Plural valuation of nature for equity and sustainability: Insights from the Global South

Noelia Zafra-Calvo a, Patricia Balvanera b,w, Unai Pascual a,c,d,*, Juliana Merçon e, Berta Martín-López f, Meine van Noordwijk g,h, Tuyeni Heita Mwampamba b, Sharachchandra Lele i, Chinwe Ifejika Speranza j, Paola Arias-Arévalo k, Diego Cabrol l,u, Daniel M. Cáceres l, Patrick O'Farrell m,n, Suneetha Mazhenchery Subramanian o,p, Soubadra Devy i, Siddhartha Krishnan i, Rachel Carmenta q, Louise Guibrunet b, Yoanna Kraus-Elsin r, Hannah Moersberger s, Joji Cariño t, Sandra Díaz u,v

a Basque Centre for Climate Change, Scientific Campus of the University of the Basque Country, Leioa 48940, Bilbao, Spain
b Instituto de Investigaciones en Ecosistemas y Sustentabilidad, Universidad Nacional Autónoma de México, 58190 Morelia, Mexico
c Basque Foundation for Science, Ikerbasque, Bilbao, Spain
d Centre for Development and Environment, University of Bern, Bern, Switzerland
e Instituto de Investigaciones en Educación, Universidad Veracruzana, Veracruz, Mexico
f Institute for Ethics and Transdisciplinary Sustainability Research, Faculty of Sustainability, Leuphana University of Lüneburg, Lüneburg, Germany
g World Agroforestry (ICRAF), Bogor 16115, Indonesia
h Plant Production Systems, Wageningen University, Wageningen 6708 PB, The Netherlands
i Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Sriramapura, Jakkur Post, Bangalore 560 064, India
j Institute of Geography, University of Bern, Hallerstrasse 12, 3012 Bern, Switzerland
k Departamento de Economía, Facultad de Ciencias Sociales y Económicas, Universidad del Valle – Cali, Colombia
l Facultad de Ciencias Agropecuarias, Universidad Nacional de Córdoba-CONICET, Argentina
m Council for Scientific and Industrial Research, Pretoria, South Africa
n FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Rondebosch 7701, South Africa
o United Nations University, Institute for the Advanced Study of Sustainability, Tokyo 150-8925, Japan
p United Nations University, International Institute for Global Health, Kuala Lumpur 50490, Malaysia
q Department of Geography, University of Cambridge, Cambridge, United Kingdom
r Instituto Humboldt, calle 28 A#15-09, Bogotá D.C. 3202767, Colombia
s Future Earth Paris Hub, Centre National de la Recherche Scientifique (CNRS), 75005 Paris, France
t Forest Peoples Programme, 1c Fosseway Business Centre, Stratford Road, Moreton-in-Marsh GL56 9NQ, United Kingdom
u Instituto Multidisciplinario de Biología Vegetal (IMBIV CONICET-UNC), Córdoba, Argentina
v FCEFyN, Universidad Nacional de Córdoba, CC 495, 5000 Córdoba, Argentina
w Unidad Académica de Estudios Territoriales, Universidad Nacional Autónoma de México, Reforma s/n Centro, Oaxaca 68000, Mexico

*** Corresponding author**

Abstract
Plural valuation is about eliciting the diverse values of nature articulated by different stakeholders in order to inform decision making towards achieving more equitable and sustainable outcomes. We explore what approaches align with plural valuation on the ground, as well as how different social-ecological contexts play a role in translating plural valuation into decisions and outcomes. Based on a co-constructed analytical approach relying upon empirical information from ten cases from the Global South, we find that plural valuation contributes to equitable and sustainable outcomes if the valuation process: 1) is based on participatory elicitation approaches; 2) is framed with a clear action-oriented purpose; 3) provides space for marginalized stakeholders to articulate their values in ways that can be included in decisions; 4) is used as a tool to identify and help reconcile different cognitive models about human-nature relations held by different stakeholders; and 5) fosters open communication and collaboration between stakeholders. We also find that power asymmetries can hinder plural valuation. As interest and support for undertaking plural valuation grows, a deeper understanding is needed regarding how plural valuation may adapt to different purposes, approaches, and social-ecological contexts to contributing to social equity and sustainability.

Highlights
- Plural valuation (PV) reveals diverse values of nature held by different stakeholders
- PV's purpose, approach and context shape the achievement of equitable and sustainable outcomes
- Participation, action-oriented purposes, inclusion of marginalized stakeholders and reconciliation of different cognitive models are crucial PV components
- Power asymmetries can severely constrain PV's potential, which is strengthened by collaboration.

Keywords: knowledge co-production, transdisciplinarity, power relations, values

1. Introduction
The magnitude of today's biodiversity and climate crisis calls for urgent transformative change in public decision-making and planning processes in order to reverse current trends and catalyse pathways towards just and sustainable futures. The fabric of nature that supports human well-being is declining fast, generating a cascade of negative interdependent impacts for people and ecosystems worldwide (Chaplin-Kramer et al., 2019). These impacts are borne unequally among different social groups and world regions, and globally agreed policy targets (e.g., Sustainable Development Goals) are unlikely to be met unless the direct and indirect drivers of the impacts are addressed (IPBES, 2019).

Addressing current unsustainable social and environmental conditions not only requires identifying their drivers, but also undertaking strategic actions that lead to fundamental changes in the social-ecological system as a whole (Meadows, 1999a; Abson, et al. 2016; Fischer and Riechers, 2019). The literature on social-ecological systems shows that transformative change requires recognising and catalysing the diverse values of and about nature held by multiple

stakeholders (Andrachuk and Armitage, 2015; Arias-Arévalo et al., 2017; Pereira et al., 2018). The inclusion of plural knowledges into decision making and consequent actions are also essential requirements for addressing social inequalities (Aragão et al., 2016). Demands for greater democratization, transparency and accountability in decision-making are being spearheaded around the world by multiple citizens' groups, community-based and non-governmental organisations, and social movements for civil and political rights, gender equality, environmental justice and indigenous people's rights. These demands have been also supported by a growing cohort of sustainability scientists (see Chan et al., 2018; Jacobs et al., 2020). Indeed, depending on how valuation of nature is undertaken, the decisions and their impacts will most likely vary, with implications for who wins and who loses from such decisions (Pascual et al., 2017). Agenda-setting plans at different scales can trigger the valuation of nature with distinct potential impacts on different stakeholders under growing asymmetries in social power relations (Martinez-Alier et al., 2003).

Plural valuation (PV hereafter) focuses on eliciting and integrating the diverse values of nature into decision-making and action, with a holistic vision. It has increasingly been advocated for addressing the biodiversity crisis and specifically to respond to the need for environmental justice (Aragão et al., 2016; Rusch et al., 2017; Boillat et al., 2020). PV can be generally defined as a process that assesses the diversity of values that are attributed to nature in a given society, and how these values relate to each other, with the aim of bringing such plurality into decision making (Rincon-Ruiz et al., 2019). PV recognizes diversity in the values held by stakeholders given their worldviews, knowledge systems and power relations (Pascual et al., 2017). The intellectual shift from monistic (i.e., valuation based on a single metric or a single worldview about human-nature relations) to pluralistic valuation is being fostered by the convergence of ideas towards the development of a social-ecological systems approach within sustainability science (Bennett et al., 2016) and is already impacting on global science-policy initiatives, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Pascual et al., 2017; Diaz et al., 2018).

There is a growing community of researchers advocating for a shift towards PV in order to foster just and environmentally sustainable outcomes from decisions, especially from public bodies. Their key underlying conditions are for PV to recognize and capture the interplay of the multiple perspectives on human-nature relations, multiple knowledges and the associated diversity of values, and create transparent and participatory spaces that can incorporate such values into decision-making. This community of scholars also recognize that valuation and sustainability science are necessarily value laden (Pascual et al., 2017, Nielsen et al., 2019, Jacobs et al., 2020).

Here we explore the above assumptions and shed light on the extent to which social and institutional conditions enable or constrain the capacity of PV to contribute to equitable and sustainable outcomes. We do this by assessing ten case studies from the Global South in which different perspectives associated with PV have been considered. The analysis is based on available data from the case studies, the development of a conceptual framework on PV and a corresponding analytical approach based on an interdisciplinary collaborative co-learning process involving multiple workshops that took place between 2017 and 2019. We specifically

(i) assessed the intent (purpose) and ways (approaches) through which researchers engaged in PV approaches in the ten cases studies, (ii) analyzed the extent to which PV contributed in those local social-ecological contexts to decision-making that led to equitable and sustainable outcomes, and (iii) identified what were the key enablers and constraints for PV in achieving the desirable outcomes.

2. Plural valuation grounds

Plural valuation of nature is emerging from the interplay among different research traditions, and is based on a wide range of schools of thought (Figure 1). For instance, action research was developed as early as in the 1940s to foster collective experimentation and iterative learning through evidence collected on the ground. As a result, participatory rural appraisal techniques started to be widely applied around the 1970s and 1980s by development studies scholars (e.g. see Chambers, 1994), although they did not explicitly make visible the role played by the diverse values of nature held by different people. These participatory assessments provided fertile ground to new participatory sustainable livelihood approaches for informing development policy research, where the idea of investing in natural assets started to gain traction (Ashley and Carney, 1999). Around the same time, a plethora of other participatory methods were being developed in order to elicit the perspectives of disempowered people, especially in order to deepen understanding about the diversity and commonalities of people's concepts of well-being (or ill-being), and good (or bad) quality of life. Many of these approaches did, for instance, emphasize the locally-specific perceptions of the poor about the meanings, values and understandings of their environmental context (e.g. Brocklesby and Hinshelwood, 2001). In parallel, participatory (social) multi-criteria evaluation techniques were being developed throughout the 90s by ecological economists (e.g. Munda et al., 1994; Martinez-Alier et al., 1998) as a response to mainstream monetary valuation approaches of the environment which leaned towards a (monistic) utilitarian framing (Wegner and Pascual, 2011) and which were starting to be applied in developing country contexts (e.g. Aylward and Barbier, 1992).

