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Institutionalising environmental valuation: Insights from 7 Indonesian national agencies

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Abstract: Ecosystem services (ES) valuation is increasingly entrenched in environmental policy and decision-making. Beyond efforts to quantify good and services, valuation explicitly seeks to equate ES values in monetary terms to help inform decision-making, e.g. by accounting for the depreciation of natural capital. However, there is growing concern over the gaps between intention, research, legislation and actual implementation. There are also particularly few insights about how environmental valuation is institutionalised in most tropical developing countries, particularly from the perspective of the government agencies often charged with operationalising valuation and integrating it into their decision-making. We highlight the role that national government agencies play in shaping ES valuation, specifically how valuation is codified through legislation. We then consider ES valuation in the context of 7 Indonesian government agencies, drawing on review of legislation to consider, the stated objectives of valuation of each agency, ES values recognised, and valuation methods employed. The review highlights the diversity of agencies involved in valuation, beyond those traditionally associated with environmental management. It also reveals the diversity and discrepancies in ES good/services values and methods employed. It illustrates the implications of these differences--including direct practical implications for environmental management as well as for how we envision human-environment relations. The review yields insights into the need to think more actively about how different government agencies internalise and propose to operationalise ES concepts. This includes a need for more critical and pragmatic interrogation of the identification and fixing of values, the purposes of valuation, the technical scope and methods of valuation, and the politics of valuation.

1. Introduction

Tropical ecosystems provide a wide range and complex set of resources and services to individuals and society. These include direct use values related to timber, minerals and non-timber forest products that can be managed and extracted, as well as various non-consumptive and indirect values associated with hydrological, pollination, carbon stocks and recreation. Nature also yields diverse intrinsic and non-material cultural, religious, historical and intrinsic values that are prized by society (Daily 1997; Costanza 2008).

There are growing efforts to account for these diverse values, which traditional markets often fail to recognise, into environmental decision-making. To this end, many initiatives are accounting not only for the extractive potential of natural resources, but also the broader suite of benefits derived from tropical ecosystems (Costanza et al. 1997; TEEB, 2010; Bateman et al., 2013). These efforts include a range of affiliated concepts such as environmental valuation, natural capital valuation and green accounting that seek to integrate environmental valuation into formal decision-making processes. These are manifest in growing number of initiatives including multilateral efforts such as The Millennium Ecosystem Assessment (MEA 2006), The Economics of Ecosystems and Biodiversity (TEEB 2014), the World Bank's Wealth Accounting and the Valuation of Ecosystem Services partnership (WAVES 2015) and Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES 2015). There are also various private sector efforts to integrate ES values into business practices such as the Natural Capital Declaration (2012) and a range of national legislative and accounting efforts (overview in Gomez-Baggethún and Pérez-Ruiz 2011).

These efforts not only quantify, but also place monetary values on environmental goods and services (Costanza and Daily 1992; see Gomez-Baggethun et al. 2009; Kull et al. 2015). This translates environmental values into a common language within which many trade-offs are understood and decisions are made (TEEB 2010), and is often considered important for internalizing environmental externalities and accounting for the depreciation of natural capital that otherwise could lead to the under-provision or destruction of ES (Barbier, 2014).

Significant research has been dedicated to understanding ES quantification (Naeem et al. 2015), alongside a critical literature that questions environmental commodification (e.g., McAfee 1999, 2015; Salzman and Ruhl 2000; McCauley 2006; Gomez-Baggethún and Pérez-Ruiz 2011). However, there are growing demands for valuation-based tools to demonstrate more tangible contributions to environmental decision-making (Daily et al. 2009; Muradian and Rival 2012; Gómez-Bagghentún and Muradian 2015).

To this end, there are also emerging efforts to understand the institutional dimensions of environmental valuation. This includes research on the enabling governance conditions and guidelines to support the integration of valuation into decision-making (e.g., Waite et al. 2014; Rosenthal et al. 2014), and of how formal and informal institutions mediate the formation of values (Vatn and Bromley 1994; Vatn 2005, 2009).

Despite these advances, much less is known about how environmental valuation is actually institutionalized by different government agencies and then translated into decision making and environmental management (cf. Daily et al. 2009). This is particularly pressing in the context of many tropical countries, where valuation tools are increasingly applied to help balance environmental and economic objectives.

This paper focuses on institutionalisation of ES valuation through legislation, drawing on the case of valuation across 7 national Indonesian agencies, ranging from the Ministry of Forests to the Ministry of Finance. Drawing on their corresponding legislation, we consider the stated objectives of valuation of each agency, present the diversity of environmental values recognised, and consider diversity of, often conflicting, valuation methods employed. It interrogates gaps between ecological economics and political ecology (cf. Kallis et al. 2013; Kull et al. 2015), as well as disconnects between academe and practice (cf. Laurans et al. 2014). It is motivated by an interest in the potential for ES valuation to actively strengthen environmental decision-making and practice, as well as a recognition of the need to actively avoid the "tragedy of well-intentioned valuation" (Gomez-Baggethún and Pérez-Ruiz 2011).

2. Institutionalization of environmental/ES values

2.1 ES valuation in the policy process

There are emerging efforts to better understand the different pathways through which valuation is institutionalised and translated into decision-making. These are largely revealing an "implementation gap" (see Laurans and Mermet 2014), suggesting that that valuation has not yet entered mainstream practice to actually strengthen environmental decision-making in most contexts (see Kushner et al. 2012; Laurans et al. 2013). "There appears to be a discrepancy between the massive presence of Ecosystem Services (economic) Valuations in the literature and the small number of examples where it is documented and demonstrated that they have been instrumental in changing policies" (Laurans and Mermet 2014).

