

## 1    1. Introduction

2    Nature-based solutions (NbS) are an opportunity to address environmental and social challenges within urban  
3    contexts. With half the world population residing in cities since 2017 (United Nations [UN], 2019),  
4    environmental challenges such as climate change-related impacts, ecosystem degradation, infrastructural  
5    degradation, and societal wellbeing, poverty, and unemployment, and lack of social cohesion will impact more  
6    people more frequently. NbS are no-regrets solutions (Intergovernmental Panel on Climate Change [IPCC],  
7    2007) that provide multiple services and benefits derived from ecosystem functions. These ecosystem services  
8    can contribute to alleviate these challenges such as lowering urban temperatures, controlling flooding,  
9    enhancing identity, increasing biodiversity and providing a platform for social interaction (Millennium  
10   Ecosystem Assessment [MEA], 2005). NbS are being employed in different parts of the world and at different  
11   scales with a preponderance of top-down approaches. While top-down approaches may provide results to  
12   address some of the environmental challenges, including citizens and their communities in the planning and  
13   design processes ensures equity and long-term sustainability.

14   Participatory approaches to NbS planning and implementation are needed to effectively accrue environmental  
15   and societal benefits (Frantzeskaki, 2019) in both the immediate and long terms. Participation in this  
16   manuscript is meant to include the involvement of individual citizens or residents and their communities in the  
17   planning process. Participation provides communities and individuals with the opportunity to weigh in on  
18   projects especially if they are beneficiaries of various ecosystem services (ES) (Schröter et al., 2017) delivered  
19   by NbS. The employment of participatory approaches to NbS is important because it enables acceptance and  
20   adoption of solutions by citizens due to deeper understanding and therefore faster uptake and mainstreaming  
21   of the concept (Kumar et al., 2020). Participation allows the incorporation of local and indigenous knowledge  
22   into urban planning and design processes (Dhar & Khirfan, 2016) and increases social resilience that is crucial  
23   for climate change adaptation (Koefoed, 2019). Furthermore, participation ensures a sense of ownership of the  
24   project planning process and outcomes (Ferreira et al., 2020). This article surveys the literature in depth to

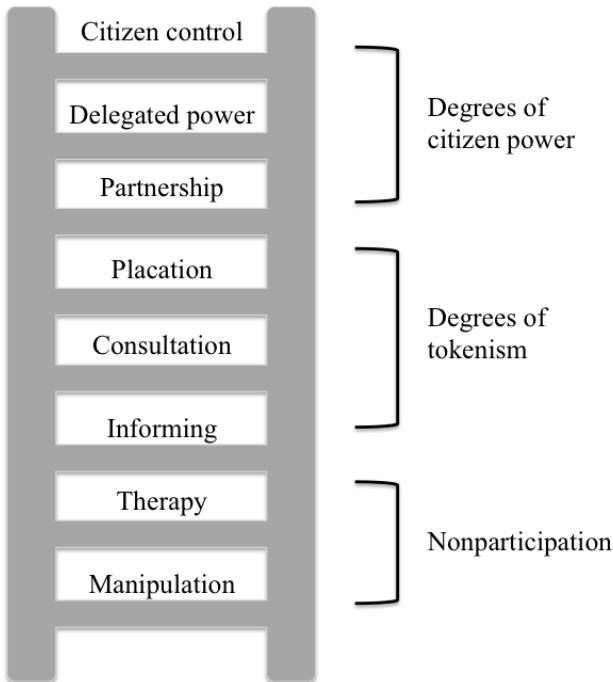
25 assess the extent to which participation is used in real-world projects that incorporate NbS and the employed  
26 different depths of participation, as defined by Arnstein (1969).

## 28 **1.1 Levels of participation in urban planning and design**

29 Participation has long been present in urban design and planning (Cushing & Renata, 2015), with strong  
30 traditions in the UK, US and Canada. Much of the literature on participation has established the importance  
31 and need by way of theoretical discussions, policy recommendations, and sign-posting future research  
32 directions (Loft et al, 2015; Randrup et al., 2016; Voytenko et al., 2016). By contrast, empirical data and real  
33 world case studies that employ participation are not equally prevalent in the literature (Ferreira et al., 2020;  
34 Kumar et al. 2020; Menconi et al., 2020). This may be because projects are not documented or published in  
35 peer-reviewed journals, or documented elsewhere such as grey literature and dedicated websites. Therefore, in  
36 peer-reviewed academic literature, there is a discrepancy between the theoretically mapped and recommended  
37 pathways to participation and their realization (Wamsler et al., 2020b). Moreover, there is a lack of connection  
38 between real world case studies and the development of theory of participation (e.g. Kumar et al., 2020). This  
39 literature review seeks to bridge this gap by linking theory and practice.

40 A key element to bridging the gap between participatory theory and practice is the understanding and  
41 classification of the different levels of citizen participation. In her seminal article published fifty one years  
42 ago, Arnstein (1969) continues to provide the basis for a robust classification of the different levels of citizen  
43 participation. The classification is organized into eight ‘ladder rungs’ of participation (Figure 1) providing a  
44 continuum from non-participation to total immersion (i.e. power is delegated to citizens) in the planning  
45 process. The lower rungs are ‘manipulation’ and ‘therapy’ educating people with a top-down approach. The  
46 middle rungs are ‘informing’, ‘consultation’ and ’placation’ representing tokenism where participants are  
47 heard with no guarantee that their contribution will affect the planning outcome. It is at the three upper rungs  
48 (‘partnership’, ‘delegated power’, and citizen control’) of the ladder where the highest level of participation is  
49 found. Attaining the highest levels of participation is an indication of the level of democratic processes of a

50 society, allowing citizens to share and potentially control the planning process. It is these middle and higher  
 51 rungs of participation that prompt this investigation to explore the extent of deployment in real world NbS  
 52 projects. The work of Arnstein (1969) has become the basis for many, pursuant research on participation  
 53 prompting variant classification schemes of levels of participation.



54  
 55 **Figure 1 Ladder of participation, reproduced from Arnstein (1969)**  
 56

57 Arnstein's classification is still referenced by many authors working on participation (Baum, 2015) often  
 58 providing a conceptual basis for the development of new measurement tools and classification frameworks  
 59 (Kindon et al., 2007). The original work by Arnstein emerged from within the urban planning discipline.  
 60 Pursuant work that categorizes levels of participation is rooted or influenced by Arnstein that is either applied  
 61 within urban planning or adopted into other disciplines. The work by Davidson (1998), known as the 'wheel  
 62 of participation', measured community involvement in planning on a four-level scale (i.e. inform, consult,  
 63 participate, and empower) with three sub-categories providing varying depths of involvement for each main  
 64 category. Tippett et al. (2007) built on this wheel to inform participation in ecological and environmental  
 65 planning. Lawrence (2006) created a synthesis of participatory approaches, classifying existing frameworks

from Arnstein (1969), Pretty et al. (1995), Farrington (1998) Nelson and Wright (1995) across four levels of participation (i.e. transformative, collaborative, functional, consultative). Similarly, Kindon et al. (2007) categorized existing frameworks from Arnstein (1969), Hart (1992) and Pretty et al. (1995) along a ‘participation continuum’ from co-option to collective action. Rau et al. (2011) developed the ‘participation pyramid’ for application in the renewable energy sector to assess acceptance of new technologies. Luyet et al. (2012) focused on stakeholder participation in environmental projects, measuring five ‘degrees of involvement’: empowerment, co-decision, collaboration, consultation, and information. While Wilker et al. (2016) adopted the same framework for green infrastructure planning. Similarly, Soma et al. (2018) focused on ‘stakeholder contributions’ with five categories that include stakeholder-based initiatives, government-based initiatives, science-based initiatives, voting, and no responsibility. Furthermore, the ‘public participation ladder’ by Wiedemann and Femers (1993) was developed for the field of risk communication and conflict management in waste management. Wiedemann and Femers ladder employs six levels of public participation as follows: public partnership in the final decision, public participation in assessing risk and recommending solutions, public participation in defining interests and determining the agenda, public right to object, informing the public, and the public right to know. Following Wiedemann and Femers (1993), Bizjak et al. (2017) applied the ‘public participation ladder’ to assess public participation in the use of social media tools. Finally, the International Association for Public Participation (IAP2) developed a framework (2009) which is not extensively referenced, but has almost identical categories that of Luyet et al. (2012). This framework has been applied to assess the public’s role in any public participation process. Ambrose-Oji et al. (2011) based their ‘spectrum of public participation’ on the IAP2 framework, specifically developed for forest and woodland planning with four levels of participation (i.e. partnership, involve, consult, inform). It is evident that the classification and categorization frameworks presented are directly based on, or influenced by Arnstein (1969), making her contribution foundational to the literature on participation. In this article, we have chosen Arnstein’s ladder of participation as the basis for the different levels of participation used in the analysis of the reviewed literature on participation and NbS. We focus on the highest levels of

