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# Co-Production Boundaries of Nature-Based Solutions for Urban Regeneration: The Case of a Healthy Corridor

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## Abstract

Co-production, rooted in public collaborative management (Ostrom, 1996) or science and technology (Jasanoff, 2013) evolution, has demonstrated its innovative and transformative character within participatory processes. However, there is little empirical evidence that scrutinises these contexts of interaction. Equality of partnership in many cases is used as a discursive rhetoric that seeks to prescribe co-production above any difficulty, uncertainty, conflict, or unwanted situation. As a starting point, our proposal considers co-production as a social practice, composed of multiple layers and different participatory processes, activities, and strategies. Grounded in co-production approaches, the study draws upon the ongoing evaluation findings of the European project URBiNAT, which focuses on inclusive urban regeneration through nature-based solutions. The qualitative methods of evaluation (interviews and participant observation), applied during the co-production activities in the city of Porto (Portugal), provide evidence of how the various stakeholders—elected politicians, citizens, technicians, and researchers—participate in the co-production dynamic. The boundaries of a multi-stakeholder process are revealed with the goal of implementing healthy corridors in peripheral neighbourhoods. The intended evaluation analysis lies in the techniques, the agents, the dynamics, the knowledge, and the degrees of co-production. This analysis will contribute to the lack of explicit consideration of the impacts of nature-based solutions in urban regeneration pathways, especially those related to the social fabric underlined in Dumitru et al. (2020).

## Keywords

co-production; healthy corridors; nature-based solutions; peripheral neighbourhoods; Portugal; urban regeneration

## 1. Introduction

The transition from an industrial-based society to a knowledge-based society confirms the vital role of knowledge (Jessop et al., 2008; OECD, 1996) in the decision-making process within social and economic spheres and in continuous learning activities. Concepts such as the quintuple helix and mode three of knowledge production (Carayannis et al., 2012; Carayannis & Campbell, 2012; Gibbons et al., 1994) promote the openness of knowledge production towards new social and unconventional actors. In the case of nature-based solutions (NBS), the co-production rationale proposed is no different, and the dwellers are increasingly intertwined with public urban governance issues.

In 1988, Von Hippel's avant-garde work on the democratisation of innovation had already placed individuals and consumers in a more active position under the co-production processes of companies and universities (Von Hippel, 1988). In the social sector, the role of citizens and organisations in the provision of public services also extended the co-production boundaries (Pestoff et al., 2015). Co-production stipulates that the participation of citizens, end users or consumers, and clients, individuals or groups is crucial to the production of public services, participatory processes, and product development, respectively (Bandola-Gill et al., 2023; Brandsen & Honingh, 2018; Stott, 2018; Von Hippel, 2005). The potential partnership established between those who supply and who consume transformed the services and their results simultaneously (Von Hippel, 2005).

Overall, co-production places different knowledge in dialogue and consistent interaction. When integrated as a practical strategy for supporting social learning promoted through the interaction of a multiplicity of forms of knowledge within the governing process (Bandola-Gill et al., 2023), co-production can produce better solutions because the beneficiaries are the ones who better know their needs and, therefore, can customise their solutions. Ostrom's findings in the 1970s concluded that many public services were provided by different public or private and individual or collective actors and input from outsiders was transformed into goods and services (Ostrom, 1996). Through co-production in governance systems, social challenges are faced with plural resources, which would not be possible if citizens, private stakeholders, and public actors behaved in isolation (Pestoff, 2011). International policy recommendations, such as the *International Guidelines on Urban and Territorial Planning* (UN-Habitat, 2018), towards a more inclusive and sustainable city and society highlight this governing perspective.

It is not by chance that the European Commission's (Directorate-General for Research and Innovation [DGRI], 2015) strategy for NBS highlighted the power of collaboration and co-production (Naumann et al., 2023) as a means for designing and implementing solutions, considering their multiple benefits and added value. NBS co-production refers to multi-actors and multi-levels wherein the stakeholders are encouraged to be actively involved in courses of action for NBS (DGRI, 2015). Nevertheless, while previous projects have failed to focus critically on actual NBS co-production practices, policymakers' appropriation of these co-production approaches is still a challenge. There is a growing body of literature addressing the residual evaluation of the social dimension of its practices, effects, and impacts interwoven with NBS (Dumitru et al., 2020; Remme & Haarstad, 2022; Stijnen, 2021; van der Jagt et al., 2022). The evaluation schemes for NBS were conceptualised considering social cohesion and well-being impacts as indirect or secondary to the environment, and the absence of evidence on the distinct uses of NBS by different groups is raised by Dumitru et al. (2020).

This article examines the results of the co-production of the healthy corridor (HC) and its ongoing qualitative evaluation within the URBiNAT, a European H2020-funded project focused on inclusive urban regeneration through NBS. Qualitative methods, applied during the co-diagnostic, co-design, and co-implementation activities in the city of Porto (Portugal) and in other complementary cities provide evidence of how the various stakeholders—public authorities, local associations and citizens, municipal technicians, and academic researchers—participate in the co-production dynamic established by the project flow. The evidence seeks to address the research question: Under what conditions do co-production processes effectively promote the active involvement of citizens in urban regeneration and NBS implementation? The boundaries of a multi-relational process and multi-stakeholder are revealed with the ultimate goal of implementing HCs in peripheral neighbourhoods. This article aims to respond to the absence of analytical reflection on co-production complexity, increasing the chances of appropriation by political decision-makers.

