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Essays and Perspectives

Valuations of nature and its contributions to people in South America's Southern Cone: taking stock and looking forward

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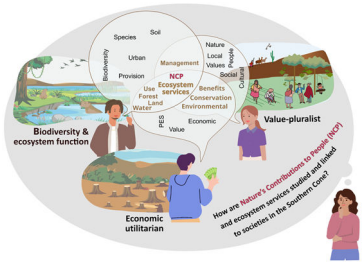
HIGHLIGHTS

- Since 2015, research on ecosystem services and nature's contributions to people has consolidated in the Southern Cone.
- Economic and sociocultural studies are well-established, but ecological perspectives still predominate.
- Most studies do not engage social actors or governance frameworks.
- Advancing plural valuations requires enhanced bridging, negotiation, social networking, and governance abilities.

GRAPHICAL ABSTRACT



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ABSTRACT

Sustainability sciences and policies are striving to achieve biodiversity conservation and social well-being. Academics and managers have developed concepts like ecosystem services (ES) and nature's contributions to people (NCP) to bridge disciplines and knowledge systems to more fully account for nature's multiple values in research and decisions. However, there is consensus on the need to enhance plural valuations of nature and their uptake in theory and practice. Consequently, we assessed the status and trends of ES/NCP research in South America's Southern Cone. Delimiting our geographic focus allowed better interpretation of findings for the science-society interface (e.g., social actors, public policies, funding, capacities). We found a critical mass of empirical studies since about 2015 with three epistemic communities coexisting. While 'economic utilitarian' and 'value-pluralist' perspectives have become well represented in the last decade, 'biodiversity and ecosystem function' studies continue to predominate. Coverage is heterogeneous; some ecoregions (e.g., Serra do Mar, Valdivian Rainforest) are more studied. Research has predominantly addressed Regulating ES/NCP, been conducted at local and regional scales, and employed field sampling of biophysical indicators. Furthermore, societal engagement is low, mostly based on social actors as study subjects. Likewise, we found weak insertion in governance frameworks, considering both the number of studies with an explicit policy-orientation and those funded or supported by governmental management agencies or public policy structures. Based on these trends, we reflect on existing and needed capacities to promote more plural approaches to conservation and development. There is a general gap in abilities to institutionalize science-society platforms, including enhancing negotiation, social networking, and practical management skills. By mapping these opportunities and challenges, we seek to open pathways forward for science and capacity-building that integrates biodiversity with just and sustainable development.

Introduction

The 'relational turn' in sustainability sciences (West et al., 2020) focused attention on how people not only live *from* nature (i.e., prioritizing it as a means to an end, or its instrumental value) or consider it important in and of itself (i.e., as a means unto itself, or its intrinsic value), but also relate to it in ways like living *in*, *with*, and *as* nature (i.e., highlighting it as a means for individual and social relationships, or its relational value) (Pascual et al., 2023). This paradigm shift is evidenced in environmental scholarship (Himes et al., 2024) and policies (e.g., Escazú Agreement on Environmental Information, Participation, and Justice in Latin America and the Caribbean (CEPAL, 2022); Kunming-Montreal Global Biodiversity Framework (KMGBF) (CBD, 2022)). Consequently, academics and managers now strive to develop more inclusive tools and strategies that overcome two major legacies: prioritizing monistic ecological approaches for conservation or economic strategies for development, and making decisions at the expense of local perspectives and needs (IPBES, 2022; Raymond et al., 2023).

Therefore, there is a need to (1) diagnose how nature is being conceived and addressed in research and policy; and (2) consider what capacities can better integrate it with society (IPBES, 2022). For example, the KMGBF Target 3 calls on countries to protect 30% of their lands and seas by 2030 (the so-called '30 × 30 target'), and explicitly requires that this ostensibly mainstream conservation goal must be achieved by incorporating Indigenous Peoples and local communities (IPs&LCs), recognizing their rights and territories, and integrating their worldviews, knowledge systems, and values (CBD, 2022). However, National Biodiversity Strategies & Action Plans (NBSAPs) have not fully reflected nature's multiple values (Murali et al., 2024), and efforts to approve a new plural-values monitoring program failed to achieve consensus at the CBD's 16th Conference of the Parties (COP16), despite advances in other areas of social engagement (Anderson, 2025).

For several decades, efforts have sought to value nature beyond ecology. In the 1980s, North American ecologists proposed 'ecosystem

services' (ES) as a metaphor to express in what they perceived as the economics-based language of decision-makers how ecosystem functions (e.g., decomposition, nutrient cycling, primary production) are at the basis of human physical and social continuity (Ehrlich and Mooney, 1983). Subsequently, ecological economics worked to operationalize ES, concentrating initially on economic valuations, but including vigorous debates around appropriate conceptual frameworks and methods (e.g., Costanza et al., 1997; TEEB, 2010). The Millennium Ecosystem Assessment (MA, 2005) globalized and politicized ES and focused on a broader conceptualization of well-being. In the 2010s, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) deepened these efforts and explicitly linked them to decision-making (Larigauderie and Mooney, 2010). Via IPBES' participatory processes to ensure academic rigor and political legitimacy, a wider range of disciplines and ways of knowing were engaged, including Indigenous and local knowledge (ILK), and produced a more inclusive conceptual framework (Díaz et al., 2015). The notion of 'nature's contributions to people' (NCP, Díaz et al., 2018) was proposed to cover all contributions, both positive and negative, of nature to the well-being of people as individuals, members of societies, or humankind as a whole, encompassing ES and analogous categories, but reframing the human-nature relationship beyond Western-centric or narrowly economic discourses.