A heterogeneous field is in the making that combines and integrates different disciplinary and methodological traditions to make more explicit the role of a wider set of values of nature (Fig. 1). Several authors have put forward guiding tools to be used when undertaking PV (e.g. Etxano et al., 2015; Jacobs et al., 2016; Arias-Arévalo et al., 2018; Rincón-Ruiz et al.,2019). Similarly, deliberative economic valuation is also applied drawing on fields such as environmental ethics, environmental psychology, and environmental sociology (e.g. Kenter, 2016; Lliso et al., 2020). There is thus an emergent wave of valuation studies designed to document the diverse and intertwined ecological, socio-cultural and economic dimensions of the values of nature. We argue that all of these approaches are enriching social-ecological systems thinking and are helping to coalesce a new field of transdisciplinary sustainability research (Merçon et al., 2019), which connects science, society and policy (Clark et al., 2016), as well as with approaches that contribute to negotiation and social-ecological conflict resolution processes (van Noordwijk and Coe, 2019).

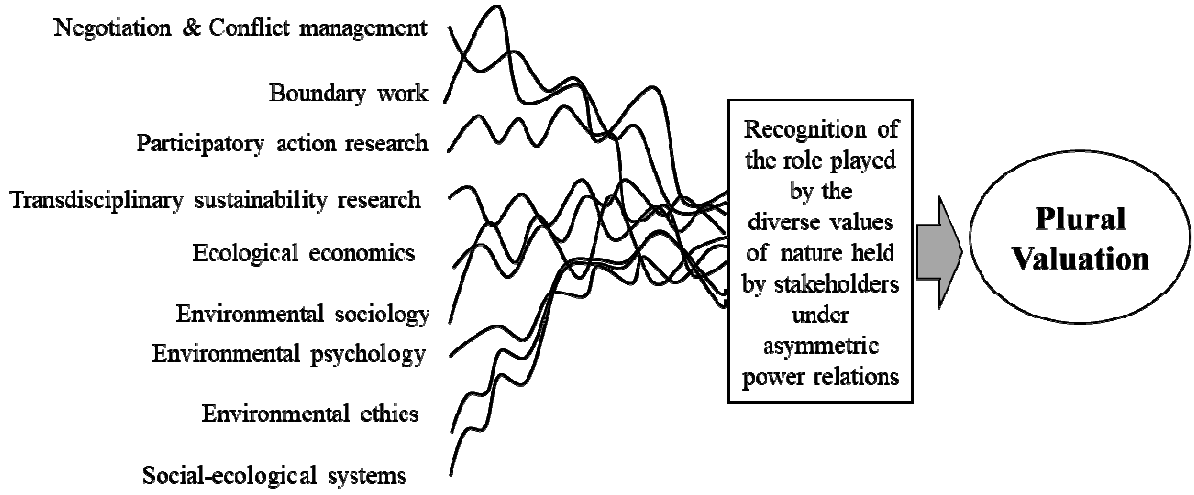

Figure 1. Plural valuation is a rapidly evolving field derived from multiple conceptual and methodological approaches to make visible the diversity of values of nature held by different stakeholders towards decision making that fosters social equity and environmental sustainability. A subset of applied research fields that are connected with the ten study cases are shown to coalesce, each in their own way, into plural valuation.

Different approaches to elicit the multiple values of nature enriches the debates on valuation but there is also a need to compare and systematize the application of such approaches. A collaborative comparative analysis, through co-learning, can be used to assess the commonalities among such diverse sets of perspectives in order to provide practical grounding to the notion of PV and to empirically assess its effects

3. Material and methods

3.1. Case studies

Given that PV is still an eclectic but rapidly evolving field, we present here a joint and encompassing analysis to better understand the use and effects of PV processes in a range of local contexts. We focus on the Global South because it is where colonial legacies (Jayaprakash and Hickey, 2019), weak institutional structures and continuous power struggles (Di Gregorio et al., 2019), as well as increasing pressures on natural assets (Levers et al., 2019) drive some of the most drastic impacts and rapid landscape transformations. It is also where the increasing global demand for natural assets are largely borne, especially by local stakeholders (Chaplin-Kramer et al., 2019; IPBES, 2019). Yet, the values held by the people who are most severely impacted by landscape transformation remain invisible, as a result of strong power imbalances, through narrow valuation practices, thus contributing to perpetuating social-ecological inequalities, injustices and conflicts (Sikor, 2013; Fisher et al., 2018).

We used an information-oriented selection approach (Runeson and Höst, 2009) to identify ten case studies across eight countries: Indonesia, India, South Africa, Tanzania, Kenya, Argentina, Colombia and Mexico, (Figure 2). Each of the cases was documented by a research partner, also co-author of this article. Three main criteria guided the selection of the case studies. First, the set of cases had to offer a rich diversity of inter- or trans-disciplinary work on valuation. Second,

each case had to be associated with a valuation process to make visible the diverse values held by different local stakeholders that could serve as an input for negotiating decisions and actions. Third, the research partners had a deep understanding of their case studies as well as an interest in engaging in a co-learning process to jointly develop a conceptual and analytical approach towards shedding light on PV in the Global South.

The cases addressed various social-ecological issues. These included, inter alia: the evictions of coffee-farmers supposedly to secure water for hydropower generation (Sumberjaya, Indonesia); power asymmetries in the devolution processes of forest management to local people following the introduction of the Forest Rights Act (Odisha, India); inequity in the distribution of social impacts and human well-being contributions of protected areas (Darjeeling Himalayas, India); need to leverage multiple forms of societal demand for traditionally known medicinal plants (Kerala and Tamil Nadu, India); water use and governance (Laikipia, Kenya); implementation of participatory processes for designing REDD+ (Kilosa, Tanzania); green space use in urban areas (Cape Town, South Africa); discussion of a law aimed at protecting native forest (Cordoba, Argentina); need to give voice to marginalized people in watershed management (Otún, Colombia); and the creation of a citizens' network in response to the top-down decree of a protected area (Xalapa, Mexico). Details about the case studies can be found in the supplementary material (Section A).

We first co-developed a conceptual framework, followed by an analytical framework and a systematic assessment of all ten cases and the corresponding data analysis through an iterative co-learning process among all the research partners involved in the study. The identification of the key nexuses among all the cases led to the framing of the conceptual and analytical frameworks. Then, research partners participated in four three-day workshops (November 2017 in Oaxaca, Mexico; June 2018 in Morelia, Mexico; October 2018 in Bangalore, India; and June 2019 in Zigoitia, Basque Country) to jointly develop and operationalize the conceptual framework and the required empirical approach for comparing data across all the cases. The results from the data analysis were interpreted and refined in an iterative way. The co-learning process spanned over two years (2017-2019).

