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Deliverable 4: Report on outcomes of meetings, consultations, webinars and workshops leading to the publication of a 'Co-creation for cities' guidebook and infographics



DOCUMENT PROPERTIES

Nature Document	<i>Deliverable 4</i> : Report on outcomes of meetings, consultations, webinars and workshops leading to the publication of a 'Co-creation for cities' guidebook and infographics
Work Package	WP2 Accelerator Masterplanning
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Dissemination level	Confidential, only for members of the consortium (including the Commission Services)
Deadline	June 2019

DPI: 10.5281/zenodo.7011030

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Co-creation and co-production have been recognised as a novel collaborative mode of urban governance, which allows for deep participation to leverage and weave together local, expert and tacit knowledge and ultimately to advance urban sustainability and resilience. Co-creation and co-production promote collaborations and partnerships among diverse actors – including civil servants, citizens, planners, entrepreneurs, architects, scientists and engineers – in the design, implementation and eventually stewarding of nature-based solutions (NBS). In this way, they can support the generation of new and more integrated knowledge that lead to the design of multifunctional NBS (pertaining not only to their mere technical design but also to their financing, business models and social innovations) addressing local needs and mobilising local opportunities. In addition, the collaborative nature of co-creation and co-production generates novel and shared problem framings and visions, spurs new relationships between actors (for example between local government and citizens, across city departments) and triggers the (re-)definition of roles and responsibilities and empowerment of actors to become engaged in NBS advocating and stewarding.

This report presents the work-in-progress on how in Connecting Nature we have developed the frameworks and guidebooks for co-production of NBS and reflexive monitoring via an iterative co-production process between the scientific partners and cities – so far together with the Connecting Nature frontrunner cities Genk (Belgium), Glasgow (United Kingdom) and Poznań (Poland). Next to supporting the co-production processes on the ground, the framework also integrates insights on how different cities design co-production processes in practice, including the starting considerations/objectives, when and how (not) to connect to which types of actors, the tools used and opportunities and challenges encountered. The frameworks allow to systematise knowledge from the experiences with co-production and reflexive monitoring from cities back to the conceptual level of the design principles and to thus develop conceptually grounded and practice-proven guidebooks with empirical examples and lessons.

Setting up high quality, viable and effective co-production requires good process designs, knowledge about the right tools and methods, as well as enabling conditions that provide the basis for co-production.

In summary, the framework encompasses the following building blocks:

- **Co-production design principles** that provide a heuristic to design and evaluate knowledge co-production processes. Next to facilitating the design and implementation of co-production processes, the principles allow for the outcomes and impacts of co-production to be mapped and measured, for example, whether knowledge-based outputs inform strategic urban agendas.
- **Co-production tools and methods** that can be used in specific co-production activities and settings so as to facilitate discussions, interactions and knowledge exchanges between actors in line with a specific objective (e.g. vision development, problem framing).
- **Reflexive monitoring framework** that includes a set of tools and methods to continuously learn about how the co-production process proceeds and to identify follow-up actions and consequently adapt the process of NBS implementation on-the-go.

We have worked with the cities in Connecting Nature to co-produce and apply the frameworks of co-production and reflexive monitoring. In this way, we could advance and apply the frameworks and methods as reported here, as well as learn from the cities' experiences to derive conclusions for co-production and reflexive monitoring of NBS implementation. Both frameworks have proven valuable in both cities to support the co-production of NBS and to identify and navigate critical conditions, opportunities and barriers for co-production. Specifically, the insights help to characterise co-production journeys and patterns in cities and to derive lessons learned. From the insight on needs, barriers, opportunities and lessons for co-production, we can further expand the co-production framework by identifying co-production capacities that embody the conditions that need to be in place to enable and facilitate co-production.

This work has resulted in two draft guidebooks on co-production (Appendix A) and reflexive monitoring (Appendix B), which combine the theoretical review and practical experiences and examples and will be further enriched as the project moves along. The guidebooks are conceived as methodological guidance and rich cookbooks based on the theoretical review and practical experiences and examples with co-production and reflexive monitoring that are presented here.



1. Introduction

1.1 Background

Nature-based solutions (NBS) harbour opportunities for simultaneously conserving and regenerating ecosystems and biodiversity while combatting climate change and its impacts and providing essential benefits for human wellbeing (e.g. space for recreation, social cohesion and mental health, economic benefits) (European Commission, 2015; Laforteza et al., 2018). The recent push to incorporate NBS into city-making has resulted in a plethora of research and demonstration projects in cities globally (World Bank, 2008; Frantzeskaki et al., 2016; Collier et al., 2017; DG Environment, 2017). The large-scale implementation of NBS in cities can have a transformative impact on social and human-nature relations, contributing to social innovations and new business models (Frantzeskaki et al., 2017). This refers to a ‘scaling up’ of NBS, for example through the replication of demonstration projects, expansion of NBS, and the organisational and market roll-out of NBS on city scale (Ehnert et al., 2018; van Winden & Carvalho, 2016).

However, NBS challenge existing urban policy and planning that make decisions in sectoral silos (e.g. energy, mobility, tourism) and start from fixed problem definitions and the delivery of short-term benefits without participation of local communities (Kabisch et al., 2017; Sekulova and Anguelovski, 2017). The benefits of NBS only accrue when they are embedded in urban social-ecological systems – i.e. they need to reflect environmental conditions and needs, as well as socio-economic aspects such as political, social and economic priorities, norms and values, human perceptions and institutional contexts characterising specific local neighbourhoods, the city as a whole and regional connectivity (Kabisch et al., 2017; Pauleit et al., 2017). While NBS are often still initiated and financed by local governments, their salience and long-term viability (e.g. through new business models) require knowledge from multiple actors (e.g. citizens, NGOs, social innovation networks, businesses, scientists) so as to fit city needs and contexts (Frantzeskaki, 2019; Nel et al., 2015; Cowling et al. 2008). Urban governance and planning have been criticised for lack of opportunities for citizens to articulate their perspectives. In addition, the traditional structure of city departments and the “sectoral language” and the compartmentalisation of professionals with different educational background and objectives create islands of knowledge and trap knowledge in siloes. This also impedes the large-scale implementation of NBS, which depends on appropriate funding, political and social support, enabling regulatory frameworks and knowledge about how to fit individual NBS to diverse contexts (Connop et al., 2016; Kabisch et al., 2016).

In this context, co-creation and co-production have been recognised as a novel collaborative mode of urban governance, which allows for deep participation to leverage and weave together local, expert and tacit knowledge and ultimately to advance urban sustainability and resilience (European Commission, 2015; Frantzeskaki, 2019; Frantzeskaki and Kabisch, 2016). Co-creation and co-production promote collaborations and partnerships among diverse actors – including civil servants, citizens, planners, entrepreneurs, architects, scientists and engineers – in the design, implementation and eventually stewarding of NBS. In this way, they can support the generation of new and more integrated knowledge that lead to the design of multifunctional NBS (pertaining not only to their mere technical design but also to their financing, business models and social innovations) addressing local needs and mobilising local opportunities. In addition, the collaborative nature of co-creation and co-production generates novel and shared problem framings and visions, spurs new relationships between actors (for example between local government and citizens, across city departments) and triggers the (re-)definition of roles and responsibilities and empowerment of actors to become engaged in NBS advocating and stewarding (Frantzeskaki and Kabisch, 2016; Hölscher et al. 2017). There is the aspiration to develop and apply co-creation and co-production not only for the design and implementation of NBS but also to engage in a continuous process with stakeholders at multiple scales and across sectors to contribute to post-implementation sustainability (Biggs et al., 2018). Co-creation/co-production are recognised by the European Union as a key mechanism to deal with sustainability challenges (Box 1).

While there is a demand for innovation of and experimentation with new and more collaborative governance approaches that off-the-shelf, or best-practice approaches cannot satisfy, co-creation and co-production are not yet very common in the urban settings, and they depend on the time, efforts and skills of those generating and weaving together diverse knowledges (Tengö et al., 2017). The 2018 IPCC Cities and Climate Science Conference, the first of its kind, identified the need to develop greater insights into the process of co-creation and co-production and the factors that deliver successful outcomes. This also requires new types of frameworks to support the design and facilitation of co-creation/co-production processes. So far, co-creation/co-production models do not exist in the academic literature, which does not only hinder good quality process designs but also



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the evaluation of impacts (Durose et al., 2018; Voorberg et al., 2014). Different settings are reported such as dialogues, transformative spaces, co-production spaces that have similar formats to workshops and focus groups. This calls for new transdisciplinary research to devise new formats for co-creation/co-production that innovate also their operational dimensions.

Box 1: How does co-creation contribute to the implementation of European Union policies?

With the increasing interest of the European Union to deal headfirst with sustainability challenges through innovation, we content that co-creation is a suitable approach to generate and to institutionalise multiple forms of innovation. This view is supported by the Innovation Union and the Smart Specialisation Strategies documents of the European Union. Specifically, we see that co-creation will aid the implementation of smart specialisation strategies (European Commission, 2012, p.8) through the successful implementation of NBS as large-scale demonstrators and investment attractors in cities. Similarly, the open innovation approach underpinning the European Commission's Horizon 2020 strategy calls for "a complex co-creation process involving knowledge flows across the entire economic and social environment" in an effort to shift away from predefined and isolated innovation activities (European Commission, 2016b, p. 11)

Thus far we have not identified specific expectations or mentions of co-creation in the resource policies of European Union, referring to Biodiversity Strategy, Energy Strategy, Common Agricultural Policy and Water and Flood Directives. With the exception of the Water and Flood Directives that require participatory approaches and integrated management approaches, co-creation is a novel mode of governance novel for the European Union. The Urban Agenda for Europe and the New Urban Agenda of United Nations Habitat III both refer to more open approaches for governance and planning that include and capitalise on innovation, pointing in this way to co-creation modes of urban governance. Similarly, the research and innovation policy agenda of the European Commission on NBS puts co-creation at centre stage for developing and scaling NBS (European Commission, 2015).

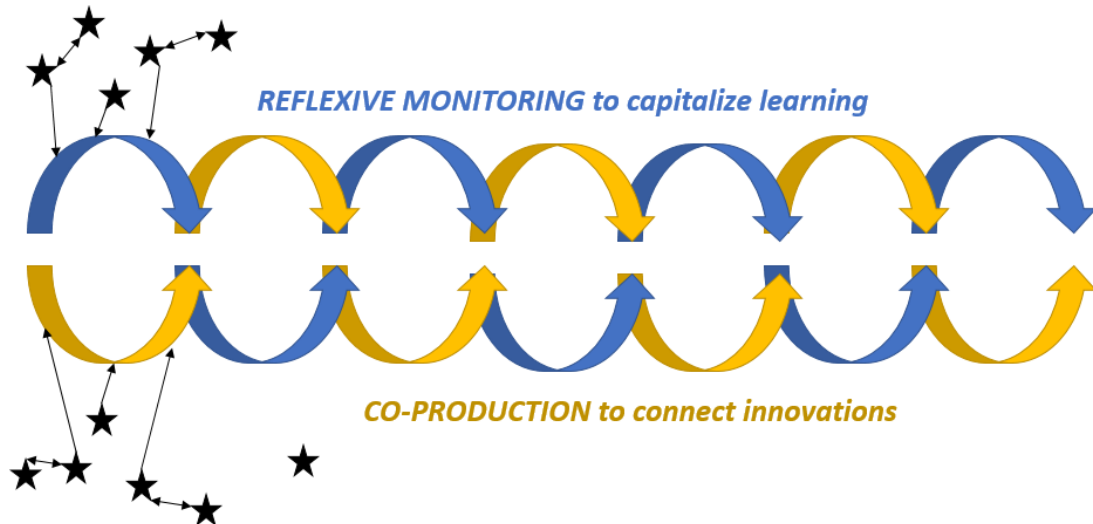
1.2 Aim

Our aim is to 'co-produce' with scientific partners and cities in the Connecting Nature project a design framework for the design and implementation of the concrete steps, activities and tools that are used in the co-production of NBS. The challenge is to design co-production processes in a way that they effectively bring together multiple actors to exchange knowledge and ideas on an inclusive, open, transparent, equal and legitimate basis. A framework for co-production will improve not only the different designs of co-production processes but also allow for the impact to be mapped, traced and even measured. Next to supporting the co-production processes on the ground, the framework also integrates insights on how different cities design co-production processes in practice, including the starting considerations/objectives, when and how (not) to connect to which types of actors, the tools used and opportunities and challenges encountered.

While initially the focus of Connecting Nature was on the concept of 'co-creation', given that we have a specified goal to generate knowledge about the NBS exemplar, the urban governance approach that we will adopt is co-production. Both co-creation and co-production are modes of transdisciplinary research and have become recently conceptualised as modes of collaborative governance (Frantzeskaki, 2019). Co-production aims to actively involve different stakeholders in the production of knowledge-based outputs targeting specific urban challenges – i.e. the goals of co-production are (albeit broadly) pre-defined (such as developing NBS) (Frantzeskaki and Kabisch, 2016). Co-creation is broader in the scope and open ended in the output generation.

The learning-by-doing and iterative nature of co-production processes necessitates on-going learning processes that allow navigating barriers and opportunities through process adaptations on the go. This is why the co-production needs to be complemented by a parallel reflexive monitoring process (Figure 1). Reflexive monitoring is a dynamic and novel way to capture and assess processes of learning by doing and doing by learning with a focus on learning in situ and real time, not retrospectively (Beers and van Mierlo, 2017). Monitoring and assessment are introduced right at the beginning of planning to start by taking stock of innovations, needs and knowledges that exist in the cities, rather than starting from specific and pre-determined problems and solutions. This enables to systematically link learning to urban planning and implementation cycles, thus facilitating flexible and adaptive responses as well as generating insights on critical steps and lessons learned throughout the co-

Figure 1: Co-production and reflexive monitoring for innovating city-making with NBS



The ultimate objective of both the co-production and reflexive monitoring frameworks is to learn with and for cities and from these insights to develop guidebooks as cookbooks on how to design co-production processes for the implementation and scaling for NBS. The frameworks allow to systematise knowledge from the experiences with co-production and reflexive monitoring from cities back to the conceptual level of the design principles and to thus develop conceptually grounded and practice-proven guidebooks with empirical examples and lessons. The guidebooks will allow cities to rethink and redesign ongoing processes to become co-production processes, and in this way to advance urban planning practice from siloed decision-making and consulting and informing citizens and other urban actors to an intrinsically collaborative form of participation, where knowledge, designs and plans are co-produced together and the knowledge and expertise of all actors is appreciated.

This Deliverable presents the work-in-progress on how in Connecting Nature we have developed the frameworks and guidebooks for co-production and reflexive monitoring via an iterative co-production process between the scientific partners and cities – so far together with the Connecting Nature frontrunner cities Genk (Belgium), Glasgow (United Kingdom) and Poznań (Poland). Section 2 presents our co-production method. We consulted scientific literature on NBS governance to understand the state of play and we identified the specific governance needs for NBS governance in the three frontrunner cities. This provides insights into how NBS are to date being governed and how co-production can help to address the needs for NBS governance (Section 3). In addition, we reviewed scientific literature on co-creation and co-production as well as reflexive monitoring to develop conceptual frameworks for both approaches (Section 4). In webinars and workshops with the Connecting Nature cities, we have adapted these frameworks to incorporate practice-based knowledge. We have also applied the frameworks within the three frontrunner cities to support the implementation of their NBS demonstrator, which will be used to embed NBS as an established form of city-making. This has yielded insights and lessons on the practical implementation of co-production and reflexive monitoring for the design, implementation, stewarding and scaling of NBS (Section 5). Section 6 provides an outlook on the next step of co-production between scientific partners and cities in Connecting Nature to inform both their city-making practice as well as the guidebooks on co-production and reflexive monitoring.

1.3 Accompanying guidebooks for co-production and reflexive monitoring

This Deliverable is complemented by two guidebooks that have been conceived as methodological guidance and rich cookbooks based on the theoretical review and practical experiences and examples with co-production and reflexive monitoring that are presented here. The guidebooks speak to urban policymakers and urban planners, but



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also others who are interested in setting up co-production and reflexive monitoring processes.

The **Co-production Guidebook** (Appendix A) outlines a design-based thinking on co-production, including best practices and tools and cities experiences in a structured way. The guidebook will become a rich cookbook for good quality co-production processes with diverse practical insights from on-the-ground urban planning practice.

The **Reflexive Monitoring Guidebook** (Appendix B) presents the background and approach to reflexive monitoring, as well as the city's learning experiences captured through the process. It contains a portfolio of tools to map the learning journeys of the cities in a systematic way.

The guidebook will be continuously updated as the project moves along and more experiences from the Connecting Nature frontrunner and fast-follower cities will be collected.



2. Methods

We have co-produced the approaches to co-production and reflexive monitoring iteratively between researchers and planners of the cities in the Connecting Nature project. So far, we have worked with the three frontrunner cities – Genk (Belgium), Glasgow (United Kingdom) and Poznań (Poland) (see Box 2) – to co-develop their approach to the co-production and reflexive monitoring of the design and implementation of their NBS demonstrator, as well as to identify lessons learned that will benefit other cities interested in designing, implementing and stewarding NBS.

The iterative co-production process builds on the following steps:

- A literature review on conceptualisations, approaches and lessons about co-creation and co-production, with a specific focus on the application in cities.
- A literature review about reflexive monitoring approaches and tools, with a specific focus on how to bring lessons from reflexive monitoring to co-production practice and scaling of NBS.
- A focused review of existing literature and reports on existing NBS governance models in cities (drawing e.g. on the governance work of other projects such as Nature4Cities, see Sekulova and Anguelovski, 2017) and an analysis of dominant governance modes of NBS interventions presented in the Connecting Nature database (Dumitru et al. 2018 – CN Deliverable 1.1).
- Frontrunner city workshops in every frontrunner city – in Genk (26.02.2018), Glasgow (11.04.2018), Poznań (26.04.2018) – with focus groups to assess (a) organisational conditions, barriers and strategies, (b) policy needs and (c) experiences with co-production, to explain, co-create and tailor the co-production and reflexive monitoring methodology for their city, to identify good practices per co-production principle of the framework.
- Peer-to-peer learning and reflecting on own practices for co-production with all frontrunner cities and fast-follower cities as reflectors in the General Assembly meeting of the Connecting Nature project held in Ioannina, Greece, in June 2018.
- A workshop with the Brazilian multiplier cities about co-creation and the co-production principles by the ICLEI team in Brasilia (09.07.2018).
- A webinar with all frontrunner cities to introduce the complete reflexive monitoring methodology, process steps and tools (10.09.2018).
- Since September 2018, we have realised monthly reflexive monitoring coaching webinars with each frontrunner city that will continue throughout the project.
- A webinar with all frontrunner cities to present and discuss the first draft version of the co-production guidebook (02.11.2018).
- An eye opener workshop on the reflexive monitoring methodology with all frontrunner cities in Rotterdam, the Netherlands (20.11.2018).
- A focus group with all frontrunner cities to present the co-production processes they put in place for the NBS exemplar in Rotterdam, the Netherlands (21.11.2018).
- A webinar to introduce the reflexive monitoring process methodology to the fast-follower cities (12.12.2018).
- A webinar to introduce the co-production framework and principles to the fast-follower cities (14.01.2019).
- A workshop on co-creation/co-production principles and good practices from the frontrunner and the fast-follower cities with a peer-to-peer learning set up in Nicosia during the 'Learning Transfer Workshop'



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- A workshop on the reflexive monitoring methodology and good practices from the frontrunner and the fast-follower cities with a peer-to-peer learning set up in Nicosia during the 'Learning Transfer Workshop' (23.01.2019).
- Analysis of frontrunner cities' reports on their co-production processes, including translation of the co-production principles, presentation of their activities and methods and reflection on lessons, opportunities and barriers.
- Analysis of frontrunner cities' reports on their Learning History Narratives that include reflections on their key learning outcomes for their co-production processes as well as on their experiences with the reflexive monitoring methodology.
- Analysis of interviews conducted by CN team using questionnaire with expert on emergent, innovative and novel NBS experiments
- Literature review on organisational barriers and strategies for dealing with co-producing NBS from an organisational perspective (based on Adina et al., 2018 – CN Deliverable 1.1 – and further extended). The review included studies on innovation, co-creation and organisational change in both private and public sector organisations.
- Analysis of organisational barriers and strategies for dealing with innovation and scaling of NBS of frontrunner cities Genk, Glasgow and Poznan (Deliverable 1). Two online meetings were held in the summer of 2018, with two of the three FRCs (Genk in 27.06.2018 and Poznan in 12.07.2018).

Box 2: Learning with and for Connecting Nature cities in developing NBS exemplars

This guidebook is the result of a co-production process between research partners and European cities within the scope of the Connecting Nature project (www.connectingnature.eu). Connecting Nature is a European research project funded by the European Commission's Horizon 2020 Innovation Action Programme. The aims are to support the scaling of nature-based solutions (NBS) in cities and to position Europe as a global leader in the innovation and implementation of NBS by co-producing a toolkit for cities seeking to deliver NBS on a large scale.

