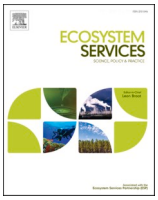
Ecosystem Services 69 (2024) 101655

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser



Full Length Article

Ecosystem Services Justice: The Emergence of a Critical Research Field

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A B S T R A C T

Ecosystem services justice is an emergent research field. Over the past decade, research on ecosystem services has increasingly developed a justice perspective and incorporated it into its conceptual and empirical frameworks. This perspective aims at providing a review of the emergent strands of research addressing ecosystem services justice, and at creating an outlook on future research needs and frontiers. The review departs from central critiques to the ecosystem service approach, which have been foundational for the research field of ecosystem services justice. To be precise, we address three different research strands on which justice issues arise. First, ecosystem services production, considering the (increasing) commodification of ecosystem services, the concentration of ecosystem services production assets and the role of trade-offs in production capacities. Second, the distribution of ecosystem services benefits under the aspects of unequal vulnerabilities, the consideration of accessibility and individual's capabilities to obtain ecosystem services. Third, the recognition of ecosystem services pluralisms, including socially differentiated forms of wellbeing, plural values and knowledge concerning ecosystem services. While ES justice has strongly advanced from a scientific perspective, we are still lacking a stronger reflection of these advances in practice. Future research, we argue, needs to develop holistic procedural frameworks for integrating the complexity of ecosystem services justice, addressing the ecosystem services production under consideration of historic inequalities, the distribution of ecosystem services benefits with respect to people's diverse needs, vulnerabilities, and capabilities, as well as diverse wellbeing-, value-, and knowledge-systems. The social-ecological understanding of ecosystem services co-production, which recognizes the dynamic and reciprocal relationship between humans and ecosystems, is identified as a crucial framing for this endeavor.

1. Introduction

The concept of ecosystem services (ES) emerged in the latter half of the 20th century as a result of collaborations between ecologists and economists. It has significantly influenced discussions on environmental protection and prompted a fundamental change in the way Western societies perceive nature conservation and management, shifting from an intrinsic to an anthropocentric motivation (Gómez-Baggethun et al., 2010). However, despite this anthropocentric paradigm shift, the broader consideration of justice implications in environmental protection and management has for a long time not been embraced by ES research. On the contrary, the conventional framing of ES has often been regarded as an obstacle to addressing equity concerns and unjust conservation outcomes (Corbera et al., 2007; Sikor, 2013; Berbés-Blázquez et al., 2016).

Here, we define ES justice (*cf.* Sikor, 2013; Langemeyer & Connolly, 2020) as the fair and equitable production and distribution of ES among different individuals, communities, and stakeholders, without discrimination based on factors such as gender, race, ethnicity, income, or any other characteristic. ES justice recognizes the diverse needs and desires for ecosystem services and emphasizes the importance of ecological conditions that support justice (Holland, 2008), as well as socially inclusive decision-making processes related to ES (Chan et al., 2012b). ES justice acknowledges that some social groups disproportionately experience either the benefits or the burdens associated with ES production and distribution, often due to social, economic, or political factors, as well as individual capabilities to seize ES benefits (Mandle et al., 2020, Loos et al., 2022). The objective of a justice approach to ES is to reduce these inequities and ensure that all individuals and communities, both present and future, have fair and equitable access to ES and their benefits as a foundation for human flourishing (*cf.* Schlosberg, 2013).

This perspective aims to provide an overview of the emergent strands of research addressing ES justice that developed over the past decade. Moreover, we aim to provide an outlook on current research needs and

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https://doi.org/10.1016/j.ecoser.2024.101655
Received 5 June 2023; Received in revised form 26 June 2024; Accepted 14 August 2024
Available online 27 August 2024

new frontiers. All co-authors have significantly contributed to and, in various ways, helped shape the field of ES justice. Nonetheless, this perspective does not stem from a systematic literature review; instead, our article selection reflects our informed understanding of the field and is guided by our own judgments of relevance.

In the following, we depart from the major critiques to the ES approach regarding its treatment of justice, which we assume have helped advancing the approach in both its ontology and epistemological framings (*cf.* Craig et al., 2019). We group these critiques into three different strands of ES justice literature: (1) ES production, (2) ES distribution, and (3) recognition of ES pluralism including socially differentiated needs, desires, values and forms of knowledge concerning ES. Unlike previous justice frameworks applied to ES, which draw from the classical environmental justice triad of recognition, procedure, and distribution (e.g., Sikor, 2013; Baró et al., 2021), we do not consider "procedural justice" as a separate aspect. Instead, we view it as an integrated and overarching condition that influences the just production, distribution of ES, and recognition of needs and desires regarding ES and their benefits.

Our decision to delineate ES justice into these three strands—production, distribution, and pluralism—is inspired by the availability-accessibility-attractiveness framework developed by Biernacka & Kronenberg (2019) and emerges from a critical examination of the lifecycle of ES, and how they are generated, allocated, and perceived across different societal segments. This approach addresses gaps within traditional justice models by offering a more nuanced understanding of ES dynamics.

The first strand that we consider in our perspective refers to ES production. Distinguishing between ES production and distribution highlights the initial phase of ES generation and the conditions under which it occurs, aspects often overlooked yet critical to justice outcomes. This distinction allows for a deeper analysis of the mechanisms influencing ES production and their impact on distribution, underscoring the importance of the production phase in achieving equitable ES outcomes. We recognize that ES production can be a fundamental outcome and source of injustices, especially in contexts characterized by historical inequalities in land distribution, particularly in countries of the Global South (Laterra et al., 2019; Martínez-Harms et al., 2019; Nahuelhual et al., 2018). These injustices are perpetuated by the prevailing conceptualization of ES as a "stock-and-flow" model, which views ES as unidirectional flows of benefits from nature to people. This static and reductionist perspective treats ecosystems merely as service providers to humans, while disregarding the complex relationships between humans and nature, and the dynamic role that people play in shaping ecosystems to enable ES production (Andersson et al., 2007; Dominati et al., 2019). In response to this limitation, the co-production perspective, as a new line of inquiry, has gained strength in the past decade. The co-production perspective emphasizes the role of human agency in generating ES (Palomo et al., 2016; Raymond et al., 2018). This perspective allows for a better understanding of the interactions between social and ecological systems and places emphasis on institutions and natural resource governance structures, including land distribution regimes, that modulate the production of ES. It recognizes that the production of ES is shaped by the actions, decisions, and governance arrangements of individuals and communities within social-ecological systems (Kachler et al., 2023).

