Gender – Power - Knowledge".

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ORAL SESSION

A.7.5

A multi-criteria framework for assessing emergy use in socio-ecological systems

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Keywords: emergy accounting, input-output analysis, urban metabolism.

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The social and ecological impacts from urbanization require integrated management of cities and their resource metabolism for long-term sustainability and economic prosperity. Traditionally, network models are used to study internal metabolic processes in cities, complementing the traditional "black box" urban models, to account for the input of material and energy resources and the output of final products and wastes. This study introduces a multi-criteria assessment framework by integrating a hybrid-unit input-output model with the emergy accounting method to estimate the environmental support provided to urban socio-economic systems. By focusing on the internal organization and functioning of urban socio-economic systems, the proposed framework strengthens the understanding of both ecological and socio-economic flows exchanged among industries and the environment.

The following research methods were utilized. The national monetary use and supply data were regionalized using the supply-side [1] and location quotient (LQ) approaches. Then, the regional shares of monetary and energy production were obtained using these two approaches. These shares were applied to disaggregate Vienna's energy balance data. Consequently, the regional energy use data were integrated with regional energy supply data through the Leontief's "commodity by industry model". The matrix method was integrated with reflexive method to estimate transformities of industrial sectors [2].

The hybrid-unit emergy input-output model was developed using the multi-factor energy input-output model based on the national economic system [3]. By following this approach, economic services provided by the energy industries were incorporated into the analysis [3]. Moreover, the framework assisted in the identification of emergy use patterns and in the estimation of the total environmental support provided to the Vienna's socio-ecological system.

The results show that the "Renewable energy" sector is supported by a large emergy consumption, confirming the importance of renewable energy in the context of Vienna's regional economy. Among the tertiary sectors, "public administration and defense, social security", "transportation and storage", and "human health and social work activities" are characterized by a high emergy support, confirming a strong policy commitment to provide high quality social services oriented towards smart cities and urban sustainability in line with the Vienna's development strategy (Urban Development Plan STEP, 2025). The lowest emergy use of the "mining and quarrying" sector shows that this sector is not prioritized by the Vienna's government focused on improving circular economy strategies and renewable energy production.

Future strategies should consider applying supply-side and demand-side interventions to continue improving the share of renewable energies while promoting and supporting sectors with low emergy consumption (i.e., organic agriculture).

The multi-criteria assessment framework developed in this study allows to investigate the urban metabolism of cities and regional contexts through the identification of sustainable pathways rooted in material circularity and resource efficiency, supporting the design of policies in line with the "integrated wealth assessment" and "circular economy" principles.

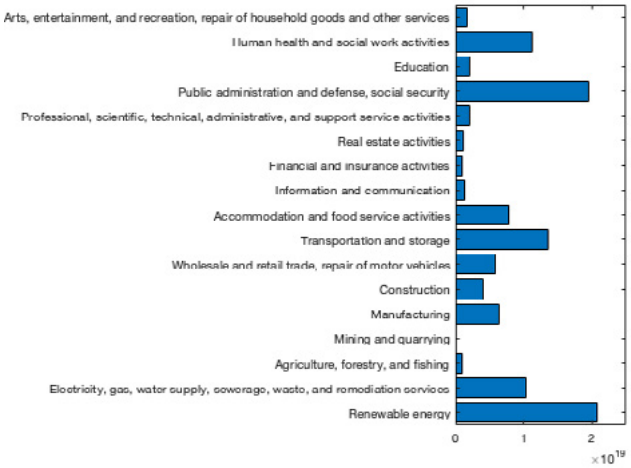

Figure 1. Total emergy consumption (seJ) by sector in Vienna.

Acknowledgments: This work was supported by Jasmin Gülden Sterzl, Energy Statistics at Statistik Austria.

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Homo oeconomicus and self-interest or homo sustinens and social and environmental responsibility – incentives to resign from travelling by car in urban ecosystems (a preliminary research)

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Keywords: sustainable mobility, homo oeconomicus, homo sustinens

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Purpose: Unsustainable path of the development of urban mobility results in more and more advanced solutions towards creating incentives to change citizens' transport behaviour and to resign from travelling by car. Multiple studies proved low elasticity of the students' demand for individual motorisation, meaning an extremely low propensity to switch from a car to more sustainable transport modes [i.e. 1, 2, 3]. On the other hand, many studies revealed the tendency to use different means of transport, dependent on particular factors [i.e. 4, 5, 6]. The goal of the research is to identify the frequency and reasons transport users resign from travelling by car and to assess which determinants play a more important role while choosing public transport or cycling instead of a car – self-interest or concerns for the local community and/or the environment?

Methods/approach: To achieve the research goal, a primary research was carried out in May 2021 as an online survey among students at the WSB University in Wrocław (Poland) within the course on *Transport Economics*. 255 completed questionnaires were received, and the findings cannot be generalised to the whole population.

Findings: Research results revealed respondents were often likely to resign from travelling by car. However, reasons related to self-interest outweighed concerns for the community and the environment, though respondents knew that cycling and travelling by public transport is a better solution in terms of social and environmental interests. To some extent, the research results show the effectiveness of sustainable policy tools aimed at restrictions for car drivers. Based on findings, respondents were rather homo oeconomicus confirming the knowledge-behaviour gap [i.e. 7].

Research limitations/implications: The study is only a preliminary research conducted among students at only one private university in Poland and shows transport behaviour of mostly young respondents. As the research had a form of an experiment conducted and discussed during lectures, it did not include some important factors influencing transport choices.

Implications: Findings can be a basis for sustainable mobility policy recommendations because they show determinants of resignation from travelling by car in urban areas.

Acknowledgments: This work was supported by the University of Wrocław, Poland.

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Conference topics: Social awareness of urban ecosystems, Life quality in cities

ORAL SESSION

A.7.7

Green space and mental health in Kigali city, Rwanda: an exploratory study

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Keywords: Green space, urban nature, trauma, mental health

Green space and mental health are new topics in Rwanda. While much research has been done concerning psychological approaches to improving mental health following the 1994 genocide against Tutsi, there has little attention to the role of green spaces in promoting mental well-being in Kigali city. Our place-based study examines the relationship between uses of green space and mental wellbeing based on self-report among a convenience sample of the population of Kigali city that participated in green space during period of data collection. We enrolled 420 participants in between May and August 2020 in three distinct and separate green spaces in Kigali city using a targeted sampling method and established survey instruments translated into Kinyarwanda. Regarding access to green spaces, more than 63.5%(n=268) of our sample scored good in mental wellbeing while 36.5(n=154) scored less than the standardized cutoff for mental well being. The logistic regression analysis was found to contribute to the model. The unstandardized Beta weight for household income, enjoying green spaces, and visiting three types of green space were significantly associated with mental well-being with P<0.005. The estimated odds ratio favored an increase of mental wellbeing associated with exposure to flowers and plants in green space [OR=1.680CI=1.012 to 2.787] and living nearest open space [OR =1.664, CI=1.039 to 2.663] with P-value <0.005. Gender, education level, occupation, were not found to be significant predictors of these outcomes. The results suggest that green spaces may significantly contribute to restoration and mental wellbeing. Promoting preservation and expansion of public green space in fast-growing cities such as Kigali may be justified as a form of green therapy to offset the effects of trauma and stress on the mental health of the urban population.

Urban acupuncture: past, present, and its future potential in the transition to greener cities

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Keywords: urban acupuncture, green cities, urban challenges

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Urban acupuncture is an easily understandable metaphor derived from traditional Chinese medicine, where planning actions stimulate "the city's nervous system with tiny interventions that can have a catalytic effect on the organism as a whole" [1].

To understand the potential of urban acupuncture in the transition to greener cities, a review of early pioneers; their planning projects and understanding of urban acpuncutre will be given. These pioneers include but are not limited to Jamie Lerner (the former Mayor in Curitiba, Brasil), Manuel de Sola Morales (Spanish, Architect/Planner) and Marco Casagrande (Finnish, Architect/planner). Contemporary implementation of urban acupuncture has included inexpensive, easily implementable, bottom-up initiatives in urban spaces associated to physical (i.e., creation of playgrounds, housing rehabilitation, "plug-in" housing) and social interventions (i.e., addressing social dissonance and alienation, derelict spaces, crime).

Urban acupuncture has made its way into sustainability planning and has been referred to as eco-acupuncture in Australia and Greece for example. Many cities in Europe are looking for ways to become greener to combat urban problems such as: climate change and extreme heat, a loss of biodiversity or simply to maintain a high quality of life.

Considering the dense nature of cities and the often-impossible task of obtaining large plots of land, the "SALUTE4CE" project (2019-2022) led by the Institute for Ecology of Industrial Areas (IETU), examines the extent to which Urban Environmental Acupuncture (UEA) can be used to expand urban green infrastructure by utilizing micro spaces (i.e. alleyways, facades, courtyards, roofs, or abandoned plots). As part of the SALUTE4CE project, researchers at the Leibniz Institute of Ecological Urban and Regional Development (IOER) have developed a *transnational action plan concept* to guide implementation of UEA within four European countries [2]. In the session we will share and discuss our knowledge and ideas to improve UEA as a planning concept.

A critical reflection is offered pinpointing helpful and challenging aspects of UEA. For example, its participatory approach, low budget, applicability to an array of urban problems and focus on physical interventions point to positive developments in creating green space. Challenging aspects include its intuitive approach and transferability from the human body to cities, which tends to be confusing and interpreated as esoteric by some outside of the academic community.

Finally, UEA has the potential to address concerns of the EU. Specifically, regarding the "enterprising and incentivizing" of green infrastructure to increase biodiversity through citizen action, social partnerships and within research; in addition, UEA addresses the urban heat island effect, is a creative innovative method to integrate green infrastructure and improve knowledge regarding the benefits of ecosystem services [3][4].

Figure 1. Illustration of Urban Environmental Acupuncture (UEA) (Source: Franka Strangfeld)

Suggestions for future research and improvement of UEA in the transition to greener cities will be given.

Acknowledgments: EU Interreg CENTRAL EUROPE

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ORAL SESSION

A. 8.2

Application of urban environmental acupuncture in European cities – first results of SALUTE4CE project

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In many cases of European cities it is difficult to save large areas for planting greenery. The attractive sites are often used for settlements by developers or for investments which provide profits for the city budget. It also concerns Brownfield's which usually have existing infrastructure (access roads, media) so it is difficult to decide about other but productive functions.

On the other hand authorities of the cities are aware of the necessity for ensuring green spaces to inhabitants for many reasons. These are not only needs for rest, recreation and aesthetic surroundings but also growing requirements for adaptation of urban areas to climate change. In adaptation programs development of green and blue infrastructure is one of the main groups of actions aiming at strengthening of urban resilience. [1]

The idea of SALUTE4CE project was consisting in using small sites (spots, lots) for planting greenery in urban areas. These places are not attractive for other functions due to their small size therefore they easily can be used for this purpose. Urban acupuncture is one of urban planning instruments, which could be used for selective intervention in précised defined urban space. The technique of urban acupuncture draws its concept from traditional Chinese medicine. Just as the medical Chinese technique of acupuncture is aimed at relieving stress in the human body, the goal of urban acupuncture is to relieve stress in the urban structure. As an instrument of urban planning, acupuncture became popular in the 1970s. Now, the urban acupuncture is perceived as an efficient alternative to the large scale projects due to micro-targeting and low-cost intervention, which could offer attractive and social accepted solution. [2]

The project would also provide a wide promotion of the idea of restoring native vegetation in the selected spots in urban space. Growing requirements for development of green infrastructure in urban areas turn attention to the native vegetation.

Today in the era of globalization urban space becomes more and more homogenic. Centers of cities are similar to each other and this similarity concerns also greenery. The same decoration plants are growing in all climatic zones. Also the production of common sorts adaptable to various habitat conditions is stimulated by the market. The lack of native species is perceived as more and more important. They are available in local banks of genes but they are not used besides in botanic gardens.

The project is being implemented in form of four action plans concerning urban environmental acupuncture (UEA) system in four functional urban areas in Germany, Italy, Poland and Slovakia. Also pilot interventions as parts of the UEA present the examples of applying nature based solutions including native vegetation.

The methodology of selecting sites and choosing interventions has been elaborated within the project. This methodology gave the basis for construction of UEA systems which were then consulted and verified at meetings with inhabitants. This group of stakeholders was particularly interested in visible examples showing how the individual interventions would improve the places they live in.

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Estimating the cooling effect of pocket green space in high density urbanareas in Shanghai, China

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Keywords: pocket green space, cooling effect, land surface temperature, landscape features

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Recently, pocket green spaces (PGS), i.e., small green spaces, have attracted growing attention for their various ecological and social services. As a crucial part of urban green spaces in high-density urban areas, PGS facilitates recreation and relaxation for neighborhoods and thus improves the livability of cities at the local scale. However, whether and how the PGS cools the urban heat island effect is still unclear.

This research was performed in the highly developed areas of the city of Shanghai during hot summer daytime. We applied a set of cooling effect indicators to estimate the cooling extent, cooling intensity, and cooling efficiency of PGS. We further examined whether and how landscape features within and surrounding the PGS influence its cooling effects.

The results showed that (1) using four cooling indicators, maximum local cool island intensity (MLCII), maximum cooing distance (MCD), maximum cooling area (MCA), and maximum cooling efficiency (MCE), we clarify the mitigation effect of PGS. (2) 90% of PGS are cooler than their surroundings. The maximum cooling intensity for PGS can reach 3.6 ℃, and the cooling distance ranged from 22 m to 213 m. (3) Among the landscape features, the land surface temperature of PGS logarithmically decreased with its area, and the maximum local cool island intensity, and maximum cooling area logarithmically increased with the area of PGS. (4) The vegetation types and their composition within the PGS also influenced their surface temperature and the cooling effect. The PGS dominated by tree-shrub-grass showed the highest cooling efficiency, and should be highly recommended for urban climate adaptive planning. (5) The surrounding landscape patterns, especially the patch density and the landscape shape index, influence the cooling effect of PGS at both class and landscape levels. These findings add new knowledge on factors influencing the cooling effect of PGS, and provide the biophysical theoretical basis for developing nature-based cooling strategies for urban landscape designers and planners.

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ORAL SESSION

A.8.4

Small-scale nature-based solutions cooling the neighborhood. Case study of preschools' gardens in Poznań

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Currently, about 50% of the global population lives in urban settings, and by 2050 it is projected that share will grow to 70% [1]. Urban areas are increasingly exposed to the impacts of climate change like the more frequent occurrence of extreme events e.g. heatwaves, strong winds, flash floods [2][3]. Paralelly, cities are affected by urban heat island [4] what makes the urban thermal conditions an urgent issue to tackle towards healthy cities.

Taking the above into account and a fact that certain demographic groups, such as children, are more sensitive to the health issues associated with urban living, particularly in combination with climate change [5][6], in this study we aim to recognize: 1) the thermal conditions of preschool gardens based on the land surface temperature (LST) distribution in the city; 2) the potential of small-scale nature-based solutions (NbS) such as preschool gardens to lower the temperature at site scale.

In the study we used Landsat 8 Provisional Surface Temperature images (5 scenes) taken in summer seasons in years 2018-2020 at 09.49 GMT during clear sky weather (cloudiness 0-1%) without radiation disturbances (like precipitation, fast wind). As proposed by Majkowska et al. [7] we calculated average LST values for each pixel (aLST) to generate aLST distribution map for Poznań (Fig. 1). Data on the number of kindergartens including public and non-public institutions, their location and information on the number of children as of October 1, 2019 were obtained from the Education Department of the Poznań City Hall. The inputs was processed by using GIS software to measure distribution of aLST in preschool gardens as well as to generate thermal profiles.

The results show that mean aLST for preschools without green space is higher about 1 °C than for preschools with their own gardens (N=101). The average cooling effect of monitored NbSs (N=3) was estimated at 0,3 °C (aLST), although the differences in aLST between the preschool gardens and their surrounding were higher and mostly exceeded 1 °C.

The results reveal the extent to which preschool gardens might enhance local thermal comfort in urban built-up areas towards mitigation children's exposition to high temperatures. However, various factors might strengthen or reduce the cooling potential of preschools' gardens at the site scale and further insight into space designing and management impacting on local thermal conditions should be developed.

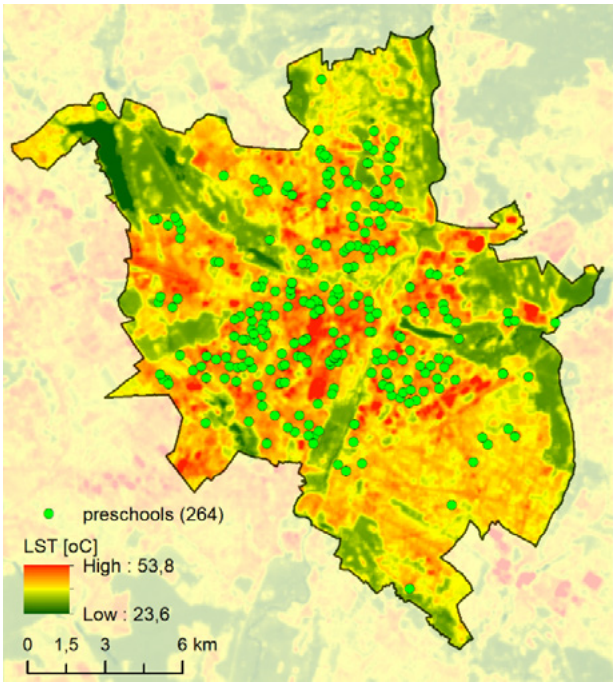

Figure 1. Location of preschools in the City of Poznań on the background of LST distribution map
(source: own elaboration based on Landsat 8 images)

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"Futureproofing Luton": Engaging local stakeholder partners in co-producing an Air Quality Arboretum-meadow

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Trees are key to futureproofing our towns and cities as they provide resilience in the face of the climate crisis [1], filter air pollution, enhance biodiversity, and provide significant health benefits [2], including mental wellbeing associated with feeling connected to nature. In comparison with short-mown amenity grass, urban meadows enhance aesthetic enjoyment and wellbeing for local users whilst providing pollen, nectar and habitat for invertebrates . Yet these benefits are often misunderstood and undervalued or overlooked by local people and in the local decision-making process [3].

Our public engagement and outreach project aims to co-produce an air quality arboretum-meadow on a redundant mini-golf site in Wardown Park, within the High Town ward of Luton, Bedfordshire, UK. The ward has significant BAME communities, with 17.9%* Asian/Asian British residents and 12.2% Black/African/Caribbean/Black British. In High Town there are 17.8% households where no people have English as their main language, 18.6% residents over 16 have no qualifications and 30.8% women are economically inactive. The Arboretum-meadow includes nine tree species which most effectively combat air pollution whilst supporting biodiversity: *Tilia platyphyllos*; *Tilia cordata*; *Pinus nigra*; *Acer campestre*; *Juglans regia*; *Liriodendron tulipfera*; Cedrus atlantica; *Gleditsia triacanthos*; *Acer pseudoplatanus*. These have been selected with reference to potential carbon capture and pollution filtration using data from an i-Tree Eco Inventory Report on Public Trees in Luton (2017). Habitat suitability was also considered. The meadow mix sown is an all-round annual meadow mix including forb species which will flower sequentially through summer 2020, providing colour and human interest as well as resources for pollinators.

We aim to provide an educational resource for the wider community focusing on climate change, the causes of pollution, the value of trees and meadows, particularly in relation to air quality, health and wellbeing, wildlife and biodiversity, whilst prioritising connecting local children with nature. The project was launched in October 2019, with tree planting involving multiple stakeholders including young Ecowarriors and teachers completed in February 2020. Due to the COVID-19 lockdown, it was impossible to involve the children in seeding the meadow, but this was completed by the Luton Parks Service. We are now developing interactive online resources allowing the children to continue engaging with the arboretum-meadow on independent visits with parents. We move forward to investigate the research objectives, with a particular focus on the impact of the pandemic on delivering the project.

Semi-structured interviews [after 3] will be held with diverse stakeholder partners to identify and explore the motivations, priorities and values of different stakeholder groups involved in planning, designing and delivering the arboretum-meadow project. The interviews will also address stakeholder perceptions of the key opportunities and challenges of working with multiple stakeholder partners, and perceptions of the success of the project in connecting children with nature and in providing an educational resource for the wider community. Participants' perspectives on the impact of the COVID-19 pandemic on the successful delivery of the project will also be gauged. Our research provides a transferable case study with relevance to future practice in establishing an arboretum-meadow through a public engagement approach. It provides insight into the potential for public engagement and outreach initiatives to contribute to "futureproofing" towns and cities by building climate resilience. The ongoing challenge of the COVID-19 pandemic allows us to explore the potential for alternative methods of engagement to deliver a co-produced project under such conditions.

Figure 1. Young Eco-warriors planting the arboretum

Acknowledgments: This work was supported by a Public Engagement Award from the Faculty of Environment and Technology, UWE Bristol.

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ORAL SESSION

A.8.6

Implementation of Green Acupuncture Concept to environmental education for primary and lower-secondary schoolS

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Keywords: green acupuncture, green space, environmental education, school orchards

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One of the things we are constantly confronted with as of 21st century is a constant change. The changes concern cities, their development, green spaces as well as education schemas. The development and use of information technologies often reduce natural learning processes through confrontation with how the world and nature work. This paper deals with the possibility of involving environmental education in the process of improving the state of the urban environment through the creation of green dots.

Green spaces in the city are naturally positively evaluated and perceived. According to [1], especially in Western European countries, two thirds of the population live within 500 m of greenery with a minimum size of 2 ha. While this information is positive, it is still necessary to pay attention also to the development of significantly smaller green areas directly within the cities.

Green spaces in the urban structure, as mentioned by [2], bring to society number of benefits - economic, health related and ecological. Ecological benefits are, for example, ecosystem services. These ecosystem services and their capabilities depend on quality and functionality and usability for the population [3].

In the Czech Republic and Slovakia, after the year 1989, when political regime has changed, school gardens stopped in most schools to fulfill their primary educative purpose. Many of them were rebuilt into just a school playground or to some other function. Many of them remained an overgrown space that was not much used, which has lost its former function. These places are small, they are an integral part of the public space and they represent problematic spots, therefore they pose good opportunity for the green acupuncture application. Green acupuncture can be perceived primarily as the development of green dots in the structure of the city, which can have, for example, positive effects on the reduction of temperature islands [4]. In terms of strategy and application of green acupuncture, school gardens are an ideal place to connect between greenery in the city and education.

Currently, the issue of research-oriented teaching comes to the form, in which, among other things, teachers are expected to teach in the form of examples, problem situations or guidance for self-discovery [5]. The school garden or school orchard directly offers a number of examples, problem situations and leads students to their own discoveries. And not only that. During the activities in the school orchard, interdisciplinary relationships can be applied to a large extent. They can use knowledge from other subjects and, conversely, the knowledge and skills acquired in building and caring for a school garden can help them to better understand the new curriculum.

Building and caring for a school garden or orchard can make a significant contribution to understanding the processes on which the world stands. After all, nature did not provide everything necessary for the men only in the past, but it still provides even to these days. It is precisely direct contact with the nature, with its productive capacity, but of course also with other aspects, that is what today's young people are often lacking.

The content of the article will be a description of the educational module for primary school pupils (pupils aged 6-15) with a focus on the aspects of green acupuncture in urban areas. The aim of the educational module is to clarify the principles of functioning of greenery in the city in relation to the historical context of settlements. The module is participatory and interactive with the aim of actively involving students in the project and implementation part. An integral part is the concept of learning by doing.

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Global problems and perspectives of urban protected areas

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Keywords: urban protected areas, global perspective,

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In many parts of the world, cities have established urban protected areas (such as national urban parks in Sweden, Finland and South Africa; urban natural reserves, urban nature parks and urban wilderness in United States; urban natural parks in Australia) as a way to preserve urban biodiversity and provide ecosystem services, but also as a planning tool to control the increasing pressure of urbanization on green and blue spaces. Urban protected areas can deliver obvious benefits for urban biodiversity (habitats for wild species), urban residents (improved human welfare and happiness through interaction with nature), urban economies (increased land value, fostering various economic activities) and public administration (decreased expenses for public space management, alternatives for urban regeneration).

Regardless of their perceived benefits, urban protected areas management remain a challenge for municipalities. Different approaches for planning, design and management, limited knowledge about human and nature interactions in urban settings, high management costs, and especially the high pressure of developers made urban protected areas increasingly fragile.

Using a systematic literature review of scientific and grey literature, the current paper proposes a global view of the challenges of urban protected areas, and an evidenced-based approach on aspects related to their management: (a) rationale of designation and the conservation status of protected elements; (b) integration in the national legislation and in the general framework of urban planning and management systems; (c) connection with local and regional economies; (d) features of human use and preferences for specific forms of urban nature; (e) efficiency of urbanization control; and (f) ecological networking with other categories of natural protected areas. We used relevant case studies to present different experiences of urban protected areas designation and management (e.g. Eco Park - Stockholm, Schöneberger Südgelände Nature Park - Berlin, Văcărești Park - Bucharest, Hämeenlinna National Urban Park, Table Mountain National Park - Cape Town).

Results reveal firstly the high diversity existing at international level between urban protected areas, deriving especially from: (a) the diversity of conservation interests, covering a wide spectrum of elements (high biodiversity, landscape features, historical context etc.); (b) the geographical setting and urban patterns; (c) differences in approaches in legislation and urban planning systems. Secondly, we created a tentative typology of urban protected areas according to their main features, and included the main benefits they deliver to the municipality. In the end, we also identified some of the main challenges associated with urban protected areas and discussed best-practices in coping with them.

The perspectives of urban protected areas are strongly influenced by the cities' capacity to harmonize human-nature interactions, to integrate them in urban economy and to connect with the nature conservation efforts. Such results are useful not only for scientific community, but to all relevant stakeholders at urban level (public administration, developers, NGOs or general public) in providing solid arguments in the promotion of the emerging concept of urban protected areas.

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ORAL SESSION

B.1.2

Nature protection becomes urban – a European perspective

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The increasingly urban world, where more than half of humanity lives, will further grow and come closer to protected areas, often surround them, for which these areas are mostly not especially prepared for. Land designated as protected from development has grown dramatically during the last decades. This creates a trend toward ever-increasing proximity between urban areas and protected areas. Threats by humans in these areas overall correlated significantly with proximity to an urban area (1). Conservation of nature from development is an overall target not only ethically but also to make use of nature to overcome loss of biodiversity and human experiences of nature in increasingly dense cities.

The traditional first step is simply to establish protected areas. IUCN defines a protected area as clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Urban protected areas (UPA) become a specific type of protected areas. They don't have internationally a formal separate recognition, nor is there a global inventory of them. The international conservation activities traditionally have concentrated in the past on protecting large, remote areas with relatively intact natural ecosystems (wildernesses). Much less attention has been given to urban places and urban people (2). Thousands of protected areas are worldwide already impacted by urban neigbourhoods and many more will be impacted in the future (1). The legal status of protected areas regulates utilization and management. The protection strategies and the management have to include the specifity of the locations.

Many protected areas especially in the densely settled Europe become urban protected areas because of their closeness to urban areas. This is a challenge for biodiversity protection and visitor management to avoid damages but also to allow access and nature experience. The target of urban nature conservation is maintenance of species and biocenosis' as a basis for direct contact of the citizens with natural elements of their environment.

The relation of urban protected areas and cities and towns consists of threats, efforts and new and novel experiences of nature by urban dwellers. The European Natura 2000 network for conservation of rare and threatened species and their natural habitats was selected as a comparable category of nature protection. The results of investigations will be demonstrated in different case studies:

i) Which **challenges** of urban protected areas **are how managed in international cases**,

ii) **The European Natura 2000 network** was investigated in its proximity to urban settlements in two of the most densely settled region of Europe, Belgium and Côte d'Azur, Southern France. The results show the extreme narrow connection between nature with conservation targets and settlements.

iii) The **connection of protection and utilization in river re-naturalization** was in example studies in Germany investigated. The results show that integration of wild areas into traditionally urban green spaces does have a chance to be accepted. The biodiversity has increased by this integration.

iv) **Integration of novel urban ecosystems is ongoing** - strength, results and efforts of the German program "Cities dare wilderness" (Federal Agency for Nature Conservation, BfN) will be explained on the example of Dessau-Roßlau case study. The results show the wide range of perspectives how to integrate wild areas in cities and how to manage them for urban users.

Finally novel perspective on urban protected areas and its management will be developed and proposed for further discussions.

The abstracts should be uploaded in the ABSTRACTS symposium **Urban protected areas in relation to urban biodiversity and ecosystem service** of the conference site www.sure2020.org

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Plant species richness and abundance are influenced by land use types in the urban areas

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Keywords: Urban green space, Land use type, plant diversity, species abundance, species richness.

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Urbanization is accelerating worldwide. Urban area is characterized by high landscape heterogeneity and and highly dynamics of land use land cover changes associated with rapid urbanization processes, which severely influenced urban plant diversity. How urban land use land cover support urban plant diversity, and what is the relationship between land use and urban plant diversity of various taxon group are still unclear.

In this study, totally 260 sample plots, which were generated by stratified randomly sampling method and scattered on the entire mainland of Shanghai, have been surveyed to record all vascular plants in the growing seasons from 2013-2017. ANOVA analyses, rarefaction curve, species rank abundance curve and indicator species analysis were used to quantify the differences of species diversity in different taxon on six land use types. The results showed that totally 653 species were recorded, they belong to 424 genera and 125 families. Residential land has the highest numbers of total species pool (434 species, accounting for 66.46%), then followed by agricultural land (425 species and accounting for 65.08%) and green land (401 species and accounting for 61.41%). The species with highest abundance were the common species in the six land use types, while the distribution of species with lowest abundance showed different patterns. Land use types have significant effect on plant species in the majority of taxonomic groups. At plot scale, significant difference of species diversity existed among two or more kinds of land use types except for the native plant species; The land use type of residential had the highest average species richness of families, genera, species, respectively; The agricultural land had the highest average Shannon-Wiener diversity and species richness of herb; The abandoned land had the highest average species richness of native herb plants and native spontaneous plants. These three land use types were supportive to plant diversity in Shanghai. However, the public facility land had the lowest Shannon-Wiener diversity due to the lowest evenness of species.

These results could provide insights into urban land use planning and management to effectively protect urban diversity.

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ORAL SESSION

B.1.4

Insights about the urban protected areas in Romania

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Keywords: urban protected areas, potential, restrictions, urban development

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In 2015, the Romanian Government decided to design the first natural protected area inside of the city: Văcărești Natural Park (Bucharest). The discussion about considering the urban natural protected areas in the national legislation started later and is very close to a positive outcome. However, the interest of Romanian cities in designing urban protected areas remains limited. The insufficient understanding of benefits, Văcărești Natural Park experience, and concern about the further restrictions make these planning tools unattractive. This presentation proposes a national inventory of the sites that could be considered urban protected areas and estimates their potential contribution to the conservation of urban biodiversity, improving the human experience of nature and increasing the potential of implementing a urban green infrastructure approach in urban planning. Major Romanian cities are considered for analysis and relevant criteria used to choose sites with high potential to become successful urban protected areas. The urban spatial plans and local strategies on climate change mitigation and adaptation are considered to assess the interest of cities in green approaches. The study provides a relevant insight to the National Urban Policy, which proposes a new sustainable future for Romanian cities.

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Ecosystem services of urban woodland: A review

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With the development of urbanization, urban residents are more and more depending from the remaining shrinking natural urban environment. By the end of 2018, the urban population has accounted for more than 50% of the total population in the world. Woodland is a type of land which mostly covered with dense growths of woods and provides habitat for spectific fauna. Among various types of woodland, urban woodland has the closest connection with urban dwellers. Urban woodland, with an area of at least 0.3 ha, is a part of cultural landscapes and locates in both periphery as well as interior of city. It is one of primary means of keeping citizens in touch with nature and natural processes [1]. Urban woodland can provide a distinct forest climate, specific habitat conditions and multiple benefits from their ecosystem services for urban residents, such as health and well-being, recreation, climate regulation and hydrological balance, forestry as well as biodiversity.

Urban forest refers to the entirety of urban tree stock and it includes urban woodland as well as any other trees on both public and private land. However, because of the different concepts of "urban forest" and "urban woodland" by different scholars, it leads to the mixed use of the two terms in different scientific publications. In this paper, we regard urban woodland as tree population excluding urban park. The aims are to understand research status of urban woodland and its ecosystem services better, which can be used to facilitate urban planning and management for biodiversity and sustainability development as well. It also has the potential to benefit not only human well-being but also urban ecosystem.

In order to better understand the subject of urban woodland, we reviewed in a comprehensive inventory all the relevant scientific journal publications (subjects include both "urban forest" and "urban woodland" because of their mixed use) in Web of Sciences. We found that research on urban forest and urban woodland both started in 1970s. Based on the review, publications on urban forest (from year 1973 to 2019) and which on urban woodland (from year 1976 to 2019) were identified. Then we selected the journal publications that are actually urban wooland related. Moreover, we analyzed the selected publications focus on urban woodland and splitted them by 19 keywords ("ecosystem service(s)", "biodiversity", "landscape fragmentation", "vegetation structure", "habitat (conservation)", "fauna", "flora", "water", "soil", "air purrify", "climate regulation", "carbon storage", "health", "well-being", "nature experience", "safety", "noise", "recreation", "timber production",) as well as 6 research strategies/methods ("GIS", "remote-sensing", "measurement", "case study", "landscape scale", "investigation") and 4 targets ("management", "planning", "assessment", "theory"). The results showed:

1) the numbers of publications on urban woodland rise slowly, with its peak in 2016. Researchers from USA contributed most, followed by those from European countries and China. However, investigations on this subject in developing countries are mostly absent.

2) We also found that most commonly studied topics on urban woodland were related to "biodiversity", followed by "flora" and "habitat (conservation)". Meanwhile, "management" was the hotspot target and the most commonly strategy/method was "case study". Furthermore, research on "ecosystem services" of urban woodland is less published, especially on "safety" and "carbon storage".

3) There exist large differences in the level of recognition, policy and management of urban woodland among different countries. Many European coutries such as Germany and Denmark have a good concept of using, conserving and developing local urban woodland resources. Many cities in North America also have a series of planning and management systems for urban woodland. However, many urban residents, e.g. in Chinese cities, are more likely to visit urban green spaces with completed infrastructure such as urban parks than to visit urban woodland due to longer distance and doubts about the safety of woodlands, although China has a very long tradition of living in harmony with nature (regard human beings as a part of nature) which supports the integration of woodland into urban stettings.

Acknowledgments: This work was supported by China Scholarship Fund.

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ORAL SESSION

B.1.6

Outdoor recreation participation in Istanbul, Turkey: An investigation of frequency, length, travel time and activities

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Keywords: Outdoor Recreation, Recreation Area, Travel Time, Activities, Istanbul

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Although outdoor recreation participation has been studied extensively, little research has come from megacities and from less developed regions of the world. This paper examined outdoor recreation participation and its predictors in Istanbul, an increasingly urbanized and populated megacity, in Turkey. The results show that outdoor recreation in nature is quite common. Nearly half of the questioned had visited a nature area at least once a week or more often, nearly three quarter invested a long travel time to these areas of between 30 minutes to 2 hours, about two third spent longer than 2 hours at the area, and about one third is simply leisurely walking there. The frequency of visits was almost the single predictor of travel time. Visit frequencies were predicted by the travel time and visit length. Activity type and traveling longer than 2 hours predicted the length of visits. Recreational activity type was predicted by visit length and travel time. Age, gender, occupation and socio-economic status (SES) level of resided district were not associated to outdoor participation.

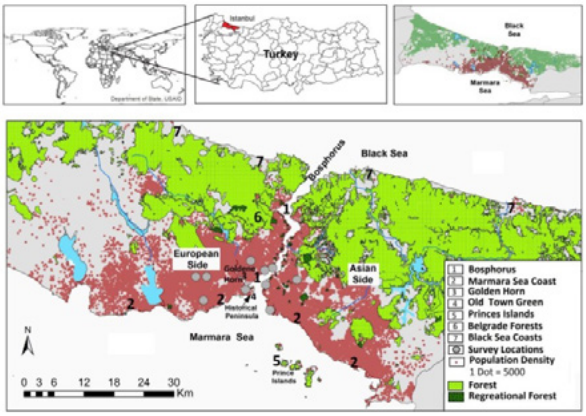

Figure 1. Distribution of outdoor nature recreation area in Istanbul (own elevation)

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Avian species richness decline along a tropical urbanisation gradient in Bangkok (Thailand) and possible ways for mitigation

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South-east Asia is one of the world's most rapidly urbanising regions, for example Bangkok's population has grown from 6.4 million in 2000 to 10.4 million in 2019 with resultant urban expansion substantially reducing vegetation cover. Whilst it is well established that avian species richness is lower in highly urbanised locations the answers to two key equations remain equivocal. First, in temperate regions and at fine spatial scales avian species richness tends to peak at intermediate levels of urbaniation. This pattern is attributed to higher habitat diversity in these sub-urban regions, but it is unclear if such patters arise in tropical regions. Second, the extent to which habitat restoration in urban areas can promote higher species richness is uncertain. Whilst many bird species are highly mobile and can colonise distant habitat patches colonisation potential may be reduced by surrounding intensively urbanised land, and habitat quality in such patches may be lowered by pressures from the surrounding urban matrix. Here, we assess spatial patterns in avian species richness and the composition of avian assemblages along and urban to rural gradient throughout the Bangkok region using repeated point count data (visited 3 times during March to July 2018) from 150 1km x 1km grid cells selected using random stratification across the gradient. In each cell, point counts were conducted in a randomly selected location and within the largest available patch of woodland or trees. We contrast avian assemblages in these two locations along the urbanisation gradient to provide a proxy of the potential for increasing urban tree-cover to enhance avian communities. Over 140 bird species were detected across all survey points. Avian diversity in woodland patches was consistently higher than in randomised locations. Althrough bird species richness declines linearly with increasing urbanisation intensity, the beneficial impacts of woodland patches appear to be maintained across the urbanisation gradient. Urban avian diversity will thus be adversely impacted by urban development but there is considerable potential to mitigate these impacts by increasing tree densities within urban greenspaces.

ORAL SESSION

B.2.2

Identification and designation of critical urban wildlife habitats based on heat map of bird species-case study of A River basin master plan in China

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Keywords: Urban wildlife habitats, urban biodiversity, heat map

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Designation of critical wildlife habitats outside nature reserves based on the analysis of biodiversity is significant to the establishment of urban ecological protection network. In this paper, a method of identifying and designating critical wildlife habitats based on heatmap of birds is discussed based on the case study of the master plan for ecological convervasion and high-quality development of Qi River Basin in Henan Province,China. Qi river originates from Taihang Mountain and flows through the City Hebi with 83 km. The river water quality meets the requirement of national class II water quality standard all the year round and is currently the least polluted river in northern China. Diverse habitats and rich species are found in the river basin.However, with rapid urban and rural development, the habitats have become more vulnerable to human disturbance. Therefore, the designation of protected areas is the top priority of biodiversity conservation in the new master plan.

Based on the data of Hebi branch of wild bird Association of friends of nature for more than 10 years, combined with field investigation of the planning team, birds, especially waterfowl, are taken as indicator species, and the average home range of six ecological types of bird species, namely, swimming bird, wading bird, raptors, songbirds, land birds and climbing birds, is taken as the activity radius. The heat map analysis is carried out to identify the bird habitat hotspots in the river basin. Critical habitats for protection, recovery and restoration are defined, and the protection and restoration measures are put forward respectively. Biodiversity indicators, continuous monitoring mechanism with organized citizen science and experts' survey as well as detailed action plans are also proposed.

The results of birds' heatmap identification also support to define the benchmark width of ecological control line along the river waterfront, and further put forward the negative list and positive list to control human behaviors, so as to avoid the negative impact of urban- rural development on the habitat and to realize the harmonious coexistence of human and nature.

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Local and landscape factors influence urban ground dwelling arthropods in non-recreational green spaces

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Keywords: remnant sites, arthropods, vienna

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Within rapidly growing cities, non-recreational urban green spaces (NRGS), which are not accessible for citizens (e.g. vacant lots), can be valuable habitats for arthropods [1,2]. Although it is known that NRGS can contribute to arthropod diversity [2], studies are rare and little is known about how environmental factors affect arthropods on NRGS, especially when they differ in management, isolation, and site history.

The aim of this study was to evaluate whether vacant lots, green roofs and railway embankments differ regarding activity density, order richness, order diversity and order composition of ground dwelling arthropods and to assess the influence of local and landscape scale factors on arthopods' response in Vienna, Austria.

We collected arthropods with pitfall-traps and identified them to order level. Further, we quantified vegetation cover and measured temperature at the local level and characterized the surroundings of NRGS at the landscape level. The data were analyzed using ANOVA, NMDS and GLM.

Between April and June 2019, we collected 12 orders of arthropods. Collembola made up 90% of all individuals, followed by Formicidae, Sternorrhyncha, Araneae and Thysanoptera. Green roofs had the lowest order richness and vacant lots had twice as much activity density when Collembola was excluded compared to the other NRGS. There were no differences regarding activity density (when Collembola was included), order diversity and order composition.

Local factors were more important for activity density, order diversity, order composition and for Collembola. In contrast, activity density excluding Collembola was only affected by landscape scale factors: homogeneous green spaces within 250 m had a negative influence and within 500 m a positive effect. Order richness was not affected by any environmental factor.

Activity density, order diversity and order composition were influenced by the high occurrence of Collembola and hence highly affected by open ground since Collembola prefer less dense vegetation [3].

The surroundings at the landscape level were more important for activity density excluding Collembola because the most common orders in this study had high dispersal abilities. Homogeneous green spaces within 500 m were valuable stepping stones for urban arthropods, whereas within 250 m the occurrence of heterogenous green spaces was more important as they can be considered an extension to the local habitat.

The differences between vacant lots and green roofs and railway embankments regarding overall activity density when Collembola was excluded might be driven by complexity of ground cover and plant species richness as vacant lots might offer different patches of successional stages (where the former building was removed) and have already a high variety of garden plant species.

These results show that NRGS contribute to ground dwelling arthropods in Vienna and future urban planning should manage NRGS with complex ground cover to offer a mosaic of different patches of open and dense vegetation.

Table 1. Impact of environmental factors on activity density with (AD) and without Collembola (AD-C), order richness (OR), order diversity (OD) and the difference among NRGS.

	AD	AD-C	OR	OD
Open ground	6.791*	-	-	-6.515*
Veg. diversity	-0.293*	-	-0,855	0.384
Mean temp.	0.160*	-	-	-
Het. green (250)	-	-	-	-11.941
Het. green (500)	2.420*	-	-	-3.267*
Hom. green (250)	-	-4.104*	-	-
Hom. green (500)	-	1.635*	-	-3491
Green roof	-	-0.818*	-6.040*	-0.480
Railway emb.	-	-0.740*	-2.651	-0.943

*significant influence of an environmental factor and differences to the baseline: vacant lot.

Acknowledgments: This work was supported by the ÖBB and the landowners/or caretakers which gave us access to their premises.

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ORAL SESSION

B.2.4

Protection of ruderal vegetation habitats in post-industrial recreational areas as a way of increasing biodiversity through natural succession

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Keywords: protected postindustrial biodiversity, natural succession, educational recreation

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For centuries, Upper Silesia was an arena for the development of heavy industry. Mostly ruderal vegetation usually developed in degraded areas. They are habitats for many species. Some of them rare and even strictly protected. This proves the favorable process of naturalization of the resulting greenery. As a result of strong development pressure, many valuable leisure places are replaced by housing development. There is a way to protect them in the form of protected ecological use or a natural landscape complex. The presentation discusses the basics and effects of such activities that are carried out in Świętochłowice in the years 2002-2021.

The first ecological site established in 2003 in Świętochłowice was Foryśka Pond (5.5 ha) [1]. The site includes a pond and a meadow next to a housing estate. Near the pond, is coal heap with tree stand consisting of poplars. There are allotments nearby. 74 species of vascular plants have been identified in the area. Ruderal species dominate here. Only 11 species of birds have been observed here with the Eurasian Penduline Tit. Red-eared turtles introduced here, are observed as a treat. Some street furniture and educational boards were put here. The protection of the area stopped the tendency to develop the area with garages. Although it is not a particularly rich place, it is an important element of the local nature and serves the residents.

The second ecological use is the "Las na Góra Hugona" (17.0 ha) established in 2004, the area of post-mining heaps, dumps, and a quarry with an interesting relief. 110 species of vascular plants have been recorded here. The succession process developed here mostly the oak-hornbeam forest with a large share of ruderal plants. The protected orchid *Epipactis helleborine* appeared here. There are 92 species of vertebrates here. The birds have been observed here, among others, the kingfisher *Alcedo atthis*. Various species of frogs can be found here, newts and toads. Educational path boards have been placed there, but they are still being destroyed. The threats here are motorcyclists and users of quads and the fact that a compact housing estate is being built on the edge of the site.

The third area is Lasek Chropaczowski (13.4 ha) established in 2009 [2]. The riparian forest in the center of the area is especially valuable. In the northern part there is oak-hornbeam trees, and in the southern part grove of poplar hybrids. The area is nicely sculpted due to the remains of industrial embankments. 95 species of vascular plants have been identified here including *Epipactis helleborine*. There are frogs, toads, newts and the grass snake *Natrix natrix*. Only 19 species of birds have been described here, incl. the oriole *Oriolus oriolus*. Bats also nest there. Protection in the form of ecological use has secured this area against the expansion of residential buildings.

In 2021, the "Lipinka Valley" nature and landscape complex (40.9 ha) was established [3]. It is a place with a post-zinc heap, the remains of coal mines, and a natural watercourse. The waters contaminated with heavy metals are purified by reeds so that at the edge of the complex live in this water the caddisflies *Trichoptera* and young fry, which are the food of kingfishers. There are 387 species of vascular plants with, among others, protected orchids. There are 47 species of birds including the tawny owl *Strix aluco*. Many other animals too. The area of the complex is located between the districts of Lipina, Chropaczów and Godula, and is used for leisure. Unfortunately it was devastated by off-road vehicles. The site of the strictly protected *Epipactis palustris* was nearly destroyed. Motorcyclists ran over the surface of the zinc heap, creating clouds of toxic dust. It is the only place of this type in Świętochłowice and unique in the scale of the agglomeration. The conservation project also included recreational and educational infrastructure. Apart from valuable nature, there are remains of probably the largest zinc smelters in Europe and bunkers from the Second World War.

It is necessary to preserve green areas with potential for biological diversity. Sometimes the elements of greenery are ready, but it is necessary to assign them such a role, because treated as wasteland, they are devastated and can be lost.

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Small animals in discarded containers – understudied ecological trap in urban forests

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Keywords: littering, microhabitat, urban ecosystem

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Nowadays, littering is one of the biggest challenges facing environmental conservation. Among waste, beverage containers, such as bottles and cans, belong to these most common threats [1]. Although negative effect of containers on animals was noticed soon after their emergence in the environment (middle of XX. century [2]), so far this issue has been poorly studied.

The aim of this study was to assess: a) diversity of animal taxa attracted by discarded containers, b) mortality level of trapped animals, and c) likeliness of adapting discarded trash as an alternative microhabitat.

The study was conducted in 10 urban woodlands in the city of Wrocław, Poland. In total, 939 open containers were collected, including 792 bottles, 146 cans and 1 cardboard box. Among them 37% were inhabited by live animals. In 56% of containers a total number of 10162 dead individuals was found. The most common were Insecta (orders: Coleoptera, Diptera, Hymenoptera), Malacostraca (Isopoda), Arachnida (Opiliones, Sarcoptiformes) and Gastropoda (Stylommatophora) (Fig. 1). Dead individuals included also 23 vertebrates: small mammals, reptile and amphibian, which were found in 16 (1.7%) containers. We also noted that discarded containers are used by animals directly: as granary (small mammals), nest (ants), breeding (e.g. flies), feeding (e.g. snails), and hiding sites (e.g. spiders), as well as indirectly: as nest (ant nest in empty shell of previously died snail), breeding (e.g. silphids breed in containers with dead mammals), and feeding site (e.g. spiders prey on trapped animals).

Our study revealed that discarded containers may serve as microhabitats for various animals, however for most of them they became a deadly trap [3,4]. To reduce this problem, we strongly suggest to organize repeatable cleanup and education actions. There is also an urgent need to implement new container deposit legislation.

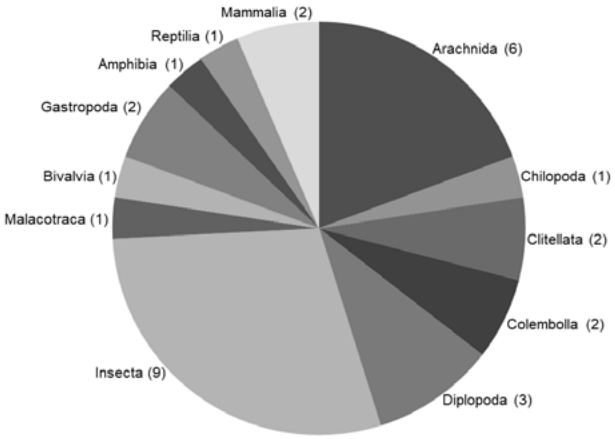

Figure 1. Number of orders per class threatened to getting trapped in discarded containers.

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ORAL SESSION

B.2.6

Wild mammals and urbanities: Investigating human perceptions of urban wildlife for urban planning and biodiversity conservation

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Keywords: Urban Wildlife – Human Perception – Urban Greenspace Planing

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Animals in human settlements were needed for food, wool production, farming and as companions [1]. However, some animals followed into residential areas without being desired [2;3]. With increasing land take due to urbanization, transportation and agriculture, natural habitats for a variety of animals are decreasing [4], and some start to settle in urban areas [5-7]. There, they benefit from food waste, lack of hunting, and low numbers of predators [1]. Their presence causes controversy, as some citizens believe that wildlife does not belong in cities [5], while others actively enjoy observing them [3;4]. While some animals are associated with health threats and damage, e.g. rats (*Rattus rattus*) and wild boars (*Sus scrofa*), others are seen as positive for living in cities, e.g. squirrels (*Sciurus vulgaris*) [1-3]. Next to these, foxes (*Vulpes vulpes*), hedgehogs (*Erinaceus europaeus*), stone martens (*Martes foina*), deer (*Capreolus capreolus*) and wild rabbits (*Oryctolagus cuniculus*) were focused in this study. Aditionally, raccoons (*Procyon lotor*) and coypus (*Myocastor coypus*) were included as invasive [8;9], brown hares (*Lepus lepus*) as threated [10] and beavers (*Castor fiber*) as reintroduced/returned species [11;12].

To protect and provide habitat for species in urban areas, human-wildlife relationships need to be understood and addressed in urban planning [13;14]. For this purpose, 37 experts from city administration, hunting and nature conservation in four German cities (i.e. Berlin (B), Hamburg (H), Munich (M) and Cologne (C)) were interviewed in 2020 about their views on benefits of/conflicts with urban wildlife. Recurring elements were “that people do not accept untidy green spaces, which would be good for animals” (B5). Often this might due to “lack of connection to nature. anything about ecosystems and green spaces come with wildlife” (B7). In addition to education, “wilder” greenspaces could promote coexistence and engage citizens with the topic (e.g. C6). The interviews were combined with a nation-wide web-based survey among German residents (with in total approx. 3,000 responses). Respondents in all cities considered squirrels as most and wild boars as least desirable (see Fig. 1).

While understanding human-wildlife relationships is gaining increasing attention, it is particularly crucial in human dominated landscapes; i.e. particularly when it comes to urban ecology. Only with societal engagement, multispecies planning and agreed measures can coexistence work and lead to more biophlic cities.

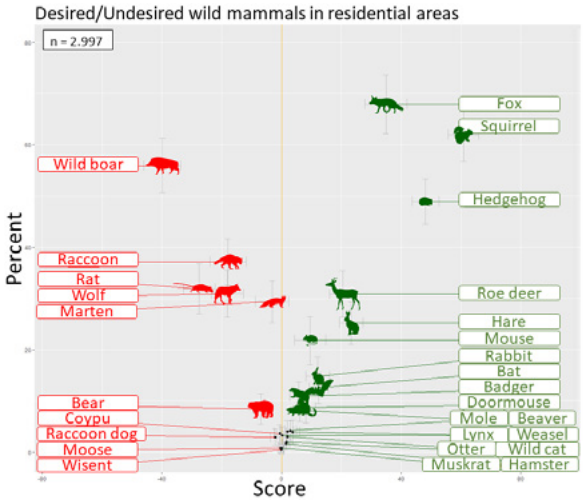

Figure 1. Like and Dislike of wildlife in residential areas

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Ecosystem Service of Pollination. Evaluation of potential wild bee habitats in an urban area

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Keywords: biodiversity, functional traits, urban green infrastructure

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Protecting pollinators such as insects benefits both biodiversity and agricultural food production. Wild bees are considered as some of the most effective pollinators. However, in Germany the ecosystem service of pollination is at stake as insect populations decline [1]. Wild bees suffer amongst others from scarce foraging and nesting places especially in highly intensified agricultural areas which are characterized by a simplification of the landscape with only few semi-natural elements like hedges and extensive grassland being left. These semi-natural elements provide important nesting and foraging habitats if they are sufficiently connected.

To assess the status of wild bee habitat in the EU, an expert-based evaluation model by Zulian et al. (2013) was developed displaying the habitat potential of wild bees [2]. This model uses CORINE land cover data (CLC) and the outcome is a map of potential wild bee habitats with a spatial resolution of 25 m. Each ecosystem type (CLC-class) was evaluated regarding its potential provision of flowers, nesting habitats and connectivity regarding to small solitary wild bees who can cover a flight distance of approximately 200 m. Based on this model, a habitat potential map for wild bees was created specifically for Germany with a resolution of 5 m, using data of the German land cover model LBM-DE which has a minimum mapping unit of 1 ha. Additionally, small linear elements from the official topographic-cartographic information system ATKIS were integrated [3].

The final map of habitat potential shows drawbacks in the areas of cities, as the CLC-class nomenclature in cities is rather coarse and small green elements are not sufficiently detailed, leading to an underestimation of the habitat potential in these areas [2, 3]. Cities can harbour a high diversity of different bee species. In contrast to many other pollinating insects, bees can adapt to the patchy distribution of foraging and nesting possibilities within urban areas. They benefit from both maintained urban green areas, fallow land, urban trees, and small patches of vegetation in the city [4, 5].

However, some bee species with specific functional traits can cope better with urban habitats than others. Due to the large-scale sealing of surfaces in cities and scarcity of rare plant species, soil nesting species and pollen-specialists are under-represented within the urban wild bee fauna. Cavity-nesting species, however, find nesting opportunities in buildings and other human made structures in highly sealed areas, and generalists can make use of the large variety of native and non-native plant species [4]. So, in the further development of the habitat potential map, it can be useful to consider the filtering effect of the urban environment on the occurrence of wild bee species with different functional traits.

However, it is difficult to generalize the effect of urbanization on bee species because studies, investigating wild bees in urban areas, use different designs and sampling methods [6]. Since 2019, an extensive sampling scheme of wild bees has been conducted in the city of Braunschweig and its hinterland [7] and meanwhile includes more than 100 sampling plots. These unique efforts offer the possibility to measure the predictive capacity of the existing habitat map [2] for this city and its rural hinterland and to improve the validity of the model.

This presentation will show the modelling approach of assessing potential floral availability and nesting sites from CLC data. Furthermore, the contribution will outline current knowledge of the effect of urbanization on bee species. Finally, first conceptual ideas are presented how to assess the validity of the habitat map in the case of Braunschweig and its hinterland.

As cities have the potential to act as a refuge area for specific wild bee species which often find less hospitable conditions in intensified agricultural areas, urban spatial planning should be more focused on conserving green habitats to protect the ecosystem service of pollination. The consistent field samplings in Braunschweig are an appropriate basis to improve the spatial detail of the model and to differentiate between various wild bee functional groups for an urban area and its rural hinterland.

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ORAL SESSION

B.2.7

Growing in the city: urban evolutionary ecology of avian growth rates

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Keywords: *urbanisation, growth rate, birds*

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Rapid environmental change driven by urbanisation offers a unique insight into the adaptive potential of urban-dwelling organisms [1]: indeed, urban areas are characterised by patches of contrasted habitat distinct from each other by a suite of other biotic and abiotic factors, all of which have the potential to induce distinct selective pressures on urban dwelling organisms [2]. Despite mounting evidence for urban-driven phenotypic differentiation across taxa, commonly measured in terms of morphological life-history shifts [3], knowledge of the impact of urbanisation on offspring developmental rates and subsequent survival is to date very limited. In addition, the role of selection on urban-driven phenotypical divergence remains poorly understood [4], [5], [6]. Here, we studied nestling development in a gradient of urbanisation set in Warsaw, Poland, in two nestbox breeding passerine species: great tits (*Parus major*) and blue tits (*Cyanistes caeruleus*). Each nestbox in the study system was assessed for surrounding percentage of Impervious Surface Area (ISA): ISA constitutes a convenient proxy of urbanisation as it covaries with a large array of urban-driven axes of environmental variation: positively with temperature (urban heat island effect), sound and light pollution, and negatively with tree cover and distance to roads [7]. Importantly, characterising urbanisation at specific locations (such as nestboxes) with fine-resolution ISA data from remote sensing, allows for straightforward comparisons of the magnitude of ISA-driven biological effect sizes between studies [7]. Weight measurements of individual nestlings were collected during three breeding seasons and at different ages of development. Even though the asymptotic mass and the growth rate were not associated with ISA, the age of fastest growth (*i.e.* inflection point) of both species was delayed in nests characterised by higher levels of ISA in their vicinity. Furthermore, nestling body mass decreased with higher percentages of ISA around the nestbox: specifically, this association was consistently negative in 5 and 10 days old great tits and in 10 and 15 days old blue tits. Importantly, in both species, the survival of nestlings in mid-development (between day 5 and day 10) was negatively associated with the level of ISA. Although survival in 15 days old nestlings did not depend on ISA, our results suggest that ISA-driven selective mortality occurs at the age of maximum food demand (when tits are *c.* 10 days old [8]). Finally, an analysis of selection differentials performed for three levels of ISA (low, middle and high) revealed a positive association between mass at day 2 and survival at fledging: in particular, the strength of selection for heavier nestlings at birth increased in high-ISA environments. Our study highlights the considerable impact of imperviousness, here used as a proxy of urbanisation, on offspring development, body mass and survival and demonstrates increased selection on avian birth weight in high ISA environments.

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Modernistic large housing estates in Central Europe as urban refuges of floral biodiversity

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Keywords: biodiversity, gardening management, greenery architecture, green infrastructure, landscape ecology

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With the development of cities, the anthropisation of vegetation in urbanized space is progressing. This results in biodiversity loss and associated biotic and functional homogenization. These three processes are particularly intense in densely built-up and highly populated cities. The counteraction of anthropisation is to maximize the biodiversity of urban ecosystems through nature best solutions. The EU Biodiversity Strategy for 2030 is the mandate for such solutions. Its aim is to halt the loss of biodiversity by all possible means. Many public green spaces have a large biodiversity capital, including rich resources of native plant species. In Central and Eastern Europe, these include green spaces accompanying large-scale modernistic housing estates of multi-dwelling buildings (blocks). In Poland, they were built in the 1960s to 1980s, according to the guidelines of the Athens Charter Constatations. Today, about 40% of the national population lives in these buildings. Flats in blocks are sought after on the real estate market, among other things, because of the large amount of greenery among the blocks. Modernistic housing estates of Western Europe on the one hand and, those of Central and Eastern Europe on the other hand, despite their implementation in different socio-economic conditions, have many common features. These include e.g. peripheral location and large green areas around the buildings based on the greenery standard 9.5-14 m^2/per capita. Scientific research has shown that both these features generate a state of floral biodiversity.

The end of the Real Socialism era began a period of housing investments in market economy. In modernistic housing estates, there is an urban densification of development at the expense of green areas. The architectural compositions of vegetation lose their original features and spontaneous vegetation loses its natural potential. So far, no one has explored this potential. The threat of housing densification has inspired geobotanical research to fill this knowledge gap. The programme 'Poznań Modern Estates' is being implemented in Poznań. Its aim is to promote Poznań's urban planning thoughts and, through the entries in local spatial development plans, to protect historical model spatial systems from the 1960s -1980s. The research procedure of our studies was prepared in such a way as to show the biodiversity pattern for urban units covered by this program.

