



Actors mainstreaming nature-based solutions in cities: A case study of Melbourne's change agents and pathways for urban sustainability transformations

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ABSTRACT

Nature-based solutions (NBS) are implemented across multiple cities worldwide and feature as promising solutions in local and global agendas. As solutions that can deal with interlinked urban challenges, NBS are being taken up by cities in different geographies and are considered to be mainstreaming. The process, referred to as mainstreaming, and how this can be achieved needs to be better understood, which is identified as a research gap. In this paper, we examine the roles that actors can undertake that contribute to the mainstreaming of NBS in cities. The aim is to understand the roles that urban actors, especially those within local governments, assume in the process of NBS mainstreaming to mobilise and implement novel and innovative strategic solutions for cities. This topic is explored in a case study of the metropolitan Melbourne region in Australia, where urban forest strategies are gaining traction in local governments for addressing urban resilience concerns. We present how the roles different actors assume contribute to the (re)shaping, building, and/or transformation of institutions to attain climate and ecologically resilient cities. The main contribution of this paper is a pathways framework that illustrates how sustainability norms can move through the mainstreaming process, facilitated by the roles that actors undertake – to champion, advocate, and realise transformative discourses and actions within urban politics and urban practices. Our key findings are framed as success factors of mainstreaming agencies and pathways underpinning transformation, which are: commitment longevity, innovative capacity, collaborative mindset, and on-ground delivery.

1. Introduction

Many cities are experiencing environmental challenges such as floods, heatwaves, and droughts of increasing intensity. In the context of globally declining biodiversity and ecosystems, coupled with the impacts of a changing climate, cities are important places to develop and implement solutions to mitigate and/or adapt to these effects (IPBES, 2019; IPCC, 2022). It has also been argued that transformative changes to address the combined biodiversity and climate crises require a fundamental shift in how we understand and value nature (Duvall et al., 2018; UNEP, 2021). Many cities across the globe adopt nature-based solutions (NBS) as interventions to restore urban ecosystems and

implement greening strategies (Andersson et al., 2014; Gulsrud et al., 2018; Mell, 2020) that enable place-based urban resilience and biodiversity restoration (Davies and Laforteza, 2019; Xie and Bulkeley, 2020).

NBS, as an example of systemic sustainability solutions, “are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits” (UNEP, 2022: 13). Therefore, NBS are essential for pursuing urban sustainability outcomes to address phenomena such as heat islands and biodiversity

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loss (Kabisch et al., 2022). They have been emphasised across different global reports for their potential as transformative solutions to shift urban planning from a barrier to an opportunity for enabling biodiversity and climate adaptation benefits (IPBES, 2019; IPCC, 2022). Furthermore, there is evidence that NBS deliver multiple co-benefits for addressing contemporary urban challenges such as biodiversity loss (IPBES, 2019), climate change, and social cohesion, as well as generating sustainable jobs (Raymond et al., 2017; Frantzeskaki et al., 2019). How urban planning can play a facilitative role in achieving sustainability and enabling urban transitions has also been identified as a research gap in the NBS scholarship (Davies and Laforteza, 2019; Frantzeskaki, 2019; Kabisch et al., 2022).

Furthermore, NBS have been challenging to introduce in urban planning because they require a shift towards system's thinking and collaborative planning in how they are implemented, maintained, and managed (Frantzeskaki et al., 2020; Sarabi et al., 2021). This effort gets even more complex and requires closer examination when cities move from place-based and small-scale experiments of NBS adoption, to widespread inclusion within urban agendas and programs (Grönholm, 2022; Tozer et al., 2022; Wickenberg et al., 2022; Xie et al., 2022). Such widespread adoption implies that the mainstreaming of NBS is taking place.

In this paper, we examine mainstreaming from the perspective of actors' roles. This focus on the actors, and specifically their roles that can advocate for, (pro)actively pursue, and ultimately achieve transformative change, is conceptually under-developed in sustainability transitions research (e.g., Avelino and Wittmayer, 2016; Fischer and Newig, 2016; Lee et al., 2017; Wittmayer et al., 2017; De Roeck and Van Poeck, 2023). We define mainstreaming as a governance process rather than an outcome, that unfolds across the multi-level governance landscape of cities, and its understanding requires contextualised examination of a city or metropolitan region (Adams et al., 2023a). This definition draws on a sustainability transitions perspective, in which mainstreaming is a process that embeds or institutionalises sustainability solutions, including NBS, as a transformative pathway in the way that cities are planned (Tozer et al., 2022; Xie et al., 2022). We further identify two key factors from the perspective of how actors can facilitate transformative change by using their roles to pursue mainstreaming: 1) mainstreaming is underpinned by the purposeful and cumulative actions of multiple actors, and 2) mainstreaming should be considered a strategy for 'doing sustainability transitions'.

The concept of mainstreaming in urban sustainability transitions discourses is however still under-developed and often presented as an outcome of a process, and thus requires a more robust conceptualisation (Adams et al., 2023a). Therefore, the focus of our research is on actors' roles, interactions, and capacities to (re)shape, build, and/or transform institutions to better understand how diverse urban actors can facilitate mainstreaming. Clarifying how actors drive processes of mainstreaming urban NBS is important for emphasising the impact of actors in operationalising mainstreaming processes. This paper is about deepening the conceptualisation of actors' roles to better understand how their agency is enacted and thus can be used to produce change, i.e., how they positively contribute to processes of sustainability transitions (e.g., Irvine and Bai, 2019). In other words, we do not focus on the barriers of and to transformative change, which have been explored in other contributions (e.g., Kabisch et al., 2016; Sarabi et al., 2019, 2021; Dorst et al., 2021, 2022). In addition, actors and agency in sustainability transitions literature are often understood as important, whether their intent is to pursue or resist transformative change (see Section 2.2). In this paper, we explicitly elaborate on the ways in which actors' roles can be operationalised to further our understanding and knowledge on the ways they create opportunities and pathways of and for mainstreaming.

We aim to make actors' roles in processes of mainstreaming visible by analysing an empirical case study of urban forestry governance in metropolitan Melbourne as an example of NBS mainstreaming. By exploring actors' roles and how they configure, this paper deepens and

expands the conceptual underpinning of mainstreaming and how this agency within local government can drive urban sustainability transitions. In addition, the governance of NBS takes place in a context of multi-level governance because environmental concerns occur across different scales, with different jurisdictions having responsibilities and powers (Bulkeley and Betsill, 2005; Macdonald et al., 2021). In the Australian context, urban planning responsibilities and powers are primarily distributed across Local and State governments. Furthermore, it is important to deepen our understanding of the emerging metropolitan level of governance and its potential to facilitate sustainable and resilient cities (Davidson and Gleeson, 2018; Coenen et al., 2020). In this study, we focus on the experiences of actors within, or connected with, local governments but in the context of multi-level governance. This focus helps us to examine the implications of overlapping jurisdictions (Kay, 2017), specifically local, metropolitan, and State.

This study investigates the roles actors can undertake to facilitate the mainstreaming of NBS in cities by asking the following research question: *How can a deeper understanding of roles and how roles configure inform urban politics and planning practices for mobilising transformative change for cities?* This is important to understand better how NBS can contribute to urban sustainability transitions from an urban governance perspective, specifically the underlying processes, rules, and actors whose agency can mobilise and activate transformative efforts. Asking 'who is activating transformations?' requires a conceptual foundation that actor-centered institutionalism can provide of how purposeful actors interact and create opportunities for transformative change to be implemented (Scharpf, 2018). Specifically, we draw on conceptualisations of actors within transitions literature to better explain the multi-actor and multi-process transformative dynamics (Avelino and Wittmayer, 2016; Wittmayer et al., 2017).

The paper is structured as follows: Section 2 describes the theoretical and conceptual framework, Section 3 explains the case study methodology and methods, Section 4 presents results about role archetypes and how they can configure to facilitate mainstreaming pathways. Finally, in Section 5 mainstreaming pathways and success factors for agency in urban NBS mainstreaming are defined.

2. Theoretical framework

This section outlines the theoretical framework we draw on to guide the analysis of interview data and to explain the theoretical foundations of our case study. We do this to better understand different actor roles, how their configurations can facilitate NBS mainstreaming processes, and to elevate and enhance the consideration of actors' roles to (re) shape, build, and ultimately transform urban (planning) institutions. In this study, we take a new institutionalism perspective that views institutions as "clusters of rights, rules, and decision-making procedures" in which the social dynamics of governance are emphasised (Young, 2008: 7). Therefore, in the following sub-sections, we explain the theoretical background of actors in sustainability transitions, as well as the relationship between actors and institutions, which are used to frame our conceptual framework.

2.1. Actors and institutions

The ways urban actors pursue transformative solutions, through processes of sustainability transitions, is crucial for understanding how cities can become more ecologically and climate resilient, by creating or re-shaping urban planning institutions (Frantzeskaki and Bush, 2021). Therefore, different types of actors are important for prompting and accelerating urban sustainability transitions, however the roles actors undertake in these processes are yet to be fully understood (Wittmayer et al., 2017). We argue that conceptually deepening an actor-centered perspective is useful for understanding how (local) urban actors (re) shape, build, and/or transform institutions through the mainstreaming of NBS in cities (inspired by Scharpf, 2018).