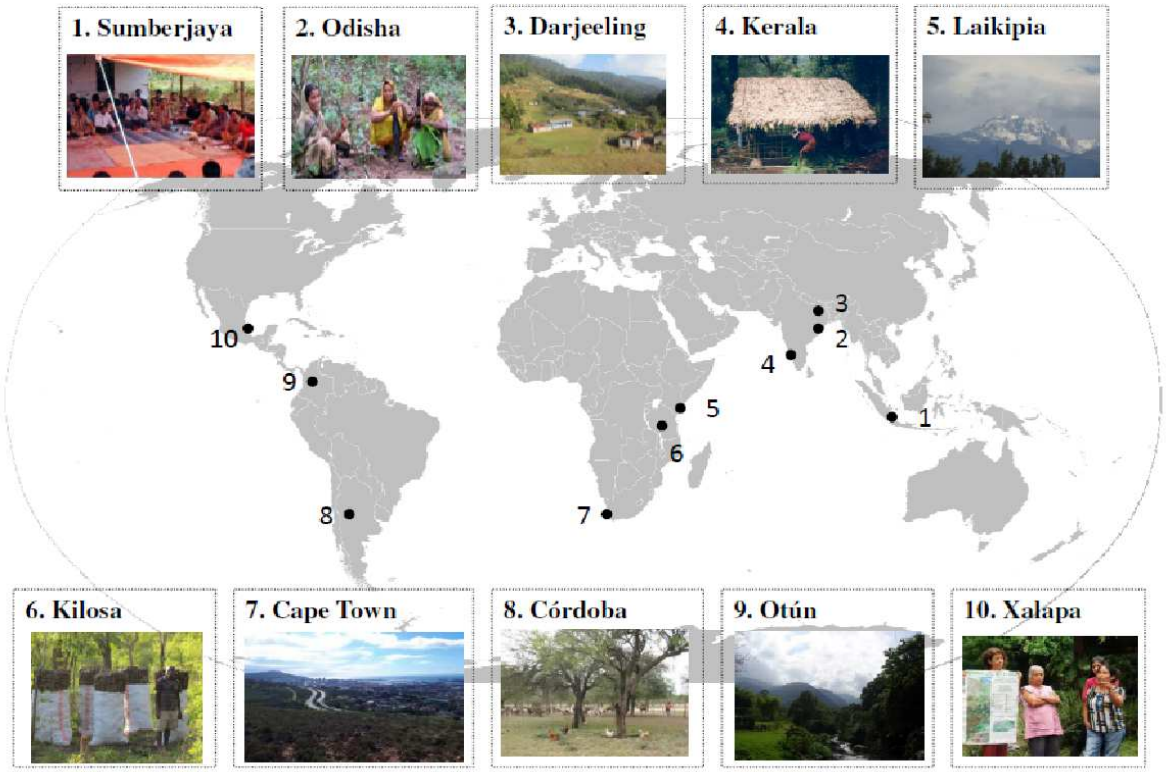

Figure 2: Location of the case studies in the Global South in which plural valuation was undertaken: 1) Sumberjaya, Indonesia (IDN), 2) Odisha, India (IND1), 3) Darjeeling Himalayas, India (IND2), 4) Kerala and Tamil Nadu, India (IND3), 5) Laikipia, Kenya (KEN), 6) Kiolosa, Tanzania (TZA), 7) Cape Town, South Africa (ZAF), 8) Córdoba, Argentina (ARG), 9) Otún, Colombia (COL), and 10) Xalapa, Mexico (MEX).

3.2. The conceptual framework

We conceptualize plural valuation of nature as a process of knowledge generation that seeks to inform decision making and actions which affect human-nature relations by considering stakeholders' diverse values. It relies on exploring the place-based relevant knowledge systems in order to i) elicit, describe and analyse the diversity of values held by different stakeholders or/and to ii) assess the actual or potential impacts of decisions (and subsequent actions) on people and nature. One main idea behind PV is a process that could be useful as a negotiation support tool involving an iterative cycle of sustained feedback between negotiation and decisions, actions and outcomes. Thus, in our view, PV goes beyond the mere elicitation of a diversity of values (Figure 3).

PV can be undertaken for different purposes and using different approaches. PV may be triggered by a variety of locally specific issues (see section 3.1). PV can be used to explore the values associated with an issue at stake or/and as a tool to support social-ecological transformation (1a in Figure. 3). Depending on the PV approach taken and the main purpose which motivates its use, the process can generate salient, credible and legitimate co-produced knowledge about values that can in turn influence policy formulation and contribute to decisions

and/or actions (Leimona et al., 2015, Clark et al., 2016). In addition, approaches to PV (1b in Fig. 3) may differ with respect to: i) the types of valuation metrics used (e.g. qualitative, quantitative), ii) the types of values it aims to reveal (e.g. instrumental and relational or a combination of both), iii) whether it is designed to help reconcile different values or to recognize trade-offs, and iv) the extent to which participatory approaches are applied (Jacobs et al. 2016; Arias-Arevalo et al., 2018).

The new knowledge about the diversity of values that is generated through PV (2a in Fig. 3) can be used as input to decision making, allowing PV to be considered as a negotiation support tool that can influence human-nature relations and that can lead to subsequent changes in social-ecological outcomes (2b in Fig. 3). PV may reveal conflicting perspectives and interests, and set the stage for negotiating these differences and disputes (Jacobs et al., 2018). It can help to understand how decisions are taken and which preferences are considered and articulated into actions (van Noordwijk et al., 2019). In this way PV can also help identify power assymetries as well as structural inequalities, in terms of access to and control over natural assets (Drimie et al., 2018).

Outcomes from natural resource management decisions are likely to affect social equity and ecological sustainability (McShane et al., 2011). These social-ecological outcomes include both inter- and intra- generational outcomes. For instance, positive social-ecological outcomes might align with ‘just transitions’ that reconcile sustainable use of natural assets with a meaningful commitment to sufficiency, understood as the satisfaction of all individuals’ needs without consuming more than their fair share (e.g., Swilling and Annecke, 2012; WCED, 1987 and IPBES, 2019).

The way PV is conducted as a research endeavour largely depends on the social-ecological context in which it can be undertaken. Institutional, economic, social, cultural and political factors can enable or impede the PV process at any stage. Additionally, many factors can affect how insights gained from PV may be integrated into decision making (3a in Fig. 3). Likewise, these factors may also influence how PV may be used as a negotiation support tool and how potential actions may be implemented on the ground (Keenan et al., 2019) (3b in Fig. 3). The outcomes of the entire PV cycle may create new opportunities and initiate a new cycle of PV or feedbacks by having shifted stakeholders’ views and values, actions and outcomes. The transformational change required to shift situations out of gridlock may require a different number of full iterations of the PV cycle.

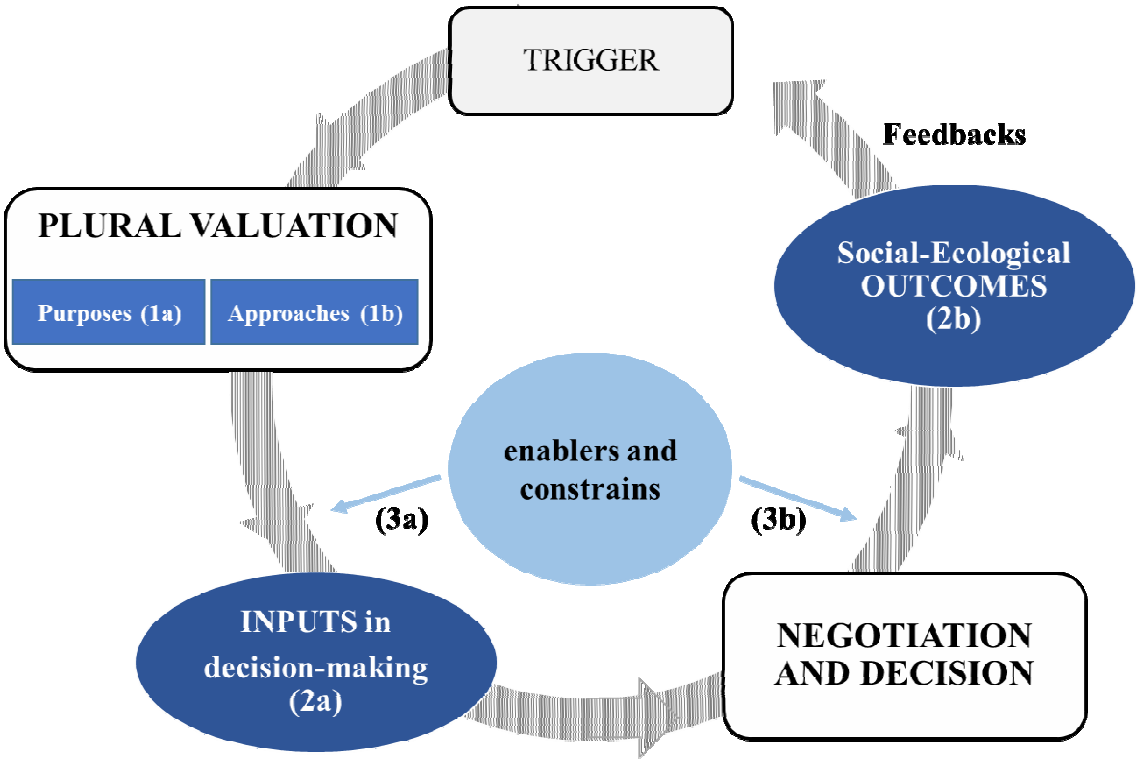

Figure 3: Conceptual framework of plural valuation. PV is triggered by the desire to unlock an issue. It can have different purposes (1a) and be undertaken using several approaches (1b). The knowledge generated acts as an input into decision making (2a) and can become a tool for negotiation and subsequent action, generating specific social-ecological outcomes (2b) that can contribute to social equity and ecological sustainability. PV is influenced by a variety of enablers and constraints that mediate how PV knowledge is integrated into decision making (3a) and how actions are implemented (3b). Changes in the perception of stakeholders about an issue at stake may trigger a new PV cycle (see key terms used in the conceptual framework in Table B1, Section B supp. material.).

3.3. The analytical approach

Drawing on the conceptual framework, we developed an analytical approach to gather relevant information from the ten case studies. We analysed the purpose, approach and context of the PV within each of the case studies following an iterative bottom-up question-based approach (Eisenhardt, 1989). As the key components of PV were identified, a shared protocol to collect the information across studies was developed, and the approach to compare data across cases was co-designed. Consequently, the analytical approach is a function of how the PV is conceptualized (Fig. 3) and how it was applied in the ten case studies, as well as how the broad terms of social equity and ecological sustainability were iteratively considered and agreed upon by all research partners. The research questions that guided data collection from each case study are described next.

3.3.1. With what intent (purpose) and in which ways (approaches) research partners engaged in PV?

We first collected information about the original purpose of the valuation in each case study to understand the motivations the research partners' engagement with local stakeholders and the specific valuation approach they used (1a in Fig 3). We classified the purpose of PV using four dichotomous variables that represent whether the purpose was exploratory, informative, action-oriented or policy-oriented (cf. Table 1a).

