Chapter 4.[1] Value expression in decision-making

Supplementary material

The designations employed and the presentation of material on the maps used in the assessment do not imply the expression of any opinion whatsoever on the part of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. These maps have been prepared or used for the sole purpose of facilitating the assessment of the broad biogeographical areas represented therein

[1] This is the final text version of the supplementary material of Chapter 4 of the IPBES methodological assessment of the diverse values and valuation of nature (https://doi.org/10.5281/zenodo.6522261).

Annex 4.1. Three ways of internalizing externalities in an Indonesian landscape

Indonesia's 'protection forests' are expected to secure regular river flows and protect downstream areas from floods and landslides. Government-sponsored and spontaneous migration from densely populated Java has, however, brought farmers to the mountainous part of neighbouring Sumatra, where soils and climate are suitable for coffee production. Part of the protection forest became converted to coffee gardens. Forest authorities evicted farmers, uprooted coffee plants, and planted fast-growing exotic trees to reclaim the forest, probably making it worse, hydrologically (Verbist et al. 2010). Environmental protection efforts thus had clear social externalities. In an area that became a well-known hotspot of conflicts a hydropower facility did not operate at planned capacity and complained that the sediment load of the river caused blackouts in the province. The 'Negotiation Support' approach (van Noordwijk et al. 2001; Clark et al. 2016), targeted internalization of both social and environmental externalities (Suyanto et al. 2007). Coffee production can be ecologically reconciled with the watershed functions expected; within existing legal frameworks conflicts between local people, forest authorities, the hydropower company, and local government could be transformed. In a phased approach, tenurial security for farmers in the contested protection forest zone was the first priority (Arifin et al. 2009), supporting land stewardship through agroforestry. River-care co-investment to reduce sediment load of the river followed (Jack et al. 2009; Leimona et al. 2015), as did support for the marketing of environment-friendly coffee. The Sumberjaya toponym ('source of wealth') can finally live up to its expectations (van Noordwijk et al. 2019), as it combines rule-, incentive- and motivation-based approaches to internalization after a phase of violent conflicts.

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Annex 4.2. Multi-layered decision-making transforming values

The conflict over control of atmospheric nitrogen emissions in the Netherlands illustrates the plural values, the multi-layered process of decision making, and the role of publicly accepted goals and institutions that are legally empowered. A court decision in 2019 (Raad van State, 2020) obliged all government agencies to stop any activity that can increase atmospheric nitrogen deposition in natural habitats. The most immediate effect was on building permits, as dust adds to the deposition load. However, plans to tackle agriculture as the primary source of atmospheric nitrogen deposition led to widespread farmer protests and backtracking of provincial governments tasked with the implementation of emission reductions (van der Ploeg, 2020), pushing changes in agricultural policy back to the national level. In the 1970's evidence for atmospheric nitrogen deposition as a driver of eutrophication of oligotrophic habitats and loss of its associated biodiversity started to accumulate (Aber, 1992; van Breemen & van Dijk, 1988), amplified by the 'acid rain' concern over forest dieback (Gundersen et al., 1998). While the underlying values of nature at stake were 'intrinsic', 'relational' as well as 'instrumental', pressures to define limits to tolerable pollution, ultimately led to European Policy agreements with legal status. For many years the Dutch government pleaded for exceptions, claiming future technological improvements would deal with the issue until trespassing a 'good governance' obligation was the basis for the legal case. Meanwhile, the farmer protest pitted very specific and economic individual costs of measures and an emotional appeal that animal welfare was at stake, against the 'arbitrary' nature of generic thresholds. These specific (marginal) costs contrast with the generic ecological benefits for society that can be expected from honouring the standards agreed in the past.

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Annex 4.3. Evolution in policies for environmental impacts appraisal

To get a stronger sense of how institutions meant to avoid loss of biodiversity and other environmental damage have evolved, this annex will zoom in on an important step in environmental decision-making about large infrastructure projects, viz., the environmental impact appraisal.

The idea of incorporating some evaluation of public benefits and costs in decision-making is generally traced back to the Flood Control Act of 1936 passed by the US Congress, requiring the US Army Corps of Engineers' to carry out such analysis to justify investments in water resource projects (Armah et al., 2009; Persky, 2001). From the 1960s or so, formal cost-benefit analysis became mandatory in the USA and slowly spread to other countries, although the inclusion of environmental impacts was limited.

Environmental impact analysis, focusing on a non-economic and non-commensurable assessment of the environmental impacts of large projects, emerged with the enactment of the National Environmental Policy Act in the USA in 1970 (Sadler, 1996). The concept then spread to Canada, Australia and New Zealand, and later to the UK and EU, so that by 1996 more than 100 countries had adopted it (Sadler, 1996), and by 2011 almost all (more than 180) UN member countries 'have some form of national legislation that contains reference to environmental impact analysis or an equivalent process' (Morgan, 2012).

The definition and scope of environmental impact analysis varies significantly. In some cases, an economic analysis is included in the environmental impact analysis. Indeed, 'extended' cost-benefit analysis, which incorporates environmental impacts, depends upon the biophysical assessment provided by environmental impact analysis. Such environmentally extended cost-benefit analysis began to be included in some decision-making from the 1970s, although the spread was uneven and its scope and quality variable (Hanley, 2001). The overall trend, however, is that while cost-benefit analyses continue to be required in the USA and EU countries, there is decreasing attention being paid to cost-benefit analyses in developing countries and an increasing reliance (possibly over-reliance, Naber, 2012) on the environmental impact analysis process. Despite the widespread commitments to forest and landscape restoration, a recent stocktake found only a limited body of cost-benefit analysis studies in recent literature (Wainaina et al., 2020).

There have also been other possible expansions in the scope or scale of the environmental impact analysis to include social impact assessment (SIA), cumulative impact assessment (CEIA: the impacts of multiple projects in one region), and strategic environmental assessment (SEA) that goes beyond projects to the sector as a whole. The adoption of these wider assessments, however, is much more limited (Ortolano & Shepherd, 1995b).

The contribution of the environmental impact analysis process is not just the systematic (expert-driven) ex-ante assessment of the likely environmental (and/or social) impacts of a project to 'inform' decision-making, but also the element of 'procedural democracy' that includes public input into determining scope, identifying alternatives, impact assessment and even decision-making, which provides opportunities for negotiation and compromise (Morgan, 2012; Naber, 2012). Almost all countries have also embraced this dimension of the environmental impact analysis process in their legislations, under various rubrics of 'public hearing', 'public consultation' or 'public participation'. But there is more variation in terms of the depth to which public participation is enabled; in general, the EU and USA demand much greater disclosure and participation at multiple stages (screening, scoping, preparation, decision-making), whereas developing countries have emphasized the technical dimension and limited public participation to the final stage, with often limited transparency as well (Naber, 2012).

Other measures that have emerged in various countries to better incorporate environmental values and concerns into decision-making include (inter alia) setting up of separate green tribunals or green courts to adjudicate environmental matters (e.g., India: Sahu, 2016) or court systems themselves widening citizens' locus standi and space for public interest litigation (Dembowski, 2000; Hassan & Azfar, 2004; Konkes, 2018; Wang & Gao, 2010), or governments setting up separate environmental scrutiny panels (such as the Environmental Assessment Board in Ontario, Canada). There is also, however, evidence of recent attempts to weaken environmental appraisal across several countries (Ghosh, 2020; Tollefson, 2018; UN Environment, 2018).

While a detailed content analysis of the values expressed in the different appraisal instruments is out of the scope of this analysis, one may summarize them as follows:

- Conventional cost-benefit analysis captures the purely material values involved;
- Environmental impact analysis methods capture impacts framed in terms of instrumental values (loss of material resources, public health) and some intrinsic values (biodiversity), but rarely capture relational values;
- Social impact assessments try to capture some of the impacts on relational values (which may include relationship not just with nature but also with historical or religious sites/structures, etc.), along with the social expression of material impacts;
- Public consultations in theory provide space for the expression of all values, but usually with little clarity how these expressions may be sorted, aggregated or assessed in terms of their relative importance, unless the process includes a participatory multi-criteria decision analysis.

Over the last 50 years, while there appears to be an overall adoption of institutions incorporating environmental values and concerns in decision-making on large projects, the pertinent question is how these institutions perform on the ground vis-à-vis their stated objectives, viz, more attention to environmental values, to values of environmentally impacted communities, and to more rigour in assessing the impacts on those values. Here, the evidence suggests that there is a big gap between theory and practice (Cashmore et al., 2004, 2010; Morgan, 2012; Sadler, 1996; UN Environment, 2018), whether in terms of the technical rigour of the assessment or its procedural democracy elements. The two elements are not entirely separate: public participation is meant to bring diverse sources of knowledge into the ex-ante assessment itself. But the public deliberation (and possibly decision-making) about the findings of the assessment remains a distinct element.

In the UK, reviews have suggested that, while environmental impact analysis has facilitated environmental awareness, there is lack of internalisation, limited consideration of alternatives, and lack of cumulative assessments (Glasson, 1999; Jha-Thakur & Fischer, 2016). Problems at all stages (screening, scoping, consideration of alternatives, environmental impact analysis quality, etc.) are also reported for EU countries (Morgan, 2012; Naber, 2012).

The challenge is bigger in countries that emerged from the material and discursive impacts of colonialism, and therefore feeling the need to focus on development at all costs. EIAs are simply waived in many cases (Naber, 2012), or implemented as a formality, with no quality control and no accountability (Morgan, 2012; Naber, 2012; Sandrp, 2014a, 2014c; UN Environment, 2018) and indeed clouded by conflict of interest as they are commissioned by the project proponents themselves (Kohli & Menon, 2005; Paliwal, 2006; Vargas et al., 2020). Not surprisingly, a national audit of the environmental clearance process in India (including specifically of dam projects) found significant deficiencies in the EIA reports and projects getting clearances in spite of these deficiencies (Comptroller and Auditor General, 2016; Sandrp, 2017).

The lacunae in EIA-in-practice observed across countries are on many dimensions: biodiversity (Collard et al., 2020; Samarakoon & Rowan, 2008), health impacts, downstream hydrological and

ecological impacts, and material impacts on local livelihoods (Baird, 2009). Further examples of shoddy EIAs have been exposed (Sandrp, 2014b).

An analysis of five dam projects with trans-boundary implications across south-east Asia and Africa revealed similar patterns of inaccuracy of project design, under-estimation of negative impacts, and particular inattention to socio-cultural and livelihood impacts (Bruch et al., 2008). The failure of public participation in the appraisal process, i.e., the mobilization of local knowledge, contributes to this problem (Bruch et al., 2008). One may conclude that, in the vast majority of cases, environmental impact analyses, even in terms of their 'information-generation' element, end up becoming green-washing (UN Environment, 2018).

The procedural participation and consultation components of environmental appraisal (prior to decision-making—which is discussed separately below) are even more lackadaisical in their implementation than the technical assessment components, especially when it comes to countries of the Global South. Studies of hydropower projects in the Indian Himalayan states (Sinclair & Diduck, 2000) and large projects in other states (Rajvanshi, 2003; Sainath & Rajan, 2015) all reveal deviations from the idea of public consultation in many ways; similar reports from Indonesia (Marzuki, 2009), Bulgaria (Almer & Koontz, 2004) and a 4-developing country study (Stærdahl et al., 2004) show that this phenomenon is widespread. Studies from the EU (Wesselink et al., 2011) and Canada (Sinclair et al., 2012) show that limited public participation also dogs processes in OECD countries. The situation in the USA is somewhat better, possibly because '(i) EIA implementation is heavily influenced by court actions brought by NGOs; (ii) freedom-of-information laws make it relatively easy for citizens to obtain copies of documents in the files of government agencies; and (iii) the NEPA process encourages citizen participation in agency decision making' (Ortolano & Shepherd, 1995).

In conclusion, most countries have moved towards incorporating some formal process of environmental appraisal (typically environmental impact analyses) into their decision-making processes on big environmentally disruptive projects, while cost-benefit analysis as a decision-making tool has declined overall. Many countries have also embraced some form of public consultation and made the overall process more transparent. However, there remains a big gap between the theory and practice of environmental impact analysis, and social impact assessments, cumulative environmental impact assessments and strategic environmental assessments are largely missing. The information EIAs produce is often incomplete, inaccurate, and biased. Public hearings continue to largely range from perfunctory to instrumental in developing countries, while being somewhat more rigorous in certain OECD countries. Thus, if environmental impact analysis documents are meant to 'recognize' values and public hearings are meant to provide 'procedures' for incorporating them, both steps fall far short of the ideas of recognition and procedural justice respectively. Note that what is sacrificed here is the intrinsic value of democratic process, not necessarily any particular values towards nature. For instance, (Sinclair & Diduck, 2000) point out that concerns raised at public hearings may be about jobs for the displaced or affected community. But even these concerns do not necessarily get acted upon as documented for the examples discussed in *section 4.5.5*.

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Annex 4.4. Avoiding new value externalities through policy design

Details on studies and findings on the effects of policy discourses on pro-environmental values

Here we provide a more detailed summary of the studies on policy discourse.

It should be noted that the studies included here cover a range of outcome variables related to pro-environmental values, from attitudinal variables such as "interest in conservation" (Andrews et al. 2013) or "policy support" (Bakaki & Bernauer, 2016), to behavioural intentions (Steinhorst et al. 2015) and observed behaviour (Bolderdijk et al. 2013).

There is inconclusive evidence on the effects of instrumental value frames on pro-environmental values. Three studies (Andrews et al. 2013, Bolderdijk et al. 2013, Rode et al. 2021) present suggestive evidence for a detrimental effect of instrumental value framings. Andrews et al. (2013) measure farmers' interest in conservation tillage after being exposed to a letter informing them about the merits of respective tillage practices. Next to a control treatment only highlighting potential pro-environmental effects, they employ three different instrumental framings. A "profit frame" highlights potential increases in farm profits, whereas two "payment frames" mention the possibility to receive payments after implementing respective practices (one mentions payments for ecosystem services, the other carbon-offset payments). While on average there are no differences between treatments with respect to subjects' "interest in conservation tillage", the study finds a relevant subgroup effect for conventional tillers (i.e., those farmers currently not using conservation tillage). Compared to the control case, the conventional tillers in the "profit frame" express significantly less interest in conservation tillage. Bolderdijk et al. (2013) test the effect of different appeals to perform a free tyre-check at a gas station. They post signs next to the petrol pumps having a "free tyre-check" coupon attached to them together with one of four messages on the reasons to perform such a check (a control condition stating no particular reasons, and safety, economic (saving money) and biospheric (for the environment) reasons, respectively). In the case highlighting economic reasons, gas station customers took significantly less coupons than in the control condition. Finally, Rode et al. (2021) survey business professionals about their intentions to engage in sustainability and also present them with hypothetical green business investments to decide about. Apart from a control group, respondents in two treatment groups were first presented with different messages pertaining to sustainability. In one case, an instrumental "business case" framing is applied, in the other one a non-instrumental "responsibility" framing. They find that, compared to a responsibility framing (not the control group), a business case framing results in a lower willingness to invest in sustainability, when there is a trade-off between sustainability and profit (either monetary or reputational). However, two other studies do not find such a detrimental effect of instrumental value framings. Bakaki & Bernauer (2016) elicit policy support (or opposition) to climate policy with a survey-embedded experiment. In the survey, the justification of climate policy is framed differently in several treatments. Next to a control frame (climate risk reduction), economic, health, and social benefits are framed. The study does not find any significant differences between the control and treatment conditions. Evans et al. (2013) conduct a series of experiments in which they prime different motives for car-sharing. Next to a control condition, the primes either involve self-transcendent (pro-environmental) motives, self-interested (financial) motives or a combination of both. The outcome variable is observed recycling behaviour. The results show that the priming of self-interested motives does not lead to a change in recycling behaviour compared to the control condition. Finally, two studies find that, compared to a control condition, instrumental value frames may increase pro-environmental values. Steinhorst et al. (2015) elicit the effects of framed electricity saving tips on a battery of climate-friendly intentions, including saving electricity. The tips are either framed as pro-environmentally or financially motivated.

Compared to the control condition, both framings increase electricity-saving intentions significantly. Rode et al. (2017) investigate the effect of different value-related arguments on the approval of a large hydropower dam project. Participants in the treatment groups are either presented with moral-ecological (i.e., non-instrumental) or ecosystem services (i.e., instrumental) arguments. The ecosystem services arguments are presented in three different versions: a qualitative list of effects on ecosystem services, a monetary valuation and cost-benefit analysis in support of the dam, and finally, a monetary valuation and cost-benefit analysis not in favour of the dam. Moreover, three further treatments combine the moral-ecological argument with each version of the ecosystem services argument. Compared to a control treatment, all versions of the ecosystem services argument significantly reduce dam approval rates. Moral ecological arguments and a cost-benefit analysis not being in favour of the dam were about equally effective and outperformed the other two versions of the ecosystem services framing in reducing dam approval.

There is inconclusive evidence on the effects of non-instrumental value frames on pro-environmental values. Three studies present suggestive evidence that non-instrumental value framings enhance pro-environmental values. In the study by Rode et al. (2017) moral-ecological arguments significantly reduced approval rates of a dam project that would harm the environment, as compared to a control treatment. The results of Evans et al. (2013) show that the priming of non-instrumental ("self-transcendent") motives leads a significantly greater percentage of participants to recycle than when priming "self-interested" motives or in the control condition without priming. Finally, in Steinhorst et al.' (2015), the non-instrumental ("pro-environmental") framing increased electricity-saving intentions significantly and also led to significant spill-over effects to other climate-friendly intentions. However, the study of Bolderdijk et al. (2013) did not find support for a positive effect of non-instrumental discourses, as a biospheric ("for the environment") appeal did not lead to more tyre-check coupons being taken compared to the control appeal in which no particular reasons were provided.

There is inconclusive evidence on the effects of a combination of instrumental and non-instrumental value frames on pro-environmental values. In the study by Evans et al. (2013), the combination of instrumental ("self-interested") and non-instrumental ("self-transcendent") frames did not lead to a significant increase of recycling behaviour compared to the control group, while the non-instrumental frame alone led to a reduction in such behaviour. This suggests a detrimental effect of adding the instrumental value frame in this setting. In the study by Rode et al. (2017), however, a combination of instrumental ("ecosystem services") and non-instrumental ("moral-ecological) arguments led to the lowest approval rates towards the environmentally harmful dam project.

Details on studies and findings on motivation crowding effects of economic incentive policies and the impact of policy design and process on motivation crowding

A review of empirical studies assessing motivational crowding effects in the context of conservation policies[2] yielded 56 studies, of which 53 measured motivation crowding effects of introducing such a policy (see *Table SM4.1*; the other three only measured relative motivation crowding effects of policy variants). The majority focussed on positive economic incentives such as payments for ecosystem services, while the rest focussed on negative incentives (e.g., mostly legal restrictions and fines), and some included both. Most studies were based on an experimental approach (mostly lab or lab-in-the-field experiments), while some used a quasi-experimental, case-study or survey-based approach. Most studies measured motivation crowding indirectly via comparing policy outcomes to a baseline or between different policy treatments. Such 'during-policy' measures have the disadvantage that they can only assess the total impact of a policy, which is composed of the direct

[2] Systematic review on motivational crowding by economic incentives in conservation policies (https://doi.org/10.5281/zenodo.4390995).

incentive effect and the potential motivation crowding effect (potentially also other policy impacts, such as affecting knowledge or beliefs). Therefore, we consider evidence from such studies focussing purely on 'during-policy' effects (i.e., contemporaneous effects) as suggestive, unless they find a negative effect of the policy. Some studies used a 'post-incentive' approach, comparing outcomes after the policy was discontinued to those before the policy was introduced (i.e., assessing thus permanent or long-lasting effects). A reduction in conservation in comparison to the baseline is then interpreted as crowding out, while an increase indicates crowding in. A more rigorous approach is to compute this relative to a control where no policy was introduced in between. Other studies directly measure motivations. The studies thus vary in analytical rigour. It is also likely that the number of null effects in the set of studies identified is underrepresented due to a publication bias against studies finding a null effect (Rode et al. 2015).

Of the 56 studies listed in *Table SM4.1*, 32 studies analysed impacts of variants of one or more specific policy features on motivation crowding (see *Table SM4.2*). These studies often only assessed the variants' relative performance or motivation crowding effects, while some studies also allowed measuring the motivation crowding effect of the individual variants. Another few studies drew conclusions on motivation crowding effects based on comparing subsamples of study participants that had engaged to different degrees in certain policy features (e.g., participation in meetings or use of public benefits) (e.g., Vollan 2008; Kaczan et al. 2019). The latter set of studies suffer from self-selection bias in identifying the specific effect of the policy variant of interest (indicated by grey font in *Table SM4.2*).

Table SM4.2 shows all policy features for which different variants were compared with regards to their motivation crowding effects in existing studies. Some studies also compare individual policy instruments (external bonus payment, external fine) in a context with and without communication (Andersson et al. 2018, Abatayo and Lynham 2016, respectively). We see communication as a contextual feature and/or a complementary policy feature, which can affect extrinsic and/or intrinsic motivations, and no study from our summary disentangled these potential effects. Thus, we did not include these studies in our summary of motivation crowding effects of individual policy features and only discussed communication as a potentially relevant contextual and/or complementary policy feature that could explain variation in results on some of the other policy features.

Here we present more detailed descriptions of the studies and their results. We also discuss additional findings from *Table SM4.2* that were not included in the main text because the evidence was based on a single study or a study suffering from methodological weaknesses.

'Hard' policy design features

Level of incentive

Motivation crowding effects of economic incentive policies arguably depend on how the specific incentive level is calibrated in a given context. Evidence suggests that extrinsic motivations tend to become more salient as the level of the incentive increases.

With eight studies focussed on comparing different levels of incentive, this is one of the policy features most analysed in the literature. Framed lab-in-the-field experiments by Cardenas (2004), Rodríguez-Sickert et al. (2008) and Lopez et al. (2012) suggest that a weakly enforced low penalty may induce crowding in of other motivations for resource conservation by prescribing the desired behaviour without attaching harsh punishments to the prescription. Higher yet equally weakly enforced penalties do not induce additional cooperation in these experiments. Designed to induce solely extrinsically motivated actors to adopt the desired behaviour (i.e., they induce risk neutral agents to comply with the socially optimal strategy), these high penalties likely increase the salience of extrinsic motivations at the expense of other motivations for resource conservation (Bowles and

Polanía-Reyes 2012). (A further experimental study by Reichhuber et al. 2009 also suggests crowding out of intrinsic motivation by a high collective tax, but their study does not allow comparing motivation crowding of high vs. low collective tax.) The results of lab-in-the-field experiments by Velez et al. (2010) and Travers et al. (2011) however suggest that the specific level of mild, indicative penalties may not be altogether irrelevant. Travers et al. (2011) compare two levels of penalties, none of which is expected to actually induce the socially optimal behaviour for rational self-regarding participants. They find that only the relatively higher penalty actually induced cooperation. Similarly, Velez et al (2010) find that only the relatively higher medium penalty consistently does not crowd out cooperation in the different regional contexts they studied. Thus the level of the penalty could also be important to indicate the strength of, and support to, the desirable behaviour that the policy aims to materialise.

Studying the impacts of the level of payments for ecosystem services for resource and biodiversity conservation, studies by Handberg and Angelsen (2019) and Chervier et al (2019) do not yield definitive conclusions. In a framed lab-in-the-field experiment similar to the one by Cardenas (2004), Handberg and Angelsen find that the positive effect of a bonus payment for conservation on cooperative behaviour decreases as the payment level increases. According to the authors' conceptual framework, this may suggest a reduction in other motivations for forest conservation (crowding out) and/or an increase in other motivations for forest use. It should be noted that all of the above studies focussed on the policy phase only and did not measure intrinsic motivations directly, so that the results are authors' interpretations of the potential mechanism explaining the observed patterns of behaviour. As such they should be interpreted as suggestive. Using a quasi-experimental research design, Chervier et al. (2019) study the impacts of payment level in agreements for forest conservation. They find that as the payment level increases, so does the probability to perceive monetary values from forest conservation. They show that this comes mainly at the expense of values linked to subsistence_goals and interpret the finding as crowding out. However, subsistence goals could rather be seen as part of extrinsic motivations. The authors find no effect of payments for ecosystem services on non-use values, which would be more appropriately interpreted as part of intrinsic motivations. Thus, their results suggest crowding in of monetary extrinsic motivations with arguably no effects on intrinsic motivations. Finally, the experiment by Velez et al. (2010) points at the importance of analysing these effects within the specific social-ecological and governance context in which incentives are deployed. Although they find that, on average, both low and medium weakly enforced penalties may crowd out motivations for conservation, they show that the effect may vary from one region to another. Depending on previous patterns of interactions between externally imposed and endogenously crafted regulations, penalties may consistently or inconsistently support conservation efforts. As the authors suggest, lower penalties may support or hinder collective action for resource conservation depending on the context. Their medium penalty, on the other hand, consistently does not worsen and in some cases improves cooperation in the cases they analysed.

Targeting

Whether facing disadvantageous policy conditions, e.g., due to policies targeting particular areas, induces motivation crowding effects appears to depend on whether the policy is perceived as fair by the target population, which in turn is likely to be context-dependent.

Two lab-in-the-field experimental studies assessed whether some form of targeting of payments for ecosystem services that imposed unequal policy conditions on different subgroups of resource users caused motivation crowding. Moros et al. (2020) introduced three types of payments for ecosystem services removal in the post-policy stage: removing the payments for ecosystem services for all group members, and removing it only for the majority of the groups in a session, based on either randomization or the number of water sources. They found a post-policy crowding in effect for all three treatments, with no significant difference across the three rules. The authors explain their result by previous findings that in contexts of weak state presence payments for ecosystem services

participants see the payments as a long-waited recognition by the state and a fair redistribution of conservation costs, a perception that prevails even when payments are eventually removed (ibid). The idea that unequal policy conditions do not cause crowding out if the conditions are perceived as fair is also supported by a study of Bernal-Escobar et al. (2021c). They analysed motivation crowding effects under three scenarios of policy inequality: (1) a high priority area where payments for ecosystem services are implemented next to a low priority area that is excluded from payments for ecosystem services, (2) a protected area with land-use restrictions surrounded by a buffer area where payments for ecosystem services are implemented, and (3) a protected area where payments for ecosystem services are implemented on top of land-use restrictions, surrounded by a buffer area with only payments for ecosystem services. Thus, payments for ecosystem services were implemented in one area while one of three policies was established in the other area: no policy, fine policy or policy mix of fine and payments for ecosystem services. They find suggestive evidence of crowding out among those facing the disadvantaged policy in the form of being excluded from payments for ecosystem services or facing the policy mix. Surprisingly, issuing a fine in a protected area was perceived as increasing perceived fairness, thereby leading to an unexpected direction of effect for that case. The authors conclude that it is important to comprehend local logics of fairness before payments for ecosystem services implementation (Bernal-Escobar et al. 2021c).

Unit of control

The relative performance of payments based on individual vs. collective performance depends on pre-existing social ties, the degree of communication, and perceived fairness, which itself depends on the local setting.