Each Connecting Nature city has an NBS exemplar which will be implemented through the support of the Connecting Nature and will be used to embed the implementation of NBS as an established form of city making. So far, we have worked with three cities to co-develop their approach to the co-production of the design and implementation of their NBS demonstrator, as well as to identify lessons learned that will benefit other cities interested in designing, implementing and stewarding NBS.

Genk (Belgium, population around 65.000) is developing a multifunctional blue-green urban valley – the Stiemerbeek Valley, a neglected corridor of 8 kilometres running through the city and suffering from poor water quality. The objectives are to connect nature with nature, citizens with nature, citizens with citizens, and nature with entrepreneurship by facilitating connections between sites urban neighbourhoods and nature. A suite of pilot projects have been selected for implementation – including the Gardens of Waterschrei, Slagmolen, SUDS and SODA and the Valleyroute – that range from redeveloping a former mill as an arts and information centre and gateway to the Stiemer, to engaging with private landholders to develop rain gardens and other sustainable urban drainage system (SUDS) features to attenuate rainwater across the Stiemer catchment.

The Scottish city of **Glasgow's** (United Kingdom, population around 590.000) approach to developing a scaled up NBS exemplar is underpinned by its strategic Open Space Strategy (OSS) and accompanying Local Context Analysis. Based on a wealth of data and spatial analysis, the OSS aims to provide a strategic vision on, and coordinate the responsibilities associated with, the open spaces to ensure a well-managed, well-located and well-connected network of open spaces that operate as part of a wider green network and offer multiple benefits and address multiple pressing challenges. The 15 Local Context Analyses show how to translate the strategic goals



into operational projects within 15 areas of the city, with the aim that local communities will be embedded in developing projects at this scale.

Poznań (Poland, population around 540.000) aims to develop and up-scale small-scale NBS – such as natural kindergartens and open gardens – in different parts of the city and in this way create a rich green network. Poznań's historic city-wide system of green wedges and rings based on the Warta river valley is threatened by development pressures and the dense city core lacks green spaces. The scaled-up exemplar is an initiative led by the municipality to reinvigorate the existing green system by developing a number of green 'stepping stones' within the dense urban core that increase the accessibility of greenspace and enrich the multifunctionality (including recreation and cultural potential) of the green wedges. These are being developed as open gardens in kindergartens. The open gardens are complemented educational programmes aiming to change the relation of Poznań's (youngest) citizens with nature and a 'toolbox' through which the municipality supports citizens setting up bottom-up NBS initiatives.



3. Governance of nature-based solutions: needs and opportunities for co-production

Greening interventions have for a long time been part of urban policy and planning, with local governments having historically taken a leading role in designing, implementing and maintaining urban green (Sekulova and Anguelovski, 2017). The recognition of NBS as transformative solutions to address multiple contemporary urban challenges simultaneously – including climate change, social erosion, air pollution, biodiversity degradation – has strongly pushed for incorporating NBS more prominently into city-making (Frantzeskaki et al., 2016; Collier et al., 2017; DG Environment, 2017). In these novel initiatives, next to local governments also other actors from local communities, businesses, research institutes, regional and national governments, amongst others, (are called on to) support knowledge generation on and stewarding and self-organising of urban greening initiatives (Frantzeskaki, 2019).

In this context, we understand urban NBS governance as the intentional coordination of NBS design, implementation, stewarding and scaling in cities. The ‘governance’ element relates to the intentional actions or interventions to coordinate social actions and address a collective problem (Kooiman, 1993; Jessop, 1997). Governance encompasses both the formal and informal structures, processes and rules that determine how people in societies make decisions and share power, as well as the diverse types of public and private actors performing acts of governing (Patterson et al., 2016; Biermann et al., 2009). The ‘urban’ element draws attention to action that target the scale of cities, while recognising their multi-scalar effects as well as the complex multi-level governance structures and networks that act in urban systems (McCann et al., 2016). Finally, the ‘NBS’ element refers to NBS as specific type of solutions to address complex urban problems and that require coordination and collaboration across multiple actors, sectors and scales to facilitate multifunctional design and benefits that are fit to context and to spur long-term stewarding and scaling. We distinguish between four – partially overlapping and iterative – phases of NBS governance, relating to the design, implementation (including capital investment), stewarding (including long-term operation and maintenance) and scaling (including the replication and expansion of specific NBS solutions). Strictly speaking, the governance of NBS cannot be separated from urban governance of other policy priorities and goals that it is linked to (e.g. mobility, health) but requires integrated approaches.

NBS governance needs to be a collaborative undertaking to design and implement NBS as multifaceted solutions with the potential to deliver across multiple planning and community agendas (Davies and Laforteza, 2019). While urban NBS governance refers to the range of actors who have a role in developing, stewarding and scaling NBS in cities, as well as the structural contexts that influence their interactions (e.g. organisational structures within city departments, partnerships) and how NBS are aligned with social, political and business priorities and goals, co-production is a specific type of governance activities that enable collaboration. Governance can be exercised in form of different governance modes – which embody different combinations of actors and networks, forms and mechanisms of interaction (e.g. top-down control, informal rules) and objectives (Lange et al., 2013). Co-production processes underpin collaborative governance modes by which multiple actors co-define problems, priorities, values, solutions and interventions. In this way, it may be an approach to close the coordination and collaboration gap in urban (NBS) governance.

In this section, we first review dominant modes of NBS governance to date, which indicates a shift towards more collaborative, reflexive and adaptive approaches. We then present our analysis of NBS governance needs – in terms of visible gaps in policy, market and organisational structures and processes – in Genk, Glasgow and Poznań with regards to NBS design, implementation and scaling that further underpin the need for collaborative knowledge generation and partnership building, i.e. co-production. Finally, we introduce and define co-production as a set of governance activities to facilitate collaborative NBS governance and address the identified NBS governance needs. The premise is that setting up co-production processes that can weave in diverse knowledge will benefit the city and its inhabitants as a whole. In this way, co-production may burst open siloes and enable delivering joint public service delivery by policymakers, urban planners, scientists, business and investment community, and citizens, amongst others.

3.1 Modes for governing nature-based solutions in cities

Traditionally, many urban green initiatives were, and are still, initiated and governed by state actors (Sekulova and Anguelovski, 2017; Young and McPherson, 2013). Local governments are the traditional main source of overall vision, planning and management of green infrastructure. In delivering NBS, over time the role of local



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governments or public stewardship in NBS in cities has shifted, driven in part by reduced capacities and the growing authority of other actors in urban governance (Sekulova and Angelovski, 2017). The number of green spaces, especially urban community gardens, initiated and managed in a bottom-up fashion is notably increasing in cities in the global North. This approach often builds on framing/seeing gardening as a type of politics struggling for a radically different, socially just and ecologically sustainable city, or as a new form of intervention in urban politics and planning (ibid.). Also the private sector has started to be dominant driving force in implementing NBS. This is particularly relevant for green roofs and facades. Still, local policies most frequently drive NBS implementation and the majority of NBS projects financed through the budgets of local authorities.

We reviewed NBS governance models in cities to types of NBS interventions presented in the Connecting Nature database (Haase and Dushkova, 2019; Haase and Dushkova, *in preparation*) (Table 1). We distinguish between three main types of NBS: (Type 1) solutions that involve making better use of existing natural or protected ecosystems (e.g. measures to increase fish stocks in an intact wetland to enhance food security); (Type 2) solutions based on developing sustainable management protocols and procedures for managed or restored ecosystems (e.g. re-establishing traditional agro-forestry systems based on commercial tree species to support poverty alleviation); (Type 3) solutions that involve creating new ecosystems (e.g. green walls, green roofs) (Cohen-Shacham et al., 2016).

The Table makes clear that most NBS are implemented by public, governmental actors, especially when they involve large-scale changes in physical infrastructure (e.g. for land management or coastal protection) and change in legislation and regulation. NBS interventions that more prominently involve private stakeholders include green installations on buildings (e.g. green walls) or greening of public spaces (e.g. urban gardening).

Table 1: NBS governance models linked to NBS interventions

Type of NBS	NBS intervention	Example from CN database	Initiator	Stakeholders involved	Method of implementation
Green infrastructure					
Building-scale interventions (actions on rooftops, facades and community spaces of the buildings)	<i>Green roofs</i>	Building regulations for green roofs (Basel, CHE)	public	Canton Basel	Change in legislation or regulation
		Green Roof Policy (Sheffield, UK)	public	Sheffield City Council	Change in legislation or regulation
	<i>Green facades, walls and vertical gardens</i>	All united for more biodiversity (Strasbourg, FR)	public, private	Scientific or technical advisors, NGOs	Networking, sharing knowledge, ESS analysis, green infrastructure development
		Green Allure for Nijmegen (NL)	public	City of Nijmegen (government), scientific or technical advisors	Change in physical infrastructure
	<i>Rainwater harvesting actions</i>	Crosstowers Amsterdam (NL)	private	governmental institutions, private	Change in physical infrastructure
		Herontwikkeling krachtwijk Wielwijk (Dordrecht, NL)	public	governmental institutions, public, private	Change in physical infrastructure
	<i>Community courtyards</i>	Kaltluftkorridore (Stuttgart, DE)	public	Governmental (Municipality of Stuttgart)	Financial incentives, GI, change in legislation or regulation, change in physical infrastructure
	<i>Greening spaces between buildings</i>	Natur in grauen Zonen (Duisburg, Erfurt, Wiesloch, DE)	public/private	Public-private partnership	Financial incentives, Change in physical infrastructure

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Public spaces. Actions in public-living areas, urban parks and other urban features of the public space	<i>Urban regeneration</i>	Lisbon (POR): NBS Enhancing Resilience through Urban Regeneration	Public	City Council (Regional planning Authorities)	green corridors, street trees, urban agriculture
		Shape Your World (Stockholm, SE)	Botkyrka Municipality	Local government, research institutions and social entrepreneurs	Social networking, communication, change in physical infrastructure, workshop
	<i>Renaturing abandoned areas and opportunity plots</i>	Fornebu Airport (Oslo, NOOR)	public	Staatsbygg, Oslo, Baerun (governmental)	Change in physical infrastructure
		Open Lab Ebbinge (Groningen, NL)	Retailers Association Ebbingekwartier	Local government, local business, local community, civil society, knowledge institutes	Social networking, change in physical infrastructure
	<i>Urban parks</i>	Madrid Rio Project (ESP)	public	Madrid City Council, Spanish Government	Change in physical infrastructure
	<i>Urban gardening</i>	Urban Gardening initiative Peace Garden (Rotterdam, NL)	private (citizens and NGO)	Municipality	research (interviews), workshop in which stakeholders
		Local Initiative in Hungary: Magház (Szeged, HU)	private	public, private	GI development, networking and workshop, sharing knowledge
<i>Greening streets</i>	Mayors Street Trees Programme (London, UK)	public	Municipality of London and Boroughs	Change in physical infrastructure	
Peri-urban and rural land management					
Interventions in natural areas and management of the rural land	<i>Natural protected areas</i>	Persina protected nature park – (Nikopol, Belene and Svishtov)	public, scientific or technical advisors	governmental institutions, public, private	networking, sharing knowledge, big data, ESS analysis, green infrastructure development
	<i>Wetlands</i>	Cheap and effective climate change adaptation in Hareskoven (DK)	public	Municipality of Furesø, Furesø Spildevand A/S	Change in physical infrastructure
	<i>Peri-urban parks</i>	Landscape-ecological planning in urban and peri-urban area (Trnava, SK)	scientific experts / technical advisers	Institute of landscape ecology Slovak	data acquisition, develop workable methods for ESS evaluation
	<i>Rural land management</i>	Bio Region Mühlviertel (Danube-Bohemian Forest, 41 municipalities)	7 LEADER regions of the Mühlviertel, EUREGIO Bavarian forest, Bohemian Forest	Federal State of Upper Austria, BIO Austria, farming and agriculture companies	regional implementation concept
Water management					
Water management (Interventions in	<i>Sustainable urban drainage systems</i>	Queen Marys Walk (Llanelli, UK)	public	governmental institutions (Natural Resources Wales and Carmarthenshire)	Change in physical infrastructure

water bodies and drainage systems)				County Council, Welsh Government	
	<i>Sustainable urban drainage systems</i>	Ekostaden Augustenborg (Malmö, SE)	public	Government of Sweden, Municipality of Malmö, EU URBAN Programme	Change in physical infrastructure
	<i>Renaturing rivers and streams</i>	River Ravensbourne at Cornmill Gardens (London, UK)	public	London Borough of Lewisham and Environment Agency	Change in physical infrastructure
	<i>Controlled flood plains</i>	Room for the River Deventer	public	Groot Salland Water Authority, Vallei and Veluwe Water Authority, City of Deventer, Province of Overijssel, IJsselandschap Foundation, Rijkswaterstaat	Change in physical infrastructure
Coastal management					
Coastline/coast interventions	<i>Dune restoration</i>	Urban hybrid dunes in Barcelona (Barcelona, ES)	public	governmental institutions (City administration)	Change in physical infrastructure
	<i>Beach regeneration</i>	Dune recovery (Torres Vedras, PRT)	public	governmental institutions (City Municipality, Portuguese Environmental Ministry)	Change in physical infrastructure
	<i>Salt marsh and coastal wetland regeneration</i>	Coastline Renovation (Andrano Region, IT)	public	governmental institutions (Municipality of Adriano)	Change in physical infrastructure
Multi NBS					
Urban Living Labs		The Community Energy Lab (Tottenham, London, UK)	Government, private (SMEs, social enterprises, cooperatives), public (NGOs).	private	financial incentives, sharing knowledge, networking
Smart cities		Smart Cities Demo Aspern (Aspern – Vienna’s Urban Lakeside)	private, governmental institutions	governmental institutions (City of Vienna), private, scientific or technical advisors	application of best-practice methods, Change in physical infrastructure, sharing knowledge
Eco-villages		Ecovillage Bergen (Bergen near Amsterdam, NL)	public	public	green infrastructure development, networking and workshop, sharing knowledge

Public agencies tend to withdraw particularly in managing and financing, resulting in a gap between state-driven NBS projects and commitments to their long-term stewardship (Sekulova and Anguelovski, 2017). Changes in public administration could leave particular interventions without maintenance funds (Nesshöver et al., 2017): There are examples where local governments’ attempts to work with volunteers through planting events, online outreach and public education activities have become a one-off measure, which did not result in the establishment of a long-term management of trees (Young and McPherson, 2013). Given green infrastructure alone cannot provide the (monetary) value it produces, its continuous support through a “dedicated fund” within the city budget



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In this context, one of the dominant visions on the governance of NBS rests upon the idea of sharing costs and risks between the private sector and the state (Sekulova and Anguelovski, 2017). Up to date, the mobilisation of the private sectors is risky and expensive, leading to forms of social exclusion and the need for the state to guarantee risk (Kabisch et al., 2016; Nesshöver et al., 2017). Volunteerism and public engagement is another means through which the implementation and stewardship of NBS is conducted. Bottom-up projects could create a policy climate for a radically different, socially just and ecologically sustainable city. However, here also significant challenges in the context of gentrification pressures and persistent uneven landscapes of socio-economic power relations emerge (Sekulova and Anguelovski, 2017).

This has led to calls for more adaptive and inclusive modes of NBS governance, which embraces experimental approaches, where evaluation of goals, measures and outcomes are built into continuous learning, and which creates institutional spaces for cross-sectoral dialogues amongst different stakeholders (Kabisch et al., 2017; Andersson et al., 2014; Buijs et al., 2018). The participatory component of this type of governance is about relying on multiple actors for continuous knowledge generation, e.g. citizen science, knowledge transfer over time and practical management. This will in turn be of importance for the social support of the NBS existence and awareness of its changing functional design over time. Moreover, the engagement of a large variety of actors is also a matter of creating economic insurance, where different financial resources can be activated to sustain functionality over time. For these reasons, participatory approaches to co-design, co-creation and co-management ('co-co-co') of NBS are advocated (European Commission, 2016a; Pauleit et al., 2017; Frantzeskaki and Kabisch, 2016). For example, Buijs et al. (2018) show how active citizens can significantly contribute to urban green infrastructure planning and implementation, for example by developing large parks with volunteers or designing a network of green corridors. As they show a large diversity of citizen-local government collaborations and different pathways for upscaling innovative discourses and practices, they term this 'mosaic governance' that can facilitate a combination of long-term, more formalised strategic approaches with more incremental approaches that correspond with localised, fragmented and informal efforts of local communities.

3.2 Governance needs for innovating and scaling nature-based solutions

NBS pose new challenges to urban governance, which result in implementation gaps in terms of designing, implementing, stewarding and scaling NBS. To identify the underlying root causes of NBS implementation gaps in Genk, Glasgow and Poznań, we have identified their governance needs: a governance need is the combination of governance processes and conditions that are required to bridge the gap between a strategy or solution, a problem and an objective in form of a desired situation. The governance needs include policy, market and organisational needs (processes and conditions to facilitate collaboration and knowledge generation).

The analysis of the Connecting Nature frontrunner cities' needs enabled us to identify the governance processes and conditions that are required to design, implement and scale NBS across policy, market and organisational needs (Table 2). The needs refer to the availability of knowledge about NBS that is dispersed across multiple actors, skills and resources for (co-)design and implementation, and partnerships.

Table 2: Governance needs for multi-functional NBS implementation and scaling and related challenges in Genk, Glasgow and Poznań

Needs	Genk	Glasgow	Poznań
Knowledge about NBS as multifunctional and innovative solutions	<p>Knowledge about multiple, strategic and economic benefits of NBS</p> <p>Knowledge about developing (alternative) business and finance opportunities and models for NBS</p> <p>Knowledge about technical design and designing for multiple functions</p>	<p>Knowledge about approaches and selection processes for NBS</p> <p>Knowledge about benefits, innovation and entrepreneurship around multi-functional NBS, focus on engineering solutions</p> <p>Knowledge about real-time and long-term monitoring,</p>	<p>Knowledge about multifunctional benefits of NBS</p> <p>Knowledge about effectiveness and value for money about NBS</p> <p>Knowledge about identifying and assessing (best uses for) specific sites for NBS</p>

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	<p>Knowledge about baseline data, indicators for monitoring and evaluation</p> <p>Knowledge about risks and threats and how to deal with them</p>	<p>absence of data regarding private land</p> <p>Knowledge about specific needs of a place</p>	<p>Knowledge about maintaining NBS e.g. in relation to dealing with weather challenges</p>
<p>Interdepartmental partnerships for collaboration on multifunctional NBS</p>	<p>Predominant culture of working in departmental silos, fragmented management responsibilities for NBS</p> <p>Some inter-departmental rivalry, lack of trust, and competition for political support and resources</p> <p>No informal means/space for communication across departments</p> <p>Lack of awareness of the NBS exemplar outside the department</p>	<p>Independently organised departments pursue separate goals, with little communication nor sharing of goals and financial means, resulting in resource constraints (also due to major budget cuts)</p> <p>No informal means/space for communication</p> <p>Dispersed responsibilities for development and maintenance of NBS</p> <p>Arms-Length Organisations within the city structure may prove challenging in terms of remit and responsibility</p>	<p>Competences and responsibilities for urban greening and water management spread across different departments</p> <p>No alignment of priorities between competing land uses</p> <p>Lack of cross-cutting knowledge by senior staff</p> <p>No informal means/space for communication</p> <p>Interdepartmental cooperation only based on informal relationships</p>
<p>Lasting partnerships between urban actors and the local government</p>	<p>Top-down, municipality-led and city-dependent implementation of (NBS) infrastructure projects</p> <p>Little culture in shared and partnership working between the municipality and residents</p> <p>Inexperience in balancing engagement activities with stakeholder fatigue over a long planning period</p> <p>Lack of societal awareness of impacts and benefits of NBS on communities</p> <p>Identifying and connecting capacities and creativity of urban actors (e.g. social innovation initiatives)</p>	<p>Top down delivery of services and care</p> <p>Expectation by residents that the council will look after green assets</p> <p>Little experience or culture of engaging and sustaining partnerships directly with residents and smaller scale stakeholders</p> <p>Communities do not necessarily understand benefits, functions and stewarding of NBS</p>	<p>Lack of communication skills and information flows for mobilising and collaboration with residents</p> <p>No trust and understanding between different private partners, e.g. grassroots movements and developers</p> <p>Lack of appreciation of importance of public consultations</p>
<p>Political and policy support for multi-beneficial NBS</p>	<p>Political uncertainty due to political cycles, implying changing priorities</p> <p>A role model/champion is missing</p> <p>Scaling up at city level requires changes of governance of water infrastructure at the provincial or regional level</p>	<p>Lack of innovation culture: risk-aversion as default</p> <p>Political uncertainty due to political cycles/elections</p> <p>A role model/champion is missing</p> <p>Limited awareness of NBS (benefits) among decision-makers</p>	<p>Lack of (inclusion in) specific policies to facilitate NBS implementation</p> <p>Risk-aversion: keeping a certain image is important</p> <p>Limited awareness of NBS (benefits) among decision-makers</p> <p>Tendering/procurement process over-emphasises costs over multifunctional benefits</p>

			Political uncertainty due to political cycles/elections
Organisational resources for multifunctional NBS delivery	No resources for dealing with changes and information overload	No resources for dealing with changes and information overload, exacerbated by major budget cuts	No resources for dealing with changes and information overload

Firstly, we identify **knowledge needs about NBS as multifunctional and innovative solutions**, including design, financing, monitoring and evaluating. NBS require understanding of the specific local contexts and design options, as well as the monitoring, evaluation and dissemination of NBS benefits. Mobilising the multiple benefits of NBS requires integration of knowledge across disciplines – for example urban ecology, landscape planning, ecological education, business models. A problem is the dispersed knowledge on NBS and the lack of knowledge systematisation (Albert et al., 2019; Raymond et al., 2017). The large-scale implementation of NBS requires knowledge about what works and what does not work under specific conditions. This need does not only concern the localisation, design and operation of NBS but also their delivery of economic benefits and business opportunities, for example relating to the possibility to generate income from tourism in the Stiemer Valley in Genk. This need does not only concern the localisation, design and operation of NBS but also knowledge about their delivery of economic benefits and business opportunities, for example relating to the possibility to generate income from tourism in the Stiemer Valley in Genk. Accordingly, knowledge about financing of NBS is a challenge. We identified three recurring phases in the financing of NBS – financing the design and planning phase, financing the initial capital investment and financing the ongoing operational and maintenance costs. Different stakeholders and sources of financing are often involved in these different phases increasing the complexity of financing of NBS. While public agencies often invest heavily in the initial phases of planning and capital investment, they (need to) look for opportunities to reduce their ongoing financial commitment by engaging with other actors in the operation and maintenance phase. In some cases this leaves a gap in financing in the latter phase (Sekulova and Anguelovski, 2017; Nesshöver et al., 2017). The complexity of financing NBS is further compounded by a continuous change in the sources of financing both public and private. Sources of public financing such as grants are subject to varying restrictions and conditions which create uncertainty. New sources of private and blended financing are emerging in particular in relation to large-scale infrastructure type NBS projects.

