Weaving notions of justice into urban ecosystem services research and practice

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ABSTRACT

In a rising urban age planning for cities around the globe is increasingly based on assessments of ecosystem services, making enhanced considerations of ecosystem service justice critically important. Yet, justice remains a 'blind spot' in urban ecosystem service models and research, which can be traced back to the ecological and economic legacies of the concept itself. This legacy reproduces the normative focus on natural capital as a guarantee of sustaining ecosystem services, enforces a static understanding of nature that insufficiently considers human agency, and conceptualizes ecosystem service flows from nature to humans in a way that does not reflect the social-ecological structure and constantly shifting priorities of the urban realm. In response, this conceptual paper aims at broadening the analytical foundation for justice in urban ecosystem service assessments by presenting a model that links the co-production of urban ecosystem services (including infrastructure, institutions, and perceptions) with established lines of recognition, procedural, and distributional justice. It further highlights the need to embed these classical dimensions of justice within both spatial (downscaled and inter-scalar approaches) and temporal (interrelated past, present, and future conditions) justice frames. Relying on urban environmental, social, spatial and temporal justice theory as well ecosystem service scholarship, we outline theoretical entry points and provide practical examples for weaving notions of justice into urban ecosystem service research and practice, while highlighting future research needs.

1. Introduction

Urbanisation in the Anthropocene is increasingly embedded in planetary systems and processes (Brenner and Schmid, 2017; Graham, 1999) reaching far beyond local political boundaries (Seto et al., 2017; Castells, 2010; Hall and Pain, 2006). As a consequence, cities are intensively driving global environmental change (Seto et al., 2010) and are important political arenas for shaping the overall distribution of material and immaterial benefits that nature provides to people (Anguelovski et al., 2019; Elmqvist et al., 2013; Merrifield, 2013), here referred to as ecosystem services (ES). In this context of planetary urbanisation, new urban-centred theoretical framings are required that support an empirical approach to urban ES justice.

The ES concept has become a dominant metaphor, accounting instrument, and planning tool (Gómez-Baggethun and Barton, 2013), creating a major paradigm shift from natural preservation for nature's sake towards sustaining nature's benefits for people. ES are also becoming a key framework for the analysis of benefits provided by the push since the 1990s to create green infrastructure and, more recently, "nature-based solutions" in urban areas (Demuzere et al., 2014; Hansen et al., 2015; Raymond et al., 2017). Yet, despite proximate intellectual endeavours to link justice and urban ecology, calls for a stronger contemplation of justice within ES assessments, especially from an empirical perspective (*cf.* Sikor et al., 2014), have gone largely unheaded (Biernacka and Kronenberg, 2019; Ernstson, 2013; Kabisch, 2019).

Currently, only a few real-world urban greening interventions consider direct distributional effects in an effort to ensure inclusive ES outcomes. Even when those with an equity consideration are accounted for, almost all urban greening efforts neglect complex social-ecological processes that unfold across space and over time into emergent new forms of injustice for certain social groups (Anguelovski et al., 2019). These may, for example, include gentrification processes related to the implementation of new urban parks (Anguelovski et al., 2018; Cole et al., 2017; Gould and Lewis, 2016; Pearsall and Eller, 2020) or

metabolic benefit (and burden) shifting between cities and the urban hinterland through the implementation new forms of urban agriculture, such as roof-top gardening (Goldstein et al., 2016; McClintock, 2010; Sanyé-Mengual et al., 2015; Piezer et al., 2019).

The justice challenge with regard to the provision of ES is embedded in large, systemic interactions that are especially acute in dense urban areas where effects concentrate. As a result, the direct omission of efforts to mitigate unjust policy outcomes, for example by compensating for the lack of distributional justice considerations in the general ES framework through enhanced stakeholder participation (*e.g.* Hauck et al., 2014), is only one aspect of what is missing with regard to the justice perspective in urban ES practice. Without developing the broader model that accounts for systemic interactions by incorporating distributive, procedural, and recognition aspects of ES justice as well as the perspective of larger spatial and temporal implications of urban greening, ES approaches put into practice are unlikely to unfold in a just manner. Furthermore, firmly anchoring notions of justice in ES theory points toward new directions for research that require questioning some of the fundamental assumptions and traditions in ES studies stemming from the economic and ecological origins of the concept.

1.1. Justice and ecosystem services

Justice is understood here as a variegated set of conditions — primarily concerned with distribution of resources, political processes, and social recognition — that allows for full human flourishing (Schlosberg, 2013). If conditions within a given society systematically support some, but hinder other individuals or groups with regard to basic flourishing (*i.e.* fundamentally thriving within reasonable limits) according to achievable outcomes that they value in order to live a healthy and fulfilled life, then that society is to some degree unjust (Fraser, 1995). A common example of such conditions is based on gender-related inequalities, which may routinely ensure that women (for example) are less healthy and more vulnerable to physical and financial violence (Nussbaum, 2000). A particular extension of this issue that has been largely overlooked by the urban ES literature is expressed in gender-related barriers to the recreational benefits of urban green spaces (*e.g.* Wang et al., 2015; Wendel et al., 2012).

Of course, without a functioning ecosystem there can be no human condition, just or otherwise. Therefore, even while the societal conditions that support social justice are debated and being updated alongside an increasingly planetary view of urbanisation (Brenner, 2018; Shi et al., 2016), it is simultaneously necessary to account for the specific effects on the underlying 'ecological condition for justice' (Holland, 2008). As many scholars have pointed out, these realms are two sides of the same social-ecological coin, a point which highlights the need for an explicit model of urban ES justice that links closely with a contemporary perspective on urbanisation and social justice. Such reconciliation requires at once including considerations of recognition, procedural and distributive justice across different spatial and temporal scales (Ernstson, 2013).

This is not to say that there has been no attention paid to explicit justice questions in urban ES research (*e.g.* Depietri et al., 2016; Jennings et al., 2016; Juntti and Lundi, 2017; Wilkinson et al., 2013), but rather that the urban ES framework has yet to reconcile a wider range of issues raised by scholars of urban social justice and planetary urbanisation within a model of urban ES justice (Marshall & Gonzalez-Melen, 2016). The urban ES literature — as Ernstson (2013) critically emphasized — has primarily and narrowly approached justice from a static and local perspective of distributive justice, most commonly analysing social trade-offs in relation to greening outcomes. These trade-off accounting studies focus on unequal distributions of benefits between different social groups in a limited spatial and temporal context and within a given state of infrastructure provision, institutional norms and individual perceptions (*e.g.* Baró et al., 2019; Egerer et al., 2018; Escobedo et al., 2015; Maia et al., 2020). While these studies are

of value for understanding one portion of the social justice challenge of urban ES — namely the spatially and temporally particular instances of injustice in the distribution of benefits (Turkelboom et al., 2018) — they do not account well for inter-scalar (tele-)connections characterizing ES injustice (*e.g.* Corbera et al., 2019). Furthermore, they are not sufficient to uncover the dynamics of how ES inequalities formed in the past or how the future distribution of benefits is likely to unfold (Jenerette et al., 2011; Derkzen et al., 2017).

The conceptual challenge at hand is not resolved through simple alignment of ES with sustainability frameworks. Such an effort has proven insufficient because most mainstream applied approaches to sustainability (*e.g.* Sustainable Development Goals) emphasize economic growth in a manner that allows certain aspects of the multiple domains of justice to be sacrificed (*e.g.* distributional goals may be explicitly targeted while procedural justice is scarcely attended to). As a consequence of neglect for who, how, and where questions, the 'equity deficit' — where substantive considerations of social equity and justice are excluded — described by Agyeman (2008) for environmental sustainability is extended to urban environmental policies. Said differently, in the absence of a more balanced accounting for social justice in urban ES research, practical ES approaches are likely to recreate prior patterns of sustainability initiatives where those with political power do not consider the unequal distribution of nature's benefits to the detriment of economically, socially, and/or racially disadvantaged groups, both within cities and across scales through global urbanisation networks of ES (Wolch et al., 2014; Wyly, 2015). In response, a distinct model of urban ES justice is needed as a foundation for carving out a different path. The model we develop does so by incorporating distributive, procedural, and recognition aspects of justice into a single framework that also accounts for scalar and temporal dimensions of urbanisation.