Several lab-in-the-field experimental studies compare positive incentives based on individual performance (‘individual payments’) to those based on group performance (‘collective payments’). Narloch et al. (2012), in a study with Peruvian and Bolivian farmers, find suggestive evidence that collective payments induce crowding out compared to individual payments. They explain this by individual rewards triggering reciprocity, while collective rewards caused free-riding. A specificity of their study is that the collective payment is only obtained if the group achieves a threshold conservation level, while this is not the case for the individual payment, thus inducing an additional source of uncertainty for participants in the group payment. Moreover, no communication was allowed in their study, which likely hampered coordination within the group. In a follow-up study with Peruvian farmers (Midler et al. 2015) both payments were conditional on the group achieving the threshold conservation level, so that the only difference was that the individual payment level was based on individual vs. group performance. The authors found that, overall, individual payments outperformed collective payments. The results suggest that both individual and collective rewards lead to crowding out where intrinsic motivations for conservation pre-existed, but crowding out by collective rewards was larger. Survey results indicated that participants perceived as unfair the fact that the collective payment level is dependent on total group cooperation, which could contribute to the result. Collective payments performed better when implemented in groups with strong social ties and when communication was possible. In an adapted version of Midler et al.‘s (2015) study, Moros et al. (2019) measured different types of motivations directly in a survey following the lab-in-the-field experiment, thus measuring post-policy motivation crowding effects. They found that the individual payment has no motivation crowding effect, while the collective payment crowded-in social motivations (related to social approval or reputation) but had no effect on other motivations. The authors explain the effect on social motivations by collective payments activating the psychological mechanism of social belongingness and connectedness to a group. In an adapted version of Narloch et al. 2012, Moros et al. (2020) include a post-policy stage. They find that both the individual and the collective incentive arguably crowd in other motivations in the longer-run (once the policy is discontinued). In one of their treatments the crowding in effect is larger for individual payments, in another the two are equally strong. In another study, Kaczan et al. (2019) compared an

individual to a collective payment for ecosystem services in an experiment with Tanzanian farmers, not allowing for communication. While the payments were in place, the individual payment performed better than the collective one. The authors indicate that there were incentives to free ride under group payments for ecosystem services, but that also the collective payments for ecosystem services seemed to induce crowding out. Once the policy was removed, neither individual nor collective payments had a lasting motivation crowding effect. In a related experimental study with farmers in rural Laos, Salk et al. (2017) made the individual payment conditional on crossing an individual threshold, while the collective payment was again conditional on a group-level threshold. This study allowed for free communication in all treatments. It found that the collective payment outperformed the individual payment. This is remarkable because the conditionality on group-level threshold again introduced an uncertainty in the collective payment compared to the individual payment and thus an incentive to free-ride. The authors explain the result by the collective payment leading to increased communication and being perceived by local respondents as fairer. Moreover, the Lao setting was characterized by strong kinship ties and a tradition of reciprocity and risk-coping dependency. The study also assessed longer-run motivation crowding impacts in a post-policy phase and found no post-incentive motivation crowding effect regardless of whether the individual or the collective payment had been implemented (Salk et al., 2017). The empirical results support a conclusion made in the review by Kerr et al. (2014) that for groups already cooperating effectively an attractive collective payment offer can stimulate additional conservation, while in contexts where groups are newly formed or have little or no tradition of collective natural resource management, a collective payments for ecosystem services initiative may generate a conflict with the need to build cooperation gradually.

Other 'hard' policy design features

Further 'hard' policy design features have been analysed by only one or two studies. One early study (Vollan 2008) compared motivation crowding for negative vs. positive incentives (controlling regulation incl. fines vs. rewards) and finds that only the negative incentive caused crowding out, and only for the case that the percentage of group members voting for such an incentive was low. However, the results are likely to suffer from self-selection bias because the incentives are not externally given, but voted on. Moreover, the strength of the incentives is not directly comparable, and the result could rather capture an impact of voting (which again would suffer from self-selection bias). Furthermore, the policies were framed in different ways, with the reward providing an environmental motivation and the restrictions providing no explanation at all. As *Table SM4.1* indicates, positive incentives can also cause crowding out. The result of Vollan (2008) can thus not be generalized. Reichhuber et al. (2009) find suggestive evidence that a combined collective tax and subsidy scheme outperforms a collective high tax scheme, potentially by inducing crowding in of intrinsic motivations.

Three studies examined the motivation crowding effects of different aspects of conditionality in payments for ecosystem services, each focussing on a different aspect. Garcia-Armado et al. (2013) conduct structured interviews in Mexico, where both payments for ecosystem services and an integrated conservation and development projects co-exist. One major difference between the two is likely to be that payments for ecosystem services are conditional on adoption of ecosystem services-providing activities or outcomes, while benefits obtained from the integrated conservation and development projects are not. The authors indicate that payments for ecosystem services seems to induce crowding out, while integrated conservation and development projects does not. However, their study suffers from self-selection bias, and from the fact that the two programs co-exist, making it difficult to disentangle their effects. Moreover, the incentive levels of the two programs are different and programs differ also in other aspects, thus making the two programs not really comparable. The other two studies focus on payments for ecosystem services, so some degree of conditionality is already included since the level of payments depends on performance. Kaczan et al. (2017), in a lab-

in-the-field experiment simulating a collective payment for forest conservation in Mexico, tested the effect of introducing an additional fine that was levied if the group failed to achieve a threshold and with the fine being proportional to the degree of deviating from the threshold. The authors refer to this treatment as 'conditioning on additionality'. During implementation, introducing the fine increased conservation, which could simply be due to the added incentive. However, post-policy, a positive effect on conservation prevailed, indicating that the additional conditionality feature (punishing non-additionality compared to a threshold) crowded-in other motivations. Focus group discussions indicated that most participants considered such a community-level sanction as fair. The third study (Dörschner and Musshoff 2015) compared the behavioural effects of a payments for ecosystem services program conditional on pro-environmental activities vs. environmental outcomes. In a lab-in-the-field experiment with German agricultural managers, they found that the outcome-based payment outperformed the activities-based payment. Outcomes involved a stochastic element, and the expected profit from both payments was equal. Since most participants were risk- averse, one would have expected that the activities-based payment would have performed better. That the opposite is the case provides suggestive evidence for a crowding in effect of results-based payments. However, as the authors indicate, alternative explanations are possible, e.g., that the results-based program is more in line with producing agricultural outputs thereby activating profit-related motivations more. Because the three studies differ in focus and sample, and only one of the studies provided a rigorous measure of motivation crowding, it is not possible to draw generalizations on conditionality and motivation crowding.

Framing of the policy instrument

Communicating (framing) a policy in line with local values can help avoid crowding out or even induce crowding in.

Some aspects of how a policy is communicated (so-called framing) can affect motivation crowding. First, some authors have argued that it could play a role whether payments for ecosystem services programs refer to the payment as compensation, reward, co-investment or just as payment (Ezzine de Blas et al. 2019, van Noordwijk et al. 2012). Only one study, conducted with traditional farmers in Colombia, empirically assessed such impacts of payment framing (Bernal-Escobar 2021a). It found that indeed framing the payment as a reward that acknowledges forest conservation as an achievement induced crowding-in relative to simply using the word 'payment' (Bernal-Escobar 2021a). By contrast, framing payments for ecosystem services as compensation had no effect (Bernal-Escobar 2021a). The positive impact of the reward framing could be explained by an increment in farmers' feelings of competence due to the recognition of their ability to conserve (Ezzine de Blas et al., 2019). The argument that using the term co-investment may perform particularly well in contexts where property rights are not clearly defined (van Noordwijk et al. 2012) appears plausible, but has not been empirically tested. Second, *integrating plural values in payments for ecosystem services communication* appears to be helpful in contexts where values other than instrumental values are prevalent in the target population (Ezzine de Blas et al., 2019). Maca-Millán et al. (2021) found that emphasizing intrinsic and relational values in the context of payments for ecosystem services led to a crowding in of intrinsic motivations, while not doing so induced crowding out. Their intervention included a guided reflection through which participants were primed to reconnect with nature by eliciting positive feelings and recalling pleasant memories surrounding forests and rivers, thus aligning with locally relevant values. Lliso et al. (2021) found that a crowding in effect could be achieved in an indigenous community in Colombia by emphasizing relational values, but in a Campesino community by emphasizing instrumental values. In sum, these studies indicate that emphasizing those values that are in line with pre-existing human-nature relational models could reduce the risk of crowding out and even induce crowding in. Bernal-Escobar et al.'s (2021a) study points in a similar direction by showing suggestive evidence that an emphasis on cultural ecosystem services obtained from forest conservation in a payments for ecosystem services program induced

crowding in compared to emphasizing only regulatory water services targeted by the program, and that this effect is stronger for farmers who reported moral reasons for taking pro-environmental actions. Emphasizing cultural values in their study could alternatively be interpreted as emphasizing more locally-relevant benefits. Whether this affects motivation crowding is, however, inconclusive, as two other studies explicitly examined whether motivation crowding depends on which beneficiaries are emphasized in a payments for ecosystem services program and found no significant effect. Andrews et al. (2013) found no impact on motivation crowding among United States farmers from emphasizing to them that the targeted activity also increased profits for farmers themselves. In a study with Colombian farmers, Bernal-Escobar et al. (2021b) find suggestive evidence that stating that people in the more distant capital benefitted from the ecosystem services incentivized in a payments for ecosystem services programs did not significantly affect motivation crowding compared to the case where beneficiaries were people in the farmers' own district.

Policy process

Participation in the design and enforcement of incentives has the potential to crowd in intrinsic motivations. Participation in the selection of the appropriate incentive scheme may itself not be enough.

Several studies suggest that allowing the relevant actors to participate in the design (selection) of a specific incentive scheme may crowd in their intrinsic motivations for resource conservation (Vollan 2008, Travers et al. 2011, Gatiso et al. 2015, Kaczan et al. 2017). However, the few studies in our sample that compare similar groups and same incentive structures, thus disentangling the sole effect of participatory rulemaking on resource management, found no specific effects of allowing participants to vote for their desired policies (Rodríguez-Sickert et al. 2008, DeCaro et al. 2015, Abatayo and Lynham 2016). Rather, the laboratory experiment by DeCaro et al. (2015) indicates that it is the combination of voting and participating in enforcement (decentralised punishment) that increases voluntary cooperation significantly, while neither voting nor enforcement separately do. Giving participants the chance to vote for and participate in the enforcement of their governing rules arguably crowds in a series of intrinsic and extrinsic motivations that sustains cooperation even after the rules are removed and decentralised punishment is no longer possible. Similarly, Abatayo and Lynham (2016) observe that cooperation is higher when participants get the chance to vote for their rules and communicate among themselves than when the rules are imposed on them and no communication is allowed. Here as well, a combination of intrinsic and extrinsic motivations arguably underpins this relatively higher level of cooperation. In sum, the evidence suggests that allowing participation in the process of crafting *and* enforcing rules has indeed the potential to crowd in intrinsic motivation provided it allows for opportunities of social interaction and social learning (see also Ostrom 2000, Frey et al. 2004, Bowles and Polanía-Reyes 2012, Bowles 2016, Ezzine-de-Blas 2019, Dannenberg and Gallier 2020), while participation in policy choice may in itself not be enough.

Complementary policies

A few studies assessed the impacts of adding complementary policy interventions in a policy mix with economic incentives. Maca-Millan et al. (2021) find that adding public recognition to complement a payment for ecosystem services program had a crowding in effect. Two studies examined adding a norm-related intervention to an economic incentive policy and found no effect on motivation crowding. Kerr et al. (2019) conducted a lab-in-the-field experiment with Tibetan yak herders, contextualized around patrolling against illegal wildlife trapping. They found that adding a small, non-incentivized payments for ecosystem services had a significant strengthening effect on the perceived injunctive norm, but adding to this an external injunctive norm appeal does not affect the patrolling decision nor (post-policy) motivation crowding. Kits et al. (2014), in a lab experiment resembling United States conservation auctions, tested whether the motivation crowding effects of

the auction differed depending on whether participants were offered opportunities for social interaction. Social interaction was implemented as a combination of allowing communication and providing information on other group members‘ cooperation behaviour. The latter can be interpreted as a descriptive norm. The results indicated that adding social interaction did not affect motivation crowding. A crowding out effect was observed with and without social interaction. However, since two features are varied at the same time (information that can be used to deduce a descriptive norm, and communication) the effects of each of these cannot be disentangled. Also because the two studies add different norms, no general conclusions could be drawn from this small set of evidence.

Table SM4.1. Empirical studies assessing motivation crowding effects in the context of biodiversity and ecosystem services

Authors (Year)	Country where study was conducted	Type of incentive (positive or negative)	Conservation issue	Type of community	Empirical method	When is motivation crowding measured? (during and/or post incentive)	Outcome measure	Any evidence of crowding out/crowding in?
1. Abatayo/ Lynham (2016)	USA	Negative	over-use natural resources (fish, grazing, …)	Westernized (students)	laboratory experiment	during and post incentive	Behaviour (in experiment)	No
2. Agrawal et al. (2015)	India	Positive	forest conservation	Westernized	natural experiment	during incentive	Behaviour (self-reported) + Motivational	Crowding out; crowding in suggestive
3. Alix-Garcia et al. (2018)	Mexico	Positive	forest conservation	Traditional + Indigenous	natural experiment	during incentive	Behaviour (in real field setting)	Crowding in suggestive
4. Andersson et al. (2018)	Bolivia, Indonesia, Peru, Tanzania, Uganda	Positive	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	post incentive	Behaviour (in experiment)	Crowding in suggestive
5. Andrews et al. (2013)	USA	Positive	conservation (biodiversity)/ agriculture	Westernized	survey-based experiment	during incentive	Motivational	Crowding out suggestive
6. Bakaki/ Bernauer (2016)	Brazil	Positive	forest conservation	Westernized + Traditional + Indigenous	survey-based experiment	during incentive	Motivational	No
7. Bottazzi et al. (2018)	Bolivia	Positive	water resources	Traditional	case study	during and post incentive	Behaviour (self-reported + intentions) + Motivational	Crowding out suggestive; Crowding in suggestive
8. Cardenas (2004)	Colombia	Negative	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	No
9. Cardenas et al. (2000)	Colombia	Negative	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive

10. Chervier et al. (2019)	Cambodia	Positive	forest conservation	Traditional	natural experiment	during incentive	Motivational	Crowding out
11. d'Adda (2011)	Bolivia	Negative	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive
12. Darragh/ Emery (2018)	England	Positive	conservation (biodiversity) / agriculture	Westernized	case study	post incentive	Behaviour (intentions) + Motivational	Crowding out suggestive; Crowding in suggestive
13. DeCaro et al. (2015)	USA	Negative	conservation (biodiversity) / agriculture	Westernized	laboratory experiment	during and post incentive	Behaviour (in experiment) + Motivational	Crowding in
14. Di Falco/ Sharma(2018)	Fiji	Positive	other	Traditional + Indigenous	lab-in-the-field experiment	during and post incentive	Behaviour (self-reported) + Motivational	No
15. Dörschner/ Musshoff (2015)	Germany	Positive	conservation (biodiversity) / agriculture	Westernized	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding in suggestive
16. Fisher (2012)	Uganda	Positive	forest conservation	Traditional	case study	during incentive	Motivational	Crowding out suggestive
17. García-Amado et al. (2011)	Mexico	Positive	forest use (resource extraction / illegal logging / over-use)	Traditional	case study	during incentive	Behaviour (intentions)	No
18. García-Amado et al. (2013)	Mexico	Positive	forest use (resource extraction / illegal logging / over-use)	Traditional	natural experiment	during incentive	Motivational	Crowding out
19. Gatiso et al. (2015)	Ethiopia	Negative	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive
20. Greiner/ Gregg (2011)	Australia	Positive and negative	conservation (biodiversity) / agriculture	Westernized	lab-in-the-field experiment	during incentive	Motivational	Crowding out suggestive
21. Handberg/ Angelsen (2019)	Tanzania	Positive	forest conservation	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment) + Motivational	Crowding out suggestive

22. Hu et al. (2019)	China	Positive	other	Westernized	case study	during incentive	Behaviour (intentions)	Crowding out suggestive
23. Ito et al. (2018)	Japan	Positive	water resources	Westernized + Traditional	case study	during incentive	Behaviour (self-reported)	Crowding out suggestive
24. Jack (2009)	Kenya	Negative	water resources	Traditional	lab-in-the-field experiment	post incentive	Behaviour (in experiment)	Crowding out
25. Janssen et al. (2010)	US	Negative	over-use natural resources (fish, grazing, …)	Westernized (students)	laboratory experiment	post incentive	Behaviour (in experiment)	Crowding out
26. Kaczan et al. (2017)	Mexico	Positive	forest conservation	Traditional	lab-in-the-field experiment	during and post incentive	Behaviour (in experiment)	Crowding out suggestive; Crowding in suggestive
27. Kaczan et al. (2019)	Tanzania	Positive and negative	forest conservation	Traditional	lab-in-the-field experiment	during and post incentive	Behaviour (in experiment)	Crowding out suggestive (for payments for ecosystem services); Crowding in suggestive (for regulation)
28. Kerr et al. (2012)	Tanzania, Mexico	Positive	other	Traditional	natural field experiment	during incentive	Behaviour (in real field setting + intentions)	Crowding out (Mexico); Crowding out suggestive (Tanzania)
29. Kerr et al. (2019)	China	Positive	other	Ethnic	lab-in-the-field experiment	during and post incentive	Behaviour (intentions)	Crowding in
30. Kits et al. (2014)	Canada	Positive	conservation (biodiversity) / agriculture	Westernized	laboratory experiment	during and post incentive	Behaviour (in experiment)	Crowding out
31. Lliso et al. (2021)	Colombia	Positive	forest conservation	Traditional + Ethnic + Indigenous	lab-in-the-field experiment	during and post incentive	Behaviour (in experiment)	Crowding in

32. Lopez et al. (2012)	Colombia	Negative	other	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	No
33. Maca-Millán et al. (2021)	Colombia	Positive	forest conservation	Traditional	lab-in-the-field experiment	post incentive	Behaviour (in experiment)	Crowding out; Crowding in
34. Madrigal-Ballestero et al. (2013)	Costa Rica	Positive and negative	over-use natural resources (fish, grazing, …)	Traditional	case study	during incentive	Behaviour (in real field setting)	Crowding out suggestive
35. Martin et al. (2014).	Rwanda	Positive	forest conservation	Traditional	natural field experiment	during incentive	Behaviour (in real field setting)	Crowding in suggestive
36. Matzdorf/ Lorenz (2010)	Germany	Positive	conservation (biodiversity) / agriculture	Westernized	case study	during incentive	Behaviour (self-reported)	Crowding in suggestive
37. Midler et al. (2015)	Peru	Positive	conservation (biodiversity) / agriculture	Traditional + Ethnic	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive
38. Moros et al. (2019)	Colombia	Positive	forest conservation	Westernized + Traditional + Ethnic	lab-in-the-field experiment	during incentives	Behaviour (in experiment) + Motivational	Crowding out; Crowding in
39. Moros et al. (2020)	Colombia	Positive	forest conservation	Traditional	lab-in-the field experiment	post incentive	Behaviour (in experiment)	Crowding in suggestive
40. Narloch et al. (2012)	Bolivia, Peru	Positive	conservation (biodiversity) / agriculture	Westernized + Traditional + Ethnic	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive; Crowding in suggestive
41. Nieratka et al. (2015)	Mexico	Positive	forest conservation	Indigenous	case study	during incentive	Behaviour (in real field setting)	Crowding in suggestive
42. Polomé (2016)	France	Positive	forest conservation	Westernized	case study	during incentive	Behaviour (self-reported)	Crowding out suggestive
43. Reichhuber et al. (2009)	Ethiopia	Positive and negative	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive

44. Rodríguez-Sickert et al. (2008)	Colombia	Negative	over-use natural resources (fish, grazing, …)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding in suggestive
45. Salk et al. (2017)	Lao People's Democratic	Positive	forest use (resource extraction / illegal logging / over-use)	Traditional	lab-in-the-field experiment	during and post incentive	Behaviour (in experiment) + Motivational	No
46. Sherren et al. (2020)	Canada	Positive	conservation (biodiversity) / agriculture	Westernized	case study	during incentive	Behaviour (self-reported) + Motivational	Crowding in suggestive
47. Sommerville et al. (2010)	Madagascar	Positive	forest use (resource extraction / illegal logging / over-use)	Traditional + Ethnic	natural experiment	during incentive	Behaviour (self-reported + intentions) + Motivational	Crowding in suggestive
48. Travers et al. (2011)	Cambodia	Positive and negative	over-use natural resources (fish, grazing, …)	Traditional	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive
49. Van Hecken et al. (2019)	Nicaragua	Positive	forest use (resource extraction / illegal logging / over-use)	Westernized + Traditional	case study	during incentive	Behaviour (intentions) + Motivational	Crowding out suggestive
50. Van Hecken/ Bastiaensen (2010)	Nicaragua	Positive	conservation (biodiversity) / agriculture	Westernized + Traditional	natural field experiment	during incentive	Behaviour (in real field setting) + Motivational	Crowding out suggestive
51. Velez et al. (2010)	Colombia	Negative	over-use natural resources (fish, grazing, …)	Traditional + Ethnic	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive
52. Vollan (2008)	South Afrika, Namibia	Positive and negative	over-use natural resources (fish, grazing, …)	Ethnic	lab-in-the-field experiment	during incentive	Behaviour (in experiment)	Crowding out suggestive
53. Yasué/ Kirkpatrick (2018)	Australia	Positive	other	Westernized + Traditional	case study	during incentive	Behaviour (self-reported) + Motivational	No
Studies measuring relative motivation crowding effects of policy variants only								
54. Bernal-Escobar et al. (2021a)	Colombia	Positive	forest conservation	Traditional	lab-in-the-field experiment	during and post incentive	Behaviour (in experiment)	NA

55. Bernal-Escobar et al. (2021b)	Colombia	Positive	forest conservation	Traditional	lab-in-the-field experiment	post incentive	Behaviour (in experiment)	NA
56. Bernal-Escobar et al. (2021c)	Colombia	Positive and negative	forest conservation/ water services	Traditional	lab-in-the-field experiment	during and post incentive	Behaviour (in experiment)	NA

Note: *During incentive* means there is data on what happened when the incentive was in place; *post incentive* means there is data on what happened when the incentive was removed again. *Suggestiv*e here means that at least one of the following applies: non-parametric results found an effect, but in regression analysis it was not significant at 10% level; measuring or assessing motivation crowding was not the purpose of the study; study did not really allow disentangling effects on motivation crowding from other potentially relevant driver(s); result was speculative. *Relative motivation crowding effects* means that the study only compared motivation crowding effects across policy variants (but not relative to a no policy control). *NA* (not applicable) means thus that the motivation crowding effect of introducing the policy was not measured.

Table SM4.2. Studies analysing impacts of specific policy features

Policy feature	Variants analysed	No. of studies	Studies	Result
"Hard" policy design features (23 studies)				
Type of incentive	Positive vs. negative	2	Reichhuber et al. (2009)	Suggestive evidence that a combined collective tax and subsidy scheme outperforms a collective high tax scheme, potentially by inducing crowding in of intrinsic motivations.
			Vollan (2008)	Suggestive evidence that external restriction + fines induces crowding out in groups with a low voting result for such a rule. External reward does not induce crowding out, even in such a low voting scenario. (Study suffers from self-selection bias.)
Incentive level	High, low (sometimes medium)	8	Cardenas (2004)	Both low and high penalty increase cooperation likewise, suggesting that low penalty may cause crowding in and high penalty may, at least partially, cause crowding out of intrinsic motivations.
			Chervier et al. (2019)	Payment level does not affect intrinsic motivation (only money-related and subsistence-related motivations).
			Handberg/ Angelsen (2019)	Increase in cooperation is lower than expected as payment level increases. Evidence thus suggests crowding out for higher levels of payments for ecosystem services.
			Lopez et al. (2012)	Both low and high penalty increase cooperation likewise, suggesting that low penalty may cause crowding in I and high penalty may, at least partially, cause crowding out of intrinsic motivations.
			Reichhuber et al. (2009)	Suggestive evidence that high collective tax may, at least partially, crowding out intrinsic motivations. (However, the study does not allow comparing motivation crowding of high vs. low collective tax.)
			Rodríguez-Sickert et al. (2008)	Both low and high penalty increase cooperation likewise, suggesting that low penalty may cause crowding in and high penalty may, at least partially, cause crowding out of intrinsic motivations.
			Travers et al. (2011)	Low penalty does not affect cooperation but high penalty increases it; this could be due to high penalty causing crowding in of intrinsic motivations.
			Velez et al. (2010)	Both low and medium penalty decrease cooperation likewise, suggesting that both types of penalty may cause crowding out of intrinsic motivations. The authors report context-specific effects, however
Targeting	Equal vs. unequal conditions (Some receive incentive, others	2	Bernal-Escobar (2021b)	Suggestive evidence of crowding out if a policy setting is perceived unfair (payments for ecosystem services exclusion, implementing payments for ecosystem services inside and outside of a protected area; surprisingly, issuing restrictions in protected areas, but

	not or different one)			payments for ecosystem services in neighbouring area is perceived as fair).
			Moros et al. (2020)	Crowding in (post-policy) for all variants (partial removal of payments for ecosystem services following different criteria and full removal).
Duration of incentive	Length of time incentive is in place	1	Garcia-Armado et al. (2013)	A rise of utilitarian/ monetary motivations to the detriment of intrinsic ones is observed as the number of years under payments for ecosystem services increase. (However, the study suffers from self-selection bias.)
Conditionality	Degree of conditionality	2	Garcia-Armado et al. (2013)	Payments for ecosystem services seems to induce crowding out, while integrated conservation and development projects does not. (However, study suffers from self-selection bias, different incentive levels and co-existence of the two programs.)
			Kaczan et al. (2017)	Conditioning on additionality (introducing a fine conditional on reaching a target) induced crowding in (post-policy).
	Based on activity or results	1	Dörschner/ Musshoff (2015)	Suggestive evidence for crowding in by results-based payment compared to activity-based payment.
Unit of control	Incentive based on individual performance ('individual incentive') or group performance ('group incentive')	7	Agrawal et al. (2015)	Within an integrated conservation and development projects: more collective benefits caused crowding in; suggestive evidence that more private benefits caused crowding out. (However, study suffers from self-selection bias.)
			Kaczan et al. (2019)	Individual payments for ecosystem services performed better than group payments for ecosystem services. Post-policy: no motivation crowding effect of either variant.
			Midler et al. (2015)	Suggestive evidence that both individual and collective rewards lead to crowding out, but effect is larger for collective rewards. (Both were conditional on a group-level threshold.)
			Moros et al. (2020)	Crowding in (post-policy) for both individual and collective payment; suggestive evidence that the crowding in effect is larger for individual payment (holds only in their partial removal treatment).
			Moros et al. (2019)	Individual payment has no motivation crowding effect; crowding in of social motivations by collective payment (no effect on other motivations).
			Narloch et al. (2012)	Suggestive evidence that collective rewards induce crowding out compared to individual rewards.
			Salk et al. (2017)	Collective payment outperformed individual payment; no post-incentive motivation crowding effect of either.
Framing of the policy instrument (for payments for ecosystem services) 6 Studies				
Payment framing	Payment vs. reward vs.	1	Bernal-Escobar et al. (2021a)	'Reward' induced crowding in relative to 'payment'; no effect for 'Compensation'.

	compensation or co-investment			
Value framing	Emphasizing instrumental or other (e.g., relational) values and value frames	3	Lliso et al. (2021)	Crowding in for indigenous community under relational value framing, and for Campesino community under instrumental value framing.
			Maca-Millan et al. (2020)	Priming & emphasizing intrinsic and relational values turned crowding out into crowding in.
			Bernal-Escobar et al. (2021a)	Suggestive evidence of relative crowding in through emphasizing cultural ecosystem services (effect is stronger for farmers reporting having moral reasons for conservation).
Beneficiary framing	Emphasizing different beneficiary groups	2	Andrews et al. (2013)	No motivation crowding effect of emphasizing profitability of activity for payment recipients.
			Bernal-Escobar et al. (2021c)	No significant difference in motivation crowding when beneficiaries of water services provided are in the same district or distant capital.
Policy process (8 studies)				
Degree of participation	Rules externally imposed or voted on	8	Abatayo/ Lynham (2016)	Suggestive evidence that whether regulations are exogenous or endogenous does not affect motivation crowding.
			DeCaro et al. (2015)	The combination of voting and enforcement (decentralised punishment)—neither voting nor enforcement separately—increase voluntary cooperation. Evidence suggests crowding in of both intrinsic and extrinsic motivations as a possible underlying mechanism.
			Gatiso et al. (2015)	Imposed sanctions cause crowding out, self-determined sanctions do not. (For the groups with LOW initial endowment, the result suffers from self-selection bias.)
			Kaczan et al. (2017)	The evidence suggests that maximum participation (i.e. rule proposed by a random participant is submitted to a majority vote by rest of participants) causes crowding in compared to case of no such vote.
			Moros et al. (2019)	Being able to vote on type of payment has a crowding out effect under individual payment, no effect under collective payment. (This finding is biased by self-selection effects.)
			Rodríguez-Sickert et al. (2008)	No difference between voted and imposed fine regimes.
			Travers et al. (2011)	Allowing participants to vote on who receives a bonus payment is associated with higher cooperation than assigning the payment externally. This suggests crowding in by participation.
			Vollan (2008)	Crowding out in scenarios where the penalty rule had been chosen with the lowest possible group support for the rule. (However, study suffers from self-selection bias.)
Complementary policies (Adding other elements, such as…) (4 studies)				

Public recognition	Added or not	2	Maca-Millan et al. (2020)	Public recognition had a crowding-in effect relative to a traditional payment for ecosystem services.
Norm/ Info on others' behaviour	Added or not	2	Kerr et al. (2019)	Adding an injunctive norm appeal to payments for ecosystem services does not affect cooperation nor (post-policy) motivation crowding (crowding in was observed both with and without the norm appeal).
			Kits et al. (2014)	Adding social interaction (information on other group members' behaviour + communication) does not affect motivation crowding (crowding out was observed with and without social interaction).