However, there is also emerging evidence that valuation is being more actively integrated into policy processes, including in tropical developing countries (Ruckelshause et al. 2013; Waite et al. 2014; Sills et al. 2014; Phelps et al. 2014). Moreover, there is broadening examination of the diverse way in which valuation can be helpful to improve environmental conditions (see Billet et al. 2012; Rodriguez-Labajos and Martinez-Alier 2013; Kallis et al., 2013;), including in ways that can be inclusive and socially responsible (see Chan et al. 2012; Kallis et al. 2013).

Leveraging ES valuation to inform environmental decisions faces many technical, logistical and ethical demands (see Daily et al. 2009; Kallis et al. 2013; Garmendia and Pascual, 2013; Adams, 2014). Critically, this translation also relies on a range of mediating institutions (Fig 1A), for example:

- Markets for ecosystem services that translate environmental values into financial incentives for improved stewardship;
- Voluntary commitments by individuals and the private sector actors that internalise environmental values into their decision-making and/or business practices (e.g. through certification);
- Deliberative multi-stakeholder processes that serve to negotiate different values and priorities to then inform decisions, and

- Environmental legislation that translates environmental values into disincentives associated with non-compliance (e.g., of environmental standards) and allow for operationalizing the liabilities associated with environmental damages (e.g. due to oil spill, forest destruction, etc.)

These different types of arrangements leverage information, incentives and disincentives, politics and priorities in ways that recognise, calculate and internalise ES values (Fig. 1). These form part of a range of complex and interactive policy processes in which valuation can inform decisions (e.g., Sabatier 2007; Watson 2005).

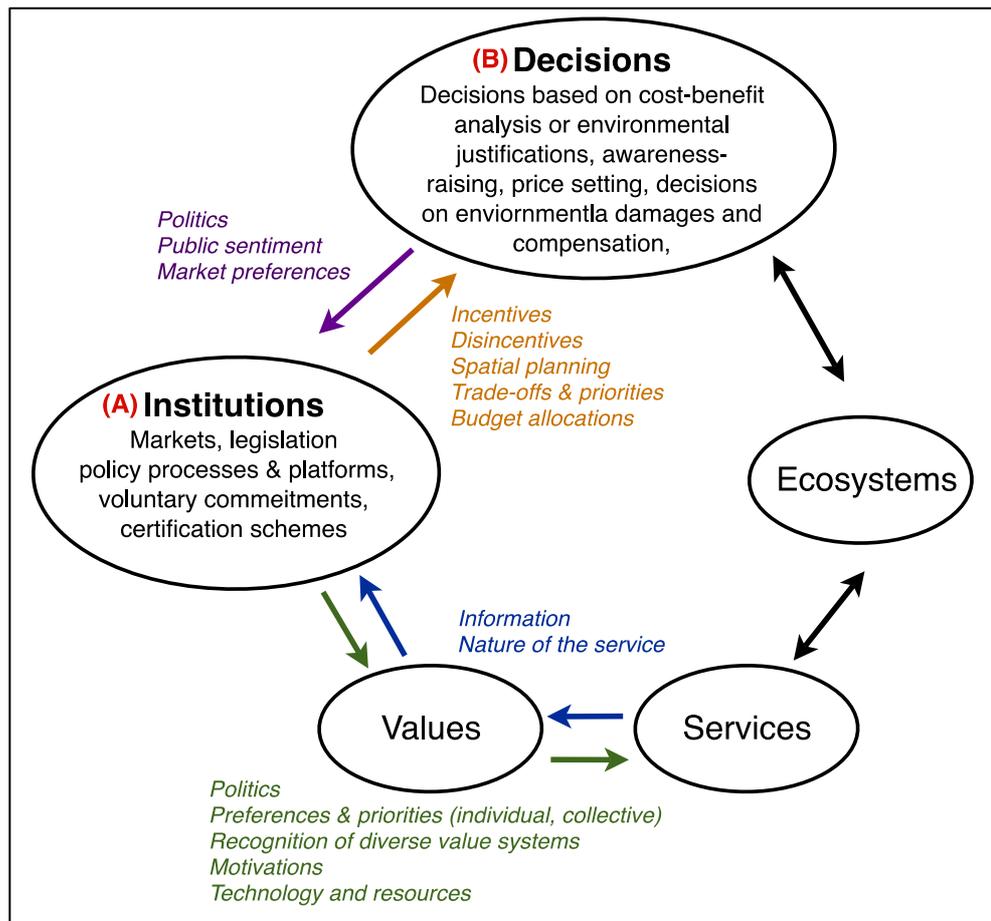


Figure 1. Simplified framework of how ES valuation is integrated into decision-making, focused on the institutional dimensions that influence decisions. (A) Types of institutional arrangements that help institutionalize and translate values into decisions. (B) Types of decisions in which ES valuation can be used. Note that any two ovals in the figure could be linked with arrows. (Based on Daily et al. 2009).