The second strand of ES justice we highlight is constituted by ES distribution. This is the classical dimension for understanding ES justice, and present in most frameworks. While the production of ES is the fundamental condition for people to obtain ES, the production and distribution are often characterized by spatial and societal mismatches. Traditionally influenced by classical economic principles, the ES framework has predominantly focused on Pareto-optimal solutions and associated gains in net benefits – this means ignoring distributional effects in ES. Consequently, the consideration of social differentiation among ES receptors and the distributional implications have often been overlooked in ES applications (Brück et al., 2022; Langemeyer & Connolly, 2020). The spatial and social differentiation of ES distribution challenges the assumption that an increase in availability of ES automatically results in equitable wellbeing outcomes, which has also been referred to as the "trickle-down effect" (*cf.* Wieland et al., 2016). Recent contributions to ES research highlight that individuals possess varying capacities and face different constraints, which may restrict their ability to translate ES into tangible benefits (Daw et al., 2011; Fortnam et al., 2019; Masterson et al., 2019). These include purchase power, but also physical and educational characteristics as well as historical legacies of the potential ES receptor. While Pareto optimal solutions do not inherently lead to unfair allocations of ES benefits, they require a complementary understanding and management of the dynamics between "winners and losers" in a socially disaggregated manner to address ES justice concerns. This involves recognizing and addressing disparities in access related to ES to achieve a more equitable distribution of those benefits within society as well as individual capabilities that ultimately enable or hinder the just distribution of ES benefits (Fischer and Eastwood, 2016).

The third strand of ES justice that we address pertains to ES pluralism. Our inclusion of ES pluralism recognizes the myriad of values, needs, and knowledge systems that shape interactions with ES. This aspect of our framework seeks to advance beyond the limitations of a generic approach to justice by acknowledging the socio-cultural dimensions that underlie ES benefits and burdens, thus offering a more inclusive perspective on ES justice. Influenced by parallel developments in environmental economics, ES valuation has for a long time predominantly relied on monetary valuation approaches (Arias-Arévalo et al., 2018). While monetary valuation has been regarded as a powerful communication tool that has facilitated the integration of the ES approach into practice (Gómez-Baggethun et al., 2010; Braat & DeGroot, 2012; Kieslich & Salles, 2021), it has also faced substantial criticism for its limited consideration of plural values, needs, and interests held by different groups of people, as well as different epistemological and ontological understandings of nature (Kallis et al., 2013; Zoderer et al., 2016). Similarly, the use of economic terminology such as 'ES demand', common in ES literature, has laid the groundwork for highlighting mismatches between ES needs and distribution. Yet, it generally lacks a differentiated understanding of who is producing ES, and whose demands are considered, often overlooking the specific needs and values of diverse communities (Zoderer et al., 2019). In response, authors have argued for the disaggregated understanding of human well-being (Daw, 2011; Dawson & Martin, 2015), the recognition of plural values, emphasizing the necessity of accounting for value incommensurabilities (Martinez-Alier et al., 1998; O'Neill, 1997; Arias-Arévalo et al., 2018), and the integration of knowledge pluralism (Borie & Hulme, 2015; Hoelting,et al., 2024). This has fostered a major rethink in environmental valuation in the last decade, exemplified by initiatives like the recent IPBES values report (IPBES, 2022), and serves as an important entry point for enhancing ES justice and ensuring a more inclusive and just approach to environmental management and conservation.

In summary, the critical perspective on the ES approach from a justice standpoint has stimulated a robust body of research that has pushed ES scholarship beyond its initial boundaries. This shift has resulted in a greater recognition of the role of ES in promoting just social outcomes and a heightened awareness of the need to avoid undesirable and unjust consequences stemming from the uncritical application of the ES approach (Kronenberg and Hubacek, 2013; Sikor, 2013; Langemeyer and Connolly, 2020).

In the following, we will delve into these advancements made in ES justice research with more detail. Following the three major strands of ES production, ES distribution and ES pluralism, we will further scrutinize several sub-strands that have shown critical to advance the research field of ES justice. Fig. 1 provides an overview of the major strands and sub-strands, which we distinguish.

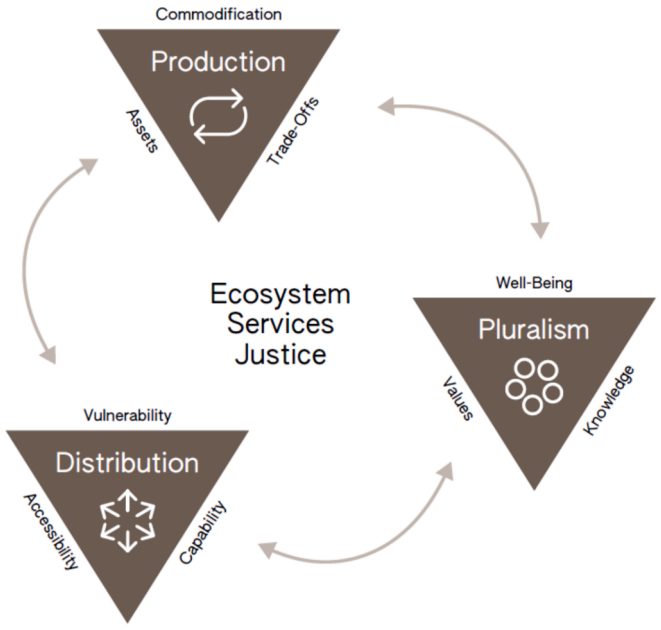

Fig. 1. Major strands and sub-strands of an emerging Ecosystem Services Justice literature. Production emphasizes the role of human agency in generating ecosystem services; Distribution focuses on diverse access, baseline priorities, and capacities to benefit from ecosystem services; Pluralism acknowledges the diversity in well-being, values, and knowledge systems regarding ecosystem services. These three strands mutually influence each other, with procedural aspects understood as an integrated and overarching condition that ties them together.