In this process, Craig et al. (2019) identified 'neoclassical economic utilitarian' and 'value-pluralist' as two ES-related epistemic communities that highlight tensions between focusing on nature's instrumental values (measured with biophysical and monetary indicators) versus emphasizing its relational values (using sociocultural indicators) (Anderson et al., 2022). Arguably, ecological studies constitute a third school of thought; while the original ES metaphor clearly drew upon the authors' Western, capitalist milieu (Ehrlich and Mooney, 1983; Craig et al., 2019), these studies are embedded in the tradition of 'biodiversity and ecosystem function' (BEF) research that consolidated in the 1990s to spotlight how biodiversity matters to ecosystem structure and dynamics, particularly in light of biodiversity loss (e.g., Jones and Lawton, 1995). Ostensibly, BEF becomes biodiversity and ecosystem services by intention (e.g., to raise awareness of biodiversity's importance to society), more than methodology (i.e., still largely focused on biophysical processes).

Now, to be more effective and ethical, environmental research and policy are challenged to more reflexively navigate these deeper levels of value plurality (e.g., onto-epistemic heterogeneity, Hakkarainen et al., 2020). In response, the Nature's Contributions to Argentina (CONATURAR) Network, dedicated to integrating biodiversity with just and sustainable development, assessed the literature to determine: (1) temporal trends in ES/NCP studies; (2) the ways biodiversity and ES/NCP are conceived in these studies; and (3) the relationship of ES/NCP studies to society. While rooted in ecology, we expected to find a shift towards more plural approaches in response to global trends (Craig et al., 2019). We also predicted that studies would focus mostly on Regulating ES/NCP and ecosystems, rather than specific species or taxonomic groups. Furthermore, we anticipated that the link with society would be weak, mostly engaging social actors as research subjects and having little integration to governance (Balvanera et al., 2012; Castro-Díaz et al., 2022; IPBES, 2022). We delimited our search to the Southern Cone, encompassing all of continental Argentina, Chile, Paraguay, and Uruguay, and overlapping ecoregions with Bolivia and Brazil (Fig. S1), to ground interpretations in specific socio-political contexts. Finally, we reflected on the relevance of our findings for advancing more plural approaches to people-nature research and practice *vis-à-vis* the science-society interface (Box 1) and capacity-building (Box 2).

Review methodology

We used the Scopus database from 1970 to 2023 to determine status and trends in ES/NCP research (see Appendix I). Scopus provides detailed publication-level data (e.g., author affiliations, abstracts, funding sources) and, despite being weighted towards English, includes regional journals in Spanish and Portuguese. Applying the Preferred Reporting Items for Systematic Reviews (PRISMA; Page et al., 2021), we established criteria to identify, screen, determine eligibility, and include peer-reviewed documents (journals, books, chapters) in our analysis (Table S1, Fig. S2). Search terms were: "ecosystem service," "nature's contribution*" or "NCP" (n = 60,996 publications). We filtered for publications from Argentina, Bolivia, Brazil, Chile, Malvinas/Falklands, Paraguay, and Uruguay (n = 4,004) and screened these titles, abstracts, and keywords to determine geographic and conceptual eligibility.

We screened all studies from the Southern Cone, defined as all of Argentina, Chile, Paraguay, and Uruguay and the portions of Bolivia and Brazil with shared ecoregions, based on Olson et al. (2001) and Spalding et al. (2007) (n = 1,746). For Brazil, these pertained to the southern Atlantic Rainforest, encompassing Serra do Mar Coastal Forest, Araucaria Moist Forest, and Alto Paraná Atlantic Forest, and Uruguayan Savanna; for Bolivia, we included Central Andean Puna, Central Andean Dry Puna, Southern Andean Yungas, Bolivian Montane Dry Forest, and Dry Chaco (Fig. S1). Studies without a geographic location (reviews, perspectives, essays) were included if they made reference to the study area, and broad-scale studies had to have at least one data point from the delimited ecoregions.

Documents were coded as (1) unrelated (e.g., used NCP for topics like 'non-collagen proteins' or 'net community production'); (2) justification/framing (used ES/NCP only as the reason or context for the study); (3) relevance (only mentioning that the findings are relevant for ES/NCP); and (4) empirical (explicitly addressing ES/NCP). Only empirical studies were evaluated (n = 434). Screening team members were trained in online sessions that established protocol and criteria. Quality control was conducted by randomly checking 10% of the cases to detect systematic problems that could be addressed with the team. Finally, coordinators checked the final database for consistency. These publications were downloaded in PDF. The review was accompanied by online workshops and feedback sessions to consistently apply and resolve discrepancies.

Data collection and analysis

Data were coded as per Table S1, which describes each analytical variable, how it was categorized, the rationale for each criterion, and the relationship to research questions/hypotheses (Appendix I). First, the team classified publication-related attributes (year of publication, location of first author) and the study's geographic location (coordinates, ecoregion) and scale (Local, Regional, National, Cross-national, Continental, Cross-continental, Global; IPBES, 2022). Then, we assessed study operational parameters, including methodological approach (Conceptual, Experimental, Field sampling/case study, Modeling/mapping, Review; Ballari et al., 2020) and indicators measured/studied (Biophysical, Sociocultural, Monetary, Secondary social, Health, adapting IPBES, 2022).

Furthermore, we determined whether the main concept used in the study was ES or NCP. Then, the epistemic community to which the study pertained was classified, adapting Craig et al. (2019)'s 'neoclassical economic utilitarian' (focusing largely on nature's instrumental values and encompassing environmental and some ecological economics approaches) and 'value-pluralist' (recognizing nature's relational values and the context-specific conditions of how people perceive, relate to, and value nature) categories by adding 'biodiversity and ecosystem function' (BEF; arising from the ecology tradition that seeks to link biodiversity with ecosystem-level processes, expanded to benefits to society) (Anderson et al., 2022). We also considered to what aspect of nature the ES/NCP concept was applied (i.e., focused on Organisms, Ecosystems, Landscapes). Finally, we recorded the specific ES/NCP as studied in each publication and coded these based on the Material, Non-Material, and Regulating categories of Díaz et al. (2018). To