We understand the way that actors pursue transformative solutions as a process of institution building, meaning that institutions are in a social process of creation among multiple actors, rather than being static and fixed (Underdal, 2008). Therefore, actors are integral in both building and maintaining institutions (Underdal, 2008; Brown et al., 2013) as actors continue to shape institutions over time (Brown et al., 2013). Brown et al. (2013) conceptualise actors that can leverage both practical and systemic change as champions. These actors may also be referred to as frontrunners, or actors who have the capacity to develop niche spaces (Loorbach et al., 2017). Therefore, the ways actors use their roles to drive institutional changes is crucial for understanding the factors that can make NBS mainstreaming in cities successful over time.

In this study, we draw on actor-centered institutionalism which focuses on how actors interact within, or, as part of their institutional settings, i.e., describing and explaining behaviour and interactions of social phenomena (Scharpf, 2018). Importantly, this draws attention to the fact that actors' roles and institutions (shaping them, making them, changing them) are relational, further, that actors can act in clusters (also configurations or constellations) or as individuals (Scharpf, 2018). We also draw on the notion of actor configurations, which are descriptions of who is involved, how they are involved, how different actors interact, as well as the institutional setting they act within (Scharpf, 2018). Importantly, we focus on actor roles, which have been introduced and conceptualised in sustainability transitions literature by Wittmayer et al. (2017). The ontological positioning of roles in sustainability transitions can therefore be understood as a spectrum, from actors having pre-determined roles within the activities expected to actors having more agency to construct or (re)create and use their role (Wittmayer et al., 2017).

2.2. Actors working in sustainability transitions as agents of change

Actors in sustainability transitions are often framed as a duality of 'niche' or 'radical' and 'regime' or 'incumbent' actors. Such a framing splits actors into two broad categories, those who pursue and those who resist (transformative) change (e.g., Geels, 2014; Fischer and Newig, 2016; Fastenrath and Braun, 2018). However, the complexity of actors and agency mean that a mix of actors, for example, through networks or collective action, are responsible for pursuing sustainability transitions, across sectors and levels of governance (Avelino and Wittmayer, 2016; Fischer and Newig, 2016; Fastenrath and Braun, 2018; Gugerell and Penker, 2020; Kirs et al., 2022). This is frequently understood through power and power dynamics among different actors (Smith et al., 2005; Avelino and Wittmayer, 2016). Power can manifest in two ways: to drive change (Tan et al., 2021; Wickenberg et al., 2022) or reinforce the status quo, i.e., to resist change (Smith et al., 2005; Geels, 2014).

In the sustainability transitions literature, change agents have been described as: driving and learning from experimentation (Wickenberg et al., 2022); leading projects or programs (Mintrom and Rogers, 2022; Wickenberg et al., 2022); having political or strategic power and influence to make change happen, e.g., a Mayor's agenda (Lee et al., 2017) or local government decision-making powers (Tan et al., 2021); and working as part of (small or large) networks (Fischer and Newig, 2016; Gugerell and Penker, 2020). Change agents are hence often defined by their actions to create and develop niches or approaches for sustainability transitions (Gugerell and Penker, 2020; Kirs et al., 2022) and can leverage more change through networks or influence broader socio-political change (Gugerell and Penker, 2020).

2.3. Conceptual framework

Drawing on an existing set of role archetypes provided in Adams et al. (2023a) this study aims to further operationalise an actors' roles typology for mainstreaming (Fig. 1), through an empirical case study, to better understand: 1) the characteristics and responsibilities of the different roles, 2) how the different roles configure to create

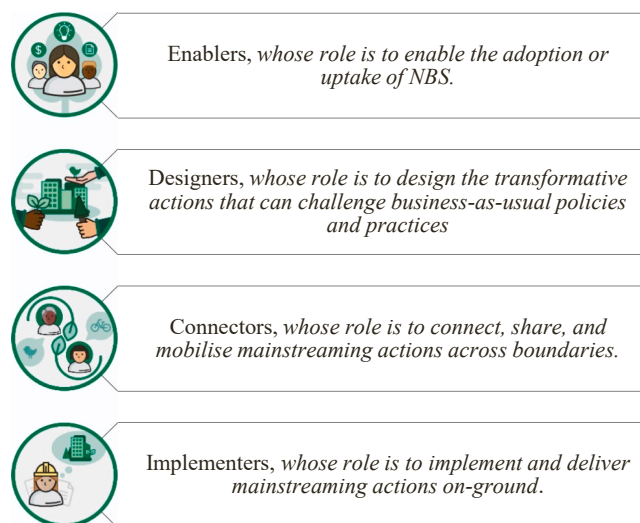


Fig. 1. Mainstreaming roles typology, building on Adams et al. (2023a).

opportunities and strategies for mainstreaming, and 3) the implications of (change) agency on the (re)shaping, building, and/or transformation of institutions for urban planning and governance. We therefore unpack the impact of agency, specifically amongst local government actors, in achieving the mainstreaming of NBS in cities. The framework has three interconnected elements to deconstruct processes of mainstreaming from an agency perspective: role archetypes, role configurations, and pathways for sustainable transformations.

The role typology by Adams et al. (2023a), has four discrete role archetypes illustrated in Fig. 1, which describes who does mainstreaming and how, which we elaborate on through the empirical case study. We further explain the relationality of roles, i.e., through analysing how enablers, designers, connectors, and implementers configure, to add a deeper understanding of the complexities of undertaking mainstreaming actions. The configuration of roles is important for understanding the *system of actors*, or “webs of roles, which interact, interrelate and co-evolve with one another” (Wittmayer et al., 2017: 50), that facilitate and mobilise mainstreaming actions to promote sustainability as a norm. The mainstreaming pathways help to illustrate how actors can use their roles to pursue strategies, programs, and projects to achieve change, whether system-wide or incrementally.

3. Methodology

This paper presents a case study of urban forestry actors either within or closely connected with local government across metropolitan Melbourne, south-eastern Australia (Fig. 2). We explore urban forestry as an example of how the mainstreaming of NBS can unfold in cities. The 32 Councils across metropolitan Melbourne cover diverse environmental landscapes and have different priorities and capacities for pursuing NBS mainstreaming. Heat has been identified as a major concern for Australian cities, and climate-related risks of drought, rainfall, and extreme weather such as floods and fires are highlighted as drivers for urban planning for metropolitan Melbourne (DELWP, 2017).

This qualitative explanatory case study has an embedded design to focus on local Councils within their metropolitan context to generate generalisable lessons through a theory-building approach (Yin, 2003). An embedded case design is useful for exploring the local and metropolitan factors that contribute to the mainstreaming of NBS in cities. Metropolitan Melbourne was selected for this case study because NBS mainstreaming action is evident. The City of Melbourne's urban forestry program is a frontrunner and has had visibility and influence in Australia and internationally (Gulrud et al., 2018). Furthermore, urban forestry is now prevalent across metropolitan Melbourne, as most



Fig. 2. Map of metropolitan Melbourne local government areas (LGAs), with included LGAs highlighted. Full list of LGAs can be found in the Supplementary Material. Fig. 2 was created by the authors and incorporates or was developed using Administrative Boundaries © Geoscape Australia (DISR 2020a, 2020b) licensed by the Commonwealth of Australia under Creative Commons Attribution 4.0 International license (CC BY 4.0).

Councils across the metropolitan region either have or plan to adopt urban forestry strategies. This prevalence is also evident in the establishment of a metropolitan-wide platform for urban forestry through the *Living Melbourne: our metropolitan urban forest strategy* (Bush et al., 2020; Coenen et al., 2020; Fastenrath et al., 2020; Hartigan et al., 2021).

Participants for this study were purposively selected for their expertise and involvement in the research and practice of urban forestry in metropolitan Melbourne. Thirty-two (32) interviews were conducted (online) in March–May 2022 with urban forestry planners and practitioners within Councils ($n=25$), as well as academics in the field ($n=6$) and *Living Melbourne* ($n=1$). Participants were recruited from 18 of the 32 metropolitan Melbourne Councils (Fig. 2). Seventeen (17) of the included Councils had one participant (list in Supplementary Material), while multiple participants were recruited from the City of Melbourne ($n=8$). Interview questions were formulated to discuss the creation and implementation of urban forest strategies and programs in local governments. For example, in relation to how an urban forest strategy was developed, local actions, regional platforms and collaborations, community engagement, and future needs. In addition, the final question asked the participants to provide feedback on an early conceptualisation of the role archetypes explored in this paper. The full list of the interview questions is provided in the supplementary materials.

The inductive theory-building approach we utilise draws on elements of grounded theory (Charmaz and Bryant 2008) to examine the roles of actors in urban NBS mainstreaming. Therefore, the analysis draws on a process of coding to identify and understand themes emerging from the data (Davidson et al., 2017; Byrne, 2022). The three rounds of coding, expanding on the role typology identified in Adams et al. (2023a), to analyse how role archetypes and the configuration of roles can (re)shape, build, and/or transform institutions are outlined in the Supplementary Material.

4. Results

In this section, we outline the results from our case study regarding the role archetypes and configurations that we identified. This also builds on prior research and conceptualisation provided in Adams et al.

(2023a). The quotes used in the results illustrate our identified role archetypes and configurations. A summary of the role archetypes is presented in Tables 1 and 2, and a summary of the role configurations is provided in Table 3.