Specifically, we outline a dynamic understanding of urban ES production cycles (Langemeyer, 2015) that is meant to challenge the ecological and economic legacies of the ES concept (Gómez-Baggethun et al., 2010) and the predominance of utilitarian stock-flow models in its conceptualization (Potschin-Young et al., 2018). Such a dynamic understanding of an urban ES production cycle, based on the assumption of ES co-production (Andersson et al., 2007; Berbés-Blázquez et al., 2016; Boulton et al., 2018; Juntti and Lundi, 2017), needs to incorporate a broad conceptualization of the manifold aspects of justice in ES research and practice while acknowledging the inter-scalar character and shifting spatial reach of planetary urban processes (Graham, 1999) embedded in a range of simultaneous temporal dynamics being shaped by urbanisation (Massey, 1992). Such understanding would acknowledge that fair distribution of ES demands recognition of historic inequalities embedded in ES production and consumption patterns alongside current needs in combination with mechanisms to account for changing (green) infrastructures in the future, shifting societal needs across different social groups, and inclusive procedures that impact actions, actors, institutions or states of affairs within urban decision-making praxis.

This approach to ES production would also recognize broad spatial and temporal forces that shape ES provision as a result of urbanisation. Access to a spectrum of generalized ES, such as food and clean water, underlies the prospects for human flourishing regardless of geographic location (Heynen, 2014; Wachsmuth, 2012), but there are also highly localized conditions that are critical in determining different levels of accessibility to ecosystem benefits, such as opportunities for recreation, which are often of limited availability in urban areas (Alkan-Olsson et al., 2020; Andersson et al., 2019). As well, urbanisation at once shapes intra-generational dynamics of wellbeing and inter-generational endowments of resources for living a fulfilled life. Therefore, simultaneous attention to the social-ecological interactions that determine access to ES and the preservation of a basic ecological condition upon which just social systems can be built is essential.

In order to outline a model that accounts for the range of issues impacting justice, this article presents a novel approach to thinking

about urban ES justice that expands on prior efforts in three ways. First, it critically scrutinizes the ecological and economic traditions embedded in the ES concept that need to be addressed in order to fully account for the challenges in producing urban ES justice. Second, it responds to the call from within the ES scholarship to overcome the fragmented and incomplete understanding of how the multiple dimensions of justice beyond distribution — including, for instance, recognition and procedural justice (Fraser, 1995) — can inform (urban) ES research and practice (*e.g.* Dawson et al., 2018; Enssle and Kabisch, 2020; Ernstson, 2013; Pascual et al., 2014). Third, it internalizes the particular spatial challenge raised by planetary processes of urbanization (Heynen, 2003; Jansson, 2013) and it pushes toward a more balanced approach to the temporal implications of ES (Anguelovski et al., 2020; Derkzen et al., 2017; Wilkinson et al., 2013).

Overall, this article highlights the multiple entry- and docking-points for social justice that already exist within ES scholarship and indicates the gaps to be closed for a coherent approach to the wider empirical project of urban ES justice. It begins with a reflection on the historic legacies of ES scholarship, highlighting conceptual burdens for urban ES-based equity analyses that need to be overcome. Importantly, we recognize that the lack of consideration for justice in urban ES analyses is in part reflective of the limited role played by humanities and social sciences (beyond economists) in developing and shaping the ES concept. Following this background, we respond to the repeated calls for stronger considerations of equity and justice in urban ES research that expand understanding of how such considerations can be operationalized (Ernstson, 2013; Haase et al., 2017). Here, we provide a new approach to conceptualizing how justice fits into the dynamic relationship between people and urban nature in the process of co-producing ES, including the interlinked character of perceptions, institutions and infrastructure (Biernacka and Kronenberg, 2018; 2019 Andersson et al., 2019), which act as filters for the uptake of urban ES. Unlike the environmental justice (EJ) and urban political ecology literatures (which have seen a sustained effort to mine the lessons of social justice scholarship, *e.g.* Heynen et al., 2006; Schlosberg, 2013; Swyngedouw and Heynen, 2003) — from which we pull important lessons — urban ES research is still developing a robust engagement with a justice framework. We set out here some proposed guideposts for such engagement.

2. Conceptual legacies

Although the ES concept lacks a single, coherent framework, and is the object of continued normative and epistemological debates (Lele, 2013), a major cause for the 'equity deficit' in ES research is generally ascribed to the ecological and economic legacies of the concept (Gómez-Baggethun et al., 2010; Díaz et al., 2018; Pascual et al., 2014). These legacies have intellectual tendrils that still reach into the mainstream application of the concept today. Thus, before teasing out important advances in ES research and presenting the conceptualization of urban ES justice, it is worthwhile to briefly revisit the historic legacy embedded in the ES concept that hampers a stronger embrace of social justice perspectives.

While the ecological-economic legacy of ES dates back to the 1970s (*e.g.* Ehrlich and Ehrlich, 1981), it received an important reinterpretation through the highly influential Brundtland (1987) report introducing *sustainable development* as the principle of "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This understanding includes social equity as a consideration, but there has been a notable lack of attention to such concerns relative to ecological preservation and economic growth goals (Agyeman, 2008). The ES model, premised on maintaining natural capital to sustain future generations' wellbeing (Costanza and Daly, 1992), has developed in a similar fashion. The lack of equity focus within sustainability was reflected as well in the foundational economic metaphor of ES as 'stocks of natural capital' that

sustain the flow of benefits (*e.g.* ibid.) — a concept which continues to dominate the current scientific understanding of ES. The 'stock-and-flow' framing (Norgaard, 2010), which is firmly anchored within a utilitarian view of nature's value, is also reflected in the ES 'cascade model' — today, probably the most influential conceptual framework in ES theory and practice (Potschin-Young et al., 2018). In this model, the biophysical ecosystem structure and associated processes determine the flow of ES benefits, to which finally values are attributed (MA, 2005; Potschin and Haines-Young, 2011).

With other social sciences only timidly embracing the ES approach, environmental economists have been at the forefront of determining the (monetary) value of ES based on their utility and thereby have shaped the interpretations of ES as the concept is translated from a policy metaphor to a scientific approach and increasingly applied in practice (Gómez-Baggethun et al., 2010; Lele, 2013; Norgaard, 2010). While monetary valuation has been strongly disputed and there is an ongoing partial push-back within contemporary ES scholarship (*e.g.*, Corbera et al., 2007; Matulis, 2014), the utilitarian economic goal of a 'potential Pareto improvement' (*i.e. economic efficiency*), occurring when the sum of benefits outweighs the sum of the costs (*e.g.* of a project or a policy), is more persistent and remains as either the explicit or implicit motivation for decision-making based on ES assessments (Saarikoski et al., 2016). This economic legacy neglects distributional effects by definition as it favours a 'homogenous approach to communities' that fails to consider social diversity (Chaudhary et al., 2018:99). It presents complex social-ecological relationships as neutral exchanges between 'nature' and 'people' governed by economic rationality, thereby concealing conflicts and power imbalances in specific geographical and historical contexts (Kull et al., 2015). One exception to this circumstance is found in the literature on payments for ES, where ES justice considerations are often explicit. While utilitarian thinking is also prevalent here; strong emphasis is put on the ES provider-user relationships and related injustices, where the monetary value of ES benefits (*i.e.* the marginal utility) stands at the centre of compensation payments to reward the efforts of the ES providers (*cf.* Sikor et al., 2013).

While the economic utility paradigm, striving for the maximization of net benefits, remains dominant in ES assessments, the practical responses to repeated calls (*e.g.* Kosoy and Corbera, 2010; Saarikoski et al., 2016) for empirical considerations of social incommensurability of values and differences in preferences related to differences in socioeconomic situations remain scarce. Despite important conceptual advances, empirical ES literature still often overlooks inherent (*i.e.* intrinsic) nature values as well as relational values of and about nature (including eudaimonistic values) that are non-utilitarian (Chan et al., 2016, 2018; Jax et al., 2013). Díaz et al. (2018) assume that this deficiency is related to the alienation between ES research and other scientific fields more concerned with justice, especially the social sciences, which they argue has accelerated since the path-leading Millennium Ecosystem Assessment (MA, 2005). The consequence is an enduring lack of differentiated understanding of people's perceptions, cultural framings, epistemological perspectives and the distribution of benefits and values in practice (Chan et al., 2012; Díaz et al., 2018; Norgaard, 2010), which constitutes a major obstacle for ES scholarship to develop an empirical justice perspective (Pascual et al., 2014).