Although the URBiNAT project uses the term *co-creation* (Caitana et al., 2020) due to the description of the call and NBS project goals (Naumann et al., 2023), the authors decided to explore the co-production concept in dialogue with the approach of this thematic issue, favouring a more encompassing term. The extensive literature on co-production and its use across a variety of fields offers strong fundamentals to validate the methodology. In addition, co-creation and co-production are often used interchangeably and they share a few commonalities (Brandsen & Honingh, 2018; Voorberg et al., 2015). Following the Brandsen and Honingh (2018) discussion, co-creation is “the newer and more slippery term” (p. 10), whereas co-production is closer to being a consolidated definition. Co-production is associated with the design and implementation phase of the production, whereas co-creation refers to the engagement of citizens in the strategic level and planning stage (Brandsen & Honingh, 2018). If we apply this lens in our empirical case, the co-production is suited to the outcomes of the HCs.

## 2. The Vital Role of Co-Production in Nature-Based Transformation of Urban Neighbourhoods

### 2.1. Definitions

The application of co-production can be observed in at least three fundamental spheres. Firstly, co-production in the private sector is seen as the means by which co-producers can produce their goods and services more efficiently and develop specific solutions for their needs (Voorberg et al., 2015). Secondly, in the scientific co-production context which assumes that political processes are shaped by scientific and technical aspects, just as technical definitions are also produced by sociopolitical pressures and powers (de Sousa Santos, 2003; Jasanoff, 2010, 2013). Thirdly, within the public sector and local governance, co-production attributes the status of citizens to individuals, who claim their positioning within active citizenship and involvement (Verschuere et al., 2012). It is aligned with the social innovation path in which civic participation is seen as a key condition for innovative policy-making processes. Co-production is also related to social innovation (Moulaert et al., 2013), as it seeks to create consistent solutions that aim to meet social needs. Thereby, it fundamentally changes social relations of power, of positions, and of rules among multiple stakeholders (André & Abreu, 2006).

The recent systematic search performed by Bandola-Gill et al. (2023) identified five different meanings of co-production across diverse disciplinary bodies of knowledge: (a) co-production as a relationship between

science and politics, anchored above all in Jasanoff's (2010, 2013) arguments mentioned previously; (b) co-production as knowledge democracy, which refers to the collaborative forms of knowledge production integrating local and indigenous perspectives; (c) co-production as transdisciplinarity, crossing different institutional settings in which different forms of knowledge are produced; (d) co-production as boundary management, focused on the usability of knowledge produced, searching for the balance between scientists' perspectives on what is useful and what is usable in practice; and (e) co-production as a research use intervention, which reflects its focus on the use of evidence in policymaking and public services (Bandola-Gill et al., 2023).

The association of the co-production approach with NBS practices thus reflects the continued flow and trend consolidated in the literature. Considering that NBS are inspired and supported by nature, providing benefits to the economy and social systems (DGRI, 2015; Frantzeskaki, 2019), they are, by themselves, co-produced, combine multiple agents and benefits, technologies, knowledge, and are implemented in specific local cultural dynamics. The multidisciplinary nature of co-production interconnects the NBS to a diverse composition of knowledge and skills, based on radical collaborations and creative energy (Alméstár et al., 2023), which gives added value to the design and implementation process of the NBS. In this way, co-production is, therefore, not only a means of implementing green solutions but also an essential part of them.

Some characteristics of wealthy NBS are the iterative processes for the adoption of a variety of disciplines and interdisciplinary and transdisciplinary modalities (Faivre et al., 2017), including opportunities for learning by doing and local adaptation. This perspective is clearly aligned with the intense and vibrant environment promoted by co-production, where the citizens are taken into account as valuable partners, for example, in the provision of services (Pestoff, 2011; Voorberg et al., 2015), in the improvement of urban space, or in the assessment of solutions.

## 2.2. Influencing Factors

Under the reflection on self-organisation induced by institutions, Ostrom (1996) indicates the following community attributes that determine the conditions for co-production: trust, reciprocity, reputation, sharing of values and goals among members, heterogeneity, social capital, cultural repertoire, and group size. She emphasises co-production as "the process through which inputs used to provide a good or service are contributed by individuals who are not the same organisations" (Ostrom, 1996, p. 1073). Co-production can take on different nuances and the citizens assume different roles. As co-implementers, citizen empowerment is the main goal. They are engaged at the operational stage of the service production process in order to balance their expectations and experience of the service, the citizens as co-designers to improve the quality of existing public services; and the citizens as initiators refers to users' involvement in formulating and developing both operational and strategic modes of co-production (Stott, 2018; Voorberg et al., 2015).

In order to improve co-production implementation, Stott (2018) defines four principles of co-production: inclusion, in particular, the engagement of users/groups excluded and the guarantee of accessible information; reciprocity based on mutual benefits, transparency, and power-sharing; the innovation principle oriented to the changes and to the learning experiences; and, lastly, added value based on concrete use of the initiatives and dialogue with other institutions.

