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Ecosystem services and nature's contribution to people: negotiating diverse values and trade-offs in land systems

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Land is increasingly managed to serve multiple societal demands. Beyond food, fiber, habitation, and recreation, land is now being called on to meet demands for carbon sequestration, water purification, biodiversity conservation, and many others. Meeting these multiple demands requires negotiating trade-offs among the choices and differing values placed on them by diverse stakeholders and institutions. Here, we review recent advances in understanding the role of diverse values and trade-offs in managing landscapes to support multiple demands, from a land systems perspective. Recent work by the IPBES and others has recognized the need to accommodate a greater diversity of values into decision-making through the framework of 'nature's contributions to people (NCP)' providing a perspective on human–nature relations that goes beyond a stock-flow, ecosystem services, decision-making framing. NCP offers real potential to enable land system science to better integrate the many diverse value systems of stakeholders and institutions into efforts to better understand and more fairly govern the increasingly wicked tradeoffs of land systems in the Anthropocene, especially under conditions of less well functioning institutions and governance.

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Introduction

Humans have long managed landscapes to service multiple societal demands, from food and shelter to sacred spaces and other cultural needs [1]. Now, as more than three quarters of Earth's terrestrial surface is managed to meet a combination of classic human needs via agriculture, forestry and settlements [2,3], landscapes are increasingly being called on to sustain a wider variety of services, many previously provided by lands left unmanaged, from wildlife habitat to flood control, water purification, pollination services, sequestration of carbon emissions in vegetation and soils and to avoid biodiversity losses [4].

Land management is governed by social interactions among stakeholders and institutions (norms and rules) interacting in both directions with dynamic ecosystems in heterogeneous landscapes. Wicked challenges arise in governing these complex social-ecological systems, or land systems, as a result of trade-offs among the outcomes of different management decisions for both people and ecosystems [5–7], whenever strategies (re)produce both winners and losers, when the values and aims of management solutions are defined differently by different stakeholders, and where solutions yield additional problems [8••]. To add complexity, the operational scale and pace of change in land systems is generally increasing together with global economies and the acceleration of human social change in the Anthropocene [9]. These complexities and associated conflicts over land resources have only increased as the competing demands and interests of a wider range of stakeholders collide within and across Earth's rapidly evolving landscapes, together with entirely new demands on land management, from reducing the environmental harm caused by intensive agriculture and other human infrastructure to the provision of ecosystem services and the conservation of biodiversity.

While there continues to be scholarly interest in 'optimizing' landscape configurations to navigate trade-offs among ecosystem services (e.g. Ref. [10]), further stimulated by ongoing development of land sharing/land sparing models [11], richer models of social-ecological interaction in landscape decision-making are emerging, in efforts to integrate demand side aspects, such as the coproduction of ecosystem services [4,12], in accounting for both social and ecological trade-offs among competing demands for different land system services [13,14], and in efforts to negotiate these while recognizing uneven power

relations among actors [15]. At the same time, there is a growing realization that conservation of biodiversity and ecosystems will often be at the losing end in such optimization efforts, for example, in policies oriented toward greenhouse gas abatement [16,17•], as their implicit valuation framing, often associated with a utilitarian, transactional, ecosystem services framing (e.g. the more carbon that forests can sequester, the better), conflicts with a wide array of more complex and culturally contingent human–nature relations and associated values (e.g. forests as sacred; forests have rights; forests are habitat) [16,18].

The need to negotiate among broader sets of values held and articulated by diverse stakeholders and institutions to produce better social-ecological outcomes in land systems, including open normative discussions on what better outcomes are or should be, is emerging as a key concern in land system science [19•,20,21]. Conservation science is also increasingly concerned with understanding and addressing issues of equity and justice [22,23•] and more diverse stakeholder values and demands [24••], for both ethical and applied reasons; governance efforts risk failure when issues around stakeholder concerns, fairness and power relations are not duly addressed [22,25•,26–28,29•,30].

Our normative stance is that successful efforts to negotiate land decisions are those that account for and address the wicked challenges and tradeoffs emerging from the varied and conflicting demands and value systems of diverse stakeholders and institutions [19•]. That is, decisions based on landscape models need to better factor in the social realities associated with negotiation among stakeholders' diverse interests and value systems, in which conditions of unequal power relations and locked-in institutions tend to (re)produce winners and losers. Such social realities and conditions, and their role in producing harmful outcomes, especially for the most vulnerable actors in society, are exemplified in current efforts to manage trade-offs between agricultural production, climate change mitigation and biodiversity conservation [31–33].

