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Whose values count? A review of the nature valuation studies with a focus on justice

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The Values Assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services shows that multiple valuation methods and approaches exist to assess diverse value types. The evidence is based on the largest review of academic valuation studies on nature to date, developed for the Values Assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). We evaluate studies according to environmental justice criteria. The results suggest that although diverse value types and indicators are assessed across studies, few individual studies are plural, and studies fail to provide evidence on distributive justice and score low on procedural justice indicators. We provide a set of recommendations for incorporating issues of justice in the design of valuation studies.

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Introduction

Recognising the diverse values of nature and nature's contributions to people (NCP) is considered a key leverage point for transformative change towards just and sustainable futures [14]. These diverse values underpin and shape policy objectives, actions and

interventions towards achieving goals related to nature and ecosystems [29]. Recognising value plurality requires that stakeholders who hold different values are considered and involved in valuation practices and decisions based on those values [50]. However, power imbalances may imply that some stakeholders and values are disregarded [30]. This can cause large disparities in benefit and burden distributions [3], and a lack of social acceptance and legitimacy [7], and ultimately lead to a lack of compliance, or even conflicts and policy failure [11,36].

The ability of valuation to contribute to transformative change hence depends on considering three standard dimensions of environmental justice: distributive, procedural and recognition justice [40]. Distributive justice concerns the fairness of the distribution of burdens or losses and benefits or gains, and relates to the outcomes of policies [22]. Procedural justice refers to fairness of the political processes in which natural resources, ecosystem services or NCP are distributed (ibid.), which is important both for democratic reasons and for the effectiveness of policies [8]. Finally, recognition justice considers plural values, grounded in the respect for ways of life, local knowledge and cultural differences [38], is important to develop integrative, contextualised and inclusive interventions. It requires that social structures that produce discrimination and disrespect are not reproduced in the valuation process and outcomes [20].

Incorporating ideas of environmental justice into valuation studies engages with the central question of 'whose values are assessed'. The answer depends on who is identified as a relevant stakeholder (community of justice) or affected party (distributive justice), who can meaningfully participate in decision-making (procedural justice) and whose and which values are included (recognition justice). Furthermore, the term 'value' has different meanings across cultural, academic and decision-making contexts. Sustainability, justice and prosperity are broad values influenced by worldviews [1]. Broad values in turn influence specific values (intrinsic, instrumental and relational) in given situations and contexts [33]. These considerations involve specific choices for the procedural design of a valuation study as well as the choice of valuation method(s) [44]. The Values Assessment (VA) of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) provides strong evidence that numerous valuation methods and approaches exist to assess diverse values of nature [44]. Wisely combining methods could capture the wide variety of values of diverse stakeholders. However, in practice, achieving justice in valuation is challenging because of the political context in which valuation studies are conducted, and practical limitations [21,27]. This systematic literature review focuses on the extent to which valuation studies meet

environmental justice objectives in their design and implementation.

As the largest review to date of the academic valuation literature on nature, NCP and ecosystem services, we use a set of criteria developed in the IPBES VA database to assess valuation studies along distributive, procedural and recognition justice dimensions. Based on the review, we recommend approaches to better address justice in valuation studies.

Review

Evaluation criteria

We developed a set of evaluation criteria (see [Appendix A](#) for full details) to assess the community of justice considered in studies, and to what extent empirical valuation studies have built distributive, procedural and recognition justice aspects into their design and execution [39].

Community of justice

Underlying the question of whose values count in valuation studies is the consideration of the *community of justice*, that is, which entities (human or otherwise) are considered entitled to moral consideration and therefore relevant for the application, deserving to be treated justly and their values included [40,48]. This can involve (subgroups of) the current human population, but also be expanded to include future or past generations (for intragenerational equity), as well as animals, non-human beings or mother earth. For example, the 'living with nature' life frame links conservation of biodiversity with interspecies justice [1].