While the normative utilitarian dimensions of ES scholarship are a primary limiting factor with regard to the integration of social justice concerns, there is also a decided thematic bias emerging from ecological legacies in relation to the rural origins of the ES concept with which to contend. Where social science research conducted through an economic lens mainly focused on utility values as an endpoint of linear and unidirectional processes of value creation by nature, ecologists including their urban offshoot maintain an often limited focus on ecological structure and functions (the beginning of the ES cascade) as the source of ES flows (Haase et al., 2014). This (rural) conceptualization of stock-and-flow thinking is predominant in the ES work influenced by

the cascade model and the Millennium Ecosystem Assessment, but insufficiently reflects the urban realm. More precisely, it overemphasizes the maintenance of (pristine) ecosystems in order to guarantee sustainable flows of ES. Consequently, it overlooks the fundamental character of urban ES being deeply co-produced by natural and human assets (Andersson et al., 2007; Boulton et al., 2018; Raymond et al., 2018) and does not fully account for the planetary nature of urbanisation processes (Brenner and Schmid, 2017), where urban demands drive the production of ES (*e.g.* in the form of food and recreation) at the global scale. The over-emphasis on the biophysical structures underlying the generation of ES benefits in urban ES assessments (*cf.* Haase et al., 2014) is due to an insufficient consideration of the dynamics of service-providing social structures, institutions and ecosystem governance, as well as constantly changing needs and wants among urban citizens and shifting priorities for specific ES (*cf.* Andersson et al., 2019).

In short, the bias toward ecological structure and function in ES research belies its own social-ecological aspect. It can be disputed whether and to what extent stock-flow models are useful in reflecting non-urban realities under global production processes (*cf.* Spangenberg et al., 2014), but they surely fall short in describing the production of urban ES for and within metropolitan regions, which are critically determined by the importance of feedbacks from governance patterns, human agency, and relations of power in shaping ecosystems as well as the concentrated production and accessibility of ES (Krasny et al., 2014; Langemeyer et al., 2018). For a consistent urban ES justice framework, it is essential to overcome the predominance of this dualistic and unidirectional understanding of ES that flow from "nature" to "people" (*cf.* Peterson et al., 2018a), which overemphasise natural processes and underplay the critical importance of integrated social-ecological systems.

The conceptual approach named 'nature's contributions to people' emerging from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Díaz et al., 2018) more strongly embraces of the notion that there is an intertwined aspect of human and ecological processes, yet it still maintains a largely dualistic view of nature and society (Peterson et al., 2018b). Building on previous endeavours (*e.g.* Spangenberg et al., 2014), a less dualistic understanding that departs significantly from the stock-and-flow model is currently developing within urban social-ecological systems literature. For instance, Langemeyer (2015) highlighted the circular relationship between human preference systems, urban governance and managed ecosystems. This literature sees urban ES as intertwined and fully embedded in (bio-)physical structures (which includes green, blue and built elements) that are responsive to the urban institutional context and determined by people's cultural and individual perceptions to realize those benefits (Andersson et al., 2019). This integrated conceptualization of ES production is a necessary foundation for a systematic consideration of urban ES justice because it allows for secondary (and potentially detrimental) feedback processes to be taken into account.

In brief, equity, fairness, or justice are often not explicitly part of the historic lineage of 'outcome variables' in both normative and analytical ES frameworks (Lele, 2013). Some have even criticized the ES approach as a tool for reinforcing inequalities and injustice (Corbera et al., 2007; McAfee, 2012; Matulis, 2014). The economic and ecological legacies are reflected within the normative goal of maintaining 'natural capital' for future generations (MA, 2005); an idea that prioritizes inter-generational justice over intra-generational justice and largely ignores the relationship between the two, which creates an imbalance in the prioritisation given to the different temporal dimensions of ES provision (Gómez-Baggethun et al., 2010; Aragão et al., 2016). As a consequence, ES scholarship often undervalues the interdependent aspects of inter- and intra-generational justice. Some have even criticized the ES approach as a tool for reinforcing inequalities and injustice (Corbera et al., 2007; McAfee, 2012; Matulis, 2014). These qualities of the ES approach

reflect in part the still shy engagement with the concept by urbanists and social scientists, other than economists (DeGroot et al., 2018), and the corresponding lack of a coherent urban ES justice conceptualization.

Yet, as ES scholarship has also made some considerable progress beyond its ecological and economic origins (Sikor, 2013; Maes et al., 2018; Corbera, 2015), we see good reason to push it further toward inclusion of explicit social justice concerns. In the following section, we highlight the alternative trends in ES theory, practice, and research, which parallel the classical ecological and economic paradigms and which, as we show, when properly teased out, allow for the ES framework to support comprehensive equity and justice assessments of urban greening.

3. Expanding the meaning of social justice for urban ecosystem services research

The ES framework has an inherently positive connotation of ecosystem–society relationships. Yet, for developing a framework of ES justice, it is critical to also consider negative outcomes, or 'burdens', of greening that accompany the production of ES (Lele, 2013). Burdens might include potential environmental impacts from the material and energy inputs required to maintain urban ES, as well as considerations of physical, psychological and societal detriments of urban greening (Langemeyer and Gómez-Baggethun, 2018). For example, green roof strategies must consider environmental burden shifting related to enhanced demand for water, nutrient and energy imports; street tree selection must consider allergenic species; and green space and urban park creation must acknowledge the greenhouse gas emissions involved with production of new spaces and social effects like the sensation of insecurity by some female park users (*cf.* Wang et al., 2015; Wendel et al., 2012) as well as the secondary effect of enhanced property prices in the surrounding area that may drive gentrification processes (Łaszkiewicz et al., 2018; Maia et al., 2020).

The urban EJ perspective, which developed parallel to, but not much in conversation with, the somewhat younger urban ES approach, has explicitly addressed these issues. While also focussing on human-ecosystem interactions, the urban EJ approach started from a more explicit focus on detrimental effects and inequities in human experiences. These different foci have led to a logical separation in terms of level of uptake and connection with issues of social justice. As a result, advances in thinking around EJ can inform efforts to further incorporate social justice into ES research and practice. Analogously, the tools for measuring ES developed within ES scholarship can inform EJ analysis in ways that push that field forward (*e.g.* Baró et al., 2019; Maia et al., 2020). Thus, a synthetic perspective of the two fields is perhaps a reasonable goal within research and practice.

The urban EJ movement launched in the late twentieth century in the U.S. as a variant of environmentalism premised on principles defined by people of colour that – similarly to current urban ES equity scholarship – initially focused almost entirely on distributional justice issues (Taylor, 2000; Agyeman et al., 2016). Early urban EJ work highlighted inequities in the concentrations of toxic waste and other environmental hazards in or near low-income and non-White communities (Bullard, 1990). By the 2010s, however, there was a push to shift EJ toward a more variegated and nuanced approach that examines justice issues associated with urban environmental health and well-being from a distributional, procedural, and recognition perspective (Walker, 2009; Mohai et al., 2009). This shift toward a more pluralistic understanding of justice continues to elevate concerns over decision-making processes (participation) and stigmatization of places associated with certain social groups (recognition, or 'interaction') to nearly as central a position as long-standing questions of socio-spatial distribution of environmental goods and bads.

Efforts to integrate a similarly variegated view of social justice in ES research (*cf.* Sikor, 2013; Dawson et al., 2018) have generally not been

accounted for in the urban ES realm, and only a few approaches have embedded this variegated view within wider concepts of spatial and temporal justice (*e.g.* Derkzen et al., 2017). Rather, as with early EJ scholarship, this work is generally limited to examinations of distributional justice issues alone (Boone et al., 2010; Schwarz et al., 2015; Baró et al., 2019), although considerations of other dimensions of justice are to some extent present (*cf.* Cohen et al., 2019; Enssle and Kabisch, 2020; Ernstson, 2013; Martin et al., 2016). While these efforts are important foundational elements for a fully-developed understanding of urban ES justice, a strictly distributional perspective is highly limiting for well-known reasons, including a contested view of what actually entails a just distribution (i.e. there are several competing principles for making such a determination) and the need to account for other essential elements to theorizing justice (Sikor, 2013; Lukasiewicz et al., 2017; Lamont, 2017). As well, a longstanding critique of the strictly distributional approach highlights the inattention to issues related to identity and power that generate distributional injustices and may not be visible from pure resource allocation perspectives (Fraser, 1998; Young, 1990). In response, there is an emerging call within ES scholarship to conceptualise ES justice in a more nuanced fashion (*e.g.* Dawson et al., 2018), and this approach is especially projected onto the realm of urban greening (Wolch et al., 2014).

