
References

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Localizing Sustainable Development Goals (SDGs) Through Co-creation of Nature-Based Solutions (NBS)

Towards an Assessment Framework for Local Governments

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Working Definitions

Nature-based Solutions

According to the European Commission's definition (See also https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en) (2015), nature-based solutions (NBS) are solutions that are “*inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse,*

nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.”

Sustainable Development Goals

The 17 global Sustainable Development Goals were introduced in 2015 by the United Nations General Assembly as part of a new global development agenda to be achieved by the year 2030. They comprise 169 targets addressing the developmental challenges facing the world including economic growth, urbanization, poverty, inequality, climate change, environmental degradation, peace and justice, see <https://sdgs.un.org/goals>.

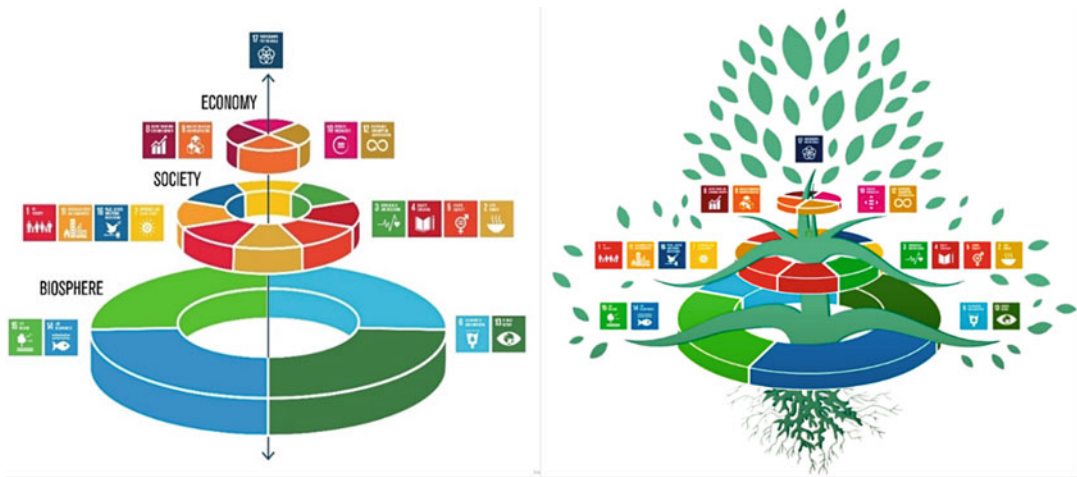
Introduction: NBS, Co-creation and the SDGs, a Possible Triangulation

NBS have the aim to address many urban challenges such as climate change, biodiversity loss, urban heat island, and deforestation; those challenges put pressures on human health and well-being to natural capital depletion, and the security of food, water as well as energy. The EU’s research & innovation (R&I) policy has been investing in NBS research and implementation, considering their superior potential to optimize the synergies between nature, society, and the economy (Faivre et al., 2017). NBS address specific demands or challenges, and at the same time seek to maximize other environmental, social, and economic co-benefits for health, the economy, society, and the environment (European Commission, 2015, 6). Considering the need for evidence on the realistic effectiveness of NBS, research, innovation, and demonstration Horizon 2020 projects in cities have been contributing to set up urban living laboratories (ULLs) for innovation, experimentation, and testing of good practices, methods, and tools with the view to exploit a range of ecological, social, and economic co-benefits for all (Chausson et al., 2020; Seddon et al., 2020).

The Horizon 2020 EU’s research framework program accounts for over 240 million euros of investment in research and innovation in the field of NBS related projects (Davies et al., 2021, 54). Around 20 projects with specific focus on NBS were launched from 2014 to 2020, among which there are “Research and Innovation Actions” (RIAs) and “Innovation Actions” (IAs). Being RIAs projects that include basic and applied research, technology development and integration, testing and validation on a small-scale prototype in a laboratory or simulated environment, whereas IAs may include prototyping, testing, demonstrating, piloting, large-scale product validation, and market replication. At least 12 of the spearheaded NBS projects are dedicated to activities and research in cities (urban and peri-urban areas), among which eight are “Innovation Actions” and four are “Research and Innovation Actions” (Somarakis et al., 2019). In brief, those projects endeavor to explore how NBS work in different urban contexts with differing political, social, cultural, institutional, environmental, and economic situations (Dushkova & Haase, 2020).

In 2015, the United Nations General Assembly formally adopted the universal, integrated, and transformative 2030 Agenda for Sustainable Development, along with a set of 17 Sustainable Development Goals and 169 associated targets. The relationship between NBS and the SDGs (SDG reference is generally omitted since we refer to the official website here, <https://sdgs.un.org/goals>) has since then been highlighted in a number of publications, highlighting that NBS can be directly relevant to SDGs (Lo, 2016; Dudley et al., 2017; Vasseur et al., 2017) or even deliver on all 17 SDGs (Osieyo, 2020). Publications also advocate for NBS as cost-effective and no-regret solutions to address the complex task of meeting SDGs at a local scale in the long term (Acharya et al., 2020). Nonetheless, the recognition that NBS can contribute to SDGs on the local scale is present in only few examples from literature and practice recently (Beceiro et al., 2022; Schmidt et al., 2022).