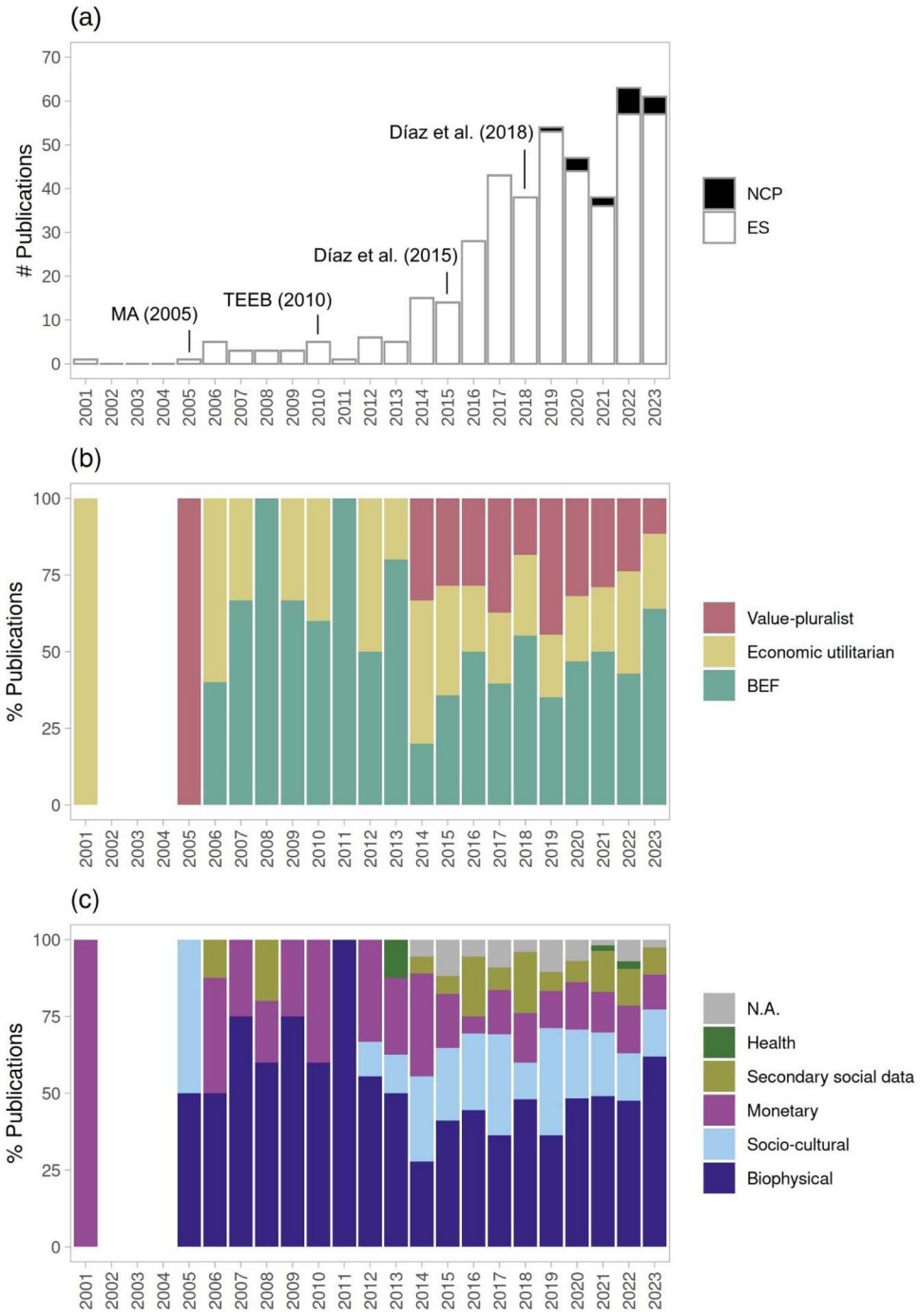

Fig. 1. Publications of empirical studies on ecosystem services (ES) and nature's contributions to people (NCP) in the Southern Cone of South America. (A) Temporal trends in the number of publications, highlighting the year of seminal works at a global scale and distinguishing a focus on ES or NCP. Years with no records had studies that mentioned ES/NCP merely to justify the work, but were not empirical treatments of the subject. (B) The proportion of literature per year that is based on three different epistemic communities, classified as biodiversity & ecosystem function (BEF), neoclassical economic utilitarian, and value-pluralist perspectives. (C) The proportion of literature per year using particular value indicators, distinguishing biophysical, sociocultural, monetary, secondary social data, and health measures. N.A. refers to studies that did not describe specific variables and instead were conceptual or literature reviews.

standardize data between ES/NCP typologies, water-related and supporting ES were classified here as Regulating. Cultural ES were classified as Non-Material and other Provisioning ES as Material.

To evaluate the relationship of studies to society, first we determined which social actors were identified. Adapting Tapella (2007), we distinguished three actor types based on their agency over and affectation by decisions: Primary (make decisions about ES/NCP and depend upon them), Secondary (influence decisions, but do not depend directly upon them), and Tertiary (do not make direct decisions, but rely upon ES/NCP) and defined people-nature relationships within these categories based on rationalities of utilitarian (Resource, Manager, Work-related) versus relational connections with nature (Lifestyle, Specialist, Place-based). Furthermore, we considered how social actors were involved along a gradient of No engagement, Study subjects, Recipients of information, Community science, Co-design/implementation (adapting Arnstein, 1969). We also considered governance, including the orientation of studies as Informative (basic research that mentions or justifies itself in the context of a policy), Applied (designed to apply in