91 participation (consultation, placation, partnership, delegated power and citizen control) to explore the levels of  
92 deployment in in NbS projects.

## 93 94 **1.2 Nature Based Solutions and participation**

95 Nature-based solutions (NbS) have been rapidly gaining attention within the fields of landscape architecture,  
96 urban planning and design and the sciences around the built environment since the publication of the  
97 Millenium Ecosystem Assessment (MEA, 2005). This report highlighted the blight of ecosystems worldwide,  
98 but also shed light on benefits that society can accrue from natural systems. These benefits or ecosystem  
99 services (ES) are defined as “functions and processes of ecosystems that benefit humans, directly or indirectly,  
00 whether humans perceive those benefits or not” (Costanza et al., 2017, p. 5). Furthermore, NbS are defined as  
01 “actions to protect, sustainably manage and restore natural or modified ecosystems that address societal  
02 challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits”  
03 (Cohen-Shacham et al., 2016, xii). As such, NbS are actions based on ‘living solutions’ that deliver and realize  
04 ES, where NbS is an umbrella term that inherently encompasses ES (Albert et al., 2017; Ferreira et al., 2020).

05 NbS are spatial and physical measures that deliver multiple benefits across different types of interventions.  
06 NbS benefits can be categorized under the four ES categories (MEA, 2005): provisioning, regulating, cultural,  
07 and supportive (MEA, 2005). NbS initiatives are mostly multifunctional (Ferreira et al., 2020) where multiple  
08 benefits are simultaneously delivered from a single project. For example, urban community gardens contribute  
09 to food provision (provisioning services) as well as an opportunity for social interaction and connection with  
10 nature (cultural services) (Rosol, 2010). Similarly, different NbS types such as parks, street trees, urban  
11 forests, urban agriculture, swales, rain gardens, green roofs, and green walls provide single or multiple  
12 benefits that include but not limited to recreation, water management, temperature regulation, pest control, soil  
13 formation and education (Ferreira et al., 2020). To ensure the delivery of these benefits, NbS solutions need to  
14 be well designed, engineered and implemented. While technical aspects guarantee proper functioning of NbS  
15 systems, the key to long term sustainability and continued delivery of ES resides in participation of the public

16 in project formation and stewardship as well as the public's perceptions, awareness and acceptance of NbS  
17 (Frantzeskaki, 2019; Wamsler et al., 2020b).

18 The nexus of public participation and NbS is relatively young. The research literature on NbS is abundant with  
19 studies that address types of benefits accrued (Cohen-Shacham et al., 2016); applications to environmental  
20 challenges such as water and climate change (Koefoed, 2019); and policy focused studies providing  
21 approaches and frameworks to mainstream NbS policies (Cohen-Shacham et al., 2016). The very few articles  
22 that address NbS and participation have primarily focused on methods and modes of participation, perception  
23 and acceptance of NbS. The recent review paper by Ferreira et al. (2020) addressed perceptions, preferences,  
24 and perspectives of the public towards NbS and participatory processes and methods. They find that  
25 "stakeholder and citizen participation is increasingly recognized as promising; however, research in several  
26 domains is still lacking" (p.1). In their book chapter, van Ham and Klimmek (2017) discussed participation in  
27 NbS from the perspective of partnership building based on real-world studies in urban areas. Their case  
28 studies suggest different levels and types of citizen participation in projects, where the deepest level reached is  
29 consultation. Similarly, while Cushing and Renata (2015) conducted a thorough landscape architectural  
30 literature review on trends within the discipline and concluded that both "sustainability and green  
31 infrastructure" and "participation and collaboration" have been increasingly widespread, they failed to connect  
32 the two notions and analyse the nexus.

33 Grey literature on NbS also provides some practical guidance on how to implement NbS that include  
34 methodological steps from inception to implementation as well as governance. The guide by Breukers and  
35 Jeuken (2017) developed a step-by-step manual on the process of co-production and co-creation of NbS. This  
36 includes six steps that begin with inception, inclusion of multi-tier stakeholders and providing guidance on  
37 maintenance after implementation through active participation. The underlying philosophy of the approach is  
38 intensive citizen and stakeholder participation in the project process with high citizen control across all project  
39 phases. On the other hand, the Nature-based Solutions Handbook (Somarakis, et al., 2019) provides detailed  
40 explanation on how to develop NbS projects. In the sections on design, planning, and implementation,

41 participation is included as a generic planning theme rather than a fundamental planning approach. To our  
42 knowledge, the peer-reviewed and the grey literature in this introduction do not provide sufficient insight to  
43 the employment and analysis of different levels and depths of participation in NbS.

44

45 Since this literature review assesses the levels of participation in NbS in real world projects, it is essential that  
46 assessment is done against implementation criteria. We have identified five criteria for deeper assessment and  
47 analysis of the different participatory levels, across the selected sample of manuscripts for this literature  
48 review. We briefly describe their significance and relation to participatory levels. The way these criteria are  
49 used in the study is explained in the methods section.

50

51 Understanding levels of participation (Arnstein's ladder) against the first implementation criteria: 'mode of  
52 participation' (analogue or digital) and the second implementation criteria: 'facilitator tools' inform which  
53 methods and tools are used to implement different NbS solutions at what level of participation. In a digital  
54 age, it is important to examine to what extent digital technologies, tools and platforms are present (or not) in  
55 the facilitation of different levels of participation. Including the first criteria allows for definition of gaps and  
56 potential future focus in a world that is increasing in its virtual connectivity. The third implementation criteria  
57 is 'framework for implementation'. In a world where complex and global issues (i.e. climate change,  
58 ecosystem degradation and loss, and epidemics) are on the rise, frameworks are necessary to dissect issues and  
59 provide easy to understand processes for implementation. A 'framework for implementation' provides a  
60 structure, a sequence of steps, a set of tools, an inventory of stakeholders, making it easier to manage and  
61 facilitate participation in a project, while maintaining focus on the aims and expected outcomes. Frameworks  
62 for implementation are important for more complex projects as they help create action plans, define goals and  
63 can facilitate bringing various stakeholders to collaborate. Matching different 'frameworks for  
64 implementation' in the literature with different levels of participation helps to identify appropriate approaches  
65 in planning for and addressing specific environmental and societal issues, along with the appropriate level of

56 participation.