Building on and extending recent efforts within urban ES scholarship to engage more fully with questions of justice, the first layer of our proposed conceptual model links several approaches, shown in Fig. 1, to achieve urban ES justice. The figure reflects advances in urban ES research (*e.g.* Langemeyer, 2015; Andersson et al., 2019) that account for the fundamental and interrelated role of (a) infrastructure including built and green infrastructure limiting or enabling the (local) availability of ES, (b) institutions, including human agency and urban governance systems (policy and planning) that determine access to and control over ES (Berbés-Blázquez et al., 2016) and shape urban

ecosystems (structure and functions), and (c) people's perceptions understood as the subjective and context-dependent definition of ES benefits and their importance (Juntti and Lundi, 2017; Biernacka and Kronenberg, 2019). Bringing these three elements together is essential because, for example, urban park projects with infrastructural and institutional elements designed to achieve distributional and procedural justice can overcome psychological barriers to accessibility rooted in recognition injustices (Seymour, 2012). ES provision requires all of these 'filters' (Andersson et al., 2019) operating at once in order to achieve a just outcome.

Moving outward on the figure, ES justice is dependent on three filters of urban ES production highlighted in the centre — infrastructure, institutions, and perceptions, each of which are substantially linked with a type of justice. Distributive justice is primarily linked with infrastructure because it is outcomes-oriented, addressing the final uptake of ES benefits by different societal groups (Chaudhary et al., 2018), which are based on the available (green) infrastructure and ES generating processes, but also on institutional barriers and social perceptions (Andersson et al., 2019; Biernacka and Kronenberg, 2019). Procedural justice links with the institutional filter because it focuses on the processes and power relationships in decision-making and the governance of urban greening, including the framing of and people's participation in decision-making affecting ES (*cf.* Zafra-Calvo et al., 2017). Recognition justice is most closely aligned with perceptions because it involves acknowledging people's distinct identities and histories (He and Sikor, 2015) and is related to the plurality in ES needs, as well as multiple types and levels of people's preferences (or values) attached to ES benefits, including notions of what is perceived to be just.

The three ES justice dimensions and associated ES filters are also interrelated among themselves (Sikor, 2013). For example, recognition justice is fundamental to participation in decision-making processes
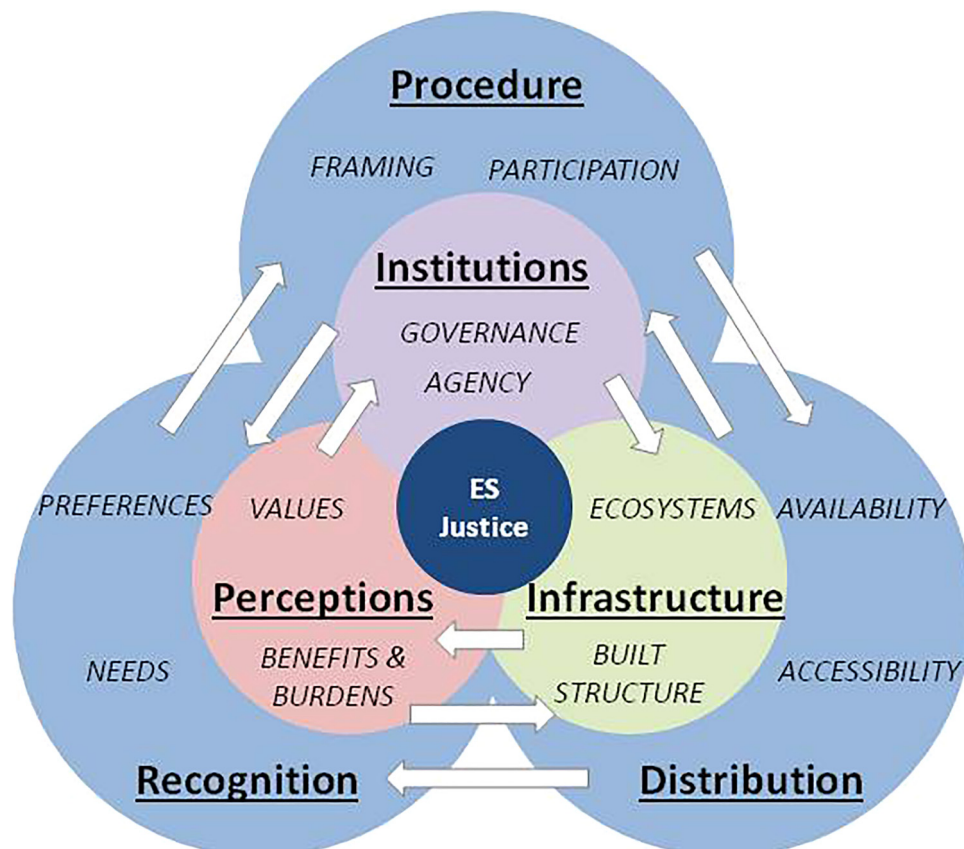

Fig. 1. Core elements of the empirical urban ecosystem services justice model: Recognition, procedure, distribution.

(*aka* procedural justice), both of which fundamentally influence distribution justice of ES. This tight interrelation is recognized (and debated) in the wider social justice literature and points toward a need to see the urban EJ and urban ES perspectives as closely related efforts.

EJ scholars and activists have always refused to define the environment in strictly ecological terms (Schlosberg, 2013), seeing it instead as the totality of social, built, and ecological systems that structure human and non-human life experiences. This perspective is reflective of the ES understanding of integrated social-ecological (-technical) systems and is increasingly mirrored by urban ecosystem (service) research (Andersson et al., 2019; Depietri and McPhearson et al., 2017). Yet, both perspectives are reaching their intellectual limits with regard to questions of justice. Taken together, these efforts push us toward an EJ emphasis on distributional, recognition, and procedural justice as a means for considering the depth and interconnection between infrastructure, institutions and perceptions in shaping overall ES justice. In the sections that follow, we describe each of the elements that comprise this first layer of the synthetic conceptual model of urban ES justice proposed in Fig. 1 (the full model is outlined in subsequent sections) and delineate where progress has already been made in urban ES research.

3.1. Recognition justice

Recognition justice regards the consideration of different social and cultural values, including the specific understanding of what is just (He and Sikor, 2015) and the needs and preferences of different social groups (Dawson et al., 2018). If a group's interests and values are systematically excluded from decision-making about the resources of society that allow for human flourishing, then recognition injustice has occurred (Fraser, 1995). This is particularly related to circumstances wherein certain groups and neighbourhoods are stigmatized due to negative (mis)conceptions and thus they are not afforded the right to participate in the public realm without shame or disrespect (Honneth, 2004). In a clear example, systems of apartheid involve extreme recognition injustice because exclusion is based entirely on one identity as inferior. Even after apartheid in South Africa, this led to repressive EJ challenges for Black South Africans (McDonald, 2004). In another more common example, urban park users often perceive spaces quite differently. In Brooklyn, New York, drummers have been gathering from nearby immigrant and black neighbourhoods since the late 1960s to hold boisterous drum circles, which recent whiter and wealthier residents have classified as objectionable and a nuisance. Increasingly, the view of newer residents is more emphasized in public conversation (Gould & Lewis, 2012).

There is a strong precedent for connecting ES scholarship to the fundamental concerns of recognition justice through the rich literature on 'value pluralism' (Gómez-Baggethun and Barton, 2013) and recent discussions on different epistemologies of nature's contributions to people (Díaz et al., 2018). These advances are fundamentally based on the assumption of incommensurability of values, which means values cannot be reduced to a single (monetary) metric (Gómez-Baggethun and Barton, 2013) without systematically excluding certain people based solely on their assumed cultural identity and associated value preferences. The literature around plural values of ES emphasizes the need for considering people's non-utilitarian preferences, including intrinsic and relational values connected to ES (*e.g.* Chan et al., 2016) as well as culturally different conceptualizations of nature (*e.g.* Díaz et al., 2018) alongside monetary valuation approaches stemming from predominant utilitarian paradigms in ES research.

The focus on plural values has made crucial advances in enlarging the capacity to operationalize recognition justice through ES research. From the theoretically rich and multifaceted debate around an 'integrated valuation' (Aragão et al., 2016) of 'plural values' (Kenter, 2016) emerges the need for empirically disaggregated recognition of different societal groups and their preferences and values (Dawson

et al., 2018). Ernstson (2013) was the first to recognize the articulation of (plural) values as a necessary step for urban ES justice. Multiple methods have been developed and applied to capture the plurality of values (see Arias-Arévalo et al., 2018), both from epistemological (*i.e.* considering value types such as utility values, relational values and intrinsic values) and ontological (*i.e.* addressing multiple value dimensions such as ecological, socio-cultural and economic) perspectives. For example, Langemeyer et al. (2015) showed for an urban park in Barcelona that non-monetary and monetary valuation approaches conducted with the same sample group led to different outcomes with regard to the value of ES.