These various institutional arrangements (Fig. 1A) can contribute to a number of different types of environmental decisions (Fig. 1B). Bille et al. (2012) summarise key ways in which ES valuation can inform decisions. Perhaps most notably, valuation is often associated with quantitative cost-benefit analyses, to enable evidence-based decision-making. Modeling-based tools (e.g., InVest, <http://www.naturalcapitalproject.org/InVEST.html>; ARIES, <http://www.ariesonline.org/>), make it increasingly viable to use valuation to identify trade-offs among services at multiple scales. Valuation is also used in price-setting, such as to inform environmental tax rates or Payments for Ecosystem Services (PES).

For example, REDD+ forest carbon schemes leverage valuation to commoditize forest carbon stocks, in an effort to incentivize more sustainable land use (Sills et al. 2014). Valuation can also be used to evaluate environmental damages, such as related to pollution or deforestation, to inform liability and compensation claims. In particular, monetary estimates of damages can help shape prosecutions, judicial decisions, and determine amounts for compensation to damages parties (see Kontoleon et al. 2002; Schopp and Pendergrass 2003; White and Heckenberg 2011; Phelps et al. 2014). Finally, valuation can support justifications and awareness-raising. For example, there have been a number of efforts to make a "business case" for conservation by highlighting the diverse values of natural capital to human wellbeing and the economy (Barbier and Sathiratai 2004; MEA 2005; Folke 2006; TEEB 2015). This policy use often seeks to align conservation and economic development objectives, and is central to framing many corporate sustainability initiatives (NCP 2015) and "green economy" policies in which the environmental impacts of everyday economic activities are internalized into decision-making and business processes (see UNEP 2011).

2.2 Government legislation as key value articulating institutions

Mediating institutions articulate decisions about what ES values are included, how they are defined and conceptualized, how valuation tools are used, and what data they use (Vatn 2005). Amidst the various formal and informal mediating institutions (Fig 1A), government agencies and legislation are often central to many of these processes (Fig. 1). The codification of knowledge and rules via legislation establishes the legal and policy frameworks that guide many national, local and global environmental agreements (Cowan and Foray 1997; Muradian and Gómez-Baggenhun 2013). This is particularly true where many key decision-making processes (e.g., concession allocation, land-use planning, mapping), technologies (mapping, valuation), and forest areas are vested in the state, like in many tropical countries. State engagement also represents mandated standards and contracts of accountability, and relate to decisions and transitions at scale, beyond individual or project-level actions and values (Norgaard 2010). State agencies and their legislation are thus often focal to articulating the values that underlie many environmental decisions (Jacobs 1997; Vatn 2005; see Daily et al. 2009; Kallis et al. 2013; Ruckelshause et al. 2013; Muradian and Gómez-Baggenhun 2013).

To date, efforts to understand valuation have focused heavily on incentive-based environmental schemes, often based on theory and/or the academic literature (Ferraro and Kiss 2002; Fisher et al. 2008; Kizing et al. 2011; Bille et al. 2012). However, the prospective relevance of ES valuation to policy is far broader (see Sect. 1.1), and there is a need to understand how valuation is actually internalised and practised within government agencies and processes (cf. Waite et al. 2014).

Within these agencies, values are manifest in a number of ways, including budget allocations, public statements, policy briefs, and the perceptions of staff and management. We focus on a critical dimension: the formal codification of environmental values through legislation. Codification does not necessarily equate to actual practise, and there are limitations to an approach that is both "state-centric and fiscally focused" (Brousseau et al. 2012). Nevertheless, legislation is a fundamental part of state decision-making. Legal-regulatory context can define values, processes, actors and priorities (e.g., Salzman and Rhul 2000; Bille et al.

2012; Waite et al. 2014; cf. Rosenthal et al. 2014). Moreover, in the context of jurisdictional ambiguity, budget limitations and inter-agency conflicts (e.g., in Indonesia, Sahide and Giessen 2015), formalised responsibilities and processes through legislation can be particularly important to ensuring clarity. Legislation further provides an accessible, tangible and specific window into how State agencies define "(1) who and in what capacity should be considered during decision-making, (2) define what is considered relevant data and how that data is to be handled" (Vatn 2005). As such, legislation espouses specific types of values, assumptions and choices (cf. Gasparatos 2010) that embody one very important type of value articulation institution.

2.3 Valuation in the tropics: Indonesian case

Critically, there is a further need for insights on these institutional processes from tropical developing countries, where valuation techniques and instruments are increasingly applied (e.g., WAVES 2015; NCP 2015). Valuation efforts in these contexts, however, can face very different cultural and institutional contexts (e.g., political transparency, property rights regimes, participation and power dynamics, data availability, human-environment relationships, relationships to markets, etc.), and may be particularly contentious where land tenure claims are unclear and the rights of local and indigenous peoples are weakly recognized (Kenner 2014). Particularly in comparatively "low governance" contexts, clear legislation is, arguably, particularly important to help provide greater structure and clarity.

We focus on Indonesia as an example of where ES valuation is increasingly proposed in environmental management. Indonesia is a hotspot for biodiversity and forest carbon conservation (Kapos et al. 2008), but is also experiencing rapid environmental change--including as a result of the rapid expansion of high-value oil palm agriculture (Koh and Wilcove 2008) and illegal resource extraction. For example, Human Rights Watch estimated that in 2006 Indonesia lost almost US\$2 billion from untaxed illegal logging (HRW 2009). In 2013, the Indonesian State Auditor reported 26 mining and plantation companies for illegal forest encroachment resulting in state losses equivalent to approximately US\$7.7 million (BPK 2013). The use and non-use impacts of these types of damages are potentially orders of magnitude greater (e.g., MAPPI 2012; see van Beukering et al. 2009).