2. Ecosystem services production

The production of ES refers to the process by which natural ecosystems generate and provide benefits or services that are valuable to human wellbeing (Smith et al., 2017). Understanding the production of ES involves assessing the capacity of ecosystems to generate these services. However, this production of ES is often facilitated by humans, often referred to as ES co-production (Fedele et al., 2017; Fischer and Eastwood, 2016; Spangenberg et al., 2014). For instance, forest management is fostering carbon sequestration, farming and fishing allowing for food provision, or urban planning creating green spaces as the foundation for recreation. Introducing human agency and other forms of capital into understanding ES production has fundamentally challenged the metaphor of the ES cascade's unidimensional understanding of ecosystems as the origin of ES, and has opened ground for research addressing the dynamic interactions between human activities and nature underpinning ES production by social-ecological systems (Andersson et al., 2007; Chan et al., 2012b). Understanding the production of ES as not merely ecological processes but as determined by social-ecological systems provides a direct avenue to understand ES production as inherently related to questions of equity and justice, influenced by power relations, institutions, and governance arrangements (Lele, 2013). Here, we distinguish three often interrelated lines of ES production research focusing on (a) the commodification of ES production, (b) ES production assets, and (c) the wide literature on ES trade-offs.

2.1. Commodification

Many ES are important commodities, and the production of ES is an important source of income and financial revenues, for instance, in the form of agricultural production, fishery, and recreational tourism. Inequalities in ES production can therefore exacerbate socio-economic disparities and injustices. For example, landowners, whose income heavily relies on ES, such as food provision, timber and non-timber forest products production, and the provision of recreation opportunities, are directly impacted by the performance of natural, financial, and human inputs which generate the productivity of these ES. Inequalities in the productivity of ES can lead to disparities in income among landowners. Emerging research has focused on examining the unequal distribution of ES production, both within and between regions, communities, and individuals, primarily in developing countries of the Global South (Chen et al., 2022; Metzger et al., 2021; Ramirez-Gomez et al., 2020).

Over the past years, an increasing commodification of ES can be observed that modifies the social-ecological dynamics underpinning ES production and that require specific attention from an ES justice perspective. This increasing commodification of ES can be observed in classical commodities, such as food production, which is increasingly driven by global market demands rather local subsistence need, freshwater privatization, and commercialization, as well as expanding markets for cultural ES – e.g. in form of tourism. Following the auge in ES approaches, the creation of ES market and ES payment schemes has also fostered the commodification of regulating ES, such as carbon sequestration and storage.

While environmental conflicts in agricultural production or tourism have rarely been framed as issues of ES justice (Hanaček et al., 2021), the concept of ES justice has its origins primarily in the literature about payments for ES. This line of studies has focused on the influence of institutional factors, such as policies, governance structures, and support mechanisms, on the capacity of farms and landowners to produce ES and on the effectiveness and equity of these institutional arrangements (Corbera et al., 2007; Meza Prado et al. 2021). Studies on payments for ES, mainly conducted in the Global South, show potential inequalities and injustices caused by payment mechanisms (Benra et al., 2022; Kolinjivadi et al. 2015; Wünscher 2008). Thus, although payments for ES are intended to solve environmental problems, such as global climate change through the creation and selling of carbon credits, they may aggravate injustices. This counterintuitive negative socio-economic consequence of payments for ES has been labeled "the ecosystem service curse" (Kronenberg and Hubacek, 2013) mainly linked to problems of rent seeking, unequal bargaining power and volatility of payments.

Research has shown that injustices in the form of "elite capture" particularly emerge when payments are allocated exclusively in terms of maximization of the production of single ES (Warren and Visser, 2016; To et al., 2012), such as carbon sequestration. To the contrary, bundling and pooling of ES can be more appropriate procedures to enhance ES justice, providing targeted support for small landowners (Wang and Wolf 2019; Benra et al., 2022). Kaczan et al. (2017) describe that by combining the ES provided by different landowners (i.e. additionality), it becomes possible to generate larger-scale benefits and distribute payments more equitably. Consequently, authors advocate for moving beyond maximizing ES production criteria. Among the recommendations arising from this literature, are the use of multiple targeting, including ecological (e.g., rather than forest area, species uniqueness or conservation status), economic and social criteria (Benra et al., 2022), and to address legal frameworks, governance structures, market mechanisms, societal preferences, as well as historical asset distribution (Bryan et al. 2010; Gou et al. 2020). With an increasing commodification of ES, the concentration of land and other assets further ignites inequalities and the concentration of modern financial capital in the hands of a few, widening the gap between them and the rest of the population (ILC, 2020; OXFAM, 2023; Chomba et al., 2016). The appropriation of ES and the analysis of ES production in the context of land and green grabbing (Dell'Angelo et al., 2017; Fairhead et al., 2012; Holmes, 2014) can be expected to emerge as a significant research frontier in the future.

2.2. Assets

The second aspect of justice in ecosystem services (ES) production

concerns the concentration of assets like financial capital, education, and land ownership, which leads to inequalities (Benra et al., 2019; Coomes et al., 2017; Nahuelhual et al., 2019). Such disparities not only skew the distribution of ES market revenues, promoting the commodification of ES in sectors like agriculture, but also impact the fairness of ES payment schemes. Moreover, uneven asset distribution can result in unequal abilities to influence ES-related policies, planning, and management, further exacerbating injustices in ES production.