57 The last two criteria focus on the different scales of the subject matter addressed in the literature at the nexus  
58 of participation and NbS. These two criteria are ‘overarching environmental theme’ and ‘NbS focus’. At the  
59 macro level, understanding the relationship between an ‘overarching environmental theme’ (e.g. climate  
70 change, water management) and the participatory level makes a significant difference in how each case study  
71 informs the development of the field. This should help inform strategic leadership, policymaking and  
72 management to mainstream NbS and widen social acceptance on particular environmental avenues. At the  
73 micro level, within ‘NbS focus’ we distinguish ‘overall concept’ with cases treating NbS solutions as a  
74 complex matter with no single thematic focus within, but simultaneously considering multiple themes in a  
75 comprehensive manner as a system of different NbS elements functioning in unison. Regarding the single  
76 thematic focus within ‘NbS focus’ (e.g. urban agriculture, water), these reveal specific trends and gaps within  
77 a niche where more participatory projects could be employed focusing on specific NbS components. The  
78 analysis of inter-relationships between the depths of participation and the five criteria helps to map where does  
79 current research stand in employing participatory approaches to NbS, reflect on strong relationships and  
80 identify gaps to inform future research.

81 In order to employ NbS focused participatory approaches to design and implement more democratic  
82 ecological solutions for our future landscapes and utilise a broader knowledge-base, it is important to  
83 investigate to what extent these participatory approaches are currently being employed in urban planning and  
84 design. The literature was studied to establish relationships between the level of participation and the different  
85 aspects of implementation, thus informing future research and application to enable the advancement of these  
86 solutions to the widest extent. While several reviews on the theoretical aspects of participation in NbS have  
87 been completed (e.g. Loft et al., 2015; Nesshöver et al., 2017), here we are solely focusing on real-world cases  
88 in the upper rungs of Arnstein’s ladder, wherein lies the novelty of this paper.

89 The literature review and the broad analysis were carried out to answer the following research questions:

- To what extent do real-world NbS projects employ deeper levels of participation and different modes of delivery?
- What is the relationship between the levels of participation and its modes of delivery?

## 94 2. Methods

95 To present a structured overview of the evidence related to participatory approaches advancing the  
 96 employment of ES and NbS, a comprehensive review was conducted, similar to a scoping study.

### 98 2.1 Data sources and search terms:

99 Two databases, Science Direct and Scopus were searched with the assistance of a librarian, who ensured a  
 00 comprehensive and systematic search. The search was completed on 18-19 March, 2019 and further refined in  
 01 June 2020. After several test searches and discussions on keywords, the research team searched for the phrase  
 02 "civic ecology" or the combination of the below two concepts and related keywords using truncation and  
 03 wildcards.

| Concept 1: Participatory   | Concept 2: NbS   |
|--|--|
| cooperative OR cooperation OR coproduction OR<br>"active citizenship" OR "citizen science" OR<br>"bottom up" OR "participatory action research" OR<br>participation OR participatory OR "deliberate<br>experimentation*" OR "sustainable neighborhood"<br>OR "learning by doing" | "nature based solution" OR "green<br>infrastructure" OR "ecological design"<br>OR "green urbanism" OR "ecological<br>infrastructure" OR "ecosystem based<br>adaptation" OR "urban green space" |

04 **Table 1 Search keywords used for the search concepts: Participatory and NbS**

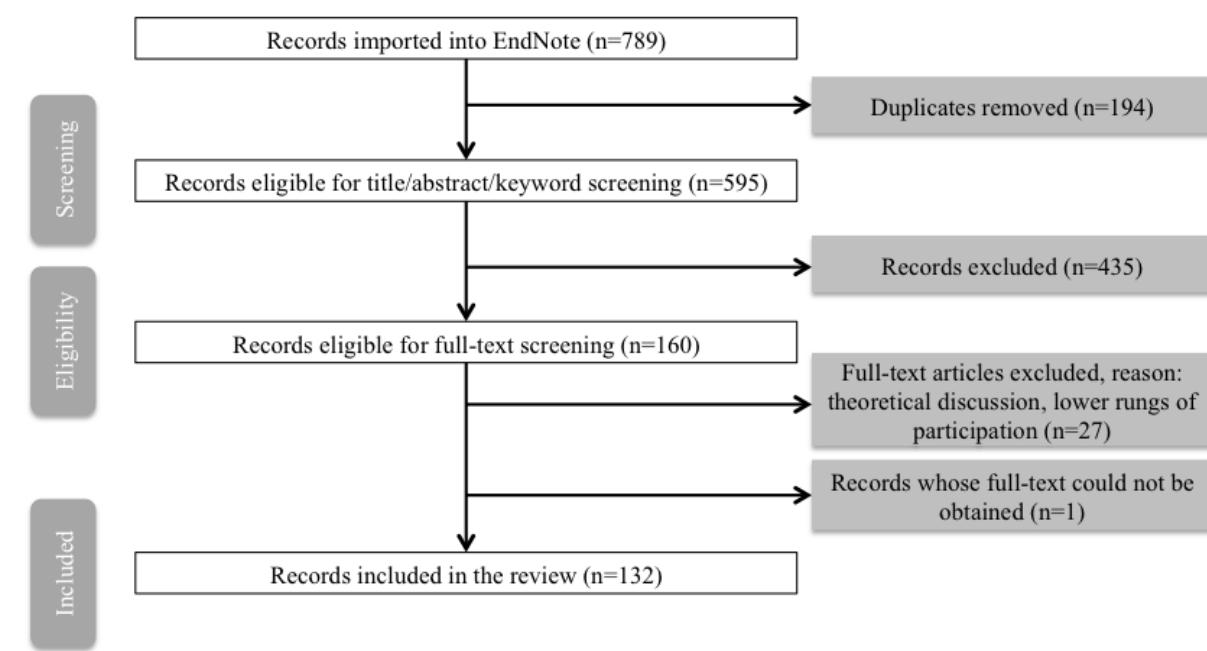
05  
 06 **2.2 Eligibility criteria:**

07 There were no limitations applied with respect to publication year, language or geographical location. Eligible  
 08 materials included: journal articles, books/book chapters, theses/dissertations, conference papers/proceedings,  
 09 and reports. Abstracts, posters and oral presentations were excluded.

10

11 **2.3 Search and selection process:**

12 The search yielded 789 manuscripts, which were imported to a bibliography managing software (EndNote®).  
 13 Following the elimination of 194 duplicates, 595 items were exported to Microsoft Excel to be screened by  
 14 two reviewers against exclusion criteria. Exclusions were based on the following considerations: relevance of  
 15 topic, level of participation, and manuscripts with theoretical focus and no implementation element (i.e. no  
 16 real-world case study). Relevance of topic was assessed based on spatial focus (i.e. urban or non-urban) and  
 17 evidence of inclusion of the two search concepts (see Table 1.) (e.g. some manuscripts contain ‘participatory’  
 18 as a keyword, but in fact do not employ the concept). The level of participation is measured against Arnstein’s  
 19 ladder of citizen participation (1969). Only items in rungs 4 – consultation to 8 – citizen control are included  
 20 since the focus of this review is deeper levels of participatory approaches. Lastly, items with theoretical focus  
 21 are also omitted, as the focus is on real-world cases. Following the procedure in Figure 1, the final number of  
 22 documents reviewed was 132.



23

**Figure 2 Flow chart of selection process****2.4 Data extraction and synthesis of results:**

To study the nexus of NbS and participation, we classified and analysed the reviewed literature assessing the depth of participation and according to five additional criteria. We created a table containing all 132 manuscripts (see Appendix B), which were then evaluated across six domains, and this table acted as a framework for the analysis.

The first column, ‘Level of participation’ is the basis of comparison with the other columns (e.g. relationship between the ‘Level of participation’ and ‘Mode of participation’). And based on Arnstein (1969), includes: citizen control, delegated power, partnership, placation and consultation (rungs 4 to 8).