As a result, Indonesia has also attracted significant efforts to translate environmental values into monetary values, to both promote conservation and strengthen environmental decision-making. This includes a range of Payments for Ecosystem Service (PES) schemes associated with the valuation of watershed services (Prasetyo et al. 2009), and forest carbon stocks via REDD+ schemes (Sills et al. 2014). This parallels a long history of government-supported initiatives to make forests economically valuable resources.

Indonesia is also a focal country for the WAVES partnership, led by the World Bank in cooperating with the Ministry of National Development Planning (BAPPENAS) to promote "sustainable development by ensuring natural resources are mainstreamed in development planning and national economic accounts" (WAVES 2015). Concurrently, the United Nations Office for REDD+ Coordination in Indonesia is exploring valuation strategies to promote "policies necessary to transition to a green economy in Indonesia" (UNORCID 2015). Indonesia further has significant,

evolving legislation that seeks to integrate a wide range of environmental values into decision-making (Table 1), including to inform liability and compensation claims for environmental damage. Indonesia thus provides particular insights into understanding the diverse pathways through which valuation can inform environmental management.

3. Methods

3.1 Focus group on valuation in Indonesia

A 2-day focus group on ES valuation in Indonesia was held at the Center for International Forestry Research (CIFOR) in Bogor, Indonesia in 2014. This involved a wide range of the agencies involved in valuation, and focused on identifying their respective roles, perspectives on policy challenges, and relevant pieces of national-level legislation (laws, guidelines, regulations, decrees) (Table 1).

The meeting included participants from the Attorney General Office (Kejaksaan Agung Republik Indonesia), Indonesian National Police (Kepolisian Republik Indonesia), Corruption Eradication Commission (Komisi Pemberantasan Korupsi), State Auditor (Badan Pemeriksa Keuangan, BPK), Financial and Development Supervisory Board (Badan Pemeriksaan Keuangan dan Pembangunan), Ministry of Forestry (Kementerian Kehutanan), Ministry of Agriculture (Kementerian Pertanian), Ministry of Finance (Kementerian Keuangan), Bogor Agricultural Institute (Institut Pertanian Bogor), Indonesian Corruption Watch (ICW) and Forest Watch Indonesia (FWI). The Ministry of Environment was unable to attend, but their inputs were collected through a follow-up meeting.

Each agency presented their roles related to valuation and participated in open, moderated group discussion about their agencies role in valuation. The discussion also served to collectively identify key challenges to operationalising valuation in Indonesia (see Phelps et al. 2014).

3.2 Review of Indonesian legislation

We collected legislation related to the environment for each of the identified institutions, to characterise how they approach valuation. This included primary legislation, which granted each agencies its mandates to pursue certain roles (including related to valuation), but did not often include details about valuation. As such, our review also drew on subsidiary legislation, usually at the Ministerial level, which tended to articulate the details of valuation (see Table 1).

Legislation was collected from the various agency offices, online, and via the www.hukumonline.com database, and were included if they explicitly involve placing a monetary value on environmental goods and services, regardless of whether related to environmental markets, taxation, decision-making processes or compensation. We also consulted domestic experts to help ensure we had captured the most salient pieces of legislation. We excluded energy and mineral resources due to the particular complexities of the related legislation, and our particular interest on forests ecosystems. We prioritised the most recent legislation, which is important in Indonesia because amendments are usually addressed through new legislation.

Where available, we also drew on diverse supporting documents (reports, press releases, presentations) to help us interpret and understand these pieces of legislation and agencies' approach to valuation. This represents a somewhat unique dataset, largely considering the barriers to Anglophone researchers, as well as the logistical challenges of accessing copies of some of the relevant documents.

Table 1. Agencies involved in ES valuation and key relevant legislation and guidelines

Agency	Primary legislation granting mandate	Subsidiary legislation or document with specific valuation details
Ministry of Finance	<ul style="list-style-type: none"> • Law no. 17 of 2003 on State finance 	<ul style="list-style-type: none"> • Directorate General of State Asset. Guidelines for valuation of natural resources: Valuation of forestry and estate crops (2008). • Directorate General of State Asset Regulation no. PER02/KN/2011 on Technical guidelines for the valuation of assets under the state control in the form of natural resources. • Directorate General of State Asset Regulation no. PER10/KN/2012 on Guidelines for valuation of production forest • Ministry of Finance Regulation no. 98 of 2010 on Valuation of assets under the state control in the form of natural resources
Ministry of Environment*	<ul style="list-style-type: none"> • Law no. 32 of 2009 on Environmental protection and management 	<ul style="list-style-type: none"> • Ministry of Environment Regulation 7/2014 on Environmental loss due to pollution and environmental damages • Ministry of Environment Regulation number 14 of 2012 on Economic Valuation on Peat land Ecosystem • Ministry of Environment Regulation number 15 year 2012 on the Economic Valuation Guidelines on Forest Ecosystem