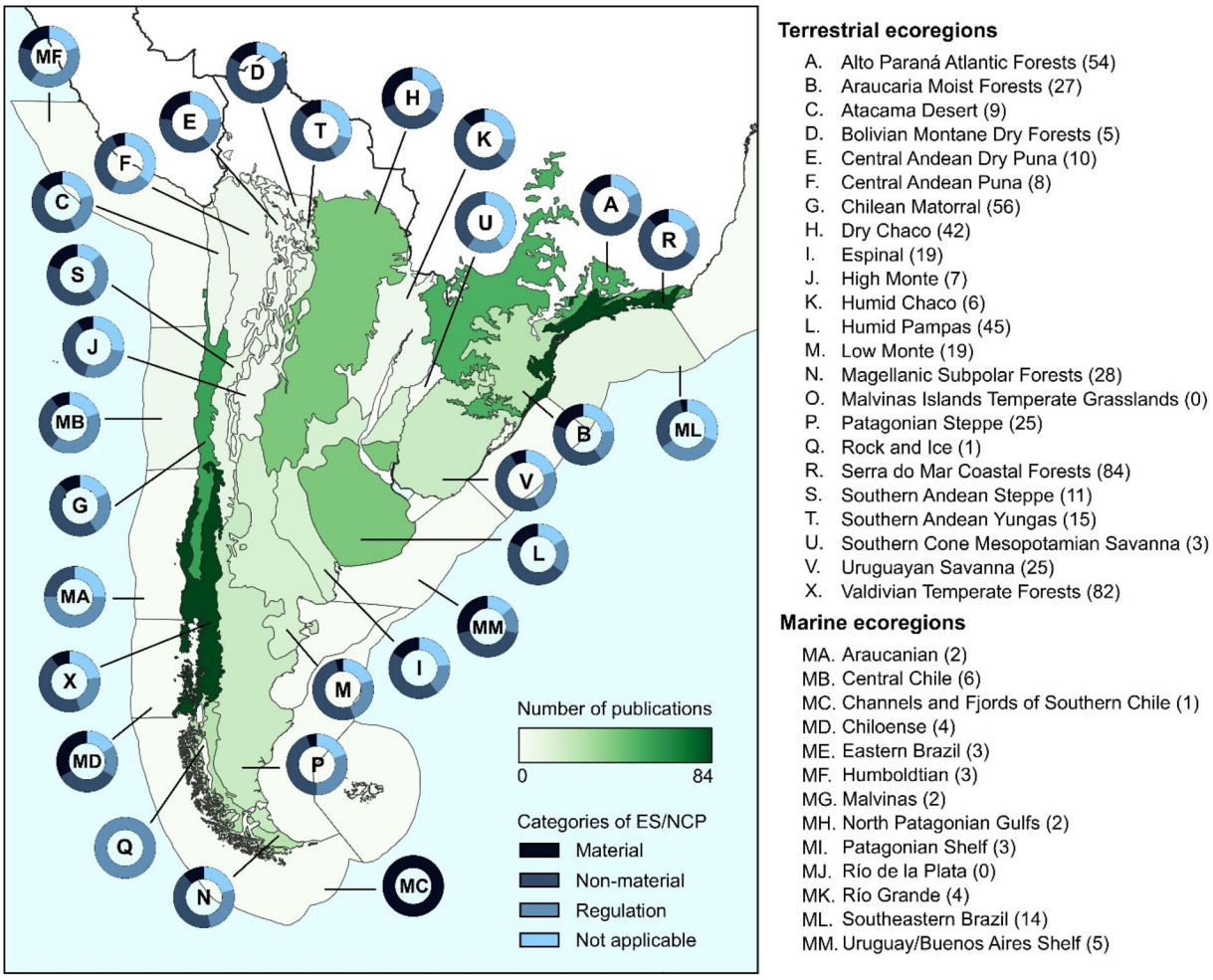

Fig. 2. Number of publications per ecoregion, as per Olson et al. (2001) and Spalding et al. (2007). Studies were also categorized by which broad categories of nature's contributions to people were being studied. Ecosystem services were adapted to the typology of Diaz et al. (2018). See also Appendix I.

real-world settings), and Policy-oriented (done with or as part of a regulatory framework) (adapting Zafra-Calvo et al., 2020). Finally, funding sources cited by publications were classified as Basic-academic (traditional scholarly funding sources), Applied-academic (targeted programs and NGOs); Applied-government (sources of support from management agencies), and Policy-specific (sources related to particular policies or laws).

We analyzed temporal trends in the number of publications using ES and NCP, and the relative contribution (%) of publications pertaining to the three epistemic communities and employing specific value indicators. Then, we determined the spatial distribution of publications, the focus on specific elements of nature, and social actor engagement. To further assess the relationships between these epistemic communities, we used the abstracts to create word clouds of the most frequent terms (Silge and Robinson, 2017) and conducted a lexical analysis of cosine similarity, a mathematical metric common to large language models that takes into account occurrence, frequency, and salience of terms, to measure the similarity between two vectors in a multi-dimensional space (Han et al., 2011), which in this case allows not only detecting shared terms, but their use in context or meaning (see details in Appendix I). All analyses were performed using R Software (v4.1.2; R Core Team, 2021).

Finally, we reflected on the implications of these findings in the context of capacities needed to navigate plural valuations of nature so that ES/NCP are not monistic lenses (Box 2), but rather suite of tools applied appropriately in specific contexts (IPBES, 2022; Kelemen et al., 2023). For this qualitative analysis, we returned to the database and searched for terms related to these capacities, including conflict, cost-benefit, deliberation, facilitation, motivation, participation, synergies, and trade-offs (see details in Appendix III).

Findings for the Southern Cone

Status and trends in ES/NCP studies

Despite international consolidation beginning in the late 1990s (e.g., Daily, 1997), we only found a critical mass of empirical ES/NCP research in the Southern Cone around 2015 (Fig. 1A). Furthermore, 75% of studies evoking these concepts since 2001 were mere mentions to frame/justify ecological studies or give broader relevance to findings (Fig. S1). Consolidation in the Southern Cone occurred after the publication of seminal work on monetary valuation at the planetary scale (e.g., Costanza et al., 1997; TEEB, 2010) and the first global effort to institutionalize ES and expanded the framing to a broader understanding of well-being (MA, 2005). This time lag highlights that there is not a seamless flow of ideas between the Global North and South (Anderson et al., 2015; Ballari et al., 2020).

