



REGREEN

NATURE-BASED SOLUTIONS

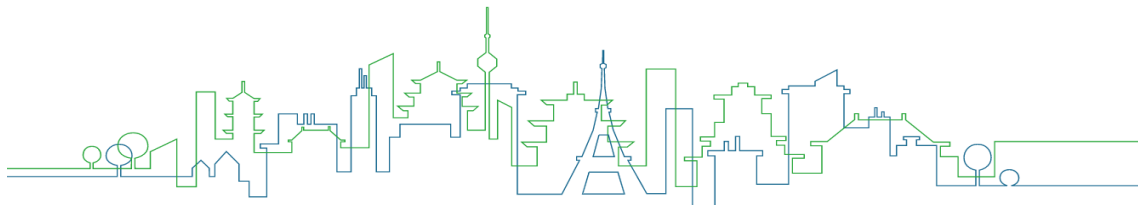
Fostering nature-based solutions for smart, green and healthy urban transitions in Europe and China

Deliverable N°4.5

WP N°4 Wellbeing assessments and valuing benefits of nature-based solutions

MIXED-METHOD INTEGRATION OF EVIDENCE AND VALUATION FINDINGS FOR ULLS

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EXECUTIVE SUMMARY

“Value” is a multi-faceted concept. Even though we often think of value in terms of ascribing a monetary worth to goods and services, it is a term that relates to a variety of different forms of evidence about how people experience, interpret, and perceive entities such as Nature based Solutions (NBS). More broadly, ‘values’ relating to NBS can reflect principles and moral perspectives on importance and priorities.

This document, a key output from REGREEN Task 4.4, brings together the activities from across Work Package 4 “Wellbeing assessments and valuing benefits of nature-based solutions”. The primary objectives of the report are: 1) to summarise the multiple ways in which the health and wellbeing related values of NBS were investigated; 2) to illustrate the benefit of taking these multiple approaches to understanding NBS values; and 3) to present an integrated picture of what was learned.

Producing and using different types of evidence of the value of NBS facilitates a more comprehensive understanding of the complexities of their selection, delivery, and reception. The different forms of evidence, individually and in combination, can reveal if and how an NBS action had the intended impact, clarifying who or what benefited, to what degree, and in what ways. A further purpose is that different audiences need, and will respond to, different types of evidence.

There are risks to using constrained types of values and evidence in decision making relating to NBS. This includes the potential that decisions are made which fail to achieve optimum benefits, or at worst, could result in severe unintended consequences including wasted resources, or even harm to individuals or communities.

Some of the specific methodologies used in WP4 to understand the multiple values of NBS include:

- Theory building and complex systems to understand the multiple outcomes, feedback loops, and unexpected consequences of implementation of a specific NBS, street trees.
- Ecological momentary assessment of the experiences, behaviours, and moods of people in urban parks in three of the Urban Living Labs.
- Photo-elicitation to capture the responses of community groups to green space, specifically street trees.
- Deliberative valuation to explore people’s perceptions and preferences regarding ecosystem services and subsequent benefits, and disbenefits of NBS.
- Ecosystem service valuation of the public green spaces in Paris in terms of their cooling effect on nearby residents and the associated reduced risk of heat related mortality.

Individually, the results of each study carry great meaning, but when considered as a whole, knowledge built from different types of evidence of value have revealed the multifaceted nature of the value of NBS.

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1 INTRODUCTION

1.1 Purpose of the document

This document is the key output from REGREEN Task 4.4 and brings together the activities from across Work Package 4 “Wellbeing assessments and valuing benefits of nature-based solutions”. The primary objectives of the report are 1) to summarise the multiple ways in which the health and wellbeing related values of Nature-Based Solutions (NBS) were investigated; 2) to illustrate the benefit of taking these multiple approaches to understanding NBS values and 3) to present an integrated picture of what we have learned.

This document relates to and draws upon all other REGREEN WP4 deliverables, it also relates to specific activities of other Work Packages, especially WP2 and WP3.

1.2 Scope of the document

The primary topic covered by this document is the integrated, multiple method evaluation of the health and wellbeing-related values of NBS, particularly in the context of the REGREEN Urban Living Labs (ULLs).

1.3 Structure of the document

Section 2 summarises what is meant by ‘values’ in this context and sets the scene. It includes an infographic that represents the activities carried out in WP4, which are further explained in the remainder of the document. Section 3 argues for the importance of different approaches to valuing NBS, and the merit of bringing them together for different audiences. Section 4 situates this work in the context of the wider REGREEN conceptual framework and approach to NBS. In Section 5, each of the approaches used, exemplar findings, and reference to relevant deliverables and publications are summarised. Finally, Section 6 focuses on integration of the approaches described.

2 WHAT ARE VALUES, AND WHAT DIFFERENT TYPES ARE THERE?

“Value” is a multi-faceted concept. Even though we often think of value in terms of ascribing a monetary worth to goods and services, it is a term that can be used in a variety of different ways. Two key meanings³ are:

- To infer principles or morals e.g. “Core values of our NBS programme are to deliver multiple benefits for the environment and our society”
- To economically evaluate outcomes of investments, programmes etc. (note that economic evaluation can include non-monetary value)

Clearly there are connections; understanding the ‘value’ of an NBS intervention may support delivery of personal, organisational or policy ‘values’. Values are reflected in relevant goal-setting, such as the Sustainable Development Goals⁴ (e.g. “Sustainable cities and communities”; “Good health and wellbeing”), and progress toward those goals can be measured through evaluation. There is an extensive literature on environmental values more broadly (see for example Dietz et al, 2005), which is beyond the scope of this report.

It is, however, helpful to consider the multiple values that we might assign or attribute to Nature Based Solutions.⁵ This is certainly the case in considering the health and wellbeing values of NBS, where different types of evidence and associated values can be used to assess their benefits, importance, usefulness and delivery. It is clear that some values cannot easily (and some would argue *should not*) be evaluated in terms of monetary worth or any kind of quantitative estimate – for example spiritual experiences of nature (Baur, 2018). Further discussion of these different dimensions of the concept of value can be found in a recent report for the World Health Organisation (WHO, 2023).

Different types of evidence used to understand and measure values associated with NBS, and can include (this is not an exhaustive list):

- numerical data, e.g. quantifying health impacts through mortality or hospital admission rates.
- monetary values, which may be ascribed using various methods, and are often considered useful due to policy/decision-making relevance and potential utility as a comparable quantity.
- qualitative evidence, which can help reveal, in more depth and in citizens’ own words, values such as perceptions, aims and intentions, and their experiences.
- cultural evidence, which can come in the form of, for example, texts, images or performances, can reveal values held by communities.
- evaluative evidence, which can take numerical, economic, qualitative or many other forms, can reveal if an action (such as an NBS) had the intended consequences. Evaluations may indicate who or what benefited, to what degree and in what ways.

The infographic presented in Figure 1 summarises the five approaches to considering NBS values for wellbeing undertaken through REGREEN. These are explored further in section 5, and in related deliverables and outputs.

³ <https://www.ovsp.net/culture-change/>

⁴ <https://sdgs.un.org/goals>

⁵ See for example <https://www.naturvation.eu/library.html>

UNDERSTANDING THE MULTIPLE VALUES OF NATURE BASED SOLUTIONS

WHY DO WE VALUE?

Nature based solutions (NBS) have wide-ranging benefits for communities, human health and the environment.