4.1. Role archetypes

Here, we provide the results from our case study regarding the four role archetypes, especially to describe their characteristics, i.e., what is typical of the role (Table 1). These archetypes are empirically grounded through the analysis and synthesis of interview data, i.e., on the basis of what was learnt from interviews to inform the role typology. We use this to describe the actions the identified roles can take to mainstream urban NBS.





4.1.1. Mainstreaming enablers

The role of ‘Mainstreaming Enabler’ describes actors who have the capacity to enable the pursuit of mainstreaming nature-based solutions in urban agendas. As such, they have the power or authority to make decisions, which legitimise mainstreaming actions, such as through mandates, budget allocation, and/or providing resources (Adams et al., 2023a). They may, therefore, be seen as ‘gatekeepers’ of success in the pursuit of mainstreaming NBS in cities, which means they also have the capacity to re-enforce systemic inertia. As one interviewee described: “the high-level decision makers, if they decide to champion it, then things can fly quickly but if they don’t really own it and drive it, then they can be an obstacle so things can go quite slowly” [R2–1].

Mainstreaming Enabler functionalities stem from their capacity to enable the adoption or uptake of urban NBS. Their role is therefore often top-down in that they have the power to direct mainstreaming actions and/or have the capacity to provide resourcing for it (e.g., funding, staffing). They tend to be political actors who can make the decision to adopt urban NBS and/or maintain a commitment to implementing urban NBS (e.g., Lee et al., 2017; Tan et al., 2021). Therefore, although individuals may play this role, their actions are often underpinned by the legitimacy or authority of a Council or government department. Specific actors within an organisation that fit this role are positions such as CEO,

Table 1

Actors' roles typology with interview examples of mainstreaming actions and who plays each role in mainstreaming nature-based solutions in Melbourne, Australia.

Role Archetype	Mainstreaming actions	Who plays this role?
 <p>Mainstreaming Enablers</p>	<ul style="list-style-type: none"> Decision-making and/or rule setting Organisational or executive management and leadership Resourcing (e.g., time, money, staff, data, research) Financing, budget allocation 	<ul style="list-style-type: none"> Politicians (e.g., Councillors) Executive leadership, CEOs Directors, managers Council, Government Department Non-government authority (e.g., water authorities)
 <p>Mainstreaming Designers</p>	<ul style="list-style-type: none"> Knowledge (co)production Business case or justification Policy formulation Story/messaging Thought leadership (visioning) Strategic leadership Advocacy 	<ul style="list-style-type: none"> Academics Consultants Technical experts Strategic planners Council officers External advocates (e.g., community)
 <p>Mainstreaming Connectors</p>	<p>They communicate and act across (intermediate):</p> <ul style="list-style-type: none"> Sectoral or jurisdictional boundaries Policy domains Internal/external <p>Through, for example:</p> <ul style="list-style-type: none"> Community education and engagement Intra-organisational communication Networking (external) 	<p>Any position that also engages, shares, or participates in networks that involve internal and/or external stakeholders (e.g., community outreach or programs, across organisational silos). Examples of local government networks in metropolitan Melbourne:</p> <ul style="list-style-type: none"> Living Melbourne Greenhouse Alliances Municipal Association of Victoria Greening the West
 <p>Mainstreaming Implementers</p>	<ul style="list-style-type: none"> Project oversight and co-ordination Operational and project delivery (e.g., tree planting, maintenance, management) 	<ul style="list-style-type: none"> Local Council Staff (e.g., urban foresters, arborists, open space/landscape architects) Contracted workers (e.g., tree crews) Community volunteers (e.g., friends' groups, Traditional Owners groups, community organisations, local residents) Teams or departments within Council (e.g., open space, trees, parks, gardens, or infrastructure management/delivery) Statutory planners Water Authorities (e.g., Melbourne Water) Catchment Management Authorities

Councillor, Director, or manager.

Most interviewees highlighted primarily the importance of their local Council to mandate urban forestry and allocate budget towards growing the urban forest, with State Government playing a smaller role through grant funding. Many interviewees noted that their Council's urban forest strategies, as endorsed strategies, gives it standing at Council to have budget allocated for implementation. In other words, setting the direction and committing financing to attaining outcomes, signalling that it is a priority. For example, the importance and prioritisation of the urban forest in decision-making processes, for ongoing funding, as one interviewee recalled: "when we told [Council] about what the future costs are going to be, they didn't blink. They were very aware and very supportive" [R2–12].





4.1.2. Mainstreaming designers

The role of 'Mainstreaming Designer' describes actors who have vision to create and drive mainstreaming pathways (Adams et al., 2023a). As such, they have the knowledge and expertise to advocate, develop, and mobilise mainstreaming actions. They may, therefore, be seen as thought leaders for the mainstreaming of NBS in cities through

their pressure or influence on decision-makers to adopt transformative solutions. In other words, they actively seek to influence policy- and decision-making (e.g., Fastenrath and Braun, 2018). As one interviewee stated, which exemplifies this archetype: they are the actors who think strategically, with the capacity to "imagine a better future urban forest and inspire others to believe in it too". The same interviewee continued to describe this type of actor: "you've got to be able to get the budget, you've got to be able to be given the staff to do this or to get people on board, [the person] who can really influence others. (...) They're able to communicate well and influence others and drive change" [R1–9].

Mainstreaming Designer functionalities stem from their expertise and capacity to innovate and envision changes to business-as-usual urban policies and practices (Adams et al., 2023a). This role is often focused on (new) solutions and ways of thinking that facilitate or create mainstreaming actions, such as leading urban experiments (e.g., Wickenberg et al., 2022.). This means they are often strategic actors, including strategic planners, technical experts, academics, and consultants, who can create and exploit windows of opportunity to imagine a new future and can leverage and/or design urban sustainability transition pathways.

Table 2
Summary of role archetype characteristics with evidence from interviews.

Role archetype	Role characteristics	Example from interviews
	Decision-making authority and legitimacy	<ul style="list-style-type: none"> Political champions in local government, i.e., Councillors “it’s very, very, very popular and it’s got great support at a high-level within the organisation” [R2–14].
	Resourcing mainstreaming activities, such as allocating budget, staffing Allocating budget for urban forestry actions Local government staffing for formulating and implementing urban forestry plans	<ul style="list-style-type: none"> Local government mandates and budget allocation Grant funding from external sources, e.g., State Government “The State Government’s provided significant grant funding that’s allowed us to then leverage some of the work even more” [R2–12]. Staff knowledge, skills, and capacity “City of Melbourne has employed a highly skilled and sophisticated team of people over the years” [R1–6].
	Activating visions to enhance the urban forest, and urban nature more generally Informing decision-makers, gaining political buy-in, and advocating for transformative change	<ul style="list-style-type: none"> Recognising problems and opportunities Strategic and future-oriented planning Inspiring and influencing decision-makers to support transformative change, e.g., through evidence and business case “There was a distinct opportunity which arose out of the impact of the Millennium Drought...What I did was to gather some significant and compelling data and to present that to my senior management and to Council, saying this is the way we should move forward. And at that time they gave me support to embark on that” [R1–4].
	Intra-organisational to bridge and communicate across organisational silos, e.g., different local government departments	<ul style="list-style-type: none"> Urban forestry as a cross-organisational strategy and program “This has 100% been a cross-organisational project, it’s had to involve all levels of Council, it’s been technical officers, arborists, senior levels, and executive management” [R2–11].
	Inter-organisational to build relationships and partnerships with external stakeholders, such as community engagement, practitioner and/or city networks	<ul style="list-style-type: none"> Practitioner networks such as Council Arboriculture Victoria Intermediary institutions such as Living Melbourne Community engagement processes through participation in policy consultation, citizen science programs such as the City of Melbourne’s Citizen Forester Program, and education “The implementation of the policy is basically a process of educating the community on the benefits of having an urban forest or having trees planted on their properties” [R2–15].
	Co-ordination and oversight of the implementation of urban forestry programs	<ul style="list-style-type: none"> Co-ordinating urban forestry programs “About 50% of my role is dedicated to co-ordinating all the different urban forest items that we have in our green action plan, so there’s around 34 items. So it’s basically my job to monitor and evaluate how each of those are tracking” [R2–10].
	Delivery and operationalisation of urban forestry actions, i.e., management of the urban forest	<ul style="list-style-type: none"> Delivery of urban forestry programs, by local governments, water authorities, as well as other organisations/individuals responsible for land management “Council officers, particularly within our infrastructure department and our open space department have been the main players for that implementation” [R2–11].

Most interviewees emphasised the critical role of Mainstreaming Designers to inform decision-makers. For example, one interviewee stated: “because at some point there’s a decision. (...) But I think before you get to that point, there’s always a lot of work that is done bottom-up. (...) identifying the risks, providing solutions, making these issues a priority and raising awareness to the high level [decision-makers]. (...) Normally that doesn’t happen without a lot of pestering” [R2–6]. Which means they are responsible for making the urban forestry (business) case to gain political buy-in for the innovation or transformative thinking that underpin mainstreaming pathways. Therefore, in addition to their strategic and thought leadership to imagine and facilitate transformative change (envision the future), they need to be able to communicate their vision. This describes a skill and capacity to convince Mainstreaming Enablers of the significance and importance of forging a new pathway. One interviewee explained the process: “how do we get this approved by our decision-makers before we could even communicate it? We had to get their buy-in, I probably put a lot of time and effort into how we tell the story, how we develop the narrative” [R1–10].