Distributive justice

We evaluated whether studies provided insight into the distribution of outcomes as a societal goal that the study informs, where this distribution is assessed in terms of *intragenerational* justice, that is, the distribution of nature-related gains and losses within one generation, and *intergenerational* justice, that is, the distribution across generations. We recorded how distributive justice was assessed, for example, through disaggregation (across generations, stakeholder groups, locations or other sociodemographic dimensions), inequality indices or perceptions of distributive justice and needs of future generations.

Procedural justice

To assess the procedural justice of valuation studies, we considered (a) representation related to who is involved in the valuation study and whether the sample is either statistically or politically representative [13], (b) inclusiveness of the valuation procedures in the extent to which participants are enabled to get involved through adapting the procedures to the capacities of the

participants, (c) participation level and the extent to which involvement is meaningful and allows participants to influence the procedures and outcomes [46], (d) addressing power imbalances to foster participatory parity [6] and (e) transparency of the process [6].

Recognition justice

To assess the extent to which valuation studies were *inclusive* [20,37], we evaluated whether studies included different types of knowledge, such as scientific, lay people's or policy-makers' knowledge. The extent to which *broad values* [1,17], defined as the underlying perspectives, worldviews and life value frames that underpin values, were identified was evaluated by considering whether the applications explicitly mentioned concepts such as reciprocity, enjoyment, tradition or prosperity associated with the four different *life value frames* by O'Connor and Kenter [26].

Following the IPBES conceptual framework [12] and the IPBES Europe and Central Asia assessment [16], we evaluated whether the studies assessed different valuation *targets*. These 32 targets relate to three main dimensions: (a) values directly linked to nature itself (including biodiversity and ecosystem structure and processes); (b) values derived from NCP (regulating, material and non-material); and (c) values linked to good quality of life (e.g. cultural, societal and individual well-being values). These targets can be grouped into value foci (see Appendix A). We reviewed applications for their assessment of *use and non-use* values following the Total Economic Value (TEV) classification [45]. For the classification by Díaz et al. [12], we recorded whether studies valued *intrinsic, instrumental or relational values*. We include both these value frameworks as we do not want to exclude or prioritise any particular value definition or introduce bias towards any classification.

We acknowledge that some of the criteria are inter-related or dependent, such as the community of justice and distributive equity, and the community of justice and who is being represented in the study, and therefore refrain from aggregating overall 'scores' of studies over the justice domains.

Data

The data are drawn from a systematic review, developed for the IPBES VA. The dataset represents the most extensive review of academic, peer-reviewed papers written in English and reporting on global valuation studies. Details of the method can be found in Appendix B. Our results are based on an analysis of 1163 studies

that presented empirical valuation evidence. The sampled studies covered different valuation methods from various disciplines, which use monetary, biophysical and sociocultural indicators to assess values (see Appendix C).

