REGREEN
NATURE-BASED SOLUTIONS

Fostering nature-based solutions for smart, green and healthy urban transitions in Europe and China

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WP N° 7 Urban Living Labs

KNOWLEDGE CO-PRODUCTION WITHIN THE EUROPEAN ULLS

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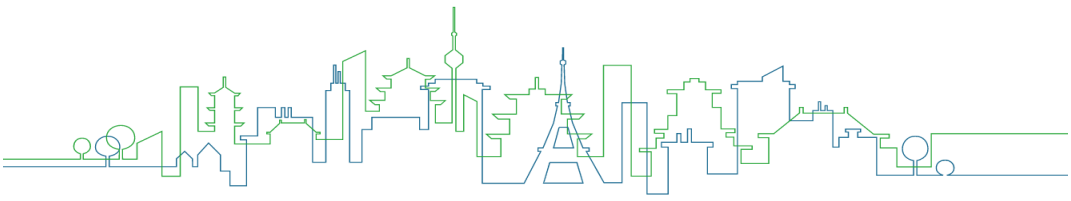

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EXECUTIVE SUMMARY

This document reports on the co-production of knowledge that took place within the three European Urban Living Labs (ULLs) within REGREEN, Aarhus in Denmark, Velika Gorica in Croatia, and the Paris region in France. The work is based on document analysis of progress reports and deliverables, workshop with partners in REGREEN and interviews with contact persons at the ULLs. The results show the involvement of the ULLs in the knowledge co-production within all the different tasks of REGREEN as well as that their role within the knowledge production varied. Different modes of engagement at different stages reflect different needs and thus roles for the ULL in the project. The result of the interviews also shows that municipal organisation influences engagement with the capacity of an ULL to both engage and disseminate is determined by size of organisation, financial power, mandate and structure but also remits on the topic as well as dedicated key actors. The role of communication, both between researchers and the public organisations representing the ULLs as well as internally within the public organisations are influencing the work. Clear communication of expectations and timelines early in the project is important to make collaboration more effective and productive for the public organisations. Another aspect raised was the communication and dissemination of the knowledge output to provide a larger impact, and hence contribute towards transformative change. Making results available through formats and in a language that is accessible by stakeholders working in the organization and in practice at large. However, the co-production of results is decisive to safeguard a learning process, which expects a continuous communication in form of feedback loops and thus a more genuine process of change can take place.

The study highlights the importance of European funded projects to raise the awareness of a topic such as Nature Based Solutions (NBS) within organisations, thereby creating a clear mandate and generating agency to shape and move forward the implementation of NBS.

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1 INTRODUCTION

1.1 Purpose of the document

The REGREEN project aims to promote urban liveability, through fostering nature-based solutions in Europe and China using evidence-based tools and improved urban governance accelerating the transition towards equitable, green and healthy cities. Central to the project is the use of Urban Living Labs, three in Europe and three in China. This report outlines the different processes of knowledge creation, communication and dissemination taking place within the European Urban Living Labs (Aarhus, Paris Region and Velika Gorica) within REGREEN. The report aims to explore the role of the ULLs within the project and what impact the REGREEN project has had more broadly within the organisations representing the ULLs (Aarhus Municipality, Paris Region and Velika Gorica Municipality).

The report does hence try to identify what potential there is for a research project like REGREEN to contribute towards knowledge development and transformative change within different types of organisations.

1.2 Scope of the document

The report focuses primarily on the involvement of the three ULLs, Aarhus, Paris Region and Velika Gorica in relation to the primary research Work Packages within REGREEN, WP2, 3, 4, 5 and 6. The work in the report is based on: the activities reported within the progress reports of REGREEN; a workshop involving the different researchers; and interviews with the contact persons in the three ULLs. In addition, for Aarhus, three more people were interviewed in order to explore the wider impact of REGREEN within the municipality. It was decided to focus solely on the processes taking place within the three European ULLs and hence excluded the three Chinese ULLs. This is based on the different status of the Chinese ULLs with the city administration not being partners in the project, and hence less directly engaged in the project and also the delay in time with the research taking place in China. We have also limited the analysis of the different tasks to those that were had been ongoing for a while by March 2023.

1.3 Structure of the document

The report starts with an introduction of the concept of Urban Living Labs, description of the three European ULLs and an overview of the overall structure of the REGREEN project with regards to Work Packages and tasks.

In order to explore the process of knowledge co-creation we present an analytical framework for capturing the process taking place within the ULLs in relation to REGREEN.

The method section outlines the three main steps, document analysis, workshop and interviews with contact persons of the ULLs.

Within the result section the results from the document analysis and workshop are presented firstly, followed by the results from the interview.

In the discussion the findings from the analysis of the REGEEN project is discussed in relation to processes of knowledge co-creation and transformative change.

2 URBAN LIVING LAB

2.1 ULL approach – what signifies it?

> *"Living Labs are user-centered, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings"* (The European Network of Living Labs (ENoLL))

Urban Living Labs (ULLs) are part of a wider interest and politics of experimental governance approaches and innovation processes to influence sustainable futures (Evans et al., 2016). Even though there are various understandings and approaches of so-called *Real World Labs* (Schäpke et al., 2018), they all represent open research environments, that explore in real-time society-science interfaces and function as arenas for learning. Core characteristics are that they *contribute to transformation*, *experiments are a core research method*; *transdisciplinarity* is understood *as core research mode*; *long-term orientation*, *scalability*, and *transferability of results*; as well as *learning and reflexivity* are central (ibid.).

As König and Evans (2013: 2) put it: "*The purpose of living laboratories is not only to allow novel things to be tried that would not be possible in conventional urban settings, but to also carefully monitor their social and physical impacts in order to provide a robust knowledge base for learning*." Recognizing and understanding the mechanisms between the actors and sites involved not only offers a learning arena for the actual local urban setting, though allows to abstract lessons learned to be applied elsewhere.

The goal of the REGREEN research project is to promote urban liveability, through fostering NBS in Europe and China using evidence-based tools and improved urban governance accelerating the transition towards equitable, green and healthy cities. This lends itself well with an ULL approach, providing an arena for transdisciplinary, transferability, learning and reflectivity that could aid in the transformation towards sustainable cities.

2.2 ULLs within REGREEN

2.2.1 The overall role of the ULLs within REGREEN

In the project description ULLs has a central role in the REGREEN concept, as the arena for co-creation of knowledge involving local citizens, schools, businesses, organisations and public administrations enabling new forms of urban innovation. The ULLs has been the testbed, where generic tools will be used to bring together the scientific results, new ideas and methods from the other project activities, and apply them in practise with citizens, urban planners, local businesses and other stakeholders. The aim is that this will result in novel approaches, methods and tools that could be integrated into decision support systems, guidelines and standards for developing and deploying urban NBS at a systemic and strategic level. The ULLs will thereby be the anchor for learning among scientists, urban planners and stakeholders through workshops, study tours, hand-on products (e.g., knowledge catalogues), and digital platforms.

In REGREEN there is a particular focus on the needs of vulnerable groups (such as young children, gender aspects, and socially deprived). Within REGREEN there are three European and three Chinese ULLs representing different sizes, locations, climates and socioeconomic preconditions. The ULLs range in scale from entire urban systems (including peri-urban areas), to local activities in neighbourhoods. In this deliverable the focus will be solely on the European ULLs. These are Aarhus, (Denmark), Paris region (Ile de France, France) and Velika Gorica (Croatia), see Figure 1.

The ULL has been organised within a separate Work Package, WP 7 Coordination of ULLs and below are the description based on the project proposal.

Analysis/activity	Aarhus	Ile de France	Velika Gorica
Urban drivers and pressures	•••	•••	•••
Cost-effectiveness of NBS	•••	•••	•••
Air pollution	•	•••	•
Noise mitigation	•••	•••	•••
Urban Heat Island	••	•••	•••
Urban flooding	•••	••	••
Water quality	••	•••	••
Biodiversity	••	•••	••
Recreation and amenity	•••	•••	•••
Social Media Data Mining	•••	•••	•••
Photo-elicitacion	•••	•••	•••
Value functions - ES	•••	•••	•••
Deliberative valuation	•••	•••	•••
Technology for env. school	•••	n/a	•••
Citizen Science	•••	•••	•••
Case study of governance systems	•••	•••	•••
Experimental policy learning	•••	•••	•••
NBS Training of technicians	•••	•••	•••
Meet-ups	•••	•••	•••
Accelerator programme	•••	•••	•••
Ideation events	•••	•••	•••
ULL field trips	•••	•••	•••
ULL transition workshops	•••	•••	•••

••• Thorough investigation e.g. via fine-scale modelling or in-depth analysis of perceptions.
•• Less thorough investigation e.g. using same approach, but with fewer interventions.
• Coarse, raps investigation, e.g. via coarse resolution or use of unit values. n/a not applicable.

Figure 1: The European ULL within REGREEN and activities taking place within them. (www.regreen-project.eu)

2.2.2 ULL Aarhus

The city of Aarhus is the 2nd largest city in Denmark with 273 000 inhabitants. It is located at 56.09°N-10.13°E on the east coast of Jutland. The city has a typical temperate climate with an average annual precipitation of 596 mm and an monthly average temperature range from -2 to 20℃. The municipality of Aarhus has the 2nd largest population in Denmark with a land area of 468 km2 and a total population of 341,000. The city of Aarhus occupies 91 km^2. The urban population density is around 3,000 people per km^2 compared to an average of 272 people per km^2 for the whole of the municipality. Over 90% of the inhabitants have access to green space within 500 meters from their home with an objective to sustain or increase green area per inhabitant through green blue structure planning in spite of densification. The city anticipates a densification with an additional 75,000 inhabitants by 2030. The water supply company of Aarhus Municipality will invest annually 19 Million EUR over the next 65 years to reach full separation of rainwater from wastewater using NBS and NBS hybrids to create a flood resilient city with rainwater on the surface instead of in pipes; Aarhus Municipality has decided to double the total nature area in the municipality by 2030 and increase the area with forested land by 60% by 2030 to ensure drinking water provision and improve recreation, biodiversity, social habitation and health and it focuses on improving accessibility to green areas to all citizens. Agricultural land and forested land account for under 60% and 11% of the land area respectively, protected areas including water surfaces 6% and settlements about 25%.

Environmental pressures: sea level rise, very high groundwater levels, and cloudbursts leading to pluvial flooding events causes disruption as well as economic and social costs. Pressures from intensive land use practices and urban land cover pose a substantial challenge to meet biodiversity SDG goals. Population growth in a densifying city adds to soil sealing, puts additional pressures on existing urban and peri-urban green spaces, increases demand for recreational green space and adds to the challenge of finding space for NBS to manage pluvial flooding.

2.2.3 ULL Paris Region

The Paris Region, France is the capital region of France, consisting of 8 Départements. It is located at 48.3°N-2.3°E, with a land area of 12,012 km^2. It has 12 million inhabitants, or 18.2% of the population of France. 21% of the territory is urbanised (16% totally impermeable), 23% covered by forests and 47% of the territory is composed of cultivated, mainly intensive open field crops. Paris region has 35 Natura 2000 sites and 11 Regional Nature Reserves and hosts many endangered species or taxa. Biodiversity has greatly depleted over the last decade, especially visible in agricultural areas and in urban parks and gardens. On the other hand, plants observed in urban informal spaces have increased by more than 90% in just 7 years. Green space per inhabitant is very scarce within the inner ring of Ile de France consisting of 4 Départements, varying between 2-10 m^2 by administrative unit. The region experiences substantial land take with more than 900 hectares of rural areas consumed each year by urbanisation. The municipality of Paris has an ambitious plan underway to expand green space through 100 ha green roofs and squares as well as an additional 30 ha of urban agriculture.

Environmental pressures: Urban heat islands represent a substantial risk in the region, exacerbated by heat waves and generally rising temperatures. In the 2003 and 2018 heatwave events, the Paris region was particularly vulnerable due to a very dense urban fabric, heavy traffic and lack of vegetation. Nocturnal temperatures differ in the range of 2.5℃ or up to 10℃ in special cases compared to rural areas. Ile-de-France also faces severe riverine and pluvial flooding events, which become more frequent and can be associated with intensive farming on the Seine basin, the lack of trees and hedges in agricultural areas, but also the lack of green infrastructure in peri-urban and urban areas to absorb excess of rainwater and slow water flow. Heavy traffic causes severe air pollution peaks every summer.

2.2.4 Velika Gorica

The City of Velika Gorica is the 6th largest city in Croatia with 63,517 inhabitants. It is located at 45.42°N-16.04°E close to the capital City of Zagreb in the central part of the Republic of Croatia. The city has an average annual precipitation of 495 mm and an annual average temperature range from -4 to 27℃. The municipality is the largest in the County of Zagreb, covering 328 km^2. The urban area covers only around 13 km^2 (ca. 4%) and was intensively constructed during the 1970s and 1980s. With 32.000 inhabitants, the urban population density is around 2.500 people per km^2 compared to 193 people per km^2 on average for the whole of the municipality. Urban green space accounts for about 1 km^2, with a target to reach 1.6 km^2 corresponding to 40 m^2 per inhabitant. Free urban public gardens have been introduced to interested citizens, covering close to 12,000 m^2 . In the near vicinity, lowland, humid wooded areas host the highest woodland biodiversity nationally. Separation of rainwater from the sewage system, accomplished in the 1970s, is based on grey infrastructure solutions, which partly causes flooding in downstream rural settlements. Agricultural land and forested land account for 37 and 38% of the land area respectively, water surfaces 4% and settlements 20%.

Environmental pressures: high traffic, heating with wood and oil combined with vast agricultural areas around the city and close vicinity to the main state airport contribute to excessive pollution, particularly of airborne particles during winter months. Land take for increasing urbanisation due to the proximity to the capital, Zagreb, add pressures on existing ecosystems. During recent years the city experienced an increased frequency and scale of flooding events and heat waves.

2.3 STRUCTURE OF THE REGREEN PROJECT

2.3.1 Overview and structure of the project

The REGREEN project constitutes of eight Work Packages of which WP 1 is a management Work Package. The other WPs are:

- WP2: Challenges and nature-based solutions
- WP3: Mapping and modelling ecosystem services
- WP4: Wellbeing assessments and valuing benefits of nature-based solutions
- WP5: Education, participation and awareness
- WP6: Governance and planning of urban nature-based solutions
- WP7: Urban Living Labs
- WP8: Innovation and Impact creation

The focus of this report is primarily on the main research Work Packages namely WP2, 3, 4, and 6. WP 7: Urban Living Labs is primarily focusing on the coordination of the ULLs and WP8: Innovation and Impact Creation is primarily focusing on outreach and exploitation. Below the different tasks for each WP is outlined, for full description of the WP and the task see Appendix 1.

WP 2: Challenges and nature-based solutions defines the challenges faced by the ULL and the potential solutions that can be provided by NBS. This WP underpins the activity that is taking place in many others and run throughout the project. The specific tasks involved are:

- Task 2.1 Conceptual framework for REGREEN that will underpin the work of the project.
- Task 2.2. Understanding urban drivers and pressures through defining, quantifying and mapping the key drivers and pressures within the ULLs.
- Task 2.3. Establishing a NBS knowledge base that forms a practical and scientific foundation of information on NBS across REGREEN's activities.
- Task 2.4. Cost-effectiveness of NBS addressing the knowledge gap relating to the efficacy and cost-effectiveness of NBS (noting the difference between this and cost-benefit analysis) including CEA studies will be carried out for selected NBS in the ULLs.
- Task 2.5. Informing solutions which builds on the previous tasks to provide a set of guidelines to inform business-focused developments of NBS solutions and development of decision support toolkits This includes a matrix of NBS interventions within the ULLs allowing a strategic assessment of individual NBS across the ULLs.

WP3 Mapping and modelling ecosystem services and biodiversity in their multiple expressions for human well-being provided by NBS through the development of an approach integrating multiple socio-ecological functions and services in varied cultural and climatic contexts. The specific tasks involved are:

- Task 3.1 – Evaluating of scale-dependent data and model applications for the ULLs.
- Task 3.2 – Modelling ES provided by multifunctional GI and NBS interventions tailored to selected ULLs.
- Task 3.3 - Integrated assessment to determine demand for future NBS interventions through the establishment of a framework to combine quantitative and qualitative data that explain

the urban demand of NBS from multifunctional green infrastructure by exploring their benefits and values for the ULLs.

- Task 3.4 – Develop tools and guidelines for mapping and modelling ES for the ULLs.

WP4 Wellbeing assessments and valuing benefits of nature-based solutions. The specific tasks involved are:

- Task 4.1: Evidence review and synthesis of a nature-based solution of interest across ULLs (street trees) and a wellbeing outcome of relevance for the ULLs (mental health).
- Task 4.2.1: An ecological momentary assessment of interactions with urban natural environments to be used with residents in the ULL to assess their experiences in a number of geo-located sites identified as nature-based solutions.
- Task 4.2.2: Photo-elicitation with community groups - A purposive sample of residents in each European ULL exploring their perceptions and experiences of nature-based solutions.
- Task 4.3.1 - Deliberative valuation through workshops with citizens in each of the European ULLs.
- Task 4.3.2 - Application of value functions to determine the value of ecosystem services from NBS for services which are being modelled in WP3 for the ULLs.

WP5: Education, participation and awareness collaborates with educational institutions and municipalities across ULLs to develop educational programs and digital tools to foster children's appreciation, understanding and involvement in local NBS. The specific tasks involved are:

- Task 5.1: Children's interaction with nature, exploring how children are differently positioned regarding natural environments in specific contexts within the ULLs.
- Task 5.2 Technology for nature-based learning, developing accessible technological learning tools to promote active physical and cognitive engagement with nature and facilitate experiences that generate reflection on NBS within the ULLs.