The “SDG wedding cake,” see Fig. 1, conceptualized by the Stockholm Resilience Institute (Folke et al., 2016), presents a holistic view of



Localizing Sustainable Development Goals (SDGs) Through Co-creation of Nature-Based Solutions (NBS), Fig. 1 The “SDG Wedding-Cake” by Stockholm Resilience Centre (<https://www.stockholmresilience.org/research/research-news/2016-06-14-the-sdgs-wedding-cake.html>) (left side) and an image (right side)

by the University of Oxford under its “Nature-Based Solutions Initiative (NbSI)” on the fundamental importance of NBS to the hazards and impacts of climate change, using the SRC’s framework to highlight the interconnection of NBS with all SDGs. (Sources: Folke et al., 2016; IUCN, 2020)

the SDGs, in which the prosperity and well-being of societies are depicted as dependent on the health of the planet. The cake’s concept moves away from a sectorial approach in which social, economic, and ecological development are seen as separate parts, instead putting forward an interconnection between NBS and all SDGs as if economies and societies are embedded parts of the biosphere. The model highlights the intertwined nature of social-ecological systems and suggests the biosphere as the basis for sustainable development. The authors introduce the notion of “biosphere stewardship,” raising the challenge of stewardship in tune with the biosphere as critical for sustainable development. The cake’s concept advocates that focusing primarily on human well-being and social resilience while remaining disconnected from the biosphere and its stewardship is not a recipe for long-term sustainability. By framing biosphere stewardship as a process of engaging people to collaborate with shared visions across different levels and scales. Among few, Folke et al. (2016) and Kabisch et al. (2019) also provide an initial framework for a triangulation between NBS, co-creation, and SDGs.

Literature Review: NBS, Co-creation, and SDGs

NBS are increasingly recognized as a feasible means to address urban sustainability challenges and climate change actions (e.g., SDG 11 and 13), see also IUCN French Committee (2019). On a practical level there is an urge to engage a variety of stakeholders in an inclusive and efficient collaborative co-creation framework for NBS planning and implementation (Mahmoud & Morello, 2020). Particularly, a recent pan-European research and innovation projects’ stream (*Demonstrating innovative nature-based solutions in cities*) is focusing on the application of NBS to address social inclusiveness (SDG 10) and shared governance challenges within urban regeneration processes (https://cordis.europa.eu/programme/id/H2020_SCC-02-2016-2017). This requires a paradigm shift from a theoretical to a practical framework of collaborative decision-making processes. Further, there is a missing link between practical collaborative processes and the SDG goals. Since the focus of these projects is primarily on pilot demonstration of NBS and experimentation with different planning approaches, ULLs

are the preferred approach and arena to plan, design, and implement NBS while placing citizens at the center of decision-making mechanisms and processes (Bulkeley et al., 2018; Zingraff-Hamed et al., 2020).

SDGs and How Localized NBS Contribute to Their Attainment

The SDGs stand out as a holistic framework to provide structure and direction to nations, regions, and cities toward a sustainable future. Since the adoption of the UN SDGs in 2015, progress has been made but there is still a lot to be done for cities and gaps to be filled (De Maio et al., 2020). While there are many existing sustainability frameworks, the SDGs provide the most comprehensive and integrated approach for tracking sustainable development targets. In fact, SDGs present a major milestone for the local-to-global conversation by making room for local demands to be voiced at the global stage.

Although SDGs are set for national governments, they are quite relevant for local governments, since the establishment of partnerships with multiple stakeholders has been recognized as a crucial component of strategies linked to the 2030 Agenda, and indeed, “most SDGs will not be achievable without local level support” (Schuthof et al., 2019, 3). However, limitations to localizing SDGs in regional and urban development must also be acknowledged; these include political power, limited public finances, low institutional capacities to work across departments, absence of intergovernmental and multi-level cooperation and multi-stakeholder participation (Trejo-nieto, 2021). These limitations make the co-creation approach to implement SDGs very bumpy within ULLs and local governments.

In literature, NBS multifunctionality and ability to deliver several environmental, economic, and societal co-benefits such as social cohesion, awareness on biodiversity, GI ecosystem service provisioning, and human health and well-being (European Commission, 2020) which make them suited for indirectly or directly addressing all SDGs (Gómez Martín et al., 2020). Specifically, NBS are directly relevant to SDG 1 (no poverty), SDG 2 (food security), SDG 3 (health and well-

being), SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (conservation and sustainable use of oceans, seas, and marine resources), and SDG 15 (protection, restoration, and promotion of sustainable use of terrestrial ecosystems), see Vasseur et al., 2017; Wendling et al., 2018; Cohen-Shacham et al., 2019. In sum, given the multifunctional character of NBS, these will indirectly contribute to all 17 SDGs, see also (Mahmoud, et al., 2022).

Co-creation, ULLs, and SDGs

Co-creation is understood as *“the systematic engagement of all relevant stakeholders from the start to the end of a project (and beyond) towards ensuring a smooth urban transition”* (Beck, 2018). What differentiates co-creation from more traditional forms of stakeholder engagement is the intensity of citizen involvement and the influence of societal actors in and on processes (Frantzeskaki & Rok, 2018; Menny et al., 2018). As an emerging form of collective urban governance and experimentation, ULLs are set up to address sustainability challenges and opportunities created by rapid urbanization. ULLs involve citizens in co-creation processes to increase social acceptance, foster NBS place-based ownership, support and plant the seed for co-implementation and co-maintenance of NBS (Malmberg et al., 2017; Breukers & Duneworks, 2017). In fact, active engagement of all relevant stakeholders from the very beginning of the planning process and throughout is likely to produce mutually valued outcomes (i.e., vision narratives, new understandings of problems and opportunities, etc.), and can thus build ground for trust, shared responsibility, and ownership of the NBS infrastructure (Voorberg et al., 2015; Pauleit et al., 2019).

ULLs have different goals and are initiated by various actors, forming different types of partnerships (Voytenko et al., 2016). ULLs are therefore where SDGs can be pursued locally and closest to citizens, who are critical partners to implement sustainability on the ground. In fact, *“ULLs are advanced as an explicit form of place-based*

interventions delivering sustainability goals for cities” (Bulkeley et al., 2016; Menny et al., 2018). As comprehensive as SDGs are, they demand sectoral integration and require the transformation of managerial systems and systematic urban planning policies. And it is precisely in ULLs that diverse actors (public bodies, civil society, private actors) are brought together to experiment co-creation processes while addressing urban place-based challenges (Connop et al., 2015; von Wirth et al., 2019). ULLs can also be an important arena to give insight into experimentation with integrated approaches across sectors and departments.