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Annex 4.5. Deforestation and burning in the Amazon: from symptoms of two coexisting value dimensions towards opportunities for an inclusive notion of "humanity" and more plural valuations.[3]

Introduction

The Amazonia is the largest tropical forest on the planet with recognized importance in conserving biodiversity and in providing essential NCPs, including more than 50,000 terrestrial vascular plant species (Peres et al. 2010; Celentano et al. 2017) being the region of the world with the most intact forests (Potapov et al. 2017). The Amazon biome is home of a great diversity of cultures: today, an estimated 1.7 million people belonging to some 375 indigenous groups live within ~3,344 indigenous territories (IT) and ~522 protected natural areas (Walker et al. 2020). Their territories cover the eight nations (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela) and one overseas territory (French Guiana) (*Figure SM4.1*). Amazon ITs alone cover nearly one third (30%; including IT/protected area overlap) of the region's land area (Walker et al. 2020). Here biological, linguistic and cultural diversity converge and highlight the relevance to sustainability of the distinct forms of place-based knowledge that indigenous and local languages encode. Amazonia also provides vital NCPs such as regulation of the water cycle and climate-buffering forests, elucidating the meaningfulness of biophysical values. However, Amazonia is going through a process of environmental degradation that is expressed in alarming rise in deforestation, loss of biodiversity, water pollution, deterioration of the indigenous populations and cultural values and degradation of environmental quality in urban areas (FAO 2016; Savarese 2020; Tsavkko 2020). These forests are being highly degraded by changes in land use that are associated with large monoculture plantations (soybean), insecurity of indigenous and non-indigenous land property rights, weak institutional framework of land regulation, and dismantling of anti-deforestation policies (Griffin 2017; Kehoe et al. 2019; Lima et al. 2019; Phillips 2019; Reydon et al 2020). The devastating destructive threats to the vast biocultural diversity are aggravated by epidemiological outburst, resource contamination or depletion as a consequence of illegal mining operations, and incursions by armed illicit groups, that in turn trigger cultural change and ecological knowledge loss (RAISG 2020). Brazil has been the world leader in tropical deforestation, clearing an average of 19,500km^2/year from 1996 to 2005 (Pereira et al. 2019). If deforestation continues to rise, reaching about 40% of the total forest area and causing global temperatures to rise by 4°Celsius, much of the central, eastern, and southern Amazon will surely become a savannah. This phenomenon is known as the tipping point (Nobre & Borma 2009; Walker et al. 2019). In other studies, this imbalance point would be 20% of the deforested area (Lovejoy & Nobre 2018). By August 2018, 19.5% of the forest had been deforested (Pereira et al. 2020).

A growing body of evidence have demonstrated that Amazon Indigenous Territories act as barriers to outside pressures associated to frontier expansion, reducing deforestation and fire occurrence compared with areas outside their boundaries (e.g., SI 2020; Blackman & Veit 2018; Nepstad et al. 2006; Oliveira et al 2007). Overall, deforestation and different fire type occurrence (De Berenguer et al. 2020) reveal symptoms of a prevailing view of humans as separated from nature, a fragmented vision of how people value nature as a resource to be exploited by extractive activities even starting in the 16th century with colonization (Kengen 2019). Thus, the continued loss of forests by large-scale agricultural systems, livestock farming, extraction of timber and electricity generation have also given rise to unprecedented opportunities for the spread of disease vectors and increased prevalence of multiple zoonotic diseases (those that can be passed from animals to humans), including

[3] Literature review for the Amazonia case-study (https://doi.org/10.5281/zenodo.4396203).

coronaviruses, the latest causing COVID-19 (Afelt et al. 2018; White & Rasgour 2020; Ellwanger et al. 2020).

Contrast between two coexisting value dimensions

Two value dimensions are currently prevailing in Amazon. First, *verticality* as a way of thinking and perceiving reality and society characterized by the split and separation between its members. Human life and social relationships become a search for guarantees that justify the position of the subject at a high level, within the assumed scale (Erazo 2020; Santos 2006). This value system favours individual interests and profit-making. For instance, many resources are available for activities that drive biological and cultural diversity loss even more than for activities that revitalise and maintain them. These activities include focusing on market-based solutions and technological fixes that have a strong likelihood of generating further damage. Examples of such controversial actions include carbon trading, geo-engineering, synthetic biology and gene drives (Local Biodiversity Outlooks 2020; Evans et al. 2014; Gallemore & Jespersen 2016; Osborne 2015).

By contrast, a second trend is reflected in the intercultural *horizontality* (Zent 2013; Quijano 2016) as collaborative and reciprocal actions between groups. It is part of the Amazonian and High Andean communities (Erazo 2020) whose cultural and cosmological values of biodiversity tie the wild nature and cultivated plants. Thus, indigenous communities have conserved and managed a diversity of ecosystems underpinned by social, nutritional, medicinal, cultural, ritual, and ecological values (Levis et al. 2018; Garí 2001). The following agroecological systems echo horizontality by encompassing ecological and social values, land management strategies and local knowledge forms and practices.

Scientific research supports the claim that at least 40% of American tropical forests are the result of past human behaviors (Brown & Lugo 1990). Similarly, a significant number of agricultural products were domesticated by the Amerindians: wild and cultivated American flora inventories have a debt with indigenous peoples. Native Amazonian and Andean populations ethos validate their status as creative constructive agents in the compositions, structures and dynamics of areas that they have occupied customarily:

- Anthropogenic Amazonian forests, landscapes formations (Balée 1989; Goldammer 1992; Heckenberger et al. 2003; Balée y Ericson 2006) of diverse species & dominances (Bolivia, Brazil, Ecuador, Venezuela) including the construction and maintenance of botanical richness with the highest beta and alpha diversity in the Guyana shield in Venezuela (Zent & Zent 2004).
- Mounds and raised fields among ancient indigenous groups (Bolivia, Venezuela, Colombia; Denevan 1992, Langstroth 1996), are topographic modifications still managed by contemporary groups, and far from being isolated are very numerous (over 10,000 islands of forest, Erickson 2010) since at least 5c. a.C (Walker 2004).
- Domestication or semi-domestication of fruit trees since the beginning of Holocene (Schüle 1992). Amazonian manage, facilitate and protect hundreds of species (Irvine, 1987, Balée 1992, Clement 2006; Shepard y Ramírez 2011). To this process must be added significantly the food security strategies of timeless spatial and temporal scales (Fausto & Neves 2018), and the experimental agroforestry plots known as chagra/chacra (Coronel & Solórzano 2017; Rodríguez 2010). As a result, Amazonian ecological systems seemed to be conceived as an immense garden experiencing constantly agro-ecological processes where people had a very active role in its configuration (Levis et al 2018). Likewise, indigenous agroecological practices such as chacras, provides food security, health care, and biocultural resilience (Garí 2001). Remarkable examples are the enormous agro-diversity of varieties of important products underscoring staples food such

as potatoes (a single locality in the high Andes records 2500 varieties https://www.potatopro.com/news/2019/native-potatoes-new-hope-peruvian-producers), or manioc with more of 200 varieties (Salick et al 1997), sweet potato with more than 50 or even banana with over 40 types. Despite Amazonian soils being considered very acidic and in an era of genetic erosion, Amazonian indigenous peoples have been for centuries until today "ensuring in situ conservation and enhancement of agrodiversity" (da Cunha & Morim 2017).

- Positive impact of agricultural activities and prey populations supporting the hypothesis of hunting garden or horticultural-forest mosaics that attract prey (Linares 1976; Zent 1992, 1998).
- Diverse soil types fabricated by prehispanic peoples (*terra preta do indio*) highly appreciated for its nutritional properties displaying anthropic horizons from 70 centimeters to 1.2 meters deep, and expanding from less than a hectare to hundreds of hectares with 30-150 centimeters deep (Lehmann 2009; Morcote-Ríos et al. 2013; Schmidth 2013), that even could contribute to mitigate the climatic change (Schmidth et al. 2014).

Role of monistic values of nature in policies with impact on unsustainable conditions

Despite the complex biocultural mosaic aforementioned, state agricultural policies and development discourses (linked to national security concerns) expanding since the 1950's promoted cash-crop monocultures and large cattle pasturelands (Kengen 2019). It is interesting to note that the Amazon was valued as an empty land according to the political slogan in the year 1953: "a land without people for a people without land" (Hecht & Rajao 2020). Currently, deforestation by soy and-cattle frontiers is also affected by changes in world commodity prices, advances in genetic crops (Kehoe et al. 2019; Nolte et al. 2017), and especially by the price of land i.e., the least deforested areas have the lowest land prices, while deforested areas have the highest prices (Reydon et al. 2020). In this way, the prioritization of monistic values of land and nature in decisions and policies (and the concomitant lack of diversity of values) has contributed to the current unsustainable conditions: impact of deforestation on zoonotic disease risks, climate crisis, biodiversity loss and water insecurity; increasing the risk of virus pandemics such as COVID-19 to indigenous and local communities (FILAC 2020; Coshikox 2020).

Towards a construction of plural valuation and a holistic sense of nature

The worldwide COVID-19 has exposed the vulnerabilities and imbalances in our relationships with nature. Thus, addressing unsustainable conditions require holistic approaches linking culture and nature within more plural valuations across health, food, social, political and economic systems (Bakalis et al. 2020; Zafra-Calvo et al. 2020). Decisions could be made about which scales and actors have legitimate authority, how to align with laws and regulatory categories, and how to deploy valuation within an uneven terrain of decision-making influence (Tadaki et al. 2020). What counts as plural valuation might well vary according to the valuation purpose, and the identification and selection of actors with interests, influence and resources guided by their respective value systems. In order to meet objectives and targets for a plan, decision-making about the value of areas should reflect these patterns. In line with this, two complementary levels are proposed here to assess the performance of values-led decision-support tools: on the ground level with local community empowerment, and at broader spatial scales (Paim et al. 2020; Reydon et al. 2020).

On the ground level, actions, partnership development and collaboration between knowledge systems could include the following points: investing in and supporting alliances to guarantee respect for

human rights and human dignity; policy support and funding for grassroots food initiatives such as community seed banks, cooperatives, technological innovations and indigenous management practices (e.g., Erazo 2020; Nature Conservancy 2020; Local Biodiversity Outlooks 2020); also, by involving local people, their deeper local knowledge, spiritual and cultural values in developing forest restoration policies giving them incentives to take part with women playing vital roles (RMIB-LAC 2020; De Urzedo & Fisher 2018); embracing local economies, agroecological projects for nutrition, food security and health care; recognition of customary sustainable use and small-scale production; all of which offer multiple benefits for resilient systems and climate change mitigation and adaptation (Coronel & Solórzano 2017; Hanazaki et al 2018; Phillips 2019).

At the broader spatial scales, the Nexus approach (Paim et al. 2020) entails cooperation and dialogue amongst the institutions representing the water-energy-food sectors for the formulation of genuinely integrated policy. It also involves multi-level governance schemes among the local, regional, national, and international levels, and among different stakeholders, including government, the private sector, and civil society. Likewise, stronger institutional frameworks would encompass land regulation and the re-establishment of government command and control policies by monitoring, control, and inspection actions (Reydon et al. 2020; West and Fearnside 2021).

Education for sustainable development (Ruiz-Mallén & Heras 2020; Wamsler 2020) and more plural valuations can certainly open opportunities for transdisciplinary approaches, including One Health and green economy perspectives (Bonilla-Aldana et al 2020). Hence, restoration of the foundational role of ecosystems providing NCPs is crucial as a strategic response to zoonotic disease regulation, the current Covid-19 pandemic crisis, and reduction of future risks (Everard et al 2020; IPES 2020).

Inclusive notion of "humanity"

Overcoming dualism, disparities and separation in interactions between humans and more-than-human nature is crucial to addressing the current biodiversity and health crises. Indigenous societies disclose ways of knowing and being evoking different visions of culture and nature working together through relevant connections (Local Biodiversity Outlooks 2020). For instance, Amazonian languages lack a word for nature. The cosmos though, seems to be conceived as a sphere of life, an unnamed but clear concept of a life seat, similar to what the English geologist Eduard Suess (1875) defined as *the place on Earth's surface where life dwells: Biosphäre.* Nature as a unified non-human domain does not exist as an idea among Amerindians (Descola 1986): like people, some animals, plants, stones, mountains, rivers (and many other cosmic's components) have cultures (Viveiros de Castro 1986). Among Amazonians, nature and culture are not analogical concepts, rather, conform one non-divisible sphere of life, a system of development, a growing process and space where things happen, entities move, coexist, and where existential dynamics, perceived or real, take place (Zent 2014a). Amerindians pragmatically declare the elision of Western dichotomies (nature vs. culture) and consider utopian to name two spheres because only one is vital. Furthermore, such biosphere is populated with an immeasurable variety of persons that may be perceptually perceived as different in shape to *Homo sapiens* but nevertheless, they are endowed with the same intellectual and cognitive functions (Stolze Lima 1996). Personhood or the inter-subjective condition of the entities of the cosmos embrace no just humans, but includes a wide-range of entities, which expands the possibilities of appropriate interactions and communications among the cosmos beings: this condition establishes *a priori* -in behavior and words- a web of more horizontal, dialogic and polysemic interactions (Zent 2013).

Humanity as non-exclusive essential quality or condition of a single life form has been reported among many Amerindian groups from the Andes to the Arctic, since Hallowell explained the comprehensive human ontology among the Ojibwa (1960). A myriad of beings could potentially be *humans*, although it changes among the ethnic group in question: plants, animals, mushrooms, stars,

the sun, the moon, topographic features, mountains, rocks, etc., are not merely animated, but rather people in a different morphological appearance (Belaunde 2005). As opposed to being treated as objects, they are considered subjects, persons, bestowed with consciousness, intentionality, agency and even souls, therefore all of them have a role to play in the universe. The common original condition of men and animals is not animality but humanity as a condition, not humans as a species. Opposite of what Darwin claimed. Humanity is the original substance of most phenomena: the common or original condition of entities (Viveiros de Castro 2003). The laws of the society of all beings considered humans govern all biosphere dynamics (Descola) including the changeable predatory performances, subsistence and economic behavior to reproduce life (extraction, production, distribution, etc.), social relationships (kinship, conflicts, rituals, ethos of communication, etc.).

Amerindian universe is intersubjective. Besides humans, their universe is populated by uncountable other subjects with the same dynamics of interrelationships, social links, interpenetration and interdependence among them, each one attending their perspectives, interests and needs. Cardinal values shared all through the Americas by indigenous peoples are linguistically coded, a few representative example follow:

- *ijtïakï-bëjkyadï*: sharing/reciprocity, are the main conditions of being alive. The world order is a vast space of interconnectedness and exchange. Even people are partible and are not conceived as individuals but as *dividuals* such as in Melanesia (Strathern 1988; Mondragón 2007).
- *balebï*: motion, mobility, everything is persistently moving in the universe (Zent 2014b), in different spheres (water bodies, air, stars, human fluids, the sap of plants).
- *au wai*: interpenetration of essences and substance sparked by movement (Belunde 2005): being alive is the result of the penetration in our bodies of essences that sustain life (air, food, liquids, plants, animals, water, sun and moon lights, etc.). Amerindians emphasize a ceaseless gratitude towards myriads of entities that allow live (Kimmerer 2017)
- *wëjlakï bëjkya*: the consciousness that the outer world or environment is not apprehended equally by all species or individuals (similar to what Uexküll called umwelt 1909), therefore should be taken into account to preserve the world-order, its motions and interpenetrations respecting all entities stances (Zent 2014b).
- *me dekae-jkyo*: a bond to the Earth, living and engaging with one's surroundings, to immerse in their space or homeland (Zent 2013).

Such hyper-awareness of all living things' dependence on each other and other elements of the biophysical environment at macro-and-micro-scales in the cosmos creates among Amerindian peoples a clear ethos of group's responsibilities to construct or destroy the biosphere. Comparable to the Greek theory of discontinuity of matter based on the particle model (Leucipo 450 a. C., Democritus 460-370 a. C.), for Amerindians the transformation of the substance and matter are endless processes. People are responsible for the continuity, maintenance and change of the biosphere: the diverse ways to hunt, farm, fish, construct or destroy settlements and to define ways to articulate or interrelate with the cosmos entities and surroundings generate diverse life ecologies and ecogonies (causal roots that trigger people behaviors towards the biosphere Zent 2013). Ultimately, the actual shape of forests, savannas, rapids, rivers, mountains, agrodiversity and biodiversity, in significant degrees result from peoples' behaviors.

Conclusion

Major deforestation and recent zoonoses suggest that humanity must transform the current imbalance in our relationship with the natural world, underlining the ways in which values affect actions or behaviours. Promoting more plural valuations that guide more sustainable relationships by values-led approaches exemplified in indigenous and local communities, provide potential for changing

humanity's relationships. The inclusive notion of '*humanity'* proposed here facilitates more integrative forms of relation. The fact that indigenous lifestyles play a crucial role in conserving biodiversity acting as barrier to deforestation in Amazonia, demonstrate that their value systems and forms of knowledge have much to teach for addressing global ecological and sociocultural crises. Thus, transitions towards a plurality of systems and sustainability will embody integration of values, knowledge systems and actions on the ground level and at broader spatial scales (*Figure SM4.2*). In this way, plural valuations can facilitate the visibility of diverse values held by different actors acting at different scales e.g., cosmological, ecological, biophysical, economic and social values. Also, collaborative and integrative approaches in the interdependencies across the health, water, energy and food sectors are promising to tackle the growing pressures arising from climate crises. Likewise, education in multicultural contexts offer ways of bringing diverse knowledge systems together, ILK with science. It is worth to note that more singular approaches were also effective in reducing deforestation of the Amazon rainforest by the implementation of command and control policies. Ultimately, cooperation and dialogue among monistic and plural valuations at all levels should lead us towards more equitable and fair decision-making processes.

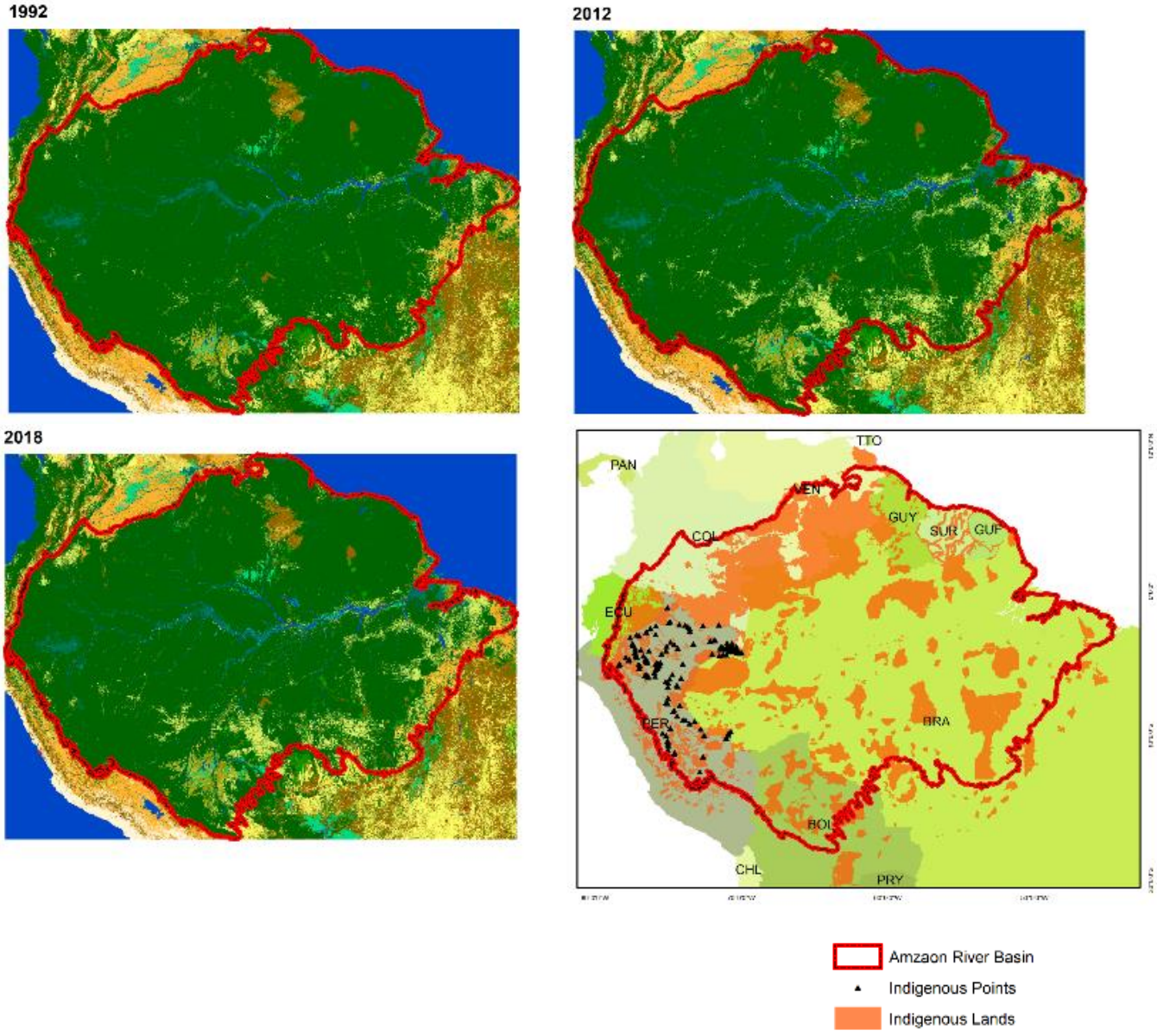

Figure SM4.1. Amazon River Basin - Sequence of biological and cultural maps. Amazon basin showing overlap of biological and cultural diversity. First three maps illustrate land use cover for the years 1992, 2012 and 2018, revealing a marked

contrast between forest (green) and agricultural areas (yellow). Fourth map exhibits Indigenous Territories (orange and black) distributed across the nine-nation region contained within the limit of the Amazon Basin (red line). 2012 has been reported as a year with a marked drop in deforestation as a result of effective policy control. Land use cover is available at: [http://maps.elie.ucl.ac.be/CCI/viewer/download/CCI-LC_Maps_Legend.pdf]

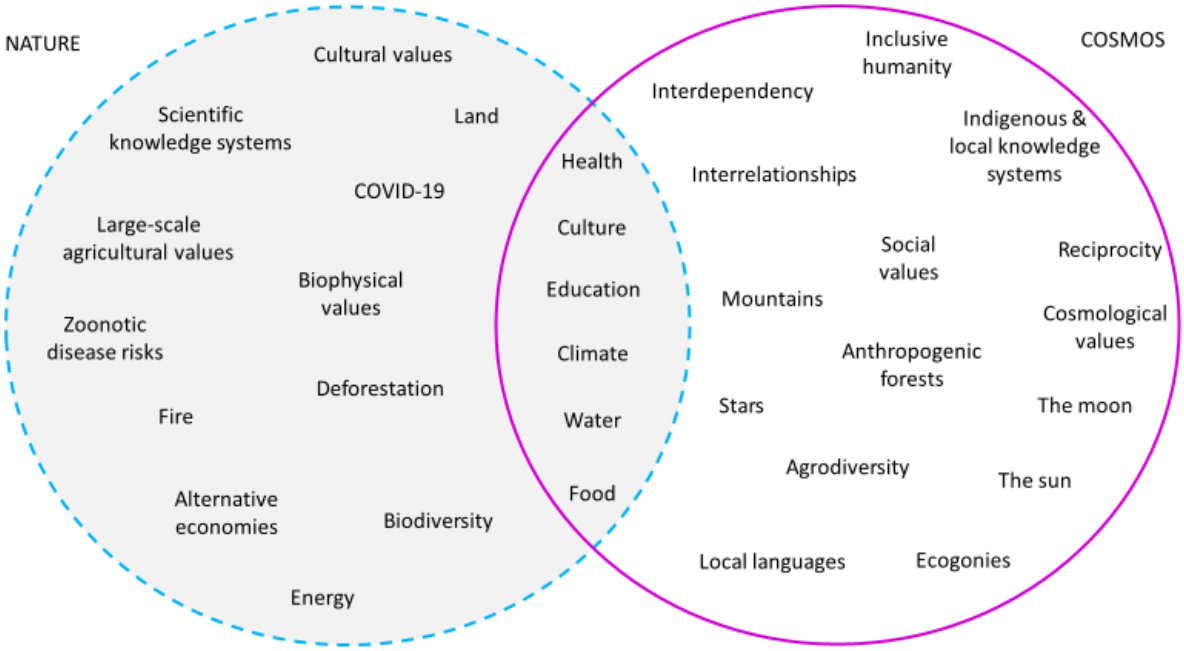

Figure SM4.2. Illustrative representation of systemic-holistic relationships

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Annex 4.6. Uptake criteria further defined and exemplified

The uptake criteria specified in *Table 4.3* (see *4.6.2.2*) are further defined and exemplified below.