  Task 5.3 Citizen science, participatory education, and community planning – through elaboration on current citizen science programs (CSP), creating new models of citizen science that integrate educational, sociocultural and governance perspectives and explore ways of incorporating citizen science into community NBS planning within the ULLs.
- Task 5.4 Co-creation of NBS for children's play and learning activities taking place in Alnarp landscape laboratory (SLU).

WP6 The governance and planning of urban nature-based solutions, examines how city governing and planning institutions within different systems of governance address major challenges and transitions through integrating NBS. The specific tasks involved are:

- Task 6.1 – Governance including planning systems - examines how governance systems work in the urban areas of the ULLs to promote integrated policy approaches for NBS-based long-term transitions and focusses on institutional arrangements of urban governance, different administrative approaches and how these deliver different outcomes depending on the city and governance cultures and histories.

- Task 6.2 Experimental policy learning through co-creation processes with the ULLs the task explores how experimental governing approaches can be used to foster innovative solutions and policy learning among the public, stakeholders and city authorities to nurture innovative and novel governance and policy approaches to NBS.
- Task 6.3 Transferability of NBS based governance ideas among cities explores feasibility of transferring NBS-related policy innovations and learning approaches across different urban contexts through co-creation processes within the European ULLs.
- Task 6.4 Stimulating novel approaches for managing urban land take and integrating NBS in urban planning systems investigates new approaches to plan urban land take and new methods of integrating NBS firmly in planning systems within the ULLs.

3 KNOWLEDGE CO-PRODUCTION AND TRANSFORMATIVE CAPACITY

3.1 Introduction

Urban Living Labs (ULL) are lifted forward as an approach that explores in real-time society-science interfaces and function as arenas for learning (Bulkeley et al., 2016). The specificity of what constitutes an Urban Living Lab can vary in different projects and in scientific literature, though central for most ULLs is that they contribute to transformative change as they allow to test novel processes, actor constellations and practices that otherwise may not unfold. ULL represents transdisciplinary approaches, in which knowledge co-production takes place across disciplines and sectors, integrating more than academic expertise and highlighting practice-based knowledge. Research methods are often of explorative and experimental character and aim at long-term strategies and solutions. Learning and reflexivity are core objectives and qualities of an ULL to detect mechanisms that are scalable and transferable (see e.g. Schäpke et al. 2018).

Within this report we are specifically interested to explore in what different ways the ULL approach within REGREEN has been with regards to co-creation and potential transformative capacity for the contributing ULL. This will help us to explore further the benefits and possibilities as well as challenges and barriers that are within large-scale international research projects for providing a mechanism for utilising the full benefits of NBS.

We have in the work with this report primarily come to focus on three aspects in relation to co-creation and transformative change:

1. Urban Living Labs as a governance arrangement including novel actor constellations.
2. Urban Living Labs as a spatial medium for explorative studies.
3. Urban Living Labs different roles in co-production of knowledge

The reason for this decision was that ULL is both representing a (new) governance arrangement and has a particular spatial component and impact and the explicit focus of this deliverable which is to explore the ULL approach impact on the knowledge co-production process.

In the section below we will outline the theoretical framework with regards to these three aspects that are used as an analytical lens to explore the process of knowledge co-production taking place within the REGREEN project and its wider impact within the ULLs.

3.2 Governance arrangements in Urban Living Labs - operational structure

To meet contemporary societal challenges that are often wicked and complex, knowledge production and solution approaches have to cross disciplines and sectors and incorporate new constellations of actors (Polk, 2015; Wolfram & Frantzeskaki, 2016; Bulkeley et al., 2019). Here ULLs offer research and learning environments as well as models for knowledge co-production. Living Lab approaches may build upon the *quadruple helix* (state + academia + industry + civil society) if not the *quintuple helix* (state + academia + industry + civil society + (natural) environment) innovation model (Carayannis et al, 2012), which is basically describing the constellations of actors for knowledge production in a societal context, developing beyond the triple helix model (state + academia + industry), from a knowledge economy to a socio-ecological transition. But in practice how an ULL constellation unfolds varies, depending on remit, structure and perceived longevity of the ULLs.

Thus, (new) governance arrangements allow potential novel co-production of knowledge: "*In reframing urban development experimentation* [it] *shifts the balance of power between actors, empowering some while disempowering others, and privileging new forms of knowledge and evidence in the process*" (Karvonen et al. 2014 in Evans et al, 2016:3). Decisive for the co-production process is the agency and power distribution between the actors in an ULL. The *politics of experimentation* can be investigated according to its inclusive character; who is allowed to take part and with what kind of agency and knowledge, who might be excluded and how? What are potential consequences? The ULL governance structure is "*the means through which power and agency are orchestrated and take effect*" (Bulkeley et al., 2016) and might explain the success or also challenges in a co-production practice. 'Failures' are important opportunities to learn and should not be underestimated in their value.

Laborgne et al. (2021) highlight the local anchoring of an ULL to be meaningful and successful. This means that local stakeholders need to be engaged from the beginning and impact ULLs goals, to shape opportunities for active commitment and thus also enable identification and local ownership of the ULL activities. Those potentially new forms of collaboration can impact existing or may shape new roles, qualifications and legitimacies. Those aspects will be of importance for the implementation and/or amendments of policies and how ULLs take socio-spatial shapes.

3.3 Urban Living Labs as spatial medium for explorative studies in real time

Taking an ULL as an arena for learning in real-time, relationships and mechanisms can be observed and studied, new ideas can be tested with a likely response in that real-world environment. This offers opportunities for developing more targeted measures and developing a change-management approach of socio-spatial character. However, those change processes take time and thus a genuine ULL approach needs to span over a longer time horizon (Laborgne et al., 2021).

With an interest in impacting actual practices and socio-spatial arrangements the observation and active engagement in the "*reworking* [of] *the relationships between social and material networks in the context of existing economic, social, and political trajectories*" (Evans et al, 2016: 4) can be key. Selecting and identifying measures as well as monitoring effects can lead to a re-alignment of knowledge and resources. ULLs as actual sites, their spatial components, interventions,

demonstrations, consequences etc. play an important role as they are experienced, do communicate and translate governance arrangements into materialities and socio-spatial relations and thus affect the perception of impact. As spatial medium ULLs can help to clarify potential transformative capacities (Wolfram et al., 2019); i.e., by demonstrating alternatives that can be experienced and tested. The spatial experience allows an increased awareness if not understanding of systemic relations and governance networks and can thus help to recognise e.g., societal deficits as well as community strength (ibid.).

The physical and temporal conditions of the ULLs do reflect the underlying governance arrangements. Ideally the ULL represents an iterative and reflexive process of knowledge co-production, learning and sharing of lessons, reassessing and further developing. This in turn may create more flexible and temporary structures, which are under scrutiny in their real-life contexts.

3.4 Roles for Urban Living Labs within knowledge co-production

A ULL and actors within it have different roles in the knowledge co-production taking place. Kronsell and Mukhtar-Landgren (2018) investigate the role of municipalities in experimental governance arrangements, which they define as "*multi-actor collaborations,* [that have] *informal elements,* [and] *public–private interactions are common*" (Kronsell & Mukhtar-Landgren, 2018: 991). Understanding ULL as one form of experimental governance, particular interest lies on 'how' municipalities may act to facilitate ULLs. They identify roles that municipalities could take (ibid: 992ff):

- the '*promoter'* stays in the hierarchical logic, with a top-down approach, in which municipal actors initiate, finance, and implement ULL on their own.
- the '*enabler*' refer[s] to the role of local government in facilitating, co-ordinating and encouraging action through partnership with private- and voluntary-sector agencies, and to various forms of community engagement.
- the *'partner'* is not associated with formal steering or authority but related to engaging or participating in partnership on fairly equal terms and as such represents a conceptual shift away from authority-centred towards network-centred governance processes.

Next to those three active roles, there is also a possibility of a so-called 'non-role', as passive position (ibid.). However, in any case and also if strategically chosen or if assigned, municipalities do have a role in impacting these co-creation processes. Shifting roles in new governance arrangements certainly impact questions of power and legitimacy. The role of democratic representation and power to implement or regulate changes may stay with the municipality (ibid.) and needs to be thought together with a new interest in experimental governance to impact transformative change due to potential new mandates and power relations in those co-production processes.

Sustainability challenges ask for new capacities and thus also new roles and abilities. Urban transformative capacity can be understood as "*the collective ability of the stakeholders involved in urban development to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across multiple complex systems that constitute the cities they relate to*" (Wolfram, 2016:126). Developing transformative capacity is always relational in the sense that it relates to a given context of space, actors, institutions, though also to their (systemic) interrelationships, to power and values (Wolfram et al., 2019). There are simultaneously processes of *exnovation* (expose and dismantle path-dependencies) and *innovation* (create, nurture and anchor novelties) as well as a processes of *diversity and contestation* and *aligning of diverse actions* going on (Wolfram, 2016). A combination of different types of capacities needs to be considered; e.g. Hölscher

et al. (2018) identified *stewarding, unlocking, transforming,* and *orchestrating* that operate different agencies within and beyond existing system structures.

The potential for transformative capacities thus relates to various core characteristics of so-called real-world *laboratories* (a collective term which includes ULLs) (Schäpke et al, 2018): e.g., to *contribute to transformation* by representing actual observed socio-spatial transformation processes and/or transformative research that *detects the mechanisms* for such change. There is still little or no coherent knowledge on how transformative change and inclusive models, such as ULLs, could contribute here. *Experiments* as one core research method (type, form of knowledge, level of control) need always scrutiny and reflection if and when appropriate, depending on the type of lab and experiment. *Transdisciplinarity* as research mode (intensity of participation, participants, integration of different knowledge – scientific and societal) is complex and it is important to identify key actors that are able to translate and connect across boundaries to push transformative change, be aware of the value of ownership as well as possible conflicts in knowledge integration processes. *Long-term orientation, scalability and transferability* of results need to deal with the situated and context dependent character of a ULL; further, funding structures can have strong influence on e.g., physical presence of labs, diffusion of ideas in society as well as type of studies/research (e.g., longitudinal), which in turn influences what and how something is scaled/transferred. Labs as arenas for *learning and reflexivity* (competency development, social learning, transdisciplinary collaboration and respective reflexivity) can and should make use of multiple models of learning to achieve best's benefits; however, this may also expect unlearning for radical change as well as reflexive co-learning (ibid.).

4 METHOD

To understand the knowledge production processes in the ULLs, the actor constellations, their communication practice and formats as well as in- and outputs were of interest. The following aspects were investigated for each of the European ULLs:

- **Organizational structure of each ULL organization in relation to NBS** (who sits in the organization, who is involved, which department, collaboration partners for the ULL contact persons).
- **Stakeholder communication** (with whom and how do stakeholders communicate about/within the ULL, how do they disseminate the knowledge, are there potential barriers (e.g., language, complexity, time)).
- **Knowledge co-creation process** (how has collaboration been performed/designed between the ULL organizations and researchers, at which scale, e.g., task level).
- **Influence and impact of ULLs in municipalities** (any concrete impact, such as on a policy plan, actual planting of vegetation, change in political mandate; as well as more implicit impacts of changes in discourses and agenda setting practices).

In order to understand the processes taking place and the role of the ULLs within the REGREEN project we carried out a two-step analysis:

Step 1. WP perspective – Document study and internal workshop at REGREEN project meeting.

Step 2. ULL perspective – Semi-structured interviews with ULL contact persons.

4.1 WP perspective

4.1.1 Document study

We used an analytical framework with a questionnaire to analyse the documents, as outlined in Table 1. The questions were posed in three different steps:

1. Deliverables
2. Progress reports
3. Minutes from meetings

Table 1: Analytical framework applied to each task (in parts inspired by Arts, Leroy, & van Tatenhove, 2006)

Theme	Questions for the task	Explanation
Knowledge co-creation	Method deployed	What methods are used?
	Knowledge input	What knowledge – input into the task – specifically from the ULLs?
	Knowledge output	What type of knowledge is produced?
	User of Knowledge	Who will use the knowledge?
Governance arrangement	Actors	Who has been included?
	Resources	Type of knowledge?
	Rules for collaboration	Flow of information – knowledge Mode of communication
	Discourse for collaboration	Type of exchange?
	Benefits for collaboration	Defined explicit or implicit
Measure of success	Definition of success	Is and if so how is success defined? (explicit or implicit; scientific or for ULLs)
	Measurement of success	Scientific, impact, etc.
Spatial scale	Scale of task	What is the area used in the task?
	Time scale	What time frame is considered in the task?
	Type of task	What method does the task contain?
	Objective	What is the objective of the task?
	Impacts on the ULL	Changes taking place in the ULL as a result of the project
	Potential for upscaling	Is this discussed within the tasks?

This information was summarised as a table for each task and later transferred into a figure for each WP outlining the involvement and role of the ULLs in the different tasks.

4.1.2 Workshop

A summary of all tasks with regards to governance arrangement as well as spatial scale was sent to the task leader as well as WP leads to confirm the description as well as to add complimentary information not captured through the analysis of the written material.

4.2 ULL perspective

4.2.1 Interviews with ULL coordinators

Based on the results from the desk study interview questions were formulated for semi-structured interviews with all three European ULL coordinators. In the Aarhus ULL other stakeholders at the municipality that were engaged within REGREEN were also interviewed. The choice of Aarhus was due to the larger involvement of different members of staff within the organisation as well as time limitation for carrying out similar interviews in all three ULLs. Each interview was transcribed and coded in relation to organizational structure, stakeholder communication, knowledge co-production, influence of REGREEN on the ULL and, concluding reflections.

5 RESULTS

5.1 Co-production of knowledge within the tasks of REGREEN – an overview of the involvement of ULLs in research activities

5.1.1 Overview

The below section provides an analysis of the different tasks carried out within REGREEN with regards to:

- Knowledge co-creation taking place within the ULL
- Governance arrangement
- Spatial scale of task
- Measure of success
- Interaction with the European ULLs

This information is based on the progress reports, deliverables and workshop with WP and task leaders within the REGREEN project.

5.1.2 WP 2: Challenges and NBS

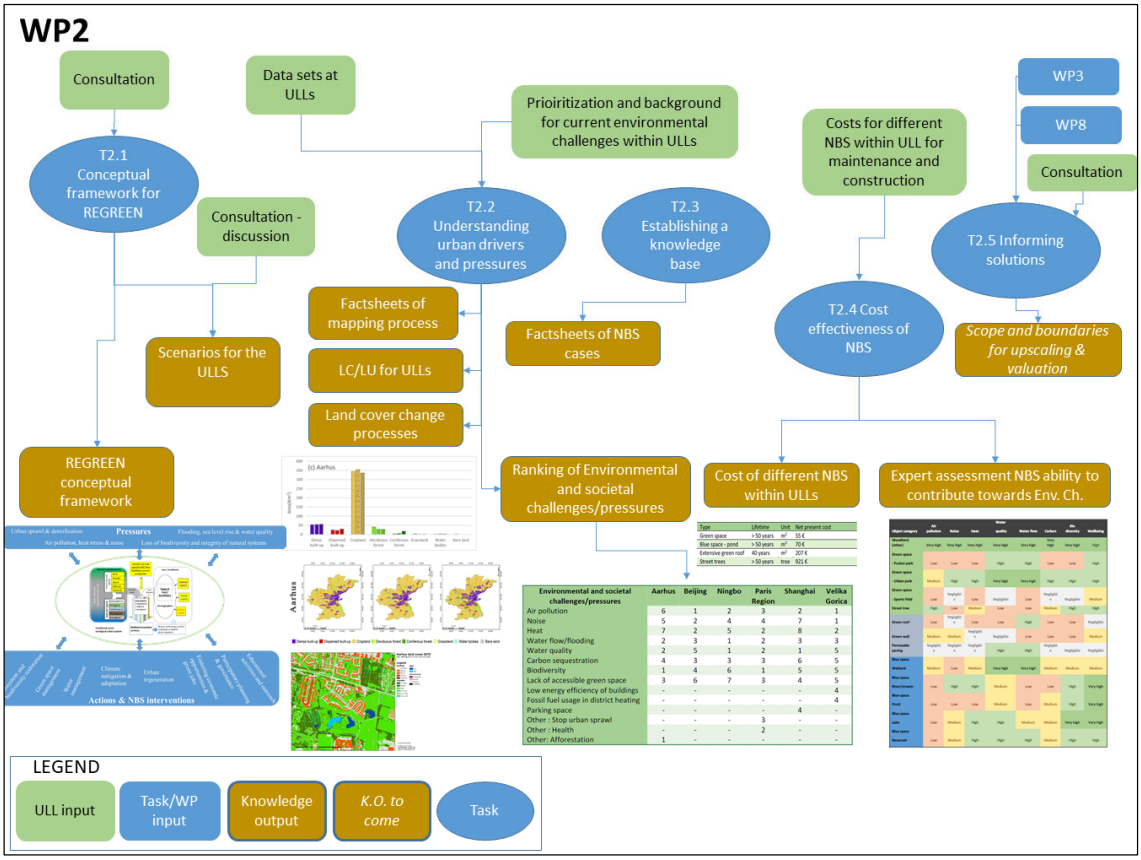

Figure 2. Mapping of knowledge production within Work Package 2.

WP 2 is constituted of five different tasks, producing a wide range of different knowledge output and with different involvement of the ULLs within this process, as outlined in Figure 2.

T2.1 Conceptual framework for REGREEN – Within this task a conceptual framework to guide the work within REGREEN was the first knowledge output. This was done through multiple interactions between the researchers involved in the task and with the ULL coordinators involved in discussions during REGREEN project meetings. In addition, a second type of knowledge, produced and located under T2.1, was the development of future scenarios for each ULL which are used in tasks for WP3, 4 and 6. The scenarios were developed in collaboration with the ULL coordinators via multiple meetings.