This review summarizes emerging issues and questions relating to governing land systems with attention to the social-ecological trade-offs arising from stakeholders with competing views, and interests, in turn determining and influencing the value systems embedded in institutions governing biodiversity and ecosystems, and maps out needs for future work in the short term. In particular, we explore key questions raised by a new framework 'Nature's Contributions to People' (NCP) [24••,34••,35], which has been suggested as a more inclusive approach stemming from but going beyond conventional ecosystem services modelling and valuation frameworks. We focus on the potential of NCP in terms of better recognizing and addressing the complex social-ecological trade-offs in governing land systems fairly and sustainably across diverse governance systems and stakeholder communities with differing cognitive frameworks conditioning their interactions with nature [36•].

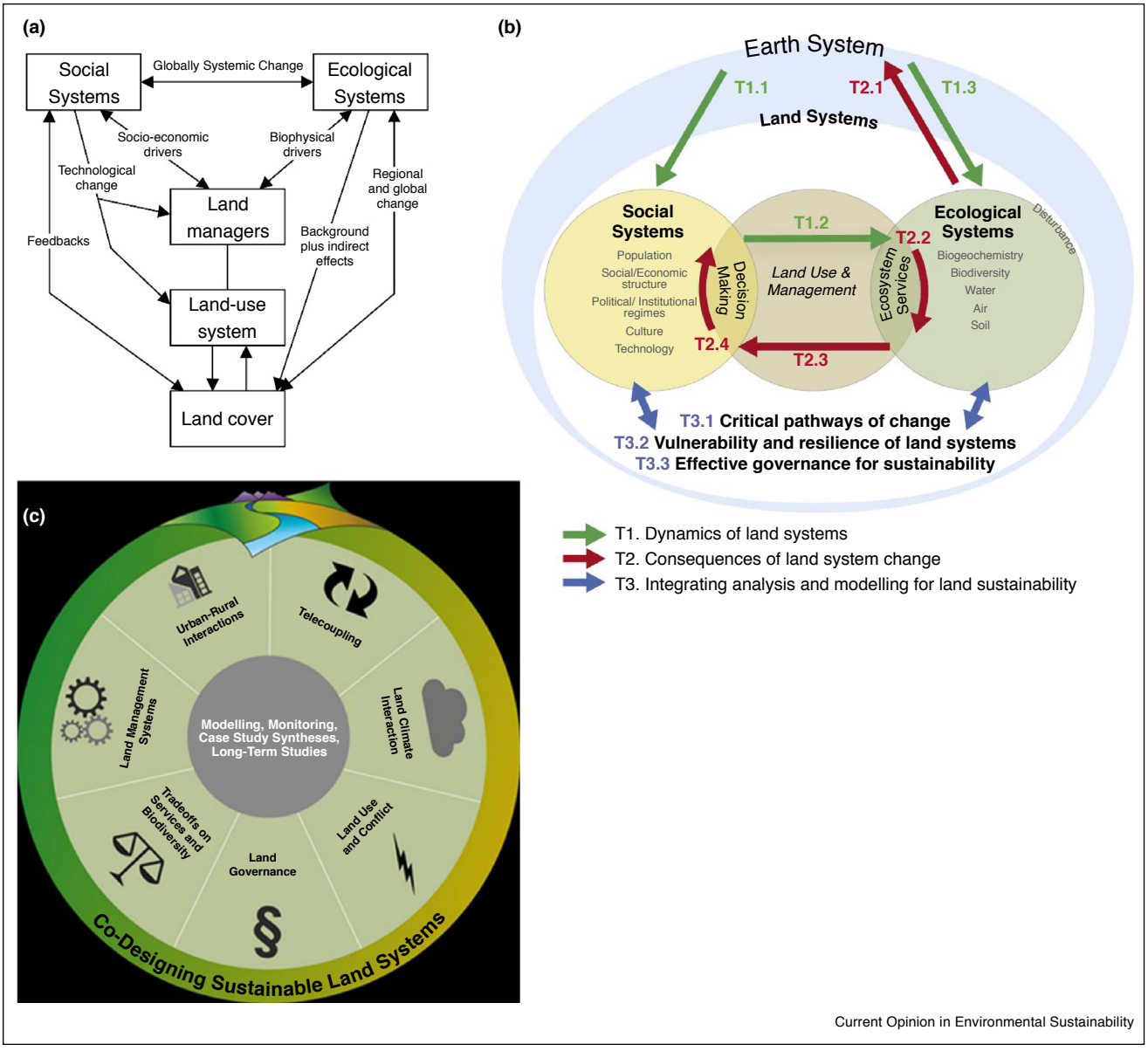
Land systems, ecosystem services, and nature's contributions to people