Results

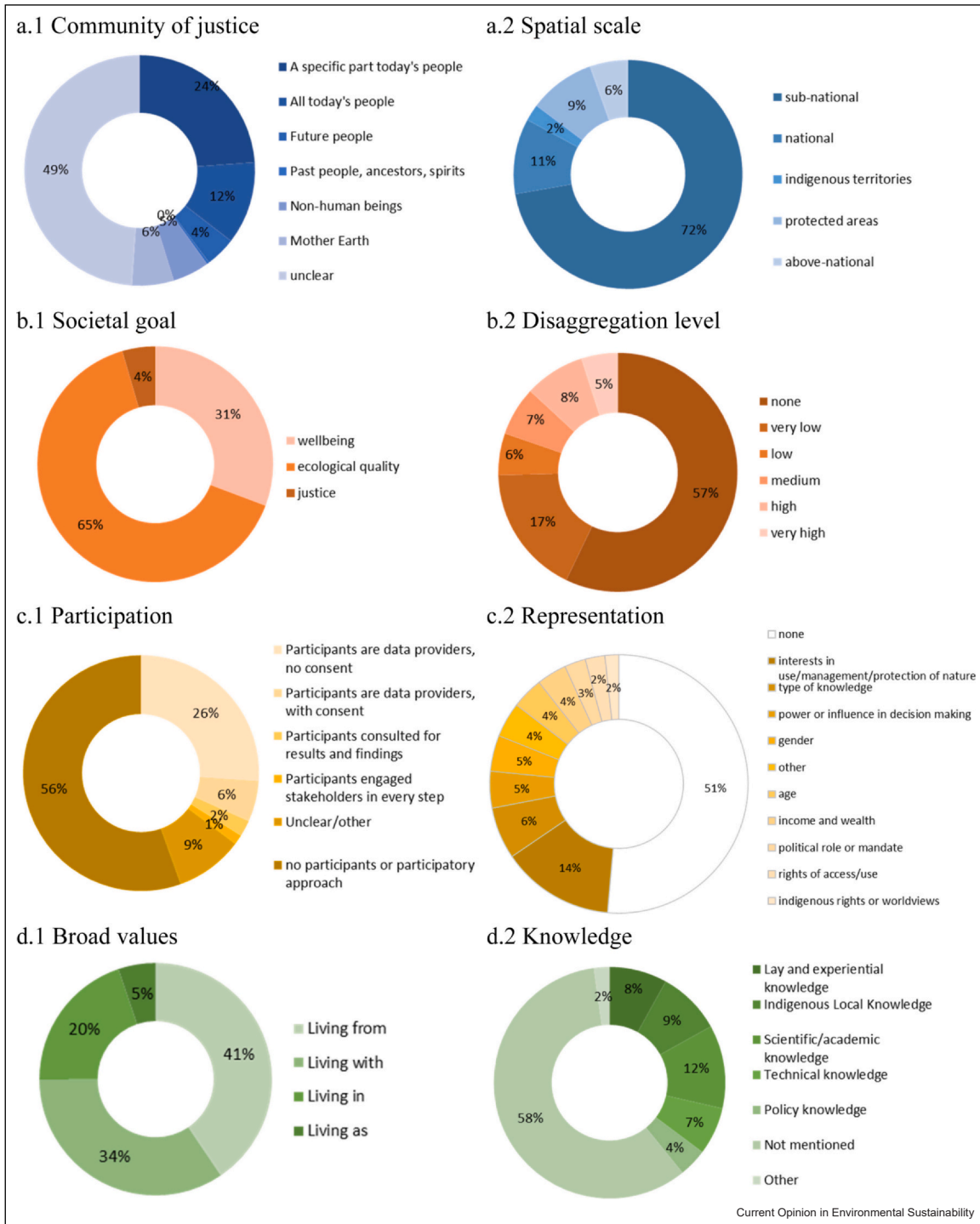
Community of justice

We find that most studies ignore a large part of the affected entities, and focus on a very small community of justice. In half of the reviewed studies, the community of justice is not identified explicitly in the papers, that is, it is not clear which human or other entity is considered entitled to moral consideration (Figure 1.a.1). The community of justice is rarely extended beyond humans, or beyond current generations by looking at the values of past or future generations, ancestors or spirits. This narrow focus in time also applies to the spatial (administrative) scale; most studies assess sub-national values (Figure 1.a.2) even though it is well-known that consequences of ecosystem changes may reach out far in time and space [5]. The literature is also biased towards high-income countries: 45% of the applications in the studies were conducted in high, 11% in low, 19% in lower middle and 26% in upper-middle-income countries — this distribution suggests that the overall literature pays insufficient attention to cross-border impacts of environmental change, and also underrepresents the values and knowledge systems of entire nations.

Distributive justice

Our results suggest that evidence for the consideration of distributive justice in the valuation literature is very scarce. Studies rarely explicitly focus on informing how justice as a primary societal objective is achieved (Figure 1.b.1). Studies assessing distributive outcomes primarily look at intragenerational justice by showing how values differ across stakeholder groups or space. Among the studies that assess human well-being, less than half analyse whether these values differ across stakeholder groups or by sociodemographic factors (gender, age, income and education) (Figure 1.b.2). It should be noted that our results provide no immediate evidence that those people or groups whose values are least often assessed in the literature are also those who bear the net losses of mismanagement; net losers cannot be reliably identified due to study design differences, missing baselines and incomparable disaggregation approaches (Figure 1.b.2).