Table 1a. Variables selected to assess the purpose of PV in the case studies

	Description	
Exploratory	Valuation used primarily to improve knowledge	Yes: 1; No: 0
Informative	Valuation used primarily to change the perspectives of stakeholders	Yes: 1; No: 0
Action-oriented	Valuation used primarily used to generate actions by stakeholders in specific contexts, but not necessarily at influencing policy	Yes: 1; No: 0
Policy-oriented	Valuation used primarily to produce outcomes through the design and/or implementation of policies	Yes: 1; No: 0

In order to define the valuation approach (1b in Fig. 3), six dichotomous variables were used to enable comparative insights (cf. Table 1b). The variables relate to whether PV (i) was based on the use of multiple metrics; (ii) revealed instrumental and relational values; (iii) revealed moral duties and responsibility towards nature; (iv) recognized and/or tried to reconcile different cognitive models about human-nature relations (Muradian and Pascual, 2018); (v) carried out participatory and/or deliberative methods; and (vi) recognized trade-offs between values and/or revealed conflicts among values held by different stakeholders.

Table 1b. Variables selected to assess the approaches used in PV in the case studies

	Description	
Multiple metrics	Valuation used diverse quantitative or qualitative metrics, or combinations thereof.	Yes: 1; No:0
Revealed instrumental and relational values	Valuation included value notions referring to the importance of nature and NCP* as means towards ends (e.g. water as input for agriculture; instrumental values); and referring to the importance assigned to the relationships between humans and nature (e.g. sacred values, identity, sense of place; relational values).	Yes: 1; No: 0
Revealed moral duties or responsibility/care principles towards nature	Valuation included the recognition of nature as moral subject (e.g. intrinsic values, nature's rights) and principles such as stewardship of nature	Yes: 1; No: 0
Reconciled different cognitive models about human-nature relations	Valuation allowed stakeholders with different cognitive models about human-nature relations to become aware of such differences or ended up sharing worldviews about their position with respect to nature.	Yes: 1; No: 0
Used participatory or deliberative methods	Valuation used participatory and deliberative methods to ensure that diverse stakeholders' values and interests were included; or approaches aimed at placing decision-making in stakeholders' hands. Note: Values elicitation based on just consulting or informing stakeholders were classified as not participatory.	Yes: 1; No: 0

Recognized trade-offs between NCP* or values	Values elicitation revealed compromises between NCP* or values. It included a description of how different people have different values and the trade-offs between these values (e.g. water for production vs water for human consumption).	Yes: 1; No: 0

* NCP: Nature's Contributions to People

3.3.2. To what extent PV contributed to decision making that produced equitable and sustainable outcomes?

We used two qualitative variables to characterize the way PV acts as a useful input into decision making and negotiation (2a in Fig 3). We explored the extent to which PV helped: (i) reveal conflicts and synergies among stakeholders' values, and (ii) include under-represented or marginalized values (Table 2a).

Table 2a. Variables designed to assess the inputs of PV into decision making in the case studies

	Description	
Conflicts and synergies were revealed	PV revealed conflicts or synergies among values, NCP* or stakeholders.	0: Not at all; 1: To some extent; 2: Yes
Values of marginalized stakeholders were included	Values expressed by less powerful stakeholders and minority groups were included in decision making.	0: Not at all; 1: To some extent; 2: Yes

* NCP: Nature's Contributions to People

We developed four variables to assess the types of social-ecological outcomes that were derived from the PV cycle (2b in Fig. 3). We described outcomes as: (i) sustaining the flow of nature's contributions to people, NCP; (ii) achieving a equitable distribution of NCP; (iii) improving the quality of life (QoL) of marginalized stakeholders; and (iv) mitigating social-environmental conflicts among stakeholders **(Table 2b).**

Table 2b. Variables used to assess the social-ecological outcomes from the PV cycle in the case studies

	Description	
Improved sustainable flows of NCP*	The quality or quantity of NCP* flows was improved. Note: If there were several NCP* at stake and all of them were improved in terms of their sustainability provision, it was labelled as "2", if only some of them were improved it was labelled as "1".	0: Not at all; 1:To some extent; 2: Yes
Improved distributional equity of access to NCP*	Uneven access or use of NCP* by stakeholders was improved.	0: Not at all; 1:To some extent; 2: Yes
Improved the QoL** of marginalized people	One or more components of the QoL** of less powerful stakeholders were improved (e.g. livelihoods, health, good social relationships, security, cultural identity, and freedom of choice and action). Note: the notion of QoL** was locally context-dependent.	0: Not at all; 1: To some extent; 2: Yes

Reduced conflicts among stakeholders	Conflicts among stakeholders were diminished or resolved.	0: Not at all; 1: To some extent; 2: Yes

* NCP: Nature's Contributions to People; **QoL: Quality of Life

3.3.3. What were the key enablers and constraints of PV?

Open-ended questions were used to gather information that could describe the social-ecological context and the key constraints and enablers of (i) the integration of PV into decision making and negotiation (3a in Fig. 3). and (ii) decisions based on valuation to equitable and sustainable outcomes (3b in Fig. 3).

3.4 Data analysis

3.4.1 With what intent (purpose) and in which ways (approaches) did researchers engage in PV?

We developed typologies for the ten case studies according to their purpose and approach and used such typologies in a 2D hierarchical clustering analysis. The clusters were represented in a heatmap and a bar-diagram to depict the percentage of cases in each cluster that were characterized by the diverse purposes and features of PV. The 2D hierarchical clustering analysis is an agglomerative clustering method that seeks to create hierarchies of clusters (in our case the case studies, and PV purpose and approach) by progressively merging them into two different clusters that resulted in two dendrograms (Greenacre and Primicerio, 2013). Based on these two dendrograms, a heatmap displays the relation of each of the variables related to the purpose and approach to a case study (Wilkinson and Friendly, 2008). We used Ward's method as an agglomerative hierarchical method and Euclidean distance (Ward, 1963).

3.4.2 To what extent did PV processes contributed to decision making towards achieving more equitable and sustainable outcomes?

We sorted the case studies using principal components analysis (PCA) according to (i) the degree to which outputs of PV were included into decision making and negotiation (Table 2a), and (ii) the extent to which the case studies achieved equitable and sustainable outcomes resulting from the PV cycle (Greenacre and Primicerio, 2013). The PCA results were visualized using the first two principal component ordination axes (PCA1 and PCA2) which helps illustrate the patterns of associations between the case studies and the ordination axes.

All statistical analyses were performed using XLSTAT software (https://www.xlstat.com/en/; version 19.01).

3.4.3 What were the key enablers and constraints to allow for PV to take place?

Enablers and constraints (such as political will to support PV or the level of asymmetric power relations in decision making) were identified based on the narratives provided by the research partners. The content of the narratives was split into statements (Bergman, 2010). The conversion of the narratives into short statements involved carefully considering the socio-cultural and political context in which PV, decisions and actions took place in each case study. This required understanding the contexts from which the narratives emerged and exploring the

ways in which theories of reality and relations of power were encoded into aspects such as the syntax or style (Nursey-Bray et al., 2010). Based on the statements, we constructed a typology of subcategories for enables and constrains according to how they affected (i) the inclusion of PV into decision making processes (category I, 3a in Fig. 3), and (ii) the translation of decisions into socially equitable and ecologically sustainable outcomes (category II, 3b in Fig. 3). To do that, we used open coding methods (Ayala-Orozco et al., 2018), starting with a set of codes that were adjusted as the data were being analysed to ensure maximal homogeneity within subcategories. The dataset collected from the case studies can be found in the Supp. Material (Section C**).**

4. Results

4.1. With what intent (purpose) and in which ways (approaches) did researchers engage in PV?

All the case studies were clustered into two groups distinguished by their purpose and the valuation approach used (Figure 4; cluster A in purple and cluster B in blue). Patterns are also shown in a heatmap of the 2D hierarchical clustering analysis (Fig. D1 in Supp. Material). The defining features of the clusters was the use, or not, of participatory approaches and action-oriented purposes. All the case studies in cluster B applied participatory approaches and aimed at translating elicited values into specific actions, while those in cluster A did not do so.