The second column is ‘Mode of participation’, which is either analogue/offline, digital/online or blended/hybrid combining the two former. The third column, ‘Facilitator tool’ or mechanism of participation, includes qualitative information for scientists and professionals. Under each case study, the methods and tools of engagement are listed (e.g. survey, charrette, modelling) and can be used as a practical resource to choose facilitating methods for future projects. The fourth column is ‘Framework for implementation’, which is binary, either there is or there is not. Manuscripts with a framework for implementation are listed with the specific ones used, again to benefit future research. The fifth column, ‘Overarching environmental theme’ has four values: environmental stewardship; resilience, climate change; biodiversity, conservation and environmental governance, management, planning. This categorizes the cases according to the broader subject addressed. The sixth column is the ‘Nature-based solutions focus’ column, where seven values are listed: overall concept, cultural ES (CES), urban green space (UGS), urban gardening (UG), urban agriculture (UA), urban forestry (UF) and water provides more detailed subject focus. These ‘higher level’ value groups were accrued of various niche topics, listed in Appendix A. This was done for ease of analysis and because some terms are equivalent or very similar (e.g. ‘environmental management’ and ‘natural resource management’).

The basis of defining typologies was their emergence in the reviewed literature. Some of the categories are not mutually exclusive: urban green space; urban forestry; urban agriculture; urban gardening. However, there are

49 significant differences justifying the division. Urban green space can refer to more general types of urban  
50 green, for example parks and green corridors (e.g. Bonnes et al., 2007). Urban forestry is a specific typology  
51 with its particular ES benefits (e.g. Fors et al., 2019). Urban agriculture is another distinguished category,  
52 delineating the cases explicitly stating sole focus on cultivation of edibles and food (e.g. Ackerman et al.,  
53 2014). Finally, urban gardening is again distinct and a category that substantially emerged in the reviewed  
54 manuscripts, with its particular ES benefits (e.g. Soga et al., 2017), noting that it can include growing food but  
55 also planting as therapy and horticulture without yielding edibles. Furthermore, urban gardening has specific  
56 ES benefits that are not assigned to the previously described ‘urban green landscape’ categories, for example  
57 social innovation for sustainable urban development, a space for awareness raising and education and a  
58 platform for other community activities (e.g. Cabral et al., 2017).

59 Finally, the last column references the reviewed manuscript. The table in Appendix B is designed to be a  
60 practical resource to assist researchers in selecting methods most suitable to the environmental projects they  
61 are designing.

62 Table 2 below provides a reference to scholars and practitioners in the field to understand the extent that  
63 participation is incorporated in NbS studies in relation to urban landscapes. Brief generalised results are  
64 presented showing overall trends and percentages from the total pool. In addition, connections and relations  
65 are further discussed in the discussion section.

### 66 67 **3. Results and discussion**

68 The results are presented to answer our research questions. The first research question investigates to what  
69 extent do real-world NbS projects employ deeper levels of participation and different modes of delivery. This  
70 is answered in section 3.1 and summarized in Table 2. Building on the findings of the first question, the  
71 second question is being answered consecutively. This question investigates the relationship between the  
72 various levels of participation and it modes of delivery, summarized in section 3.2 and Table 3, and unpacked  
73 in depth in sections 3.3-3.6.

### 3.1.Trends of Levels of Participation in NbS

The results show that conventional levels of participation dominate the literature on participation and NbS while the deeper levels are less utilized. In addition to the level of participation, the criteria of assessment are further explained in the text below and summarized in Table 2. The table contains the reviewed manuscripts broken down according to each category of analysis in a column that contains the appropriate sub-categories.

The columns are independent of each other.

| <b>Level of Participation</b>    | <b>Mode of Participation</b>     | <b>Facilitator tool or mechanism of participation</b> | <b>Framework for implementation</b> | <b>Overarching environmental theme</b>                 | <b>Nature-based solution focus</b> |
|----------------------------------|----------------------------------|---|-------------------------------------|--|------------------------------------|
| Citizen Control (7.5%)           | Analogue (62.9%)                 | Active citizenship                                    | No Framework (79.5%)                | Biodiversity, Conservation (9.8%)                      | Overall Concept (32.6%)            |
| Delegated Power (8.3%)           |                                  | Civic ecology, policy                                 |                                     | Environmental Stewardship (25.7%)                      | Cultural ES (6.8%)                 |
| Partnership (23.5%)              | Digital (12.1%)                  | Citizen science, design charrette, GIS                | Framework (20.5%)                   |  | Urban Green Space (17.4%)          |
| Placation (3.8%)                 |                                  | Policy, active citizenship                            |                                     | Resilience, Climate Change (20.4%)                     | Urban Gardening (11.4%)            |
| Consultation (47%)               | Blended (25%)                    | Survey, questionnaire, interview                      |                                     |  | Urban Agriculture (7.6%)           |
| Other (9.8%)                     |                                  |   |                                     | Environmental Governance, Management, Planning (43.9%) | Forestry (6%)                      |
| Total reviewed manuscripts: 100% | Total reviewed manuscripts: 100% | * See full list of qualitative values in Appendix B   | Total reviewed manuscripts: 100%    | Total reviewed manuscripts: 100%                       | Total reviewed manuscripts: 100%   |

**Table 2 Overall table of themes and results. Each column contains sub-categories and their percentage of the overall manuscripts. Each column is to be read separately. The ‘Facilitator tool/mechanism of participation’ theme has qualitative values and too many variables to allocate percentages for them, only examples corresponding with each degree of participation (Column 1.) were included.**

The results indicate that the most commonly applied degrees of participation in NbS projects are 'consultation' (47%) and 'partnership' (23.5%), while the deepest levels of participation, 'citizen control' (7.5%) and 'delegated power' (8.3%) have a significantly smaller share. On the other hand, analogue/offline 'mode of participation' was employed in 62.9% of the reviewed manuscripts, which may indicate a reluctance or barrier to incorporating digital approaches in participatory projects. Digital mode on the other hand scored a share of 12.1% of the reviewed literature. The 'facilitator tools' or 'mechanisms of participation' resulted in a varied and large number of entries preventing its presentation in this text. Table 2 includes the most typical tools found at each participatory level and appendix B includes an extensive list.

Levels of participation often dictate the type of 'facilitator tools' or 'mechanisms of participation' (e.g. the most common tool for consultation is survey, interview). For example, citizen control (deepest level of participation) requires active citizenship, where citizens organize themselves in a multiform manner, mobilize resources and act in the public interest in order to protect rights and take care of common goods' (Moro, 2012, p. 11). Therefore it is a particularly powerful mechanism for environmental stewardship and in some cases it can successfully change urban planning outcomes (e.g. Rosol, 2010; Thomas et al., 2016). Civic ecology can drive ecological conservation and restore biodiversity (e.g. Battisti et al., 2017) in the context of delegated power. Policy as a facilitator mechanism is crucially important as it enables and can urge participation (e.g. Tippett, 2005) and 'citizen science' (e.g. Rae et al., 2019) is gaining increased recognition, often going hand-in-hand with GIS (e.g. Raymond et al., 2016). Design charrettes (e.g. Dhar & Khirfan, 2016) are more resource intensive and complex therefore requiring a longer facilitation process for deeper participatory levels, such as partnership. Tools such as surveys (e.g. Larondelle & Haase, 2017) and interviews (e.g. Soga et al., 2017) are well-established ways to data collection and were used at multiple levels of participation, predominantly at the consultation level. The extensive list of 'facilitator tools' or 'mechanisms of participation' can be found in Appendix B.

When considering the implementation of frameworks to direct a project or research, the results show that close to 80% of the studies did not employ any framework for implementation, while the remaining 20% did. These

12 frameworks are either developed as part of a project (e.g. DesignWays, Tippett, 2005) or employ already  
13 existing ones (e.g. living lab, Derr, 2018).