Figure 1



Results of review on a subset of criteria for community of justice (a.1 and a.2), distributive justice (b.1 and b.2), procedural justice (c.1 and c.2) and recognition justice (d.1 and d.2). **(a.1):** 24% of the studies considers specific subgroups of the current human population, 12% for the current generation of people globally, 4% for future generations, 5% for non-human entities, <1% assessed past generations' values and 6% for mother earth. **(a.2):** 72% of studies assess values in administrative areas at a sub-national scale; only 2% of studies take indigenous territories as their study area. **(b.1):** About 4% of the studies focus on achieving distributive justice as a primary societal objective for the valuation study. **(b.2):** 57% of the studies that assess human well-being do not disaggregate by stakeholder group or sociodemographic characteristics, whereas 5% (very high) analyses well-being along income, age, gender, education and stakeholder groups. **(c.1):** 26% of studies did not ask for consent and only used participants as data providers; 6% only asked for consent; 2% shared findings; 1% involved participants throughout the valuation process. **(c.2):** 51%

of studies did not involve human participants; 14% identified and targeted different social groups in terms of interests (14%), type of knowledge (6%), power (5%), gender (5%) or age (4%). **(d.1):** 'living from nature' is the perspective reflected in 41% of studies, followed by the 'living with' (34%), 'living in' (20%), and 'living as' (5%) perspectives. **(d.2):** 8% of studies included values held by the general public (lay/experiential knowledge); the majority (58%) do not mention the type of knowledge included in the valuation.

Procedural justice

The evaluation of procedural justice criteria suggests that, even though participatory and transdisciplinary research are on the rise, many studies do not actively involve human participants or take a participatory approach in the valuation process, such as studies that focus on the value of non-human aspects of ecosystems to assess individual organisms, biodiversity or biophysical processes (Figure 1.c.1). Noticeable is the lack of reporting on consent — in about a quarter of the studies with human participants, the participants were mere data providers. It also remains unclear how studies try to safeguard the inclusiveness of the valuation procedures; 88% of studies did not report on this, and approaches used are the bare minimum to collect data, such as using local languages (6%) and to adapting the communication media and channels (3%). In terms of transparency, most of the reviewed studies provide a general (49%) or detailed (41%) process description. However, only 3% of the studies share the data collection protocols and methods with their participants.

In general, participants rarely meaningfully participate and influence the valuation process or receive information about the findings of the valuation. The power imbalances in such participatory processes are hardly ever attended to: less than 1% of the studies mention that power asymmetries were present, and even fewer addressed these in the valuation process. This implies that the quality of the participatory processes in participatory studies cannot be evaluated.

Regarding representation, about half of the studies identify and target different social groups (Figure 1.c.2), based on either socio-economic characteristics or political role. Another half does not involve human participants at any stage of the valuation process, but uses other data such as documents or biophysical measurements. Only 19% of studies explicitly evaluate the representativeness of their participants. Of these, 10% provide information on the political representation, that is, of different stakeholder groups, whereas 7% evaluate the statistical representation of the sample, that is, in comparison with the total population of the study area.

Recognition justice

The valuation literature of the last decade is also still dominated by studies that focus on use and instrumental

values, failing to recognise other ways of valuing and relating to nature. With respect to the assessment of broad values, 'living from nature' is the most commonly included perspective (41% of studies) (Figure 1.d.1), which is also reflected in the results for the different value classifications. Instrumental values of nature for human well-being are most frequently assessed (74% of valuation applications reviewed), compared with intrinsic values of nature (20%) and relational values (6%). This corresponds to findings for the TEV framework, where use values (direct in 47%, indirect in 25% of studies) dominate, followed by existence values (20%), whereas option (5%), altruistic (2%) and bequest values (1%) are rare.

Many studies (59%) fail to mention and recognise different types of knowledge, and another 12% are based only on scientific or academic expertise (Figure 1.d.2). This extends to guiding principles in many Indigenous Peoples' ways of life rooted in traditions of and notions of kinship, reciprocity, care and respect towards nature [15,25]. Indigenous People and Local Community (IPLC) knowledge systems and values are rarely recognised as legitimate, and also not adequately represented by non-indigenous valuation methods [23,48]. Only 9% of studies mentioned indigenous knowledge — and only 2% of studies were conducted in indigenous peoples' territories.