Timeliness

H1: *Time-lags between initiation and completion of studies may imply that decision processes have moved on or shifted agendas.*

The hypothesis suggests that studies that have documented uptake are likely to have taken advantage of windows of opportunity in the issue cycle. Increasing complexity of ecosystem services assessments increases the time needed to complete them and reduces the likelihood that they can react to issue cycle opportunities. Long time-lags between collecting valuation data and publication may even mean that values are no longer current as social, economic and political priorities have moved on.

Although the importance of timeliness is mentioned by several scholars (Albert et al., 2014; Langemeyer et al., 2016; Rosenthal et al., 2015) literature on the issue of timeliness in the actual uptake of ecosystem services valuation is scarce. This may firstly be the case because timeliness is often overlooked when evaluating the uptake of ecosystem services valuation; salience, credibility, legitimacy and costs feature more prominently in assessments of ecosystem services valuation uptake (Fabian et al., 2019; Posner et al., 2016; van Oudenhoven et al., 2018). Another issue is that there may be a positive bias in the literature because scholars more often report when ecosystem services valuation was able to make use of a certain window of opportunity, while they do not reflect upon occasions when it did not.

Perhaps more importantly, however, is the issue that timeliness in itself is difficult to assess. As MacDonald et al. (2014) show, the timeliness of ecosystem services valuation is not only about conducting it at the right moment, but also about getting it to the right person at the right moment. In their study of the Murray-Darling Basin in Australia, they demonstrate that ecosystem services valuation was implemented into policy at regional scale but did not always reach those operating locally. Timing was one of the explanations interviewees offered as they mentioned that they had only become aware of the study well after they were asked to review the regional policy (during the consultation phase). As such, results did not necessarily trickle down to local practices. Scholars may find that the ecosystem services valuation they conducted reached those asking for the ecosystem services valuation (or those directly involved) in time and conclude timeliness is not an issue, overlooking the fact that their study did not reach others in need of the results in time. As Dick et al. (2017) mention, change in action takes time and sometimes it can be too early to tell whether ecosystem services valuation uptake has taken place.

In conclusion, in addition to time constraints and shifting policy agendas, the complex network of individuals working on a particular issue poses a challenge to the uptake of valuation knowledge. MacDonald et al. (2014, p.1458) also mention that the mobility of people in and out of organizations poses challenges to maintaining the relationship between (scientific) experts and practitioners. They therefore argue that '*developing knowledge about ecosystem services will require on-going engagement with the policy analysts who can be quite mobile*'. Timeliness is therefore also about involving and maintaining an enduring relationship with those in need of knowledge about ecosystem services valuation.

Salience

H2.1: *Lack of 'actionable' targets within existing institutional framing and mandates of decision-makers*

H2.2: *The regulatory framework is not conducive to use of certain types of valuation output*

Salient studies address 'actionable' options in the decision arena, comparing impacts including budgetary and legal consequences. Research that addresses this assumption is to be found in studies that analyse, and compare, methods for instrumental decision-making with national institutional rules for decision-making, in particular by using economic rationalisation. How much do legislation procedures include rules that favour the use of tools such as cost-benefit ex-ante analyses of policies and laws? To what extent are decision-makers trained to use specific types of instrumental method outputs, such as safe minimum standards, cost-effectiveness, cost-benefit or multi-criteria ranking of decision alternatives?

This hypothesis also relates to the traditional academic framings of the 'use of ecosystem service valuation' problem by economists: methodologies to correct "market failures" in the process of decision-making have been made available since cost-benefit analysis has been conceptualised in the mid-19th century, and then elaborated with environmental economics after the 1950s. However, an explanation for lacking uptake might be that regulatory frameworks in many countries do not admit valuation evidence as a basis for decision-support and policy design. This kind of explanation for a lack of economic analysis uptake was among the first to be observed in historical use of ecosystem services valuation papers. Liu et al. (2010), Navrud & Pruckner (1997) and Braüer (2003) had for instance highlighted how institutional contexts, especially in continental Europe, are unfavourable for economic analysis of environmental policies and issues. Boxes in section *4.2.4* provide examples of both conducive and unconducive regulatory contexts. Section *4.3* looks further at institutional characteristics favourable to different types of ecosystem services/NCP valuation.

Credibility

H3.1: *Lack of support for and use of a shared understanding of the underlying patterns and processes; unsupported assumptions; and/or non-transparent methods*

H3.2: *Valuation outputs that are too uncertain relative to decision-support requirements (biophysical and monetary)*

H3.3: *Decision-makers do not have sufficient training in valuation methods*

H3.4: Lack of standardization of valuation methods

Credible studies build on a shared understanding of how things work, conditions and trends and prospects of consequences, through transparent methods with explicit assumptions and documented uncertainty. Understanding needs to be shared about the nature of the problem, spatial and time scale and what constitutes relevant knowledge. Nature valuation is a tool meant to add credibility and support to environmental decision-making (Bagstad et al., 2013), but all methods developed and in use have faced criticisms. Credibility has also been defined as "the (perceived) quality, validity and scientific adequacy of the knowledge exchanged" at the science-policy interface (Sarkki et al., 2014). The means by which knowledge is produced and the people holding the knowledge both lend quality, validity and adequacy to information, e.g., valuation studies used to define and drive policy decisions. For example, for stated preference valuation methods, credibility issues stem from respondent uncertainty (e.g., Hanley et al., 2009), hypothetical bias (Murphy et al., 2005), part-whole bias (Boyle et al., 1994) or embedding effect (Diamond & Hausman, 1994; Kahneman & Knetsch, 1992), issues

in discounting choices (Arrow et al., 2013), and limited understanding of spatial variations of welfare effects of environmental goods and services (Glenk et al., 2020) among others. Mixed method approaches that address valuation gaps are popular but are limited by large participant group sizes (Bunse et al., 2015). Credibility in methods improves when issues like those listed above, are accounted for in documented, applicable and comparable case studies, with that documentation available to stakeholders.

With respect to ecosystem services, Seppelt et al. (2011) argued that the varied use of the term "ecosystem service" is in itself a credibility issue with no clear documentation of whether studies are referring to the same services, and if they are at all comparable. Their work identified problems like absence of feedback considerations between ecosystem services, lack of consistent definitions for system boundaries and limited in-depth involvement of stakeholders. The authors advocated for stakeholders to be involved in identifying ecosystem services of concern, evaluating indicators of ecosystem service assessments and ground-truthing management options. Mukherjee et al. (2014) exemplify these stakeholder roles in their study where they engaged with 106 experts to categorize and score mangrove ecosystem services before matching them with economic valuation data available in peer-reviewed literature. Their study showed valuation biases in favour of high-utility services like fishing, tourism and coastal protection, at the expense of '*fodder, water bioremediation, protection from salt intrusion, aesthetic value, pharmaceuticals and environmental risk indicators*'. They concluded that encouraging greater value pluralism maintains and improves credibility of ecosystem valuation. Thus, it is noted that maintaining value pluralism is increasingly challenging within expanding spatial and time scales.

Valuation studies are carried out subject to researchers' available financial and time resources, which often limit the possibility of follow up surveys to assess if and how value outcomes have changed. Single point valuation studies cannot therefore account for uncertainty of future changes to input variables, nor uncertainty of future changes to the valuation output itself (French & Gabrielli, 2004). In a study involving public and private decision- makers, of the range of ecosystem assessment and valuation tools available, models that offer the most in terms of quantitative data have been found to be too high in cost and time requirements (Bagstad et al., 2013). In geographic regions with even more difficult access to funding and required expertise, the widespread use and application of high-data-producing tools is further limited. This becomes problematic when considering that valuation studies accumulate uncertainties in method assumptions/models, human preferences, and biophysical system attributes (Tinch et al., 2019), added to aspects of system dynamics (delays in effects and leverage points), all of which can remain hidden in more preferred rapid assessment methods.

Drawing parallels with integration of climate change data in decision-making, organizations and decision-makers often have difficulties understanding and communicating latent risks, and uncertainties of those risks, to assets and resources, operations, services and the public (Palutikof et al., 2019). Similarly, decision-makers' understanding and communication of nature valuation outputs suffer from problems like (i) difficulties in measuring intangible benefits and the capabilities to express these intangible benefits (Sangha et al., 2019); (ii) identifying and acknowledging the complete range of stakeholders, as well as if and how their roles change over time (Felipe-Lucia et al., 2015); (iii) dissonance between method choices and valuation uptake by the private sector versus public sector (Tinch et al., 2019); and (iv) inconsistency in the socio-political relevance of ecosystem services and nature valuation (Seppelt et al., 2011).

Lastly, with respect to the inadequate literacy of decision-makers in economics, Driml (1997, p. 147) expresses this viewpoint: *'(...) Another likely factor [of low level of use of ecosystem services valuation in Australia] is that many management agencies do not employ people with the necessary training to make the best use of the economic information that is available'*. This may be considered a surmountable capacity-building issue relative to the other credibility issues.

Legitimacy

H4.1: *Lack of full representation of the perspectives of all legitimate stakeholders and impressions of serving vested interests*

H4.2: *Valuation knowledge hampers political strategies that require a certain opacity or ambiguity*

Legitimacy is the perceived fairness and balance in representation of multiple points of view in an assessment process and is particularly important if involved actors have conflicting values and contested knowledge systems at the local level, and when decisions implicate winners and losers (Berghöfer et al., 2016; Marin-Burgos et al., 2015). Posner et al. (2016) and Ruckelshaus et al. (2015) indicate that legitimacy is of paramount significance to achieving results of use and with impact. Yet, as Horcea-Milcu et al. (2019) note, in sustainability science the emphasis so far has been on ensuring that all relevant stakeholders are included in participatory processes, where they are able to express their values (e.g., Leventon et al., 2016; Newig & Fritsch, 2009). There is less focus on how the values of multiple stakeholders are negotiated: whose values count, how they are included, and how they shape processes? Therefore, as Vatn (2009) notes, concern over choices of methods is necessary to avoid deliberation becoming an arena only for those with good 'ability to say'. 'Ability to say' may furthermore be connected to power in terms of 'authority to say', as well as the correlation between 'willingness-to-pay' and income.

Against this background, Kenter (2016) notes that legitimacy on the part of those involved has been quite limited in the vast majority of empirical deliberative monetary valuation studies, raising questions about values elicited. Spash (2007) also documents that practitioners in the valuation field seem to pay little attention to issues of concern in appraisal processes. Marin-Burgos et al. (2015) discuss, for instance, contesting legitimacy of voluntary sustainability certification schemes in the Roundtable on Sustainable Palm Oil in Colombia, a case where core values of local actors conflict with those of the marked-based governance system and there are power asymmetries. Similarly, Oilwatch (2012) points out that tools such as multi-criteria assessments can be useful, but when there is a disconnect with local processes, they can be confusing and even dangerous. In this context, Martínez-Alier (2002) underlines that one particular valuation of ecosystem goods and services produced and/or lost may be recognized as a legitimate perspective among several, but if it is a reductionist one, then it might also harm the social legitimacy of other values. In this context, he asks: 'who has the power to simplify complexity, imposing a particular standard and procedure of valuation?' As a case in point, Huber (2019) by pointing at knowledge politics in Himalayan hydropower governance, documents that improper valuation and strategic ignorance of environmental risks facilitates the appropriation of economic benefits by powerful interest groups, and at the same time, increase the hazardousness of hydropower infrastructure and accelerate processes of social marginalization. Finally, in the context of indigenous peoples, colonization has attempted to de-legitimize governance structures (Alfered & Corntassel, 2005). For example, customary law has been replaced by colonial law, thereby delegitimizing practices and rules inherent in local values (Alfered & Corntassel, 2005). To illustrate, in Canada, the Indian Act has altered traditional forms of governance, and hence values guiding natural resource management such as spring burning, have been delegitimized and even made illegal (Morden, 2016).

Other authors have argued that monetary valuation may be incompatible with local ontologies of nature and its value (Sullivan, 2009) (see *Chapter 2* for further discussion).

Process documentation

H5: *Lack of independent assessment of influence on decision-making at appropriate timescales*

Processes and results that are well documented, transparent and comprehensible are preconditions for credibility and legitimacy criteria mentioned above. Patenaude et al. (2019) developed a systematic impact reporting framework and concluded from their analysis that there exists no clear definition regarding the impact of ecosystem service science. Attributional and consequential impact analysis is needed for successful application on a global scale. Berghöfer et al. (2016) identify as a key requirement the clear link between the valuation process and the public and private policy-making. Additionally, Posner et al. (2016) recognize the need to better understand the decision-making processes by scientists for an impact on decisions in practice. As valuation is a complex process in itself, there is a lack of documentation for decision-making in general and of the use of valuation. This connects to the lack of independent assessment of the influence on decision-making so far in the published literature (Fisher et al., 2008; Martinez-Harms et al., 2015). The reason for this lack could be due to the involvement of different groups in the valuation process at different levels and by means of various methods (Bagstad et al., 2013; Christie et al., 2012; Martinez-Harms et al., 2015; Kronenberg & Anderson 2019). Many methods are time-consuming (e.g., participatory methods) and the results and documentation must be meaningful and understandable for the users. Bagstad et al., (2013) mention the demand for standardized protocols for decision-support tools, but at the same time the need to adapt to local conditions which applies for the valuation process as well. For an independent assessment of the influence on decision-making, the decision-makers need to be involved in a further step which is not documented to its full extent. Keenan et al. (2019) conclude from their Australian case study the need for a unified and consistent ecosystem services reporting framework. Summing up, there is a need for a process documentation that fulfils multiple demands. The documentation process follows the involved timescales to close the loops and connects the involved parties.

Study cost

H6: *The cost of ecosystem service valuation restricts its use.*

It has often been argued by policy makers that the process of acquiring information about non-market value estimates for environmental goods takes too long and is too costly (Windle & Rolfe, 2011). However, only a few valuation studies have documented the human resource or time costs required to produce valuation results. Gowan et al. (2006) indicate the cost of a survey for ecosystem service valuation in Elwha River, US, which cost 6.2 million USD to complete, although the number includes the cost for finding the optimal dam removal methods. Harrison & Lesley (1996) estimate that the cost of the environmental damage assessment for the impact of the Exxon Valdez oil spill was 3 million USD, of which the field cost was 500,000 USD, and stated that '*less costly methods would allow one to conduct more surveys of any given environmental injury*'. No data was found on the profits made by environmental consultancies on damage assessment studies. It was pointed out by Harrison & Lesleley (1996) that cost was a constraint on the survey and attributed the high survey cost to the length of the survey and the fact that it was conducted in-person survey.

Barton (2007) documents the information cost and time spent for valuation of ecosystem services by value transfer in a research-driven study, which amounted to 20,000 USD and 15 man-weeks in total, which is much lower than the estimates of the studies above. Since the 2000s, online surveys have become available, and considering that the cost of a paper-based survey for choice modelling is calculated at 70 USD per survey and its duration at three months, while an online survey costs 15 USD per survey and takes around two weeks to complete, increasing and more competition have been further driving down costs of online surveys (Windle & Rolfe, 2011). Bagstad et al. (2013) describe

17 ecosystem services tools, among which five were mentioned as low-cost or cost-effective; nine, however, were mentioned as time consuming.

In conclusion, most studies show the cost of valuation has been high, and insist that the lower cost will be, the more opportunities for valuation to be utilized. Although online surveys and use of value transfer have lowered its cost, cost still restricts the use of valuation.

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Annex 4.7. Further details from previous reviews on valuation uptake

Laurans et al. (2013) found that only 2% of valuation studies reviewed in Ecological Economics documented use of ecosystem service valuation be it for informative, decisive or technical purposes. More recently Mandle et al. (2020) and Chan & Satterfield (2020) have conducted systematic reviews of hypotheses of lacking decision-relevance (see supplement for details of their findings).

More recent systematic reviews argue that the literature on ecosystem services over the past decades is evolving towards more decision and policy relevance, but important gaps and potential remain (Mandle et al. 2020; Chan & Satterfield, 2020).

Mandle et al. (2020) conducted a review of 'ecosystem service' and 'environmental service' literature in Web of Science and the ability of assessments to evaluate value change, distributional impact and vulnerability. They found only 13% of assessments included the full cause-effect chain from sea/landscape to ecosystem service value and only 7% considered distribution of ecosystem service benefits. Mediating factors for ecosystem service delivery were only considered in 35% of assessments.

Chan & Satterfield (2020) looked at related features of decision relevance in over three decades in ecosystem service literature. Despite 24% of studies looking at biophysical aspects of ecosystem services only 2.4% evaluated biophysical change. The proportion addressing policy and social dimensions is small (14%) but has been rising. Decomposing policy relevance, they find a significant increase in policy addressing equity issues, but no change in over three decades in studies of policy efficacy. Studies of ecosystem service values as drivers of change have only appeared in the last decade (1.5%).

For some methods published reviews of use as documented in government reports are available. For example, while reviews of actual impacts assessment reports are difficult and hence rare, there are several global and regional reviews of legislations on impact assessments (Loayza, 2012; UNEP, 2018; Acerbi et al, 2014; ELAW, n.d). For instance, the global review of EIA legislations by UNEP (2018) signals that while many countries and international financial institutions require the assessment of cumulative impacts on nature and biodiversity, they are also criticized as not being effective and there is need for a better measurement of ecosystem services. Furthermore, despite the increasing use of EIA in different parts of the world, uptake and implementation of legal requirements are found to be slow mainly due to lacking access to data on impacts on ecosystem services (UNEP, 2018).

Analysis of uptake using *Chapter 3* sample of valuation corpus

Using the same corpus, but a sample for 2010-2020[4], *Chapter 3* conducted a parallel systematic review with in-depth classification of valuation methods. Using this sample *Chapter 4* looked at the likelihood of *economic* valuation methods being taken up relative to other methods defined in *Chapter 3*.

[4] Systematic PCIV (Principles, Criteria, Indicators, Verifiers) review on valuation methods (https://doi.org/10.5281/zenodo.4404678).

Economic valuation methods identified in the *Chapter 3* review and assessed in *Figure 4.14* (see *4.6.3.3*) included:

- production function method
- economic (other)
- transfer approach
- market prices
- travel cost
- hedonic valuation method
- choice experiments
- contingent valuation
- shadow pricing
- cost based methods

All other valuation methods assess in *Figure 4.14* (see *4.6.3.3*) included:

- Questionnaires
- Impact assessments
- Scenario planning
- Interviews
- Stated preferences (other)
- Expert workshops
- ES mapping and modelling and/or valuation
- Biophysical assessment methods (species distributions, habitat suitability, conservation planning methods, ecosystem mapping)
- Participatory mapping methods a.k.a. PGIS and PPGIS
- Deliberative valuation
- Livelihood dependence
- Integrated modelling
- Participant observation
- Photo series analysis
- Happiness surveys
- Q methodology
- Photo voice
- Delphi panels
- Participatory rural appraisal

Decision-making tools not included in the category of "other valuation methods" in *Figure 4.14* (see *4.6.3.3*) included

- Cost-effectiveness analysis
- Cost-benefit analysis
- Multi-criteria decision analysis

Figure 4.14 (see *4.6.3.3*) compares the frequencies of the different categories of uptake for economic valuation methods and all other methods except decision-making tools as defined above.

Table SM4.3. Relative uptake of economic valuation methods

Categories of uptake	Economic valuation all (n)	All other excluding decision-making tools (n)	Total (N)	Economic valuation methods (%)	All other valuation methods excluding decision-making tools (%)
Cursory reference to uptake (desired)	306	596		86.67%	90.00%
Documented uptake researcher initiated (test)	35	47		9.92%	7.10%
Documented uptake stakeholder initiated (use)	12	19		3.40	2.87%
Sum	353	662	1015	100.00%	100.00%

Discussion

Results from the valuation uptake review should be considered with the following caveat.

Keyword screening of valuation applications

The systematic review of valuation uptake is based on sampling from a list of method keywords that could be identified in the title and abstract of papers. *Chapter 4* used a somewhat narrower definition of valuation methods than *Chapter 3*. Due to sampling choices, in particular the method keywords 'benefit/value transfer', 'participatory GIS', 'Q-method' and 'narrative analysis' may have been under-represented relative to the *Chapter 3* sample. The effect on uptake is not clear, as it depends on whether actual uptake for these methods is higher or lower than the average.

False positive classification of uptake

The validation exercise was conducted for 'false positives' – classification uncertainty was documented regarding uptake of valuation[11] -, i.e., checking whether studies identified as uptake by reviewers were independently verified as such. There was no validation of 'false negatives' because (i) the objective of the study was to identify an expected minority of studies documenting uptake, so the expected bias is towards positive identification, (ii) the efficiency of identifying false negatives is much lower considering the expected large majority of no uptake studies. Validation of false negatives was expected to be much more time intensive per study than assessing false positives, and the review did not have the person power to carry this out within the scope of the study. To our knowledge false negatives have not been addressed either in other valuation blindspot reviews cited in the introduction.

A validation of the subsample of "documented uptake" studies was undertaken by the coordinating lead author and 2 co-coordinators of the review who coincided with the contributing authors in 38% (N=68) of studies that they were substantively documented as valuation uptake.

Without further clarification, the upper uptake uncertainty range for documented uptake is [9.4% (Ns=178/N=1900), 15.7% (Ns=178/N=1123)]. Applying the correction factor of 38% (62% false positives) found in the validation, a lower bound uptake is [3.5% (Ns=68/N=1900) ,5.9% (Ns=68/N=1123)].

Sources of valuation applications

It is necessary to be careful in arguing that valuation of ecosystem services and nature's contributions to people is not being used at all. The results reported here concern the research literature published in scientific journals. It does not cover 'grey literature' consulting reports commissioned by non-research organizations. Valuation uptake in policy documents is addressed in several boxes on country specific experiences. These country examples present a mixed picture, with a country like the UK showing greater policy uptake than the scientific literature would suggest.

Studies in the systematic review were classified into informative, decisive and technical purposes, which in turn had sub-classes of specific purposes. The discussion of the results above focuses on these main purposes.

Given the qualitative nature of the classification system, sub-classes were defined more for the purpose of providing a detailed definition of the main purposes, than to provide a fine-grained classification for statistical analysis.

Review results in light of informative purposes

The valuation uptake for informative purposes contributes to discussions, modifies points of view, and demonstrates the interest to certain policy options, but does not determine a choice with respect to a specific decision and/or have a technical purpose. Four informative purposes are identified, namely value formation/expression/affirmation with regard to nature; advocacy and awareness raising of total value, trade-offs, conflicts; evaluation of already made decisions and policies adopted; assessment of historic trends with accounting and indicators.

In the literature, it is possible to find an example for each informative purpose where different valuation tools are used. Kenter (2016) for instance, uses deliberative monetary valuation, systems modelling and participatory mapping to assess shared values of ecosystem services and explores contrasts between individual willingness to pay and shared values expressed as group-deliberated fair prices. He shows how deliberation on social-ecological systems impact on value formation, and how participatory mapping might elicit distinct values not reflected in the monetary valuation. Costanza et al. (1997) and Hernández-Blanco et al. (2020) estimate the total current economic value of ecosystem services based on published studies using various valuation methods and a few original calculations to raise awareness with regard to the importance of ecosystems for society. Munda & Russi (2008) undertake a social multi-criteria evaluation of rural electrification and solar energy investment decisions made in Spain to facilitate the design of more effective energy policies for rural communities in the future. Fish et al. (2016) and Villamagna & Giesecke (2014) present many and diverse ways to elicit values (from questionnaire surveys, qualitative mapping, group discussion and a participatory arts-based research processes), which feed in multi-indicator frameworks accounting for material and non-material qualities of local landscapes to local communities.

In terms of results, after reviewing N=935 studies with a general valuation uptake purpose for the pilot**,** broadly similar patterns to the Laurans et al. (2013) study were found: informative purposes were more frequently (67%) used than decisive and technical instrument design in studies that had either 'cursory reference to uptake' or 'documented uptake'. And, among the four informative purposes identified in the literature, of the 67% of studies with an informative purpose (N=625), the majority of informative studies (59%) had the purpose of awareness raising, and then formative/affirmative (22.2%) and ex-post justification (16.2%) of a decision. Notably, the use of valuation as input to accounting and indicators was the lowest scoring purpose (6.7%). This would suggest that valuation of ecosystem services/nature's contributions to people studies has emphasized general rather than specific or applied informative purposes. This might be expected as research projects interact mostly with stakeholders outside the decision-relevant contexts. But still, Laurans & Mermet (2014) point out that studies for informative purposes can have a decisive effect over time as they can help reframe the policy debate. In terms of testing the hypotheses depicted by Laurans et al. (2013), the sub-section further discusses insights on their relevance for blindspots in the informative purpose category (ecosystem services valuation may be too often inaccurate; may contain fundamental inadequacies; the cost of ecosystem services valuation may restrict their use; decision-makers may not have sufficient training in the language and axioms of economic analysis; regulatory frameworks may not be conducive to the use of ecosystem services valuation; ecosystem services valuation, by enhancing transparency, may hamper political strategies that require a certain opacity).

Review results in light of decisive purposes

Valuation uptake, in this case, is where a given economic analysis has been commissioned to support the process of choosing over options. It deals with cases where a specific decision can be identified, for which a valuation was carried out before the decision was taken ("ex-ante" valuations). It can comprise situations where the analysis was not (only) specifically commissioned to support the very decision that was taken, as long as it is shown that the valuation was used to elect a given option in a given decision-making process. Three main criteria define this type of use of valuation: (i) the possibility to identify a specific decision; (ii) valuation has been produced before the decision (ex-ante); (iii) its result, or its process, has been used, by actors other than the authors, to define alternatives and / or to choose among them.

When this use of valuation is cursorily mentioned four exclusive categories of potential use are possible:

- Ecosystem services valuation meant to produce guidance with respect to values and data, considered in further decisions. For instance, Van Houtven et al. (2017) propose a meta-analysis of willingness to pay for water quality improvement that could be used to better define future water policies. They however note that the heterogeneity of the valuation contexts reduces the range and usability of the meta-values their analysis has produced;
- The process of producing an ecosystem service value is meant to structure the alternative, and / or to organize the participation in a process where choices are made among those alternatives. Garmendia et al. (2010) for instance, depict an experiment where a participatory process enabled collectively defining coastal zone policy options and expressing preferences across this range of alternatives. Fish et al. (2016) define and categorise viewpoints and perspectives of citizens over landscape management so as to document the various ways the landscapes matter to people, and this is conveyed to people in charge of designing a local space and landscape management plan;
- Ecosystem services valuation is meant to define policy or project alternatives, such as in Naidoo et al. (2009), where authors demonstrate that the various values associated with sound forests can inform choices made with respect to the development of palm oil

plantations. It is also intended to choose among these alternatives, as when Schleiniger (1999) defines the most cost-effective ways to abate nitrogen emissions in Switzerland;

- Ecosystem services valuation is meant to define environmental (typically, ecological) criteria used in managing ecosystems, space, protected areas. For instance, Schröter et al. (2014) produce ecosystem services valuations intended to inform and optimise the management of forest biodiversity in a county of Norway.