T2.2 Understanding urban drivers and pressures - Urban drivers and pressures within the ULLs and was done through two different approaches. Firstly, environmental and societal challenges/pressure were identified and later prioritized in collaboration with each ULL through meetings and email exchanges where the ULL contributed with local knowledge. This resulted in a knowledge output in the form of a table listing challenges and their priority for the ULLs. The ULLs also provided background information explaining why these challenges are so important. This provided input within REGREEN for the selection and prioritization of modelling carried out in T3.2.

Secondly, land cover mapping was carried out (by UFZ, FU and THU) for three years (2000, 2010 and 2020) for all three European ULLs, using spatial data sets partly provided by the ULLs, through a mapping routine of Google Earth Engine (GEE). The knowledge output was a multi-temporal, ten-year-increment dataset containing the changes in the urban area along seven land- cover classes at a 30m

resolution. This allowed measurement/description of land cover change processes over the past two decades for all three European ULLs as a knowledge output described through diagrams and text. The work was published as a peer-reviewed scientific article.

Since some of the models used in T3.2 as well as the work conducted in T3.3 require a higher spatial resolution with finer categorical details, both with regards to the thematic content as well as refined spatial information, the three European ULLs are mapped at neighbourhood scale, independent of data availability, see Figure 7.3 for an example of Aarhus. This work has been carried out by UFZ with assistance from the ULLs and for areas identified by the ULLs as being most relevant.

The mapping processes was described in factsheets, presenting the approach used, and distributed to the ULLs.

Task 2.3. Establishing a NBS knowledge base - The task was carried out as a review and identification of best practice example of NBS cases based on criteria identified in a meeting at the 2nd project meeting. The ULL contacts provided input on NBS cases to be included in the final set of 14 cases identified by the ICLEI team. The knowledge output was 14 fact sheets of NBS cases collated in D2.2 and distributed through OPPLA and REGREEN homepage.

Task 2.4. Cost-effectiveness of NBS - This produced an overview of costs for different forms of green structure elements that can serve as NBS. A review of costs for green and blue spaces in urban and peri-urban areas, but also de-pavement projects, street trees, green roofs and green walls was carried out and complimented by costs provided through contacts with the ULLs for ULL Aarhus and ULL Paris Region as well as specifically for Åbyhøj area (ULL Aarhus) and Croult river in Gonesse (ULL Paris Region). The knowledge output was tables (with accompanying text) providing costs for establishment and maintenance. The result of the review summarized the median costs for different NBS in relation to units for green space, blue space (pond), extensive green roof and street trees.

The results were further discussed in relation to how the cost-effectiveness analysis can be expanded to account for the potential multiple benefits provided by nature in urban and peri-urban areas that are in line with the spatial planning policy objectives by local authorities.

In addition, an expert assessment of different NBS ability to contribute towards different environmental and societal challenges and pressures was carried out resulting in a knowledge output primarily in the form of a matrix describing the ecosystem service output from different NBS, generally (not ULL specific).

T2.5. Informing solutions - The work is carried out in close collaboration with the ULLs through various forms of interactions such as workshops.

Part of the work of T2.5 is reported in D2.4 Guidance on development of the toolkit for exploring options and potential benefits of NBS design (Tuerk et al. 2021). This was developed in collaboration with the ULLs in order to take into account their needs. The report presents a matrix of NBS interventions within ULLs and assesses their applicability to other situations, allowing a strategic assessment of individual NBS across the ULLs.

Table 2: Publications produced in Work Package 2.

Task	Name	Type	Audience
T2.1	D2.1 Report on assessment of driers and pressures leading to urban challenges, across the ULLs, including spatial and temporal components	Report	REGREEN
T2.2	Banzhaf, E., Wu, W., Luo, X, Knopp, J. Integrated mapping of spatial urban dynamics to evaluate ecosystem services – a European-Chinese exploration. Part 1 – Methodology for land cover mapping tailored for spatial allocation of ES features. Submitted to MDPI Journal Remote Sensing	Scientific paper	Scientific community
	Wu, W.; Ma, J.; Meadows, M.E.; Banzhaf, E.; Huang, T.-Y.; Liu, Y-F.; Zhao, B. (2021). Spatio-temporal changes in urban green space in 107 Chinese cities (1990-2019): The role of economic drivers and policy. International Journal of Applied Earth Observations and Geoinformation 103, 102525. https://doi.org/10.1016/j.jag.2021.102525.	Scientific paper	Scientific community
	Data made available via Zenodo: Wanben Wu (2022). Europe and China Refined Land cover (ECRLC) V2 (2020, 10m) (Version V2) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5846090	Data	Partners, scientific community
	Factsheets on: • Mapping by using Google Earth Engine (GEE) • Urban land cover mapping framework • Urban morphology mapping framework	Factsheets	Planners, REGREEN
T2.3	D2.2 NBS knowledge base collective report	Report	Cities
T2.4	D2.3 Cost-effectiveness of NBS in the urban environment	Report	REGREEN
T2.5	D2.4 Guidance on development of the toolkit for exploring options and potential benefits of NBS design	University	

Summary – knowledge co-creation in WP2

The different task carried out in the WP 2 was to a large extent focused on understanding the ULLs (e.g. scenario development, understanding of urban drivers and pressures, costs associated with NBS). Here the ULLs provided a crucial role in providing information to the researchers within the task but also to provide reflections and insights into the results based on their needs and requirements. Within the Work Packages there has been several reports and scientific papers but also factsheets for more easily communication to the practice, see Table 3.

5.1.3 WP3: Mapping and modelling ecosystem services

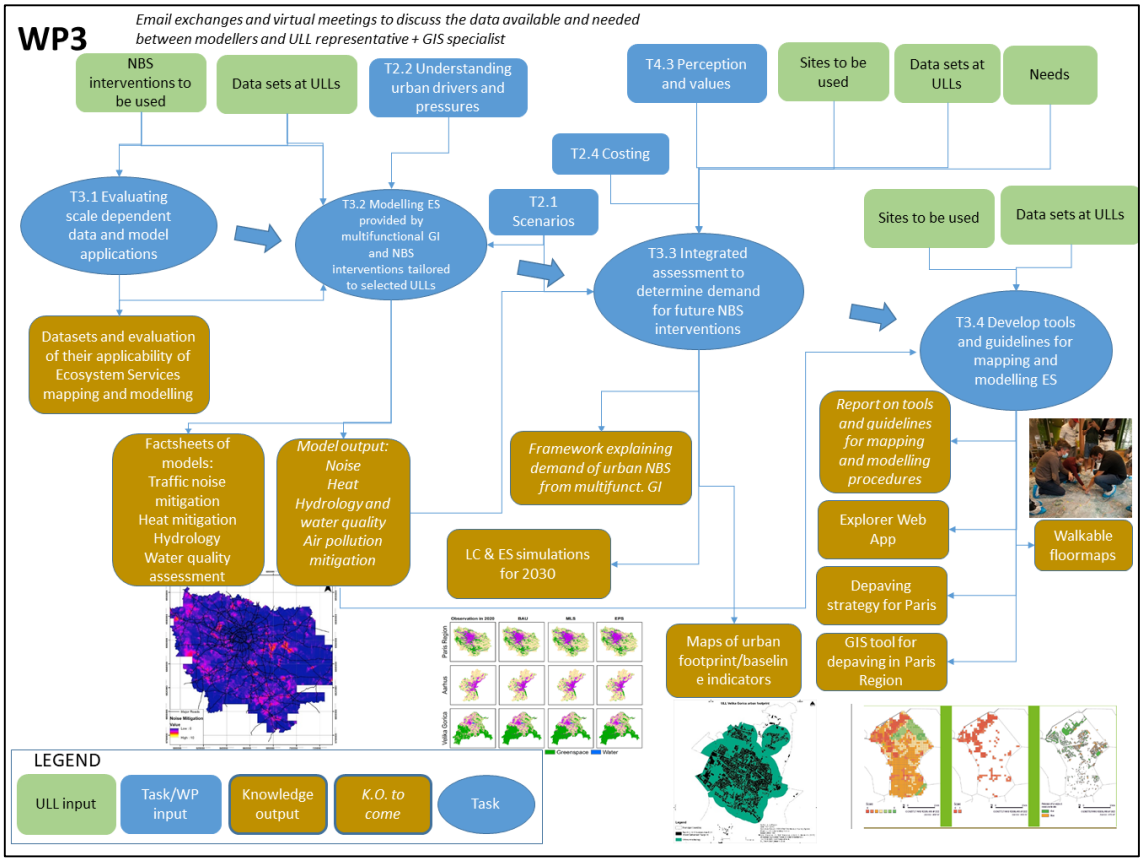

Figure 3: Mapping of knowledge production within Work Package 3.

WP 3 is closely linked to WP 2 and is formed by four different tasks that are linked. The input from the ULLs focuses mostly on the provision of site-specific knowledge and data. The knowledge output ranges from data sets, fact sheets, apps to approaches.

T3.1 Evaluation of scale-dependent data and model applications – This task produced an overview of data sets and their capability for ecosystem service mapping and modelling that formed the input for T3.2. The input from the ULLs was mainly in relation to providing data and participating in discussions on details of existing data sets and missing data sets and their availability elsewhere.

The data sets collected included publicly available data by European agencies, allowing consistency across the European ULLs. All data were stored on our REGREEN SharePoint to share with everybody in the project. The collaboration with the European ULLs allowed a common understanding of the pinpointed needs for ES which guided the selection of appropriate model and scale for their application. By tailoring them to specific sites, they allow optimal design of operational NBS.

T.3.2 Evaluation of scale-dependent data and model applications -The task objective is to model ecosystem services within the European ULLs. This needs interaction between the researchers and ULLs for identifying available data sets needed for the modelling as well as more detail on areas to be used as outlined in T3.1. The ecosystem services that were modelled were decided in collaboration with ULLs in relation to their needs and were noise, heat, hydrology and water quality, air pollution mitigation with exploration of biodiversity, carbon stock, and education potential.

Task 3.3 - Integrated assessment to determine demand for future NBS interventions - This task summarised the key final ecosystem service model outputs and the precise metrics, which were calculated or modelled for future scenarios. The knowledge output produced were in the form of land cover and ecosystem service simulations for 2030 and maps of urban footprint/baseline indicators bringing in socio-economic data. The ULLs were involved with regards to the sites to be analysed, identifying the needs and providing data sets that were used as input. In parallel, for each ecosystem service, economists in WP4 discussed the possible valuation options for each service and considering wider aspects such as which sort of impacts to focus on (human health, ecological, business impacts, etc.), and time frames for valuation. This assessment needed to consider the needs across all services as well as individual services and ULLs. Discussions have also been conducted with economists in WP2 around the cost of interventions to ensure consistency.

In addition, a framework is being developed explaining demand for urban NBS from multifunctional Green Infrastructure.

Task 3.4 – Develop tools and guidelines for mapping and modelling ES – This task has multiple knowledge outputs in the forms of maps, reports and tools. During the virtual project meetings in Leipzig (PM2, November 2020) Graz (PM3, March 2021) and Paris (PM4, May 2021), the format and outcome of this task was discussed with participation of representatives of ULLs, modellers in WP3 (UKCEH and JR) and representatives of WP8 (JR and ZEZ). Critical issues, such as what types of ES modelling and site-specific modelling outcomes are relevant to stakeholders were identified. Among these, the need to assess multiple ES related to NBS interventions. This task and the report D3.4 (Report on tools and guidelines for mapping and modelling procedures) will provide critical information to D8.2 (Decision support tool online). Specific tools/guidelines developed:

Walkable floor maps represent a knowledge output produced for all three European ULLS. The maps consist of aerial photos / satellite images and, as such, present a static view of a study area which is rolled out on the floor providing possibilities to walk around the city. This static view of an area is supplemented and made dynamic through QR codes which tell stories about present and planned activities with respect to NBS in the area. Within REGREEN floor maps are used as a learning approach to synthesise different aspects related to education and governance in the REGREEN project. The ULLs has been engaged in their development and subsequent use in workshops with regards to sites to be used, data sets, but also framing and arranging the workshops.

Strategies for depavement and regreening. A methodology developed by IPR (T3.4) for identifying the depaving and regreening potential in cities. The method will help local authorities to target urban areas where renaturing represents a key strategy to restore biodiversity, adapt to climate change and improve people's health. The deliverable is also based on feedback from respondents in the field, it provides recommendations on how to implement depaving and re-greening projects in the best possible conditions. The work included feedback from respondents in the field and provides recommendations on how to implement depaving and re-greening projects in the best possible conditions.

Table 3: Publications produced in Work Package 3.

Task	Name	Type	Audience
T3.1	D3.1 Synthesis report on current datasets and their applicability of ecosystem services mapping and modelling	REPORT	REGREEN
	Wu, W., Luo, X, Knopp, J., Jones, L., Banzhaf, E. Integrated mapping of spatial urban dynamics to evaluate ecosystem services – a European-Chinese exploration. Part 2 - Spatial patterns of urbanisation processes to estimate equity in ecosystem services provision.	Scientific article	Scientific community
T3.2	Education potential from Biodiversity' using Aarhus as a case study.	Conference presentation	Scientific community
	Factsheets on: • Water quality assessment model QUESTOR • Atmospheric chemistry transport model (EMEP) and weather research and forecast model (WRF) - EMEP-WRF • Hydrological modelling • Traffic noise mitigation • Heat mitigation •	Factsheets	Planners, REGREEN
	Miller et al. (submitted). Hydrological assessment of urban NBS in Ecosystem Service toolkit applications.	Scientific article	Scientific community
	Baker, H.J., Hutchins, M.G. and Miller, J.D., 2021. How robust is the evidence for beneficial hydrological effects of urban tree planting?. Hydrological Sciences Journal, 66(8), pp.1306-1320.	Scientific article	Scientific community
T3.3	Banzhaf, E.; Anderson, S.; Grandin, G.; Hardiman, R.; Jensen, A.; Jones, L.; Knopp, J.; Levin, G.; Russel, D.; Wu, W.; Yang, J.; Zandersen, M. Urban-Rural Dependencies and Opportunities to Design Nature-Based Solutions for Resilience in Europe and China. Land 2022, 11, 480.	Scientific article	Scientific community
	Wu, W.; Luo, X.; Knopp, J.; Jones, L.; Banzhaf, E. A European-Chinese Exploration: Part 2—Urban Ecosystem Service Patterns, Processes, and Contributions to Environmental Equity under Different Scenarios. Remote Sens. 2022, 14, 3488	Scientific article	Scientific community
	Ellen Banzhaf, Wanben Wu, Xiangyu Luo, & Julius Knopp. (2021). Europe and China Refined Land cover (ECRLC) [Data set]. In Remote Sensing (Version V1, Vol. 13, p. 1744). Zenodo	Data sets	Scientific community, partners
	Wanben Wu. (2022). Europe and China Refined Land cover (ECRLC) (10m) (Version V2) [Data set]. Zenodo.	Data sets	Scientific community, partners
	Wanben Wu, Xiangyu Luo, Julius Knopp, Laurence Jones, & Ellen Banzhaf. (2022). Refined Land cover for Beijing, Shanghai, Ningbo in China and Paris Region, Velika	Data sets	Scientific community, partners

Task	Name	Type	Audience
	Gorica, Aarhus in Europe under different scenarios in 2030 [Data set]. In Remote Sensing (Version V1, Vol. 14, p. 3488). Zenodo.		
	Elze, S. & Banzhaf, E. 2022. High-precision monitoring of urban structures to understand changes in multiple ecosystem services. Urban Forestry & Urban Greening, 73, 127616. doi.org/10.1016/j.ufug.2022.127616.	Scientific article	Scientific community
T3.4	D3.2 Guidelines for depaving and re-greening strategies	Report	REGREEN, planners
	D3.3 Laurence Jones; Sally Anderson; Jeppe Læssøe; Ellen Banzhaf; Anne Jensen; David Neil Bird; James Miller; Michael Hutchins; Jun Yang; Joanne Garrett; Tim Taylor; Benedict Wheeler; Rebecca Lovell; David Fletcher; Yueming Qu; Massimo Vieno; Marianne Zandersen. (submitted) A typology for urban Green Infrastructure, to guide multifunctional planning of nature-based solutions. Revised and re-submitted to Elsevier journal Nature Based Solutions	Scientific paper	Scientific community

Summary – knowledge co-creation in WP3

Within WP3, the modelling of different ecosystem services was a large part of the Work Package, with T3.1. providing an initial evaluation of data sets. Within this task, the ULL provided data sets to be used but was also crucial through discussions of future scenarios and NBS interventions to be used in the modelling. The contact person for the ULLs was also part of discussion of the spatial areas for the models to be applied at. In T3.4 the ULLs had an important role in the testing and use of the tools developed. Here ULL Paris also had a role of being a sub-task leader with the development of a depavement strategy for the Paris region. Within WP 3 a set of fact sheets were developed to outline the models, see Table 4, in addition to reports and scientific publications.