Yet, more empirical approaches to operationalize the theoretical, epistemological and ontological advances of the plural values literature and methods for the integrated valuation of ES are required in urban green infrastructure planning. In line with Martin et al. (2016), a first step to improve recognition is the acknowledgement that ES governance underlies a particular value and moral paradigm, which may produce the perception of injustice from a different ontological perspective. Normative aspects are important both in the conceptualisation of ES and in their measurement and evaluation (Jax et al., 2013), which highlights the importance of recognizing unequal power relations and influences in ES governance (Martin et al., 2016). A pragmatic step forward would be to follow the EJ model and to strengthen the focus on people's experiences of ES. This would mean expanded assessments of the preferences and needs for ES by different societal groups in the form of dialogue rather than predefined ecosystem service models, and with specific emphasis on vulnerable, historically disadvantaged and silenced groups within society. Unnikrishnan et al. (2016) argue that 'knowledge of historical contexts of access to ecosystem services […] can help understand trends in contemporary management'.

Common approaches in assessing urban ES values, such as individual valuation surveys and group valuation, impart clear advantages in presenting plural values (Camps-Calvet et al., 2016; Alkan-Olsson et al., 2020), though small sample sizes bear the risk of missing particular viewpoints and larger-scale interests. Novel ES valuation approaches, such as the assessment of social media data differentiated by users and geography are promising in terms of recognizing the preferences across broader social groups and larger scales (*e.g.* Calcagni et al., 2019), but include their own methodological drawbacks and biases (*e.g.* Lenormand et al., 2018). The same holds true for the representation of values by stakeholder representatives as commonly applied across larger areas.

Here, there is no universal answer from a theoretical ES perspective (He and Sikor, 2015). ES differ dramatically in their entitlement, with place attachment, aesthetics, and noise and heat reduction being relevant at the local scale, air pollution reduction at the regional scale and carbon sequestration at the global scale (see section 3.4). In addition, values and needs change over time (see section 3.5) and in an ideal process of urban planning, the recognition of values and preferences would be assessed at different scales in different moments of time. Recognition justice can thus only be the initial step for weaving notions of ES justice into urban planning — it is closely interlinked with the concept of procedural justice and points toward important questions: How is the use of the ES concept framed? Whose values are included and seen as important in decision-making processes (*cf*. Jax et al., 2013)?

Succinctly, an empirical approach to recognition justice requires acknowledging and balancing power inequalities in the articulation and measurement of values. For example, this would mean comparing the values of local communities with those communicated by decision-makers, or those by private companies vs. minority interests (*cf*. He and Sikor, 2015). To the extent that recognition has been linked with participation within ES valuation, typically more attention is paid to the groups rendered 'visible' to or by the institutions that define participation formats and regulations (Agarwal, 2001; Velicu and Kaika, 2017). The EJ literature has a long history of addressing power

inequalities around the environment, resulting in insights that are highly relevant to ES valuation processes that link recognitoin with participatory engagement (Wolch et al., 2014).

3.2. Procedural justice

As with recognition justice, the path toward procedural justice has a precedent within emerging ES scholarship. The classical stock-flow model of ES has generally considered valuation as an endpoint; however, 'it is difficult to isolate valuation from decision-making processes because people feel there are strong ethical or moral issues at stake that need to be debated' (Kenter, 2016). Consequently, stakeholder participation has been promoted to add legitimacy to ES-based decision-making (Hauck et al., 2014), especially since the recognition of plural values (Kenter, 2016). In this vein, group-based deliberative ES valuation has developed in a manner that can be neatly integrated into land use decision-making processes (*e.g.* Langemeyer et al., 2018; Kenter, 2016), and thus constitutes an entry point for enhancing procedural justice. Importantly, though, these group-based deliberations may be top-down or bottom-up and do not necessarily result in more just outcomes (Silver et al., 2010). The open-ended aspect of participation highlights a central issue for urban ES justice.

In the urban environment, procedural justice is largely about the presence of equitable spaces of engagement (Martin et al., 2016) that determine who is involved with shaping the social, built, and ecological conditions of the city and how that involvement takes place. The path toward procedural justice is premised on participatory democracy with collaborative and communicative engagement across a wide set of stakeholders (Fischer, 2009). Participation is theorized to lead to more just outcomes because it reinforces social rights and increases equity in decision-making (Cunill, 2004). Furthermore, participatory planning that integrates stakeholder knowledge strengthens public decisions by reducing blind spots and enhances locally-atuned benefits (Shrader-Frechette, 2002) — something partially recognized by urban ES scholarship (*e.g.* Hauck et al., 2014). A procedural injustice has occurred if the process by which decisions are made is not inclusive and fair in terms of who is impacted by a given regulation; who is given voice in decision-making; and who can access relevant information (Connolly and Steil, 2009). For example, when recent immigrant groups are excluded from the design and use of parks and public spaces because of legal and language limitations or ethnocentric planning processes, their cultural norms for use, and thus ability to access ES from the park, may be illegalized or designed out (*e.g.* Kabisch and Haase, 2014). Here again, it is evident that recognition justice is tightly linked with procedural justice.

EJ literature highlights the point that, beyond allowing subjects to enter dialogue as representatives of certain social groups, the terms under which this participation takes place and the level of influence stakeholders have on the decision-making process will depend on the formal and informal rules and power structures that define (environmental) politics and the 'framing' of decision-making relative to existing norms around ES provision (Scott and Oelofse, 2005). Thus, enhancing procedural justice in ES provision requires not only the identification of different interest groups with regard to valuation, but also an examination of the social-political and cultural context, institutions, governance structures, and power relations within which decision-making is taking place (*cf.* Dawson et al., 2018; Pascual et al., 2017). This is the case because the prioritization of one set of ES over another may not only be related to participation or scientific goals but also to the wider framing of decision-making processes, as well as the overarching approach to ES, for example in terms of utilitarian stock-flow models. Established norms around who has better opportunities to participate in ES planning impacts this framing, while laws can set the boundaries for fair processes (Aragão et al., 2016).

For instance, if the importance of urban ES is framed in terms of monetary benefits and costs, flood mitigation and other ES that reduce

costly damage to built infrastructure are likely to be prioritized. If the framing is focused on wider objectives of increased human health, food and water provision, air pollution reduction and recreational services are more likely to be prioritized. To date framing of ES decision-making, including legal framing (*cf.* Ibid.), remains insufficiently addressed by the urban ES literature to fully understand its justice implications. However, framing influences the consideration of policy options and limits alternative choices in ES decision-making (Opdam et al., 2015), and is, thus, likely to have profound importance for just ES planning.

In brief, procedural justice is widely seen as an important basis upon which recognition and distributional justice is achieved, but there is disagreement over whether fair and participatory procedures comprise the essential route toward just outcomes, or rather are best characterized as necessary but insufficient conditions (Fainstein, 2010). Generally, EJ has seen open and participatory decision-making processes as a central concern, but not adopted an essentialist approach to procedural justice — EJ is more than fair procedures. With regard to urban ES justice, this is perhaps a productive stance to adopt. Participation is an important aspect, but because ES is not a neutral concept, it cannot be assumed that this is sufficient. Rather, ES embeds a set of predefined assumptions and limits policy options, with implications for urban design and the (re-) distribution of benefits among urban dwellers (*cf.* Kotsila et al., 2020). This raises wider spatial and temporal concerns and associated recognition and distribution challenges that need to be considered separately within the development of a concept of urban ES justice.

3.3. Distributional justice

Distributional justice is perhaps one of the most theorized concepts within Western society, and has been at the heart of Western urban planning and EJ scholarship since at least the 1980s (Taylor, 2000; Connolly and Steil, 2009). Political philosopher John Rawls (1971) developed the most commonly employed (and critiqued) notion of justice as that circumstance which people would prefer if they were deciding how to distribute the resources of society from the perspective of their 'original position' behind a 'veil of ignorance' and knew nothing of what their social position or capabilities would be. For Rawls, this meant that distributional injustice occurs when societal resources are unevenly accessible to the point where some individual or group is harmed. For example, the urban EJ movement in the United States was founded on empirical evidence of unjust distribution of environmental hazards that exposed low income and minority communities to health risks (Bullard, 1990). While distribution equity is a main pillar of social justice theory, other approaches (especially procedural and recognition) were developed to address its main weakness: a focus on distributional outcomes does not illuminate the structural obstacles to achieving a just distribution (Marcuse, 2009).