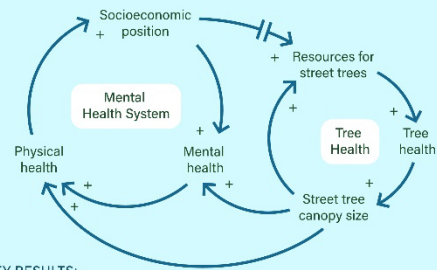
Holistically valuing all the benefits (and disbenefits) can inform decision making. Each of the approaches used here contributes to the collective valuation of nature-based solutions in urban areas.

1

SYSTEMS THINKING THROUGH CAUSAL LOOP DIAGRAMS

Using a systems thinking approach, we reviewed existing evidence and consulted stakeholders on NBS in urban areas to develop our causal loop diagrams. They visualise the outcomes, feedback loops, and unexpected consequences of NBS on communities.

Here's an example that looks at the links between street trees and mental health:



KEY RESULTS:

The health of the street trees is important - maintenance is needed to ensure they reach the age and size when the benefits to mental health are realised.

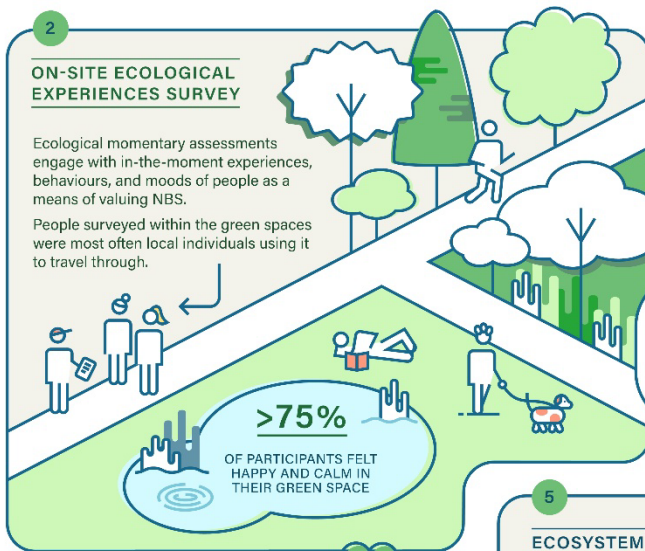
Communities that don't experience benefits may be less likely to advocate for future investment in street trees, ultimately leading to increased inequalities.

2

ON-SITE ECOLOGICAL EXPERIENCES SURVEY

Ecological momentary assessments engage with in-the-moment experiences, behaviours, and moods of people as a means of valuing NBS.

People surveyed within the green spaces were most often local individuals using it to travel through.



4

DELIBERATIVE VALUATION

Deliberative valuation utilises small groups of citizens who discuss and choose between NBS scenarios and their costs to inform the economic valuation of NBS benefits in urban areas.

This method helps understand preferences and guide environmental policy and decision-making.

CITIZENS ARE WILLING TO PAY FOR A **12%** TREE CANOPY COVER INCREASE

3

PHOTO-ELICITATION WITH COMMUNITY GROUPS

Photo-elicitation uses photographs to prompt discussions to uncover information, feelings, and memories about NBS.

"I remember the whole community gathered to plant these trees. I still remember that planting... When I think about it now, it still keeps my heart warm and I'm proud." (VELIKA GORICA)

"That experience [moving around in the city] is enhanced by the existence of trees, and you can follow the seasons, when you can see that new leaves are coming out, you can see birds' nests in the trees." (AARHUS)



5

ECOSYSTEM SERVICE VALUATION

Ecosystem service valuation assigns measurable economic value to the processes through which nature contributes to human well-being.

Our work valued the cooling effect of green spaces for Paris residents and the associated reduced risk of mortality.



57% OF PEOPLE IN CENTRAL PARIS LIVED CLOSE ENOUGH TO GREEN SPACES TO BENEFIT FROM COOLING EFFECTS

Figure 1: Infographic summarising five key approaches to considering NBS wellbeing values

3 WHY INTEGRATE VALUES?

This section establishes the context for the integration of different types of values emerging from WP4. It is not intended to be comprehensive, and we acknowledge that some of the issues are contested and debateable.

3.1 What do different kinds of values tell us?

Evidence of different types of values exists in many forms within the REGREEN project and in other NBS-related programmes of work. Each kind of value, and the different types of evidence that illustrate those values, provides context for the exploration and assessment of implementing nature-based solutions in urban environments to foster their equitable and green transition.

We have gathered qualitative, quantitative and visual evidence within this project. Each type of evidence reveals the variety of values associated with NBS. Qualitative evidence helps reveal, in more depth and in their own words, values people may hold about NBS such as their perceptions, aims and intentions, and experiences. As described above, these values can also represent individual or organisational principles, reflecting the things that are important to them. Quantitative evidence can also be used to demonstrate people's values, but typically the emphasis is on the extent and representativeness rather than depth. It can also provide metrics on process and outcomes by which NBS may be evaluated to inform decision-making.

Many forms of evidence contributed to the REGREEN project, including numerical, spatial, economic, cultural images, as well as interviews and focus groups. This breadth of evidence, individually and in combination, can reveal if and how an NBS action had the intended impact, clarifying who or what benefited, to what degree, and in what ways. Individually, they each carry great meaning, but when considered as a whole, they highlight the multifaceted nature of the value of NBS.

3.2 How can different types of evidence support arguments for NBS?

Producing and using different types of evidence of the value of NBS facilitates an understanding of the complexities of NBS (EC, 2021). NBS are multi-functional, with complex environmental, social and economic impacts. Actively working to develop, assess, and communicate a broad, mixed value and evidence base enhances our understanding of the potential or realised multifunctionality and co-benefits of NBS. Better understanding of this complexity can help strengthen arguments for the implementation of NBS.

Different evidence types reveal subtleties in the arguments for or against NBS. Uncovering why some individuals or communities are supportive or not and the ways in which we can tailor communications to help improve understanding. Evaluating NBS through multiple methods helps clarify the extent, depth and equity of impacts. The evidence produced can help inform NBS strategy, ensuring the right option – environmentally, geographically, economically, as well as socially – is identified. The evidence can help refine implementation and delivery plans and, crucially, indicate unintended consequences and potential mitigating factors to avoid failure (Dushkova & Haase, 2020). This promotes further use of NBS.

Finally, different types of evidence and value can help strengthen the arguments for the long-term sustainability and active management of NBS to ensure that multifunctionality and co-benefits are realised. To fully understand NBS in the long-term, different future scenarios relating to, for instance, political, fiscal, or climatic changes, requires a breadth of types of values and evidence.

3.3 What evidence or information do different audiences need?

An essential purpose of gathering different types of evidence to contribute to assessing nature-based solutions in urban communities is that different audiences need, and will respond to, different types of evidence.

Advocating for and implementing NBS necessitates communicating with audiences who have varying levels of involvement, NBS literacy, and capacity to engage in the process. Similarly, different types of evidence are needed at different stages of NBS planning and delivery. For example, whilst numerical cost-benefit evidence will be valued by decision-makers weighing up which option to commission, this can be supplemented and enriched by other forms of evidence that can indicate reception and response of local communities to a change. Other audiences, such as individuals or communities who are being consulted on future plans, are likely to require evidence that can tell a story about the changes they may experience, alongside indications of the impacts.