4.1.3. Mainstreaming connectors

The role of ‘Mainstreaming Connector’ describes actors who have the capacity to mobilise mainstreaming actions across silos or fragmentation of organisations, sectoral interests, or metropolitan areas (Adams et al., 2023a). As such, they network, communicate, engage, and sell a story beyond jurisdictional boundaries, i.e., they can function as intermediaries (e.g., Fischer and Newig, 2016; Frantzeskaki and Bush, 2021). They may therefore be a bridging influence across multiple and diverse urban stakeholders, for example, as a community-facing role, they can enable the diffusion, distribution, and communication of mainstreaming actions to gain acceptance. Several interviewees noted that this is often a ‘co-role’, as one interviewee said: “I don’t think it’s a specific role. I think everyone’s got that in their role, especially when you’re trying to drive change” [R2–17]. Another interviewee also noted that this can be a high-level role: “there’s a lot of politicians in that space” [R2–18].

Mainstreaming Connector functionalities stem from their capacity to translate the importance and intention of mainstreaming actions. As one interviewee stated: “being able to translate all of that knowledge, expertise, technical information into a way that resonates with the

general community, I think is one of the biggest opportunities that we have in this space” [R1–6]. They can facilitate and/or participate in the diffusion of mainstreaming actions through inter-organisational connections such as knowledge and practitioner networks or community engagement and intra-organisational connections to bridge internal or organisational silos for the creation of cross-organisational approaches. Further, one interviewee identified actors who fit this role: “industry organisers, who are facilitating the sharing of knowledge. And I think you see that through the Greener Spaces Better Places⁴ network and the consultants who are doing the urban forestry work, who shared knowledge between different municipalities” [R1–1].

Many interviewees focused on the fluidity and cross-cutting nature of Mainstreaming Connectors, as well as their increasing importance for achieving mainstreaming, such as their ability to facilitate networking, such as through Living Melbourne, as one interviewee observed: “their role was to bring everyone together and connect people, like herding cats, and if it wasn’t for that role, that work wouldn’t have happened - and it’s a special skill set” [R1–9]. Furthermore, they are integral to developing collaborative knowledges and practices, or a community of practice. This can manifest through creating and participating in networks and/or engaging and empowering the multiple owners of the urban forest, as one interviewee stated: “there was a very conscious step towards working collaboratively with all of the owners of the forest” [R1–4]. For example, the same interviewee explained the City of Melbourne’s participatory approach to develop urban forest precinct plans⁵: “it was almost a co-designed document, and the visions for each plan were developed and written by the community” [R1–4]. Further, that community engagement has multiple forms, such as education and citizen science programs to raise awareness, as one interviewee mentioned their Council’s involvement in the City Nature Challenge: “it’s about encouraging our community to get out there, discover and learn about nature” [R2–1].

4.1.4. Mainstreaming implementers

The role of ‘Mainstreaming Implementer’ describes actors who have implementation-oriented capabilities to realise mainstreaming outputs and outcomes (Adams et al., 2023a), including project managers, statutory planners, arborists, urban foresters, and community volunteers. They do this by co-ordinating and/or delivering on-ground mainstreaming actions, such as tree planting and urban forest maintenance and management, i.e., they operationalise mainstreaming actions in practice (e.g., Mintrom and Rogers, 2022). They have two responsibilities: co-ordination and delivery. Describing the relationship between the two responsibilities one interviewee explained that co-ordinators are facilitators, asking what delivery actors “need to actually put this into action, so they can concentrate on that”. The same interviewee continued, explaining their role as a co-ordinator: “And I can develop the strategy and process. I can do the talking. I can prepare funding nominations for capital works and communicate this information to continue to build capacity so they can implement that into practice” [R2–17].

Mainstreaming Implementer functionalities stem from their capacity to bring a plan to life in the city. Actors who co-ordinate strategic actions therefore have an “oversight of implementation” function [R1–1]. Actors who have delivery roles are technical experts, such as arborists, who plant, manage, and monitor the urban forest, i.e., those “who actually do the on-groundwork” [R1–12]. Therefore, they are responsible for *doing urban forestry*, in relation to operationalising urban forest strategies.

Many interviewees highlight the operational aspect of the role, characterising them as actors who are “making things happen” [R2–2]. Most interviewees recognised this role archetype as the usual business of

Council, or departments within Council, as one interviewee stated: “I think Councils are well placed to do the doing around urban forest management on the ground” [R2–19]. Other interviewees mentioned non-Council actors who are also responsible for delivery roles, such as water authorities (Table 1). Lastly, as one interviewee noted, this archetype will change depending on the needs of Council: “as we start to progress the other actions of the strategy, particularly the changes to our planning scheme, there will be more actors that will play a part of that implementation-oriented role” [R2–11].

4.2. Role configurations

In this section, we present how role archetypes configure, i.e., work together as a system or web (e.g., Wittmayer et al., 2017) to facilitate, mobilise, and drive NBS mainstreaming processes. Fig. 3 illustrates the role typology from Section 4.1, which guides this further analysis to explain how the distinct contributions of each archetype can create and develop, by configuring, what we are conceptualising as *mainstreaming pathways*.

By examining how these roles configure, we add consideration of the relationality, overlapping, intersecting, and complexity of agency to better understand the (re)shaping, building, and transformation of institutions. Roles can configure to 1) legitimise, support, and direct mainstreaming actions; 2) guide and inform decisions and partnerships or networks; 3) develop and review policies and plans; 4) collaborate, share, and build knowledge and best practices; and 5) co-ordinate, deliver, and maintain on-ground urban forestry actions (Table 3). We examine this from the perspective of three mainstreaming pathways that can (re)shape, build, and ultimately transform urban (planning) institutions: reforming, bridging, and translating.

4.2.1. Mainstreaming pathway 1: reforming

When roles configure to reform systems and ‘ways of doing’ they can be considered as either *prescriptive* or *emergent*. Both are important for deconstructing the configuration of roles for the adoption and prioritisation of urban NBS in planning decisions and planning approaches.

Mainstreaming Enablers, with their top-down power or authority, political legitimacy, and capacity to invest in mainstreaming actions are primarily prescriptive actors who can direct a reforming pathway. Whereas, Mainstreaming Designers, Connectors, and Implementers, with their bottom-up drive, action-orientation, knowledge, and skills, are primarily emergent actors within a reforming pathway. For example, Mainstreaming Designers drive the adoption of urban NBS through influencing or convincing Mainstreaming Enablers to embrace transformative ways of thinking about and planning cities (Table 3). One interviewee noted that the Council assumes the role of Mainstreaming Enabler and Mainstreaming Designers, i.e., Council officers/employees, “need to inform them so that they can make evidence-based decisions, set the agenda and disseminate resources”. The same interviewee continued: “The politicians really love to hear from them, they do the data and the research, and the politicians say: ‘oh that’s really interesting. Let’s put that in our plan’” [R2–18].

Furthermore, many interviewees emphasised the bottom-up directionality of NBS mainstreaming intentions. Therefore, roles can also configure to reform the mainstream through the advocacy, drive, and intentionality of Mainstreaming Designers, Connectors, and/or Implementers to put urban forestry on the agenda of Mainstreaming Enablers (and keep it there). One interviewee stated, of the City of Melbourne’s urban forest strategy: “It came from the bottom-up. But it came from a powerful bottom-up, so some of the pioneers, they had a lot of political capital” [R1–8]. Another interviewee reflected: “I found that everyone was attracted to the data. And it was like, well, it doesn’t really matter if you don’t know what to do with it once you have it, because you can put it together and if nobody’s interested, you’ve lost your battle” [R1–10].

⁴ Formerly Vision202020.

⁵ Precinct plans are subsidiary neighbourhood-scale action plans to the City of Melbourne’s urban forest strategy.