From an organisational perspective, the systematic review conducted by Voorberg et al. (2015) cites the following as dominant influential factors: compatibility of public organisations with citizens' participation, open attitude towards citizens' participation, risk-averse administrative culture, and presence of clear incentives for co-production. According to the authors, one of the basic conditions, particularly in the public sector, is the infrastructure for communicating with citizens, which improves accountability strategies and makes public action more transparent. The attitude of public and political officials, directors, and municipal technicians influences the timing, location, and extent to which co-production occurs (Voorberg et al., 2015). These organisations also operate as intermediary agents who have the ability to create an adequate context of collaboration.

From a citizen's perspective, their personal characteristics determine, to a large extent, whether they are willing to participate, although individual and collective attitudes should also be considered. The greater the involvement of the citizen, the more conscious and interested in the needs of the community they are (Voorberg et al., 2015).

Other influencing factors are related to the sociomateriality approach, arguing that the materials are performative and not inert (Fenwick, 2012). In the URBiNAT project, diverse participation techniques were integrated to achieve a wider diversity of participants and their continuous involvement. However, these tools complement the human relations and sociabilities between the different parties and do not replace them. In a study about co-production dedicated to the renaturalisation of urban spaces through forest management (Campbell et al., 2016), trust appears in all cases as a central element in co-production processes. The authors themselves admitted that the boundaries between the environmental sciences and decision-making are increasingly mixed and confused, and therefore nearness requires strong bonds of trust. In addition, Pestoff (2011) argues that professionals and citizens develop a mutual and interdependent partnership, in which both parties are at risk and need to trust each other.

### 2.3. Limits

The goal of NBS co-production includes the experiences, views, and skills of many different stakeholders to establish long-term strategies to address specific problems jointly (Remme & Haarstad, 2022). This comprehensive description underlines the new participants in urban nature governance, new solutions, as well as the diversity of views on nature (Remme & Haarstad, 2022). However, Remme and Haarstad (2022, p. 3) found that it is "unclear whether the use of these advanced participation techniques has been able to overcome the tendency for the ideals of NBS to be subsumed under the more instrumental goals of the governance system of which these solutions are part." Additionally, there is a lack of evidence on adverse effects, in particular, the social costs of urban greening (Torres et al., 2021).

More recently, there has been a clear inclination towards successful examples of participatory NBS, leading to a lack of evidence on downsides and failures, as well as on co-production monitoring and assessment for urban NBS (Remme & Haarstad, 2022; van der Jagt et al., 2022). This then influences the quality and limits improvements that can be made to them. Moreover, political emptying (depoliticising) makes the visibility of vulnerabilities, asymmetries, and political commitment harder (van der Jagt et al., 2022).

Horizontal relations between public professionals and citizens can be complex. Public authorities or professional attitudes influence the co-production process; there may be reluctance and resistance or conceptions that citizens' behaviour is unpredictable (Voorberg et al., 2015). Another scholarly perspective corroborates the concept of "value co-destruction" proposed by Järvi et al. (2018); it means the actors involved in a partnership do not have certain resources, such as lack of information and/or inadequate communication. Failures in the interaction processes may result in a loss of trust, frustration, and a decline in the state of well-being (Järvi et al., 2018).

Despite being broadly supportive of the idea of participation, some critical perspectives have examined potential weaknesses in participatory approaches. From this standpoint, there is potential for participation to deteriorate trust if the participants do not feel their contributions or opinions made any impact (Remme & Haarstad, 2022). Although public involvement is widely recognised as crucial for the sustainability of NBS, many policymakers defend that a deeper participatory process may hinder rather than improve the development of projects (Remme & Haarstad, 2022). It is difficult to convince them to adopt a participative position. It is the reason why some NBS co-productions can emerge exclusively from a community-based perspective and adopt self-management logic.

### 3. Methodology

With a view to understanding co-production in its empirical diversity, this article considers the co-diagnostic, co-design, and co-implementation stage of the HC in the Campanhã civil parish, Porto, as its case study and includes comparable information from other front-runner and follower cities involved. We evaluated NBS co-production for the following reasons: as a tentative way to reveal what really happens in these scenarios of interaction; the multiple benefits from evaluation methods, such as the correction of route deviations, accountability, and a better understanding of where we are; and to strengthen the participatory dimension (citizens' voices and perception) towards knowledge-based evidence on NBS co-production.

The results of HC co-production and the ongoing evaluation research (Weiss, 1998) provide evidence of how the stakeholders participate in the relational dynamic established by the project flow. The analysis of key project task documentation, semi-structured interviews (citizens and municipal political representatives), and participating and direct observation were privileged methods. Additionally, the HC urban plan of Porto is the result of the co-production process developed in 2018 and is to be concluded in 2024. In the current stage, we can highlight some of the lessons learnt from the co-production process, through our lens as authors, researchers, and members of the Porto task force. Regarding ethical concerns, during the data collection activities, informed consent was applied and participants, also, consented orally. Interpretative and advanced analysis will be presented in Deliverable 5.6. based on the URBiNAT analytical framework.

The empirical context, described in the next section, corresponds to the co-diagnostic, co-design, and co-implementation stages, organised in order to design, decide, and implement the HC solution. The discussion is oriented around five main co-production themes: the techniques of co-production, the agents of co-production, the dynamics of co-production, the co-production of knowledge, and the degrees of co-production. The socio-material analysis (Fenwick, 2012) is particularly relevant to demonstrate the mutual implication of the social and material components for the practices of NBS co-production.