In the years 2017-2020, research was conducted on the plant biodiversity of green areas in modernistic large housing estates (blocks-of-flats) in Poznań (Poland) and Salzburg (Austria). The former, represents the model of real socialism, while the latter a market economy model. The paper will present the results of the following research tasks: 1/ floral biodiversity (plant species richness and diversity) of spontaneous vascular flora of the large housing estates, and urban parks (with reference to Borysiak et al. 2020) - based on field mapping; 2/ natural value of the flora found; 3/ relationship of plant biodiversity with architectural composition of greenery. Recommendations will also be made to urban planners and greenery architects to, not only protect against the loss of the existing plant biodiversity, but, also, to increase plant natural resources. One of such recommendations is to enrich residential and park green areas with structures related to the different stages of biocoenotic succession. It is also recommended to change the standards of gardening management, based on the knowledge of plant autecology and chorology, phytosociology and vegetation dynamics.

The research has shown that the vegetation in green areas of modernistic estates in both Poland and Austria have a significant contribution to urban plant biodiversity. This is due to the low degree of anthropisation of the vegetation. Large green spaces offer the possibility of introducing new ecological structures to enhance floral biodiversity. Both the quantity and the ecological quality of greenery in modernist blocks of flats estates are a good model for planning new urban units with large housing estates.

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ORAL SESSION

B.3.3

Biodiver-city responses to urbanisation: a multi-taxon approach in a coastal mediterranean city

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Keywords: urbanization gradient, land cover

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Urbanisation is one of the main drivers of land-use change and biodiversity loss, as it induces severe environmental changes and habitat fragmentation. However, urban areas retain the potential to support diverse communities, on condition that suitable habitat patches occur.

The current study investigated how biodiversity responds to urbanisation in a medium-sized densely built Mediterranean city (Patras, Greece), following a multi-taxon approach. It aimed to disentangle the effect of landscape composition (land cover) and specific habitat characteristics on bird, butterfly and bat diversity patterns and community composition along an urbanisation gradient.

For this, the study area was stratified into three zones of decreasing built cover that was derived from the Urban Atlas [1]: urban (> 50% b.c.), suburban (30-50% b.c.) and peri-urban zone (< 30% b.c.). Sampling sites were randomly selected and evenly distributed along the urbanisation gradient.

Breeding and wintering bird communities were sampled with 10-min point counts, butterflies were surveyed with 300-m transects in spring, and bats with 300-m transects during the post-breeding season.

Land cover (i.e. buildings, impervious surfaces, woody vegetation, open green spaces with grass and herbs, and water bodies) was assessed for each sampling site. Moreover, local habitat characteristics were assessed for butterflies, i.e. plant species richness, flower and larval host-plant abundance, and vegetation height. Additionally, temperature, relative humidity, the number of streetlamps and distance to the closest water body were measured for each bat sampling site, as these factors were expected to influence bat activity.

Non-parametric tests were employed for diversity comparisons among the urbanisation zones. GLMs and GLMMs were used to examine the effect of land cover and habitat characteristics on bird and butterfly, and bat diversity, respectively. Ordination techniques were used to investigate the relationship between community structure, and land cover and habitat characteristics.

Overall, a negative effect of urbanization on biotic communities was found. The response differed among the studied taxa. Bird diversity increased along the decreasing urbanisation gradient and peaked in the peri-urban zone. The wintering bird community was more diverse than the breeding one in the urbanised areas, indicating that the urban environment provides feeding and perching opportunities for wintering birds. Open green spaces were found to be very important for breeding birds, while woody vegetation and impervious surface cover were positively associated with the wintering community.

Butterfly diversity was generally low in the urban and suburban zones but increased significantly in the peri-urban zone. Built-up areas affected diversity and community structure negatively, while the effect of local habitat characteristics was negligible, likely implying a strong influence of landscape features.

Bat diversity in the entire study area was generally low, suggesting a negative effect of urbanisation. One synurbic species (*Pipistrellus kuhlii*) dominated the community (> 70% of the total recorded bat activity). A positive relationship between built-up areas and bat activity was found, probably because this species usually forages around streetlamps in built-up areas. Other bat species occurred occasionally, and particularly close to the few remaining natural or artificial water bodies.

The findings of the current study underline the generally negative effect of the built-up areas for most taxa. Management initiatives and practices should target at the maintenance of a network of suitable habitat patches across the entire urban environment and at the restoration of the few remaining urban green spaces and water bodies.

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Integrated nesting aids into façades for wild bees – a case study in Stuttgart, Germany

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Keywords: experimental building physics, urban ecology, wild bees

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Intensive agriculture, deforestation, sealing of green spaces and structural impoverishment are among other things reasons for the global decline in biodiversity. In particular, the loss of insects is enormous.

The built environment, (especially vertical surfaces) is a possibility that has been severely underestimated to date. More attention should be paid to the opportunities in these areas. Although previous literature has recognized, that green areas have benefits on the microclimate, the physiological wellbeing, the abundance and diversity of fauna, the vast majority of buildings are still not biodiversity friendly. Buildings with smooth concrete or glass surfaces, without openings or any greenery are nowadays state-of-the-art in contemporary architecture. An increase of sealed and built-up areas, as well as high-tech and smart buildings, are existing long-term trends, which require many resources and are usually neither sustainable nor biodiversity-friendly. The Intergovernmental Platform on Biodiversity and Ecosystem Services' (IPBES) published in 2019 a report, that estimates about one million species are threatened worldwide. These calculations include nearly 550,000 threatened insects, which account for 75% of all species [1]. Although urbanization is a main driver for the loss of biodiversity, many species frequently occur in cities. However, especially compared to intensively managed agricultural areas, cities can function as nature reserves [2]. Artificial nesting boxes help birds and bats to adapt to changes in their habitats. Insects, with their enormous importance for humans as well as for insectivorous species, are often even completely ignored. Urban development that creates new habitats, e.g. in the building envelope, could be a puzzle piece in supporting urban biodiversity.

There are a lot of parameters and interactions that influence acceptance of artificial nesting aids by people and by insects, too. Impacts are among others building physical behavior of the exterior wall, forms of greenery, especially flowers as source of pollen and nectar, social and ecological requirement. Residents and insects alike have certain physical comfort zones that have to be considered. Additionally, the surrounding, like flowering vegetation, habitat types and structure matter in case of insects.

Pre considerations in this investigation were among other things the research of common construction-types in Stuttgart, as well as certain environmental limitations of selected target species (hymenoptera/APIDAE). This lead to 3 different test setups in 2 locations (in total 6 test setups). Each includes 4 nesting-aid materials which are measured continuously and in samples.

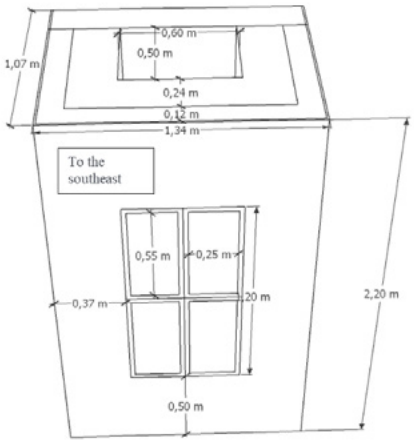

Figure 1. Exemplary test setup with thermal insulation system (ETICS) including 4 different materials of integrated nesting aids for wild bees.

The ecological parameters are reported all 2-3 weeks. First results of measurements will be demonstrated. Furthermore, some results of a survey on acceptance and awareness of integrated habitat systems for insects will be presented. The majority of the interviewees welcomed species protection measures, provided that the absence of claims could be proofed. Moreover, future research needs will be discussed, especially on the socio-ecological and technical level. Only by taking into account civil society and ecological requirements integrated habitat systems for insects will achieve their goal.

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ORAL SESSION

B.3.5

Bees Beneath Your Feet: Urban Sidewalks as Novel Urban Ecosystems and Habitat for Aculeate Insects

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Keywords: Aculeata, novel urban ecosystems, pavement interstices, sidewalk cracks, urban wildlife

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Berlin's Strategy to Protect Bees and other Pollinators was launched in 2018, building on long and intense efforts to preserve existing places of wilderness and foster biodiversity in the city. For Berlin residents, this shift is visible in the roadside grasslands that are left to bloom and grow where tidiness used to prevail, and in designated flowering areas popping up in many places. But people might not only be passing by pollinators flying around grass verges along sidewalk more often in the future; they are already walking on top of them, nesting in the pavement cracks beneath their feet.

In a pilot study, we assess this novel urban habitat and map aculeate insects, i.e. mainly wild bees, digging wasps and ants, as well as their respective parasitoids, along an urban gradient in Berlin, with a focus on the urban heat island effect, soil qualities and pavement characteristics. Identifying wild bees or digging wasps that nest beneath the pavement typically involves hours of careful observation and catching them at the right moment. Data on pavement-dwelling aculeate insects is scarce: a study in Oldenburg from 1982 reported 22 species, 9 of them being wild bees [1]. Two students investigated a short transect of next to our institute and identified 16 species in total, including 6 species of wild bees [2]. To achieve such an inventory at a larger scale and over a longer period of time, we are currently experimenting with DNA barcoding from soil samples that are collected from nesting entrances.

While there are a number of studies focusing on urban sidewalk vegetation [3] and the hashtag #krautschau (german for 'weed exhibition') has gone viral, there is currently neither research on nor awareness of urban pavements as potential habitat for wild bees and other insects. Human settlements can support high biodiversity [4], and the need to integrate biodiversity into urban planning and upvalue novel urban ecosystems is evident [5]. Pavements, built entirely for the need of humans, have been in the focus of research on sustainable cities mainly with respect to their sealing and heating properties [6]. Our project addresses several questions: what is the 'ideal' urban pavement from the perspective of urban climate resilience, and can pavements be sustainably designed to consider biodiversity as well? What is their contribution to urban ecosystem services? How variable are pavements in their capacity to support subterranean digging insects, and how diverse are they in cities around the world?

Figure Selected pavement-dwelling insects, including the two most 'iconic' and common ones in Berlin: the Pantalon Bee, Dasypoda hirtipes, and the European Beewolf, Philanthus triangulum.

Now it's you who we would like to ask: What is your favourite pavement crack and sidewalknesting site in your city? Did you ever observe insects nesting there? We highly welcome photographic and anecdotal observations!

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The biogeophysical and socioeconomic drivers of biodiversity across metropolitan areas in North Carolina, USA

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Keywords: city systems, eBird, urban biodiversity

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The 21st Century will be known as the Urban Century, for North Carolina and the world. Between 2010 and 2020, North Carolina's population is projected to increase by more than 1 million people (11%), the majority of whom will reside in the Charlotte, Research Triangle, and Wilmington metropolitan areas. It is unclear to what extent this pattern of urbanization will impact the biodiversity of these areas given their varied biogeographic and socioeconomic contexts. A better understanding of the functioning of urban systems in terms of the relative importance of drivers of biodiversity, particularly those that operate at metropolitan area or city scales, is needed to fill this gap. We set out to identify the biogeographic and socioeconomic predictors of bird diversity in the fifteen metropolitan statistical areas of North Carolina, a state characterized by a high degree of climatic, topographic, ecological, social, and economic variation. We used eBird complete checklists and publicly-available climatic, land cover, and socioeconomic data to identify the bottom-up (e.g., individual human decision-making or local habitat quality) and top-down (e.g., municipal plans and policies) forcings on biodiversity across metropolitan areas. We found a signficant interaction between metropolitan area human population size and landscape habitat amount on bird species richness. Landscape habitat amount had a positive effect on species richness in the largest metropolitan areas, a negative effect in medium-sized metropolitan areas, and no effect in the smallest metropolitan areas. Our investigation of multiple and interacting socioeconomic and biogeophysical drivers of biodiversity across urban areas has the potential to reveal new patterns and mechanisms of urban system functioning and to generate ground-breaking new research questions. Comparisons across urban areas may lead to more rapid identification and diffusion of „best-practice" policies that cost-effectively maintain and improve urban biodiversity.

Acknowledgments: This work was supported by a University of North Carolina Inter-institutional Planning Grant.

ORAL SESSION

B.3.7

Animal-aided design-bridging the gap between landscape architecture and conservation

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Keywords: Urban design, built-up area, species protection

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Biodiversity underlies many of the ecosystem services demanded by humans. For cities, the design of 'green infrastructures' or 'nature-based solutions' has been proposed to maintain the provisioning of these services and the preservation of biodiversity. It is unclear, however, how such green infrastructure can be implemented, given existing planning practices that generally ignore biodiversity. Urban open spaces are normally designed by landscape architects with a primary focus on plants, aesthetic design and functionality for human users. As a consequence, conservation of species only plays a minor role, in fact, protected animals are often considered detrimental to the design, e.g. when the need to conserve a protected species demands modifications of a building project. Conversely, conservationists are often in favor of protected areas, also in cities, with little access for humans and no human design.

We propose 'Animal-Aided Design' (AAD) as a methodology for the design of urban open spaces, to integrate conservation into open space planning. The basic idea of AAD is to include the presence of animals in the planning process, such that they are an integral part of the design. For AAD, the desired species are chosen at the beginning of a project. The requirements of the target species then not only set boundary conditions for the design, but also serve as an inspiration for the design itself. The aim of AAD is to establish a stable population at the project site, or contribute to population growth of species with larger habitats. AAD thus allows a combination of good urban design with species conservation. We illustrate our approach with designs for urban spaces in Germany.

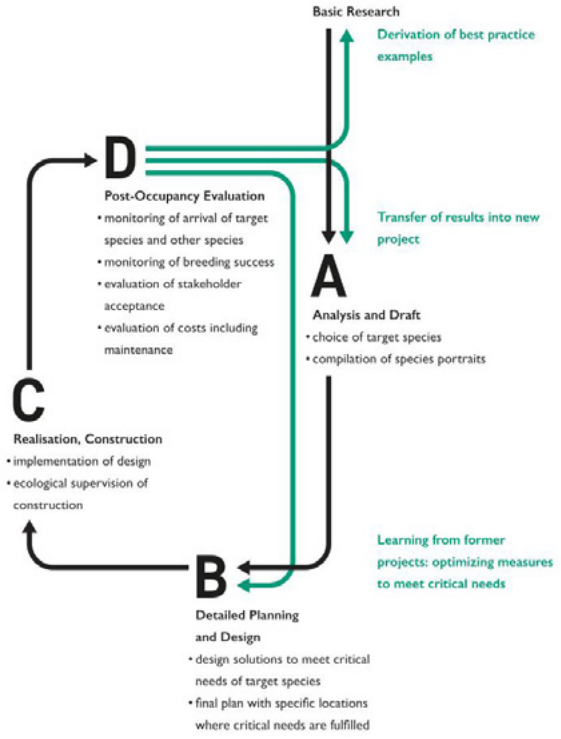

Figure 1. The planning cycle of Animal-Aided Design, listing important work steps along the different phases of the planning cycle of project-based planning (black arrows, Analysis and draft, Detailed planning and design, realisation, post-occupancy evaluation, black line). Basic ecological research, in particular on habitat requirements of the species, provides the knowledge critical for planning. Green arrows indicate how project evaluation and monitoring will improve the design future projects and inform ecological research.

Bird functional traits under urbanization – a meta-analysis

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Keywords: bird communities, urbanization, systematic review

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The terrestrial areas of the Earth have been immensely altered by urban expansion, which severely affects biodiversity and poses major challenges on its conservation [1].

We examined the effects of urbanization on bird communities via their functional traits within the frame of a systematic review using hierarchical and categorical meta-analyses. We selected five functional traits for our study: foraging technique, diet, nesting behaviour, migration status and body mass of the investigated bird species. The different bird species were studied along an urbanization gradient, where the degree of urbanization ranged from highly to less urbanized areas, rural regions were also part of the gradient. We only considered research articles from European countries, and we focused on passerine species.

In our findings, urbanization had an overall, but slight, positive effect on bird species considered as generalists in terms of the examined traits. The most negatively affected species along the urbanization gradient were those more closely related to the presence of semi-natural areas. In contrast, omnivorous bird species, such as the Eurasian tree sparrow *(Passer montanus)*, the common blackbird *(Turdus merula)* or the common starling *(Sturnus vulgaris)*, were more abundant in city centres compared to periurban areas. In terms of foraging technique, bird species feeding at ground level were more likely to occur in highly urbanized areas, because the absence of trees prevents the occurrence of species feeding on shrubs and trees. Furthermore, as nest sites are limited to buildings and other artificial cavities in city centres, cavity nesting species become dominant. Resident species, finding their resource needs throughout the year in cities, seem to profit from urban environment in contrast to short and long distance migrants. Finally, we did not find any effect on the body mass of birds through urbanization. Food and nes site availability are the most important drivers in limiting specialist species in utilizing city centres [2], therefore only species well adapted to urbanization can thrive.

Our study shows that urbanization has a positive effect on species considered as generalists, thus cities have a major filtering effect. Meanwhile specialists lose their habitat, leading to large scale homogenization and simplification of bird communities. Nevertheless, bird species traits have an important role in determining the occurrence of bird species in European cities [3].

Acknowledgments: This work was supported by the Economic Development and Innovation Operational Programme of Hungary, Grant/Award Number: GINOP-2.3.2-15-2016-00019

[1] P. Batáry, K. Kurucz, M. Suarez-Rubio and D.E. Chamberlain *Global Change Biology* 2018, **24,** 1046-1054.
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ORAL SESSION

B.4.2

Changes in bird communities of different types of green spaces along an urbanization gradient

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Keywords: community composition, functional traits, species richness

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Urbanization contributes to the decline of natural habitats resulting in species loss, and biotic and functional homogenization of communities of different taxa [1]. Green infrastructures are considered as important biodiversity hotspots in the city [2]. However, there have been no studies that have assessed how biodiversity is affected by different types of green spaces with the interaction of the increasing level of urbanization in the surrounding matrix.

In our study we investigated the effect of urbanization on bird communities (species richness, functional traits and community composition) in two major types of green spaces (allotments and public parks) along an urbanization gradient in Göttingen, Germany. We used the point-count method for bird observations. To determine the level of urbanization, we calculated sealed area percentage around green infrastructures.

Altogether we observed 1449 birds belonging to 48 species. Our results showed that urbanization did not affect species and functional diversity of birds in this mid-sized, green city. Furthermore, green infrastructure type shaped avian species richness and some functional traits. We found higher species richness as well as more tropical migrant and ground or near-ground nesting individuals in parks compared to allotments, where more cavity-nesting and resident birds were recorded. In the case of community composition, we also found differences between green infrastructure types.

As shown in *Figure 1*, species, such as European serin (*Serinus serinus*), black and common redstart (*Phoenicurus ochruros*, *P. phoenicurus*), great tit (*Parus major*), linnet (*Carduelis cannabina*) and Eurasian trees sparrow (*Passer montanus*) showed a preference for allotments, whereas species like European goldfinch (*Carduelis carduelis*), European robin (*Erithacus rubecula*), blackcap (*Sylvia atricapilla*), chaffinch (*Fringilla coelebs*), wood pigeon (*Columba palumbus*), chiffchaff (*Phylloscopus collybita*) and fieldfare (*Turdus pilaris*) were associated with parks (Figure 1).

As different types of green infrastructures can contribute to the presence of different species and functional trait variations, their positive effect on bird diversity can be enhanced when they are present together in an urban landscape. Our findings suggest that green spaces with a high variety of local characteristics should be provided in order to ensure diverse bird communities in cities.

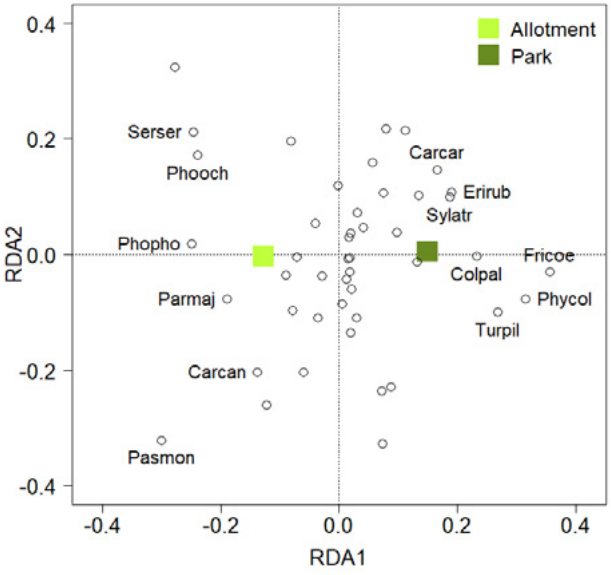

Figure 1. Effect of green infrastructure type on community composition of birds in the city based on the first two axes of a Redundancy analysis (RDA). Each point represents a bird species, abbreviated names are given for selected species (e.g. Turpil is *Turdus pilaris*)

Acknowledgments: This work was supported by the Economic Development and Innovation Operational Programme of Hungary, Grant/Award Number: GINOP-2.3.2-15-2016-00019

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[2] C.T. Callaghan et al., *Landscape Ecology* 2019, **34,** 1231-1246.

Multiscale effects of habitat and surrounding built-up areas on waterbird diversity in the Yangtze River Floodplain

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Keywords: Biodiversity conservation; Waterbird habitat; The landscape matrix; Built-up area; Urban and rural planning

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Context With the expansion in urbanization, understanding how biodiversity responds to the altered landscape becomes a major concern. Most studies focus on habitat effects on biodiversity, yet much less attention has been paid to surrounding landscape matrices and their joint effects.

Objective We investigated how habitat and landscape matrices affect waterbird diversity across scales in the Yangtze River Floodplain, a typical area with high biodiversity and severe human-wildlife conflict.

Methods The compositional and structural features of the landscape were calculated at fine and coarse scales. The ordinary least squares regression model was adopted, following a test showing no significant spatial autocorrelation in the spatial lag and spatial error models, to estimate the relationship between landscape metrics and waterbird diversity.

Results Well-connected grassland and shrub surrounded by isolated and regular-shaped developed area maintained higher waterbird diversity at fine scales. Regular-shaped developed area and cropland, irregular-shaped forest, and aggregated distribution of wetland and shrub positively affected waterbird diversity at coarse scales.

Conclusions Habitat and landscape matrices jointly affected waterbird diversity. Regular-shaped developed area facilitated higher waterbird diversity and showed the most pronounced effect at coarse scales. The conservation efforts should not only focus on habitat quality and capacity, but also habitat connectivity and complexity when formulating development plans. We suggest planners minimize the expansion of the developed area into critical habitats and leave buffers to maintain habitat connectivity and shape complexity to reduce the disturbance to birds. Our findings provide important insights and practical measures to protect biodiversity in human-dominated landscapes.

ORAL SESSION

B.4.4

Non-linearities in bird responses across urbanization gradients: a meta-analysis

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Keywords: biodiversity, suburban, systematic review

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Urbanization is one of the most extreme forms of environmental alteration, posing a major threat to biodiversity.

We studied the effects of urbanization on avian communities via a systematic review using hierarchical and categorical meta-analyses. Altogether, we found 42 observations from 37 case studies for species richness and 23 observations from 20 case studies for abundance.

Urbanization had an overall strong negative effect on bird species richness, whereas abundance increased marginally with urbanization. There was no evidence that city size played a role in influencing the relationship between urbanization and either species richness or abundance. Studies that examined long gradients (i.e. from urban to rural) were more likely to detect negative urbanization effects on species richness than studies that considered short gradients (i.e. urban vs. suburban or urban vs. rural areas). In contrast, we found little evidence that the effect of urbanization on abundance was influenced by gradient length. Effects of urbanization on species richness were more negative for studies including public green spaces (parks and other amenity areas) in the sampled landscapes. In contrast, studies performed solely in the urban matrix (i.e. no green spaces) revealed a strong positive effect on bird abundance. When performing subset analyses on urban–suburban, suburban–rural and suburban–natural comparisons, species richness decreased from natural to urban areas, but with a stronger decrease at the urban–suburban interface, whereas bird abundance showed a clear intermediate peak along the urban–rural gradient although abundance in natural areas was comparable to that in suburban areas (Figure 1). This suggests that species loss happens especially at the urban–suburban interface, and that the highest abundances occur in suburban areas compared to urban or rural areas.

Thus, our study shows the importance of suburban areas, where the majority of birds occur with fairly high species richness [1].

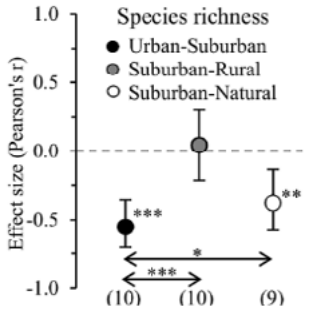

Figure 1. Subset analysis on the effects of urbanization on species richness of birds for urban–suburban vs. suburban–rural and urban–suburban vs. suburban–natural comparisons. Asterisks (*p < .05; **p < .01; ***p < .001) above effect size symbols denote a significant difference from zero (within-group heterogeneity), whereas those above a horizontal arrow indicate a significant difference between urban–suburban and suburban–rural and urban–suburban vs. suburban–natural comparisons.

Acknowledgments: This work was supported by the Economic Development and Innovation Operational Programme of Hungary, Grant/Award Number: GINOP-2.3.2-15-2016-00019

[1] P. Batáry, K. Kurucz, M. Suarez-Rubio[3] and D.E. Chamberlain *Global Change Biology* 2018, **24,** 1046-1054.

Our parks - hotspots or ecological traps for songbird migration? A bioacoustic approach employing Blackbird (*Turdus merula*) male songs

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Keywords: Blackbird song, bioindicator, urban parks

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Are our cities biodiversity friendly? a fundamental question in socio-ecological systems, the answer to which lais at the crossroads between accelerated urban development and environmental management. On that premise falls the issue of bird migration.

Songbird migratory routes stretch outside protected areas to a significant extent, frequently cutting across towns and cities. Habitat loss, rapid urbanization and city attractants urge songbirds to cross and exploit metropolitan parks as migration stepping-stones. While city microclimate and park plant composition may set the stage for adequate stopover sites, there is more to be taken into account when considering ornitho-diversity songbird conservation in urban ecosystems. Anthropogenic noise and artificial lightening are urban-specific pressures, potentially adding extra charge to an already costly event. Frequency overlap and signal disruption can have considerable impact on migrant species group cohesion and inter-individual communication, distinctly hindering migratory low-pitched songbirds. Our study was carried out in light of ex-situ conservation on migratory routes, aiming to ease habitat quality assessment, through bio-indicators. Park-preferential, urban exploiter bird species, susceptible to environmental changes in urban parks could provide relevant data relative to habitat state in urban ecosystems.

Our three-year study (2017 – 2020) assesses if an exploration of Blackbird (*Turdus merula*) acoustic adaptations can offer quick insight on urban parks sustainability as migration stepping-stones for songbirds. Throughout the study period we recorded the dusk territoriality song of male Blackbirds, to avoid dawn chorus song overlap. Recordings were taken from march till june, every two weeks, in four metropolitan parks in Bucharest, Romania (Kiseleff Park, Cişmigiu Park, Dimitrie Brândză Botanical Garden and Carol Ist Park). At the moment of recording, we simmultaneously monitored the level of background noise at the recording point. The songs were analyzed for motif syllable pitch and note duration with Raven-Lite software. For songbird migration data, point counts and transect monitoring were used to identify and assess songbird populations (particularly low-pitched migrants), in the same urban parks.

Statistical analysis in XLSTAT Life Sciences, revealed that male Blackbirds consistently upshifted the note pitch of their songs' motives relative to higher levels of anthropogenic noise. Furthermore, their territoriality songs advertised longer motif syllables in noisier parks, regardless of park size. Artificial night lightening was observed to induce prolonged dusk singing in male Blackbirds.

We did not account for park plant composition, since the chosen parks had similar proportions of native versus exotic plants, a comparable degree of fragmentation as well as tree coverage. Furthermore, all parks advertised at least one bird feeder and one constant, accessible water source (lake/pond). Our assessment of songbird migration over central Bucharest parks listed 44 species, and estimated that approximately 60% of oscines (Ord. Passeriformes, clade Passeri) are low or mixt pitched (25 species). Amid these, 10 species of low / mixt pitched songbirds have been found solely in parks with decreased levels of blackground noise and inconsequential night lightening. A comparison with the trend on Blackbird acoustic response relative to anthropogenic noise revealed that higher values for Blackbird acoustic adaptations equated a drop in species abundance and diversity for low-pitched songbird migrants in urban parks.

Within this framework, we appreciate that further research could relate song adaptations to anthropogenic pressures in urban Blackbirds to illustrate a low-pitch threshold. This may equate either a decline in Blackbird numbers or a consistent behavioural change in response, thus consolidating this taxon's position as a reliable bioindicator of urban parks. Impact assessment of anthropogenic noise and artificial lightening could be done prior to songbird migration. This has ample overtones for park design and adequate planning of ex-situ conservation strategies alongside migratory routes.

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ORAL SESSION

B.4.6

Urban habitats in the landscape of kochi city established from bird species distribution

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Keywords: urban habitat, biodiversity, bird fauna

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Urban habitats offer a wide-variety of resources and provide a wide-range of dwellings for the sustenance of urban life. Planning efforts for conservation of urban biodiversity and management of habitats in urban settings need to focus on identification of specific habitats. To address different habitat categories in urban areas, the study attempts to identify and describe specific urban habitats in the urban landscape of Kochi city, Kerala, India, based on the species distribution of Bird fauna.

The present assessment is the part of a two year long urban biodiversity monitoring of Bird fauna conducted from June 2018 to May 2020 in Kochi city. For identifying habitats from the landscape, site suitability approach with random sampling is employed as suggested by Cassini [1]. The entire study area (50 km^2) was divided into 0.5 km x 0.5 km grids using QGIS software. A total of 30 sampling grids were randomly selected from the study area and the sampling points were chosen in a regular pattern form the sampling grids. Sampling was carried out following fixed-radius (30m) point-count method for 5 minutes once in a month. All the individuals spotted were identified and the land elements utilised by each of the individual species is noted. The land element in which a species exhibited a clear and strong association is identified as a habitat. All the identified habitats were categorized as per the Urban Habitats Biodiversity Assessment (UrHBA) procedure by Farinha-Marques et al. [2] and the species composition of each urban habitat was evaluated. A sample map that depicts the variations in the spatial arrangement of habitat structure was also prepared with the aid of QGIS software.

From the sampling, a total of 38 urban habitats were identified from the landscape of Kochi City based on the distribution data of 162 species of birds observed. The land elements utilised by each species were recognised as 38 urban habitat categories under five super-categories - Artificial Built Elements - Non-Life Form Categories (8), Sparsely Vegetated - Life Form Categories (14), Trees and Shrubs (8), Wetland Herbaceous (3) and Terrestrial Herbaceous (5).

Among the five major urban habitat categories, most of the species utilises Sparsely Vegetated - Life Form categories (33%), followed by Trees and Shrubs (27%), Artificial Built Elements - Non-Life Form (18%), Wetland Herbaceous (12%) and Terrestrial Herbaceous (10%). The species at high risk of extinction are distributed mostly in the Sparsely Vegetated categories. The migratory species exploits all the five categories, of which Sparsely Vegetated habitats are the most favourable habitat for the migrants. Among the 38 urban habitat categories, Forest Phanerophytes supports greater number of bird species.

The heterogeneous landscape of Kochi city possesses wide variety of urban habitats that provide excellent dwellings for a large number of bird species. The diverse tree and shrub vegetation in the city and the climbers and creepers attached with the trees, shrubs and buildings serve as the happy abode of a large number of terrestrial bird species. The wide variety of aquatic water bodies and marshlands in the city with sparse vegetation and nearby estuary provide all the amenities for the aquatic bird species. Therefore urgent conservation measures need to be adopted to these critical urban habitat categories to ensure the protection of diverse urban bird fauna.

The composition and complexity of habitats determined are the indication of 'habitat availability' and 'habitat quality' of the urban landscape. This accentuates the ability of this urban area to support diverse flora and fauna and indicates its overall urban biodiversity. Appropriate management measures can be adopted for the conservation of 'Critical habitats' that are crucial for the existence and survival of several species. The baseline data can be incorporated in urban planning for identifying priority areas for conservation to safeguard biodiversity of the urban landscapes.

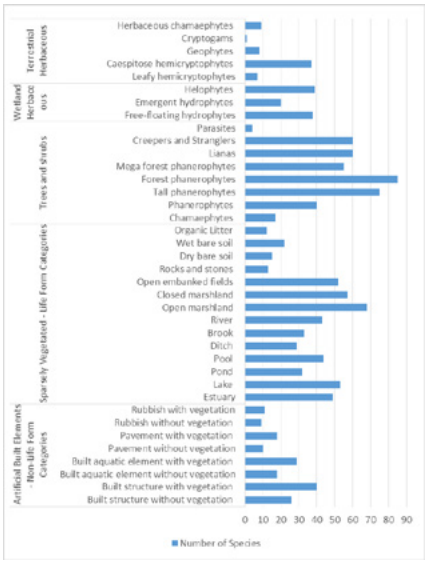

Figure 1. Species distribution in the urban habitats of Kochi city

Acknowledgements: This work was supported by research fellowship from Mahatma Gandhi University, Kottayam, Kerala, India.

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How might biodiversity in cities stimulate education, and can we map this potential?

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Keywords: natural capital, urban greenspace, bluespace

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Learning is a creative process, stimulated by our spatial, physical and social surroundings. Children tend to inhabit these surroundings differently than adults. They attend to shapes, sounds and colors, and explore the opportunites offered by different types of environments for movement, imaginative play and spontaneous games.

Many urban environments offer a plethora of natural features in greenspace and bluespace. These may be highly modified compared with the wider countryside, but are very accessible on a daily basis. They include natural greenspace features, such as street trees, trees, bushes and hedges, visible in or forming part of the boundaries to private gardens, or situated in pocket parks and larger parks. In the form of bluespace, these include streams, rivers, canals or the sea. Our contention is that there is room for advancing the use of these materials and environments as part of formal and informal education.

In this study, we focus on opportunities for learning in children of primary school age. We develop a conceptual framework which characterises how natural elements in cities can be used to stimulate active, responsive learning, both in institutional settings and everyday activities. We present a typology of natural elements to categorise these aspects: 1) objects to collect, 2) sensory components to see and experience (visual aesthetics, sound, movement, smell), 3) settings for play/social interaction and which can also be shaped/transformed, either alone or with others, and 4) inspiration for imaginative play.

We show how such natural elements can be used through different activities to stimulate learning, i.e. as learning tools in both formal educational settings and informal settings in home neigborhoods, or on the way to and from school.

Based on this typology, we develop a suite of indicators which allow mapping of the potential for urban biodiversity to provide material to enrich learning. In this study we map these indicators for one European city, to show the spatial arrangement of the potential for biodiversity to contribute to education. This information may be useful for planners as well as schools to improve urban environments for learning.

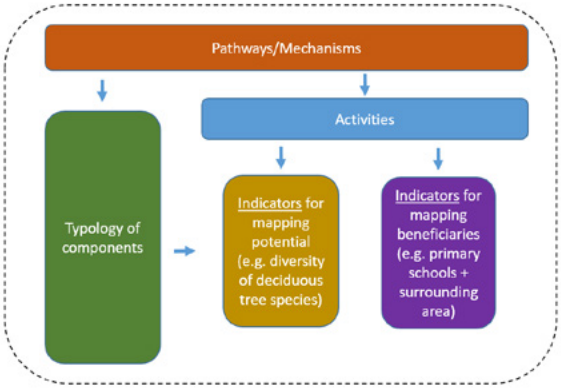

Figure 1. Conceptual framework for education potential from urban biodiversity

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ORAL SESSION

B.5.2

Perception of the urban park biodiversity by their users

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Keywords: plant biodiversity, urban park, cultural ecosystem services

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Increasing urbanization and the demand for public spaces with vegetation have obliged urban planners and landscape architects to design green areas according to the needs of city dwellers. Urban parks are public spaces found in every city and often used for recreation. They are important because of the recreational cultural ecosystem services (CES), as well as the large capital of plant biodiversity (biodiversity = native plant species richness and diversity + natural and semi-natural vegetation) in urban spaces, which are increasingly subject to biotic and functional homogenization as a result of escalating anthropization. The recreational CES and natural role of greenery are closely linked. There is a relationship between CES and plant biodiversity. European cities have implemented the European Union Biodiversity Strategy for 2030. The aim of this document is to halt the loss of biodiversity by all possible means. Urban greenery is being rebuilt in terms of its architectural form. For example, in the urban parks, within the framework of nature-based solutions, high-maintenance lawns are increasingly being turned into urban meadows (also called flowering meadows, grass-free lawns, planted meadows, tapestry lawns). It is also recommended that gardening practices be changed from high- to low-maintenance in order to improve plant biodiversity. Scientific studies have shown that not all users of green infrastructure within cities accept natural plantings.

In 2017, spontaneous vascular flora of the urban parks of Poznań in Poland and Salzburg in Austria (Borysiak et al. 2020) was examined. Enrichment of the park's greenery with structures associated with different stages of biocoenotic succession was recommended. Changes are to be introduced only on the basis of the knowledge of autecology and plant chorology, as well as phytosociology and vegetation dynamics. Changes carried out according to this principle are not only to protect against the loss of the existing biodiversity, but also to increase it. In technical terms, the proposed changes are feasible (with availability of funds). However, due to the lack of acceptance by users of urban parks, nature-based solutions may not be feasible.

In 2019, a study was carried out to examine the attitude of city dwellers toward ecological changes with respect to the composition of urban park vegetation. The research was conducted using a thematic questionnaire. The respondents expressed their opinions on whether or not the proposed changes: 1/ meet their needs? 2/ are acceptable to them? 3/ should be modified according to their own vision? Fifty questions were asked in the form of giving opinion. The questions were prepared in reference to the classification of cultural ecosystem services in CICES V5.1. Residents (156 persons) of Poznań filled-in the survey. The substantive basis for survey was the respondents' perception of the plant biodiversity of urban parks (diverse in terms of age, gender and socio-economic status).

Borysiak J., Breuste J., Mizgajski A. 2020. Urban Biodiversity Under Global Trends and Drivers - a Comparative Study of Urban Parks in Poznań (Poland) and Salzburg (Austria). In: Breuste et al. (eds.). Making Green Cities – Concepts, Challenges and Practice. Springer. pp. 319-331.

The human perception of the bird biodiversity that inhabits a Neotropical City

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Keywords: urban ecology, multiple least-cost-corridors, urban landscape

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The perception of the urban landscape is multisensory and involves many actors, including the animals that inhabit cities, like the birds, a group of vital importance for ecological balance, seed dispersal and pollination [1]. However, even though they are essential, do people perceive them? In this context, this article aims to identify the human perception of birds in an urban environment.

This study was carried out in the Brazilian city of Bauru (São Paulo State). Brazil harbors the second largest bird diversity in the world. Bauru is a medium-size city with more than 371 thousand inhabitants; its landscape presents high heterogeneity, with streams, rivers, different sizes of forest fragments and important urban parks [2].

To reach our goal, bird surveys were carried out in 12 green spaces selected based on historical value and location, and in 24 streets with different levels of afforestation, selected using multiple least cost corridors, simulated by LSCorridors software [3]. We used the *point count* method [4], in which all species seen or heard are continuously noted for a specified time. The surveys were carried out in the morning (6am-10am), during the summer (December to March 2018/2019) and spring (September to December 2019) of the southern hemisphere. This period coincides with the breeding season of most species, including migratory birds [1]. We repeated the survey six times at the 36 sites, totaling 216 field observations.

We formulated semi-structured questionnaires with open and closed questions to the population of Bauru [5]. We applied the questionnaire using Google Forms tool and sent them by e-mail, and through Facebook and WhatsApp groups from Bauru residents.

2342 birds were recorded in the urban landscape of Bauru, belonging to 97 species, 35 families and 16 orders. This shows that 36% of the total species pool in the municipality also inhabit urban areas. The families with the highest number of species were Tyrannidae (18 species) and Thraupidae (10).

Until now, 52 people answered our questionnaire and 90.4% of them believe that birds have a fundamental role on seed dispersion, 78.8% that birds contribute to plant pollination, and 82.7% think that birds help in the ecological balance of the urban environment.

The questionnaire also presented images and audios of the birds so that users could indicate which ones they knew. Great Kiskadeei (*Pitangus sulphuratus*) was the most heard and seen bird species and it is also the most frequently observed. The results showed that most people understand the importance of birds and recognize the most frequent species. However, the same does not happen with the perception of the songs.

Considering bird songs, few respondents were able to recognize them, which shows that this sense is still little explored by people, even if they comprise highly frequent songs of the most cosmopolitan species. Since 11.5% of the respondents have never heard any of the bird songs, we believe that the noise pollution (mainly traffic noise) and the highly dynamic urban life make it difficult for people to hear or notice bird songs within cities.

Regarding birds that live in urban areas, 78.9% of the respondents believed that only less than 30% of species are able to live in urban areas, showing that people have a low perception of the quantity of bird species in situ. This can be confirmed when it is observed that the percentage of people who saw birds with a median frequency in the squares and central parks does not reach 15%.

Cities are ecological and socioeconomic spaces for living and non-living things [6] and understanding how human and ecological processes coexist can help cities become more sustainable places [7]. A highly 'imaginable' city would invite our eyes and ears to have an active participation in the city, so that the sensory domain would be expanded and deepened [8]. In this sense, studying birds and perceiving them as part of the urban landscape, can be useful to stimulate the imaginability of cities and, at the same time, contribute to the conservation of a group of animals that is particularly important for the ecological balance of urban ecosystems.

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ORAL SESSION

B.5.4

Determine the biodiversity and nature awareness of college students: the case of Evka 3 (Izmir-Turkey)

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Keywords: urban biodiversity, collage student awareness

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Urban parks play an important role in harboring and enhancing the urban biodiversity. Biodiversity of urban areas has a direct link to human wellbeing through nature experience. Awareness of biological diversity and richness is important as cities grow rapidly to fulfill physical and social needs. Urbanization often separates people from the nature. This could fundamentally influence the way people value nature, biodiversity and their willingness to protect it. Conserving urban biodiversity generate benefits for urban dwellers.

This study aims to (1) determine the biodiversity of fifteen urban parks in Evka 3 Neighborhood in the city of Izmir (2) determine the biodiversity and nature awareness of 303 landscape architecture college students.

Plant (tree and shrubs) and animal diversity of the parks were defined by field observations between January to December 2020. The biodiversity and nature awareness of the students were determined by online questionnaire.

The Simpson's index was used to analyze the biodiversity of the parks. The index results showed that the biodiversity of plants, birds and insects are high in the large parks with high plant cover.

Chi Square Test was used to evaluate the questionaree. The test results showed that the student`s perceptions, knowledge and awareness of native species and urban biodiversity is proportional to the level of their education.

Enhancing human-nature interactions through wild food foraging on public urban green spaces

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Keywords: edible city, urban non-timber forest product, wild plant gathering

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Introduction

The presence of urban nature has many positive effects on the health and well-being of urban dwellers. These benefits can be still enhanced when urban dwellers engage in meaningful emotional and sensory interaction with urban nature. Urban wild food foraging – conceptualised as picking, pinching or gathering edible organs of plants and mushrooms that grow without intentional tending and cultivation for food production in cities (adapted from [1]) – is an activity that promotes this direct interaction. However, urban foraging has received little research attention [2], which is particularly a shortcoming as urban foraging appeals equally to a wide range of urban dwellers, regardless of gender, age, education, income or cultural and ethnic background [3], [4], and is therefore particularly well suited to promote interaction between people and nature in cities. Furthermore, it is important to increase knowledge about urban foraging as the activity is widespread, for example one third of urban dwellers in Berlin report foraging wild foods [3], and the global COVID-19 pandemic has further raised awareness of the need to regionalise food production.

In this study, we explored urban wild food foraging, specifically the plant species foraged, the backgrounds of urban foragers and the barriers to urban foraging, to better understand how urban dwellers relate to wild nature in cities and to learn how best to enhance human-nature interactions by means of foraging in cities.

Methods

We used a structured questionnaire to survey a total of 458 residents of Vienna, Austria. The sample consisted of visitors of urban green spaces, who were interviewed face-to-face, and urban dwellers experienced with urban foraging, who completed an online survey. The survey included an identification task of eight wild food species, ratings on perceptions, knowledge and behaviour regarding urban wild food foraging and ratings of potential barriers to urban foraging.

Results

Seventy-one percent of all urban dwellers interviewed and 64 % of the visitors of public urban green spaces reported that they had previously foraged wild food species in Vienna. Each of the eight wild food plants included in the survey was reported on average to be foraged less frequently than every 2-3 years. Herbaceous plant species and small shrubs were reported to be foraged more frequently in the countryside than in the city, whereas there is no such difference between urban and rural foraging when it comes to large shrubs and trees.

People who reported to forage more frequently had a greater nature relatedness, more childhood foraging experiences and lived on the outskirts of the city rather than in the city centre. The urban foragers were heterogeneous in relation to their sex, age, education and length of residence in the city.

Social acceptance of urban foraging, lack of availability and lack of access to uncontaminated wild foods and an unclear legal framework were perceived to be barriers, whereas the respondents were aware of the potential negative ecological impacts of foraging and most reported to know how to avoid it.

Discussion

This study confirms that urban foraging is a widespread practice and that many urban dwellers benefit from this direct interaction with nature. Although many Viennese dwellers forage, foraging frequencies were much lower compared with cities in the Global South. Urban dwellers' relatedness with nature is linked to, and may even be enhanced by, urban foraging, which in turn promises positive effects on the health and well-being. Considering that urban foraging is largely unsupported politically in Vienna as elsewhere [2], this highlights the potential for the managed expansion of urban foraging to increase human-nature interactions and the relatedness to nature, health and well-being of urban dwellers. However, to promote urban foraging, the legal framework for foraging, access to low-contamination foraging areas, the availability of wild foods and the social acceptance of the activity need to be improved in addition to monitoring the ecological impact [5].

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ORAL SESSION

B.5.6

The relationship between knowing and liking for 91 urban animal species among students

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Keywords: Urban ecology, animal preferences, animal familiarity

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Nature in cities is important for urban inhabitants, and contributes to many benefits and ecosystem services in urban environments. Urban green infrastructure, to list a few benefits, provides citizens with the option to escape from the busyness of the city, with space for entertainment and relaxation, and with the possibility to experience nature and come in contact with animals.

However, because of the densification of urban environments, space for nature within cities is currently decreasing. There is a general consensus that we have to conserve and increase nature in cities, not to lose the benefits provided by nature. In addition to this, there is a fear of an "extinction of experience" of nature, in which urban inhabitants become increasingly estranged from nature. This can lead to a decrease in quality of life for citizens, and lead to environmental injustice, since more affluent urban inhabitants might still be able to travel out of the city to experience nature while the less well-off citizens are in danger of being deprived of nature. To avoid this, many cities have biodiversity strategies and plans to create green infrastructure. Nature-Based Solutions such as Animal-Aided Design [1]the design of 'green infra- structures' or 'nature-based solutions' has been proposed to maintain the provisioning of these services and the preser- vation of biodiversity. It is unclear, however, how such green infrastructure can be implemented, given existing planning practices that generally ignore biodiversity. Urban open spaces are normally designed by landscape architects with a primary focus on plants, aesthetic design and functionality for human users. As a consequence, conservation of species only plays a minor role, in fact, protected animals are often considered detrimental to the design, e.g. when the need to conserve a protected species demands modifications of a building project. Conversely, conservationists are often in favor of protected areas, also in cities, with little access for humans and no human design. We propose 'Animal-Aided Design' (AAD are increasingly being used to include animals in the design of cities.

When animals are incorporated into the design of green infrastructure, it is important that those animals do not negatively affect, but instead enhance the provided services. In the case of cultural services, well liked animals add to the value of the services provided. The inclusion of well liked species might also add to the successful implementation of urban green infrastructure. Despite this, there are few studies that compare attitudes towards multiple urban animals. Some investigations towards this have been conducted in Norway and Japan [2, 3]many wild animals (including vertebrates and invertebrates. However, most studies regarding attitudes towards urban animals concern individual species, and because of the varying ways that attitude is defined in these studies, they cannot easily be compared to each other.

This paucity of studies on this topic encouraged us to investigate people's opinions towards different animals in an urban environment, and to investigate whether this is correlated to their familiarity. Here, we present results from a survey-based study on students' familiarity with, and attitudes towards, 91 animals that can be found in or around cities in Germany. We've investigated 1) how familiar students are with animals in the city, and how much they liked them; 2) whether the better known animals were also the better liked ones; 3) whether people that were more familiar with a certain animal also had a better opinion of that animal; and 4) how demographics influence people's familiarity with a certain animal, and their opinion about it.

In short, the results were as follows: 1) the students were familiar with most animals, but not all animals were equally liked: arthropods were on average less liked than mammals, birds, or herpetofauna; 2) the better known species were not the better liked ones, but on average attitudes towards better known species were more extreme (*Fig. 1*); 3) in general, the people that were more familiar with a certain animal had a better opinion of that animal; and 4) demographics can expose differences in familiarity and opinion with animals between groups of people. Future studies will investigate what attitude types [4] coincide with liking or disliking a certain animal.

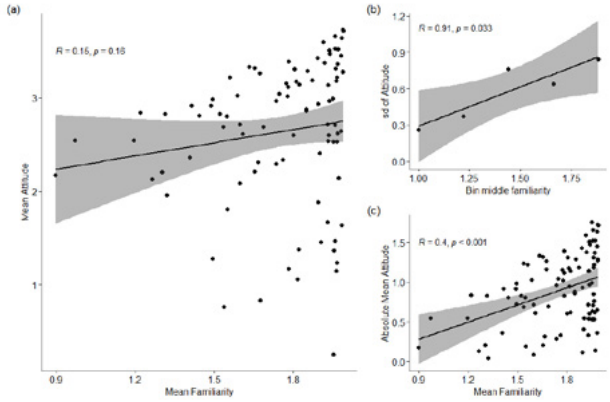

Figure 1. Across-species patterns in participants' attitude towards and familiarity with animal species. (a) Correlation between the average scores of familiarity and attitude, calculated for each species. (b) Correlation between the standard deviation of attitude and mean familiarity. Species were allocated to one of 5 bins based on their familiarity scores, and the standard deviation of attitude was then calculated within the bin. (c) Correlation between mean familiarity and the absolute value of attitude, calculated by subtracting 2 from the mean scores and taking the absolute value.

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Nature Based Solutions as an ideal tool and the answer to a wide range of challenges arising from global climate change, starting with informal settlements in developing countries to the Global North cities

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Keywords: nature based solution, natural disasters, adaptation

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One of the most important challenges facing the world today, are the consequences of currently observed climate change, which exert clearly noticeable influence onto our daily lives. It is also increased the number of disaster-related events that affect on 200 million people worldwide every year[1]. These phenomena have a very diverse character: from heat waves or extreme colds to heavy rains and prolonged droughts, we also observe an increase in the number of strong winds and floods, etc.

According to the IPCC report, developing countries are the most vulnerable to the effects of natural disasters. This is evidenced by the fact that 95% of those who died in natural disasters came from these countries. The most vulnerable communities are those who live in the cities in marginal areas and in informal settlements. The effects of disasters are also felt by the societies of highly developed countries, and the most concerning for them are dangerous heat waves, which particularly affect the older age groups of the population [2]. City's adaptation actions to the consequences of natural disasters, will be one of the most important challenges facing many countries - as well as their communities.

We know that the world population will continue to increase and will live mainly in urban areas. According to the UN - by 2050 68% of the world's population is projected to live in the cities [3]. It is worth noting that, 81% of the population currently live in urban areas in Latin America and the Caribbean (2018 r.) [3]. But very often these citizens haven't any prospects to living outside the informal settlements - it is assumed that 1 in 7 people in the world live in substandard buildings and in 2030 every 4 of them will live there [4]. In 2012 113 million people lived in such neighborhoods in Latin America, and in 2020 will live 160 million there [5]. In Europe, where the number of immigrants is increasing, this problem has also started to be noticed.

Another challenge confronting the future of cities is to stop degradation of the urban fabric in the center of cities, very often inhabited by socially excluded people. Climate change forces authorities and local communities to introduce specific solutions related to e.g. adaptation or mitigation of cities to these changes. However, this requires certain funds that poor countries or citizens living in problem areas cannot afford. Investment actions which exploits gray infrastructure (which is not a flexible solution and has a certain capacity) to protect cities, for example, from floods or residents against heat waves require particularly large amounts of funding. It is also cost-intensive to transform brownfield sites into green investments such as parks.

Often, only people in good financial condition benefit from these city investments, as we are currently observing in many places around the world. To address this problem, we are looking for low-cost solutions (also available to the poorer residents of the city), but also multi-functional solutions with many-sided benefits - not only as part of the cities' adaptation to climate change, but also as a tool ensuring ecosystem services, giving measurable social or economic benefits.

However, for their impact on the city to be sufficient, these solutions should be massively used and connected in a network in short connection chains. Nowadays this action is possible to in many cities in particular through carefully selected and prepared tools. The main aim of the proposed lecture is to show how to adapt cities to climate change or for the upcoming natural disasters, by using nature-based solutions in discricts with social and environmental problems to support the local community and using local resources. The possibility of implementing these solutions in urban areas will be presented based on examples from cities located in Latin America and the Caribbean (Argentina, Chile and Dominican Republic) and European cities (Poland and Germany).

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ORAL SESSION

C.1.2

Vulnerability, Multifunctionality and Sustainability: Co-creation of an integrated multi-criteria decision approach for nature-based solutions

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Keywords: multi-criteria analysis, integrated assessment, urban planning

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Nature-based solutions (NBS) are a valuable option in mitigating many of the environmental challenges cities are facing [1][2]. Still, urban policies and governance practices has not yet incorporated them effectively in their spatial planning [3], which may be related to a lack of key knowledge on which strategies work best when addressing social and environmental needs. Previous studies have developed evaluation tools for specific NBS aspects, such as environmental impacts [1] or potential benefits [4], however, a more broad and holistic approach would be useful for the better development of NBS across cities.

In response, this research aims to expand the notions around the evaluation of NBS in urban environments by proposing a conceptual model linking three different dimensions that play a crucial role in NBS spatial planning and design (see Figure 1): *Vulnerability*, referring to the exposure to social and environmental risks and the difficulty of individuals, groups or ecological systems to adapt to changes, *Multifunctionality*, addressing the capacity that green infrastructure possesses to provide a variety of ecosystem services (provisioning, regulating, supporting and cultural), and *Sustainability*, here understood as the ability to preserve the activities and infrastructures of an area over time without compromising natural resources or causing detrimental social impacts.

To achieve the integration of these concepts, a Multi-criteria Decision Analysis (MCDA) approach is co-created together with planners from the Metropolitan Area of Barcelona as the study area. Subsequently, the approach has been operationalized through a participatory stakeholder process focusing on the establishment of green corridors across the study area. Stakeholders supported the selection and weighting of a set of evaluation criteria under the dimensions of vulnerability, multifunctionality and sustainability.

Results highlighted the capacity of the framework to complement the evaluation of NBS, due to its capacity for including alternatives and allowing for weighted variables concerning NBS and the urban context where they are implemented. Limitations of the model are addressed, mainly relating to the complexity of the multi-dimensional and multi-layered assessment. Overall, we assume that the approach we present allows for obtaining a clear vision of what are the priority factors to be considered when planning for a particular NBS, and that could easily be replicated in other study areas.

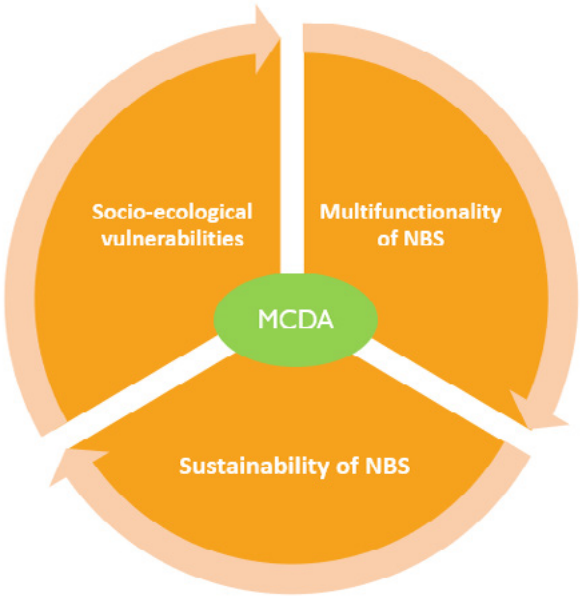

Figure 1. NBS evaluation dimensions integrated via MCDA

Acknowledgments: This work was funded by an ERC Consolidator Grant awarded to Gara Villalba (818002-URBAG)

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A new evaluation framework for Nature-Based Solutions (NBS) projects based on the application of performance questions and indicators approach

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Keywords: effectiveness, nature-based solutions, indicators, surrogate measures, environmental quality

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Nature-based solutions (NBSs) work with nature to benefit both natural ecosystems and the people that depend on them. This concept reflects the paradigm that nature provides solution to global challenges and turns them into opportunities (EC 2015; Science for Environment Policy 2021). One of the key features of NBSs is their high effectiveness and economic and resource efficiency in solving problems compared to traditional grey interventions. These aspects, however, have so far attracted little attention in the literature but should be considered, as the evaluation of NBS projects before implementation provides an opportunity to use them as practical tools.

This paper aims to present a new evaluation framework of NBS projects (at the stage of solution selection) based on the application of performance questions and indicators approach. The framework consists of three main stages: (1) the formulation of the project aim(s) including the problem(s) to be solved, the scales of the expected effects and thresholds to be achieved; (2) the elimination of solutions that do not fit the local conditions and setting requirements; and (3) the examination of the performance questions.

To consider the whole spectrum of influencing factors, a systematic review (Scopus database, October 2020) was performed to indicate the main concepts related to the issue of NBS effectiveness including: (1) stakeholders' participation, (2) policy and management capability, (3) economic efficiency, (4) analysis of synergies and trade-offs, (5) adaptation to local conditions, (6) adequate spatial scale, and (7) performance in the long-term (examples are: Chausson et al. 2020; Dumitru et al. 2020; Raymond et al. 2017) (*Figure 1*).

In the current study around 130 qualitative and quantitative indicators were identified for the evaluation of NBS projects. They are based on different data sources including: (1) draft of a project for the solution implementation (indices such as the existence/number of different facilities, level of energy produced from renewable sources or projected area of green space on buildings); (2) Sociological studies (indices such as level of social acceptance, impact on social learning and innovations, impact on conflict prevention); (3) Existing legal provisions and valid registers (indices such as existence of bureaucratic obstacles, and the type of institutional bodies responsible for a given area; (4) Spatial (GIS) analysis (NDVI, landscape metrics).

Regarding the impact on the state of knowledge, the present work contributes to the discussion on the conceptual sphere of NBS, its practical implementation by introducing multi-perspective standards and guidelines for the selection of possible NBS projects and deals with the complexity of synergies and trade-off between benefits.

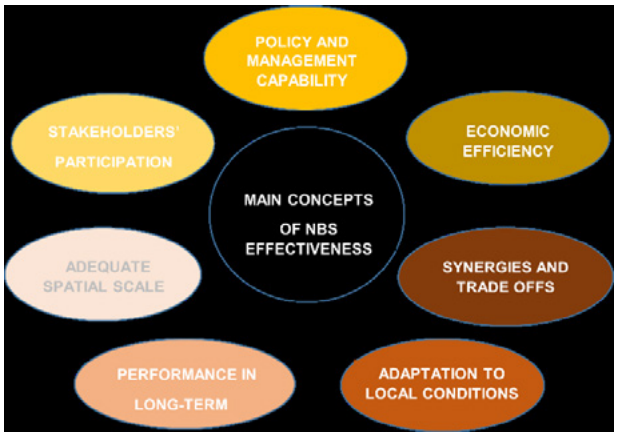

Figure 1. Main concepts related to the NBS effectiveness

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ORAL SESSION

C.1.4

Green Belt Independencia as a strategy to strengthen social-ecological peripheries in Lima, Peru

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Keywords: Co-creation; Nature-based Solution; Green Belt; Periurban

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The metropolis of Lima, the capital of Perú, congregates approximately 10 million inhabitants, representing almost 30% of the country´s population and 30% of the national GDP. The city, located on the coastal desert with extremely limited water resources, grew -demographically and spatially- squeezed between the Pacific Ocean and the lower Andean hills, expanding horizontally to accommodate the high influx of people, most of them who settled their self-constructed houses on public land. Part of these human settlements are installed near or over a fragile seasonal ecosystem, the Lomas (Fog Oasis). Usually occupying the peripheral frontier of the metropolis, some of the lomas are currently embedded in the urban matrix and have become ecological patches.