In terms of results of the uptake review, it is noted that this type of use of valuation is what matches the most with common academic economic analysis thinking. This uptake is indeed the closest to the academic economics assumptions: cost-benefit analysis is meant to rationalise public choices (Pearce & Turner, 1990). In the initial uptake review of Laurans et al. (2013), it was therefore not surprising that decisive use of valuation was the most numerous single expected uptake of valuation. However, when subcategories were added, it was observed that informative use of valuation was even more present in the intentions manifested by ecosystem services valuation authors. What came more as a surprise, and will have to be further evaluated, is the relative paucity of use cases in this category. Although use cases were numerically and proportionally higher for this category than for others, the number and proportion of papers depicting and analysing actual (and not potential) decisive use of valuation were modest.

Review results in light of technical purposes

Technical objectives of a valuation allow informing policy instruments directly e.g., by informing pricing goods and using service valuing for loss compensation. This kind of valuation has been used to value a minimum standard for harvesting quotas, a conservation target for reserve site selection, and to establish pollution emission standards. Explicit use for pricing is seen in cases where ecosystem service valuation is used to determine taxes, fees and other purely economic instruments. Lastly, a 'textbook' technical application of ecosystem service valuation is in determining damage and compensation costs for legal purposes. This use of valuation is characterized by Laurans et al. (2013) as one that occurs after a decision for a project or policy has been made and deals with the implementation aspect of that project or policy.

Looking at how technical purposes are represented in peer reviewed literature, of the ecosystem services/nature's contributions to people studies in the uptake reviewed, only 10% were classified as technical with 90% of those focused on using valuation for pricing of ecosystem services or setting incentive levels. Only 9 studies dealt with damage compensation. While this review is not exhaustive of the range of ecosystem services/nature's contributions to people studies published, it does echo the findings of Laurans et al. (2013) in terms of the paucity of this kind of study. De Groot et al. (2012) screened 320 publications, covering some 300 case study locations for ES valuation and collating all of these in an Ecosystem Service Value Database. They recognized that even if the database allowed them to standardize monetary values of specific ecosystem service types and defined areas like parks, the purpose is to inform decisions on trade-offs rather than direct price setting, suggesting that low representation of technical use of valuation studies is expected. Studies of technical use of valuation are highly context specific and may have limited applications outside of similar contexts, unless for informative or comparative purposes, suggesting issues of timeliness. Monetary valuation approaches tend to aggregate the values expressed by a survey sample and use that to represent the value of the service to society, even when broader groups of individuals may attribute significantly different values to an ecosystem service (Small et al., 2017), in addition to that value changing over time from when a study was conducted, making repeatability challenging. Förster et al. (2019) used valuation experts to define a set of criteria by which they found only 6 of 109 valuation studies could be used in decision making for German national policies. They noted more studies on provisioning services than regulating and cultural services, and possible issues of lacking representativeness of ecosystem

services users. All of these examples serve to highlight why technical use of valuation may be limited in peer reviewed literature.

However, valuation for policy design could be expected to be commissioned by local and national governments as consultancies, which due to the political nature of decision-making may be confidential and remain unpublished. If published, it would be expected that technical policy design valuation studies be more present in the non-academic grey literature with no easily searchable repository of knowledge. In consequence, conclusions about a 'blindspot' regarding technical applications of ecosystem services/NCP valuation continue to be a knowledge gap in this assessment.

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Annex 4.8. Coincidence of Aichi target 2 reporting and valuation at country level[5]

Figure SM4.3 shows the distribution of Aichi 2 target achievement in National Reports to the Convention on Biological Diversity[6]. Around 24% of countries reported being on track or exceeding Aichi 2 targets. The figure also shows three indicators of uptake of valuation that, hypothetically, should increase the likelihood of national reporting of Aichi target 2 progress on valuation: (i) number of national valuation studies of nature's contributions to people, (ii) implementation of the System of Environmental and Economic Accounts Central Framework (SEEA CF) and (iii) implementation of SEEA Ecosystems Accounts (EA) at national level as reported by UN CEEA (2021a, b). In this analysis it was hypothesised that SEEA CF implementation both increases likelihood of SEEA EA implementation, and both increase likelihood of Aichi target2 fulfilment. Another hypothesis was that the number of NCP valuation studies in a country, including ecosystem services, both increases the likelihood of SEEA EA implementation and reporting of Aichi target 2 fulfilment. The variable "Number of NCP valuation studies" (conducted during 1990-2020) corresponds to the levels in *Figure SM4.3* in the main text, where very limited (0-100 studies), limited (100-200 studies), some (200-1000 studies), high (>1000 studies).

The data support the assertion that national authorities reporting to the Convention on Biological Diversity on the uptake of valuation of biodiversity in policy does not correlate closely with valuation progress in a majority of countries. It was found that more valuation studies and priori SEEA CF implementation tend to increase the likelihood of SEEA EA implementation. Among the minority of countries reporting on Aichi target 2, SEEA CF and EA implementation is somewhat reflected in national reporting on Aichi 2 target reporting (*Figure SM4.4*). A number of countries implementing SEEA CF and SEEA EA do not report this in their national reports to the Convention on Biological Diversity. The global picture is that Aichi 2 target reporting had gaps in many countries, failing to reflect SEEA accounting ongoing at national accounting level, and was also not in proportion to the amount of valuation research published for each country. This national level data indicates a lack of communication in many countries between national biodiversity policy agencies, statistical agencies implementing SEEA and national valuation research communities.

[5] Coincidence of Aichi target 2 reporting and valuation at country level (http://doi.org/10.5281/zenodo.6468917).

[6] Data on National Reporting to the CBD of Aichi target 2 was provided by the CBD Secretariate (January 2021). Similar data has been reported earlier in Global Biodiversity Outlook 5 (GBO-5), based on evidence from the IPBES Global Assessment published 2019. Percentages reported on Aichi target #2 may differ with GBO-5 because the data we use here is more recent and we report "unknown" and "not reported" categories which were not included in GBO-5.

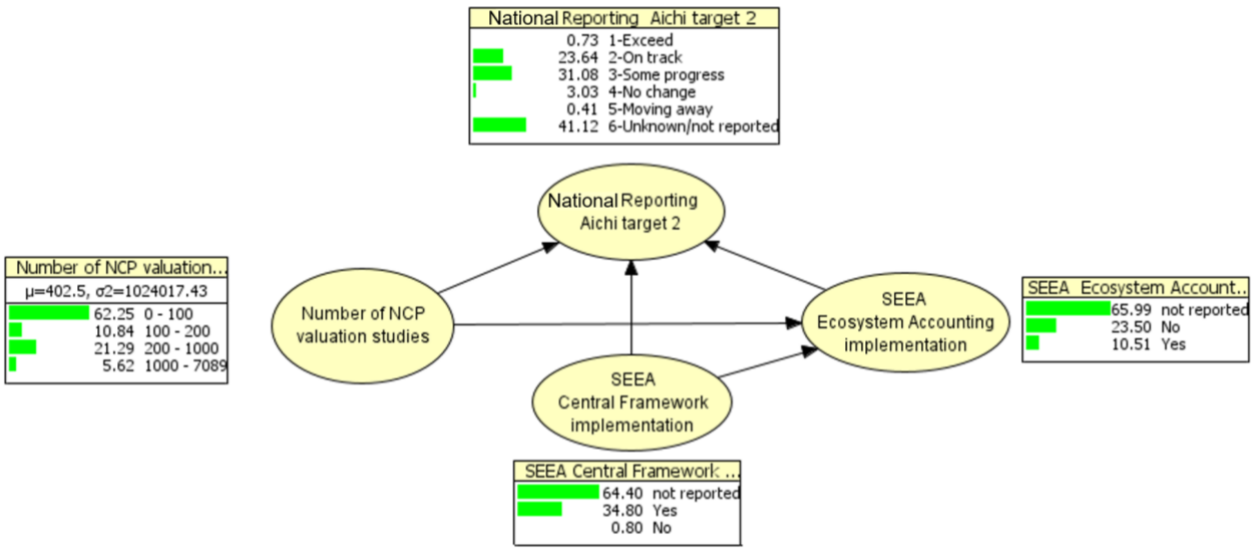

Figure SM4.3. Likelihood of valuation research and accounting in national biodiversity strategies and action plans reporting national level achievement of valuation targets (Aichi target 2)

The country level data has been analysed with a Bayesian network in Hugin software, where nodes represent conditional probability distributions, and arrows represent hypotheses about causes. Valuation research studies by country were obtained from the literature corpus used for uptake review in *Chapter 4* (see data protocol). Valuation study frequency per country was grouped into categorical variables: very limited valuation research (<100 studies 1990-2020), limited (100-200 studies), some (200-1000) or high (>1000 studies), based on an analysis of discretization ranges that best correlated with the uptake variables (discretization tool in Hugin software).

Figure SM4.4 shows that countries reporting Aichi 2 target "exceeded" or on "on track" were likely to be countries with the fewest NCP valuation studies carried out in their countries (45%). They were about as likely as not to be implementing SEEA Central framework (47.29 %), and were unlikely to be implementing SEEA ecosystem accounting (15.5%).

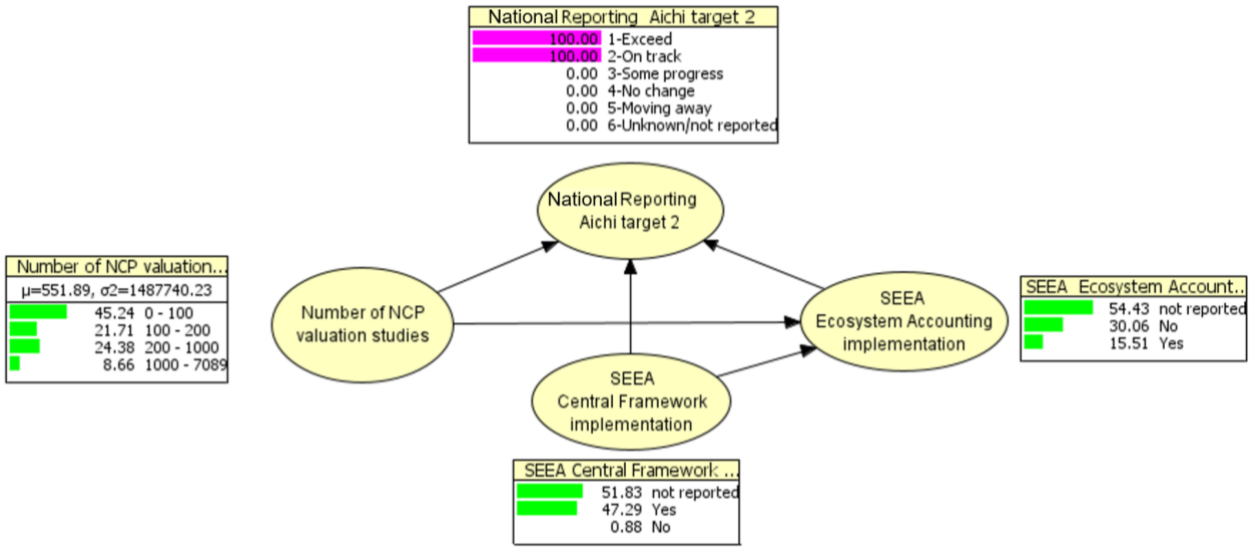

Figure SM4.4. Likelihood of national biodiversity strategies and action plans reporting national level achievement of valuation targets (Aichi target 2), SEEA implementation and of valuation research in countries implementing SEEA EA or Natural capital accounting

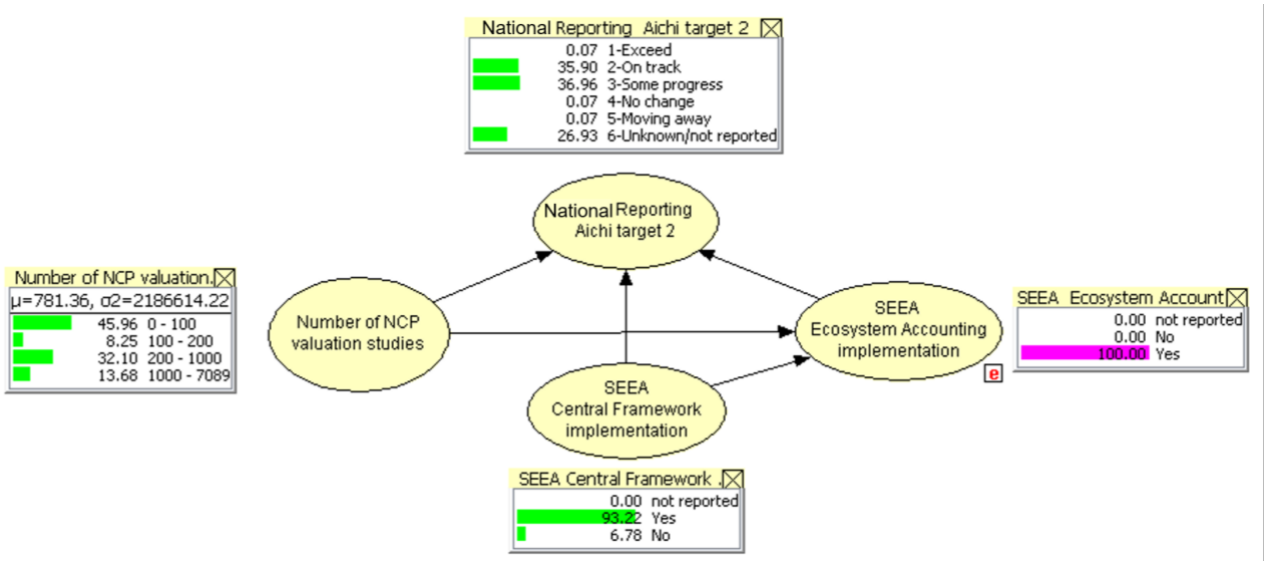

Figure SM4.5 Likelihood of countries implementing SEEA ecosystem accounting having a high volume of valuation research and priori implementation of SEEA Central framework

Conversely, *Figure SM4.5* shows that countries implementing SEEA ecosystem accounting at national level were likely to already implement SEEA CF (93 %), but this was not necessarily related to a high level of historical valuation research in the country (46% of countries had less than 100 studies during 1990-2020). Countries implementing SEEA Ecosystem Accounting had a variable approach to Aichi target 2 in national reports to the Convention on Biological Diversity, reporting "on track" (36%), "some progress" (37 %) or not reported (27%).

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Annex 4.9. Public natural capital accounting and policy uptake at the national level

The SEEA organizes environmental and economic data in an integrated and conceptually coherent set of accounts to produce information to mainstream the environment into policymaking. Traditionally, the SEEA's main purpose has been to support macro-economic and sectoral decision-making, as well as reporting on the economy-environment nexus. The spatial and biophysical foundation of the more recent ecosystem accounting approach has the potential to inform (sub)national and local stakeholders and their decision-making needs, such as in land-use planning. The SEEA is also increasingly seen as providing a framework for organizing data to underpin global reporting such as on the Sustainable Development Goals and the Convention on Biological Diversity. As many of the challenges countries face today are highly interconnected across domains (economic, social, environmental), stakeholders, and scales (local, national, global; Hoekstra, 2020), integrated policy frameworks based on an integrated information system, that enable policy makers to address these challenges are needed. Recently, accounts have been used to provide support across a range of policies (Edens, 2020). The ecosystem accounts follow a more participatory process including stakeholder consultation, in part because of its multi-disciplinary nature which necessitates collaboration across various agencies.

Macroeconomic policy support

In Mexico, the accounts are used for informing macro-economic policies regarding the costs of natural resources depletion and environmental degradation in the form of an Environmentally-Adjusted Net Domestic Product. China has developed a Gross Ecosystem Product indicator as complementary measure to GDP to quantify the value of the contributions of nature to economic activity as part of its transition towards inclusive green growth (Ouyang et al., 2020).

Biodiversity policy support

The accounts have also been used to support biodiversity policies, for instance, in South Africa (Statistics South Africa, 2021b) that has compiled accounts for protected areas, Brazil that has compiled accounts for threatened species (IBGE, 2020) and Uganda for Chimpanzees (UNEP WCMC & IDEEA, 2017).

Emissions tracking and climate policy support

Climate policies also benefit from accounts compilation. The Dutch carbon accounts for instance quantified emissions from soil subsidence which has had an impact on water management regimes (Hein, 2020; Hein et al., 2020a, 2020b). Indonesia compiled ecosystem accounts for peatlands, which have an important role in identifying the physical and monetary impacts of peatland rehabilitation and emissions monitoring (The World Bank & BPS, 2019).

Sectoral policy support

A range of sectoral policies has been supported by ecosystem accounts, such as forest policy in the UK (Forestry England, 2019) and Guatemala (Vargas, 2015), water policy in South Africa (Nel & Driver 2015) and the Philippines (Porras & Goodrich, 2017).

Spatial planning

The spatial nature of the ecosystem accounts supports land-use and planning decisions, e.g., in Rwanda (Bagstad et al., 2019). For example, in China, GEP accounting has been used to inform a range of other decision-making contexts, including eco-compensation policies, for ecological "red-lining" (Ouyang et al., 2016).

There is overall strong agreement on the significant potential of the accounts for policy making, as evidenced by several countries that have established high-level committees for mainstreaming (UK and Italy s NCA Committees) or India's Committee on Greening the Accounts (MOSPI, 2013) or developed an elaborate SEEA strategy and action plan (Statistics South Africa, 2021a; Commonwealth Australia, 2018). Various countries or regions have established a legal base for the accounts (the EU, Mexico, Philippines). In summary, accounts can be an important vehicle for mainstreaming of biodiversity and ecosystems in a wide range of decision-contexts and are becoming increasingly widespread. For enhanced policy uptake accounts need to be developed in close collaboration with the intended users and stakeholders. Further documentation of national level application of natural capital accounting to policy can be found in supplementary materials, Edens (2020) and on the UN SEEA webpage (UN SEEA, 2021a).

During the Global Consultation on the SEEA EA draft (UN SEEA 2021b), a number of countries voiced concerns about monetary valuation. The arguments against valuation included that it would be inappropriate for National Statistical Offices to undertake the compilation of monetary values because of the need to use imputations and make assumptions when doing non-market valuation, and that more piloting and experimentation would be required. There were also conceptual concerns raised regarding the interpretation of the System of National Accounts (SNA) as it pertains to exchange values in non-market contexts and to the overall ecosystem accounting framework portraying ecosystems as transactors of ecosystem services. Finally, caution on the interpretation of the results was raised, highlighting the risk of misuse or inappropriate interpretation by policy makers, potentially leading to perverse or biased outcomes. Arguments by proponents for including the monetary valuation chapters as part of the standard included, that the valuation approach used in the SEEA EA is based on existing SNA principles adapted to the environmental context, similar for instance to the valuation of unpaid household work; that ecosystem accounting fits within the changing role of NSOs towards becoming data stewards; that concerns on the quality of estimates do not imply that the conceptual framework itself is deficient; and that concerns about misuse of data are common to all statistics, and can be addressed by proper dissemination practices. Finally, in light of the high level of policy interest, the importance to have standardization of measuring ecosystem services was mentioned, which would otherwise be implemented in different ways.

During subsequent discussions a compromise was found. In March 2021 the UN Statistical Commission agreed to remove the "Experimental" from the title of the revised SEEA Ecosystem Accounting, adopting chapters 1-7 describing the accounting framework and the physical accounts as an international statistical standard. They also recognized that, Chapters 8-11 of the SEEA Ecosystem Accounting describe internationally recognized statistical principles and recommendations for the valuation of ecosystem services and assets (UNSD 2021). Countries were encouraged to address outstanding issues in the SEEA EA research agenda to allow monetary accounts to become a standard in the near future (UN CEEA 2021). The UN Common Agenda Report (UN 2021) calls for "new measures to complement GDP" and urges "Member States and others to already begin implementation of the recent System of Environmental-Economic Accounting (SEEA) Ecosystem Accounting."

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Annex 4.10. Ecosystem service valuation in policy in the European Union

This supplement is a longer version of the abridged text in *4.6.4.3*.

Achieving the environmental objectives of European Union policy requires the long-sought mainstreaming of environmental concerns across all policy sectors. Economic valuation of environmental impacts, services and assets has an important role to play in achieving that.

The European Union policy agenda has long been characterised by tension between conservation and economic prosperity; politically, the 'Lisbon agenda' for growth, jobs and innovation came to dominate the 'Gothenburg strategy' for sustainable development.[7] Although the European Union has remained at the forefront of developing environmental policy commitments and targets internationally, for example the 2030 Agenda (European Union n.d.-b[8])[9] global and European pressures have further marginalised environmental objectives in European Union policy making.[10]

Late in 2019, the European Commission presented the "European Green Deal", "Europe's new agenda for sustainable growth"[11] followed by the Green Deal Investment Plan,[12] Just Transition Mechanism,[13] proposed European Climate Law (COM(2020) 80 final), new Circular Economy Action Plan (COM/2020/98 final), and European Union Biodiversity Strategy for 2030. The main focus of the Green Deal is climate neutrality by 2050, with decoupling of growth from resource use, and social justice ("no person and no place is left behind").

[7] The Amsterdam Treaty (OJ C 340 of 10.11.1997) sought both '*a high level of protection and improvement of the quality of the environment*' and '*sustainable and non-inflationary growth, a high degree of competitiveness and convergence of economic performance*'. Article 6 called for mainstreaming of environmental concerns in all Community policies: the Cardiff process (COM/98/0333 final) aimed to achieve this, with mixed results. Conflicting strategies were developed: the Lisbon Strategy envisioned the European Union becoming '*the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion*', by 2010 (Lisbon Presidency Conclusions; European Council 2000). The following year, the Sustainable Development Strategy (SDS) (Gothenburg Presidency Conclusions; European Council 2001) emphasized the need to balance the three pillars of sustainable development: the Lisbon emphasis on innovation, growth, and jobs became the dominant political focus (Steurer and Berger, 2010). Hence the Sixth EAP was much less ambitious than the Fifth, linking environmental action to objectives for growth, competitiveness and employment, while the Europe 2020 strategy (COM(2010) 2020 final) proposed five headline targets for boosting growth and employment, and one on climate/energy policy (split off from environment via DG CLIMA), and biodiversity was subsumed in one of seven flagship initiatives, 'Resource efficient Europe' (COM(2011) 571 final). Other strategies followed, including the Green Infrastructure strategy (COM(2013) 249 final), European Union Biodiversity Strategy to 2020 (COM/2011/0244 final), the Seventh EAP (Decision 1386/2013/EU) and the first Circular Economy Action Plan (COM(2015) 614 final).

[8] "The European Union was instrumental in shaping the global 2030 Agenda, which is fully consistent with Europe's vision and has now become the world's blueprint for global sustainable development" (European Commission n.d.-c).

[9] The European Union aims to implement the 2030 Agenda through fully integrating the SDGs in European policy and priorities, including reorienting the budget towards long-term objectives via the Multiannual Financial Framework beyond 2020.

[10] Including the global and euro financial crises, failure to meet the Lisbon goals, migration and energy security concerns, rising populism and differentiated integration between member states (including Brexit) and the disconnect between the longer term environmental challenges and the short-term exigencies of electoral politics (Zito et al., 2019).

[11] "Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, Europe needs a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy" (European Commission n.d.-a)

[12], The European Green Deal Investment Plan (EGDIP), also referred to as Sustainable Europe Investment Plan (SEIP), is the investment pillar of the Green Deal. To achieve the goals set by the European Green Deal, the Plan will mobilise at least €1 trillion in sustainable investments over the next decade (European Commission 2020b).

[13] The Just Transition Mechanism (JTM) is a key tool to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind. It provides targeted support to help mobilise at least €150 billion over the period 2021-2027 in the most affected regions, to alleviate the socio-economic impact of the transition (European Commission n.d.-d)

Thus despite years of efforts, environmental policy (other than climate policy) remains marginalised, and the latest "State of Nature in the EU" report (COM(2020) 635 final) "*underlines the need for a step-change in action if we are to have any serious chance of putting Europe's biodiversity on a path to recovery by 2030*."

Solving this impasse requires effective mainstreaming, and that would be greatly aided by strategic valuation evidence, taking account of cumulative impacts, that can be used to build business cases, direct financing, monitor progress and support instruments such as PES. The policy environment is such that mainstreaming all but requires valuation: for example the European Union Parliament resolution on European Union Forest Strategy invites the Commission to "explore options to incentivise and remunerate climate, biodiversity and other ecosystem services appropriately" and "stresses the importance of developing and ensuring a market-based bio-economy in the EU" (European Parliament, 2020). Ensuring sustainability and environmental justice within such frameworks requires strong valuation evidence for non-market services.

To date, although valuation evidence is increasingly used in communicating policy priorities,[14] European Union policy has made little use of environmental valuation evidence. Some policies leave space for valuation, in particular the Water Framework Directive (European Commission n.d.-b), where environmental and resource costs and benefits can be used under Article 4 (exemptions based on disproportionate costs) and Article 9 (cost recovery of water services). The Marine Strategy Framework Directive calls for "economic and social analysis of the use of those waters and of the cost of degradation of the marine environment", while the Environmental Liability Directive allows valuation if resource equivalence methods are not feasible.[15]

Greater use of valuation has been promoted in particular by the European Union Biodiversity Strategy for 2020 (COM(2011) 244 final) which called for assessing values of ecosystem services and for integration of values in accounting and reporting.[16] This promising avenue led to a sustained research effort in ecosystem service assessment, valuation, and reporting, through Mapping and Assessment of Ecosystems and their Services (Biodiversity Information System for Europe, n.d.) and Knowledge Innovation Project on Integrated System for Natural Capital and Ecosystem Services Accounting in the European Union (European Commission, 2021; European Union, 2019) [17] and supporting research projects. Although the Mapping and Assessment of Ecosystems and their Services first European Union-wide ecosystem assessment (European Commission - Joint Research Centre 2020) does not include any monetary estimates, it lays the foundations for ecosystem service quantification and valuation at the European scale. The new European Union Biodiversity Strategy 2030 section "Measuring and integrating the value of nature" (COM(2020) 380 final)[18] includes the aim to further

[14] For example the EUBS2030 includes a Business Case for Biodiversity that cites several monetary values as well as jobs linked to nature at the European Union level (European Commission 2020a).

[15] "If it is not possible to use the first-choice resource-to-resource or service-to-service equivalence approaches, then alternative valuation techniques shall be used. The competent authority may prescribe the method, for example monetary valuation, to determine the extent of the necessary complementary and compensatory remedial measures."

[16] Action 5 Improve knowledge of ecosystems and their services in the EU. Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at European Union and national level by 2020.

[17] KIP INCA aims to develop natural capital accounts to understand dependence on ecosystems at multiple levels: macro-indicators to use alongside GDP, support for European Union Sectoral policies, promoting environmentally responsible business practices, and contributing to a globally consistent approach to account for ecosystems and their value (UNSEEA and UNSEEA EEA).