Forest Department *	<ul style="list-style-type: none"> • Law no. 41 of 1999 on Forestry • Government Regulation no. 12 of 2014 on Non-tax state revenues applicable at the Ministry of Forestry 	<ul style="list-style-type: none"> • Ministry of Forestry Regulation no. 68/Menhut-II/2014 on Determination of reference prices to calculate forest resource rent provision, compensation of tree stand, and replacement of tree stand value
Supreme Audit Agency (BPK)	<ul style="list-style-type: none"> • Law no. 15 of 2006 on Supreme Audit Agency 	<ul style="list-style-type: none"> • Refers to ministerial guidelines
Board of Finance and Development Supervision (BPKP)	<ul style="list-style-type: none"> • Presidential Regulation no. 192 of 2014 on the Internal State Auditor 	<ul style="list-style-type: none"> • Refers to ministerial guidelines
Central Statistical Agency (BPS)	<ul style="list-style-type: none"> • Law no. 16 of 1997 on Statistics 	<ul style="list-style-type: none"> • Central Statistical Agency. Integrated system of environment and economic balance sheet (Sisnerling) 2008-2012. (2013)
Ministry of National Development Planning (BAPPENAS)	<ul style="list-style-type: none"> • Law no. 25 of 2004 on National development planning system 	<ul style="list-style-type: none"> • Refers to individual ministerial regulations

*The Ministries of Environment and Forest have been merged into a single agency in late 2014, although their governing legislation remains separate.

Using an iterative process, we identified categories for data extraction from each piece of legislation. This included categories of environmental goods and services valued, how each is defined, and the methods by which each is valued. We further broadly characterised the policy objectives of valuation as embodied by each state agency. We further characterised each piece of legislation according to 11 broad valuation approaches that emerged from across the document review. We did not evaluate the extent to which legislation had been operationalised because of lack of data, sensitivities within and across agencies, and because of lack of resources and government agency engagement necessary to meaningfully explore their internal processes.

4. Results

4.1 Agencies and objectives for valuation

The review highlighted that valuation is not only associated with agencies traditionally associated with the environment, but is a stated tool and activity for use across different parts of the government, including the Ministry of Finance, Central Statistics Agency (BPS), Ministry of National Development Planning (BAPPENAS),

and the two auditors offices: Supreme Audit Agency (BPK) and the Board of Finance and Development Supervision (BPKP)¹

These bodies are involved in valuation with a range of distinct objectives (Table 2). We identified five principle categories of use for valuation embodied in legislation

- 1) National-level "green" accounting and information provision. Several agencies are involved in collecting data about natural resource stocks at a somewhat generic, national-level to demonstrate the value of ecosystem services, engage with international environmental accounting efforts, and inform general planning processes. These include initiatives by the Min. of National Development Planning, Central Statistics Bureau and the Ministry of Finance.
- 2) Cost-benefit analyses to inform specific decisions. These more local, situation-specific processes seek to use valuation to inform more specific spatial and land-use planning decisions that involve sub-national
- 3) Taxation of forest-based goods and services. Indonesia has long collected taxes for timber harvest, as well as mandated contributions to a national reforestation fund. Tax collection has recently been extended to include a broader range of revenue-generating goods and services from the forest sector (Government Regulation no. 12 of 2014).
- 4) Audits of state finances. As a state asset, valuation can be applied to natural resource stocks, where there are considered state assets, as part of audits of financial management. This has been, to date, restricted to timber stocks that have clear, established market values.
- 5) Compensation in legal suits for environmental harm. Where environmental damage results in liability suits that result in financial compensation to the state or individuals, valuation can be used to measure damages. This principally includes efforts by the Min. of Environment, and where corruption is involved, the state auditors.

Notably, valuation for price-setting to inform payment schemes, although a prevailing theme in the literature, is not represented in formal legislation. Indonesia does, however, host related national payment for water and forest carbon schemes.

¹ The two auditors are both mandated to conduct financial audits. The principle difference between them involve reporting lines. The State Auditor (BPK) is an independent public agency conducts audits (financial audits, performance audits, and special purpose audits) of all public offices (Central and local government, state-owned enterprises, public services board, Bank of Indonesia, legislative bodies, and other bodies that manage state finances), including those who are related to the forest sector, and reports to Indonesia's legislative bodies (*Dewan Perwakilan Rakyat*, *Dewan Perwakilan Daerah*). In contrast, the Board of Finance and Development Supervision (BPKP) is as a non-department agency that reports to the President, and supervises the implementation of the state budget and activities under the Executive branch. Both agencies supports law enforcement agencies to calculate state losses arising from corruption.

Table 2. Stated objectives each agency for conducting ES valuation

Agency	Type of use	Principle objective(s)
Ministry of Finance	General provision of information	Valuation of natural resources that are recognised as state assets to contribute to a national natural resource balance sheet.
Ministry of Environment	Compensation	Valuation of natural resource damages to inform civil proceedings and out-of-court dispute resolution.
	Cost-benefit analyses for decision-making	Valuation of forest, and specifically peatland ecosystems, to help managers understand the importance of conservation and to inform spatial planning.
Ministry of Forests	Taxation	Valuation to inform collecting a wide range of state revenues from forests.
Supreme Audit Agency (BPK)	Financial audits	Valuation as part of financial audits to determine whether public money is collected and expended in accordance with the existing laws and regulations.
	Compensation	Where there is evidence of misappropriation or corruption resulting in financial losses to the state, the auditor is responsible for calculating these losses to inform compensation to the state.
Board of Finance and Development Supervision (BPKP)	Financial audits	Valuation as part of financial audits to determine whether public money is collected and expended in accordance with the existing laws and regulations.
	Compensation	Where there is evidence of misappropriation or corruption resulting in financial losses to the state, the auditor is responsible for calculating these losses to inform compensation to the state.
Central Bureau of Statistics (BPS)	General provision of information	Valuation to provide the government and public with data on environmental statistics.
Ministry of National Development Planning (BAPPENAS)	General provision of information	Valuation to inform national development planning, across sectors and agencies, with a focus on economic development in the forestry sector.