Moreover, ULLs operate as sites where co-creation methods can be directly tested with end users and through which learning loops can take place in real time (Mahmoud et al., 2021). Allowing for joint dynamics of stakeholder engagement processes at the local level, ULLs contribute with co-production of knowledge to foster transition towards more collaborative governance structures in cities, encouraging more balanced power distribution, local leadership, and ownership via community involvement (Lund, 2018; Xie & Bulkeley, 2020).

Diversity of NBS types and scales brings in different timelines within an ULL co-creation pathway (Mahmoud & Morello, 2020). For instance, within the same ULL there could be a variety of “NBS in place” that requires different execution timelines and skills for co-design and co-implementation. In fact, NBS timelines widely differ: the spatial-temporal implementation tends to be the most challenging dimension because it varies according to the type of NBS (e.g., building-scale interventions, public space interventions, water body systems, transport linear infrastructure, natural areas, and ecological habitat interventions), see (Morello et al., 2019). These differences drive the need to be addressed with various implementation techniques and processes to overcome long-term maintenance timelines and development responsibilities.

In this sense, co-creation pathways and methodologies present an alternative trajectory to get NBS implemented in ULLs in a way that is inclusively shared and collectively governed;

especially regarding the localization of SDGs in urban regeneration processes, some factors are to be considered. **Firstly**, NBS are living systems that continuously evolve and require caretaking and maintenance; hence, the importance of a shared co-management and collaborative governance of the interventions. **Secondly**, integrating NBS within existing urban regeneration dynamics requires the involvement of a multiplicity of stakeholders, as well as the activation of a solid and complex shared governance model, see (Mahmoud & Morello, 2021). **Lastly**, consolidated groups of interests and associated stratification of practices, as well as different memories of local communities, call for an inclusive approach to decision-making, which can bring a diversity of perspectives into the design process and thus takes a longer time to develop.

To sum up, on the one hand, the abovementioned complexity is related to the suitability of NBS, and the specific impact generated by a given NBS in place to be measured against the SDGs. On the other hand, the node to these co-creation pathways applied for NBS delivery remains the impact measurement against SDGs. In the following sections, this entry explores the co-creation methodology and co-creation pathways applied within the CLEVER Cities project to foster NBS implementation.

Identifying the Knowledge Gaps Around Co-creation of NBS in Relation to the SDGs

Why integrate SDGs in NBS co-creation? A possible answer is: Aligning with the universally recognized targets and speaking the common language of the 2030 Agenda can help break silos in the agenda of local governments and boost partnerships, leading to concrete societal transformative change (Kirsop-Taylor et al., 2021). Also, the SDGs provide a common framework of targets and thus, impacts to be achieved by co-creation of NBS.

Several knowledge gaps identified by the authors make it difficult to harness the full

potential of co-created NBS in relation to the SDGs. That is due to the novelty of the co-creation topic within projects for NBS implementation (only 3 European-funded projects started in 2017, 6 in 2018, and 2 in 2019), see also (Carlotta et al., 2020: 19). However, recently a remarkable effort has been carried out to connect different SDGs to NBS objectives by Somarakis et al. (2019, 29,30).

The first hindrance arises from translating SDG targets to NBS implementation in practice and related local actions, since the integration of local needs, priorities, local capacities, and expectations are critical factors to determine SDG attainment (Tosun & Leininger, 2017). (Keeys & Huemann, 2017; Kotsila et al., 2020; Xie & Bulkeley, 2020). **The second knowledge gap** is a methodological one. There is an absence of standardized co-creation frameworks in investigated methods and practical guidances in all NBS projects (no one size fits all) (Kruger et al., 2018; Forde, 2020); most H2020 projects with a focus on co-created NBS pilot projects establish their own co-creation pathways and possible indicators for monitoring the impacts of their own co-creation processes, see (Mahmoud & Morello, 2018). Multiple differing co-creation frameworks are used, hence, there is a lack of a “universal” technical language in the co-creation discourse, especially as highlighted in the latest NBS sister projects recurrent EC NBS Task Force meetings. (Starting March 2020, a specific Task Force (VI) was formed between sister projects, these Task Forces are promoted by the EC “Network Nature” in order to facilitate the NBS projects collaboration, they meet every two months. The focus of this TF(VI) in specific is to uptake a common approach on co-creation processes that involve multiplicity of stakeholders and involve citizens in the whole process of NBS co-governance and implementation.) This methodological gap was identified by assessing numerous online workshops, publications, and meetings in addition to active participation in different TFs.

Further, for local governments to design relevant approaches and programmes and consequently evaluate methods to effectively deliver on the SDGs, guidance is needed on how to

localize targets on a city scale and thus, derive required actions. Local authorities and municipalities are lacking an analysis framework that associates local co-creation processes, stakeholder validation, and impacts of NBS in relation to the SDGs (Beceiro et al., 2020). Currently, a set of consolidated performance and impact indicators are missing, so no streamlined analysis of success (or failure) against the SDGs can be performed. In most cases, partners of ongoing Horizon2020 NBS projects are the ones to assess their co-creation processes in terms of effectivity considering their local contexts and urban regeneration planning framework, which makes it difficult to establish a comparable framework.

This relates to the third knowledge gap: the lack of a concrete set of KPIs that analyze co-creation processes impacts and associated success or failure, added values as a work-in-progress and not just after finalization. That is off-course logic since the NBS H2020 projects only embedded co-creation pathways as a novel innovation policy during the latest 2 or 3 years; hence, it needs to be considered that there is no consolidated knowledge at this point but an ongoing effort to cover the knowledge gap. Scholars often look at the impact of NBS in terms of monitoring the performance of environmental, societal, and economic challenges, which is in correlation to the SDGs (Colléony & Shwartz, 2019; Connop et al., 2020; Lam et al., 2020). However, only a few recent references look at the SDGs while also reviewing the methodological co-creation frameworks (Kabisch et al., 2019; Dumitru et al., 2020).