The importance of distributional issues is elevated for ES because a specific greening policy or planning intervention may shift benefits and detriments from one individual to another, but might simultaneously also cause beneficial and detrimental effects across different ES domains for a single societal group or even an individual. For instance, the transformation of informal allotment gardens into the integrated food growing and recreational park Quinta da Granja in Lisbon in 2011 meant a reduction of space for (private) growing activities, and a shift from the delivery of multiple ES related with urban gardening (Camps-Calvet et al., 2016) for a few to recreational benefits for the many. The example (described by Costa et al., 2016:221) shows that distributional effects cannot be properly evaluated without considerations of recognition and procedural justice. It also shows that common aggregated assessments of ES, such as those inherent to Pareto-optimization approaches, contribute little to enlarge the understanding of (distributional) justice outcomes of urban ES planning and management (Chaudhary and McGregor, 2018) and require, instead, a differentiated

analysis of trade-offs between different societal groups, with regard to both beneficial as well as detrimental effects.

Despite its longer tradition as a field of study and its more developed understanding as a concept, distributional justice concerns have not received widespread attention within the ES literature. Attempts to more strongly address distributional justice of ES by looking closer at the accessibility (Chaudhary and McGregor, 2018) and uneven provision (Larson et al., 2016; Turkelboom et al., 2017, Goldenberg et al., 2018; Baró et al., 2019) of different ES by groups of society, such as caste, income and gender, still remain a small niche in urban ES research. This is surprising as other ES sub-fields, namely the payments for ES literature, have more strongly addressed questions of distributional justice over the past decade (Corbera et al., 2007; Sikor, 2013). As well, the deficit of distributional analyses has been noted by several scholars. Sievers-Glotzbach (2013):162 highlights the need to 'consider the distribution of access rights to ecosystem services'. Along this line of argument, distributional justice in urban areas was conceptualized with regard to the availability and accessibility of green spaces to different societal groups (Lukasiewicz et al., 2017); whereas, Elmqvist et al. (2013) articulated the need for explicit attention to the distribution and trade-offs between specific benefits and detrimental ecosystem–society relationships. Ernstson (2013) developed a model for specifically integrating the concept of distributional justice into ES scholarship. Distinguishing generation of ES, distribution of ES, and articulation of ES values, he puts specific emphasis on the spatial complexity both in ecological (urban green areas as interconnected nodes of ecological flows) and social terms (competing networks of value articulation). Thereby, he indicates pathways for moving between spatial levels in the analysis of distributional justice of ES, which we further address under 4.1. In addition, we claim the need to acknowledge temporal asymmetries in the distribution of benefits and detriments from urban greening, not least in the face of potential 'green gentrification' (Anguelovski et al., 2018; Gould and Lewis, 2016), in relation to novel thoughts on urban resilience (Elmqvist et al., 2019), which are further discussed in the section 4.2.

In summary, we argue that established distribution, recognition, and procedure analyses are foundational for larger spatial and temporal justice issues. Distributional, recognition, and procedural justice depend on aligned governance, social, and ecosystem processes. In turn, larger spatial and temporal justice goals can only be built upon functional distributional, recognition, and procedural justice measures. Thus, spatial and temporal justice, addressed in the following section, are understood here as built-upon and cross-cutting the classical justice trilogy, but also relating to each of the areas in this trilogy.

4. Expanding the frontiers of urban ecosystem service justice

As shown in section 3, small bodies of urban ES literature have developed around each of the three dimensions of justice that have been taken up within EJ literature (and within literature on social justice more broadly), with a focus on the distributional dimension (e.g. Ernstson, 2013). However, much work remains in each of these domains given the historic disregard in ES scholarship. We argue that while expanded work on the justice trilogy is necessary, this still falls short of a comprehensive understanding of urban ES justice in at least two respects.

First, individual accounts of the types of justice do not incorporate wider issues of spatial justice that particularly acknowledge the simultaneous spatial demands of planetary urbanisation. While some injustices are only becoming evident through super local-scale perspectives (Alkan-Olsson et al., 2020), others demand consideration of metabolic (or life-cycle) impacts at a planetary scale related to urban ES uptake (Heynen, 2014; Wachsmuth, 2012). This additional spatial justice dimension acknowledges that the interrelations between the types of social justice are, in part, determined by multi-scalar connections between local and global ES processes.

Second, temporal perspectives on justice that account at once for inter- and intra-generational justice (as opposed to one or the other) are mostly omitted (Forsyth, 2014). This expanded temporal justice dimension proceeds from the recognition that acknowledging present manifestations of past and historic inequalities is often essential in order to ensure just outcomes for future generations (Meyer, 2017). These additional areas of inquiry have been taken up elsewhere (e.g. Lukasiewicz et al., 2017) but need to be explicitly linked with the ES framework in order to explicate a full urban ES justice model.

4.1. Spatial justice

Spatial justice is one means by which theorists have focused on particularly inter-scalar and inter-related issues (Swyngedouw and Hynen, 2003) of recognition, procedure, and distribution within an urban context (Dikeç, 2001; Soja, 2013). As these scholars have pointed out, the particularly spatial element of justice concerns requires its own consideration because the spatial organization of society is a distinct political target that can be shaped in ways that acutely further or hinder social justice. This point is especially apt for the purpose of creating an empirical urban ES justice framework capable of providing analytical guidance to urban greening policies and ES thinking more broadly because of the spatial nature of ES. For such a framework, two issues are most relevant. These include the 'socioenvironmental metabolic relations that come together' in a specific global-local place (Swyngedouw and Heynen, 2003) as well as how environmental externalities and injustice play out at different spatial scales (Heynen, 2003). We refer to these issues in our model as 'downscale' and 'interscale' ES justice, respectively (Fig. 2).

The extended model launches a spatial dimension of justice, introducing the empirical relevance of downscale and interscale relations. The downscale aspect of spatial justice shown on the left side of the axis in our model concerns the mechanisms through which space becomes a container for social division that is obscured by aggregated measures of ES provisions. To downscale these measures is to account for spatial difference like social segregation, class-oriented placemaking, and (inner-city) distribution of different needs for ES. For example some areas have higher flood risks (Norman et al., 2012), increased exposure to poor air quality (Grineski et al., 2007), better access to ES benefits (Baró et al., 2019), or higher need for ES (Langemeyer et al., 2020). It has been highlighted that 'inequity appears stronger when studied at smaller spatial scales' (Tan and Samsudin, 2017). Although this type of spatial justice is closely related to and often incorporated within distributional justice considerations, urban ES justice demands specific attention to the fact that spatial ES justice not only builds on individual consideration of recognition, procedural, and distributional forms of justice, but also establishes a model for how these forms of justice interact within existing spatial configurations (Soja, 2010).

A second spatial justice concern, shown on the right side of the axis, regards 'interscalar' relations (i.e. Soja, 2010:13). In his seminal essay, Ernstson (2013) emphasizes the fact that many ES are characterized by dependencies between cities as consumption areas and regional, national and global production areas. And many ES consumed in cities are produced at the cost of livelihoods of the global poor (Jax et al., 2013; Martínez-Alier, 2002). Most acutely, this refers to circumstances where efforts to improve ES justice originate in cities and then diffuse throughout to larger, and sometimes perverse, effect. For example, in Philadelphia, there was an effort with many ES benefits to equitably distribute green infrastructure flood mitigation and water purification. However, the cultural preferences for such infrastructure were not accounted for to the detriment of low income and minority neighbourhoods, resulting in an unjust riskscape in the city (Shokry et al., 2020). As such outcomes are aggregated throughout the globe, the end result is an extreme imbalance in the distribution of risk according to sociocultural divisions. With regard to the overall effect, localized distributional and recognition justice aggregate in such a way that only a larger
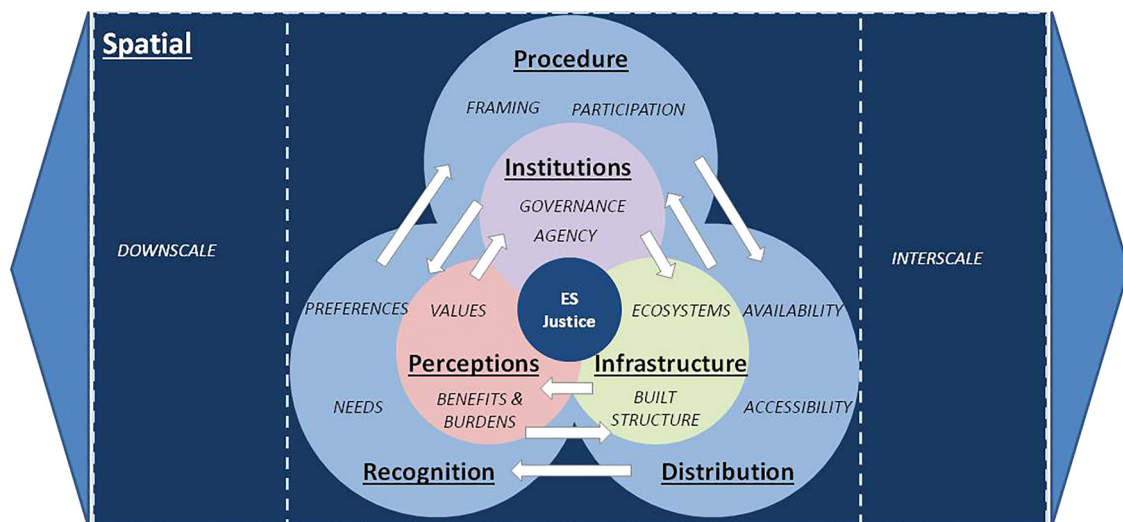
Fig. 2. Toward an empirical urban ecosystem services justice model: Spatial dimension included.

spatial justice perspective could account for, which highlights the need to conceptualize the importance of scale in the spatial distribution of ES (Ernstson, 2013).