14 As to the thematic focus of the literature, the study looked at overarching themes as well as specific NbS  
15 focus. Four main themes were identified as follows: ‘environmental governance, management, planning’  
16 (43.9%), followed by ‘environmental stewardship’ (25.7%), then ‘resilience, climate change’ (20.4%) and  
17 finally ‘biodiversity, conservation’ (9.8%). Seven focus areas were identified for NbS. 32.6% of reviewed  
18 items have addressed the overall concept of NbS rather than one specific aspect. The remaining six sub-  
19 categories address specific areas as follows: water (18.2%), urban green space (17.4%), urban gardening  
20 (11.4%), urban agriculture (7.6%), forestry and cultural ES both occur at 6.8%.

### 21

### 22 **3.2. Relating levels of participation to modes of deployment**

23 In addition to identifying overall trends, our analysis using a second matrix (Table 3) also resulted in  
24 identifying specific relationships that emerged from the literature and derived by mapping participation  
25 degrees with criteria related to mode of participation, framework for implementation, environmental theme  
26 and NbS focus. The number of articles at the intersection of categories and criteria are presented in Table 3.  
27 This matrix helped to identify related themes and the strongest relationships as derived from the literature. The  
28 discussed findings, identified with the matrix are as follows. The first is ‘dominant levels of participation:  
29 consultation and partnership’ and second ‘deepest levels of participation: citizen control and delegated power’.  
30 The third and fourth discussed relationships are ‘degree of participation with an analogue/offline mode’ and  
31 ‘degree of participation and absence of a framework for implementation’. The first two themes (dominant  
32 levels of participation and deepest levels of participation) are discussed in relation to the topical focus  
33 (environmental theme and NbS focus). The consecutive two sections discuss levels of participation in relation  
34 to the mode of delivery (mode of participation and framework for implementation). Based on the results of the  
35 literature review and the relationships identified in the matrix in Table 3, the following four sections discuss  
36 our findings.

| Degree of participation  | Mode of participation |                  |                  | Frame-work for impleme-tation |           | Overarching environmental theme |                           |                            |  | Nature-based solution focus |                   |                   |                      |                        |                     |       |
|--------------------------|-----------------------|------------------|------------------|-------------------------------|-----------|---------------------------------|---------------------------|----------------------------|--|-----------------------------|-------------------|-------------------|----------------------|------------------------|---------------------|-------|
|                          | Anologue / offline    | Digital / online | Blended / hybrid | No Framework                  | Framework | Biodiversity, conservation      | Environmental stewardship | Resilience, climate change | Environmental governance, management, planning | Overall concept             | Cultural ES (CES) | Urban green space | Urban gardening (UG) | Urban agriculture (UA) | Urban Forestry (UF) | Water |
| 8 - Citizen control (10) | 9                     | 0                | 1                | 10                            | 0         | 1                               | 5                         | 4                          | 0  | 0                           | 2                 | 2                 | 3                    | 2                      | 1                   | 0     |
| 7 - Delegated power (11) | 9                     | 0                | 2                | 6                             | 5         | 1                               | 8                         | 2                          | 0  | 4                           | 0                 | 2                 | 2                    | 1                      | 1                   | 1     |
| 6 - Partnership (31)     | 19                    | 0                | 13               | 15                            | 16        | 0                               | 10                        | 9                          | 12   | 11                          | 0                 | 3                 | 1                    | 4                      | 2                   | 10    |
| 5 - Placation (5)        | 3                     | 0                | 2                | 4                             | 1         | 2                               | 0                         | 0                          | 3  | 1                           | 0                 | 1                 | 0                    | 0                      | 0                   | 3     |
| 4 - Consultation (62)    | 39                    | 14               | 9                | 58                            | 4         | 6                               | 8                         | 9                          | 39   | 22                          | 5                 | 13                | 7                    | 2                      | 3                   | 10    |
| Other (13)               | 8                     | 0                | 5                | 12                            | 1         | 3                               | 3                         | 3                          | 4  | 5                           | 2                 | 2                 | 2                    | 1                      | 1                   | 0     |
| Total number of cases    | 132                   |                  |                  | 132                           |           | 132                             |                           |                            |  | 132                         |                   |                   |                      |                        |                     |       |

**Table 3 Matrix showing the number of articles for each type of participation, mapped against ‘mode of participation’, ‘framework for implementation’, ‘overarching environmental theme’ and ‘nature-based solution focus’.** (Grey shading marks the highest number of cases occurring, indicating a strong relationship. Zeros mark the total absence of cases.)

### 3.3. Dominant levels of participation: Consultation and partnership

‘Consultation’ is the dominant participatory level found in the reviewed literature followed by ‘partnership’. ‘Consultation’ represents a middle level of tokenism (Arnstein, 1969) and was widely used in 63 manuscripts out of 132. ‘Partnership’ was used in 31 documents out of 132 and represents a higher level of citizen engagement and some control (Arnstein, 1969; Kindon et al., 2007, Wiedemann & Femers, 1993). The prevalent use of these level of participation in urban planning and design may very well be an indicator of the nature of the field where projects and policy processes require the combined involvement of expert planners, citizens and policy makers. The following will present both categories in lieu of the reviewed literature.

Firstly, we found that in the reviewed literature the wide employment of participation at the ‘consultation’ level is mostly due to research focus on assessing user behaviour, preferences and values associated with green spaces (parks and urban gardens in particular, e.g. Barau, 2015; Ives et al., 2017;). Literature at ‘consultation’ level is important in informing future urban planning and development practices; however, it is

56 not yet known to what extent available findings inform practices. Secondly, the widespread occurrence of the  
57 ‘partnership’ level can be due to increasing recognition of citizens as partners by researchers and  
58 municipalities around the world (Lovan et al., 2017). There is a growing number of research projects (e.g.  
59 Purtik et al., 2016) as well as community projects (e.g. Jordan et al., 2019) where citizens are enabled to  
60 design, work with and/or co-manage spaces and/or infrastructural elements (e.g. water, Meyer et al., 2018).  
61 Lastly, the expanding availability of new tools and technologies also increases the capability to facilitate  
62 participation at various depths (Fradera et al., 2015), opening up possibilities to further projects at  
63 ‘consultation’ and ‘partnership’ levels.

64

65 The overarching environmental focus of manuscripts employing ‘consultation’ and ‘partnership’ are  
66 environmental governance, management, and planning with most cases working at ‘consultation’ level. This  
67 topical focus is hardly surprising since some of the major barriers to the advancement of NbS are situated in  
68 governance and policymaking (see e.g. Travaline et al., 2015) as well as urban and landscape planning (see  
69 e.g. Pichler-Milanovič & Foški, 2015). In addition, management and maintenance are also on-going  
70 challenges since governments globally struggle with the upkeep of public spaces (see e.g. Everett & Lamond,  
71 2018). This topical focus begins to be extensively mentioned starting 2005 with gradually increasing  
72 proliferation until the present.

73 The second most discussed topic is environmental stewardship, corresponding with ‘consultation’ and  
74 ‘partnership’, and to a lesser extent, ‘delegated power’ and ‘citizen control’. Notably, most of the reviewed  
75 literature is very recent, dating from 2016. Resilience and climate change (e.g. Lien & Brown, 2018) have the  
76 third-highest share across the environmental theme. This may be attributed to the timely publication of the  
77 IPCC report (2007), which first drew attention to the significance of adaptation measures to address future  
78 uncertainties and resulting vulnerabilities, where NbS are identified as key climate change adaptation  
79 strategies (Infield, et al., 2018).