Land system science evolved alongside the development of the ecosystem services (ES) concept and the two approaches have cross-fertilized by using land use and land cover studies to quantify ecosystem service flows and land use changes as key drivers of changes in ES [37,38]. The ES framework has been incorporated into several iterations of land system science frameworks and has progressed from broad conceptualizations of ecological systems and land systems as mutual drivers of change in both systems (the LUCC framework; Figure 1a), to 'Ecological systems and their services' in the Global Land Project Science Plan (Figure 1b), to more specifically addressing 'trade-offs on services and biodiversity' in the latest Global Land Programme framework (Figure 1c).

The ES approach of the Millennium Ecosystem Assessment [39] more than a decade ago has been applied in multiple land systems frameworks, theories and applications [17•,20,40–42]. Such ES applications in land system science have, however, often been limited to the more easily quantified ES, generally by focusing on services that tend to be associated with readily commensurable economic value [17•,43]. Moreover, in studies assessing land use change impacts on ES there has been a relatively narrow focus on provisioning services (mainly food production) and impacts on carbon sequestration and biodiversity [40] with relatively less emphasis on regulating services and especially the less readily defined cultural services [44,45]. This has led to sustained debates and criticism of ES frameworks for crowding out other values and perspectives on human–nature relationships that do not fit squarely within a natural capital stock/economic benefit flow framing [16,34••,35,46]. Operationally, this has also led to policy instruments such as Payment for Ecosystem Services (PES) schemes [22,47] and associated ones including REDD+ [48,49] that often do not adequately integrate diverse and often competing value systems by relevant stakeholders or address important social trade-offs that can render such instruments of limited capacity to transform institutions governing land systems toward being more sustainable, efficient and just in the longer term [46].

Partly as a response to these concerns, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) is proposing the NCP framework (Figure 2) with the objective of ensuring broader inclusiveness in terms of scientific disciplines, particularly giving further space to the humanities and social sciences, but also to other