## 4. Results of the Co-Production of an HC Urban Plan

The co-production of the HC urban plan in URBiNAT was developed under the living labs that are local actions in the real context, activated in each community, to promote a bottom-up process, where citizens can gradually take control of the participatory process by developing solutions for their needs together with other actors (Steen & van Bueren, 2017; URBiNAT, 2021d). The activation of the living lab created the environment for co-production through the identification of actors interested in being involved, taking into consideration intersectoral, interdisciplinary, intercultural, and intersectional dimensions. This participatory process is framed by a co-production methodology that proposes an open and flexible process adapted to each participatory culture. It is organised into four interactive stages: co-diagnostic to identify the uses and needs, co-design to propose ideas and develop solutions, co-implementation to activate actions and build products, and co-monitoring to evaluate the process and monitoring the effects of NBS (Mahmoud & Morello, 2021; URBiNAT, 2021a). This path follows the modern design method steps—analyses, synthesis 1, synthesis 2, evaluation/critique, and communication (Broadbent, 1968, p. 129)—but it integrates the collaborative approach and the material and immaterial dimension of NBS. The challenge of co-producing an HC is, therefore, an opportunity to rethink the concept of NBS through a social approach. To inspire the co-production process, URBiNAT developed a living NBS catalogue that organises territorial and technological solutions, embracing products and infrastructures, and also a participatory and social and solidarity economy, comprising processes and services (URBiNAT, 2021c).

### 4.1. *The Front-Runner and Follower Cities*

The urban context, taken as an empirical object in this article, refers to an area of intervention in the Campanhã civil parish, located in the east of Porto, and comprises three main neighbourhoods (Falcão, Lagarteiro, and Cerco). This parish is an urban social housing area whose social indicators reveal the inequality faced by many inhabitants and families with low access to employment, education, health, decent housing, and public space. It is, however, a green area due to its agricultural pattern and consolidated network of social organisations and schools. Its peripheral location is stressed due to fragmentation provoked by mobility infrastructures that cut territorial relations.

The other URBiNAT cities are working in an intervention area with the same characteristics as Porto: social housing neighbourhoods located in the periphery of the cities where the population face the challenges of mobility to the city centre, lack of public transportation, informal green areas, security challenges, high level of unemployment, and lack of resources. These areas do, however, have a strong sense of belonging and an active group of citizens and associations developing social projects. Nadezhda district, in Sofia, Bulgaria, is a dense area of several social housing neighbourhoods built under the socialist regime. In Nantes, France, Nantes Nord, located in the north-western part of the city, is a large area under development by Project Globale. In Siena, Ravacciano is very close to the historical city centre; in Nova Gorica, the Koren area is on the border with the Italian city of Gorizia; in Brussels, Never over Heembeek is on the border with the Flemish region; in Hoje-Tastrup, intervention areas of Gregersen Quarter are inhabited by minorities with integration difficulties. Unlike previous cases, in Khorramabad, GelSefid and Bajgiran are in the city centre and not on the periphery.



## 4.2. The Co-Production Pathway

The co-production steps aim to engage citizens at the three levels of commitment: involvement, interaction, and integration, from an episodic participation activity to the development and implementation of each NBS (Moniz et al., 2022). The activities were organised in parallel with adults (individuals and associations) and with school-age children from local primary schools. The compilation detailed in Table 1 refers to the project participants with different degrees and frequency. It includes associations and individual citizens that have continuously participated in project local activities since 2019 and also participants of public events. In the case of COT.CS, it is an average number, considering the turnover characteristic of the groups. More than 900 citizens were reached.

During the co-diagnostics, the activation of the living lab became a key action of the local task in order to map the local stakeholders and engage them in the project: firstly, the engagement of the Porto municipal government, through a presentation to all political representatives and heads of departments to nominate a representative in each department; secondly, a meeting with these representatives to learn more about their experience in NBS and participatory processes; thirdly, a meeting with local associations and institutions to present URBiNAT and create synergies with their local projects; fourthly, meetings with local primary schools to involve children in the identification of the needs and challenges of their territory; finally, a public meeting in the central square of Corujeira (kick-off meeting), to present URBiNAT to a wider public with activities that involved data collection and also inviting them to future activities. In parallel, researchers collected data from municipal and national surveys as well as from specific tools, including spatial analyses, health and well-being questionnaires for the population, and behavioural mapping in the intervention area. The co-diagnostic stage was challenging for the Porto task force since there was a need for full interaction between the knowledge co-produced by the local stakeholders and the knowledge produced by academics and municipalities. The co-diagnostic activities activated the living lab and established several territorial and social needs (see Table 2) that were the triggers for the co-design stage. These included green areas, pedestrian paths, lightning, autochthonous plants, play areas for children, cleanliness and maintenance of public spaces, community spaces, local economy, respect for existing memory, synergies with projects, and participatory opportunities.

The co-design is organised in seven steps, according to the methodology proposed in the co-production process: transformation to present the local diagnostic and plan activities, self-projection to prepare workshops, ideation to co-select NBS, design to develop NBS with citizens and technicians, validation of NBS in meetings with all actors, discussions of the positive aspects and challenges using the TRIZ method, and systematisation of the proposal in the urban plan. During the ideation stage, and considering the characteristics of the territory, new NBS were identified and organised into four main categories more closely connected with the municipal departments: public space and nature, culture and sports, social economy, and education and environment (see Table 2).