Secondly, there is a **need for inter-departmental partnerships within the local government structure** for collaboration on multifunctional NBS. Collaboration across city departments is needed for NBS as multifaceted solutions with the potential to pool resources and agendas and deliver across multiple planning and community agendas (Davies and Laforteza, 2019). The need links to the challenges of siloed working within city governments, lack of clear responsibilities for NBS implementation and maintenance and lack of trust and conflict where costs of NBS are borne by one city budget whilst benefits accrue more broadly. The need also points to the need for wide awareness about NBS benefits within city governments. For example, due to lack of knowledge, NBS can often be overlooked by policymakers in strategic policies. A good example of this is evident in the lack of engagement of finance and economic departments in the planning of NBS. We identified a clear lack of financial planning expertise among the NBS project planning teams in each front-runner city and a corresponding lack of knowledge of NBS in the finance department. The finance departments are often highly skilled in financial engineering and building blended financing solutions with external partners. The lack of cooperation also extends to a missed opportunity to explore the use of financial instruments like fiscal tariffs or incentives to stimulate the take up of NBS.

Thirdly, there is a **need for (knowledge on) establishing lasting partnerships between urban actors and the local government** for multifunctional NBS. Making NBS locally relevant, leveraging business opportunities and ensuring societal support requires partnerships across communities of interest. Partnerships with local communities, businesses, ecologists, landscape architects and knowledge institutes enable to better localise and embed NBS in urban life (Nesshöver et al., 2017; Connop et al., 2016; Keune et al., 2015). However, there is often a lack of culture and knowledge about how to enter into such collaborative engagement and partnership, and also some lack of trust level of prejudice between the local government and other urban stakeholders. This requires new skills on how to collaborate with for example social innovation initiatives given that they have capacities and creativity in connecting urban actors across the city (Frantzeskaki et al., 2017). From a financing perspective, we identified a lack of systematic engagement of business and investment stakeholders in NBS in the cities. Where collaboration did occur, this arose spontaneously and/or evolved iteratively in relation to emerging city needs to outsource NBS delivery.



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Fourthly, there is a **need for political and policy support** to enable the development and scaling of multi-functional NBS. Especially political uncertainty due to short-term election cycles risk that there will be changing priorities, especially when there is limited awareness of NBS benefits among decision-makers and limited institutional embedding of NBS implementation. Across frontrunner cities, we identified a risk-averse planning culture, as well as short-term financing frameworks that emphasise costs over benefits. This need also points to the challenge of institutional and regulatory alignment across governance scales. In Genk, scaling up NBS at city level requires changes of water governance at provisional and regional levels. We identified political support as the most important enabler of financing of NBS across all cities. Conversely a lack of political support for NBS can present a major barrier to implementation of NBS. Political support for NBS has been identified as opportunistic rather than consistent – securing other sources of financing (even relatively small) can be sufficient to leverage political backing, securing high profile events such as the Commonwealth Games in Glasgow can swing budgets towards NBS investment etc.

Finally, we identified the **need for organisational resources** that are cross-cutting to address the other needs: currently all three cities state to have too limited organisational resources and capacities for collecting the knowledge needed for NBS implementation, dealing with and analysing the amount of information, and engaging in the partnership-building within the city government as well as with urban actors.

3.3 Co-production as a new form of urban governance for NBS

Co-production is a novel form of collaborative NBS governance to address complex urban problems in an inclusive way and to develop and scale novel, shared and multi-functional solutions. Originally, co-creation and co-production were introduced as modes of transdisciplinary research, focusing on the interface between science and decision-making but over time it emerged that it is more of “an effort to draw on diverse knowledge” (Wyborn, 2015, p.57). Given that in cities, knowledge about problems, needs, solutions and institutions lies in diverse actors, co-creation and co-production are suitable approaches to bridge across actors and simultaneously address knowledge needs, build partnerships and ensure political and societal commitment and resources. Co-creation and co-production relate to intrinsically collaborative modes of governance, where other urban actors are not just consulted or informed but involved from the very beginning in problem definition and solution finding processes. In this way, they can bridge large-scale implementation of NBS to the design needs for specific localities, by facilitating a cross-cutting perspective and improved evidence base on the benefits and potentials of (specific) NBS within a city and become embedded in (new) institutions and practices for urban development and in urban life more generally. The benefits do not just refer to the design and implementation of NBS, but also to their long-term stewarding and scaling, as for example communities can be motivated to participate in the maintenance of urban green space.

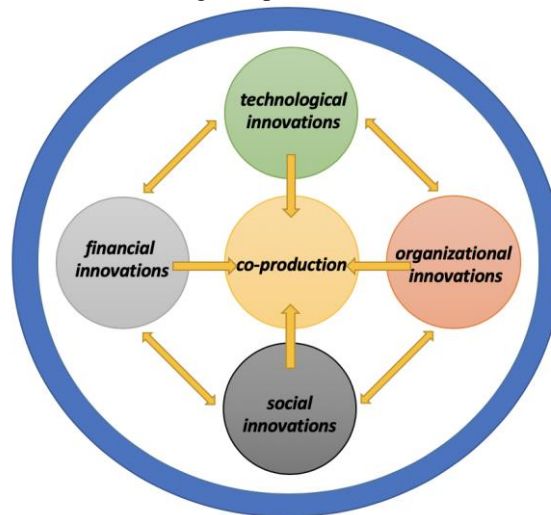
Co-production **brings together urban actors and promotes collaborations, partnerships and knowledge integration** amongst these for the design, implementation, stewarding and scaling of NBS. Co-production responds to the need for creating new institutional spaces for multiple perspectives and knowledges to come together (Vingola et al., 2009, p. 694; Devolder and Block, 2015) and for accounting for “competing value systems” (Gulsrud et al., 2018, p.165). For example, co-production may bring together civil servants from across city departments to create synergies between different policy priorities and goals and connect nature-based solutions to other strategies, agendas and financial means. Co-production might also bring civil servants together with local entrepreneurs and business actors, experts (e.g. researchers, advisors, consultants) and communities. In this way, co-production weaves together knowledge about how to develop new business cases for NBS, expert knowledge about technical solutions and civic-tacit knowledge about local needs.

In this way, co-production holds the potential of democratising urban planning by opening to multiple stakeholders based on their knowledge rather than their power political position or resources holding. Active participation of citizens and other urban stakeholders/agents in co-production bears the potential to weave together diverse knowledge and develop solutions that will benefit the city and its inhabitants as a whole by generating comprehensive insights for urban planning – such as new visions, strategic agendas, new problem framings and innovative solutions (Frantzeskaki and Kabisch, 2016; Roorda et al., 2014). Additionally, it aims to activate, mobilise and empower diverse actors and hence make urban planning a joint process of discovery for better urban futures and environments and move towards “joint public service delivery by professionals and citizens” (Voorberg et al., 2014, p. 8). Co-production spurs new relationships between actors that are normally not in contact with each other and thus creates new opportunities for partnerships and collaboration. Through entering a process of co-production, diverse actors have the opportunity to learn about each other’s realities, enabling deeper relationships and more effective collaboration and more joined-up service delivery (Hölscher et al., 2017).

Co-production **boosts innovation and connects innovative ideas to policy agendas and social priorities for large-scale implementation** by allowing to exchange ideas on needs and solution options in an open rather than pre-defined way. One of the reasons is that co-production approaches resonate when there is no identified solution yet but rather open-ended questions or concept solutions under discussion. Co-production facilitates openness to new and different perspectives and ideas and reveals synergies between multiple policy and societal priorities and goals. Bringing multiple actors with diverse needs and perspectives together therefore strengthens the position of NBS as innovative and multifunctional solutions for dealing with contemporary sustainability challenges in cities, including climate change, air pollution and social inequality.

Recent research supports the premise that co-creation and co-production “might nurture innovations of a new kind” (Felt et al., 2016, p. 732; see also Pollock, 2016). The role of innovation for dealing with climate change and shifting towards sustainable cities has been widely recognised (Westley et al., 2011). Innovations that are supported through co-production are multiple (Figure 2): for example, Dunn, Brown, Bos, and Bakker (2017) find that multi-stakeholder co-production processes can generate business from science-based innovation. In addition, processes of co-production enhance situated learning, meaning learning on enhancing skills and new identities, reshaping roles and establishing new social ties and in this way contributing to social innovation (Heiskanen and Matschoss, 2017; Hölscher et al., 2017). Especially when multiple innovative ideas and solutions are connected to each other and to strategic priorities this can produce “the cascade of resources required to bring innovation to markets and scale it up” (Westley et al., 2011, p. 767). For example, multi-stakeholder co-production processes have shown to generate new business opportunities, social innovations, integrated policies and transversal institutions.

Figure 2: Connecting multiple innovations through co-production



The co-production of nature-based solutions can **provide a democratic entry point to addressing many urban challenges simultaneously**. Initially specific NBS interventions may seek to address a climate change related problem, such as the urban heat island, episodic rainfall and flooding, noise and dust, and so on. In the process to co-developing NBS, communities of interest and communities of influence open dialogues into wider areas where the main climate-related issue, behavioural inflexibility, can be addressed in a more normalised manner.



4. A framework for co-producing nature-based solutions

So far, a framework that facilitates the design as well as evaluation of co-production processes is missing (Durose et al., 2018; Voorberg et al., 2014). As co-production is a novel form of collaborative governance it challenges existing ways of decision-making and planning in cities. The challenge is to design co-production in a way that it effectively brings together multiple actors to exchange knowledge and ideas. A framework for co-production will improve not only the different designs of co-production processes but also allow for the impact to be mapped, traced and even measured, for example in terms of social innovation (Voorberg et al., 2014).

Based on our literature review on co-production as well as our exchanges on and experiences with co-production in cities, we develop a framework of co-production to enable urban actors – including policymakers, planners, researchers, business and finance communities and citizens – to design their own repertoire of co-production processes and activities, as well as to rethink and redesign on-going processes to become co-production processes. This makes it possible to advance urban NBS governance and planning practice in an adaptive, collaborative and reflexive way.

Setting up high quality, viable and effective co-production requires good process designs, knowledge about the right tools and methods, as well as enabling conditions that provide the basis for co-production. The heart of the framework are design principles to guide the set up and evaluation of co-production processes (Section 4.1). Based on feedback from cities, we have added a review on tools and methods to use during co-production activities (Section 4.2). In addition, we have developed a framework for reflexive monitoring to support the learning-by-doing and doing-by-learning nature of co-production processes for NBS implementation, which require learning throughout (Section 4.3).

In summary, the framework encompasses the following building blocks:

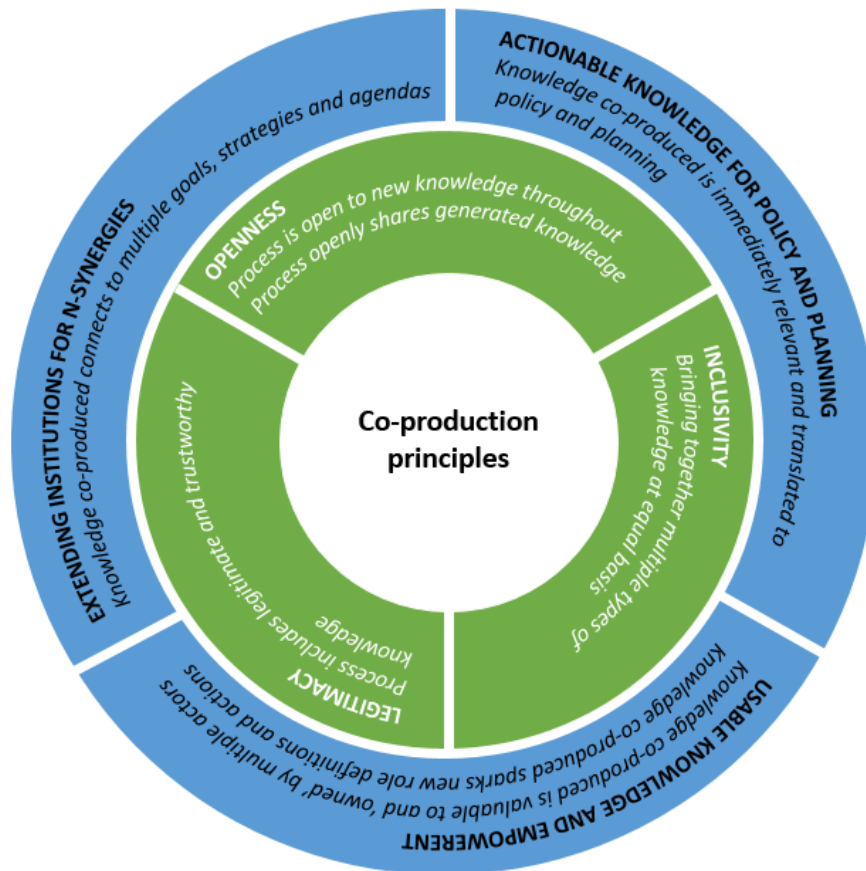
- ***Co-production design principles*** that provide a heuristic to design and evaluate knowledge co-production processes. Next to facilitating the design and implementation of co-production processes, the principles allow for the outcomes and impacts of co-production to be mapped and measured, for example, whether knowledge-based outputs inform strategic urban agendas.
- ***Co-production tools and methods*** that can be used in specific co-production activities and settings so as to facilitate discussions, interactions and knowledge exchanges between actors in line with a specific objective (e.g. vision development, problem framing).
- ***Reflexive monitoring framework*** that includes a set of tools and methods to continuously learn about how the co-production process proceeds and to identify follow-up actions and consequently adapt the process of NBS implementation on-the-go.

4.1 Design principles for co-production

We consider the design framework of co-production of knowledge presented in Frantzeskaki and Kabisch (2016) to be a suitable starting framework that provides a heuristic to design and evaluate knowledge co-production processes. The framework responds to the need for integrating both process as well as output design considerations into the set-up of co-production processes. Along these lines, scholars particularly lament the lack of a systematic framework with metrics to measure the impacts of co-production (Durose et al., 2018; Voorberg et al., 2014). With regard to measure the impact of co-production on social innovation, Voorberg et al. (2014, p. 16) suggest to “separate the process of co-creation from the outcomes”. The design framework by Frantzeskaki and Kabisch (2016) differentiates process principles from input and output principles, which allows to link outputs to process design as well as to measure both legitimacy, effectiveness and salience of process and output.

In summary, the design framework consists of six design principles that provide a heuristic to design settings of knowledge co-production as well as to evaluate co-production processes about their comprehensiveness and fitness to socio-political contexts they are embedded in (Figure 3; Table 3). There are three *process* design principles that identify critical criteria for ensuring the procedural quality of co-production processes in terms of their inclusiveness, openness and legitimacy. In addition, three *output* design principles identify what kind of results are generated throughout co-production processes and how they feed into urban policies, strategic agendas,

Figure 3: Design principles for co-production



The framework was enriched by an extensive literature review on co-production and on organisational barriers and strategies for co-production, as well as the experiences by the Connecting Nature frontrunner cities.

The extensive literature review on co-production with the view on identifying principles and models for process design, and the synthesis from it, adds the following to the co-production principles:

- We extend the framework by introducing one new design principle: we add ‘extending institutions’ as an output principle that captures how the co-produced knowledge relates to multiple planning strategies and agendas, positioning the co-production process as a mediating and orchestrating process across different institutions. As such, co-production extends from knowledge outputs only. A co-production process can also extend institutions as a procedural outcome of connecting to different urban agendas.
- Co-production processes are not yet very common in the urban settings; thus far they are not conceptualized in-depth nor applied in practice. The literature review revealed a richness of cases for common pool resources such as fisheries, forests, water and only the recent years on urban commons like green spaces (urban parks, urban forests and urban waterfronts including lakes and creeks). The majority of the urban research papers refer to terms of collaborative and participatory planning that share similar principles with co-production as we define it but not to the full extent. In addition, most research focuses solely on the planning phase but not on implementation (including financing) and long-term operation and stewarding. In the majority of the literature on participatory and collaborative planning, openness and inclusivity are highlighted as critical conditions. The legitimacy of knowledge is highlighted in research on policy-science interfaces and in research on role of researchers in urban policy, planning and governance specifically in view of the changing roles of scientists (Felt et al., 2016; Adler et al., 2017; Daedlow et al., 2016).
- Co-production models do not exist in the academic literature. Different settings are reported such as



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dialogues, transformative spaces, co-production spaces that have similar formats to workshops and focus groups. It remains for the future transdisciplinary research to devise new formats for co-production that innovate also the operational dimensions of it, and that link co-production settings and activities to different phases of NBS design, implementation, stewarding and scaling.

The co-production of the framework with the cities of Connecting Nature project resulted in the following conceptual additions to the co-production principles:

- By ensuring that openness, legitimacy and inclusivity are safeguarded in a co-production process, we can assess procedural quality of these processes in cities.
- Thinking about and designing co-production processes is about putting all the guiding principles to work together and in synergy with each other. However, the current practice in urban planning and experience rests on how specific principles are safeguarded and considered that often compromise the rest of the principles. Therefore, the design challenge of co-production processes rests in navigating and operating in bridging these principles and understanding the trade-offs between them.
- Institutional relevance and credibility of co-production processes is a critical factor for starting up co-production for the nature-based solution exemplar in the cities. It is therefore important that cities create an enabling context through advocating the actionable and usable (knowledge) outputs of the co-production process in relation to urban priorities and objectives/agendas. Hence, in practice, output credibility may be the starting point of a co-production process and its expected goal as well.