Although the literature on payments for ES has incorporated a spatial justice perspective (*e.g.* Corbera et al., 2007; Sikor et al., 2013), a wider conceptualization and assessment of scale-related injustice is mostly lacking in urban ES scholarship (Pascual et al., 2017, but see Depietri et al., 2016). A promising entry point for urban ES spatial justice research is constituted by the emerging literature on tele-coupling or connections of ES (Seto et al., 2012). So far, this literature has particularly highlighted ways to improve recognition justice related to ES consumption and production across different spatial scales (*cf.* Corbera et al., 2019). In this regard, Pascual et al. (2017) recommend that ES research integrate other analytical approaches, such as urban metabolic flows, life cycle analysis and risk-based approaches to better recognise what they refer to as 'off-stage burdens'. Expanding this line of thinking toward the interactions among recognition, procedural, and distributional issues is an important entry point into a wider spatial justice model of urban ES.

The most prominent examples to counteract scale-related injustices in praxis are payment systems for the rural-urban transfer of ES, such as watershed programs to pay farmers in order to maintain water purification capacities benefitting urban populations, for example described for New York and Munich (Grolleau and McCann, 2012). These systems are specifically designed to alleviate inequities in ES provision and demonstrate that analyses of mismatches between ecosystem supply and demand in urban areas provide an entry point for recognizing spatial-scale related injustices (Baró et al., 2015). However, there are also examples where payment systems work at cross-purposes across scales. For example, popular cap-and-trade emissions programs can reduce greenhouse gas emissions at the multi-national scale but also intensify spatial clustering of emissions in historically over-exposed areas (Stuhlmacher et al., 2019). These outcomes highlight the need for an integrated spatial model that accounts for the mixed effects across scales.

Urban ES scholarship has produced some important assessments regarding the dependency of urban areas on their hinterland. In the case of Barcelona, ES supply-demand mismatch analyses have highlighted the strong dependency of the city on its global hinterland. For example, for air pollution reduction — one of the core challenges for urban planners in Barcelona — the dependency is reported to be extreme; only 0.52 percent of municipal NO_2-emission are mitigated by urban vegetation, while 99.48 percent are posted as a burden on the city's regional surroundings (Baró et al., 2014). A similar situation

exists for Barcelona's carbon emissions, of which only 0.47 percent can be compensated by urban green infrastructure (ibid.), forcing the city to rely on ecosystems globally for mitigation. Similarly, urban areas unequally demand ES from the global hinterland for recreational activities or tourism, the production of food, water and raw material (Grimm et al., 2008). Thinking about a just transfer of ES to cities, primarily means questioning the relationship between the consumers of ES and their (rural) stewards (Barnaud et al., 2018) as well as negative effects on people and non-human beings in remote areas — potentially producing unjust geographies globally. More generally, spatial ES justice requires considering if the transfer of ES from outside to inside cities hampers individuals and groups elsewhere from flourishing.

The arenas for solving questions of spatial justice in ES are as wide as the spectrum of ES, and vary primarily with the transfer of each single ES (*cf.* Demuzere et al., 2014). A fair recognition of ES needs and preferences would consequently require a multi-scale plural approach to valuation. An example has recently been presented by Langemeyer et al. (2020) in the form of a decision-making framework that combines ES needs at a super local scale with those defined at the city scale — different groups have different needs at different scales, and sometimes these scalar needs are at odds. Thus, scale is a highly political notion (Smith, 1992). ES, such as recreation, urban temperature reduction, and opportunities for social cohesion, are produced *in situ* and require local arenas to solve injustices. Spatial justice regarding the provision of water, air purification and carbon sequestration requires regional or even global political treaties; examples are given by the Intergovernmental Panel on Climate Change or regional payment schemes. Due to the lack of practicality of capturing people's values globally, vicarious information needs to be taken into account, making sure that local to global entitlements are considered within urban decision-making.

4.2. Temporal justice

The temporal dimension of urban ES justice research necessitates breaking down the binary approach to inter- and intra-generational justice that still characterizes ES research. As discussed in section 2, ES scholarship has a strong focus on inter-generational justice in terms of sustaining natural capital and a flow of benefits for future generations (Gómez-Baggethun et al., 2010), while still nascent studies focus on notions of intra-generational justice. The segregated thinking focused on either (blurry) long-term sustainability targets for future generations or narrow present distributional assessments minimizes the complex interrelation between future, present, and past conditions of social-ecological systems. Preservation of future ES is reliant on shifts in the
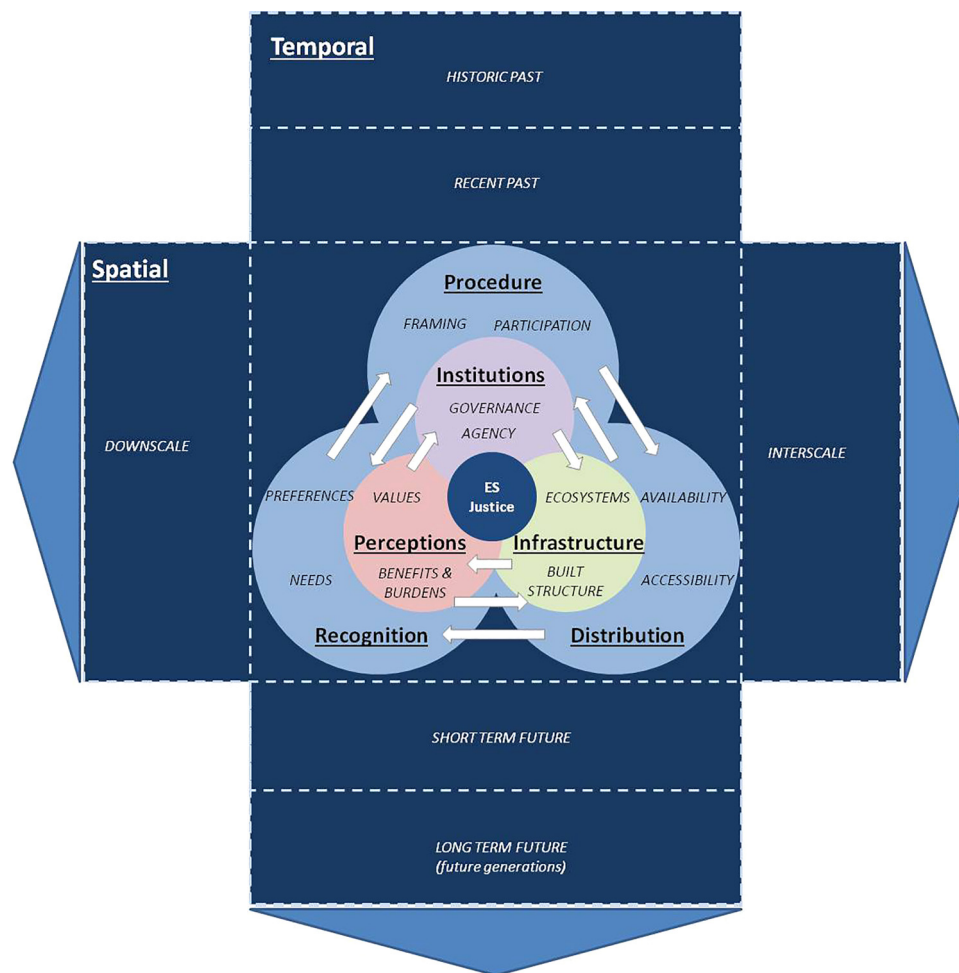
Fig. 3. Full empirical urban ecosystem services justice model: Temporal dimension included.

provision and demand for specific ES, which may have distributional effects both within the current society and in future societies, but which are also rooted in unequal distribution, recognition, and participation in the past (Anguelovski et al., 2020). In other words, societal changes over prior periods affect whether ES distribution and access occurring now will adhere to notions of justice in the future. This interrelated temporal justice challenge is represented on the vertical axis of our model (Fig. 3).