While inequalities in the distribution of natural capital assets occur due to geographical differences in biophysical potentials and conditions, social institutions (e.g. land allocation policies and property rights) determine inequalities in the allocation of ES production assets. For instance, estimates suggest that if land were distributed equally among all individuals globally, each person would be allocated 0.66 ha of agricultural land (Ritchie and Roser, 2013). However, a small proportion of the global population effectively controls most of the land and assets. Resource inequality has many documented sources — from historical factors to political stability and conflict, some of which have been explored in the ES literature. For instance, some authors have investigated factors such as land use patterns, natural features, and land endowments, whereas others have focused on unequal natural and financial asset distribution (Wilkinson and Pickett, 2009; Nahuelhual et al., 2018; 2020; Atkinson and Ovando, 2021). Similarly, socio-economic factors, such as income, wealth, education, and access to resources, have shown to influence the capacity of landowners to produce ES, by enabling or constraining the adoption of specific land management practices (Timberlake et al., 2022). Moreover, studies have explored the disparities in access to information, awareness, and technical knowledge that may exist among landowners, and how these disparities can affect the adoption of land management practices (e.g. Manyise and Dentoni 2021), thereby creating linkages with capacity building as foundation to counteract asset concentrations (e.g., Duff et al., 2017).

Acknowledging and addressing inequalities in assets for ES production is critical from an ES justice perspective. This involves a critical understanding of diverse actors' assets, for instance due to their education, institutional power or financial capital, and inequalities in assets related capabilities to plan, shape, and manage social-ecological systems to produce specific ES. In short, the literature on justice in ES production challenges the conventional "stock-and-flow" framework of ES, which simplifies ecosystems as one-way providers of ES and benefits. Instead, it highlights the complex interactions between the initial endowment of natural capital and access to it from a social-ecological perspective, considering historical factors that shape these relationships (Coomes et al., 2016; Jullian and Nahuelhual, 2021). These interactions contribute to visualizing the unequal capacity of landowners and land units to produce ES (Boillat et al., 2020). Furthermore, the literature emphasizes ES co-production, recognizing that ES arise from the combination of a landscape's biophysical capacity and the management abilities of landowners, emphasizing human agency (Dominati et al., 2019), property and capital as crucial and unequally distributed assets for ES production.

2.3. Trade-offs

Determining the ES production is foundational for the distribution of revenues derived from ES commercialization, as well as the distribution of ES benefits discussed in the subsequent chapter. While the multifunctionality is often highlighted as a key characteristic of ecosystems, green infrastructure, and nature-based solutions (Hansen and Pauleit, 2014), it obscures the reality that planning, and management frequently target the maximization of a single service. This approach can lead to trade-offs in the optimization of social-ecological systems for specific ES production. Trade-offs in ES, defined as the increase in production of one ES at the expense of others, have become increasingly significant in the ES literature in recent years (Turkelboom et al., 2018). These trade-offs are particularly evident in urbanized landscapes with limited and contested spaces, where different interest groups compete to produce ES—whether this is food production, flood protection, heat mitigation, carbon sequestration, or recreation.

A wide range of literature, often related to land-use, green infrastructure, and, more recently, nature-based solutions planning, has explored how to manage and moderate these trade-offs and prioritize ES production, which is a crucial aspect of ES justice. For example, stakeholder engagement processes and multi-criteria analysis frameworks have been developed to support equitable decisions in ES production (Langemeyer et al., 2020). Additionally, the literature on ES trade-offs is beginning to consider indirectly embodied ES, such as irrigation water in food production. Innovative combinations of metabolic and life-cycle approaches enable the assessment of net ES gains against the depletion of resources required for their production (Camacho-Caballero et al., 2024), thus enhancing our understanding of social-ecological burden shifting (Boillat et al., 2020). An important area of research is the examination of ES trade-offs across various scales and locations, as highlighted by studies on ES teleconnections and telecoupling (Corbera et al., 2019; Boillat et al., 2020). This includes, for instance, considering indirect ES depletion, e.g. water use and carbon emissions, related to imports in the form of food, raw materials, and commodities.

In short, equity and justice must be more strongly addressed in the production of ES. A growing body of literature deepens our understanding of the complex dynamics underlying ES production and challenges us to move beyond simplistic stock-flow ES frameworks. ES production justice advances a better understanding of the interplay between beneficiaries and those disadvantaged by the commodification of ES, acknowledges human agency in the distribution of natural capital as ES production assets, and recognizes ES trade-offs in ecosystem planning and management.

3. Ecosystem services distribution

Distributional inequality is a pressing challenge in both social and environmental contexts, significantly impacting human well-being (Hamann et al., 2008; Bennett et al., 2015). In this context, it is crucial to understand ES and the derived benefits as "objects of distribution" (Sievers-Glotzbach, 2013). Justice, in terms of ES distribution, entails the fair and equitable allocation of benefits and burdens among all social groups, considering spatial and temporal dimensions (Schlosberg, 2013). Research in this field seeks to address questions regarding which social groups benefit from ES provision and how these distributions can be made more equitable (Ernstson, 2013; Langemeyer & Connolly, 2020; Sikor, 2013). It focuses on the distribution of ES across various social factors such as race, ethnicity, and income (Baró et al., 2019; Law et al., 2022; Selmi et al., 2021). Moreover, intergenerational considerations are taken into account, acknowledging the importance of equitable distributions of ES across generations (Boillat et al., 2020). The emerging research on ES distribution can be categorized into three key lines of study: (a) vulnerability, (b) the differentiated understanding of accessibility, and (c) people's capabilities to benefit from ES.

3.1. Vulnerability

ES are crucial for sustaining human well-being and biodiversity, yet their distribution across societies is often uneven, raising questions of justice and equity. A key concept in addressing these disparities is vulnerability, which refers to the varying sensitivities of individuals and communities to anticipate, cope with, resist, and recover from the impacts of environmental and socio-economic stressors (Fineman, 2018; Camacho-Caballero et al., 2024). Understanding vulnerability is essential for ES justice because it highlights how different groups are differentially affected by environmental changes and policies, often exacerbating existing inequalities. Recognizing and addressing these vulnerabilities is therefore critical in the development of fair and

equitable ES regulating and governing institutions and management strategies.