[18] "Biodiversity considerations need to be better integrated into public and business decision-making at all levels. Building on existing work, the Commission will develop in 2021 methods, criteria and standards to describe the essential features of biodiversity, its services, values, and sustainable use. These will include measuring the environmental footprint of products and organizations on the environment, including through life-cycle approaches and natural capital accounting. In this context, the Commission will support the establishment of an international natural capital accounting initiative." (COM(2020) 380 final).

develop, in 2021, "methods, criteria and standards to describe the essential features of biodiversity, its services, values, and sustainable use." Methods cited are environmental footprints, life-cycle approaches, and natural capital accounting. There is no direct mention of monetary valuation, but accounting requires that, and European Union progress (European Commission 2021; Vysna et al., 2021) towards ecosystem accounting that is compatible with the recently adopted UN statistical standard for ecosystem accounting (SEEA EA) is to be welcomed. Nevertheless, there may be a risk that the focus on accounting, green/blue growth and market instruments could promote exchange values at the expense of welfare values. This would be a regressive step insofar as representing values to people and improving environmental justice are concerned.

Evidence suggests that the policy relevance of ecosystem service assessment and valuation could be enhanced. There has been some criticism of the practical impact and validity of applied cost-benefit analysis when it has been used by Member States to assess policy targets of European Union Directives (Feuillette et al. 2016).[19] The European Court of Auditors (2019) found failings in the Commission's implementation of environmental accounting that reduced their usefulness for policy makers.[20] The ValuES project (ValuES n.d.) found assessments often fail to "achieve their full potential in terms of practical usefulness and policy relevance" in part through failure to balance "the trio of credibility, legitimacy and relevance": "Numbers rarely speak for themselves" (Berghöfer et al., 2016).

Hence, the development of tools and evidence is only part of the solution. Although the use of 'ecosystem services' framing is now mainstream, valuation is still often mistrusted or misunderstood by policy makers. This reflects tensions between intrinsic and anthropocentric conservation motives (Tinch et al., 2019)[21], resistance to the concept of non-use values, and unfamiliarity with the tools and methods of valuation. Decision-making practices and cultures vary across Member States, and unless explicitly harmonized by European Union directives such as the WFD, leaving the choice of environmental policy assessment criteria to individual Member States is consistent with subsidiarity. At the European Union scale, demonstrating successful uses of valuation and accounting will be an essential component of mainstreaming and achieving the goals of the Green Deal.

[19] "A tool used as a retrospective pseudo-justification was turned into a tool used against sustainable water management by some commercial stakeholders unwilling to make further investments" (Feuillete et al., 2016).

[20] Problems included: not setting out a long-term view of EEEA data needs and indicators for policy support, a strategy that lacks a comprehensive action plan, slow progress, focus on data availability/maturity and administrative burdens for Member States over compiled data needs, implementation of EEEA modules without a full cost-benefit analysis, and not using EEEA modules to their full potential for monitoring environmental policies.

[21] For example, the EUBS20 has the longer-term goal for 2050, European Union biodiversity and the ecosystem services it provides "*are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided*" (European Commission, 2011).

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Annex 4.11. Case study of how ecosystem service assessments have influenced UK Policy

UK environmental policy has been significantly influenced by ecosystem service assessments. The Millennium Ecosystem Assessment (MEA, 2005) was considered by the UK Parliament[22] leading to a scoping study for an English assessment (Haines-Young & Potschin 2008) and then[23] the UK National Ecosystem Assessment (UK NEA 2009). The UK National Ecosystem Assessment assessed the state of biodiversity and ecosystems, examined benefits to society, and applied ecosystem valuation across the UK. Results demonstrated that failing to account for values of ecosystem services "forgoes opportunities for major enhancements in ecosystem services, with negative consequences for social well-being" (UK NEA 2011) and called for greater inclusion of non-market values in decision-making.

Previous work had made similar recommendations; but the UK National Ecosystem Assessment was government-commissioned and launched by the Secretary of State for Defra and the Minister for Government Policy in the Cabinet Office. Similarly, the Natural Capital Committee (NCC), established in 2011 to advise the Government on sustainable use of natural capital, reports directly to the Economic Affairs Committee of the Cabinet. The Environment White Paper (HM Government 2011) took mainstreaming the value of nature in decision-making as a defining theme.

Since then, the Natural Capital Committee has produced several reports including annual reports on the state of UK natural capital and advice on issues such as accounting for the value of nature, restoration of natural capital, and the economic case for investing in natural capital (Department for Environment, Food & Rural Affairs, 2016). Defra and the Office for National Statistics (ONS) published a roadmap for natural capital (2012, 2015, 2018) (Office for National Statistics 2018) and the Office for National Statistics now publishes both Environmental Accounts (Office for National Statistics 2020) and Natural Capital Accounts (Office for National Statistics 2019). In 2014 the government commissioned the UK National Ecosystem Assessment Follow-On to further develop and communicate the evidence base and enhance its relevance to decision and policy making across the UK (Albon et al., 2019).

In 2017, the Natural Capital Committee recommended development of a 25 Year Environment Plan and major revisions to the HM Treasury "Green Book" (Natural Capital Committee, 2017; HM Treasury, 2020). The resulting Plan (Department for Environment, Food & Rural Affairs & The Rt Hon Michael Gove MP 2018) (a "sister document" to the Clean Growth Strategy (Department for Business, Energy & Industrial Strategy 2017)), draws together many targets and strategies, with a central focus on "protecting and growing natural capital" (Curnow 2019). The forthcoming Environment Bill will provide the statutory instruments for achieving these goals (UK Parliament 2021).

The Green Book revision (2018) saw greater emphasis on valuing non-market impacts, measurement and monitoring of natural capital stocks, and recognition that cumulative effects on natural capital of multiple decisions must be considered, measured, and valued (Department for Environment, Food & Rural Affairs 2020a). Lower discount rates for health impacts were introduced.

In both cases, much of the substance already existed (Department for Environment, Food & Rural Affairs 2018), but dispersed across different strategies and guidance, applied in a piecemeal fashion (Tinch et al., 2014). A key innovation is the Plan pulling everything together under a coherent framework. Evidence of policy mainstreaming is the incorporation of the Plan in the manifestos of

[22] House of Commons Environmental Audit Committee 2007

[23] In conjunction with Devolved Assemblies, in order to allow a UK-wide approach.

all major political parties and in its launch in the first environment-focused speech by a British Prime Minister in 17 years (Greenhouse, 2018).

Alongside these processes, there have been major efforts in developing evidence and tools for natural capital valuation (Özdemiroğlu 2019). Defra has drawn together tools, data sets and case studies to publish extensive guidance on Enabling a Natural Capital Approach (ENCA) (Department for Environment, Food & Rural Affairs 2020b), supporting decision-makers and analysts in applying Green Book principles. Corporate natural capital accounts have been compiled by many UK public sector bodies and private companies (Dickie & Neupauer 2019). Valuation evidence is being used to justify investment in natural capital, for example in catchment management (Mathieu et al., 2018). Work is ongoing: for example HMT has commissioned an independent, global review of the Economics of Biodiversity (Dasgupta 2021).

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Annex 4.12. Corporate accounting and nature-related financial disclosure

Environmental, social and governance (ESG) data enable financial institutions to identify material social, governance and environmental risks and opportunities are often used by the finance sector for excluding companies with high ESG risk from investment portfolios, investing in low ESG-risk companies, and in some cases engaging with companies to reduce their ESG risks (MSCI, Sustainalytics, FSE RUSSELL, ISS, Trucost). Positive screening means that rather than excluding companies, investors select companies that set positive examples of responsible business practices. Unlike negative screening, positive screening requires an analysis of complex ESG factors including environmental issues. Within the environmental dimension, much attention has been given to climate risk as climate change tops the list of ESG concerns for investors (PRI, 2019). To support the Paris climate agreement, the Financial Stability Board (FSB) created the task force on climate-related financial disclosure (TCFD) in 2015. This voluntary disclosure platform was designed *to 'provide a framework for companies and other organizations to develop more effective climate-related financial disclosures through their existing reporting processes" and support "more informed investment, credit [or lending], and insurance underwriting decisions'* (TCFD, 2017). The task force on climate-related financial disclosure has defined climate-related risks into two major categories: transition risks (transition to a lower-carbon economy) and physical risk (impacts of climate change; TCFD, 2017). The demand for climate-related disclosure and data has increased significantly since the release of the task force on climate-related financial disclosure recommendations (PRI, 2019). For example, more than 450 investors with $40 trillion American dollars (USD) under assets under management committed to engage with the world's largest corporate greenhouse gas emitters to strengthen their climate-related disclosures by implementing the task force on climate-related financial disclosure recommendations as part of Climate Action 100+ (Climate Action 100+, 2021). In June 2020, several financial institutions alongside government and multinational companies announced a new initiative intended to help corporates measure, disclose and minimise their nature-related financial risks (the task force on nature-related financial disclosures (TNFD)).The framework will provide corporates in all sectors with best-practice advice for measuring the financial risks they are facing as a result of the over-exploitation of natural resources (i.e., deforestation, overfishing, poor soil management) and as a result of extreme weather events (TNFD, n.d.).

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Annex 4.13. Further references regarding policy instruments

This set of references were gathered and analysed to provide further evidence to section *4.6.5*, especially, to support the information in *Table 4.4*. The policy instruments consulted had been organized by country.

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New Zealand

Co-management arrangement with Ngai Tūhoe iwi by incorporating Tūhoe customary values and laws (Ruru, J. 2014. Tūhoe-Crown settlement – Te Urewera Act 2014. Māori Law Review).

All regional and territorial councils with responsibility for environmental management are also required to take into account any iwi environmental management plans for a given area (Thompson-Fawcett [Ngāti Whātua] et al. 2017. Indigenous resource management plans:

transporting non-indigenous people into the indigenous world. Planning Practice & Research 32(3): 259-273. http://dx.doi. org/10.1080/02697459.2017.1308641).

A recent New Zealand decision to grant legal personhood to the Whanganui River led to significant changes in management practices. This legal settlement is rooted in the reciprocal relationships between the Maori people and the river, expressed in Maori language as "*Ko au te Awa, ko te Awa ko au.*" [I am the River, and the River is me.] (Whanganui River Maori Trust Board 2014. Available on: http://www.wrmtb.co.nz/new_updates/Whanganui_River_Settlement_Ratification_2014_v2.pdf)

Annex 4.14. Uptake case #1: Declaration of Atrato river as subject of biocultural rights, Colombia[24]

Context

The Department of Chocó is one of the richest territories in natural, ethnic and cultural diversity. It is conceived as an "ecoregional complex", encompassing four regions of rich humid and tropical ecosystems (mangrove ecosystems, grasslands, humid forest, guandal forest) (Rangel 2004) that are defined as one of the most biodiverse places on the planet. Additionally, it has a hydrographic network that is made up of three basins, namely: the Atrato River (with an approximate area of 40,000 km^2), the San Juan River (with a surface of 15,000 km^2), and the Baudó River (with an area of 5,400 km^2). The territorial forms that predominate in the basin are collective territories of black communities, indigenous *resguardos* (reservations) and protected areas. The Atrato River is one of the most important rivers in the world, it is born west of the Andes Mountain range, specifically in the *Cerro Plateado* at 3,700 meters above sea level, its extension is 750 kilometres, of which 500 are navigable. The widest part of the river has a length of 500 meters, and as for its depth, it is estimated that it can reach up to 40 meters. It receives more than 15 rivers and 300 streams among which, some of the main are the following rivers: *Andágueda, Baté, Bojayá, Buchadó, Cabí, Cacarica, Capá, Domingodó, Napipí, Neguá, Munguidó, Murrí, Opogodó, Puné, Quito, Salaquí, Sucio, Tagachí* and *Truandó*.

Nearly 471,601 people live in the department, of which 70% are Afro-Colombian and 11% are indigenous. There are approximately 2'915,339 hectares titled as collective territories of black communities, which correspond to 24 of the 30 municipalities of the department, and where approximately 591 black communities are settled. In addition, there are approximately 116 indigenous resguardos with populations of the ethnic groups Emberadóbida, Emberakatio, Emberachamí and Wounaan (Proyecto Azul,2014), as well as mestizo communities.

Mechanized mining exploitation is a complex phenomenon that began with the extraction carried out by foreign people from the region who own the machinery. As time passed by, the activity intensified and spread in the territory. In this sense, the Ombudsman's Office verified that: "in different territories of ethnic communities (indigenous and Afro-Colombian) in the country, from the mid-eighties to today, a significant group of foreign actors has come in an aggressive way, without consultation and without the control of the competent authorities, developing mining activities in an indiscriminate and irrational way, which has implied a massive degradation and modification of large part of these territories, that hold high levels of biodiversity" (Pueblo, 2010). Mining has modified, transcendentally, the culture of rural communities, which is evidenced in the emergence of various phenomena, such as prostitution, economic dependence due to a progressive abandonment of other traditional economic practices, community divisions, and unschooling.

The impacts of these extractive economies are not only reduced to serious environmental devastations, such as deforestation, mercury pollution of water sources, loss of biodiversity, diversion and depletion of riverbeds, abrupt deterioration of the landscape, among others. It has also brought great social impacts over traditional practices, such as agriculture, mining, forestry, livestock, hunting, fishing and gathering of natural products, which have been the activities used over time by Black Communities to guarantee their permanence in the territory, the conservation of life and their self-sustainable development, (Cocomopoca Community Council, Ethno-development Plan - productive component). Likewise, there have been internal social conflicts, family ties breakage,

[24] This case was originally written and submitted as a contribution to *Chapter 4* in Spanish. For the purposes of analysis and presentation of the data, the case has been translated into English.

processes of young people unschooling, phenomena of prostitution, intimidation of social leaders, lack of exercise of ethnic authority, among others (Constitutional Court, 2016).

Table SM4.4. Damages

Actors	Damages
Community councils, indigenous resguardos, mestizo communities	**Cultural:** The environmental damages in the Atrato River basin cause great impacts on ethnic communities to the extent that they promote displacement, increased school dropouts, high rates of prostitution, and in general, threaten the traditional ways of life of the communities. This occurs due to a lack of respect for, and impediment to, the development of ancestral subsistence activities such as agriculture (planting bananas and other products for own consumption -called *pancoger*-) and artisanal mining (*barequeo*). On the contrary, it imposes a single mode of livelihood: mechanized mining (Constitutional Court, 2016).
	Health: Fishing is the main economic activity of a great number of families, who sell the fish and also, consume it. However, fishing has been hampered and tragically diminished, as the toxic substances and heavy metals that seep into the river are absorbed by the fish. In February 2014, a specialized study was published by the Javeriana University, the von Humboldt Institute, the World Wide Fund for Nature (WWF), the Technological University of Chocó, the University of Tolima, the University of Antioquia, the Catholic University of the East, Funindes and the Aquaculture and Fisheries Authority AUNAP. In this diagnosis it was possible to establish that out of the 186 freshwater species existing in the Biogeographic Chocó (63 of them endemic, i.e., they are not found anywhere else in the world), 15 species are in high threat and risk as a consequence of the environmental impact caused by mining and forestry activities at the Atrato River basin.
	To water: The levels of water pollution in the waters of the Atrato, derived from the mining activity, and the consequences on the health of the inhabitants of the riverside populations, especially in the municipalities of Lloró, Bagadó and Atrato, have reached a critical point. According to the recent report prepared by the Ombudsman's Office, the Atrato, San Juan, Andágueda, Apartadó, Bebará, Bebaramá, Quito and Dagua rivers have been contaminated and their channels diverted. The Cabí River is also affected by toxic spills, something that is alarming because the Quibdó aqueduct is supplied with the waters of this flow.

Valuation of the basin

After a process of reflection, generated during training events in the Bajo Atrato with the Association of Community Councils of Bajo Atrato (ASCOBA), framed in the regional peace agenda of the Inter-Ethnic Solidarity Forum Chocó (FISCH), there was a reflection on the situation of the damage to the Atrato River. Others who joined this process were the Greater Community Council of the Popular Peasant Organization of Alto Atrato (COCOMOPOCA) and the Greater Community Council of the Integral Peasant Association of Atrato (COCOMACIA), which came together to seek solutions to the environmental conflicts in the basin. This initiative was led by the FISCH and legally accompanied by the organization Tierra Digna. This initiative was supported by the Quibdó Diocese and had technical support from the Institute for Environmental Research of the Pacific (IIAP) and from the Technological University of Chocó (UTCH).

The guardianship of the Atrato is finally brought in 2015 with the purpose of obtaining the protection and safeguarding of the fundamental rights to life, health, a healthy environment, food, water, and territory, of the Afro-descendant communities, which have been systematically threatened and infringed due to the serious damage and contamination of the Atrato River. It was intended that the guardianship judge protected the fundamental rights, and that they issued a series of orders and

measures that would allow the articulation of structural solutions to the problems that were generating a socio-environmental crisis in the basin.

Table SM4.5. Involved actors (source: Constitutional Court, 2016).

Petitioners (Plaintiff)	Greater Community Council of the Popular Peasant Organization of Alto Atrato (COCOMOPOCA), Greater Community Council of the Integral Peasant Association of Atrato (COCOMACIA), Association of Community Councils of Bajo Atrato (ASCOBA) Inter-ethnic Forum Solidaridad Chocó (FISCH), and others.
Actuated (Defendant)	Ministry of Environment and Sustainable Development, Regional Autonomous Corporation for the Sustainable Development of Chocó CODECHOCÓ, Corporation for the Sustainable Development of Urabá - CORPOURABA, Ministry of Health and Social Protection, Ministry of Mines and Energy, National Mining Agency, Ministry of Agriculture and Rural Development, Ministry of Housing, city and territory - Vice Minister of Water and Basic Sanitation, Ministry of National Defence, Ministry of National Education, the Departments - Governments of Chocó and Antioquia, the Municipalities - Mayors of: Acandí, Bojayá, Lloró, Medio Atrato, Murindó, Quibdó, Vigía del Fuerte (Antioquia), Turbo (Antioquia), Riosucio, Río Quito, Unguía, Carmen del Darién, Bagadó, Carmen de Atrato, Yuto

Table SM4.6. Participant actors (source: Constitutional Court, 2016).

Community / organization	**Institutional / Academic / Others**	**Non-governmental organizations**
ASCOBA COCOMOPOCA COCOMACIA FISCH Community councils of the Quito River	IIAP UTCH Quibdó Diocese Cartagena University Colombia National University Colombian Ichthyologist Association Observatory of ethnic and peasant territories Environmental and Agrarian Procurator (# 9), Quibdó - Chocó (Official whose function is to ensure the collective rights of citizens)	Tierra Digna WWF Diakonia

In relation to the policy construction cycle (*Figure SM4.6*), the sociocultural and academic assessment process has occurred in the phases of *Agenda Definition* and *Sentence Implementation*. Regarding the valuation purposes, these were identified during the stage of informing the stakeholders (*Purpose 2*) and during the decision and design of plans and actions (*Purpose 3*).

It has been seen that for these communities, the territory and its resources are closely linked to their existence and survival from a religious, political, social, economic and recreational point of view. Therefore, it is not an object that can be dominated but an essential element of the ecosystems and biodiversity with which they interact on a daily basis (for example, rivers and forests). The impact of illegal mining is so strong that, as the plaintiffs have pointed out, it has come to separate families, increase violence and stimulate the loss of ancestral beliefs and traditions of the black communities that inhabit the Atrato River basin in Chocó. On the other hand, the indiscriminate intervention on the basin has caused problems of deforestation, degradation of the productive soil layer and, perhaps the most serious one, the contamination of one of the main water sources of the Department of Chocó, on which many communities depend (Constitutional Court, 2016).

Valuation methods

Visits for judicial inspection and collection of relevant testimonies. The Magistrate was requested to order the judicial inspection diligence ex officio. This was accompanied by the Director of the Biology Department of the Javeriana University in Bogotá, Ecologist of the University Pontificia Javeriana, co-author of the report carried out with the Humboldt Institute in relation to the threat to freshwater fish in the Atrato River. In addition, technical concepts from specialists in different areas were consulted in order to confirm the violation of fundamental rights and take the respective measures (Constitutional Court, 2016).

The Court's visit had four ways of looking at the problem, which were built jointly with the communities: a public hearing, participation in a forum of social organizations, a boat tour, a community assembly in one of the affected communities, and a helicopter overflight.

During the morning of Thursday 28 January, a hearing was held at the Quibdó Palace of Justice. In a small room, 40 people listened to the communities and institutions that gave their testimony on Friday, 29 January. The Court travelled to the community of Paimadó, the main town of the municipality of Río Quito. It was during the two-hour journey, where the presence of "dragons", dredgers and backhoes became evident.

In Paimadó, a community assembly was held. The Court listened to the community.

On Saturday 30 January, the Court flew over part of the affected rivers in a military helicopter (Albarracín, 2016).

Testimonies. The Magistrate was requested ex officio to decree the testimonies of 4 people:

A. Diana Rojas Leivi from the Inter-Ethnic Forum Solidaridad Chocó (FISCH).
B. William Rivas from the Greater Community Council of the Integral Peasant Association of Atrato (COCOMACIA).
C. Helcías Ayala from the Pacific Environmental Research Institute IIAP of the Quibdó – Chocó.
D. Sterlin Londoño from the Quibdó Diocese.

Achievements earned with the sentence and obstacles towards its implementation

The collective work of the plaintiff organizations and their allies was a key element in promoting the resolution by the constitutional court. In November 2016, the Constitutional Court, through Sentence T-622/16, recognized the Atrato River and its tributaries as subjects of rights, that the defendant state authorities are responsible for the serious humanitarian and environmental crisis in the Atrato River basin (Chocó), its tributaries and neighbouring territories, which warrants the comprehensive and articulated approach of a series of measures strongly bounded to the communities that inhabit this territory (Constitutional Court 2016.)

This verdict represents a call to the institutions involved, so that the pertinent measures be taken in the search for possible solutions to this serious environmental, economic and social crisis that the affected communities are going through. The road is long since it implies the participation of the institutional framework, the civil society organizations and the allocation of sufficient resources that allow action with measurable results through the indicators of improvement of the quality of life of the people and the reduction of the impacts over the associated ecosystems.

Since the Constitutional Court’s verdict, the commission of guardians was created. On the side of the government, the State appointed the Ministry of Environment as the guardian of the River, under

Decree 1148 of 2017. On the side of the plaintiff organizations, since 31 August 2017, together with other ethnic-territorial and social organizations in the territory, we have formed the *Collegiate Body of Community Guardians of the Atrato* as a representative body of the river responsible of ensuring that the rights of the Atrato River are fulfilled. This collegiate body is made up of seven organizations: ASCOBA, COCOMACIA, COCOMOPOCA, the Carmen de Atrato Social and Environmental Board, the Quito River Community Councils, the Board for Dialogue and Agreement of Indigenous Peoples of Chocó, and the Inter-ethnic Forum Solidaridad Chocó - FISCH. After several obstacles (*Table SM4.4*), among which were the lack of political will and the ignorance of the ethnic processes in the territory by various actors responsible for the orders [contemplated in the sentence], we finally managed to officially form the Commission of Guardians that ruled this fourth order, through Resolution 0907 of 2018. Since obtaining responsibility, the guardian organizations defined several lines of work to empower their communities based on the verdict and have promoted its implementation through training spaces, pedagogy and political impact.

Pedagogy: One of the functions of the guardian role has been the pedagogy and dissemination of sentence T-622, given that the appropriation of the Sentence by the community and society, in general, will be the essential component for an effective change. That is why since the enactment of the sentence we have been promoting, within our communities, numerous spaces for its socialization. Many of these works occur in spaces open for answers to the workshops where guardians have participated, while others are spaces created solely for the socialization of the T-622. Work has also been carried out hand in hand with the educational institutions of the basin, in spaces with young people, talking with them about the importance of caring for nature, and learning from them their priorities and future visions of the territory.

Political impact: this has been promoted to achieve the implementation of T-622 and to attract more allies and general support for our mission. For this reason, we have organized meetings for making political lobby with the responsible entities that should carry the orders by the sentence, as well as with others that have responsibilities given by the same sentence. For this purpose we have managed to organize advocacy tours to Bogotá, to activate the communication channels with these entities, given their absence in the territory. The accompaniment of the Monitoring Committee in these spaces has been crucial for us.

Within the framework of these tours we have also engaged in dialogues with the Embassies of Sweden, Germany, Austria and England, among others, and with articulation scenarios such as the Human Rights Group of the European Union. We have also had international advocacy tours, visiting the United Kingdom, Belgium, Switzerland, France, among others. Within the framework of these spaces, we have been able to verify the great support of various actors of the international community who have their eyes on the implementation of this sentence, and who have accompanied us and supported us in the exercise of our role as leaders.

What has happened with the implementation of the Sentence?

The verdict has been a great challenge for both the State and other organizations. At the national level there are the ministries of the orders Minambiente (environment), Minagricultura (agriculture), Mindefensa (defense), and Minsalud (health). At the departmental level, the Government of Chocó and Antioquia and its corporations CODECHOCO and CORPOURABA. At the local level, the municipal mayors of the basin, and at the community organizational level, the community councils and indigenous resguardos. Because we were not prepared for a verdict of this nature, one of the greatest challenges was the articulation and joint work between the parties towards the same objective: to save the Atrato River and, at the same time, guarantee the permanence of their communities. To this day, progress has been made towards achieving the orders provided in the Sentence.

Table SM4.7 Orders provided in the Sentence and progress.