5.1.4 WP4 Wellbeing assessments and valuing benefits of nature-based solutions

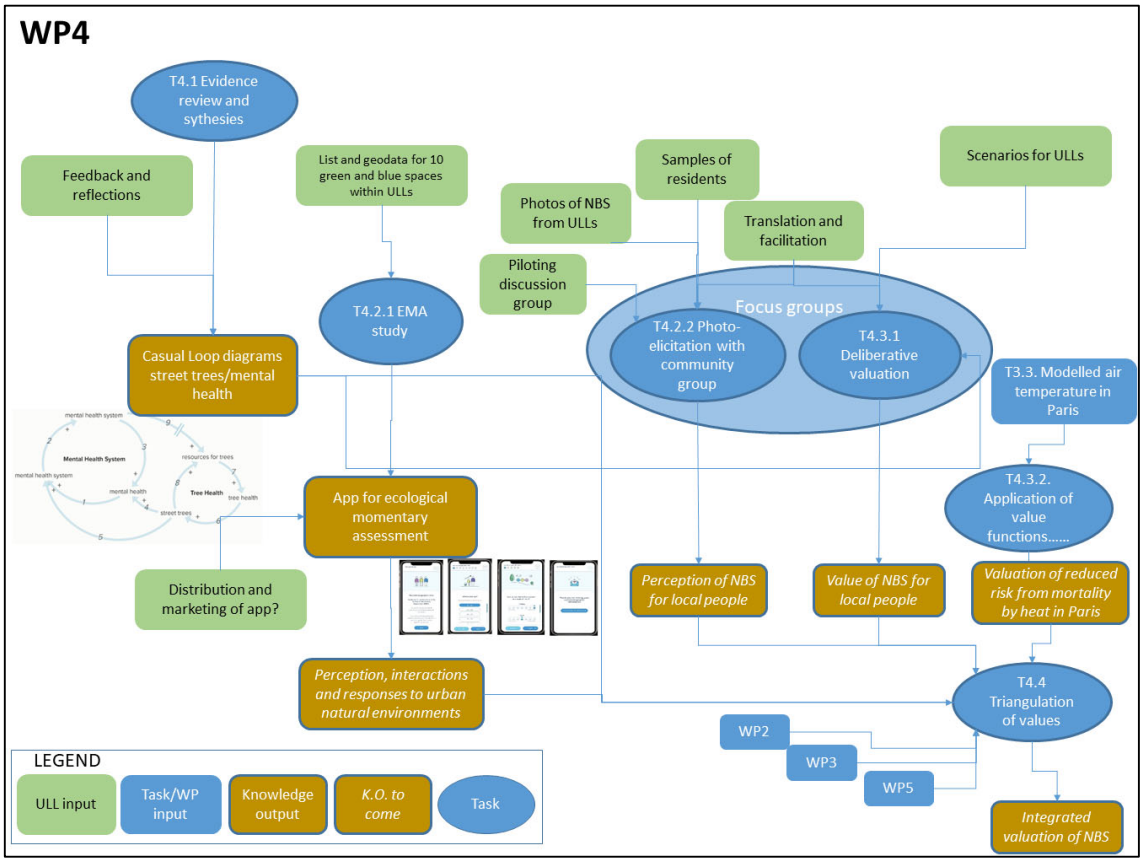

Figure 4: Mapping of knowledge production within Work Package 4.

Task 4.1: Evidence review and synthesis - The objective of the task was to review and synthesise the evidence the relationship between street trees and mental health. This was done as a Causal Loop Diagram (CLD) model. The model was validated with all three European ULLs, in addition to two experts, through on-line meetings. Several people from the ULLs participated in these meetings.

Task 4.2.1: An ecological momentary assessment of interactions with urban natural environments - The objective of the task was to provide a momentary assessment of interactions with urban natural environments within the ULLs. The ULLs contact persons together with researchers in the task curated a list and geodata of 10 green and blue spaces in the ULLs representing diverse uses and functions. These areas were selected for conducting the ecological momentary assessment on-site.

Task 4.2.2: Photo-elicitation with community groups - The objective of the task was to explore the perceptions and experiences of NBS by local people using focus groups. Local ULL partners have provided local NBS photos for the photo-elicitation and helped in identifying a diverse sample of residents for the focus groups as well as providing a venue for hosting these exercises. A protocol has been developed for online focus groups; that includes direct translation within a video conference call through the recruitment of a translation company. These has also supported translation of relevant project documents for recruitment.

Task 4.3.2 - Application of value functions to determine the value of ecosystem services from NBS for services which are being modelled in WP3 - The task carried out a valuation of the reduced risk from mortality by heat from public green spaces for residents in Paris. This task involved collaboration with WP3 and the use of an output from WP3 of modelled air temperature for Paris. The task also reviewed literature for relative risks of mortality associated with temperature for a range of cities in France. The modelling work was carried out for three days during the heat wave in 2019. Public green spaces were selected for further analysis where they were at least 100 m from the nearest other green space or water body and a minimum size of 1000 m2. Based on the maximum detectable cooling distance, and temperature; the health effect in terms of lives saved and lives saved per square meter green space; and the economic value using the value of a statistical life was calculated.

There was no direct involvement of the ULL in the task but the ULLs has been involved in T3.3 which fed into the task.

Table 4. Publications produced in Work Package 4.

Task	Name	Type	Audience
T4.1	D4.1 Report on progress in WP4, focusing on evidence review, perceptions and assessment of the totality of benefits and values		
	D4.2 Alvarado et al. (submitted) "Using causal loop diagrams to develop complexity-informed hypotheses: reflections on opportunities and challenges". For submission to Special Issue Qualitative Aspects of Systems Dynamics Modeling in the journal System Dynamics Review.	Scientific article	Scientific community
	Alvarado et al. (In review) "How may street trees impact mental health? A complexity-informed synthesis using causal loop diagrams". Ecology & Society.	Scientific article	Scientific community

Summary – knowledge co-creation in WP4

WP4 focused on the assessment of well-being and evaluation of benefits of NBS, and within this task the primary role of the ULLs was to provide information such as photos and areas to be used and to facilitate the workshops carried out. They were also involved in the piloting of the workshops. Within T4.1. each ULL was invited to a workshop to reflect on the results from a literature review on the relationship between street trees and mental health. There has also been involvement of the ULLs with regards to facilitating the different workshops taking place as well as providing materials such as photographs and sites to be used. Table 5 lists the publications produced.

5.1.5 WP5 Education, participation and awareness

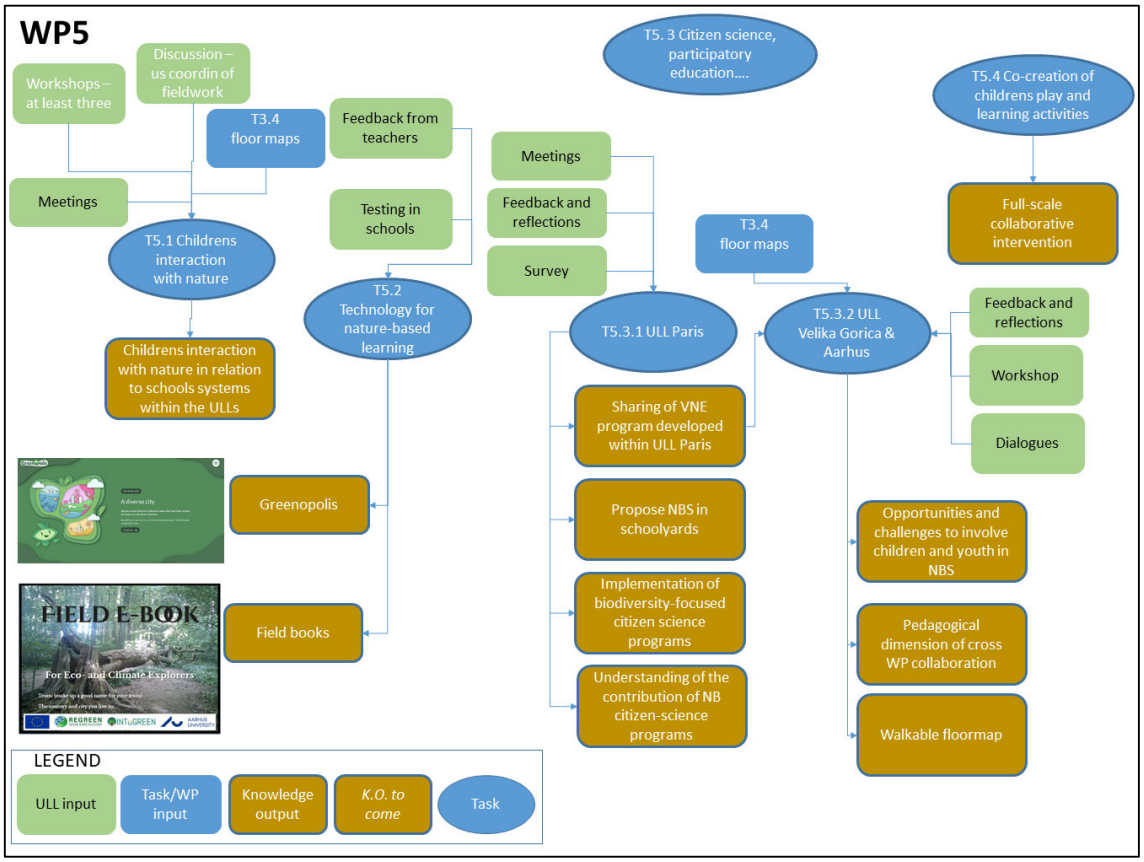

Figure 5: Mapping of knowledge production within Work Package 5.

Task 5.1: Children's interaction with nature - Plans for collaboration were developed (Aarhus, Velika Gorica) for preliminary field study of the kinds of differences among children that matter for their relationships with nature and thus their learning processes. There has been meetings and workshops with the ULLs.

The workshops carried out have been part of a cross-WP project to explore pedagogical use of walkable floor maps for citizen involvement with NBS in ULLS.

Task 5.2 Technology for nature-based learning - A digital project protocol was developed and tested by schools with the aim of promoting students' awareness, perception and imagination of their near environment – its physical features, biodiversity, greenspaces – and how they engage with this environment. Feedback was provided by teachers in the school. The visualisation tool entails student-made 'Field e-books' that both document nature-based learning processes and provide a child's perspective on local environments. The process of development involved feedback from teachers on the 'Field E-books for Eco and Climate Explorers'.

Development of a digital educational platform, Greenopolis, which were tested with a school class outside in a NBS in Copenhagen and two school classes in Paris: one class with pupils, age 10-12 years, and one school class with pupils, age 8-10.

Task 5.3.1 ULL Paris - The objectives for this task which included a deep involvement of teachers were: (i) To carry out an inventory of the biodiversity present in the school thanks to the use of the Vigie-Nature-Ecole (VNE) citizen-science protocols and to send the data collected with the students to the program coordinators; (ii) to propose NBS to improve the state of biodiversity in the school and/or activities that promote new relationships with nature; (iii) to monitor the state of biodiversity following these initiatives and assess their impact on biodiversity, and send the data collected with the students to the coordinators of the participatory science program.
Within the task there was a wide engagement with schools including meetings with teachers and interviews with school children. Consistently with the objective to make teachers independent, the WP5 coordinators mostly monitored the activities carried out in the schools remotely, by video and telephone with the teachers.

Researchers from WP5 and WP6 visited three schools (one primary, one middle and one high school), discussed with the teachers and the pupils, and tested a first version of the Greenopolis application with a class of 6ème (10-12 years old children).

Task 5.3.2 ULLs Velika Gorica & Aarhus - In both cases, COVID-19 has caused postponements of visits and direct contacts with local stakeholders. Virtual tools have meanwhile made it possible to start up the collaborative process.

In Aarhus direct contact was taken with the principal of one school with plans for establishing a 'children's forest' at the school area, with the aim of focusing research activities on this school. A visit to the school was arranged, which included a meeting with the school manager and an interview with a science teacher. At the meeting, it was agreed to move forward by setting up a workshop with all teachers at the school. This workshop enabled researchers to present and get feedback on the VNE-citizen science teaching kit as well as on action-oriented environmental education methodologies.

Furthermore, several other stakeholders have been identified that could play a role in NBS with schools. Among them are employees from municipal departments of Technology & Environment, Child & Youth and Innovation & Citizen, the Museum of Natural History. Furthermore, a unit offering teaching materials to schools in Aarhus (Ulf I Aarhus), the national science extension organization ASTRA as well as local NGOs were identified. Further on in Aarhus there the idea of walkable floor maps as interactive governance and learning tools into concrete designs was elaborated upon and tested. This development work took place as an internal REGREEN collaboration process between researchers from WP3, WP5 and WP6, as well as a collaboration process between this group of researchers and ULL Aarhus. Feedback from key stakeholders, experts and potential users was provided by a workshop on the 9th of November 2022. Based on the feedback, the prospect was revised and followed up by dialogues with key persons from two schools and a university college who are interested in further collaboration with Regreen researchers on testing and elaborating interactive walkable floor maps in their local areas. The result of this process has been an expansion of our plans for production and test of floor maps from originally one overall floor map of the municipality of Aarhus to extra five maps, showing two suburb areas with the two involved schools as well as three maps of the city and harbor areas, which we plan to test in relation to the NBS governance process in Aarhus as well as in collaboration with two associate professors in Geography and their students at VIA University College in Aarhus.

In **Velika Gorica** several virtual meetings have been held to provide a sense of the state of the art and develop a joint plan for the coming years. There was an introduction of the VNE citizen science part by offering schools in Velika Gorica 2-3 adapted and translated protocols from the VNE participation kit provided by Natural History Museum in Paris. The City of Velika Gorica has drafted a work plan for the development of preliminary design of permaculture gardens, which should be worked out in existing schoolyards and then planted by school children, staff, parents, and other potential

supporters of local schools. This would potentially be done in a form of local crowdsourcing, where parents and outside supporters of a school (local companies, citizens) would give donations, either in the form of money, tree saplings, tools or other materials, or even participation in the work and planting.

Task 5.4 Co-creation of NBS for children's play and learning activities - This task took place in a so-called Landscape Laboratory in Alnarp, Sweden, where a co-creation activity was taking place with local kindergartens, and did not involve any of the Regreen ULLs.

Table 5: Publications produced in Work Package 5.

Task	Name	Type	Audience
T5.1	D 5.1. Children, Education and Nature-based Solutions:	Report	REGREEN
T5.2	D5.2 Eductational digital platform (includes Greenopolis and Field E-book)	Online	Schools
T5.3.1	Citizen-science learning tools for the teachers, in French (https://formation.vigienature-ecole.fr/)	Online	Schools
	VNE protocols in English	Online	Schools
	Exploring Nature-Based Solutions in Your Classroom MOOC	MOOC	Students
	Citizen science at schools	Podcast	Open
	Prévot, A.C. 2021. La nature à l'oeil nu. CNRS Editions		
	Experience of nature. Conversation avec Mogens Laerke	Conference presentation	Scientific communit
	Lombaerde, J. 2021. Gluant.. et degueulasse ! Les élèves face aux activités de nature, Lille University, MNHN	MSc thesis	Scientific communit
	Hedblom M., Prévot A.C., Grégoire A. 2022. Science Fiction Blockbuster Movies – A Problem or a Path to Urban Greenery? Urban Forestry and Urban Greening, in press	Scientific article	Scientific community
T5.4	Herngren, L, Ågren J. (2021) Children and the Earth: a design study on the relationship between place, nature contact and environmentalism. Alnarp: SLU.	MSc thesis	Scientific community

Summary – knowledge co-creation in WP5

The work carried out in WP5 was to large extent taking place in collaboration with schools in each ULL. In Paris most of the work was done with the Natural History Museum in Paris, and hence IPR was not involved at all in this WP. Initially the ULL contact persons was part of a discussion in order to coordinate the field work carried out and later also involved in the floor maps workshops taking place. With regards to the development of technology for NBS learning and the activities taking place in the schools, these were mostly involving teachers at selected schools through workshops, dialogues, surveys and meetings allowing feedback and reflections.

5.1.6 WP6. The governance and planning of urban nature-based solutions

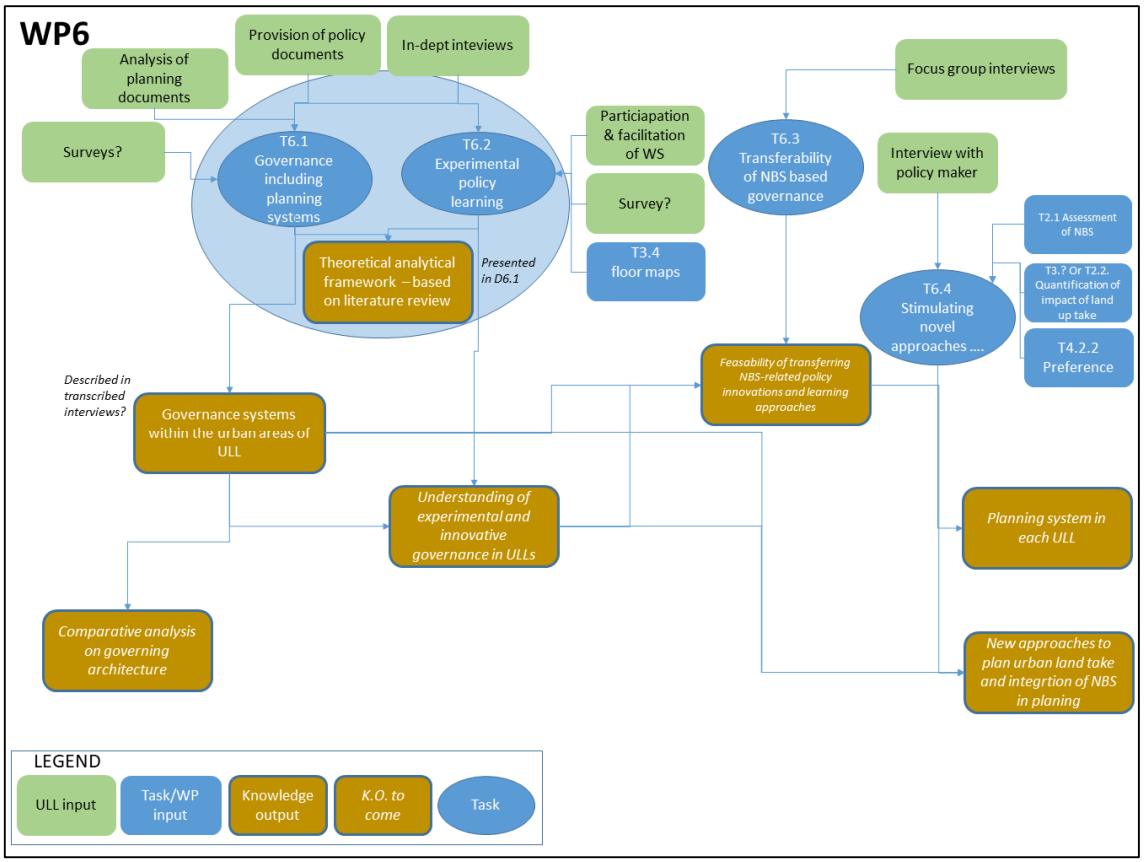

Figure 6: Mapping of knowledge production within Work Package 6.