Table 3: Design principles for co-production

Design principles	Quality criteria for design principle	Supporting references
Process design principles		
Inclusivity <i>Bringing together multiple types of knowledge at equal basis</i>	* Tacit knowledge and expert knowledge to be equally appreciated and considered, looking beyond ‘usual suspects’ * Process is attentive to different actors’ needs in terms of their time and availability profiles * Process builds on an open and safe setting that nurtures trust and learning * Systems’ knowledge on feedback loops and processes as well as knowledge on how systems and relations between actors change	Adler et al., 2017; Udovyk and Gilek, 2014; Wyborn, 2015; Vignola et al., 2009; Newton et al., 2012; Spruijt et al., 2014; Fernandez, 2016; Tengo et al., 2017; Shuttenberg and Guth, 2015; Van der Voorn et al., 2015, p.6; Gulsrud et al., 2018; Hysing, 2015, p.30-31
Openness <i>Process is open to new knowledge throughout and openly shares knowledge</i>	* Process is open to new types of knowledge and actors throughout and actively seeks out new types of knowledge * Process is reflexive and adaptive to integrate new types of knowledge and actors * Process (e.g. data, findings, results) are openly shared and disseminated * Process enables collaborative planning culture with open attitude for citizen and private sector participation for public policy and planning issues	Carton and Ache, 2017; Newton et al., 2012; Thompson et al., 2017; Voorberg et al., 2014; Tengo et al., 2017; Udovyk and Gilek, 2014

<p>Legitimacy</p> <p><i>Process includes legitimate and credible knowledge</i></p>	<ul style="list-style-type: none"> * Credibility of sources, researchers and research processes entering the process and generated results are checked as a guarantee that the input and co-produced knowledge can be trusted * Process is facilitated in a just way to give equal voice to diverse actors and knowledges * Participants to have trust on the co-production process and in the initiators of this process 	<p>Dunn et al., 2017; Wesselink et al., 2013; Voorberg et al., 2014; Shuttenberg and Guth, 2015</p>
<p>Output design principles</p>		
<p>Actionable knowledge for policy and planning</p> <p><i>Knowledge co-produced is immediately relevant and translated to policy and planning</i></p>	<ul style="list-style-type: none"> * Knowledge outputs shape new institutions and practices of planning (e.g. engaging citizens/stakeholders) * Co-production allows the enrichment of scientifically derived solutions by practice and their adoption into practice * Institutionalisation and capitalization of co-produced knowledge in practices, routines, and/or policies or plans 	<p>Wyborn, 2015; Newton et al., 2012; Voorberg et al., 2014; Daedlow et al., 2016; Steiner, 2014; Shuttenberg and Guth, 2015; Brink et al., 2018; Yamaki, 2016</p>
<p>Usable knowledge and empowerment</p> <p><i>Knowledge co-produced is valuable to and "owned" by multiple actors, knowledge sparks new role definitions and action</i></p>	<ul style="list-style-type: none"> * Knowledge outputs are contextually relevant and valued to inform real-life problems and solutions * Knowledge outputs trigger new and deeper relationships and a shared (re-)definition of roles and responsibilities * Knowledge outputs become institutionalised and capitalised in practices and routines of societal actors 	<p>Thompson et al., 2017; Daedlow et al., 2016; Shuttenberg and Guth, 2015; Brink et al., 2018; Yamaki, 2016, p.213</p>
<p>Extending institutions for n-synergies</p> <p><i>Knowledge co-produced connects to multiple goals, strategies and agendas</i></p>	<ul style="list-style-type: none"> * Knowledge outputs are mediated to and aligned with wider/other city strategies, programmes and goals (e.g. NBS to food strategy and air pollution/mobility) * Knowledge outputs adapt or stretch the institutional space given for co-production to enable cross-cutting collaboration, learning and integration 	<p>Carton and Ache, 2017; Daedlow et al., 2016; Tengo et al., 2017</p>

4.1.1 Inclusivity: bringing together multiple types of knowledge at equal basis

Co-production of knowledge requires different types of knowledge to be considered, deliberated and eventually weaved together in a dialogue process. Inclusivity refers to a process that brings together different types of knowledge with the aim to complement and enrich each other towards a co-produced outcome.

The key starting position of co-production is to **recognise and involve on an equal basis the different types of knowledge** that exist in and can be brought by different urban actors. Different types of knowledges include, for example, expert knowledge of scientists and consultants, tacit knowledge of policymakers, planners, city ecologists, entrepreneurs and social workers that includes the experience and proficiency needed to apply it in specific contexts, and civic-tacit knowledge from residents. Active and equal-level engagement of actors ensures that contextual knowledge is becoming available, enables the unmasking of resistance to change dynamics and drivers as well as possible leverage points for system change. It is therefore essential for inclusivity in a process to recognise the different types of knowledge that exist in and can be brought by different urban actors. Writings from participatory governance originating from Integrated Water Management research and practice make strong arguments and a valid case for the importance of inclusion of tacit knowledge in policy and planning. Recent research on co-production supports this and extends to various types of tacit knowledge as well. Fernández (2016, p. 173) defines that tacit knowledge is “encompassed by a view of expertise that includes not only technical information, but also the experience and proficiency needed to apply it under specific contexts, being aware of uncertainties, risks, and knowledge gaps”. Carton and Ache (2017, p. 237) further support that co-production through engagement of experts and citizens in urban projects enables democratisation of knowledge and it can



“impact professional research and planning”. This means that expert knowledge did not get distinguished nor compartmentalized from tacit, or, experiential knowledge other actors bring in the co-production process.

Another important type of knowledge relates to **knowledge about specific opportunities and impacts on (radical change towards) sustainability**, such as knowledge on values and interests at stake, how to alter systems and account for these values and how relationships between actors and institutions (need to) change. Next to the different sources of knowledge that relate to whose values are at stake and to actor-specific tacit or expert knowledge, it is important to consider different forms of knowledge relating to the impact in sustainability transitions. Adler et al. (2017) mention that next to systems’ knowledge and knowledge on values and interests at stake, it is important to consider ‘transformation knowledge’ on how to alter systems and “to account for these values”. We further add to this that transformation knowledge needs to consider knowledge on how different relations between actors change so as to gain insights on how respective institutions need to change (Hölscher et al., 2018a; Wittmayer, 2016).

Ensuring inclusivity of different forms of knowledge is a way **to design and facilitate a just process**, in terms of equally appreciating and acknowledging different actors based on their information/knowledge inputs. This principle is acknowledged in research on urban justice especially in United States scholarship. For example, Shrestha et al. (2014, p.5) argue that a genuinely inclusive process in the climate-constrained urban world requires more informed deliberation between urban development professionals and disadvantaged communities. This further implies rethinking the way in which urban expertise is organized – making it more collaborative with the people who are suffering diverse forms of social exclusion and ensuring that it is grounded in their lived reality”. Facilitating just co-production processes requires attentiveness to different actors’ time restrictions and availability profiles. Genuinely inclusive processes move beyond inviting the usual suspects and resourceful actors. For example, in light of the unequally distributed burden of climate change impacts on urban populations, disadvantaged communities need an explicit and strong voice in urban adaptation planning. Particularly the process format considerably influences whether or not actors can be reached to participate in co-production processes (Hölscher et al., 2017).

Inclusivity requires **open and safe process settings that build trust and nurture a learning-oriented attitude** for candid knowledge exchange and integration. Inclusivity is not just a matter of being inviting but having the ability to co-produce. This means that all activities need to be designed with accessibility and diverse ways of communicating, listening and learning. For knowledge exchange and integration to be productive and constructive, process settings need to allow open exchange based on trust and shared language (Hölscher et al., 2017). Participants need to be encouraged to leave their pre-conceptions and potential prejudices behind. Especially experts have to be made aware of their often abstract language and concepts that are not easily accessible to laymen. This requires openness and a learning-oriented attitude, for example from researchers to collaborate and connect with other actors in communicating their science to diverse audiences (Armitage et al., 2015). Next to this, skilled guiding discussions and brokering different contents are critical requirements for inclusivity. Along these lines, Maiello et al. (2011, p. 1167) argue that “transdisciplinarity requires appropriate organisational skills that can guide the discussions and broker different contents in order to produce new knowledge, embodying citizens experience, scientists insights and policy makers awareness of public need”. Such facilitation and brokering roles can be taken up by anybody – experiences from cities suggest that city offers and planners, as well as scientists often take them up. Ernst et al. (2017) point at the changing roles of researchers in co-production processes, specifically examining the dynamics when researchers take mediating roles in multi-actor participation/engagement processes, proposing a new role of researchers as ‘epistemediators’.

When the city government is implementing co-production processes, the **organisational role for inclusivity is to ensure that the principles of inclusivity are kept**. As co-production differs from established ways of working, the city government – or the employees that implement co-production – has to deal with changing the organisations way of operating, for example by establishing new alliances, ensuring the needed skills are available, changing the roles of its employees. In order to do so, leaders are essential, as their role is to support, motivate and empower the employees and organisational structures that offer space for collaborative work and innovation (Stenmark et al., 2011). Thus, leadership may be a good way to ensure not only that co-creation happens in a healthy manner for the employees and organisation, but also to ensure that inclusivity principle is protected. Another point of view is based on the individual, dispositional characteristics of leaders related to successful coping with organisational change. When leaders have a positive self-concept (individual's perception that he or she possesses the skills necessary to execute the required response set to ensure a desired outcome, that the consequences of such efforts are within the person's control, the individual believes himself to be capable, significant, successful, and worthy and have a tendency to experience positive emotional states) and tolerance toward risk (have the ability to deal with uncertainty, novel situations, and risk) they perceive themselves as

Establishing an inclusive approach requires also that both **employees and institutions reframe their perceptions**. First, the mind-sets about partnership and roles must change in order that all the participants begin to think in fundamentally new ways. Here, a shift from a ‘narrative of constraint’ (which focuses on obstacles and limitations), to a ‘narrative of growth’ (which expects challenges in the learning process) is recommended in order to enable new practices and visions (O’Meara et al., 2008). Once the mind-sets about partnership begin to change, some practices can be of use: starting small, making clear that entry into co-creation is voluntary, ensuring that collaboration is meaningful and not just an (other) empty promise, regularly questioning motivations and practices (Cook-Sather et al., 2014), and making use of technologies to support co-creation (Moore and Gilmartin, 2010). Also, one of the key identified in effectively co-creating new knowledge is good communication: clearly articulating what co-creation means and requires as well as outlining the broader benefits and complexities involved (Bovill et al., 2016).

4.1.2 Openness: opening to new knowledge and actors throughout and sharing knowledge

Co-production processes evolve over long periods of time, during which new knowledge insights, demands and needs emerge and new actors may enter the horizon bringing additional knowledge. It is therefore important for a co-production process to be open to new actors and new knowledge that they bring. At the same time, in order to make sure that relevant knowledge is as much included as possible and that results become meaningful to policy, planning and the wider public, openness also extends to the far-reaching communication and sharing of the produced knowledge. It implies open sharing of data and findings throughout the process not only between the co-producers of knowledge but also to newcomers in the process. In this sense, openness conditions inclusivity: for ensuring that different types of actors and knowledge are included, openness to diversity of actors and their opinions is needed.

For openness to be ensured, it is important for facilitators and organisers of the process to have an **open attitude for citizen and private sector participation** for public policy and planning issues combined with **reflective and collaborative planning culture** to flexibly respond to new insights, demands and needs. Co-production processes need to embrace that knowledge will always remain arbitrary to some degree and that flexibility is needed to respond to new insights, demands and needs (Wyborn, 2015). At the same time, since “knowledge is contested” (Hysing, 2015, p. 30), “more public and broader involvement and deliberation” between multiple actors can ensure that planning can cope with the uncertainty and complexity of proposed solutions due to the multiple types of knowledge contributing to it. This challenges existing ways of working, which tend to start from more or less fixed problem definitions and solution ideas. It requires giving explicit time and space for continuously reflecting on the progress, whether different types of knowledge is needed or emerging and whether adaptations are needed.

Openness needs to be actively enabled and nurtured by **open sharing of data and findings** not only between the co-producers of knowledge but also to outsiders and newcomers in the process. During a process there are different levels in the openness of the data and findings, ranging from the initiators of the process (including the organising team), to the participants (people who were involved in one or more meetings), other stakeholders (people or organisations that will be affected by the outcomes of the process), and finally the public (everyone). Widely communicating and sharing the results of co-production ensures that the results are given back to the participating actors and it can mobilise new actors and knowledge. Data and findings can be shared in multiple ways, for example via social media channels, public dissemination events or informal cross-departmental meetings within city departments.

4.1.3 Legitimacy: including legitimate and trustworthy knowledge

Co-production of knowledge requires that the knowledge that enters in the process to be legitimate and trustworthy. Legitimacy relates to both the type of knowledge entering the co-production process, and whether it is credible and can be trusted, as well as the mode of engagement to ensure that knowledge is accepted on an equal basis and that it is not pushed for certain interests: According to Reinecke (2015, p. 515) “knowledge is seen as legitimate if different values are respected in a fair and unbiased knowledge production process”. Legitimacy can be assessed by the source of knowledge, the credibility of its generation and the fairness in how it is brought into the co-production process.



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Legitimacy implies **input and procedural quality are ensured** and in result, requires different assessment methods for checking legitimacy of knowledge. With diverse sources of knowledge being included, it is important to uphold quality criteria that render the knowledge legitimate and ultimately enhance the transfer and uptake of results in society and policy. As a result, legitimate co-production requires different assessment methods for checking legitimacy of knowledge – for example by conducting source-checks and critically assessing underlying interests. There is a risk that unchecked knowledge fundamentally hinders the co-production of problem framings and solutions and divert the process from productive exchange – think of contemporary “Fake News” debates that undermine open and honest societal discourses.

Likewise, the co-production process and outcomes need to be **rigorously designed and assessed** to ensure legitimacy of process and results. In co-production processes, diverse actors are involved with different opinions, interests and power sources. Legitimacy warrants respecting different, perhaps divergent or contradictory values in a fair and unbiased process. This requires facilitation of co-production to pay attention that everybody has an equal voice in co-production discussions and feels safe to voice their opinion. When contextual knowledge becomes available, it improves the quality of engagement and may lead to “stakeholder learning and collective support for the outcomes, which in turn increases their legitimacy” (van der Voorn et al., 2015, p. 6).

Legitimacy of knowledge inputs in a co-production process and legitimacy of the co-produced knowledge-based outcomes also implies a **new role of research and researchers**. The expected and conventional role of research in co-production processes is to ensure “transparency of the assessment with respect to the “state of the art” in the related scientific fields” (Wiek and Binder, 2005, p. 593). The shifting role of researchers from sole knowledge producers to co-producers entails the responsibility of systematisation of the co-produced knowledge and to provide conclusions about how to manage and cope with knowledge that does not adhere to scientific quality standards. Udovyk and Gilek (2014, p. 17), assert that there is a “new role of science from providing conclusions and truth to providing evidence and indicators to manage and cope with imperfect knowledge”.

4.1.4 Actionable knowledge for policy and planning

Co-production processes are geared into producing actionable knowledge-based outputs that are immediately relevant for policy and planning agendas and goals. The outputs are a direct result of the actions taken through the process and depend on the objectives set for the process, such as the development of a management plan, or a better informed and more articulated community. Outcomes are the consequences of the outputs and the process (Burgess and Clark, 2009, p. 164). Co-production processes are often linked to on-going strategic processes and seek to complement planning and decision-making processes. They complement planning and decision-making processes because, in co-production processes, “policy makers to become more intelligent customers, better able to define questions to science and reflect uncertainties appropriately in policy formulation” (Holmes and Clark, 2006, p. 704). Therefore, a primary objective of knowledge co-production is to yield knowledge-based outputs that inform existing policy strategies and agendas, enrich solutions and planning actions, and shape new planning practices – also in terms of new practices in engaging citizens/stakeholders.

Knowledge-based become actionable when they are **actively linked to existing strategies, goals and processes** and reach the ‘relevant’ actors. By ensuring that the co-produced knowledge and other co-produced outputs are immediately relevant for policy and planning agendas and goals, it further institutionalises both the co-production process and the co-produced knowledge and their strategic importance is safeguarded (Tengö et al., 2017). In addition, it is important for the involved and non-involved actors in co-production processes to be able to trace/see how the co-produced knowledge informed solutions and also became actionable in terms of being institutionalised in practices, routines, policies or plans.

Actionable knowledge requires **organisational structures and cultures for collaboration and knowledge transfer** to both enable co-production processes (especially within city governments) and to help outputs inform governance, policies and procedures. Actionable knowledge is conditioned by the organisational context in which it is co-produced: Given the fact that actionable outputs have at their core knowledge transfer from multiple actors and fostering and including this new type of knowledge into governance, policies and procedures, collaboration at intra-organisational, inter-organisational networks and system levels becomes a key factor for successful innovation processes and outcomes (Marasco et al., 2018). This happens across the organisations’ boundaries through the sharing of ideas, knowledge, expertise and opportunities (Ketchen et al., 2007), engaging a broad spectrum of external parties (e.g. customers, suppliers, competitors, universities and research institutes) and covering a range of collaboration forms and approaches in relation to an interactive, distributed and open nature of innovation, including alliances, partnerships, networks and cooperative agreements (Feranita et al., 2017).



There are several opportunities and barriers for **creating an organisational context within city governments that is conducive to co-production and taking up actionable knowledge**. Generally speaking, to ensure good collaboration between institutions and communities of knowledge, dis-/satisfaction with the outcome, perceived fairness (when employees feel treated fair by their organisation), and sense of community are along co-production experience major determinants for negative as well as positive reactions of innovation community members (Gebauer et al., 2013). Key barriers for intra-organisational and inter-departmental collaboration are a lack of trust, unclear roles and responsibilities and insufficient time (Albers et al., 2016). Consequently, if the responsibilities, roles and tasks are clearly defined, if work processes are precise and clear, if the tasks among the employees and among divisions or departments are well coordinated, and if feedback is offered on a regular basis and expected results that have been achieved are regularly talked about, role conflicts and ambiguity can be averted, and subsequently, trust can be built. Another barrier identified for developing interdepartmental relationships and collaboration is work overload, resulting in less interest to engage in new tasks, projects or relationships. The employees, if they feel they already have too much work to do and too little time for their current tasks, become less interested to engage in new tasks or projects that come along their way, and they are less interested to develop new (interdepartmental) relationships, show less initiative and creativity. There are multiple ways of avoiding a high workload within the organisation, including involving employees in defining their own workloads and setting up strategies for cutting down on interruptions (Nielsen and Randall, 2009; Schermerhorn et al., 2003). Social support, as help in resolving problems encountered while doing the assigned tasks, is important for a strong organisational culture and also helps to reduce stress, role conflicts and employee turnover (Wu and Parker, 2017; Viswesvaran et al., 1999). Support can be promoted within the organisation through sharing success and risks, involving others in decision making, explaining the importance of colleagues, focusing on intra-team and inter-team relationships, and talk openly in team meetings about problems and seeking advice from colleagues. Because sharing, fostering and translating knowledge involves creativity, use of skills and independent decision-making, autonomy and participation in decision making become essential resources and drivers for co-production (Cabrera, Collins and Salgado, 2006; Hammond et al., 2011). Autonomy can be promoted through sharing information and clear definitions of roles and responsibilities between colleagues, a clear definition of the zone of autonomy and supporting the employees to decide on their own, encouragement (from management) to explore possible avenues to a solution, and consultation processes held in a clear and adequate manner (MacNaughton et al., 2013).

Because co-production practices will evolve as structures and norms change at an institution, **flexibility is an essential organisational driver for co-production** (Bovill et al., 2016). Looking at the city government as an organisation in its integrality, an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights is an organisation more conducive for co-production and for transferring the outside knowledge into new procedures and policies. This type of organisation is referred to as “learning organisation”, skilled in five main activities: systematic problem solving, experimentation with new approaches, learning from their own experience and past history, learning from the experiences and best practices of others, and transferring knowledge quickly and efficiently throughout the organisation (Garvin, 1993). Research shows that organisational structures more supportive for collaboration and co-creation are those more complex (Damanpour and Schneider, 2006), in which its members are invited to participate in the decision processes related to their work (decentralised structure), and in which not all organisational activities are manifested in written documents regarding procedures, job descriptions, regulations and policy manuals (low formalisation) (Cohendet and Simon, 2007; Jung et al., 2008). The centralised organisations tend to be less responsive to environmental demands, as their mid-level managers and operators are less autonomous and flexible in their interactions (Moon, 1999). Also, a high formalisation tends to cause administrative delay and poor communication and to hinder the process of adaptation and learning (Hage and Aiken, 1970). The size of the organisation (larger organisations are more efficient in knowledge transfer) and the absorptive capacity (ability to recognise, assimilate and apply new external knowledge) are also two consistent facilitators for organisational knowledge transfer (Van Wijk et al., 2008).

4.1.5 Usable knowledge and empowerment for societal engagement and uptake

Co-production processes generate meaningful knowledge outputs that are valuable to multiple societal actors and that empower them to take action based on this knowledge. Participating in co-production processes prompts social learning processes, by which multiple actors exchange and enrich their perspectives, develop new relationships to one another and learn about concrete ways of how to apply their new knowledge:

“Social learning emphasizes social interactions and the sharing of knowledge between stakeholders (both people and organisations) through learning-by-doing about the issues under discussion and can empower participants by co-generating knowledge and increasing the participants’ capacity to use this knowledge.



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It also has the possibility of transforming relationships through the development of new relationships, changing stakeholders' perceptions of each other's views, transforming adversarial relationships, and enabling participants to identify new ways of working together" (Yamaki, 2016, p.213).

For example, co-production may help infrastructuring communities with skills, knowledge and tools to self-govern and organise, which offer opportunities for enhancing local, place-and community-based resilience and adaptive capacity as well as motivating utilisation and stewarding of NBS in the long-term. In this sense, co-production also becomes an empowerment process that promotes a culture of shared responsibilities for implementing collaborative actions and solving collective problems by promoting a (re-)definition of roles and responsibilities and a sense of intrinsic motivation to act based on shared ownership over the NBS (Hölscher et al., 2017). Co-production is therefore a process instrument to reach new outcomes for place-making by institutionalising and capitalising co-produced knowledge in practices and routines of society at large.