The Lomas Program, created in 2010, promotes their conservation and development as "ecological parks" and involves initiatives by the city government as well as citizen organizations (Lomas Network), to protect this ecosystem and improve the distribution and equitable, safe access to qualified urban green areas, largely related to human health, well-being, and social justice [1]. The Program comes under the umbrella of the Lima Ecological Infrastructure Plan proposed in 2014; although not officially approved, its approach is currently being integrated into the Metropolitan Urban Development Plan 2040 and the Lima Climate Change Plan. In 2019, more than 13,000 hectares of Lomas were declared as a Regional Conservation Area; currently, a Master Plan is being developed with intense community participation, focusing on two main strategies: ecosystem conservation, land use and occupation control; and development of ecotourism routes with urban communities [2].

The Independencia Green Belt Project is a complementary strategy to create a buffer zone alongside the lomas-city interface as a protective border to restrain the expansion of irregular human settlements while providing cultural services and improves biodiversity. The initiative is a pilot intervention that is being implemented in the middle-lower income district of Independencia, where 19% of the population lives in high-risk conditions, settled on steep slopes. Here, an urban forest park of 4,800 native trees irrigated with treated wastewater has been installed in two phases by a consortium formed by multiple private, public, national, and international parties with strong community support. During the first phase, 3,300 trees were planted by the NGO PREDES with USAID support in 2015; currently, another 1,500 trees are being planted by PERIFERIA with carbon compensation funding from a local construction company. Moreover, other microscale green initiaties are being developed with the community to diversify the green interface between the city and the lomas and create a network of multipurpose spaces.

This recent plantation, soon showed to be a great opportunity to effectively incorporate Nature-based thinking [3]. It is thus becoming a collective endeavor that implicates a co-creation strategy with a transdisciplinary approach, involving stakeholders from the local community, municipality, university, NGO, and private parties whose values and perceived benefits range from biodiversity protection to improved habitat, discouraging land trafficking, preventing landslides, generating greater identity, and promoting a sense of belonging and care.

The evidence and monitoring that the Nature based Solution approach requires, is being developed with an innovative format that involves shared responsibility of the actors. This easens the burden over the budget-stressed local government and increases local participation. A public-private committee is being set up as a means to ensure maintance and monitoring even during municipal government instability and turnover. Local communities and universities students ensure data collection whilst undergraduate and postgraduate thesis are being conducted to support evidence collection and analysis.

The Independencia Green Belt project follows a similar path of Lomas Program. Supported by an increasingly strong group of organizations and citizens interested to conserve and boost touristic routes, besides the empowered community, eager to achieve better conditions of living and a healthy place for their families, the project gains strengthen based on social- ecological systems that also contributes for a economic activation.

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Socio-ecological networks to address nature, urban planning and human well-being challenges in cities: lessons learned from Bogota, Colombia

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Keywords: nature based solutions, green infrastructure, urban biodiversity

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Bogota is the largest urban agglomeration of Colombia with a population close to 8 million inhabitants. In the last three decades, the population of Bogota has increased from 4,22 to 8 million inhabitants, reaching a population density close to 20,5 inhabitants per km2 [1]. Bogota grew rapidly during the 20th century through several rural migrations motivated by the searching for better life conditions as well as because the violence generated by the armed conflict in Colombia [2].

The rapid expansion of the city of Bogota favoured the concentration of goods and services that had a positive influence on the social and economic development of their growing population. However, the urban growth of Bogota has also generated significant environmental impacts related to the degradation of several natural ecosystems, as well as air pollution, degradation of water bodies, loss of natural and agricultural covers and green spaces, [1].

Some of the most significant impacts of the urbanisation processes of Bogota have been related to the extreme pollution of several rivers that cross the city, particularly the Río Bogota that runs through its western limit [3]. In addition, a severe reduction and degradation of an extensive coverage of wetlands that covered the city occurred. The same has happened with the forest covers in the hills that surround the eastern part of Bogota [3].

As a result of this extensive loss and degradation of green and blue infrastructures, Bogota has seriously compromised the vital supply of essential ecosystem services included those related to the provision of drinking water, capture of atmospheric pollutants, runoff control, disasters mitigation as well as cultural services related to recreation, mental well-being, and social cohesion [4].

In response, Bogota has been adopting the ecological networks concept, in order to guide the incorporation of ecosystems and green and blue infrastructures in urban planning instruments. In fact, the embracement of the local concept of Main Ecological Structure (EEP), has contributed to reconcile urban development with the conservation of structures and functions of ecosystems, as well as their ability to provide ecosystem services. EEP has major impacts in the decision-making process to guide territorial planning at the city level [5].

Our primary purpose is presenting the EEP case study in Bogota in order to highlight opportunities offered by planned networks of urban green and blue infrastructures to address those social challenges to increase human well-being, as well as reducing the poverty and inequality that characterize the Latin American cities. We show how the incorporation of ecological networks on the urban planning instruments of Bogota have been contributing to mitigate the negative effects of arguably a disordered at one hand, and informal at the other hand, urban growth of Bogota on their biophysical structure and population well-being. Therefore, several efforts to protect and maintain the EEP in Bogota are presented, including the case of the hills around the eastern part of the city called the "Cerros Orientales de Bogota".

Finally, we discuss how the protection, restoration, and sustainable use of the EEP in the long term, will only be possible with intervention processes based on collaborative work with different stakeholders. The use of Nature-Based Solutions (NBS) could offer an excellent framework to progress in this purpose, helping to reduce the conflict between social and economic development demands, and nature conservation requirements in Bogota.

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ORAL SESSION

C.1.6

Evaluating the sensitivity of the i-Tree Eco pollution model to different pollution data inputs: a case study from Warsaw, Poland

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Urban trees provide a range of ecosystem services, including air purification. This specific ecosystem service can be quantified using i-Tree Eco software, but the software has some limitations. One limitation is that the pollution model used in the software cannot take into account spatial differences in pollutant concentrations, which occur in every city due to the diversity of polluters. This study aimed to investigate to what extent this limitation of the i-Tree Eco pollution model can influence the results obtained. The study was conducted in such a way that the i-Tree Eco project was broken down into four sub-projects, in which data on the concentration of selected pollutants from different air quality monitoring stations were analyzed using the coefficient of variation (CV). Three stations were designated as "urban background" type stations and one was a "traffic" type station. The study revealed relatively low variation ($0.05 < CV < 0.23$) in estimated quantities obtained based on concentrations of pollutants retrieved from different air quality monitoring stations of the same type ("urban background" type stations) and relatively high variation ($0.24 < CV < 0.57$) in estimated quantities obtained on data retrieved from different types of stations ("urban background" versus "traffic"). When data on air pollutant concentrations used in the model is from the "traffic" station type, trees provide air purification ecosystem services with an annual value almost twice as high (EUR 310 000) as when the data used is from "urban background" stations type (EUR 165 000). The results highlight the importance of ensuring that appropriate air pollution data for running a particular type of i-Tree Eco project is used.

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Applying socio-ecological lens to blue-green solutions in cities

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Keywords: urban ecohydrology, nature-based solutions, ecosystem services, society

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Being for almost two centuries a synonym of environmental security and residential comfort, nowadays cities challenge their inhabitants with life quality declining due to pollution, noise, living costs, and climate hazards. Meanwhile society expects also increasing access to nature and possibility to follow more ecological lifestyle. As technology and engineering failed to meet those expectations, and adaptability of cities became a must, nature-based solutions (NBS) got to the center of interest of researchers, decision makers and civil society.

NBS are a promise of multiply benefits in the areas of i.e. the city regeneration, multi-functional watershed management, ecosystem restoration, reduction of matter and energy use, and increasing carbon sequestration [1], [2]. The pre-conditions of engaging nature in city management are: access to source of inspiration and other services of nature, efficient transfer of those services from donor to recipient areas, and establishing of enabling environment in cities. The latter involves: availability of space, long-term planning perspective, sustained water supply, and societal consensus over costs and priorities [3]. Complexity of the issue makes it an example of a wicked problem, with characteristic features being: i) Value / perception conflicts among multiple stakeholders, ii) Knowledge uncertainty: not even scientists agree on causes and effects of the problems, iii) Dynamic complexity: problems evolve faster than solutions, and solutions are part of the problem, and iv) No testing: due to high societal and economic costs of trial - failure approach. Consequently dealing with such problem requires: broad access to information, holistic thinking, flexible approaches, working across agency boundaries, effective engagement of stakeholders in understanding the problem and deriving solutions, and tolerance to uncertainty.

The presentation targets at raising discussion over the process of building capacity for broader and successful implementation of NBS, considering natural, social and economic capitals. The inspiration becomes the Eastern European City – Łódź (Poland), being, since 2005, one of the UNESCO IHP Ecohydrology demonstration sites of using ecosystem properties as management tool [4].

We demonstrate how the stakeholders perceive risks to environmental and water resources of the City (see Figure 1), which components of blue-green infrastructure raise interest, how they correspond with real demand to set up an enabling environment (both in biophysical and socio-economic terms) for NBS implementations, and what are the opportunities and obstacles to develop innovative and across – boundaries approaches. Based on long-term socio-ecological research, we also want to present the mutual learning process, indicating so far progress and failures, and the reasons behind.

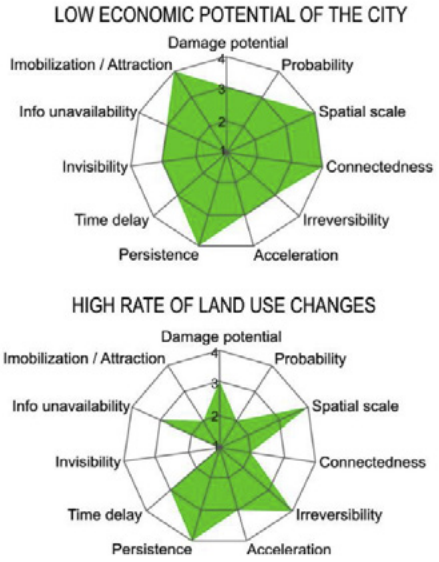

Figure 1. The risk profiles (characteristic features) of two out of the four drivers of environment and water resources in the City of Lódź. Values on the axes correspond with the boundaries in the following way: 4 – high, 3 – medium/high, 2 – medium/low, 1 – low [5].

Acknowledgments: This work was supported by H2020 project NAIAD (http://naiad2020.eu). Currently it is carried under the umbrella of ERA-Net JPI-WATER project ATENAS.

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ORAL SESSION

C.2.2

Evidences of nature-based solutions for water security in urban context: aspect, scale and implementation

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Keywords: nature-based solutions,water scarcity, urban flooding

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Globally cities are increasingly experiencing climate change and urbanization impacts with greater threat on their water resources. Climate change has not only initiated global warming but has also increased the frequency and severity of extreme climate conditions such as heavy rainstorms leading to urban pluvial and fluvial flooding, while extreme hot weather and rising potable water demand have exacerbated water scarcity . In this context, to tackle the concerns of urban water security and related risks nature-based solutions (NbS) have been promoted internationally as an alternative to energy and cost intensive gray measures to incorporate sustainable urban transition in cities. NbS draw their inspiration and support from nature while providing several ecological, social and economic benefits.

The intent of this paper is to gather and infer from evidences in deployment of different types NbS for urban water security in terms of urban pluvial flooding and hydro-meteorological droughts, their scales of application (building, neighbourhood and city level) across different type of cities (small, medium, large and mega-sized), while considering various processes and aspects (environmental, social or economical) in which they were evolved.

Based on the these criteria scientific literature was explored through a set of search strings using ISI Web of Science database. It presented 468 results, out of which 119 were found relevant and in addition snowballing technique was used to include repeatedly cited articles which did not appear in the search.

The selected papers were qualitatively and quantitatively assessed using thematic coding analysis prescribed by Saldaña (2016) [1]. The coding was done based on inductive and deductive methods. Inter-relations of various codes was assessed by interlinking them through co-occurrences. The co-occurrence is signified by c-coefficient in qualitative analysis, which indicates the strength of relation between the two codes and adds value to the qualitative oriented analysis. The interactions between various criteria were categorized based on their high, low or no co-occurrences.

The literature resulted various NbS strategies in urban context which varied from simple de-culverting and permeable pavements to more elaborate applications such as bio-retention-detention ponds and urban forests. From the results it is evident that the studies focused more on urban flooding in comparison to drought risks and often lacked integrated assessments. A common terminology of stormwater management can be seen as an evolving paradigm for research. The methods quantified urban flooding more often than for drought risks which were generally considered as in-direct co-benefits.

In scale of implementation it was observed that greater variety of NbS were implemented at neighbourhood-level and city-level, and there is a wider opportunity to upscale building-level NbS strategies. Though further studies need to be conducted for their replicability under different social, ecological and economical conditions. With respect to type of cities and regions (based on UNDESA's categorization by population) higher co-occurrence of NbS was observed for urban settlements, small and medium-sized cities from global north, in comparison to medium-size, large and mega cities from global south, with significantly higher scientific reporting from global north regions.

Finally, most of the NbS strategies were evolved considering environmental aspects, followed by economic and social aspects. Since NbS are promoted as more holistic approaches to address societal challenges, their integrated assessments are still under-represented in the scientific discourse. Hence, the concept of NbS need to explore the social aspect normatively and focus on their interactions eventually leading to identification of multiple benefits, their synergies and trade-offs.

Thus, the paper attempts to bring insights on NbS for urban water security from current scientific literature highlighting the gaps and opportunities which can be used to further advance the research.

Acknowledgments: This work was supported by Leibniz Institute of Ecological Urban and Regional Development under Dresden Leibniz Graduate School Fellowship.

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Urban dam reservoir as a source of ecosytem services for recreational fishing

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Keywords: angling, ecosystem services, Poland, urban dam reservoir

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Recreational fishing provides many important ecosystem services (ES) (Newton et al. 2018). Therefore, the assessment and quantification of ES provided by angling is crucial to properly define fisheries management techniques which aim to maintain and increase the benefits obtained from water ecosystems (Bryhn et al. 2020; Worthington et al. 2020). However, the question is how we can quantify different types of ES? To answer this, the main aim of this study was to assess ES provided by recreational fishing at the Zemborzycki urban dam reservoir (ZR) located in Lublin (Poland).

The ZR is a dam reservoir built in 1974 of the area of 278 ha, the coastline of 13,000 m long and the average depth of 2.2 m. The water quality deteriorated over time and the problem of cyanobacterial blooms and rapidly progressing water eutrophication appeared in the entire reservoir from the early 1990s to present (Chmiel et al. 2020). The ZR is located close to the city of Lublin and is used for diverse recreational. Additionally, the reservoir is intensively used for angling.

The study consists of four main stages and is build on the following research questions: (1) What types of ES may provide recreational fishing? (2) What types of ES provide the study area? (3) What types of data are needed to assess the ES of ZR? (4) What are the values of ES? Firstly, possible types of ES provided by recreational fishing were listed according to the Common International Classification of ES (CICES V5.1). To do so, the literature search was conducted in March 2021 based on the Scopus database. Secondly, the relevance of each service to the character of the study areas was analyzed based on the following criteria: location; natural values; served functions; state of ecological quality; types of users. Five data sources occurred to be crucial to the assessment of the total set of ES: (1) the database of the Polish Angling Association, Lublin District (PAA Lublin) (2014-2018); (2) open interviews directed to the Director of the PAA Lublin and the Commander of the Community Fishing Guard (CFG); (3) interviews with 178 anglers; (4) previous studies investigating the amount of groundbait used by anglers and potential nutrient load.

The literature review (25 papers) showed that possible ES types belong to 17 classes of services. Food provision from wild-capture fisheries was the most frequently mentioned class. The most numerous types of services were connected to the cultural dimension. The study area, however, served 15 classes of ES, as is a not use as a biomass productivity service from cultivated fish and is not recognized due to the 'iconic fish species'. Among them, food delivery (mean yearly value = 8589.12kg of fish caught), de-stress and contemplating the beauty of landscape function (80% of respondents) and strengthening social relations (90% of anglers belongs to the same fishing clubs) were shown to be of primary importance for recreational fishing (*Figure 1*).

The results obtained allowed to measure, both the services and disservices provided by the ZR. Besides, they showed how complex is the human – recreation – environment relations. Moreover, study contributes to the improvement of the fishery management by verifying the species of fish in the context of their desire and the potential recreational pressure.

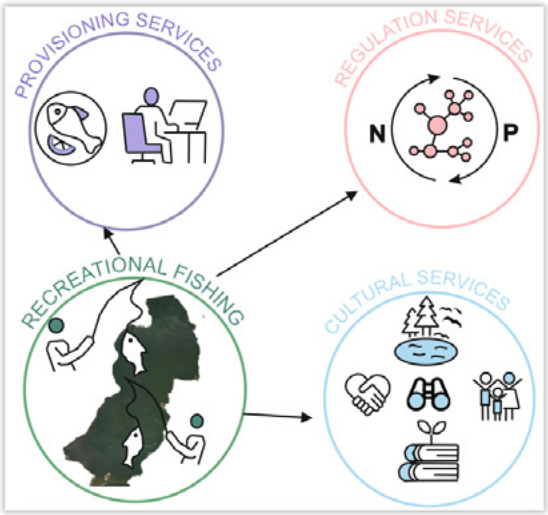

Figure 1. Ecosystem services provided by the study area

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ORAL SESSION

C.2.4

Landcover based hydrological modeling and comparison between different urban areas, case study in Szeged, Hungary

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Keywords: green infrasturure, sustainable urban water management, urban hydrology

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As a result of changed environmental conditions, climate change may have other effects in cities than natural areas. Due to the different land cover parameters and the rate of artificial surfaces, the examination of hydrological processes in urban areas also requires a different approach. The application of sustainable methods by urban planning is crucial in the effective preparation against the increasing negative effects of climate change [3]. For this, it is important to have adequate data on the hydrological processes, for which modeling can be an appropriate tool. The concept of a sustainable urban environment is challenged by the growing population and the horizontal growth of the cities (urban sprawl). The deficient water management infrastructure can cause serious problems, specifically for urban water pollution, and thus for the well-being of city dwellers. In modern urban planning, proper integration of the green infrastructure can be the basis for sustainable water management. Nature based (green) solutions that take advantage of the mitigating effects of vegetation combined with traditional gray solutions can make the urban water cycle more sustainable. The primary role of green infrastructure in uban water management is the contribution to reducing surface runoff and retaining excess water [4]. Due to their complex structure, size and characteristics, trees can play a significant role in runoff reduction and infiltration [1]. Due to increasing climate uncertainty, it is important to be aware of the volume and spatial extent of hydrological processes in urban areas, as well as the contribution of green infrastructure towards the modifications of these processes.

Knowledge of urban district-level processes is also essential, because most sustainable urban water management systems emphasize the need to address problems locally. In order to obtain information about different urban districts, hydrological modeling may be an appropriate tool to get information on areas and processes for which measured data is not available. The model we used (i-Tree Hydro) pays special attention to the role of vegetation in the urban water cycle. The modeling is based on a comprehensive meteorological database, which, together with a detailed landcover database, provides a detailed picture of the role of vegetation [2]. For the land cover database, it is necessary to define the main vegetation categories (trees, shrubs, lawns) and the land cover beneath the tree canopy, which was done by segment-based classification. The results include information about the surface runoff, the extent of infiltration as well as how the vegetation is able to reduce the surface runoff by interception and evaporation. Within the runoff, we can also perform investigations of the runoff categories to provide information on the extent of runoff on impervious and pervious surfaces. In our study we compared different parts of Szeged (Hungary) by their hydrological properties. The districts have different type of land cover, which also predicts the extent of the hydrological processes. In our examination, we compared areas with different building density (e.g. densely built-up areas, housing estate districts) and vegetation rate. Based on our results so far, vegetation, especially woody vegetation can play a significant role in the modification of hydrological processes.

In addition to comparing the hydrological processes of areas with different land cover, we also get a detailed picture of the processes that characterize each area. With the help of modeled data, we can reveal what kind of regulations and interventions are needed for the gray or green infrastructure in each of the studied districts in order to facilitate decision making.

Acknowledgments: This work was supported by the European Union program SCC-03-2016: New governance, business, financing models and economic impact assessment tools for sustainable cities with nature-based solutions (urban re-naturing) [grant number 730468]. This work was carried out under the research project Nature4Cities (N4C) – "Nature Based Solutions for re-naturing cities: knowledge diffusion and decision support platform through new collaborative models

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The Trentino blueprint: a resilient strategy for sustainable development of marginal territories in Alpine context

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Keywords: fragile landscapes; water ecosystems; marginal areas

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The current circumstances that we are experiencing, with the massive spreading of Coronavirus all over the world, especially in the most densely populated urban areas, have activated many reflections about the relation among natural and urban environments. The countryside, the hamlets, the inner areas, the small villages, became among the most valuable places to live, work, relax, and enjoy the everyday life. Very often these areas coincide with the most fragile territories for natural and human risks and where a new development path has to be defined. In Italy, the contexts addressed by the Italian National Strategy on Inner Areas (SNAI) are often lacking successful regional policies and systemic territorial approaches to achieve effective transformations. These issues are addressed by the project "B4R Branding4Resilience" and the contribution aims to present and discuss the first results of the B4R research in Trento Autonomous Province (Italy). A new role of these peripheral contexts in relation to growing metropolitan areas is a possibility for a more respectful, integrated, and balanced human-natural lifestyle [1].

Studies and funding initiatives have mainly focused on economic, services and infrastructure marginality, basing the classification of the so-called "inner areas" (SNAI, Italian Ministry for Cohesion 2014) or "inner peripheries" (PROFECY, ESPON 2017) on quantitative indicators. The value of natural resources, the contemporary interpretation of ancient processes to manage the land, and the innovative practices to take care of landscape and building heritage in extreme contexts, have never been taken into account as indicators of quality of life. During the last year, a generalist interest in mountain areas, villages and life has grown but a sensitive, respectful and sustainable design-driven approach should be adopted in order not to compromise these territorial resources with a spread and uncontrolled "urbanized" approach. In fact, while urban areas are growing, expanding often-generating problems of congestion and pollution, other areas over Europe are suffering from an increasing trend of depopulation and marginalization. Nowadays more than 60% of European population live outside urban contexts [2].

In accordance to B4R topics, the main goal of the research unit in Trento is to pursue leadership in "innovating with nature" through locally implementable actions in small thermal villages, specifically focusing on the Val di Sole pilot area. The aim is to create a territorial strategy on the value of the water resources, by promoting the enhancement of their territorial capital through spatial transformation. The interdisciplinary methodology is based on integration among landscape ecology, territorial metabolism, cartography and data mapping, and circular economy that the authors propose as integrated systems to comprehend the dynamics of marginal territories. An in-depth data collecting process is used to explore the natural identity of the Val di Sole and its ecological, spatial and social elements. The contribution will illustrate the preliminary results of the exploratory phase: the Val di Sole blueprint as a tool to drive scenarios to implement thermal landscapes as resources for the territories, as well as to support a sustainable development that connects places for a better quality of life.

The research approach proposes a territorial brand that promotes resilience, as it is re-generative and adaptive, whose change's processes and subsequent benefits are to be assessed in space and time through community's inclusion, in order to preserve the local identity of the area and to renew the historic wellbeing tourist offer. To increase resilience, the development of nature-based activities is promoted in relation to blue and green infrastructure: the blue infrastructure corresponds to the hydrological network, where springs and thermal waters are at the center of the enhancement process; the green infrastructures [3] are the environmental routes that connect together the natural resource and the ecological paths. In order to do that, an interdisciplinary and multiscalar methodology has been adopted to combine a quality and quantitative approaches: a data collecting process is used to explore the natural identity of the Val di Sole to contemplate both ecological and spatial elements such as physical and immaterial qualities, weakness and needs of local communities.

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ORAL SESSION

C.2.6

Multipurpose Green infrastructure to water regulation and walkability along the urbanized valley of Mandaqui

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Keywords: Urban Green Infrastructure, Multifunctionality, Urban Ecosystem Services

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The study presents the integration of Green Infrastructure on the case of Mandaqui creek and watershed, in São Paulo city, Brazil, with special atenction to the bottom valley, where the Engenheiro Caetano Álvares avenue is installed. As a representative example of the historical process of land occupation and environmental dinamics in São Paulo, the bottom valley is approached as an opportunity to shift this linear monofunctional infrastructure [1] into a multifunctional axis, able to catalyze the green and blue inside the urban tissue of São Paulo, while promoting a range of benefits. Therefore, the study intents to understand which the possible synergies, trade-offs and disservices are related to water regulation and walkability along the valley and framed by the watershed.

São Paulo has drastically expanded its area during the last century to accommodate more than 10 million inhabitants, or more than 20 million once the metropolitan conurbation is considered. Planning has been articulating by two main objectives: to make more soil available to accommodate distinctive land use; and to install a transportation network based on vehicular mobility of people and goods [2]. To accomplish these objectives the hidrological system was assumed as a strict part of the drainage network and its flood plains were destinized to receive part of the structural street network besides large extensions of building areas. Therefore, environmental consequences of the intensive sanitation, vehicle based mobility and the increaselly paving are related directly with water contamination, flooding, and the proportionate reduction of green and blue surfaces in the city, together with the loss of a range on Ecosystem Services (ES) accessible to people.

The Mandaqui creek was sanitized during the 70´s following these principles and current flows underground for 2/3 of its extension (approximately 4km) and confineted on open concrete canal during the last 1/3, between the avenue lanes. Above the closed canal, there is one of the most used green areas of the whole water basin, constracting with the scarcity of green during and walkable conditions on the last third of the creek. This contradiction, to find green where the water is hidden and the lack of green where the canal is open, exposes an antithesis of what the former landscape would look like and how it functioned. The case representes a current problem in São Paulo, the abbesses of green areas accessible to people and favorable walkable conditions.

In order to study possibilities to change this reality the concept of Green Infrastructure (GI) initially defined by Benedict & McMahon [3], and intensely discussed since its first use back on the 90´s, was systematize into a set of six guiding principles to design, install and operate the GI in urban areas, as listed:1. Multifunctionality; 2. Connectivity; 3. Green - gray integration; 4. Multiple scales; 5. Importance of Context; 6. Transdisciplinary process [4]. The principle 1 to 4 will receive attention.

Green - gray integration emphasizes the high potential GI has to be mixed with traditional infrastructures, particularly on high occupied land as the Mandaqui wahtershed. Special attencial will be taken to this capacity to blend stormwater runoff control with low impact development (LID) non-source point pollution treatment [5], and the integration with transportation infrastructure [6]. Multifunctionality, as the key principle, was related to Ecosystem Services in order to frame the understanding of possible synergies, trade-offs and disservices between LID structures and how they can contribute to amplify the amount of accessible green areas on the water basin while improve walkability along the Mandaqui axis. The principle of Connectivity aims to physically link the Multi-scales at the watershed and beyond. Figure 01 presents the relation between GI principles, walkability, and stormwater management.

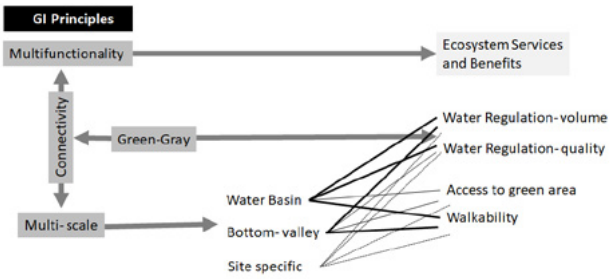

Figure 1. Green Infrastructure principles related stormwater management and walkability.

The methodology comprises a variety of GIS spatial analysis considering previous hydraulic studies, accesibility and walkability criteria. Processes involved geomorphology analysis related with land occupation and LID typologies, organized as follow:

1. Evaluation of current provision and demand of ES (water regulation, access to green areas and walkability conditions).
2. Geomorphological landscape analysis, identification and characterization of open spaces types.
3. Potential to receive defined LID (macro and micro scale).
4. Potential to increase walkability.
5. Literature review and observation to approach synergies, trade-offs and disservices.

The results showed landscape topography impacts walkability out of the valley, besides the predominance of sinuous streets that increases distances. On the other hand, the low density and the presence of industrial and former industrial plots along the valley may provide new possibilities to change the configuration of creek and mobility infrastructures in order to deal with the large volumes of water while equalize walkable conditions and structure a green multifunctional network through different scales.

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Upscaling nature-based solutions for climate change adaptation: potential and benefits in three european cities

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Nature-based Solutions (NbS) are increasingly promoted as cost-effective strategies to sustainably address a variety of urban challenges, including climate change [1]. Many exemplary projects have demonstrated the potential of single, small- and medium-scale NbS, to foster climate change adaptation [2]. The challenge now lies in moving from demonstration projects to a full-scale deployment of NbS. However, to set policy goals for NbS implementation, policy-makers need to know the amount of different NbS types that can fit in the urban space and the benefits that can be expected.

This research aims to assess the expected benefits and co-benefits of a full-scale implementation of NbS for climate-change adaptation in selected European cities. More specifically, it focuses on three questions:

1. What is the potential to implement different types of NbS in different European cities?

2. What benefits and co-benefits can be expected from such full-scale implementation?

3. How does the urban structure of the cities affect the potential to upscale NbS, and the expected benefits?

We selected three European cities as case studies: Barcelona (Spain), Utrecht (the Netherlands), and Malmö (Sweden). They are representative of the variety of urban forms and climatic conditions across EU, but share common issues related to climate change adaptation.

For each city, we developed six land cover scenarios. We mapped the current land cover at a resolution of 1 m, considering eight classes that include different vegetation typologies. Then, NbS implementation scenarios were created through GIS-based algorithms that translate a set of rules about NbS size and location into land cover changes. The scenarios simulate: i) installing extensive green roofs on all suitable roofs; ii) planting street trees wherever enough space is available; iii) desealing large parking areas; iv) enhancing vegetation in urban parks, and v) combining all of the above.

We assessed the scenarios considering two climate change-related benefits -heat mitigation and stormwater regulation-, and three co-benefits, namely carbon storage, biodiversity potential, and overall greenness. Climate change adaptation benefits were quantified through the InVest 'Urban Cooling' and 'Urban Flood Risk Mitigation' models [3]. Carbon storage was modelled as a function of land cover, adopting values retrieved from the literature. Biodiversity potential at the block level was calculated through an index based on structural diversity and share of green area [4]. Overall greenness was measured as the share of green and blue areas in a 500-m neighborhood of each point.

The three case study cities are characterized by different densities and distributions of land covers, with the 'green' classes that sum up to around 35% of the city area in Barcelona and more than 60% in both Utrecht and Malmö. This affects the potential for NbS upscaling. Barcelona outclasses the other cities in the 'green roofs' scenario, which affects more than 10% of the city area. Malmö shows the highest potential for street trees, with the addition of more than 52,000 new trees and an increase in tree coverage of more than 12%. Desealing parking areas produced the greatest results in Utrecht, where 1.16% of the city area is involved, corresponding to a reduction of around 4% of the current sealed areas.

Green roofs implementation produces the greatest increase in stormwater regulation and biodiversity potential in all cities, while enhancing vegetation in urban parks has the greatest effects on heat mitigation. The best results in terms of overall greenness come from street tree planting in Utrecht and Malmö, and from interventions in urban parks in Barcelona. However, the rankings of the scenarios change when considering the benefits produced per unit area of intervention.

Overall, the research reveals that the potential of NbS upscaling depends on two factors: 1) the existing opportunities to integrate NbS in the urban fabric of the cities, and 2) the capacity of each NbS type to deliver benefits in certain conditions. These two factors, combined, explain why the same scenario performs better in one city compared to another, and should be both considered when assessing the potential effects of NbS upscaling in specific contexts.

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ORAL SESSION

C.3.2

Perceptions of Nature-Based Solutions and their barriers and drivers for mainstreaming in South Korea

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Keywords: nature-based solutions, climate change adaptation, ecosystem adaptation, flood risk management, risk perception, NBS governance

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In July and August 2020, record-breaking floods hit South Korea, which is no exception to the global trend of increasing extreme meteo-hydrological events. This raises unsettling questions about how South Korea will cope with future extreme flooding events that exceed the engineered capacity of current interventions. In response to such extreme climate patterns, nature-based solutions (NBS) have come to the fore as novel and sustainable Flood Risk Management (FRM) measures [1]. Nature-based solutions (NBS) are seen as a promising adaptation measure for sustainably dealing with diverse societal challenges and are also considered to deliver multiple benefits [2]. Aiming to understand what hampers and stimulates the mainstreaming of NBS, this paper examines the diverging conceptualization of NBS, the attitudinal (e.g. emotions and beliefs), and contextual (e.g. legal and political aspects) barriers and drivers of NBS for flood risks in South Korea. Semi-structured interviews were conducted with 11 experts. The analysis found 11 barriers and five drivers in the attitudinal domain, and 13 barriers and two drivers in the contextual domain.

As for the conceptualization of NBS, we discovered a divergence; while the majority of experts conceptualize NBS as an instrumental value that helps to achieve a variety of co-benefits, such as aesthetic and recreational values with technological advancement. Fewer experts conceptualize NBS concerning their intrinsic value, i.e. the promotion of socio-ecological considerations in flood risk management.

Our research corroborated that some factors of barriers and drivers already seen from the previous research in different cultural settings are valid in South Korea likewise. Some showed peculiar aspects intertwined with the Korean context. Amongst all, all interviewed experts argued that utility-related factors, which relate to direct monetary benefits including subsidies, compensation, or expected increases in land prices, are the most critical driver for gaining public acceptability of NBS. At the same time, moral hazards or 'greenwashing' that can be accompanied with the focus of co-benefits were also mentioned. Underestimated capacity of NBS to manage the flood risks effectively due to their elements that mimic nature and the high degree of uncertainty involved is in line with the previous literature. We found that this view frames NBS as merely an auxiliary choice rather than a primary solution that decision-makers might select to mitigate the immediate risks. Blurred accountability in the current FRM system was acknowledged as a hurdle that leads to conflicts of interest within organizations and inhibiting the co-production process. Politicization of ecological policy in Korea was shown to hinder goals to safeguard nature and society through the implementation of NBS by polarizing opinions with the conflicts. So far, although ecological issues often represent a certain political ideology in some cultures [e.g. 3], the topic has rarely been discussed in the context of NBS governance.

This research tries to bridge the gap between current efforts for mainstreaming in NBS for FRM prevailingly in Europe with the South Korean context. We revealed that the current common knowledge and experienced practitioners, researchers, and government officials have in relation to NBS, and how they see barriers and drivers of mainstreaming NBS in South Korea. However, the findings are not just limited to the South Korean context—they can also contribute towards current research primarily focused on other cultural and institutional contexts. The study further suggests more clear conceptualization agreed at a national level is essential for the long-term sustainable FRM with a proper understanding of NBS between the professionals.

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Applicability of nature-based solutions in different urban fabrics: a case study on urban water management in the Helsinki metropolitan area

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Keywords: nature-based solutions, urban form, urban water management

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Climate change has forced cities to search for ways to reduce their carbon footprint and adapt to changing conditions. Densification has been a guiding principle in urban planning aiming to cut emissions from transport and infrastructure and save carbon sinks. Curbing urban sprawl helps to sustain green infrastructure, but in densified areas, challenges in water management can grow. Flooding, drought periods, heat island effects, poor water quality and loss of biodiversity are frequent problems in many urban areas. When traditional technical solutions have turned out to be insufficient, nature-based solutions (NBS) have offered new opportunities.

NBS in urban water management include green spaces and surfaces increasing water retention, infiltration basins, rain gardens, permeable pavements, bioswales, constructed wetlands, and restoration of brooks and rivers. NBS typically aim to bring multiple benefits. In addition to water management, they can e.g. improve environmental quality, increase recreation opportunities and enhance biodiversity.

In densely built urban areas, the availability of space is often a critical question for NBS. The cities need to reconcile new development and water retention measures. While there is a quickly growing knowledge base on NBS, only little attention has been paid to the significance of urban form for NBS and the ways in which NBS can be combined with other urban development goals.

In this paper, the main aim is to examine how the applicability of NBS for urban water management depends on the location in the urban area. This study focuses on the interaction of the built environment, transport system and green infrastructure in urban planning and assesses the consequences for NBS.

The analysis of urban form relies here on the theory of three urban fabrics developed by Newman et al. (2016) [1]. They distinguish walking, transit and automobile city as separate but overlapping systems with specific elements, functions and qualities. The approach allows to examine the interplay of land use and transport and analyse the street and building typologies and urban functions. The analysis can be complemented with a more detailed examination of blue-green infrastructure elements, thus enabling the investigation of the opportunities and challenges of NBS in each fabric.

The empirical analysis of the study includes a comprehensive examination of urban development, land use and NBS options in the Helsinki Metropolitan Area, Finland. In addition, planning situations are analyzed in case areas that represent different types of urban fabrics.

The study includes a GIS-based examination of buildings, transport routes, parking facilities, soil sealing, green area network, and job and population development. The datasets are used to identify urban fabrics and their elements. The study applies green area factor used in the City of Helsinki [2] to examine the development of green surfaces and infiltration capacity, and . Furthermore, flood risks mappings and modelling are used to detect the need and potential for NBS. Data on existing NBS are collected from urban planners of case areas through interviews and workshop discussions. The location, size, functionality, success factors and barriers of NBS are discussed with the planners.

The results indicate that the type and role of NBS vary according to the urban fabric and planning situation. Infill development includes special challenges in combining old and new buildings as well as technical and green infrastructure. Transport solutions have a major significance in terms of space available for NBS. In dense areas, there is a need to organize parking in a way that saves space for green surfaces and other water retention structures. In suburban areas, it is essential that NBS are a standard part of planning of residential and transport areas. Many critical factors in NBS implementation depend on the urban fabric and its qualities. The urban fabric approach provides a tool for NBS planning and strategy making both locally and on city-regional level.

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ORAL SESSION

C.3.4

Nature-Based Solutions vs. Greenwashing? Green space in developers' sales strategies – a sase study of Poznań

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Keywords: nature-based solutions, marketing strategies, greenwashing, urban greenery, residential buildings, developers' buildings, Poznan, city development

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The implementation of nature-based solutions (NbS) largely depends on the strategic planning of green infrastructure (GI) and the answer to the question how to plan and maintain urban green areas under the investment pressure. The concept of NbS is not common in design practice in Poland. This term is not clearly expressed even in the development strategies of large cities such as Poznań [1]. NbS can be used in development projects in different scales, individual buildings and building complexes. According to the authors, when developers refer to ecological values in promotional campaigns, in many cases these are examples of greenwashing (GW). Sherrif-Shuping [2] indicates that GW is a common phenomenon in the development business and that developers use it to gain social acceptance for their investments. In their advertisements they present photorealistic renderings with lush greenery inside the designed housing estate and in the vicinity of the investment (*Green Marketing Strategy*).

The authors wanted to find out: how often and in what way greenery was presented in renderings; what types of vegetation were presented; and what the developers' approach to the existing greenery was. The authors analysed development offers in Poznań, which is a big city in Poland with an urban greenery system based on a concept from the 1930's. We selected and analysed 73 offers of 25 developers. All the investments were analysed for the texts of advertisements and illustrations (plans, renderings). At the first stage analysis were carried according to 3 groups of criteria: 1- Creating an image of a green estate, 2 - Types of green space, 3 - Approach to existing resources. Information on planned green areas (e.g. type, location, access) and the approach to the existing green space resources (e.g. conservation, building developments) was collected. The first stage of the research showed the importance of greenery in developers' strategies. Their approach to the existing green space resources was also analysed. The analysis enabled to assess whether the offers met the NbS assumptions or if it was GW. In further research another 4 criteria for NbS housing estates were distinguished: low-maintenance greenery; maximisation of the bioactive surface; modern technologies and concepts related to greenery; protection of the existing natural resources on site. The following items were regarded as 4 symptoms of GW: impossible to implement plans and views of green complexes shown in renderings; cutting down already growing trees despite showing them in renderings and declarations of 'green estates'; distorted views of greenery outside the development complex; no greenery in the surroundings despite the declared green area out of the estate.

The research showed that the greenery presented in these projects reflected social expectations of the space surrounding one's place of residence. The research proved that the marketing strategies of developers in Poznań should be treated as GW (tab. 1.). NbS characteristics can be credited only to a few estates. However, symptoms of GW were often identified in the same cases.

Are NbS likely to be applied in housing estates, if there are no systemic regulations forcing the use of environmentally friendly solutions?

Table 1. The number of housing estates and the number of NbS and GW criteria they meet.

NbS/GW	4 GW	3 GW	2 GW	1 GW	0 GW
0 NbS	3	12	15	13	5
1 NbS	-	-	2	5	1
2 NbS	2	1	2	5	4
3 NbS	-	-	-	-	1
4 NbS	-	-	2	-	-

Acknowledgments: This work was supported by the framework of the Polish Ministry of Science and Higher Education's program: "Regional Initiative Excellence" in the years 2019–2022 (No. 005/RID/2018/19)", financing amount 12 000 000 PLN

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Setting the Social Impact monitoring framework for NBS: methodology, drawbacks and measurement case study from Milan.

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Keywords: nature-based solutions, urban regeneration, horizon 2020

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Nature-based solutions (NBS) are currently being employed in many European Commission Horizon 2020 projects in reaction to the increasing number of environmental threats, such as climate change, unsustainable urbanization, degradation and loss of natural capital and ecosystem services, etc [1, 2]social and economic challenges into innovation opportunities. They can address a variety of societal challenges in sustainable ways, with the potential to contribute to green growth, ‚future-proofing' society, fostering citizen well-being, providing business opportunities and positioning Europe as a leader in world markets. 2. Nature-based solutions are actions which are inspired by, supported by or copied from nature. They have tremendous potential to be energy and resource-efficient and resilient to change, but to be successful they must be adapted to local conditions. 3. Many nature-based solutions result in multiple co-benefits for health, the economy, society and the environment, and thus they can represent more efficient and cost-effective solutions than more traditional approaches. 4. An EU Research & Innovation (R&I.

In practice, implementing NBS concept exceeds the boundaries of traditional sustainable urban development (SUD) approaches that aim to 'protect and preserve nature' by considering the enhancement and restoration of urban green networks, as well as the social inclusion in urban planning policies. In addition to that, NBS are not simply "just" green; they root all the way down to be considered sleeve urban design tools for green and blue infrastructure in more complex urban regeneration processes.

While many scientific contributions discuss the definitions and the theoretical frameworks of nature-based solutions; hands on experiences and evidence are still needed to improve our understanding of the range of economic, social and environmental benefits provided by NBS in cities, in order to promote their inclusion in urban planning policies and decision-making processes.

In this research we tackle the usage of nature-based solutions as a driver to catalyze urban regeneration strategies in practice specifically in social inclusion methods. **Firstly,** we examine the relevance of using NBS in addressing sustainable urban development (SUD) challenges by analyzing gaps and opportunities for binding NBS into urban planning policies [3, 4]. **Secondly,** we overview the major challenges and co-benefits across different societal cohesion and environmental justice bottlenecks during implementation. **Thirdly,** we cross reference a Wind-rose multi-model of co-benefits analysis for NBS, see Figure 1. This analysis is based on a social monitoring plan elaborated within the CLEVER Cities project – H2020 project / GA No. 776604– Milan case study. The monitoring framework of the case study is divided on Macro/ Micro indicators, that measure four main indicators through different target groups, a multiplicity of measurement tools (surveys, on site observations, interviews with stakeholders, focus groups and online questionnaires). **Lastly,** this research paper emphasizes the social added values of NBS in long-term urban regeneration projects. Insights from the framework results emphasize the need of citizen participation in the process of co-designing and co-monitoring towards place-based ownership and increase of sense of belonging within the NBS projects in practice.

The research results highlight the drawbacks on the long-term process of monitoring related to social cohesion aspects that, hence, makes the results outdated by the end of the project lifetime. Another relevant drawback is the lack of unified measurement methodological framework in many similar H2020 sisters' project. The finding is emphasized from the forthcoming work of Task Force II established on evaluating the NBS impact in place [5].

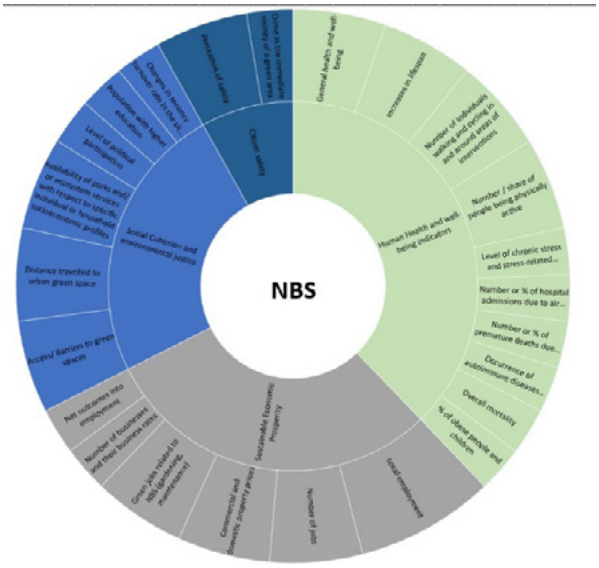

Figure 1: Wind-rose multi-model of co-benefits of NBS

Acknowledgments: This work was supported by Department of Architecture and Urban Studies, Politecnico di Milano.

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ORAL SESSION

C.3.6

Nature based solutions for soil remediation in urban areas: combination of biochar and nanotechnology

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Keywords: Nature Based Solutions, soil remediation, nanotechnology

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The industrial transition across Europe has revealed a number of 'brownfields'. Brownfields are urban or periurban sites affected by abandonment and pollutants concentration exceeding soil screening levels. These sites are derelict and underused, and they require intervention to bring them back to beneficial use.

In this sense, Nature Based Solutions (NBS) appear as approaches inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits. These technologies include stabilization in situ and phytoremediation of polluted soils [1, 2].

Here, we present an exemplifying pilot scale remediation performed in a brownfield area by means of NBS application. The study site, known as Nitrastur, is located in northern Spain [3]. It was a fertilizer plant, whose activities affected severely soil quality as a consequence of unappropiate waste disposal (point-source pollution) and diffuse pollution.. Around to 20 ha of polluted soils revealed high contents of As, Cd, Cu, Pb and Zn exceeding the soil screening levels.

The field scale experiment was designed for treating in situ polluted soil in controlled plots of one squared metre of surface. Four treatments were applied. First, zero valent iron nanoparticles (nZVI) were added to the soil of one plot using 1% w/w dose. Second treatment consisted on the application of 7% w/w biochar, made by the pyrolysis of plant debris. A a mixture of both amendments were applied in a third soil. Finally, polluted soil without amendments was used as control. After a maduration time of soil and amendments for 3 days, plots were seeded using *Brassica juncea* L.

Pollutants availability and soil properties were monitored over soil samples at three different times. Furthermore, changes on cultivable bacteria were monitored by plate counting and changes on total bacteria communities structure were monitored by fragment analysis ARISA.

The evolution of plants was monitored using a chlorophyll fluorometer (LI- 6400XT) at the end of the experiment and before the flowering stage. Moreover, plants were also collected for analyses. Roots and aerial part were separated and conserved using nitrogen liquid. Pollutants concentration were determined in each plant part, and several physiological parameters (oxidative stress and chorophyll pigments) were determined for controlling toxicity effects.

Results revealed that the application of nZVI and biochar, alone and in combination, were succesful. Biochar application decreased drastically soil available concentracions of Cd, Cu, and Zn, causing better immobilization results than nZVI addition. However, the combination of both amendments achieved the best result for Pb immobilization, revealing a synergistic effect of both amendments.

Higher differences were found in plants monitorization. Fresh biomass was higher in the biochar treatment, while nZVI addition decreased slightly the recollected plant biomass. Regarding pollutants, their concentrations were higher in plants from control than from the treated soils, with some exceptions. For example, the application of biochar increased slightly the As concentration in the aerial part of the plant, although when combined with nZVI, this increase was mitigated.

Differences on physiological parameters were detected between soil treatments due to pollutants immobilization, nutrients addition and possible toxicity effects from amendments. Regarding soil microbiology, minor differences were found between treatments, and changes were attributed to soil manipulation at the beginning of the experiments and climatology impacts.

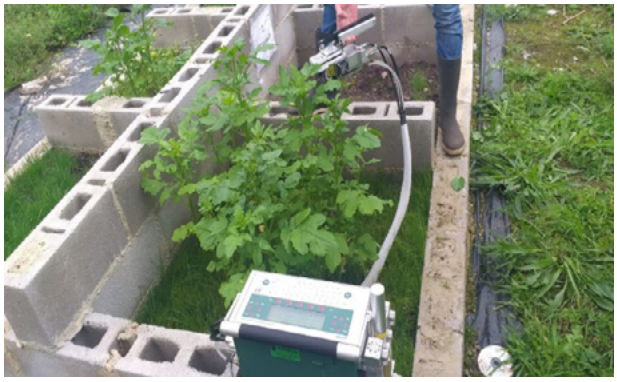

Figure 1. Plant monitoring during the experiment.

Acknowledgments: This work was supported by the Ministerio de Economía y Competitividad (MINECO, Spain), under the project CTM 2016-75894-P.

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FAIR management of NBS intervention related monitoring data across cities

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Keywords: monitoring, data-management, NBS

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Currently, many European Cities collaborate with research teams in projects funded through the European Commission Horizon 2020 programme. Thereby, the consortia plan and implement NBS (nature based solutions) to improve the urban natural environment and the quality of life of the citizens.

Sound local monitoring data are an essential prerequisite to specify problems in the urban environment and to define the details of the NBS interventions suitable to improve the particular situations. Likewise, after implementation, monitoring data are needed to test the effects of these interventions. Monitoring data also provide information to relevant stakeholders, firstly about the need to act and, later on, such data help to determine whether the interventions were justified.

GoGreenRoutes (https://gogreenroutes.eu) is one of these projects. The consortium applies a common data management concept to enable an effective data sharing among the six participating cities – Burgas (BG), Lahti (FI), Limerick (IE), Tallin (ES), Umea (SE), Versailles (FR) – and among all other project participants.

Moreover, such a concept forms an indispensable prerequisite for data sharing within the wider NBS community and for data dissemination to the project stakeholders in line with the principles of FAIR (Findable, Accessible, Interoperable, Reusable) and Open Research Data (ORD).

Datasets will be stored locally in the participating cities' data stores and made available through a central data hub as part of the project website (technically via API requests). This meta-data portal applies a four-fold query mechanism based upon

(1) Metadata-keywords in line with defined key performance indicators (KPIs) and translated in the languages of all participating cities,

(2) free-text searches,

(3) a unique tag "gogreenroutes" that separates project data from other local data,

(4) data provenance that enables finding data from a particular city.

Through this data hub, GoGreenRoutes will make its datasets available in digital form to anyone. Nevertheless, to preserve privacy, GoGreenRoutes applies the principle of sharing its data "*as open as possible, as closed as necessary*".

Besides datasets generated by the project, the Data Hub is designed to also make available selected ancillary datasets from the cities' data stores.

Data re-use will be further supported in that project-generated datasets will be interpreted in the related project deliverables (reports) whereby also the specific production method will be described which much increases data utility, reliability and comprehensibility to third parties.

Each city applies its own standard procedures for the upload of data to the municipal data store. Although these procedures vary between cities, in each case, data quality is assured, in particular complete and correct metadata attribution.

The decentralised data management approach brings about that GoGreenRoutes will not have one project-wide metadata standard. However, this will not cause issues in terms of data discoverability, considering the similarity of commonly used metadata schemas (e.g. the INSPIRE directive recommends ISO 19115/19139 as metadata standards for geographical data).

Moreover, a common naming convention will foster data sharing and ease of identification across the project. This naming convention will facilitate project-wide data identification in that it de-facto collects a common set of project-related basic metadata within the name.

The multi-lingual keyword system as a basic controlled vocabulary, will enable a semantic integration of all datasets generated by the project. KPIs will be defined to follow the Network Nature Task Force 2 NBS Impact Evaluation Handbook [1], and thus, a large part of them will also be familiar to interested parties from outside of the project, who are active in the field of NBS implementation.

The decentralised approach to data storage will make certain that all project-generated data will be protected from loss and be preserved for future use also after the end of the lifetime of the project. The participating cities' data stores exist independently of project resources and, therefore, all data will be kept therein for further re-use by the cities, project parties, and interested third parties alike.

Acknowledgments: This work has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869764.

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ORAL SESSION

C.4.1

Simulating urban parks crowding to manage access during lockdowns

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Keywords: COVID-19; accessibility; urban parks

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During the COVID-19 emergency, cities around the world introduced measures to guarantee physical distancing that restricted access to urban parks and green areas, with potentially negative effects on citizens' health and wellbeing. This study aims at providing insights to manage access to urban green space in physical distancing times, when the risk of crowding should be avoided. Using the city of Trento (Italy) as a case study, the study simulates policy scenarios corresponding to different restrictions and assesses their effects on green space access and crowding. Policy scenarios are obtained by combining different distances that people are allowed to travel, different types of green areas available for public use (only urban parks or parks and schoolyards), and different target populations (all residents or only people with no private gardens). The results unveil the trade-off between access and crowding of green areas, and can be used to suggest policy interventions and regulations that can be adopted in an emergency (figure 1). Particularly, the study shows that: i) The relationship between distance threshold and the percentage of people with access to green areas is non-linear, and this should be carefully considered when proposing travel restrictions; ii) Changing the maximum travel distance does not produce major effects on the number of crowded green areas, hence additional or alternative measures need to be adopted; iii) Off-the-shelf measures, such as opening schoolyards, are beneficial and can be implemented rapidly in an emergency. Finally, the study reveals "hotspots" of green space deprivation/overcrowding in the city that should be addressed by urban planning to ensure that green space continues to benefit citizens also during emergency conditions.

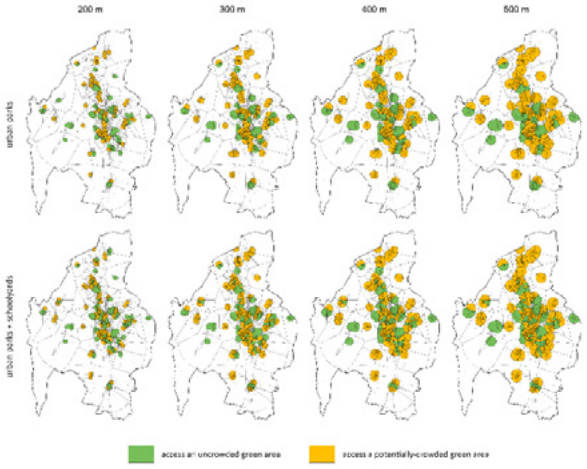

Figure 1. Accessibility and crowing of green areas under different policy scenarios

Socio-ecological urban river restoration to mitigate flood risk, improve recreational potential, and provide suitable habitats: lessons learned from munich, germany

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Keywords: nature based solutions, river restoration, urban biodiversity

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Munich is Germany's third-largest city and the capital and the largest urban agglomeration of Bavaria with a population close to 1.5 million inhabitants, 2.6 including the surrounding suburban areas [1]. Munich is often known as the "economic capital" of Germany because it holds the headquarters of many companies, has the strongest economy of any German large city and a low unemployment rate. This city is located within the Northern Alpine Foreland. It is built on the elevated plains of Upper Bavaria that results from the fluvio-glacial out-wash and previous glacier melts. The construction of the city benefited from its proximity to the Isar River, but its frequent and extreme flooding have long affected the settlements. Consequently, Munich benefits presently from vast housing-free riverine areas with high recreational potential.

The Isar River is 292.3 km long and has a catchment area of 8,964.57 km² that sources in the Austrian Karwendel Mountains. It flows north through southern Germany and joins the Danube River in Deggendorf. It crosses the city of Munich. Naturally, the river Isar is an alpine braided river with large gravel bars but hydro-morphological modifications starting in the late 19 heavily changed its natural characteristics. After a major flood in 1813 which killed more than 100 people and caused the collapse of a main bridge in Munich [2], the first systematic hard engineering and flow regulation of the Isar [2] was implemented. The late 19th and early 20th centuries saw a radical turn from a traditional use of the river to an intensive hydro-electric production with 43 hydroelectric power plants and many water diversion that caused severe river degradations [3]. River degradations were not the only drivers recalling for a restoration of the river. Climate change is expected to increase extreme weather even in the alps and models suggest an increase of up to 25% of the rain volume within the Isar catchment area and an increase of 12% in the 100-year return period maximum discharge of the Isar River [4].

Despite the urgency to take actions, it took more than forty years of intense efforts before the restoration of the Isar river in Munich transpired. The first plan of a river restoration was designed in 1970. From 1970 to 1985 civil society and lobbyists demanded for a near-natural river in Munich and pressured the politicians with very little success at the beginning. Between 1985 and 1990, advocacy groups gradually gained recognition and were invited to co-design the restoration. The hydraulic calculations investigating Munich's exposure to flood risk led to the formal start of planning in 1987 and this lasted until 1999. Between 2000 and 2011, eight kilometers of the Isar River in southern Munich were restored as part of the Isar-Plan. In 2007, it won the first German award "Gewässerentwicklungspreis" for river development [5]. It was a predecessor of a nature-based solution to mitigate flood risk in urban areas, a pioneer in collaborative planning, which started out with advocacy groups and rapidly evolved into a Living Lab approach [6] and is also a prime example for polycentric governance. The Isar River restoration is widely recognized as a model of good practice and a well-known example of socio-ecological river planning [7].

Acknowledgments: This work is part of the PHUSICOS project that received H2020 Grant Agreement No. 776681

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ORAL SESSION

C.4.3

Providing contact with nature for young generation – a case study of kindergartens in Poznań, Poland

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Keywords: green space availability, outdoor activities, preschool garden, children

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The contact with nature is proved to be valuable for health, wellbeing, and development of children [1]. Meanwhile, the urban environment and contemporary urban lifestyle limits the opportunity for contact with nature [2],[3]. Since, children in preschool age spend a significant amount of time during weekdays in kindergarten, we aimed 1) to identify what are the opportunities for preschoolers' contact with nature during a stay in kindergarten, including availability of kindergartens' own outdoor spaces and neighbouring green spaces; 2) to recognise to what extent kindergartens are using the existing opportunities to provide children with contact with nature.

We investigated the practices in public and non-public kindergartens through the prism of staff awareness about the importance of contact with nature for children. Additionally, we identified the impact of the COVID-19 pandemic on outdoor activities provided by kindergartens.

To analysed the availability of neighboring green areas we used the ArcMap software and the "Near" and "Multiple ring buffer" tools. To acquire data on the frequency and duration of outdoor activities of preschoolers, in kindergartens' own outdoor spaces and green spaces located in their vicinity as well as to identify the level of awareness of kindergartens' staff about the importance of contact with nature for children development, we invited 264 kindergartens to participate in the online survey. The survey was conducted between January and March 2020 (before the COVID-19 pandemic in Poland). As much as 104 answers was collected. In March 2021, a supplementary telephone interview with kindergartens was conducted to investigate how the COVID-19 pandemic has changed the use of internal and external green spaces. We applied statistical data analysis using the STATISTICA software.

Our results showed the great awareness among kindergartens of the importance of contact with nature for children development. Regardless various availability of neighbouring green spaces, 45,6% of kindergartens declare to visit external green spaces at least once a week. There are differences between practices of public and non-public institutions in this regard. Non-public kindergartens use the opportunity to visit and enjoy external green spaces more often than public ones. As much as 65.9% of non-public preschools and only 28.5% of the public preschools declared that they take children to visit external green spaces once a week or more frequently.

As much as 93,1% of kindergartens declare to have their own outdoor spaces available for children. Preschoolers, spend daily on average 103 min outdoor during their stay in kindergarten's (161 min in public kindergartens and 99 min in non-public entities). The COVID-19 pandemic did not change the frequency of usage of own outdoor spaces of most institutions but significantly reduced the visits in external green spaces.

Recognising the existing opportunities for contact with nature and its usage is crucial for directing future actions not only in Poznań but in any city that wants to ensure or improve contact with nature for children through the NbS.