Task 6.1 Governance including planning systems - Drawing on a literature review a theoretical framework and conceptual approach for local governing architectures was developed. This in order to capture and address the formal and legal structures of NBS governance, the informal and tacit aspects of NBS policymaking and politics, and their interplay. Based on developed criteria's specific policies, measures and/or strategies were selected for fieldwork consisting of interviews with policy makers within the ULLs. The ULLs have provided policy documents that were analysed as part of the task, the analysis was done through a common analytical approach, informed by the conceptual framework and adapted in iteration with the tentative and ad hoc findings in the policy analysis and interaction

Scoping interviews with policy makers in the ULLs were piloted and followed by the conduction of qualitative semi-structured interviews with policy makers in all three European ULLs. In Paris and in Velika Gorica, the interviews have been carried out virtually, while the interviews in Aarhus was done in-person when the lock down was lifted.

The output was a description of the governing architecture within each ULLs as well as a comparative analysis of the position and role of NBS in these, which has been presented at REGREEN meetings and at scientific conferences. This includes a focus on barriers and enablers for uptake and development of NBS and is additionally discussed with ULLs.

Task 6.2 Experimental policy learning - The examination of experimental politics within REGREEN builds on the policy institutional architectures of the ULLs.

Policy workshops in Aarhus, Velika Gorica, and Paris has been organized on experimental politics for urban NBS and to design the conceptual framework for defining and understanding what is meant by

experimental governance for NBS. The workshop included interactive artifacts such as floor maps or mood boards and involved public policy makers and ULL-based stakeholders.

Task 6.3 Transferability of NBS based governance ideas among cities - Explores feasibility of transferring NBS-related policy innovations and learning approaches across different urban contexts through co-creation processes. Drawing on the baseline data from Task 6.1 and Task 6.2 alongside focus group interviews with key stakeholders in the ULLs, the different contextual factors listed above that have enabled or held back NBS policy success was mapped out

Task 6.4 Stimulating novel approaches for managing urban land take and integrating NBS in urban planning systems –

Interviews were carried out in the ULLs with policy makers and civil society respondents who are active in the promotion of NBS in order to understand the planning system, gather information about how land take and soil sealing are addressed and then focus on NBS integration in planning documents in each ULL. This work will help to do a state of the art of issues, to compare different ULL strategies and then complete with different types of guidelines for a coherent integration of NBS and land take reduction in urban planning (ex. Regulations, economic incentives, political, public or private policies, etc.).

Summary – knowledge co-creation in WP6

Within WP6 there was a large involvement of the ULLs within the different tasks, mainly with a role to provide information in various form. Initially through the ULL contact persons providing different types of policy and planning documents for their ULLs to be analysed in order to understand the context. For the consecutive tasks, the involvement of the ULLs was primarily to provide participants for in-depth and focus group interviews as well as participate and facilitate the workshops with the walkable floor maps.

Table 6: Publications produced in Work Package 6 (based on progress report M36).

Task	Name	Type	Audience
T6.1	D6.1 Report on a research protocol for governance study (M8)	Report	REGREEN
	D6.2 Jensen, A., N. Kirsop-Taylor, M.S.R. Jensen, D. Russel, R. Hardiman, I. Kaltenegger and L. Morère (in preparation) Governing architectures and the governance of NBS. Journal of Environmental Politics.	Scientific article	Scientific community
	D6.2 Kirsop-Taylor N, Russel D, Jensen A (2021). Urban governance and policy mixes for nature-based solutions and integrated water policy. Journal of Environmental Policy & Planning, 1-15	Scientific article	Scientifid community
	Mayor, B, H Toxopeus, S McQuaid, E Croci, B Lucchitta, SE Reddy, A Egusquiza, MA Altamirano, T Trumbic, A Tuerk, G García, EFeliu, C Malandrino, J Schante, A Jensen, and EL Gunn, 2021. State of the Art and Latest Advances in Exploring Business Models for Nature-Based Solutions. Sustainability 13, no. 13: 7413.	Scientific article	Scientific community

Task	Name	Type	Audience
T6.2	Kirsop-Taylor N, Russel D (2022). Agencies navigating the political at the science-to-policy interface for nature-based solutions. Environmental Science and Policy, 127, 303-310	Scientific article	Scientific community

5.2 Knowledge co-creation in the ULLs – based on the interviews within the ULLs

5.2.1 ULL Aarhus

The interviews took place on the 13th of March 2023 in Aarhus and were carried out with the two main contact persons from the ULL (2h) as well as three representatives from other parts of the organization (30 minutes each).

I Organisation

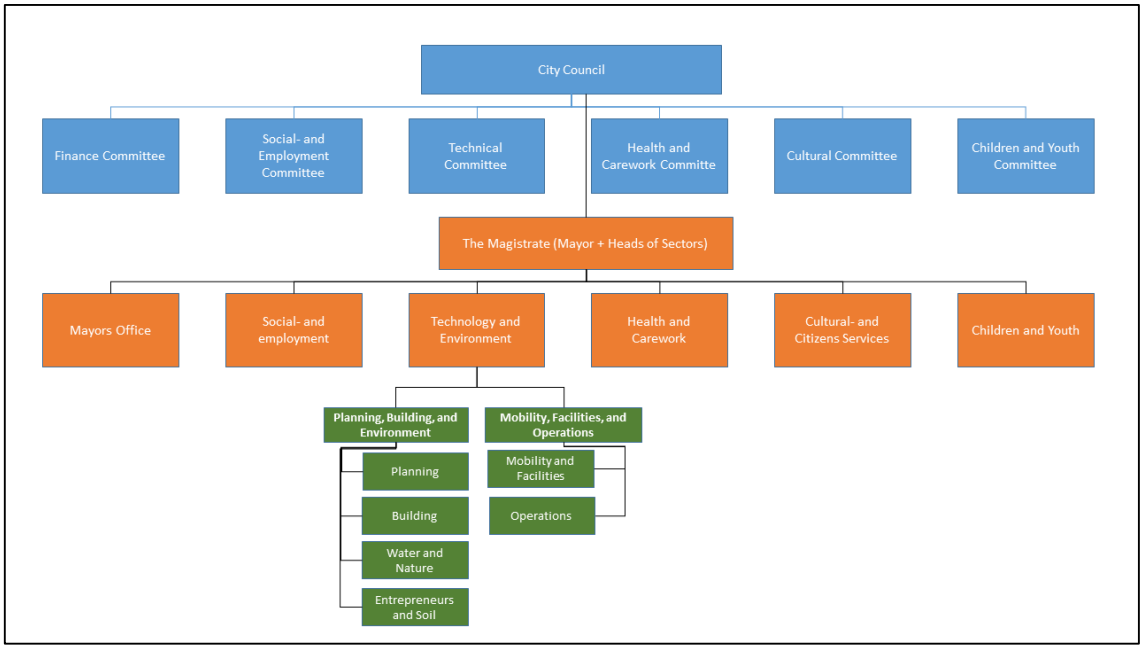

Figure 7: Organisational chart of Aarhus municipality

All the interviewed people are within the department of Water and Nature, but with slightly different roles. The work with NBS within Aarhus municipality is mainly carried out within the unit of Technology and Environment, and primarily within department of Water and Nature. However, there is a cross sectorial group at the municipality working on a programme for Blue-green infrastructure, under which NBS related content falls and where decisions on NBS are being made. The program is funded through the technical committee, which also in dialogue directs the funding for NBS projects. The dialogue between department of Water and Nature and the Technical committee (the political body) is continuous through meetings, with the committee learning about NBS and how it could be used to address environmental challenges such as ground water, climate adaptation, biodiversity and carbon sequestration. There is an interest from the Technical Committee to want to understand and learn despite political parties and changes in power.

Other collaboration taking place is with 1-2 people at unit of Health & Carework as well as unit of Children & Youth, with whom there is also two shared positions with each of the two sections.

There is also a network group on increasing biodiversity on land belonging to other sectors (such as school yards, care homes etc.), but with the most people still from Technology and Environment.

II Stakeholder communication

The coordination and networking has been a large part of the REGREEN project, with the main communication with the municipality taking place within the department of Water and Nature. The communication was mainly through one of the ULL contact persons and was mainly carried out through email but also through visits by the contact person to other departments where the REGREEN project were presented to different groups in the municipalities.

A challenge in REGREEN has been the different timelines that the researchers and municipalities are working on. In the beginning it was unclear what the researchers expected of the ULLs were and hence what to communicate to external stakeholders took 1,5 years into the project.

A successful mode for communicating more widely within the organization was the dedicated workshops that were arranged during the project meeting in 2023 in Aarhus, which allowed meeting space between researchers and staff from the municipalities, allowing more in-depth interaction between a broader group of staff in the ULL and researchers.

A stakeholder group that has been missing within REGREEN is the private and business side of NBS, which is a group that today has a high interest but limited influence with regards to NBS. However, there is interest from the municipality to increase their influence and role in NBS.

With regards to for an effective communication of the last part of the project the ULL suggests that the communication team could be involved, in order to identify short stories about the results in the last part of the project. With the story telling of the REGREEN project having a large potential. The main target for the results is planners and their own department and where there is a great potential for the tools to be used to engage with politicians. However, there is a challenge in making the tools, such as the floor map, more accessible.

A barrier for a more widespread communication of the results is that the written REGREEN material is all in English, and many of the ULL colleagues are not trained in reading English. Short communication/summaries in Danish would increase the distribution of the knowledge produced within REGREEN.

III Knowledge co-production

According to the interviewed, the involvement of Aarhus ULL within REGREEN was in the initial stage of the project mainly as a provider of information to the researchers regarding the local situation in Aarhus. Another general point made of the respondents were that the researcher within REGREEN often started the WPs and tasks on an abstract level which the ULL found hard to engage with, particularly early on in the project. Making the connection between the abstract level and what concrete is happening and is of relevant for the ULL was hence difficult for the ULL contact persons.

In WP2 the role of Aarhus ULL in the different tasks came mainly to have a consultative role, providing information on local context with regards to several of the tasks, such as T2.1 Development of Conceptual framework and Scenario, T2.2 Ranking of environmental and societal challenges, and T2.3 Cost-effectiveness of NBS. The consultation took place through meetings, but also through dialogues via emails. Task 2.3 Knowledge base of NBS with fact sheets was in the interview highlighted as one

example of output that had spread in the organization and was used as inspiration, despite the fact that there was no active communication around them from the contact persons. With the development of the scenarios within T2.1. the dialogue was more intensive and was done in a more of a partnership between the ULL and researchers where Aarhus ULL identified pressures and benefits relevant for the ULL. In contrast, in the development the conceptual framework within T2.1, where the ULL was consulted, they found it hard to engage and contribute towards due to the abstract level of the task. A general perception in the ULL is that most of the tasks within WP2 did not provide any direct output that could be fed into the organization and if so, would have needed some transitional work to make it relevant for Aarhus municipality.

WP3 shows a similar pattern as WP2, with the ULL mostly having a consultation role in providing information in order to provide a local context for the researchers, though a more intens exchange. For T3.1 Data sets and their applicability and T3.2 Modelling, the dialogue has come to focus mostly on spatial data, with one of the researchers at AU having a main role as a liason between Aarhus municipality and the REGREEN researchers. Aarhus ULL see a great potential in the model outputs but they would need the spatial data, which they at the interview had not received, in order to make them have an impact on their work. For Task 3.3 Exploring demand of NBS and T3.4 Sceniaros in the City explorer tool, the dialogue has been more extensive and hence Aarhus ULL has had a larger role in forming the tasks and the outputs and where Aarhus ULL see a great potential in the results being useful in the future. This was taken a step further in the work with the walkable floormaps in T3.4 where Aarhus ULL took part in the development of the material and the setting for its use, though not the approach and methods for their development. The walkable floormap is also a product that have a potential for further use beyond REGREEN at for instance different type of green festivals.

For WP 4 the ULL has mainly had a facilitating role, providing information such as photographs and facilitating workshops such as for T4.2.2 and T4.3.1. For the CLD in T4.1, this was extended by also asking representatives from the ULL to provide feedback on the preliminary result of the literature review. The work with the Ecological Momentary Appraisal app provided a lot of consultation and information from the ULL with regards to areas to be used but also testing of the App. While the knowledge that has been produced within the tasks has not been widely spread and had an impact in the ULL, Aarhus ULL recognise the great potential in getting more solid information on soft values.

For WP 5 the ULL has been involved in T5.1 Childrens interaction with nature and T5.3.2 Walkable floor maps, though not with the usual collaborators for NBS. Within T5.1. their role has mainly been providing an initial contact with schools, and there is a potential for the results to be used further by schools. With regards to T5.3.2. there was a dialogue between the ULL and the researchers in the development of the floor map and the workshop. This has provided maps for the contributing schools that have the potential to be used further by the teachers.

In WP6, the ULL has been having a role as provider of information for the researcher, through the provision of policy and planning document, identifying interviewees and facilitating workshops. The results that are coming out is believed to be of interest, but it is unclear of how they will be used and what kind of impact. There was also expressed a fear for things to have been misinterpreted in the interviews and workshops with regards to the discussed situations.

IV Influence of REGREEN on the ULL

REGREEN has provided an opportunity to reach out more broadly about NBS across departments at Aarhus municipality. However, this process was already started before the project with for instance the staff being employed at double departments, and hence working across sectors. REGREEN is here

believed by the interviewees to have strengthened this cross-sectoral process further, with its broad topic spanning across different disciplines (*building transdisciplinary capacities*). The project has provided an opportunity to increase the political awareness of NBS but also to increase the general awareness of NBS within the organization. This through both the space provided for smaller meeting opportunities to discuss topics that are not necessarily linked to a specific plan or implementation (*in-depth topical learning processes*). Both the use of floor maps and the training workshop in real life are examples of such meeting spaces where there has been little prestige and need to make decisions and achievements present. The perception is that these opportunities provided by REGREEN have allowed the organization to mature in working with NBS and blue-green infrastructure.

The governance interview allowed reflection on Aarhus municipality own organization and roles, looking on other way of planning and getting closer to each other. This has also allowed an increased awareness of the way they do things.

Taking part in REGREEN has also allowed them to be better prepared when joining other EU-projects, in order for them to better benefit the organization, and moving from the more passive role that they have been having within REGREEN to becoming a more active partner.

By REGREEN being an international project there is also a broadening of the reference projects to bring into the everyday work that several of the interviewees were highlighting. This through both the field visits but also the examples collected.

A lasting legacy of REGREEN is the network, both with the REGREEN partners and the network formed at Aarhus Municipality.

5.2.2 ULL Paris Region

I Organisational structure

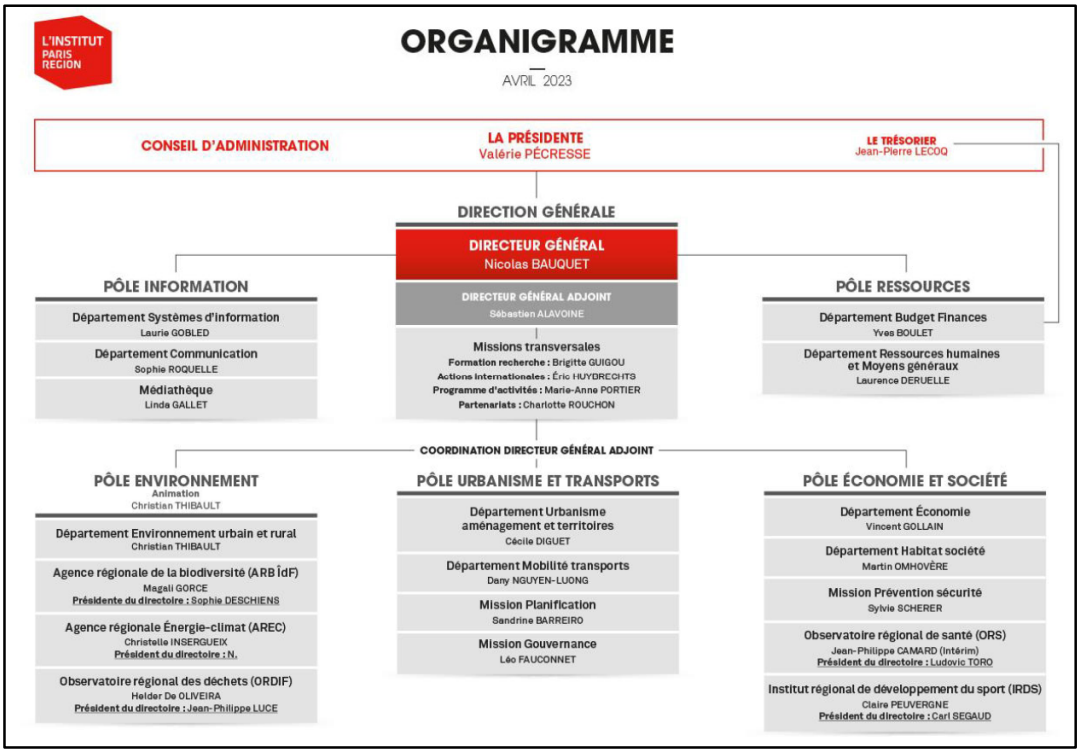

Figure 8: Organisational chart of Institute Paris Region.