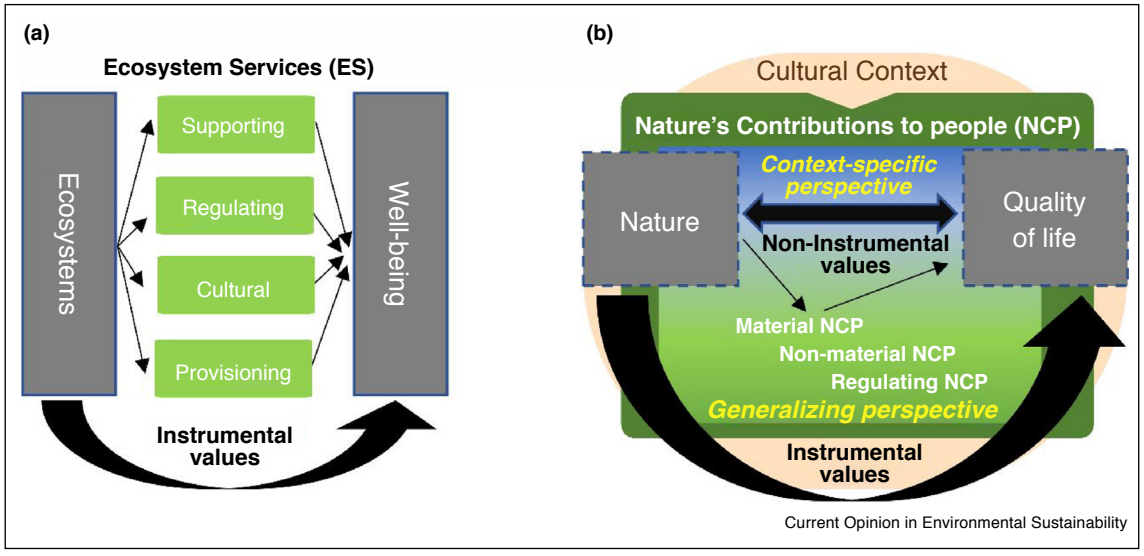
Figure 1



Evolving representations of Ecosystem Services in Land System Science frameworks.
(a) LUCC framework (1995), redrawn from Ref. [73]; **(b)** Global Land Project Science Plan [74]; **(c)** Research priorities in the Global Land Programme Science Plan. 2016–2021.

knowledge systems, including those practiced by indigenous peoples and local communities. It also offers more explicit recognition of the role of knowledge systems and cultural contexts in determining different ways in which human–nature relations take shape around the world [24••,34••]. It conceptualizes (both positive and negative) contributions from nature to people's quality of life as 'Material', 'non-Material' and 'Regulating', with explicit fluidity among such categories from a scientific perspective. For example, food may be seen as much as a material contribution as a non-material one based on intangible aspects that it may be associated with (e.g. rights, identity, spirituality, etc.). NCP also embeds non-Western concepts such as 'Mother Earth' or 'Living in harmony with nature' that connect with diverse ways of understanding human–nature relations and hence values *of* and *about* nature. This has led to heated debates on whether there is actually a need for NCP beyond ES, with some ES scholars claiming that ES already captures all elements of NCP, for example Ref. [50], and that a multiplicity of terms may confuse policy makers [51,52], and about the appropriateness of replacing the scientific terms

Figure 2



Frameworks from Ecosystem Services (ES; **(a)**) to Nature's Contributions to People (NCP; **(b)**).
In ES, ecosystems are connected with human wellbeing, usually positively, via 'flows' of discrete types of ES that are considered amenable, through instrumental values, to measurement, monetization, exchange within market systems, and through bargaining and integration in existing policy tools such as taxes, subsidies and other economic incentive schemes (e.g. PES). In NCP, values connecting nature with human quality life are determined by the cultural lenses of the actors involved and may be viewed as a gradient between two perspectives. From a *context-specific perspective* (in blue), nature is intrinsically connected with quality of life, from 'harmony with nature' to 'rights of nature', to other cultural norms and individual beliefs, representing key non-instrumental values. From a *generalizing perspective* (in green), NCP may also connect nature with quality of life through instrumental values, but these are not necessarily discrete or always measurable in quantitative terms and may be bundled (e.g. food's contribution may be both material and non-material). Both perspectives may also overlap (there is also a combination of blue and green). In NCP, nature and quality of life themselves are also treated as fluid concepts (dashed, rather than closed boxes).

'ecosystem' and 'biodiversity' with that of 'nature' [35,53]. This debate reflects a need to recognize the value of incorporating a diversity of socio-ecological framings used by different epistemic communities in sustainability science and more broadly [46,54–56].

This debate notwithstanding, the essential question for land system science is whether and in what ways such broader framing will be useful in examining, understanding, and addressing land system processes and their social-ecological outcomes. More specifically, the question is whether NCP will allow land system science to enhance the way value trade-offs are handled beyond the more *generalizing* perspective on values that is fundamental to the ES approach. The ES focus on instrumental values, like economic valuations, that are generalizable, quantifiable and exchangeable across stakeholders through existing or surrogate markets, generally ignores values that are more *context-specific*, such as *relational values* [57•,58] that may not be quantifiable and exchangeable, especially in terms of how institutional, cultural and social aspects of land systems are dealt with, including those relating to issues of justice and power relations. The NCP framework aims to engage with the full richness of valuation systems relevant to human–environment interactions.

As illustrated in Figure 1, land systems science, land management and land use policies have already been widely influenced by ES frameworks, especially the idea of offering economic incentives to landowners for delivering socially valuable ecosystem services. This has been applied in a range of local contexts via PES with varying success [59], but it has proven more challenging to develop PES programs for global public services, for example for carbon sequestration, which is now being approached in more conventional ways with donor funding [60], not least because of on-the ground challenges, including social opposition, that programs and initiatives, such as market oriented REDD + approaches, have faced [47,61]. These challenges indicate that ES approaches, together with associated evaluation techniques, such as cost-benefit analysis, may fall short in achieving effective and equitable policy outcomes in more complex land systems [62].