As expected, NCP is a nascent concept since 2019, used mostly by value-pluralist studies. Unexpectedly, though, we did not observe a whole-scale shift in ES/NCP research (i.e., one epistemic community

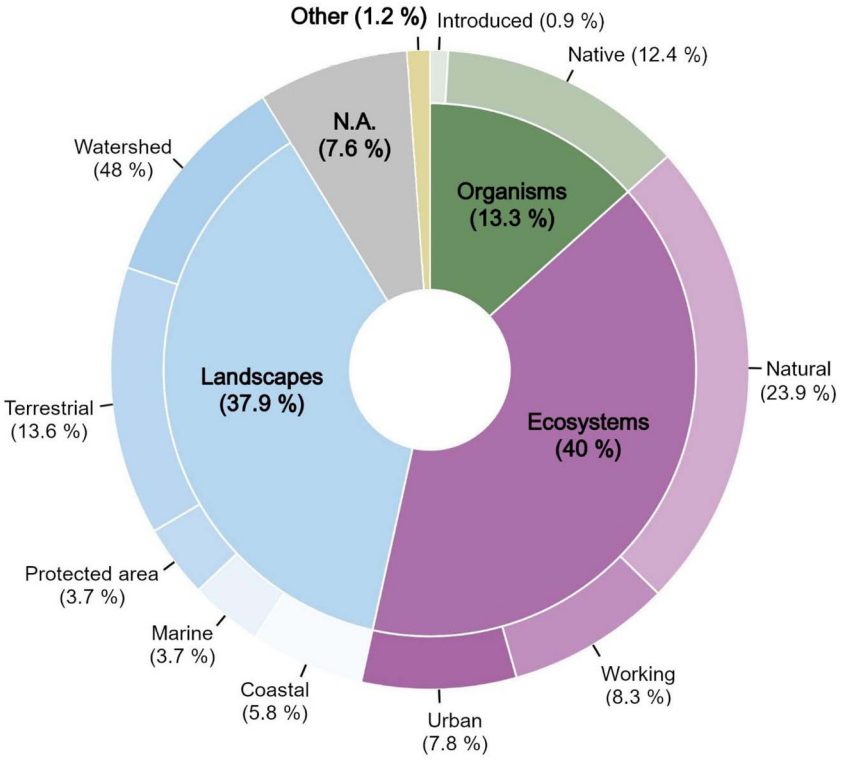

Fig. 3. The focus on specific elements of nature was classified as to whether ecosystem services and nature's contributions to people research in the Southern Cone was on the level of landscapes, ecosystems (or habitats), or organisms (i.e., species or taxonomic groups). The 'other' category encompassed studies about biogeochemistry and functional diversity, N.A. (not applicable) indicates studies that were conceptual and did not have a specific focus.

entirely replacing another). Instead of evolving from BEF to economic utilitarian to value-pluralist studies, our findings evidenced a coexistence of these epistemic communities, further supported by a lack of trends in value indicators (Fig. 1B, C). Overall, BEF research and biophysical indicators still predominate (48% and 61% of studies, respectively), aligning with global findings that 65% of nature-valuation studies focus on improving ecological status, compared to 31% on human well-being and 4% on justice (IPBES, 2022). While these communities clearly shared an emphasis on ES/NCP, they had largely divergent semantic spaces with only 10% cosine similarity, indicating even when employing the same terms, they were addressing largely different issues and contexts. This result further highlights the need to not only implement new or 'better' paradigms, but to develop mutual understandings and navigate between different epistemic communities and effectively apply approaches in appropriate contexts (Raymond et al., 2023).

While there was engagement in global and continental-scale research, we found these Southern Cone studies mostly occur at local and regional levels (45% and 39%, respectively, Fig. S3), which coincides with general trends (IPBES, 2022). Methodologically, they are largely based on field sampling and modeling/mapping (48% and 24%, respectively, Fig. S4). Furthermore, there does not appear to be a major influence of 'parachute science' by foreign scholars (*sensu* De Vos and Schwartz, 2022); 86% of publications were done by research teams whose first author's affiliation was in the study area (Fig. S4).

Ways in which nature and ES/NCP are conceived

Aligning with BEF, we see this research has been weighted towards Regulating ES/NCP (65%), compared to Material (27%) and Non-Material (28%) (*note: total is* >100%*, as one study can address multiple ES/NCP*). Distribution of research was not homogeneous; the most studied ecoregions were Serra do Mar (and other associated southern Atlantic rainforests), Valdivian Rainforests (and the adjacent Chilean Matorral), Humid Pampas, and Dry Chaco, while marine ecoregions and the northwestern Andes and Humid Chaco were relatively less studied (Fig. 2).

ES/NCP research has focused principally on ecosystems and landscapes (Fig. 3). Only 13% of studies explored relationships between ES/NCP and organisms, with <1% addressing invasive introduced species (see Table S2 for list of species/groups). Despite an emphasis on natural ecosystems (24% of all studies), human-dominated systems were well represented. Together, working and urban ecosystems and terrestrial, coastal, and marine landscapes (i.e., habitat mosaics that include agriculture, cities, fisheries, and other uses) made up 39% of studies. Within these productive systems, a substantial amount of literature looked at the direct driver of land use/land change (LULC), including how to improve ES/NCP in the context of agroforestry and restoration projects.