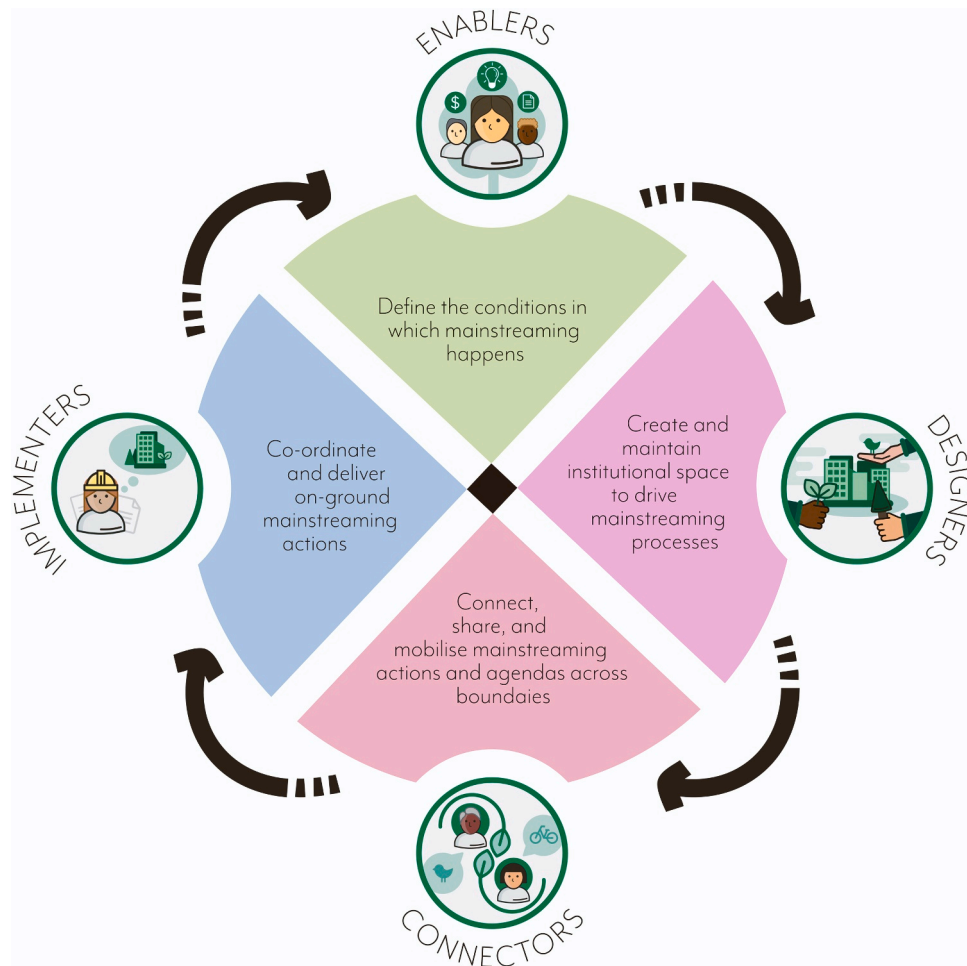


Fig. 3. Actors' roles typology for mainstreaming. Source: Authors, building on Adams et al. (2023a).

4.2.2. Mainstreaming pathway 2: bridging

When roles configure to bridge actors and their actions they can be considered as either *monocentric* or *polycentric*. Both are important for deconstructing the configuration of roles that can cumulatively or iteratively change how cities are thought of and the ways they are planned and governed. The focus, therefore, is on the skills of actors to play the role of Mainstreaming Connectors (Table 3).





Bridging configurations can be understood as monocentric when mainstreaming actions diffuse from a single point, such as from pioneers and exemplars. This explains NBS mainstreaming agency from the perspective of conscious leadership and sharing knowledge and practice from experience. For example, some interviewees pointed to the pioneering urban forestry work of the City of Melbourne, which has had an influence on the metropolitan Melbourne region, as well as other Australian and international cities (e.g., Gulsrud et al., 2018). As one interviewee said: "it set a benchmark for what a fairly sophisticated policy document looks like in that space" [R1–3]. Another interviewee elaborated on its impact: "it was done through soft power, through leading-by-example, and through various workshops and in a sense creating a community of practice around nature-based solutions" [R1–8].

Bridging configurations can be understood as polycentric when developed through a process of networking and collaboration. This explains the NBS mainstreaming agency from the perspective of building partnerships, networks, and communities of practice that develop standing and legitimacy across the metropolitan region (i.e., that transcend individual Council jurisdictions). One interviewee attributed this to disciplinary openness: "It's one of those fields where everybody,

we're in it because we want to make cities a better place, and so the willingness to share information and collaborate and partner is very strong amongst all parties, which makes a huge difference" [R1–6]. For example, the agency that facilitates the emergence and momentum of (sub)regional partnerships to deliver NBS, including Living Melbourne and Greening the West (western metropolitan Melbourne Councils). As one interviewee explained: "I'm one of the chairs of the Greening the West Strategic Committee. It's been great because it provides an environment where the West can come together and try to put a little bit more pressure, liaise, and sometimes influence certain areas and decisions that are more impactful to our region" [R2–6].

How roles are configured to bridge mainstreaming actions is particularly important as the emergence of leaders and the development of networks are interdependent. Interviewees mentioned three key examples of this interdependence. One interviewee noted: "The City of Melbourne's strategy was the seed, but definitely Vision 2020 was the tree that grew and started to really bring the people together in a way that those communities hadn't been brought before" [R1–10]. Another interviewee reiterated this sentiment in relation to Living Melbourne: "there wouldn't be a Living Melbourne strategy without the City of Melbourne's urban forest strategy. That's an absolute given. The leadership and the vanguard attitude of the City of Melbourne has enabled all the other LGAs to follow" [R1–5]. A further interviewee stated, to show that it is not just the City of Melbourne that has become leaders in this space: "There are local governments with pockets of innovation occurring. Greening the West is very much the City of Brimbank and its ability to bring others together. I think it's symbolic of a particular individual that has connections" [R2–3].

Table 3
Configuration of roles and mainstreaming pathways.

Role Archetypes	Mainstreaming Enablers	Mainstreaming Pathways		
		Reforming	Bridging	Translating
		Legitimises: mandate, endorse policies Supports: resource, finance urban NBS Guides: soft powers, advocacy	Legitimises: mandate, endorse policies	Directs: top-down (hard powers) e.g. laws Supports: resource, finance urban NBS
		Informs: evidence-base, justification Guides: thought leadership, policy formulation	Guides: thought leadership, policy formulation Develops: innovation, urban experimentation Reviews: learn and improve	Guides: thought leadership, policy formulation Develops: innovation, urban experimentation Reviews: learn and improve
		Guides: relationship building, stakeholder engagement Collaborates: transboundary partnerships and projects	Shares: best practices, knowledge, resources Builds: create and participate in networks Guides: relationship building, stakeholder engagement Collaborates: transboundary partnerships and projects	Guides: relationship building, stakeholder engagement Collaborates: transboundary partnerships and projects
		Guides: practice-based, technical, and local knowledges	Co-ordinates: manage programs	Delivers: implement projects Maintains: on-ground management over time Co-ordinates: manage programs Guides: practice-based, technical, and local knowledges

4.2.3. Mainstreaming pathway 3: translating

When roles configure to translate actions and knowledge they can be considered as either *passive* or *disruptive*. Translating configurations can be understood as passive when mainstreaming actions conform to business-as-usual procedures, such as formulating policies and implementing projects without altering existing processes and approaches but introducing NBS as solutions, for example adopting new terminology in policies and practice (Wilkinson et al., 2013; Baravikova, 2020). On the other hand, translating configurations are disruptive when (pre)existing norms are challenged. How the actors’ roles facilitate flows of knowledge and action is critical for understanding not only what is being mainstreamed and how, but also how actors learn from and through NBS mainstreaming processes (e.g., Wickenberg et al., 2022).

We focus on the disruptive translating configurations to develop insight into agency in NBS mainstreaming. The disruptive knowledge(s), ambitions, and strategies include re-framing how urban nature is considered and how this new understanding is (co)created and used. This can manifest through transformative thinking and thought leadership, in which, for example, Mainstreaming Designers re-frame assumptions about the city. As one interviewee explained: “there was a point where we realised that we had to do something, we couldn’t do nothing. And so it was a transformative change in the way the urban

forest was considered. I mean, when I first started talking about ‘urban forest’, nobody had even heard the term within the municipality” [R1–4]. This is further underpinned by an improved understanding of knowledge needs to create and implement urban forestry, as another interviewee described: “before we would have researchers come to us with their ideas and at that point it pivoted, and we started to commission our own research for our own purposes. And that’s where our work got stronger, but also the universities started to really understand what would make a difference for practitioners” [R1–10]. This knowledge perspective can also be seen as relationship building for translating knowledge and intentions to mainstreaming actions, as one interviewee said: “the best ones are ongoing relationships that you have with the academics that you know, often there’s a lot of informal collaborations that happen around the sidelines” [R1–2].

5. Discussion

The discussion draws on the typology of roles and analysis of how these mainstreaming roles can configure to deconstruct three mainstreaming pathways (Fig. 4). We argue that mainstreaming is an ongoing process in which actors, as conceptualised in the roles’ typology, pursue transformative change to enable, design, connect, and implement

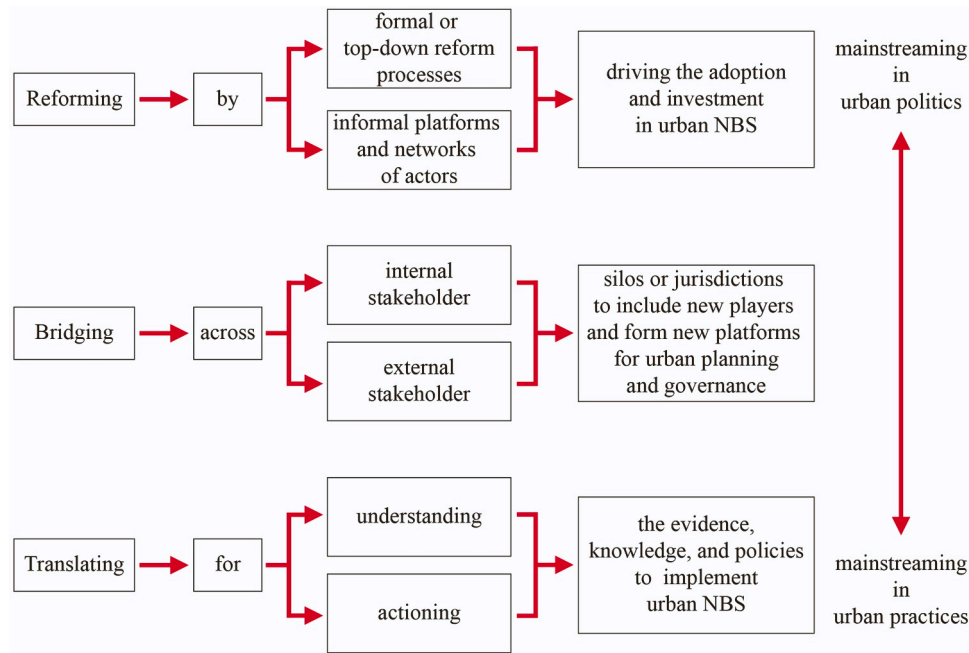


Fig. 4. Mainstreaming pathways of nature-based solutions in cities built up from actors' actions and roles (Source: Authors).

strategies that shape and support sustainability transitions processes. In summary, Enablers *provide the authoritative settings* for other actors to mainstream; Designers create new ways of doing and organising to mainstream, i.e., they are not simply *actors with vision*, but *actors who use their vision*; Connectors mobilise collaborative and collective action, i.e., *building narratives and agendas across silos*; and Implementers deliver on-ground mainstreaming actions, i.e., *doing urban forestry*. We consider mainstreaming pathways through the lens of capacity to (re)shape, build, and/or transform institutions by or from the mainstreaming of NBS in cities. These mainstreaming pathways are useful for gaining deeper insight into how change agents operate in cities.