Across the studies reviewed, a wide range of value targets have been assessed, but — with the exception of some applications — individual studies tend to value single-value foci. Overall, the number of studies that addressed the different valuation targets (grouped into the dimensions of nature, NCP or quality of life) was comparable. In total, 78% of the studies in our database include fewer than five out of the 32 targets, and another 18% valued between six and 10 targets (18%).

Conclusions and recommendations

Our results show that valuation studies largely fail to address multiple environmental justice criteria. This practice likely limits its influence on justice considerations in policy instrument design [4,49,9]. If environmental valuation is to contribute not only to sustainable, but also to just futures, important transformations are needed in the way valuation is undertaken.

Increasing attention to environmental justice in valuation of nature, biodiversity and NCP will require an overhaul in the processes and focus of valuation studies, including a reallocation of efforts and resources, recognising that practical limitations can affect the quality of valuation studies. For participatory and transdisciplinary approaches, valuation practitioners will need to adopt new skills in managing and dealing with power relationships during the process of valuation, and study-commissioning bodies will need to adopt new, more inclusive approaches to decision-making. It also requires academia to embrace the complexity of inter- and transdisciplinary research and integrate social sciences into global change research [24]. Here, we provide recommendations for reducing injustices in valuation practice across justice's dimensions (see also Ref. [18]).

Community of justice

A first step in improving valuation efforts would be for every study to be explicit about whose values are targeted in the study (i.e. who is their community of justice?). This would entail applying interdisciplinary, social-ecological approaches [28,35] consisting of iterative stakeholder analyses to understand the diversity of actors involved, vulnerable groups, affected and affecting groups and differentiated powers to influence the outcomes [34]. To avoid reinforcing existing inequalities, the focus should go beyond distributive justice to ensure that procedural and recognition justice are upheld [20]. Distant and non-directly affected stakeholder groups, particularly in the Global South, should also be considered [31].

Distributive justice

Presenting and discussing inequities in the distributions of outcomes of different management options in valuation studies should be a priority, as this may enable decision-makers to design more equitable strategies, choose fairer interventions or implement compensation strategies. Approaches exist to show disaggregated results for the full community of justice of the study [10,47] or using various discount rates. Most are relatively simple and practical to implement, and — when adopted — would increase the visibility of inequitable

outcomes. Making intergenerational distributive justice perspectives a required part of a valuation study would contribute to sustainability and justice [32], for example, by asking participants explicitly to consider the needs or rights of future generations, and evaluate the future impacts of their decisions.

Procedural justice

To increase the transformational power of valuation, a minimum requirement should be to strengthen transparency by more meaningful engagement of stakeholders in developing methodological protocols, generating the data and interpreting the results ([43] this SI). As such, valuation practitioners and commissioning bodies should promote transdisciplinary approaches [19] where stakeholders can have active roles in valuation. Reporting back the findings to participants (or making provisions for these feedbacks both in the project budgeting and timing) should be common practice. Adhering to minimum ethical guidelines (e.g. Free Prior and Informed Consent) is a low-hanging fruit, but more important is the use and evaluation of the implementation of best-practice guidelines for transdisciplinary approaches.

Recognition

The presence of plural values requires that practitioners involve multiple stakeholders holding different values, and embody multiple epistemologies and methods [2]. It is essential to consider adding methods to move from 'living from' worldviews towards assessing relational values and value frames of 'living in' and 'living as', associated with care, belonging, respect and reciprocity — where relevant in context. Such values are particularly entrenched in the values and knowledge of IPLC, and require IPLC approaches.

Data Availability

All data on which this perspective is based are available in the IPBES methodological assessment on diverse values and valuation of nature.

Declaration of Competing Interest

None.