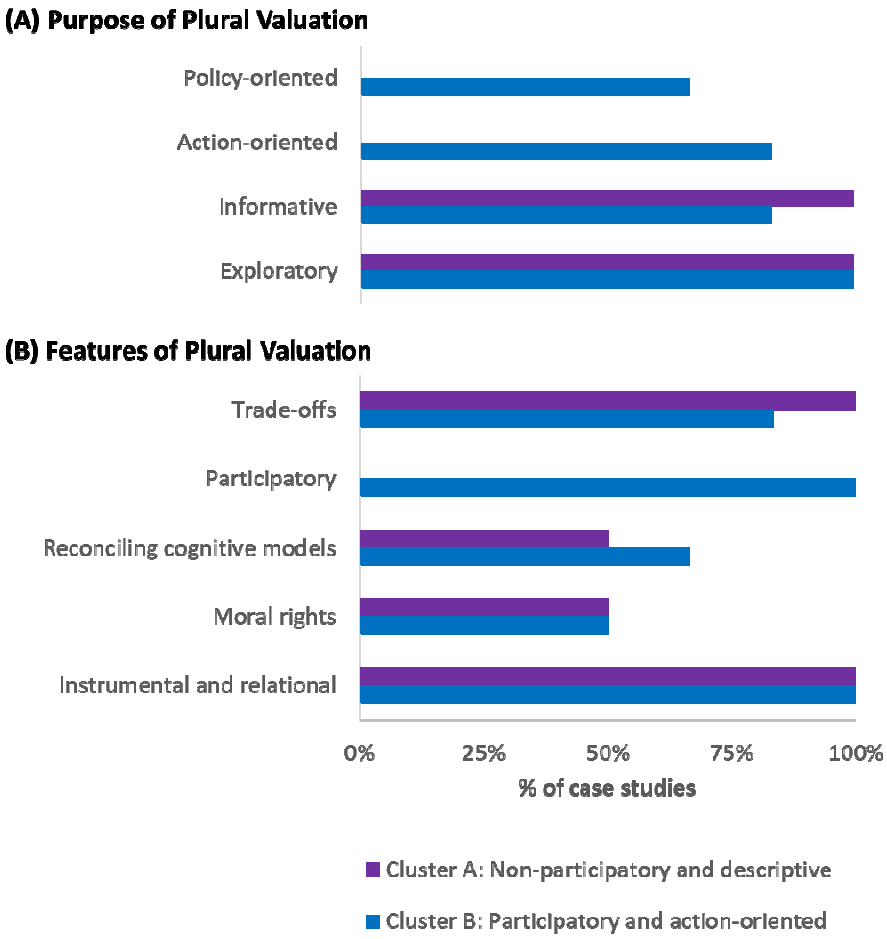

Figure 4. Study cases were identified as belonging to two different clusters. The characteristics of the two clusters are portrayed using the percentage (%) (*x* axis) of case studies from each of the clusters (clusters A in purple and B in blue) that were characterized by the different purposes and features of PV. Cluster A includes the case studies of Otun (COL), Cape Town (ZAF), Odisha, Kerala and Tamil Nadu (IND1 and IND3). Case studies in cluster B include Darjeeling Himalayas (IND2), Xalapa (MEX), Cordoba (ARG), Sumberjaya (IDN), Kilosa (TZA), and Laikipia (KEN).

4.2. To what extent did PV processes contributed to decision making towards achieving equitable and sustainable outcomes?

Across case studies, valuation processes differed with respect to their degree of integration into decision making and how equitable and sustainable the associated outcomes were. The ten case studies were distributed along two axes: PCA1 and PCA2 (Figure 5). PCA1 in the horizontal axis, can be interpreted as the degree to which case studies achieve socially equitable and ecologically sustainable outcomes (or positive social-ecological outcomes). PCA2 in the vertical axis, can be interpreted as the extent to which the inputs from PV contributed to decision making and negotiation by stakeholders holding different values.

Attaining equitable and sustainable outcomes (PCA1) and the contribution of PV to decision making (PCA2) explained 85% of the total variance among case studies, with most of the variance (62%) being explained by PCA1. The variables that contributed more to PCA1 include whether PV contributed to improving (i) the flow of NCP, (ii) the distributional equity of NCP, (iii) the QoL of marginalized stakeholders, (iii) social conflicts by ameliorating them. Another important share of the variance among case studies (22.4%) was explained by PCA2. The variables that contributed more to PCA2 included whether PV (i) revealed conflicts among stakeholders and (ii) uncovered marginalized values that were then included into decision making (see PCA factor loadings and squared cosines in Table D1 in Supp. Material).

The data suggest that when PV was used in a participatory manner and it was designed as action- or policy-oriented, it led to outcomes that are associated with improved equity and sustainability. This is shown by the four cases that scored high for PCA1: Sumberjaya (IDN), Kilosa (TZA), Laikipia (KEN), and Xalapa (MEX). We also found that providing the necessary space for marginalized stakeholders to articulate and include their values into decisions is critical when including PV into decision making, but interestingly we did not find this to be a requisite for achieving equitable and sustainable outcomes. From the four study cases that scored high for PCA2, only two also scored high for PCA1: Sumberjaya (IDN) and Laikipia (KEN). Two additional case studies scored high for PCA1, but low for PCA2, and thus reached the desired outcomes without providing space for articulating values by all stakeholders: Kilosa (TSA) and Xalapa (MEX).

We found that reconciling cognitive models about human-nature relations of different stakeholders in valuation process is essential for achieving equitable and sustainable outcomes. This was shown by two case studies in cluster B: Cordoba (ARG) and Darjeeling (IND2). Despite the fact that they used participatory approaches and were action-oriented, they did not

obtain the expected equitable and sustainable outcomes from decision making as they did not undertake the reconciliation of the cognitive models of all stakeholders in the PV (see Fig. 4 in section 4.1).

Another interesting finding is that the desired outcomes cannot be obtained when non-participatory approaches and descriptive purposes are at the core of the valuation process. All case studies from cluster A scored low for PCA1. Whilst the PV in Otún (COL), Odisha (IND1), Kerala and Tamil Nadu (IND3) from cluster A revealed conflicts and synergies between the values of several stakeholders and included the values of marginalized stakeholders in decision-making, they did not reach the desired equitable and sustainable outcomes. Additionally, PV in Cape Town (ZAF) also lacked the reconciliation of cognitive models of stakeholders.

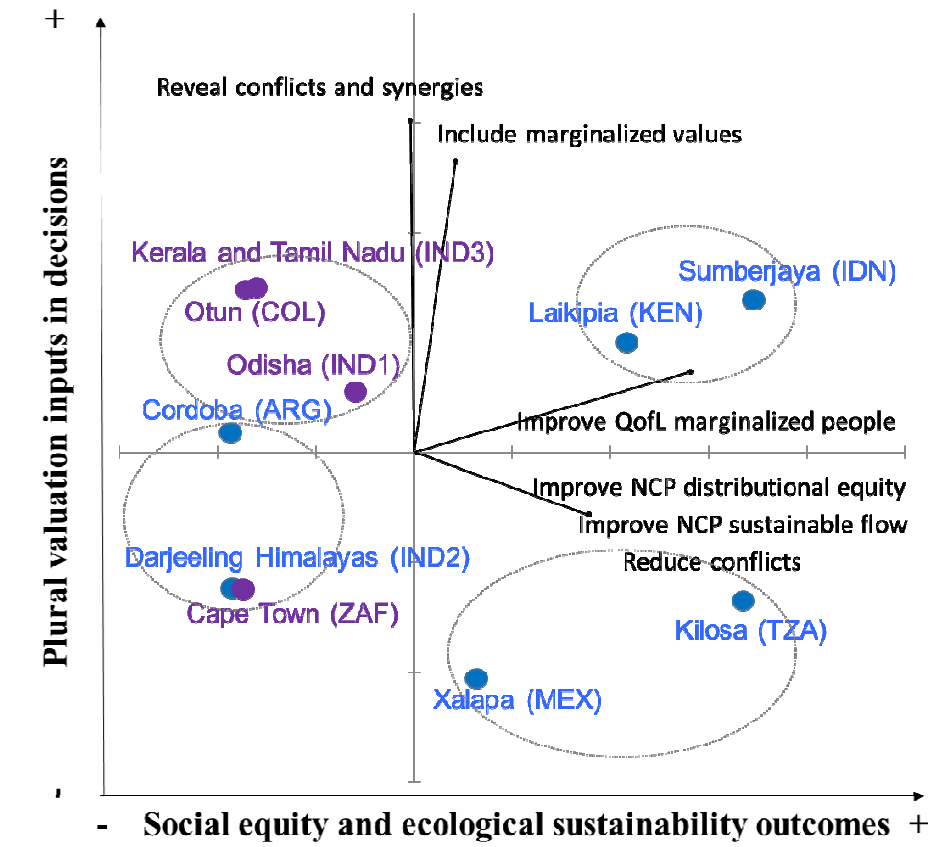

Figure 5. The ten PV case studies differed with respect to their outcomes (horizontal axis) and their integration in decision making processes (vertical axis), as shown from the results of the Principal Component Analysis (PCA). A case study is represented by the same colour of the two different clusters identified through the clustering analysis (see Fig. 4: cluster A in purple and cluster B in blue). Case studies with a high score for PCA1 (horizontal axis) led to equitable and sustainable outcomes. Case studies with a high score for PCA2 (vertical axis) revealed conflicts and/or synergies and included the values of marginalized stakeholders as inputs into decision making.

4.3. What were the key enablers and constraints to allow for PV to take place?

Enablers and constraints of category I and II were grouped into four subcategories through coding: (i) communication and collaboration, (ii) methods and logistics, (iii) visions and interests, and (iv) political context. The subcategory communication and collaboration refers to the interactive process in which different stakeholders effectively communicate and work together. In the methods and logistics subcategory, we consider the methodological approach taken, and logistical issues such as funding, availability of trained staff, accessibility to the project area, and feasibility to develop PV or implement actions derived from decisions. Visions and interests denote the capacity of the stakeholders to share visions and interests and to converge (or not) to implement actions, sharing risks and responsibilities. The political context in which PV takes place refers to its setting (e.g. legal framework, pre-existing policies), as well as the power dynamics by which PV is conditioned (e.g. political interference) or current governance frameworks (presence or absence of political space).