4.2 Types of ES values

We identified six broad categories of environmental goods and services that are included in Indonesian legislation, across the seven agencies: timber stocks, hydrological goods and services, forest carbon stocks, non-timber forest products, tourism and biodiversity (Table 4).

Table 4. Checklist of environmental goods and services valued by seven government agencies

	Timber	Hydrological	Carbon	NTFPs	Tourism	Biodiversity
Min. Forestry	X	X		X	X	X
Min. Environment	X	X	X	X	X	X
Min. Finance	X	X	X	X	X	X
State Auditor*	X					
Board of Supervision*	X					
Statistics Agency*	X					

Importantly, extractive timber values are consistently recognised in monetary terms across agencies, but other ecosystem services are unevenly valued. Notably, bodies with cross-agency mandates (State Auditor, Board of Supervision, Statistic Agency) have comparatively narrow scopes when it comes to ES valuation--limited to timber. In fact, these three bodies follow other agency legislation, and so technically could account for values beyond timber, but there is no evidence that this represents the perspectives, practice or plans within those agencies. In this respect, the Ministry of Finance standards out for its very broad approach to valuation, broadly matching that embodied in Ministry of Environment legislation.

Definitions of ecosystem goods and services vary widely across legislation and related agencies, involving differences in terminology as well as different levels of clarity regarding specific ecological functions. For example, while four agencies (involving 5 key pieces of legislation) specifically recognise the monetary value of hydrological functions, these actually refer to fundamentally different sets of goods and services, ranging from direct use of water resources for commercial purposes, to household use, to flood protection, to a wide range of general but unspecified services (Table 5).

Table 5. Definitions of hydrological goods and services across Indonesian legislation

Government Regulation no. 12 of 2014	Commercial water use within conservation forests, both direct consumptive use and hydroelectric power generation
Ministry of Environment Regulation no. 7 of 2014	Water flow regulation, erosion control, and direct consumptive use
Ministry of Environment Regulation no. 14 and no. 15 of 2012	Flood protection and "water flow" services (unspecified) in state forest lands
Ministry of Finance Guidelines for valuation of natural resources 2008	Direct consumptive use of water service (unspecified) and general hydrological services (unspecified) within protection forests

Similarly, while all of the studied agencies recognise that timber stocks hold a monetary value, definitions vary considerably (Table 7). These include specifications that define timber into different categories, such as distinguishing trees for charcoal versus timber (Min. Finance), or only recognising the value of specific hardwood species (Central Statistics Bureau).

4.3 Valuation methods

There is still not full consensus among experts over how to measure or value key ecosystem services, with some quantification and valuation methods still contested and/or under development (TEEB, 2010; Spash, 2008). Similarly, there remain academic and practitioner debates over the value of certain types of valuation methods (e.g., contingent valuation, Swanson and Kontoleon n.d.; see also Clive Spash critics about contingent valuation, travel cost etc.). Unsurprisingly, these types of issues carry into legislation (e.g. Salzman and Ruhl, 2000; Ruhl and Salzman, 2007) .

Across the agencies and legislation, we identified 14 approaches to valuation. This diversity reflects the diversity of legislation objectives, from articulating compensation regimes to informing spatial planning. It also reflects differences in the breadth of how these values are understood.

Table 6. Categories of government valuation approaches

Valuation approaches	Explanation
Market price	Value per unit in a specific marketplace (local, national, global)
Surrogate product price	Market value of comparable good
Permit price	Government-fixed price to secure a permit for an economic activity
Tax rate	Government-fixed tax rate based on a market or reference price
Price per unit	Government-fixed price per unit
Restoration Cost	Cost of restoring the original system
Procurement/Replacement Cost	Cost of procuring an alternative good or service or replacing an ecosystem
Travel cost	Cost of travel to a target destination
Production cost	Cost of extracting and processing a good
Contingent valuation	Survey-based value of non-marketed resources
Abatement cost	Cost to a businesses for removing or reducing an undesirable item for which they are responsible
Asset/income loss	Loss to assets, income or wellbeing from environmental damage
Monitoring cost	Cost of verifying and monitoring compliance

The review also revealed considerable diversity in valuation approaches taken for the same environmental good/service. For example, although the economic value of timber is widely recognised across agencies and legislation, there is very little consistency in how the value is calculated (Table 7).

Table 7. Heterogeneity in the valuation of timber across government agencies.

Agency	Timber definition	Valuation approach	Valuation
Min. Finance	Charcoal from mangrove forests designated as production forests	Production cost	Costs of extraction and processing into charcoal (e.g., raw materials, labour, equipment and supplies, and maintenance, based on local survey)
Min. Finance	Woodchips from mangrove forests designated as production forests	Market price	Potential harvest volume per hectare * total mangrove forest area * local market price
Min. Finance	Timber from production forests	Market price	Forest area * potential harvest volume (based on purposive field sampling of trees >30cm DBH) * local market price (based on the survey of local wood depot)
Min. Forestry	Taxes on concessions within production forests	Reference price (price per unit, tax rate)	Timber volume (from production or transport report) * reference price * taxes (Resource Rent Provision, Reforestation Fund)^
Supreme Audit Agency (BPK)	Timber on state forest land	Reference price (price per unit, tax rate)	Timber volume (from production or transport report) * reference price * taxes (Resource Rent Provision, Reforestation Fund)^
Board Fin. Dev. Supervision (BPKP)	Timber on state forest land	Reference price (price per unit, tax rate)	Timber volume (from production or transport report) * reference price * taxes (Resource Rent Provision, Reforestation Fund)^
Central Statistics Bureau (BPS)	Timber from production forests, restricted to certain types of species: teak in Java, and for "mix hardwoods" in Java and select outer islands.	Market price	Net present value in local market (based on the number of years until maturity and a discount factor) * timber stock (from Min. Forest report of national stocks)
Min. Environ.	Timber from production forests	Market price	Local market price - extraction cost - normal profit (assumed 15% return on investment) * stock estimate (based on