5.1. Pathways for sustainability transformation through NBS mainstreaming roles

We refer to 'pathways' in terms of pathways to achieve mainstreaming, directed or built by actors (in their roles). Therefore, a mainstreaming pathway is a way to conceptually organise how actors' roles contribute to defining, pursuing, and progressing processes of mainstreaming. These pathways align with urban politics and practices:

- *Urban politics* relates to high-level decision-making authorities and processes, i.e., how mainstreaming pathways are supported.
- *Urban practices* relate to day-to-day planning, strategies, and on-ground implementation, i.e., how mainstreaming is enacted.

The focus of this study leans towards urban practices because of the selected participants, i.e., local government officers. Here we synthesise the findings from this study to define three mainstreaming pathways, which are illustrated in Fig. 4.

We argue that the way we position actors in mainstreaming is useful to better understand how transformative change is mobilised and progresses to ensure institutions are fit-for-purpose for climate-resilient and liveable cities. Therefore, different actors, as described in the role typology, invest in, develop, share, and deliver mainstreaming strategies and actions to build pathways for (re)shaping, building, or transforming urban planning institutions. It is especially important to consider how these roles configure to organise and build capacity to pursue mainstreaming pathways. For example, our roles typology helps to enhance

the understanding of mainstreaming from an agency perspective, which is not sufficiently conceptualised in the literature (Adams et al., 2023a). As it is often noted in sustainability transitions research, there are ongoing gaps in understanding actors in transitions, for example a lack of conceptual or analytical tools to understand how they make change happen (De Roeck and Van Poeck, 2023). Therefore, with this study we also contribute to deepening the conceptualisation of actors' roles for sustainability transitions literature, expanding on the work of Wittmayer et al. (2017).

These mainstreaming pathways can provide an organising framework for better understanding how mainstreaming can be framed from an agency perspective. We argue that the *system of actors* is important to contextualise the mainstreaming pathways, to understand how changes are happening and to capture actors' impact on transforming institutions. Therefore, the identified mainstreaming pathways should be considered as examples of how actors can build capacities to design and transform *institutional spaces* that help facilitate the mainstreaming of NBS in cities (Adams et al., 2023b).

5.1.1. Mainstreaming pathway 1: reforming

Mainstreaming agencies can be explained with a *reforming pathway*. A reforming pathway describes a shift in urban politics and/or the way actors participate in formal and informal platforms and networks. The perspective of the political, governance and planning of cities is particularly important for understanding how and who enables NBS mainstreaming. This is important for understanding the impact of NBS mainstreaming thinking and (political) awareness of adopting urban NBS. Therefore, providing insight into existing institutional settings to track how reforms can materialise and evolve.

5.1.2. Mainstreaming pathway 2: bridging

Mainstreaming agencies can be explained through a *bridging pathway*. A bridging pathway can describe how different stakeholders interact. The bridging pathway focuses on the boundaries or silos of knowledge and action for mainstreaming NBS in cities. This is important for understanding the sophistication and maturity of NBS mainstreaming actions beyond silos or fragmented systems, and ultimately the creation and emergence of new urban governance modes. Therefore, providing insight into how mainstreaming actions can be activated,

mobilised, and diffused in cities and across metropolitan regions.

5.1.3. Mainstreaming pathway 3: translating

Mainstreaming agencies can progress through a *translating pathway*. A translating pathway can describe how mainstreaming unfolds in practice. The translating pathway can explain how actors create, understand, and action knowledge and strategies through the implementation of sustainability solutions in cities. This is important for understanding the processes and impact of mainstreaming NBS knowledge and transformative intentions to realisation in policy and action. Therefore, providing insight into what is mainstreamed and how it can progress through the system of urban planning knowledge, policy, and implementation, focusing on how actors use NBS knowledge.

5.1.4. Synergies across mainstreaming pathways

Given this paper is proposing a novel conceptual framework, it is worth further examination to identify what the points of synergy may be among the identified mainstreaming pathways (Fig. 4). In other words, what are the stepping stones for creating and maintaining flexible and versatile institutional spaces? We argue that the proposed mainstreaming pathways can operate cohesively to create and capitalise on opportunities to design and develop urban sustainability transformations.

Specifically for local governments, our study has found that the different types of actors and their agency are useful to deepen insights into how mainstreaming is and can be facilitated and accelerated. For example, the *interaction and multi-directionality of actors who contribute to mainstreaming pathways*, such as the bottom-up and top-down influences that different actors' roles can have in a reforming pathway or how actors can participate in constructive research-policy-practice interfaces in a bridging pathway (e.g., Adams et al., 2023b). This is a useful way to understand the connections among the pathways, in relation to actors proactively building relationships that may transcend barriers among actors with different powers, authorities, and/or knowledges.

Another synergy may be seen in *how mainstreaming actions diffuse across institutional space*, for example, the emergence of leaders and their impact on mainstreaming pathways locally and/or regionally when configured in a bridging pathway. This can also be a feature of a translating pathway in relation to (co)creating the knowledges and practices that inform and pursue mainstreaming. For example, to better understand and appreciate the drivers and mechanisms that actors can leverage to design and realise mainstreaming in cities (Adams et al., 2024).

The ways that actors can contribute diffusion processes across institutional spaces is critical for understanding how the emergence of new institutions can be facilitated. The new conceptual framework developed in this paper helps to operationalise our understanding of actors in mainstreaming, and therefore how they can proactively navigate mainstreaming pathways.

5.1.5. Success factors

In addition to the mainstreaming pathways, we identify four 'success factors' of agency in NBS mainstreaming for cities to (re)shape, build, and/or transform institutions. This is an important consideration in relation to how actors, in their roles, can make and/or navigate institutional spaces, and when they do this, are they able to transcend entrenched barriers to change, such as lack of financial resources (Fünfgeld et al., 2023; Ibrahim et al., 2023; Mumtaz, 2023; Peskett et al., 2023) or limitations in long-term planning capacities (Hansen et al., 2022; Skill et al., 2023)?

Success factor 1:

Commitment longevity is important for NBS mainstreaming to ensure that there is ongoing (political) support and by extension financing for urban NBS implementation and management. The long-term and ongoing commitment to NBS mainstreaming also has positive implications for the investment in and embeddedness of NBS in the politics, policy, and planning of cities. Commitment longevity is

therefore underpinned by the mainstreaming actions of Mainstreaming Enablers and their capacity to direct or enforce top-down mainstreaming pathways.

Success factor 2:

Innovative capacity is important to ensure that actors have the flexibility to avoid unintended consequences or unsustainable lock-ins. The continuous and ongoing emergence of new ways of thinking, approaching, and implementing urban NBS is essential for progressing the knowledge and practices for attaining climate and ecologically resilient cities. Innovative capacity is therefore facilitated by Mainstreaming Designers as leaders in urban NBS mainstreaming to envision change and drive mainstreaming pathways.

Success factor 3:

Collaborative mindset is crucial to continue building collective or disciplinary knowledge and understanding for urban NBS. Creating and participating in networks and communities of practice to improve shared knowledge and accessibility to best practice insights is important to ensure mainstreaming pathways enable the (re)shaping, building, and/or transforming of institutions that prioritise inclusivity. Collaborative mindset is therefore facilitated, mobilised, and maintained by Mainstreaming Connectors' mainstreaming actions, especially to drive bridging mainstreaming pathways.

Success factor 4:

On-ground delivery is an important element for understanding, evaluating, and reviewing mainstreaming pathways. It can show us what has been achieved and by extension what can be learned through implementation. This can provide insight into what has yet to work and how to improve the operationalisation of mainstreaming actions. On-ground delivery is therefore underpinned by the capabilities of Mainstreaming Implementers to follow, learn from, and facilitate bottom-up mainstreaming pathways.

6. Conclusion

Our analysis of actors' roles through the case study of urban forestry in metropolitan Melbourne provides critical insights on key role archetypes and configurations that can be considered for understanding mainstreaming pathways. Drawing on these insights, we propose a framework for agency in mainstreaming consisting of interconnected role archetypes, configurations, mainstreaming pathways, and success factors. This provides important conceptual underpinnings for how institutions can transform via NBS mainstreaming.