Another shortcoming is the standardization of co-creation processes with a proliferation of methods and guidance (Kruger et al., 2018; Forde, 2020). Not all NBS are “co-creatable” in the same way, nor are the same efforts required during an NBS implementation process in terms of stakeholder engagement and co-management with the groups of interest.

Lastly, **there is a research and evidence gap** on the added value of co-creation processes for NBS design, co-implementation, and co-monitoring, and thus, of the co-creation impacts on NBS delivery and even more, of the

sustainability of NBS, as well as of how co-creation processes ultimately contribute to achieving SDGs.

A Methodological Approach: Toward Structuring a Co-creation Assessment Framework for Local Governments Related to SDGs

A quick search query on Scopus (NBS AND SDGs) revealed a number of 105 papers over the last 10 years focusing on NBS and SDGs. (The query was limited to titles, abstracts and keywords of the publications then corrected manually: 32 out of 105 in the year 2020 and 69 records in 2021, 13 records in 2022 till the submission of manuscript.) Predominant research foci are environmental, societal, and economic impacts of NBS with an intrinsic link to the SDGs (Colléony & Shwartz, 2019; Connop et al., 2020; Lam et al., 2020). However, research and respective papers focusing on SDGs in relation to co-creation is still scarce. Co-creation in relation to SDGs was only addressed in 42 documents, (Co-creation term is also used in business and educational ambits; hence an elaboration was needed to review queries accuracy.) out of which only three focused on NBS. In other databases, such as Springer, co-creation features prominently in public policies and social sciences (80 documents). However, no correlation with either NBS or SDGs could be found in any of the publications when limited to the domain of environmental and social policies (Elsevier, 2015) as of date.

In this research, the co-creation phases developed in the CLEVER Cities project are the base for creating links with the SDG targets. In this project, a list of potential co-creation KPIs are developed, which will be used in this entry as a hinge point for creating an assessment framework for local governments to evaluate the “added value” of inclusive shared governance models in NBS implementation and urban regeneration planning.

The present tentative model for an assessment framework considers five macro categories (see Linking co-creation phases to the SDGs) as related to the phases of the co-creation pathway

within CLEVER Cities as an anchor to identify the correlation between co-creation and SDGs. In this model, SDGs and their associated targets relevant to co-creation processes were identified through the perspective of desired impacts to be generated by “NBS in place,” such as reducing inequality, increase well-being, increase social cohesion and inclusivity, etc.

CLEVER Cities Co-creation Framework in Five Phases: Methodological Testing and Implementation

In this work, the authors analyze where (in which phases) and how the SDGs come into play along the NBS co-creation pathway. For the purpose of pragmatism, this entry refers only to the CLEVER Cities co-creation framework, which represents a modular and complete pathway that covers all the potential phases of collaboration and stakeholder engagement around NBS (Mahmoud & Morello, 2018, 2020; Morello et al., 2018). For instance, co-creation could be implemented on a variety of NBS delivery phases, such as co-design, co-implementation, co-monitoring, and co-development. Since, literature argues that co-creation has emerged in connection to the participatory approach in public policies and human-centered design, where it is about empowering people in decision-making processes and working practices (Voorberg et al., 2015; Jansen & Pieters, 2017; Frantzeskaki, 2019). Hence, it was considered that co-creation tools for NBS implementation in practice encounter a variety of user types and possible platforms to bring together citizens, stakeholders, researchers, academia, and policymakers to address collective urban challenges.

In the CLEVER Cities’ pathway, co-creation goes beyond running simple collaborative workshops. In the latest article, Basnou et al. (2020, 1) refer to the need for a well-planned co-design process and engagement strategy that supports inclusive participation and social learning through enabling dialogue, co-production of knowledge, and equity in urban and territorial planning processes. In fact, in the CLEVER Cities framework, the complete sequenced co-creation pathway (See CLEVER Cities

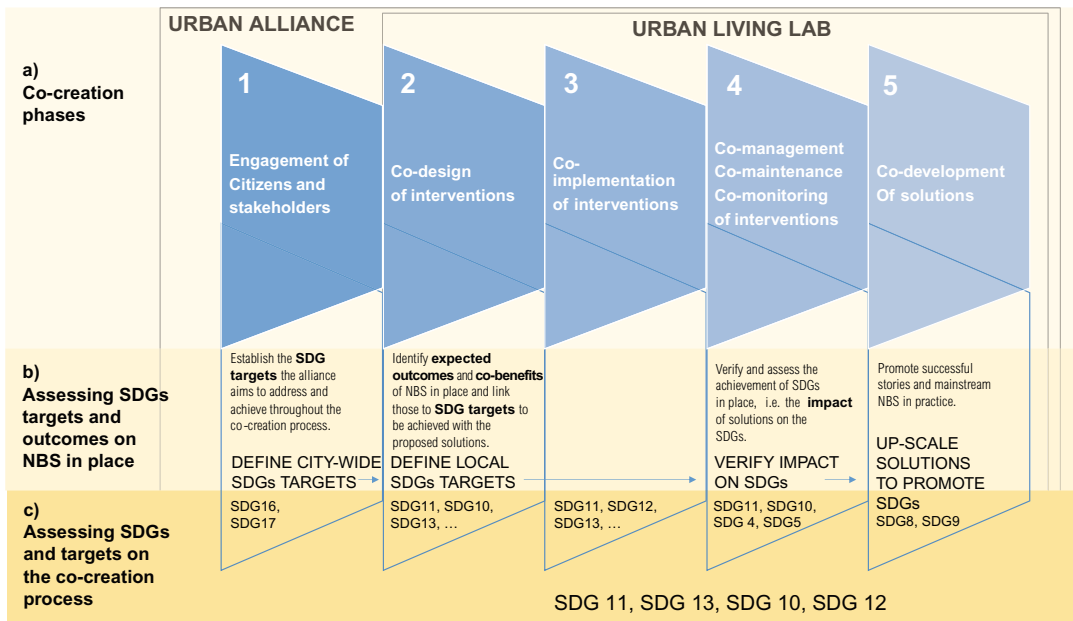
Co-creation Guidance website, <https://clevercitiesguidance.wordpress.com/>) represents a flexible structure to be put in practice in the ULL, i.e., a place-based medium for fostering inclusive urban regeneration processes. Hence, the process of implementing NBS according to a collaborative co-design process that involves stakeholders from the start until the end requires the development of guidelines drawing special attention on achieving more social inclusiveness, and consequently, enhance shared governance and collaborative decision-making mechanisms.