The Institute Paris Region (IPR) is a think tank on urbanism, planning and environment that has around 200 members of staff. The two ULL contact persons at IPR that was interviewed are within the Agency for Biodiversity which presently has around 20 members of staff. The Agency for Biodiversity leads the work on biodiversity issues and nature-based solutions but has lately come to also work across with other departments in response to the increased attention to biodiversity. Often, they are called in to provide concrete input or have a meeting in relation to biodiversity and NBS. The role of IPR is only as guidance and providing expertise and public advice, through free publications. The decision-making power are at the government of Paris region and the municipalities in the region, and where IPR could provide inspiration and expertise.

A reflection made during the interview was also that it would have been better to use as city from the Paris Region as ULL and the IPR as a partner. As it was, there was a struggle with the dual role of both being a partner that does research but also a ULL though on a regional level but with no decision-making power with regards to implementing NBS or planning, policy and strategies.

II Stakeholder communication

Most of the clients and communications are done with cities, and these have been the same in REGREEN such as the Municipality of Aulnay-sous-Bois, which was used as a pilot city.

IPR are also used to work on other projects with the Natural History Museum, which is part of REGREEN. The difference compared to these other projects is that in REGREEN IPR has collaborated with international universities and research institute, while normally they work with French academic institutes.

The outreach and communication with regards to REGREEN has been limited, both within their team at IPR as well as external stakeholders. Several explanations for this were given. The language barriers French English were mentioned several times. The interviewee expressed that for effective communication, with local stakeholders in the Paris region, information needs to be in French and hence written material needs to be translated to French. It has also been unclear of what has been achieved, how the knowledge produced could be used and which stakeholders that could be interested in the information. There was also a sense that some of the work carried out in REGREEN, such as the EMA app was to some extent duplicating work already carried out in the Paris Region and hence of less relevance for local stakeholders.

The perception is that the REGREEN Newsletter has been an effective tool for communication, but also that social media are used a lot in other projects to communicate with stakeholders, but less within REGREEN.

For future communication with REGREEN the target audience should be the municipalities, though there is a need for the communication to be concrete and applicable for them in order to be effective.

A suggestion for future projects is also to provide short communications on outputs such as papers and deliverables targeting specifically the ULLs, through for instance 5 min presentations at meetings.

III Knowledge co-creation

Within REGREEN IPR had a dual role as both research partners leading tasks (T3.4 Depavement strategies and T6.4 Planning) and as a ULL partner. Their view was that might have been more suitable for IPR to have been only a research partner and with a municipality in the Paris region representing the ULL. There was also expressed a confusion and unclarity of some of the terms, such as governance, and here the limitation of work carried out in English which provides limitations in expression and

understanding. The importance of a common framework, definition and objective was highlighted as something that could have been made clearer earlier in the project. Part of the reason why these are seen as problems might have been emphasized by the lack of physical meetings in the earlier stages of the project, due to Covid-19 restrictions, where these obstacles become more pronounced in on-line meetings.

Within WP2 the perception was that a lot of the knowledge developed within the early tasks was done through an active interaction between the researchers and the IPR. This included the development of the conceptual framework (T2.1) where IPR shared their definition of NBS with regards to biodiversity and ecological aspects, the scenarios developed (T2.1) and the ranking of the environmental and societal challenges within the ULLs (T2.2). For the cost effectiveness (T2.4) the role of the IPR was provider of information on costs through emails. Output from the project has mainly been limited to the contact persons team or the IPR at large so far (T2.2, T2.3 and T2.4). However, the contact persons are considering a publication of 2-3 pages in French with regards to costs-effectiveness of NBS (T2.4), which will be communicated more broadly. IPR has before REGREEN already published studies in relation to scenarios and hence the scenarios within REGREEN has not been communicated to anyone since it seen as doubling existing work.

Within WP3, the first task (T3.1 Evaluation of data sets and their applicability) relied on a heavy interaction between IPR and the researchers in charge of T3.1. The output was feeding into other tasks of REGREEN and not into the work carried out at IPR. For the task T3.2, T3.3 and T3.4 Floor maps, the role of the ULL was to contribute with information or being consulted with regards to the needs. Here the model outputs in T3.2. has been communicated within the team at IPR but not further within the organization nor to any municipalities. The view is that the output is potentially interesting but there is so far a lack of visualization of the output that is easy communicated and hence not easy to show colleagues. If the spatial data or the maps were available for the IPR it would be easier to communicate the result more widely. For the floor maps the potential of them was recognized but there is a need for guideline/manuals for the use of them in order to be communicated and used more broadly. So far floor maps have been communicated to the contact persons team, IPR and Aulnay-sous-Bois municipality. Within WP3 IPR lead the task on depavement (T3.4) where they developed the method and carried out the work. The resulting report and on-line tool (Cartoviz) have been widely communicated to all stakeholders in the Paris Region but also on a national level. This is in line with a new polity on renaturation with a budget of 10 million EUR to help cities.

Within WP4 the role of IPR in the different tasks has been through mails and vision meetings and hence mostly in a consultation role with regards to the task carried out. They have provided resources such as photographs, list of geodata, samples of residents, translations and facilitated workshops. The output has so far not been communicated outside the team with the exception of the Casual Loop Diagrams on the relationship between street trees and mental health that has been communicated to team at the Natural History Museum.

Within WP5 the Natural History Museum was the main partner and hence the contribution of IPR was limited to an initial involvement in the choosing of schools to be involved.

For WP6 the main role was to support the research with interviewees, policy document and contacts with regard to T6.1, T6.2, T6.3. For the latter two tasks IPR was also involved in the facilitation of the workshops that used the floor maps from T5.4. So far, the comparative analysis of governing architecture has been communicated within the team and the results from the workshop on feasibility of transferring NBS related policy, innovations and learning approaches has been communicated to

Aulnay-sous-Bois. IPR was responsible for T6.4 and the development of the guideline and will here be involving the other ULLs as well as the researchers in WP6.

IV General influence of REGREEN on the ULL

The main influence of REGREEN is raising the awareness of NBS and particularly the work on the depaving strategy developed within the project. Since the work with depaving was part of a European project it was regarded as more significant and taken more serious by politicians. The strategy has also moved into planning and policies on a municipal level.

It is recognized that work like the Heat mortality map has a potential for making an impact in the Paris Region in relation to the Climate Adaptation Strategy. However, this work has not been communicated yet.

The project has not resulted in any change in work mood nor new directions for the contact persons work, but it has led to getting to know some colleagues at other departments better because of the need of their expertise. Hence, the work might have become more transversally and open to engage with other colleagues. Through the team's interaction there has been a learning, mainly in relation to new tools and structure, but it is hard to quantify. But the contact persons expressed during the interview that there has been a lack of systematic learning and up-take of information from reports and deliverable within IPR due to limited time for reading.

Taking part in a European project has improved preparedness for joining new European research projects in order to benefit the organisation and the Paris Region better. One particular aspect mentioned was that there is a preparedness to make sure already in the proposal writing to better accommodate what their need is and what is going to be useful for IPR and the Paris Regions municipalities.

5.2.3 ULL Velika Gorica

I Organisational structure

From the municipality of Velika Gorica, the Department of Spatial planning, Construction and Environmental Protection is involved in REGREEN. This is also the with primary responsibility regarding NBS in Velika Gorica. While decisions regarding NBS is made in the department, this needs to be confirmed by a person at the mayor's office. The group working on NBS is small - it involves the contact person and two more employees. This means that a lot of the work regarding NBS is subcontracted or requires partnership outside the municipal organization. This is the case for making and designing the plans and strategies as well as the construction and planting of NBS. There is a shortage of staff resources at the municipality to make plans or strategies, but they take a very active role in providing information to the developers and are active in feeding the ideas of the city as organization and citizens to strategic documents. Within the municipality there is also a traffic department that is to some extent involved in NBS in their role as handling the maintenance of public green spaces in Velika Gorica. It is not unusual other departments to exchange and collaborate as well if they have touching points of interest or at mayor's proposal.

Within REGREEN, ZEZ has also been part of the ULL Velika Gorica. ZEZ is a non-profit energy cooperation, and REGREEN is their first NBS project though they have experience of working with the municipality in Velika Gorica through other type of projects. The involvement of ZEZ in REGREEN has provided an opportunity for a larger involvement by Velika Gorica in REGREEN then would have been possible with the limited number of staff that are employed in Velika Gorica working with NBS.

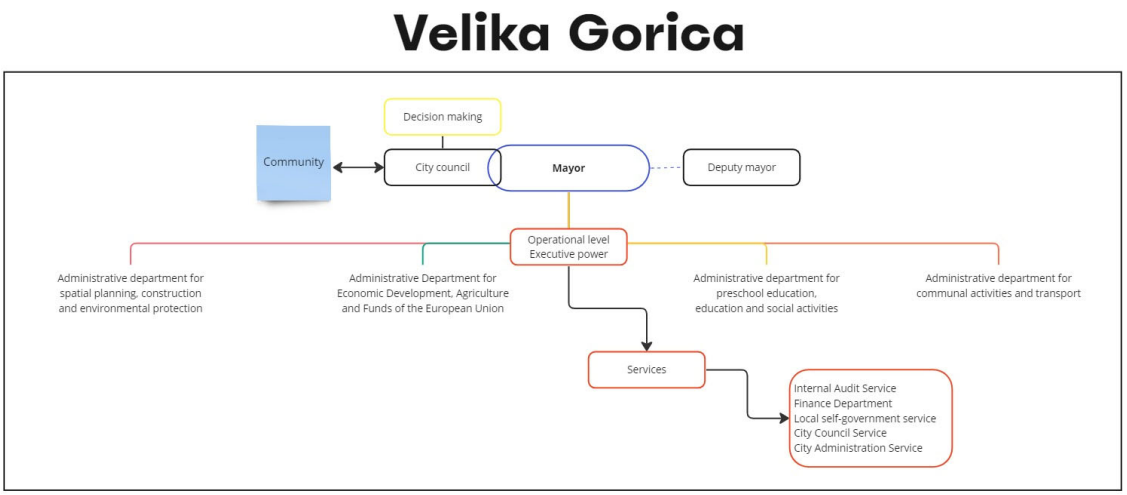

Figure 9: Organisational chart of Velika Gorica municipality

II Communication

Having only a small unit that is working with NBS in Velika Gorica means that a lot of communication with stakeholders is in relation to subcontracting, explaining what the municipality wants and needs to ensure their needs are met. Lately this has involved the subcontracting of the development of different strategies and a new comprehensive plan.

The communication of the REGREEN project within Velika Gorica has mainly been done in through email and in the form of pictures to evoke interest and that the experience is that people do not read long emails. For instance, the heat map was sent by one of the contact persons as a picture to a wider group in Velika Gorica rather than a text, which raised further interest for the results. In line with this the different deliverables and reports has not been further distributed within the Velika Gorica ULL by the contact persons

The results of the REGREEN project have been communicated through different type of events, where people and organizations that are interested in NBS attend. This includes the training workshop organized by IPR, which beside local staff also involved the Ministry of Spatial Planning, Construction and State Property and Green Fund, representatives from the city of Zagreb and different organizations that are often used for subcontracting. At the workshop in WP6, representatives from the public company that manage the public green spaces, different departments in the municipalities such as building side, school sector, tourist perspective and different green companies were attending. In WP5 the role was mainly to connect with the schools, but the work was carried out was done without involvement from the contact persons from VG and ZEZ.

The work with REGREEN has hence come to involve communication with a wide range of stakeholders, however, the view is that those stakeholders that are reached with communication are mostly those that already are working with NBS. A strategy to launch the concept more broadly has been to make three separate programs for the municipality where NBS is included – Clean Air; Climate Change and Nature Protection. The aim being to ensure outreach to a broader audience and communication of the message wider compared to one program focusing on NBS, which is seen as having a smaller reader group within the municipality.

There was expressed a problem in identifying the right stakeholder for the different deliverables and hence this meant that a lot of time the information tended to get stuck at the contact person. There is also a language barrier - the administration and citizens would prefer to get written material in

Croatian rather than in English. With regards to the workshops all of them were carried out in Croatian language in order to increase engagement by the participants.

III Knowledge co-creation

Within WP2 and 3 the interaction with the team at Velika Gorica mainly focused on providing input and feedback related to their needs with regards to modelling and providing an understanding for the researchers with regards to the situation in Velika Gorica. In the municipality the spatial, GIS, data is handled by a separate company and hence the request from the modelers in WP2 and 3 was handled through them. The interaction with the municipality were taking place in the form of dialogues during meetings and individual calls and emails, asking for feedback, what the municipality would like to see and what could be useful and that fed into several of the tasks in WP 2 and WP3. The outcome from the different tasks is considered impressive by the municipality and has been communicated during the workshops and different events taking place in Velika Gorica. For instance, the maps are perceived as particularly powerful in communicating the benefits of NBS for climate regulation. Another tool mentioned is the walkable floor maps where there has been a lot of engagement of the ULL in developing and communicating the tool.

For WP4 a lot of the engagement has been in providing information and facilitating the research carried out within REGREEN. For instance, the team at Velika Gorica has provided input and tested the Ecological Momentary Appraisal app developed within T42.1, provided photos, participants and help with translations related to the workshops taking place in T4.2.2 and T4.3.1 and the results are viewed as potentially being very useful for the municipalities. For the work of Casual Loop Diagrams the team provided input and response to the preliminary results.

With regards to WP 5 the role was mainly to connect the researchers with the schools and besides that there was limited interaction. The ULL received information from the researchers with regards to the children's relationship on NBS for Velika Gorica and what the children would need in their settlements.

In relation to WP6 the ULL facilitated the research by providing policy documents and interviewees. There were many people from Velika Gorica involved in the workshops run by the researchers and facilitated by the ULL. The participants were a mix of associations and city departments contributing to the discussions of the ideal city.

Beside the specific of the project there has also been an on-going learning within both ZAZ and Velika Gorica regarding spreading information and knowledge both on a more general level of NBS but also the specific tasks taking place elsewhere in REGREEN such as the work on depavement carried out by IRP and the play-biotopes developed by SLU.

IV General Influence of REGREEN on the ULL

The REGREEN project has raised the recognition of NBS and provided a mandate to talk about NBS and push that agenda more broadly within the municipality, for instance the public city company that maintains all the public green spaces. The different media posts in relation to REGREEN helped to reach new stakeholders that normally would not talk about NBS. The project has allowed the municipality to subcontract the work on a green strategy for Velika Gorica and also to attain funding for the schools gardening project. But the project has also improved the capacity of city staff, and all stakeholders on the topic of NBS. The REGRREEN also allowed the formation of a partnership between the cooperative and city were both benefited learning from each organisational standpoint to gain momentum and keep up with pushing NBS topics.

The project has been used by the mayor to negotiate different things around the city and change different sublets. For instance, there is currently work with students to identify and map different NBS within the city. Another example is the tree planting that took place but also changes in the physical plan that now requires that every plot being build need to have 35% and two trees planted within it. This is something that is envisioned to continue and be a lasting legacy of REGREEN within Velika Gorica.

REGREEN has resulted in many new ideas and connections that has been put into action through the comprehensive plan and the three programs (Clean air, Climate change and Environmental protection) but the problem now is the implementation of the proposed measures and identifying funds for sub-contracting the development of plans and designs needed for implementation.

Through the workshops that were funded and run within REGREEN as well as the project meeting in Velika Gorica in 2022, there has also been opportunities to engage with a broader set of stakeholders and establish new connections. For instance, after the workshop with IPR there has been interest from organizations from other parts of Croatia to develop new ideas. An example is the Fund for Environmental protection that took part and has afterwards shown further interest in the Green Strategy developed and the measures included. Several of the participants at the workshop also had a broader remit than Velika Gorica (e.g., National organizations, City of Zagreb, subcontracting companies) and hence the message from REGREEN have had an influence on a national level in Croatia.

The case that REGREEN is a European- funded project has led to an increased interest compared to a national project and have made people more willing to attend events and workshops as well as taking in the results of the project. The REGREEN project has provided means for a small municipality to connect with experts in the field of NBS, and hence allowed Velika Gorica to become a Croatian authority on the topic of NBS. In particular, it has been appreciated that the project visited the city. This has raised the profile of NBS in Velika Gorica. The view of the municipality is that it has gotten far more out of the project than it anticipated.

6 DISCUSSION

6.1 ULLs within REGREEN

Within the REGREEN project the ULLs were locally represented by a single public organisation for each city/region. Within the partnership the collaboration between academia (but not local academia) and public organisations were built into the consortium of REGREEN. However, fostering local collaboration with civil society, industry and other public organisations were depending on the engagement of the three REGREEN public organisations in order to form the *quadruple helix* that would allow a knowledge production for a socio-ecological transitions (Carayannis et al, 2012).