Communication and collaboration between multiple stakeholders (government, NGOs, academia, etc.) were key enablers of PV (Table 3). Strong collaboration and good communication were deemed essential for PV to be included into decision making (seven out of ten case studies), and inadequate communication and distrust prevented the achievement of equitable and sustainable outcomes. In addition, the political context became a key obstacle for PV to achieve its desired goals. More specifically, the lack of political will, but also shifting power dynamics and decisions perceived as being threats to the status quo (e.g. in Kilosa, TZA) or direct political interference (e.g. in Laikipia, KEN), were mentioned as key factors hindering the contribution of PV to decisions and towards achieving desirable outcomes. Other obstacles of PV included logistical constraints such as lack of funds or time.

Table 3. Category I and II factors that enabled or constrained the use of PV in decision making and from reaching socially equitable and ecologically sustainable outcomes in each of the clusters of case studies.

Use of PV into decision-making (frequency and examples)	**Contribution of PV towards socially equitable and ecologically sustainable outcomes (frequency and examples)**
i. Enablers	
1. Communication and collaboration	
7 cases studies (cs). Cluster A: Collaboration with facilitators (IND3); Collaboration with advocacy groups (IND1); Engagement in meaningful conversation with different actors on issues and solutions (IND3); Strong outreach (IND1). Cluster B: Strong collaboration between different sectors (KEN); Strong collaboration between community groups, NGO, academia - network able to negotiate (MEX); Strong collaboration between community groups, NGO, academia - network able to negotiate (MEX); Collaboration with local partners on the ground (KEN); Trust building (TZA, KEN, IND2, IDN); Involvement of government officials in learning (IDN)	3 cs. Cluster B: Collaboration with community and other stakeholders (IND2); Effective communication and information exchange of project progress to high level decision makers at national level (TZA); Transparency (IND2); Access to information on water resources (KEN)
2. Methodological and logistical	

1cs. Cluster B: Funding availability (TZA); Staff trained in participatory processes (TZA); Participatory process a funding requirement (TZA); Easy access to project area (TZA): Possibility to follow-up process in iterative steps (TZA): Ease of information flow and communication (TZA)	2 cs. Cluster B: Polycentric nature of organization (MEX); Stepwise approach to community forest arguments and evaluation criteria (IDN)
3. Visions and interests	
2cs. Cluster B: Compatible valuation logics (ARG); Shared vision on sustainability and equity (MEX); Common interest among key stakeholders (ARG); Strong interest in study/protected area (KEN)	2 cs. Cluster B: Citizens motivation in building the network (MEX); Commitments and willingness to improve sustainability and wellbeing (IND2);
4. Political context	
2 cs. Cluster B: Political capacity to pressure and dialogue (MEX); Some influence by members of marginal communities who are part of governmental institutions (IND2); PV recognized as open legitimate process (MEX)	3 cs. Cluster A: Political capacity to influence decision (IND1). Cluster B: Strong support of local government officer (TZA); Certain politicians and government officers supporting project (KEN)
ii. Constraints	
1. Communication and collaboration	
1 cs. Cluster B: Unclear communication (IDN)	6 cs. Cluster A: Absence of local participation (appropriation) (COL); Difficulty of building trust with marginalized stakeholders (IND3); Language barriers (IND3). Cluster B: Lack of access to information results due to technical language (KEN); Contrasting communication styles (MEX); Unwillingness to negotiate or create alliances (ARG); Distrust (IDN)
2. Methodological and logistical	
2 cs. Cluster A: Lack of staff (MEX, IND1); Cluster B: Lack of resources (government and other stakeholders) (MEX)	5 cs. Cluster A: Academic degree oriented (ARG, COL, ZAF); Lack of time (ARG, COL, ZAF); Lack of funds (ARG, COL, ZAF): Distant location (COL). Cluster B: Lack of access to biophysical data (KEN); Lack of experience in bottom up approaches by local stakeholders/institutions (TZA)
3. Visions and interests	
0 cs.	3 cs. Cluster B: Multiple cognitive models (IDN) ; Reconciliation of cognitive models was not conducted (ARG); Presence of conflicts (IDN); Lack of recognition of marginalized people`s rights (IND2)
4. Political context	
3 cs. Cluster B: Lack of political will (MEX); Political interference (KEN); Limited capacities of authorities to implement (KEN, TZA)	7 cs. Cluster A: Lack of political will (COL); Absence of formal decision making space (IND1); Decision makers conceive PV as out of scope with their mission/obligation (COL, ARG)- Cluster B: Lack of political will (MEX, TZA); Decision making process unfavorable for inclusion of PV findings (MEX); Opposition to PV results threaten the status quo (KEN); Lack of previous experiences demonstrating sustainable use of resource to decision makers (TZA); Absence of social decision making space (IND2)

5. Discussion

Scholarship about plural valuation has been developing quickly in the last decade from different theoretical traditions. It has evolved from diverse methodological approaches, such in ecological economics (Martinez Alier et al., 1998) in order to make visible the diversity of values of and about nature held by people (Pascual et al 2017; Arias-Arévalo et al., 2018) with the final goal of finding solutions to achieving equitable and sustainable outcomes from decision making, especially at the local level (Jacobs et al. 2016, 2018) (see **Table E1 in Section E of the supplementary materials**). We contribute a conceptual framework and analytical approach to understand the PV process and associated outcomes. Our contribution was guided by in-depth analysis of ten case studies from the Global South, where the need to address unsustainability and social equity is most acute. We found important differences among case studies and identified the PV purposes, approaches and contexts that contributed to equitable and sustainable outcomes.

Our findings show that creating space for marginalized stakeholders to articulate and include their values in decision making is required for carrying out successful PV. This space allows for decision making to be informed by a plurality of values; however, it does not on its own lead to equitable and sustainable outcomes. The purpose for undertaking PV matters. Decisions that engage the values of marginalized stakeholders and address their concerns and interests are more likely to allow for decisions to positively contribute to their QoL as already observed by different scholars (e.g. Daw et al., 2017, Ramirez-Gomez et al., 2017). Yet, when the main purpose of PV is exploratory or informative, the full diversity of values elicited are generally not incorporated in decision-making processes (and actions), and hence equitable and sustainable outcomes are less likely to be achieved. For example, in the case of Otún (COL) the values of marginalized smallholder farmers highlighted their preferences about how to manage the watershed, but given that the original purpose of the PV was not aimed at including their views in the management plan of the watershed, actions directed to improve their QoL were not implemented and consequently their QoL did not improve.

Only those cases in which PV was initiated with the purpose of guiding action were able to attain desired outcomes in terms of equity and sustainability. Social-ecological transformation strongly relies on how the goals and expectations of valuation research are framed. Research and action are becoming increasingly linked into a wide range of participatory action research approaches in which implementation of solutions is a core part of the PV research agenda. In participatory action research, what matters is who decides the research agenda and who benefits from it (Casey et al., 2018). Action research was deemed critical in some of our case studies to support activities that led to social and organizational changes targeted at the stakeholders affected by the issue that triggered PV in the first place. For example, in Xalapa (MEX) PV promoted collective action by a diversity of stakeholders to manage a protected area with successful outcomes. In this vein, we find that the approaches used in valuation also matter: only when PV relied upon participatory methods it did contribute to desired social-ecological outcomes.

Some of the participatory methods used in the case studies included participatory appraisals (Sumberjaya, IND; or Laikipia, KEN), participatory scenario planning (Kilosa, TZA), and photo elicitation surveys and deliberative focus groups (Cordoba, ARG). The quality and legitimacy of

the participatory process depends on how participation is framed, especially determined by the roles assumed by participants, the differences in the engagement of participants, and the level of democratization of the decision-making process in which PV is integrated (Carnoye and Lopes, 2015). Setting the boundaries of inclusion and identifying representative stakeholders is a considerable challenge and one which shapes the PV exercise. For instance, in the Kilosa (TZA) case study, the stakeholder analysis overlooked migratory pastoralists who were absent from the area during the stakeholder identification process. Consequently, their perspectives, values and knowledge systems did not feature into the decisions taken until much later in the implementation. Difficulties in negotiations around the use of the land arose and ultimately compromised the equity of the actions that were decided.

Identifying and reconciling stakeholders' cognitive models about human-nature relations was found to be critical for PV to be able to support decisions that could enhance equitable and sustainable outcomes, concurring with Muradian and Pascual (2018). Making visible the different worldviews, assumptions and ideologies that influence values and decisions about how social-ecological systems should be managed, using tools such as describing and sharing mental models (Biggs et al., 2011), transformed the way the different stakeholders conceptualized the issues at stake. For example, in Sumberjaya (IDN) a rapid hydrological appraisal method was developed to explore the similarities and contradictions among knowledge systems, and allowed farmers to use data from science-based monitoring and analysis to challenge government policies. Conversely, the lack of reconciliation of cognitive models held by stakeholders jeopardized the PV outcomes in other cases. For example, in the case study from Cordoba (ARG) the new forest law included the values and way of understanding how the forest should be managed by one of two opposing groups, generating a strong feeling of injustice among the group whose legal draft was not accepted (Cáceres et al., 2016).