Orders	Responsible	Progress
To recognize the Atrato River, its basin and its tributaries as an entity who holds rights and to create the Commission of Guardians.	Ministry of Environment and Sustainable Development; Collegiate Body of Community Guardians of the Atrato	The Sentence enabled the creation of the Commission of Guardians of the Atrato River, who are the spokespersons of the River. The Court ordered to designate two guardians, one from the State and another one from the communities. On the side of the government, Decree 1148 of 2017 was signed. Such Decree designates the Misitry of Environment and Sustainable Development as the guardian from the State. On the side of the communities, since 31 August 2017, plaintiff organizations, in an articulate manner along with other ethnic-territorial and social organizations, created the Collegiate Body of Community Guardians of the Atrato as the representative body. Internal regulations were established for the operability of the Collegiate Body of Community Guardians of the Atrato. This establishes the way the configuration, functioning, decision-making processes, as a sole body, in which participate seven organizations, which are ASCOBA, COCOMACIA, COMOMOPOCA, the Carmen de Atrato Social and Environmental Board, the Quito River Community Councils, the Board for Dialogue and Agreement of Indigenous Peoples of Chocó, and the Inter-ethnic Forum Solidaridad Chocó. Once both guardians, one from the State and one from the communities, were established, it was possible to officially create the Guardians Commission that was mandatory given the fourth order, through Resolution 0907 of 2018. Following this event, a set of rules, regarding the operation of the Commission, was built and collaboratively subscribed between the parts, defining aspects related to decision-making, such as the recurrence of the meetings, and the configuration of the Advisory Team. The Advisory Team is integrated and was installed by IIAP, UTCH, WWF, the Humboldt Institute and the Antioquia University, but the created set of rules established a procedure for defining the concerted admission of new assessors. The Guardians Commission holds periodic meetings, every two months. Until today, 13 sessions have been celebrated, with the purpose of monitoring the implementation of the Sentence.
Plan to decontaminate the sources of water in Chocó, starting with the Atrato River basin, recover its ecosystems and avoid additional damage	Ministries of: Environment, Finance and Defence. Codechocó and CorpoUrabá Governments and Municipalities. * In conjunction with the petitioner communities	Action plan created collectively along with the communities: For the construction of the action plan, together with the Ministry of the Environment, we structured a series of phases that would allow for a sufficient level of community participation in the process. Phase I consisted of spaces between Guardians of the Atrato and the institutions responsible for the order, and a Phase II that involved the base communities. Phase I: This first phase consisted of Technical Tables, which took place between the municipality of Quibdó and Atrato, from December 2018 to July 2019. With the participation of the Ministry of the Environment, collegiate body of guardians, institutions involved in the order and advisory team. In these technical tables the lines of action of the plan were defined, agreeing that there would be five. Three of them would be strategical about (1) improvement of environmental quality, (2) planning and environmental ordering of the territory, and (3) sustainable production. The other two tables would be about (4) environmental governance, and (5) about information and knowledge management. Subsequently, they were intended to address each line one by one, establishing the main problems identified in relation to this aspect,

		presenting proposals for actions to overcome them and carrying out a training phase regarding concepts that had to be shared from their conceptualization, for example, governance and governability, recovery, rehabilitation, restoration, among others. Within this phase, the Ministry of the Environment served as the responsible leader, thus generating the call to the other institutions to the space, proposing the main methodologies, and assuming the role of secretariat, with which the material resulting from the group work of each space for its systematization. The minutes of each of these spaces were prepared jointly by the Ministry and the Technical Secretariat of the Collegiate Body, as well as the convocation of the Advisory Team of the Commission. As a result of this joint work, the preliminary version of the action plan was obtained, which had a draft, in July 2019, and another one in September. Phase II: This phase took place throughout all the municipalities of the Atrato basin, in September and December 2019. For this phase, the MADS signed an inter-administrative agreement (605-2019) with the Pacific Environmental Research Institute (IIAP), which made possible to bring the Sentence to the territory and guarantee the direct participation of the communities in the collective construction of the action plan, participation that was unavoidable for its proper construction. The Collegiate Body's Technical Secretariat exposed to the Ministry the importance of community guardians playing a leading role in this phase and that the appropriate means should be generated for such a purpose. It was thus that, within the agreement, the community guardians were able to play a central role, allowed by the articulation between the Collegiate Body and the IIAP, in carrying out 30 municipal workshops and 3 subregional workshops for the upper, middle and lower parts of the watershed of the Atrato, with the participation of all institutional delegates and communities from all the municipalities of the basin (15 municipalities in total with the participation of black, indigenous and mestizo communities), both the plaintiffs and the defendants. The work of the guardians consisted of supporting the call for participating in municipal workshops, leading the spaces for socialization of sentence T-622 and its advances, leading together with the technical team of the Ministry and IIAP the construction work tables for each line of action with the participants, systematize the information of the workshops, and deliver the respective reports. Additionally, three major products were finalized, the first one was an educational communication strategy of the Sentence from a biocultural perspective, while the second one referred to a strategy on effective participation, and finally, the third one was a protocol on respecting the biocultural perspective within the territory. The collective work on this Phase II complemented the work carried out during Phase I, that is, the preliminary version of the action plan; while it also enabled that the final product obtained were the finalized action plan by the end of November. Lastly, this plan was protocolized by the guardians, the Ministry of Environment and the community leaders on December 21, 2019.
Collective action plan to neutralize and definitively eradicate the illegal mining activities in Atrato and other tributaries	Defence Ministry, National Police – Unit against illegal mining, National Army, Prosecutor's Office, Governments and Municipalities,	Creation of the action plan (I commit myself to the Atrato). Without the participation of the petitioners or of their Guardian Body. As the Collegiate Body of Guardians, we consider that the advances on the implementation of the sixth order have not answered to the needs of the Atrato River, nor to those of the territories and communities that are interrelated with the River.

	agreed in conjunction with the petitioner communities	Due to the policies of the Defence Ministry, civilians cannot participate in the formulation or execution of the plan of the sixth order. This lack of participation, even if we understand it as coming from a State security policy of higher level, has implied the exclusion of the Collegiate Body as representatives of the communities and of the Atrato River as a subject of rights.
Integral action plan that allows to recuperate the traditional ways of living and food, within the frame of the concept of **ethnodevelopment**, that ensure the basic minimum for achieving food security.	Ministry of Agriculture, Ministry of Interior, Ministry of Treasury, Planning National Department, Social Prosperity Department, Governments and Municipalities, agreed in conjunction with the petitioner communities.	This seventh order is the most important one for the communities, given that is correct implementation would become a driving force of direct and immediate change in the dignified life of our communities and of the River, since it would create a harmonic development with our traditions and environment, which automatically would allow to redirect the region's economy taking importance away from extractive activities, and in consequence, reducing the high anthropogenic pressures over the basing, enabling the communities to re-establish their rights to food sovereignty, culture, autonomy, etc. ***This order has an action plan which is under a collective validation stage.*** During the generation of the first version of the plan, leaders within the Atrato basin of communitarian black organizations, of indigenous resguardos and of mestizos communities, participated. Currently, technical tables are taking place, for the validation within fifteen municipalities of the basin. These municipalities are: Carmen de Atrato, Bagado, Lloro, Atrato, Rio Quito, Quibdò, Medio Atrato, Bojaya, Vigía de Fuerte, Murindo, Carmen del Darién, Riosucio, Unguia, Turbo y Acandi.
Toxicological and epidemiological studies in the Atrato and its communities	Ministry of Environment, Ministry of Health, Health National Institute, Codechocó and Corpourabá	Action plan created to implement the toxicological and epidemiological studies in the communities of the basin. Toxicological and epidemiological studies fulfilled.

Figures

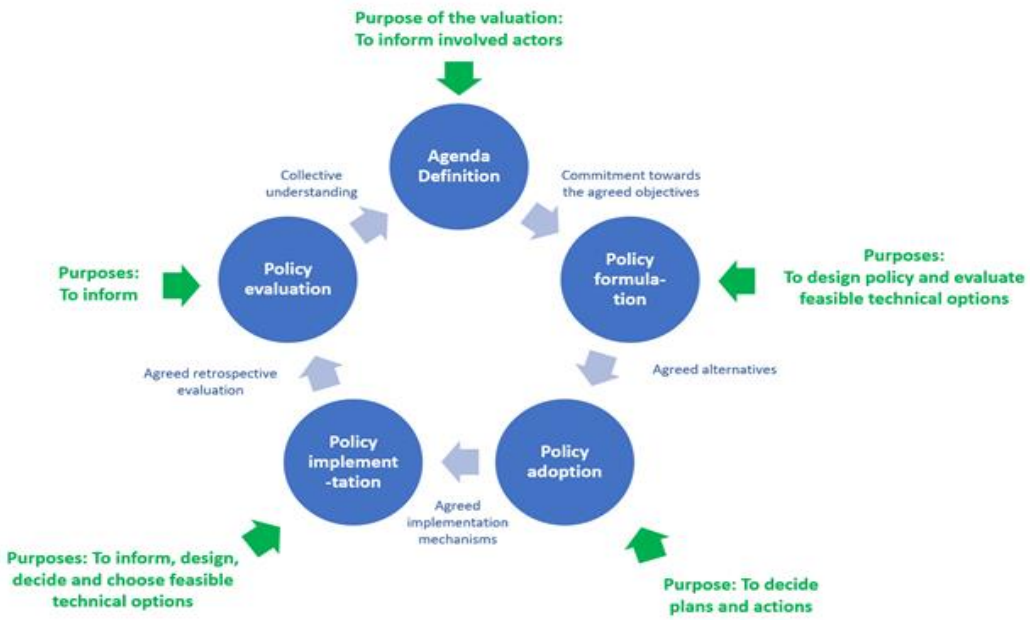

Figure SM4.6. Valuation purposes in the policy cycle.

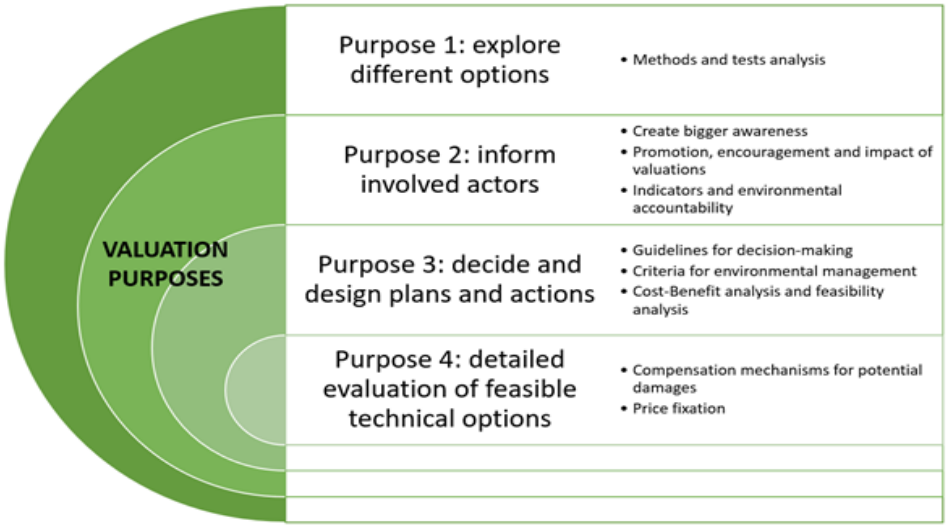

Figure SM4.7. Valuation types according to their purpose, and examples.

Table SM4.8. Identification of potential barriers for the incorporation of diverse values in policies

Potential barriers for value integration		**Influence level of the barrier***				**Possible clarifying notes**
		L	**M**	**H**	**N.A.**	
1. OPPORTUNITY	H1. Long time between the valuation and implementation of programs and plans considered in the sentence		■			
2. PERTINENCE	H2.1 Absence of concrete goals	■				
	H2.2. Inoperable rules			■		
3. CREDIBILITY	H3.1 Disagreement about the causes				■	
	H3.2 Shortage of data and information				■	
	H3.3. Excessive uncertainty					Not understandable
	H3.4 Insufficient training on the part of local actors to carry out the valuations				■	
	H3.5 Availability of specialized personnel at the local level			■		
	H3.6 Lack of adaptation of valuation methods to local conditions				■	
4. LEGITIMACY	H4.1: Lack of representativeness of all the actors involved	■				
	H4.2 Lack of political will to comply with the measures contemplated in the sentence			■		

	H4. Lack of participatory deliberation processes					
	H4.4 Dominant position and influence of certain actors in decision-making processes					
5. PROCESS DOCUMENTATION	H5 Lack of Independence in the valuation process					
6. COSTS	H6: High costs of the valuation studies					
7. OTHER BARRIERS	H7: Lack of monetary resources for the implementation of the sentence					
	H8: Protection and security for the guardians and social leaders					

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Annex 4.15. Uptake case #2: Valuation of forest ecosystem services for design of a headwater conservation tax in Kanagawa, Japan

Overview of headwater conservation tax and related ES valuation in Kanagawa

Kanagawa Prefecture, Japan, which is 30 km West of Tokyo, has long been an industrial agglomeration with a population density more than 10 times the national average. Expansion of industrial and residential areas has contributed to a loss of 10% of the area's forest cover which was estimated at 11000 km2 from 1965 to 2015. Rapid increase in water demand, along with water pollution led to 10400 million JPY (roughly 1200 JPY per person) of additional annual expense to conserve headwaters (Takai, 2013) by Kanagawa Prefectural government. The government planned to introduce a new headwater conservation tax (HCT) for conservation of headwaters. In the tax design process, the government contracted an economic valuation study to estimate the value of forest ecosystem services in the prefecture. A valuation was conducted by a researcher in 2002 and CV and CM were applied to the valuation (Yoshida, 2004a; 2004b; 2003). A practitioner applied both CV and CM to identify residents' WTP for forest maintenance such as thinning, switching from conifer to broadleaf trees, as well as their WTP for a hypothetical HCT. Valuation results showed a WTP ranging from 397 JPY/household for CV to 260 JPY/household for CM, with the forest and headwaters estimated at 14.2 to 9.7 billion JPY in value. Under various discussion based on the valuation results, in 2007 the Prefectural Government introduced a headwater conservation tax under the Kanagawa Prefecture Tax Ordinance (Kanagawa Prefecture, 2019) of 300 JPY/person with 0.025% of income (Kanagawa Prefecture, 2007).

How was the valuation used?

The local government firstly estimated the cost for conservation and maintenance of forest ecosystem to enhance water related forest ecosystem services. the valuation results were compared with the conservation cost to find out the cost is within residents' WTP and found that the cost is lower than residents' WTP, which means that the cost was acceptable to residents. This usage of the valuation is regarded as a kind of cost-benefit analysis and decisive purpose. Secondly, the valuation was used to prove that there is no difference in WTP for each river basin. As the beneficiaries of forest maintenance are located in specific areas, while the tax burden is uniformly shared among all residents in the prefectures, there is a possibility that the controversy will come up in the local parliament. However, the results revealed that there was no difference in the WTP for each basin, which was used as the basis for uniform taxation throughout the prefecture. This is technical purpose of the valuation uptake. Third, the results, which showed that the WTP positively correlated with income, were used as part of the basis for introducing proportional taxation in the HCT. The government wanted to determine whether residents' accepted amount of tax is proportional to their income to introduce proportional taxation. Reflecting these findings, the prefectural government introduced the HCT with proportional taxation.

Then after re-estimation of the cost and the adjustment of expected income, the government set a first proposal to introduce an income tax of 300 JPY/person plus 0.032% of income for a conservation fund (Takai, 2013), and based on this proposal discussion with residents and in the local Council initiated. In 2007 the government introduced a HCT under the Kanagawa Prefecture Tax Ordinance (Kanagawa Prefecture, 2019) of 300 JPY /person with 0.025% of income (Kanagawa Prefecture, 2007).

The second valuation for HCT in 2014

Twelve years after the first valuation, the second economic valuation (CV) was conducted in 2014 to find out whether current taxation level was still within residents' WTP. The results showed that the WTP is higher than current amount of HCT although it was declined compared to the first valuation in 2002 and proven that current tax level is reasonable. The first valuation was conducted by environmental economist, while the second one was by a consulting firm. This is mainly because valuation techniques have improved and environmental valuation have become more popular in a society. The uptake of the second valuation can be seen as informative purpose (justification).

Application of the analysis framework

Figure SM4.8 shows the case of Kanagawa applied to the analysis framework. For the first evaluation conducted in 2002, it was used as an ex-ante evaluation for the tax scheme to understand residents' WTP and the needs for the tax, which was seen as informative purpose within the framework. Such demand-side information is important for policymakers (Hayashi et al., 2021). As a result, establishment of HCT was agreed. Then the use of the valuation moved to tax design purpose, which is regarded as technical purpose. Here, the evaluation was used to confirm whether the cost burden of forest maintenance was below the WTP. This corresponds to the cost-benefit analysis and to decisive purpose. As a result, it was confirmed that the cost burden was smaller than WTP, so the cost amount was provided as the initial taxation level as a starting point for discussions at the Local Council. The evaluation was also used as rational for universal taxation throughout the prefecture and income proportional taxation. All these uptakes are technical purposes.

For a post-tax evaluation, the second evaluation conducted in 2014 was used for ex-ante justification to confirm whether the current tax level is still within the residents' WTP. This uptake is seen as informative purpose.

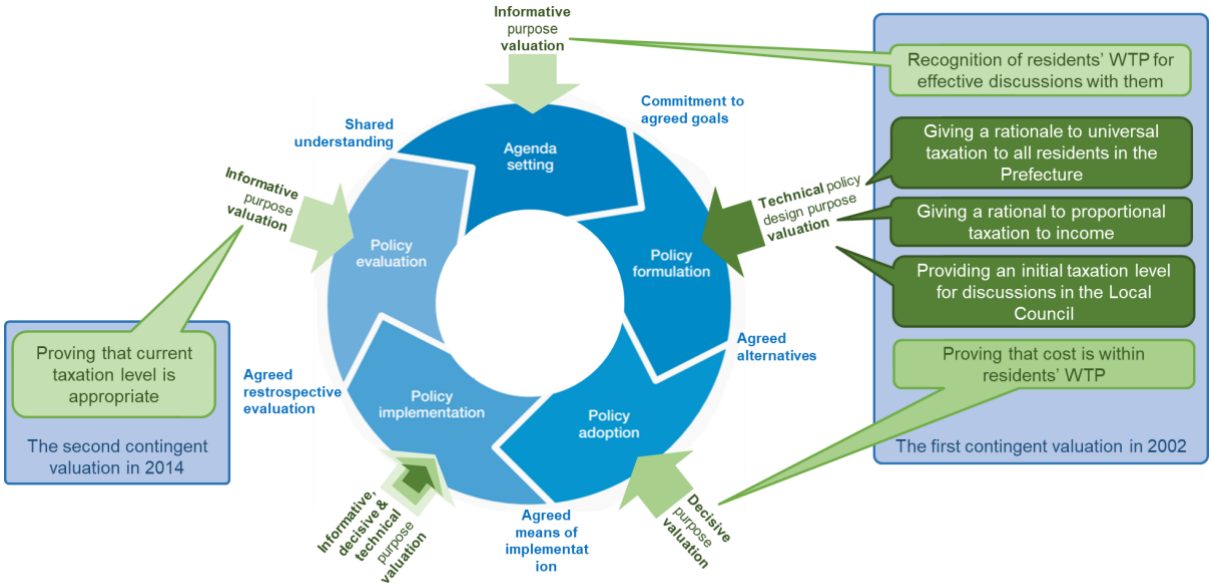

Figure SM4.8. Application of uptake analysis framework for Kanagawa case

Correspondence to the uptake hypothesis

Table SM4.9 shows application of the hypotheses for valuation uptake. Of total 12 hypotheses, two are irrelevant and seven out of the remaining ten have been addressed. For H1 and H2.1, the

government began discussions on establishing a new tax in 2001, and since then "actionable target" and "agenda" had been consistently unchanged until the introduction of the tax. For H3.1, H3.2 and H3.4, since the policy makers did not have sufficient knowledge about ES valuation, it was carried out by an expert, and he applied well-designed and realistic scenarios for a questionnaire survey for CV. After the analysis, he had some briefing sessions on valuation methodologies for executives in the government and the Local Council. In the briefings, the effectiveness and the reliability of valuation methods are explained. Regarding H4.1: the representativeness, the representativeness is ensured by sampling the respondents of the CV questionnaire survey from all the residents in the prefecture. Finally, for the H5: process documentation, the details of the valuations are recorded in some documents with both published and unpublished forms.

In this way, in Kanagawa case, the government corresponds to most of the hypotheses so that it can be up taken in discussion on the establishment of HCT. The Kanagawa case is demand-driven valuation that the objectives and purposes of the valuation was concreted prior to the initiation of the valuation. H1 and H2.1 were well-considered along with the valuation design. In this case. these two hypotheses are prerequisite for uptake.

Table SM4.9. Overcoming barriers to valuation uptake

Criteria for valuation uptake -	**Barriers to uptake hypotheses**	**Case study notes**
1.Timeliness	H1.Study time-lags relative to stakeholder need	Study was designed to provide information at appropriate timing.
2.Salience	H2.1 Lack of 'actionable' targets	The valuation had a clear target: establishment of HCT.
	H2.2.Non-conducive regulatory context	Actually, there is no conductive regulatory context. The need for valuation was beyond the regulatory context.
3.Credibility	H3.1 Disagreement on causality	A practitioner (researcher) explained valuation methodologies and its (dis)advantages to main stakeholders.
	H3.2 Lacking data	Contingent valuation was conducted on well-defined scenarios
	H3.3.Excessive uncertainty	The valuations did not cope with uncertainty. Uncertainty was not matter so much in this case.
	H3.4 Insufficient stakeholder training in valuation	For first valuation, an expert conducted the valuation, and for second one, an advisory board was established to give technical advices to practitioners.
	H3.5 Lack of standardization of valuation methods	There was no standardization of valuation methods at the time
4.Legitimacy	H4.1: Lack of full representation of stakeholders	Respondents of questionnaire survey were sampled from all residents in the Prefecture and was nearly full representation of stakeholders.
	H4.2 Political use/blocking of valuation knowledge power	The valuation provided an initial taxation level for political discussion prior to political intervention.
5. Process documentation	H5 Lack of independent assessment	The detail of the valuations was reported in both published and unpublished (gray) literatures.
6. Information cost	H6: Valuation study costs	The cost of valuation was covered by governmental budget, and was not a major constraint.
Other		

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Annex 4.16. Uptake case #3: Valuation of the restoration of Lake St Lucia, South Africa

Table SM4.10 provides further detail on relevant barriers to valuation uptake in the case study and how they were overcome.

Table SM4.10. Detail on relevant barriers to valuation uptake in the case study of Lake St Lucia, South Africa

Criteria for valuation uptake	Barrier to uptake hypotheses	Case study notes
1.Timeliness	H1.Study time-lags relative to stakeholder need	The study was commissioned decades after the degradation began, but at a point when situation was widely known as a result of its having deteriorated to the point of drying out, and the public had been exposed to news coverage of extensive fish die-offs etc. This was good timing in that there was strong public support to fix it. The authority had been working to raise funds for the study from much earlier.
2.Salience	H2.1 Lack of 'actionable' targets	There were very clear targets for the system. As the most important estuarine system in the country, scientists had already determined that the estuary should be in an excellent state of health. More importantly, the health of the system needed to be restored in order to maintain its World Heritage Site status.
	H2.2.Non-conducive regulatory context	In this case, most of the system fell within a very large protected area. However, this did not include the lower uMfolozi river and parts of its floodplain that would have been periodically back-flooded before the sugar farmers intervened. Another challenge was the elevation of silt loads in the uMfolozi from its catchment areas which are well beyond the jurisdiction of the conservation agency.
3.Credibility	H3.1 Disagreement on causality	This was one of the biggest challenges of the study. There were many well-entrenched beliefs and opposing "theories" about the complex dynamics of the estuary system, among the scientific community as well as the public. The study had to involve extensive analysis of data stretching back 100 years in order to unravel some of this and come to firm conclusions.
	H3.2 Lacking data	Because of its importance there were some good data on the system, including its changes over time, but nowhere near what would have been ideal. Comprehensive baseline data collection on many aspects was a necessary part of the study.
	H3.3. Excessive uncertainty	While the valuation study was solid, projection of changes in value is fraught with uncertainty. In this study, much of this uncertainty lay in predicting the biophysical response of the system. The economic links to the biophysical characteristics were less uncertain.
	H3.4 Insufficient stakeholder training in valuation	This study focused on a few key types of value which were familiar and easy to understand, since those values were already large enough to be able to swing the decision. This meant there was minimal contestation on the basis of not being able to understand the values or how they were estimated. This was borne out in stakeholder meetings. Non-use values were not estimated, although these values would undoubtedly be very large.
	H3.5 Lack of standardization of valuation methods	The studies were subjected to comprehensive peer review which ensured that methods were reliable and values expressed appropriately.
4.Legitimacy	H4.1: Lack of full representation of stakeholders	This study was embedded in a lengthy and comprehensive stakeholder process undertaken by outside consultants as well as the iSimangaliso Wetland Park Authority.

	H4.2 Political use/blocking of valuation knowledge power	The iSimangaliso Wetland Park Authority had full control over how information on the study was released, and managed a politically-charged situation
5. Process documentation	H5 Lack of independent assessment	The study underwent extensive peer review, including technical meetings with a wide range of stakeholders.
6. Information cost	H6: Valuation study costs	Including the biophysical and engineering components, the valuation study cost approximately $750,000. The overall process, which included the stakeholder component, cost around $9 million.

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Annex 4.17. Uptake case #4: Values of nature in UK marine and coastal policy

Table SM4.11 provides further detail on relevant barriers to valuation uptake in the case study and how they were overcome.

Table SM4.11. Details on relevant barriers to valuation uptake in the case study of nature in UK marine and coastal policy.

Criteria for valuation uptake	Barriers to uptake hypotheses	Case study notes
1.Timeliness	H1.Study time-lags relative to stakeholder need	The Hastings case (Orchard-Webb et al. 2016) did not inform a specific decision point but fed into going consideration of sustainable development policy within Hastings Borough Council, as well as focusing on capacity building within the Hastings Fisheries Local Action Group (FLAG). In contrast the Community Voice study (Ranger et al. 2016) fed into a concrete decision making process around formal management planning of two marine protected areas, including the consultation on and establishment of bylaws, and was explicitly timed as such.
2.Salience	H2.1 Lack of 'actionable' targets	The Hastings study served to inform goal setting and visioning, both associated with identification of broad value priorities, within the local stakeholder community within the agenda setting phase of decisions. The value priorities and goals, such as protecting the environment, fairness and inclusion, and the need to balance them, were reflected in the local development plan. The targets considered by the Community Voice study were very clear; the conservation objectives of the two MPAs under consideration were already established and the work focused on identifying ways to achieve these objectives in a way that balanced social needs and reflected cultural and community values.
	H2.2.Non-conducive regulatory context	Because the Hastings study did not serve to inform a single particular decision point but rather focused on exploration and capacity building with a pre-existing group of stakeholders (the Fisheries Local Action Group), it was very broad in scope, which meant that the deliberative valuation could 'move around' different regulatory obstacles, some of which were more flexible and conducive (e.g., local development planning) and others which were deemed as particularly nonconducive, especially the EU's Common Fisheries Policy and associated quota regimes which was viewed to struggle with the integration of local knowledge and values, and which was seen by participants as an expression of pre-existing power relations dominated by competing national industrial fisheries interests. The policy environment was seen to be heavily dominant with a narrow 'living from nature' framing and a top down and technocratic focus on knowledge, without much regard for local community values or the other ways of understanding values of nature (living in, with and as nature). In contrast, the regulatory environment around local fisheries management, relevant to both studies, was seen to be much more flexible; firstly because in the institutionalization of regional Inshore Fisheries and Conservation Authorities (IFCAs), there was a joint remit for nature conservation and fisheries management which meant the institutional setup was more naturally predisposed to integration of different stakeholder frames, values, and interests; secondly because the boards of these IFCAs had representation of diverse relevant stakeholder interests; thirdly, because they operated at a relevant scale, which was small enough to be anchored in the local communities but large enough to have some resources. The institutionalization of the IFCAs as such reflected many of the principles of the CBD Ecosystem Approach, which was in turn conducive to consideration of and bridging of multiple values of the sea. In terms of regulation, for marine environments in particular the challenge is not just in

		setting regulations but in enforcing them. The regional IFCA in the Ranger et al. (2016) study was no exception. But this meant that buy-in from a critical mass of local stakeholders and fishers in particular was essential to achieve social norms for compliance, which was conducive to participatory and deliberative approaches rather than more top down or technocratic analyses. One important limitation of the regulatory context that was frustrating to participants was that issues that did not directly relate to fisheries and conservation, such as aggregate extraction, were not within the scope of the valuation as a result of this not being within the IFCA scope of management. This negatively influenced the conduciveness to uptake in terms of these areas that participants wished to debate, but were asked not to because there was no clear path for uptake of their values and views around these issues.
3.Credibility	H3.1 Disagreement on causality	Orchard-Webb et al. (2016) explicitly considered causality by working with the stakeholder group to develop causal loop diagrams, which allowed bridging of different viewpoints and consensus building on the nature of the social-ecological system. This subsequently informed the latter stages of the deliberative valuation. Ranger et al. (2016) also facilitated multiple viewpoints of causality through the ethnographic film, and by allowing local stakeholders to explicitly challenge or complement scientific data presented based on local knowledge. As such the research approach was reflective of postnormal science, where knowledge is validated by an extended peer community (Ainscough et al. 2019)
	H3.2 Lacking data	The approaches described above also provided an opportunity for stakeholders to infer and interpolate situations where data was missing, insufficient or uncertain. The approaches were carefully designed in accordance with the Deliberative Value Formation model (Kenter et al. 2016), which highlights the importance of capacity for deliberation. This was addressed through explicit warm up and confidence building exercises, and the balancing of group deliberation with individual exercises, including the ethnographic film interviews by Ranger et al. (2016). Group dynamics and composition of sub group discussions were managed to take advantage of different expertises and backgrounds, but also facilitated to help prevent dominance. Nonetheless, Orchard-Webb et al. (2016) point out that the ideal of equal participation could be approximated but not be fully achieved, because of peoples' natural tendency to defer to those with greater experience or professional status.
	H3.3.Excessive uncertainty	
	H3.4 Insufficient stakeholder training in valuation	
	H3.5 Lack of standardization of valuation methods	The two studies balanced a degree of standardization according to the best practice of the Deliberative Value Formation model (Kenter et al. 2016) with a design that could be highly customized and adapted to the local context.
4.Legitimacy	H4.1: Lack of full representation of stakeholders	The stakeholder representations were generally seen as positive by participants in both studies and had built on explicit stakeholder mapping and analysis. However, in the Hastings study, participants themselves closely recognized that there was an underrepresentation of citizens from relatively deprived areas further away from the coast, which nonetheless had an important stake in the potential futures and decisions that were being discussed. The researchers later sought to replicate the work in these areas but were unable to secure the resources to do so.
	H4.2 Political use/blocking of valuation knowledge power	N/a
5. Process documentation	H5 Lack of independent assessment	In both studies, there was explicit participation of decision makers, either within the deliberative valuation process itself (Orchard-Webb et al. 2016), or in the organization and design of the process (Ranger et al. 2016). In this sense, the lack of independence of decision making was conducive to

		uptake. However, this was balanced in terms of perceived legitimacy by that the chief designers and facilitators of the process were independent, not from the local area, and where appropriate challenged local decision makers equally to other participants.
6. Information cost	H6: Valuation study costs	The Orchard-Webb et al. (2016) study, consisting of three half day valuation workshops with 10 participants and three facilitators, cost approximately £19,000 (2014), including direct staff costs but not including staff overhead costs, and including a £100 incentive to participants. The Ranger et al. (2016) study, consisting of 41 video interviews and three half day workshops with 90 participants and five facilitators and researchers, cost approximately £25,000 including staff costs but excluding overheads. There were no participant incentive payments in this study.
Other		The use of visual media, particularly ethnographic film within the Community Voice study, to view point and illustrate different broad and specific values around the marine management issues, strongly supported communication and hence uptake in the decision making process as well as perception of legitimacy of the consequent decisions by stakeholders.