As important as the type of evidence is the ways in which it was gathered and/or created. All audiences will want to know the evidence they have been presented is robust, reliable, and valid.

3.4 What are the consequences of using constrained types of values and evidence in decision making?

NBS are complex and multifaceted actions. Using constrained types of values and evidence in decision making limits the effectiveness of the NBS implementation, delivery, and function. Where relevant factors are not taken into account the viability and potential success of the NBS is threatened. This includes the potential that decisions are made which fail to achieve optimum benefits, or at worst, could result in severe unintended consequences including wasted resources, or even harm to individual or communities.

3.5 What other factors need to be considered when making use of values?

Evidence and values relating to NBS, whether produced to inform decision making about suitability and implementation, or evaluation of impact, should always be considered in context (Albert et al., 2021). For example, what is considered of high value in one location or for one community may be considered differently in another location or by a different community.

It's important to consider what conditions are required for NBS to meet their potential, especially in terms of delivering multi-functionality and addressing inequalities. For example, understanding the context of an NBS intervention could help to increase the range of ecosystem services it delivers. In some contexts, delivery of an NBS might serve to reduce health inequalities, whilst in another context that same NBS may increase health inequalities (Cole et al, 2017; Rigolon et al, 2021).

3.6 Do different values arise for different communities and, if so, why does this matter?

The values of NBS for different communities are likely to be as distinctive as the communities themselves. Different communities and stakeholders are very likely to have different preferences for NBS, cost-benefit tolerances, attitudes towards the necessity of NBS, and especially regarding the type of impact anticipated or experienced. These differences are likely to correspond to their attitudes and opinions towards NBS and past experiences, amongst other factors (Han et al, 2023).

Acknowledging that different values arise for different communities is necessary to identify suitable NBS options, as effective modes of delivery and implementation. Such acknowledgement allows for

more informed and meaningful dialogues about NBS and enhancing urban liveability between different communities and stakeholders.

4 HOW DOES THE REGREEN CONCEPTUAL FRAMEWORK HELP US UNDERSTAND THE IMPORTANCE OF MULTIPLE VALUES AND TYPES OF EVIDENCE?

The REGREEN conceptual framework outlines how people play a role in the multiple dimensions of NBS, and how their values shape how we make decisions about new NBS, or how to manage existing NBS in different ways.

People are involved with NBS in three main roles, illustrated in Figure 2. People are directly responsible for managing or creating NBS. Their values and priorities shape the management decisions that shape the characteristics and features of an NBS that have the potential to provide a benefit (this human capital input is shown in the left hand and central part of the diagram in Figure 2a). The second aspect is the people that directly or indirectly make use of the NBS and receive benefits from it. This could include passive benefits from trees removing air pollution or storing carbon or could be more active benefits from recreation or relaxation within a public park for example. The values and perceptions of a particular NBS (for example a pocket park or other public green space) held by members of the public will influence how often they visit the green space, for what purposes, and how far they are willing to travel to make use of it (Jones et al. 2022a). Thirdly, at a societal level beyond decisions made by individual users, there are a range of business, municipal, NGO and other institutions who make decisions or have some form of interest in how NBS are used or managed, and these institutional decisions each bring their own perspectives on what values are important, or not. A description of how the quality, attributes and services provided by green infrastructure influence the interactions of users and managers with that space, depending on their needs and their own characteristics, can be found in Jones et al. (2022b), and a categorisation of the different types of NBS used in REGREEN can be found in Jones et al. (2022c).

Taken together, all these dimensions should ideally be factored into decision-making on NBS. Therefore, when thinking about the types of values that can be collated, and how they can be presented or conveyed, it is necessary to understand which aspects of the system they relate to, and why they are important in decision-making. The REGREEN project has been able to characterise many different aspects of these values, tying in to different societal and structural components represented in our framework.

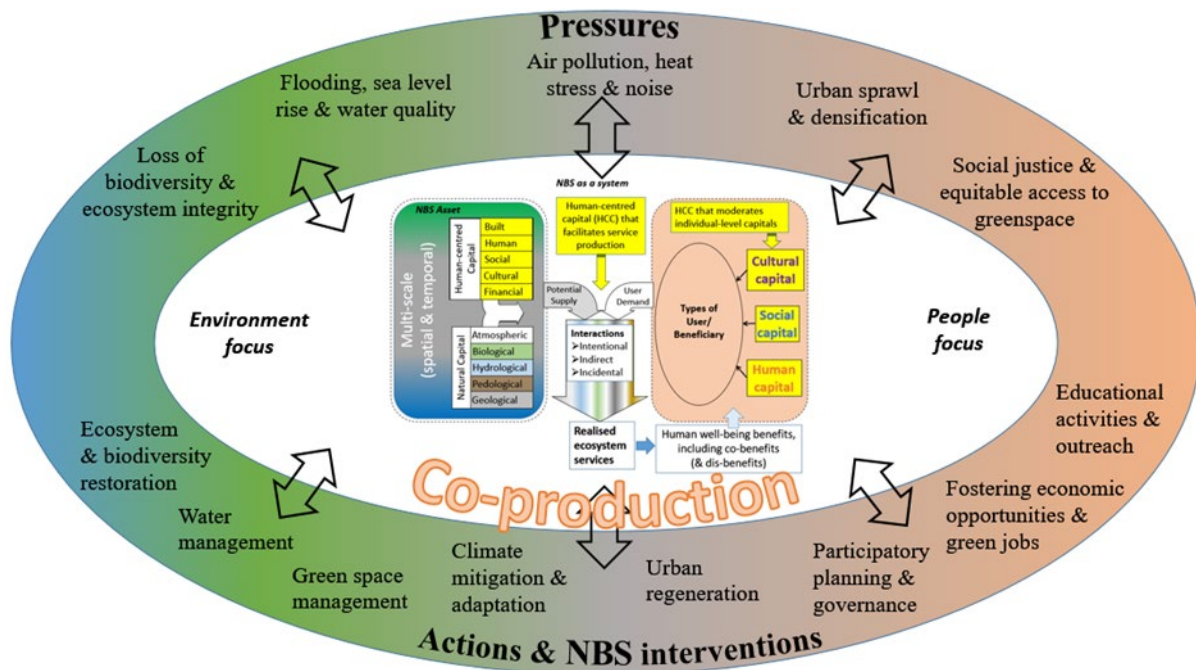
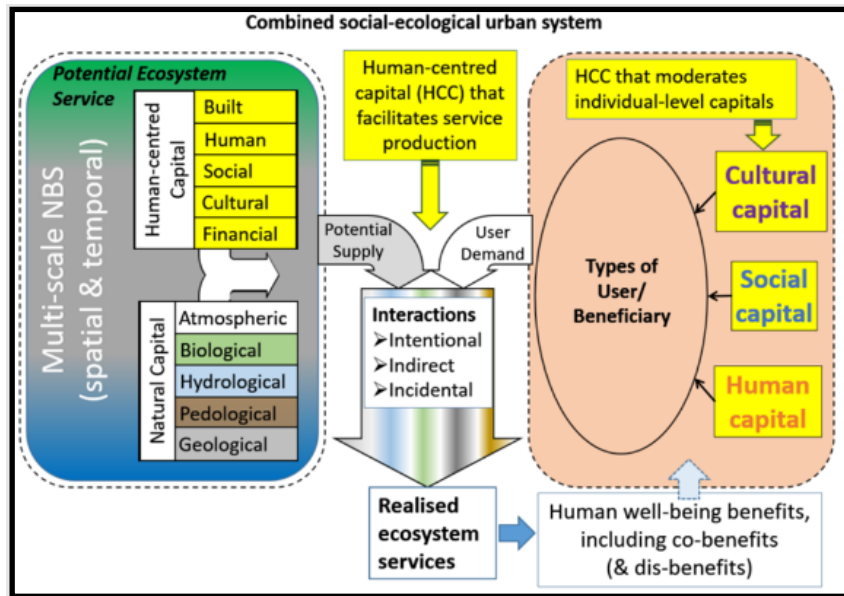
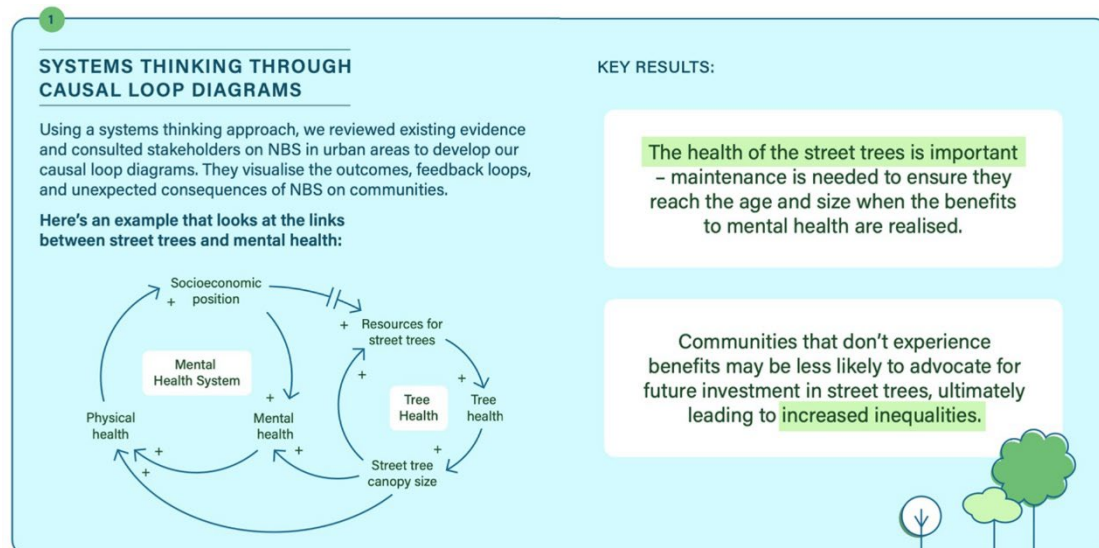