Appendix A – evaluation criteria

| | |
|--|---|
| Distributive justice | |
| The application | <ul style="list-style-type: none"> • Does not mention intragenerational justice-related aspects • Mentions but does not assess intragenerational justice-related aspects • Provides information or assesses intragenerational justice-related aspects • Unclear |
| The application | <ul style="list-style-type: none"> • Does not mention intergenerational justice-related aspects • Mentions but does not assess intergenerational justice-related aspects • Provides information or assesses intergenerational justice-related aspects • Unclear |
| Procedural justice | |
| The application deals with representation of different stakeholders and minorities | <ul style="list-style-type: none"> • Does not reflect on representation of the application of the method in its case study in results or discussion • Discussing and reflecting on who was included • Presenting results and data on representation (by showing no. of individuals and diversity of stakeholder groups, disparities etc.) • Unclear |
| The application included | <ul style="list-style-type: none"> • Diverse stakeholders groups (e.g. sectors, governance) • Binary gender (women, men) • Broader gender (women, men, LGBTQ +x) • Age class • Income/property class • IP and LC • Other minorities (e.g. disabled people) |
| Inclusiveness of participation: the application considers inclusiveness | <ul style="list-style-type: none"> • No features to ensure inclusive participation of different stakeholders • Allowing inclusive participation by accommodating the needs of different participants, for example, through the type of communication (verbal/written/visuals/otherwise, (extra) time, place, costs (compensation), child care, language(s) used, group composition and size) • Unclear/not mentioned |
| The study reports about participation level | <ul style="list-style-type: none"> • Does not reflect on participation level of the application of the method in its case study in results or discussion • Discussing participation level, for example, by reflecting on how different people, stakeholders and minorities participated, whether everybody was able to participate • Presents results and data on participation level |
| W.r.t. meaningful participation, the application | <ul style="list-style-type: none"> • Did not take a participatory approach • Only informed participants • Consulted participants as 'passive' data providers, without clear consent procedures • Consulted participants as 'passive' data providers, with clear consent (PFIC, GDPR) • Consulted and discussed results and findings with participants • Engaged stakeholders in every step, including question framing, method selection, results and conclusions and reporting • Other • Unclear |
| Power: the application | <ul style="list-style-type: none"> • Does not reflect on power dynamics of the application of the method in their case study in results or discussion • Discussing on power dynamics, for example, by reflecting on whether everybody was able to participate, and the existing power dynamics in the process • Presents results and data on power dynamics (by, e.g. showing speaking time, interruptions, use of physical space,..) |
| The application is transparent about the valuation process | <ul style="list-style-type: none"> • No info provided • General description on the process provided • Detailed descriptions provided in paper or supplements • Method's instruments (e.g. protocols and data collection material such as questionnaires) are shared with the general public and study participants in a way suitable for those groups and in line with ethics regulations • Method's proceedings documentation (e.g. notes about meetings, discussions, decisions and appeals) is shared with general public, stakeholders and study participants in a way suitable for those groups and in line with ethics regulations • Other • Unclear |
| Recognition justice | |