Relationship of ES/NCP studies to society

As expected, most ES/NCP studies (60%) took generalized ecological perspectives (i.e., were not based on particular social actors). Examples were found for actors within all categories, ranging from agribusiness

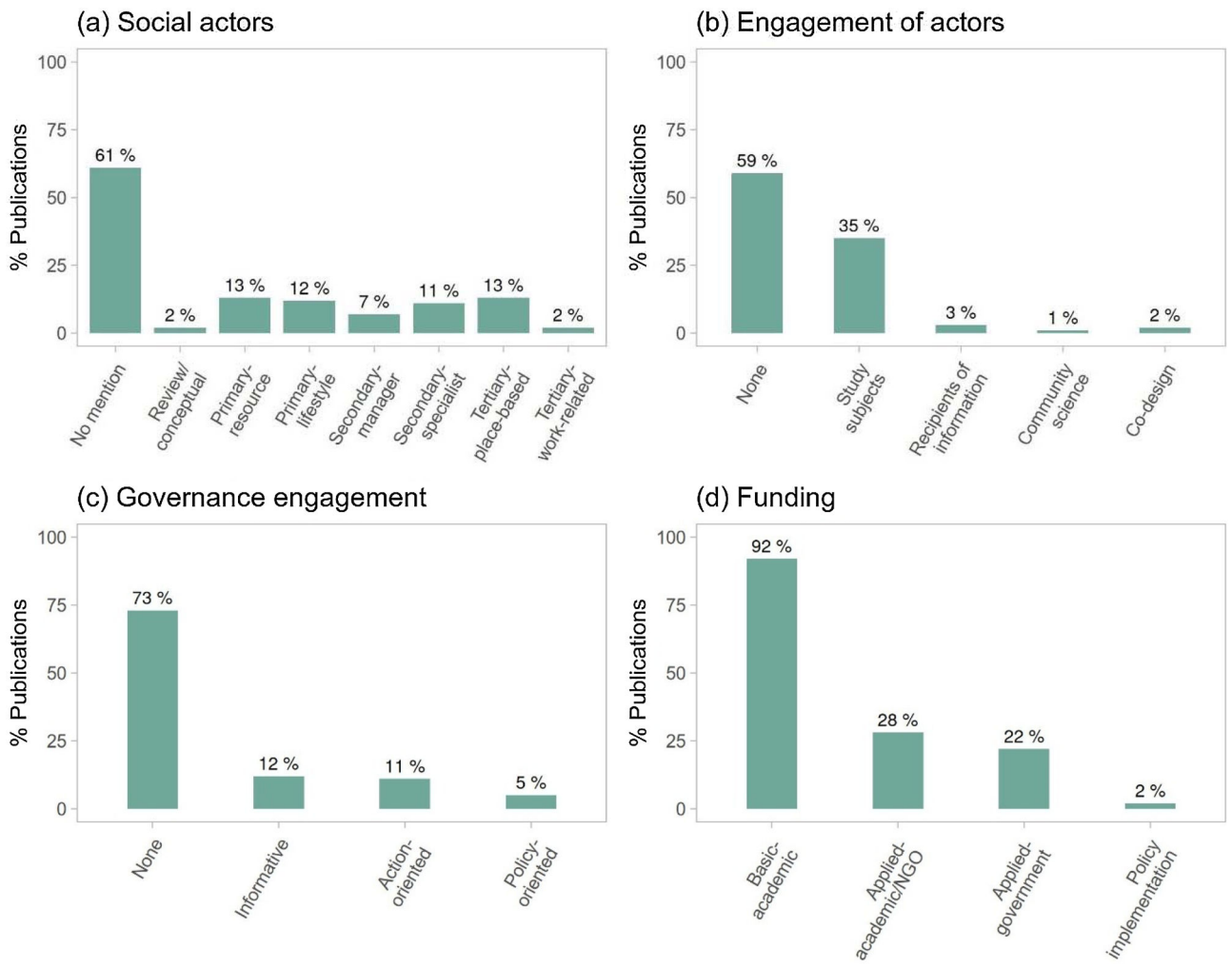

Fig. 4. The relationship of research on ecosystem services and nature's contributions to people in the Southern Cone was assessed considering the proportion of studies that addressed (A) social actors, distinguishing primary (make decisions about ES/NCP and depend upon them), secondary (influence decisions about ES/NCP, but do not depend directly upon them), and tertiary (do not make direct decisions about ES/NCP, but do rely upon them) and people-nature relationships within these categories based on different 'logics'; (B) the level of engagement of these actors along a gradient of participation; (C) a similar gradient regarding the level of engagement with governance frameworks, including regulations, laws, and public policies, and (D) the types of funding sources cited in the work. Totals for A and D can be greater than 100%, since one publication could have multiple actors or funding sources. Categories are described in detail in Appendix I.

and mining companies to peasants and soldiers (Table S3). Yet, there were no trends regarding which types were studied, and none was the subject of more than 13% of publications (Fig. 4A). Among the 30% of studies that addressed actors, individuals and social groups were treated mostly as study subjects (e.g., consulted through interviews and surveys). Only 2% involved co-design/implementation that allowed reciprocal interaction between researchers and communities, thereby giving greater voice and agency to people's own speech and behavior as primary data (e.g., Totino et al., 2023) (Fig. 4B). This finding agrees with a Latin America-wide review of explicitly participatory ES studies that demonstrated most only involved different forms of consultation with local communities without deeper involvement (Castro-Díaz et al., 2022).

Furthermore, engagement with public policies and regulations was low (~27% of publications). Overall, 12% of studies sought to be generally informative and mentioned particular public policies, while 11% were action-oriented (i.e., applicable to specific regulations with some detail or explicit reference to the importance and value and the need to apply them in governance contexts). Just 5% explicitly linked with a specific regulatory framework (Fig. 4C). Aligning with overall weak science-society linkages, this body of research has been mostly funded by basic (92% of those reporting funding cited traditional science agencies or universities) and applied (28% cited targeted funding programs or NGOs) sources. Less frequent were studies supported by governmental management agencies (22%) and specific public policy implementation frameworks (2%) (Fig. 4D) (*note: totals for panels A and B can be* >100% *because a single publication could have multiple social actors and funding sources*).