Generating meaningful knowledge and empowerment **open and constructive process settings** that nurture social learning, appreciate diverse ideas, opinions and roles and motivate actors to co-define roles and responsibilities. In this sense, perceived fairness and sense of community are major determinants for how outcomes and results of co-production processes are taken up. Co-production is crucially different from conventional participation processes that often merely ask community actors to provide input. Co-production builds on collaborative social learning, which emphasises social interactions and the sharing of knowledge and experienced realities between multiple actors through learning-by-doing and doing-by-learning about the issues under discussion. Interim benefits for societal participants need to be discussed and continuously evaluated (Brink et al., 2018, p.779). The creation of open process settings that build on trust, mutual understanding and equal participation require new skills and mind-sets so that participants' are prompted to move beyond their usual expectations and roles and enter into co-productive relationships. It is also important to integrate the communities' feedback (creative contribution) when taking decisions. In other words, the active engagement of the community members in the decision-making process is equally important for co-creation (Gebauer et al., 2013).

It is also important that in the design of the co-production process **communication strategies** are employed, including active communication tools like visiting the exemplar sites, marketing of the exemplar and also marketing of the co-production process through city's media channels, presentation of the co-production process and of the exemplar to the conferences, round table discussions (European Commission, 2012, p. 50) as well as active translation of outputs to different agendas by having concerted workshops/seminars/roundtables/meetings with civil society and business actors. New formats of conferences and seminars have also seen valuable in making the co-produced knowledge relevant and hence usable to different stakeholders (Frantzeskaki and Rok, 2018). For example, for achieving wide implementation of co-produced strategies and outputs, the European Commission emphasises the need to stimulate the participation of diverse actors through conferences because all stakeholders in a city or region are supposed to adhere to the strategy. In the context of NBS, conferences and seminars can be 'check points' or process-adaptation points for the social and business relevance of the outputs as well as for communicating more broadly the value of the process and of the exemplar in the cities and their regions.

Another important aspect to consider is **how intermediaries can facilitate in making co-produced knowledge usable**. One way beyond their participation/engagement in the co-production process is to allow them to expand the institutional space by mechanisms of support, lobbying and knowledge transfer to broader networks (Matschoss and Heiskanen, 2017). Intermediaries as "actors and institutions who enable exchange of knowledge, skill development and perform connecting and mediating functions to support an innovation" (Bush et al., 2017, p.138) can be NGOs, university researchers or even city networks (like ICLEI, C40).

4.1.6 Extending Institutions: for n-synergies: connecting knowledge to multiple goals, strategies and agendas

Co-production processes may operate in the margins of institutions and by producing new knowledge actionable and usable for them, they 'stretch' institutional boundaries. As complex societal problems cannot be addressed through siloed approaches but require the active search for synergies in terms of how different problems relate to one another and how addressing one problem might reproduce another. Multifunctional solutions like NBS offer the potential to address multiple policy priorities and goals simultaneously, such as biodiversity, climate adaptation, health, air pollution and recreation. Co-production in this sense can be positioned as a mediating process across multiple different institutions, which both requires and prompts the creation of space for new



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discussions that bring multiple topics, goals and problem perceptions together. For example, a co-production process on NBS can end up to also include discussions on food, mobility and air quality in the city. This guiding principle is hence about the process of embedding the actionable knowledge in urban planning and policy.

Extending institutions as an output design and quality guiding principle is formulated from the co-production process between researchers and city officers of the Connecting Nature project. During the workshops in the cities of Glasgow, Poznań and Genk we identified three overarching policy needs (see section 3.2): the need for coordination across urban projects, urban agendas, and disconnected knowledge in the city and in the social sphere. Co-production processes can mediate and coordinate by weaving different knowledge and co-producing outcomes that link otherwise siloed departments and disconnected urban agendas. Recent literature on co-production has a blind spot on this institutional output of a co-production process. Even writings on policy integration theorise on the importance of institutional coordination and integration but neglect the procedural aspect of achieving such integration.

Extending institutions necessitates coordination across urban projects and urban agendas through **mediation of traditionally disconnected knowledge** in the city and social sphere. The extent to which a co-production process is able to extend existing institutions depends on the institutional space in which the co-production process happens. Co-production processes contribute to this by bringing in and weaving different knowledges that link otherwise siloed departments and disconnected urban agendas. Intermediaries can contribute to linking co-produced knowledge to multiple institutions, for example by lobbying and transferring knowledge to their broader networks. Research programs with co-production as the mode of scientific inquiry operate as intermediaries across actors and governance levels, allowing for co-production processes to mediate different urban agendas, different forms of tacit knowledge and overall connect disconnected or disaggregated policy expertise within cities.

Extending institutions through co-production processes and the co-produced knowledge outputs requires **aligning multiple strategic goals and agendas**. Institutional and organisational rigidities, lack of clear mandates, disconnected funding streams and conflicting political priorities are key barriers to integrated solutions. Long-term and systemic visions provide a shared orientation for aligning priorities, motivating actors and designing co-beneficial solutions like NBS while taking the interests of multiple, including most vulnerable actors into account. While co-production offers opportunities for co-defining and thus aligning integrated and long-term strategic goals and agendas, these need to be linked to other strategic levels of goal formulation – such as on long-term urban development programmes, urban food strategies etc.

The city government's **organisational culture, including amount of trust and risk-taking ability, leadership, social relationships and communication** determine the transfer of knowledge across sectors and departments (Chen et al., 2006). Dynamic environments require organic, flexible alliance organisational structural arrangements. Because inter-organisational knowledge transfer is complex and a lot of factors are influencing it, the transfer process has to be managed effectively in order for it to be successful (Al-Jabri and Al-Busaidi, 2018).

4.2 Co-production tools and methods

A co-production process typically consists of a sequence of activities to find solutions to a specific challenge (which may be re-defined throughout). Tools and methods are highly diverse, and depend on the goals of the co-production process, and a specific co-production activity or step (for example the framing of a problem), as well as the specific types of actors involved. For example, visioning exercises serve to generate inspiring future images and ideas; they are particularly useful at the beginning of a longer co-production journey to align diverse actors and to create long-term, systemic and normative aspirations that guide the development of concrete innovative solutions like NBS.

There is a plethora of co-production tools and methods out there. We introduce and illustrate examples of tools and methods that have proven to facilitate co-production processes. The examples are gathered from several projects that are related to new and innovative methods that we have identified to be relevant for co-production: the European projects SIC¹ (Social Innovation Community) and MUSIC² (Mitigation in Urban Context: Solutions for

¹ <https://www.siceurope.eu/>, and for the tools: <https://www.silearning.eu/tools/>

² <https://drift.eur.nl/projects/music/>, the tools are in the guidance manual, see Roorda et al. 2014: https://drift.eur.nl/wp-content/uploads/2016/11/DRIFT-Transition_management_in_the_urban_context-guidance_manual.pdf



Innovative Cities, see Roorda et al. 2014). Besides, we would like to refer to two additional sources for tools and methods specifically: Nesta³ (an UK-based foundation on innovation, see Bound and Mulgan 2019) and Frog⁴ (a design company from San Francisco).

4.2.1 Exploring local dynamics to deepening understanding of the context and challenge

Rather than starting from pre-defined problem definitions and solution approaches, tools and methods to examine local dynamics suggest a stepping back to first systematically question assumptions, problem perceptions and dominant solutions (Roorda et al., 2014). As they encourage holistic perspectives, the tools and methods help to account for the complexity of the world we live in – insofar as possible. They shift the focus from superficial solutions to systemic challenges and opportunities, by revealing root causes of problems. Applying these tools and methods in a co-productive way enriches the perspectives on problems and solutions and provides a useful starting point for collaborative processes by generating encouraging participants to look beyond their own expertise, question their beliefs and values, making perceptions explicit and developing shared understandings.

Table 4: Methods and tools to explore local dynamics

Methods and tools	What is it (for)?	How to use it?
System analysis (Roorda et al., 2014)	The system analysis is an in-depth description and visual representation of the system behind a problem or solution. It allows to take on a systemic view and see connections between the different factors, dynamics and actors that might otherwise not have been perceived. It also maps out the flow of materials, energy, information and money throughout the system. This allows to understand where possible opportunities might lie to increase value, efficiency and/or efficacy.	The system analysis consists of 4 steps: (1) Delineate the system in space, time and themes (e.g. CO2 emissions from energy use and mobility in the city, looking at the past 40 years) (2) Using post-it notes, jot down the main social, environmental and economic elements of the system in question (e.g. labour force, air quality, housing); (3) Create arrow types for the different material, energy, information and money flows throughout the system; (4) Describe the system elements flows and identify key dynamics, problems and opportunities. The analysis can be visualised by drawing a system map.
Checking your challenge https://www.silearning.eu/tools-archive/checking-your-challenge/	Taking a step back and analysing the problem in-depth is the first step towards an effective solution to that problem. What first might seem be the obvious problem, is often connected to underlying factors and larger problems. Seeing the context of the problem helps to rethink the problem and make it more specific.	It is preferred to use the tool in groups, but it can also be done individually. When done in groups, try to include people that have knowledge from the problem in the specific local context. Also including people with different backgrounds and expertise helps to enrich the problem definition. The questions in the sheet help to start the conversation and thinking, start with the 'Daring' section and work clockwise.
Thinking hats https://www.silearning.eu/tools-archive/thinking-hats/	In Thinking Hats a problem or topic is viewed from six different angles. By wearing one of the hats, you are forced to think and discuss in a structured and different way about the problem. The six roles are: factual, emotional, logical, cautious, out of the box and management.	The tool can be done in two different ways: either everyone wears the same hat and discusses from the same point of view, or each person in the group wears a different hat and there is discussion from different angles at the same time. In the last case, use real hats or markers that show from which angle you are talking.

³ Bound and Mulgan (2019), tools are in the compendium: <https://www.nesta.org.uk/report/compendium-innovation-methods/>

⁴ The collective action toolkit for social impact: <https://www.frogdesign.com/work/frog-collective-action-toolkit>

4.2.2 Mapping actors and networks to explore the actor landscape and identify collaborators

Mapping actors and networks helps to become more aware of the actor landscape in the city and concerning a specific challenge or area (Roorda et al., 2014). Tools to map actors and networks can be useful at the beginning of co-production processes to identify potential participants and in particular to unveil actors who are not usually thought of, as well as to identify otherwise invisible actors such as associations, citizen groups and businesses that are already active in making their surroundings more sustainable. Applied in a co-productive way they help to map determine actor-specific needs, skills and resources and thus facilitate the search for solutions and definition of roles and responsibilities in a collaborative way.

Table 5: Methods and tools to explore the actor landscape and identify collaborators

Methods and tools	What is it (for)?	How to use it?
Actor mapping (cf. Roorda et al., 2014)	Identification of key actors and actor groups, their relationships, interest coalitions in a specific action area. Can also help to identify potential collaborators or workshop participants.	Systematic screening and identification of actors in a particular action area, including description of e.g. relationships, activities and interests. Analyse the actors by mapping them closer or further away from the centre. The closer actors are positioned to the centre point the stronger is their influence or value.
Who inspires us https://www.silearning.eu/tools-archive/who-inspires-us/	Who inspires us helps to see which people you as a team could approach for help on solving a problem, ask for more information on a topic or just inspire you during a process. It maps connections, but also potential beneficiaries to your project.	The tool template consists of five different steps which help to identify people in relatively a short time. Teams are asked to write down names of persons that might help to solve a problem, after which teams share these and lastly try to find commonalities.
Skill share https://www.silearning.eu/tools-archive/skill-share/	“Skill share” is a great tool to determine internal capacities for innovating and skills the participants have or may need to achieve their goal. This tool is also great for detecting personal values, motivational triggers and roles of each team member and developing mutual understanding and respect.	Tool template consists of detailed instructions for executing this activity. Follow the instructions for achieving maximum results.

4.2.3 Visioning and strategizing for sustainable futures and solution pathways

Visioning and strategizing tools and methods focus on the exchange of perspectives on possible futures and the creation of a shared future perspective (Roorda et al. 2014; Wiek and Iwaniec 2014). Although it is easy to talk about a sustainable urban future, it is hard to imagine what this actually means and how pathways towards that future could look like. These tools and methods help to encourage participants to think in new and creative ways and to draw up visionary images that provide guiding ideas and a storyline for the future. Long-term perspectives are anchor points for short-term NBS interventions and help to link them to broader agendas and goals as well as to strategically plan NBS implementations and how to go about them in a co-productive way. The generated future narratives, ideas and images can also be used to communicate with a broader audience.

Table 6: Methods and tools to envision and strategize for sustainable futures and solution pathways

Methods and tools	What is it (for)?	How to use it?
Visioning	Developing of images and stories about a desired future in the long-term (e.g.,	Envisioning follows four steps: 1) Collecting multiple ideas for the future of

<p>(Roorda et al., 2014)</p>	<p>“where would we want to be in 2050?”) that guide and motivate mid- and short-term action.</p>	<p>the city (option to use inputs such as presentations, movies, collages); 2) Formulating guiding sustainability principles by reflecting on ideas for the future (e.g. “local companies deliver societal return to the city and its citizens”); 3) Creating visionary images to enrich principles (e.g. “what does closing material loops mean for our city?”); 4) Elaborating and reflecting on the vision (e.g. “Is this a future we want to attain?”, “Who would (not) profit from this development?”) and discussing synergies between the ideas.</p>
<p>Brainstorm web https://www.silearning.eu/tools-archive/brainstorm-web/</p>	<p>Brainstorm web is a tool that helps to have a good brainstorm in a group. It can be used for a more in-depth problem definition, but also to gather ideas on visions and solutions. The main challenge is to trigger a certain ‘fast thinking’ in which ideas are generated in a non-judgemental way as it is about quantity, and not quality.</p>	<p>Brainstorm web is a group process that can facilitate many topics. Some basic rules do apply, for example to be open for all ideas and to avoid “but...”. See for more rules the reference link. Moreover, it can be helpful to first start brainstorming individually in silence, before sharing and brainstorming in the group.</p>
<p>Backcasting (Roorda et al., 2014)</p>	<p>Backcasting is best applied after a joint visioning exercise. It serves to develop several transition pathways, each describing a possible route from the present towards the envisioned future, for example “from an oil-dependent economy to a diverse economy with a diversity of employment”. The pathways are neither fixed plans nor detailed scenarios, but inspiring storylines that include goals and action ideas for the short-, mid- and long-term. They provide insights into what is needed to reach the envisioned future.</p>	<p>The first step in the backcasting meetings is to identify a range of transition pathways by asking the participants to formulate fundamental changes in a “from (the present) – to (the vision)” format (e.g. “from centralised to decentralised energy production”) and clustering these. The pathways (or a selection thereof) can be further elaborated within the group or subgroups – typical questions for the elaboration of pathways are: What changes were needed to bring about the vision? What were milestones starting from 2050 (e.g. in 2030, 2018, ...)? What corresponding interventions and actions were needed? Which actors were important for reaching these milestones?</p>

4.2.4 Ideating and prototyping solutions

Tools and methods for ideating and prototyping serve to identify concrete and innovative solutions like concrete NBS interventions in an open-ended way. These tools and methods can be applied after the co-production of a shared vision and transition pathways (see tools for visioning and strategizing) (Roorda et al., 2014). In this way, short-term actions can be identified in line with the transition pathways, which supports the generation of innovative and systemic solutions that are oriented towards delivering benefits in the long-term and in relation to multiple goals. Transition experiments – also iconic projects or breakthrough actions – are solutions or initiatives to explore and learn about the shifts required to deliver the change required for achieving a long-term sustainability vision. What differentiates these from other innovation projects is that they take societal challenges rather than specific innovation (i.e. a solution) as a starting point.

Table 7: Methods and tools for ideation and prototyping solutions

Methods and tools	What is it (for)?	How to use it?
Idea card	The Idea Card helps to organise and communicate or present ideas. It is	The tool consists of several questions: first it asks to frame the underlying challenge,

<p>https://www.silearning.eu/tools-archive/idea-card/</p>	<p>especially helpful in a stage after ideas are generated in for example a brainstorm.</p>	<p>after which the desired future, the idea and the working of the idea are filled in. Answering these questions can be done both individually and in groups.</p>
<p>Pitch desk https://www.silearning.eu/tools-archive/pitch-deck/</p>	<p>Pitch Desk challenges you to frame your solution in an in-depth way. It is aimed at presenting your idea to others, like investors, but can also be used to work out an idea in detail.</p>	<p>The pitch desk identifies 10 steps that together give a holistic overview of a project. It is designed in order to be communicated to potential investors, but can be used for other presentations or just internally. It includes a.o. the identification of (market) gaps, sustainability and funding.</p>
<p>Usability testing https://www.silearning.eu/tools-archive/usability-testing/</p>	<p>This tool helps to test the initiative/service/product in their natural settings and with potential users/the target audience. If this is not possible, usability testing can be conducted in a more “laboratory” setting. The aim is to see whether the idea works and whether it should be adjusted.</p>	<p>First the target audience is identified, which should comprise at least one representative of each user group. These representatives become the ‘evaluators’. The testing consists of three phases: 1) The Briefing Session in which the evaluators are told what to do. 2) In the Evaluation Period the evaluators inspect on their own the product/service at least two times. In the second round they comment on the product/service in relation to specific evaluation tasks/surveys. 3) In the Debriefing Session evaluators come together as a group to discuss their findings and brainstorm ways to fix any problems.</p>

4.2.5 Building team spirit and collaboration

Successful co-production rests on the built-up of team spirit and collaboration by diverse actors to pool their skills, knowledge and resources and engage in joint idea generation and implementation. Tools and methods for building team spirit and collaboration underpin how participants of a co-production process enter joint learning processes, build mutual trust, (re-)define their roles and develop new relations to one another. By providing shared experiences, they also facilitate long-term collaboration of actors by changing perceptions of one another and growing new networks and ties.

Table 8: Methods and tools for building team spirit and collaboration

Methods and tools	What is it (for)?	How to use it?
<p>Team Canvas https://www.silearning.eu/tools-archive/team-canvas/</p>	<p>Team Canvas helps to align teams and achieve cohesion among team values, goals and performances. It can be used when forming a team, adding a new team member to the group, clarifying goals, addressing overall team achievements etc. It summarises all the elements needed for a team to get the overview of group abilities.</p>	<p>The tool consists of 9 different sections, ranging from people&roles, to values or strengths. Take about 15 minutes for each section, which can be filled in individually or as a group. For a good team alignment, the team should at least agree on sections 1, 2, 4, 5 and 9. For these sections, some more time might be needed for discussion.</p>
<p>Conservation theatre (Heras and Tabara, 2017)</p>	<p>Conservation theatre is a participatory form of theatre, in which all participants play the protagonists in their own theatre play. It provides a shared and emotional experiences that enhances creativity, compassion, imagination and trust. It then</p>	<p>Conservation theatre experiences encourage community stakeholders to create their own theatrical plays. For instance, applied for community monitoring in Mexico, by developing theatrical pieces using local cultural</p>



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	<p>becomes a means of collective inquiry and discussion to help people identify and frame their most pressing concerns in their own terms, as well as how they could be addressed.</p>	<p>expressions, villagers could express their own opinions and share concerns about the work of the Forestry Department. Their feedback was then used to improve the management program of local forest resources.</p>
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4.2.6 Mobilising actors and networks

Co-production processes can gain more visibility, support and traction when they are actively reaching out to new actors to engage and inform about the generated knowledge (Roorda et al., 2014; Hölscher, 2018). Tools and methods to mobilise actors and networks are diverse, for example an open call to generate a vast amount of ideas at the beginning of co-production processes, organising network events and publicity for informing, engaging and motivating wider audiences. Engaging more and more actors can lead to a critical mass for ‘mainstreaming’ sustainability. The goal is to have a lasting impact by engaging with different actors in other fields and networks.