			survey or GIS evaluation)
Min. Environ.	Timber on any land	Restoration cost	Actual cost of restoration (replanting and associated costs such as transport and compost) + site maintenance cost
<p>^ Reference prices for timber have historically been managed by the Ministry of Trade, and were last updated in 2012 (Ministry of Trade number 12/M-DAG/PER/3/2012 on Stipulation of Reference Price for Forest Products to Calculate the Forest Product Provision Tax). Starting in 2014, responsibility for setting the reference price was moved to the Ministry of Forestry Regulation P68/Menhut-II/2014 on Determination of Reference Prices for the Calculation of Forest Resource Provision, Compensation of Stand Value and Replacement of Tree Stand</p>			

5. Discussion

Codification of environmental values through legislation represents a formal, public statement about what we consider important. It involves a range of decisions, not only about which environmental services are identified as valuable, but also about how those values are understood, measured and applied to decision-making. These decisions reflect on how we envision human-environment relations, and can have direct tangible implications for environmental management.

Indonesian legislation highlights a range of such decisions across agencies and legislation. Notably, the review reveals a diversity of state bodies involved in ES valuation, beyond those traditionally associated with environmental management, and that these value with very different objectives, focus on different goods and services, and use varied methods for their quantification.

The results highlight the need to think more actively about the mechanics of how different government agencies and their legislation internalise and propose to operationalise ES concepts. This requires more critical and pragmatic interrogation of (1) how legislation codifies, defines and fixes public environmental values into legislation; (2) what valuation is expected to achieve across government agencies; (3) the scope, methods and technical nuances of valuation promulgated through legislation, and (4) the broader politics of ES valuation and related decision-making. These include specific insights for Indonesia, especially in the context of the recent (late 2014) merger of the Ministry of Environment and the Forest Department. Moreover, the Indonesian case reflects more widespread, if often overlooked, challenges to leveraging ES valuation to inform environmental management.

5.1 Codified environmental values through legislation

Legislation on ES valuation serve as articulating institutions in perhaps the most literal sense. In Indonesia, most notably, the majority of the reviewed legislation recognises only a limited set of environmental goods and services, notably timber (Table 4). None acknowledge broader non-marketed and non-material cultural, spiritual, historical, scientific and educational services (see critiques in Gómez-Baggethun and Ruiz-Pérez 2011; Chan et al. 2012). In the cases of several agencies, timber values are further only reflected in so much as they can be taxed by the state, with broader ecosystem services left unaccounted (e.g., Table 4). In contrast, several agencies (Min. Environment, Min. Finance) take much more expansive views of ES valuation. Indonesian legislation can also be characterised by its strong focus on marketable goods and services. These types of choices, not unique to Indonesia,

reflect strong biases towards certain types of values, as well as view that often equates valuation with commodification (McAffee et al. 2015; ref). Yet, some of Indonesia's most detailed and coherent legislation on valuation (e.g. ???) specifically deals with compensation for environmental harm, and so are explicitly concerned with environmental justice.

These types of decisions reflect broader public values and principles that underlie the broader political system (see Eskridge 1989). These both reflect, and reinforce certain frames for thinking about the environment (see Gasparatos 2010), as "using different value articulating institutions will tend to give different outcomes or preferred solutions" (Vatn 2005). As such, there is need to reflect on how and whether legislation reflects the public interest, and accurately reflects both collective and different actor groups' views on the environment, notably those of indigenous groups that populate many of Indonesian islands.

This is particularly important because, once introduced, these types of choices can become quickly entrenched and will often "not disappear until the institutions, industries and cultural practices in which frames were made real disappear" (Lakoff 2010). Values, and related information, change over time and, in many cases, are themselves fluid (Garmendia and Stagl, 2010). Yet, many of the valuation approaches we encountered were static. For example, government default values for timber were fixed or infrequently updated, even in the context of timber markets that are dynamic and adjusting. There was similarly little scope for updating default values, such as those used for by the Ministry of Environment to value biodiversity and genetic resources. Despite a changing concepts of ES, legislation largely draws on existing established concepts. such, there is equally a need to allow scope for legislation that can evolve changing understanding and priorities. Despite an apparent fixing of values in Indonesia, legislation also reveals challenges to this path-dependence as other actors create their own codifications of value where different ideas are co-existing and evolving (cf. Cowan and Foray 1997). Most notably, the Ministry of Finance is challenging status-quo, testing valuation approaches that extend beyond those employed by other agencies (Table 4).