The literature on social disaggregation (e.g. Brück et al., 2022; Chaudhary et al., 2018; Daw et al., 2011; Horcea-Milcu et al., 2016; Lau et al., 2018) offers a valuable critique of the dominant aggregated ES accounting approaches, which primarily focus on maximizing net benefits and often overlook socially differentiated distributions of ES-related benefits and burdens (e.g. Andersson et al., 2021). However, studies that specifically examine the disaggregation of ES outputs by beneficiaries are still rare (Brück et al., 2022; Mandle et al., 2020; Suich et al., 2015), and do not consider underpinning needs and vulnerabilities. When disaggregation is undertaken, it typically involves capturing people's reported use of ES (e.g. Chaudhary et al., 2018; Lakerveld et al., 2015; Lau et al., 2019) or assessing spatial differences in the distribution of ES supply or flow among beneficiary groups (e.g. Baró et al., 2019; Mullin et al., 2018). Regarding the latter, urban ES studies have made significant contributions, experiencing exponential growth in recent years (Calderon-Argelich et al., 2021; Langhans et al., 2023). For example, Nylelele et al. (2020) evaluated the spatial distribution of urban ES among different population groups in New York, while Shiraishi et al. (2023) assessed the distribution of urban forest benefits in Cali, Colombia. Kato-Huerta and Geneletti (2023) recently developed an ES justice index to support urban green space planning from a distributional perspective. Further advancing beyond an ES net-benefit approach, an emerging line of research starts highlighting distributional justice aspects of ES flows in relation to varying vulnerabilities and needs among societal groups (Herreros-Cantis & McPhearson, 2021). These studies acknowledge the existence of different needs and baseline disparities in access to ES, rather than a net-gain observation across different societal groups. At the core of environmental studies, vulnerability emerges as a multifaceted concept crucial for understanding varying degrees of exposure and resilience across ecosystems and human communities. A nuanced examination of vulnerability encompasses socio-economic disparities and systemic factors, ranging from exposure to (environmental) risk, for instance climate change induced, to income inequality and social marginalization (Camacho-Caballero et al., 2024). These elements often converge to heighten the susceptibility of marginalized communities to risks, underscoring the urgent need to integrate principles of justice within environmental assessments and planning (IPCC, 2022).

3.2. Accessibility

Research on social disaggregation has also raised awareness about the unequal opportunities of individuals in accessing benefits, ultimately leading to possible ES injustices (Bennet et al., 2015; Berbés-Blázquez et al., 2017; Daw et al., 2016). Classically ES research has approached access as determined by rights, i.e. property rights (Dade et al., 2022; Vallet et al., 2019). Through these rights an ES beneficiary might gain or lose the ability to exclude others from using an ES, for instance by excluding others from consuming classically marketed ES like food and fiber, and access to outdoor recreation.

Yet, following the "theory of access", as proposed by Ribot and Peluso (2003), the ES accessibility has been expanded beyond the notion of rights and greater attention has been placed to the varying conditions that influence an individual's abilities to shape and control access to ES benefits (e.g. Horcea-Milcu et al., 2016; Lapointe et al., 2019; Langhans et al., 2023), encompassing the broader social, political, and economic context. Barriers to access can differ across beneficiary groups, as they face distinct personal and structural constraints (Lapointe et al., 2020; Szaboova et al., 2020) as well as power asymmetries (Felipe-Lucia et al., 2015). Ernstson (2013) and Langemeyer & Connolly (2020) have further developed ES justice models that emphasize the significance of power relations and institutional arrangements in enabling or constraining access to ES. Barnaud et al. (2018) and Vallet et al. (2019) have contributed to this discussion by highlighting the need to account for social relationships and institutional arrangements that influence people's ability to access ES. These frameworks go beyond the simple notion of possessing rights and highlight the importance of understanding the structural and relational mechanisms that indirectly facilitate access to specific ES, such as knowledge, technologies, capital, and social relations. In short, the literature on ES accessibility implies that people's access to ES benefits is multidimensional, context-dependent, socially differentiated (Szaboova et al., 2020).

Future research and policies need to better acknowledge and cater to the diverse needs and vulnerabilities across all societal groups, by moving beyond merely identifying potential 'winners and losers' to actively mitigating inequities in ES distribution (Bennett et al., 2015; Daw et al., 2011; Mandle et al., 2020). This approach requires a nuanced understanding of the complex interplay of factors influencing access, including rights, social, political, and economic contexts, as well as power dynamics and institutional arrangements (Felipe-Lucia et al., 2015; Langemeyer & Connolly, 2020). Contributions from Ribot and Peluso (2003), Ernstson (2013), and Barnaud et al. (2018) have laid the groundwork by highlighting the importance of considering broader structural and relational mechanisms that facilitate access to specific ES. Moving forward, the incorporation of intersectionality and a more differentiated understanding of the root causes of socio-spatial injustices (Anguelovski et al., 2021) is likely to shape the field. This evolution suggests a shift towards more equitable ES distribution and justice, ensuring inclusive governance and decision-making processes, building on the critical lessons learned about social disparities in access.

3.3. Capability

Another strand of literature elucidates differences in ES distribution from the perspective of the capabilities approach, which was first introduced and developed by Sen (1985) and Nussbaum (2001). Unlike the above described focus on accessibility, the capabilities approach embeds ES in wider processes of human flourishing and empowerment, putting emphasis on the individuals' varying opportunities to be and do what they deem important for living a good life and flourish (Polishchuk & Rauschmayer, 2012; Leach et al., 1999). Following this approach, the derivation of benefits for well-being depends on people's subjective notion of what is considered a good life (see section on well-being pluralism) and on the contributions of a range of personal, social, and environmental "conversation factors" (Robeyns, 2005). For instance, in an empirical application to coastal ES, Chaigneau et al. (2019) classify conversation factors into three types, suggesting that the formation of capabilities depends on monetary factors (e.g. selling fish), use factors (e.g. cooking fish), and experiential factors (e.g. sharing fish). Each of these factors, in contributing to capability formation, can generate a potentially wide range of benefits for well-being. In directing attention to multi-dimensional conversation factors, the capabilities approach provides a framework for integrating both personal abilities (e.g. bodily, mental condition) as well as contextual conditions such as norms, societal practices, geographic location or climate (Forsyth, 2015). Furthermore, the framework highlights co-dependencies between ES and their varied functions, insofar as ES themselves can be important (environmental) conversation factors for the realization of benefits from other ES (Polishchuk & Rauschmayer, 2012).