| <i>(continued)</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|--------------|-------------|----------------------|----------------------|-------------------------|-------------------------|-----------------------|-----------------------|--------------|--------------|------------------------|-----------------|----------------------------------|----------------|---|----------------|---------------------------|----------------|-----------------------|----------------|-----------------------------------|----------------|--|----------------|--|----------------|--|----------------|--|----------------|---|----------------|--|
| Recognition of broad values: presence of (diverse) life value frame-related terminology | <p>Presence list checkboxes:</p> <p>living from nature:</p> <ul style="list-style-type: none"> • Livelihood security • Human welfare and prosperity • Happiness • Responsibility (as sustainable use) • Intragenerational and intergenerational justice <p>Living with nature:</p> <ul style="list-style-type: none"> • Responsibility as respectful cohabitation • Coexistence • Care (supporting regeneration, reducing harm) • Protecting the environment • Stewardship • Rights of nature • Inter- and multispecies justice <p>Living in nature:</p> <ul style="list-style-type: none"> • Tradition • Enjoyment • Beauty and aesthetic experience • Inspiration • Health • Care (as maintenance, supporting regeneration and healing) • Awe • Belonging and rootedness • Bio-cultural diversity <p>Living as nature:</p> <ul style="list-style-type: none"> • Care • Reciprocity • Harmony with nature • Reciprocal responsibilities • Livelihood sovereignty • Spiritual sovereignty • Recognition justice • Respect • Responsibility and care for the land • Kinship and interpenetration with non-human persons • Self-determination | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| The application is explicitly based on the following type of knowledge: | <ul style="list-style-type: none"> • Lay and experiential knowledge, held by consumers, citizens and general public • Indigenous local knowledge, held by Indigenous Peoples or like-minded community members or representatives • Scientific knowledge or academic expertise, held by academics or researchers • Technical knowledge, held by people in relevant professions (excl. academics) • Policy knowledge, held by policymakers, (excl. academics) • Other, namely... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| The application assesses the following 'targets of valuation' | <p>Matrix checkboxes:</p> <p>Line 1: 'mentioned but not analysed' Line 2: 'explicitly analysed'</p> <table border="0"> <tr> <td>Value target</td> <td>Value focus</td> </tr> <tr> <td>Individual organisms</td> <td>Individual organisms</td> </tr> <tr> <td>Biophysical assemblages</td> <td>Biophysical assemblages</td> </tr> <tr> <td>Biophysical processes</td> <td>Biophysical processes</td> </tr> <tr> <td>Biodiversity</td> <td>Biodiversity</td> </tr> <tr> <td>Maintenance of options</td> <td>Options for NCP</td> </tr> <tr> <td>Habitat creation and maintenance</td> <td>Regulating NCP</td> </tr> <tr> <td>Pollination and dispersal of seeds and other propagules</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of air quality</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of climate</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of ocean acidification</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of freshwater quantity, flow and timing</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of freshwater and coastal water quality</td> <td>Regulating NCP</td> </tr> <tr> <td>Formation, protection and decontamination of soils and sediments</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of hazards and extreme events</td> <td>Regulating NCP</td> </tr> <tr> <td>Regulation of organisms detrimental to humans</td> <td>Regulating NCP</td> </tr> </table> | Value target | Value focus | Individual organisms | Individual organisms | Biophysical assemblages | Biophysical assemblages | Biophysical processes | Biophysical processes | Biodiversity | Biodiversity | Maintenance of options | Options for NCP | Habitat creation and maintenance | Regulating NCP | Pollination and dispersal of seeds and other propagules | Regulating NCP | Regulation of air quality | Regulating NCP | Regulation of climate | Regulating NCP | Regulation of ocean acidification | Regulating NCP | Regulation of freshwater quantity, flow and timing | Regulating NCP | Regulation of freshwater and coastal water quality | Regulating NCP | Formation, protection and decontamination of soils and sediments | Regulating NCP | Regulation of hazards and extreme events | Regulating NCP | Regulation of organisms detrimental to humans | Regulating NCP | |
| Value target | Value focus | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Individual organisms | Individual organisms | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biophysical assemblages | Biophysical assemblages | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biophysical processes | Biophysical processes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biodiversity | Biodiversity | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maintenance of options | Options for NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat creation and maintenance | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pollination and dispersal of seeds and other propagules | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of air quality | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of climate | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of ocean acidification | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of freshwater quantity, flow and timing | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of freshwater and coastal water quality | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Formation, protection and decontamination of soils and sediments | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of hazards and extreme events | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regulation of organisms detrimental to humans | Regulating NCP | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

(continued)