Despite the fact intellectual and political spaces are emerging in the region to contribute to the 'relational turn' in environmental and development policies (e.g., Escazú Agreement; Anderson, 2025; Gallegos-Riofrio et al., 2022), our assessment found little ES/NCP research directly embedded in these socio-political processes (Box 1). For example, we saw no systematic research programs geared towards

Box 1

Links between research and society.

Social and policy domains of science-society linkages are underrepresented in ES/NCP literature from the Southern Cone (Fig. 4) and globally (IPBES, 2022). This gap is not merely due to a lack of knowledge or funding, but rather how studies are conceived and designed. For example, identified policy-relevant research gaps included: assessing the actors and values affected by decisions, targeting those directly involved in decision-making (e.g., Fig. 4.A), or investigating how to create organizations that are legitimate and effective science-policy platforms. In the Southern Cone, only a few public policies are cited often, particularly Brazil's 1965 Forestry Law (#4,771) and its subsequent modifications, and Argentina's 2007 Native Forestry Law (#26.331) (Table S4). Yet, to date, regulatory structures have not produced studies with greater levels of societal engagement. For instance, none of this review's 10 studies co-designed with social actors were conducted in the context of specific ES/NCP policies. Such poor science-policy integration aligns with expectations regarding the region's overall segmented environmental governance institutions (Alonso Roldán et al., 2019) and with the difficulty of including multiple rationalities for more equitable management structures (Nahuelhual et al., 2018). Indeed, co-designed studies identified here were idiosyncratic, further supporting the need to institutionalize policy-relevant research. Formalizing these structures could apply a simple heuristic of evaluating how human-nature relationships are framed, considering living not just *from* nature, but also *with*, *in*, or *as* nature, to determine whether a greater plurality of perspectives is expressed in research and policies (Kenter and O'Conner, 2022). Furthermore, Southern Cone studies have not sufficiently addressed traditional governance systems, including fisher-managed bays, Indigenous territories, commons used by rural communities, or *quilombos* (an Afro-descendant legal territorial status in Brazil). One such case, as depicted here in the Puna ecoregion (photos by Y. Arzamendia and S. Enrietti, respectively), involves the study and traditional management of native camelids (Arzamendia et al., 2021). This project highlighted the importance of long-term continuity and institutional structures to expand epistemic perspectives and to incorporate diverse actors and associated worldviews in the design of research and governance, bridging local to international policy scales regarding the management and conservation of these species and their ES/NCP.

overcoming the barriers to contextualize global ideas and practices for specific socio-cultural and governance contexts (Anderson et al., 2015). Few studies explicitly considered policy implementation, such as the implications of replacing Brazil's 1965 Forest Code with a new law in 2012 on native vegetation, thus bringing about significant changes in the vegetation conserved or restored on rural properties. None of the identified policy-relevant studies incorporated participatory processes.

In this literature, we observed a coexistence of approaches, and the fact that we did not find a paradigm shift in a strict Kuhnian sense (i.e., one school of thought replacing another to become 'normal science') opens an opportunity to focus capacity-building towards navigating diverse values and valuations of nature. Fostering constructive engagement, rather than a single 'better' way, would be a more coherent embodiment of calls for plurality and reflexivity, but still requires new ways of organizing research, collaborative teams, science-society platforms, and professional training (Hakkarainen et al., 2020; Makinen-Rosedta et al., 2023; Metzger et al., 2024).

Going forward

Navigating towards greater plurality in sustainability sciences and practice will require increasing dialogue between approaches and traditions, rather than ossifying into disjunct knowledge silos. Instead of aiming for consensus or imposing new static recipes, we propose that researchers and practitioners should avail themselves to a toolbox of concepts and methods based on building six capacity domains that relate to abilities to (1) recognize and understand diverse values and (2) integrate and articulate them in institutions (Box 2).

The ability to **motivate** others to consider inclusive approaches to conservation and sustainability applies to a suite of social actors, ranging from researchers and authorities to urbanites and businesses. We found that Southern Cone ES/NCP research has studied human-dominated systems (e.g., cities, agricultural habitats) and addressed important direct drivers of change (e.g., LULC). Furthermore, while much effort has been devoted to quantifying negative outcomes of decisions (i.e., loss of ES/NCP due to LULC), there was also attention to positive LULC for restoration, particularly agroforestry. Furthermore, research has identified factors that influence landowner motivation to participate in payment for ES programs (PES), but only one study looked at the contextual reasons (e.g., program design) why farmers engage with rural extension initiatives (Schröter et al., 2015). Future work in this domain could enhance consideration of indirect drivers, like consumption patterns and governance systems, and non-economic motivations for pro-environmental behavior (Appendix III.A).

The **analytical** skills displayed in these studies were mostly related to field sampling and modeling/mapping (Fig. S3, Appendix III.B). There is existing capacity to provide knowledge based on spatially-explicit tools that quantify ecosystem dynamics (e.g., due to LULC). Plus, there are well-developed PES monetary valuation methods. Besides filling knowledge gaps for particular ecoregions, future work could seek to generate information from other worldview and knowledge systems, including greater IPs&LCs leadership in these processes, as current studies are weighted not only towards Western scientific knowledge, but also 'expert' opinions. This capacity is particularly lacking in terms of modeling/mapping, which had no examples of using ILK in the region.

Few studies mentioned the capacity to **bridge** between different knowledge systems or social actors. From the 23 publications identified (Appendix III.C), bridging concepts were generally mentioned as a need or future possibility to improve governance or reduce conflict. Only two studies explicitly used this capacity to increase success at incorporating plural values into decisions (e.g., via shared learning or assimilation of knowledge). Cost-benefit analysis, one potential bridging method, was only associated with economic valuations of PES. Similarly, multi-criteria decision-making methods were used infrequently (only five studies), but were more plural. They allowed the determination of what values are at stake in a decision, where they are (i.e., mapping), and how to guide decisions about ES/NCP. While we saw limited capacity to bridge between specific values, there were no explicit efforts to incorporate deeper value levels like worldviews and knowledge systems. Also, bridging is more than just an accounting exercise, and requires the ability to facilitate between actors which is lacking and in the future ES/NCP research would be well served by considering the need to build legitimacy and salience for diverse social actors, which goes beyond a traditional academic focus on rigor as the definition of quality knowledge (Turner et al., 2016).