In summary, socially and spatially disaggregated ES studies have provided descriptive insights on inequalities in the distribution of ES benefits. Moreover, studies on access and capabilities have highlighted the multidimensional nature of people's access to ES benefits, shedding light on causality, potential mechanisms and contextual constraints that shape ES distribution. The design of governance arrangements and institutions has shown to be crucial in order to promote distributional justice of ES (Nahuelhual et al., 2018; Sievers-Glotzbach, 2013: 164). By acknowledging the diverse mechanisms that influence vulnerability, enable, or restrict accessibility, as well as by providing novel understandings towards people's abilities and political, social, and

environmental opportunities to benefit from ES, ES justice research is increasingly providing the tools this design requires.

4. Ecosystem services pluralisms

The third major strand of ES justice research focuses on the recognition and inclusion of ES pluralism in ES assessments and decision-making processes. In particular, it refers to the recognition and inclusion of different perspectives, needs, values and forms of knowledge of different stakeholders and societal members. While the traditional ES assessment has been primarily based on monetary approaches and a dualistic understanding of the human-nature relationship, it has been increasingly criticized for taking limited account of the different perspectives, values and interests of different societal groups (Loos et al., 2022). This has triggered a fundamental rethinking of ES assessment and led to calls for a disaggregated understanding of well-being, recognition of value diversity and the inclusion of diverse knowledge systems. In this context, three key aspects emerge in the ES literature: Well-being pluralism, values pluralism, and knowledge pluralism. The following sections address the importance of these dimensions in promoting a more inclusive and equitable approach to ES management and conservation.

4.1. Wellbeing pluralism

Human wellbeing is a central aspect of ES frameworks, recognizing how ecosystems contribute to well-being through the provision of diverse services (e.g. Diaz et al., 2015; Haines-Young and Potschin, 2010; Rendón et al., 2018). The Millennium Ecosystem Assessment (MA, 2005) was among the first to acknowledge the multidimensional nature of well-being and its links to various ES, encompassing material well-being, health, security, and social relations (Agarwala et al., 2014; Summers et al., 2012). However, the MA has also faced criticism for its aggregated outcomes (Lele et al., 2013). Similarly, ES research has been criticized for prioritizing economic aspects of well-being and assuming a uniform understanding among communities (Agarwala et al., 2014; Daw et al., 2016).

In the past decade, ES scholarship has increasingly recognized the multi-dimensionality and diversity of the well-being concept, particularly in poverty reduction research in the Global South (Daw et al., 2011; Dawson & Martin, 2015; Pascual et al., 2017). For instance, the Ecosystem Services for Poverty Alleviation (ESPA) program advocates for a socially disaggregated perspective to understand how ES translate into well-being benefits for different societal members (Coulthard et al., 2018; Dawson & Martin, 2015; Schreckenberg et al., 2018). This is because different groups have diverse needs and aspirations that influence the contribution of ES to their well-being (Daw et al., 2011). Like the capability approach (Robeyns, 2005; see also previous section), both individual and structural circumstances influence people's reliance on ES, with poorer individuals generally relying more on ES due to limited availability of alternatives (TEEB, 2010; Agarwala et al., 2014; Daw et al., 2011). Furthermore, the well-being outcomes generated by ES are influenced by people's social identities, entitlements, and livelihood activities (Fortnam et al., 2019; Robinson et al., 2018), as well as their access to alternatives and other forms of capital, such as human, social, and physical capital (Mandle et al., 2020). Gendered roles, for instance, affect the importance of fuelwood within households; in a context where women were traditionally responsible for cooking and sanitation practices, they showed to place more importance on this provisioning ES (Chaigneau et al., 2019; Lau et al., 2019).

While ES research has become more attentive to differences in needs, aspirations, and circumstances, less attention has been given to different understandings of well-being (Hoelting,et al., 2024; Kenter, 2018). Agarwala et al. (2014) highlight the need for a more integrated conception of well-being, considering contextually relevant components, their interrelationships, and how they are evaluated and interpreted. Well-being components like wealth, health, and education may be perceived differently based on the notion of a good and flourishing life (Betley et al., 2021). By adopting a wellbeing pluralism approach, ES research aims to move beyond narrow utilitarian framings and consider a broader range of values, priorities, and preferences shaping human well-being. This recognition of diverse perspectives promotes equitable and sustainable management of ecosystems and ES.

4.2. Value Pluralism

Value pluralism in ES research acknowledges the diversity of values and the fact that different groups can attribute different meanings and importance to the same ES. Scholars such as Martinez-Alier et al. (1998), O'Neill (1997), and Arias-Arévalo et al. (2018) have emphasized the need to account for the incommensurability of values and expand the epistemological and ontological foundations of ES research. This perspective calls for a broader range of "valuation languages" to capture the diverse values associated with ES, moving beyond relying solely on monetary valuation (Jax et al., 2013; Himes and Muraca, 2018).

Key aspects of value pluralism in ES research involve considering multiple value perspectives (Arias-Arévalo et al., 2017; Riechers et al., 2020; Schmitt et. al., 2022), promoting stakeholder inclusion and participation (Kenter et al., 2016; Zafra-Calvo et al., 2020), developing methods for value articulation and assessment that go beyond mere monetary assessments (e.g. socio-cultural valuation; Christie et al., 2019; Jacobs et al., 2018), recognizing trade-offs and their implications for decision-making (Turkelboom et al., 2018; Lliso et al., 2022), and acknowledging the contextual and situational nature of values (Chan et al., 2016; Fish et al., 2016). It recognizes that values can vary across different social and cultural contexts, and that different groups may prioritize and appreciate ES differently (Martin-Lopez et al., 2012; Oteros-Rozas et al., 2014; Zoderer et al., 2019). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has strongly supported the perspective of value pluralism in ES research (e.g. Andersson et al., 2022). In its work, IPBES has embraced a multi-dimensional value framework that includes instrumental, intrinsic, and relational values (Díaz et al., 2018; Pascual et al., 2017). This means acknowledging and considering the diverse perspectives and needs of different social groups, including marginalized and vulnerable groups, but also indigenous communities. Following, incorporating plural ES values requires a context-specific and situational understanding, as values can be shaped by local conditions, cultural norms, and social identities (Langemeyer & Connolly, 2020). Overall, value pluralism in ES research expands the scope of understanding and valuing ES beyond economic considerations. It recognizes the importance of diverse values, promotes inclusive decision-making processes, and aims to incorporate the voices and perspectives of various stakeholders, leading to more equitable and contextually relevant approaches to managing and valuing ecosystems and their services.