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|---|---|---|
| | <p>Energy Food and feed Materials Medicinal, biochemical and genetic resources Learning and inspiration Physical and psychological experiences Supporting identities Living well in harmony with nature Identity and autonomy Spirituality and religions Art and cultural heritage Sustainability and resilience Diversity and options Governance and justice Health and well-being Education and knowledge Good social relations Security and livelihoods</p> | <p>Material NCP Material NCP Material NCP Material NCP Non-material NCP Non-material NCP Non-material NCP Cultural Cultural Cultural Cultural Societal Societal Societal Societal Individual Individual Individual Individual</p> |
| <p>The application assesses the following ‘types of economic values’:</p> | <p>Matrix checkboxes: Line 1: ‘mentioned but not analysed’ Line 2: ‘explicitly analysed’ Columns:</p> | |
| | <ul style="list-style-type: none"> • Use values: direct use: consumptive (e.g. crops, livestock and aquaculture — provisioning ES) • Use values: direct use: non-consumptive (e.g. recreation, spiritual/cultural well-being and education — cultural ES) • Use values: indirect use (e.g. pest control, pollination and soil fertility — often regulating ES) • Option values (future use of known and unknown benefits) • Non-use values: philanthropic: bequest value (e.g. satisfaction of knowing future generation’s benefits) • Non-use values: philanthropic: altruistic value (e.g. satisfaction of knowing other people’s benefits) • Non-use values: biodiversity: existence value (e.g. satisfaction of knowing that species/ ecosystem exists) | |
| <p>The application has the following ‘justification of valuation’</p> | <ul style="list-style-type: none"> • Emphasis on instrumental values (monetary and non-monetary), also reference to life-support values (fundamental relational values) of processes that support human existence and prosperity as well as to some eudaimonic relational values (sustaining environmental resources that contribute to happy and prosperous human lives) • Emphasis on intrinsic values (inherent worth, dignity of nonhuman beings as well as non-instrumental values), life-support values (fundamental-relational) of processes that support the existence and flourishing of nonhuman beings and some eudaimonic relational values (sustaining a good because of a virtuous and fulfilled human life) • Emphasis on eudaimonic (sustaining a good because meaningful, aesthetic and non-alienated human life) and constitutive relational values (essential components of human identity, practices and cultural meanings)^a • Emphasis on constitutive relational values (relations that constitute who people and communities of human and nonhuman beings are), intrinsic values from a non-dualistic perspective (e.g. as related to the agency of all life) and eudaimonic values (sustaining nature because of an interdependent life)^a | |
| <p>Based on the above verifiers, who are the subjects of the Community of justice: the application takes into account distribution, inclusion, representation and recognition (multiple possible)</p> | <ul style="list-style-type: none"> • A specific part of the current people • All current people • Future people • Past people, ancestors • Non-human beings • Mother earth • The study does not look at justice towards anything or anyone | |

^aIn the review, the two different types of relational values were merged as the papers did not allow for a clear identification of either of the types.

Appendix B – selection of reviewed papers

To begin with, published nature valuation studies were identified through searches in Web of Science (see [41] for the method). The abundance of valuation studies over global regions and through time resulted in a georeferenced database of 48 329 publications. From this database, a random sample was drawn of 3128 papers published between 2010 and 2020, stratified over four method families (see [42] for details) and four IPBES regions, for the in-depth systematic review. Papers that did not mention to report on valuation applications in their title or abstract were discarded. Next, the full content of these articles was reviewed according to a large set of questions, including justice aspects. Where papers presented multiple case studies or method applications, these were scored as separate valuation applications unless they were combined to inform decision-making. Papers that did not report the results from the valuation were discarded. This left 1163 studies of relevance.

Appendix C – list of methods included in the database

- Big data methods
- Biophysical and biodiversity assessments
- Choice experiments
- Conceptual models
- Contingent valuation
- Correlative analysis
- Cost-based methods
- Cost–benefit analysis
- Cost-effectiveness/benefit ratio analysis
- Deliberative valuation method
- Document analysis
- Economic (other)
- ES modelling and valuation
- Ethnology-based approach
- Focus groups/expert workshops
- Hedonic valuation method
- Integrated modelling (others)
- Integrated valuation
- Integrated valuation (other)
- Interviews
- Mapping
- Market prices
- Modelling interlinkages
- Multicriteria decision analysis
- Non-participant observation
- Participant observation
- Participatory (other)
- Participatory mapping
- Participatory rural appraisal
- Photo-elicitation
- Preference assessment (other)
- Production function method
- Q-methodology
- Questionnaires
- Revealed preference (other)
- Scenarios
- Spatial correlative analysis
- Stated preferences (other)
- Storytelling/oral tradition (elder’s interpretation)
- Structured expert elicitation
- Transfer approach

- Travel cost
- Well-being indicators

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- of special interest
- of outstanding interest.

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