The CLEVER Cities phases of co-creation are five, see Fig. 2, **area (a) Co-creation phases** for an exhaustive illustration of the co-creation phases and coverage of stakeholder mapping and engagement of citizens, co-designing, co-implementation, co-monitoring, and co-development of NBS.

Why ULLs Are the Field of NBS Implementation in CLEVER Cities

ULLs involve citizens in co-creation processes as a means to increase social acceptance, foster support, and plant the seed for

co-implementation and co-maintenance of the NBS (Malmberg et al., 2017; Breukers & Duneworks, 2017). Active engagement from the very beginning is likely to produce mutually valued outcomes and can thus build ground for trust, responsibility, and ownership of the NBS infrastructure (Malmberg et al., 2017; Hansen et al., 2019). Following (IAP2, 2014; Emerson & Nabatchi, 2015), stakeholder engagement can range from information, consultation, involvement, and collaboration into actual empowerment. It differs with regard to the extent of power, willingness and influences stakeholders have on decision-making processes and on the development of the final solution. In CLEVER Cities, this engagement process starts gradually in the so-called urban alliance phase, which is the initial phase of identifying city-wide targets to be achieved throughout the partnership activation. In this sense, it is very relevant within the CLEVER Cities co-creation pathways to consolidate mature and inclusive Urban Innovation Partnerships (UIP), designed to host community leaders, local associations, local SMEs, etc.



Localizing Sustainable Development Goals (SDGs) Through Co-creation of Nature-Based Solutions (NBS), Fig. 2 Co-creation phases and SDGs correlations. (Source: The Authors)

Results: A Possible Assessment Framework for the NBS Co-creation Process and to Assess Tangible Outcomes of “NBS in Place” Against Achieving the SDGs

The CLEVER Cities’ co-creation pathway contribution to the SDGs can be investigated from the perspective of process itself or from the standpoint of generated impacts. In terms of process the efficacy of the process itself in embedding the SDGs along NBS implementation can be assessed, as well as the of the level of inclusiveness process toward a real shared governance, where no one is left behind. In terms of impact, co-created “NBS in place” can be evaluated regarding the tangible outcomes and impacts of the process (Many efforts are done by CLEVER Cities sisters projects on planning assessment, for instance see also <https://connectingnature.eu/innovations/impact-assessment>) such as co-benefits generated by specific actions. These two dimensions, the process to implement NBS on one side, and the tangible outcomes and impacts of “NBS in place” on the side, are strictly related. In fact, if the process explicitly emphasizes the SDGs as value proposition and final targets of the co-creation activity, then one can expect outcomes to happen as the final achievement of NBS implementation in place-based local actions.

As illustrated in Fig. 2, **area (b)** assessing SDGs targets and outcomes on NBS in place, to see the final achievement and tangible outcome of the “NBS in place,” the co-creation phases safeguard that the wider environmental and societal scopes, hence the SDGs, are well monitored along the whole process. The result of the process is the NBS in its physical setting: once implemented (co-implementation) and in operation (co-management), its outcomes and impacts can be assessed against the different SDGs.

Linking Co-creation Phases to the SDGs

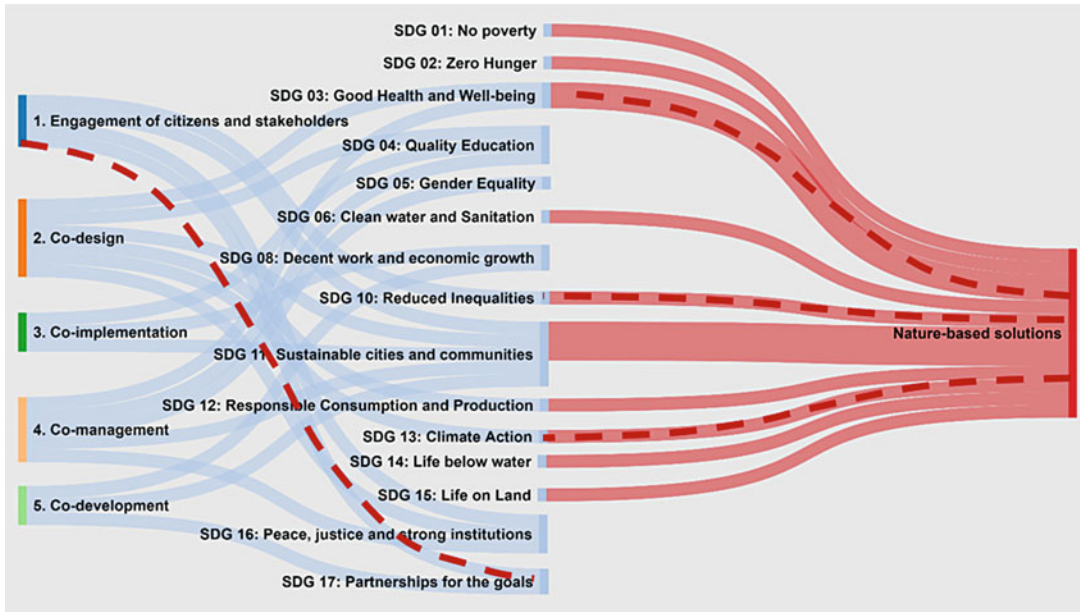
In the CLEVER Cities project, success and drawbacks of the co-creation pathway are measured against five major macro indicators areas (This

categorization is a work in progress by the first two authors, it was requested by the EC in review meetings to showcase of the process co-creation success and added value. The categories are mainly based on the development of the co-creation pathway implementation in FR Cities and the outcomes of the project till September 2021, three workshops were carried out to confirm which indicators are most common to all three FR cities.):