4.3. Knowledge pluralism

In the context of ES, knowledge pluralism acknowledges the existence of different worldviews and multiple understandings of nature, humanity and the relationship between the two (Borie & Hulme, 2015; Hoelting, et al., 2023). It recognizes that there are multiple forms of knowledge, such as the western-based scientific knowledge, indigenous and local knowledge, and that each type of knowledge can provide complementary insights and perspectives (Tengö et al., 2017). Considering these different epistemic perspectives is not only required for a better understanding of both value and well-being pluralism (Kenter, 2018; Pascual et al., 2017; Zafra-Calvo et al., 2020), but also for achieving both recognition and procedural justice in the context of ES research and practice (Loos et al., 2022). As different forms of knowledge are often incommensurable and highly contested among each other, embracing knowledge pluralism in ES research and decision-

making requires the careful and equitable interweaving of diverse knowledge systems and the participation and empowerment of different knowledge holders (Tengö et al., 2014, 2017). Despite its importance and interrelationship with value and well-being pluralism, knowledge pluralism has received much less attention in ES research. Here, we highlight two, albeit small, strands in the ES literature that we believe could lay the basis for a more in-depth consideration and theorization of knowledge pluralism in achieving ES justice. These include the literature on the implications of dominant framings and language and their implications for knowledge production in the field of ES, and the emerging literature on the social (co–)construction of services and benefits.

As highlighted by Kull et al., (2015: 126), the ES concept "frames the world in a particular way", helping us to structure ideas and thoughts and communicate them across different contexts also acting as a boundary object (Abson et al., 2014; Steger et al., 2018), while also influencing what we can know and how. Traditionally, research on ES has produced scientific knowledge using biophysical models, maps or (economic) assessments. This builds on the dualistic understanding of human-nature relationships implicit in the "stock and flow" model, which sees nature as an object that can be quantified and measured (e.g. Schröter et al., 2014). However, less tangible values, relational or more holistic understandings of human-nature relationships are often overlooked when the language of ES and natural capital becomes the only consideration in knowledge production and decision-making (Ainscough et al., 2019). Recent developments within IPBES and the development of its NCP framework can partly be seen as a response to these emerging, critical discussions within the ES literature (IPBES, 2019; 2022). While not rejecting the overall anthropocentric framing of the ES concept, they create space for alternative, contextualized understandings of human-nature relations (e.g. "nature's gifts") (Díaz et al., 2018; Hill et al., 2021), as well as indigenous and local knowledge systems in ES and biodiversity decision-making (Borie & Hulme, 2015; Pascual et al., 2017). This also includes the consideration of knowledge representations, which are often grounded in lived experiences and embodied knowledge, and are better conveyed through narratives (Díaz et al., 2018; Gould et al., 2019).

The second strand of literature relates to the social co-construction of ES and benefits and recognizes that people may have different forms of knowledge and attach different meanings to different components of the ES cascade (Fischer & Eastwood, 2016; Fish et al., 2016; Raymond et al., 2018). This co-construction process depends on personal situations and cultural and social contexts (Fischer & Eastwood, 2016). Ecosystem processes become service potentials when people assign use-values to them (Spangenberg et al., 2014; Zoderer et al., 2019), which is influenced by culture, identity, and societal discourses (Chan et al., 2012a). In addition, people can have different understandings of what characterizes and defines an ES (Zoderer et al., 2020). Thus, understanding the differences in people's relationships with ecosystems requires caution when applying standardized definitions of ES, such as by the MA (2005) or CICES (2018). Recognizing the variations in the perception and understanding of ES among people provides a nuanced understanding of potential conflicts and helps avoid misinterpreting differences solely as preferences and values (Andersson et al., 2019; Zoderer et al., 2019; Hoelting et al., 2024). Overall, both literature strands highlight the need for incorporating different forms of knowledge in ES assessments and decision-making to capture the complexity of people's relationship with ecosystems and avoid oversimplifications that might lead to unjust outcomes.

In summary, research on the three components of ES pluralism outlined here — wellbeing, value and knowledge pluralism — provides a deeper understanding of the complexity of people's relationship with nature. In particular, it highlights that different individuals or social groups may experience different wellbeing outcomes from ecosystem services due to different needs, values and understandings of well-being, ecosystem services, and the overall human-nature relationship. By acknowledging this complexity and the highly intertwined nature of these different forms of pluralism, ES justice research is increasingly laying the basis for a more differentiated account of equitable and just ES outcomes. Most importantly, it highlights under which conditions differences in ES production and distribution are ultimately experienced as ES injustices by different groups of individuals and attempts to consider these different perspectives in ES decision-making processes.

5. Outlook

This perspective provides a synthesis of the development of the emerging research field of ES justice, by highlighting previous advances and pointing out future research needs and frontiers. Traditionally, ES studies have predominantly adopted an egalitarian approach to equity and justice. However, as we have shown here, based on important critiques accompanying the expansion of the ES research field, an important body of literature on ES justice has grown over the past decade. Not least, we argue, the social-ecological co-production perspective of ES, which recognizes the dynamic and reciprocal relationship between humans and ecosystems, must be highlighted as an underpinning framework for a better understanding of the complexity and diversity of ES justice (Palomo et al., 2016; Kachler et al., 2023). This concluding section highlights the core takeaways from this synthesis and calls for future research from the three key research strands that have emerged in the ES justice literature on (a) ES production, (b) ES distribution, and (c) ES pluralisms including the recognition of plural wellbeing, values, and knowledge systems, and their uptake in governance procedures of the production and distribution of ES.