This is a promising direction in urban policy since through providing opportunities for regular outdoor play during childhood, we might influence the inclination towards interacting with nature in the future [4], [5]. This in turn proves to be beneficial for humans and nature.

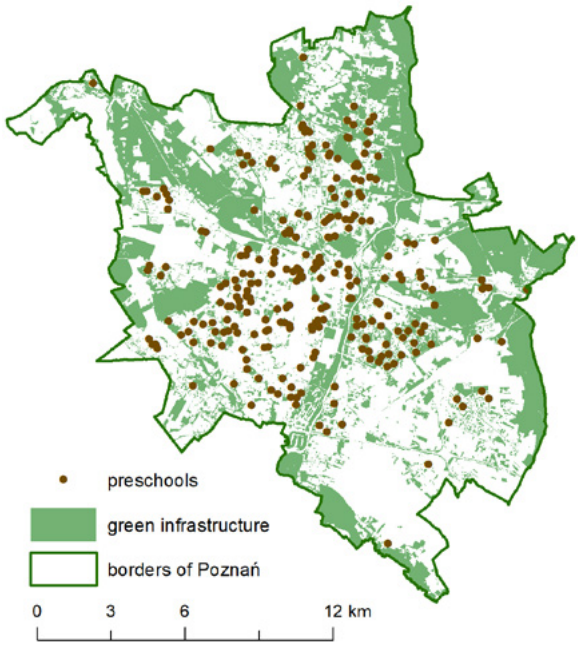

Figure 1. Location of preschools in the City of Poznań

Acknowledgments: The study was conducted within the project CONNECTING Nature, that receives funds from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730222.

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Play-biotopes for children´s play and learning

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keywords: Nature based solutions, Play environments, Children

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Natural areas in cities are decreasing and reducing children's contact with nature. On the same time a succession of studies have been showing how children with access to spacious, green areas which contain a good mixture of more closed and open surfaces, engage in health-promoting play behavior with direct effects on their sleep patterns, attentiveness, fitness and overall wellbeing (Mårtensson et al. 2009; Söderström 2012). Yet, how children's activity depend on elements and structures in nature is only vaguely described in this scientific literature, and we know little about what particular attributes make such places fulfilling their potential. *Play biotopes* describe how characteristics in the overall layout, topography and vegetation compose complex "habitats" that engage children in particular activities (Fjørtoft 2012). In this paper we elaborate on this concept to describe the specific role and potential for children of particular places in natural environmet. We suggest paying attention to the overall composition of specific landscapes and the particular affordances they comprise which together form play biotopes. Distinct content in the landscape and its flora and fauna are attributed to particular values for play, learning, and restoration, but also as commonly in naturbased solutions, serving several ends on the same time. The goal is a common terminology to describe nature based settings for children, merging terminology from ecology with concepts from landscape architecture and environmental psychology.

Acknowledgments: This work was supported by the EU Horizon 2020-project REGREEN (Grant Agreement No. 821016).

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Green streets: Places for recreation during crisis time?

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Keywords: COVID-19 (SARS-CoV-2) pandemic, recreational outdoor activity, vegetated green streets

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Since more than one year the COVID-19 (SARS-CoV-2) pandemic causes severe crises and disruption in people's private and public live. Especially now, access to urban green spaces seems to be essential for physical and mental well-being. Partially, severe regulations implemented around the world have, however, prevented society from freely visiting green spaces. In some places and during some periods of the pandemic, some cities even decided on closing parks, playgrounds etc. to regulate social distancing. This put a spotlight on the inequality in access to urban green spaces, and possibilities for outdoor activities. As a result, many people used regular streets for outdoor activities because they were easily accessible but not as frequented by traffic as in times before the pandemic.

In this study, our objective was thus to examine the use and relevance of streetscapes for outdoor activities in cities under pandemic conditions. We hypothesized that streetscapes support various outdoor activities and act as substitutes for urban green spaces during crisis times. We generated an online questionnaire that was answered by over 400 international respondents, and from diverse sociocultural contexts.

Our results clearly showed that people used streetscapes for a variety of activities, many of which were reported as their primary physical activity also. Walking was the most common activity in the streets, regardless of sociocultural or geographic settings, yet other activities, such as jogging, differed between countries and people's sociocultural backgrounds.

Our findings highlight the important role of streetscapes in enabling people to engage in regular physical activity during the pandemic. Recognizing streetscapes as important public open spaces within neighborhoods could help address inequality in access to green space, an issue that seems more important than ever before.

Figure 1. Playing tennis across a street gate during severe lockdown suggest that empty streetscapes can act as outdoor spaces for recreational purposes.

Analysis of urban forest buffer zones as a tool of implementation of Nature-Based Solutions – a case study of Poznań (Poland)

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Keywords: land use, high greenery, canopy ratio, forest edge, spatial planning

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Forests are some of the most valuable resources of urban green infrastructure. The tightening of areas in the vicinity of forests, changes in water relations, disruption of the continuity of wildlife corridors and the growing number of users cause the degradation of urban forest ecosystems. This study is an analysis of urban forest buffer zones in the context of land use type, the high greenery ratio and spatial planning strategy which could serve as a Nature-based Solutions. The study was conducted in Poznań (Poland) – a big city in Central Europe, which is typical in terms of its spatial structure and intensive urbanisation. Poznań has a wedge-shaped urban green space system, in which forests are the most important element.

The main objectives of this study were: (1) to highlight changes in urban forest buffer zones; (2) to examine the influence of the land use type on the high greenery ratio in urban forest buffer zones; (3) to indicate the potential of analysis of urban forest buffer zones as a spatial planning tool enhancing the provision of ecosystem services.

The forest areas were digitised with the GIS software Arc Map 10.5.1 on the basis of available orthophoto maps and land cover maps from the resources of the Poznań Spatial Information System, which were imported as WMS layers. We analysed the vicinity of Poznań urban forests (a buffer zone width of 500 m) to determine general trends and the extent of changes in land use around forests. The vicinity of forests was classified into one of five general categories of land cover: 1. Development areas; 2. Open waters 3. Arranged green space; 4. Open spaces (fields, former farmlands, meadows); 5. Forests outside the city. The forest vicinity was examined at two time points – 1997 and 2019 and additionaly supplemented by simulation of the future development in the context of current planning documents. Next, land use types were identified in the buffer zone extending at a width of 100 m: areas with roads, industrial areas, areas with facilities providing services, multi-family housing areas, single-family housing areas, dispersed development areas, allotment gardens, public areas of arranged green space, areas with meadows and trees, former farmlands with successive vegetation, arable lands, open waters and forests outside the city limits. The share of high greenery in separated homogeneous sections corresponding to the land use type was calculated. Finaly we analysed planning documents for Poznań and the neighbouring communes, checked the coverage and provisions of local spatial development plans concerning forests and their vicinities.

The study showed significant changes in the urban forest buffer zones, where open space is being developed. The forecast based on planning documents showed that the negative trend would continue. Further analysis involved determining the degree of coverage of the buffer zones with high vegetation, which could be treated as a forest extension and an element mitigating the negative transition between the forest and the city. Different land use types were taken into consideration, especially developed areas. The study involved development of the concept supporting green infrastructure in urban forest buffer zones, regardless of the land use type. The study showed that Urban Forest Buffer Zones have already worked but more accidentally than as an effect of planned strategy. The significance of planning tools in the development of urban forest buffer zones was indicated. Urban Forest should have strict spatial planning regulations like planting high greenery in a specific part of a plot, the share of bioactive area etc. The study could serve as an example for other urban contexts, regarding rapid housing development and developing the strategies for spatial planning with the focus on Nature-based Solutions.

ORAL SESSION

C.4.7

Nature Based Solution applied on brownfields versus resident's feelings – A summary of the results of the first phase of the research

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Keywords: urban environmental acupuncture, security, brownfields

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Green spots in urban environment are becoming important factors in adapting to climate change. In the adaptation strategies [1], [2], [3], [4], [5] we can find several requirements for the incorporation of green spots into the urban structure. The term Nature based solution (NBS) includes a number of solutions that can positively contribute to reducing a problem in a city (heat stress, storm water, air quality, soil sealing). NBS are living solutions inspired by, continuously supported by and using nature, which are designed to address various societal challenges in a resource-efficient and adaptable manner and to provide simultaneously economic, social and environmental benefits [5].

However, the use of the NBS is associated with problems of their location and the feelings of the citizens.

For the research, following definition of suitable places for urban environmental acupuncture has been used. As defined in project Salute4CE, a potentially suitable place for application of a Nature-based solution as a part of urban environmental acupuncture is, a place that is not maintained, is neglected or no longer fulfills its function, (brownfields), a smaller site - ideally up to 0.2 ha but no more than 0.6 ha to allow feasible implementation, a place that spoils image of its surroundings or even reduces property prices in the vicinity.

The connection between elements of urban greenery and citizens and their sense of security was mentioned as early as in the 19th century, as stated by [6]but it is still a current topic.

Feeling of security appears in theories in the field of human needs. The most famous one is the Maslow theory [7]. This leads to interpretation that the feeling of safety and security is very important for the population; some preliminary surveys found out that some of the NBS cause residents feeling insecure.

The research is based on these three aspects. Places with a high concentration of brownfields. Places with sensory thermal stress. A NBS that can evokes a feeling of danger.

The example of the city of Ostrava shows that in places with a high concentration of brownfields (possible location of NBS), residents feel thermal discomfort and a sense of danger. If it is decided to place any of the possible NBS in these localities, it is necessary to take into account the opinions of the citizens. Therefore, the survey interacted among residents focused on their feelings of danger caused by individual NBS.

This paper summarizes the results of the first phases of research research focused on the feelings of the population associated with individual Nature based solutions. 28 types of suitable NBS selected within project SALUTE4CE were applied in the survey. Respondents were selected from the group of Ostrava citizens Respondents in the questionnaire assessed the feelings of possible danger of individual NBS (feeling danger, neutral feeling , feeling of safety). The results were mostly confirmed that all feelings of dangers related to these NBS, are visual barriers.

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Environmental impacts of urbanisation on the example of the Slovakia

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Keywords: land use changes, urbanisation, impacts, Slovakia

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The development of urbanisation is linked to qualitative and quantitative changes of the landscape and its components aimed at strengthening economic, administrative and cultural-social functions, which are associated with ever-increasing pressures on ecosystems and their individual components. These pressures are subject to various factors – socio-economic, political, environmental, etc. [3]

Independent Slovakia belongs to young European states. The communist period lasted from 1948 to 1989 in the different political-administrative forms. Character of landscape was dependent on centrally managed economy. The for ms of landuse were influenced mainly by activities with related to collective agriculture and industry, as well as urbanization processes. After 1989 (after so called Velvet revolution), land use again began to change dramatically like in many post-communist countries. Slovakia joined the European Union in 2004 and this milestone had also enormous effects for landscape changes.

The transformation of central planning into a market economy was the basis of these changes, which conditioned following strong pressure of investors on the landscape, construction of technological parks, shopping and logistics centers, transport infrastructure, but also construction of residential complexes, etc. The conversion of natural and semi-natural ecosystems into building lands represents activities with significant negative ecological impacts (e. g. habitat destruction due to the reduction of forest and urban vegetation, top-quality soils for non-agricultural activities, etc.). Effects on ecosystems and their negative consequences are also recorded due to rapidly changing needs and consumption patterns (luxury living, transportation and energy). These trends negatively reflect not only on the ecosystem changes and as threats of ecosystem services, but also on the deterioration of the quality of the environment.

Urban sprawl puts pressure to landscape, especially in Bratislava and other bigger cities of Slovakia. According to the European Environment Agency's study on urban sprawl [2] between the mid-1950s and the end of the 1990s industry, commercial and transport services have grown at a significant rate and the residential areas at a moderate rate in Slovakia.

Bratislava (capital city of Slovakia) is among the cities that were affected by the strong centralised planning systems that prevailed during the communist era and that are now facing the same rapid urban sprawl as many other European cities. On the other hand, Slovakia has areas where urbanization has the opposite trend. Rural settlements are abandoned as well as large areas of agricultural land. The character of land use has fundamentally changed over the past 30 years (see Figure 1).

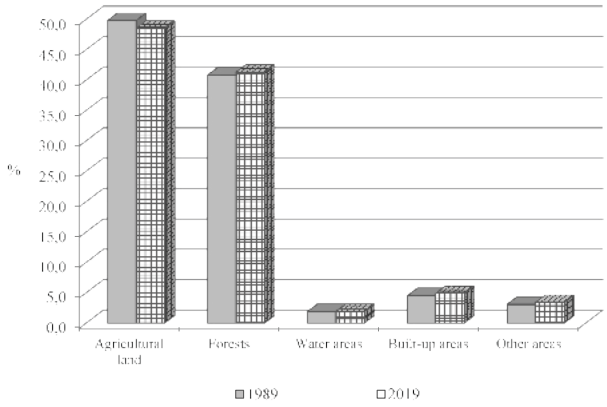

Figure 1. Land use in Slovakia in 1989 and 2019 [%] [1]

In the paper we will present the evaluation of the environmental impact of the urbanisation development in Slovakia. We will also present the main driving forces of these changes and the major ecological and environmental problems caused by these changes. The paper will present an example of an integrated approach to assessing the environmental impacts of urban development.

Acknowledgments: This work was supported by the project VEGA no. 1/0658/19.

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ORAL SESSION

D.1.2

Everything in its right place? On the spatial dimension of biophilic and biophobicdevelopments in cities

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Keywords: Biophilic City, Remote Sensing, Gardens, Berlin

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Biophilic cities are putting nature first in their policy. Such a tendency towards supporting live, is at the top of the menu for an attractive modern city. It especially applies to policy focussed on the extension of urban greenery as this is a pre-requisite for many human-nature interactions, various ecosystem services and generally underpins well-being of urban dwellers and biodiversity in cities. With our case study city Berlin, Germany, we can show that despite urban population growth continuous greening is possible showing an example for biophilic urban design. For the analysis, we contrasted the development in vegetation density over 30 years measured with subpixel fractions based on a Landsat remote sensing time series (for 2015: MAE 0.12), with population density developments [1]. While Berlin in general shows a pathway for positive biophilic developments, biophobic developments are also present. An area of pronounced vegetation decline are private residential gardens.

Garden city areas are one of the dominant urban forms in many regions of the world directly incorporating private green. While less sustainably from a traffic perspective, they offer the potential of large gardening areas and thus might foster beneficial and mutual human-nature interactions. Gardens provide many ecosystem services and can this way be real hotspots of biodiversity, food production, happiness and relaxation [2].

A threat for vegetation in garden cities are infill developments and microsealing transforming the gardens to gravel- or stone gardens or car parking infrastructure [1]. While reasons for infill are manifold, microsealing towards mulch or gravel gardens can be understood as a biophobic mindset not wanting to interact with the complexity of natural processes as those might be laboursome to control. Generally, denser vegetation can be linked to more time spend in the front yard [2]. Front yards are especially prone to the disregard of the wild and spontaneous side of nature, as people consider those spaces as important for an orderly self-portrayal—stating everything is in its right place (see an early example for this in Europe in Figure 1).

Even though there is "evidence that satisfaction with one's front garden […] increased as the proportion of vegetation was enhanced" [2], we frequently observe the loss in native, planted and spontaneous vegetation in Berlin. Policy for restricting such sealing tendencies at private grounds differ substantially between cities.

For working towards green(er) policies and to reconnect people to the biosphere —bringing aspects of biophilia in—we see potential in exploring the potential in using environmental data e.g. from remote sensing. Spatial-temporal continuous and consistent analysis can help in studying both benefits and composition of urban green infrastructure like gardens and can help to enforce policies [3]. What is more, the data serves as a means for communication, if combined with web-app technology like e.g. R Shiny or WebGIS so that evidence can be freely circulated in society [4].

Figure 1. A scene from the movie "Mon Oncle" (Gaumon, 1958) by Jacques Tati portraying a very orderly arranged garden with dominance of concrete and gravel representing a modernistic family home.

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Moscow urban growth pattern: sprawl or not?

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Keywords: urban growth, urban spraw, agglomeration

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Over the past 30 years, Moscow has grown in absolute terms much faster than any other city in Russia. The concentration of the headquarters of all leading Russian taxpayers in the Moscow jurisdiction has led to a huge gap in wages and living standards between Moscow and any other region. Moscow is called a "vacuum cleaner" because of the internal migration inflow that it generates, pulling the most active population out of all other urban centers [1]. This determines the continuing rise in real estate prices in Moscow and the interest of business in the implementation of new construction projects.

Ensuring the fulfillment of the tasks of housing construction, the authorities of Moscow, the Moscow region and a number of adjacent constituent entities of the Russian Federation create conditions for the most favorable conditions for construction companies, including through the provision of additional land plots, the coordination of programs for the creation of transport and social infrastructure, the removal of existing restrictions for the development of specially protected natural areas , forestry and agricultural lands. As a result of this policy, the area of the built-up area is increasing not only within the boundaries of Moscow, but also in the orbit of its influence, which forces us to speak of signs of urban sprawl.

The observed features of Moscow's urban growth are largely due to the transitional state of the spatial planning system in Russia, when the centralized administrative-command system that existed in the USSR was destroyed, and the new system that ensures the observance of public interests in the real estate market has not yet formed or is providing insufficient influence. The accelerated urban development of Moscow is becoming one of the consequences of the policy of centralizing powers and resources on a national scale. Following the traditions of the Soviet administrative approach led to the expansion of the administrative boundaries of Moscow at the expense of the Moscow region in 2012 with an increase in the area of the territory by 2.5 times. At the same time, in terms of the concentration of built-up areas and night lights, the real Moscow agglomeration goes beyond the boundaries of not only Moscow as a subject of the Russian Federation, but also beyond the boundaries of the Moscow region.

The political reaction to the emerging contradictions is closely related to the special status of Moscow as a constituent entity of the Russian Federation and the greater independence corresponding to this status in determining the target guidelines of urban planning policy and ways to achieve them.

The peculiarity of Moscow is manifested in the fact that, due to high land prices, Moscow remains the leader in the transformation of built-up areas among the cities of Russia. At the first stage of this process, compaction development in Moscow took place in territories that were free of construction or were used ineffectively, which was regulated by market conditions and the investment attractiveness of the sites. At the next stage, the transformation of territories that have the potential for cost-effective compaction began to require the forced redistribution of land, in particular, transport, production, and utilities, as well as the participation of the budget in the creation or reconstruction of expensive infrastructure. The current stage (since 2017) is associated with the spread of transformation processes to residential buildings in 1956-1968 and later, including both dilapidated buildings and suitable for living [4]. At the same time, as a rule, 5-storey buildings are demolished and replaced by 17-20-storey buildings.

Based on remote sensing data [3], we estimated the growth of built-up areas and population density for the period from 1991 to 2015, taking into account the distance from the city center, for which Red Square was taken. It was found that the change in indicators was heterogeneous in space: within 20 km of the "central" zone, the population density increased by 40%, while in the "peripheral" zone 20-60 km from the center, the density increased less significantly than the share of built-up areas. At the same time, the average population density within 60 km from the center increased during the period under review. Based on the definition of the urban sprawl [4], we believe that in Moscow there was no urban sprawl, but uncontrolled urban growth associated with further densification of the central part and simultaneously with territorial expansion in the periphery.

Acknowledgments: This work was supported by ...

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ORAL SESSION

D.1.4

Towards sustainable urban communities: a composite spatial accessibility assessment for residential suitability based on network Big Data

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Keywords: sustainable cities, spaitial accessibility assessment residential suitability, big data

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Suitable spatial allocation of residential public services is vital to realize the sustainable community and city (the 11th SDGs). Here, by combining network Big Data (POIs) and GIS spatial analysis, we developed a composite spatial accessibility assessment method for the residential suitability of urban public services covering health care, leisure, commerce, transportation, and education services. Xiamen City, China is the test site. We found that although most public facilities had concentrated on Xiamen Island, the local transportation and education services were still in shortage with high density of local population. Meanwhile, Tong'an still has advantages on the amount of public facilities. However, the high-quality facilities were deficient as well as that in the other off-island districts. The Xiamen's residential accessibility of transportation, commerce, and health care service have apparent mutual consistency regarding spatial allocation. Nevertheless, residential education and leisure services showed regional disparity. Evident inequality could be witnessed by compared the residential composite suitability between the communities on Xiamen island and those in the off-island parts, which has enormous negative impacts on the sustainability development of Xiamen City. Our study hopes to provide dedicated supports for designing the sustainable community and city, especially for those in the developing countries.

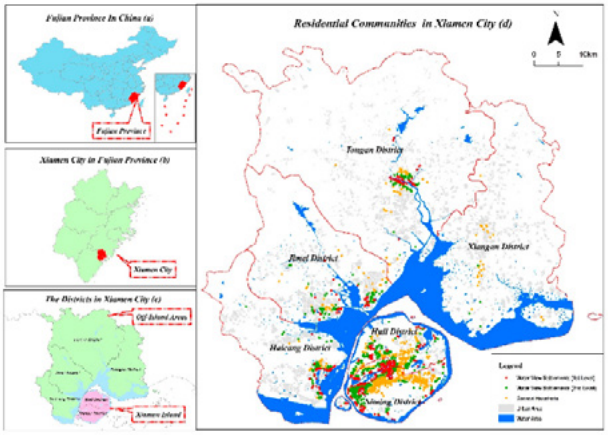

Figure 1. Residential communities in the study area (Xiamen City)

The abstracts should be uploaded in the ABSTRACTS section of the conference site www.sure2020.org

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Parks in context: Advancing citywide spatial quality assessments of urban green spaces using fine-scaled indicators

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Keywords: context, ecosystem services, green space quality, indicators, Leipzig, OSM, spatial assessment

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Urban green spaces have gained attention due to their increasing relevance to human well-being in the context of challenges related to urbanization and climate change. Detailed, systematic, citywide assessments of specific urban green space characteristics that provide a sufficient understanding of resident interactions with green spaces and respective ecosystem service flows are lacking.

We chose the city of Leipzig, one of the fastest growing cities in Germany, as a case study to assess the quality of publicly available green spaces by incorporating spatial context as a key dimension in determining their actual quality (Figure 1). We established 33 indicators that describe (a) natural elements, e.g., the types and configuration of vegetation and the proportion of water bodies; (b) built elements, e.g., various recreational facilities and path density; and (c) the embeddedness of green spaces within the built, social and natural environment (context), e.g., the number of neighboring residents, nearby green or blue elements and exposure to traffic. Based on these indicators, we developed a scoring approach that provides an evaluation of green space quality in terms of the potential to provide recreational ecosystem services. We identified and discussed spatial gaps and deficits in the quality of green space supply as well as leverage points for making operational improvements at the individual green space level.

In the case of Leipzig, we found that mainly smaller parks provided the highest indicator values and quality scores, indicating that they serve as important green spaces in the dense inner-city areas and complement the city's extensive forests, which are rather available around the built-up area. When assessing the potential for improving the quality of parks, we mainly identified context measures as being the most needed but also as feasible leverage points for management interventions, e.g., through traffic reduction or better connections to public transport.

Our approach is comprehensive for the case of urban parks in a Central European context but is flexible enough to allow for adaption to other urban green space types and regions. Depending on the specific case, weighted or different sets of indicators may be more suitable and could be complemented by additional aspects. Furthermore, our proposed UGS quality indicators can be applied in detailed ecosystem service assessments or models.

Our study provides urban planning guidance for identifying untapped potential for ecosystem services provision, e.g., due to usage barriers, and may help to balance the trade-offs between benefits for citizens and ecology and thus improve green spaces for people and nature at the same time.

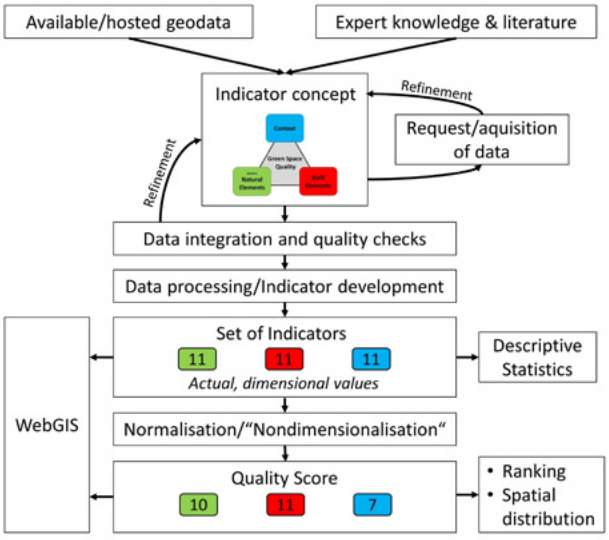

Figure 1. Workflow chart of the study.

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ORAL SESSION

D.1.6

Analysis of the visibility and signal strength of the LoRaWAN network i n an urbanized area on the example from campus of the Nicolaus Copernicus University in Toruń

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Keywords: LoRaWAN, SmartCity, Industry 4.0, light pollution, visibility

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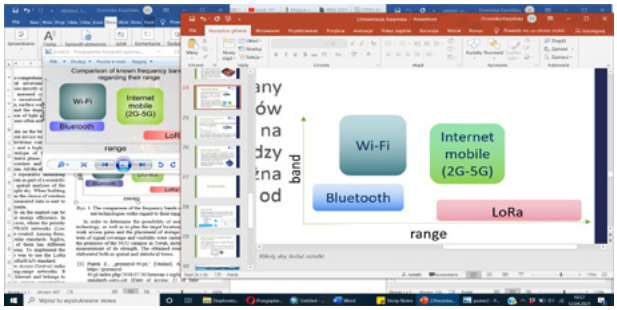
In order to assess and define the comprehensive quality of the surrounding geographical environment, it is necessary to measure selected factors directly or indirectly affecting its condition and the assessed components. Among the components to be monitored, one can distinguish, the air and its pollution, surface waters and the level of their cleanliness, soils and the degree of their erosion, as well as the phenomenon of light pollution of the night sky, which is more and more often noticed by the naked eye.

In order to regularly collect data on the brightness of the night sky, a remote measurement device was designed and built, based on specialized electronic components, a wireless bus, programming code and a high-sensitivity digital light recorder. The prototype of the device underwent the technology demostrator phase, calibration based on professional SQM recorders and long-term operational testing in field conditions. All the above stages were used to build a set of 38 repeatable measuring devices, ultimately installed in Toruń as part of a scientific project concerning multi-criteria spatial analysis of the phenomenon of pollution of the night sky. When building the sensor sets, the key element was the choice of wireless technology, thanks to which the measured data is sent to the server that stores the measurements.

Wireless technologies available on the market can be divided according to the range or energy efficiency. In order to support many mobile devices, where the priority is long, wireless operation, LPWAN networks (*Low Power Wide Area Networks*) were created. Among them, we can distinguish the most popular standards: Sigfox, LoRaWAN and NB-IoT. Each of them has different parameters and targeted applications. To implement the assumed project, the best choice was to use the LoRa technology, which is part of the LoRaWAN standard.

LoRaWAN is a MAC (*Medium Access Control)* radio communication protocol for long-range networks. It allows devices to connect to the Internet and belongs to the wireless protocols with low power consumption LPWAN [1]. LoRaWAN is one of the solutions used for communication between IoT (Internet of Things) devices, supporting the idea of Smart City, Industry 4.0 and Smart Environment. It enables the creation of sensor networks with long-range communication. Such a solution is used not only in the transmission of road, logistic and environmental information, but also supports portable patient monitoring devices and allows for the management of entire cities and their monitoring [2, 3].

A wireless communication technology designed specifically for the LoRaWAN standard is LoRa (*Long Range*). It complements and fills the gap between known technologies such as Wi-Fi, Bluetooth and LTE (Fig. 1). LoRa technology is a type of signal modulation using the CSS (*Chirp Spread Spectrum*) technique, which consists in spreading the spectrum of the transmitted signal. The great advantage of LoRa transmission is its long range. It is, depending on the signal quality, device class and introduced parameters, from several hundred meters to even several hundred kilometers [2].



Rys. 1. The comparison of the frequency bands of different technologies withe ragard to their range.

In order to determine the possibility of using LoRa technology, as well as to plan the target locations of network access gates and the placement of storage devices, tests of signal coverage and visibility were carried out on the premises of the NCU campus in Toruń, including the measurement of its strength. The obtained results will be used in the design of the LoRaWAN wireless network throughout Toruń and, in the future, in other cities. On their basis, it is possible to select potential locations for devices in order to minimize the number of needed access gates, while increasing the connectable systems recording selected environmental parameters (light, noise, dust and chemical pollution) and covering a large area. The construction of a wireless network based on the LoRaWAN standard, thanks to which many measuring devices can be connected, fits into the design framework of the multi-area idea of a smart city, as an important element of the industrial revolution 4.0 taking place before our eyes.

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Which role can urban wilderness play in eco-cities?

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Keywords: Biodiversity protection, nature experience, urban wildernesss, supply and demand, acceptance and management

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Wild urban ecosystems are an increasingly important element of sustainable cities around the world. Urban wilderness is developing as a socio-ecological concept. The often missed legal status of urban wildernesses doesn't regulate utilization and management clearly. Wildernesses exist in many cities as natural remnants e.g. woodlands or wetlands, ancient wildernesses and new wildernesses, novel ecosystems. The urban wilderness concept consists of major components:

- **Targets** for wildernesses: Biodiversity protection and nature experience,
- **Supply** of different wilderness areas and types,
- **Acceptance** of wilderness in societal differentiated and cultural different urban societies,
- **Access** to and **disturbances** of strictly protected urban wildernesses and
- **Management** of urban wildernesses.

The presentation shows the importance of wildernesses in eco-cities as specific part of nature, untouched and (mostly) not managed. The targets biodiversity and nature experience will be explained. Supply, acceptance, access and management will be presented on examples of Salzburg, Austria. The selection of Salzburg as example city is based on the fact that this city is seen as best embedded in nature, has 54% green spaces of the total area and is highly accepted as "ideal green city". The target is to develop management strategies of these areas to

i) Preserve or increase biodiversity and
ii) Extend and develop them for nature experiences.

The study based on

- Identification of locations, types (woodland wilderness, urban fens and water related wildernesses) of urban wildernesses, and protection status
- A survey among green space users on urban wildernesses and key interviews with decision makers in nature management,
- Identification of damages and use and
- Proposals for nature management.

The results for urban wildernesss show:

- Development targets are often not clear,
- Only ancient wildernesses, not novel, are protected,
- The areas are often too small to preserve biodiversity,
- Knowledge about natural processes and structures, the basis of wildernesses use and protection, is very low,
- The general acceptance of wildernesses is surprisingly high, but most urban nature managers are skeptical about acceptance,
- Most urban dwellers are afraid on risks in wild spaces and avoid to access,
- Urban wildernesses are best places for nature experience,
- Most damages are human disturbances, and
- Urban wildernesses need management for biodiversity and nature experience.

The wildernesses are much valued for biodiversity and nature experience, but in comparison to well-maintained urban green spaces rarely used, often damaged and insufficient managed to fulfill its tasks.

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ORAL SESSION

D.2.2

Alley activation as a practical neighborhood sustainability strategy: integrating green energy, rainwater harvesting and community-Driven Placemaking in Detroit

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Keywords: Urban alleys, green infrastructure, sustainability

The value of urban alleys as a source of sustainability solutions is an emerging area of research and practice. In Detroit, many alleys have long been obstructed by debris and overgrown vegetation. The recent widespread clearing of these clogged alleys presents an opportunity to rethink alley function. **Alley Activation** refers to the process of clearing alleyways and converting them from dormant or forbidding spaces to inviting and productive spaces that contribute to sustainability goals. However, the capacity of Detroit's alley network to enhance neighborhood sustainability is so far untested, outside of a few high-profile, capital intensive projects located in the downtown core. Green alley programs tend to be narrowly focused on environmental benefits, such as reducing stormwater and heat island effects, rather than being holistic community-based reinventions. Our project specifically addresses this question of inclusive impact, looking beyond the narrow consideration of alternative pavements and plantings to consider how alleys might be "plugged in" to the surrounding neighborhood in ways that reflect local history and needs while also addressing multiple sustainability goals. We undertake the process of alley activation as envisioned from the ground up, incorporating technologies in response to identified community goals and needs, including those related to environment, equity, and economy. In particular, we bring together elements of **blue-green infrastructure** (rainwater harvesting) with **upcycled green energy** (combined wind and solar) and **community-driven placemaking** to build an open-ended platform for alley activation that can be both replicated and tailored across many different Detroit neighborhoods that are facing similar challenges within locally distinctive contexts. In this presentation, we propose that newly activated alleys might serve as a green capillary system that significantly contributes to municipal sustainability goals and the cultural, social and economic life of neighborhoods. We describe a pilot project that is now moving from the ideation to the implementation phase, with in-depth description of the social and environmental context. The final project will serve as a small-scale proof-of-concept, advancing the real-world application of sustainable technology within the setting of a partner neighborhood, utilizing alleyways that will serve as an open-air laboratory and demonstration site. We will gather primary data on the effectiveness of this installation in terms of stormwater management and off-grid energy production. We will also map and model its potential extension through Detroit's extensive alleyway network, projecting the environmental, social and economic benefits to both local communities and the city government if this form of alley activation is implemented on a neighborhood or citywide scale. Finally, ethnographic methods will be used to evaluate and inform each step of the alley activation plan. This extension and application of existing research will concretely support policymakers and local communities in moving towards creative, sustainable activation of alleys in Detroit and beyond.

How tree canopy effects the air quality of cities: the case of Karsiyaka (Izmir-Turkey)

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Keywords: tree cover, urban air quality

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Air quality has become major concern in many cities. Poor air quality is a serious threat to human health, causing problems for the respiratory system and cardiovascular diseases. Green areas and trees are important components of the urban ecosystems and they provide valuable ecosystem services. They improve air quality by filtering atmospheric particulates such as nitrogen dioxide (NO2), particulate matter (PM2.5-10) and sulphur dioxide (SO2). They also act as a sink for carbon dioxide (CO2) by fixing carbon during photosynthesis and storing carbon as biomass. Cities set several goals to tackle air pollution problem and increase urban resilience. Increase amount of green areas and canopy cover are common solutions for many cities.

This study aims assess the benefits of tree cover for air quality in Karsiyaka (Izmir, Turkey) and to test the two scenarios to increase canopy cover for 30% and 40%. The air purification benefits of urban tree cover for a year will be estimated by dry deposition. Results will be discussed based on urban resilience and urban green management.

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ORAL SESSION

D.2.4

Linear parks as a nature based recreation areas in metropol cities. A case study of Istanbul

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Keywords: Linear Parks, natural recreation area, blue green intersection areas, activities, Istanbul

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One of the major problems facing megacities is the lack of ourdoor regeneration areas. The green area in the residential areas of Istanbul is 2.2 square meters per person. This ratio means that Istanbul appears as a poor city among the world's green metropolises. However, Istanbul is a metropolis with advantages due to its geographical location. Scientific research has shown that the city has more than 15 million inhabitants and that the coastal line is preferred for recreational purposes. The fact that the city's residential area forms around the Sea of Marmara and the Bosphorus enables many people to reach the coastal zone in less than 30 minutes. This situation requires that city plan be made suitable for the use of recreation. However, developments in the city show that some old industrial areas in the coastal areas are not used for this purpose. In these areas, gated communities are built for high-income people, and the old working-class neighborhoods that form just behind the old industrial areas are separated from the sea. River valleys and lakeshore are also reserved areas for linear parks for Istanbul, which is located on a plateau.

The aim of this study is to demonstrate the importance of these areas for the city's natural recreation needs by showing the structure of the coastal areas.

"In a survey we identified the water related linear parks in the zones: i) Bosporus European side, ii) Bosphorus Asian side, iii) Golden Horn, and iv) Marmara Sea. We evaluated these parks by a set of scaled indicators on a) nature elements, b) infrastructure, c) cleanness and security, and d) utilization intensity. In the best ranked linear parks in each group (4) we investigated by interviews of randomly selected visitors 1) perception to urban green, 2) acceptance of park quality, 3) frequency and duration of visits, 4) sufficiency with equipment, safety and cleanness.

The results show that quality of parks, accessibility and time/distance to reach the parks are the most important factors for section of park for untilization."

[1] This study was carried out within the scope of „RESEARCH ON NATURE BASED RECREATION AREAS IN METROPOL CITIES- TUBITAK 2219" Scientific research project.

The role of eco-city projects in the transformation of practices and institutions on stormwater – learning from existing experiences in Linz (Austria) and Toulouse (France)

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Keywords: Sustainable Drainage Systems (SuDS), socio-technical change, institutions

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Conventional urban stormwater management has as hallmarks the fast conveyance of stormwater out of cities and top-down governance structures. While this paradigm has become widespread in practice, many challenges have arisen as a result of its adoption in a context of climate change and increasing urban population, e.g.: 1) a low resilience to flooding; and 2) the absence of formal structures to involve all required stakeholders. This reality calls for a systemic transformation.

In order to respond to the prevailing environmental challenges and showcase commitment for their resolution, the eco-city concept was introduced in the sustainability agenda in the 1990s. A proliferation of eco-city initiatives has been observed since then. The strategies put into practice include in many cases the development of more sustainable stormwater management schemes. Eco-city projects have been used as protected spaces for the comprehensive adoption of Sustainable Drainage Systems (SuDS), a promising strategy to address the issues posed by conventional stormwater management. Through SuDS, natural processes are mimicked to handle e.g. floods.

Compared with traditional approaches, there is, however, a distinct shortage of evidence regarding the major sustainability of SuDS. Scholar literature has mainly focused on the evaluation of the technical performance of usually single SuDS elements, while the transformative potential of experiences with SuDS in social (e.g. change in people's attitude) and technical (e.g. change in the way techniques are implemented) terms have been little explored. Changes in the actors' institutions (i.e. their knowledge, values, policies, etc.) have been almost not analysed. Further, the dynamics occurring above the single project scale also require further scholar attention.

This paper analyses the role of eco-city projects as vehicles of socio-technical change in the field of stormwater management. In particular, the potential of SuDS implementation as a vehicle for change in people's institutions and practices, and at the city scale is assessed. An indicator-based approach has been created and applied for the assessment of the institutions (not least the knowledge and perception), actions, power forms and feeling of power (i.e. feeling of being able to contribute to a paradigm shift) of residents and professionals involved in two eco-city projects where SuDS have been deployed: the solarCity (Linz, Austria), and Monges-Croix du Sud (Cornebarrieu, Toulouse agglomeration, France). In order to compare the reality in eco-cities to that in conventional quarters, identical analyses have been conducted in analogous conventional quarters: in Linz (Austria) and in Colomiers (Toulouse agglomeration, France). In addition, interviews have been carried out with local professionals to uncover the influence of their participation in eco-city projects in their daily practices and up-scaling effects.

Findings reveal that the mere implementation of SuDS appears to have little effect on paradigm shift in both urban areas. No significant divergences exist in residents' institutions and practices among eco-cities and conventional quarters. Stormwater management practices remains an issue out of mind and the strains of conventional systems are usually not recognised. Even if SuDS have been implemented, their presence is unnoticed by most residents. Thus, SuDS implementation does not equate to SuDS experience, which brings about no change on residents' attitude toward stormwater. For the majority of respondents, however, stormwater is as a very valuable resource and should be managed on site, where it should furnish ecological but especially social functions. This shows a widespread worldview supportive of sustainable approaches, which has, however, not resulted into action. No residents are engaged in the sustainable development of their quarter, and only 10 to 20% collects stormwater. Some reasons explaining this reality are the absence of participatory processes/ communication channels with residents and a widespread feeling of powerless, when it comes to actively contribute to socio-technical changes. Inaction entails the maintenance of conventional practices, also in eco-districts, i.e. reinforcive power is exerted.

A similar worldview is shared among residents and professionals. For most of the latter, the participation in eco-city projects has translated into a recognition of the weaknesses of conventional systems, even though this has impacted differently their succeeding projects: 1) some stakeholders started to support SuDS adoption after the acquisition of knowledge on SuDS functioning; whereas 2) policy changes have played a more important role for some others. Eco-city projects are generally perceived as special and very ambitious projects with no further consequences for future practices at the city level. This constrains the up-scaling of the eco-city model, which proves insufficient if no shift is promoted in its mode of implementation. Work on citizens' involvement and empowerment is needed, if socio-technical change to sustainability is to be attained.

The abstract should be uploaded in the abstracts session "Eco-cities - Planning, Design, Development, and Management Practices" of the conference site www.sure2020.org.

ORAL SESSION

D.2.6

Ecosystem services of urban parks: the case of Evka 3 (Izmir-Turkey)

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Urban parks provide a wide variety of ecosystem services such as water and air purification, noise reduction, microclimate regulation, carbon sequestration and flood prevention. The type and amount of ecosystem services of the urban parks will vary with the structural and ecologic characteristics of them.

This paper has two main objectives (1) to assess spatial distribution of urban parks in Evka3 neighborhood in Izmir and (2) to calculate three regulating ecosystem services (carbon sequestration, air purification and runoff retention) generated by them. The spatial pattern of the parks was quantified by using five area and edge landscape metrics by using FRAGSTATS 3.4 and ecosystem services were estimated by using i-Tree Eco model.

Results showed that urban parks cover small portion of the neighborhood and, they are mostly small and unevenly distributed in the study area with low connectivity. Also, ecosystem services varied greatly with vegetation type.

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Human-nature resonance – a relational approach to inform sustainable urban transformation

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Keywords: urban human-nature relations, urban sustainability transformation, inner transformation

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Despite increasing efforts by research and policy to approach sustainability, modern acceleration- and technology-centered society´s impact on nonhuman nature is intensifying the socio-ecological crisis such as climate change, resource depletion and human exhaustion. For a significant turnaround, current sustainability research calls to engage with fundamental paradigms and the question how to overcome the dichotomy between society-nature and human-nonhuman. To better capture the complex and dynamic nature of human-nature-interconnectedness and their reciprocity, current sustainability research argues to understand socio-ecological systems from a relational perspective. Taking into account that urban sustainability requires integrative solutions framing cities as socio-ecological systems, this paper argues that a relational approach can inform in particular urban ecology research and strengthens its role in sustainability transformation science. However, surprisingly reciprocal individual and collective urban human-nature-relations for sustainability transformation are understudied so far.

Against this backdrop, this conceptual contribution introduces the interdisciplinary account "human-nature resonance" by further elaborating the theory of resonance by Rosa (2019) [1]. The theory from the field of Critical Theory uses the term resonance as a metaphor to describe responsive relationships between a subject (human) and object (world) whereby resonance is understood as the positive counter-term for alienation. The theory has a descriptive and normative character, describing the quality of relationships and reflecting on solutions for successful lives for acceleration-oriented modern societies characterized by an increasing disconnection such as from body, work, and nature [1].

To specify the ontology, epistemology and ethical implication of resonance for human-nature relations, this paper interlinks significant relational discourses (i.e., indigenous knowledge, process philosophy, affect studies, ecopsychology, deep ecology, ecofeminism, relational values). In the focus of the concept stands the reciprocal external-material and internal-philosophical intra-connectedness between human and nonhuman nature co-constituted by multidimensional processes of discovering, learning/knowing and feeling human-nature relations. In the light of sustainability transformation, it is argued that a relational quality of resonance fosters individual and collective modes of being affected and self-efficacy catalyzing responses of care.

Based on its conceptualization, the talk will discuss implications of human-nature resonance in an urban context. Urban human-nature resonance then does not aim to study the city as an object but human-nature relations taking place *in cities*. Resonating relations embed in material terms processes which affect individual and collective responses demanding to use nature's resources for vital needs only and respecting natures´ regenerative capacities such as through urban biocycles or sufficiency-oriented urban development. In terms of internal-philosophical human-nature relations, urban processes that promote inner self-reflection, awareness, embodiment, spirituality and mindfulness are crucial pillars of human-nature resonance. Urban human-nature resonance can then take into account indigenous spiritual beliefs about nature and place-based practices and their role to foster biocultural stewardship and internal well-being in cities.

Human-nature resonance can be considered a bridging concept that enables to understand interlinkages between the ecological crisis characterized by overshooting planetary boundaries and an internal crisis of consciousness instrumentalising nonhuman and internal human nature. To advance a relational approach for urban ecology and sustainable urban transformation, the paper discusses in the end pathways to operationalize human-nature resonance in cities suggesting strategies for case study selection and creative methods of empirical social research such as intraviews or urban strolling. In the end, this contribution aims at stimulating an interdisciplinary research agenda conceiving complex inner and external urban sustainability challenges together and exploring modes of relational selves that experience, think and feel responsive human-nature relations for a flourishing life in cities.

Acknowledgments: This work was supported by the Leibniz Best Minds Competition, Leibniz-Junior Research Group under Grant J76/2019.

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ORAL SESSION

D.3.2

What the Global North needs to know about Urban Ecology in the Global South

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Keywords: Informality, Human health, Urban ecosystem services

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In 2018, the online platform, The Nature of Cities, published a Global Roundtable discussion answering the following question: "What is one thing every ecologist should know about urban ecology?" [1]. This discussion was a response to the paper "100 articles every ecologist should read" [2]. Importantly, the Roundtable authors highlighted topics which they felt were "core material for understanding the broad science of ecology today" which were mostly missing from the 100 listed papers [1]. The highlighted topics included "social ecology, biophilia, justice, poverty, gender, values, the Global South, design, climate change, policy ... and ... urban ecology" [1].

The disturbing truth is that to date, despite acknowledging the importance of the Global South (GS), the discipline of Urban Ecology is dominated by Global North (GN) approaches, theories, examples and understanding. Statistics remind us that more than half of the world's population now live in urban areas and more importantly, that most of the future growth is projected to be in the GS [3]. The lack of research in the GS and its significance for truly providing a holistic view of urban environments prompted the global collaboration of mostly GS scientists (53 authors from 20 countries) to contribute to the book "Urban Ecology in the Global South" [4]. Throughout the book it became clear that despite generalities, the GS has unique environments, dyanamics and realities that do not reflect GN situations, which emphasizes the importance of addressing the lack of research in this region. In this paper we present the main findings from the book by highlighting recurring themes in GS research that resonated throughout the chapters of the book [5]. The recurring and emergent themes are: "rapid change; informality; vulnerability; legacies of colonialism; weak or constrained planning and implementation of policies, plans and regulations; connectivity; partnerships and local knowledge and action; biological invasions; environmental injustice; and context matters."

Moreover, we proposed eight themes on which we think future research efforts should be focused to advance and enhance urban ecological understandings of GS cities and how they fit into current GN framings [5]. The future research themes include: "inequality; informality; urban–rural links; small and medium-sized towns and cities; urban green infrastructure, biodiversity and ecosystem services; understanding and accommodating multiple worldviews of urban nature; human health and urban nature, and specific research approaches" [5].

The UN Sustainable Development Goals boldly envision a better future for all global citizens [6]. By heeding the call to further probe and understand the emerging themes and future research directions; we as scientists and affected citizens can come closer to this envisioned dream of inclusive and equal futures for all regions by fully acknowledging GS realities and thereby seeking truly universal frameworks and understandings from across the globe.

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The role of spatial planning in fostering urban development and nature conservation

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Keywords: Planning outcomes; spatial modelling; urban compactness; nature conservation.

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Urban expansion will continue at a fast rate, precisely in peri-urban areas of developing countries surrounded by biodiversity hotspots [1]. In Latin America, the need to assess and potentially restructure urban and environmental planning instruments appears in a scenario where urban expansion is difficult to manage [1, 2]. Indicators based on spatially explicit data sets has been suggested as an effective tool to evaluate the implementation of spatial planning since they can shed light on the efficiency of planning measures and the fulfilment of claimed objectives [3.4]. The aim of this study was to develop and apply a framework to evaluate the efficiency of spatial plans in fostering compact cities, providing basic services and supplying housing, and ensuring nature conservation.

The study area lies in a coastal region in São Paulo State, Brazil, which is characterized by fast urban expansion mostly as the result of economic policies for developing the tourism and transportation sectors [5]. We evaluate the 2005 Ecological-Economic Zoning (EEZ), and two municipal master plans (2006). We used Partial Least Squares - Path Modelling (PLS-PM) to explain the relationship between land-use strategies and indicators for measuring plan implementation. We analysed the content of the three spatial plans, and we assigned each zone to a land-use strategy: Urban Use, Multifunctional Uses and Protected Areas and Native Forest Maintenance (NFM). To evaluate the planning outcomes, we proposed three indicators: Urban Compactness, Basic Service and Housing (BSH), and Nature Conservation. The framework also recognizes other drivers, such as changes in population density and socioeconomic conditions, and topographic information.

Our findings suggest that the evaluated plans were influenced by the land-use pattern at the time the plan was approved (2005), which suggests that the study region is having a defensive planning strategy. Two out of three of the evaluated plans were considered efficient for nature conservation in terms of forest persistence. For all evaluated plans, the urban use strategy was important to explain the urban compactness indicator, but most of the new urban isolated areas occurred outside of the zones with urban use strategy. Nonetheless, BSH indicators were explained better or equally by Socioeconomic drivers and by the Multifunctional Use strategy than by the Urban Use strategy.

In general, the urban use strategy can be considered efficient in promoting more efficient cities, but not so muchin containing urban sprawl. Our findings are in line with similar studies showing that areas outside of the urban cores are often deprived of efficient strategical planning [6,7]. The increase of basic services and households was not sufficient to attend the regional demand and the inadequacy of these services remains a problem in the region. In Brazil and Latin America, the urban sprawl and spatial segregation have frequently been documented as the result of historical inequality of public policies and economic interest [8]. Efficient policies to contain the urban sprawl and to address the increasing demand for basic services and housing are still needed in the studied region.

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ORAL SESSION

D.3.4

Collaborative decision-making in natural resource management conflicts. Evidence from Romania

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Keywords: environmetal conflicts, joint action, collaboration

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Collaboration a vital prerequisite for success in natural resource management disputes as it facilitates sustainable environmental outcomes. Our study aims to look at the factors which appear to contribute to the effectiveness of collaborative problem-solving efforts in case studies of environmental conflicts in Romania. The selected case studies illustrate the conflicts confronting our society today, i.e., transportation-related conflicts, human-wildlife conflicts, built-up zones in protected areas. A theoretical framework for collaborative governance [1], specifically the elements of collaboration dynamics (Figure 1) and the method of multi-value qualitative comparative analysis (mvQCA) are used to compare the selected case studies and identify the factors that bring success in the resolution of the conflicts. According to the theoretical framework for collaborative governance (Figure 1), the success, or effectiveness, of collaborative activities depends largely on the interaction of principled engagement, shared motivation and joint action. Fourteen case studies out of twenty-seven emerged as good examples of how collaborative dispute resolution can be effective: an increased understanding of the underlying interests of all stakeholders makes it highly likely for parties to reach agreements. Furthermore, our results show that in none of the cases was the final agreement reached easily, while the effectiveness of the agreements that were reached seemed to depend on how the interactions between the parties and their joint actions were handled. Specifically, the interplay between shared motivation and joint action, or a high level of shared motivation or a high level of joint action alone is sufficient for the effectiveness of collaboration. For example, the factor shared motivation was realized by attending meetings organized according to a standard agenda in order to keep the disputants from raising their voices and by participating in meetings where disputants were asked to explain their concerns and plans. Parties' engagement in joint action proved useful in the pursuit of an effective collaborative process. State and private actors/agencies pushed the process and supported it with resources (technical and financial). This brought the relevant stakeholders to the table. Even where good practice concerning collaborative conflict resolution emerged, the agreement was not always durable. For example, the lack of governmental agencies committed to the implementation of a collaborative approach raises questions about the legitimacy of collaborative efforts.

Furthermore, none of the categories of principled engagement emerged out of the sufficient configuration for effective collaboration. This demonstrates that engagement activities and joint actions are still uncommon in Romania.

Our study of Romania's environmental conflict experiences describes both successful and problematic aspects of collaborative approaches to environmental conflict resolution. It discusses new insights on the theory and practice of collaborative governance that might lead to an improvement of the collaborative processes in natural resources management in the future.

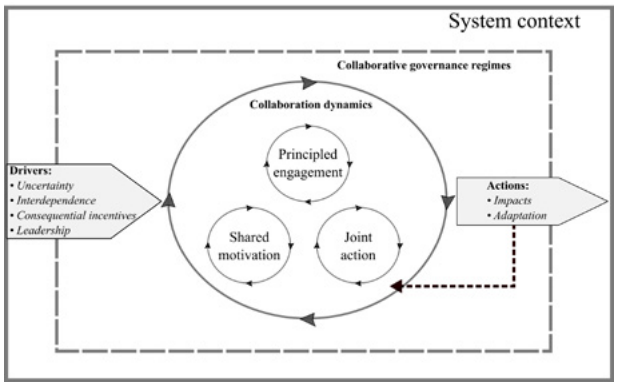

Figure 1. The framework for collaborative governance [1]

Acknowledgments: This work was supported by the Romanian National Authority for Scientific Research UEFISCDI grant number PN-III-P1-1.1-PD-2016-0248.

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Interdisciplinarity and co-design in Urban Sustainability Transformations

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Keywords: urban sustainability transformations, SDGs, co-design

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With the Agenda 2030 and the 17 Sustainable Development Goals (SDGs), the United Nations member states have adopted a global framework for Sustainable Development. As the title of the Agenda 2030 indicates, the over aim is to *Transforming our world* [1].

Here, it is particularly cities that clearly show the need for transformations to sustainability as current forms of urban development have been proved widely unsustainable [2]. In this context, Urban Sustainability Transformations are considered as radical, multi-dimensional alterations to a given system that can go across system borders and deal with multiple as well as uncertain development options [3].

It is particularly the double side of cities as culprits and victims of Global Environmental Change, that calls for transformations towards more sustainable development. High exploitation of scarce resources such as land, water and energy go frequently hand in hand with growing social inequality in terms of resource distribution and accessibility. Thus, cities also bear the potential to contribute substantially to a more sustainable world.

Since the adoption of the 2030 Agenda in 2015, profound societal and technological changes have taken place, with the Covid-19 pandemic as the most radical game changer [4]. It clearly underlines the pressing need for urgent action in terms of, for example, social and public health, and the environment. In this sense, the COVID 19 pandemic can open upa a window of opportunity to a more sustainable future, including the enhanced resilience of socio-ecological systems.

This obviously links sustainability transformations with urban ecology in the overall need for fundamental changes that are robust and guarantee the resilience of cities in the long run. This implies more systemic research and integrated solutions in cities. Furthermore, more inclusive approaches, taken up by means of transdisciplinarity, co-design and co-production, bear the potential to more resilient cities by implementing the SDGs [4]. Thus, the implementation of the SGDs is by no means an easy task.

In this context, a co-desing process in terms of knowledge production, targeting at German cities with urban stakeholders has shown what administration and practitioners actually need from science in order to implement the SDG in cities. Overall, knowledge on the process of SDG implementation is required, as well as on the interdependencies between different sustainability targets, and associated to this, on the interlinked processes [5]. This again pinpoints at the interdisci-plinarity between urban ecology and sustainability transformations.

In conclusion, multural learning between different discisplines as well as between science and practicioners is key in order to produce the knowledge on how to implement the SDGs in cities and to transforming our world towards sustainability.

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ORAL SESSION

D.3.6

Urban ecology and transformations to sustainability: mapping the road ahead

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Keywords: transformations, urban ecology, paradigms

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The field of urban ecology has developed in recent years into a domain of interdisciplinary scholarship that exemplifies relational thinking and embraces complexity. The 'ecology *of* cities' paradigm has revealed the necessity of viewing urban spaces as both ecological and social, and in many ways represents the type of scholarship necessary in the Anthropocene. However, in recent years, and in response to an acute global awareness of humanity's threat to future planetary health, policy and scientific discourse has embraced concepts of transformation, and have applied these to urban systems. This 'transformative' turn in sustainability scholarship is characterised by a recognition of system complexities but also a normative imperative for wholesale change to social, environmental and economic structures. The concept of transformation – enshrined in the United Nation's Agenda 2030 and the Sustainable Development Goals – simultaneously affirms much of urban ecology's scholarly tenets and challenges the discipline. This paper identifies and explores three fundamental challenges to urban ecology presented by sustainability transformations, and offers suggestions as to how it might navigate these in the future.

The first challenge identified relates to the scale and rate of change. While much of urban ecology has focused on observing biotic responses to urban structures and processes, sustainability transformations attends to intentional, desirable, non-linear, system-wide change. This presents challenges particularly in the context of biodiversity conservation, when infrastructure related to energy and transport are considered. How concepts of maintenance and stability intersect with transformative change is an area for further exploration. The second challenge relates to the instrumentalisation of nature. There is presently an implicit tension between protecting and enhancing urban biodiversity for its intrinsic value, and research that seeks to promote urban biota as a means to enhance other (often anthropocentric) outcomes. Nature-Based Solutions is an example of this latter framework, whereby nature is framed as a helpful way of promoting urban resilience and sustainability. There is a need for urban ecology to explicitly address how nature is presented in urban transformation scholarship and practice. Finally, there is a challenge related to the subjective dimensions of urban nature. Transformational thinking invites critique of the fundamental values, goals and paradigms upon which urban systems are built. Greater attention has been paid recently to the importance of relational values for nature, recognising that subjective experiences (e.g. cultural and spiritual attachments to nature) and ethics of care and stewardship are have been overlooked as legitimate foundations of earth governance. Further embracing these subjective dimensions of urban nature presents both opportunities and challenges for urban ecology going forward. This presentation illustrates each of these three points with selected examples from cities around the world.

Impacts of air temperature and its extremes on human mortality in Shanghai, China

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Keywords: air temperature, mortality, Shanghai

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Global air temperature increased significantly due to global climate change, which will also enhance the frequency and intensity of extreme weather events, such as heat waves and cold spells with varying degrees of adverse impacts on public health, even bringing out excess human mortality. In this study, we examined the relationships of the maximum, mean, and minimum air temperatures with the total non-accidental, cardiovascular, and respiratory mortalities in Shanghai in 2003. We found that V-shaped associations existed between several cause-specific mortalities and daily maximum, mean and minimum air temperatures. Threshold temperatures around 24 to 26 °C existed for different age groups for non-accidental, cardiovascular and respiratory mortalities. Negative linear relationships existed between mortality and air temperatures when the temperature is below the threshold. The relative risks for total non-accidental, cardiovascular and respiratory mortalities increase 2.02% (95% CI: 1.75%-2.30%), 2.28% (95% CI: 2.05%-2.51%), and 3.68% (95% CI: 3.26%-4.10%), respectively, as the daily mean air temperature gets 1 °C further below the threshold. Positive linear relationships exist when the daily mean air temperature is above the threshold. The relative mortality risks increase 1.62% (95% CI: 1.03%-2.22%), 4.11% (95% CI: 2.62%-5.63%) and 5.08% (95% CI: 1.49%-8.79%) as the daily mean temperature increasing 1 °C above the threshold. Two heat waves and one cold spell were identified during 2003, and both kinds of extreme events brought out excess mortality. The first heat wave lasting for 19 days had significant impacts on total non-accidental, cardiovascular and respiratory mortalities, and the relative mortality risk increased 15% (95% CI: 11%-20%), 21% (95% CI: 12%-30%) and 18 % (95% CI: 5%-32%) for the three kinds of mortalities respectively compared to the reference periods before and after the heat waves. The second heat wave lasting for 14 days had significant impact on total non-accidental and cardiovascular mortality, but no significant effect on respiratory mortality. The relative risks of the total non-accidental and cardiovascular mortalities from the second heatwave were less than half of those of the first heatwave. The cold spell lasting for 7 days also had significant impacts on total non-accidental and cardiovascular mortalities, and increased the relative risks by 8% (95% CI: 2%-14%) and 15% (95% CI: 5%-27%), respectively, but with no significant effect on the respiratory mortality. We also found the elderly population are more sensitive to temperature variation than the younger people. Our results suggest that air temperature is a significant factor influencing human mortality, particularly for the elderly. Our findings provide strong evidence to adopt mitigation measures to protect the elderly during heatwaves and cold spells, and perhaps developed a public health warning system, given the frequency and intensity of such extreme weather events are likely to increase under a warming climate.