Figure 2: The REGREEN conceptual framework, showing how NBS actions can deliver solutions in response to pressures, and the role of people in multiple dimensions of this process. Top image (a) shows the inner part of the diagram in the lower section (b).

5 HOW WE DEVELOPED DIFFERENT TYPES OF EVIDENCE AND RELATED VALUES IN REGREEN

Each of the following sections relates to one of the tasks within REGREEN Work Package 4; describing the methodology employed and briefly summarising exemplar findings. Additional detail can be found in relevant REGREEN deliverables or other outputs associated with tasks, such as journal papers.

5.1 Theory building and complex systems to understand NBS



Theory Building and Systems Thinking methods and approaches provides a series of tools which are specifically designed to help clarify multiple outcomes, feedback loops, and unexpected consequences of an intervention. They are especially useful when developing frameworks and hypotheses relating to the complex multi-factorial relationships between the specific type of NBS and the desired impacts (Rutter et al, 2017; Alvarado et al, 2023a).

Complex systems approaches can help clarify the non-linear, bidirectionality of benefits arising through both direct and indirect pathways, and the influence of contextual factors. They can reveal, and then take into account, factors such as the geographic and climatic context, the fiscal situation, as well as patterns of exposures (Sterman, 2000).

Using a systems-thinking approach, we conducted a review and synthesis of evidence with consultation from stakeholders about NBS and mental health to inform the other tasks for this work package, the wider project, and the Urban Living Labs (ULLs). We focused on a specific example of NBS, street trees. Causal loop diagrams were developed to understand the dynamics between street trees and mental health outcomes (see Figure 3).

Evidence has demonstrated a link between street trees and better health and wellbeing. However, through the development and analysis of the casual loop diagrams, which were constructed with evidence relevant to Europe and China, we identified a number of factors that help us understand how the wellbeing benefits, or lack thereof, and for whom, arise from provision of street trees. First, many of the social and environmental benefits of the street trees, including canopy size, are linked to tree health. Thus, provision of sufficient resources to maintain tree health are needed to ensure they reach the size and age when impacts such as mental health benefits are realised. Street trees require more support and intervention than trees in other settings to grow and thrive. We also found that communities who have already experienced the benefits of street trees, and are capable of the stewardship required, may be more likely to advocate for additional street trees. Contrarily,

communities with scarce or poorly maintained street trees, or less social and community capital, will not experience the same benefits, if any, and are therefore less likely to want further investment. We suggested this feedback loop would perpetuate the existing inequity between provision of street trees in communities and thus the benefits from NBS. Finally, and bringing the threads together, we found that additional resource for street tree maintenance is essential in low socio-economic status areas. Similar to the above, failing to provide this additional support is another potential cause of inequality in NBS benefit.

Through this evidence review and exploration of NBS values we concluded that street trees and human health and wellbeing are intimately tied together through a looping feedback system. Within this system, the greatest benefit to our mental health and wellbeing is dependent upon the health of the street trees themselves. This finding indicates that street tree maintenance through community stewardship and availability of resources must be considered when advocating for street trees for improved health outcomes.

Further information can be found in REGREEN Deliverable D4.2, and in these papers:

- Alvarado, M.R., Lovell, R., Guell, C., Taylor, T., Fullam, J., Garside, R., Zandersen, M., Wheeler, B.W., 2023. Street trees and mental health: developing systems thinking-informed hypotheses using causal loop diagramming. *Ecology and Society* 28: 2. <https://doi.org/10.5751/ES-14013-280201>
- Alvarado, M., Garrett, J., Fullam, J., Lovell, R., Guell, C., Taylor, T., Garside, R., Zandersen, M., Wheeler, B.W., 2023. Using causal loop diagrams to develop evaluative research propositions: opportunities and challenges in applications to nature-based solutions. *System Dynamics Review*. <https://doi.org/10.1002/sdr.1756>