Similarly, we expected to find low capacity to **negotiate and manage** competing interests. While terms like conflict, synergy, and trade-off were frequent in this literature, they were mostly about defining (i.e., analytical capacity) these issues, rather than resolving them (i.e., via deliberation, which only had three studies) (Appendix III.D). The extant literature, however, showed some attention to the topic of participation, though very few studies were actually co-designed (Fig. 4C). Furthermore, Latin American-wide reviews have shown little capacity of ES/NCP researchers to integrate across countries (i.e., evidenced through co-authorships, Castro-Díaz et al., 2022). However, Balvanera et al. (2020) highlighted the success of specific efforts to produce greater interactions (e.g., the CISEN network developed around Neotropical ES congresses). Overall, we found little evidence of meaningful social and political engagement, which is part of the broader ability to construct social **networks** (Box 1, Appendix III.E).

Finally, practical **governance** capacities were almost absent in this literature. Considering the 19 studies that evoked 'governance', they

Box 2
Capacities for plural valuation and management of nature.

The transformations required for more just and sustainable futures involve personal, collective, organizational, and systemic changes ranging from recognizing nature's multiple values, to integrating them into existing decision-making structures, to reforming institutions to account for plural values, and to aligning social norms with these principles (Pascual et al., 2023). Transformative change also depends on transversal knowledge and skills like the ability to create co-learning processes and to manage inequitable power dynamics (Kelemen et al., 2023). Specifically, more plural environmental research and policy can be attained by building upon six capacity domains (IPBES, 2022): (1) **Motivational capacity** involves attending the reasons individuals or social groups engage with conservation (e.g., factors influencing participation in payments for ecosystem services) and building awareness of particular problems (e.g., which direct and indirect drivers of socio ecological change are studied, IPBES, 2019). (2) **Analytical capacity** determines which types of knowledge are produced (e.g., expert, ILK) and is conditioned by which methodological tools and techniques are employed. (3) **Bridging capacity** links different ways of knowing/doing through procedures like multi-criteria decision-making or abilities like facilitation. (4) **Negotiating capacity** implies navigating trade-offs, synergies, and conflicts between NCP and social actors. (5) **Social networking capacity** encompasses the ability to learn, adapt, and act together. (6) **Governance capacity** refers to the suite of practical skills to administer processes or create institutions that embody inclusivity. The first three capacities relate broadly to recognizing and understanding diverse values and are based largely on research *per se*; the second three involve ensuring values are articulated in institutions, which entails engaging policy frameworks and funding contexts in which research is conducted (Kelemen et al., 2023). Reflecting on them in the context of advancing more plural approaches to ES/NCP research in the Southern Cone allows identifying existing strengths and emerging opportunities to fill gaps going forward as part of efforts to institutionalize science-society platforms.

covered a range of issues like sustainable development, territorial and coastal-marine planning, strategic environmental assessments, and watershed management, but did not address specific management practicalities (Appendix III.F). Recurring themes, though, included the need to overcome fragmented governance systems, the lack of cooperation between actors, the importance of collaborative approaches, and the need to integrate local knowledge for the transition to more sustainable and equitable environmental governance. Therefore, clearly, synergizing existing efforts (e.g., CISEN, CONATURAR) requires new institution-building capacities to bring ES/NCP science into policy and management. Globally, this body of research has been shown to focus on technical aspects of valuations, while practice has prioritized capacity-building on analytical tool-kits and awareness-raising (Allan et al., 2022). Yet, the science-society gaps identified here for the Southern Cone clearly warrant greater abilities to create meaningful participation and engagement via governance capacities involving co-learning processes and managing inequitable power dynamics (Kelemen et al., 2023). Including these perspectives, knowledge systems, and approaches in policy formulation requires new abilities to formalize inclusive structures; otherwise, social actor participation in decision-making is unviable.

Closing remarks

ES and NCP are concepts intended to help link nature and society (Raymond et al., 2023). Their current usage in the Southern Cone does not seamlessly track global trends. While there is a continued predominance of ecological perspectives, we found a coexistence of BEF, economic utilitarian, and value-pluralist approaches. The emergence of NCP in recent years is part of efforts to navigate the multiple values of nature (e.g., of the 16 NCP-focused papers identified, 13 were value-pluralist), which requires not just filling geographic, methodological, or knowledge gaps, but also strengthening inter- and transdisciplinary research (Metzger et al., 2024). It implies enhancing broader capacities to link science-society in meaningful engagement platforms that produce salient and legitimate information that can be taken up into decisions from individual to collective levels (Pascual et al., 2023). Latin America offers much to the world in this 'relational turn' to sustainability and inclusive conservation (e.g., Escobar, 2018; Gallegos-Riofrio et al., 2022). By being reflexive about our research and training programs, we can strengthen a knowledge dialogue from our own territories that benefits biodiversity conservation and just and sustainable development for Latin America and the world (Anderson et al., 2015).

CRediT authorship contribution statement

Conceptualization: CBA, DMT, YA, DC, SD, AEJV.
Data curation: CBA, DMT.
Formal analysis: CBA, DMT, JLB, IB, DAC, JCB, MC, CC, SD, LE, SH, PYH, JCO, ARR, LRP, VR, ESH, ESD, AT, ABV, YA, GG, JN, AEJV.
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Project administration: CBA, DMT, AEJV.
Resources: CBA, YA, DC, SD, JN, AEJV.
Supervision: CBA, DMT.
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Visualization: CBA, DMT, MC, PYH, VR, AT, LRP, SD.
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Appendix A. Supplementary data

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