Negotiating diverse values and trade-offs in land systems

We thus argue that ES optimization models have proved most helpful in facilitating effective governance under relatively 'tame' land system conditions, in which stakeholders, values, institutions, and environments are comparatively homogenous, well-integrated, and well

understood. These conditions appear mainly in land systems under low pressure to transform and where conflicts are negotiable via well-functioning institutions with transparent and open governance and legal systems that enable stakeholders to access and contest decision-making processes. Under such conditions, ES values may be negotiated and governed effectively through economic and other systems of exchange. However, such stable conditions are rarely found, especially, though not only, in the Global South. In other contexts, where high levels of social inequality, stemming from highly unequal power relations, is found together with highly contrasting worldviews and value systems relating to land and systems of governance and exchange that are relatively complex and context-specific, broader valuation frameworks and toolkits are needed, and likely essential, for effective and just land system governance [8••,23•,36•]. Such frameworks and toolkits, focused on engaging with, and not, simplifying, obscuring or avoiding, the wicked challenges of land use decision-making under conditions of unequal power relations, competing interests, and diversity of values, might help to avoid (re)producing conditions that promote latent or explicit land conflicts.

ES approaches, despite their focus on policy and capacity to map and model biophysical synergies and trade-offs among ES, including winners and losers, necessitate simplifying the full spectrum of stakeholder values, especially by (a)voiding or downplaying non-instrumental values, such as relational values associated with land [57•]. While the field of sociocultural valuation has enriched the ES approach, often this approach is used to fill loosely defined and operationalized cultural ecosystem services [63] and falls short on connecting non-instrumental values with management decisions, for example related to landscape stewardship [57•,64]. Hence, when non-instrumental values of land are underestimated, applying ES trade-off 'optimization' approaches in designing incentive programs can create value conflicts between participants and programs [64]. Thus the question that arises is whether and to what extent it is possible (or even desirable) to move toward a more sophisticated ES approach that would be able to capture and operationalize non-utilitarian values associated with relations with nature and among people through nature, or whether a mosaic of complementary framings is indeed required to enrich land system science given the contrasting and sometimes highly conflictual cognitive models about human–nature relations that also give rise to concerns over equity and justice [36•].