Specifically, building on case study evidence, the roles of actors have been elaborated on, as enablers, designers, connectors, or implementers, providing important insights on the mechanisms by which actors may generate change. Importantly, this is linked with role configurations relating to mainstreaming pathways of reforming, bridging, or translating.

The framework proposed by this study has been developed inductively and iteratively, building on an existing conceptualisation of actor roles for mainstreaming NBS in cities. Building on this understanding of actor roles, our analysis and synthesis focused on understanding how mainstreaming agencies and pathways can unfold successfully. As the focus was on positive actions towards NBS mainstreaming, this in turn may obscure barriers or obstacles associated with capacity and resources of different Councils to follow or pursue effective mainstreaming pathways.

The focus was deliberately on actors within or closely linked with local government, to deconstruct NBS mainstreaming agencies, and describing the types of role archetypes and pathways they can follow. To allow this framework to be more widely applicable to more general sustainability transitions, future research should focus on agency from different perspectives in relation to changing roles over time, actor roles and mainstreaming pathways across multi-level governance, and exploring the agency of actors also across broader society, including business, and academia; most of which were beyond the scope of this

current study.

CRedit authorship contribution statement

Niki Frantzeskaki: Conceptualization, Supervision, Writing – review & editing. **Clare Adams:** Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. **Magnus Moglia:** Conceptualization, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.envsci.2024.103723](https://doi.org/10.1016/j.envsci.2024.103723).

References

- Adams, Clare, Frantzeskaki, Niki, Moglia, Magnus, 2023a. Mainstreaming nature-based solutions in cities: a systematic literature review and a proposal for facilitating urban transitions. *Land Use Policy* 130, 106661. <https://doi.org/10.1016/j.landusepol.2023.106661>.
- Adams, Clare, Frantzeskaki, Niki, Moglia, Magnus, 2023b. Space for mainstreaming? Learning from the implementation of urban forest strategies in metropolitan Melbourne. *Aust. Plan.* 1–16. <https://doi.org/10.1080/07293682.2023.2268222>.
- Adams, Clare, Moglia, Magnus, Frantzeskaki, Niki, 2024. Realising transformative agendas in cities through mainstreaming urban nature-based solutions. *Urban For. Urban Green.* 91, 128160 <https://doi.org/10.1016/j.ufug.2023.128160>.
- Andersson, E., Barthel, S., Borgström, S., Colding, J., Elmqvist, T., Folke, C., Gren, A., 2014. Reconnecting cities to the biosphere: Stewardship of green infrastructure and urban ecosystem services. *Ambio* 43, 445–453. <https://doi.org/10.1007/s13280-014-0506-y>.
- Avelino, F., Wittmayer, J.M., 2016. Shifting power relations in sustainability transitions: a multi-actor perspective. *J. Environ. Policy Plan.* 18, 628–649. <https://doi.org/10.1080/1523908X.2015.1112259>.
- Baravikova, A., 2020. 'The uptake of new concepts in urban greening: Insights from Poland'. *Urban For. Urban Green.* 56. <https://doi.org/10.1016/j.ufug.2020.126798>.
- Brown, R.R., Farrelly, M.A., Loorbach, D.A., 2013. Actors working the institutions in sustainability transitions: the case of Melbourne's stormwater management. *Glob. Environ. Change* 23, 701–718. <https://doi.org/10.1016/j.gloenvcha.2013.02.013>.
- Bulkeley, Harriet, Betsill, Michele, 2005. Rethinking sustainable cities: multilevel governance and the 'urban' politics of climate change. *Environ. Polit.* 14, 42–63. <https://doi.org/10.1080/0964401042000310178>.
- Bush, J., Coffey, B., Fastenrath, S., 2020. Governing urban greening at a metropolitan scale: an analysis of the Living Melbourne strategy. *Aust. Plan.* <https://doi.org/10.1080/07293682.2020.1739093>.
- Byrne, David, 2022. A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Qual. Quant.* 56, 1391–1412. <https://doi.org/10.1007/s1135-021-01182-y>.
- Charmaz, K., Bryant, A., 2008. *Grounded theory*. In: Given, L.M. (Ed.), *The SAGE encyclopedia of qualitative research methods*. SAGE, Los Angeles.
- Coenen, L., Davidson, K., Frantzeskaki, N., Grenfell, N., Håkansson, I., Hartigan, M., 2020. Metropolitan governance in action? Learning from metropolitan Melbourne's urban forest strategy. *Aust. Plan.* 56, 144–148. <https://doi.org/10.1080/07293682.2020.1740286>.
- Davidson, Judith, Thompson, Shanna, Harris, Andrew, 2017. Qualitative data analysis software practices in complex research teams: troubling the assumptions about transparency and portability. *Qual. Inq.* 23, 779–788. <https://doi.org/10.1177/1077800417731082>.
- Davidson, Kathryn, Gleeson, Brendan, 2018. New socio-ecological imperatives for cities: possibilities and Dilemmas for Australian Metropolitan governance. *Urban Policy Res.* 36, 230–241. <https://doi.org/10.1080/0811146.2017.1354848>.
- Davies, C., Laforzezza, R., 2019. Transitional path to the adoption of nature-based solutions. *Land Use Policy* 80, 406–09. <https://doi.org/10.1016/j.landusepol.2018.09.020>.
- De Roeck, Frederik, Van Poeck, Katrien, 2023. Agency in action: towards a transactional approach for analyzing agency in sustainability transitions. *Environ. Innov. Soc. Transit.* 48, 100757 <https://doi.org/10.1016/j.eist.2023.100757>.
- DELWP, 2017. "Plan Melbourne 2017-2050." In. Melbourne, Victoria, Australia: The State of Victoria Department of Environment, Land, Water and Planning.
- DISR, 2020a. 'VIC Local Government Areas - Geoscape Administrative Boundaries', Commonwealth of Australia. (<https://data.gov.au/data/dataset/b90c2a19-d978-4e14-bb15-1114b46464fb>).
- DISR, 2020b. 'VIC State Boundary - Geoscape Administrative Boundaries', Commonwealth of Australia. (<https://data.gov.au/data/dataset/b90c2a19-d978-4e14-bb15-1114b46464fb>).
- Dorst, H., van der Jagt, A., Runhaar, H., Raven, R., 2021. Structural conditions for the wider uptake of urban nature-based solutions – A conceptual framework. *Cities*, 11610.1016/j.cities.2021.103283.
- Dorst, H., van der Jagt, A., Toxopeus, H., Tozer, L., Raven, R., Runhaar, H., 2022. What's behind the barriers? Uncovering structural conditions working against urban nature-based solutions'. *Landsc. Urban Plan.* 220 <https://doi.org/10.1016/j.landurbplan.2021.104335>.
- Duvall, Phoebe, Lennon, Mick, Scott, Mark, 2018. The 'natures' of planning: evolving conceptualizations of nature as expressed in urban planning theory and practice. *Eur. Plan. Stud.* 26, 480–501. <https://doi.org/10.1080/09654313.2017.1404556>.
- Fastenrath, S., Bush, J., Coenen, L., 2020. Scaling-up nature-based solutions. Lessons from the Living Melbourne strategy. *Geoforum* 116, 63–72. <https://doi.org/10.1016/j.geoforum.2020.07.011>.
- Fastenrath, Sebastian, Braun, Boris, 2018. Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany). *Appl. Geogr.* 90, 339–349. <https://doi.org/10.1016/j.apgeog.2016.09.004>.
- Fischer, Lisa-Britt, Newig, Jens, 2016. Importance of actors and agency in sustainability transitions: a systematic exploration of the literature. *Sustainability*. <https://doi.org/10.3390/su8050476>.
- Frantzeskaki, N., 2019. Seven lessons for planning nature-based solutions in cities. *Environ. Sci. Policy* 93, 101–111. <https://doi.org/10.1016/j.envsci.2018.12.033>.
- Frantzeskaki, N., Bush, J., 2021. Governance of nature-based solutions through intermediaries for urban transitions – A case study from Melbourne, Australia. *Urban For. Urban Green.* 64, 1–9.
- Frantzeskaki, N., McPhearson, T., Collier, M.J., Kendal, D., Bulkeley, H., Dumitru, A., Walsh, C., Noble, K., Van Wyk, E., Ordóñez, C., Oke, C., Pintér, L., 2019. Nature-based solutions for urban climate change adaptation: linking science, policy, and practice communities for evidence-based decision-making. *BioScience* 69, 455–466. <https://doi.org/10.1093/biosci/biz042>.
- Frantzeskaki, N., Vandergert, P., Connop, S., Schipper, K., Zwierczowska, I., Collier, M., Lodder, M., 2020. Examining the policy needs for implementing nature-based solutions in cities: Findings from city-wide transdisciplinary experiences in Glasgow (UK), Genk (Belgium) and Poznań (Poland). *Land Use Policy*, 9610.1016/j.landusepol.2020.104688.
- Fünfgeld, H., Fila, D., Dahmann, H., 2023. Upscaling climate change adaptation in small- and medium-sized municipalities: current barriers and future potentials. *Curr. Opin. Environ. Sustain.* 61 <https://doi.org/10.1016/j.cusust.2023.101263>.
- Geels, Frank W., 2014. Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective. *Theory, Cult. Soc.* 31, 21–40. <https://doi.org/10.1177/0263276414531627>.
- Grönholm, S., 2022. 'Experimental governance and urban climate action – a mainstreaming paradox?' *Curr. Res. Environ. Sustain.* 4, 10.1016/j.crust.2022.100139.
- Gugerell, Christina, Penker, Marianne, 2020. Change Agents' Perspectives on Spatial-Relational Proximities and Urban Food Niches. *Sustainability*. <https://doi.org/10.3390/su12062333>.
- Gulrsrud, N.M., Hertzog, K., Shears, I., 2018. Innovative urban forestry governance in Melbourne?: investigating "green placemaking" as a nature-based solution. *Environ. Res.* 161, 158–167. <https://doi.org/10.1016/j.envres.2017.11.005>.
- Hansen, R., M. Buizer, A. Buijs, S. Pauleit, T. Mattijssen, H. Fors, A. van der Jagt, N. Kabisch, M. Cook, T. Delshammar, T.B. Randrup, S. Erlwein, K. Vierikko, H. Nieminen, J. Langemeyer, C. Soson Texereau, A.C. Luz, M. Nastran, A.S. Olafsson, M. Steen Møller, D. Haase, W. Rolf, B. Ambrose-Oji, C. Branquinho, G. Havik, J. Kronenberg, and C. Konijnendijk. 2022. 'Transformative or piecemeal? Changes in green space planning and governance in eleven European cities', *European Planning Studies* 10.1080/09654313.2022.2139594.
- Hartigan, M., Fitzsimons, J., Grenfell, M., Kent, T., 2021. Developing a metropolitan-wide urban forest strategy for a large, expanding and densifying capital city: lessons from Melbourne, Australia. *Land* 10, 10.3390/land10080809.
- Ibrahim, A., K. Bartsch, and E. Sharifi. 2023. 'Waterways transformation and green stormwater infrastructure: enabling governance for Adelaide's River Torrens Catchment, Australia', *International Journal of Water Resources Development* 10.1080/07900627.2022.2163624.
- IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany.
- IPCC, 2022. *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