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ORAL SESSION

D.4.2

Quantifying thermal comfort on five urban squares in a temperate climate in contrasting climatic conditions

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Keywords: Urban squares, Urban greenery, Human thermal comfort

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Urban squares are an important element of urban settlements that have a huge importance for peoples' quality of life. In particular in densely built urban areas with limited supply of larger parks, they are needed to meet social demands during the whole year. Therefore, they should be designed to encourage physical activities outdoors, allowing for social interactions by attracting people from the local community [1] and promote the thermal well-being of their visitors all year round.

Existing studies have focused on assessed greening designs of public squares and their microclimatic influences during a hot summer day, using the ENVI-met [2] model to compare thermal comfort values [3]especially under climate change. Urban planning needs to address this problem focusing on areas where people are exposed to heat such as in public squares. Typical square designs include green infrastructure which can positively affect outdoor thermal comfort by providing regulating ecosystem services, but knowledge on the effectiveness of different design approaches is still limited. The present study assessed typical greening designs of rectangular public squares and their microclimatic influences during a hot summer day both during day and night-time conditions. By using a validated ENVI-met V4 model, thermal comfort values expressed by the physiologically equivalent temperature (PET; explore the potential for climate change adaptation in landscape architectural design [4]; analyze the different thermal performances of various urban squares with varying morphological and greenery characteristics [5]; [6].

Despite of these researches, there is a scarcity of systematic information on the performance of different designs of greenery on urban squares under current and climate change conditions [7], [8], [9], [10]. Moreover, there is a lack of knowledge for the design of squares that balances between seasonally varying thermal comfort demands in temperate climates. This research aims to fill this gap.

To this end, the potential of different types and elements of urban greenery to improve the human thermal comfort of typical urban squares and to mitigate climate change impacts were assessed. Five urban squares in densely built neighbourhoods of Munich, Germany were selected for this study. Differing in size and shape, number and arrangement of trees, type of pavement and boundaries, their microclimate and thermal comfort was analyzed in different weather conditions. Using the ENVI-met model [2], the parameters used to characterize the selected urban squares, were simulated at micro-scale to measure the impact of each parameter on the human thermal comfort of the urban squares in summer and winter weather conditions.

Initial results from two of five chosen squares with similar area and amount of trees but contrasting ground surface cover show the large influence of paved areas on PET. Hohenzollernplatz (10.150m²) with a high proportion of sealed areas showed a higher Physiological Equivalent Temperature (PET) [11] in all analyzed scenarios compared with the Bordeauxplatz (14.014m²), a square with a high proportional cover of grass. In the following stages of this research, we will extend the analyses to the three other squares. The effects of pavement and buildings will also be analyzed through a comparison between Alter Hof and Alpenplatz, a square with similar shape and area (3.317m²) but with permeable soil and openness to wind flow. Furthermore, we included Marstallplatz an irregular rectangle of 9.517m², highly sealed and with few trees small clusters to explore whether this arrangement can be beneficial to reduce the night urban heat island during summer weather conditions due to the high sky view factor. Overall, the design of each square design, in particular their greenery arrangement and amount of different surface cover types has a distinct influence on PET in summer and winter weather conditions.

The results obtained up to now demonstrated that it is necessary to consider diverse arrangements of vegetation to optimize human thermal comfort in diverse climatic conditions. In future studies, the potential of the analyzed arrangements will be tested in additional seasons.

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Primary exploration about the effect of urban landscape on land surface temperature -A geographically weighted regression analysis of Nanjing

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Keywords: urban green spaces, urban heat island, geographically weighted regression

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Urban heat island (UHI) has become a serious urban climate issue for its negative impact on ecological safety, energy consuming, public health and social justice [1-3]. Researches have revealed that urban green spaces (UGS) and buildings play a leading role in the formation of UHI. However, we find that the spatial heterogeneity of the relationship between the urban landscape and UHI might be underestimated. To investigate this problem, we take Nanjing as an example to carry out a series of analyses at fine scale with the help of reclassify and Geographically weighted regression (GWR).

A 9km×9km square area in the city center of Nanjing, including all the areas inside the Ming City Wall which has been the urban core for over 600 years, is selected to conduct the analyses. First, using ENVI 5.3 software, a 30m-resolution image of Landsat-8 (8/11/2013) downloaded from USGS is used to calculate land surface temperature (LST) based on the radiative transfer equation. Meanwhile, the NDVI, NDWI and NDBI indexes are calculated by band math to quantify the urban landscape. Second, at the ArcGIS 10.6 platform, using the quantile method to reclassify the LST raster map into 10 classes (Fig.1) [4]. Class 1 to 10 is in the order from the lowest temperature to the highest. Taking the LST of Class 1 area as the dependent variable and NDVI, NDBI, NDWI of the same area as the independent variables to conduct multivariable stepwise regression analysis by SPSS 22.0. Then, taking the Class 1 and Class 2 areas together as the subject to conduct the regression analysis in the same way. Next, the Class 1, 2 and 3, until all the 10 classes are been analyzed. Finally, taking the OLS and GWR analyses between the LST and the significant variables based on the regression results above.

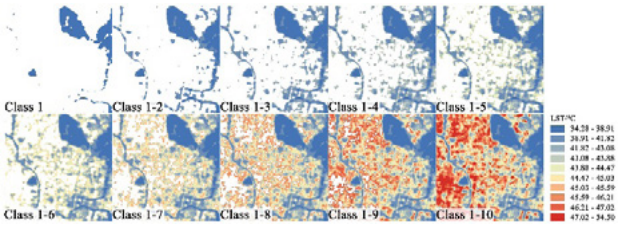

Figure1. The classification of LST map

The results of 10 regression analyses indicate that NDBI is been excluded in the first 4 regression analyses and NDVI is been excluded in the last 6 regression analyses as its collinearity with other variables. In other words, NDVI and NDWI have the significant negative relationship with LST in the lower temperature area while NDBI has the remarkable positive impact on LST in the higher temperature area. Besides, the highest adjust R^2 (0.560) and coefficients of NDVI (-16.566) and NDWI (-26.212) are in the Class 1 to 4 area, which means the UGS has the most significant cooling effect in this particular area. The highest coefficient of NDBI (25.517) is in the Class 1 to 10 area, which suggests that buildings have the most prominent impact on the LST in the whole city center.

Then we choose Class 1 to 4 area and Class 1 to 10 area as the examples to compare the model performance of OLS and GWR in ArcGIS. The *Moran's I* is been calculated in advance to confirm that there is spatial autocorrelation to carry out GWR analysis. It is shown that the GWR model has much lower AIC and higher adjust R^2 (eg. 288859, 0.854 for the NDBI, respectively) than OLS model (eg. 411130, 0.432 for the NDBI, respectively), which proves that GWR is more reasonable when it comes to the spatial research of UHI. According to the Local R^2 and coefficients distribution of GWR, it's concluded that NDVI, NDBI and NDWI has higher explanation ability to LST in the area near the large-scale UGS like Qinhuai River, Xuanwu Lake and Zijin Mountain.

The paper is expected to be a supplement to previous research. We typically think that NDVI has the negative relationship with LST and NDBI is the opposite [5]. However, few researches pay attention to which particular area shows the most decisive impact. Based on the results, we can specifically focus on the most significant area to furthurly investigate the cooling effect of UGS by removing other interferences. Meanwhile, the spatial non-stationarity in the relationship between the LST and variables should be taken into consideration [6]. In a word, urban climate should be thoroughly explored due to the complexity of urban landscape and it is essential to provide site-specific suggestions about climate migitation and urban planning. Further detailed research on the cooling mechanism of UGS and optimizing strategies will be conducted in the near future.

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ORAL SESSION

D.4.4

Simulating the potential of urban greenery in increasing urban outdoor comfort in high density cities

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Keywords: Urban greenery, Outdoor comfort, high density, UMEP

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Over the past decades, intense urbanization processes resulted in built environments with a severe lack of green spaces and thus with low potential for mitigating the heat stress. Green spaces are the main providers of ecosystem services in cities and play a relevant role, among others, in regulating the local microclimate and in mitigating the Urban Heat Island effect. However, despite their importance, the implementation of green infrastructure still struggles and challenges the lack of available open spaces to be set as new urban green areas.

This article addresses the potential effectiveness of trees in reducing the energy demand for cooling urban environment of high density cities. Scenarios of implementation of Green Infrastructure are proposed and simulated with the GIS-based and spatial explicit model UMEP, which evaluates the contributes of vegetation in reducing the Median Radiant Temperature and thus increase the outdoor comfort. Scenarios are identified and spatially located according to different factors namely: the presence of public/private areas; land use/land cover; species of trees; ecomic and urban feasibility of the transformations.

The case study is given by a mixed density urban settlement in Sicily, and analyses and simulation are carried out at high resolutions.

Results from the simulations show that a good compromise among costs of implementation, physical feasibility and effectiveness in increasing the outdoor comfort is obtained with a scenario that foreseen the double of existing green areas in public opens spaces (fig. 1).

Figure 1. Most effective reening scenario

Urban heat island- case study in the city of Split, Croatia

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Keywords: urban heat island, mediterranean, temperature, urban growth

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Urban heat island is the most researched microclimatic phenomenon caused by increasing urbanization. The intensity of the urban heat island is influenced by the size of the city and population density, meteorological features, topography, materials used in construction of the city as well as the share of green areas. Although the effect of urban heat island is not a direct consequence of climate change, it is projected to be even more pronounced in the second half of the century, due to the overall temperature rise caused by global warming [1]. The city of Split is the second largest city in the Republic of Croatia and the main center of Split-Dalmatia County. Split is a Mediterranean city laying on the coastline of the Adriatic Sea. Economic domestic migrations throughout the history, war events as well as the need for larger accommodation capacity due to the predominance of tourism as the main activity, led to growing urbanization and significant changes in the structure and the appearance of the city. Data on urbanization in the city of Split in the last 30 years are showing an increase in urbanization for 50,92 % [2].

The field research of the urban heat island in the city of Split was conducted in the summer months of 2019. In the city of Split, four special regions stand out according to build-up-green ratio and the nature of the material that prevails. In each region, two stations were selected for simultaneously measuring surface and air temperature using the device Testo 810 termometer. Measuring was conducted immediately after the sunset. It has been determined that the heated substrate is increasing the air temperature. Field measurement of air and surface temperature over a period of three months showed a significant temperature difference between less and more pronounced urbanized parts of the city. The largest measured difference between the individual stations in one day amounts to 3 ºC. When analyzing the results, we come to the conclsion that the formation of the urban heat island corresponds to the areas of growing urbanization. This paper lays a good foundation for further research and study of the issue of rapid and unplanned mass construction and its consequences on urban ecology.

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D.4.6

Urban microclimate regulation in the city of tyumen: cooling effect

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Keywords: ecosystem services, cooling effect, urban heat island

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The cooling effects of urban blue-green infrastructure play an important role in reducing the occurrence of urban heat islands (UHIs). The phenomenon of the urban heat island was already detected in Tyumen in the years 1977 and 1978; at that time, the excess heat was in the range of 1.8 °C to 2.0 °C, mainly over the central part of the city (according to field observations at eight points in January, April, July and October). The hot summer of 2020 further highlighted the demand for the supply of cool air.

To compare the provided and demanded volumes of the ES cooling, we first developed a UHI map for the city of Tyumen. This was realized by aggregating data on surface temperatures from the LANDSAT 8 space images (specifically, we used Landsat 8 images taken on 22 June 2015, 10 July 2016, 14 August 2017, 16 July 2018 and 19 July 2019).

After these processing steps, each pixel of the geothermal scene contained information on the temperature in degrees Celsius. Annual geothermal scenes (data from 22 June 2015, 10 July 2016, 14 August 2017, 16 July 2018, 19 July 2019) were aggregated to identify persistent temperature anomalies and urban heat islands. The geothermal scenes were aggregated using the Raster Calculator tool to determine average pixel temperatures.

The cooling effect is considered an ecosystem service during hot summer days when thermal heat stress occurs. According to the Physiological Equivalent Temperature (PET) index [1], the temperature range of 18 to 23 °C does not create heat stress for the population during summer months. If the average temperature is lower than 23 °C, therefore, we will not consider the cooling effect to be an ecosystem service. To evaluate the beneficial cooling effect as well as define and evaluate territories suffering heat stress, we used the geothermal scene containing information on the surface temperature in degrees Celsius. Applying the raster calculator in ArcGIS PRO software, we subtracted 23 °C (the maximum temperature of comfortable thermal conditions) from the geothermal scene's pixel temperature attribute. Pixels with minus values provided cool air, while those with plus values required cool air.

A hexagon fishnet was used to aggregate each pixel's values with a radius of 500 m using the average value calculation method (Figure 1). In this case, the average value indicates the extent of the cooling effect for people within a radius of 500 m. Hexagon fishnet was chosen because it is the most suitable for aggregating data concerning accessibility at the urban scale. The hexagons with negative values have sufficient cooling effect while hexagons with positive values have insufficient cooling.

The surface temperature analysis using satellite images LANDSAT 8 pinpointed areas with higher temperatures (areas undergoing heat stress) and those below the maximum comfortable temperature (area providing a cooling effect). Urban heat islands are created by particular designs and characteristics of urban surfaces, which lead to a change in the energy balance. Specifically, changes in the energy balance are caused by various thermal volumetric properties (heat capacity and thermal conductivity) and radiation properties (albedo, emissivity) of surfaces: for example, dark surfaces absorb significantly more solar radiation (city roads, paved parking lots near offices, shopping centers, residential buildings) and higher temperatures are detected over multi-story residential buildings, industrial and energy facilities as well as flat-roofed shopping centers. In our analysis the temperature above these surfaces was over 23 °C, and therefore cooling is required. In comparison, the surface temperatures of green areas (parks, squares, green areas of low-rise private residential buildings) and water surfaces were lower. The temperature above these surfaces was below 23 °C, and therefore these sites provide a cooling effect.

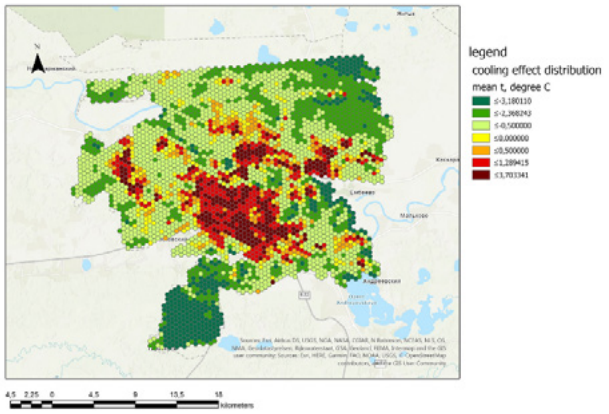

Figure 2. Distribution of the demand (red) and supply (green) of cool air

While only 23% of the urban area of Tyumen requires "cooling effect", this particular area is home to 87% of residents.

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Co-creation for climate change – needs for actions to vitalise drivers and diminish barriers

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This study determines the conditions and provides a recommendation for fostering co-creation for climate change adaptation and mitigation (CCA&M). In postulating that insufficient co-creation by stakeholders in the quadruple helix model is an important factor contributing to the low effectiveness of climate actions in the regions, we have focused our research on identifying real stakeholder engagement in climate action and identifying the needs, barriers and drivers for strengthening the co-creation process. We identified the needs for action highlighted by stakeholders as having an impact on reducing barriers and stimulating drivers.

We treated the identified needs for action as leverage points [1], [2] to increase the effectiveness of climate actions. The concept allows for the identification of places in a system where a small shift can lead to fundamental changes in the system as a whole and thus help to overcome barriers and to identify the sub systems, issues, areas, times, places and sectors for effective interventions [1].

The objectives of the investigation included:

- determination of the role, competence and scope of activity of individual stakeholders in cooperation with CCA&M;
- identification of needs for action, barriers and drivers for climate action, as perceived by different stakeholders;
- systematisation of the necessary actions in the system of three realms of leverage points (knowledge, values, institutions), where engagement and co-creation could be strengthened and have a chance to increase the effectiveness of climate action taken by stakeholders;
- formulation of recommendations to create a favourable milieu for the efficient co- creation of effective CCA&M solutions.

On the basis of the quadruple helix concept, we took into account representatives of academia and education, business, local government and civil society. The results of the present practise recognition showed that the existing stakeholders' cooperation is usually of a superficial character or adopts the simplest forms of consultation or knowledge transfer.

Next, we systematised the opinions of each stakeholder group on barriers, drivers and needs for action as co-creation factors. Needs for actions specifically highlighted by stakeholders refer to the realm of knowledge. The development of knowledge reinforces the scientific basis for decision-makers' decisions, for the rationalisation of social behaviour and for the creation of an innovative education system including the training of specialists in the field of climate change prevention and adaptation. The second group of needs for actions connects to the value system. The needs identified by the stakeholders result from the lack of constructive dialogue, low culture of dialogue, reluctance to build compromise and lack of agreement over particular interests. Needs for action also pointed out the need for institutional changes that will create conditions conducive to the development of common goals and strategies for CCA&M by all stakeholders.

We recommend knowledge-based co-creation, which puts the importance of climate action in the value system and leads to paradigm re-evaluation. The implementation of the identified needs for action requires the support of institutions, whereby they develop standards of cooperation and mechanisms for their implementation as a sustainable framework for stakeholder cooperation.

The conducted research allowed us to verify the functioning of the quadruple helix for climate action in Poznań Agglomeration. A leverage-points perspective in our research allowed the recognition of influential leverage points relating to change in realms, which can lead to a transformative change in a complex system of co-creation for climate action.

The research has proofed how operates the quadruple helix for climate action in Poznań Agglomeration, and we believe that this case study can be a reference point for regions at a similar level of development, and that the methods used and results obtained can be applied in similar real contexts, to foster local stakeholders in climate action.

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ORAL SESSION

D.5.2

Spatially explicit and integrated assessment of groundwater recharge and cooling by evapotranspiration

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Keywords: groundwater recharge, evapotranspiration, cooling

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'Hydrological cycle and water flow regulation' as well as 'Temperature regulation' are two prominent ecosystem services present in almost any assessment of the significance of urban green infrastructure. Since the energy budget and the water budget of any surfaces are interwoven, it makes sense to look for methodical solutions integrating both aspects. Sophisticated semi-deterministic urban climate modeling, such as with ENVI-met, is a well established method that can be applied for block-sized urban areas [1]. The model parametrization is time-consuming and needs substantial expertise. For larger areas, the method reaches its limits. On the other end of the spatial scale, measuring and modeling the cooling effect of single trees is helpful, e.g. [2], [3], [4]. However, too often imprudent use of the two ecosystem services neglects the specific time-scales, on which biophysical variables should be measured to express the ecosystem services provision. In our contribution, we approach this challenge by simulating the water and energy budget on a daily basis using the RUBINFLUX approach [5].

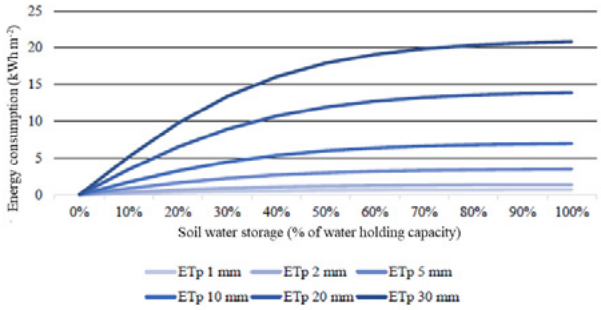

Figure 1. Energy consumption as a function of the relative soil water storage

RUBINFLUX combines a novel approach for drainage from the unsaturated zone with proven hydrological components. The drainage is calculated as a natural exponential function using the difference between the actual storage and the water storage at field capacity without making use of the Richards equation. Groundwater recharge and evapotranspiration are the model's relevant output variables that can be transformed to evaluate ecosystem services. The output variables are being made available for a wide range of land use/land cover types and take the specific water holding capacities of the soil into account. We also consider the specific moisture conditions of wetlands and water surfaces.

According to the basic relation expressed by the (latent) heat of vaporization, evapotranspiration means energy consumption. To evaporate 1 liter of water (at 20 °C) 0.694 kWh is needed. It becomes obvious that for the cooling effect of evapotranspiration, the varying soil water status in the course of the year is decisive, which is largely governed by climate. Ecosystem service assessments in use take the energy consumption by evapotranspiration during the whole summer half year as the basic biophysical parameter. We question this practice because the cooling is necessary only during heat waves. For these shorter periods, the effect of different soil moisture status is of great importance. Performing a sensitivity analysis, we first quantify the effect of different soil moisture status on the energy budget in general. Second, we compare two heat waves that occurred in the same year, but at different times of the year. We group the findings to meaningful periods of different lengths. Based on the differences in cooling, we discuss the question, which periods are meaningful and should be taken as the basis for the assessment of the cooling effect of urban ecosystems. We elucidate the importance of selecting the adequate length and timing for the assessment. Our results come from an urban area in Bochum, Germany.

Acknowledgments: This work was supported by the research project "Implementation of the Concept of Ecosystem Services in the Planning of Green Infrastructure to Strengthen the Resilience of the Metropolis Ruhr and Shanghai – research grant 01LE1805A", funded by the Bundesministerium für Bildung und Forschung (BMBF).

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Crowd-mapping supporting climate action. Case study of six pilot regions in the TeRRIFICA project

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Keywords: crowd-mapping, citizen science, climate change, climate action

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One of the TeRRIFICAs aims is to recognize and to gather citizen knowledge and findings on climate change challenges in six pilot regions: Spain, Germany, France, Serbia, Poland, and Belarus [1]. The selected pilot regions cover the diversity of climate change mitigation and adaptation approaches in Central-South, East-West, urban-rural, EU-non-EU settings. The data collections from such different regions will contribute to the identification of relevant variables and factors affecting the effectiveness of climate action.

The crowd-mapping approach answers above mentioned needs by giving the possibility to involve any partner/resident/stakeholder in the survey dedicated to the identification of grey and green-blue infrastructure in the regions relevant to climate change challenges and solutions in territorial context.

Taking the above into considerations we developed the crowd-mapping tool platform [2] based on the concept of the Volunteered Geographic Information System [3][4], RRI principles [5] and the recommendations from Rzeszewski & Kotus [6]. With the tool, the users can mark on the virtual map positive as well as negative spots within the five climate-change-related areas: air temperature, air quality, water, wind, and soil. They have also the opportunity to share more information in the survey form that pops up after adding a pin on the map. The crowd-mapping data collections are then processed and used as a key input for the identification of climate change hot spots and the co-creation of desirable solutions by stakeholders (living labs).

At this point, users mapped 936 spots in all of the regions. Almost 80% of pins were added in regions in Serbia (Belgrade) and Belarus (Minsk). 53,5% of points are linked to the air temperature category. The fewest points (7,6%) were added in the wind category (Fig 1). 52,4% of total pins represent negative aspects of mapped spots, 47,6% positive ones.

In the presentation, we would like to show the detailed status of mapping climate change effects in six pilot regions and position challenges in a territorial context.

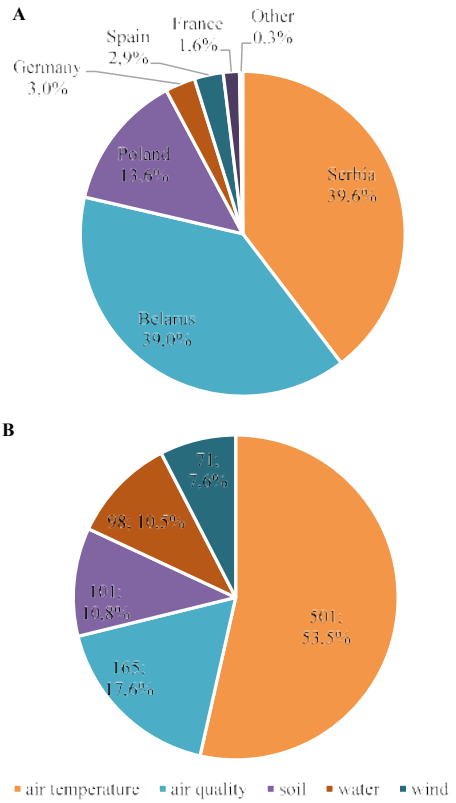

Figure 1. The crowd-mapping results – points added to the map: A – by pilot regions, B – by categories (source: the crowd-mapping tool database, 2021-03-23)

Acknowledgement: The study was conducted within the project TeRRIFICA, that receives funds from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824489.

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ORAL SESSION

D.5.4

The adoption of Performance-based Planning for setting urban design parameters against climate changes. An urban cooling application in Milano city

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Keywords: Urban heat island, climate-proof cities, Ecosystem services

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The rapid urban expansion connected to the increase of world's population lives in urban areas (a proportion that is expected to reach 68 % by 2050) [1,2] have caused an increase of pollution and air/surface temperatures of cities differently from the rural surrounding areas. These dynamics characterised cities exacerbating the Urban Heat Island (UHI) effect, a phenomenon further worsened by global warming. Contemporary cities are strongly affected by the UHI phenomenon, which is becoming one of the most significant climate change-related hazards with huge consequences for health and human well-being

The research investigates the contribution of urban green areas in mitigating and reducing the UHI effect in a highly urbanised context: the city of Milan (Lombardy region, north-west Italy). The city is the second-most densely populated in Italy with 7,641.45 inhabitants/sq km [3] and is situated at the core of an extensive socio-economic and settlement system, namely, the Metropolitan Region of Milan.

An empirical study was conducted to verify how the Cooling Capacity (CC) of ecosystems is related to urban design parameters, such as the density, quantity and height of buildings, the presence of green areas with vegetation, the rate of imperviousness of materials, and other morphological criteria. CC is seen as one of the most fundamental urban Ecosystem Services (ES) with multiple health benefits. The study – already published in Sustainable Cities and Society journal [4]presenting a challenge for dense anthropic areas affected by climate change with enormous consequences for health and human well-being. Ecosystem Services (ES – shows how adopting an ES-based approach could support the definition of urban design parameters and criteria for mitigating heatwaves effect while decreasing high temperatures in urban areas and enhancing territorial resilience.

The CC assessment was developed using the urban ES models of InVEST software (Integrated Valuation of Ecosystem Services and Tradeoffs, version 3.8.5) [5].

The mapping and assessment of CC were associated to some historical periods of the city of Milan, attributable to specific "urban planning seasons", aiming to verify the adoption of specific urban design that can have contributed to the microclimatic regulation and urban comfort. The historical planning periods include i) Beruto's city, late 19th century; ii) Modern city, early 20th century; iii) 60 s–70 s city, late 20th century; and iv) Contemporary city, 21st century.

Empirical findings demonstrate what are the main Urban design parameters that influence the CC of the city. The Territorial utilisation index usually defines as estimating the impact of an urban transformation derived by the building expansion of cities; it is not a key variable in defining a climate-proof city, while the footprint and the distribution of the gross floor areas are much more relevant. In fact, from the study emerges that it is more important to design compact green areas and not fragmented ones to maximising the cooling efficiency. Moreover, urban parks can provide tangible CC benefits if the compact green surfaces are at least 2 ha in size. Lastly, instead of fixing a minimum quantity of trees for green areas, it is more important to select trees species with high shadowing capacity, thus maximising the canopy during the hot season. Tree cover has a major influence on tree density, highlights the importance of selecting tree species.

These results reinforce the recent developments and approaches on rethinking the Urban planning standard system according to a quantitative parameter and its qualitative dimension using design solutions based on ecosystem performances. The study allows integrating ES consideration in the Planning process, solving one of the key lack that still today limits the adoption of ES into land-use planning and decision-making processes

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Forecasting the cooling potential and drought resistance of street trees by species' functional traits

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Keywords: urban trees, climate adaption, resilient cities

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The ongoing climate change has a vast influence especially on urban areas (Revi et al., 2014). Due to highly sealed surfaces, building structures etc., urban areas show much higher air temperatures in comparison to their surrounding countryside (so-called urban heat island effect) (Taha et al., 1988). An increase in extreme weather events such as droughts and heat waves exacerbates the situation in urban areas, and thus in places where the majority of the world's human population lives (United Nations, 2008).

To mitigate those effects and to adapt cities to future climate beams the focus towards the already existing as well as possible future urban green infrastructure. In particular, urban trees play a major role in this context. Beside the quite effective regulation of temperature by transpiration and shade, they provide diverse ecosystem services including recreational and aesthetic effects, sequestering of carbon, filtering of air pollutants, etc. (Armson et al., 2012; Gillner et al., 2014, Weber, 2013). But as only a healthy and vital tree is capable of providing services (Gillner et al., 2014; Moser et al., 2016), it is necessary to find species, which can cope with extreme heat and limited water supply.

In this context, we investigate the potential of plant functional traits as indicators for the cooling effect (Grote et al., 2016) and drought resistance (Cativelli et al., 2008) of street trees. Functional traits reflect the adaptation of species towards their environment (e.g. thicker leaves in arid areas) and can be linked to ecosystem services (Lavorel & Grigulis, 2012). Across five tree species/cultivars at nine sites in the city of Leipzig, Germany, we measured, beside the characteristics of the sites (e.g., degree of sealing), climatic differences between spaces under tree crowns vs. spaces not covered by tree crowns (e.g., air temperature, air humidity), as well as several physiological and morphological traits of tree species (e.g. leaf water potential (predawn/midday), specific leaf area, stomata per mm^2 etc.). In the talk, first results linking traits to climatic parameters will be presented.

Developing trait-based indicators of both urban trees drought resistance and cooling potential is of high importance in the face of climate change and the predicted consequences for urban areas. It can provide a helpful instrument for urban planners.

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ORAL SESSION

D.5.6

Urban trees as climate messengers: communicating ecosystem services with sensors and web-app

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Keywords: Urban trees, climate regulating ecosystem services, beacons

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Urban trees are pivotal elements of urban green infrastructure and provide a range of ecosystem services, with climate regulation being amongst the most important to citizens and most relevant at the local scale [1]. This cooling is amongst environmental effects of green infrastructure that are summarized as regulating ecosystem services. While the concept of ecosystem services has gained widespread acceptance in academic and planning literature and discourses, there is still potential for better communicating the benefits of urban green to the broader public. The talk presents a young citizen science project that combined a microclimate sensor network for monitoring phenology and transpirational cooling of urban trees. The project had two main objectives: First, strengthening citizen science opportunities for involvement into research and awareness raising for urban trees and microclimate regulation [2]. Second, developing a web-app that supports data collection by citizen scientists and ensures data integrity.

The overall research question was: how does urban climate effect urban trees and vice versa? To observe and analyze these effects, the young citizen scientists carry out a phenological monitoring supported by a web app. The monitored trees are equipped with microclimate sensors that measure air temperature and relative humidity in the tree crown. The onset and speed of leaf development indicates the reaction of different tree species to urban weather and climate [3]. At full foliage stage, cooling and shading are measured and compared to reference measurements to quantify microclimate benefits of urban trees.

The web-app is tailor-made and entirely based on open-source project software. The front-end is an easy-to-use interface for data collection on phenology and microclimate with mobile devices (Figure 1). Behind that is a database interface that is designed to 1) deliver data on individual urban trees in defined time intervals, 2) collect data from microclimate sensors (beacons) in the trees via Bluetooth and to send it to the database over the internet connection of the mobile end device on which the app is running. The app (currently for Android OS) scans for beacons in the environment, transfers sensor data to the database and calls websites with content on project results, e.g. diagrams, photos or maps created and designed by the young citizen scientists. The app and the database support joint resource management and sharing of the raw data among the researchers and young citizen scientist. The whole bundle (app, database and beacons) creates an innovative learning environment in which urban trees become smart, equipped with sensors that measure their microclimate benefits and broadcast information on these ecosystem services for display in the app.

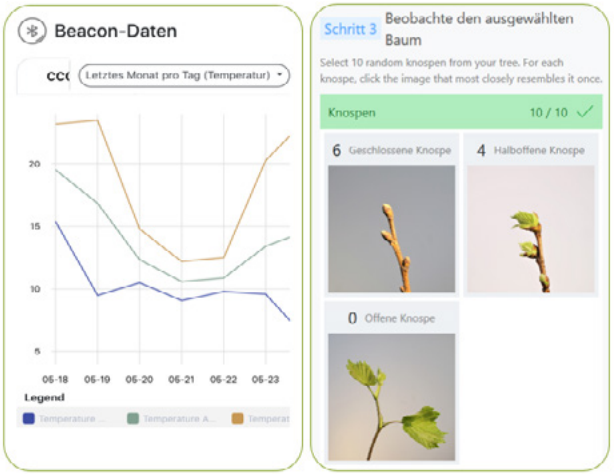

Figure 1: Tailor-made open source Web-App for microclimate (a) and phenology (b) data collection.

Beyond constantly logging measurements of air temperature and relative humidity, the sensors broadcast visualizations of the ecosystem services in a format that is accessible and understandable for citizens. The talk presents these insights in an interactive format and shows examples of geovisualizations and geocommunication with smart urban trees.

Acknowledgements: This work was supported by the Sparkling Science research programme of the Federal Ministry of Science, Research and Economy (BMWFW), Austria, 6th call, project "Urban trees as climate messengers", project number SPA 06/005.

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Affordable housing and densification policies. Opportunities and threads from sprawl to compaction.

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Keywords: affortable housing, sprawl, densification

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At the end of the 20st century several, mostly western countries, started to implement policies and strategies for densification on already developed, mostly suburban areas in order to icrease the housing offer and provide affortable housing. This process usually creates a debate between a range of actors: state and local authorities renegotiating the extent of their urban planning powers; developers riding the emerging wave of opportunity supported by the compact city agenda; and powerful local residents who spend much of their research in order to suspen the densification of their suburb[1]. The paper aknowledges the diversity of suburban densification regimes[2] and questions (1) the environmental arguments favouring densification especially when used to defend projects or initiatives which are actually determined by other agendas; (2) the importance and the impact of urban morphology, as the decisive identifier of density, in terms of public space and urban realm, place satisfaction and mobility.

The paper is aiming to preliminary assess the concept of densification through planning incentives introduced to provide affordable housing in Cyprus.

Urbanisation occurred in Cyprus in the second half of the 20th century and, during the first stages, it was almost exclusively based on a typology of freestanding houses in an independent plot. In this context, the single-family detached home is still the preferred lifestyle among the society. The absence of even elementarty neighbourhood layout plans and the patchy plot-to-plot development facilitating only to serve private car circulation and the profitable or speculative patterns of land division has led to the vast expansion of the suburban areas[3]. In 2019 the government initiated a set of planning and other incentives on affordable housing than promote densification of suburban areas.

The paper attemps firstly, a rough summary on the profile and the impact of similar planning policy measures elsewhere providing a structured outline. The existing processes of private initiated housing and urban development in Cyprus are informed by the key conclusions of the global cases a structured outline. Recent studies on neighbourhood development in Cyprus[3] have revealed numerous shortcomings of the neighbourhood production. The features of form and layout, green and environmental aspects, finally mobility, and car usage are seen as the main weaknesses of the urban areas. The paper analyses four study neighbourhood in Nicosia in order to examine the existing condition versus the opportunities and threads arise from densification incentives. Early suburbia, city centre, 1980's suburbs and 2010's suburbs are four distinct typologies of urban space[3] subject the densification measures. For these four types of suburban space, present and possible future scenarios are assessed through three major features: (i) urban form and public realm, (ii) Green, soil sealing, (iii) parking and mobility. How the environmental arguments favouring densification are faced in each different type of neighbourhhod? How would the new urban morphology relate to urban realm, place satisfaction and mobility?

Acknowledgments: This work has been supported by work done at Frederick University – UPDU, Urban Planning and Development Unit (www.frederick.ac.cy/updu).

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ORAL SESSION

D.6.2

Urban sprawl and compact development in the metropolitan region of athens

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Keywords: urban sprawl, compact city, Athens

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Urban sprawl and its opposite, "compact city", are particularly important concepts for sustainable territorial planning, because they are closely related to the degree of conservation of natural resources (especially agricultural land) as well as the degree of energy consumption and pollution of air, soil and water corresponding to different configurations of the transport system. Urban sprawl has many aspects. It involves the diffusion out of the suburban zone of a city, in areas with low density and (usually) rural development. It is also connected with strict separation of land uses and corresponds to different forms of planning having in common the high rates of dependence on private cars. "Compact city" is associated with relatively high densities of residential and mixed land uses. It relies on an efficient public transport system and corresponds to a spatial distribution that encourages walking and cycling, thus leading to low energy consumption per person and less air pollution. Even more important: a relatively large population (with sufficient density) offers a larger potential of social interaction. Therefore, "compact city" is a more sustainable model of urban development.

In the Metropolitan Region of Athens (MRA) the dispersion is the main feature of the areas which were built during the last thirty years; the pre-existing local urban centres have been developed less than needed to cover the demand of the considerable additional population regarding local public as well as private services. In this sense, the respective local urban centres remained weak, and the entire urban development model differs by far from the "compact city" model. The fact that urban sprawl is excessive in the MRA leaded to the previously mentioned negative social and environmental impact.

The paper attempts an evaluation of the urban sprawl effects in the MRA during the last three decades as well as of the compact city policies implemented.

It starts from an in-depth discussion of the urban sprawl / compact city conceptual framework and the respective policy objectives and indicators used focusing on their relations with the concepts of "smart green and just city" and urban resilience. This section concludes with a brief discussion of the positive effects that compact city policies might have on strengthening health systems so that they can better deal with crises such as the covid-19 pandemic - see, indicatively, in [1].

The paper continues with the analysis of the specific characteristics of urban sprawl in the MRA to define the respective territorial patterns and main drivers of change. To this end we use detailed land use data and data on economic and social dynamics of the region elaborated through methods using, among other, appropriate indicators of sustainable territorial development. We use land use data derived from Corine Land Cover (CLC), Urban Atlas and specific sources and economic, social, and environmental data derived from Urban Audit as well as from specific local statistics and surveys – see, indicatively, in [2].

Then, we proceed to the evaluation of the negative territorial, economic, social, and environmental effects of the urban sprawl in the specific case of MRA using, for the comparison with other urban regions in Greece and EU countries, among other, widely accepted sustainability goals (ONU, EU, OECD) and respective indicators – see, indicatively, in [3] and [4].

In next, we evaluate the policies and the specific planning instruments implemented for limiting urban sprawl in the case of the MRA concluding by identifying their main weaknesses. Finally, we proceed to proposals for overcoming these weaknesses in the case of MRA which are of interest for several other urban regions that have similar spatial characteristics to MRA.

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Mapping impervious surface fraction using phenology-integrated linear spectral mixture analysis based on Google Earth Engine

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Keywords: impervious surface extraction, linear spectral mixture analysis, phenology-integrating

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Impervious Surface Area (ISA), as an important indicator of urbanization and the environment, has been estimated by several methods to meet the various demands in urban ecological and environmental studies. Among, the spectral mixture analysis (SMA) method using satellite images has been proved to be the most powerful approach for long-term tracking the dynamics of ISA associated with urbanization processes. [1]. The SMA is a subpixel classification method which is suitable for urban area with high landscape -heterogeneity, especially when using moderate spatial resolution remote sensing images such as the Landsat. The traditional SMA for urban area, which is based on V(vegetation)-I (impervious surface)-S(soil) model [2], is limited by the intra-group similarity between soil and impervious surface, as well as the inter-group variability of impervious surface's spectra. Many previous studies have addressed this problem [3]. Among them, Fisher transformation has proved to produce reliable and more stable results compared to established SMA approaches [4]. However, due to the high collinearity between soil and impervious surface, ancillary information (e.g., nighttime light, phenological information) is needed to effectively distinguish impervious surface from soil.

In this study, a novel approach that incorporates phenological information into the unmixing process is proposed. This approach was called the phenology-integrated and Fisher transformed linear spectral mixture analysis (PF-LSMA), which used the seasonal Landsat images and image-based endmembers selection model of High albedo, low albedo, evergreen vegetation, and non-evergreen vegetation (H-L-EV-NV model). The Fisher transformation was also implemented to further reduce between-class similarity and within-class variability. We performed our study using Shanghai, China as a case study, our results demonstrated that the PF-LSMA approach could well address the collinearity between soil and impervious surface and improved the accuracy in impervious surface estimation in the urban-rural area comparing with the Fisher transformation unmixing method (F-LSMA) (RMSE=0.141). The further comparisons with the existing global impervious surface products of GAIA [5] (with RMSE=0.150) and NUACI [6] (with RMSE=0.146) showed that our ISA product (with RMSE=0.127) was better with higher accuracy and spatial resolution. The algorithm of our approach was developed in Google Earth Engine (GEE) platform, which is easy to operate with no computational requirement on the terminal computers, therefore, can be automatically implemented to extract ISA for long-term studies at various scales from city to regional and global levels.

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ORAL SESSION

D.6.4

Quality of landscapes of small towns and its evaluation

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Keywords: urban landscapes, landscape design and planning, landscape quality

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In recent years a paradigm based on the concept of sustainable development has begun to form, combining the assessment of urban space both comfortable for living and meeting the requirements of landscape planning. The key areas in the sustainable development of the city are the planning of industrial production, energy, transport, water supply and waste managment. As Jan Gehl points out [1], good urban landscapes and good transportation are two sides of the same coin. Moving from one point to another in a city should be assessed cumulatively, with pedestrians, cycling and public transport being the main contributors. The high density of stops in the transport network, the stability and quality of public transport, walking accessibility and good bike paths create a high-quality environment for movement within the city, while simultaneously solving social and environmental problems. Social sustainability is another important aspect of sustainable development. Equal access to the urban area, to public spaces in the city, can only be ensured if there is an optimized system of movement around the city.

Based on the paradigm of neo-urbanism [1] and developments in the field of landscape ecology [2, 3] a methodology for assessing the quality of the urban landscape was developed. One of the requirements for it was the ease of use by specialists of city services, who often do not have the necessary scientific competencies for complex scientific research. The technique was tested during the expedition "Cultural landscapes of small towns" in 4 small towns of the Lipetsk region (Russia): Zadonsk, Lebedyan, Usman, Chaplygin. The evaluation form was drawn up in such a way that the time spent on the description of the area did not exceed 15 minutes, taking into account the need for a visual survey of the entire territory adjacent to the point of description. The evaluation was broken down into 13 categories: sidewalk; lawn; roads; vegetation; architecture; bike paths; road safety; lighting; common yard; private yards; visual pollution; noise; park, square, resting place. For each category a rating scale was drawn up describing the key rating points. During the field works assessments were made in Zadonsk - 114 points, Lebedyan - 61 points, Usman - 79 points, Chaplygin - 52 points. The summary chart of the average scores by categories (Figure 1) shows a fairly similar situation for these small towns despite the differences in their landscape conditions and the history of the city's development.

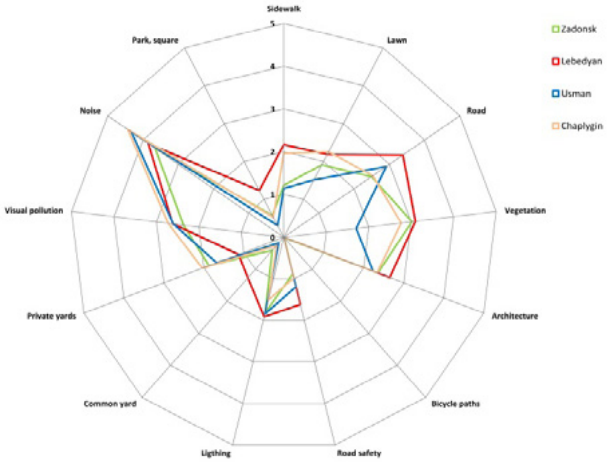

Figure 1. Combined diagram of average values of evaluation scores by categories of urban landscape quality

In general the quality of the landscapes of small towns and, accordingly, in many respects, the comfort of the urban environment in small towns is not very high. This contradicts the widespread perception of them as quiet green oases compared to large cities. One of the characteristic results supporting this conclusion is the complete lack of infrastructure for cycling in all 4 towns. Another negative factor that lowers the rating values is the small number of green spaces (parks, squares) and public spaces, as well as the not very good condition of the existing ones.

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Identification of landscape changes and its driving forces – case study of two urban communities in Poland

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Keywords: landscape changes, driving forces, landscape

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Between years 2006 and 2018 Poland experienced economic development in consequence to joining the European Union [1]. This development had strong influence on landscape. Forces identified in time which caused noticeable changes in the landscape and significantly influenced the direction of further transformations are called driving forces of landscape changes [2,3]. We used two case studies to illustrate and analyze landscape changes and its driving forces in rural-urban and urban communities. First case study was the rural-urban commune of Kąty Wrocławskie in Lower Silesia region which is under strong influence of the neighboring city of Wrocław. Second case study was urban commune of Ostrów Wielkopolski in the region of Greater Poland which represents a medium size city located in the distance of approx. 100 km from bigger cities. To identify landscape changes and its driving forces we used three stage procedure (Fig. 1). At the first stage we identified main landscape changes on the basis of Corine Land Cover database. With the use of land cover data we prepared landscape changes maps and calculated Landscape Change Index to identify the level and directions of changes and analyze spatial distribution of those changes. At the second stage we used archival ortophotomaps to analyze them in detail to identify landscape changes that were not available at the first stage. At the third stage we used participatory approach to identify proximate and underlaying driving forces of those changes. The survey illustrating the areas of landscape changes concerning its driving forces and influence of those changes on landscape, was distributed among the inhabitants of both case study areas. In-depth direct interviews with people over 50 years old were conducted to reach respondent which have the longest relationship with their place of residence. This study shows that landscape changes were bigger in the period between 2006 and 2012 comparing to 2012-2018. The most significant changes in the landscape are connected with conversion from agricultural land to residential area which is directly connected to wealth growth and growing need for better housing conditions. Conversion from agricultural areas into mining, industrial and commercial areas as well as the land abandonment and forest succession processes have also been noticeable landscape changes recognised by the residents of analysed communes.

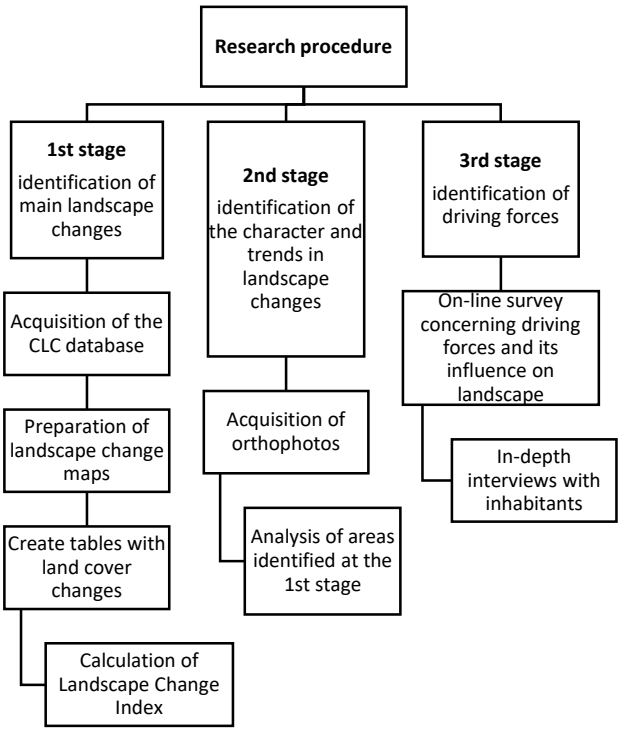

Figure 1. Research procedure

Acknowledgments: This work was funded by National Science Centre, Poland (grant no. 2018/31/D/HS4/00659)

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ORAL SESSION

D.6.6

Preparing for the just transition from local economies' perspective. Belchatow Brown Coal Basin case study (Central Poland)

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Keywords: coal-dependent commune, just transition, investment expenditures

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Coal facilities closure is a great challenge for coal-dependent communes, particularly those located in peripheral areas [1]. However, the coal phase-out should not be considered as an economic shock – it is not an unpredicted event that suddenly changes the status quo of a given community. It means that knowing details of decommissioning plans, local authorities can adopt strategies appropriate to local context and undertake various investments, supporting adaptation to the changing economy.

Research area is covered by two communes located in Belchatow Brown Coal Basin: Kleszczow commune and Rzasnia commune. For both communes, taxes and fees paid by PGE GiEK (the owner of Belchatow Mine and Belchatow Power Plant) constitute a considerable part of the budget revenue, however it is incomparably higher in Kleszczow commune. Consequently, the investment capacities in analyzed communes differ noticeably, what is relevant as regards their ability to succeed in the changing economy. The paper offers a comparison of above-mentioned local self-governments in terms of the structure of investment expenditures in three areas, which are crucial from the point of view of the long-term development: technical infrastructure, social infrastructure and environmental protection. Based on the analysis of investment decisions undertaken in both communes, the author answers the question if the allocation of public funds provides appropriate conditions mitigating the negative effects of the industrial facilities closure?

The study of the structure of capital expenses is based on the acts of Kleszczow Commune Council, adopting the local budget for respective years (from 1995 to 2020). In case of Rzasnia commune, the analysis of the acts adopting the budget covers the years 2002 to 2020, considering that the first works aimed at removing the overburden in Rzasnia commune started in 2002. In addition, examples of investments for the long-term socio-economic development and environmental protection implemented so far are presented. The research is also completed by the recommendations for policy makers on actions that have not been taken yet and that are essential from the point of view of preparation for the transition.

Results of the study suggest that investigated communes (in a number of ways similar to each other) represent two diverse approaches to investing in the development, thereby the environmental, social and economic basis for the transition they provide differ. In both local self-governments, the largest part of the capital expenses in all analyzed areas has been allocated to the road infrastructure. The percentage share of investment expenditures on environmental protection is noticeably higher in Rzasnia commune (39%) than in Kleszczow commune (19%). As far as capital expenses on social infrastructure are concerned – they are greater in case of Kleszczow commune (30%), however the difference can be assessed as relatively small (namely 8%).

Theoretical part of the paper is focused on the issues of the just transition process and the role of local authorities in effective planning for the post-coal future. Broadly defined robust institutions and good governance (in the sense of competent, efficient, incorrupt and trustworthy authorities, functioning within the system based on the rule of law and transparency) shall be considered as central to determine the long-term development and policy-making towards the inclusive prosperity. However, in order to create firm basis for the development in the post-coal future, alongside good institutions, access to financial resources is indispensable. This fact is well illustrated by experiences of communes located in Belchatow region, which relevantly differ in terms of the budget revenue. In Kleszczow commune, which financially benefit the most from the mining and energy industry, local authorities have invested in a number of projects mitigating the negative effects of the coal phase-out. Remaining communes in the region cannot afford to investments on such a scale, therefore a close cooperation of individual self-government units is necessary. The first step of the collaboration should be the establishment of local governments association and the initiation of the work on the regional transition plan, appropriate to the local context and developed in cooperation with local residents.

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How efficient is urban agriculture regarding the food-energy-water nexus?

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Urban agriculture can be defined as the production of food in the city or its periphery. It covers both professional farming and gardening, and includes a wide diversity of forms from home gardens to rooftop farms, and functions from food production to education or social integration [1]. While studies have attempted to measure how urban agriculture can contribute to food security, there is no consensus on its potential across contexts, with projections ranging between 10 and 77% of city inhabitants' fresh fruit and vegetable needs [2,3]. Many of the existing studies do not specify the types of crops produced or the cropping techniques, highlighting a general lack of case studies. Questions are also being raised about the efficiency of urban agriculture regarding water, energy, and nutrient consumption. A major goal of the FEW-meter project is to fill this research gap on two main issues: productivity and production efficiency of urban agriculture.

A large and diverse sample of functioning urban farms and gardens were recruited to participate in the project. 76 urban farms, gardens, and individual plots were studied in 5 countries (Poland, Germany, France, United Kingdom and the United States of America) over the growing season in 2019. Sites were initially classified in four categories according to their main characteristics (based on commercial purpose, and individual or collective use of space): individual gardens (58 plots), collective gardens (9 sites), commercial and community farms (7 sites) and mixed models (2 sites).

Data were collected from March 1st to October 31st 2019, using a common methodological framework and through a citizen-science approach. Gardeners used harvest booklets to record harvest data (e.g. date of harvest, quantities of crops) and quantities and sources of inputs (e.g. fertilizer, water consumption, energy). Other data were collected by the researchers to describe the sites' land use, the garden/farm management and infrastructure.

Data were uploaded throughout the growing season to a relational database using the Airtable platform. Real-life events that impacted food production and resource consumption were also recorded and uploaded (e.g. water leaks). Data affected by these events were adjusted by researchers when possible, and otherwise were not considered sufficiently robust, and those sites (3) were not included in subsequent analyses.

Next, we compared food production and resource use efficiency across farm/garden types and countries, and compared these results to existing literature on urban and conventional agriculture. We assessed correlations between variables (site area, yield, nutrient input…) to evaluate patterns and further characterize profiles of food production and resource use efficiency. We found that the case farms generally used water, energy, and land efficiently compared to conventional agriculture, but with a high variability between individual sites.

The main use of this work is to allow comparison of production efficiency across urban agriculture types. We provide valuable primary data, collected with a standard protocol, that is generally lacking elsewhere. This will allow further analysis regarding urban agriculture and the food-energy-water nexus for future studies.

Table 1. 2019 results synthesis for the 73 sample sites.

	Mean	Standard Deviation	Median
Yield (kg/m²)	**1.86**	**1.41**	**1.47**
L water/kg produced	**97.0**	**243**	**34.9**
Energy (kWh)/kg produced	**1.00**	**3.08**	**0.08**
Number of different crops	**20.3**	**15.9**	**16.5**
% of farm area cultivated	**72.7**	**26.0**	**85.6**
% of farm area in food production	**32.1**	**16.8**	**30.3**
Economic value of production (€)	**3,282**	**10,514**	**260**

Acknowledgments: The FEW-meter project is funded by the Sustainable Urbanisation Global Initative (SUGI) Food-Water-Energy Nexus. More information at http://www.fewmeter.org/.

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ORAL SESSION

E.1.2

How to measure the multiple benefits of urban agriculture: A review of multi-criteria tools for the development of a ua index

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Keywords: urban agriculture, multi-criteria analysis, sustainability assessment

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As part of its recent resurgence in the Global North, urban agriculture (UA) has been described in popular media and policy as providing multiple benefits, including the provision of healthy food, and environmental, economic and social benefits [1]. These claims are not always supported by evidence for two reasons. First, urban agriculture is a relatively new research topic with limited empirical research; and second, studies often only analyse a single dimension of UA, such as yields (see for example Saha and Eckelman [2]). By such metrics, UA often performs poorly against industrial agricultural and appears to be a drain of water, land, and other resources. However, if we expand the types of benefits measured to other social, economic and ecological benefits, UA can look efficient. Ignoring these benefits both limits our understanding of how UA contributes to greener cities and deprioritises the practice in policy circles. A multi-criteria quantification of the manifold dimensions of UA is needed to properly capture and communicate the potential contributions of UA to more sustainable communities.

A holistic measure of UA hinges on combining diverse data types (quantitative and qualitative) that are measured differently. The aim of this presentation is to review some methods to combine diverse indicators, discuss their suitability to the development of a rapid appraisal multi-dimensional tool for urban agriculture, termed here the UA Index, and test them on a small sample of case studies. Methods reviewed are typically used to compare multiple options and evaluate them against benchmarks or identify a preferable choice.

The methods selected for this study were the Weighted Product Model (WPM) and the Composite Indicators methodology. The former is a multi-criteria decision-making tool capable of eliminating units of measure through its particular structure [3]; the latter is an OECD promoted methodology to measure multidimensional concepts which cannot be measured using a single indicator [4]. Five indicators were considered in this study: Water, Energy, Food, Social Benefits and Climate Change. Evaluations were carried out on five case studies, which are part of a broader project of evaluation of urban agriculture from a Food/Energy/Water nexus perspective [5].

Appraisals of the case studies using these methods differed. However, the OECD rating system seemed to be more appropriate as an approach that 'levels up' diverse indicators. As expected, changes in prioritization and weighing of the five indicators shifted the relative performance of the case studies, highlighting the importance of value-choices and preferences among users of such an UA Index.

The methods demonstrated here could be applied to other samples of UA case studies and have practical outcomes. An index could support decisions about which types of UA to promote, or could demonstrate how different policy choices would favor particular forms of UA, or could help ensure that UA benefits are optimized. It can be also used to understand how different organisational types of urban agriculture (e.g. allotments and community gardens) influence patterns of resource use and productivity. It is also an insightful evaluation tool that can account for trade-offs in performance across multiple dimensions, and identify cases that balance multiple benefits, or optimize on a single dimension.

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Business in sight: Allotment gardening as a way of making money and protecting farmland with regard to a new agro-friendly trend

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Keywords: private allotment gardens, economic viability, agrarian landscape

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The advent of allotment gardens in the world is closely linked to philanthropic activity helping impoverished families whose living conditions in rapidly industrializing cities were very bad. The land used for such initiatives was offered either by rich manufacturers, local authorities or parishes to the needy [1]. Although, over time, plots were rented by people of different social strata, making them available did not reflect their market economy value and the payment was low. The basic idea of the movement was its egalitarian nature. Everyone paid the same low rent to for their plot [2]. Nonetheless, a recent surge in demand for allotments that have appeared in the past few years has led to the creation of private allotment gardens in some countries [3]. For instance, a company in the UK started renting out allotments to people at a much higher price than the municipality which got mixed welcome [4].

Spain does not have a long tradition of allotment gardening, but also in this country gardens have had philanthropic character since the very beginning, e.g. Rio Tinto Mines. In some cases, plots were taken over illegally and as a result they were free of charge [5], [6]. Two factors influenced a rapid increase in the number of allotment gardens in Spain: the economic crisis and pro-environmental initiatives of various green movements [7], [8], [9]. However, irrespective of the motivation behind establishing such gardens, whether they were set up for environmental reasons or as a solution for the economic situation, the payment for using them, if any, was symbolic [10]. Nevertheless, also in this country the recent success of allotment gardens, their rapid development and increasing demand, particularly in big cities, has encouraged private entities to see the business potential in leasing such areas. Therefore, currently there are three types of allotment gardens in Spain, i.e. municipal, associative and private [11]. The latter seems to have received little attention in the literature. Our 2018-2020 study of private allotment projects in the province of Seville aims to contribute to closing this research gap.

For allotment gardens to be considered a business, the land must be private property and in these "private gardens" three agents are involved: owners, citizens and society as a whole.

As regards the owners, during the years of the real estate boom (1998-2008) many landowners wanted to sell or rent the land to construction companies to build houses. Since the beginning of the economic crisis in 2008 the same owners have been thinking of renting their land to people from cities that are looking for an agricultural experience. They appear to have the same idea and the same goal: to earn money even if the offer changes. At first, they wanted to make money with the construction sector and now they want to profit from renting the land to produce vegetables. Owners seem to be more interested in collecting the rent than in the quality and quantity of products cultivated on the plot.

Secondly, for citizens holding lease, a private allotment garden is an opportunity to enter the rural world under a new agro-friendly paradigm. Many citizens want to try cultivating land and therefore they need someone to provide them with a suitable plot, the equipment, and accompanying service near their home at a reasonable price. There is an interesting observation: in the 19th and 20th centuries Spaniards fled from the countryside to cities, whereas nowadays Spanish city dwellers pay to have a vegetable plot.

Finally, for society as a whole, it means a positive use of land nearby or even within the city as it prevents land development and offers a healthy activity for its citizens. In other words, these allotment gardens protect the agricultural landscape and reinvent rural-urban relations.

We argue that private allotment gardens may be an attractive complement to the municipality offer, a source of income for the owners and contribute to the protection of farmland within city limits. In spite of that, one should not forget that the nature of these private allotment gardens differs from the municipal or associative ones, that is to say, philanthropic gardens. As their existence and continuous presence depend primarily on the will of private land owners.