The way PV is conceptualized has deep implications in terms of its potential outcomes. PV can play an important role in achieving more equitable and sustainable outcomes when valuation is seen as a process of knowledge generation designed to be integrated in decision-making and action. Notably, narrow conceptualizations of PV such as for elicitation of values alone, is more likely to contribute to limited outcomes as observed in the case of Cape Town (ZAF). Instead, when PV is used as a negotiation support tool in an iterative cycle of continued feedback between negotiation and decisions, actions and outcomes, the QoL of the marginalized people is more likely to improve and the flow of NCP to be more sustainable. For instance, in Laikipia (KEN) and Sumberjaya (IDN) enhancements were achieved in equitable (e.g. improving the QoL of marginalized people and reducing conflicts), and sustainable (improving the sustainability of the provision of NCP) outcomes. In Sumberjaya (IDN), PV was employed as a negotiation support tool that led to agreements about management and governance instruments (community-based forest management) that all stakeholders could commit to. This led to improved equity (e.g. non-eviction of smallholder farmers) and sustainability (e.g. via lessening deforestation). Similarly, collaborative research, and the articulation of different knowledge systems and shifts in power balance, allowed for new policy instruments, such as the creation and growing importance of a water resources users' association in Laikipia (KEN).

Communication and collaboration between stakeholders appear as key enablers of PV. Trust, transparency and collaboration between stakeholders is required to create a set of practical, permissible decisions that can be translated into action which can result in equity and sustainability (Gray et al., 2013). In this sense, the elicitation of values and the processes of reconciliation of cognitive models require a 'third place' (Oldenburg and Brissett, 1982) in which stakeholders are given an equal voice so that trust, creativity, and shared understanding can develop (Djenontin and Meadow, 2018). In our case studies we observed that trust and shared understanding allowed communication and collaboration between researchers conducting valuation and the relevant stakeholders, which in turn also created the conditions for participatory approaches and the reconciliation of different cognitive models and visions.

Two factors were found as key constraints for PV to be able to contribute towards desirable social-ecological outcomes: the lack of political space and the will to include PV in decision making, as well as the existence of uneven power relations that prevented the diversity of values from being included in decision making. Unequal power relations can hamper any PV process at any stage, from elicitation, to negotiation and the translation of decisions into actions that can foster equity and sustainable use of nature (Cook et al., 2013; Morrison et al., 2019). Along the valuation process, power dynamics can be navigated to avert challenges or solve conflicts particularly when stakeholders hold divergent views of the benefits, burdens and solutions to the problem (Carmenta et al., 2017). Frequently, what makes a factor, e.g., the inclusion of political stakeholders in PV, to become an enabler or a constraint is determined by the nuanced local context. For example, the participation of political stakeholders was a critical constraint in Laikipia (KEN), whereas in Kilosa (TZA) the support of a district officer made all the difference as to the acceptability of the project in local government.

All in all we posit that PV can be instrumental for achieving equitable and sustainable outcomes, but it is worth noting that we faced several challenges that should be addressed in further research. First, we identified the main purpose and approach of the different PV processes in an open-ended way (Sikor et al., 2014; Poole 2018), which determined the variables chosen for the analysis. Future research needs to consider whether other relevant variables should be included to assess the role played by PV. Second, some proxies were used to reflect the outcomes of PV. For instance, procedural equity was approached by looking at the extent of conflict mitigation, as the two are generally positively linked (Wall and Nolan, 1987). Ideally, further empirical research could provide deeper insights into the validity of some of the proxies used in the study. Additional work could also broaden our understanding about information gaps and boost the availability of empirical evidence, such as how the diversity of values and knowledge co-production are linked to socially equitable and ecologically sustainable resource management (Lynam et al., 2007; Djenontin and Meadow, 2018), or institutions and governance systems (Armitage et al., 2011; Tengö et al., 2017). A larger set of study cases could also allow to explore in further detail the context-dependent mechanisms that operate at different stages of PV.

6. Conclusion

Plural valuation is increasingly being called for to address the challenges associated with sustainability and justice. One example of its potential contributions is the ongoing IPBES Values Assessment, which aims to assess methods that acknowledge, bridge and integrate the diverse values and valuation methodologies for policy and decision-making support. PV is about making visible the diverse values people hold about nature, with particular emphasis on including the voices of those who are marginalized and who often bear the largest burden of environmental degradation. The promise is that, once certain conditions have been met, PV can contribute to equitable and sustainable flow of benefits from nature to people, thus improving the quality of life of the most disadvantaged and often invisibilized stakeholders in decision making.

An in-depth analysis of ten case studies in the Global South revealed a large heterogeneity in terms of the approaches and purposes used in PV. Our results call for investing in efforts to mainstream PV using participatory approaches to elicit the diverse values of nature through action-oriented approaches, while reconciling the cognitive models of stakeholders and in particular by giving voice to those most marginalized. This study is an attempt to illuminate how PV may be undertaken. A key take-home message is that PV should not be seen as a mere documentation of the diversity of values about nature but rather a process that supports integrated learning among researchers, policy makers and practitioners, where communication and collaboration is fundamental for the co-production of relevant knowledge that can guide and ultimately improve decisions. The full ripening of this process is strongly supported by key enablers such as adequate communication among stakeholders. Yet, it is important to note that highly skewed power relations may hamper even the most comprehensive PV efforts, and complex nuanced political contexts are to be navigated assertively.

Plural valuation can become a key leverage tool towards transformative change by improving decision making processes through mainstreaming diverse voices, reconciling contrasting or even conflicting cognitive models, and opening space for new policy tools and institutional arrangements. To do so, as with all forms of valuation, plural valuation necessarily relies on the normative position of the involved researchers (Sanders et al. 2020). In an increasingly unequal and unsustainable world, the use of plural valuation in all its forms must thus acknowledge the value frame on which it relies if sustainability and equity are to be fostered in a meaningful way.

References

Abson, D.J., Fischer, J., Leventon, J. et al. (2016). Leverage points for sustainability transformation. Ambio 46(1), 30–39.

Andrachuk, M., Armitage D. (2015) Understanding social-ecological change and transformation through community perceptions of system identity. Ecology and Society 20(4), 26.

Aragão, A., Jacobs, S., Cliquet, A. (2016). What's law got to do with it? Why environmental justice is essential to ecosystem service valuation. Ecosystem Services 22, 221–227.

Arias-Arévalo, P.,Martín-López, B., and Gómez-Baggethun, E. (2017). Exploring intrinsic, instrumental, and relational values for sustainable management of social-ecological systems. Ecology and Society 22(4):43.

Arias-Arévalo P., Gómez-Baggethun E., Martín-López B., et al. (2018) Widening the evaluative space for ecosystem services: A taxonomy of plural values and valuation methods. Environmental Values 27 (1), 29-53.

Armitage, D., Berkes, F., Dale, A., et al. (2011) Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. Global Environmental Change 21, 995-1004.

Ashley, C., Carney, D. (1999). Sustainable livelihoods: Lessons from early experience (Vol. 7, No. 1). London: Department for International Development.

Ayala-Orozco, B., Rosell, J.A., Merçon, J., et al. (2018) Challenges and Strategies in Place-Based Multi-Stakeholder Collaboration for Sustainability: Learning from Experiences in the Global South. Sustainability 10, 3217.

Aylward, B., Barbier, E.B. 1992. Valuing environmental functions in developing countries. Biodiversity & Conservation 1(1): 34-50

Bennett, E., Solan, M., Biggs, R., et al. (2016). Bright spots: seeds of a good Anthropocene. Frontiers in Ecology and the Environment 14(8): 441– 448.

Bergman, M.M. (2010) On concepts and paradigms in mixed methods research. Journal of Mixed Methods Research 4 (3), 171-175.

Biggs, D., Abel, N., Knight, A.T., et al. (2011) The implementation crisis in conservation planning: could "mental models" help? Conservation Letters 4(3), 169-183.

Boillat, S., et al. (2020) Why telecoupling research needs to account for environmental justice. *Journal of Land Use Science*: 1-10

Brocklesby, M.A., Hinshelwood, E. (2001). Poverty and the environment: what the poor say. An assessment of Poverty-Environment Linkages in Participatory Poverty Assessments. Centre for Development Studies, University of Wales, Swansea.

Caceres, D., Silvetti, F., Diaz, S. (2016) The rocky path from policy-relevant science to policy implementation— a case study from the South American Chaco. Current Opinion in Environmental Sustainability 19, 57–66.

Carmenta, R., Zabala, A., Daeli, et al. (2017). Perceptions across scales of governance and the Indonesian peatland fires. Global Environmental Change 46, 50-59.

Carnoye, L., Lopes, R. (2015) Participatory environmental valuation: a comparative analysis of four case studies. Sustainability 7, 9823–9845.

Casey, M., O' Leary, D., Coghlan, D. (2017) Unpacking action research and implementation science: Implications for nursing. Journal of Advanced Nursing 74(5), 1051-1058.

Chambers, R. 1983. Rural development: putting the last first. Harlow: Prentice Hall. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/178

Chambers, R. (1994) The origins and practice of participatory rural appraisal. World development 22(7): 953-969.

Chan, K.M.A, Gould, R. and Pascual, U. (2018). Relational values: What are they and what's the fuss about? Current Opinion in Environmental Sustainability 35, 1-7.

Chaplin-Kramer, R., Sharp, R.P., Weil, C., et al (2019). Global Modelling of Nature's Contributions to People. Science. Forthcoming 11th October 2019.

Clark, N. E., Lovell, R., Wheeler, B.W., et al. (2014) Biodiversity, cultural pathways, and human health: a framework. Trends in Ecology & Evolution 29(4), 198–204.

Clark, W.C., Tomich, T.P., van Noordwijk, M., et al. (2016) Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). Proceedings of the National Academy of Sciences 113(17): 4615–4622.

Cook, C.N., Mascia, M.B., Schwartz, M.W., et al (2013) Achieving conservation science that bridges the knowledge-action boundary. Conservation Biology 27, 669–678.