First, the research on ES production justice challenges the conventional "stock-and-flow" framework of ES, recognizing the complex interactions between natural capital, social-ecological dynamics, and historical factors that shape the production of ES. It emphasizes the role of human agency, co-production, commodification of ES, and trade-offs in the ES production. Moving forward, this research strand calls for instruments that incorporate justice elements to counteract production inequalities and promote just outcomes on the ground. For instance, well-designed PES schemes, grounded in ES production justice principles, may provide a way to address structural production inequalities by rewarding the contributions of underprivileged actors in the co-production of ES (Benra et al., 2022; Pascual et al., 2017). To transition towards fair modes of ES production, it is essential to closely examine and be more sensitive to variations in (historic) assets distribution (Coulthard et al., 2018) and future processes of enclosure and land-grabbing to control for ES production means.

Second, research on ES distribution justice highlights the inequalities in the distribution of ES benefits among different groups. By acknowledging the diverse mechanisms that enable or restrict accessibility and by providing novel understandings of diverse abilities to benefit from ES (Langhans et al., 2023), this research strand offers valuable tools to address complexities related to ES distribution and allows to examine the multidimensional nature of access to ES benefits, influenced by power relations, institutional arrangements, and contextual factors. When used in practice, ES justice is still often limited to the consideration of unequal distributions of ES benefits, for example, the racial make-up of those who most benefit from the access of green space in a city, or how different social and cultural groups may lose access to natural resources (Calderon-Argelich et al., 2021; Langhans et al., 2023). We call for a stronger consideration of inequalities in people's needs for ES and capabilities to obtain them. This involves on the one hand considering spatially differentiated vulnerabilities (Camacho-Caballero et al, 2024), including diverse risks and social sensitivities (Herreros-Cantis & McPhearson, 2021). On the other hand, it means considering differences in people's capabilities to access ES (Andersson et al., 2021). This leads to acknowledging and questioning the interplay of power, institutions, and governance in shaping the distribution and allocation of ES benefits among societal groups (Langemeyer & Connolly, 2020).

Finally, the acknowledgement of plural wellbeing, values, and knowledge systems in ES research is crucial for addressing justice and equity concerns. To fully address justice and equity in ES research and governance, a comprehensive and integrated approach addressing this triad is necessary. This means to consider social differences and variations in needs, values, and knowledge systems that shape the translation of ES into well-being outcomes (Daw et al., 2011; Lakerveld et al., 2015). It expands the criteria for equity beyond equality, encompassing considerations of needs, merits, and deservedness to understand for whom and under which conditions unequal ES distribution and production turn into injustices (Sikor et al., 2014). Future research must address procedural aspects to acknowledge ES pluralisms, accounting for the diverse needs, vulnerabilities, and understandings of wellbeing and ES benefits among different societal groups. Furthermore, the consideration of what is just might be disputed, only a few studies have previously employed an inductive approach to consider pluralistic notions of justice among different stakeholder groups and how they influence environmental practices and related societal conflicts (e.g. He and Sikor, 2015). Depending on the research context and the beneficiary group being studied, different justice criteria may apply and shape our understanding of what is considered fair and just. Recognizing this plurality of justice criteria is crucial for assessing situations where potential inequalities and trade-offs among societal groups translate into significant (in)equity and (in)justices, and for preventing ES governance and decision-making from causing societal conflicts and further exacerbate marginalization of the most vulnerable groups (Dawson & Martin, 2015).

By integrating the three dimensions of ES production, distribution, and pluralism, this perspective provides a comprehensive view of ES justice. Specifically, it moves beyond the simple supply–demand dichotomy prevalent in ES assessments by factoring in the production processes and the socio-cultural underpinnings of ES production and distribution, thereby offering a richer, more contextually grounded understanding of ES justice. Reimagining the justice framework in this manner allows us to present a holistic view of the ES landscape, one that better accounts for the intricacies of how ES are produced, distributed, and valued. This approach not only provides a stronger analytical foundation for understanding ES justice but also highlights the advantages over traditional models by emphasizing the interconnectedness of social-ecological processes and social justice issues.

Yet, the single approaches laid out are only piecemeal without novel procedural frameworks across multiple dimensions of space and time. We thus call for new and integrated approaches to incorporate ES justice from a procedural perspective across multiple dimensions, perspectives, and intersectionalities (Anguelovski et al., 2020). Such an integrated approach needs to reflect on social differences throughout the entire ES chain (Daw et al., 2011; Daw et al., 2016; Lakerveld et al., 2015), including disparities in the production of ES due to power imbalances, discrepancies in accessing ES benefits resulting from individuals' varying personal abilities and structural conditions, and variations in people's values, needs and aspirations that ultimately shape the translation of ES into well-being outcomes (Coulthard et al., 2018). It is not sufficient to understand ES justice as differences in the distribution of benefits among different societal groups, but also to interpret these distributional inequities in the light of differences in mediating factors and mechanisms to access benefits, and people's diverse needs, vulnerabilities and understandings of well-being. In summary, while many scientific foundations have already been laid out, a holistic incorporation of justice into ES practice is still widely missing and requires a further rethinking of the ontology, values, ethics, and epistemologies that are implicit in current framings and assessments of ES.

CRediT authorship contribution statement

Johannes Langemeyer: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Investigation, Conceptualization, Methodology. **Felipe Benra:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Laura Nahuelhual:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **Brenda Maria Zoderer:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization.

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

No data was used for the research described in the article.

Acknowledgements

This research has been supported by the Laboratory for the Analysis of Social-Ecological Systems in a Globalized world (LASEG), Universitat Autònoma de Barcelona and Generalitat de Catalunya (2021-SGR-00182). This research contributes to ICTA-UAB "María de Maeztu" Programme for Units of Excellence of the Spanish Ministry of Science and Innovation (CEX2019-000940-M). This research was supported by the Social-Ecological Systems Institute of the Leuphana University, Lüneburg, Germany and the University of Natural Resources and Life Sciences, Vienna. During the preparation of this work the main author used OpenAI's GPT-4 model to support the language editing. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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