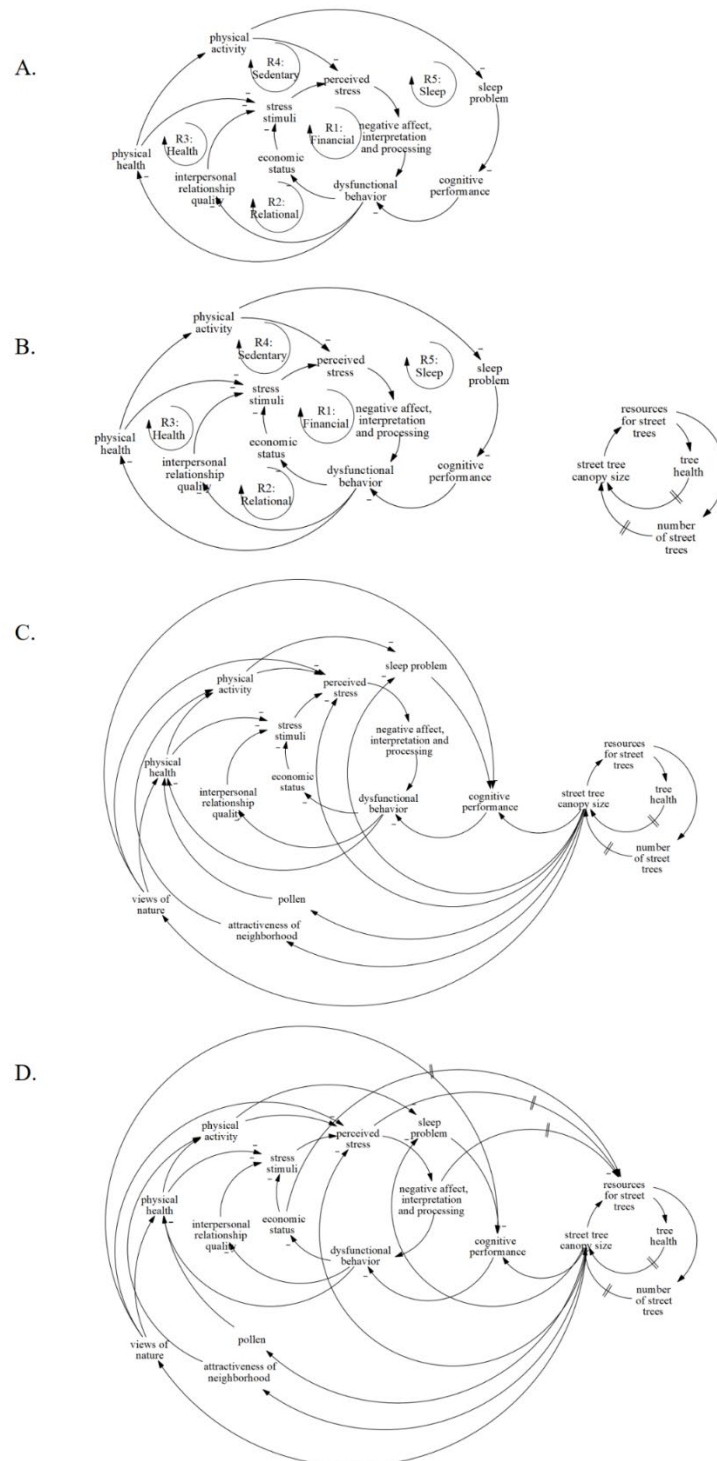
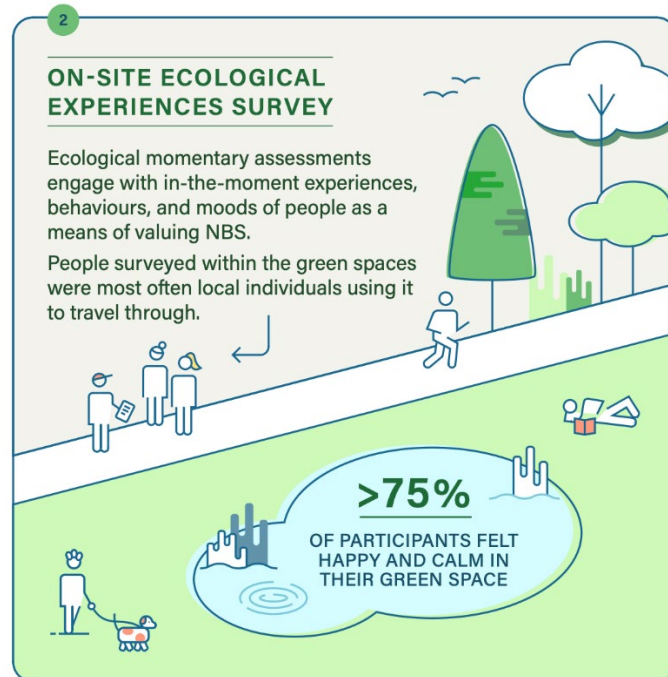


Figure 3: Progression of Causal Loop Diagrams relating street trees to mental health.

Note that arrows represent **hypothesised** causal links based on a range of evidence and stakeholder input. Minus sign (–) indicates an inverse relationship; double bar indicates a delay in the cause leading to the effect. A: Simplified mental health CLD; B: Adding simplified street tree system CLD; C: Pathways through which street tree canopy size may link to the mental health system; D: Feedback from the mental health system into the street tree system. Reproduced from Alvarado et al (2023) under Creative Commons Attribution 4.0 International License.

5.2 Perceptions, interactions and responses to urban natural environments

5.2.1 Ecological momentary assessment of interactions



One method utilised to capture the ‘real-time’ effects of urban natural environments and NBS on the wellbeing of people is Ecological Momentary Assessment (EMA). EMA is a multi-method approach that can be carried out in a variety of ways that records the experiences, behaviours, and moods of participants in place. This method emphasises the personal reactions of individuals and the accurate collection of real-time data such as detecting community responses to any environmental changes or interventions (Burke et al., 2017; Shiffman & Stone, 1998). Within REGREEN, we applied an on-site survey, which was based on an EMA framework, and assessed the effect of NBS on residents in the European ULLs while they actively engaged or interacted with that environment. Crucially, an EMA framework provides self-reported data with fewer errors and biases than usually occur with autobiographical memory recollection (Kirchner & Shiffman, 2016; Knell et al., 2017). This work aimed to capture visitor perceptions and interactions within these urban natural environments to better understand present experiences and draw those results into consideration for future NBS planning.

The survey work was conducted in several ULLs across Europe, including Aarhus, Denmark; Paris Region, France; and Velika Gorica, Croatia and focused on urban parks. Initial data analysis of the surveys has provided several key insights into the connections and experiences of individuals and their environment. The majority of participants were local individuals who spent less than 200 minutes on that visit in the green space. Further, a majority were using it primarily to travel through to other areas. This data emphasises the community importance of the green space for active travel and incidental use. Tourists composed the second largest group of visitor type highlighting another layer to the different values of the green space for different communities.

Participants also rated the perceived quality and safety of the green space with most agreeing that the green space they were in at the time of the interview was of good quality, free from vandalism, safe, and had an adequate distribution of facilities. Lastly, the data showed that most participants felt happy, calm, energised, and relaxed reflecting a positive influence of the green space on their emotional well-being and experiences. Further analysis will look at more specific relationship between demographics and perceptions of quality and safety, groups of visitors with similar interaction

patterns and emotional and well-being scores, and emotional well-being scores across different purposes of visit.