1. Stakeholder engagement in the urban alliance following the ladder of engagement (inform, consult, involve, collaborate, empower) as in Arnstein (1969).
2. Timeline and duration of engagement: In which stage of co-creation are citizens/community members/local groups and other stakeholders involved? Is there a continuity of engagement during the project lifetime?
3. Co-creation pathway governance: Flexibility and resilience of the process against experimentation and adaptation to shocks and hazards, as well as transparency of the operational process.
4. Measurable outcomes and added values of co-creation in decision-making processes and policy implications.
5. Promote successful stories of NBS and mainstreaming in practice through measuring communication and raising social awareness around NBS implementation.

SDGs, therefore, can enable a more common understanding in regard to co-creation within different phases of the processes of NBS planning, delivery, and stewardship. In this research paper, some SDGs are analyzed in relation to co-creation criteria of stakeholder involvement and inclusivity in urban regeneration (refer to Fig. 2, area c) assessing SDGs targets on the co-creation process reported above). A visual representation of the linkages between co-creation phases, “NBS in place” and the SDGs is reported in Fig. 3, on the left side.

SDGs are implicitly addressed within the overall approach to participatory decision-making and



Localizing Sustainable Development Goals (SDGs) Through Co-creation of Nature-Based Solutions (NBS), Fig. 3 Alluvial diagram connecting the SDGs to the co-creation phases (on the left) and the

“NBS in place” (on the right). In red dotted line, example of connections between Co-creation phases and SDGs on the left. Example of connection between SDG 03, 10, 13, and NBS on the right. (Source: The Authors)

shared governance. The overarching nature of SDG 16 and SDG 17, for instance, in relation to the partnerships and decision-making processes is the most correlated ones to the co-creation phase of fostering urban alliance (e.g., creating alliances and partnerships around NBS awareness such as nature forums). Furthermore, within the ULLs, the SDG 10, SDG 11, and SDG 13 relate to overcoming social inequalities and inclusivity in NBS processes inserted within a wider climate action framework. Considering responsible consumption and production, SDG 12 is addressed in co-implementation and co-management phases, whereby local assets (financial resources, skills, material resources) can be exploited. SDG 4 and SDG 5 are addressed within the co-management and the co-maintenance phases of NBS, because they relate to building knowledge and creating awareness around the relevance of nature in cities (hence improving quality education), and also offer job opportunities as well as reduce gender inequalities (e.g., citizen caretaking of NBS in public space is an example of knowledge and

skill building around nature). In regard to upstreaming successful solutions to strengthen sustainable communities (SDG11) and boosting the local economy through NBS (SDG8), the final phase of co-development addresses this, see Fig. 3. (In Fig. 3, Not all SDGs seem to have a direct link to assess the impact of NBS in place. In this case it is NA.)

Discussion: Proposed Co-creation Key Performance Indicators

Based on the topics illustrated above, two tentative lists of main KPIs are reported below. In Table 1, each phase of co-creation in relationship to the SDGs is crossed, resulting from the previous Fig. 3, toward dividing the KPIs in two main categories: (1) **Macro** categories, which are directly related to SDGs and (2) **Micro** indicators, which mainly relate to the impact generated by the NBS throughout the co-creation phase. Specifically, Table 1 addresses the fulfilment of the







Localizing Sustainable Development Goals (SDGs) Through Co-creation of Nature-Based Solutions (NBS), Table 1 correlating SDGs and co-creation phases for a possible assessment, elaborated by the authors
Key performance indicators

Co-creation phases	SDGs	Key performance indicator related to co-creation		
		Macro categories	Micro indicators	How/type of KPI
1. Urban alliance (Engagement of citizens and stakeholders)	SDG 10, 11, 16, 17	Stakeholder engagement in Urban Alliance: 1. Form of collaboration 2. Scale of engagement 3. Duration of engagement	1.1 Multiplicity of actors activating local and supralocal partnerships 1.2 Multiplicity of roles within same group of actors 1.3 Continuous follow-up and feedback loops within stakeholder groups	1.1 Quantitative, procedural 1.2 Qualitative, procedural 1.3 Impact, qualitative
2. Co-design	SDG 03, 04, 11, 12	Overcoming social inequalities and inclusivity in the processes 1. Cross analysis of objectives 2. Transparency of the process 3. Social inclusion of vulnerable groups 4. Flexibility and adaptability	2.1 Assessment of policies against citizen’s needs (TOC) 2.2 Bilateral meetings and continuous communication updates (newsletters, social media, etc.) 2.3 Representation of vulnerable groups in decision-making 2.4 Experimentation through NBS implementation to change plans	2.1 Procedural, qualitative 2.2 Procedural, quantitative 2.3 Impact, qualitative 2.4 Impact, qualitative
3. Co-implementation	SDG 04, 08, 11	Co-creation pathway governance: 1. Development of a specific plan related to place-based challenges 2. Exploitation of expertise through shared governance	3.1 Tailor placed-based NBS implementation to their desired co-benefits 3.2 Encouraging citizens to get hands on their NBS ownership and be the main decision-makers	3.1. Impact, qualitative 3.2. Procedural, qualitative
4. Co-management	SDG 03, 04, 11	Measurable outcomes and verification of added impact 1. Building Trust with citizens and build legacy 2. Encourage new partnerships and ownership	4.1 Added values of the co-creation process, what is the residual left in place after the co-design ends 4.2 Spill overs measured in new partners interested to take place and catalyze the management process.	4.1 Impact, qualitative 4.2 Impact, quantitative
5. Co-development	SDG 08, 11	Promote Successful stories of NBS and Mainstreaming in practice 1. Assessment of potential upscaling and Mainstreaming 2. Replication success factors 3. Communicate success and failures equally	5.1 Financial revenues generated by NBS upscaling and mainstreaming 5.2 Increase of frequency of uses of the ‘NBS in place’ and social recognition by citizens. 5.3 Increase communication and social awareness around NBS	5.1 Impact, quantitative 5.2 Impact, qualitative 5.3 Impact, quantitative