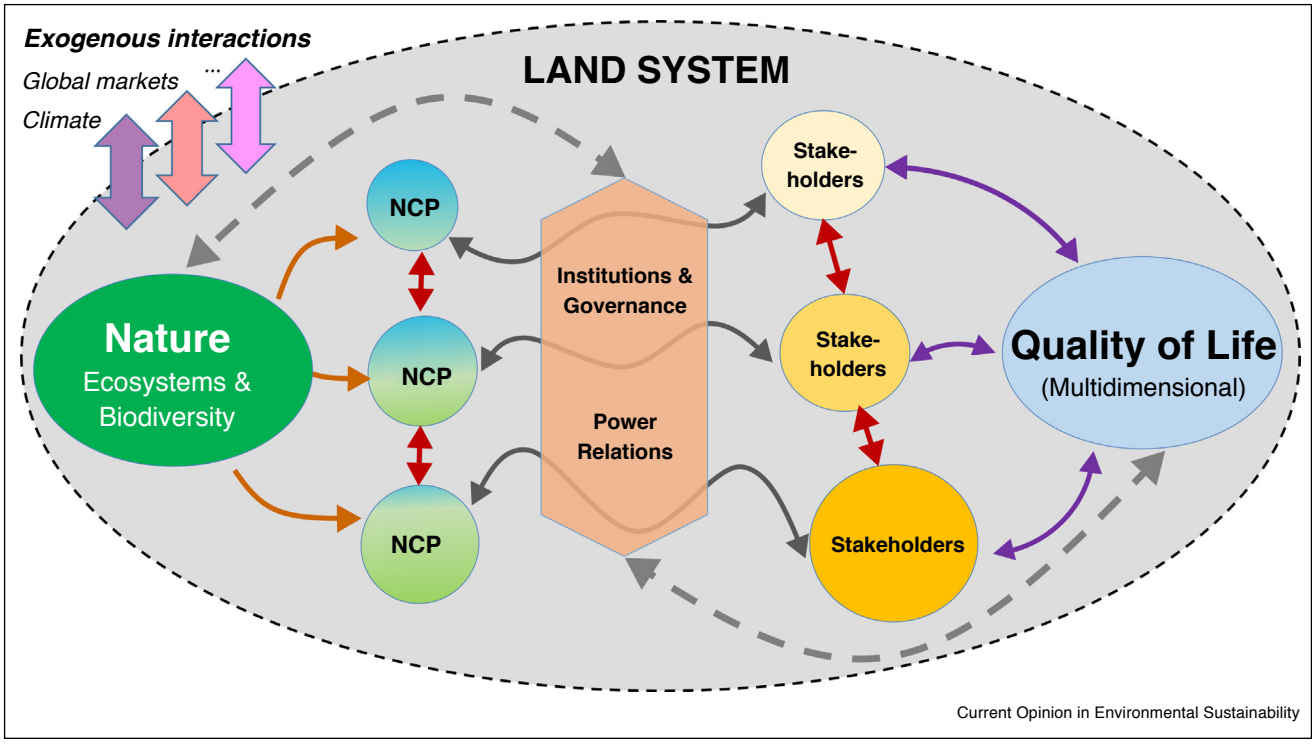
There are numerous empirical examples showing that land use policies and related changes in land systems cause serious concerns with respect to justice and equity [65–67]. Dawson *et al.* [29•] showed that spatial analysis of land use changes combined with well-being surveys in communities around a nationally protected area in Laos exhibited very limited trade-offs between development and conservation, whereas a more qualitative environmental justice approach revealed multiple significant trade-offs between conservation efforts and local practices, particularly in terms of negotiation procedures and recognition of access rights. Authorities also did not accept local conservation efforts as these did not comply with the spatial boundaries and ES-framework (biodiversity conservation and carbon sequestration) embedded in existing laws governing the nationally protected area. Similarly, Lautenbach *et al.* [19•] and Chan *et al.* [47] illustrate that ES-based land system approaches can be insufficient in elucidating and addressing core concerns of stakeholders, especially local people, if attention is not paid to diverse articulations of human–nature relations and values, beyond those of the ES approach.

In the cases described above, the NCP approach, with its broader and more flexible framework would have explicitly connected the benefits of human interactions with nature to the full range of objective, subjective, and relational dimensions that shape people's quality of life [24••,68]. NCP would also foreground potential conflicts among material and non-material relations, as well as trade-offs between the instrumental and non-instrumental values connected with land [36•,57•]. Thus, in contrast with an ES, stock-flow approach, an NCP approach would provide a better opportunity to disentangle the importance of social relations in land systems, including power relations among people, to enrich how land connects to multiple individual and collective dimensions of quality of life, as well as to include their views about such relations, based on the principle that what is good for one actor may be bad for another [68]. This may allow land system science to better understand and address the broader impacts of land management decisions on the social fabric of landscapes, including issues of governance, equity and multidimensional wellbeing, beyond the dominant instrumental value framings often favored by policy [62]. Concerns like these matters not only in land governance but are also deeply connected with the non-material dimensions of people's quality of life.

Bringing land system science and NCP together

While NCP remains a relatively new and untested framework for engaging with land systems both scientifically and operationally, NCP is inherently focused on the diversity of values and meanings associated with land and land management decisions [26] that include instrumental and non-instrumental relational values about nature [57•]. Compared to ES, NCP may therefore offer a more robust starting point for land system investigations and applications aimed at understanding and addressing land system decision-making and governance challenges on a planet entering a time of increasingly wicked conditions.

Figure 3



Bringing Nature's Contributions to People (NCP) into Land Systems.
In land systems, nature (ecosystems and biodiversity) is connected with human quality of life (multidimensional: objective, subjective and relational) through perceptions and experience that emerge through socially mediated processes (orange hexagon) of interaction among diverse stakeholders, including land users, consumers, agribusiness, conservationists, and other actors. In contrast with ES, in NCP, different stakeholders may perceive, experience, and value Nature and Quality of Life in different and more complex ways (winding bidirectional gray arrows), and NCPs vary from more *context-specific* (blue) to more *generalizing* (green) (Please see Figure 2b). Stakeholder interactions, decisions, and outcomes relating to land are conditioned on their varying relations to Nature and Quality of Life mediated through institutions, governance, power relations, and other social conditions (orange hexagon), and social conditions, nature and quality of life are also shaped by dynamic two-way interactions (gray dotted lines). Red arrows depict tradeoffs among different stakeholders (winners and losers) and among NCPs (relative valuation based on relative impacts on stakeholder wellbeing). Off-stage (exogenous) interactions include interactions of land systems with global markets, policy frameworks, dynamics of climate and other systems at higher hierarchical levels of human and Earth systems.