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ORAL SESSION

E.1.4

Is a city a good enough place for healthy food production? The soil quality of urban agriculture sites from Europe and the US

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Keywords: soil quality, food security, urban soils

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The rapidly expanding cities and the progressive urbanization process result in an increasing demand for resources supplied from outside cities, this also applies to food deliveries. The city's dependence on food supplies only from the outside affects food security. In crisis situations, the possibility of disrupting supply chains can negatively affect the provisions of basic food products, including fresh vegetables and fruit. The solution that reduces this risk is the use of urban spaces for cultivation. Nevertheless, the cultivation of crops for consumption requires good quality soil, whereas, due to intensive investment, concentrated vehicle traffic, and winter road maintenance, urban soils are strongly transformed. Such soils, called technosols, may contain various types of waste, building materials, may be contaminated with heavy metals [1], which may limit their use for urban agriculture. Despite this, vegetables and fruits are often grown in allotment gardens, community gardens, small city farms or home gardens. The quality of the soil in these urban cultivation spaces is not regularly tested due to the small scale of production and often for private use. To check the quality of soils used for growing vegetables and fruits in urban areas, we conducted studies on selected case studies in Nantes, France, New York, USA and Gorzów Wielkopolski, Poland. The case studies included allotment gardens, municipal farms and home gardens collaborating in the FEW-meter project (www.fewmeter.org). Soil samples for research were taken from the topsoil up to 20 cm, from those areas of gardens and farms where vegetables and fruit were grown. In total, 96 soil samples were collected and tested (27 from Nantes, 30 from New York and 39 from Gorzów Wielkopolski). The results of the research on soil fertility, the content of micro and macro elements as well as heavy metals indicate that urban areas can be a place for growing vegetables and fruit. With proper soil preparation and appropriate treatments, often resulting from many years of user experience and supported by the so-called citizen science soil quality can be maintained at a level favourable to urban agriculture.

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Estimating food production in allotment gardens. A comparative study of Germany and Poland

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Keywords: allotment gardens, factors food production, food distribution, urban agriculture

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In the early days of allotment gardens (AGs), their primary function was food production, which then became particularly important during various crises, e.g. wars, economic slumps [1]. With time, however, the higher standard of living, including the greater availability of food (especially fruit and vegetables), resulted in an increased interest in recreation on such plots. The growing importance of the recreational function was accompanied by reduced food production, which in some countries led to its marginalization [2], [3]. However, in the second half of the 20th century, there was a return to food production, albeit on a different scale and intensity, in European AGs [4]. Currently, food production in AGs is becoming even more important, as it fits into the concepts of NEXUS, ecosystem services, agroecological urbanism and foodscape. It is also promoted in strategic documents such as, e.g., Milan Urban Food Policy Pact, Farm to Fork Strategy and initiatives, e.g., Edible Cities Network. Furthermore, the current COVID-19 pandemic clearly highlights the importance of food security and thus the productive function of AGs as an important component of the urban food system.

The article aims to identify the importance of food provision from contemporary AGs and the factors influencing its development. Particular attention is paid to the production methods and distribution of AGs' produce. The study assesses the chance of food provision in AGs to exist in the future. The research is focused on Germany (Westphalia-Lippe) and Poland (Wielkopolska), which were among the first countries to implement the idea of allotment gardening in Europe and are presently the leaders in this field. The study was conducted in the years 2016-2020 and used a multi-step research procedure. Necessary information and materials were collected during field visits, surveys and interviews.

The research revealed that German and Polish institutions managing AGs have no access to statistical data on the food produced by garden owners. The study identified differences in the importance of the production function in the two countries. In Germany, legal regulations and the multicultural structure of the gardeners' community favours the cultivation of edible plants. In contrast, the great freedom in Polish legal regulations concerning allotment use means cultivation of horticultural crops is marginalized in favour of recreational use. It transpired that food produced by plot-holders in both countries is distributed primarily non-commercially, although some commercial distribution channels were recorded, too. However, in both regions and countries, the law allows plot-holders to use food grown on plots only for their own purposes. The research showed that the importance of the productive function in both countries changed under the influence of the same conditions and factors. However, their impact varied. Food production in AGs is determined by the individual characteristics of the plot-user (e.g. origin, lifestyle, food awareness) and external factors (e.g. political, historical, environmental, economic, and legal).

Table 1. Factors affecting the productive function of AGs in the opinion of representatives of regional and national BDG and PZD authorities. Source: own work

Factors	Factor meaning											
	very important				important				irrelevant			
	DE		PL		DE		PL		DE		PL	
	N	R	N	R	N	R	N	R	N	R	N	R
1. Location of allotment		x					X	x	X			
2. Natural conditions		x			X			x			X	
3. Historical conditions			X	x	X					x		
4. Political factors		x			X		X					x
5. Legal regulations	X	x	X					x				
6. Environmental education	X	x	X	x								
7. Living conditions			X	x	X	x						
8. Access to food							X	x	X	x		
9. Social features of plot holders	X	x					X	x				
10. Profile of plot holder	X	x	X	x								
11. Social features of household		x			X			x			X	
12. Other? hobby							X					

N – national level; R - regional level

Changing environmental, political and socioeconomic conditions, as well as up-to date concepts of urban development favour the productive function of AGs. Consequently, they should become a productive part of the urban landscape once more.

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ORAL SESSION

E.1.6

City region food self sufficiency within functional urban areas vs. metropolitan areas

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Keywords: food city region, metropolitan foodshed assessment, food provision

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European Farm to fork Strategy addresses the growing urban population demands for sustainable, healthy and local food that would increase the resilience of the food system. However, depending on the type of diet, the supply of such a food depends on agricultural, as well as socio-economic characteristics of a city region. Therefore, the aim of this article is to provide evidence on whether food city regions in Europe are able to provide at least vegetarian diet supply to their citizens. There are not clearly define food city regions in Europe, and therefore, this article aims to fill in this gap by assessing how much the functional urban areas (delimitated according to ESPON methodology) have the capacity to provide vegetable diet supply to their citizens. We apply the metropolitan foodshed assessment [1] to estimate the level of regional food self-sufficiency of the functional urban areas. We quantitatively compare the results for functional urban areas with the results for the bottom-up approach of local planning documents delimitating metropolitan areas. The approach is applied to 9 city regions representing different European countries: Wrocław (PL), Athens (EL), Berlin (DE), Copenhagen (NL), Bari (IT), Brashov (RO), Ostende (BE), Avignon (FR) [2], Barcelona (ES). In order to enable comparisons between case study areas, we use the Corine land Cover 2018 dataset, functional urban areas and the same metropolitan foodshed approach. However, we allow for local input data regarding the typical citizens diet as well as local characteristics. The results show how much of the food demand could be potentially satisfied in the functional urban areas for different types of city regions, i.e., cities located in different climates, surrounded by different geomorphological (coast, mountains, flat homogeneous areas…) and geographical (very densely populated, less densely populated, experiencing urban sprawl and shrinkage) conditions. We discuss how sustainable urbanisation might influence the foodshed area and how current land use change trends (identified in the ESPON thematic reports) might impact levels of self-sufficiency of the European Regions. The manuscript ends with the discussion on different governance options to enable diminishing the negative effects of urban-rural dichotomies. We argue that the results cover many different types of European cities and, therefore, the governance options could be transferred to other European city-regions.

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Urban agriculture's climate change impacts come from surprising places: a life cycle assessment of three rooftop farms

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Urban agriculture is promoted in many cities, while its rural counterpart ('classical' agriculture) accounts for large environmental impacts, including an estimated 26% of global greenhouse gas emissions [1]. Consequently, there is a need to understand the potential environmental impacts of urban agriculture. A leading method to quantify this is life cycle assessment, multiple environmental impacts are modeled from all inputs and outputs related to an activity or production. In the case of classical crop production, this includes processes like production of fertilizer, fuel for machinery operation (such as tractors), and delivery of food to markets.

Unlike for classical agriculture, little is known about the climate change impacts from urban agriculture— notably, the magnitude and the major sources of greenhouse gas (GHG) emissions within the life–cycle. This is because few studies have addressed this topic, and urban agriculture systems and practices are very diverse. Furthermore, urban agriculture operates differently from classical agriculture, with a unique set of objectives (including educational, community–building, and food security), or challenges and opportunities due to its urban placement [2]. As a result, data from classical agriculture may not be relevant for studying urban agriculture. Therefore, life cycle assessments of urban agriculture case studies are essential to furthering our understanding, but are currently lacking.

Here, we partnered with three urban farms in Paris, France, to collect data from one year of production and perform life cycle assessments. All three case studies were rooftop farms, with open-air cultivation in growing media, and were concerned with environmental dimensions of food production. Farm 1 was integrated with a school, with a primary goal of education. Farm 2 had a main objective of job training for the social reintegration of employees, and Farm 3 was a commercial farm. Data collection methods were adapted to each farm, and included ongoing records by farmers in notebooks; consulting past operations, sales, and purchasing records; and regular farm visits and interviews by researchers. A mix of vegetables and fruits were grown, ranging from 36–45 different crops per farm, and crops with the largest harvests included tomato, fava beans, spinach, chard, cucumber, zucchini, and green beans.

For the life cycle assessment, we used a 'farm–to–consumer' system boundary, including all inputs to the farms and delivery to the consumer (which for farms 1 and 2 was done by walking or bicycling, while for farm 3 customers drove to the farm to pick produce). Climate change impacts were calculated per kilogram of food grown. To put our results in context, we compared them to the findings of a systematic literature review we performed on life cycle assessments of urban agriculture. We evaluated 47 papers, covering 88 different farms/gardens and 259 production systems.

We found that climate change impacts for farms 1, 2, and 3 were 2.87, 0.58, and 1.50 kg CO_2 eq./kg crop. These were in line with the impacts from similar systems found in the review (rooftop, open–air, soil–based), where 18 systems had a mean and standard deviation of 1.91 ± 2.13 kg CO_2 eq/kg crop.

The impacts of these case studies were highly dependent on the inclusion of some processes that seemed unique to each farm (Figure 1). At farm 1, 53% of GHGs came from the creation of the substrate (even when it was given a generous 25–year lifetime)— especially the 15–cm layer of compost. Such a material–intensive creation of substrate is unique to urban agriculture and not necessary in classical agriculture on regular soils. Farm 2 had the unique opportunity to be installed on an existing green roof, where the substrate had already been created, so that its impacts were not attributed to the farm. But, if they had been included, they would have made up 45% of the life–cycle GHG emissions (and are included in Figure 1). For farm 3, an exceptional operations setup involved having nearly all seedlings delivered to the farm, every week, from about 300 km away, rather than starting seeds on the farm. These deliveries accounted for 41% of the GHG emissions.

These case studies may have been anomalies, or more likely, they may represent the diverse and sometimes unexpected circumstances under which urban agriculture generally operates. Our results highlight the value of assessing existing urban farms and gardens, using primary data collection, which is the only way to incorporate the unique complexities of growing food in an urban setting.

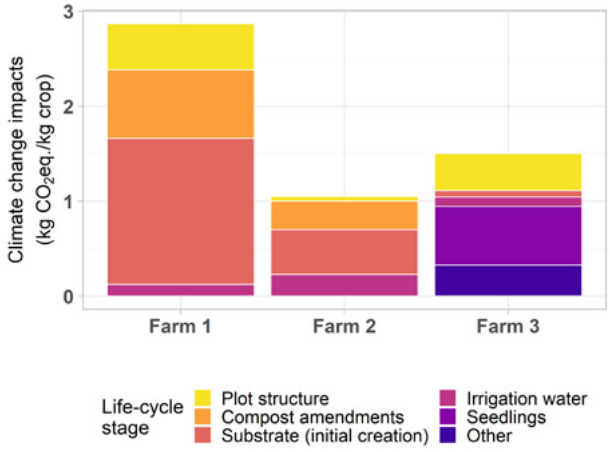

Figure 1. Climate change impacts of the three urban farms, with a breakdown showing which activities contributed the most.

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ORAL SESSION

E.2.2

An integrated approach for assessment of benefits of community gardens and their contribution to well-being of City Dwellers. Net social benefits and members and non-members perception

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Keywords: community garden, cost-benefit analysis, adaptation to climate change, perceived benefits

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Impact of globalization on cities, urbanization and, last but not least, ongoing climate change have caused an increasing interest in the quality of life in European cities using green and blue infrastructure (GBI) and possibilities of its improvement. Recent studies showed people are aware of some of the benefits provided by GBI and are willing to pay for building, extending and maintenance of these elements (e.g. [1]).

Community gardens (CG) are part of the GBI as well as urban agriculture which can address other challenges such as food self-sufficiency or development of local communities.

The aim of the paper is to present integrated approach for assessment of social benefits of CGs and their contribution to well-being of city dwellers from social, members and other city dwellers perception. We applied the developed approach on CGs in Czechia. Within this contribution the emphasis is put on following research questions: (1) What is the value of the net social benefits of community gardens in cities? (2) What are the main members' motivations for participation in CG? (3) What is the perception of CGs among non-member dwellers?

Different methods were used according to increase the robustness of the analysis. A modified cost-benefit analysis (CBA) of two different types of CG was used to assess the net social benefits of the CGs in cities. CG Kuchynka is an example of CG with terraced vegetable beds; in CG Vidimova they are using mobile garden beds.

Contrary to the prevalent qualitative surveys made in the area of members' motivations and drivers for participation in CG (e.g. [3]), we applied quantitative form of data collection using a questionnaire survey. The importance of the different motivations was examined using statistical analysis and logit models.

Similar approach using another questionnaire survey was applied in public area near CG for answering the third research question regarding the perception of CG among nonmembers city dwellers.

The economic analysis of two CGs in Prague, Czechia and results of the CBA shows that both CGs are beneficial for the society. For this time horizon of 50 years, the net present value for CG Kuchynka and CG Vidimova were estimated at EUR 31,550 and EUR 1,175 respectively.

The research among CG members shows that the main motivation for the members in Czechia is not crop production itself but, rather, the spending of leisure time, social contact and relaxation. Other key drivers include the passing on of experience and knowledge about nature to children, which is found mostly among the members with previous cultivation experience.

Pilot survey among city dwellers and non-members of CGs in public area near CG in Usti nad Labem examined how those residents perceive the CG and if their opinions are differentiated based on demographical category. The results showed that CG in Usti nad Labem is not well known among residents, and due to that mostly neutral or weakly positive opinion prevails. Despite the low awareness, most of the respondents are in favour of maintaining this CG.

Based on our results, CGs belong to important elements of GBI in cities, which provide a wide range of benefits beyond the production function itself. Both members and non-members of CG in Czechia are equally aware of this. Although non-members often do not know about existence of CGs in their neighbourhoods they consider them important and support their existence. Based on recorded motivations and perceived benefits, this integrated approach can provide guidance for policy and planning. CGs provide benefits for all local residents that exceed the costs, therefore it makes sense to support the establishing of new CGs from the society point of view.

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Food for thought: addressing urban food security risks in urban planning through urban agriculture in the Global South

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Food security has only recently been considered as a problem affecting urban environments following a long history of rural bias that dominated global discourse and development research [1]. Urban planners have been slow to recognize food security as a part of the urban agenda. Planners in the Global South are also regarded by some researchers as part of the urban food security problem, as some have made it their professional duty to rid the city of the agricultural activities they perceive as the antithesis of the clean, modern city they seek to create [2].

The lack of planning for food has been attributed to the long standing belief that food is a rural issue with a lack of connection to the built environment [3]. This argument however neglects to acknowledge the occurrence of urban agriculture and the multiple aspects of the food supply chain and inherent connections to urban planning interests.

Furthermore, the increasing pressure that cities in the Global South will face due to rapid urbanization [4] and climate change [5], combined with the unsustainability of the global food supply chain model emphasizes the need for more sustainable food production and supply approaches. This study thus argues for the adoption of urban agriculture in urban planning practice as a way for planners to engage more actively with the food supply chain, and in doing so, address the wider issues of food security and sustainable development in the Global South. The objectives of this study, therefore, include (1) to reflect on why food security is a planning issue; (2) to investigate the impact of the food supply chain on urban planning; (3) to identify best practice examples of urban food production; and (4) to provide multiple arguments for the integration of urban agriculture into urban planning practice.

The study uses a multiple-case research design in which best practice examples of urban agriculture from different Global South cities are investigated. The locations of the four cases chosen for analysis include Belo Horizonte in Brazil; Rosario in Argentina; and Cape Town and Johannesburg in South Africa. Case studies are analyses based on their contribution to food security, their effect on the local food supply chain and their impact on sustainable development. The analysis intends to provide evidence on how urban agriculture can serve as a viable method to increase food security and address the vulnerabilities of the food supply chain.

Ultimate recommendations [6] relate to the recognition of food security as a planning issue through the establishment of food policy councils. This will also aid planners to engage with the food supply chain to create more sustainable production and supply chains. Urban agriculture should be incorporated into urban planning practice, especially in land use planning and zoning designations. Lastly, the multifunctionality of urban agriculture should be harnessed to not only address food security issues, but other urban risks and to achieve sustainable development objectives.

This study was conducted for the partial completion of a BSc in Urban and Regional Planning. Building on this, a Masters study is currently ongoing which expands on the core research themes included here.

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ORAL SESSION

E.2.4

Health clinic gardens as communities of practice: stakeholders' perceptions on ecosystem services and disservices

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Gardens are essential types of green infrastructure that provide multiple ecosystem services in both rural and urban areas. They can be classified into different types and forms of ownership, and their main purpose influences the types of ecosystem services (ES) provided. Types of gardens include privately owned (home gardens, domestic gardens, community gardens) and entity owned, funded and managed (botanical gardens, school gardens, health clinic gardens). Health clinic gardens in South Africa are an initiative of the democratic government to contribute towards the nutritional needs of the surrounding community. Various stakeholders, each with varying perceptions, attitudes, and assumptions, are involved in the management and day-to-day running of these gardens to ensure optimum ES provisions. Consequently, the aim of this study was to identify the perceptions of these stakeholders on the ES and disservices of the gardens to understand and motivate for the usefulness of these gardens for communities and natural environment at large. This was done in the Bojanala District Municipality, in the North-West Province of South Africa. Various stakeholders involved in health clinic gardens were interviewed following a structured questionnaire to obtain their perceptions on ES and disservices. Their responses were rated according to perceived reactions to question during interviews. Questions were divided into the four main categories of ES outlined by the Millennium Ecosystem Assessment. Data were analysed using interpolating techniques in ArcMap (ArcGIS) called the Inverse Distance Weighted (IDW), MS Excel 2013, and Statistica 12.

Key results show that most stakeholders (98 %) perceive spiritual/sense of place ecosystem service to be the most valuable of all services at the clinic gardens with an average score of 4.42. Other important services included food provisioning (94 %, average score 4.29), biological control through insects in the garden (94 %, average score 4), local climate and protection from wind and sun provided by trees (96 %, average score 4.19), social networking through the garden (97 %, average score 4.14) and education and science from the garden (93 %, average score 3.89). Habitat and supporting services were scored the least valuable. The most dominant ecosystem disservice was crime, fear and stress (83 %, average score of 3.88). Danger was often associated with the garden and the area surrounding it. The average score for ecosystem disservices was only 2.58, indicating that other disservices such as allergies, accidents, financial/environmental costs, and damage to infrastructure were not considered as important threats in gardens. There was an inclination towards cultural ES, most of which are unique to the Bojala District. The first theme indicates that aesthetical appreciation was less about ornamental plants, but more about cleanness, openness, growing of vegetables and the greenness of the garden. Reference to fear of snakes implied a link between danger and the garden. Appreciation was expressed for the growing of plants and the development of fruit and vegetables. The concept "garden" was mostly only associated with food rather than recreation or aesthetical appreciation.

The diversity of potential knowledge gathered at clinic gardens contributes to the co-production of knowledge and creation of an enriched understanding of the problems occurring at the gardens which will enhance innovation and the potential to enhance resilience. Furthermore, an understanding of stakeholders' preferences and perceptions may contribute to the development of gardens that contribute to the "sense of place" and enhance their biocultural diversity to best serve the people they are developed for. This study contributes to a growing body of knowledge in the Global South which aims at illuminating the importance of other forms of green infrastructure which are barely explored. There is little understanding of the contributions health clinic gardens make as little is known about how people relate to them, as opposed to individual home gardens. This understanding is intrinsically important because the values associated with these gardens may be different to what is universally understood as a result of limited exploration in contexts different to those of the Global North.

Designing community forest-gardens in Budapest

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Keywords: urban agroforestry, landscape architecture, resilience

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Within the context of climate change and urban growth it has become urgent to rethink access to resilient and rich biodiversity green spaces in the cities. It has also become urgent to plant trees in the city to mitigate urban heat islands. However, instead of focusing on top down methods for planning green systems in the city, this article suggests a bottom up approach to create agroecological forests and gardens in the city with the participation of citizens. This is to encourage social resilience and community bonding in the city, with access to knowledge and contact with decision-makers and planners.

The goal of this article is to assess the role of landscape architects in planning and designing urban community agroforestry systems such as forest-gardens. The questions are how can the design be participative and what are the best tools for community design and implementation of agroforestry practices in the city? This is answered through the case of two thesis projects in Budapest.

The methodology is to do research through the project with participation of decision-makers, experts and citizens in the process and the detailed research on the choice in tree species and other layers. The results of this article are that participative permaculture design is a good tool for community development in cities and social inclusion. It is also a good strategy for building autonomous community forest-gardens.

This article is part of a thesis in Landscape Architecture, focusing on urban and peri-urban agroforestry, where the project is to create a methodology to initiate several community agroforestry spaces in the city with citizens and create a planning strategy based on an agroforestry corridor project in Budapest to be part of urban policies and long term agendas. The main goal of the thesis is to assess how agroecological principles can be used in urban planning and landscape architecture.

Acknowledgments: This work was supported by the District Mayor of the 14th District of Budapest.

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ORAL SESSION

E.3.1

Differences in motivations and social impacts across urban agriculture types: case studies in Europe and the US

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Urban agriculture is an increasingly popular approach to addressing negative social and health effects of cities. Social benefits of urban agriculture include improved health and wellbeing, economic opportunities, social cohesion, and education [1,2]. However, the extent to which urban agriculture participants are motivated by or experience these impacts has rarely been measured quantitatively, especially across the many different types of urban agriculture. This can present a challenge for urban planners in developing urban agriculture projects that are appropriate for developing specific social impacts.

To contribute to quantitative research on the relationships between motivations, urban agriculture types, and reported social benefits, we used a multi-national study of urban farms and gardens. Our analysis of the study data for this presentation answers two research questions: (1) What are urban farmers' and gardeners' reported motivations and social impacts from urban agriculture engagement? and (2) How do motivations and impacts of farming and gardening differ based on the urban agriculture type?

We invited urban gardeners and farmers from five countries to participate in a survey, specifically recruiting case studies representing different types of urban agriculture. We analyzed data from 155 participants on 74 urban agriculture sites in France, Germany, Poland, the United Kingdom, and the United States. To develop our analysis, we established a typology of spaces for urban agriculture based on three factors that characterize the relationships of the participants to each food growing space [3,4]: (1) participant roles; (2) food distribution methods; and (3) site connectivity. The resulting types of urban agriculture were classified as allotment gardens (n=54), home gardens (n=3), home farms (n=3), community gardens (n=9), hybrid community gardens (n=8), community farms (n=32), hybrid working farms (n=5), and working farms (n=41).

Through factor analysis, we identified four scales as measurements of participants' motivations and impacts: general wellbeing impacts, nutritional health impacts, economic interests, and socialization motivations. Average Likert scale scores were above the neutral point for all scales, indicating that participants overall reported agreement with motivations for engaging in urban agriculture and positive impacts from urban agriculture. The economics scale has the lowest overall mean, indicating economics was the least important scale on average.

Through multivariate analysis of variance, we document significant differences in motivations and reported impacts across types of urban agriculture. Respondents from different types of urban agriculture varied in their scale scores. General wellbeing outcomes were significantly higher for allotment gardens than working farms; socialization was a more important motivation at farms and gardens with collective production than at home farms; and economic factors were significantly more important for working farms compared to either allotment gardens or community farms.

While our results are somewhat intuitive in alignment between participants' motivations and self-selected urban agriculture types, the confirmation of this trend using a quantitative, multi-national sample is valuable. Additionally, our study illustrates a method of evaluation that can be useful for planners and policymakers looking for tailored solutions as they consider scaling up urban agriculture. While urban agriculture may be a beneficial land use, not all farms, not all organizational structures, and not all farmers and gardeners produce the same beneficial results.

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The socio-cultural benefits of urban agriculture: A scan of the literature

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The socio-cultural services provided by urban open spaces – including parks, green spaces, and plazas – have gained prominence in urban ecosystems research in recent years [1,2], yet the role of food-producing open spaces in providing these services in cities has received modest attention. In fact, ecosystems services scholarship has tended to focus on urban agriculture's food production capacity. This literature offers important insights albeit into only one of a much broader set of benefits contributed by the spaces and communities growing food in cities. Since what is not measured is likely to remain undetected by policymakers, a focus on a single benefit limits public investment, regulatory protections, and the longer-term viability of these spaces.

To understand the approaches and metrics researchers have begun to test to analyze the social and cultural benefits of urban agriculture, we conducted a systematic scan of the literature. The scan captured research in four overarching thematic areas – community cohesion, health and wellbeing, economic opportunities, and education – which were drawn from the broader scholarship on urban farming. References were limited to peer-reviewed publications in scientific journals indexed in Academic Search Complete, Web of Science, and Gale Agriculture. The sample was supplemented with additional references identified by lead scientists assessing the food-energy-water and people-related benefits of urban agriculture in five countries (Germany, France, Poland, UK, and US) [3]. These expert contributions allowed for the inclusion of non-English scientific literature and thus more inclusive data collection.

We included 268 peer-reviewed publications in the final sample. The content analysis revealed that the nascent academic literature seeking to gauge the social benefits of urban agriculture has, so far, prioritized assessments focusing on community cohesion and health and wellbeing outcomes, and to a slightly lesser extent education and economic development. Qualitative research designs are prominent though quantitative studies have been conducted. More than half of the studies collected data through interviews whereas about a fifth used an experimental or clinical trial design. The most commonl independent variable was participation in community gardening activities, with only a few studies using the time spent gardening. Top two dependent variables were measures of community cohesion (e.g., perceived trust within the community) and the gardeners' diets (e.g., fruit and vegetable consumption). Overwhelmingly, studies reported positive relationships between independent and dependent variables (e.g., participation in urban farming and increased preference for fruits and vegetables and availabiltiy at home), with only a quarter pointing to mixed, neutral, or negative associations.

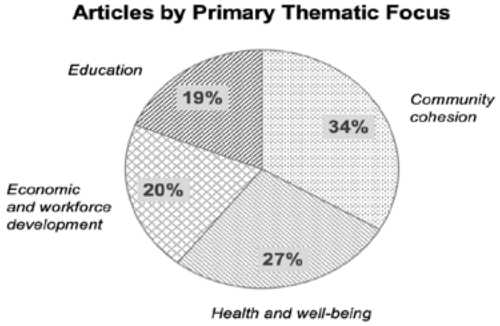

Figure 1. Articles by primary thematic focus

This paper's findings have implications for researchers using urban agriculture as a lens to theorize cities as socio-ecological systems and working to provide empirical evidence on the socio-cultural benefits of urban agriculture. Future research on the state of the art of this field should focus on conducting meta-analyses of the quantitative studies in the sample to assess consistency and generalizability of individual findings and conducting studies on the economic dimensions of urban agriculture, including how it relates to broader processes of urban development and social equity.

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ORAL SESSION

E.3.3

Socio-economic and socio-ecological benefits of allotment gardens – findings from case studies in France, Poland and Germany

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Urban agriculture is becoming increasingly important worldwide. One form of urban agriculture that is widespread in many parts of Europe is allotment gardens. They look back on a tradition of more than 150 years and have experienced a renaissance in recent years [1]. In recent decades, motivations for allotment gardening have changed and the economic motives and food supply became less important while the social-ecological motives have enlarged [2].

The aim of this study was to examine socio-ecological and socio-economic benefits of allotment gardens in France, Germany and Poland with a mixed methods approach using qualitative and quantitative social science methods. This approach aims to complement the state of research in this area with empirical data. The data used were collected with the help of garden diaries from 51 allotment gardens in 2019. Gardeners recorded resource use such as the amount of water consumed, of electricity used, or fertilizer applied and additionally the quantities of harvest by crop. Furthermore, a standardized survey helped to explore social aspects. In order to be able to make more in-depth statements about the contributions of allotment gardens to urban development, guideline-based expert interviews were also conducted.

Allotment gardeners spent on average 10 to 17 hours per week actively and another 5 to 14 hours recreationally in the allotment gardens. On average, in each garden between 111 and 214 kg of fruits, vegetables and herbs were harvested, which shows that allotment gardens ensure the access to healthy food for gardeners and their families in a high quality, comparable to organic food.

Regarding ecological aspects, we found that allotment gardens promote biodiversity in cities, for example through the number of species, the use of compost and the relatively low use of pesticides and fertilisers. Furthermore, it became clear that in all allotment gardens between 80% and 90% of surfaces are unsealed.

The findings in the economic dimension were surprising, as they revealed that no gardener stated to be motivated by economic reasons. Nevertheless, depending on their garden size and their productivity, the gardeners harvested in 2019 food with an average value per garden of 130 € in Poland, 394 € in France and 1,289 € in Germany. National differences in the living costs were considered in the calculation.

Table 1: Average plot size, harvest and economic value per garden in 2019 sorted by country.

2019	France	Germany	Poland
Average size of plot (m2)	148	531	353
Average harvest (kg)	165	214	111
Average economic value (€)	279	929	222

Another aspect we considered in our study was to investigate the role of allotment gardens as part of sustainable urban development strategies. We found that allotment gardens can especially support social-ecological aspects of urban development. Their main advantage (compared to other forms of urban agriculture) lies in their long tradition and their embeddedness into the urban landscape. Furthermore, allotment gardens are characterized by a high degree of biodiversity, which is an important factor, especially for highly-populated and high-density cities or urban districts.

Concludingly, we were able to illustrate that allotment gardens can have social and ecological benefits that should not be underestimated. In addition, we were finally able to substantiate general statements on the social, ecological and economic effects of allotment gardens with empirical findings. Allotment gardens add multifold benefits to the urban green infrastructure and can play a significant role in sustainable urban development.

Acknowledgments: This work was part of an assessment of data collected in the FEWmeter project (www.fewmeter.org). FEW-meter is an international project that investigates the resource flows of urban agriculture through case study analysis in five countries.

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The social and environmental value of public urban food forests: The case study of the Picasso Food Forest in Parma, Italy

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Keywords: food forest, urban agriculture, urban nature

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The history of urban food forestry is very recent and early projects represent highly valuable operational case studies to obtain precious information on challenges, best practices and results. The Picasso Food Forest represents the earliest documented case study of urban community food forest in Italy. By hosting several perennial woody plants, it provides ecosystem services typical of a tree system including making biodiverse fresh edible fruits, vegetables and herbaceous plant easily accessible to adults and children reconnecting them to healthy eating habits, food growing and the special experience of foraging and harvesting food directly from the plant in a nature-like setting. It has contributed to develop a neighborhood community, place attachment and meaning among the citizens that participate to its implementation or that simply attend the area. Compared to more traditional community gardens, the food forest provides a deeper interaction with the natural world and related benefits. This is achieved by exposing people to a greater understanding of ecological processes that are at the base of the food forest design and functioning, and to a more complex physical structure and biodiversity, more similar to wilderness, stimulating sense of wonder, exploration, curiosity and observation. The Picasso Food Forest represents a hotspot of biodiversity providing a plant and wildlife nursery and shelter, and a genetic bank by including several heritage and local varieties. The setting of a case study that provides inspiration for new analogous projects in Italy and Europe is one of the main achievements. The Picasso Food Forest successfully challenges issues such as biodiversity loss, community segregation, food insecurity, climate breakdown, unsustainable consumption and production systems and it provides a model to rethink not only how cities should be designed but also how we, as a species, shall provide for our needs and live on this planet.

ORAL SESSION

E.3.5

Analyzing potential user groups and their needs for an urban food forest in Berlin

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Keywords: urban food forest, urban gardening, mixed methods

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Growing cities suffer from intensifying land use competition and pressures on urban green spaces. Facing climate change, biodiversity loss and environmental injustice among others, long-term multifunctional solutions are needed. As species-rich, climate-adapted, carbon-storing and cooling places of social interaction and coherent environmental learning, Urban Food Forests (UFF) combine several ecological, climatic and social benefits and provide valuable green spaces for sustainable urban development [1].

With the aim to quantify those effects, a pilot project on UFF is going to be established in Berlin-Britz as a place for practical experimentation, field research and environmental education. In addition, the project will be also a unique and innovative example for integrating a community garden into an allotment garden, combined with a public park area, complying the growing demand for urban gardening and local recreation.

As part of an ample feasibility investigation for the project, a public participation process was implemented. The study presented here was carried out in this context to identify the needs of potential future users for the planned community garden. In particular the research questions were about the users' needs and requirements on spatial elements and the structure of the garden as well as their needs for privacy in urban gardens. Alongside the participatory process a mixed methods approach was chosen, including surveys with standardized questionnaires and participatory observations during civic participation events to gain multi-perspective and comprehensive information, using triangulation of the results [2].

Additionally, people in Berlin were randomly adressed alongside public events on urban gardening and are represented in the study. Due to the circumstances the interviewed people could be divided into two groups: persons, who applied for an allotment garden (AGs) and persons who are interested in community gardening (CGs). The results show striking differences as well as a range of similarities between the two groups. The significant findings could also be validated by overt observations during community gardening related workshops and a workshop for allotment garden applicants. Each time, observations were made focused and non-standardized by an observer as participant.

Some general differences between the participant groups could be found in the frequency of gardening: 95 % of AGs want to spend two or more days a week in the garden, while more than half of CGs indicated to be in the garden at maximum once a week. A notable trend was visible in the people's preferences concerning of garden design, where one quarter of the AGs tend to prefer an accurate and neat garden design, whereas more than 80 % of CGs tend to prefer a naturalistic garden design and even 50 % of them liked it to appear as very close to nature. Concerning privacy characteristics, two thirds of the AGs prefer rather private areas, while almost half of the CGs could imagine to share community garden space. For over 60 % of the AGs it was important to sperate private areas with fences, while about 80 % of the CGs indictaed to prefer no fencing.

Besides, some notable similarities could be discovered as well, for example, concerning the motivations for gardening (such as experience of nature, food cultivation, manual activities) or social and ethical values that people wished for gardening in a community. Furthermore, the results also revealed a comprehensive list of infrastructures required in a community garden, like a big gathering place, cooking facilities, shared tools and zones of different utilizations (relaxation areas, children's area, wild zone).

Applying mixed methods was appropriate to gain important information as a basis for integrated garden planning for the UFF in Berlin-Britz. In general, the study can be transferred to other sites, but basic knowledge about local actors and networks are required. In this study participants confirmed great interest in the concept of UFF as a multifunctional solution for future urban planning.

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What are potential ecological and economic impacts of edible green spaces in cities? Example of a community garden in Vienna, Austria

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Large-scale greening of city quarters often fails due to construction and maintenance costs. In contrast, there is high willingness of local residents to engage in urban gardening. This is also the case in aspern Seestadt, an emerging city quarter in Vienna, Austria [1]. The research project "Essbare Seestadt" [2] was intended to show if and how high costs for urban greening can be reduced via the participation of local residents, while social, ecological and environmental benefits are created through inclusion, awareness raising and participation [3]. For this study we focus on the example of a Community Garden (CG) in aspern Seestadt. Taking a CG in aspern Seestadt as an example, this study analyses the ecological potential (Global Warming Potential - GWP), biodiversity aspects, economic aspects and horticultural aspects, resulting from participatory gardening initiatives. We present small-scale effects of the CG itself and large-scale effects by upscaling the results to the theoretical spatial potential for the implementation of CG in the entire urban development area.

Methods

Primary data was collected in cooperation with the gardeners of the CG, using citizen science methods. We collected yield data of the seven most frequently cultivated crops in aspern Seestadt, data on retail prices of these crops, data on the work time spent for gardening as well as crop management processes (i.e. fertilization). To identify challenges faced by gardeners, we conducted a qualitative survey. To collect data on garden management, we conducted semi-structured key informant interviews and participant observation during garden visits.

To represent different levels of knowledge and farming systems we distinguished between three scenarios: a „beginner scenario" (BS), and two „experienced scenarios" (ES) – low and best yield. Yields for the BS are based on empirical data, yields for the ES were modelled from [4], [5], [6], [7], [8], [9] and [10]. Low yields were assumed to be half of high input yields [*cf.* 11].

A Life Cycle Assessment was carried out to calculate the GWP of the CG. Regarding socio-economic aspects, we considered two types of costs: Private costs for consumption, and public costs for maintenance of green spaces, and how these costs could potentially be reduced by urban gardening. The potential to foster biodiversity was analysed by evaluating the impact of a set of 21 specific measures on eleven groups of organisms and agrobiodiversity.

To show the potential effects of an expanded vegetable production within CG in the entire urban development area, the spatial potential for the implementation of CG was identified, quantified and linked to the GWP and cost analyses.

Results - small-scale

Results for **GWP** differ widely per crop and yield scenario. In the following, the average results per kilogram vegetable mix are considered.

- BS: 0.22 kg CO_2-eq
- ES Low Yield: 0.15 kg CO_2-eq
- ES Best Yield: 0.09 kg CO_2-eq

The BS turned out to cause highest GWP per kilogram yield. This is mainly due to low yields. ES Low Yield only shows slightly better results compared to BS. However, the ES Best Yield scenario shows significantly better results for the GWP per kilogram vegetable mix.

The analysis of **potential cost savings** illustrates that - including fixed and variable costs, but ignoring (fictitious) costs for work time - a net-profit of 2.51 €/m² could be gained for the BS. Regarding ES Low Yield net-profit could be raised to 17.13 €/m² and 39.46 €/m² for ES Best Yield scenario. When costs for work time are included, the results for BS and ES Low Yield are negative (-17.95 €/m² and -3.32 €/m² respectively), but positive for ES Best Yield (+19.00 €/m²).

Most pressing challenges for **horticultural management** faced by gardeners (n=200) are pests (44 mentions), irrigation (38), wind (24), heat (19), time management (18), crop management (16), diseases (15), and weed infestation (11). In order to respond to some of these challenges, we organized workshops in the course of the project where knowledge and experience, theory and practise was shared.

In the studied CG, a number of the possible measures to promote **biodiversity** are implemented. These comprise horticultural management measures (e.g., no use of chemical synthetical pesticides and fertilizers, usage of compost, diverse crop rotations,) as well as measures that enrich habitat diversity and add resources to the urban landscape (e.g., leaving a "wild corners").

Large-scale - extended vegetable production in aspern Seestadt

The spatial analysis identifies an area of 2.3 hectares within the already developed part of aspern Seestadt and 15.2 hectares in the entire city quarter and its surroundings, that could theoretically be used for vegetable production in potential future CG. For this scenario, **GWP savings** of 10-70t CO_2-eq were estimated. The potential **net-profits** (economic value of yielded crops minus production costs without labour costs) range from 0.35m€ up to 5.4m€, depending on the yield scenario. For one hectare CG, around 56,000€ of **public costs for maintenance** could potentially be saved due to the voluntary maintenance by private urban gardeners.

Conclusions

The combined analysis of GWP, costs, biodiversity and horticultural aspects could be a valuable approach to provide comprehensive information of the ecological, economic and process-oriented performance of urban green space projects. The results could be integrated in specific urban planning and implementation processes for edible green cities.

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ORAL SESSION

F.1.1

Services of different ecosystems – an attempt to overcome silo approaches

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Keywords: ecosystem services, national scale project, policy & decision making

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The project 'Services provided by main types of ecosystems in Poland - an applied approach' (ECOSERV-POL) is an ambitious attempt to accelerate the uptake of ecosystem services concept by practice thanks to selection a set of operational indicators. They should be tangible, accessible, operable, and robust at the same time. The project aims to identify the benefits of five main types of ecosystems (forest ecosystems, agroecosystems, urbanized ecosystems, freshwater ecosystems, and marine ecosystems), and also highlights degraded areas. Understandably, the types highlighted overlap each other, which forces the resignation from the silo approach and making arrangements for common indicators.

The integration of indicators is facilitated by a horizontal approach, which considers the ecological, cultural, and economic values provided by ecosystems, as well as the role of biodiversity and benefits at the landscape level (Fig. 1).

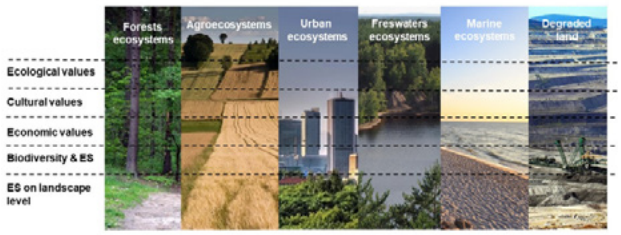

Figure 1. Project structure

The way to overcome the individualized approach to services within respective ecosystem types is defining bundles of significant ecosystem services that characterize of typical variants within ecosystem types.

According to the authors, the experience gathered at individual stages of the project implementation will allow overcoming the currently dominant consideration of individual ecosystem services without the context of the total benefits provided. This will allow the effective implementation of this approach in strategic and spatial planning.

Acknowledgments: The project 'Services provided by main types of ecosystems in Poland - an applied approach' received funding from Iceland, Liechtenstein and Norway within the EEA Financial Mechanism 2014-2021 in the amount of 1,752,940 EUR, part of which (262,941 EUR) has been co-funded by Poland. The aims of the project are transferring of scientific knowledge on ecosystem services which exists in Europe to the process of mapping and assessment of ecosystem services in Poland, as well as increasing the scientific potential and the ability of administration and interested social groups to implement this approach in environmental management.

Mapping freshwater ecosystem services related to hydrological cycle – review of approaches and their applicability in Poland

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Keywords: ecosystem services, mapping, local and regional level, freshwater management

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Water cycle related ecosystem services are scarcely identified in the MEAS framework at the European level[1]. The water related ecosystem services include among others water quantity and quality regulation as well as provision of goods directly or indirectly related to this service. While water in all its forms and phases is needed for the provision of most of the ecosystem services, the regulatory ecosystem services of the hydrological cycle should be considered as fundamental.

Freshwater ecosystems include rivers connected functionally to their valleys and groundwaters, lakes together with their riparian and hyporheic zones, wetlands and groundwater ecosystems. The ecosystem service framework should therefore account for this complexity. Ecosystem service framework such as MEAS, disintegrate these functional units, e.g. by separating wetlands from freshwater ecosystems, and only scarsely relating to floodplains. While rivers and lakes themselves provide specific ecosystem services, their provision is highly related to the condition of the ecotone, the river valley, the accompanied underground water ecosystems, etc. Hence they contribute to services generated by, e.g. agroecosystems or forests.

Links and environmental fluxes crossing the ecosystems borders imply synergies or trade-offs for the related ecosystem services. It implies a need for a complex analytical framework.

This presentation is aimed at identifying data gaps in identification and mapping freshwater ecosystem services. We will analyse available approaches to identify ecosystem services related to freshwater ecosystems. Next, we will review the existing indicators of the selected ecosystem services, followed by an assessment of their applicability in the freshwater management context in the Polish conditions with regards to data availability at three operational levels: national, regional and local. The selected indicators will be presented and mapped for Poland at the available spatial scales.

The presentation is based on the preliminary results of the EOG 2014-2021 project „Ecosystem services of main types of ecosystems in Poland – applied approach".

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Maes J., Teller A., Erhard M., Grizzetti B., Barredo J.I., Paracchini M.L., Condé S., Somma F., Orgiazzi A., Jones A., Zulian G., Vallecilo S., Petersen J.E., Marquardt D., Kovacevic V., Abdul Malak D., Marin A.I., Czúcz B., Mauri A., Loffler P., Bastrup-, W. B. *Mapping and Assessment of Ecosystems and their Services: An analytical framework for mapping and assessment of ecosystem condition in EU*. (2018). doi:10.2779/41384.

ORAL SESSION

F.1.3

Erosion control ecosystem service by vegetation with neophytes. *Rosa rugosa* Thunb. and *Salix acutifolia* Willd. in the southern Baltic coast (Poland)

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Keywords: aeolian erosion control, habitat action plan, invasion biology, neophyte

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Under CICES V5.1 classification, one of the ecosystem services at class level is the control of erosion rates (code 2.2.1.1). Aeolian accumulation and erosion can be observed in the dune zone of the southern Baltic Sea coast. There, the associated processes of geosuccession and biocoenotic succession are controlled by the psammophilous vegetation from *Ammophiletea* Br.-Bl. et R. Tx. 1943. It is formed by autogenous natural plant communities. Invasive neophytes, the rose *Rosa rugosa* and the willow *Salix acutifolia* are found in many locations. Both were introduced to the dunes in order to protect against aeolian erosion. Biological invasion process occurs in the Natura 2000 network areas. The phytocoenoses of *Ammophiletea* found there have been colonized by rose and willow introduced to habitats N2000-2120 'Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes)' and N2000-2130 'Fixed coastal dunes with herbaceous vegetation (grey dunes)'. In the dune zone of the southern Baltic coast of Poland, habitat 2120 occupies 1573 ha, and habitat 2130 occurs on 2042 ha. Both habitats are protected in 11 marine special areas of conservation (SACs). Only three of the SACs have a habitat action plan (HAP). In each of these plans, the rose and willow are recognized as invasive neophytes threatening the flora and fauna biodiversity of habitats 2120 and 2130 respectively. Protective measures for achieving a favorable conservation status of these habitats are given. These include the removal of rose and willow specimens, based on the European Union Biodiversity Strategy for 2030, and target 5 - combat invasive alien species. The scope and manner of implementation of these actions were planned differently. In the HAP for SACs PLH 220018, both neophytes occurring in areas 2120 are to be gradually eliminated, including those formerly planted and those in spontaneous invasion sites. Work is to begin with the removal of rose and willow specimens from small areas and monitored on an ongoing basis for a possible modification of protection methods. A similar procedure applies to habitat 2130, with the only difference being that the procedures are to be carried out manually, in order to avoid destroying the dune vegetation. In HAP for PLH320041 the rose and willow are to be removed without disturbing the substrate structure. On the other hand to fortify the dunes in HAP for PLH 320017, it is purely recommended not to use willow fascine, which has a tendency to take root. For habitats 2130, experts are to decide on where and how much of tree and shrub infestation is to be removed. Thus, HAPs presents three different approaches to conservation measures shaping the favorable conservation status of habitats 2120 and 2130 controlled by invasive neophytes. In our opinion, it is impossible to remove individual shrubs and/or their dense clusters, either manually or mechanically, without destroying the dune vegetation and damaging the structure of the ground. This is due to the developmental biology of both species, which possess the ability to form highly developed root systems. This functional feature, among others, confirmed the fact that they were once used to stabilize dunes. Thanks to their adaptation strategy, which they perform in conditions of aeolian accumulation and erosion, they have become quite effective in reducing erosion.

There is, however, an environmental conflict between planned (and already implemented) conservation measures and the ecological function of rose and willow, which has inspired us to search for an answer to the question: "Is it reasonable to remove shrubs that effectively provide ecosystem services only because they are invasive neophytes" ?

In 2019, the invasion of *Rosa rugosa* and *Salix acutifolia* in the PLH 320019 area was investigated. The research procedure included the following tasks: 1/ sources of rose and willow vegetative and generative propagules, 2/ field mapping of rose and willow localities in N2000-2120 habitats, 3/ features of rose and willow populations in areas of the invasion, 4/ phytocoenotic differentiation of the vegetation with participation of rose and willow specimens, 5/ influence of rose and willow specimens on the richness and diversity of plant species in N2000-2120 habitats, 6/ prediction of rose and willow invasion on N2000-2120 habitats, 7/ recommendations for HAPs concerning the management of invasive rose and willow localities on N2000-2120 habitats with reference to the concept of ecosystem services.

Differences between supply and demand for ES provided by trees in rural and urban municipalities – case studies of Nysa and Racibórz in Poland

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Keywords: mapping ES, participatory mapping, geo-questionnaires

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Trees provide many ecosystem services (ES) to people and fauna (e.g. birds, insects) in urban and rural areas. They shape landscapes and perform various environmental functions over the centuries. Recently, there has been an increased interest in scientific research on ecosystem services.

The potential for the provision of ES in Poland is higher than the European average [1]. Nevertheless, the number of trees in the central parts of Polish cities is decreasing, and it deteriorates the possibility of ES provision for inhabitants. Moreover, the range of impact of individual ES can vary significantly. Some ES have only a local impact, others influence a distance far from the Service Providing Area, or even globally [2]. Therefore, for the proper management of natural resources at our disposal, it is essential not only to assess the ES supply but also demand of it within the local community. It is crucial to set the appropriate strategic goals for securing people's needs and preserving the environment.

This work aims to assess to what scope people use the entire ES range provided by trees. Moreover we also present, what is related to that scope and what are the differences between ES supply and demand on the example of two research areas – urban and rural. In our study, we use two research methods: participatory mapping and geo-questionnaire [3,4]. The first was used to identify ES provided by trees to the local inhabitants in experts' opinions (supply). The latter allowed us to identify which ES are mostly used by inhabitants (demand). In both methods, we used the list, based on Kronenberg [5], of 18 ES provided by trees that included all ES types, like provisioning, regulation, maintenance and cultural. The research was carried out in two Polish municipalities: Racibórz (urban) and Nysa (rural), and conducted between November 2018 and July 2019.

During the participatory mapping, experts answered the series of questions concerning ES provided by trees in each municipality. They also identified and located on the map five most important ES provided by trees in their municipality. Finally, participants explained the choices they made. In total, 28 experts participated in the research including foresters, NGO representatives, environmental specialists and officials from the municipalities.

Geo-questionnaire was used to collect data on inhabitants' opinions about beneficial trees near their place of residence. They were asked to identify what ES are provided by trees essential for them and on what type of public or private land it grows. They also indicate the location of their residence. In total, information on 1765 ES located in the urban and 958 in the rural areas was obtained.

The results show the differences between experts' perception, indicated via participatory mapping, on ES supply provided by trees in rural and urban areas, which is following to the state of the art [6]. Nevertheless, in the case of ES demand, indicated via the geo-questionnaire, there is no difference for those two types of areas – inhabitants in urban and rural areas indicate the same type of ES demand, which is opposite to the experts' perception on ES. The work presents similarities and differences obtained by a comparison made using both methods in both statistical and spatial terms. The study contributes to the debate on how to understand ES demand and supply in the context of trees, and how this can influence environmental management in practice.

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ORAL SESSION

F.1.5

Ranking ecosystem services delivered by trees in urban and rural areas – case studies of Racibórz and Nysa in Poland

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Keywords: ecosystem services, analytic hierarchy process, expert knowledge

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Developing cities and densifying buildings result in a significant decrease of Urban Tree Cover UTC in urban areas [1]. That, in turn, contributes to the deterioration of inhabitants' quality of life. Trees and shrubs are the sources of many essential ecosystem services (ES) related to the production of goods, regulation of environmental processes, maintaining the quality of people and animals' living space, and providing cultural benefits such as space for recreation or aesthetic experiences [2]. Therefore, the critical aspect of urban land-use planning is the sustainable management of accessible urban green areas.

Ecosystem service mapping is a powerful support tool in this respect for decision-makers [3]. Presentation of values that trees and shrubs provide in each localization is done either based on objective parameters such as the size and species of a tree or based on various indicators that allow for comparing services provided in different locations [4, 5]. However, the literature is dominated by studies on the role that forests play in maintaining ecosystems' conditions and wood provision and the research on the importance of trees for supporting cultural ecosystem services is relatively small [6]. It shows that the accents are not evenly distributed, researchers focus only on selected benefits provided by trees and shrubs, and there are no clear rules of this selection. Meanwhile, the decision to investigate given ES types should be dictated by objective criteria, such as an importance ranking of all the benefits that trees provide to the local community.

In this study, we used expert knowledge to assess the relative importance of ES provided by trees and shrubs in urban and rural areas on the example of two polish municipalities - Racibórz and Nysa. The ranking was created by the application of the Analytical Hierarchy Process (AHP). In this method, the pairwise comparison of ES is made based on the 9-point fundamental scale of preferences created by Saaty [7]. It allows not only to indicate which ES are more critical than the others but also by how much.

In our research, a pairwise comparison has been made twice. First, each expert completed an individual online questionnaire, enabling the comparison of ES in pairs. After that, the online discussion in focus groups occurred separately for each research area. After the debate, the experts were asked to re-verify the online questionnaire responses. Their final decisions were the basis for developing the ranking for each research area, taking into account four ES categories: provisioning, regulation, habitat, and cultural ones.

The research enables us to show which ES provided by trees and shrubs are of the most significant importance for both local communities and what are the differences between the urban and rural areas in this regard. Moreover, the experts indicated major criteria that should be taken into account in the decision-making process regarding selecting the ES that are to be supported and monitored in the first place. Finally, we show the usefulness of applied methodology for ranking ES.

Acknowledgments: The research is a part of the iTre-es project funded by The National Science Center (2017/25/B/HS6/00954).

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Restoration of post-mining landscape vs ecosystem services recognition and assessment

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Keywords: restoration of degraded areas, ecosystem services, post-mining landscapes

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The post-mining areas create specific anthropogenic ecosystems with high dynamics of changes. For diverse post-mining ecosystem types, the ways of restoration are different and dependent on environmental factors, methods and time of exploitation, the scope of preventive measures. These conditions offer unique opportunities for creating new social, economic, and ecological value through the restoration of post-mining ecosystems. The first is the adaptation of post-mining ecosystems to new functions using their anthropogenic values gained during exploitation. External dumps with diverse relief, elevations gain, and slopes are suitable for forestry and recreational use. Restoration of internal dumps aimed at reconstruction for agriculture production as well as forestry, deep end basins are suitable for shaping new water bodies for ecological or recreational purposes. Second, is possible to restore the post-mining ecosystem from scratch, from point "terra nova" to multi-functional landscapes in term of the region's needs for a specific functional type of space (e.g. forestry land, agricultural land, water reservoir) and according to the expectations of the local community (e.g. recreational area). The next possibility is remaining post-mining ecosystems to natural succession.

The study aimed to identify services of various types of post-mining ecosystems comprehensively understood as a socio-ecological system and identify indicators describing the structure and level of their services. Regarding the Common International Classification of Ecosystem Services (CICES v.5.1), services have been classified into three main sections: provisioning, regulatory and cultural.

Different types of post-mining geosystems shaped in the restoration process create landscapes with utility values, both natural and cultural, which provide human benefits. They satisfy energy and material needs in terms of biotic, water, raw material, atmospheric, recreational, and balneological productivity.

The study is mainly methodological, important for assessing the benefits that humans derive from degraded ecosystems. A key element of the operationalization of the concept of ecosystem services was the selection of a set of indicators that would best serve as indicators of different types of degraded ecosystems, and the variability of which may be representative for the assessment of services.

Figure 1. Post-mining areas as socio-ecological system

Recognition and awareness of the services provided by degraded ecosystems in Poland and the development of indicators as tools for their assessment is a key element for management of post-mining areas.

Acknowledgments: The project 'Services provided by main types of ecosystems in Poland - an applied approach' received funding from Iceland, Liechtenstein and Norway within the EEA Financial Mechanism 2014-2021 in the amount of 1,752,940 EUR, part of which (262,941 EUR) has been co-funded by Poland. The aims of the project are transferring of scientific knowledge on ecosystem services which exists in Europe to the process of mapping and assessment of ecosystem services in Poland, as well as increasing the scientific potential and the ability of administration and interested social groups to implement this approach in environmental management.

ORAL SESSION

F.1.7

The link between a high-mountain community and ecosystem services of juniper forests in fann mountains (Tajikistan)

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Keywords: socio-ecological system; cultural keystone species; juniper forest; Fann Mountains

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The indigenous societies of the Fann Mountains were and remain dependent on the resources of the natural environment. The present study aimed at investigating the relationship between mountain communities and the use of ecosystem services that are subject to change due to the influence of social, economic, and political conditions. The study made use of the concept of ecosystem services, which extends the scope of analyses of the socio-ecological system to the sphere of cultural relations [1]

The application of this approach was crucial due to the dominance of juniper forests within the ecological system, given that the juniper, as a result of its connection with religion and local traditions, considered a key species for the mountain societies. The identified structure of the ecosystem services indicates the significance of the juniper in providing the indigenous community with services which, due to the economic situation of the society are characterised by greater value (wood, food, medicine) than cultural ecosystem services.

Identification of ecosystem services taking into account the concept of cultural keystone species should be a starting point for the protection and restoration of juniper forest. The results of field and social studies have shown that the stable maintenance of juniper forests ensures the existence of key species as the most important ecosystem services, e.g. provisioning, regulation and maintenance and cultural, indicating the correct relations between the society and the protection of mountain areas. The obtained results showed that the inhabitants claim that juniper forests with the participation of Juniperus semiglobosa and Juniperus seravschanica are the main elements determining not only the functioning of mountain ecosystems, but also the communities living there. This approach is capable of ensuring inclusive management of the socio-ecological system of the Fann Mountains.

The ecosystems of Central Asian juniper forests (called archa) condition and influence the socio-economic development of mountain society chiefly through providing a wide range of ecosystem services such as provisioning and maintenance and regulation. They serve as an energy source, inhibit erosion, and form a mosaic of habitats, thus ensuring the maintenance of biodiversity at all levels (species, biocenoses, landscapes, ecosystems).

2. The use of ecosystem services in the Fann Mountains is changing due to the political, demographic, and economic situation. As a result of these processes, the structure of ecosystem services changed significantly at the turn of the twentieth and twenty-first centuries.

3. The reduced use of juniper wood for fuel, abandonment of mass cattle breeding, and seasonal movement of the people is associated with the reduced use of mountain environment resources and increased potential for the natural regeneration of ecosystems.

4. The close relationship between the functioning of mountain societies and the use of the ecosystem services of juniper forests in this area equates to the partial replacement of the latter with alternative sources of services (provisioning: poplar farming, use of hard coal) and the management of hard-to-reach areas (such as pasture, fodder).

5. Recently, there has been increasingly conscious use of the cultural aspect of ecosystem services (religious worship, traditions, tourism) in terms of income, which may be grounds for optimism in the context of protecting sensitive mountain ecosystems, but at the same time poses new challenges in terms of unsustainable tourism development.

6. The concept of ecosystem services and cultural keystone species is embedded in a cultural and social context and may constitute a basis for environmental management of the Fann Mountains and other mountains regions in Central Asia (not only), combining the protection of biodiversity, reinforcement of cultural identity, and sustainable development of society in dependence on the resources of the natural environment.

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Strategic urban greenspace pattern optimization for overlandflow mitigation: improvement of ecosystem service supply as an approach

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Keywords: ecosystem services, greenspace, landscape pattern

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Due to the global climate change, cities suffer from more frequent water-logging nowadays, whereas the own capacity of rainwater regulation of the urban ecosystems is weakening with the changes in urban water cycle caused by intensive urbanization. Urban greenspace (UGS), as a primary pervious landcover in urban environments, plays an important role in preventing uncontrollable overlandflows, as the finding proved in many studies that UGS can raise the supply of overlandflow mitigation service (OMS) and lower the risk of waterlogging by way of accumulation, infiltration, and interception. However, it still remains unclear what a pattern of UGS (i.e. magnitude, configuration, spatial distribution) is the most suitable for urban ecosystems to regulate rainfall excess.

In response to the research gap, this study aims to explore the crucial features of UGS pattern that associate with the supply of OMS and hereby to provide theoretical support for optimization of UGS pattern in planning practices. For the completion of the research objective, three main research questions are addressed as:(I) How can we quantify the overlandflow mitigation service supplied by UGS? (II) What features of UGS spatial pattern relate with the water overland-flow mitigation? (III) How can we optimize UGS spatial pattern to raise the supply of the overlandflow mitigation service?

Taking Downtown Kunshan, China as the study area, we firstly built a hydrological model based on ArcGIS to simulate overlandflow pathways and corresponding catchments in the urban environment, and thereafter drew unit hydrographs of each catchment and derived three indicators, peak volume, peak timelag, and flow duration, to measure the supply of OMS. Meanwhile, we proposed a framework of UGS pattern indicators composed of 10 indices regarding magnitudinous, configurational, and spatial distributional features. In the end, taking the supply of OMS as the response variable and UGS pattern as the explanatory variable, we conducted the analyses of Pearson correlation and multiple linear backward regression, and curve estimation respectively to reveal the relations between them comprehensively. The results can be summarized as follows:

- Peak volume negatively correlates with greening rate (GR), mean patch index (MPI), shape index (SI), integral index of connectivity (IIC), and positively correlated with patch density (PD), mean Euclidean nearest-neighbor distance(mENN). Its final multiple linear regression model is composed of GR, MPI, SI and mENN. Nonlinear relations exist between peak volume and GR/mENN, respectively.
- Peak timelag negatively correlates with edge density (ED), shape index (SI), related circumscribing circle (RCC), patch density (PD), mean Euclidean Nearest-Neighbor Distance(mENN) and integral index of connectivity (IIC), while positively relates with greening rate(GR), largest patch index(LPI) and mean patch index(MPI). Its final multiple linear regression model is composed of MPI, RCC, and division index (DI). Nonlinear relations exist between peak volume and MPI/SI, respectively.
- Flow duration negatively correlates with its edge density (ED), shape index (SI), related circumscribing circle (RCC), patch density (PD), mean Euclidean Nearest-Neighbor Distance(mENN) and integral index of connectivity (IIC), while positively relates with greening rate (GR), largest patch index (LPI) and mean patch index (MPI). Its final multiplex linear regression model is composed of LPI, MPI, mENN and IIC. Nonlinear relations exist between peak volume and MPI/SI/IIC, respectively.