SDGs within the co-creation process, while Table 2 evaluates the outcomes and impacts of the “NBS in place” against the SDGs. The KPIs are then sub-divided by two different typologies: procedural and impact (This subdivision is decided by the authors with respect to the

Localizing Sustainable Development Goals (SDGs) Through Co-creation of Nature-Based Solutions (NBS), Table 2 Suggested indicators for evaluating the “NBS in place” – Some examples of indicators on SDGs 03, 10, 13, and 15

SDG	Targets	Indicators	Examples of NBS typologies
 SDG 3	Contribution to mental health	Physically and visually accessible NBS in open spaces [leaf area index, nr. f trees, m2 of tree canopy]	Tree-lined streets Green walls Fruit trees
	Contribution to physiological health	Physically accessible NBS in open spaces [leaf area index, nr. of trees, m ² of tree canopy]	Tree-lined streets Urban forests
	Contribution to a healthy diet	NBS providing food grown locally [nr. of trees, Kg. of grown food, CO ₂ emissions of grown food]	Community gardens Fruit trees Espalier fruit trees
 SDG 10	Empower and promote the social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion, or economic or other status	Lowering number of people living below 50% of median income, by age, sex, or disabilities	Community gardens Green roofs
 SDG 13	Reduce urban rainwater runoff (heavy precipitation hazard)	Volume of water absorption through vegetation roots and permeable soil [m ³]	Trees Urban forests Green roofs Green parking lots
	Mitigate outdoor climate (extreme temperatures hazard)	Measured temperature reduction [°C]	Trees Urban forests Green walls
 SDG 15	Enhance biodiversity	Species, biodiversity [nr. of species reported]	Urban forests Ecological corridors Beehives Butterfly oasis

Many NBS projects are working on the providing NBS catalogues that satisfy the NBS categorization that correspond to their standards and needs (technological, social, productive, etc.), see <http://www.labsimurb.polimi.it/nbs-catalogue/> and <https://urbinat.eu/nbs-catalogue/>

evaluation carried out with the cities and the consortium seemed to have possibility to measure procedure as part of the co-creation impacts.) measured either quantitatively or qualitatively, as explained after Table 1.

It is to be noted that the proposed subdivision is mainly assessing the generated outcomes from the CLEVER Cities’ co-creation pathway process and the associated measurable co-benefits throughout the process itself. The main idea was to divide the assessment framework into stages that look at different types of indicators, those that are of an operational nature, such as the ones related to impact, and the ones associated to procedures. Finally, it was also relevant to examine the indicators at different co-creation phases and according to data collection types (*qualitative or quantitative*). However, a final and more consolidated assessment framework is still to be defined

with the rest of the CLEVER Cities consortium. Currently, the assessment framework is being co-developed in a living document with involved cities and is subject to changes over time. A prospective scoreboard for each city to be able to assess its co-creation process in terms of inclusivity and success or failure is the final aim. (Possible Limitations: The SDG dimension was not identified during the initial development of CLEVER Cities project, the gain of relating all this to SDGs is mainly the added value of speaking the common language across different cities and to the EASME with collaboration of cities local governments.)

Table 2 provides an example for linking SDGs, targets, indicators with different NBS typologies. This relationship suggests how different NBS typologies differently respond to environmental (biosphere), social, and economic challenges. In

the impact assessment of a certain type of NBS, it is not always possible to establish linkages to all SDGs. After all, some SDGs are only relevant in specific contexts: for instance, a NBS can respond to SDG1, SDG2 (and to some extent also to SDG5) in lower income countries but these SDGs might not be addressed in richer ones. Moreover, not all types of NBS can be easily co-created (such as highly technological solutions or large-scale infrastructure). Future work will better investigate the relationship between the performance of a solution, the impact on the SDGs, as well as consider the context from a cost-benefit perspective.

Conclusions: Toward a Co-creation Assessment Framework for Local Governments Connecting NBS and SDGs

This entry has discussed the triangulation among NBS, co-creation, and the SDGs, from the implementation of the framework in the CLEVER Cities project. It shows that establishing stronger links between NBS and the SDGs in the entire co-creation process is essential because the SDG language has become universal by gaining increased popularity and application in different domains since its promotion in late 2015. Hence, speaking the SDG language benefits from the opportunity to align urban planning processes with the engagement of the civic society. This makes it easier to establish partnerships and collaborating on the same targets (win-win condition i.e., SDG 17). Moreover, it is easier to assess and quantify the progress and success of processes and outcomes through indicators converging to the 2030 Agenda because it has its established targets to be locally measured in many municipalities' strategic plans.