31 The literature that employs the two dominant levels of participation present and discuss NbS in two forms.  
32 First, as an ‘overall concept’ that includes multiple thematic foci and treated as a holistic system such as the  
33 ‘EcoDistricts Concept’ (Seltzer et al., 2010) or community values for natural capital and ES (Raymond et al.,  
34 2009). Second, as a ‘single theme focus’, where a specific sub-theme or component of the NbS system is  
35 discussed such as the Urban Green Spaces (UGS) by Shibata et al. (2011) and ‘Sustainable Drainage Systems’  
36 (SuDS) by Rae et al. (2019). The majority of the studies were published starting in 2005 coinciding with the  
37 publication of the *Millennium Ecosystem Assessment Report* (2005). Our results show that the majority of the  
38 reviewed literature is focused on presenting NbS as an overall concept rather than on specific measures or  
39 themes. These include approaches that explain the wider NbS approach (Wolch et al., 2010), ensure inclusion  
40 of particular societal groups, for example people with learning disabilities (Mathers, 2005), and widening  
41 participation in selecting key ES for valuation methods (Kelemen & Gómez-Begethum, 2008). Regarding  
42 literature with a single theme specific focus, a notable correlation is the first appearance of UGS in 2006,  
43 which became increasingly present since 2012 (Ferreira et al., 2020), in parallel with research on urban heat  
44 island effect and its mitigation. Furthermore, many studies aim to understand better the green space user needs  
45 and behaviours (consultation) to allow creating more UGS addressing local needs. The majority of ‘overall  
46 concept’ cases and cases focusing on UGS, water and UG are situated at the ‘consultation’ level.  
47  
48 The dominance of ‘consultation’ and ‘partnership’ levels in urban planning and design may explain a trend  
49 towards a mix between maintaining the decision making process with experts and policy makers while  
50 allowing some level of public participation. While the authors believe that these two modalities will remain  
51 dominant, there is ample space to improve the participatory processes, enhance the modes of delivery and  
52 ensure that they do not end up as mere tokenism.

53  
54

#### **3.4. Deepest levels of participation: Citizen control and delegated power**

According to Arnstein's ladder (1969), the highest forms of participation are citizen control and delegated power, respectively. In the reviewed literature, we found a small number of cases where 'citizen control' was utilized in 10 manuscripts and 'delegated power' in 11 out of 132, respectively. This indicates that despite of the theoretical literature advocating for projects at these higher rungs of participation, their uptake in empirical cases remains low (Dennis et al., 2016). Some of the risks and advantages of deeper participation are summarized in existing literature (Luyet et al., 2012). Considering associated risks, higher costs and longer timescales to achieve, it is still of high value that urban planners and designers aim to facilitate higher levels of participation for three main reasons. The first reason is that urban design and planning should be a more democratic process (Fainstein, 2010) where peoples' will is better represented. Secondly, people also need to feel ownership of their neighbourhood and urban spaces thus they are more willing to help with the maintenance and management of these spaces (Wongbusarakum et al., 2015) after implementation. Thirdly, if people are involved from the initial project phases, professionals can utilize citizen science throughout the whole project cycle (Jordan, 2018). These are crucial points and becoming more relevant to successfully address challenges in today's era of climate emergency. Top-down policy solutions are required to resolve some of the large scale environmental and climate related problems; but ensuring sustainability of these solutions requires a change of attitude and perception of people. Moving towards deeper levels of participation will probably contribute to changing attitudes through local empowerment and therefore, contribute to sustaining long-term solutions at the local and global scales.

However, successfully facilitating these highest forms of participation is challenging. This is due to factors of longer timescale requirements, lack of adequate budgets, the need for an interdisciplinary team and lack of institutional and regulatory frameworks (Wamsler et al., 2020b). Most research projects choose to target a lesser rung on the ladder, and the cases we found at the 'citizen control' rung mostly consisted of citizen activism (e.g. Shibata et al., 2011) and civic ecology (e.g. Tidball et al., 2018), which are forms of grassroots initiatives. This explains the complete lack of a framework for implementation in this rung, as activism seems

30 to focus on specific tangible topics and grassroots initiatives grow in an organic manner. Arguably, efficient  
31 and responsive targeting of the overall concept of NbS requires a framework for implementation to address  
32 complex challenges. Balancing the need for a framework for implementation and deep participation is a  
33 challenge and surely a gap to address. Potentially, a framework for implementation that addresses the  
34 specificities of deeper participation could help bring grassroots activists, scientists and decision-makers to  
35 work together, develop a clear action plan in a targeted manner and help embedding different stakeholder  
36 groups' interests, aims and expected outcomes under the wider NbS umbrella.

37 Some manuscripts have utilized a framework for implementation at the 'delegated power' rung (Seltzer et al.,  
38 2010). Applying these frameworks in further action research would be valuable for exploring possibilities of  
39 delegating control to citizens. Furthermore, we found that 'delegated power' is mostly based on active  
40 citizenship (e.g. Chou et al., 2017) and employed in research projects utilizing the 'collaborative learning lab'  
41 approach (e.g. Derr, 2018) since 2016. At this rung, we found an almost equal number of manuscripts with  
42 and without a framework for implementation.

43  
44 The main overarching environmental theme that the deepest levels of participation include is environmental  
45 stewardship, which corresponds with the grassroots nature of citizen control cases. Seeing the close-knit and  
46 community-focused nature of cases in these two upper rungs explains why almost all of the cases facilitate  
47 participation using conventional modes with analogue (offline) applications. In addition, the focus on  
48 environmental stewardship at the deepest level of participation further justifies the offline nature of these  
49 cases. Environmental stewardship in NbS cases are primarily focused on physical and action-based activities  
50 emphasizing their physical and hands-on nature. This is demonstrated in manuscripts that present projects that  
51 increase urban tree canopies in New York City (Million Trees NYC; Fisher et al., 2015) or civic greening  
52 initiatives in Milwaukee (Roy, 2011) or community gardening organizations (Krasny & Tidball, 2015). Of  
53 interest as well is the example of collaborative learning and how it can strengthen the adaptive capacities of

54 complex socio-ecological systems via an Urban Learning Lab (physical) model set up in a Ljubljana  
55 (Slovenia) neighbourhood (van der Jagt et al., 2019).

56 When matching NbS thematic focus with ‘citizen control’, the themes are distributed across four areas: CES,  
57 UGS, UG and UA. To illustrate, one case focuses on cultural ecosystem services where a highly deprived  
58 neighbourhood found a way to claim environmental justice and build cultural pride for African Americans in  
59 the US via activism to protect their neighbourhood and organising clean-ups (Brennan, 2019). Another  
60 example realised community gardens as forms of protest against housing developments that increase urban  
61 density (Rosol, 2010). UG thus becomes a notion to reclaim land in an ethnically and socioeconomically  
62 diverse manner (Harper & Afonso, 2016).

63 Literature addressing NbS in a holistic manner (meaning a systemic approach of interconnected elements) is  
64 scarce and recent. The manuscripts that were found at these participatory levels are collections of several case  
65 studies drawing lessons to learn from and offering strategies for multi-stakeholder collaborations for more  
66 ecological governance and management (Krasny & Tidball, 2015; Roy, 2011;); van Ham & Klimmek, 2017).

67 Contrary to the cases that employ ‘citizen control’, ‘delegated power’ has slightly more focus on the overall  
68 concept (systems approach) of NbS. To illustrate with examples, Jerome et al. (2017) studied how to  
69 encourage environmental volunteering to a greater degree (citizen control) and Seltzer et al. (2010) proposed a  
70 complex framework for implementation for neighbourhood-scale sustainability (delegated power).

71  
72 The levels of ‘citizen control’ and ‘delegated power’ can help focus on specific environmental topics and if  
73 based on a framework for implementation, can also address complex challenges and employ a holistic  
74 approach to urban development (e.g. Seltzer et al., 2010). As further research is required in relation to NbS,  
75 urban practitioners can summon local and indigenous knowledge via citizen science with these levels of  
76 participation (Fradera et al., 2015). Further research is needed to connect theory and practice at these deep  
77 levels of participation by developing pragmatic approaches that allow mainstreaming into urban planning and  
78 design processes.