At the design stage, three levels of activities were adopted: (a) face-to-face proximity meetings with the citizens in order to support them and to develop the NBS adapted to the context; (b) online intermediate meetings between the participants and URBiNAT local task force to create and develop the new NBS, mitigating the challenges imposed by the Covid-19 pandemic outbreak; and (c) collaborative key meetings that brought together all stakeholders and the URBiNAT task force to discuss further and develop the proposed new NBS.

**Table 1.** Compilation of participants and distribution of activities during the co-diagnostic, co-design, and co-implementation stages of the HC in Porto (2019–2023).

	Co-diagnostic (2019)		Co-design (2020–2021)		Co-implementation (2022–2023)		
Kick-off event	Schools	Citizens	Schools	Citizens	<i>Comissão de Trabalho do Corredor Saudável (COT.CS)</i> , Working Commission of the Healthy Corridor	Working groups	Experiments
1 event	3 events	2 events	10 events	23 events	2 meetings	20 meetings	3 events
150 participants	600 participants	40 participants	200 participants	15 participants per event, on average	40 participants	30 participants	200 participants
Citizens	Primary school (6 to 10 years old)	Associations	Primary school (6 to 10 years old) + (6 events with IAAC)	Citizens, associations, and municipal technicians	Representatives of schools, city councillors, municipal technicians, and community	Representatives of schools, municipal technicians, and community	Residents, local associations, and municipal professionals

Source: Authors' work based on URBiNAT (2021b).

**Table 2.** Needs identified during co-diagnostic and proposal developed during co-design in Porto.

Needs (co-diagnostic)	Proposals/NBS (co-design)
<b>Scope: Public space and nature</b>	
Green areas and its connection to leisure and sports activities	New green multifunctional areas for leisure and sports activities New paths for cyclable circulation New NBS Culture is Health and Outdoor for Programme Activities
Better conditions of pedestrian paths	Improvement of the conditions of existing pedestrian paths Creation of new connections.
More accessible paths for all citizens	The intervention in existing paths will soften the slope and prevent stairs
Lightning	New lightning points along the paths
Qualified green areas and nature	Multifunctional urban park, wildlife park, sensorial garden, suds (retention basins), pedestrian and cycle paths, autochthonous urban forest, slope stabilisation, and expansion of urban gardens
More autochthonous plants and trees	Planting and preservation of autochthonous species
<b>Scope: Education and environment</b>	
Play areas for children	Multifunctional green areas where children can play Pedagogical equipment in the schools' playgrounds
Adequate cleanliness and maintenance of the public space	Municipal companies integrate new areas into their cleaning and maintenance agenda Collective cleaning initiatives with children (tested in November 2021).
Education/community/better food	Pedagogical agricultural solutions to be co-implemented in elementary schools Education living lab
<b>Scope: Culture and sports</b>	
Socialisation/community/entertainment opportunities and community space improvement	Creation of safe and pleasant areas for resting, leisure, and socialisation, such as natural amphitheatres and squares Community spaces improvement More socialisation opportunities: Social market, Campanh'UP communication platform, and heritage routes
Respect existing memory	Rural walls and the trace of the Old Farmhouse of Falcão will be preserved/reintegrated New walls built respecting construction vernacular techniques Eco-construction workshops with children at schools.
<b>Scope: Social economy</b>	
Improve local economy	Social market named Campmarket Community kitchen Community urban garden named Germinário
Participatory opportunities	SuperBarrio app Working group activities Eco-construction activities In-situ experiments
Synergies with local projects	Connections between housing neighbourhoods and other public facilities Articulation with the public space project in the area Articulation with social project CLDS-REDES, Soalheira, Na praça, Sinergias

Source: URBiNAT (2021d).

After the co-diagnostic and co-design stages, the urban plan emerged from a process of negotiation established by a co-governance structure that organised two levels of co-production and co-decision: the working groups, constituted by the academia, the community, and the municipal technicians, to work on a monthly basis to develop projects, and the working commission with political representatives to take decisions and solve strategic challenges related to the process and the specific projects. To complete the co-implementation, a set of experiments is being organised by the working groups to present NBS to the general public and to test the solutions.

This structure was developed taking into consideration the methodological proposal of a stakeholder advisory board (URBiNAT, 2021b) to consolidate the participants' role in the participatory process and a municipal roadmap to establish the decision-making path during the co-creation of NBS. These two methods were appropriated differently in each URBiNAT city.

The URBiNAT co-production process was replicated in the other frontrunner cities—Nantes and Sofia—with HCs urban plans and effective implementation of NBS and in the follower cities—Hoje-Taastrup, Brussels, Siena, Nova Gorica, and Khorramabad—with an urban plan for the HC. Although these processes are not detailed in this text, they are reported in the urban plans (URBiNAT, 2021d, 2023) and they validate the co-production methodology tested in Porto and introduce complementarities and innovation (see Table 3).