Daw, T.M., Coulthard, S., Cheung, W.W.L., et al. (2015) Evaluating taboo trade-offs in ecosystems services. Proceedings of the National Academy of Sciences 112 (22), 6949-6954. 10.1073/pnas.1414900112

Diaz, S., et al. (2018). Assessing nature's contributions to people. Science 359(6373): 270-272

Di Gregorio, M., Fatorellia, L., Paavolaa, J., et al. (2019) Multi-level governance and power in climate change policy networks. Global Environmental Change 54, 64–77.

Djenontin, I.N.S., Meadow, A.M. (2018). The art of co-production of knowledge in environmental sciences and management: lessons from international practice. Environmental Management 61, 885.

Dobson, A. (2003) Social justice and environmental sustainability: ne'er the twain shall meet? in Just sustainabilities: Development in an unequal world. Earthscan 83-95.

Drimie, S., Hamann, R., Manderson, A.P., et al. (2018) Creating transformative spaces for dialogue and action: reflecting on the experience of the Southern Africa Food Lab. Ecology and Society23(3), 2.

Eisenhardt, K.M. (1989) Building Theories from Case Study Research. The Academy of Management Review 14(4), 532.

Etxano, E., Garmendia, E., Pascual, U., et al. (2015). A participatory integrated assessment approach for Natura 2000 network sites. Environment & Planning C: Government & Policy. 33(5): 1207-1232

Fischer, J., Riechers, M. (2019) A leverage points perspective on sustainability. People and Nature 1, 115-120.

Fisher, E., Bavinck M., Amsalu, A. (2018) Transforming asymmetrical conflicts over natural resources in the Global South. Ecology and Society 23(4), 28.

Garmendia, E., Pascual, U. (2013) A justice critique of environmental valuation for ecosystem governance. Chapter 8 in Sikor, T. "Justices and Injustices of Ecosystem Services" pp.161-186. Routledge. London, UK.

Gray, B., Stites, J.P. (2013). Sustainability through Partnerships: Capitalizing on Collaboration. Network for Business Sustainability.

Greenacre, M., Primicerio, R. (2013) Multivariate analysis of ecological data. www.multivariatestatistics.org

IPBES. 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science- Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES Secretariat, Bonn, Germany.

Jacobs, S., Dendoncker, N., Martín-López, B., et al. (2016) A new valuation school: Integrating diverse values of nature in resource and land use decisions. Ecosystem Services 22, 213-220.

Jacobs, S., Martín-López, B., Barton, D.N., et al. (2018) The means determine the end–Pursuing integrated valuation in practice. Ecosystem Services 29, 515-528.

Jacobs, S., Zafra-Calvo, N., Gonzalez-Jimenez, et al. (2020). Use your power for good: plural valuation of nature–the Oaxaca statement. Global Sustainability, 3

Jayaprakash, L.G. Hickey, G.M. (2019). Mistaking the map for the territory: What does the history of Bannerghatta National Park, India, tell us about the study of institutions? Society & Natural Resources,

Keenan, R.J., Pozza, G., Fitzsimons, J.A. (2019). Ecosystem services in environmental policy: Barriers and opportunities for increased adoption. Ecosystem Services 38, 100943.

Kenter, J. O. (2016). Integrating deliberative monetary valuation, systems modelling and participatory mapping to assess shared values of ecosystem services. *Ecosystem Services 21*: 291-307.

Leimona, B., Lusiana, B., van Noordwijk, M., et al. (2015) Boundary work: knowledge co-production for negotiating payment for watershed services in Indonesia. Ecosystem services 15, 45-62.

Levers, C., Müller, D. (2019) Mapping Export-Oriented Crop Production. In: Friis C., Nielsen J. (eds) Telecoupling. Palgrave Studies in Natural Resource Management. Palgrave Macmillan, Cham.

Lynam, T., De Jong, W., Sheil, D., et al. (2007). A review of tools for incorporating community knowledge, preferences, and values into decision making in natural resources management. Ecology and Society 12(1), 5.

Lliso, B., Mariel, P., Pascual, U., et al. 2020. Increasing the credibility and salience of valuation through deliberation: Lessons from the Global South. Global Environmental Change 62.

McShane, T.O., Hirsch, P. D., Trung T.C., et al. (2011) Hard choices: making trade-offs between biodiversity conservation and human well-being. Biological Conservation 144(3):966-972.

Martinez-Alier J, Munda G, O'Neill J. (1998) Weak comparability of values as a foundation for ecological economics. Ecological economics 26 (3): 277-286.

Martinez Alier J. in Just Sustainabilities. Development in an Unequal World. 2003. Edited by Julian Agyeman, Robert D. Bullard and Bob Evans.

Meadows, D. (1999). Leverage points: Places to intervene in a system. Hartland: The Sustainability Institute.

Merçon, J., Vetter, S., Tengö, M., et al. (2019). From local landscapes to international policy: contributions of the biocultural paradigm to global sustainability. Global Sustainability 2(7): 1-11.

Morrison, T.H., Adger, W.N., Brown, K., et al. (2019) The black box of power in polycentric environmental governance. Global Environmental Change 57, 101934

Munda, G., Nijkamp, P., Rietveld, P. (1994). Qualitative multicriteria evaluation for environmental management. Ecological economics 10(2): 97-112.

Muradian, R., Pascual, U. (2018). A typology of elementary forms of human-nature relations: A contribution to the valuation debate. Current Opinion in Environmental Sustainability, 35:7-14.

Nielsen, J., de Bremond, A., Chowdury, R.R., et al. (2019) Toward a normative land system science. Current Opinion in Environmental Sustainability. 38: 1-6.

Nursey-Bray, M., Marsh, H., Ross, H. (2010) Exploring Discourses in Environmental Decision Making: An Indigenous Hunting Case Study. Society & Natural Resources 23(4), 366–382.

Oldenburg, R., Brissett, D., (1982) The third place. Qualitative Sociology 5, 265.

Pascual, U., Phelps, J., Garmendia, E., et al. (2014) Social equity matters in payments for ecosystem services. BioScience 64, 1027–1036.

Pascual, U., Balvanera, P., Díaz, S., et al. (2017) Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability 26, 7-16.

Pereira, L.M.T., Karpouzoglou, N. Frantzeskaki, et al. (2018) Designing transformative spaces for sustainability in social-ecological systems. Ecology and Society 23(4), 32.

Poole, A.K. (2018) Where Is Goal 18? The Need for Biocultural Heritage in the Sustainable Development Goals. Environmental Values 27 (1), 55–80.

Ramirez-Gomez, S.O.I., Verweij, P., Best, L., et al. (2017) Participatory 3D modelling as a socially engaging and user-useful approach in ecosystem service assessments among marginalized communities. Applied Geography, 83, 63–77.

Rincón-Ruiz A, Arias-Arevalo, P., Nuñez-Hernandez J.M., et al. (2019) Applying integrated valuation of ecosystem services in Latin America: Insights from 21 case studies. Ecosystem Services 36, 100901

Runeson, P., Höst, M. (2009) Guidelines for conducting and reporting case study research in software engineering. Empirical Software Engineering 14, 131-164.

Rusch, V.E., Rusch, G.M., Goijman, A.P., et al. (2017) Ecosystem services to support environmental and socially sustainable decision-making. Ecología Aaustral 27, 162-176.

Sikor, Thomas. (2013). The justices and injustices of ecosystem services. *The Justices and Injustices of Ecosystem Services*. Routledge, 24-28.

Sikor, T., Martin, A., Fisher, J., et al. (2014). Toward an Empirical Analysis of Justice in Ecosystem Governance. Conservation Letters 7 (6), 524–32.

Swilling, M., Annecke, E. (2012) Just Transitions - Explorations of Sustainability in an Unfair World. Claremont, South Africa: UCT Press.

Scoones, I. (1998) Sustainable Rural Livelihoods: A Framework for Analysis, IDS Working Paper 72, Brighton: IDS.

Tengö, M., Hill, R., Malmer, P., et al. (2017) Weaving knowledge systems in IPBES, CBD and beyond—lessons learned for sustainability. Current Opinion in Environmental Sustainability 26, 17-25.

van Noordwijk, M. (2019) Integrated natural resource management as pathway to poverty reduction: Innovating practices, institutions and policies. Agricultural Systems 172, 60-71.

van Noordwijk, M., Coe, R. (2019) Methods in agroforestry research across its three paradigms. pp 325-346 In: van Noordwijk M (Ed.) Sustainable Development Through Trees on Farms: Agroforestry in its Fifth Decade. World Agroforestry (ICRAF), Bogor, Indonesia

Ward, J.H. (1963) Hierarchical grouping to optimize an objective function. Journal of the American Statistical Association 58, 236–244.

Wall, V.D., Nolan, L.L. (1987) Small Group Conflict: A Look at Equity, Satisfaction, and Styles of Conflict Management. Small Group Research 18 (2), 188–211.

Wegner, G., Pascual, U. (2011). Cost-benefit analysis in the context of ecosystem services for human well-being: A multidisciplinary critique. Global Environmental Change 21(2):492-504

Wilkinson, L., Friendly M. (2009) The History of the Cluster Heat Map, The American Statistician 63, 179-184,

World Commission on Environment and Development. (1987). Our Common Future (The Brundtland Report).