Table 9: Methods and tools to mobilise actors and networks

Methods and tools	What is it (for)?	How to use it?
<p>Social innovation competition</p> <p>https://www.silearning.eu/tools-archive/social-innovation-competition-outline/</p>	<p>An innovation competition asks a wide range of people to submit their ideas for innovative products, services, project, initiatives, and strategies for specific social challenges. The purpose is to identify and inspire potential innovators to come out with their ideas. Participants can include individuals, freelancers, NGOs, micro-companies... – all who aspire to further develop their idea, receive some feedback and become a part of a team with needed, complementary skills.</p>	<p>This tool consists of a series of steps that will help you design your challenge, invite the right target groups, select judges, promote and organise the event and prepare criteria for the selection of best ideas. Use this template as a brainstorming tool to list your steps in the process. Think about how to accomplish every step on the roadmap and review it several times during the organising process.</p>
<p>Social media campaign</p> <p>https://www.silearning.eu/tools-archive/designing-a-social-media-campaign/</p>	<p>The tool consists of a checklist and steps to assess a campaign message, define target audience and design a successful social media campaign.</p>	<p>Tool template consists of seven steps that help you to formulate a concise and targeted message for social media: 1) Define your “claim to fame” 2) Identify and understand target audience. 3) Create your own media channels. 4) Identify free event media guide channels. 5) Understand the phases of event communication. 6) Create great content 7) Measure success by monitoring effect of channels.</p>

4.3 Reflexive Monitoring

Co-production signifies a departure from conventional urban governance and planning approaches that tend to start from clear problem definitions and objectives and only include evaluation at the end. Throughout the process of NBS development, the questions and underlying assumptions of the expected impact change. This learning-by-doing and iterative nature of NBS co-production processes necessitate on-going learning processes that allow unveiling and navigating barriers and opportunities through process adaptations on-the-go, it requires monitoring to be on-going and flexible (cf. Sol et al., 2017; van Mierlo et al., 2010).

Reflexive monitoring is a dynamic and novel way to capture and assess processes of learning-by-doing and doing-by-learning with a focus on learning in situ and real time, not retrospectively (Beers and van Mierlo, 2017). Monitoring and assessment are introduced right at the beginning of planning to start by taking stock of



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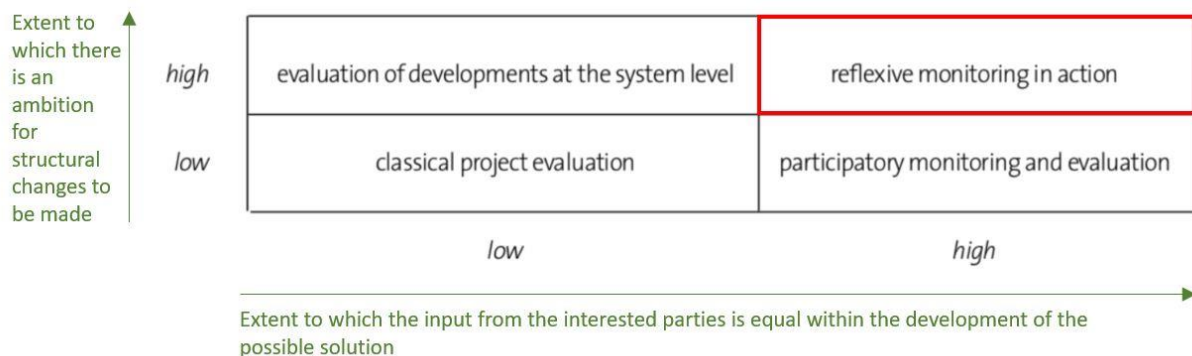
innovations, needs and knowledges that exist in the cities, rather than starting from specific and pre-determined problems and solutions. This enables to systematically link learning to NBS design, implementation, stewarding and scaling, thus facilitating flexible and adaptive responses as well as generating insights on critical steps and lessons learned throughout the process.

4.3.1 What is reflexive monitoring and what is it for?

Reflexive monitoring starts from the recognition that new modes of problem handling are needed to address sustainability challenges. Traditional – so-called rationalist and modernist – problem solving seeks to eliminate uncertainty and reduce complexity in its quest for precise and effective solutions. This “productive reduction of complexity”, as Voß and Kemp (2006, p. 5) call it, generates problems external to the realm of rationalist problem solving, so-called second order problems. However, starting from a complexity paradigm, there are no clear and pre-defined solutions to complex and uncertain problems – not the least because also understandings of what the problem is in the first place remains ambiguous and will change. In addition, solutions to such problems need to address the system as a whole rather than isolated elements of the problem. Any solution to sustainability problems does not have predictable, precise project goals at the start, since coherent structural changes at the system level are targeted. Therefore, in order to adequately address sustainability issues, it is insufficient to look at these issues – as well as initiatives or solutions to address them – in isolation (Elzen and Wieczorek, 2005; Regeer et al., 2009; Voß and Kemp, 2006). Rather, the complete system in which any issue and solution are situated needs to be taken into consideration, as well as how it changes over time towards sustainable development needs to be tracked. This form of problem handling is called reflexive problem handling (van Mierlo et al., 2010).

This is where reflexive monitoring enters the picture: reflexive monitoring starts from an intrinsically reflexive mind-set that embraces deep uncertainty, complexity and incomplete knowledge and thus the need for continuous learning and adaptation of how progress towards sustainability is sought (Beers and van Mierlo 2017). In reflexive monitoring, monitoring is not viewed as a separate activity, but one that forms a key part of the process and one that integrates all the various stakeholders. The knowledge generated through the monitoring directly feeds into the activities of the project. Reflexive monitoring is better suited to handle the uncertainty of innovative solutions; it positions monitoring as an integral process of the system innovation and it is more adaptive and stimulates a focus on structural changes (Figure 4) (Beers and van Mierlo, 2017; Sol et al., 2017; van Mierlo et al., 2010).

Figure 4: Key characteristics of Reflexive Monitoring vis-à-vis other forms of monitoring and evaluation (source: van Mierlo et al., 2010)



Reflexive monitoring encourages to **continually learn and reflect** by facilitating collective learning processes and stimulating bringing this knowledge into practice (Beers and van Mierlo, 2017). Throughout the process of NBS design, implementation, stewarding and scaling, the questions and underlying assumptions for the expected impact change, therefore the monitoring method needs to be on-going and flexible (cf. Sol et al., 2017; van Mierlo et al., 2010). The ambition of applying reflexive monitoring is to capture how an NBS initiative relates to systemic changes in the context (e.g. use of technologies, institutional structures, relationships between actors) towards long-term sustainability and to allow for adaptive planning and interventions to maintain high ambitions, while the path and destination are not necessarily drawn out precisely in advance. In this way, learning is a connected and interrelated process to planning and an explicit outcome throughout.

In reflexive monitoring, there is **no time lag between the action in the field and monitoring and evaluation,**



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since the monitoring happens throughout the process and in a participatory manner by the actors involved. In this way, reflexive monitoring can facilitate a learning process in which the involved actors collaborate to tackle challenges emerging in the process in situ and real-time, with creative innovative solutions and process adaptation (Beers and van Mierlo, 2017; van Mierlo et al., 2010). This further implies that learning becomes instrumental in improving planning rather than a separate process itself.

Finally, reflexive monitoring is able to **monitor and evaluate initiatives in a holistic and participatory manner**. It engages more actors in the process; it is better suited to handle the uncertainty of system innovation initiatives; it positions monitoring as an integral process of the system innovation; and it is more adaptive and stimulates a focus on structural changes (Beers and van Mierlo, 2017; Sol et al., 2017; van Mierlo et al., 2010).

4.3.2 Tools for reflexive monitoring

Reflexive monitoring is ultimately about finding a coherent set of methods that facilitate reflexivity and learning throughout the course of co-producing NBS. The tools were selected in a co-production process itself between the researchers and planners of the cities in the Connecting Nature project.

Implementing co-production processes to connect different innovations for designing, implementing and upscaling NBS requires novel ways of thinking, organising and acting, and novel knowledge, skills and resources. The RM process methodology makes it possible to facilitate reflexive monitoring activities in cities throughout these processes, as well as to capture lessons about how to go about these processes of implementing NBS in a co-productive way. While the former aids cities to undertake adaptations in the process itself, the latter enables the more deeply grounded formulation of effective ways to implement large scale nature-based solutions in cities.

Table 10 provides an overview of the tools that can be used for reflexive monitoring, based on van Mierlo et al. (2010) who bundled tools and research of Reflexive Monitoring in a guidebook. The Reflexive Monitoring guidebook (Appendix B) presents how we have adapted these tools for the Connecting Nature project. In the future, the guidebook will be adapted to present a clear guideline on how to set up reflexive monitoring in cities for reflexive monitoring of NBS co-production.

Table 10: Tools for Reflexive Monitoring (based on van Mierlo et al., 2010)

Tool/Method	What is this tool about?	Results
System analysis	System analysis is a tool that provides insights into the actors and factors that are working against the transformation to a more sustainable system: the inhibitors – the system faults or barriers – as well as the actors and factors that are actually encouraging that transformation: the driving forces and the system opportunities.	The outcome of applying system analysis is an overview of the system with coherent system barriers and opportunities.
Actor analysis	An actor analysis provides insight into which actors are playing a role within the system, and who should be involved with the project and in what way.	This type of analysis uncovers which actors play a role within the system, which ones should be participating in the project and in what manner.
Causal relation analysis	A causal analysis provides genuine understanding of factors that are holding back the project.	Causal analysis yields cause-and-effect relationships displayed in diagrams.
Dynamic learning agenda	The dynamic learning agenda encourages participants to continue working on change. The learning agenda is a concrete object, a brief document containing the challenges that the project is facing at that moment. These challenges are summarised in learning questions. In addition, it is a tool for commencing and supporting the dialogue about the challenges faced by the project. The agenda is dynamic because it is modified over the course of the project.	The DLA links long-term goals to concrete possibilities for action, in the form of a learning agenda containing learning questions, based on the challenges at hand, and modified during the course of the project.
Indicator sets	The indicator sets comprise two main groups: effect indicators and process indicators. The effect indicators	A set of theory based observable indicators that track the quality of

	refer to the learning and innovation process itself. A diagnosis based on the effect indicators shows whether the process needs to be strengthened. The points of leverage that can be used to strengthen the process are examined using the process indicators. This second group of indicators refers to the conditions for learning within an innovation project or innovation network.	learning and the innovation process in a system.
Reflexive process description	The reflexive process description is a representation of the process in specific terms using predefined process indicators. The process description is a document written by the monitor containing a detailed process description or tables describing the process. The document can support analysis and encourage reflection within an innovation project, but it can also serve as input for reporting to the client and for sharing the lessons learned with third parties.	A document that helps to gain or regain an overview of the reflexive process.
Audiovisual learning history	Participants can use this tool to put their learning experiences into words and record their knowledge and experience on video. The audio-visual learning history is different from other tools because it is audiovisual in nature, showing the 'personal' history of the project.	An accessible and attractive product that not only gives the viewer insights into the abstract learning experiences within the project, but also into the struggles and questions faced by the project team members.
Timeline and eye-opener workshop	The timeline method provides a working format for expressing the challenges, successes and learning experiences explicitly, together with the project participants. The eye-opener workshop is an additional tool for turning outsiders into project insiders, as it were. The experiences and results of the project are narrated in detail during the eye-opener workshop. The participants then reflect on the events, each from their own perspective. This lets them extract the lessons from the project experiences that are significant for their own situations. It is therefore not the monitor or project manager who determines which lessons are relevant, but the (potential) knowledge recipient. A timeline or eye-opener workshop takes at least three hours and is done with a small group (between three and eight participants).	The transfer of experience/knowledge, both internally and externally.



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5. Findings to date: towards capacities for co-producing nature-based solutions

We have worked with the cities in Connecting Nature to co-produce and apply the frameworks of co-production and reflexive monitoring. In this way, we could advance and apply the frameworks and methods as reported here, as well as learn from the cities' experiences to derive conclusions for co-production and reflexive monitoring of NBS implementation.

Specifically, we have worked with Genk, Glasgow and Poznań to understand and develop their co-production experiences and archetypes, the tools and methods they employ to co-produce their NBS exemplars, and to jointly identify their opportunities, challenges and lessons learned with regard to co-production. The cities have started to employ reflexive monitoring to identify critical turning points in the implementation of their NBS exemplars, learning questions and follow-up actions. We discussed them together during monthly coaching calls with each city and biannual Learning Experience webinars.

This section reports on the findings to date with regard to the applications of co-production and reflexive monitoring in the Connecting Nature frontrunner cities. Both frameworks have proven valuable in both cities to support the co-production of NBS and to identify and navigate critical conditions, opportunities and barriers for co-production. Specifically, the insights help to characterise co-production journeys and patterns in cities and to derive lessons learned. From the insight on needs, barriers, opportunities and lessons for co-production, we can further expand the co-production framework by identifying co-production capacities that embody the conditions that need to be in place to enable and facilitate co-production. Overall, this work has resulted in two draft guidebooks on co-production (Appendix A) and reflexive monitoring (Appendix B), which combine the theoretical review and practical experiences and examples and will be further enriched as the project moves along.

5.1 The value of co-production and reflexive monitoring

The frameworks for co-production and reflexive monitoring embody novel approaches and methods to support collaborative, reflexive and adaptive urban planning and governance practice with regards to NBS implementation and upscaling. Our premise is that applying the design principles and tools for co-production as well as reflexive monitoring will help cities to engage multiple urban actors, navigate barriers and mobilise opportunities for the better design, implementation, stewarding and scaling of NBS.

5.1.1 Lessons from and for applying the co-production framework

Co-production of NBS is positioned also by the IPCC Cities and Climate Change as the mode of knowledge generation and mode of urban governance fit for the complexity and urgency at hand to advance urban sustainability and resilience. Co-production offers a variety of opportunities to enrich knowledge and generate better solutions, create ownership and ensure legitimacy and saliency. Genk, Glasgow and Poznań recognise co-production as an opportunity to engage with diverse actors in their cities for the implementation of their NBS exemplar. In this way, co-production is able to address the various governance needs for knowledge, partnerships and societal and political support identified in the Connecting Nature frontrunner cities.

The co-production framework helps cities to design and evaluate co-production processes and to address their governance needs for knowledge and collaboration.

- *Co-production generates new and more integrated knowledge for context-sensitive and multifunctional solutions.* Producing new knowledge is the key aim of co-production. In the frontrunner cities, the co-production processes contributed to new knowledge generation by opening up previously isolated problem perceptions and adding new insights to possible solutions. For example, in Poznań, the involvement of the Police in the co-production of the open garden has been a novel feature, which contributed tacit knowledge about safety rules and regulations.
- *Engaging societal actors helps to integrate their voice and needs in urban policy and planning, as well as to motivate and empower them to become active in developing, using and stewarding NBS.* For example, in Genk, the set-up of Junior Teams resulted in the selection of three concrete projects that are going to be



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implemented in the Stiemervalley in collaboration with the pupils and the city government. In Poznań, the joint design of the open garden together with teachers and children also facilitated learning about how to use the garden and about human-nature relationships.

- *Co-production boosts partnerships and outreach across city departments and provides opportunities for advancing and extending urban policy and planning agendas.* The lack of inter-departmental collaboration has been identified as a NBS governance challenge in all three cities. In co-producing their NBS exemplars, the three cities also made efforts to reach out to other departments, involve them in the co-production process and keep them informed. For example, in Poznań a successful partnership with the Education Department was formed for collaborating on the open garden.

How the design principles inform the design and evaluation of co-production processes and how can good design be facilitated?

Inclusivity:

- *What for:* The inclusivity principle facilitates an opening up of urban governance and planning approaches towards looking beyond the 'usual suspects'. In the design and evaluation of co-production processes, it serves to critically reflect upon whom to invite and whether the 'right' types of actors were reached. In Poznań and Genk, inclusivity is a critical condition from the beginning and throughout the co-production process, to start with a wide brainstorm about problems and solutions. Both cities made an effort to select participants based on their different backgrounds, including for example practical, legal and operational knowledge.
- *What needs to happen for inclusivity:* Ensuring inclusivity requires the identification and opening up to new types of actors at the outset and throughout co-production processes. Since the involvement of 'unusual suspects' goes against the grain of the usual working of city governments, strong leadership and support is important for ensuring inclusivity. In Poznań, for example, it was important to also include knowledge about children's needs and opportunities for ecological education. Genk also included a business consultant within the team to include new knowledge to reach the strategic goal of connecting nature and entrepreneurship. In addition, the process needs to be attentive to different actors' needs in terms of their availability profiles. There might be a trade-off between inclusivity and legitimacy – so it needs to be carefully evaluated who should be involved and for what purpose, and what could be different forms of involving actors.

Openness:

- *What for:* The openness principle draws attention to the need for actively communicating to and engaging diverse actors, as well as for being open to diverse actors and opinions. In all cities, openness is a critical principle running throughout the process, becoming manifest in various engagement and outreaching activities. For example, in Genk multiple outreaching activities are being undertaken, such as a Stiemer Safari or bike tours, to inform about and involve actors in the valley. In Poznań, the openness principle has shown that particularly the city government needs to become still more open to new knowledge, information and actors. In Glasgow, it has been recognised that a lack of openness about the functions of open space due to risk-aversion of the city council has led to failures in the past when the design did not match the local needs.
- *What needs to happen for openness:* Openness requires flexibility in terms of recognising (and inviting) new knowledge and adapting the process and targeted results accordingly. In addition, in order to engage and widely disseminate the knowledge generated throughout the process, multiple communication formats and using the right language are important. For example, in Glasgow a challenge for openness is to use the right language to describe for example degraded open space when communicating to the public.

Legitimacy:

- *What for:* The legitimacy principle was considered important for ensuring participants' ownership over and trust in the process as well as salience, effectiveness and fitness of outputs. In Glasgow, legitimacy is critical from the beginning of the process, in order to create a sound knowledge base for the Open Space Strategy that ensures political and societal buy-in. In this context, for legitimacy it is important to



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communicate well.

- *What needs to happen for legitimacy:* Ensuring legitimacy requires critical reflection and checking of knowledge entering the process as well as of results. In addition, it is critical to make the co-production just and respectful so as to equally appreciate and give voice to different sources of knowledge. For example, in Poznań, legitimacy has been ensured by involving diverse actors in the design of the NBS – besides contractors and designers, also knowledge from the police was considered important to bring in expertise about safety regulations and rules.

Actionable knowledge:

- *What for:* Actionable knowledge can refer to different objectives – including the development of the Open Space Strategy in Glasgow to the operational development of open gardens in Poznań. While actionable knowledge refers to an output principle, the generation of actionable knowledge is taken into account from the beginning of the process.
- *What needs to happen for actionable knowledge:* For generating actionable knowledge, outputs need to be actively linked to existing strategies, goals and processes. For this, it is important to know the ‘relevant’ actors and reach out to them to inform them about the results. In addition, organisational structures and cultures within the city government – such as communication spaces and channels, openness to new knowledge – need to be strengthened so that they facilitate collaboration and knowledge transfer.

Usable knowledge:

- *What for:* Usable knowledge refers to the mobilisation and empowerment of diverse actors in the development and stewarding of NBS. In Genk and Poznań, usable knowledge is taken into consideration from the beginning of the processes, by aiming to motivate citizens to take up active roles in the re-development of the Stiemervalley (Genk) and to use the open garden (Poznań). In Glasgow, usable knowledge is aimed at as a result of actionable knowledge, for example, by working out parameters for where and how to put up trees.
- *What needs to happen for usable knowledge:* Usable knowledge relies on open and constructive process settings that facilitate social learning, trust building and a re-definition of roles and responsibilities. In this way, actors are stimulated to develop shared ownership over the process and results and to look for how they can contribute to the NBS implementation and stewarding. This also requires attention to the political dimension of co-production, including a reflection on the redistribution of roles and responsibilities of citizens vis-à-vis local governments that have different authorities, legitimacy and resource bases.

Extending institutions:

- *What for:* The extending institutions principle marks an important condition for creating institutional space for the co-production process itself as well as for connecting the generated outputs to other policy and planning agendas – e.g. for making the NBS agenda relevant for broader priorities and strategies such as air pollution, mobility and recreation and thus boost synergies and pool resources. As such, it is relevant throughout the co-production processes in all cities. In Glasgow, it is important to constantly connect the Open Space Strategy to other strategic agendas and goals for alignment and support.
- *What needs to happen for extending institutions:* Extending institutions requires the pro-active coordination across multiple urban projects and agendas so as to bridge traditionally disconnected knowledge and processes in the city. This often requires first an opening up of existing departmental silos: for example, in Poznań it was found that it is necessary to first open up the rigid way of working within the city government towards an opening up to new ideas and citizen-oriented approaches.

Synergies and trade-offs between co-production principles

- *Inclusivity of diverse actors in a co-production process can be conditioned and compromised by the principle of legitimacy.* In urban contexts that tacit knowledge is not considered of equal importance or



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value as expert knowledge, only expert knowledge is perceived as legitimate. As thus, a process may be selectively inclusive only to expert knowledge and neglect tacit knowledge all along. It was found challenging to ensure inclusivity when there is a lack of trust between the city government and citizens. For example, in Poznań it was found that the inclusive design of open gardens might be problematic when parents have ideas that are not in line with what design is feasible. Their solution was to first collaborate with the school teachers and to inform and educate them about the open garden and to thus make them mediators that respond to the parents.

- *Openness can be compromised if a co-production process is seen as instrumental for receiving or yielding knowledge/information (actionable knowledge) only.* This implies that there is a trade-off between openness and actionable knowledge: If in a process, the way outputs are made directly policy and planning relevant outweighs how the process remains open to diversity of actors, openness can be compromised the included actors only yield but do not contribute or co-produce knowledge or other outputs or when knowledge is not returned.
- *Actionable and usable knowledge come hand-in-hand.* If a co-production process only generates actionable outputs meaning knowledge-based outputs relevant for policy and planning while ignoring or limiting outputs relevant to other stakeholders, it is not a co-production process but rather a policy consultation or policy advice process. In this situation, the repertoire of process settings needs to be complemented to ensure that usable knowledge is also co-produced.