### 30       **3.5. Level of participation with an analogue/offline mode**

31 One of the most striking findings in this review was the overwhelming majority of analogue or offline mode  
32 of participation across all rungs of the ladder, while only 14 cases out of 132 used digital methods and 32 used  
33 a blended approach of online and offline modes. This can be surprising when compared to the advancements  
34 in digital technological applications in the urban planning and design field. These applications include  
35 research on ‘smart cities’ (Marsal-Llacuna & Segal, 2015), employing blockchain technologies that allow  
36 connection of urban systems (Marsal-Llacuna, 2018), and the utilization of computational modelling of  
37 projects and proposals (Pelorosso, 2020). In spite of these trends of moving towards digital technologies that  
38 planners and designers are using, our literature review found only a small share of cases where digital methods  
39 were used to facilitate participation in NbS. The small number of cases indicates that urban planners and  
40 designers continue to predominantly employ offline modes and highlights the need for physical interaction in  
41 the case of participatory processes.

42  
43 While the majority of cases employ offline modalities, there is on-going research and discussions on the  
44 power of digital tools and the possibilities they enable (e.g. virtual conferences, online collaborative  
45 platforms), illustrating how we do not necessarily have to be in the same physical location to work together,  
46 and how communication is possible in real-time, regardless of geographical location (Bizjak et al., 2017).  
47 Theoretically, online engagement makes a number of tasks easier and faster. However, we must point out that  
48 face-to-face meetings and physical interactions are still reportedly irreplaceable (Thomas et al. 2016).  
49 Furthermore, digital technologies are more expensive and require more human resources and professional  
50 knowledge at instances (e.g. programming tailored platforms for certain purposes) as barriers to wider  
51 accessibility, which also explains the overwhelming majority of offline participation. Increasing number of  
52 open data platforms exist to overcome this obstacle, though.  
53

04 Our findings show that there is absolute lack of digital technologies application in the facilitation across the  
05 upper rungs of the participatory ladder, from the top (citizen control) down to ‘placation’. On the other hand,  
06 blended/hybrid mode is modestly represented at all levels. The highest proportion of projects employing a  
07 hybrid method work at the partnership level, with low-cost facilitating tools complementing offline methods,  
08 such as GIS, online collaborative mapping and websites with tools particularly tailored to specific projects  
09 (e.g. Tang et al., 2017). The earliest manuscript illustrating hybrid participation is at ‘placation’ rung (Balram,  
10 2005) where networked computers were used within a workshop where participants were physically present in  
11 the same space but worked digitally. At the level of ‘consultation’ rung, an experiment compared ‘expert’  
12 versus ‘non-expert’ knowledge regarding air quality via GIS and employed computer modelling as digital  
13 components (Bonnes et al., 2007). These two publications were “ahead of the curve”, with no examples of  
14 other hybrid modes of participation identified until 2014. Today with rapid technological advancements that  
15 also decrease cost, we expect more case studies employing this blended approach.

16

17 In the few examples we found employing digital mode of facilitation, over 73% focus on the topic of  
18 environmental governance, management and planning, mostly using PPGIS (public participation GIS) (e.g.  
19 Rall et al., 2018) and other crowd-sourcing methods, along with a unique case employing a web-based graphic  
20 novel (Metzger et al., 2018). There is much potential in digital methods as they can open up participation to a  
21 wider audience (more equal and diverse, removing barriers due to e.g. age, disabilities), as witnessed via the  
22 advancement of citizen science, open data and crowdsourcing platforms.

23

24 Employing digital approaches (e.g. participatory GIS) will help inform urban planning and development and  
25 make surveying spaces and collecting data faster and more resource efficient, while speaking to the new tech-  
26 savvy generation. Digital facilitation enables facilitating inclusion to participate in a more diverse manner.  
27 This enables participation of groups such as some of the elderly with mobility problems or people with certain  
28 disabilities or illiterate participants (Fradera et al., 2015). Devising new approaches to deliver facilitation via

29 digital technologies is surely more inclusive, but should be done to complement analogue and face-to-face  
30 methods of participation.

### 31

### 32       **3.6. Level of participation and absence of a framework for implementation**

33 It is important to develop frameworks for implementation when addressing complex problems, e.g. when NbS  
34 are required to address multiple functions and operate at multiple scales. Some projects might not necessitate  
35 such a framework, as they might not be complex (e.g. UGS user need assessment). Out of the 132 reviewed  
36 documents, 105 (79.5%) did not use a framework and 27 (20.5%) did. The level of participation and nature of  
37 case study has a strong relationship with the (or lack of) framework for implementation. As discussed in  
38 previous sections, 62 manuscripts are at the consultation level, which historically does not require a  
39 framework for implementation (58 out of 62 documents have no framework). The overwhelming majority of  
40 employed frameworks are at the partnership level (16 out of 27 documents), possibly due to the increasing  
41 expansion of multi-stakeholder urban planning and design research projects such as the European Commission  
42 Horizon 2020 projects, where many of the calls included ‘participation’ as a core requirement.

43

44 Cases that employ a framework for implementation are scientific research projects developing and testing  
45 their own innovative frameworks or utilising an existing one based on available scientific knowledge. The  
46 earliest ones are DesignWays (Tippett, 2005), Collaborative Spatial Delphi Methodology (Balram, 2005) and  
47 Deliberative Multi-criteria Evaluation (Cork & Proctor, 2005). Consecutively comes Community Greening  
48 (Tidball & Krasny, 2007) followed by a gap until EcoDistrict Community Design Framework (Seltzer et al.,  
49 2010), the rest of frameworks fall between 2015-19. Unsurprisingly, over half of these are located within the  
50 ‘partnership’ level, since the majority of research projects either target this rung or that of ‘consultation’.  
51 ‘Partnership’ is where almost all of the Living Lab (LL) (Fors et al. 2019) concepts are located (such as  
52 Learning Alliances (LA) and Urban Learning Labs (ULLs) (Pauleit et al., 2018), Learning and Action  
53 Alliance (LAA) (O’Donnell et al., 2018) and Landscape laboratory (Fors et al., 2019)). These get increasing

54 recognition as effective facilitators for people's participation, since the concept of citizen science is spreading.  
55 The earliest literature being from 2018, illustrating how recent the concept is. 'Delegated power' and 'citizen  
56 partnership utilises the 'Ecosystem based Adaptation' (EbA) and 'Climate Vulnerability and Capacity  
57 Analysis' (CVCA) (see Rizvi et al., 2016 for both) frameworks. Consultation examples usually have no  
58 framework for implementation since facilitator tools are historically interviews and surveys, with some  
59 mapping and workshops. Frameworks found here are the deliberative Multi-Criteria Evaluation (Cork &  
60 Proctor, 2005) and a Participatory Vulnerability Assessment (Khanal & Thapa, 2018).

61 Unsurprisingly, 'citizen control' employs no framework for implementation. All manuscripts discuss  
62 grassroots initiatives, based on civic ecology and active citizenship. These grow organically, hence the lack of  
63 framework. However, scientists and researchers have been extensively studying systems theory (Balram,  
64 2005) and its possible implications on urban design and planning, identifying patterns in seemingly  
65 organically evolving cases, thus making it possible to deliberatively facilitate the deepest levels of  
66 participation via employing frameworks for implementation, opening up direction for future research.

67 Lastly, contrasting the 'framework of implementation' with mode of participation criteria, we found no case in  
68 online mode. A hybrid mode (blended of digital and analogue) was employed by 25% of the manuscripts,  
69 leaving the majority in offline/analogue category. Reasons for mostly offline frameworks for implementation,  
70 based on our review findings is that most of them are design-based (e.g. Roggema, 2016), traditionally rooted  
71 in physical interactions and hybrid ones evolved around the living labs concept, which require a physical  
72 setting. Examples include a scientific research project, TURAS (Crowe et al., 2016), the 'Community-based  
73 climate change adaptation plan of action' (CAPA) (Khadka et al., 2018) and 'Ecosystem-based Adaptation'  
74 (Rizvi et al., 2016).