The project did not explicitly involve pilots in the form of site development and test beds in either of the European ULLs. However, the use of the ULLs contextualized and provided an arena for learning in real-time, through the observation and study of relationships and mechanisms such as the land use change analysis (WP2), modelling of ecosystem services (WP3), local peoples relationship and attitudes towards NBS (WP4) and governance structures (WP6). It further allowed for an arena to test new ideas within a localized context, such as the walkable floor maps and their use as a tool for engagement (WP3, 5 and 6). Based on the interviews, it is clear that the ULLs has been inspired and learnt from the REGREEN project, but there is no mechanism to safeguard an extension of the

approach within the ULL. The need for longer time horizons is something highlighted by Laborgne et al. (2021) is needed for a genuine ULL approach. Aarhus ULL is very clear that the REGREEN project has provided an important learning experience for how to benefit as an ULL, and Aarhus is already bringing this experience into new projects, and hence this can be considered a step towards a more long-term approach. In Velika Gorica, the representatives recognized the benefit of this project, and also the advantage for the municipality of finding a continuation, expressed as REGREEN 2.0.

The role of the ULLs as providing a spatial example for transformative capacity (Wolfram et al. 2019) was brought forward in the interviews mainly with regards to the work of the walkable floor maps (mainly Aarhus and Velika Gorica, and to lesser extent Paris), but also for Paris the Depavement strategy and the examples lifted there. The use of the training workshops and the associated field trips were also highlighted as a good example of for how to communicate the results from REGREEN more broadly within the organisation and hence increasing the impact of the project within the three ULLs. However, within the REGREEN project there was no built-in approach for measuring and monitoring impact of the project.

6.2 Mode of engagement of ULLs within REGREEN

Within the REGREEN project the ULLs experienced different roles in the knowledge co-production taking place. We distinguished mainly four different roles throughout the project.

6.2.1 ULLs as an informant for knowlegde production

For several of the task the primary role of the ULL was a provider of information for the researchers involved in the tasks. This could include the provision of data such as spatial data sets in WP2 and WP3, costs for NBS as in tasks 2.4 and policy documents in WP6 but also taking part in discussions and meetings to provide contextual information necessary for carrying out the research and to make the result relevant and specific to the site.

6.2.2 ULLs as a facilitator for knowledge production

Within REGREEN the contact person at the ULLs has had a large role in facilitating the research carried out. This include making information available through identification and translations of documents but also providing assistance to the researchers within WP4 and 6 to identify relevant participants and interviews and workshops. But the role of a facilitator for the research has also involved more practical aspects related to the facilitation of interviews and workshops within the ULLs such as those taking place in WP4 and 6. The contact persons in ULLs in Aarhus and Velika Gorica have for WP5 also played a crucial role by facilitating the meetings between the researchers and schools to be involved in the specific activities as well as being involved in the workshops with the walkable floor maps.

6.2.3 ULLs an influencer on knowledge production

For some of the tasks the ULLs played a more active role in shaping the research carried out. This was done through different forms of engagement between the ULLs contact persons and researchers in the form of workshops, dialogues and meetings where repeated feedback loops were present. Examples of this is the work on scenarios developed in WP2 and used in several of the WPs but also the casual loop diagram developed in T4.1, where the task was still driven by the researchers, and the work with the walkable floor maps in WP5 and 6, where the ULLs had a more active role in shaping the tasks. The ULLs also had an active role in influencing the direction in the modelling work carried out in WP3, through the discussion of their needs both with regards to areas of interest but also to some extent what ecosystem services to model.

6.2.4 ULLs as a driver of knowledge production

Within REGREEN the ULLs were actively driving some research carried out in the project, mainly IPR who as an institute also has a role in carrying out research relevant for their remit. In REGREEN this included the sub-task in T2.5 with the developing of a de-pavement strategy for the Paris Region and also a sub-task in WP6 on planning systems. In Aarhus ULL there was previously established collaboration with researchers from Aarhus University which to some extent filled an important role in the knowledge production with a focus on the needs and requirements from Aarhus municipality. In Velika Gorica the REGREEN project allowed the ZAZ together with the municipality to collect new information with regards to existing NBS and also provided a mean for developing green strategies for the municipality based on the knowledge produced within REGREEEN.

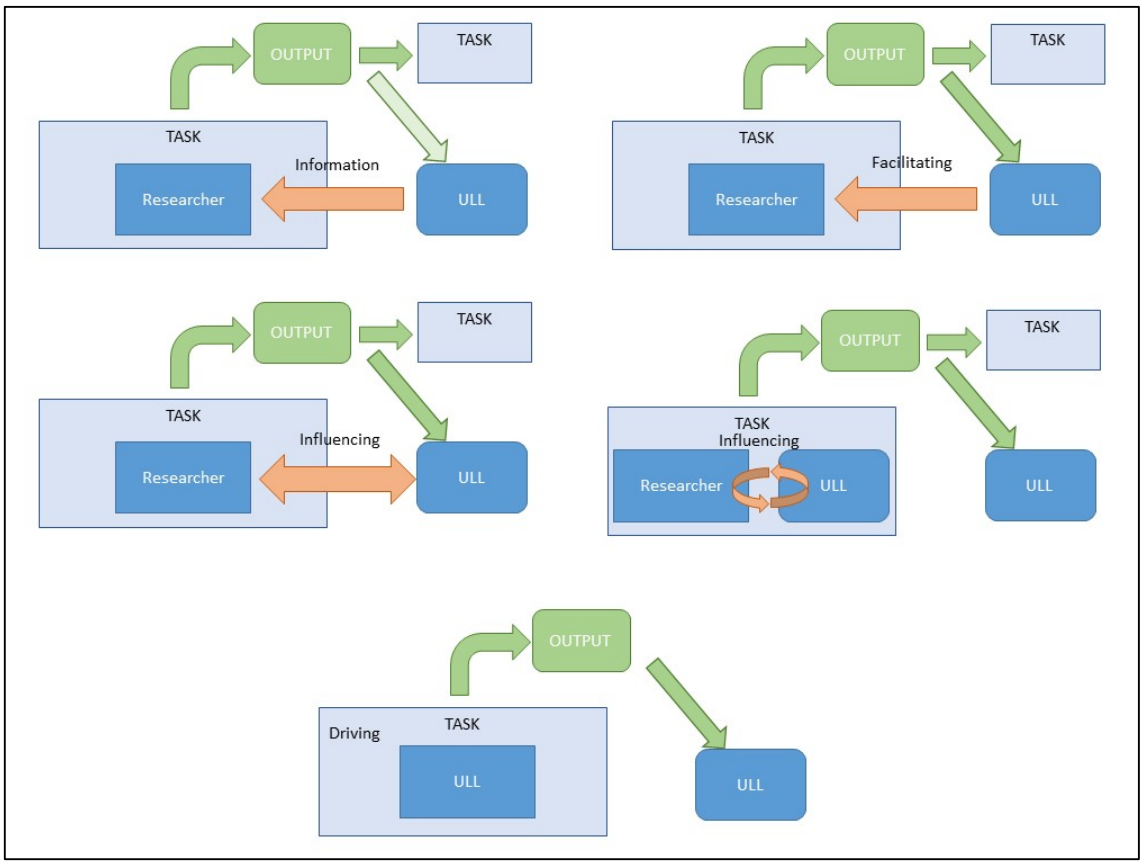

Figure 9: ULL - research interaction with regards to knowledge production.

Kronsell and Mukhtar-Landgren (2018) did in their study focus on the role the municipality could have in experimental governance such as an ULL, and distinguished the following roles: promotor, enabler and partner. Within the REGREEN the public organisations representing an ULL (IPR, Aarhus municipality and Velika Gorica municipality) have a dual role as both partners within the consortium but also as ULLs. The different roles that the organisations have had during the REGREEN projects could mainly be classified as an enabler, through the facilitation, coordination, and encouragement of actions. This is also the role that IPR, as a think-tank, has within the Paris region. However, for ULL Aarhus and to lesser extent ULL Velika Gorica, following the definitions by Kronsell and Mukhtar-Landgren, for part of the project they are also having a role as the promotor, where they are the ones

that initiate, finance and implement NBS. Recently there are initiatives in both municipalities in building private-public partnership to provide funding and implementation of NBS.

6.3 Shaping capacities of cities to impact NBS projects

6.3.1 Differing institutional arrangements

The three European ULLs within REGREEN is each of them represented by one organisation. These are very different between the three ULLs.

The two municipalities representing Aarhus ULL and Velika Gorica ULL respectively differs largely in size. Aarhus municipality is Denmark's third largest local authority with a large number of staff. The REGREEN project was based at the Water and Nature section that is a section located under the Technology and Environment Department. Within the organisation there are on-going cross sectorial work on blue-green infrastructure and NBS and a continuous dialogue with the politicians in the Technical Committee. The size of the organisation in Aarhus as well as the on-going work mean that there was a preparedness in the organisation to REGREEN and to take make use of the project to see how to address challenges such as ground water, climate adaptation, biodiversity and carbon sequestration. Within REGREEN there were two contact persons, one more senior that had contact with the politicians and the management of the department and one with time dedicated to REGREEN. This also ensured sufficient time to partake in meetings and also to engage and inform about the project more widely.

Velika Gorica on the other hand is a small municipality with a small organisation. Besides the main contact person, there is just two more people working with green infrastructure and NBS in the municipality. This means that there are short communication lines and proximity to decision-making power. However, the limited staffing also means that there is limited capacity to take on additional work related to projects such as REGREEN. In ULL Velika Gorica, this was partly solved through the liasoning with ZEZ, providing an extra resource for Velika Gorica. The small organisation in Velika Gorica has also meant a proximity to decision-making and further allows the organisation to quickly adapt and take on board the experiences from REGREEN, through for instance the development of three programs (Clean air, Climate change and Environmental protection) that were subcontracted based on the results and discussions from REGREEN.

IPR is in contrast to Aarhus and Velika Gorica a think tank and hence have a different remit. The two contact persons are based at the Agency for Biodiversity which presently has around 20 members of staff. The department is leading the work on biodiversity issues and NBS within the Paris Region with the role to provide guidance, expertise and public advice, through free publications. Due to their limited decision-making power with regards to implementing NBS a reflection by the team was that a municipality in the region would have been a better partner to represent the ULL Paris and that IPR should have only been a partner collaborating with the municipality.

6.3.2 What is in it for the local authorities?

One of the main influences that REGREEN had within the REGREEN public organisation was the increased recognition and raised awareness for NBS that an EU funded research project provided. This was mostly important regarding dissemination from the directly involved persons towards city administrators and local politicians but also towards colleagues within their own organisation. The project provided opportunities to reach out beyond the normal collaborators within all three ULLs.

All three partners highlighted the importance of REGREEN for providing research that could support on-going work with the development of strategies related to NBS. Most clear was this the case for

Velika Gorica, where new ideas and connections were developed in strategic documents such as the comprehensive plan and the three programs (Clean air, Climate change and Environmental protection)

The participation in REGREEN has also made the organisations better prepared in engaging in large scale research projects, provided better understanding of research time frames, but also better prepared on what they could expect and how they could better communicate their needs and ensure the delivery of their needs in future projects.

6.4 Communication and dissemination - modes and mechanism

6.4.1 Researcher – Cities

For the ULLs the networking opportunities with the research partners as well as between each other formed a large and appreciated part of the REGREEN project. Here the physical meeting was a vital part of fostering the networks, but also the meetings on-line through the different Work Packages and tasks provided opportunities for this. The communication flow within the organisations was mostly carried out through the contact persons at the ULLs in the form of emails and newsletters.

During the interviews it also became obvious that there was a lack of clarity for the ULLs with regards to outcomes of the specific tasks, and also how these results could be useful for the ULLs. For several of the task the main output was more directed towards the scientific community, through reports and scientific papers, and less towards the practice oriented. While the scientific articles and reports were made available, the interviews with all three ULLs showed that they experienced a lack of time for reading these, both themselves but also for their colleagues. Summaries like the ones provided in the newsletters as well as the presentations during project meetings were seen as very valuable by the ULLs. It was further expressed that social media is an effective tool for communication that could have been used more within the project.

The ULLs also highlighted the physical workshops that took place in Aarhus and Velika Gorica in conjunction to the project meeting as well as the training workshop that took place in all three ULLs as particularly valuable for communicating the results of the project. Both of these events allowed a wider group of members of staff at the organisations to a more in-depth interaction with the REGREEN consortium and the knowledge produced. This expresses positive experience of peer-to-peer learning and exchange of lessons learned as element for a more effective communication between the different type of organisations.

6.4.2 Within the public organsiations

A large part of the communication within the ULL organisations took place within their own departments, but also reaching out to other stakeholders, and primarily stakeholders which the organisation normally engages with through established channel. Within Work Package 5 there was interaction with schools in each of the ULL, this was to large extent run separately from the normal involvement of the ULL contact person. In Velika Gorica and Aarhus, the contact person was involved in establishing the contact with schools but with limited involvement with the work in WP 5 after contact were established, and in Paris Region this part was run solely by Natural History Museum with no involvement of IPR. A stakeholder group that by Aarhus municipalities was seen as have been missing within REGREEN is the private and business side of NBS. They are a group that today has a high interest but limited influence in establishment of NBS, though this could be increased.

The communication within the organisations were primarily through one of the ULL contact persons with information often forwarded through email but also through meetings to other parts of the organization and stakeholders. The role of IPR as a think tank on biodiversity meant that the

communication of the REGREEN project was part of their existing remit. In Aarhus there was already established cross departmental structures that likely made the organization more adapted for taking on the output of REGREEN. In Velika Gorica there was limited personnel involved in NBS within the municipality, however, the REGREEN project was more widely communicated, with the support of ZAZ.

A challenge that was lifted for REGREEN with regards to communicating the project and its output has been the different timelines that the researchers and municipalities are working on, where it was unclear what the expectations on the ULL was from the researchers and hence what to communicate to external stakeholders. This took time to establish, and it was not until 1,5 year into the project this became clearer. This could potentially be due to the lack of physical meetings, both within the REGREEN consortium but also internally within the public organisations.

During the interviews a challenge for communicating REGREEN mentioned by was the language barrier. In order to communicate more easily, information needs to be in the local language and hence written material needs to be translated in order to be effectively communicated. This was not budgeted nor time-allocated for by the partners.

7 CONCLUSION

Following points summarise the knowledge co-production process within the REGREEN ULLs:

- Different modes of engagement at different stages reflect different needs and thus roles for the ULL in the project. Clear communication of expectations and timelines makes collaboration more effective.

- Municipal organisation influences engagement – the capacity of an ULL to both engage and disseminate is determined by size of organisation, financial power, mandate and structure but also remits on the topic as well as dedicated key actors.

- How to communicate and disseminate output in order to provide transformative change is decisive. Making results available through formats and in a language that is accessible by stakeholders working in the organization and in practice at large. However, the co-production of results is here decisive to safeguard a learning process, which expects a continuous communication in form of feedback loops and thus a more genuine process of change can take place.

- The importance of European funded projects to raise the awareness of a topic within organisations is substantial. Real impact can be achieved when creating a clear mandate and generating agency to shape and move forward the implementation of NBS.

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9 APPENDIX

9.1.1 WP2 Challenges and NBS

This WP defines the challenges faced by urban areas and potential solutions that can be provided by green and blue infrastructure in the form of NBS. It aims to:

- Structure and quantify urban challenges encompassing biophysical constraints, man-made pressures, and social and economic considerations.
- Collate and synthesise existing best practice in NBS.
- Review cost effectiveness of NBS solutions.
- Start to scope potential solutions include a range of small- to large-scale interventions within the urban and peri-urban environment.

Background work in this WP underpins activity in many others, but also runs throughout the project. We will work closely with WP3 to define biophysical constraints, WP4 to define social-economic interactions, and carries through the project to help inform potential engagement (WP5) and business-led solutions (WP8), working through the structure of WP7 ULLs. The work is broken down into 5 tasks.

Task 2.1 Conceptual framework for REGREEN (Months: 1-3). Develop a REGREEN tailored conceptual framework guide activity in the project. This will draw on existing relevant frameworks covering NBS interventions (EKLIPSE), DPSIR approaches linked to health (DEPSEEA), the MAES Urban Pilot; valuation, benefits and disbenefits, governance and decision-making (the Valuing Nature Network framework), and ecosystem accounting approaches which distinguish natural capital extent and condition, physical service flows and economic flows (UN SEEA). This framework will also include ecosystem dis-services which are particularly important in urban areas, such as pollen, and emission of biological Volatile Organic Compounds which can exacerbate poor air quality.

Task 2.2. Understanding urban drivers and pressures (Months: 4-12). Drawing on EKLIPSE and MAES, 2016, the tasks defines, quantifies and maps the key drivers and pressures as typified in our ULLs. Contributing socio-economic factors such as deprivation, and lack of access to nearby green space, which can interact with pressures to exacerbate demand will further on be mapped (links to T3.3). The two main drivers are land use change (urban land-take) and population growth. Using EU and global products like CORINE Urban Atlas, and Global Human Settlement Layer and Google Earth Engine we will determine time courses of urban growth rates and urban composition for the ULLs as well as population development to help understand sustainability aspects of urban GI. To better understand demand for ES in Europe, we will derive ultra-fine resolution urban structure types (UST), which can be used as proxies for urban areas where socio-economic data are not available, or not freely accessible, allowing greater transferability. Where fine scale data are not available, e.g. most Chinese ULLs, USTs will be defined using standard satellite products at coarser resolution.