5.1.2 Lessons from applying reflexive monitoring

We introduced reflexive monitoring as a tool to draw attention to and facilitate on-going monitoring, learning and reflection about the co-production of NBS as a process itself. It helps to pro-actively recognise barriers and opportunities that emerge throughout the co-production process, as well as to identify and implement process adaptations. Reflexive monitoring allows for NBS co-production processes to be adjusted in order to structurally move towards long-term sustainability goals. The reflexive monitoring methodology provides a wide array of tools for encouraging learning-by-doing and doing-by-learning. Genk, Glasgow and Poznań have applied these tools throughout the co-production of their NBS exemplars, and reported how they experienced reflexive monitoring for social and policy learning. Furthermore, these cities demonstrated how reflexive monitoring has helped them to harvest lessons out of the co-production process and take actions based on these lessons. From this we can draw several lessons about reflexive monitoring as a methodological framework that supports reflexivity and adaptability in co-production processes in practice, as well as about which opportunities, barriers and adaptations they could identify with the help of the method.

The reflexive monitoring framework underpins a change of urban governance and planning towards more reflexive and adaptive approaches.

- *Reflexive monitoring helps to bring clarity in complexity.* In complex processes such as the co-production and governance of NBS, actors on multiple levels have to be dealt with and relationships between multiple processes, policy and societal priorities and goals have to be taken into account. This requires the ability to distil key process dynamics, barriers and opportunities, and to link these back to the objectives and planning process of the NBS implementation. The frontrunner city teams recognise that reflexive monitoring encourages the project team to reflect on what they are doing, how they are doing it, and why. They stress that next to analysing the process, the methodology also helps to see possibilities for influencing the context of the NBS initiative and in that sense be more transformative, more transversal and generate more impact.
- *In more hierarchical governance structures, the implementation of reflexive monitoring can be challenging.* For example, in Poznań, the governance context in which the NBS project team operates is very rigid, hierarchical and top-down. This structure seems to be at odds with the mind-set needed for reflexive monitoring. Initially, the implementation of the reflexive monitoring process therefore was challenging.
- *Reflexive monitoring is a governance innovation for social and policy learning in NBS implementation.* For the implementation of NBS, traditional structures and decision-making processes have to be radically changed. In order to navigate this process of change, learning through analysis of the system and the input



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of the various stakeholders is essential. Through reflexive monitoring, learning outcomes can be identified relating to critical components for the implementation of NBS, including the technical NBS design, the involvement of actors and the search for viable business models. The direct link to action furthermore underlines why, for example, Genk sees the tool as the ‘holy grail’ for the co-production and governance of NBS.

- *Reflexive monitoring is more than a framework: it sparks embracing a reflexive mind-set.* All cities stated that, over time, the application of reflexive monitoring resulted in lightbulb moments during which they realised that the methodology is essentially about having a reflexive mind-set, which resonates a departure of more control style and pre-defined planning action, towards learning and adapting. All three cities now try to embed this mind-set in their daily practice.
- *Through reflexive monitoring, multiple perspectives and diverse knowledge are integrated in NBS co-production and governance.* Knowledge exchange between various types of actors is facilitated and lessons learned about needs, processes etc. are valorised. For example, in Glasgow, colleagues outside of the project team attend the monthly coaching sessions and thus participate in the reflexive monitoring process of the project team. In Genk, project-outsiders can learn about and give feedback on the project progress through so-called eye-opener workshops. Furthermore, all frontrunner cities attend monthly coaching sessions, during which knowledge exchange with Connecting Nature researchers on the different building blocks for NBS design, implementation, stewarding and scaling is facilitated.

The reflexive monitoring framework helps cities to identify key learning outcomes for the co-production of NBS, which emerge throughout their NBS exemplar implementation, and to ultimately adapt and enhance their approach.

- *Learning about how to move from ‘traditional’ stakeholder engagement approaches to the co-production of NBS.* By questioning established forms of policy and planning action through reflexive monitoring made it possible to identify system barriers and opportunities. Thus, the cities were able to advance their co-production approaches. The Glasgow city-team identified the need to move beyond mere consultation processes (which is a deeply embedded tool in the city council) to engage more with the various stakeholders and therefore exploring the possibilities of citizen science. The Genk-team learned that, as a local authority, they should not take up the role of social entrepreneur, but that they should facilitate social entrepreneurship. They thus developed ‘Stiemer Deals’ is such a solution, aimed at facilitating local initiatives and entrepreneurs targeted toward local change in line with the NBS objectives.
- *Moving from a framing of ‘failure’ to ‘learning’:* *Unsuccessful co-production experiences are not moved to the background, but recorded and studied to enrich future actions.* In Poznań, there was an experience of ‘no success’ with a NBS initiatives, which normally would be quite difficult to admit in the context of the local government. However, through the use of reflexive monitoring the team analysed the process and identified the reasons for failure. This made it much easier to explain why it failed, take away lessons out of this experience and translate these lessons into follow-up actions.
- *Reflexive monitoring and its focus on system barriers and opportunities stimulates silo bursting.* The Poznań city-team reported that having a broad strategic overview using reflexive monitoring enables to set the context of implementation of different activities of the project in the frame of the entire city council. They furthermore note that the method helps to explore synergies within different departments in the city council and to embed NBS principles in the work of other departments. For example, in Poznań, the budget of the education department is tapped into for the implementation of natural kindergartens and linked ecological education programmes.

5.2 Cities’ co-production journeys: objectives, settings and archetypes

We have worked with the frontrunner cities to understand their experiences with co-production processes and how they relate these experiences to the co-production principles. In implementing their exemplars, the cities had different objectives for their co-production processes, employed co-production in different actor settings and emphasised different co-production principles throughout the process (Boxes 3-5).

We identify three different characteristics of the co-production processes that describe the objectives, settings and



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archetypes of co-production employed by the three cities. These characteristics help to derive lessons for specific types of co-production approaches. Specifically, they aid in the knowledge transfer between cities – such as between frontrunner, fast-follower cities and multiplier cities in Connecting Nature, by allowing to create learning clusters in line with the characteristics.

- *Objectives* refer to the key aims for co-production in the cities. In Genk, the aim is strategic and operational to mobilise diverse actors in the implementation and stewarding of NBS in the Stiemervalley, next to linking the NBS in the valley to other city strategies and agendas. In Poznań, the objective is largely operational, in terms of bringing actors together for the design of open gardens in specific kindergarten. In contrast, in Glasgow the objective is so far largely strategic to create the Open Space Strategy that will guide future open space implementation.
- *Settings* refer closely to the objective for co-production and the corresponding governance levels and actors to pursue the objective. For example, strategic objectives are in all cities mainly pursued within the city government and with the support of public-private partnerships to generate knowledge, while at tactical and operational levels much broader forms of partnerships also with citizens and businesses are established.
- *Archetypes* refer to how the cities translate the design principles into their co-production process and for which phase in the process they are important. The archetypes are process models of co-production in terms of specific patterns of how to apply the co-production principles.

Box 3: Co-production journey in Genk

Objectives

The city of Genk aims to develop the Stiemervalley in a co-productive way that allows to build upon the ownership, engagement and activation of a variety of usual and unusual stakeholders. The aims of the co-production process are to unite different interests and visions aiming at integrated development, collect project-relevant information and knowledge, build social cohesion, and to create support and activate stakeholders in the development of the Stiemervalley, its financing, management and use. The set-up of the project structure around the development of the master plan for the Stiemervalley supported the involvement of different partners, especially across different city departments, in the co-production process.

Co-production setting and activities

The co-production process can be distinguished into mainly internal co-production (co-production within the city government) and external co-production (together with citizens as well as diverse professionals), to actively engage colleagues, external partners of other governmental organisations and citizens. The co-production process for the development of the Stiemervalley started with development of the spatial vision for the valley, which involved internal city services, external partners and citizens. They were invited to think about the Stiemervalley in various ways, for example via bike tours, workshops, neighbourhood dialogues and a Stiemer quiz. The Stiemerprogramme was set up as overarching governance structure to oversee, coordinate and support the implementation of initiatives in the valley. The Stiemerprogramme encompasses three action tracks, including project operation (i.e. concrete spatial projects and interventions aligned to the Stiemervalley Masterplan, e.g. the pilot projects but also bottom-up initiatives), Stiemerdeals (boost new alliances between public and private actors for a social, cultural and economic upgrading of the Stiemervalley) and communication and participation (creating visibility and pride, involving actors through education and co-production, active participation and self-organisation). As part of the latter, Genk city initiated the Friends of the Stiemer in November 2018 to bring together a group of people interested in defining and supporting the Stiemerprogramme and its implementation. The role and composition of this group is still to be co-defined by the group.

Co-production pattern

The co-production process in Genk starts with ensuring inclusivity and openness to multiple actors and knowledge, with the aim to connect different disciplines and stakeholders and unite different visions and interests. The city of Genk sought to involve a wide variety of actors and does so on a continuous basis – for example through public outreaching events. Multiple formats are employed for producing actionable and usable

knowledge for all involved actors and for empowering actors to take action in self-organised projects, financing and stewarding etc. This also results in extending institutions, because it facilitated streamlining of and collaboration on different activities and plans relating to the Stiemervalley.

Box 4: Co-production journey in Glasgow

Objectives

Glasgow city focuses on developing Open Space Strategy (OSS) as a strategic tool for establishing a network of existing and new NBS projects in Glasgow. The OSS aims to provide an overarching strategic vision on, and coordinate the responsibilities associated with, the open spaces to ensure a well-coordinated network of green spaces that offer multiple benefits and address multiple pressing challenges. There is a recognition that the Strategy will have to be delivered in a challenging financial climate that is delivering fewer resources to create new open spaces, or enhance and maintain existing ones.

Co-production setting and tools

The development of the OSS has so far mainly taken place on a strategic level in a collaborative process with private partners to generate knowledge, formulate the strategic goals and ensure political support. For example, in partnership with the Glasgow & Clyde Valley Green Network Partnership (GCVGNP), existing network of open spaces across the city were evaluated regarding their quality, quantity to allow the development of an OSS that connects a network of publicly usable multifunctional open spaces across Glasgow. With advice from Greenspace Scotland, a new set of open space standards for the City Development Plan (CDP) was developed. Drafts of the OSS were put out to public consultation addressing all residents of Glasgow and relevant stakeholders, building on methods such as a public exhibition, online questionnaire and a postal questionnaire. To support the implementation of the OSS, Glasgow city will provide an outlook on how to think about co-production in more operational projects and to help facilitate social cohesion, sense of place and stewardship of open spaces, including a food growing strategy and creating a partnership plan for co-ownership with communities.

Co-production pattern

The co-production process in Glasgow starts with legitimacy of knowledge by weaving expert knowledge about open spaces in Glasgow with institutional knowledge about rules and regulations so as to extend institutions (linking the OSS to other goals and strategies) and generate actionable knowledge (about open spaces). Usable knowledge and empowerment of diverse actors are less foregrounded at the moment, but can be developed following the OSS that defines parameters for open spaces. This is also because, while the process is open and inclusive, inclusivity mainly relates to conventional consultation mechanism and openness to the provision of information to the general public.

Box 5: Co-production journey in Poznań

Objectives

In Poznań, the idea of creating 'open gardens' in kindergarten was directed to the residents by opening a small part of the preschool garden for city dwellers and thus make new green space available for other people. Thus, the overall aim for involving diverse actors (e.g. teachers, architects) in the design of the open garden was to integrate their knowledge and create co-ownership so that the garden is used effectively. The co-production processes in Poznań focused on the development of the open garden at the kindergarten no. 42 at Wilda District from the beginning of 2018 onwards. While the co-production process initially focused on the design and implementation of the open garden, efforts are made to further engage citizens and schools (including teachers, parents and children) in the utilisation and stewarding of the garden. In addition, with the ambition to upscale the

concept of ‘open gardens’ in Poznań, the city reached out to a diversity of schools and collaborated with the Education Department to identify a total of ten kindergarten with the potential to transform their gardens into nature-oriented playgrounds and to recognise whether the kindergartens would be interested in creating such open gardens. At the moment, however, there is no kindergarten that will create an open garden.

Co-production setting and activities

The management of kindergarten no. 42 at Wilda District decided to divide the pre-school garden and designated a smaller area to create an open garden. The first steps in the co-production of the open garden were held in small groups involving the kindergarten management, employees of the Project Coordination and Urban Regeneration Office, who were responsible for the coordination of the open garden project, and landscape architects, who created the conceptual design of the garden. Then, the residents were informed about the idea, including parents of preschoolers, residents from the nearest neighborhood, councilors from the housing estate council from Wilda District. The goal was to involve as many people as possible, who could present their interests and needs and contribute to the project. Throughout the process, the employees of the Project Coordination and Urban Regeneration Office and architects watched over the organisational and administrative work and sought linkages to other city departments and urban agendas.

Co-production pattern

The co-production process started with an open and inclusive setting with the goal to involve as many people as possible, who could present their viewpoints and interests throughout. Legitimate knowledge about a problem was considered critical to ensure knowledge about formal rules and regulations – such as knowledge represented by civil servants, contractors (e.g. construction law) and the policy (e.g. safety and order laws and rules) – as well as expert knowledge about pre-school and ecological education, spatial planning and landscape architecture. This resulted in particularly actionable knowledge for the design and implementation of the open garden, as well as usable knowledge on the parts of teachers, parents, children and other citizens about how to use the garden. The process resulted in extending institutions by creating more institutional space for co-production, including openness for citizen participation and more collaborative working across city departments.

5.2.1 Co-production objectives and settings

Across all cities, the co-production of the NBS exemplar takes place in multiple formats, which relate to the objectives and corresponding governance levels and actors (Table 10; cf. Loorbach, 2010; Frantzeskaki et al., 2014).

- *Strategic co-production settings* serve to develop the strategic overarching goals for NBS implementation and scaling. This provides a direction for the identification and development of specific NBS initiatives. In addition, strategic settings also serve to connect the NBS strategies to broader city strategies and agendas and thus enable wider implementation. For example, the Open Space Strategy serves as an overarching framework for open space implementation in Glasgow, and is connected to multiple other strategic agendas. Across cities, this setting mainly includes actors from within the city government, while strategic goals in Genk and Glasgow are also co-formulated with public actors.
- *Tactical co-production settings* provide space to develop the action programme for implementing the strategic goals, for example for selecting concrete projects to be implemented and developing the financing plan. In Genk, key is here the set up of project steering groups for the coordination of multiple activities. In all cities, new collaborations and partnerships are formed across departments and between public and private actors for the joint development of the action agenda and initiatives.
- *Operational co-production settings* refer to those settings, in which concrete initiatives and projects are being designed. In Genk, more formalised groups and programmes (e.g. Junior Team, Stiemerdeals) were developed to facilitate the development of initiatives from the bottom-up. In Poznań, partnerships are formed between multiple actors (e.g. kindergartens, architects) for designing the open gardens.
- *Reflexive co-production settings* refer to settings in which there is on-going monitoring and learning through reflexive monitoring. While reflexive monitoring can in principle involve diverse actors involved

in co-production process, so far the cities employ reflexive monitoring solely within their project teams that are part of the Connecting Nature project.

Table 11: Co-production objectives and settings in Genk, Glasgow and Poznań

Setting	Genk	Glasgow	Poznań
Strategic: developing and linking to strategic goals for large-scale implementation	<p>Connection to the master plan for the Stiemervalley</p> <p>Connection of master plan to other city strategies (e.g. master plan Europalaan)</p>	<p>Development of Open Space Strategy</p> <p>Connection of Open Space Strategy to other city strategies (e.g. Strategic Development Plan, Local Biodiversity Action Plan)</p>	<p>Strategic goal to create rich green network</p>
Tactical: Building partnerships and generating knowledge for implementation and scaling	<p>Development of Stiemer Programme for implementation</p> <p>Setting up project steering group for coordination and implementation (e.g. connection to thematic interventions)</p> <p>Setting up public-private partnerships for goal formulation and implementation (e.g. Friends of the Stiemer)</p>	<p>Setting up collaborations and partnerships for developing and implementing the OSS</p>	<p>Setting up collaborations across departments (e.g. Education Department) and with private actors for (identifying sites for) implementation</p>
Operational: Design, implementation and stewarding	<p>Implementation of Stiemer Programme pilot projects</p> <p>Setting up public-private groups for implementation (e.g. Stiemer Deals, Junior Team)</p>	-	<p>Implementation of open gardens at kindergarten</p> <p>Establishing collaborations with kindergarten and other actors for implementation</p>
Reflexive: Continuous learning and adaptation	<p>Reflexive monitoring within project team from city government</p>	<p>Reflexive monitoring within project team from city government</p>	<p>Reflexive monitoring within project team from city government</p>

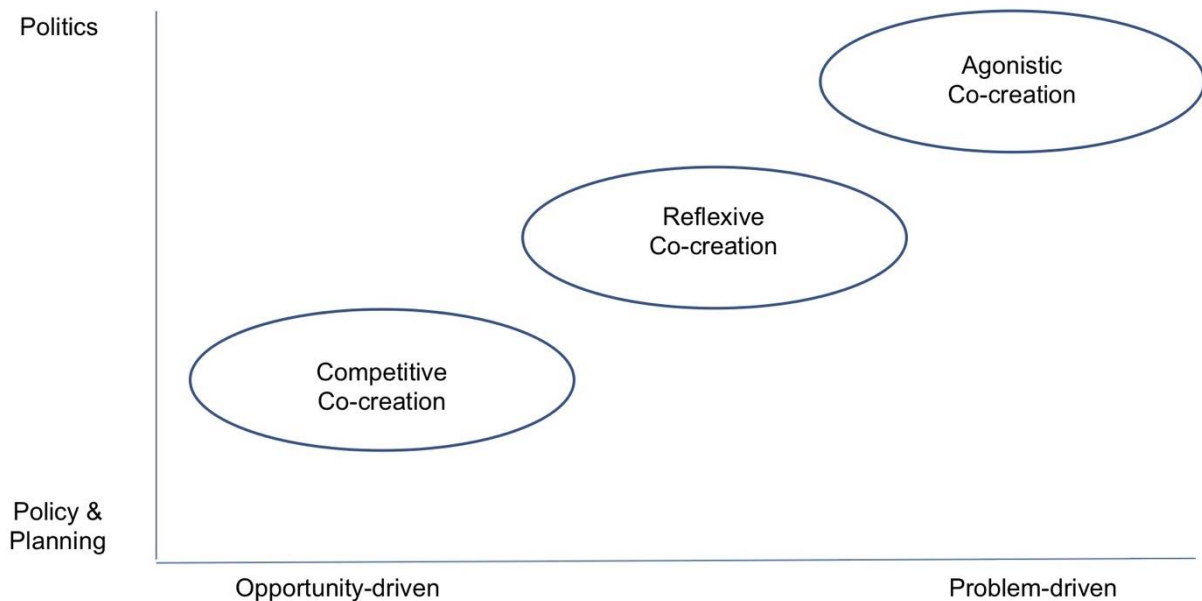
5.2.2 Co-production archetypes

We identify three co-production archetypes based on the analysis of co-production patterns in Genk, Glasgow and Poznań. The archetypes can be mapped on two axis, which distinguish whether the co-production process is (a) policy/planning-driven or politics-driven and (b) opportunity-driven or problem-driven (Figure 6).

- **Agonistic co-production** (Poznań): an open and inclusive co-production process that is stimulated and supported by legitimate knowledge about a problem that needs different handling, continuing with multiple formats and engaging openly multiple actors throughout. Outputs generated are usable and actionable knowledge that is inclusive and supports inclusiveness, and allows enrichment and advancement of multiple urban agendas and programs.
- **Competitive co-production** (Genk): a pro-active, open and inclusive process that starts with identifying opportunities and actors to design NBS in a novel and open-ended way. It ensures inclusivity and openness to multiple actors and knowledge throughout the process, employing multiple formats that produce usable knowledge for all involved actors in every step of the process and result in extending institutions.

- **Reflexive co-production** (Glasgow): weaves expert knowledge with institutional knowledge to build a legitimate knowledge basis for developing new strategies and approaches in an iterative adaptive process of co-production of knowledge that advances actionable knowledge as a basis for usable knowledge and extending institutions.

Figure 6: Co-production archetypes



5.3 Lessons learned for co-producing nature-based solutions

A number of lessons can be drawn that identify challenges and opportunities cities experienced throughout co-producing NBS. Co-production is not a panacea, this has become very evident in the co-production processes of the cities. Co-production is not yet very common in urban settings, and often goes against the grain of conventional decision-making and planning. As such, it does not only pose many challenges for those wanting to engage in co-production processes, it is also often at odds with other conventional decision-making and planning processes. Genk, Glasgow and Poznań had different experiences with co-production before Connecting Nature – with Genk having the strong experience with private actor engagement and collaboration, while Poznań did not use co-production before. All cities state that they experienced their co-production processes as huge learning processes, and many lessons have already changed urban policy and planning practice in the cities towards more collaborative, open-ended and flexible approaches.