- Irvine, Sigourney, Bai, Xuemei, 2019. Positive inertia and proactive influencing towards sustainability: systems analysis of a frontrunner city. *Urban Transform.* 1 (1) <https://doi.org/10.1186/s42854-019-0001-7>.
- Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., Haase, D., Knapp, S., Korn, H., Stadler, J., Zaunberger, K., Bonn, A., 2016. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecol. Soc.* 21, 10.5751/ES-08373-210239.
- Kabisch, N., N. Frantzeskaki, and R. Hansen. 2022. 'Principles for urban nature-based solutions', *Ambio*, 10.1007/s13280-021-01685-w.
- Kay, A., 2017. 'Multi-level governance and the study of Australian federalism.'. In: Katherine, A. Daniell, Kay, A. (Eds.), *Multi-level governance: Conceptual challenges and case studies from Australia*. ANU Press, Acton, ACT.
- Kirs, Margit, Karo, Erkki, Ukrainski, Kadri, 2022. Transformative change and policy-making: the case of bioeconomy policies in the EU frontrunners and lessons for latecomers. *Innov.: Eur. J. Soc. Sci. Res.* 35, 514–546. <https://doi.org/10.1080/13511610.2021.2003186>.
- Lee, So-Young, Zusman, Eric, Lee, Seejae, 2017. Tracing sustainability transitions in Seoul governance: enabling and scaling grassroots innovations. *Procedia Eng.* 198, 293–304. <https://doi.org/10.1016/j.proeng.2017.07.162>.
- Loorbach, Derk, Frantzeskaki, Niki, Avelino, Flor, 2017. Sustainability transitions research: transforming science and practice for societal change. *Annu. Rev. Environ. Resour.* 42, 599–626. <https://doi.org/10.1146/annurev-environ-102014-021340>.
- Macdonald, S., Monstadt, J., Friendly, A., 2021. From the Frankfurt greenbelt to the Regionalpark RheinMain: an institutional perspective on regional greenbelt governance. *Eur. Plan. Stud.* 29, 142–162. <https://doi.org/10.1080/09654313.2020.1724268>.
- Mell, I., 2020. What Future for Green Infrastructure Planning? Evaluating the Changing Environment for Green Infrastructure Planning Following the Revocation of Regional Planning Policy in England. *Plan. Pract. Res.* 35, 18–50. <https://doi.org/10.1080/02697459.2020.1714271>.
- Mintrom, Michael, Rogers, Briony C., 2022. How can we drive sustainability transitions? *Policy Des. Pract.* 5, 294–306. <https://doi.org/10.1080/25741292.2022.2057835>.
- Mumtaz, M., 2023. Intergovernmental relations in climate change governance: a Pakistani case. *Glob. Public Policy Gov.* 3, 116–136. <https://doi.org/10.1007/s43508-023-00066-1>.
- Peskett, L., Metzger, M.J., Blackstock, K., 2023. Regional scale integrated land use planning to meet multiple objectives: good in theory but challenging in practice. *Environ. Sci. Policy* 147, 292–304. <https://doi.org/10.1016/j.envsci.2023.06.022>.
- Raymond, C.M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M.R., Geneletti, D., Calfapietra, C., 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environ. Sci. Policy* 77, 15–24. <https://doi.org/10.1016/j.envsci.2017.07.008>.
- Sarabi, S.E., Han, Q., Romme, A.G.L., de Vries, B., Wendling, L., 2019. Key enablers of and barriers to the uptake and implementation of nature-based solutions in urban settings: a review. *Resources* 8, 10.3390/resources8030121.
- Sarabi, Shahryar, Han, Qi, L. Romme, A. Georges, de Vries, Bauke, Valkenburg, Rianne, den Ouden, Elke, Zalokar, Spela, Wendling, Laura, 2021. Barriers to the adoption of urban living labs for NBS implementation: a systemic perspective. *Sustainability* 13, 13276.
- Scharpf, F.W., 2018. *Games real actors play: Actor-centered institutionalism in policy research*. Routledge: New York.
- Skill, K., Farhangi, M., Trygg, K., 2023. Size matters: action space for sustainability transition among planners in Swedish municipalities. *Urban Res. Pract.*, . <https://doi.org/10.1080/17535069.2023.2209554>.
- Smith, Adrian, Stirling, Andy, Berkhout, Frans, 2005. The governance of sustainable socio-technical transitions. *Res. Policy* 34, 1491–1510. <https://doi.org/10.1016/j.respol.2005.07.005>.
- Tan, Hao, Thurbon, Elizabeth, Kim, Sung-Young, Mathews, John A., 2021. Overcoming incumbent resistance to the clean energy shift: how local governments act as change agents in coal power station closures in China. *Energy Policy* 149, 112058. <https://doi.org/10.1016/j.enpol.2020.112058>.
- Tozer, L., Bulkeley, H., van der Jagt, A., Toxopeus, H., Xie, L., Runhaar, H., 2022. Catalyzing sustainability pathways: Navigating urban nature based solutions in Europe. *Glob. Environ. Change* 74. <https://doi.org/10.1016/j.gloenvcha.2022.102521>.
- Underdal, A., 2008. Determining the causal significance of institutions: Accomplishments and challenges. In: Young, O.R., King, L.A., Schroeder, H. (Eds.), *Institutions and environmental change: Principal findings, applications, and research frontiers*. The MIT Press: Cambridge, Massachusetts.
- UNEP, 2021. 'Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies'. United Nations Environment Programme, Nairobi.
- UNEP. 2022. 'Nature-based Solutions: Opportunities and Challenges for Scaling Up'. Wickenberg, B., Kiss, B., McCormick, K., Palgan, Y.V., 2022. 'Seeds of transformative learning: investigating past experiences from implementing nature-based solutions', *Frontiers in Sustainable Cities*, 410. 3389/frsc 2022, 835511.
- Wilkinson, C., Saarne, T., Peterson, G.D., Colding, J., 2013. 'Strategic spatial planning and the ecosystem services concept - An historical exploration'. *Ecol. Soc.* 18, 10.5751/ES-05368-180137.
- Wittmayer, J., Avelino, F., van Steenbergen, F., Loorbach, D., 2017. Actor roles in transition: insights from sociological perspectives. *Environ. Innov. Soc. Transit.* 24, 45–56. <https://doi.org/10.1016/j.eist.2016.10.003>.
- Xie, L., Bulkeley, H., 2020. Nature-based solutions for urban biodiversity governance. *Environ. Sci. Policy* 110, 77–87. <https://doi.org/10.1016/j.envsci.2020.04.002>.
- Xie, L., Bulkeley, H., Tozer, L., 2022. Mainstreaming sustainable innovation: unlocking the potential of nature-based solutions for climate change and biodiversity. *Environ. Sci. Policy* 132, 119–130. <https://doi.org/10.1016/j.envsci.2022.02.017>.
- Yin, R.K., 2003. *Case study research: Design and methods*. SAGE, Thousand Oaks.
- Young, O.R., 2008. Institutions and environmental change: The scientific legacy of a decade of IDGEC research. In: Young, O.R., King, L.A., Schroeder, H. (Eds.), *Institutions and environmental change: Principal findings, applications, and research frontiers*. The MIT Press: Cambridge, Massachusetts.

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