The full model introduces a temporal dimension of justice, highlighting the need for an integrated consideration of past, present and future conditions of urban social-ecological systems. One example of the temporal challenge in ES justice can be found in urban greening projects meant to increase ES in cities that have been reported to cause social change at temporal scales outside the purview of normal planning processes (Gould and Lewis, 2016). For example, a recent study from Barcelona (Anguelovski et al., 2018), highlights the risk of 'green gentrification', that is enhanced pressure (primarily through increased housing prices) and in *ultima ratio* the expulsion of vulnerable people from a neighbourhood due to green developments, followed by reduced accessibility to locally provided ES. This shift of ES across socio-economic groups, which has previously been observed in the U.S. (*e.g.* Curran and Hamilton, 2012) but seems to be pertinent to European cities as well (*cf.* Łaszkiewicz et al., 2018), happens over medium-term time scales. The final effect seen through the green gentrification lens is one of a high degree of inter-generational injustice (future generations of socially vulnerable groups are excluded from ES improvements) as a result of current intra-generational processes premised on prior patterns of spatial injustice.

Recent urban resilience debates (Elmqvist et al., 2019) are one promising conceptual entry-point for considerations of temporal justice in ES. Underscoring the neutral character of the resilience concept, meaning resilience is not *per se* advantageous, Elmqvist et al. (2019) highlight the need for cities to evaluate if their (greening) trajectory is following a desirable pathway. From a temporal justice perspective, a desirable pathway would be given if policies adapt to changing conditions in such a way as to enhance future equity in the access to the ES. Evaluating the pathway a city is on raises two critical questions for urban greening initiatives: (1) What will be the ES that different individuals and groups require for their flourishing in the future? (shifting ES demand); (2) How can the flow of the ES that different individuals and groups require be maintained in the future? (shifting ES supply). In order to address the second question, it is particularly necessary to account for current and past patterns of unjust distribution, recognition, and participation with regard to ES provision. Following Elmqvist et al. (2019), if a city is not following a desirable pathway with regard to these two questions, its resilience must be reduced rather than enhanced and an 'abrupt transformation' should be desired.

Climate change, socio-demographic changes, and other drivers not only modify the provision of ES, but might also affect the future needs or demand for ES. In this context, urban ES justice research needs to be linked to vulnerability or risk assessments that allow planners to project shifting needs for ES in the future. For example, increased heat island effects in the inner parts of Barcelona put an additional burden on vulnerable social groups living in these areas (*cf.* Baró et al., 2019), which may lead to stronger demand for temperature regulating nature-based solutions. However, this might lead to a complex dilemma.

Returning to the example of green gentrification, some have pointed to the challenge of adding more green space in vulnerable neighbourhoods (Wolch et al., 2014); enhanced availability of specific ES, such as urban cooling have been observed to enhance these effects (Jenerette et al., 2011) and the notion has been expanded to include climate resilience (Keenan et al., 2018). However, a recent Barcelona-centred study concludes that some of these effects might be mitigated by the design of green spaces and the specific type of ES they provide (*cf.* Terra Maia et al., 2020).

Urban EJ research has recently started to directly address the justice implications of complex urban social-ecological dynamics over time (Anguelovski et al., 2018), and urban ES justice research in many ways needs to catch up. Recognising benefits and detriments of urban nature-based solutions in view of socio-economic dynamics and longer temporal scales is an important start. Longitudinal policy document analysis (Wilkinson et al., 2013) can show shifting recognition of ES in urban policy-making over time. Stronger emphasis is required as well on the linear distribution of ES benefits over time across different social groups, but also on possible rebound effects and feedbacks to the detriment of vulnerable groups. Again, such information requires an analysis that looks at longer time periods and also at larger geographical scales, including the city and supra-city scale, rather than being confined in the geographical boundaries of a single greening intervention.

A good example of attempts to account for the full temporal dimension of urban ES justice has been provided by Derkzen et al. (2017), who performed household interviews and group mapping sessions in urban communities in Bangalore, India, in order to understand shifts in ES and people's responses to these shifts. They found people's capacity to adapt to ecosystem degradation and restoration and related provision of ES depend on a household's ability to adapt and on individual circumstances, such as land tenure and financial capital, with less adaptive capacity for the poorest. By examining people's experiences the study was able to emphasize temporal shifts in ES access; thereby providing critical insights to develop adaptation strategies that safeguard the most vulnerable social groups from further marginalization.

5. Conclusions

ES assessments highlight the multiple benefits of urban green infrastructure (Haase et al., 2014), and have become a strong discursive vehicle for supporting urban greening agendas. The ES concept is thereby quickly entering into new domains; from 'awareness raising' about nature's benefits towards 'priority setting' in multiple aspects of decision-making (*cf.* Gómez-Baggethun and Barton, 2013). This means ES assessments are increasingly informing actual decisions over green infrastructure policies, planning and the implementation of nature-based solutions in cities, and are applied to evaluate the benefits resulting from the use, restoration and creation of parks and green roofs, of wetlands and riparian sites as well as changing management regimes of various types of urban natures that extend outward into the planetary system of urbanization processes. In short, ES is a tool in political processes that determine greening agendas. Given this increasing importance for ES assessments, critical reflection on the extent to which the ES concept and its application accounts for justice is demanded.

Recent developments in urban ES and urban EJ research are broadening the respective classical foci of the two fields — the flow of benefits from nature to people on the one hand and negative impacts from environmental degradation on vulnerable societal groups on the other hand (Chaudhary and McGregor, 2018). The net effect of this collective intellectual expansion might facilitate a future alignment of the two research fields that refines stock-flow dominated urban ES models by adding a more engaged approach to equity and justice. In that respect, urban ES can better serve as a tool for ensuring urban greening/sustainability initiatives are linked with social justice.

Arguably, though, even a version of urban ES that synthesizes the lessons of EJ is insufficient. For one, the decomposition of justice into

the three dimensions described here does not necessarily fully reflect the ways in which urban residents experience justice (Anguelovski et al., 2020). As Velicu and Kaika (2017) argue, EJ is not a 'formalized and preconceived "thing" to be delivered or applied' but rather an ideal that people continuously redefine. Considering this point, a more holistic consideration of justice in ES assessments would not only integrate the three different types of justice but also move deeper to problematize aspects of agency, visibility and the use of discourse as shaping factors of justice. This reveals the need for embedding ES assessments in a socio-political context where processes of environmental governance, ES valuation and negotiations over access and use of natural resources are continuously (re)defined (Swyngedouw and Heynen, 2003). However, we suggest here that careful understanding of how to deploy these three elements of justice coupled with a broad view of spatial and temporal justice forms the blueprint for highly valuable next steps forward in enabling ES scholarship to undertake systematic analyses of social equity in urban greening policies.

In this regard, an urban ES justice framework requires a full understanding of the multiple drivers of social justice and an integrated conception of the distribution of benefits across space and time. Standardized approaches for measuring and monitoring urban ES justice in such an integrated way are broadly missing. In the model we present, the framing and functioning of the governance-institutions-ecosystems dimension supports the three aspects of social justice (distribution, recognition, and procedure). However, these three aspects are themselves impacted by a wider dimension of spatial justice, which is comprised of the synthetic interactions between distribution, recognition, and procedure within urban land use as well as the multi-scalar global processes of producing urban ES. Finally, all of these dimensions are embedded within temporal dynamics that combine past, present and future ES conditions.

Importantly, considerations of justice have to be incorporated into the framing role played by ES in shaping urban land use decisions. While ES assessments are very useful in highlighting people's dependency on nature, ES is characterized by a primarily anthropocentric focus, a utilitarian perspective, and positivist worldview stemming from its conceptual legacy. As well, the ES concept 'frames the environmental problem in a particular way: as a case of the earth's life-support systems being in jeopardy, which in turn jeopardises all human well-being on spaceship earth' (Lele, 2013). Consequently, most of the ES literature has — at best — treated the question of social justice rather mechanistically, incorporating elements of a vague idea of justice. The resulting notion of justice, we argue, is too narrow and non-specific to ensure a robust link between ES and social justice in the context of planetary urbanisation.

Declaration of Competing Interest

Acknowldegements

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