Based on the findings and insights, some guidelines for UGS pattern optimization are proposed regarding urban catchments with different hydrological response attributes denoted by unit hydrograph, which are categorized into single-peaked, impulsory, accumulative, fluctuating, and slow-released. Certain category of catchments corresponds with specific goals of pattern optimization and recommended improvement approaches.

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ORAL SESSION

F.2.2

Urban Rural Interlinkage – Urbanization dynamics and its implications on land-use change and ecosystem services in Huangyan /Taizhou, China

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Keywords: Land Use, Eocosystem Services, Urban Rural Interlinkage

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Urban sprawl and associated land use changes have been cited as primary drivers of environmental change. It is less clear how land use change and impact on ecosystem services, as well as what the drivers are, especially in Chinese urban-rural interfaces in mid-sized cities. Our contribution will highlight the importance of urban-rural interfaces for sustainable land use and ecosystem services development.

Here, we mapped the dynamics of land cover from the year 1995 to 2020 based on 30 m Landsat satellite images to quantify these changes in a transect of an urban-rural continuum within the Huangyan district, Taizhou, China. The results show that urbanization induce a dramatic increase of urban area in all scales in the past 25 years (an increase of 259 % of the settlement area in the transect and of 247.2 % of the settlement area in Huangyan district). The rise has been particularly evident in the past five years from 2015 to 2020.

The huge expansion of the urban area is responsible for consumption of arable land, although the coverage of arable land even slightly increased during the research time. Meanwhile, to compensate arable land loss, large scale of natural ecosystems, such as forests, grasslands and wetlands were encroached and transferred into arable land (as well as urbanized land) continuously. The forest and woodland cover decreased by 14 % in the transect area and around 4 % in whole Taizhou from 1995 to 2020. Grassland decreased by 69.2 % in the urban-rural transect and 45.2 % in Taizhou from 1995 to 2020.

Further, the correlation of population development and an increasing of the settlement area has been analyzed to identify further drivers of change. However, and surprisingly, there seems to be no correlation between an only slow increasing population and the dramatic expansion of the urban settlement area. Urban expansion cannot be explained by population growth.

Our findings stress the importance of governing land use and ecosystem services towards a progressive regional model to sustainable urbanization. We will present first results of the Sino-German project 'Urban Rural Assembly' funded by the German Ministry of Education and Research.

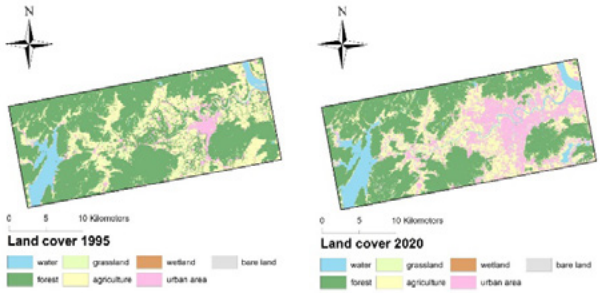

Figure 1. Land cover of the transect in1995 and 2020

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Ecosystem services application in the context of environmental-ecosystem accounting

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Keywords: ecosystem service accounting, System of Environmental and Economic Accounting, methodological concerns

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There are various methods and tools for incorporating the value of natural capital in the calculations of economic growth, such as green GDP, the Index of Sustainable Economic Welfare or environmental-economic satellite accounts. Recent results of the work led by the Statistical Commission of the United Nations lead to the adoption of statistical standard and conceptual framework reported in the System of Environmental Economic Accounts - Experimental Ecosystem Accounting (SEEA-EEA). SEEA-EEA provides a coherent approach to the assessment of the ecosystems, and measurement of the flows of services from ecosystems into economic activity and human well-being. SEEA EEA aims to assess the role of ecosystems in the economy and the contribution of ecosystem services to final products and services that are part of the economic activities recorded in the system of national accounts (SNA).

The aim of this contribution is to present a conceptual framework of SEEA EEA and discuss its applicability to the improve gorenance at different scales, from global, pan-european [1], national [2] to local with the use of different examples from scientific literature and applied studies. The contribution is structured to follow the newest guidelines of the System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA). Such methodological issues as SNA benefits and non-SNA benefits, supply and use accounts [3], intermediate vs. final ES and monetary valuation approaches will be discussed. The results provide methodological insights of the application of ecosystem accounting at various scales.

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ORAL SESSION

F.2.4

Assessing sustainability of slovak cities with the ecosystem services approach

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Keywords: Urban sustainability, Ecosystem services, Spatial planning, Landscape indicators

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Sustainable cities is anchored as one of the important sustainable development goals; increasing urban population and environmental degradation of cities represent one of the major challenges nowadays [1]. Although the population in Slovakia is not yet strictly urban (54%), environmental degradation linked with the expansion of cities is becoming more important [2]. On the other hand, the ecosystem services (ES) assessment is a mainstream approach increasingly used to assess the state of the urban environment and the prerequisites for sustainable urban development [3].

Main aim of our research is the evaluation and subsequent classification of cities in Slovakia in terms of capacity, real provision and quantitative balance of selected ecosystem services (ES). The research includes cities with a population of more than 10,000 or cities being administrative centres of a county. The national environmental database, a pilot ES assessment at the national level and available statistical data of evaluated cities were the main input data for the research.

In the first step, we have determined the spatial extent of urban areas and their adjacent territory based on certain criteria. Subsequently, we evaluated concerned cities in terms of their potential for selected ecosystem services, using the national ES assessment study as a data source. As a next step, we defined and evaluated proxy-indicator for each ES expressing the actual ES supply; and finally, we expressed the ES demand based on specified criteria including the population size or selected environmental quality indicators.

These results were subjected to statistical analysis, to determine which of the natural and socio-economic parameters are the most relevant for the ES supply value (e.g. spatial extent of cities, population size and density, functional zones, natural properties). Finally, we categorized all cities based on the level of ES provision and the determined statistical relationships. Each of the categories is characterized by a set of attributes that indicate either positive or negative implications on sustainable urban development, and thus provide valuable inputs for planning and management process [4], [5].

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Conceptualising demand for ecosystem services – an adapted spatial-structural approach

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Keywords: service demand area, service benefit area, ecosystem service mismatches

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People require multiple ecosystem services (ES) to meet their basic needs and to improve or to maintain their quality of life. Natural resources are exploited to meet these needs, threatening biodiversity and increasing pressure on the earth's ecosystems. Cities in particular are characterised by a high demand for ES due to their high population numbers. At the same time, cities are providing few ES themselves due to the strong anthropogenic changes they and their surroundings have been subject to. Comparative analyses can contribute towards relieving some of these pressures by revealing if and where unsustainable use of ES exists and identifying unmet ES demand. The gaps and problems these analyses identify can then be taken into account in sustainable and equitable urban and spatial planning.

Spatial-structural approaches can be used to clarify, analyse and visualise the spatial relationships between areas that provide and benefit from ES. However, demand areas are barely considered in existing spatial approaches [1], [2], [3], [4]. This presentation, therefore, introduces an adapted spatial-structural approach for mapping ES demand and aims to improve understanding of the mutual spatial dependencies between the demand for and the supply of ES. This adapted approach spatially relates Service Demand Areas (SDA) to already familiar ES provision and use units, namely Service Provision Areas (SPA), Service Connection Areas (SCA) and Service Benefit Areas (SBA), and can be used to schematically illustrate, understand and analyse the different forms of demand that emerge. We will demonstrate the benefits of this approach by referencing examples from urban ES contexts.

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ORAL SESSION

F.2.6

Rooftop greenery in ecological urban renewal of Shanghai: regulation, practice and performance

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Keywords: rooftop greenery, urban renewal, Shanghai

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High-density cities in China face problems with their thermal environment, insufficient activity space, and fragmentation of their ecological landscape. Vertical greening technology has become a common approach in eco-city planning and green building design to meet the ecological goals of urban renewal. This paper first introduces recent developments in vertical greening in Chinese cities from the perspective of the policy development process. At present, there are several centralized development directions in China. Xiamen takes technical analysis as the starting point, Shenzhen focuses on the whole industry chain support, and Shanghai takes the implementation of control as the core.

From 2011 to 2015, the skyrise greenery sector in Shanghai achieved significant progress in terms of green coverage area, quality, policies, and financial support. In 2015, the "Shanghai Greenery Regulations" were published, clarifying the state's stance on the duties, obligations, and rights of developers regarding skyrise greenery. Since 2008, several normative works on the technical aspects have been released, including "Shanghai Skyrise Greenery Technical Guidelines", "Handbook on Green Wall Technology", and "Skyrise Greenery Technical Standards". In 2015, Shanghai introduced technical standards, including "Guidelines on Construction and Management of Green Pillars along Highways", and "Guidelines of Skyrise Greenery in New Developments", which have further indicated an increase in political support for the skyrise greenery sector in Shanghai.

The Shanghai Green Management Bureau uses remote sensing to evaluate the location and conditions of the possible rooftops to be greened. Shanghai also encourages the installation of other forms of skyrise greenery, in addition to rooftop greenery. This rapid advancement in the skyrise greenery sector can be attributed to the enforcement of policies and regulations by the relevant authorities. In the Shanghai Vertical Green Project Planning, the target area of vertical greening is 1200 hm^2, and the index will be distributed to every district. Considering the increasing economic cost of ground-based urban greening, vertical greening has become an important technical means to improve the ecological environment in high-density urban areas, especially in city centers.

Innovative Urban Green (IUG), based at Tongji University, focuses on the research and development of experimental projects using vertical garden technology in high-density cities. In ecological urban regeneration design, vertical greening as a renewal method can have important applications in the three cross-scale stages of urban scale-block scale-building monomer. In urban areas, the two scenarios of inventory update and incremental construction are being analyzed in association with the current situation and urban planning requirements. At the same time, urban renewal using vertical greening needs to be examined in relation to the problems faced over the whole life cycle of inspection–assessment–design–construction–maintenance operation. Economic analysis and research on the environmental improvement benefit needs to be conducted and used to refine the application of vertical greening.

Various technologies were applied to an experimental roof garden renovation, including discrete measurement of the building structure, waterproof testing and transforming the roof, parametric design of the wooden structure, roof rainwater collection, an automatic irrigation system, and lightweight roof structure matrix within 150 m^2 of the campus.

Combined with the experiments of IUG, the latest skyrise greenery projects in the urban renewal of Shanghai are summarized from the integrated aspects of planning tools, sustainable design, efficiency evaluation, economic benefits, regulation capacity, and smart maintenance technology.

The Joy Garden reduced electricity consumption by 1,249 kWh every year on average. Taking 40 years as the whole life cycle, the major ecological benefit is the saving of electricity, accounting for 73.4%; the second largest benefit is the reduction in air pollution, which is 12.2% of the total benefit. For the rest of the benefits, water interception benefit takes 9.5%, and the benefit of carbon reduction appears the least, with a percentage of 9.2%.[1]

Vertical greening can be combined with the construction and optimization of green buildings, ecological city design control guidelines, and the application of ecological restoration and ecological compensation for green urban areas in the construction of high-density cities in the future.

Scenarios for the future living environment of citizens and the public activity space is also envisioned. Ideas for daily healthy indoor activity malls and hospitals for citizens' rehabilitation are proposed and the management and control of the industrial parks should be combined digitally.

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Peri-urban organic waste values for Green Infrastructure

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Green infrastructure (GI) in Urban and Peri-Urban areas is dependent upon a high level of gardening and landscaping to meet the requirements for growth of plants in the surrounding non-organic rather hostile grey infrastructure. The protection and strengthening of healthy and nutrient-rich soil is a major challenge, especially in urban areas with high emissions, intensive littering and heavy traffic. Another growing problem due to climate change is the irrigation of parks and road plantations and green buildings due to increasing climate extremes like droughts and urban floods.

The innovative challenges of increasing urban gardening, rooftop farming, sustainable plantations like living walls and walls of moss for emission cleaning purposes need smart and safe solutions for the planting substrates. The needs can be floor substrates and increasingly important organic fertilisers for aquaponic or aeroponic planting systems.

Especially urban gardening needs to guarantee a low risk of any contamination from soil in the vegetables and fruit. There is the need of quality assurance for planting substrates, where Germany has best practice experience in standardizing and monitoring the output of composting and biogas plants, participating in a Federal Quality Insurance Association to certify their products (Bundesgütegemeinschaft Kompost).

A sustainable waste management in an Urban Social Ecological system can bridge the gap between the disposal of organic waste and urban gardening and landscaping in a new cooperation model. In a classic urban infrastructure there is usually no cooperation between the municipal parks department and the responsibles for waste management.

The presentation will offer preliminary findings of the German BMBF-funded joint research project PERIVAL in China. The results given originate from the 18 months „definition phase“ in the Peri-Urban area of Beijing (Zhaoquanying town, Shunyi district).

In PERIVAL project, Peri-Urban waste values with a focus on organic waste and plastic waste are examined. The potential of organic waste from Peri-Urban and Urban areas is much lower in remaining rural Peri-Urban areas. People have private utilization of kitchen and garden waste in their predominantly rural settlements like chicken and pet feed. But the general increase of urbanisation is accompanied by a sharp rise in organic waste, been shown by organic waste collection data in Chinese and German cities in comparison.

Peri-Urban areas have remaining available uncultivated land, where they can offer high quality recycling-services for urban ecosystems. In the Perival project, a cooperation model will be developed in the R&D phase, to manage a central biomass center with all functions for the treatment of different kind of organic waste. The waste management cooperation will link urban centers with Peri-urban areas in the surrounding districts. The cooperation of organic waste management facilities in Peri-Urban areas can provide high-quality compost substrates, liquid fertilizers or fermentation residues for landscape conservation purposes.

The presentation will show the future range of a high technical standard biomass center and the organic waste valorization product diversity. Another chance is to open local biomass treatment plants for Eco-Industrial purposes. That means a local plant might be economically and ecologically meaningful, if there is a local sink for the produced renewable energy like heat and biogas. The presentation will show the potential of heat and biogas use in Beilanzhong village in Zhoquanying town (China). The Peri-urban small village has a modern infrastructure of heated greenhouses (f.e. for orchid production) and outside gardening areas (fruit, vegetables, ready-made lawn). Biogas produced from organic waste will contribute to the renewable energy supply to substitute natural, a contribution to climate protection.

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ORAL SESSION

F.3.1

Assessment of ecosystem services at urban site level – Methodological steps and development of an online tool for measure planning

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Keywords: Ecosystem service capacity, site scale, mapping, MCDA, multi-criteria analysis, online tool

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Urban ecosystem services (ES) are threatened by increased construction activities in many cities and thus need to be protected and fostered. International strategies, such as the European Biodiversity Strategy for 2030, as well as national programs, such as the German Masterplan 'Stadtnatur' (Master Plan 'Urban Nature'), call for developing and establishing appropriate actions and plans in cities to counteract the loss of biodiversity and the effects of climate change. This entails the creation of appropriate tools to support decision-making as well as promote the development and planning of useful measures. The concept of ES is an appropriate instrument to help prevent the loss of urban green spaces, to fulfill the requirements of European and national targets to preserve urban nature as well as to maintain good living conditions in urban districts.

In this talk, we address the outlined requirements and present a transferable method to map and assess the capacity of ecosystems to deliver urban ES, exemplified for two German city districts. Based on multi-criteria decision analysis (MCDA), this method was developed in cooperation with the environmental agencies of the investigated cities and incorporates site-specific data from field mapping. The results are given in the form of scores and a spatial distribution of the delimitated ecosystem types and their capacities to provide three exemplary ES ('bioclimatic regulation', 'nature experience', and 'passive recreation'). Based on this approach, a user-friendly online tool is going to be developed, which we will introduce in the presentation. The online tool is used to illustrate and estimate the potential impact of the implementation of certain measures at different urban site scales, e.g. different ecosystem types or parcels, streets or buildings. It supports the planning procedures and gives helpful arguments for certain measure options. Furthermore, it can contribute to a value-based communication aimed at fostering the preservation of urban green spaces.

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An indicator-based approach for the development of an app as an information and decision support system for urban green space users

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Keywords: green space user demand, multi-step assessment approach, recreational ecosystem services

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The literature on cultural ecosystem services (CES) has experienced an almost continuous increase in recent years, with special attention paid to recreational ecosystem services [1]. Since the cultural ecosystem services and thereby the value of an urban green space is based on the perception of the users [2], it is essential for the evaluation of the services to take both, the supply and the demand side into account. The fact that CES are non-material benefits makes them difficult to measure, which is why only a small proportion of indicators currently collect CES [3; 4] In order to ascertain what a green space offers the users, the individual green spaces have to be examined in detail.

We aim at presenting a step-wise indicators-based approach, developed for the assessment of the supply of and demand for cultural ecosystem services at the site scale. Behind the entire approach is the development of an app that is intended to support users in their search for a suitable green space according to activities (e.g. for jogging or walking). Dresden and Heidelberg (Germany) serve as pilot cities.

The approach consists of three major steps: Conceptualisation, operationalisation and evaluation. For the indicator conceptualisation, three surveys were conducted to include the user perspective. With these surveys, activities mainly carried out on urban green spaces as well as criteria the green spaces should fulfil to meet the demand are determined. Furthermore, the interviewees indicated how important they consider individual criteria for the respective activity. Indicators were developed to measure the criteria. To operationalize and measure the indicators, the focus was on open data: Open government and municipal data, volunteered geographic information (e.g. OpenStreetMap), location-based social media data and data from Europe's Sentinel-2 Earth observation satellite program. In combination with a multi-criteria decision-making approach, the criteria weights (importancies) were derived. Through a combination of the relevant criteria, identified in the surveys, final scores are calculated expressing the suitability of a green space for conducting a certain activity. This information enters the app and serves as information for the decision-support system [5].

Informed by the implicit and explicit feedback functions included in the app, it can in turn be used to close the knowledge gap on the demand side and help to evaluate the feasibility of the developed criteria. This way, it can be checked whether and how the indicators need to be improved to enhance the results for the app users.

The app as an information and decision support system for urban green space users represents a novel approach of ascertaining what users want to do while visiting green spaces and what they expect in terms of ecosystem service supply, without conducting on-site surveys.

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ORAL SESSION

F.3.3

The value of doing nothing – how informal green spaces can provide comparable ecosystem services to cultivated urban parks

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Keywords: urban vegetation, abandoned site, brownfield, green infrastructure, wilderness

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Urban green spaces have been widely recognized for their ecosystem services (ES) provisioning, but their resources are insufficient. Wastelands, the neglected areas whose maintenance has been abandoned, can complement existing green spaces, generating minimal costs for the managers. In this transdisciplinary study, we uncover the role of wastelands in the ES provisioning and preserving biodiversity, particularly in comparison to urban parks. We conducted measurements in locations that represent wastelands in two varying habitat types (upland and riparian) compared to recently established parks on the upland. We measured biophysical indicators related to ES and performed a social study to assess cultural ES. We used multivariate analysis to find the most significant indicators related to ES and biodiversity and analyzed relationships among them. Dust removal, cooling benefits, or water storage and biodiversity preservation in wastelands were comparable to urban parks. The differences were mainly due to the diverse development stage of vegetation rather than cultivation. Despite the lack of infrastructure, wastelands with dense vegetation were perceived more positively than traditionally cultivated parks. There were differences in how the ES and biodiversity were interrelated, in wastelands, the most important links were between regulating and supporting services, while in parks, cultural services prevailed.

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Assessment of the perceived quality of green spaces to derive green space supply for a balanced green space planning

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Keywords: perceived urban green space quality, green space user demand, green space planning

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Various studies have shown that not all population groups in a city have equal access to urban green spaces (UGS) [e.g., 1, 2, 3]. In addition, these studies often ignore the quality of UGS, which, however, has a major impact on the recreational value [4] as well as the use of UGS [5] and differs between socio-demographic groups [6].

Therefore, the presentation will introduce an approach that assesses the supply of different user groups with UGS, taking into account the perceived UGS quality, which is derived from user demand via surveys.

The aim of a first online survey was to collect the UGS users' demands, taking into account not only the quantity but also the quality of, for example, UGS amenities. Based on the survey results, evaluation criteria for the perceived quality of UGS were derived and calculated via indicators. By evaluating the survey results separately according to different socio-demographic aspects, the perceived quality for different user groups can be determined. In addition, distances that users are willing to travel to UGS were surveyed. In this way, user group-specific supply areas of the UGS can be calculated by assuming that only UGS within these travel distances are considered accessible. By intersecting the supply areas with the local residential population, the degree of supply with UGS having a high perceived quality can be calculated for each user group.

The concept will be tested in the city of Dresden/Germany and evaluated via surveys on selected UGS. Subsequently, surveys with selected municipal representatives throughout Germany will clarify how a tool can be developed from this concept to find use in UGS design and planning in the future.

With the tool, each city should be able to independently determine how well different population groups are provided with UGS (with a high perceived quality) and in which areas there is no access to these UGS. It also provides starting points on how and where disadvantaged urban areas can be improved to ensure that all citizens have access to UGS and their recreational services.

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ORAL SESSION

F.3.5

Accessibility to urban ecosystems services and functions in contemporary cities – A spatial Perspective

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Keywords: Urban planning, Accessibility, spatial access, equity, social subjects

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The accessibility to urban ecosystem services and other functions (transport node, public services or areas, historical areas) represents a crucial issue to be addressed when planning contemporary cities toward higher levels of sustainability and a more equal spatial distribution of these services/functions. Accessibility is directly linked to the issue of environmental justice, because it relies on the general principle that all people have a right to have access to the same services. However particular social groups may benefit from different level of accessibility more than other, depending on where the services/functions are located and how they can get to the service.

These arguments delineate a complex picture of accessibility and highlights the urgency for urban planning to design a differentiated system of ecosystem services and urban functions so to take into consideration the different demands and needs of social groups living in cities and to maximise their overall accessibility.

Targeting spontaneous vegetation of informal green spaces to enhane ecosystem services delivery in cities

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Keywords: urban vegetation, abandoned site, brownfield, green infrastructure, wilderness

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It is widely recognized that urban green spaces provide significant benefits to city resdients, including: environmental, economic and health benefits. Among various types of urban greenery a significant share constitute the abandoned sites, remain uncultivated, where the vegetation develops without much involvement of human actions. The ecological potential and the ability of such sites (here referred to as informal green spaces – IGS) to provide various ecosystem services is poorly recognized. In this study we develop an in-depth research on the flora and plant communities of informal green spaces aimed at determining their role in preserving biodiversity and ecosystem services delivery. We identified the plant species composition in 75 locations in Warsaw's urban green spaces, which we identified as bereft or with minimal vegetation maintenance and where natural succession processes take place. The sites varied from stabilized vegetation of wastelands, urban shrublands and forests to non-forest habitats, sporadically cultivated established over the course of 20 years. We determined the density of vegetation and examined its structure in relation to various green space classes. We further determined the role of various vegetation types in provisioning of ecosystem services - surface cooling, substrate moisture maintenance, and particulate matter removal. The informal green spaces we investigated consist of mainly stable forest communities dominated by invasive tree species (phytosociological *classes Robinietea, Salicetea purpureae*) and non-forest communities (classes *Molinio-Arrhenatheretea, Epilobietea* and *Artemisietea)*, largely dominated by invasive plant species. Their biodiversity is medium, and at most common forest and non-forest species are preserved. In exceptional cases they are habitats of species rare in the regional scale. The structure of forest vegetation is poorly diversified which results from the specific strategy of invasive species forming monospecific communities. The study indicates that the vegetation of the informal green spaces is largely dominated by invasive species. Despite an limited role in biodiversity preservation, due to high density and volume of vegetation the ecosystem services provisioning of such sites is high, especially for the forest plant communities. The strongly invaded sites can provide comparable ecosystem services compared to native species, sometimes even surpassing them, especially in terms of particulate matter removal and cooling benefits.

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ORAL SESSION

F.4.1

Operationalization of the ES concept for urban ecosystems – challenges from the Polish perspective

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Cities constitute a very specific functional and spatial systems characterized by rapid population growth and increase in built-up area, which limits the beneficial effects of nature on humans. At the same time, threats generated by climate change are increasing. Finding solutions that will ensure the well-being of inhabitants and improve the resilience of cities is therefore a key issue currently. One of the proposed approaches is to make use of the natural capital potential in terms of the benefits offered by ES.

As evidenced by the previous experience, the concept of ES can combine science, planning and management [1] and support the decision-making system by translating complex functions and ecosystem processes into indicators used in spatial planning and urban space management [2]. Urban ecosystem services can make visible and tangible contributions to human well-being, enabling the planning of healthy cities for current and future generations. Thus, urban ecosystem services have become the subject of many studies, although they are strongly dominated by studies conducted in large cities, including Poland [3].

It is not easy to use the concept of ES for the purposes of spatial planning and territorial governance. Especially in Poland, where due to the liberalization of spatial planning and consequent chaotic urban development, resulting in, among others, reduction of the green areas [4], or limitation of the aeration of city centers by erecting buildings inside ventilation wedges [5], the benefits provided by ecosystems become consequently impeded.

The concept of ES is becoming increasingly applied in determining the natural potential of a city and its endogenous resilience, hence allowing the assessment of the benefits driven by people mainly from biotic and water systems. Nonetheless, translating the outcomes into planning and territorial governance solutions is still a challenge requiring in-depth research. Such studies have to take into account national and regional conditions, as the competences regarding spatial planning remain within mandate of each of the EU Member States, as well as due to the territorial diversity and specific biodiversity and different social expectations.

ES research in urban ecosystems services still brings many theoretical and practical challenges. Therefore, it is necessary to be unambiguous in terms of defining concepts, selecting and constructing indicators, as well as building conceptual models, and last but not least, translating the research results into practice. In light of recent surveys on the perception of the role of social economy in spatial planning, it can be concluded that there is an agreement between scientists and practitioners in terms of opportunities and barriers regarding the implementation of the concept of social economy in urban practice [6].

The aim of this paper is to discuss challenges that were identified during the first phase of the ECOSERV-POL project, specifically in relation to the operationalization of the ES concept for urban ecosystems. We will focus both on the methodological aspects as well as on the translation of the research results into urban planning and management.

With regards to conceptual and methodological issues, we would like to highlight challenges including: (a) multifunctionality and synergies - the possibility of using synthetic indicators, (b) can every living feature in cities be / should be considered as an (eco) system that provides ES? (c) what is the classification of vegetation composed as an element of green infrastructure? (d) what are the dimensions of nature's potential to provide services in cities (abiotic, biotic, configuration, accessibility dimensions)? (e) typology of supporting services, necessary for the production or maintenance of all other ES, (f) trade-offs between ecosystem services, issue of services versus disservices (e.g. trees and shrubs in the riverbed - recreation, biodiversity vs. hydrotechnics, goldenrod patches - pollination, aesthetics vs. invasions).

From the practical point of view, we would like to point the following challenges: (a) the selection of indicators in relation to the level of spatial planning, (b) natural ecosystem classification versus blue and green infrastructure classification used in spatial planning / urban planning, (c) opportunities and the need to overcome barriers to implementing ES approach into the Polish planning system (e.g. transition from sectoral planning to integrated planning), (d) identification of social expectations.

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Ecosystem Services Policies and its implications for future urban planning in China – Insights from the Shanghai master and Baoshan District plan

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Keywords: Ecosystem Services, Urban Planning, Green Infrastructure

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'Cities worldwide not only have to ensure access to basic services (water, food, housing, energy, security, recreation...), to mitigate current environmental challenges (water, air, soil, and noise pollution), but also have to cope with geo-hazards, extreme events, and climate change impacts while facing pressure from growing populations in a globalized economy. Thus, there is an increasing reception of the Ecosystem Service (ES) framework in urban planning. In China, the central government now streamlines an ES-based approach of environmental governance accompanied by major institutional reforms. [1].

Despite the political mainstreaming of sustainable urban development, there are still substantial research gaps. State of the Art research stresses the importance of multidisciplinary and integrated in-situ assessments on ES trade-offs including the biophysical constraints of landscapes, stakeholder relationships, opportunity costs for land-use change and the time lag of ES trade-offs [2]. Studies addressing the science-policy interface revealed the need for more practice-oriented approaches, which pay attention to local geographies [3], governance cultures and institutional path dependencies [4]. Another obstacle identified in current urban GI-assessment and research is the lack of access to high-resolution land use data as well as the labor-intensive acquisition and processing of data [5].

In our research, we analyzed the state-of-the-art of China's new environmental governance, which aims to change China's land use and particularly the role of green infrastructure (GI) regarding urban planning and ES. With Shanghai as an early mover city, we focused on the Shanghai Baoshan district Master Plan as a case study, and analyzed ES supply using the matrix approach. We ascertained the supply of ES as delineated in the ecological network plan for 2035, and developed an evaluation framework based on CICES v5.1 and two expert workshops. Our approach used an integrated preliminary ES-assessment, and evaluated the consequences for the supply of ES in Baoshan district.

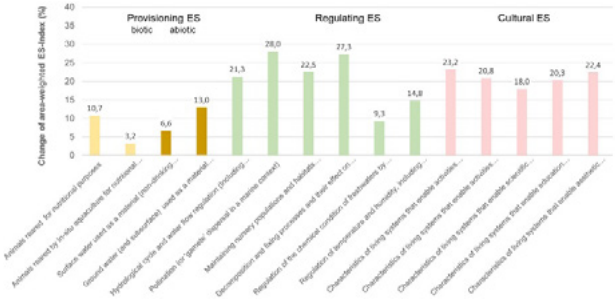

Figure 1. Predicted Change change of area-weighted ES-Indices between 2017 and 2035 in the Baoshan District, Shanghai.

The results of our assessment (figure 1) show that, if realized as planned, the district will increase the overall supply of ES, especially regulating and cultural services that play an important role within GI on the urban level.

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ORAL SESSION

F.4.3

Contribution of urban soils for Ecosystem Services: development of a large-scale soil function assessment

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Keywords: urban soils, soil ecosystem services, large-scale soil function assessment

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The research approach of ecosystem services (ES) is gaining increasing significance in the face of worldwide ecosystem degradation [1]. For instance, since the EU bio-diversity goals for 2010 could not be achieved, the Stra-tegic Plan for Biodiversity 2011-2020 places a stronger emphasis on ES. Moreover, two of the twenty targets ex-plicitly address the conservation of ecosystem services [2]. Mapping of ES is listed as a key target of the strategy and point five of the strategy urges the member states of the EU to measure and assess ecosys-tems and their ser-vices in a spatially explicit way [3]. It becomes clear that not only the ES concept in general, but especially the mapping and quantification of services are of great scientific, political and practical interest.

Soils are the basis of life for humans and other organisms. Despite this fact, this non-renewable resource is being destroyed worldwide, whereby humans degrade this basis of life more and more. The concept of ES is intended to help contain the worldwide destruction of ecosystems by recording and evaluating the services provided by na-ture and their loss, and thus making them visible to deci-sion-makers. The environmental medium soil, in which different spheres of the ecosystem overlap and various in-teractions and processes take place, offers essential con-tributions to Ecosystem Services. In many studies, how-ever, these various contributions are only insufficiently considered, so that the manifold services of soils remain hidden.

The important role of soils and their functions in the landscape budget and the need for preventive protection and sustainable land use are generally accepted, already legally secured in some European countries, and in part implemented in assessment guidelines for the evaluation of soil functions [4] [5] [6] [7]. Despite setbacks in the introduction of a Soil Framework Directive, the topic is also receiving attention at the European level, although there is still considerable potential for improvement [8]. Soils are fundamentally excellent examples of the components of the cascade of the ES Concept. They represent an important part of a society's natural capital, in which multiple soil functions exist and from which equally multiple benefits accrue to society. This "dividend" continuously flows to people. High pressure on natural capital, which can be described in terms of the example with anthropogenic soil degradation and thus the loss of fertile soils, causes this di-vidend to decrease significantly. Protective mechanisms are necessary to preserve natural capital.

So soils fulfil important functions for humans and the environment. In the German federal state of Lower Saxo-ny, this vital resource is taken into account for urban land-use planning using mainly medium-scale maps. As a con-sequence, small differences in the spatial distribution of soils, substrates and soil functions can often not be consi-dered. A larger scale is required in order to implement ap-propriate prevention and mitigation measures into binding land-use plans.

In the presented study, a method is developed and applied to evaluate the natural soil functions and the soil's ar-chive function based on relief- and substrate-oriented as well as catenal performed soil mapping. Based on field examinations, it is shown that large-scale soil investi-gations can significantly improve the data basis for soil protection with regard to the binding land-use plans. In addition, it shows that the effort of a data collection can considerably be reduced by conducting catenal-based exa-minations and by combining it with prior archaeological surveys. Finally, another favourable option, which is iden-tified in this context, is the use of soil appraisal data for the soil function assessment.

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From landscape functions to ecosystem services and co-benefits – how can we tweak these concepts for better urban planning?

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Planning and management of landscapes is informed by the analysis and evaluation of landscape components and processes. Environmental or ecological planning - or landscape planning in some countries - developed in the course of environmental movements in the 1960s and has since become part of the spatial planning systems in many countries. Sophisticated methods have been developed for analysing environmental/ecosystem components and processes, which are often based on the concept of landscape functions [1; 2].

In last two decades, new concepts to improve the conservation and sustainable use of natural resources such as ecosystem services have emerged, challenging established approaches and seeking for improved ways of environmental planning and policy-making. Conversely, the new concepts also revealed weaknesses compared to landscape functions that had been based on a holistic understanding of landscapes, resulting in a plethora of competing concepts and methodologies [3]. Moreover, other concepts gained prominence such as green infrastructure or nature-based solutions which often include ecosystem services [4]. This led to fragmented academic discourses that are also largely disconnected from the practice in spatial planning, even though recently research evolved toward applied or transdisciplinary research projects that are developed in and for real-world planning contexts.

The call to view landscapes as holistic social-ecological systemes is not new [5], but it is easily overlooked when it comes to finding ideal indicators for certain ecosystem services or testing new methods. In urban contexts, the difficulties in applying an ecosystem-based approach become even more apparent, as ecosystem properties and processes are often strongly altered by human impact and intertwined with human activities and infrastructure [6]. The understanding of ecosystem services as benefits that are provided by ecosystem properties is easily contested when thinking, for example, about ornamental parks that gain much of their (cultural) value through human intervention such as art and garden design but also by basic infrastructure such as paths and benches (see Fig. 1). Removing these human-made entities would clearly alter the value. Furthermore, measures that are useful from an ecosystem services perspective, such as planting tree species best suited to provide shade and thus cooling, may be rejected by people who live nearby and would have to deal with what they might perceive as ecosystem disservices [7].

The aim of this presentation is to discuss the potentials as well as limitations of ecosystem services in an urban planning context and also compare them to other concepts such as landscape functions and co-benefits of natur-based solutions. Based on experiences from three different European research projects, we want to stimulate the discussion on how to utilize these concepts for urban planning in a pragmatic, yet innovative manner.

Figure 1. Green corridor in Berlin: how do we evaluate benefits of urban nature that depend on human-made and ecosystem components?

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ORAL SESSION

F.4.5

Urban geosystem approach to the assessment of ecosystem services

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Keywords: urban geosystems, urban ecosystem services, trade-offs and synergies

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The quality of the urban environment is determined by buildings and infrastructure from one side and by the natural landscape from another. Heat waves, floods, lack of accessible recreational facilities, unattractiveness of the cityscapes and other natural and positional environmental factors negatively affect the quality of people's life and can be a source of social conflicts. To make decisions in the field of urban planning policy, objective, reliable and scalable information about the value of urban areas is required. Assessment of urban landscapes in terms of their supply of ecosystem services provides such information, i.e. identify areas with the highest and lowest potential for the production of various ecosystem services. Moreover, such an assessment should be based on environmental processes and functions to objectively reflect the mechanism of their formation.

Natural processes, on which the level of comfort of the urban environment depends, are simultaneously controlled by the original natural landscape and the modern landcover, whose interaction in space can be considered as an urban geographical system. Depending on the environmental and social problems or the needs of the city in the process of landscape planning, solutions can be proposed for changing the area, configuration, combination of certain urban geosystems to maintain favorable and stop undesirable processes. To substantiate the proposed solutions landscape mapping of the urban environment at the level of urban geosystems is required. Such a map allows you to create a theoretical basis for solving many fundamental and applied problems, since it identifies relatively homogeneous units that are characterized by an extensive set of parameters and determine the structure and functioning of the territory, and hence the provision of various ecosystem services.

For the case study of Lipetsk (Russia) we mapped urban geosystems (Figure 1) and assessed regulatory and cultural ecosystem services of urban landscapes. We used field, remote, chemical-analytical research methods, as well as sociological surveys of the citizens. The classification of satellite images of the territory made it possible to calculate the composition of different classes of landcover in each identified urban geosystem. A quantitative assessment of the climate regulation function at the local level was carried out on the basis of Landsat 8 TIRS bands and modeling in the InVEST software. Air quality assessment was carried out based on field measurements of alkaline-acid conditions and dust content in the snow cover. We also evaluated the availability of green infrastructure and the attractiveness of various recreational facilities for citizens.

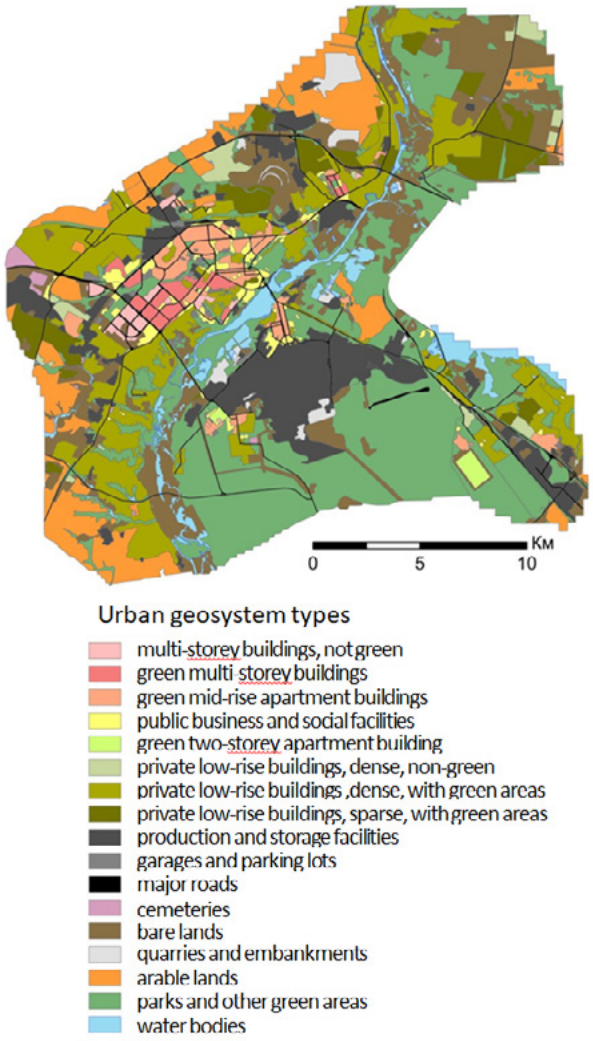

Figure 1. Types of urban geosystems in Lipetsk

Assessment of ecosystem services within allocated landscape units (rather than pixel-based approach) helped us to reveal trade-offs and synergies between different services at a scale suitable for urban planning and to identify hot spots in a city and provide directions for their suitable solution and further development. Such a comprehensive assessment of ecosystem services, and hence the value of the territory, will allow creating a strategy for sustainable nature management on a landscape basis and optimizing territorial plans and city management schemes.

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The perception of ecosystem services provided by blue spaces in Warsaw from users' point of view

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Keywords: Ecosystem services, PPGIS, blue infrastructure

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The urban ecosystem is a complex system of different, mainly man-made elements. In recent years, however, the relation between humans and nature became more and more valuable and important. The complex and interdisciplinary socio-ecological system of the urban areas is meant to be a base for the future planning and design of our cities to make them more and more sustainable.

In the presented research we will explore human–urban water relations reflected in the term of blue infrastructure or blue spaces. Blue areas are an inseparable part of an urban tissue: historically, economically, ecologically, or socially valuable, yet been in many cases forgotten and abandoned. Many of those spaces used to be a threat which needed to be controlled, canalized and buried under the ground (as many river or streams). However, in recent years there is more and more awareness on the role of water in the urban environment. Ideas such as Nature-Based Solutions aim to adapt cities to become more resilient and sustainable. At the same time, there is more and more evidence on their great importance for human health and well-being, education, and enjoyment [1] [2]. There is also more and more need to holistically approach the topic of sustainable urban water planning and design, not only from a technological or ecological point of view but taking into consideration everyday use of blue spaces [3] their values and meanings. Despite that, from the planning perspective, blue infrastructure is often combined and mentioned only as a part of green infrastructure, not as a phenomen and system which has its own specific complexity, and challenges.

To bridge that gap in Warsaw we conducted a geo-questionnaire asking our respondents to mark their favorite and least favorite places within the border of the city. We have also asked to assess (on the scale) and describe values and percept ecosystem services in those areas. We have collected 527 full answers and over 800 places marked which were analyzed showing patterns in use and preferences as well as the perceived values and ES of Warsaw blue areas.

We believe that it is an important approach and base for future planning and design solutions since the perception of benefits (feeling of the influence) [4] as well as values and meanings (as place attachment) might increase the use of blue spaces and following that influence our social fulfillment and physical and mental health. Additionally, the online geo-questionnaire (PPGIS) methodology was proved to be an efficient and effective tool for collecting user experience data, especially in the COVID-19 pandemic

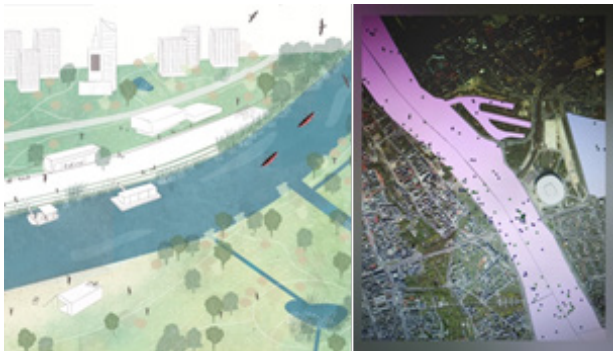

Figure 1. The illustration promoting the geo-questionnaire on the right, on the left frst, raw results of the questionnaire on the base map: Orthophoto 2020 (Główny Urząd Geodezji i Kartografii)

Acknowledgments: was supported by the National Science Centre, Poland [grant number 2018/29/N/HS4/01421], title of the project: Blue infrastructure within the cultural landscape of Warsaw

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ORAL SESSION

F.4.7

Historical dynamics of carbon storage and sequestration of urban green spaces in China during 1985-2020

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Keywords: Carbon storage and sequestration, urban green space, dynamics

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With the rapid development of global urbanization, the urban population rapidly gathers and the urban area continues to increase. The increasing trend is more obvious in China, where the urban built-up area has increased by two times between 1990 and 2015, and the proportion of population living in cities exceeds 58%. The assessment report of the Intergovernmental Panel on Climate Change (IPCC) points out that the increasing atmospheric carbon dioxide concentration caused by carbon dioxide emitted by human activities is one of the important reasons for global climate change. The intensive social activities and energy consumption lead to a large increase in urban carbon emissions, which further exacerbates the trend of cities becoming carbon sources.

With the in-depth study of global carbon cycle, more and more attention has been paid to the carbon sequestration services provided by urban green space. Carbon sequestration is a basic ecosystem service provided by urban green space. On the one hand, the vegetation on urban green space can fix atmospheric carbon dioxide into organic carbon through photosynthesis and assimilates it into organic carbon, which is converted into vegetation carbon storage. On the other hand, urban vegetation also has the effect of cooling and humidness under transpiration due to the physical shelter provided by its tree canopy. The ability of urban green space to provide carbon sequestration service is related to factors such as the size of urban green space, utilization type, vegetation composition and structure, vegetation growth and change, etc., and its influence on reducing atmospheric carbon dioxide is multifaceted.

Since China joined the Paris agreement on climate change in 2016, take active measures to cope with global climate change, promote the building of ecological civilization, and solemnly promised to improve the national independent contribution strength, to adopt a more powerful policies and measures, the carbon dioxide emissions to peak in the 2030 years ago, strive to become carbon neutral 2060 years ago. In this context, urban green space carbon sequestration services, as a nature-based solution, can increase the urban carbon sink and play an important role in achieving the goal of carbon emission peak and carbon neutrality in the process of urbanization development.

To understand the contribution of urban green space to carbon neutrality in China, this study tries to quantify the historical dynamics of carbon storage and sequestration of urban green spaces in China. We try to delineate the urban green space through urban boundary by integrating the annal land cover dataset with 30-m resolution. Then we conbine the database of carbon density for different times, cities, regions, vegetation types, urban green space types, etc. to quanatify the annual carbon storage and carbon sequestration, aiming to reveal the spatial and temporal dynamic changes of carbon storage and sequestration of urban green spaces in China.

Understanding the dynamic changes of urban carbon sequestration services is the basis for predicting future changes and guiding the formulation of future urban planning and management policies. It is of great significance to promote the realization of carbon neutrality by 2060. It is helpful to pay attention to how to reasonably predict the impact of future planning and policy on the carbon sequestration services of urban green space, so as to explore the contribution of urban green space in achieving the carbon neutral goal.

How to measure cultural ecosystem services?

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Keywords: Cultural Ecosystem Services, systematic literature review, measurement

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Cultural Ecosystem Services (CES) are defined as the characteristics of elements of nature that provide opportunities for people to derive cultural goods or benefits [1]. They are regarded as non-material or intangible outputs of ecosystems. Therefore their measurement is problematic and remains a challenge for both natural and social sciences. In this study, we aim to address this problem by examining how CES are measured in current research, and how the methods have changed over time. Therefore, we conduct a systematic review of 533 papers from Scopus, all based on empirical research, published in peer-review journals between 2010 and 2020. We present an inventory of approaches to measurement and indicators identified in the literature. We explore how CES have been conceptualised and quantified depending on a variety of factors, including operational (e.g. year of publication), spatial (e.g. scale) and ecological (e.g. types of ecosystems) ones. Using the Common International Classification of Ecosystem Services v. 5.1 [1], we investigate what types of CES are addressed the most often, and how they are related with other ES.

Our study shows that the interest in CES has been rising significantly since 2010. As many as 42% of the papers on CES published in this decade appeared in 2019 and 2020 only. Not only the interest in cultural goods and benefits derived by nature has changed, but also the way of understanding and approaching to them.

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ORAL SESSION

F.5.2

Examining ecosystem services and disservices through deliberative socio-cultural valuation

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Keywords: deliberative socio-cultural valuation, ecosystem services and disservices, urban parks

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The deliberative socio-cultural valuation of ecosystem services (ES) and disservices (EDS) is an understudied area of ES and EDS research. Participatory methods have been applied to ES and EDS valuation, but little is known on how these approaches could reveal and form shared values and impact decision-making. This paper presents the deliberative socio-cultural valuation of the Jose Rizal Plaza in Calamba City, The Philippines. The study aimed to assess how stakeholders value the ES and EDS of the park and examine how these values change when the source and constituency of the valuation are modified and when interaction is introduced. Eight online focus groups were carried out. In each, the participants were asked to distribute 100 hypothetical "importance points" to the various park ES and 100 hypothetical "concern points" to the park EDS. The valuation exercise was performed six times - four times individually and two times as a group.

Results confirm significant differences in the values assigned to several ES and EDS across the valuation exercises where the source and constituency of the valuation were shifted. The valuation exercises with varying sources and constituencies also proved useful in revealing the participants' shared assigned values. This study found that shared values transcend changes in value source and constituency. The participants share a high appreciation for enjoyment and spending free time, sports and physical fitness, relaxation and mental recreation, social relationships, and local identity and cultural heritage. In terms of the EDS, they share a significant concern only for the risk of anti-social behaviour. Results also indicated that the shared ES and EDS values differ considerably from those observed only by examining aggregated values (i.e., means). This study noted no differences in participants' values to the park ES and EDS before and after discussions when the value source and constituency are kept the same. In contrast, considering the welfare of future generations seems to impact the participants' decision-making.

This study provided evidence on the influence of value source and constituency when eliciting ES and EDS values. There is, therefore, a need for future studies to exercise caution in eliciting, reporting, and comparing values. It also demonstrated an effective means of revealing shared values among stakeholders and incorporating future concerns into socio-cultural valuation to address intergenerational equity. These unique approaches will prove useful in making more inclusive and well-informed decisions about managing natural and human-made ecosystems.

Socio-cultural valuation of urban parks: the case of jose Rizal Plaza in Calamba city, the Philippines

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Keywords: socio-cultural valuation, ecosystem services and disservices, urban parks

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The socio-cultural value of urban parks has rarely been studied, and this could be why they are undervalued and not given significant attention in city planning. This study presents the socio-cultural valuation of the ecosystem services (ES) and disservices (EDS) of the Jose Rizal Plaza in Calamba City, The Philippines. Representatives of stakeholder groups were interviewed to assemble a comprehensive list of the park's ES and EDS. An online survey was then conducted to examine how stakeholders assign values to the park ES and EDS. Finally, the configuration of conditions leading to the assigned values was analysed.

Results suggest that respondents value the park's ES more than they worry about its EDS. Overall, the respondents value cultural ES the highest, while regulating EDS were valued the lowest. In terms of EDS, the respondents were most concerned with psychological EDS and least worried about economic EDS. Specifically, the respondents assigned higher values to the ES related to the park as a place for enjoyment, relaxation, practising sports and keeping fit, and commemorating the national hero, Jose Rizal. They assigned lower values to its contribution to water recharge, purifying water, enabling seed dispersal, preventing floods, and its use as a parking space. They were more worried about the risk of anti-social behaviour, the unpleasant appearance of unmaintained areas in the park, and conflict among users and less concerned about the thoughts of the land being wasted, exposure to air pollution, and traffic.

Results from the Fuzzy-set Qualitative Comparative Analysis (fsQCA) indicated that visiting the park is necessary to cause a respondent to value its ES highly. In contrast, two conditions were necessary to cause a high valuation to EDS - not knowing the previous land use in the area where the park is built and visiting the park. For socio-economic characteristics, the top two configurations causing a high valuation to ES and EDS were the same – not having a prosocial orientation and being a local resident and not having a prosocial orientation, living near the park, and not owning a house. The same combination of environmental knowledge, perception, and behaviour led to a high appreciation for the park's benefits and a deep concern for its EDS. Those who believe that the city's environmental conditions are getting worse and admit that they have not been practising pro-environmental activities cause them to appreciate the park ES and worry that park EDS will worsen.

The study addressed several gaps of previous socio-cultural valuation studies – a general disregard for EDS, the use of ES and EDS typology exclusively from literature, and the involvement of a limited number of stakeholder groups. It also demonstrates the use of Fuzzy-set Qualitative Comparative Analysis (fsQCA) to analyse the complex conditions that affect how stakeholders assign values to ES and EDS. The study results provide baseline information on how residents utilise the park and which ES and EDS they value most. This understanding informs the city as to which amenities they could maintain and which to improve. The study also reveals the combination of conditions leading to a high valuation of ES and EDS. This information could help the city develop strategies to improve residents' appreciation of parks and their participation in initiatives related to green spaces or urban green infrastructure.

ORAL SESSION

F.5.4

Cultural ecosystem services and disservices: linking landscape and social attributes to ecotourism in protected areas

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Keywords: ecosystem services, cultural, ecotourism

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Cultural ecosystem services (CES) are often described as the non-material benefits obtained from ecosystems, while disservices (EDS) are characterized as ecosystems aspects that negatively impact human health and well-being, which are often caused or aggravated by human activities [1, 2, 3]. The number of protected and green areas with presence of traditional communities, high cultural heritage and biodiversity is huge in Brazil, however assessments of CES and EDS are still rare [4]. Ecotourism has been promoted as an alternative type of tourism based on the sustainable use of natural resources with focus on the cultural and social values of the locality [5]. Its economic potential brought in protected areas is well known, and can represent alternative income opportunities to locals and to institutions.

This study took place at RESEX Acaú-Goiana, a marine protected area (MPA) between the States of Pernambuco and Paraíba in Brazil. Four different municipalities encompasses the protected area (of 6678 ha) where communities base their livelihood on traditional fishing practices. With a great potential for recreational activities, ecotourism in the area is not very significant at the moment. The MPA is also composed of *quilombola* lands, hamlets formed by descendants of runaway slaves, providing a new frame of reference and opportunities in local development strategies for cultural and sustainable heritage.

The study combines public participation and mapping surveys of CES and EDS, assessment of recreational activities and trade-offs. Moreover, drawing a profile of the respondents, their preferences, and understanding how CES can contribute to human health and well-being, as well as in the development of public policies and actions that ensure ecosystem integrity and foster sustainable development initiatives.

The gender of the respondents was fairly balanced between women and men, with an average age of 43. In addition, most of the respondents had only completed elementary school and receive up to one Brazilian minimum wage (USD PPP 332.5).

The findings show a high density of CES with specific identified hotspots in Acaú, the biggest municipality in the MPA, with access to many beaches and the estuarine areas. Aesthetic values and scariness were (respectively) the CES and the EDS pointed out more by users. The presence of singular natural areas of scenic beauty such as the estuary, beaches and mangroves are recognized as important landscape attributes by respondents. The results of EDS identification can provide indicators for local overuse [2, 6]. It can show how EDS jeopardize full access and use of these areas by the users, even in regards to recreational activities. Another barrier in the exploitation of CES and ecotourism development is the lack of infrastructure and the conflicting relationship between communities, administration and authorities, which were reported by the respondents.

The results encourage the continuation of CES and EDS studies. They are significantly perceived by the users of the MPA, which admits their use to establish links with other categories within the ecosystem services framework, establishing a more holistic understanding of land-use and conservation.

Initiatives and approaches that foster low impact activities in protected areas and at the same time raise awareness, can benefit both nature and human well-being [7]. Moreover, the study suggests collective engagement in practices and development of participatory conservation and local strategies, such as the creation of an intercultural center combined with a mangrove species nursery. Thus, promoting the concept of protected area and biodiversity, supporting inclusivity, affirming the richness of nature values and the multicultural identity of the region, specially in relation to the *quilombolas*.

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"Been there, done that". Cultural Ecosystem Services provided by green areas along urban–periurban wilderness continuum

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Keywords: urban green, wilderness continuum, social media, Instagram, CES delivery

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As the global level of urbanization is raising, public green spaces located within urban and periurban zone remain the most accessible (and sometimes unique) option of direct contact with nature. Such a contact can provide a variety of benefits (Cultural Ecosystem Services). These benefits, however, depend on a number of natural as well as socio–economic factors. One of them is a level of wilderness of a green area: it can be assumed that people who spend their free time in a highly invested park in the city centre do it differently than in a forest located in the suburbs.

This article aims at exploring how Cultural Ecosystem Services (CES), supplied by green areas located along the wilderness continuum (Lesslie & Taylor, 1985), are delivered. We choose green areas which represent different levels of wilderness quality, and check how CES are used within each of these locations. In order to measure the use of CES, photographs taken in these areas and posted on Instagram are analysed. This is based on the assumption that people give evidence that something attracted their attention or did indeed happen (Urry 1990); that they did consume CES provided by a green area ("been there, done that"). In this respect, analyzing photographs may help to verify what kind of CES (recreational, aesthetic, or educational) are actually delivered while people spend their time in green areas.

Due to the growing popularity of social media platforms, user-generated content analysis became well-established method of CES assessment (Cheng et al. 2019). Several studies have used data obtained from photo-sharing websites with various purposes, e.g. to explore spatial patterns of tourism and recreational behaviours or measure aesthetical value of landscape in different scales. Most of the research, however, has been based on data from Flickr or Panoramio, which are less focused on spontaneous social activities and everyday life. In this study we analyse photographs uploaded on Instagram. Although it is the most popular photo-sharing platform worldwide, its use in CES research has been quite rare.

We choose photographs taken in five green areas located in Warsaw Urban Zone, Poland, during the whole 2019. These areas represent different levels of wilderness quality: two areas represent low wilderness quality (one recently developed urban park, and one historical urban park), two represent medium wilderness quality (one urban park and one suburban green area), and one represents relatively high wilderness quality (a forest located on the outskirts of Warsaw urban zone). Next, we performed the quantitative analysis of the landscape structural elements using the same logic as in case of content analysis (Babbie, 2014), used also in analyzing visual elements (Sztompka, 2005). The research procedure was composed of the following steps: First, we chose a sample of photographs representing each of five areas. Second, we identified key components of landscape for the image, and then divided them into categories. Then, content analysis of the photographs was performed. Although we assume that the main factor explaining patterns of CES delivery is wilderness, a set of different factors (such as air quality, weather conditions, etc.) was also used in order to check their possible influence on CES delivery.

The preliminary results of the analysis confirm that the way people use green areas highly depend on the level of wilderness quality. Nature is not treated as essential in urban parks, where other landscape elements, such as infrastructure or people, are more important to users.

Another interesting result is that a number of photographs posted on Instagram in each area is also a function of their wilderness: the more wild area, the less photographs are taken and uploaded by its users.

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ORAL SESSION

F.5.6

Re-naturalizing the industrial city. Cultural ecosystem services in the Quarry Park

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Keywords: Environmental planning, CES (cultural ecosystem services), participatory mapping

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Since the Eighties of the last century the European industrial cities have lived, with the great transformation of their economic model, some socio-ecological changes in their urban context. Through urban political ecology [1] we look at these socio-ecological changes considering population involvement, cultural dynamics, historical-geographical processes and the environmental justice of new urban metabolism. This approach allows us to adopt a critical point of view in analysing the geographical transformations going on in the peri-urban spaces of the Italian city of Brescia. Until some years ago this area was characterised by the exploitation of gravel mining and now it is becoming the biggest urban park ("Parco delle cave" Quarry Park) of the city through a process driven by the population. The local community fought for many years to obtain the institution of a park and avoid new exploitation forms of the area like landfills. The area is very important from an ecological point of view because of the ecosystem services it provides, like food, water and other products provisioning, temperature regulating, air cleaning, biodiversity enhancing, cultural services. This paper focuses on the cultural ecosystem services (CES) inside the park. The methodology used in our analysis is based on a participatory approach, looking in particular at the participatory action research (PAR) [2] and participatory mapping [3], [4].

We created a participatory map of the CES in the Park looking at the perception of the stakeholders, in particular the local community, and studied the ways to improve the CES [5]. This map shows the complexity of the landscape evolution of this part of the city. We study the eco-cultural values and the conflicts inside the area (due for example to the presence of industrial and agricultural activities and residential areas together and due to the mixed property, public and private), throughout the different points of view of the local community.

The first step of the analysis consists of some interviews to the local historians about the beginning of gravel mining. The second step is represented by the involvement of local associations and groups in some laboratories of CES mapping. The third step involves the community in public labs of CES mapping to complete the map and discuss alternative governance methods of the Park. To collect data we prepared a form in which participants have to indicate the places on the Park's map and to answer to a number of questions about the cultural services they provide.

The results show the complexity of the area looking both at the different types of nature and landscapes shaping the mapped places. The preliminary data show that the local community recognises the presence of CES in different types of landscapes that we have categorised into: Agricultural landscape, Natural Landscape, Urban landscape, Leisure and sport landscape, Industrial landscape. These different elements are part of the natural and human processes that have created the complex landscape of the "Parco delle Cave". This map can represent the first step of a possible interaction between the community, and its local, cultural and ecological knowledge, and the experts and municipal planners for the future environmental planning of the Park.