From the co-production experiences of the Connecting Nature frontrunner cities, we identified several lessons that speak to challenges and barriers encountered throughout co-production processes (and as also identified through the reflexive monitoring process), as well as opportunities that were identified and used to overcome them.

Challenge #1: The organisational culture within the city government does not facilitate collaborative, open-ended and flexible governance approaches.

Co-production, and the open-ended nature it implies, goes against the routine and structures of city governments that are used to making decisions in departmental silos and with clear objectives and solutions pre-defined. Paradoxically, however, collaboration is needed for developing and scaling NBS as multifunctional solutions, which touch on different goals and objectives. For example, implementing and long-term stewarding of NBS requires pooling of funding streams and knowledge. Scaling NBS requires their embedding in multiple strategies and planning agendas. Barriers manifest in this challenge do not only relate to a lack of formal and informal exchange and a culture of vertical working, but also to a lack of leadership and resources (e.g. to deal with



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overload of information), role conflicts and unclear responsibilities.

Lesson: Creating institutional space for collaboration and social support for NBS co-production requires the development of shared ownership and alignment, as well as mediation and mediation spaces across different city departments.

- Build social support by emphasising and facilitating shared ownership over long-term and strategic priorities by actively informing colleagues about objectives and outcomes.
- Create and make use of formal and informal spaces for building new personal relationships, facilitating collaboration and trust-building, and knowing whom to reach in different departments for collaboration.
- Clearly define roles and responsibilities for the design, implementation, stewarding and scaling of NBS.

Challenge #2: Setting up, designing and implementing co-production processes requires a high amount of time, openness and new skills.

Since co-production is a novel governance approach, the required experiences and skills have not yet been invested in. In addition, as it is not yet a common practice in urban governance and planning, it is often met with a high level of scepticism. It has been stated in the cities that sometimes there is just no time for participation in general, because decisions have to be made soon. In addition, there are multiple competing priorities with insufficient time, so that there is no time to learn about, discuss and trial new methods of work such as co-production. It takes time to integrate it into the everyday design.

Lesson: Institutional relevance and credibility of co-production processes, as well as leadership support and engagement are critical factors for creating an enabling context that gives space to and invests in the skills for co-production.

- Identify clear goals and measurable progress criteria to demonstrate the benefits of co-production.
- Communicate and advocate the actionable and usable knowledge output of the co-production process in relation to urban priorities and agendas.
- Invest in skills to design and facilitate co-production processes, including mediating between different interests and finding boundary objects for developing a shared language and common understanding.

Challenge #3: Reaching out to and mobilising ‘the right’ actors, such as citizens and the business and finance community, remains challenging.

Co-production ultimately intends to mobilise and empower a wide range of actors to participate in every aspect of NBS, including the design, financing and stewarding. Rather than approaching participation as asking for input or opinions, in co-production processes it is assumed that the different forms of knowledge from all participants create new knowledge and new starting points. However, it is still challenging to reach out and motivate diverse actors to participate in co-production processes, and, particularly, to motivate them to become part of the implementation and taking up own initiatives. While citizen engagement is a trodden ground, it usually still relies on asking for input rather than building on profound co-production. Similarly, engaging the business and finance community is often a rather new element for finding business and financial models for NBS. On the one hand, it relates to the lack of experience of city governments to reach out to ‘unusual suspects’ and a lack of skills in mediating different languages, interests etc. On the other hand, it is also difficult to attract people to volunteer on a regular basis (e.g. for the management of an urban garden) or engage in financing, because of a lack of knowledge about financial models or social innovations.

Lesson: Mobilising and empowering actors to become part of the process and in every aspect of NBS requires the active and open engagement from the very start of the process to reconcile different interests and create ownership and orient the co-production process towards usable knowledge and empowerment.



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- Engage actors from the beginning in the formulation of problem definitions and exploring common solutions for generating usable knowledge and empowerment that prompts participants to (re-)define their roles and responsibilities.
- Ensure ownership over and trust in the process by ensuring legitimacy of knowledge and creating enabling settings boosting creativity, inspiration and a positive atmosphere.
- Develop knowledge about the local context, including who are community managers, local entrepreneurs (reach out to those!), and about business models to support social and business innovation.

Challenge #4: It is difficult to ensure equal participation in co-production processes and to overcome dominant power dynamics and interests.

Co-production processes cannot avoid politics: politics concerns the questions of who is involved in co-production processes and who benefits from the results. For example, when powerful socio-economic interests dominate greening initiatives they might be placed above other/social equity needs and priorities. Local residents and community groups might (fear to) be affected by gentrification as a result of NBS, or NBS might only attract specific groups of actors. Politics also concerns the (re-)distribution of responsibilities of private actors vis-à-vis local governments, having different capacities and resources, as a (desired) result of co-production. Co-production does not necessarily result in equal power relations but rather in empowering people through the process of collaborative learning and governance.

Lesson: Attention needs to be paid to who are the traditionally ‘voiceless’, who are not only often under-privileged actors but also those who are not born yet, as well as to equal participation and how outcomes affect different (groups of) actors.

- Identify all kinds of actors that are affected, paying specific attention to ‘voiceless’ actors and ‘unusual suspects’.
- Monitor and evaluate co-production outcomes with regard to whom they benefit and whom they may disadvantage.

Limits of co-production: when NOT to co-produce?

While co-production offers multiple advantages to traditional planning, there can also be instances when co-production might not be the appropriate mode of governance. For example, a difference we identified from the literature review and synthesis is that the co-production mode has not been used in contexts of conflicts or situations that there is a high interest at stake for a proposed solution or project (Turreira-Garcia et al. 2018). One of the reasons is that co-production approaches resonate when there is no identified solution yet but rather open-ended questions or concept solutions under discussion. In addition, co-production is not the right form of governance when it is merely sought to generate actionable knowledge for policy and planning and outputs relevant to other stakeholders are limited or ignored. Then it is rather a policy consultation or policy advice process. In this situation, the repertoire of process settings needs to be complemented to ensure that usable knowledge is also co-produced.

5.4 Co-production capacities: creating the enabling conditions for NBS co-production

Both the co-production and the reflexive monitoring frameworks are novel and thus challenge existing urban planning and governance practice. Ensuring good quality co-production processes in line with the guiding principles therefore requires the development and strengthening of new types of institutions that create and ensure space, including time, resources and skills, for exchange and collaboration. From the insights on needs, barriers, opportunities and lessons for co-production, we can further expand the co-production framework by identifying co-production capacities that identify the conditions that need to be in place to enable and facilitate co-production.



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Conceptually, the concept of co-production capacities denotes both the structural conditions (e.g. organisational resources, institutional settings, knowledge, skills, partnerships) that facilitate co-production processes, as well as the activities by which actors can build the conditions (cf. Hölscher et al. 2018b). This makes the capacities concept an empowering concept: it can give directions for strengthening the conditions manifest in co-production capacities (ibid.). In this sense, co-production capacities are an enabler as well as an outcome of co-production processes: the experience with co-production will feed back into the capacities for co-producing NBS. For example, experiences with transition management – an operational governance framework to set up co-creation and co-production processes – have shown that they support the development of new capacities (Hölscher 2018).

We identified the capacities based on the co-production experiences and lessons from the cities, as well as by drawing on literature that identify conditions for transformation and co-production governance processes. In particular, we draw on the framework of capacities for transformation governance by Hölscher et al. (2018b; 2019), because it conceptualises the capacities by starting from the governance functions they are aimed at and subsequently identifying conditions and activities for fulfilling these. In this way, we can transfer the capacity functions and corresponding capacities to the ambition to facilitate co-production. For example, transformative capacity translates to the capacity to create space for novel processes such as co-production as well as to generate the uptake of the co-produced outputs for legitimacy, long-term commitment and scaling. In the future, we will further develop the framework by feeding in literature insights and city experiences.

5.4.1 Capacity to create space for collaboration, learning and innovation

The capacity to create space for collaboration, learning and innovation manifests in the ability to bring together diverse actors in an open-ended way that boosts innovation and social learning. Setting up co-production processes requires opening up organisational and institutional settings (e.g. by providing regulatory, financial and politically-free space) for open-ended experimentation, acquiring skills for designing and facilitating co-production processes with intended outcomes, and identifying and connecting actors for the co-production process. For example, it is important to develop communication skills to engage citizens and citizen groups in order to co-produce narratives, understandings and contextualised problem framings that will resonate the co-production of NBS. Setting the scene for co-production also requires institutional leadership that recognises knowledge gaps and navigates across departmental siloes to create inter-departmental alliances and institutional coordination for bridging the gaps (Santoro et al. 2019). This provides the stage for co-production processes that adhere to the design principles above and generate the intended outcomes.

Table 12: Capacity to create space for collaboration, learning and innovation

Conditions	What does the condition do?	How to build the condition?
Multi-actor and inclusive innovation networks	Brings in diverse actors into the co-production process that are willing to contribute.	<ul style="list-style-type: none"> Identifying and engaging actors Forming informal ‘coalitions of the willing’ Involving communities in design and implementation of experiments
(Regulatory, financial) space for innovation	Ensures that the process is as free of external constraints as possible for open-ended exchange of ideas.	<ul style="list-style-type: none"> Ensuring openness and legitimacy of co-production Temporary lifting or avoiding existing regulations
Process and content knowledge	Ensures the procedural and content-wide quality of co-production process.	<ul style="list-style-type: none"> Bringing in appropriate expertise and generate knowledge about how to design and facilitate co-production Ensuring inclusivity of different knowledge sources
Leadership for creating and using opportunities for change	Ensures political and societal support for co-production process and innovative outcomes.	<ul style="list-style-type: none"> Mobilising political leadership to put new and ambitious goals on the agenda Making use of momentum and opportunities for change Piggy-backing and quickly expressing potential of a new solution

5.4.2 Capacity to generate uptake of co-produced knowledge outputs

The capacity to generate uptake of co-produced knowledge outputs enables to embed the co-production process and its outcomes in its context. Embedding in context means that the co-production process and its results are politically and societally known and accepted, that lessons are drawn from them to improve future co-production processes and adapt the implementation of outputs and solutions, and that they are linked to strategic agendas, process and institutions. This facilitates the large-scale implementation of NBS. For example, communicating the co-benefits of NBS requires not only communication skills but also advocacy skills to ensure that an inclusive narrative is formulated (Frantzeskaki, 2019). For accelerating institutional and governance innovations that promote co-production and uptake of co-production outputs, urban planners need to act as change agents bridging narratives, creating strategic enabling space for innovation to scale and integrating evidence into urban agendas.

Table 13: Capacity to generate uptake of co-produced knowledge outputs

Conditions	What does the condition do?	How to build the condition?
Open institutions for embedding innovation	Enable embedding of co-production process and outcomes in mainstream practice.	<ul style="list-style-type: none"> • Creating open mind-set for taking up innovations in tactical agendas and daily practices • Allocating budget to developing and maintaining innovation, upscaling and replicating
Learning for replication and upscaling	Generates and translates lessons learned from co-production process and outcomes into (new) structures, strategies, practices and processes.	<ul style="list-style-type: none"> • Identifying proof-of-concept lessons from innovation to facilitate replicating and embedding • Identifying opportunities from innovation for upscaling • Identifying bricolage of solution elements to mainstream innovations into urban planning processes and decisions
Advocacy coalitions and self-sustaining innovation networks	Carry the story of the co-production process and outcomes to increase visibility, support and uptake	<ul style="list-style-type: none"> • Participating in and hosting local, regional, national and international networking, best practice and knowledge exchange events • Formalising operational public-private partnerships for continuous innovation • Setting up cross-sectoral networks and partnerships tasked with (embedding of) innovation in institutional structures
(Trans-)local support for the innovation story	Generates wide societal and political support and uptake of the co-production process and outcomes.	<ul style="list-style-type: none"> • Creating and advocating an inspiring innovation story • Showcasing innovations as market potential for the city

5.4.3 Capacity to align and mediate knowledge outputs across institutions

The capacity to align and mediate knowledge outputs across institutions facilitates the connection of co-production processes and their outcomes to other strategic agendas, processes and networks. Multifunctional solutions NBS cannot be implemented through siloed approaches but require the active search for synergies in terms of how different problems relate to one another and how addressing one problem might reproduce another. Strategically aligning multiple processes and strategies and mediating across multiple different institutions boosts the large-scale implementation of NBS.

Table 14: Capacity to align and mediate knowledge outputs across institutions

Conditions	What does the condition do?	How to build the condition?
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Co-ownership over long-term and integrated goals	Aligns multiple actors, agendas and goals with each other towards a common, long-term and integrated future direction.	<ul style="list-style-type: none"> • Developing and linking NBS to long-term sustainability and resilience goals • Identifying and measuring synergies and trade-offs • Involving multiple actors from different city departments and private organisations in strategy formulation • Public outreach and participation
Framework conditions for long-term co-benefits	Generates opportunity contexts for long-term and synergistic design, implementation and stewarding of NBS.	<ul style="list-style-type: none"> • Redefining responsibilities (e.g. for carrying costs, maintenance) • Providing guidelines for leveraging innovative, long-term and co-beneficial solutions (e.g. through competitions)
Formal and informal connection nodes and channels	Facilitates exchange, collaboration and trust building between diverse actors across sectors and scales.	<ul style="list-style-type: none"> • Establishing central connection nodes for pooling sustainability and NBS efforts at multiple levels • Identifying theme-leads and contact persons within individual departments
Intermediary spaces for knowledge sharing and trust building	Facilitates exchange, collaboration and trust building between diverse actors across sectors and scales.	<ul style="list-style-type: none"> • Creating neutral co-production spaces and knowledge partnerships to build trust for knowledge sharing and resource synergies across scales and sectors • Establishing cross-departmental co-production spaces for knowledge exchange, priority alignment and trust building

5.5 New role of ‘science *with* cities’

Having been initially originated from transdisciplinary research, focusing on the interface between science and decision-making, co-production promotes a new role of science not for cities but *with* cities. Active participation of citizens and other urban stakeholders/agents in the knowledge generation process contributes to the democratisation of the knowledge process overall (Carton and Ache, 2017, p. 237; Daedlow et al., 2016, p. 1; van der Hel, 2016, p. 166). Specifically, “by shifting the terms of engagement from ‘on’ and ‘in’ to ‘with’, the ‘researched’ are not only given voice, but play an active role in the research process itself with the idea of enacting some form of social action to improve the current situation” (Newton et al., 2012, p. 592). Thus, co-production aligns with a pragmatism approach to science. It implies that science is collaboratively produced, remains open to reflection and evaluation. It therefore challenges “the presumed dichotomies between (...) production and use of knowledge” (Popa et al., 2015, p. 48). As such co-production vests the production and the use of knowledge in one process. Based on Popa et al. 2015 (p.48) “research is understood as a mediated process of problem-solving based on experimentation, learning and context specificity.” Conclusively, co-production is an epistemological foundation for the new urban science or science of cities.

While much research procured by cities is conducted by consultants, academic research in such interfaces can be valuable where new knowledge needs to be generated (rather than a mere synthesis of existing knowledge), or, where it provides a systematisation of information (Fernandes and Guiomar, 2018; Fink, 2016). Academic research can also be beneficial where it provides a critical perspective to complex, ill-defined urban-climate challenges, and can make visible e.g. political processes that can confound, or, lead to perverse solutions (Steiner, 2014). In collaborative research, partnerships interface with policymaking, design/management and community, and researchers often fulfil multiple roles including a brokerage role between community and policy that needs to be reflected upon for safeguarding objectivity and legitimacy of the value of research (Frantzeskaki and Kabisch, 2016; Loorbach et al., 2017). Stemming from this, there are many challenges of these partnerships. A targeted and concerted effort is called for in order to identify how these partnerships play a role in the governance of different types of NBS at different scales, to understand the interactions between the processes of designing, implementing and maintaining NBS and the outcomes they generate. Research has also to chart trade-offs between NBS and social sustainability interventions (Maes and Jacobs, 2015, Faivre et al., 2017, van der Jagt et al., 2017).

The literature identifies several opportunities and challenges with regard to co-creation and co-production as a research mode directly relating to co-production.



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First, nature-based solutions have to be designed and implemented in a context of rapid urban development and challenges such as informality, high demand for services and good quality of urban life, and the scarcity of human capacity, skills and financial resources to address these challenges. The complexity and uncertainty inherent in this situation, requires knowledge from scientists, from practitioners and from the communities of influence within the cities, to be co-designed and therefore fitting to fit city needs and context (Nel et al., 2016, Cowling et al., 2008). Knowledge required for NBS is dependent on the time, efforts and skills of those generating and weaving together diverse knowledges (Tengö et al., 2017). This demands the ability to interpret knowledges across different disciplines, and a shout-out to the oft-ignored social sciences. Models for true co-production of NBS need to incorporate solid evaluation and evidence-generating mechanisms that can then inform targeted and cost-effective interventions. If co-developed carefully, plans for NBS can and should incorporate real-world experiments and projects that can clarify causality and allow for comparison between different types of NBS.

Second, it is important to bridge different knowledges between academics and planners (Thompson et al., 2017). This role is often assigned to those policy entrepreneurs, or, other intermediaries that are skilled to translate academic knowledge to planning-ready knowledge. However, in co-produced knowledge, planning-relevant outputs may be produced before academic ones (Frantzeskaki and Kabisch, 2016).

Third, it is important for leading, or, facilitating actors of the co-production process to be in a partnership to ensure a common language and common understanding of the objectives and solutions being addressed between scientists and planners (McPhearson et al., 2017). NBS are inherently devised and enacted using transdisciplinarity, with social, political, ecological and technical dimensions, while both research and municipal enactment are heavily siloed. An important issue raised by the IPCC Cities and Climate Science Platform was the need to articulate non-material benefits of NBS in a persuasive manner (through for example revenue generation, costs-savings, or, other ways of portraying the importance of defined values and meanings) such that these non-material benefits may be counted and traded-off in the same frame as other types of benefits (Díaz et al., 2018).

Fourth, co-created outcomes such as the design of a nature-based solution, or a new approach to planning and knowledge generation are the 'new commons'. This implies that it belongs to all engaged parties including researchers, practitioners and the community. When considered this way, it cannot be 'owned' by a single actor. This poses challenges for both scientists and planners/policy makers (or perhaps more accurately, the universities and local governments they work for) who are focused on creating segregated intellectual property and land uses. Similarly, the reward systems for researchers can be poorly aligned with the kinds of outputs and outcomes that are useful for practice. Researchers are rewarded for producing academic publications, while reports guiding city practice may be about the impact agendas for nature-based solution projects and may offer a fantastic opportunity for researchers to adapt to this new world. At the time of publication, there are 12 nature-based solution research and innovation projects under-way in the EU alone (Bourguignon 2017).. While scientific development of theories and evidence is of utmost importance for NBS, we should also strive for academic output that is understandable by larger audiences.



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6. Next steps

This Deliverable presents work in progress on the development, application and evaluation of a co-production framework for the co-production of NBS in cities. In the coming months and years of the Connecting Nature project, we will continue to work with the frontrunner cities to support them and learn from their experiences in co-producing their exemplars. In addition, we have started to engage with the fast-follower cities to familiarise them with the co-production and reflexive monitoring frameworks and to collect their experiences with co-production.

Besides supporting the cities and knowledge transfer between the cities in Connecting Nature and beyond, the insights will be fed into the continuously updated guidebooks on co-production and reflexive monitoring to make them rich cookbooks for helping cities to apply the approaches.

Our concrete next steps will be:

- Continuing support of frontrunner and fast-follower cities via co-production webinars and reflexive monitoring coaching calls.
- Identifying and analysing the co-production archetypes of the fast-follower cities to derive learning clusters for peer-to-peer learning.
- Co-designing co-production processes for frontrunner and fast-follower cities based on peer-to-peer learning of Connecting Nature cities during Knowledge Transfer workshop.
- Enriching the co-production and reflexive monitoring guidebooks based on experiences with Connecting Nature cities. In particular, we will work to advance the conceptualisation of co-production capacities for responding to needs and challenges for NBS co-production (see Sections 3.2 and 5.3), and we will seek to link the co-production framework to phases for NBS design, implementation, stewarding and scaling. In addition, we will expand and valorise the tools for NBS co-production and reflexive monitoring. For example, we will integrate the co-production tools with Osmos's Curatorial Planning Approach and the NBS business model canvas.

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Appendices

Appendix A: Co-producing Nature-based Solutions: A Guidebook for Policymakers and Practitioners

The guidebook is enclosed in a separate document.

Appendix B: Reflexive Monitoring guidebook

The guidebook is enclosed in a separate document.