## 5. Discussion

### 5.1. *The Supportive Techniques of Co-Production*

Inspired by a socio-material analysis (Fenwick, 2012), several resources were employed to support the activities. They included: maps, drawings, questionnaires, mockups, videos, catering services, communication tools (social media, webpage, and emails), minutes, reports, and flexible schedules, among others. Multiple social practices were adopted in the Porto case, encompassing, workshops, online and in-person meetings, field activities in the territorial area, direct observation, design thinking, photo voice, walkthrough, and interviews.

Although several strategies, methods, and techniques were co-designed and co-implemented, the co-production URBiNAT strategy was new for the municipality team. Previous strategies were more associated with collaborative and consultative modalities; as pointed out by the interviewees, “we are all learning” and “URBiNAT is just breaking new ground.” Arguably, the co-production techniques were gradually appropriated by the different co-production agents in Porto.

The interviewees drew attention to communication strategies feeding into trusting relationships, reinforcing the opportunities to make the local population aware of the project's activities. The use of digital enablers was highlighted as part of the project strategies to achieve a wider diversity of participants and their continuous involvement. However, during the interviews, the relevance of improvements became apparent and the lack of communication with neighbourhood residents who do not participate in the project was also reported.

**Table 3.** Main inputs and outputs from co-production of the HC in each city.

	Inputs			Outputs	
	Co-diagnostic	Co-design	Co-implementation	Needs	NBS
Nantes	Programme citizens dialogue in the frame of the global project 130 children, 100 adults	Programme citizens dialogue in the frame of the global project 130 children, 100 adults	Urban garden	Path connections Food Place to read	Green loop Urban garden IAAC benches to read and plant
Sofia	Close contact with the social centre and school Exhibition to present local diagnostic 160 children, 370 adults	Workshop activities with 3D models	Open-air amphitheatre	Take advantage of mineral waters Innovative classroom	Mineral water swimming pool IAAC classroom and greenhouse
Hoje-Taastrup	Engagement of citizens with an experimental urban garden 17 children, 50 adults, 6 elders	Public workshop in the municipality Hall with big-scale maps	Not applicable	Connections Security Education	A bridge connecting Danish Technological Institute and Gadehavegård New urban light setting Knowledge city
Brussels	Proximity process with "ludomobile" 120 children, 45 adults, 20 elders	Workshops for intersectional inclusive public space	Not applicable	Flood protection Culture and food Play	Improve water management resilience Farm rehabilitation Playground
Siena	Living lab office at the Ravacciano association 250 children, 40 adults, 10 elders	On-site design activities with children and adults	Not applicable	Sense of belonging Socio economy	Renovation of historical water systems Solidarity market
Nova Gorica	Local activities 101 children, 3 adults	Photowalk with citizens Co-selection with NBS cards	Not applicable	Renovate Koren river	Phytodepuration swimming pool Water square
Khorramabad	Workshop with URBiNAT partners, associations, and schools 75 children, 207 adults, 110 elders	Workshops in primary schools Workshops with adults	Entrepreneurship school	Green jobs Trees in public spaces	Entrepreneurship school Planting trees

Source: URBiNAT (2021d).

## 5.2. The Agents of Co-Production

The creation of a local coordination mechanism (task forces) with common processes established and a high degree of co-production among institutions, knowledge, and interests represents a significant result. The task force expresses vitality, keeping the participatory process active and having managed to make co-production operational through the engagement of different municipal government departments and academic representatives. The task force covers multiple scientific areas, including natural sciences, humanities, and social sciences. Nevertheless, it results in a distribution of tasks based on expertise or institution priorities, which reveals tacit disciplinary barriers. Moreover, citizens were not represented as members of the task force, thus some relevant decisions were taken without the citizens' collaboration. Table 4 presents the distribution of roles among the task force in the different stages of the co-production process.

**Table 4.** The distribution of actors within the local task force in front-runner and follower cities.

	Co-diagnostic	Co-design	Co-implementation	Co-monitoring	Co-governance
Porto	Academic (coord.)	Academic (coord)	Municipality (coord.)	Academic (coord.)	Municipality (coord.)
	Municipality	Municipality	Academic	Municipality	Academic
Nantes	Academic (coord.)	Municipality (coord.)	Municipality (coord.)	Academic (coord.)	Municipality (coord.)
	Municipality	Academic	Academic	Municipality	Academic
Sofia	Academic (coord)	Municipality (coord.)	Municipality (coord.)	Academic (coord)	Municipality (coord.)
	Municipality	Academic	Academic	Municipality	Academic
Hoje-Taastrup	Municipality (coord.)	Municipality (coord.)		Municipality (coord.)	Municipality (coord.)
	Academic	Academic Professional SLA Nature-based Design Studio		Academic	Academic
Brussels	Municipality (coord.)	Municipality (coord.)		Municipality (coord.)	Municipality (coord.)
	Academic	Professional SLA Nature-based Design Studio		Academic	
Siena	Municipality (coord.)	Municipality (coord.)		Municipality (coord.)	Municipality (coord.)
	Academic	Professional			
Nova Gorica	Academic (coord)	Academic (coord)		Academic (coord)	Municipality (coord.)
	Municipality	Municipality		Municipality	Academic
Khorramabad	Governmental institution (coord.)	Governmental institution (coord.)		Governmental institution (coord.)	Governmental institution (coord.)
	Municipality	Municipality			

Diverse roles and different attitudes throughout the process were identified. Participants assume roles as observers, mediators, facilitators, initiators, and coordinators. Sometimes these roles can overlap or be

mutually exchanged. At other times, the institutional roles may not be distinguished by all participants, which may be fruitful, because the meanings of the institutional roles did not influence the participatory process.