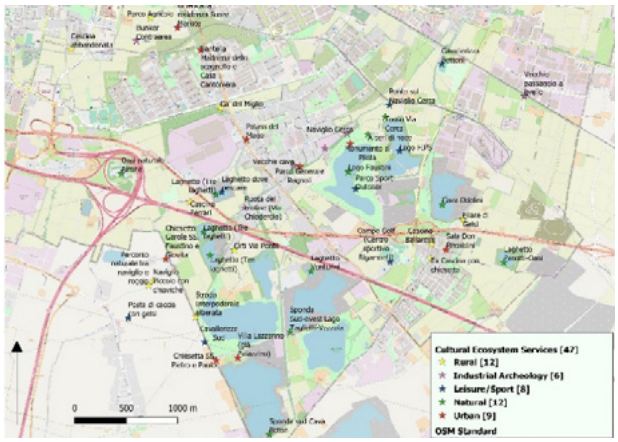

Figure 1. Participatory mapping of CES in Quarry Park

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Usability mapping: Participatory technique to integrate expert knowledge about supply and demand related to ecosystem services

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Keywords: ecosystem service mapping, integrated valuation, fishpond systems

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Today, a great variety of methods and frameworks are available to assess both supply and demand linked to ecosystem services. Despite that, efforts towards the integration of different results and their applications however are still low, which could elongate important decision-making processes and the creation of more sustainable land-use strategies. In this context, we introduce 'usability mapping', a novel method capable to summarize the results of two, Tier1 participatory mapping techniques, designed to assess the demand towards ecosystem services ('Hotspot-Warmspot mapping') [1] and their supply ('Matrix-based mapping') [2]. Our study has been conducted in the Fehértó of Szeged, one of the biggest (2000 ha), semi-natural fishpond-system in Hungary, to provide information about the ability of freshwater aquaculture to provide different ecosystem services, as it is not characterized or represented well yet in the scientific literature. During our research, the ecosystem service providing capacities of the different habitat patches (supply-side) and their actual usage (demand-side) have been evaluated separately in the case of 12, previously uncovered ecosystem services [3]. For this purpose, several semi-structured interviews were conducted with local key-informants from all relevant stakeholder groups in the study area, using the two participatory mapping techniques above. After that, an overview map has been created (Figure 1.), based on a new categorization system that could summarise the data of the two different method. Our merged results indicated that extensive reedy beds, standing waters and canals were the three most important habitat types of the fishpond system, where the level of supply and demand were both high (indicated with deeper green in Figure 1.). Besides that, our integrated method also highlighted the importance of certain artificial landscape elements (roads, lookout towers, trails) without primary ecosystem service providing ability, as they had a great, indirect role in forwarding multiple ecosystem services to people, satisfying their demands. Based on the feedbacks of local experts, usability mapping proved to be a useful and easily applicable method to practically summarise research data for decision-makers in an understandable way. Although it is still in an experimental phase and requires further studies, our method has a great potential to accelerate the planning of more sustainable land-use strategies and also to provide a base for more advanced mapping techniques in the future.

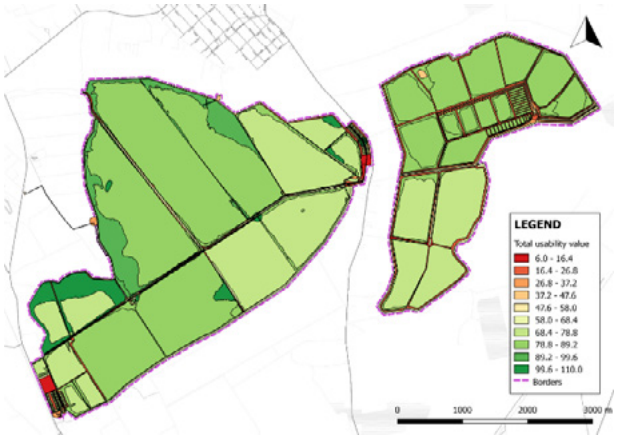

Figure 1. Integrated usability map of the Fehértó of Szeged

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Changes in taxonomic composition of water frog populations: similar patterns in urban and rural landscapes

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Keywords: *Pelophylax*, hybrydogenesis, Poland

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In Central Europe, two water frog species: pool frog *Pelophylax lessonae* and marsh frog *P. ridibundus* and their hybrid, edible frog *P. esculentus* occur. Parental species are ecologically isolated, but hybrid occurs in mixed populations with one of them and form different genetic systems of which the most widespread is *lessonae-esculentus*. We suppose that natural or human-induced changes in the environment (groundwater depletion, climate changes, land use modifications, introductions of non-native *Pelophylax* species, etc.) may results in competition for habitats and – in consequence – one of the parental species may disappear and the other may appear in its place and destabilize genetic systems. However, data on long term changes in local populations are poorly known.The aims of the study were to: a) assess the current species composition of water frogs in urban and rural landscapes, b) compare our findings with the results of previous studies conducted in these sites [1,2,3].The study was conducted Poland in the same ponds that were surveyed by Professor Leszek Berger in 1962-1970 (Poznań, urban landscape) and 1977-1997 (Dezydery Chłapowski Landscape Park, rural landscape). Because some ponds studied in the past were destroyed or dried-up, we explored also all other situated in the adjacent areas. Frogs we captured during breeding season 2020 and identified by morphology and nuclear marker gene *SAI-1*.

We found two types of population compositions in the urban area: *ridibundus-esculentus* and *esculentus-esculentus*, and three in the rural area: *ridibundus-esculentus*, *lessonae-esculentus,* and *ridibundus-esculentus-lessonae.* From two study sites (one urban and one rural) water frogs disappeared. In comparison to historical data we found significant decrease of *P. lessonae* and increase in *P. ridibundus* (Fig. 1.). Additionally we found the presence of crytptogenic Balkan water frog, *Pelophylax kurtmuelleri*, which was recently discovered in south-western Poland [4]. Frequency of *SAI-1* allele specific for this taxon reached 7.8%.

Patterns found in the both types of landscapes are in the line with the current situation of both species in Europe. Such dynamic changes show the need for further long-term monitoring of population compositions of water frogs, what is crucial for their conservation management.

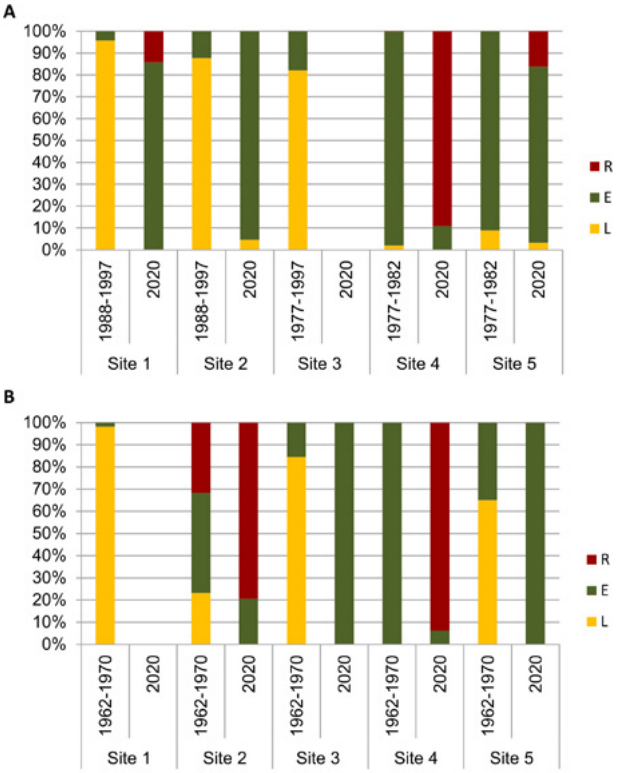

Figure 1. Changes in frequency of water frogs in urban (A) and rural (B) landscapes. R – *P. ridibundus*, E – *P. eculentus*, L – *P. lessonae.*

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From small invertebrates to large carnivores – understanding the effect of discarded containers on animals by using data from online media

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Keywords: littering, trap, biodiversity loss

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The widespread occurrence of litter is a severe threat to global ecosystems. Despite this, little is known about the possible effect of littering on animals. So far, most studies have focused on small mammal mortality in discarded beverage containers [1-3], but less attention has been paid to invertebrates or herpetofauna and no records are devoted to bigger animals.

The aim to this study was to analyse online social media, notably photos or videos, to assess the diversity of animals that are prone to getting trapped in discarded containers and check which containers are the most dangerous for a particular group on animals. Internet platforms such as Google Images, YouTube, Facebook, Instagram and Twitter were manually explored between July and November 2019. Different combinations of the following key words were used: *animal* (replaced by common name of various taxa) + *dead/ stuck/ trapped* + *bottle/ can/ container/ jar/ tin*. The search was conducted in eight of the world's most-used languages and Polish. A total of 503 records from around the world (51 countries, 6 continents) have been found. Significantly more cases were noted in urbanised habitats (72%) than in natural/semi-natural (28%) (chi-square test = 149.7, df = 1, $p < 0.0001$). Collected records include invertebrates (17 taxa, ca.1050 dead individuals), and vertebrates (98 taxa, 496 individuals including only 44 carcasses). The latter group was most frequently represented by mammals (78.5% of cases), followed by reptiles (15.3%), birds (1.2%), fish (1.0%), and amphibians (0.4%). Nearly 12.5% of the determined species are classified as vulnerable (VU), endangered (EN) or critically endangered (CR), according to the IUCN. Although most trapped individuals were smaller animals, bigger ones such as monitor lizards or large carnivores were noted. In most cases, animals were trapped in jars (32.4%), drink cans (16.6%), and steel cans (16.3%). Our results prove that discarded containers are a threat to all major group of animals.

Responsible waste management, implementation and promotion of recycling programs, extensive cleaning activities involving citizens (e.g. Clean up the World), and continuous raising of public awareness through activities like engaging people in educational projects, can contribute to reducing this problem [4].

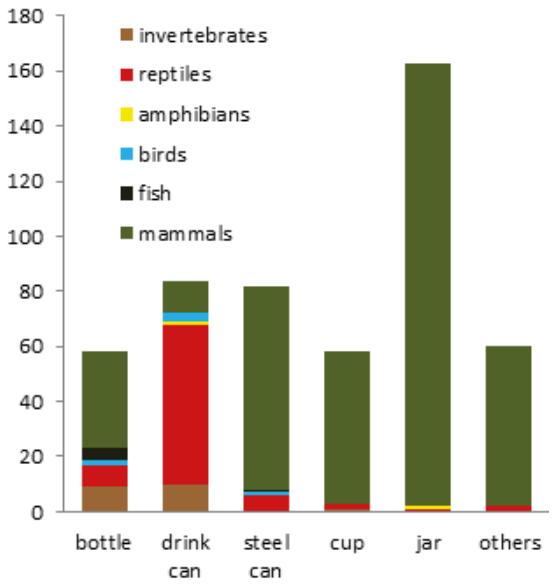

Figure 1. Number of particular group of animals that got stuck in different types of discarded containers.

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Managing public urban green spaces for increased human-wild plant interaction through urban wild food foraging

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Keywords: wild plant gathering, biodiversity conservation, edible green infrastructure

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Introduction Urban wild food foraging refers to picking or gathering edible plants and fungi, which grow spontaneously or are planted and cultivated for other purposes than food production, in cities [adapted from 1]. The foraging and consumption of wild food plants and its parts, like fruits, nuts, leaves or flowers requires an active engagement with the intended species, their occurrence in the city and the characteristics of the urban green spaces from where they are foraged. All this promotes human-wildlife interactions for urban dwellers and may consequently lead to awareness about the need for biodiversity convervation [2]. However, concerns about urban foraging were raised. Public authorities tend to be concerned about damages to vegetation on public urban green spaces through foraging and consider foraging as an additional use of public urban green spaces, which might be in conflict with other uses.

To investigate these concerns and support urban wild food foraging as human-wildlife interaction on public urban green spaces, in this study we explore i) which urban foraging practices are problematic and beneficial for conserving urban biodiversity? and ii) how does the management of public urban green spaces support or hinder sustainable human-wildlife interactions through wild food foraging?

Method To find answers, we conducted twenty-one semi-structured expert interviews with urban foragers, environmental educators, managers of public urban green spaces, open space planners, and representatives of non-governmental institutions in Vienna, Austria. We analysed the experts' views and perceptions about urban foraging in relation to i) foraging practices and their ecological impacts and ii) management measures of public urban green spaces that promote or hinder foraging. We analysed the data using qualitative content analysis.

Results We found that foragers cause but also prevent and limit damage to plant populations on public urban green spaces. The ecological impact of foraging depends on the choice of plant species, foraging location, date, quantity, technique, timing and care with which they forage. Most problematic for urban vegetation can be the foraging of rare plant species and careless foraging that compromises the integrity of foraging sites [3].

Regarding the second question, we found that larger, easily accessible public urban green spaces that are managed in a near–natural way and allow for wilderness areas are popular for foraging, even more so when they have qualities of an excursion destination. Moreover, foraging sites close to home with little contamination caused by humans, animals, traffic and chemicals and with a high density of wild food plants and high plant diversity are preferred. However, foraging site selection also differs according to subjective standards, and particularly popular wild food plants may also be foraged near sources of contamination or in intensively managed areas.

Discussion The management of public urban green spaces promotes urban wild food foraging when focus is on nature-based green space management that allows for wildlife areas and edible green infrastructure. According to our results, the promotion of wild food foraging can be in line with biodiversity conservation objectives and a green space management that is economically sustainable [4] if appropriate management measures are taken. To promote urban wild food foraging without harming urban biodiversity, the plant populations that may be affected by foraging need to be monitored and, a clear legal framework for wild food foraging established. We also recommend promoting knowledge sharing and education on sustainable wild food foraging for foragers and green space managers, for example through increased citizen participation, activation and communication.

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The role of cultivated green areas and wastelands in river valleys for the protection of bee resources in urban environments

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Keywords: Apiformes, diversity, habitat management

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River valleys are an important part of urban space and play a key role in the functioning of natural environment and the conservation of biodiversity. The advancing urbanisation of valleys contributes to the loss of their natural assets, and thus limits the occurrence of numerous groups of animals, including wild bees (Apiformes).

The aim of our study was to answer the following research questions: (1) What is the importance of different urban green spaces in river valleys for bee communities? (2) Will the preservation of cultivated green areas, which mainly serve a recreational and aesthetic function, suffice to protect bee resources in urban areas?

Field research was conducted in the years 2017–2019 in the city of Bydgoszcz in northern Poland. Our study system consisted of cultivated green areas (parks and squares - 10 sites) and wasteland areas (5 sites). Wild bees were caught from April to August (once a month). At each site, bees were sampled using the transect method (transects 200 m long and 1 m wide). Each transect walk took about 30 min to complete. The number of delimited transects was adjusted to the size of study site.

We recorded a total of 4 946 individuals of 196 species of bees (Hymenoptera: Apiformes). The analysis has shown significantly lower mean richness and abundance of bees in parks and squares, compared to wastelands. The values of the above indicators were as follows: 13 species and 231 individuals in cultivated green areas, and 35 species and 526 individuals in wasteland areas. Similarly, species diversity (Shannon index) was significantly lower in parks and squares (2.68) than in wastelands (3.55).

These values indicate that the use of the natural potential of river valley wastelands and proper management of cultivated green areas may be of key importance for the protection of bee resources in urban areas.

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Water infiltration trenches and basins as new habitats for wild bees (Apiformes) in urban ecosystems

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Keywords: Apiformes, diversity, anthropopressure

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Urban expansion is taking place all over the world, and the ever-larger cities cause significant changes in the environment, which often leads to biodiversity loss. However, there is evidence that some of the man-made types of habitats may increase the diversity of insects, including Apiformes. In the present study, we analysed the significance of water infiltration trenches and basins as new habitats for bees in the protection forest zones in Bydgoszcz (northern Poland).

Research on wild bees (Apiformes) was conducted in 2019 at the infiltration water intake of the "Czyżkówko".

We analysed 9 water infiltration trenches and 9 basins, which were periodically used and filled with water, and 5 forest clearing habitats. The results obtained were compared with forest habitats (5 sites). Möericke traps were used to catch the specimens. Insects were collected from traps from April to September.

We recorded a total of 4 912 individuals of 155 species of bees (Hymenoptera: Apiformes). We have demonstrated significant differences in the richness and abundance of bee species between forest habitats and open habitats. The values of the above indicators were significantly higher in open habitats (water infiltration trenches, water infiltration basins, forest clearing habitats). It turned out that the most attractive habitats for bees were water infiltration basins, where we observed the highest richness (58 species on average) and abundance (265 individuals on average) of bees. At the same time, we demonstrated that the main factor affecting the Apiformes community structure, apart from the type of habitat, was the extent of area humidity, which was mainly associated with the access to sunlight.

Our results show that structurally simplified and floristically poor artificial habitats formed in pine forests play a significant role for the occurrence of wild bees.

Acknowledgments: This study was supported by the Polish Minister of Science and Higher Education, under the program "Regional Initiative of Excellence" in 2019-2022 (Grant No. 008/RID/2018/19).

A pragmatic approach to localize and prioritize opportunity spaces for roof greening to mitigate urban heat islands – a case study for Krefeld, Germany

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Keywords: spatial planning, climate adaptation, remote sensing

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Urbanized areas that experience higher temperatures than outlying areas (urban heat islands) can affect a community's environment and quality of life. Due to global warming it is expected that urban heat islands (UHI) becoming more frequent, intense and long-lasting with increasing harmful impacts on people's health [1]. Cooling strategies such as vegetated layers installed on a roof surface (green roofs) are a promising multifunctional measure to mitigate urban heat, simultaneously lower greenhouse gas emissions and provide other contributions to human well-being [2, 3].

Challenges for planning and implementing green roofs are the lack of pragmatic approaches to identify and prioritize suitable locations for roof greening based on up-to-date datasets.

In this study a three step approach was developed for climate adapted planning of green roofs and subsequently applied to the city of Krefeld in Germany. First, the vulnerability to which residents of Krefeld are affected by UHIs was examined by assessing heat exposure of urban structures and heat sensitivity of urban dwellers and facilities. Second, an inventory of green roofs and potential for greening was compiled by analyzing spectral data of aerial images with the Differenced Vegetation Index (DVI). Third, results from the vulnerability analysis and inventory were merged to identify areas with priority for roof greening to reduce UHIs in the city of Krefeld. The steps were applied for the socio-ecological situation of the year 2019 and a future scenario in 2030.

Results showed that almost 300 hectares of the urban area in Krefeld are highly vulnerable to heat. In the future, these areas will nearly triple in size. More than 90% of the evaluated roofs do not have any vegetation cover and thus hold potential for greening with their considered sturctural and functional properties.

Using the three step approach provides valuable information for spatial planning of roof greening as a climate adaptation strategy and the design of urban areas. Findings of this study can be used for the development or extension of cadastres, which can serve as a communication tool between municipality and citizens and thus increase acceptance and implementation of roof greening for climate adaption.

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Functional and spatial importance of historical parks in the present urban structure on the example of Lublin, Lviv, and London

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Keywords: historic urban park, functionality, spatial structure

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In urban space, public green areas are an important element. They include parks, squares, community gardens, municipal forests, roadside vegetation, cemetery plant life, as well as plants accompanying other widely available objects. Green areas are an important element of city infrastructure, since they serve ecological, microclimate, aesthetic-landscape, and socio-economic purposes. The spatial structure of numerous urban complexes is based on interwoven modern and historical elements. Therefore, it is important to inquire about the functionality and spatial structure of historical parks in the modern image of the city. Can parks – with historical value, protected compositional setting, equipment, and old vegetation structure – meet the demands of cities of the future?

The goal of this article is to determine the functional and compositional value of three historical parks in Lublin (Poland), London (Great Britain), and Lviv (Ukraine), as well as to attempt to answer the question of how these parks provide cultural ecosystem services to citizens. The functions and elements of the structure of the analysed parks were grouped and assigned to specific classes, groups, and divisions in the cultural services section, in accordance with *Common International Classification of Ecosystem Services*, processed to fit Polish conditions. What is more, structural differences between the three analysed parks were demonstrated, and their spatial meaning in the system of urban vegetation was evaluated.

All of the analysed public parks play vital spatial and functional roles in urban structures. Despite some practical limitations due to their historic value protected by law, they fulfill the modern functional-spatial program. From that point of view, the best park is Lloyd Park in London, which combines historical value with growing needs of a modern city from the 21st century.

Mechanism of urban ecological space reconstruction based on Social-Ecological System framework: A case study of Mu-Yan waterfront scenery area in Nanjing

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Keywords: Social-Ecological Systems, urban ecological space, actor network

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Urban ecological space is the main supporter of urban sustainable development which provides multiple ecosystem services for human beings, and can be considered as a complex system interacted with social elements under the utilization and transformation of social actors[1-3]. From the perspective of Social-Ecological System framework (SESs)[4], this paper analyses the reconstruction mechanism of Nanjing Mu-Yan waterfront scenery area.The results indicate that this case had experienced three stages: the construction phase of heavy industrial base, the social conflict phase and the operation phase of tourism scenic spot. With the local government acting as the only key actor, the actor network of the heavy industrial base construction had been formed highly unified interests pattern of the government, enterprises and society, applying ecological space for political and economic functions[5]. The social conflict phase of the network has changed with power decentralization and the market growth, which accelerated the ecosystem degradation and promoted residents, scholars, media and other social actors to resist the destruction of ecological space in a bottom-up way[6].Along with the quit of incentives launched by local government, foreign business and tourists involved, market forces allied to become alternative focal actors, while local residents withdrew to the periphery of the actor network, which contributed to re-establishment of actor network and the heavy industrial base's transformation to urban park. In the reconstruction process, there was a heterogeneous actor-network[7-8], which is composed of governance body represented by governments, utilization body represented by enterprises, villagers and tourists, and other social groups such as news media and scientific experts, contributing to change the physical environment and social benefits. This paper also points out the high efficiency of government, the flexibility of the market mechanism with obvious profit intention and absence of communication between the government and the public.

Acknowledgments: This work was supported by the National Natural Science Foundation of China (Grant Nos.41771140).

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Optimum plantation arrangement to enhance outdoor thermal comfort in humid sub-tropical urban settings

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Keywords: ENVI-met, heat stress, plantation pattern

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Urban residents of developing countries in humid sub-tropical climates with inadequate green infrastructure experience severe heat stress in summers. Urban green infrastructure, particularly trees planted in appropriate patterns, can enhance outdoor thermal comfort (OTC) [1]. However, such research is lacking for humid sub-tropical cities. Therefore, we examined planting patterns in a residential neighbourhood in the city of Dehradun, India for different urban settings (park, courtyards and roadsides) due to their vital role in everyday activities and interaction.

ENVI-met, a 3D microclimatic model was used for simulation modelling. We simulated ten plantation scenarios with different shading patterns and orientation to prevailing winds. Tree characteristics and total tree canopy area were kept constant to focus on the impact of the plantation arrangements. OTC was measured using the physio-thermal index – Physiological equivalent temperature (PET) with results averaged over daytime (9 am to 5 pm) and evening time (6 pm to 9 pm).

Our results showed that the tree arrangements influenced wind speed, wind direction, and shade on the site, wherein patterns parallel to the wind performed better. The cooling effect of the planting design was more pronounced during the daytime compared to the evening time. In the streets and courtyards, PET was influenced by mean radiant temperature, whereas in the park, wind conditions primarily affected PET. In the park, double row of trees parallel to the wind directions performed best (ΔPET 1.2°C), while along the roads, groups of two trees on a single side performed better (ΔPET 1.3°C) than trees on both sides of the roads (ΔPET 0.96°C) (Refer Figure 1. for the planting scenarios). This asserts the role one-sided road plantation plays in facilitating wind movement in urban areas with low wind speeds. In the case of courtyards, the plantation in the center was more effective (ΔPET 1.4-2.0°C). Yet, due to a lower sky view factor in courtyards, tree settings need to be carefully designed to balance sun and shade without blocking wind channels and to prevent night time heat retention. Overall, planting fewer trees purposefully had a more positive impact than planting more trees inadvertently. This entails that with careful consideration of wind movement, well spread shaded spaces on a site are more crucial than confined shaded spaces to enhance overall OTC.

Moreover, despite a variation in ΔPET between the different scenarios, the average PET values were always

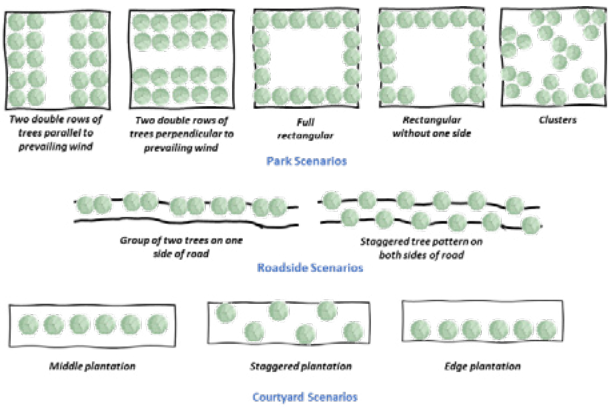

Figure 1. Plantation scenarios in the three urban settings (Not to scale or true north – *meant for tentative representation*)

above 42°C implying extreme heat stress conditions. This can be attributed to a high air temperature (>32°C) and relative humidity (60-90%) values on the simulated day, which was exacerbated by inconsistent and low wind speeds on the site. This outcome underpins the need for strategic urban development and inclusion of green space design at early planning stages to secure and facilitate wind movements. Moreover, the very low soil moisture content on the site (15-25%) might have resulted in low evaporative cooling and affected the performance of trees.

Notwithstanding the limitations of the study, it still presents new insights for multiple tree arrangements in different urban settings useful for climate change adaptation in similar climatic and urban contexts. It elaborates on the practical implications for policymakers, landscape planners, urban designers or similar actors. It also lays the groundwork for future research, which may include different tree traits or types, plantation patterns, soil or microclimatic conditions. In conclusion, the study asserts the importance of tree arrangements and their effect on shading patterns, wind flow and correspondingly on human thermal comfort in the outdoor environment.

Acknowledgements: We thank Deutscher Akademischer Austauschdienst (DAAD) for supporting this research and Urban Climate Lab, IIT Roorkee, India for providing instruments for field measurements.

[1] Zhang, Li; Zhan, Qingming; Lan, Yuliang (2018): Effects of the tree distribution and species on outdoor environment conditions in a hot summer and cold winter zone: A case study in Wuhan residential quarters. In *Building and Environment* 130, pp. 27–39. DOI: 10.1016/j.buildenv.2017.12.014

Local strategy for adaptation toclimate change and mitigation measures of the City of Tišnov

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Keywords: mitigation, blue-green infrastructure, urban resilience

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The poster presents a study "Local Strategy for Adaptation to Climate Change and Mitigation Measures of the City of Tišnov", prepared by the team of Mendel University in Brno in cooperation with the Partnership Foundation. The strategy responds to the need of the municipality Tišnov to implement measures that reduce the vulnerability of the city and its inhabitants to the impacts of ongoing climate change. The vision of the strategy is to design and recommend such adaptation and mitigation measures that will help increase the long-term resilience of Tišnov with preferential use of nature-friendly measures (blue and green measures) combined with technical and soft measures, which will have a positive effect on the quality of life of local people.

The local strategy for adaptation to climate change in the city of Tišnov consists of two consecutive parts, namely the analytical part and the design part. The design part of the strategy systematically follows the analytical part, in which the main areas and measures that reduce the impacts of climate change have been identified. These planning areas presented the main risks but also the adaptation capacity, which should be supported by the implementation of specific measures.

The study was based on available secondary data. These were, on one hand, the documents provided by the city of Tišnov, and, on the other hand, publicly available data.

Tišnov is located about 30 km northwest of Brno, the Czech Republic, at an altitude of 256 m above sea level. The population as of 31 December 2019 was 9276. 43.3% of the cadastral territory consists of agricultural land, non-agricultural land predominates (56.6%). The ratio of land types has not changed significantly over 20 years. As in the whole of the Czech Republic, arable land decreased mainly at the expense of built-up areas, courtyards, and other areas. The area of orchards decreased but the area of permanent grasslands expanded. There were no significant changes in forest land nor in water areas. In terms of the coefficient of ecological stability of the area, it is a fairly balanced landscape, in which the technical objects are relatively in line with the preserved natural structures; the result is a lower need for energy-material deposits.

The climate of Tišnov is characterized by the results of statistical processing of measured meteorological elements at the local climatological station until 1950. For the period 1961 to 2019, data from the so-called technical series are used since the actual measurement in the city cadastre did not take place.

It is necessary to emphasize the increase in air temperature in the summer months, in June by 1.9 ° C and in July and August by more than 2 ° C in the respective period. As a result, the number of ice and frost days has decreased, whereas the number of summer and tropical days has increased, indubitably with great variability in individual years [1].

Five main priorities and objectives have been identified:

Priority 1. Sustainable water management

Objective: efficient water management that includes ensuring sufficiency of drinking water, preventing water scarcity and mitigating the effects of drought

Priority 2. Healthy urban environment

Objective: to improve the care of public space, the development and proper maintenance of urban greenery

Priority 3. Healthy and resilient landscape

Objective: overall improvement of the state of the landscape, increase in ecological stability of the landscape

Priority 4. Climate responsibility

Objective: to reduce the contribution of the city to global climate change, to support the use of technical solutions for adaptation to climate change

Priority 5. Satisfied inhabitants of the city

Objective: to raise public awareness of climate change, to promote the protection and care of vulnerable groups [2].

Acknowledgments: This work was supported by city Tišnov.

[1] J.Schneider, A. Kozumplíková, L. Floková, J. Rožnovský, P. Fic, M. Čech, L. Kala: *Místní strategie adaptace na změnu klimatu města Tišnov. Analytická část (Local Strategy for Adaptation to Climate Change and Mitigation Measures of the City of Tišnov. Analytic part).* MENDELU FRRMS, Brno 2021. Czech language

[2] J.Schneider, A. Kozumplíková, L. Floková, J. Rožnovský, P. Fic, M. Čech, L. Kala: *Místní strategie adaptace na změnu klimatu města Tišnov. Návrhová část (Local Strategy for Adaptation to Climate Change and Mitigation Measures of the City of Tišnov. Design part).* MENDELU FRRMS, Brno 2021. Czech language

E-participation as a creating factor of sustainable development in the smart city 3.0 concept

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Keywords: city management, public participation, city sustainable development

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Globalization, progressing urbanization processes, civilization and technological progress force the search for new solutions to ensure the sustainable development of cities and regions. The smart city concept is one of the newest concepts for the modern cities development. Smart cities based on technological innovations (e.g. ICT, e-administration, low-carbon transport), and are complex urban systems, able to improve the functionality of any city through a network of mutual connections between people, technologies and data. Considering *a smart city* as a broad approach to the cities development, there are six components taken into account, all of which are linked and influence each other: smart people, smart living, smart governance, smart environment, smart mobility and smart economy. Over the years, the smart city concept has evolved from 1.0 to 3.0 version. In *smart city 3.0.* the main role in the urban space development should be given to residents who are the recipients and co-creators of introduced changes and the use of modern technologies. Ensuring sustainable city development based on improving the quality of life and widely understood social participation is one of the overriding purposes of smart city 3.0. The dwellers' possibilities of co-deciding about the development and management of their city should be seen in modern methods of social participation based on the use of Information and Communication Technologies (ICT). The Internet tools based on geoinformation systems can be used by public participation in spatial planning. Getting to know public opinion plays a key role in the study of urban space.

The purpose of the conducted research was to track changes in the availability of information and communication technologies. In addition, questionnaire surveys were carried out to learn the opinions on the e-participation role in shaping urban space. The results shows that digital exclusion in Poland is decreasing. Simultaneously, the chance to reach inhabitants and engage them in changing processes and making decisions through e-participation increases. The results indicate that conducting research using e-participation methods can positively influence the conscious shaping of space by the inhabitants. The general problems and barriers that can be an obstacle to the use of e-participation tools in managing urban space were also indicated.

POSTER SESSION

P.3.2

Impact of Covid-19 lockdown on air pollution in Wrocław

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The spread of the new coronavirus that causes Covid-19 has created restrictions on all types of human activities therefore impact on movement all over the world has been observed. Lockdowns ordered (albo tu jeszcze może pasować introduced) in subsequent countries had many short-term and long-term effects. One of the short-term ones, directly related to the current restrictions, is the change in air quality in urban agglomerations. It is reported that the lockdown resulted in a decrease of NO_2, PM_{10}, SO_2, $PM_{2.5}$ and CO concentrations, with a simulteanous increase in the concentrations of ozone [1]. These changes were examined in the city of Wrocław (644,000 inhabitants), Poland (central Europe). In Poland, the state of epidemic threat was introduced on March 16, 2020. From April 24 to the end of May, the restrictions were gradually relaxed. The aim of the study is to assess the impact of lockdown on air quality by analyses of the concentrations of 5 pollutants: NO_2, NO_x, $PM_{2.5}$, CO and O_3, using data from three measuring stations (one traffic-oriented and two urban-background stations),

The concentrations of the aforementioned air pollutants in the period of the most severe restrictions – which cause a significant reduction in the movement of inhabitants (01 March - 30 May) were analyzed. Due to the high hourly variability of the concentrations, the daily mean (av), median (med) and maximum (max) were determined. Then, the concentrations in the pandemic year - 2020 were compared with the corresponding values of the concentrations of these pollutants in the previous year - 2019. Statistically significant differences measured by two-sample Wilcoxon test with were identified. Lockdown caused a significant reduction in NO_2 and NO_x concentrations in the communication canyon located in the city centre (W - measuring station). It is related to the reduction of traffic volume. However, it is worth noting that this phenomenon is local. No reduction of nitrogen oxides concentrations was recorded at background stations which are not located in the vicinity of communication canyons. Even higher concentrations were observed there in 2020 (Fig. 1). The relationship is reversed for dust pollutants. In the communication canyon located in the city center (W), no statistically significant changes in $PM_{2.5}$ concentrations were recorded. On the other hand, a statistically significant decrease of the dust pollutions was recorded on the background stations. This is a unexpected conclusion, due to the fact that on the outskirts of the city there are many houses heated with solid fuel, the combustion of which is the main source of particulate matters in Poland. Due to the lockdown, the residents stay at home all day, therefore it is possible to assume increased heating. On background measuring station a CO concentration was statistically significant reduced which is not in line with the general changes in the world as presented in [1]. In Wrocław ozone concentration is not measured by traffic-oriented measuring station. Due to that fact, the only conclusion that can be made is that the O_3 concentration has increased in 2020 in suburban area. Presented insights lead to more detailed research in the field of searching for changes in relation to the long- term past values and investigating the causes of various changes in air quality during the lockdown, compared to global trends.

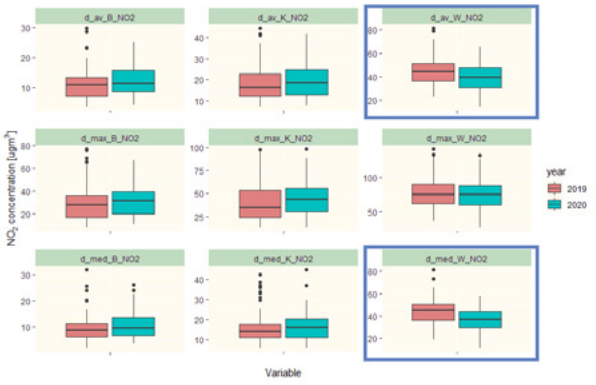

Figure 1. Boxplots for NO_2 concentration daily values in 3 measuring station, in frames a pair of statistically different variables.

Acknowledgments: The publication is financed under the Leading Reasarch Groups support project from the subsidy increased for the period 2020–2025 in the amount of 2% of the subsidy referred to Art. 387 (3) of the Law of 20 July 2018 on Higher Education and Science, obtained in 2019

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Soil quality as a key factor in producing vegetables for home consumption – a case study of urban allotments in Gorzów Wielkopolski (Poland)

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Keywords: urban agriculture, allotment gardens, food security, urban soils, heavy metals, Poland

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Cities are an important element in the food system in regard to both demand for food for urban residents and production of food in urban and peri-urban areas. Food cultivation in cities has several major advantages including reducing food miles and connecting people with nature. Allotment gardens (AGs) are an important component of urban agriculture.

In the case of vegetable production in cities for own needs, food security is a key issue. The question is whether urban soil is a good substrate to produce vegetables for home consumption. It is known that in the case of urban soils, there is a potential risk of contamination by metals. Vegetables grown in urban areas on soils with a high concentration of heavy metals (especially toxic ones) are exposed to their accumulation in edible parts, and then are incorporated into the food chain.

We analyzed the quality of soils in urban allotment gardens in the context of growing vegetables for home consumption. The research was carried out in 31 allotment plots of Gorzów Wielkopolski, a medium-sized Polish city with an average level of industrialization. We analysed the soils for the following characteristics (pH, EC, organic substance, organic carbon, humus, total nitrogen, C:N ratio, $N\text{-}NH_4$, $N\text{-}NO_3$, P, K, Ca, Mg, $S\text{-}SO_4$, Cl, Na, Fe, Cu, Zn, Mn, Ni, Cr, Cd, Pb).

The performed analyzes showed that the examined soils are rich in nutrients for the cultivation of vegetables. The soils contain a high amount of calcium, magnesium and phosphorus. At the same time, too high pH of the soil for vegetable cultivation was found. The content of toxic heavy metals – cadmium (0.22-0.59 mg · kg^{-1} d.m) and lead (3.46-16.89 mg · kg^{-1} d.m) was within the acceptable standards. However, the chemical analysis of carrot roots, as a test vegetable, showed that the permissible standards for cadmium and lead content were exceeded. Excessive uptake of these toxic metals can be reduced by lowering the soil pH and enriching it with organic carbon.

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The relationship between urban ecosystem services and human health risks: Systematic review

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Keywords: Urban ecosystem services, Human health risks, Systematic review

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Due to urbanization, there is a high demand for researches in urban ecosystems linkage to human health risks. By 2050, around 70% of the world population will live in urban areas with the rising challenges of urban space, facilities, services as well as increasing risks of safety, quality of life, health care, and many others, therefore there is a great need to analyze urban ecosystem as an urban planning tool to mitigate human health risks. The main objective of this paper is to identify the most and the least investigated urban ecosystems linked to human well-being. The systematic review method is used to analyze the existing literature on ecosystem services' impact on human health risks. Google Scholar, Science Direct, Scopus, and other targeted databases are used for the defined keywords, such as URBAN ECOSYSTEM SERVICES AND HUMAN HEALTH, URBAN ECOSYSTEM SERVICES AND HUMAN MENTAL HEALTH, and others. Moreover, this paper uses the chronological order and "Word & Word Combination Frequency" method for identified relevant publications. The results show that some ecosystem services' linkage to human health risks is more analyzed than the others. The majority of analysis is done from a single urban ecosystem perspective (e.g. green infrastructure, water supply), therefore some challenges are defined, such as the lack of researches. The majority of previous investigations focus on the urban ecosystem's impact on physical illness, but the mental health risks have not been that highly considered, because of expensive and long-lasting researches.

Involving local residents in rainwater management

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Keywords: Rainwater, Incentive Programs

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How can we mobilize citizens to manage rainwater in the existing cities ? This is the challenge facing many French municipalities today to reduce pollution and flooding. Until now, people have been encouraged to harvest and use rainwater to save drinking water. Abroad, programs encouraging residents to disconnect their stormwater from sanitation networks are more ambitious, especially in the United States and Australia. This is revealed by the international panorama of *rain garden and rain barrel programs* led to capitalize some experiences and inspire municipalites in France.

The panorama led in 2017 confirms the widespread dissemination of incentive programs for citizens to manage rainwater at source, particularly in the United States and Australia, and their large ambitions. Their representation by an interactive online mapping tool (Figure 1) makes it possible to make them known, to propose a first level of characterization and to follow their development. Thereafter, twenty incentive programs will be selected to be documented in greater depth and to draw lessons that can be transposed in France. The analyzes will cover the conditions of emergence, the targeted objectives, the subsidized devices, the eligible beneficiaries, the instructions, the accompanying actions and the organization put in place and finally the program review and lessons learned.

Keys-elements learned from the global overview: the programs are clustered in the United States, Canada and Australia. A majority of programs led by local governments, from small towns to metropolises.

Financial incentives offered (rebates, credits, prize, sharing of the costs…), although they also lean on communication and educational incentives. Four main kinds of programs developed and implemented, according to stormwater management devices: Rain Barrel, Rain Garden, Green Stormwater Infrastructure Programs and Adopt a Drain Programs.

Abroad programs are also characterised by the support local authorities give their inhabitants in adopting new stormwater management practices. The frequent elements spread in France (brochures, arguments, help-seeking forms...) are completed with tools aimed at enhancing residents capacity to act at home : guides, Frequently Asked Question (FAQ), photo gallery of local projects, tutorial videos, lists of professionals, apprenticeships, geolocalisation maps of devices already in place, soil analysis for water infiltration, display.

Figure 1. Online interactive world map of local experiences (Cerema 2017)

Acknowledgments: This work was supported by The French ministry of Ecology, Office Français de la Biodiversité.

[1] http://paysages-territoires-transitions.cerema.fr/des-jardins-de-pluie-chez-les-habitants-a198.html

POSTER SESSION

P.3.6

Urban grasslands soils: effect of grassland type and their location

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Keywords: urban ecology, urban soil, urban grasslands

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Urban grasslands are among the most abundant types of urban greenery and deliver numerous ecosystem services [1]. The urban soils are heterogeneous [2], often polluted, highly compacted, and usually rather unsuitable for plant vegetation. Basicaaly, urban soils are deficient in major nutritive elements such as N, P, K [3] organic matter and carbonates, but with higher pH comparing to non-urban soil/ natural areas [4]. Our study focused on the soil chemical analysis including pH, N, P, K, C, and Mg of urban soil samples collected from urban grasslands and the aim was to discover the distribution pattern of soil characteristics within different urban green infrastracture. We hypothesized that the soil chemical properties of urban soils will differ regarding: grassland type (lawns, parks, embankments, and roadsides) and location of patches: city center versus peripheries. More precisely: (1) patches in city center will be nutrient poor but with higher pH comparing to patches located in city peripheries, (2) that lawns will be more nutrient rich, due to fertilization, comparing to other urban grassland types as parks, road verges and river embankments.

Using a GIS technique, a set of sampling plots which represents four grassland types was placed in center and urban peripheries of Wroclaw city, Poland. Location of plots was spatially balanced, and the grassland patches was uniformly distributed throughout grassland types. The points were located in the patches using a satellite navigation. Four samples from a patch was collected, and then mixed into one sample representing the soil in the particular patch. Final soil samples were dried at room temperature for 72h, and then crushed and sieved (Ø 0.5 mm). The methods used for soil chemical analysis were as following; for total nitrogen (%) the Kiejdhal's method has been used, the Egner-Riehm spectrophotometric method applied for Phosphorus (mg/kg), Potassium (mg/kg) obtained by flame photometry method, elemental analysis method for Carbon (%), Magnesium (mg/kg) using spectrophotometric method with titanium yellows, and Soil $pH_{w/kcl}$ by potentiometric method [5]. The differences between average values within groups were checked using Kruskal-Wallis ANOVA by ranks with multiple comparisons of median as post hoc-test. The correlations between chemical properties of soils were checked using Spearman rank correlations.

The results indicates that there is no significant differences between grouping variable and soil characteristics except of potassium, considering green infrastructure as the grouping variable and where lawns both in city center and urban peripheriy have higher potassium content (P) than other urban green infrastructure.

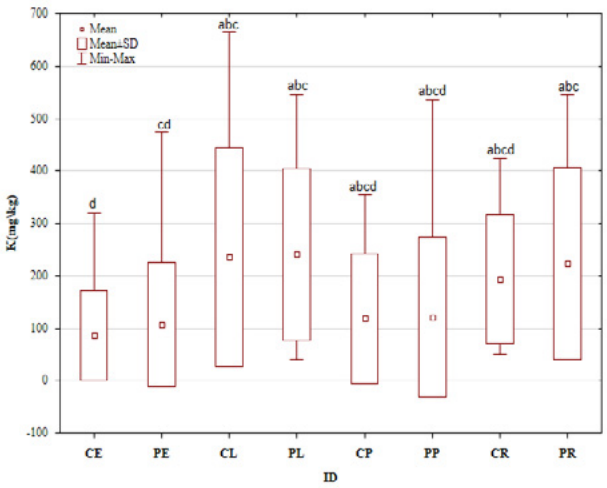

Figure 1. The boxplot shows the changes of K(mg/kg) within four different kind of urban grasslands which are located in the city center and urban periphery. The ID indicates the interaction between Location in the city: center (C) and periphery (P) and different urban green infrastructure: Embankment (E), Lawn (L), Parks (P), Road verges (R).

Acknowledgments: This work was supported by "UPWR 2.0: international and interdisciplinary programme of development of Wrocław University of Environmental and Life Sciences", co-financed by the European Social Fund under the Operational Program Knowledge Education Development, under contract No. POWR.03.05.00-00-Z062 / 18 of June 4, 2019.

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Cultural and historical landscapes as a critical element in the environmental framework of historical cities (on the example of Moscow)

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Keywords: environmental framework, landscape complexes, *historical cities, Moscow*

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An effective territorial organization of New Moscow, rational use of its territory is impossible without taking into account the natural elements of the city, taking into account the properties and potentialities of landscape complexes that integrate all the natural features specific to particular territories. Therefore, it is necessary to implement a system of cost-effective and environmentally friendly measures to preserve, restore and maintain in a stable state the natural environment and numerous natural and cultural monuments. The theoretical basis for the research is the concept of landscape planning, which relies on the objectively existing local and regional physical and geographical differentiation, i.e. the landscape structure, functional zoning and usage of the territory, while taking into account the spatial distribution of landscapes and land categories that are different in their designated purpose and characteristic usage.

A particularly important role in solving this problem must be assigned to the development of the city's environmental framework. The spatial pattern of the landscape complexes within the borders of New Moscow is such that it allows you to create a uniform environmental framework on a landscape basis, characterized by interconnectedness and complementarity of its components: environment-forming nuclei (nodes), ecological corridors and elements of ecological infrastructure. It can be based on unified landscape systems of valley sandrs and river valleys and small erosion forms nested in them, and their catchment declines that perform system-forming, environmental, and transit functions. Critical elements of environmental infrastructure include the most essential forest and marsh complexes, springs and other landscape-aquatic complexes, areas of natural green spaces, natural and recreational parks, and natural monuments. They can serve as centers of landscape and biological diversity, perform partial transit (migration) and buffer functions.

At the same time, cultural and historical landscapes and their morphological units - landscape and historical areas and complexes, as well as landscape complexes with a high concentration of landmarks, places of interest - should be the critical elements of the environmental framework, as their specificity lies in the unique combination of cultural and historical monuments and the preserved landscape environment of the historical time of their functioning. Cultural and historical landscapes, along with the elements of the morphological structure - indigenous and anthropogenically transformed natural components and complexes, include historical and cultural monuments, artifacts, sociofacts, mentifacts. These most important monuments of cultural heritage serve as a kind of "biographical chronicle" of the life of the population in certain landscape conditions at a particular historical time.

Modern Moscow is replete with integral natural historical and cultural formations that formed in specific territories with certain homogeneous natural (landscape) properties as a result of a long interaction of man and landscape that occurred during their coherent development. Most modern Moscow landscapes are distinguished by: a significant period of land development; the abundance of monuments of historical, architectural and spiritual heritage; the intactness of the monuments and their natural (landscape) environment; the originality, uniqueness (or typical nature) of the natural environment; the historicity of the landscape (preservation of the historical appearance); the ecological properties of the landscape and its high ecological and aesthetic properties.

The results of the analysis of the landscape structure and various elements of the natural and ecological framework were compiled in a series of original maps at a scale of 1: 50,000, including the maps of restored and modern landscapes of Moscow, the maps of landscape and historical sites and complexes, various integrated analytical maps of the elements of the framework. The resulting composite map was the "Map of the environmental landscape-ecological framework." All information is presented in the form of specific cartographic layers with numbered sections and explanatory texts to them. These layers are integrated into the corresponding thematic maps, which represent a unified geographic information system. This allows to quickly isolate the necessary information layer or, straight conversely, integrate them for subsequent analysis or synthesis.

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POSTER SESSION

P.4.2

Gene flow, ecosystem service, and urban planning in a Brazilian city

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Keywords: biodiversity friendly city, connectivity, tropical region

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The expansion of the cities affects the natural landscape with serious environmental impacts at distinct spatial and temporal scales, compromising the supply of ecosystems services and, consequently, human well-being within and beyond urban areas [1]. For Tropics, this is an urgent understudied matter since this region concentrates a rich biodiversity and a large proportion of the world´s population, which are expected to be the most vulnerable to the impacts of climate change and loss of ecosystem services.

Ecosystem services are the benefits that people receive directly or indirectly from functioning natural ecosystems, generally classified into four categories related to provisioning (e.g., water, food, and drugs), supporting/habitat (e.g., habitat maintenance, nutrient and water cycling and genetic diversity), regulation (e.g., climate, pollination, erosion control) and cultural services (e.g., contemplation, religion) [2]. Because these services provide critical functions to society, they are important elements in urban planning. Considering the limited space, urban areas should exhibit maximum multifunctionality and resilience.

Urban fragmentation can reduce gene flow and isolate populations, reduces genetic diversity and increases population differentiation, all of which have negative conservation implications [3]. Highly mobile organisms are expected to be less impacted by habitat fragmentation than less-mobile species, while human modification to the landscape can also indirectly increase dispersal rates between populations by creating corridors or removing barriers to gene flow. Therefore, urban landscape features act as barriers or conduits to gene flow, depending on the species' behavior and city characteristics [4].

Currently, 76% of the Brazilian population inhabit areas considered predominantly urban [5]. This means that approximately 160 million people somehow use and benefit daily from environmental resources and services found in cities. Too much to be overlooked! Pressures are likely to increase. By 2030, a significant portion of the expansion of cities located in Brazil will occur over natural habitats, turning it into one of the most affected regions of the world in terms of natural habitat loss due to urban growth [5].

In this study, we plan to estimate gene flow for three urban species from Campo Grande, a city located in the Cerrado biodiversity hotspot from Mato Grosso do Sul State, Central Brazil and verify how the results can promote a stronger association considering biodiversity conservation × ecosystem service × urban planning × human well-being. The Jatoba (*Hymenaea courbaril*; Fabaceae) is a tree species (up to 40 m height) used as wood in civil construction and in the furniture industry (provisioning) but in cities its shadow contributes for microclimate amelioration (regulation, supporting). While Jatoba flowers are majorly pollinated by bats at long distances, insects also can make this process (regulation) at short distances such as the small (5 mm) stingless bee Jatai (*Tetragonisca angustula*; Meliponini). The fruits of Jatoba are an important food resource for fauna and when unripped are predated (regulation) by the blue-and-yellow macaw (*Ara ararauna*; Pssitacidae), a mega parrot (Figure 1). Despite the distinctiveness ecosystem services provided by these three species, they have a common link that is associated to the cultural service (Figure 1). The blue-and-yellow macaw is an iconic city species; people revere large trees; people like to have Jatai colonies in their houses like a pet. (PLEASE, FIGURE 1 HERE).

Employing different approaches to assess the influence of urbanization (impervious surfaces, NDVI, number of buildings…) on gene flow for the three species we expect contribute to public policies associated to urban planning (green areas, ecological corridors), resulting in a more resilient and biodiversity-friendly city.

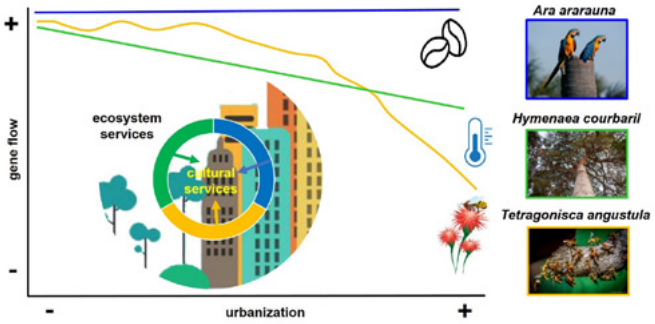

Figure 1. The expected association between gene flow and urbanization for three species in a Brazilian city with distinct ecosystem services but with a cultural connection.

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Spatial development as a driver of ecosystem change in the urbanized catchment: The case of the Różany Strumień in Poznań, Poland

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River catchments in urbanized areas are subject to strong anthropogenic pressures, associated with changes in land cover and land use, as well as environmental emissions [4]. As a result, we observe changes in the structure and quality of ecosystems, as well as the human benefits they provide. [1]. An important role in shaping human-environment relations is played by spatial planning, which findings determine the future directions of anthropogenic transformations, as well as ways to mitigate negative human impacts on the environment.

The research presented here is a case study for the Różany Strumień catchment, located in Poznań, central-western Poland. Różany Strumień is one of 11 study catchments of the Integrated Environmental Monitoring Programme (IEMP) [2]. The aim of the IEMP is to monitor the state and trends of changes in the natural environment in landscape-ecological zones representative for Poland [2].

Różany Strumień is the first catchment area of the IEMP study in Poland, located within the boundaries of an urban agglomeration and subjected to strong anthropogenic pressure associated with progressive urbanization [3]. This pressure is reflected in the encroachment of residential or service buildings and road infrastructure on the catchment area [5]. The expansion of urbanized areas contributes to the transformation of fauna and flora, reduction of soil quality, and to the change of the main watercourse recharge conditions. There is likewise an increase in surface sealing, the amount of sewage and waste [5]. Urbanization also contributes to barriers in the ecological corridor of the Różany Strumień and fragmentation of forest complexes [4].

The aim of the research is to identify future changes in spatial management and to identify the main factors of pressure on the natural environment and the planned ways to mitigate them. The research findings will help to formulate recommendations for the IEMP in terms of environmental components that should be subject to special monitoring.

The first stage of the work involved the determination of the research area. The study area included the Różany Strumień catchment area and, as a buffer, the directly adjacent areas covered by local spatial development plans. In the Polish legal system, by local spatial development plans are acts of local law that define the purpose, conditions of land use and development

A total of 29 local spatial development plans were identified, the provisions of which will shape the future management of the study catchment area and its buffer zone. For each local spatial development plan, a list of potential threats to the environment resulting from the implementation of its provisions was compiled. In this case, the reference list of threats, pressures and activities on natural habitats developed by the European Environmental Agency was used as a starting point.

In order to determine the magnitude of changes in land use, the current area of residential buildings was compared to the area designated for future development of such buildings. Cartographic methods were used for this purpose. The National Database of Topographic Objects was the data source for the current built-up area. To determine the growth of the residential area. The appendices to the local spatial development plans, presenting the expected functions of the particular areas, were used.

In the next phase, the anticipated changes in the provision of technical infrastructure were determined: the sewage system and district heating. Spatial data obtained from local authorities (Board of Geodesy and Urban Cadastre) was used.

Information obtained during the different stages of the research is currently being compiled and interpreted. The results, along with recommendations for future environmental monitoring, will be presented at the SURE 2020/21 Conference.

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Spatial development of urbanized areas as a determinant of changes in the city landscape – residential areas located in the lake district case study

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Urbanization processes are among the main causes of changes in the natural landscape. Simultaneously, the natural environment conditions strongly determine the possibility of developing built-up and urbanized areas. The varied terrain of the lake districts is both a barrier to the city spatial development, and it also determines the attractiveness and aesthetics of the landscape. Currently, sustainable urban development and the quality of life are considered more and more frequently. The analysis of changes in city spatial structure is one of the factors that can influence the inhabitants' living comfort. In studies connected to land use and changes in land-use patterns, urbanization is regarded as the main motivation for change. In a developed city space, residential areas become the most important in the structure of developed and urbanized lands. Proper spatial management considering spatial order and regarding sustainable development positively influences the quality of life and decreases construction chaos.

The purpose of the study was to analyze changes in the distribution and concentration of residential areas in the city, which is located in the lake district and to assess their impact on the landscape in the city space. Cartographic and statistical methods were used in the research. GIS tools can be used to track both qualitative (land-use type) changes and quantitative (proportions of land used for various purposes) changes. In order to conduct analyses, the city area was covered with a grid of polygons of equal dimensions that constituted the base for interpolation. Maps presenting the structure of land use, the concentration of residential areas and changes occurring over the years were presented. Furthermore, the applicability of GIS tools in analyses of changes in land-use patterns was described. The conducted research presents the direction of changes in the development of residential areas within cities administrative boundaries and indicates their relations with the natural conditioning of the area. In the given 30 years, the patterns of residential land use in analyzed city did not considerably change. Moreover, the areas that underwent the most profound changes and the highest development concentration in the studied period were identified. The results indicate that the city space and landscape are constantly changing. The building density increases, the surface of open areas is reduced. Areas, which had undergone the most changes over the years, were identified. That can be ascribed mainly to land relief and environmental features which are permanent barriers to spatial development. To a large extent, the location in the lake district determines the directions of development of developed and urban areas. Furthermore, water reservoirs are the barriers to the development of urbanized areas (including residential ones) that cannot be overcome. The presented research approach can be implemented in other spatial units, f. e.g. small, medium or large cities, metropolitan areas or rural areas.

The smart city idea from a bottom-up perspective. Insights from Bydgoszcz

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Assumptions of the smart city concept are being introduced more and more often in cities all over the world, including in Poland. The idea is so popular because, among other things, it considers urban transformation in a comprehensive way. Because of how complex the smart city idea is, there is no comprehensive definition of the concept yet but there are a few most important determinants that should characterize a smart city. Those determinants are: smart people (active, open-minded, familiar with new technologies citizens), smart economy (an economy that is innovative, entrepreneurial and efficient), smart environment (citizens and city government cares about the natural environment and air quality; the renewable energy sources are broadly used), smart government (city authorities takes into account the citizens perspective and include city residents in the process of implementing smart city initiatives), smart living (friendly living conditions; access to both cultural events and good medical services) and smart mobility (modern, zero-emission transport) [1,2,3,4].

When implementing the smart city concept, attention is paid not only to issues related to sustainable development, but also to the role of residents and city authorities in creating a better living environment, or issues of modern communication infrastructure (ICT), access to broadly understood culture and public services.

The main objective of the study is to trace the idea of smart city from the perspective of everyday users of urban space on the example of Bydgoszcz (Poland, kujawsko-pomorskie region, population 348,190). It is a city whose local authorities are implementing initiatives that meet the requirements of the smart city concept, especially the smart government element of this idea. This raises the question of the role of locals in the process. Are they observers or rather active players with a responsive attitude towards undertakings initiated by local government entities? The research yields that Bydgoszcz residents are getting involved in the activities of the city authorities. The example is the Civic Budget. It is a democratic process of local's community discussing and making decisions on how and for what purposes to spend a part of the city budget. (Fig. 1). Initiatives of this type meet the guidelines of the smart city concept because they encourage locals to join the decision-making process.

Since 2012 when the idea of Civic Budget was first introduced to the citizens of Bydgoszcz, the popularity of the program increases year-by year. In 2019 votes reached a record number of over 75,5 thousand which is almost 1,5 more than a year before. Their commitment is determined by demographic and social characteristics. Nevertheless, it is visible that the city is engaging in social dialogue and going through an accelerating process of democratisation of planning decisions when introducing new pro-environmental solutions.

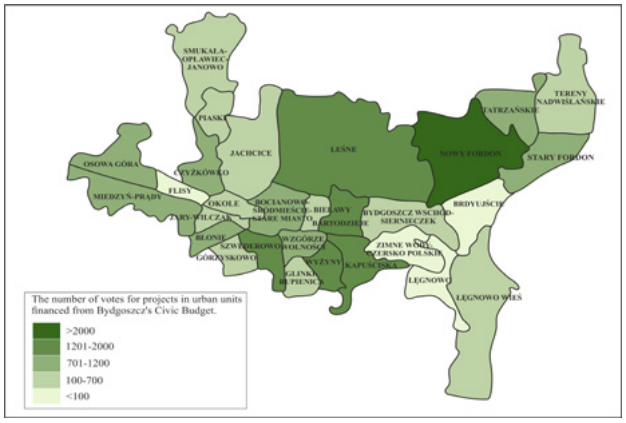

Figure 1. The number of votes for projects in urban units financed from Bydgoszcz's Civic Budget [5].

Along with the increasing number of votes grows the number of projects submitted for implementation. In 2020, despite the difficult epidemiological situation in Poland and in the world, the number of submitted projects in all urban units exceeded the previous year by almost 40.

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