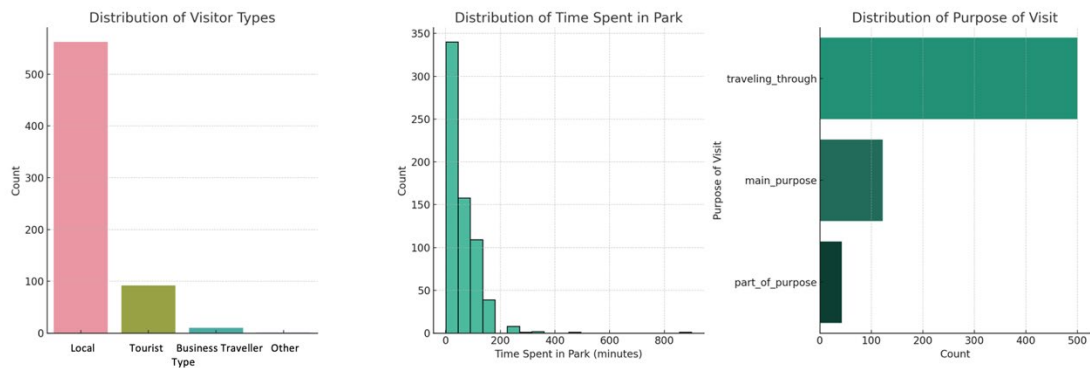


Figure 4: Examples of descriptive data emerging from on-site researcher-led questionnaire surveys in parks in Aarhus, Paris Region and Velika Gorica.



Further information is found in REGREEN Deliverable 4.6.

5.2.2 Photo-elicitation with community groups

3


PHOTO-ELICITATION WITH COMMUNITY GROUPS

Photo-elicitation uses photographs to prompt discussions to uncover information, feelings, and memories about NBS.

"I remember the whole community gathered to plant these trees. I still remember that planting... When I think about it now, it still keeps my heart warm and I'm proud."

(VELIKA GORICA)



A different method utilised to capture the responses of community groups to green space was photo-elicitation. This uses photographs and other visual media to prompt discussions within a research interview. This method can uncover a variety of responses from participants because photographs evoke information, feelings, and memories in a different way than verbal questioning. Within the REGREEN project, photo-elicitation with community groups provided qualitative evidence to assess urban residents' experiences of street trees in the context of mental health and well-being (Alvarado et al, 2023a, Coleman et al, 2022, Salmond et al, 2016). The aim of this work was to contribute to the evidence base supporting the co-creation of NBS in urban areas.

This work was conducted with two focus groups at each ULL site over 1.5 hours with 4-8 participants per group. Several photographs taken in each city were shown to the focus groups followed by

prompting questions such as asking about initial reactions, the individuals' usual observations of trees in their environment, and if they felt they could influence street tree management.

From these discussions, several key insights were formed. First, urban residents reflect that trees provide a sense of place. These feelings help individuals connect with the natural areas themselves and each other. Responses indicate that many aspects of street trees, like how they transform through the seasons, increase quality of life for individuals. Also, the space beneath them, provides a comfortable place for socialisation. While most responses were positive, some were ambivalent because street trees are too removed from true nature and others were negative like when the trees were neglected.

Next, the trees were reported to influence the residents' sense of safety and security. The residents shared that increased green space does not guarantee their safety and security and that the trees can contribute to the social injustices in their neighbourhoods. The main concern for many was the safety of women in areas where street trees block lighting and provide potential hiding places. This then led to a discussion about the reputation of certain wooded areas and how those perceived as dangerous, even though they may not be, impact an individual's positive experiences or lack thereof.

Lastly, many residents observed an 'Us v. Them' sense of agency. The sources of opposition and/or support for increasing green space, specifically street trees, varies in each city but there is an ever-present mentality of division in goals and ideals between parties. The residents felt as though the city planners sided with investors and politicians while the planners struggled to satisfy the diverse desires of different populations of citizens. There was also tension between groups of residents preventing consensus and often resulting in tree vandalism like with the felling of 'unwanted' street trees. The residents are not naïve to the trade-offs and resource constraints presented by street trees, but they do value the ecosystem services provided by well-cared for green spaces. This evidence supports community interest in fostering NBS, but a degree of cooperation between stakeholders and citizens as well as understanding the potential disservices of urban forestry (e.g. safety concerns) will be necessary.

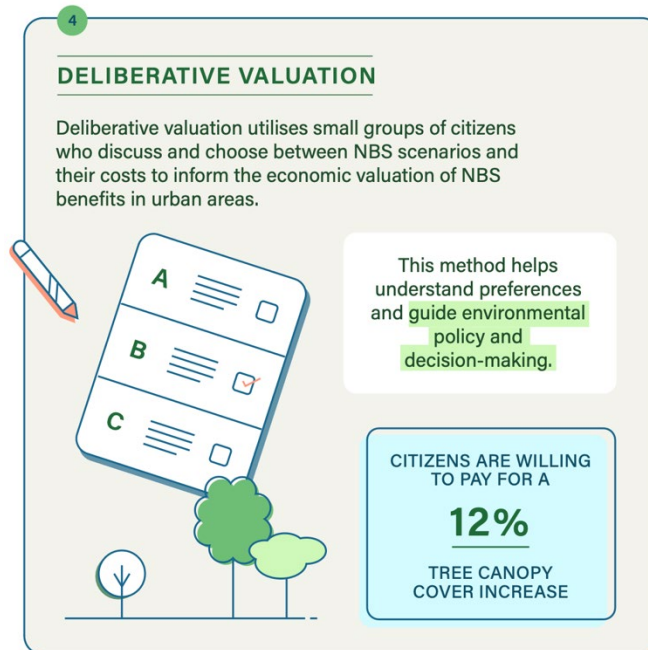
Further information is found in REGREEN Deliverable 4.3.



Figure 5: Example photos from Paris ULL shown to photo-elicitation community groups.

5.3 Benefits and economic values of NBS

5.3.1 Deliberative valuation



Deliberative Valuation Method (DVM) is a hybrid of political and economic approaches to valuing the environment. It uses both qualitative (in-depth discussion groups) and quantitative (non-market valuation) approaches in a workshop setting to form improved understanding and build preferences in relation to the environmental topic (Spash, 2007, Wilson and Howarth, 2002). DVM seeks to improve the quality of monetary valuation while offering a potentially transformative experience for participants.

In REGREEN, two workshops were held in each of the European Urban Living Labs (Aarhus, Paris Region and Velika Gorica) and in Beijing following the same structure and valuation approach but taking into account the differences in local contexts and languages. The workshops were preceded by focus groups in each of the European ULLs to understand local contexts and validate the non-market valuation approach.

The deliberative valuation workshops were composed of groups of citizens of up to 25 participants who were introduced to the topic of NBS in an urban setting, the type of associated ecosystem services and subsequent benefits, and disbenefits to people. Participants also received information on the extent and accessibility to four distinct types of NBS in their city: urban parks, green roofs, blue infrastructure and street trees. Throughout the introduction to the topic and information, participants deliberated on their practices in relation to urban nature, their experiences, perceptions and wishes for urban parks, green roofs, blue infrastructure and street trees. This discussion created a space for individuals to make statements, to listen and learn from each other, and to reflect on NBS. Participants were then introduced to a survey questionnaire containing a choice experiment and asked to fill it out individually.

The survey inquired about living conditions and access to blue and green space, their perceptions of importance of urban NBS in alleviating a range of societal challenges and perceived disbenefits in addition to standard socio-economic background questions. The choice experiment focused on the same four types of NBS – urban parks, green roofs, blue infrastructure and street trees – and offered different relative levels of increase in NBS in their city. A payment vehicle in terms of an ear-marked municipal fee paid per household over 10 years was introduced to finance the increase in urban NBS.

A status quo of no change in urban NBS and no payment fee allowed participants to decline any expansion of NBS in their city. Participants were asked across a number of choice cards (12) to select one scenario on each choice card that they would prefer, given the different levels of attributes shown in the attribute tables.