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Annex 4.18. Uptake case #5: Using multi-criteria decision analysis for collaborative development of a sustainable regulation policy for a large regulated lake, Finland

Table SM4.12 provides further detail on relevant barriers to valuation uptake in the case study and how they were overcome.

Table SM4.12. Detail on relevant barriers to valuation uptake in the case study on the collaborative development of a sustainable regulation policy for a large regulated lake, Finland

Criteria for valuation uptake - barrier to uptake hypotheses		Case study notes
1.Timeliness	H1.Study time-lags relative to stakeholder need	It was agreed by the stakeholders in the beginning of the process that a structured MCDA based process formed a framework for the policy alternative formulation process.
2.Salience	H2.1 Lack of 'actionable' targets	The project and steering group had a clear mandate: develop recommendations for a new water course regulation policy. MCDA was used as support to develop policy alternatives.
	H2.2.Non-conducive regulatory context	The process complied with Finnish legislation, where the review of old regulatory permits proceeds in stages. First, together with the various parties, ways to improve regulation policy will be sought. Only if this is not possible will a solution be sought in Water Court.
3.Credibility	H3.1 Disagreement on causality	To some extent, it was difficult to distinguish the effects of water course regulation from those caused by other human activities (e.g., pollution, eutrophication) or natural variation. In depth field investigations (e.g., littoral aquatic macrophytes, fish) realized in the project were central to quantifying physical impacts of policy alternatives.
	H3.2 Lacking data	The project lasted four years and thus there was enough time to realize profound impact studies which were used in the valuation.
	H3.3.Excessive uncertainty	Researchers external to the project audited the method implementation for biases.
	H3.4 Insufficient stakeholder training in valuation	We compiled instructions, educated participants, and used an interactive and iterative process to elicit the weights for the attributes. A great advantage of the interactive approach was that it enabled the analyst to identify whether the attribute weights obtained in the elicitation were in conflict with the arguments that the participant gave in the discussions. Due to these actions the attribute weights and priority scores of the regulation schemes better reflected the participants' true opinions.
	H3.5 Lack of standardization of valuation methods	The approach was based on MCDA methods which have a strong theoretical background and have been tested in many applications

4.Legitimacy	H4.1: Lack of full representation of stakeholders	The steering group was nominated by the Ministry of Agriculture and Forestry and was quite comprehensive. It was later supplemented because of criticism (one important fishing organization was missing)
	H4.2 Political use/blocking of valuation knowledge power	Legitimacy of MCDA was not questioned by any of the participants. MCDA provided "a learning by analyzing tool" for stakeholders and they considered MCDA important for them to clarify their own thoughts in this very complicated case. The case deviated from many typical MCDA cases in that it created a basis for the development of better alternatives, rather than selection among established alternatives.
5. Process documentation	H5 Lack of independent assessment	This issue did not arise. Maybe because the process was exceptionally transparent and interactive. Beside the steering group, there were also several working groups (tens of stakeholders participated them) which discussed, analyzed and produced information for MCDA
6. Information cost	H6: Valuation study costs	The project was one of the most costly water management project in Finland, Funding for MCDA-based policy development was not a limitation (funding sources: state, hydro power companies, regional councils)

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Annex 4.19. Uptake case #6. Uptake of non-market valuation through benefit transfer in cost-benefit assessments of United States federal regulation under the clean water act

Table SM4.13 provides further detail on relevant barriers to valuation uptake in the case study and how they were overcome.

Table SM4.13. Details of the use of benefit transfer by the environmental protection agency in assessing cost-benefits of proposed rules for section 316(b) of clean water act (EPA, 2011), as they relate to hypotheses explaining lack of valuation uptake.

Criteria for valuation uptake - barrier to uptake hypotheses		Case study notes
1.Timeliness	H1.Study time-lags relative to stakeholder need	The Environmental Protection Agency's stated preference study to estimate total (use and nonuse) value of potential improvements resulting from proposed rules could not be implemented because of time constraints, resulting in use of benefit-transfer from existing studies.
2.Salience	H2.1 Lack of 'actionable' targets	Benefit transfer is applied to determine use and non-use values for species that would benefit from reduced or avoided Impingement and Entrainment mortality resulting from each of the proposed regulatory options. Showing the benefits of the options has as target showing stakeholders the cost-benefit (also a regulatory requirement) of the proposed options.
	H2.2.Non-conducive regulatory context	Benefit cost analysis is required under Executive Order 12866 for all proposed regulatory options. The Environmental Protection Agency therefore is required to determine benefits using available and approved means, for all proposed rules under Section 316(b).
3.Credibility	H3.1 Disagreement on causality	Feedbacks exist between long term habitat degradation, climate change, and impacts arising from Impingement and Entrainment mortalities, but dissociating these is impossible within water bodies with frequent intake and discharge. Much of the data on Impingement and Entrainment mortality also do not cover enough of seasonality of compound threats. The Environmental Protection Agency required, for Section 316(b) purposes, valuation data that can demonstrate benefits of specifically avoiding or reducing Impingement and Entrainment mortality on species/habitats.
	H3.2 Lacking data	While the Environmental Protection Agency identified only a few studies for benefit transfer, they still could not use most of them because data lacking on (i) feedback effects between habitat degradation, climate change and Impingement and Entrainment mortality (ii) cumulative impacts of clustered facilities along water bodies (iii) actual losses at all facilities (iv) species abundance and diversity near intake structures (v) population models (therefore unable to accurately model biomass yields for future harvests, or benefit transfers) (vi) contribution of Impingement and Entrainment to reducing recovery potential of T&E species (vii) dollar amount for commercial and nonuse values of all affected species (viii) quantitative assessment on species extinction risk.
	H3.3.Excessive uncertainty	Qualitative assessments of uncertainty in using valuation data for benefit transfer were given as: (i) relating Impingement and Entrainment losses to impacts on regional and national fish stocks (ii) actual Impingement and Entrainment losses per million gallons of water intake per day (iii) how Impingement and Entrainment losses vary with facility-specific features, sampling date, location and type of intake structure, ecological characteristics of water bodies, variation in facilities' operations throughout the year (iv)

		whether studies used for benefit transfer are representative of affected species populations, their habitats, current threats. Quantitative assessment of uncertainty was used for the Environmental Protection Agency (2006) meta-analysis of recreational fishing benefits, and cited in the 2011 report.
	H3.4 Insufficient stakeholder training in valuation	List of stakeholders considered for estimating costs and benefits not in report.
	H3.5 Lack of standardization of valuation methods	No formal assessment of standardization of methods covered in the report, but reference is made to the Environmental Protection Agency's 2010 *Guidelines for performing economic analyses*. Discussions on the use of Habitat Equivalence Analysis to estimate non-use values indicates a lack of standardization of valuation methods for benefit transfer.
4.Legitimacy	H4.1: Lack of full representation of stakeholders	List of stakeholders considered for estimating costs and benefits not in report.
	H4.2 Political use/blocking of valuation knowledge power	Information unavailable
5. Process documentation	H5 Lack of independent assessment	Congress directed the agency to establish the Scientific Advisory Board in 1978 to review the quality and relevance of scientific and technical information used and/or proposed by the agency as a basis for regulations, including the Environmental Protection Agency's 2006, 2011 and 2014 economic assessments for proposed regulations under Section 316(b). Members of the SAB are appointed by the Environmental Protection Agency Administrator for a term of up to 3 years and comprise of non-Environmental Protection Agency experts from academia, industry, local/federal/tribal governments and non-governmental organizations.
6. Information cost	H6: Valuation study costs	Valuation study costs not included in report.
Other		

This supplementary section gives the background to the case covered in *4.6.6* with specifics on the sources of data that were used in the 2011 publication of proposed rules, and the updates made in the subsequent 2014 final regulations for Section 316(b) of the Clean Water Act. The main reason for use of benefit transfer in the 2011 proposed regulations' benefit-cost assessment was the inability to collect primary data because of time constraints. This data gap was addressed in the 2014 final rule publication as the Environmental Protection Agency conducted an original stated preference study of total use values for improvements in fishery resources and ecosystems that would result from regulating Impingement and Entrainment. In regions where the stated preference study provided better valuation coverage, benefit transfer was not used to avoid double counting of benefits (EPA, 2014). Even then, the regulatory process required that the Environmental Protection Agency obtain a review of its stated preference study by the Science Advisory Board before its inclusion in any policy-relevant benefit-cost analysis.

Valuation uptake by executive order and through litigation

The Clean Water Act was enacted in the United States in 1972 and included the national pollutant discharge elimination system permit program, whereby power plants, amongst other facilities, would apply for and have permits approved by the Environmental Protection Agency for point source

pollution of thermal and other discharges. In 1976, the Environmental Protection Agency issued regulations under Section316(b) whereby all power plants generating 500MW in operation as from or after January 1, 1970 had to retrofit closed-cycle cooling systems by July 1, 1981 while any other facility beginning operation on or after January 1, 1974, would require that backfit, regardless of size. Fifty utility companies sued the Environmental Protection Agency (Appalachian Power Co. v. Train, 566 F.2d 451 (4th Cir. 1977)) with one of their gain-de-cause being that the changes required were overly restrictive in only considering technical and engineering factors, not economic costs. Importantly, the Court found that the Environmental Protection Agency should have stated the benefits to aquatic life for the alternatives they required, and the scientific basis for those benefits. In 1979, the Environmental Protection Agency withdrew their regulations and states implemented their own requirements, with varied scope and rigor. In 1993, the Environmental Protection Agency was this time sued by environmental organizations (Cronin, et. al. v. Reilly, 93 Civ. 0314 (S.D.N.Y 1993)) for failing to enact regulation to implement Section 316(b). This was resolved by Consent Decree whereby the Environmental Protection Agency developed Section 316(b) into a 3-phased regulation: Phase I which deals with new facilities, was issued in 2001 without needing further judicial review. Phase II, which deals with large existing electric generating plants, was enacted in 2004. Phase III, which deals with offshore oil and gas facilities, was enacted in 2006. Overall Section 316(b) rules cover over 1000 electric power plants, chemical manufacturers and petroleum refiners in the United States that withdraw at least 2 million gallons of water a day from a nearby water body, and use at least 25% of that for cooling purposes.

The Environmental Protection Agency was subject to further lawsuits (Riverkeeper, Inc. v. EPA, 358 F.3d 174 (2d Cir. 2004); Riverkeeper, Inc. v. EPA, 475 F.3d 83 (2d Cir. 2007); Entergy, Inc. v. Riverkeeper, Inc., 129 S.Ct. 1498 (2009)) following which the Environmental Protection Agency suspended Phase II (2007), reissued in 2011 and finalized the rules following public comments in 2014. The new framework included using cost-benefit analysis to compare the value of fish lost to impingement and entrainment, to the costs of restructuring intake facilities using best available technology which may not be closed-loop cycling for any given facility.

Biophysical and technical context specificity of benefits transfer

In their 2011 assessment of the environmental and economic benefits of proposed rules for Phase II, the Environmental Protection Agency's study spanned 871 facilities across 7 study regions. Seventy-one percent of generators and 79% of manufacturing facilities are within 2 miles of a water body listed under Section 303(d) of the Clean Water Act as impaired by pollutants. Based on available literature, Impingement and Entrainment losses at 97 facilities per study region were extrapolated to all relevant facilities regardless of size. The Environmental Protection Agency additionally recognized that they lacked complete information on time and facility-specific features that would impact species composition and abundance of fish at risk of Impingement and Entrainment near each individual facility. In terms of monetizing avoided losses (i.e., benefits) of the new rules, the Environmental Protection Agency equated Impingement and Entrainment losses to loss of future harvested yields of fish adults, and that limiting such losses would increase harvested biomass. Lastly, Impingement and Entrainment losses in forage species – not counted in the reduced harvest yield estimates - was taken to imply a loss of potential prey for predator species, such that reducing Impingement and Entrainment mortality would increase biomass production. Thus, three metrics were used in estimating losses and benefits: (i) normalizing organisms at different life stages to age-1 equivalents, (ii) forgone fishery yield and (iii) production forgone. The emphasis on harvests and biomass production is reflected in the focus on commercial and recreational fish species for benefit estimation based on direct use values. The benefits of avoiding or reducing Impingement and Entrainment losses were estimated for 3 proposed Phase II rule options: (1) establish controls on impingement mortality at all existing facilities and determine entrainment controls on a site-specific basis (2) establish impingement controls at all existing facilities and require flow reduction for closed-

cycle cooling at facilities taking in more than 125 million gallons per day, or (3) establish impingement controls and require flow reduction commensurate with closed-cycle cooling at all existing facilities drawing over 2 million gallons per day. The Environmental Protection Agency estimated Option 1 would result in a reduction of 126.44 million lbs/year in forgone production; option 2, reductions of 541.48 million lbs/year, and option 3, reductions of 556.20 million lbs/year.

Under the 2014 rule (Fed. Reg. 48299), facilities have seven options to choose from to reduce impingement, while the best available technology they can use to reduce entrainment is determined by their permitting authority on a case-by-case basis.

Section 316(b) does not operate in isolation. Many of the water bodies from which regulated facilities draw water for cooling purposes, are listed as pollution-impaired waters under Section 303(d), with pollutants ranging from nutrients to bioaccumulative heavy metals (e.g., mercury) and polycyclic aromatic hydrocarbons resulting in state-issued fish advisories against consuming fish from these water bodies. Mortality that is regulated by 316(b) pertains to aquatic life caught on intake screens and impinged there by the intake velocity, as well as aquatic life that are carried into the system and harmed by high velocity, high pressure, high temperature and added chemicals. Species listed as threatened and endangered under the Endangered Species Act of 1973, can be harmed by Impingement and Entrainment. Indeed, the Environmental Protection Agency study identified 88 of 247 aquatic threatened/ endangered species that had life stages overlapping with cooling water intakes or had records of Impingement and Entrainment mortality. Per 2014 final ruling, all facilities must collect and annually report source water data, including hydrological and geomorphological features of any and all source waterbodies, baseline characterization data of the biological community in the vicinity of cooling water intake structures. For facilities that withdraw at least 125 million gallons per day, they are required to conduct an "entrainment characterization study" that includes a minimum of two years of entrainment data collection, comprehensive technical feasibility, and cost evaluation of possible entrainment control technologies.

Why benefits transfer?

Some species affected by cooling water intake systems that are listed as threatened/endangered under the Endangered Species Act of 1973, while already low in population numbers, do not always have direct use, and therefore no value based on harvest or sales within the regions of concern. The Environmental Protection Agency's determination of non-use values for these species was limited by lack of data on quantitative Impingement and Entrainment mortality of these species across all regions of interest for the proposed regulations. There was a need to compute economic benefits of reducing that mortality, benefits of avoiding extinction, and costs of re-establishing fisheries for species with commercial value (e.g., Salmonids). An Environmental Protection Agency sponsored stated preference study to estimate total (use and nonuse) value of potential improvements resulting from proposed rules could not be implemented because of time constraints.

Benefit transfer uptake depends on availability of primary studies

In place of a primary study, the Environmental Protection Agency used benefit transfer to estimate marginal values per fish to show the benefit to recreational anglers of reducing Impingement and Entrainment mortality. The Environmental Protection Agency (2011) identified/used the following for benefit transfer: (i) Kotchen and Reiling (2000)'s contingent valuation study of the willingness to pay a one-time tax of 2009$37.02 to create a self-sustaining population of shortnose sturgeon (Acipenser brevirostrum), listed as endangered throughout its range (Fed. Reg. 32, 1967), (ii) Stoll, Ditton and Stokes's (2009) contingent valuation study of the willingness to pay 2009$121.30 to maintain lake sturgeon (Acipenser fulvescens, listed as threatened in 20 states, but not listed under the Endangered Species Act) population levels for recreational viewing in northeast Wisconsin, (iii)

the Environmental Protection Agency's (2004) random utility model analysis using the Marine Recreational Fisheries Statistics Survey (NMFS, 2003) where California anglers' willingness to pay to catch sturgeon (species unspecified) was 2009$69.88, (iv) the Environmental Protection Agency's meta-analysis using Richardson and Loomis' (2009) framework, giving a household willingness to pay of 2009$1.02 for 0.25% change, and 2009$1.85 for 5% change in endangered/threatened fish species population (species unspecified), (v) Whitehead's (1993) contingent valuation study of North Carolina residents' willingness to pay for a loggerhead turtle (Caretta caretta, 9 distinct population segments endangered) management program that would prevent or reduce its risk of extinction over 25 years, with the Environmental Protection Agency modifying the framework to estimate a willingness to pay/household of 2009$0.35 for a 1% reduction in extinction probability resulting from any of the proposed 316(b) options, (vi) the Environmental Protection Agency's (2006) meta-analysis of 48 recreational angling studies published between 1982 and 2004, to estimate marginal values per fish for species affected by Impingement and Entrainment at Phase III facilities, which was then used to estimate recreational welfare from eliminating current Impingement and Entrainment losses using their proposed options, (vii) a modification of Johnston's et al. (2009) bioindicator-based stated preference valuation study to estimate a willingness to pay of 2009$0.76 per percentage point improvement in fish condition relative to a baseline, and this was deemed representative of non-use values in Northeast US.

The Environmental Protection Agency (2014) took into consideration qualitative assessments like (i) governmental actions like acquiring fishing licenses and fishing vessels from individual fishers (ii) creation of marine protected areas under Executive Order 13158 2001 (as a side note, the Environmental Protection Agency identified 44 facilities located within MPAs, only 25 of which had data available to estimate mortality reductions from proposed regulatory options) (iii) imposing restrictions on commercial and recreational harvests (iv) conducting large scale ecosystem restoration, in areas where stocks decline. No estimates from these governmental costs were used in their benefit-cost analysis as proxies for non-use values. The Environmental Protection Agency (2014) used a modified bioindicator-based stated preference valuation study from Zhao et al. (2013) which provided a better match to estimating a willingness to pay of 2011$0.72 per percentage point increase in the number of fish saved.

Lacking standardization of valuation methods for benefit transfer

Discussions on the use of Habitat Equivalence Analysis to estimate non-use values indicates wider discussion about the standardization of valuation methods for benefit transfer. Both the Environmental Protection Agency (2011) and the Environmental Protection Agency (2014) include methodological documentation of using Habitat Equivalency Analysis to estimate non-use values of fish lost to Impingement and Entrainment mortality by looking at the improvements needed to fish and shellfish habitat to offset that mortality; valuing the national willingness to pay at 2009$3.6 billion (3% discount rate) and 2009$3.7 billion (7%) to compensate for baseline losses. A number of studies (listed in Table 9-3 of EPA (2011)) were identified for benefit transfer to estimate annual household willingness to pay per acre of aquatic habitat within the regions of concern to the Environmental Protection Agency. In both reports however, the Environmental Protection Agency "*did not consider the habitat-based approach appropriate for primary analysis of nonuse benefits*" and did not include them in the estimates of total benefits for proposed regulatory options, nor in the final rule, but used them "*to illustrate the potential magnitude of nonuse values*" (EPA, 2014).

Benefit transfer depends on the compatibility and reliability of original studies

Despite a large number of valuation studies having been carried out, the requirements of cost-benefit analysis of federal regulations and transfer uncertainty place limitations on general uptake of benefit transfer.

Johnston et al. (2006) reviewed 48 studies from United States and Canada to get the range of marginal willingness to pay per fish for recreational anglers, and showed that variables characterizing resource, context and angler attributes had greater explanatory effect on willingness to pay values, than the valuation method used, suggesting that provided enough information is available on representativeness of the people interviewed and species/habitats valued, there should be a diversity of valuation studies for potential benefit transfer. However, the Environmental Protection Agency (2011) reported their use of benefit transfer was limited by the availability of data on species-specific, and region-specific Impingement and Entrainment mortality, and lack of population estimates [H3.1], to be able to accurately extrapolate use and non-use values.

For example, the Environmental Protection Agency (2011) identified no studies they could use on the other 5 threatened/endangered turtle species, nor on pallid sturgeon (Scaphirhynchus albus, endangered) or American paddlefish (Polyodon spathula, threatened /endangered in some states), despite all being present within their regions of concern (EPA, 2011) [H3.2]. Another example, the Environmental Protection Agency (2011) identified no other valuation study besides Johnston et al. (2009) which would "provide benefit functions of comparable quality and applicability to the 316(b) regulatory context". In the 2014 report, the Environmental Protection Agency further recognized that the bioindicator-based stated preference valuation study was more representative of the Northeast region and benefit transfer from it was therefore restricted to the North and Mid-Atlantic regions of relevance to the regulatory proposal. In parallel, they also recognized that some of the biota impacted by cooling water intake structures may be unknown because all possible species present in a water body and affected, are not tallied at every facility of concern (EPA, 2011). The Environmental Protection Agency (2011) report identifies uncertainty mostly in qualitative terms [H3.3], noting for example, that applying California-based anglers' recreational value to sturgeon and paddlefish in inland regions could be either an over or under-estimate of that region's recreational value. Statistical discussion of uncertainties arising from use of meta-analysis to estimate recreational fishing benefits are taken from EPA (2006), where they conducted a sensitivity analysis based on Krinsky and Robb (1986), generating upper and lower bounds for the marginal values. The Environmental Protection Agency (2006, 2011) reports only state that all the studies identified and used for benefit transfer followed standard methods [H3.5], with reference made to the Environmental Protection Agency (2010).

Woodward and Wui (2001) point out selection bias in studies also influence what is available for benefit transfer, meaning species or regions with a priori high value, are likely to be covered more, or to a higher standard, in valuation studies, leaving behind understudied regions and species, many of which may include threatened/endangered populations.

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Annex 4.20. Uptake case #7: Implementing gross ecosystem product (GEP) in Lishui, China

For what purpose was valuation used, in what part(s) of the policy cycle, by which stakeholders?

The informative purpose of GEP adoption in Lishui is reflected in how the indicator has been incorporated into the planning, monitoring, and evaluation dimensions of local development and governance, as described above. The implementation of GEP in local decision-making processes is an example of decisive purpose. How GEP has been used as a baseline for projects and transactions reflects the technical purpose part of the policy cycle. Stakeholders include local administrators (for informative, decisive, and technical purposes), businesses (informative and technical purposes), as well as the local residents who act as both suppliers and consumers of ecosystem services (informative, decisive, and technical purposes).

What kind of valuation method was used?

GEP is comprised of a range of ecosystem services, grouped into material (i.e., "provisioning"), regulating, and non-material (e.g., "cultural") services. Correspondingly, multiple valuation methods are used, falling into three general categories: (1) whenever possible, the physical quantity of the service is multiplied by the market transaction price; (2) where market prices are unavailable, an engineering substitution cost is used (i.e., replacement cost method); (3) if an engineering substitution cost method is not applicable, other cost estimation methods such as hedonic pricing and travel cost estimation are used.

What made valuation uptake possible - what barriers in the policy issue cycle were overcome?

With respect to the criteria identified in *Table SM4.14*, the primary barriers that were overcome to achieve valuation uptake had to do with "Salience" (H2.1 Lack of 'actionable' targets; H2.2 Non-conducive regulatory context). One of the central rationales for implementing GEP was to fill the lack of "actionable" targets with which to balance ecological conservation and economic growth. GEP is used alongside GDP to help promote a harmonized "dual growth" strategy in which economic gains do not come at the expense of nature, and investments in natural capital are increasingly profitable. Additionally, by being used as a standard for appraising projects (namely whether or not they need to provide ecological offsets) and in the evaluation of administrator performance, GEP has helped improved the regulatory context, making it more conducive for nature-positive transactions.

Table SM4.14. What barriers to uptake were overcome?

Uptake criteria	Barrier to uptake hypotheses	Study details
1.Timeliness	H1.Study time-lags relative to stakeholder needs	-
2.Salience	H2.1 Lack of 'actionable' targets	One of the central rationales for implementing GEP was to fill the lack of "actionable" targets with which to balance ecological conservation and economic growth. GEP is used alongside GDP to help promote a harmonized "dual growth" strategy in which economic gains do not come at the expense of nature, and investments in natural capital become profitable.

	H2.2 Non-conducive regulatory context	By being used as a standard for appraising projects (namely whether they need to provide ecological offsets) and in the evaluation of administrator performance, GEP has helped improved the regulatory context, making it more conducive for nature-positive transactions.
3.Credibility	H3.1 Disagreement on causality	-
	H3.2 Lacking data	-
	H3.3.Excessive uncertainty	-
	H3.4 Insufficient stakeholder training in valuation	-
	H3.5 Lack of standardization of valuation methods	-
4.Legitimacy	H4.1: Lack of full representation of stakeholders	-
	H4.2 Political use/blocking of valuation knowledge power	-
5. Process documentation	H5 Lack of independent assessment	-
6. Information cost	H6: Valuation study costs	-
Other		-

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