Task 2.3. Establishing a NBS knowledge base (Months: 1-20) Drawing on existing examples of NBS from cities around the world, this task will establish a NBS Knowledge Base to form the practical and scientific foundation of information on NBS across REGREEN's activities. This will collate good practice and barriers from past and ongoing projects (e.g. Horizon 2020 calls on Societal Challenges related to NBS and Biodiversa), by communicating with consortium members and advisory boards, interviews with city experts, policy makers, practitioners, scientists and businesses, and through rapid meta-review of scientific and grey literature. We will produce factsheets, guidelines, infographics, checklists, templates and short reports to support the WPs, and for external use, via the project website. This

task will identify new opportunities and will inspire the innovation potential, while avoiding pitfalls and unnecessary duplication with ongoing and past projects. The main topics are (main WP user in brackets): a) Social, economic, technical, managerial and financial good practises, enabling factors and barriers for the design, construction, deployment and monitoring of NBS for restored and newly created ecosystems (all WPs); b) Successful factors leading to capitalisation of multiple benefits / co-benefits of NBS (WP4); c) Cost-effectiveness factors of NBS (WP2 & 4); d) Approaches to enhance human health and well-being through NBS (WP4); e) Approaches of combining urban NBS with educational outreach (WP5); f) Methodological approaches of NBS co-creation (co-planning, co-design, co-implementation and co-monitoring) (WP6 & 7); g) Relevant knowledge platforms on NBS and their potential to support ULLs to enable ecosystems to deliver their services for more liveable, healthier and resilient cities (WP7); h) Enabling and hindering factors for making a business and investment case for NBS (WP8).

Task 2.4. Cost-effectiveness of NBS (Months 1-24) This task will address the knowledge gap relating to the efficacy and cost-effectiveness of NBS (noting the difference between this and cost-benefit analysis).Firstly, an evidence review and synthesis from peer-reviewed and grey literature on the efficacy and costings of urban NBS will be carried out. This will include studies of fully fledged CostEffectiveness Analyses (CEA) of NBS and related concepts, where available, but such evidence is expected to be scarce, hence the broader search of efficacy and costings. The review will be carried out in close collaboration with activities under Task 4.1 (review of benefits of NBS). Grey literature will i.a. be gathered through the network and project involvements of REGREEN partners (in particular ICLEI) across Europe and China. Secondly, CEA studies will be carried out for selected NBS in the ULLs. We will develop indicators for common units of ecosystem services, applying and adapting equivalency tools and incorporating the multiple-services aspects of NBS in CEA. Assessment of costings will cover both fixed costs and annual variable costs associated with monitoring and management, discounted over the project life time (e.g. 25 years), and will make comparisons with conventional solutions, where appropriate.

Task 2.5. Informing solutions (Months:13-48) Task 2.5 (T2.5) will build on the previous tasks to provide a set of guidelines to inform business-focused developments of NBS solutions and development of decision support toolkits in WP8. Key activities will be to i) set the scope/boundaries for upscaling & valuation (important for WP3, WP4, and as input to WP8), ii) Develop a set of coherent combinations of interventions/NBS, (with Task 3.3) to inform and under pin the development of a decision-support toolkit in WP8. This task will identify the appropriate boundary conditions for the scale and scope of each type of NBS intervention, to enable realistic incorporation in a decision-support framework e.g. how big an intervention do we consider (single tree to ULL-area to whole city)? How do we upscale that information, or make it transferable to other settings? Working closely with the other WPs, this will identify business and policy needs, urban population demand for the services, the ability of the NBS to deliver the services, cost-effectiveness, and any constraints on implementation. T2.5 will also inform development of a matrix of NBS interventions within ULLs and assess their applicability to other situations, working closely with WP7. This will allow a strategic assessment of individual NBS across the ULLs, and will ensure that the project can capture the multi-functional benefits within and across NBS interventions, which typically only become apparent when assessed at larger scales and through integrated analysis and interpretation. On an ongoing basis, this will inform the design and scope of modelling and valuation of ecosystem services and their benefits in WP3 & WP4, NBS activity within WP7, and design of decision support toolkits in WP8.

9.1.2 WP3 Mapping and modelling ecosystem services

WP3 maps and models ecosystem services and biodiversity in their multiple expressions for human well-being provided by NBS through through the development of an approach integrating multiple socio-ecological functions and services in varied cultural and climatic contexts. There is a close link to WP2 and its output will feed into WP4 for valuation of the calculated NBS' benefits as well as floor maps as informative technological tools for all European ULLs in WP5 and WP8.

Task 3.1 – Evaluating of scale-dependent data and model applications (Months 1-9). Developing an understanding about which scales are most appropriate for which mapping and modelling activities. Scales comprise space and time to capture the dynamics over time at the spatial scale at which NBS activities will take place.

Task 3.2 – Modelling ES provided by multifunctional GI and NBS interventions tailored to selected ULLs (Months 7-36). This is a substantial task in REGREEN, to build new and to adapt existing ecosystem service models to create new outputs of the ecological benefits of NBS, which are bespoke assessments for each ULL. Within REGREEN models will be developed for heat, hydrological-hydraulic, water quality, air pollution, noise, carbon sequestration, biodiversity. In addition there is discussion to develop a new service to be modelled around the potential for biodiversity to inform education options for younger schoolchildren.

Task 3.3 - Integrated assessment to determine demand for future NBS interventions (Months 9-45). In this task, we will establish a framework to combine quantitative and qualitative data that explain the urban demand of NBS from multifunctional green infrastructure by exploring their benefits and values. In this framework the spatially explicit urban drivers and pressures (WP 2 / WP3) will be collectively analysed with qualitative values of residential perception and responses gathered in WP4. This mixed methodology will take account of the complex interactions between drivers, pressures and perceived valuation at the most appropriate scales.

Task 3.4 – Develop tools and guidelines for mapping and modelling ES (Months 9-42). We will develop a suite of models and modelling procedures based on the innovative approaches developed in T3.1 & T3.2. These will be an input to WP8 to develop user-focused decision support toolkits. These tools will be consistent, comparable, related to specific functions and problems. The models and modelling procedures will be used to implement existing thresholds or targets to estimate service delivery (e.g., minimum recommended distance to greenspace of 300m). As thresholds are important for city authorities to strengthen their social and political decisions, we will elaborate our indicator sets to go beyond the MAES Urban Pilot indicator framework and present potential target values for explicit ESS concentrating on ecological thresholds and on socio-ecological values. So far, there are too few target values readily available for urban planning in Europe and in China. In addition, T3.4 will develop a methodology for identifying the "depaving" and "re-greening" potential in cities at the district level (spatial mapping, priority in terms of planning policies, field prospecting, and ecological engineering) and develop large and walkable floor maps for each European ULLs as a technical tool for educational and PR materials and used by WP5and WP8. Remotely sensed data will be underpinned by allocated QR codes to express each NBS site intervention.

9.1.3 WP4 Wellbeing assessments and valuing benefits of nature-based solutions

WP4 has three key objectives:

- Review and integrate current knowledge on the quantification of multiple values and benefits from NBS and restored urban ecosystems.

- Develop our understanding of how people perceive, interact with and respond to urban natural environments through exploration and integration of novel data resources and in-depth qualitative enquiry.
- Assess monetary and non-monetary values and benefits from restored and improved urban ecosystems in ULLs using a range of methodologies to capture complex networks of intervention impacts.

Task 4.1: Evidence review and synthesis - A complexity-informed review and synthesis of a nature-based solution of interest across ULLs (street trees) and a wellbeing outcome of relevance across Europe and China (mental health) to provide background, establish knowledge gaps and generate evidence to feed other tasks in WP4, and the wider project and ULLs.

Task 4.2.1: An ecological momentary assessment of interactions with urban natural environments - This task consists of the development of an ecological momentary assessment (EMA) mobile phone application (app) which will be used with residents in each European and Chinese ULL to assess their experiences in a number of geo-located sites identified as nature-based solutions.

Task 4.2.2: Photo-elicitation with community groups - A purposive sample of residents in each European ULL will be invited to a series of photo-elicitation focus groups to explore their perceptions and experiences of nature-based solutions.

Task 4.3.1 - Deliberative valuation - Drawing on the findings from Tasks 4.1 and 4.2, this task will conduct 2-3 deliberative valuation (DV) workshops with citizens in each of the European ULLs and one workshop in Beijing ULL. The workshop in Beijing will be carried out with the support of TU partners; a workshop in Shanghai may be included, subject to additional funding. The aim is to generate improved economic valuations of NBS benefits in urban and peri-urban settings compared to conventional monetary valuation approaches through a novel merge between large scale monetary survey techniques and small scale group deliberation. For REGREEN, this task will specifically verify the existence and quantify the extent of preferences towards specific scenarios of NBS interventions across ULLs while providing decision-makers and planners with a better understanding of motivations and wishes of citizens regarding how the city should look like and function.

Task 4.3.2 - Application of value functions to determine the value of ecosystem services from NBS for services which are being modelled in WP3 - This task will involve applying valuations to the health and environmental benefits (and costs) of NBS. We will draw on existing studies that use meta-analysis to value benefits. Applying existing valuation functions will allow the adjustment of values from the literature to site characteristics where possible. This activity will be adaptive according to resources and data available for the different settings; in European ULLs a thorough valuation will be implemented, while in Chinese ULLs a more limited appraisal will be possible.

9.1.4 WP5: Education, participation and awareness

WP5's overall objective is to collaborate with educational institutions and municipalities across ULLs to develop educational programs and digital tools to foster children's appreciation, understanding and involvement in local NBS. We focus broadly on citizen science (T5.3), digitally enhanced environmental learning (T5.2), dynamic vegetation playscapes (T5.4) and a comparative review of how children, growing up in different urban environments, perceive and experience nature. WP5 will also assess the transferability of the programmes, tools, devices and landscape management practices under development across ULLs (topographies, environmental issues, cultures of governance, school systems, pedagogies and languages). WP5 works with WP2-3 on educational mapping and modelling, WP4 and WP6 on local perceptions and governance of nature and with WP8 on SMEs and digital platforms.

Task 5.1: Children's interaction with nature -This task aims to explore how children are differently positioned regarding natural environments in specific contexts. The task will investigate and assess how different kinds of differences may impact children's access to nature, understandings of nature and learning processes regarding NBS. The task will also investigate how these differences potentially play into the implementation, transfer and appropriation of programmes, learning platforms and landscape interventions developed in WP5.

Task 5.2 Technology for nature-based learning - In this task, we will develop accessible technological learning tools to promote active physical and cognitive engagement with nature and facilitate experiences that generate reflection on NBS. To achieve this, we will develop a digital educational platform for enhancing schoolchildren's awareness and understanding of NBS (baseline studies, workshops, qualitative fieldwork, interviews)

Task 5.3 Citizen science, participatory education, and community planning - The aim of this task is to elaborate on current citizen science programs (CSP). The task will create new models of citizen science that integrate educational, sociocultural and governance perspectives and explore ways of incorporating citizen science into community NBS planning. The different partners will collaborate with schools and municipalities to develop, deploy and survey CSPs aimed at enhancing children's awareness of urban biodiversity as well as their ongoing engagement in community action for NBS. The aim is also to follow and assess educational processes and programmes at pupil, class, school and community levels and promote knowledge exchange across partners and ULLS.

Task 5.3.1 ULL Paris - In this task, we help schools in Paris ULL to implement biodiversity-focused citizen-science programs and propose NBS in their schoolyard. We also survey how nature-based citizen-science programs can change knowledge and attitudes of children and adults towards nature (notably based on affective or sensory relationships), the emergence of NBS projects by the pupils and the adults, and transformations in the governance of the schools. In parallel, we aim to share skills and tools developed in the ULL Paris with interested schools in the other ULLs, in close collaboration with local REGREEN partners, to address the specificities of each cultural and socio-economic context.

Task 5.3.2 ULLs Velika Gorica & Aarhus - Supplements Task 5.3.1.with the aim is to "conduct interactive research with local stakeholders to develop Citizen Science Programmes and other participatory approaches aimed at enhancing children's environmental agency". This includes an aim to "investigate and facilitate adaptation of approaches and protocols used in Vigie-Nature École and explore the potential development and incorporation of participatory approaches focusing on action competence." Furthermore, it will examine "processes of transfer and appropriation, work with local stakeholders to improve the impact of schools and children's participation and learning in local NBS governance".

Task 5.4 Co-creation of NBS for children's play and learning activities - Alnarp landscape laboratorium (SLU), the oldest and foremost landscape laboratory in Europe, provides a 1:1 experimental vegetation design and management arena that allows testing effects of full-scale management interventions on children's play behaviour and environmental learning activities. Within this task we will explore a full-scale collaborative intervention which will 1) provide knowledge for creating urban landscapes (NBS) that promote both education and play, and 2) guide development of vegetation design that is potentially transferable to schools (ULLs: Aarhus, Velika Gorica (WP7).

9.1.5 WP6 The governance and planning of urban nature-based solutions

In WP6, research and activities examine how city governing and planning institutions within different systems of governance address major challenges and transitions through integrating NBS. NBS is in the urban governance perspective a policy issue and developed as a solution across multiple policy sectors. Managing major challenges through integration of NBS involves for cities processes of

institutional leaning and adapting decision making and implementation to new and dynamic solutions, including the uptake of tools, methods and approaches for applying NBSs in urban strategic and land-use planning.

The WP6 objectives are to:

- Evaluate how governance systems work in urban areas to promote integrated policy approaches (planning, health, conservation, transport etc.) for NBS-based long term transitions taking full advantage of ESS;
- Explore how experimental governing approaches can engage public and private stakeholders in innovative and novel activities to foster policy learning around how to adapt NBS to local and future challenges;
- Examine the feasibility of transferring NBS-related policy ideas and learning approaches among urban policy institutions; and
- Stimulate novel methods for planning of NBS in cities

Task 6.1 – Governance including planning systems - examines how different systems of governance work at the city level and the impact this has on the capacity of cities to include NBS-based approaches, tools and measures in the design of transition policies for and in planning of a sustainable, climate resilient and just city. The research identifies and assesses key mechanisms of urban governance architectures aimed at integrating NBSs (WP6 objective 6.1), as set in a multi-level governance perspective, thus acknowledging the embedding of urban governance institutions in the local context while also being integrated with national (member-states, China), regional and supra national (e.g. European Unions) governance. Thus, the path-dependency of policy institutions (i.e. resistance to change) mix with institutional change in local governing institutions and is orchestrated by national-local architectures of governance. The task examines how governance systems work in the urban areas of the European ULLs to promote integrated policy approaches for NBS-based long-term transitions and focusses on institutional arrangements of urban governance, different administrative approaches and how these deliver different outcomes depending on the city and governance cultures and histories. In the Chinese context, the task aims to conduct a baseline assessment of the governance context of the Chinese ULLs, which will be compared with the more in-depth insights from European ULLs to establish overlaps and divergences in their governance contexts and approaches to including NBSs. The main method in Task 6.1 is in-depth case studies of governance systems in all the European ULLs. Data for the analysis is collected through policy document analysis, qualitative in-depth interviews and surveys in the European ULLs. Baseline data from the Chinese ULLs will mainly cover document analysis and supplementary interviews.

Task 6.2 Experimental policy learning - In co-creation processes with the European ULLs, Task 6.2 seeks to explore how experimental governing approaches can be used to foster innovative solutions and policy learning among the public, stakeholders and city authorities to nurture innovative and novel governance and policy approaches to NBS. The first aspect of this task will be to conceptualise what we understand by experimental leaning in policy institutions dealing with NBSs, to enable an evaluation tool for assessing experimental learning approaches to NBS policy innovation. The next step is to use this evaluation tool to test and co-design experimental NBS based policy making, in co-creation with the European ULLs experimental policy innovations. This work will entail methods such as field trails in which workshops, qualitative interviews and surveys to explore how different policy interventions or treatments can lead to policy learning around different NBS policy outcomes (relative success or failure). Drawing on the baseline assessment of the governance of the Chinese ULLs developed in Task 6.1, the task will explore possibilities for experimental learning around innovative NBS governance in the Chinese ULLs.

Task 6.3 Transferability of NBS based governance ideas among cities - Relates to objective 3 of this WP. It explores feasibility of transferring NBS-related policy innovations and learning approaches

across different urban contexts through co-creation processes. It does so through drawing on the base line mapping of NBS governance systems in the European ULLs from Task 6.1 to understand the policy, social, economic and environmental context in which successful NBS policy approaches and experiments (Task 6.2) have operated, to assess how readily they are transferable to other contexts. Drawing on the baseline data from Task 6.1 and Task 6.2 alongside focus group interviews with key stakeholders in the ULLs, the different contextual factors listed above that have enabled or held back NBS policy success will be mapped out. The task thus links to WP7 through co- creation activities with the European ULLs, while also drawing on the insights obtained through co-creation of baseline surveys of the Chinese ULLs. Using concepts such as 'goodness of fit' from the policy transfer literature (e.g. Dolowitz and Marsh, 2002) we can then evaluate which NBS policy innovations are very context specific and are unlikely to have much traction elsewhere and which ones have a wider practical transfer potential across the ULLs and beyond. Findings from this task will inform the NBS Transition Handbook compiled in Task 7.4

Task 6.4 Stimulating novel approaches for managing urban land take and integrating NBS in urban planning systems – Investigates new approaches to plan urban land take and new methods of integrating NBS firmly in planning systems. It does so through insights from Task 6.1, Task 6.2 and Task 6.3, findings from WP2's assessment of NBS enhancements of ecosystem provision in urban and peri-urban areas, WP3's quantification of the impact of land up take as a major driver of ecosystem fragmentation and degradation across the European and Chinese ULLs, and WP4's identification of urban citizen preferences. The integration of NBS into LU planning in European cities will be investigated with regard to new and existing urban green spaces and on urban non-motorised mobility, through adopting the tools developed in WP3 and WP4 and the experimental governance task (Task 6.2), which will enable innovative, dynamic inclusion of the multiple values of NBS. This will also recognise social impacts of changing urban environments, including the redistribution of values and benefits among urban communities and population groups. These activities will be supported by consultations with urban local planners and stakeholders, including business and citizens groups in European ULLs, including business and citizens groups. Findings will lead to guidelines for strategic planning instruments that integrate NBS in urban planning processes to be fed into WP8 digital platform. Outcomes will moreover feed into the NBS Transition handbook collated in WP7.