The results of those choice experiment responses, as well as the discussion that occurred in those spaces about the options, contributed to the quantification of NBS preferences and better understanding of the motivations of citizens.

The results of this valuation method highlighted several areas of concern for the citizens including experiencing climate pressures, a lack of trees, weighing the cost and benefit of things like green roofs, and a lack of investment in blue spaces for health and well-being benefits. Specifically, there were significant and positive preferences toward increasing canopy cover and implementation of lakes and ponds in parks. There was a significant dissatisfaction with the current level of urban nature. Other results were inconclusive like improved access to parks by creating new ones. A willingness-to-pay and resulting policy scenario was calculated based on the current levels of dissatisfaction of current provision of nature. These insights may be used to inform current and future NBS challenges especially in the realm of policymaking and governance for their utilisation.

Further information is found in REGREEN Deliverable 4.4.



























Attribute	Description of level	Picture	Icon
New Park Areas	100% of all in [ULL] live within 300m of the nearest park of minimum 1.5ha (1.5 football pitch)		
	75% of all in [ULL] live within 300m of the nearest park of minimum 1.5ha (1.5 football pitch)		
	100% of all in [ULL] have access to a pocket park in their neighbourhood. A pocket park is a small green area for relaxation, and playing.		
Green Roofs	Additional 10% public and private roofs below 30 degrees inclination are greened		
	Additional 20% public and private roofs below 30 degrees inclination are greened		
	Additional 40% public and private roofs below 30 degrees inclination are greened		
Canopy Cover	Canopy cover in [ULL] increased by additional 4% compared to today		
	Canopy cover in [ULL] increased by additional 8% compared to today		
	Canopy cover in [ULL] increased by additional 12% compared to today		
Water courses and ponds	Where possible, all underground water courses in [ULL] are daylighted and nature restored		
	Small lakes and ponds are created in 100% of parks in [ULL]		
	Small ponds are created in 10% of backyards in [ULL] on public and private areas		

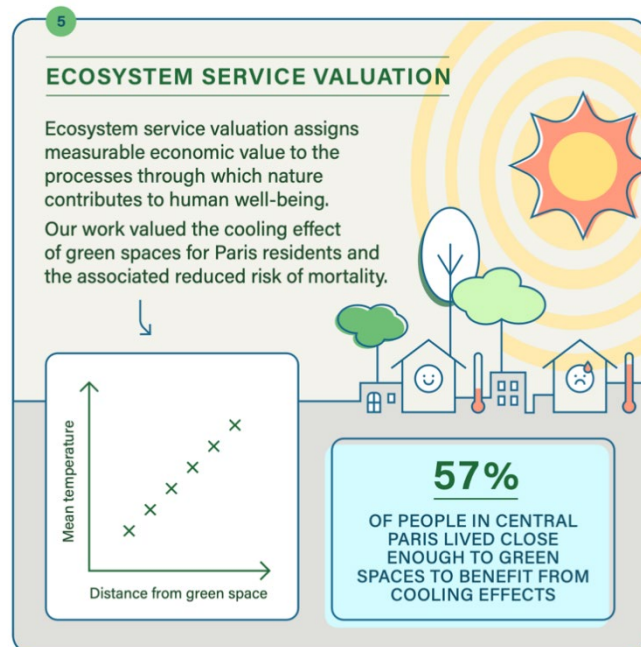
Figure 6: Attribute tables of the four urban NBS types: New park areas, green roofs, canopy cover and water courses and ponds/

Actions	Option A	Option B	Status Quo
New parks	 100% access to parks >1.5ha	 100% access to pocket parks <0.5ha	No change
Watercourses and ponds	 100% reopening where possible;	 Pond in 10% of backyards	
Canopy cover	 12 %	 8 %	
Green Roofs	 40 %	 20 %	
Earmarked municipal tax per month per household for 10 years	1.10 Eur (8HRK)	4.20 Eur (32 HRK)	
Which choice do you prefer? (put 1 tick)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Status Quo: No more than 68% live within 300m of a park of at least 1.5ha. There will be no more than the current 18 ha pocket parks. The tree cover remains at the current 10.5%. There will be no additional green roofs. There will be no additional small lakes or ponds in parks and inner courtyards

Figure 7: Example choice card from Velika Gorica

5.3.2 Ecosystem service valuation



Ecosystem services are the essential benefits that nature provides to humans, such as clean air and water, pollination of crops, and the regulation of climate. These services rely on the ecosystem components and functions underpinning them, such as the presence of trees for shade or bees for pollination. Some of these services can be mapped spatially, enabling the assessment of where and how nature contributes to human well-being in this way. Ecosystem service valuation further extends

our understanding by assigning measurable economic value to these contributions. In combination with non-monetary values, quantifying these benefits helps society make informed decisions, considering the economic aspects of preserving the environment for long-term sustainability.

A range of ecosystem services have been modelled and mapped by REGREEN's work package 3 including noise mitigation by trees, cooling of air temperature by different forms of green space (Bird et al. 2022), removal of air pollutants by trees and grass in cities, reduction in surface water flooding by green space (Miller et al. 2023), and improvements to water quality by riparian trees and other urban trees located further away from rivers. A comparison has been made of ecosystem service outcomes across the six urban living labs (Paris, Aarhus, Velika Gorica, Shanghai, Beijing, Ningbo) under projected land use change scenarios (Wu et al. 2022).

Valuing the reduced risk from mortality by heat from public green spaces in Paris

In the future, we are expecting greater heat-related health risks. In urban areas, parks and green spaces are cooler than their surrounding areas. This cooling effect can also extend beyond their boundaries representing a potential nature-based solution for mitigating and adapting to increased urban heat.

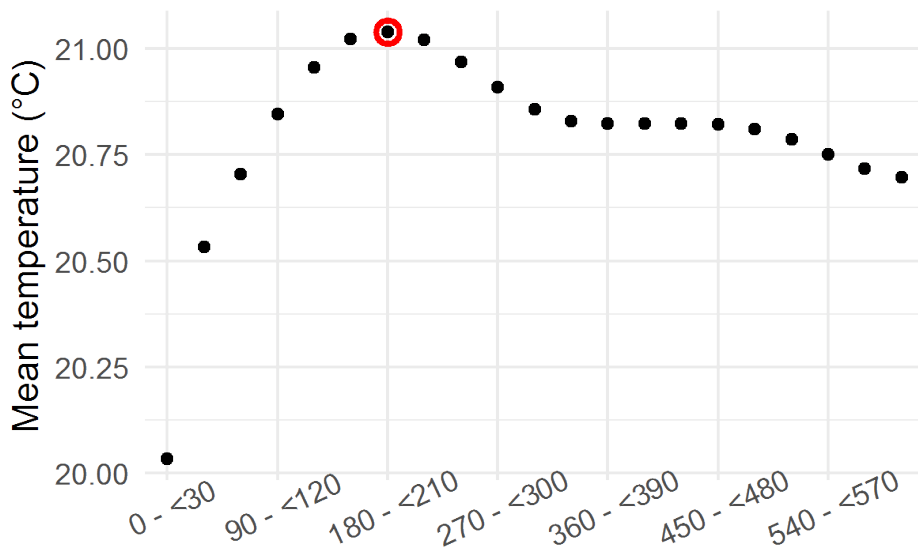
We carried out an economic valuation for the public green spaces in Paris in terms of their cooling effect on nearby residents and the associated reduced risk of heat-related mortality. We utilised high spatial resolution temperature maps for Paris in 2019, which were calculated by work package 3 (Bird et al., 2022). We carried out an initial analysis on a subset of green spaces that were not close to other green or blue spaces. We computed the maximum cooling distances from each green space, representing the farthest distance beyond which cooling effects were no longer detectable. The temperature difference between the green space and the cooling distance was then calculated to determine cooling intensity. This analysis was conducted for three hot days with varying temperatures in July 2019. Statistical modelling was then used to estimate the impact of both greenspace size and vegetation greenness on the observed cooling effects.