Interview results show us that at the start of the co-design stage, there was no immediate awareness of the local municipality's role as the local project coordinator. It influenced the changes in the second phase of the participatory process, in which the municipal government took the lead in the co-production process. According to the respondents, decision-makers should participate in the activities, as they exert influence on the final project and on the engagement of the residents. Despite the lack of involvement of councillors, their engagement (from three different departments) in the co-implementation meetings with citizens is, to a certain extent, a significant achievement.

Regarding the researchers' participation, focus is placed on their role as facilitators during the co-design phase as the agents who managed to gather participants' ideas, summarising the participants' contributions and incorporating this into the project progress. In relation to the interaction between researchers and the community, three researchers from CES and BIOPOLIS are named personally nine times during the interviews with citizens, which indicates continuous and frequent interaction. One of the interviewees even mentions continuous interaction with researchers within community-based activities beyond the project scope.

In relation to the community-based participants, the project objectives were to prioritise underrepresented and vulnerable groups. Within the co-design phase, priority groups were involved, including school-age children, people with special needs, and elderly residents. Nevertheless, since Campanhã is a civil parish characterised by its cultural diversity, the absence of representatives from the Roma community limits the project's inclusion goals. Despite their involvement mainly within the school context, sporadic participation in the co-design activities was noted. There is also still no evidence attesting to the involvement of citizens from the three neighbourhoods, as well as the lack of actors from business organisations which was mentioned during the interview with local public authorities. According to the respondents, the involvement of new actors will depend on local liaison and the guarantee of objective conditions for participation, for example, flexible timeline and financing opportunities were mentioned as fundamental in attracting more people.

### **5.3. The Dynamics of Co-Production**

Overall, the participants described the workshops and meetings as welcoming sessions, with a democratic and trusting environment for presenting ideas. The methodological choices received positive feedback, in particular, the combination of moments of "reflection and practice." The citizens did not allude to moments of tension, discordance, and complaints during the negotiation of ideas and sharing of opinions. They rarely mentioned having changed their initial propositions or feeling rejection, which reinforces the evidence of a welcoming and inclusive environment for the proposals presented by the participants.

The researchers observed that almost all the meetings were moderated or led by academics or actors from municipal government. In some meetings, the public authorities and academics were the only ones personally identified and introduced, accentuating the conventional relationship between elected politicians and citizens, based on the personalisation of some and the anonymisation of others. The adoption of

bureaucratic and technical discourse by politicians, technicians, and researchers was also observed, in opposition to more socially demanding speeches by the citizens. The community participants would not have a space to lead the analysis of the process as the politicians had and could only comment on proposals somehow reduced to their needs. The research also identified inequalities in the information domain among different actors, fundamentally related to preparatory meetings held exclusively between task force members and public authorities. These meetings were vital to guarantee political commitment and informed participation but also produced unbalanced conditions.

Although the project has produced some intermediate results, the Covid-19 effects pose some challenges to its conduct. During the co-design phase, the respondents mentioned the project length, the delay, and the desire to already have some “concrete things.” The interviewees raised concerns regarding the future after project completion and the professional teams leaving the community area.

#### **5.4. The Co-Production of Knowledge**

The co-production of knowledge became more than a challenge during the co-design stage, with two parallel processes that resulted in two HCs overlapping. One focused on the physical-territorial solutions to be built in the intervention area, with a licensing process and a public tender, and the second was dedicated to the social and cultural solutions that needed to be co-developed by the multiple stakeholders, within a community-driven process. The first one will be the territorial and green support for the second one, which will activate the use of public space by the local citizens.

The activities during the pandemic were mostly through online platforms, requiring a finely tuned agenda. This had the disadvantage of there being few spaces for open discussions. During the preparatory meetings, the local decision-makers revealed a prioritisation of technical projects over the needs expressed in the participatory process, that is over the issues of interest community-based. This occurs within a context marked by a conventional hierarchy of knowledge, technical advice taken as decisive in decision-making, and a certain amount of distrust of the participatory processes based on previous failure experiences. This distrust in relation to the completion of the project is also grounded in previous experiences of the citizens.

Speeches from politicians reinforced the co-production methodologies as the opportunity for municipal professionals to learn and not only the opportunity to make decisions based on different knowledge. The public authorities realised that by themselves they did not have all the information on the territory, as noted by the community too. While this is not a formal institutional practice of co-decision, it represents the inclusion of knowledge produced by the community in the municipal decision-making process.

During the co-design phase, four online meetings were organised between all stakeholders. As part of the systematisation, two meetings took place online with the citizens and the technical team using TRIZ methodology (September 2020 and January 2021) to discuss and validate the proposals. Following this approval, the urban project was developed and a draft version was presented at an online meeting with all actors (November 2020). During this meeting, citizens made comments and suggestions and developed four spaces in detail: the Old Falcão Farm as a social market with cultural activities, the space for sports activities, the sensorial garden, and the open-air auditorium. Figure 1 is an example of the use of online tools to co-design spaces.