Considering the CLEVER Cities' co-creation methodological pathway, a challenge is recognized in addressing and referring to the SDGs and targets. Therefore, this entry generates a basic understanding of when and how inclusive NBS-led urban regeneration implicitly intersects with the SDGs. Since anchoring the NBS co-creation framework in the 2030 Agenda is essential, a set of macro categories and micro-

Key Performance Indicators are indicated as a new framework of assessment putting together co-creation of NBS and the SDGs.

Such a conceptual framework should enable players to assess the contribution of both the implementation process of NBS on one side and the tangible outcomes and impacts of the NBS to SDGs, on the other side. In order to reach this purpose, these KPIs are a starting point for developing a practical assessment tool for local governments. These shall help local governments to (1) reflect the SDGs in co-creation and assess the performance of ULLs and inclusive shared governance toward the 2030 Agenda; and (2) measure the impact of tangible outcomes of the implemented NBS, to be evaluated on the basis of the expected SDGs as established in the co-design phase.

This entry also uncovers the knowledge gap of missing links between indicators on SDGs and NBS. The idea is to develop an easy-to-use assessment instrument for co-creation processes and impact indicators that can measure co-creation effectiveness for NBS delivery from the planning side. The entry establishes indicators for reflecting on SDGs while affording a view of the impacts of NBS within ULLs/co-creation on the practice side.

Another important aspect is showcasing the plurality of indicators that each and every project could adopt to assess their own co-creation processes to identify the major different impact originating from the co-benefits of "NBS in place." Nowadays many projects are reviewing initial objectives and reevaluating desired impacts after the COVID-19 Pandemic situation, which raises the relevance of evaluating co-creation processes to assess the dynamic changes and adjustments in terms of citizen engagement, such as online co-design activities moving to online platforms. This is also linked to the dynamic evolution of co-benefits, which increases with higher NBS effectiveness and related collaborative processes.

Lastly, the importance of the NBS capacity for addressing SDGs is highlighted, which is highly dependent on NBS multifunctionality and on the local contexts of co-creation processes. Nonetheless, engaging stakeholders in the first stages of NBS design and

implementation is key. The effectivity of co-creation processes is also highly influenced by recognizing the relevance to perform multiple stakeholder engagement within different local and supralocal partnerships.

Recommendations for Future Research

1. Exploration of the opportunity of the co-creation task forces to set up a common language.
2. Interpretation of the content on existing NBS platforms to make the connection with the SDGs.
3. Proposal of a new framework of investigation across projects rather than isolated evaluation of results (evidence-based approach).
4. Development of a co-creation KPIs' framework that is transversal amongst projects and eventually represents the shared governance fundamentals already developed for CLEVER Cities.

Cross-References

- ▶ [An Overview of the Relationship of the Sustainable Development Goals and Urban and Regional Development](#)
- ▶ [Cities in Nature](#)
- ▶ [Green Cities: Nature-Based Solutions, Renaturing and Rewilding Cities](#)
- ▶ [Sustainable Development Goals](#)

Acknowledgment Authors want to thank CLEVER Cities Project team to support different reflections on the actual co-creation processes.

Funding This document has been prepared in the framework of the European project CLEVER Cities. This project has received funding from the European Union's Horizon 2020 innovation action program under grant agreement no. 776604. The sole responsibility for the content of this publication lies with the authors.

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Low Earth Orbit

► New Orbital Urbanization

Low-Carbon Transport

Policies to Encourage Cycling in Sprawling Cities

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Introduction

Urban sprawl has been extremely detrimental for cities (Brueckner 2000). It has led to an excessive reliance on cars for travel (Rubiera Morollón 2015), with knock-on effects on congestion, health, energy consumption, and pollution (Habibi and Asadi 2011). With a climate breakdown looming, policy makers everywhere are now seeking and implementing strategies to reverse sprawl and automobility. To this end, many places have prioritized cycling alongside walking, ride-hailing, and public transport (Ogilvie et al. 2011). Cycling is expected to provide environmental, economic, and social benefits to both cyclists and society (Handy et al. 2014).

However, the rates of utilitarian cycling (as opposed to recreational cycling) remain abysmal in most places (Dixon et al. 2018).

Common natural environment barriers to cycling include frosty, scorching, and/or muggy weather, precipitation (rain and snow), and a hilly topography (An et al. 2019; Bean et al. 2021; Lee and Pojani 2019). In sprawling cities, large distances between destinations present a built environment barrier (An et al. 2019). In addition, insufficient and/or low-quality designated infrastructure undermines cycling – especially among novice cyclists and more safety-conscious persons such as women and the elderly. This is understandable given that cyclists are among the most vulnerable road users, and severe injuries and/or fatalities can occur in a collision between a moving bicycle and a car (Deffner et al. 2012; Jacobsen and Rutter 2012). In many places, car drivers lack experience in interacting with cyclists (Deffner et al. 2012) and, at least in some contexts, are known to behave aggressively towards cyclists (Johnson et al. 2014).

Some sociocultural factors are at play too. For example, in very status-conscious settings, the wealthy shun eco modes in favor of luxury cars. Here, cycling is seen as an activity for children or for the poor (Ashmore et al. 2018; Daley and Rissel 2011; Li et al. 2019). In some settings, the “mamil” image (“middle-aged men in lycra,” meaning men dressed in body-hugging spandex clothing who ride expensive racing bicycles at high speeds) is problematic. Mamil are seen as arrogant or irresponsible, and as an impediment to both drivers and pedestrians. As such, they do not help promote the status of cycling in society.

Problems can also lie with the institutions in charge of land-use and transport planning. Where these are uncoordinated, overly bureaucratic, or simply unfriendly to cycling, adequate cycling guidelines and infrastructure are typically missing (ECMT 2004). Earmarked funding is rarely provided, and cycling is constantly at risk of being shortchanged in favor of other modes, which are perceived as more deserving (Pojani et al. 2018).

Only a handful of larger Northern European and East Asian cities have managed to achieve high proportions of cycling for transport. Also, in