Both increasing size and increasing vegetation biomass were associated with increasing cooling distances and cooling intensity. The maximum temperature difference was 1.9°C. Using the relationships calculated, predicting the cooling effect by size and green-ness, we then estimated the cooling effect of all green spaces greater than 1,000m² in area in Paris for all hot days in 2019. The final step is the economic valuation. We calculated the number of people living within each cooled area, the temperatures they are exposed to and the associated relative risk of mortality. The relative risk of mortality was taken from a paper by Pascal et al (2018) where they calculated the relative risk of mortality associated with temperature for a range of cities in France. Finally, to calculate the lives saved we compared the relative risk of mortality with that if there was no cooling to calculate the expected lives saved. Then we apply the value of a statistical life to value the lives saved.

Some spaces have no value, this could be because there were either no people living nearby or there was no cooling effect. In general, larger spaces cooled a larger area around them and had larger impacts on mortality and associated economic value. However, smaller spaces could have a higher value per unit area, and this tended to be greatest for spaces with a size in the range 5000 – 10000 m².

Preliminary results suggest that an estimated 21.5 people were saved due to the cooling effect of public green spaces in Paris in 2019. Just over half of the population within the four central departments of Paris, or 57% (3,783,686 million people) were found to be living within the maximum cooling distance of green spaces and therefore benefiting from their cooling effects.

Le Parc Forestier de la Jonchère



Distance from green space boundary (m)

Figure 8: Mean temperature within 30 m rings from an example green space. The red circle identifies the maximum cooling distance

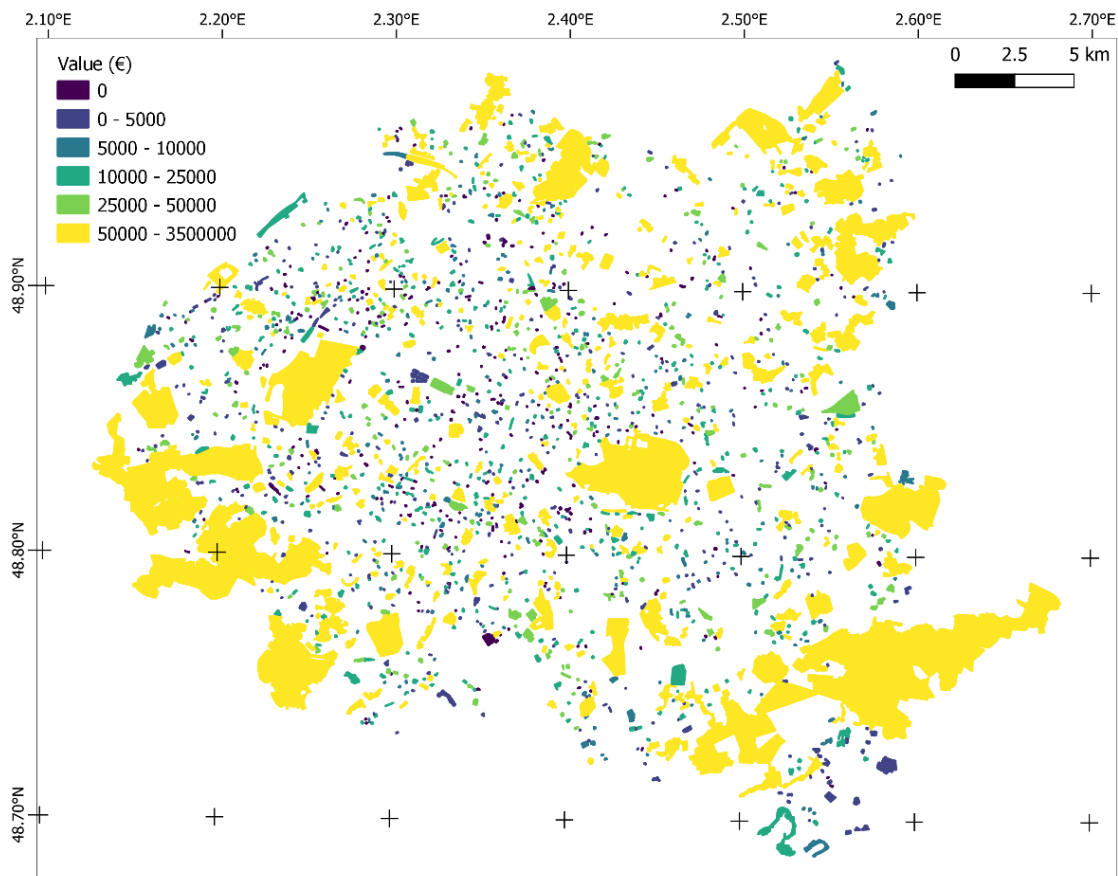


Figure 9: Total economic value for each public green space in Paris that are at least 1,000m² for all 40 hot days in Paris, 2019

6 INTEGRATION

It has been proposed that integration of evidence involves bringing together multiple elements “in such a way as to be mutually illuminating, thereby producing findings that are greater than the sum of parts” (Woolley, 2009). There are a range of formal approaches that have been developed to synthesise findings from multiple studies (Fetters et al, 2013). These are often suited to answering a single, focussed question. However, in this case we had a broad array of questions and issues to address across different NBS, different health and wellbeing outcomes and different ULL contexts. For these reasons, we took the approach that it was more appropriate to describe and illustrate the merits of the different perspectives, and especially to indicate the benefits of using a mixture of monetary and non-monetary valuation.

The work presented above illustrates how quite different ways of conceptualising, understanding and measuring wellbeing values can all produce information that is potentially useful in informing their planning, implementation and evaluation. For example, several pieces of work explored trees/street trees:

1. Theory-building work indicated the importance of tree health in order to deliver their potential benefit for mental health, and consequently that appropriate, long-term investment in tree maintenance would be important in delivering that benefit;
2. Photo-elicitation focus group work suggested that citizen involvement in tree planting could result in longer term wellbeing value of the trees as perceived by those citizens;
3. Deliberative valuation indicated that citizens stated preferences for increased tree canopy and were willing to pay for this to some extent.

Taken together, these findings could inform, support and provide evidence to justify how a municipal authority could and should invest in, manage and capitalise upon planting and maintaining the tree canopy in their area. Each type of evidence adds a different, complementary perspective to the issue at hand.

7 CONCLUSIONS

This work has demonstrated the importance of considering multiple approaches to understanding and evidencing wellbeing values associated with NBS. Through exploring different methods based on various conceptualisations of ‘value’, we have shown that through application of these approaches, a range of different benefits and types of evidence can be produced. In turn, these can speak to different audiences, and help to justify appropriate investment and resource allocation that acknowledges the multifunctionality that is core to NBS.

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