**Figure 1.** Online co-design meeting toward four proposals, 7 November 2020.

Beyond the online meetings, the community-based knowledge reflected in the citizens' proposals was systematised, analysed, and improved by technicians from different departments using a collaborative Microsoft Excel file. However, there were some challenges, such as the hindering of greater interaction between technicians and citizens, the difficulties of scheduling meetings, the time-consuming aspect for technicians committed to activities beyond their department responsibilities, the translation of technical terms, the technical discourses associated with a certain hierarchy of governance, and the usual interdisciplinary bottlenecks as well. Despite this, in the interviews, citizens indicated that the actions were perceived as collaborative and reinforced the desire for greater interaction with local public authorities and municipal technicians.

### 5.5. The Degrees of Co-Production

Considering that co-production can take on different nuances, based on the co-production of NBS projects, propose five degrees of participation: information, consultation, collaboration, co-decision, and empowerment (DGRI, 2021). Co-production begins with a degree of collaboration when the decision-making takes the stakeholders' recommendations into consideration. Under the co-decision type, cooperation with stakeholders is directed towards an agreement on a solution and implementation. Finally, the degree of empowerment means the delegation of decision-making on the project development and implementation by the stakeholders (DGRI, 2021). Other authors, such as Brandt et al. (2013), establish four levels taking into consideration 104 co-production cases analysed: information (one-way communication), consultation (closer communication, including response), collaboration (participants having notable influence), and empowerment (practitioners having decision making authority). In this way, results from the co-diagnostic, co-design, and co-implementation stages demonstrated different levels of co-production for the HCs dimensions and more opportunities for active involvement of the agents within the social and cultural solutions, as detailed in Table 5.

**Table 5.** Degree of co-production based on HC dimensions in Porto.

HC dimensions	NBS	Co-production stage	Degree		
Social and cultural solutions	Solidarity market	Co-design	Co-decision		
	Campanh'UP				
	Heritage routes				
	Community urban garden				
	Walks with yoga				
	Community kitchen			Co-Implementation	Empowerment
	Educational living laboratory				
Physical-territorial solutions	Paths	Co-design	Collaboration		
	Green areas				
	Old Falcão Farm				
	Autochthonous forest				
	Retention basins			Co-implementation	Informative
	Wildlife garden				
	Natural amphitheatre				

In the case of URBiNAT, collaboration and informative levels occur due to the physical and territorial solution requirements being less permeable to non-technical knowledge. Co-decision and empowerment happen because social and pedagogical proposals are anchored in citizens' active involvement. The solidarity market in Porto or the urban garden in Nantes are self-organised by members of the community and local associations and can be considered an empowered initiative that emerges based on autonomy and community-based resources. The open-air amphitheatre in Porto and Sofia was proposed by the citizens in the co-diagnostic and co-design stages, but the solution was developed by the local technical teams.

## 6. Conclusions

In this article, co-production is viewed as vital in the nature-based transformation of urban neighbourhoods, in particular in social housing and vulnerable areas. This article aims to answer the research question of under what conditions co-production processes effectively promote active involvement of citizens in urban regeneration and NBS implementation based on empirical cases from the URBiNAT project, which gathers diverse evidence on co-production dynamics in Porto and other follower and front-runner cities. The evaluative research perspective adopted helps to unveil the particularities of the co-production process and move towards a deeper understanding of its implementation and may contribute with new narratives and new strategies to overcome limitations and barriers.

According to the bibliography validated in URBiNAT, there are many benefits from this co-production perspective, including the expansion of access, inclusion, long-term participation of multiple stakeholders, and mutual learning because it informs decision-making processes within the NBS design, implementation, and long-term stewardship, and also improves accountability strategies, thus making the process more transparent.

Participation and discussions around NBS are generally established in a positive way. The assessment based on citizens' perception (and researcher lens) has been crucial to correct deviations and to systematise lessons learnt. An example is the activation of local task forces, which has been essential for the vitality of

co-production locally; however, measures to guarantee the representation of the underrepresented groups were insufficient.

The co-production dynamics revealed a healthy environment for participation, but the levels of interaction between the different agents were not the same. The degree of co-production is influenced by a hierarchy of knowledge, demonstrated by the HC dimensions. The distrust and predominance of discursive legitimacy on technical perspectives reduced the possibilities for displacing the frontier between technical and empirical knowledge. The techniques proved to be useful in consolidating the project's co-productive path in the present; however, the concern related to the future of the HCs after the completion of the project and the professional team leaving the community area needs to be part of the corridor's transversal strategy.

To overcome the limitations of participation, international recommendations are needed to develop a participatory culture that changes the mindset of the urban planning actors. There is a need to establish management tools at a local level, such as an alderman for citizen participation (as in Brussels municipality, a URBiNAT city), local offices to promote participation (as in Nantes Metropole, a URBiNAT city), and participatory mechanisms to engage citizens, professionals, technicians, and elected representatives.

More research and future scientific frameworks to evaluate the NBS co-production practices in detail will be an occasion to explore the virtuous relation between science and the political sphere and to contribute to the amplification of the theories on urban regeneration. In fact, this kind of assessment of NBS promotes not only their improvement and politicisation but also helps NBS solutions to move closer to their main eco-social transformative goals.

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### Conflict of Interests

The authors declare no conflict of interests.

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