75  
76 While a framework for implementation may not be applicable across all NbS participatory cases, it is of relevance  
77 to define novel frameworks that cross disciplinary boundaries and support participatory approaches (especially  
78 deeper levels) across all rungs of the ladder. Urban planning and design methodologies should aim to employ a

79 framework for implementation, when complex urban problems are targeted, to provide direction, focus and  
80 relevance to all participating entities.

81

#### 82 **4. Conclusion**

83 This literature review aimed to understand trends in the literature that employs participation in NbS with  
84 special focus on understanding the deeper levels and most prevalent modes of participation. Two key research  
85 questions directed this research, aiming to understand the different and deepest levels of participation as well  
86 as their relationship to modes of delivery. We found that the dominant levels of employed participation are  
87 ‘consultation’ and ‘partnership’ while the deepest levels, ‘citizen control’ and ‘delegated power’ remain much  
88 less used in projects. The dominant participatory modes remain conventional (non-digital or non-technology  
89 based) while there are indications that digital technology is slowly being utilized, mainly via emerging forms  
90 of hybrid participation (that is a blend of digital and non-digital methods). While complex issues such as  
91 climate change and ecological degradation are being addressed in the literature, the utilization of frameworks  
92 for implementation that address complexity remain low, with a need to increase their use.

93

94 The results of this review show that we continue to mainly use conventional approaches to participation in  
95 NbS projects, while the need to address emerging complex problems via NbS will probably require deeper  
96 levels of participation and the employment of more advanced modes of delivery. This past decade has  
97 witnessed several world popular uprisings demanding political change, pressing to address climate change  
98 mitigation and adaptation, reversing ecological and biodiversity degradation that threatens world wellbeing,  
99 and failures of several autocratic and democratic systems in delivering essential human needs. Cities and  
00 urban metropolitan areas will simultaneously be part of the problem and the solution. We believe that  
01 empowering communities and integrating them as part of the solution through deeper levels of participation  
02 while employing new modes of facilitation (e.g. collaborative learning lab (Derr, 2018), community-based

03 landscape planning (Liu & Opdam, 2014), board game (Robinson, 2015), mental modeler software (Jordan,  
04 2018)) will allow better responses to these global threats with local impacts.

05  
06 Furthermore, the findings also point to the need to adjust the way urban planners and designers approach  
07 participation especially in the context of NbS. The dominant levels of participation will need to be infused  
08 with more inclusive and accessible modalities of delivery, ranging from conventional tools to digital  
09 technologies with a special focus on hybrid approaches that combine the best of both. While ‘partnership’ and  
10 ‘consultation’ are established approaches to participation in environmental application in urban planning, there  
11 should be concerted effort to employ these levels of participation to a greater extent in specific areas within  
12 NbS thematic focus (e.g. urban agriculture and community gardens) and in the fields of biodiversity and  
13 conservation; especially since it was found that deeper levels of participation correspond with increased levels  
14 of biodiversity (Dennis & James, 2016). Such modalities will help to avoid the typical trap of falling into  
15 tokenism, for example, that merely fulfils bureaucratic purposes of cost effectiveness, especially in the Global  
16 South (Rahnema, 1992).

17  
18 Deeper levels of participation need to be developed beyond grassroots activism, that allow for mainstreaming  
19 into the top-down processes of urban planning and design without compromising their fundamental objectives.  
20 Through establishing frameworks for implementation that respond to the requirements of genuinely delegated  
21 power to people and employing novel modes of delivery, the current perceptions of the highest participatory  
22 rungs as somewhat ‘chaotic’ may be altered, which may be one of the main barriers for adoption. The  
23 application of deeper participatory levels have particular importance in relation to topics that address  
24 biodiversity and conservation, since citizen activism is required to ensure the widest employment possible.  
25 Environmental governance, management, and planning should at least aim to employ and achieve ‘delegated  
26 power’ level of participation with a multi-stakeholder approach, in the form of a public-private-people  
27 partnership model (Frantzeskaki et al. 2020; Wamsler et al., 2020b; Willems et al., 2020) that advances

authentic notions of democracy and shared governance. Furthermore, higher levels of participation mean genuine delegation of power, which, as the reviewed literature argues, is important across all domains of NbS. Not only because people should gain knowledge and deep understanding on the importance of nature's role and ecology (Frantzeskaki et al. 2020; Wamsler et al., 2020b), but also to enable their contribution to place-based knowledge. 'Partnership' is crucial in the way forward, as the old approaches to entrenched power structures (e.g. city government as sole decision-maker, 'expert designers' driving landscape projects) will not be successful in increasing resilience, adaptive capacities and in environmental stewardship (Frantzeskaki, 2019; Frantzeskaki et al., 2020; Kumar et al., 2020; Pogacar et al., 2020; Wamsler et al., 2020b; Willems et al., 2020).

37

Advocating for wider uptake of deeper levels of participation bear potential risks. Some of these risks can be mitigated by having in place appropriate policy frameworks, management guidelines and consensual trade-off mechanisms to ensure sustainable participative approaches to landscape planning, development and use on the long-term. For example, to avoid the risk of loss of accountability due to shifting power and responsibility to more stakeholders, including people (Fernandes & Guiomar, 2018). Another debated risk is capturing nature into neoliberal agendas, that can allow the exploitation of nature via technological innovations used for intensifying natural productivity, focusing the narrative on growth and sustainable capitalism (Birch et al., 2010). These are dangerous narratives leading onto unsustainable routes (see e.g. IPBES, 2019), as the current global pandemic and climate emergency are showing. We believe that the deeper levels of participation, based on values of integrity, diversity and equality, where the various stakeholders are open to learn from each other, can actually contribute to avoiding risks of capturing nature into neoliberal agendas (Randrup et al., 2020). Potential risks, other caveats and challenges of participation in NbS, including recommendations for ways forward have been discussed in the literature (e.g. Wamsler et al., 2020a). However, a higher level challenge is that the majority of literature advocating for ecological approaches to urban planning and design, including the concepts of sustainable urban development, ecosystem services, green infrastructure and nature-based

53 solutions, all still adopt a human-centred approach whereby nature is considered an asset of which humans can  
54 derive services, solutions and benefits. These technocratic and economic approaches are driving the agenda  
55 instead of a regenerative approach that safeguards nature as a core value, and in which humans are part of  
56 nature and not separate from it. These crucially important notions are beautifully reviewed and discussed by  
57 Randrup et al. (2020) who consequently propose the idea of Nature-based Thinking (NbT) to address all these  
58 shortcomings, organisational silos and lack of genuine cross-sectoral integrative approaches. Their paper  
59 proposes a transformative shift to our current approaches via the idea of this new, NbT framework to achieve a  
60 more holistic approach to urban planning, development and management, where the focus shifts to the  
61 interrelationships between ecological, social and economic aspects of urban development.

62

63 All in all, there are potential risks and dangers to be mitigated as in every research area, and there are great  
64 and promising opportunities as well. In the face of fast-paced development, increasing globalisation, climate  
65 change and the lack of safeguarding and policies, cases of citizen control contain creative examples of the  
66 power of storytelling and activism (e.g. Erixon Aalto & Ernstson, 2017) that hold promise as effective tools to  
67 save natural sites, species and important pieces of cultural heritage. A suggested push towards activism to  
68 address impacts on the environment and nature holds great potential for cultivating a generation of more  
69 ecologically oriented landscape and urban planners, which redefines their sole role as experts towards one of  
70 an expert facilitator and motivator.

71

72

73

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Appendix A

**Insert digital Appendix A here**

Appendix B

**Insert digital Appendix B here**

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