The NCP framework is only beginning to be applied in environmental management and governance settings beyond IPBES, for example Ref. [69]. Land system science has deep experience with investigating and understanding decision-making and governance processes and their social and environmental outcomes and feedbacks in heterogeneous social-ecological systems [8••,9,20,40,70]. By bringing the NCP approach into both scholarly investigations of land systems in theory and in the field, and into applied settings of land management and governance, the NCP framework may offer a broader analytical lens to the land system science community and a more flexible and adaptive toolkit for governance applications. Conversely, land system research may provide the test beds within which NCP might be further developed into a more broadly applicable approach, together with the empirical evidence needed to assess the effectiveness of NCP frameworks relative to conventional frameworks for ES and biodiversity valuation. To make this possible, it will be necessary to continue to incorporate these existing frameworks, at least as controls, to enable comparisons with NCP.

In Figure 3 we have attempted to bring the NCP framework [34••,71••] into an adaptation of the framework proposed by Müller *et al.* [7] where competition for land-based ES was explored. Here, social-ecological trade-offs relative to NCP and winners and losers of stakeholders in the land system take central stage. These trade-offs are mediated and determined by the power relationships among stakeholders, whereby competing interests and values articulated and enacted by institutions (e.g. norms and rules over access to and control over land resources) determine how NCP from landscapes are perceived (and favored or not) and by whom. The diversity of values about NCP are connected to the wellbeing of actors in different ways, as wellbeing is multidimensional (e.g. via income, security, identity, recognition,

etc.), with social equity and justice concerns being affected as a result. Such outcomes can be either protected or challenged by existing or new institutions (e.g. new legal frameworks, introduction of incentive schemes, etc.) which motivates land use decisions by actors in the landscape. The social-ecological matrix of the land system is dynamic and operates cross-scale, linking off-stage actors and institutions [72]. Evaluation of social-ecological trade-offs and synergies in land systems requires focusing the NCP lens within a gradient from a highly generalizing NCP perspective, for example, in cases of relatively homogenous landscapes and stakeholders in social settings where power relations can be modulated by well-functioning institutional arrangements, to the deeply context-specific NCP perspective, for example, in cases where stakeholders' worldviews are highly diverse and do not fit squarely with an ES-like stock-flow logic, and where non-instrumental values are important guiding principles of land use.

It will also be necessary to further develop and assess rubrics of land system evaluation that can enable the effectiveness of the NCP framework to be judged relative to the ES and other dominant frameworks—a major challenge when a diversity of stakeholders, institutions, power relations, equity, and other social issues are included in evaluating the effectiveness of land system governance. These, together with the need to assess trade-offs and issues of equity and power are also issues with which the land system science community is increasingly engaged and has much to offer.

Conclusions

The ES approach has proven to be a powerful tool for ecosystem management with a strong instrumental logic demanded by current policy, but it has not adequately addressed the diversity of non-instrumental values and worldviews, interests and power relations inherent in land systems, especially under conditions of less well functioning institutions and governance. Whether NCP's broader normative framework will enable fairer and more effective societal engagement in sustainable land management and biodiversity conservation has yet to be seen. However, we suggest that as the land system science community, including the Global Land Programme, embraces normativity, it could engage constructively with NCP to test its strengths and weaknesses in comparison with more conventional and ES frameworks. As part of this effort, land system science will be called on to reflect upon its normative stances and to move a step further into the transdisciplinary arena, where solutions to land conflicts and sustainability challenges are more pressing than ever. With NCP, land system science may better integrate the diversity of value systems of stakeholders and institutions into efforts to better understand and more fairly govern the increasingly wicked land systems of the Anthropocene.

Conflict of interest statement

Nothing declared.

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