5.2 Management implications for different agencies

Registering of ES values begs questions about what the different agencies expect valuation to achieve. The review demonstrated several distinct, largely disconnected objectives for pursuing valuation, ranging from taxation to compensation for harm (Table 3), and little integration across agencies. However, there is growing call for more critical reflection of when and why we practice valuation. (Kallis et al. 2013; Adams, 2015)

This type of enquiry is necessary in Indonesia, where the practical implications of valuation decisions by different agencies can be significant. For example, the economic value of a single Indonesian tree can vary wildly, depending on the legislation and agencies involved, whether the tree is living or has been cut down illegally, and depending on both the species and designation of the land area on which it grows (forest vs. production area) (Fig. 2).



Figure 2. The economic value of an Indonesian tree in Indonesia varies across agencies

As a result, a courtroom case on illegal logging that uses valuation to estimate the scale of environmental harm would result in one set of monetary values. However, the same good and related services could be assigned vastly different value if calculated as part of a natural capital Green or GDP exercise, and yet another set of value as defined by the Forest Department or the State Auditors. At the same time, other approaches, such as those that account for non-material values, would deliver fundamentally different assessments. Disagreements over valuation approaches have already emerged in Indonesia, such between civil society and government over the calculations of state losses resulting from illegal resource extraction (e.g., MAPPI 2009). This diversity has profound implications for policy, budget and management, and thus for social and environmental justice.

The Indonesian case thus reflects a profound need for collective enquiry into the objectives of valuation. As in other fields, valuation data is itself inadequate for actually catalyzing policy changes or evidence-based decision-making (Bille et al. 2012; Jordan and Russel). There is scope for government agencies and donors to actively explore the anticipated pathways through which they expect and want valuation to improve environmental management and social outcomes (cf. Fig. 1), potentially drawing on deliberative inter-agency discussions and approaches such as "Theory of Change" (reviewed in Chris et al. 2011). Kallis et al. (2013) argue for a principle-based analysis to help uncover instances in which use of valuation is most appropriate, based on an evaluation of its potential to improve environmental quality, ensure distributive justice and equality, maintain plurality of institutions and views, and avoid decisions that result in resource enclosure and dispossession. They argue that such reflection is central to avoiding a "tragedy of well-intentioned valuation" in which valuation technologies ultimately compromise the desired social and environmental outcomes (Gomez-Baggethún and Pérez-Ruiz 2011).

In Indonesia, this type of process is likely to uncover not only missing steps in the science-policy interface, but also debate about the most appropriate uses for valuation data. For example, some leading donor-driven valuation initiatives in Indonesia are addressing valuation to inform environmental management, but overlook its potential policy implications for compensation for environmental harm (e.g., UNORCID 2015, WAVES 2015). Despite strong concern and focus in the literature on the commoditization of natural resources and its implications particularly for local resources, this is not (yet) deeply reflected in the legislation.

The Indonesia case also reflects the importance of integrating disparate domestic valuation initiatives, which is particularly important within the civil law tradition that prioritizes coherence across statutes (Eskridge 1989). Taxation of natural resources, for example, while widely established across countries, is not necessarily well integrated into broader valuation efforts. For example, taxation of Indonesian state assets should include not only timber resources, but also non-timber forest products, carbon and water that are recognised by some state agencies, but not yet reflected by two State Auditors (Table 4). Similarly, green accounting and natural capital initiatives are often disconnected from valuation efforts to inform liability from environmental harm (e.g., BAPPENAS in Table 4; WAVES 2014). As efforts emerge to recognise ES values and integrate these into formal planning and policy processes, there is a need for internal coherence that looks across agencies and helps to align objectives, approaches and methods.

5.3 Operational and technical challenges to valuation

Many of the decisions reflected in Indonesian legislation seem to reflect pragmatic, technical considerations. For example, across the 7 agencies, the Indonesian approach focuses heavily on services with greatest market potential, such as timber, water and carbon stocks (see van Beukering et al. 2009). Even in the case of cultural and amenity services, tourism is the only service recognised in legislation, presumably because it represents one of the countries largest and growing economic sectors (WB 2015). The Indonesian approach also seems to reflect services that are most easily measurable. Both biodiversity and non-material services can be notoriously challenging to quantify and value (e.g., Nijkamp et al. 2008), especially in the context of data limitations in tropical countries and limited resources for state agencies, and are overlooked in most of the legislation.

Differences in definitions across agencies likely reflect the geography, with some distinctions across types of ecosystems (e.g. mangroves) and across different land use categories (e.g., production forest vs. state forest). These reflect distinctions in the responsibilities of different agencies, but also explicit decisions about value.

Technical determinants are equally reflected in the types of valuation methods used. The Ministry of Environment, for example, has made some provisions for non-marketable and hard-to-measure services, using fixed default values for biodiversity, genetic resources and hydrological services. Some legislation also draws on rapid surveys of local markets to facilitate valuation (e.g., for timber, non-timber forest products; Table 7). Such technical adaptations, while arguably inaccurate and undesirable (cf. Naeem et al. 2015), may be necessary in the context of limited datasets common in many tropical developing countries, at least in the short term.

Importantly, a number of the technical choices reflected in legislation lack clarity. This includes unclear or conflicting guidelines and unclear definitions. It also includes some incomplete, contradictory or inaccurate methods, outdated default values (e.g., for carbon price, biodiversity), and the potential for double counting. These types of technical issues can have profound implications for the quality, credibility and useability of the existing legislation. Such technical shortcomings are particularly salient in the context of court cases and where multiple agencies are involved. There is clear scope for improved, simplified and standardized valuation guidelines for government agencies.

5.4 Politics of valuation embodied in legislation

However, the choices reflected in the reviewed legislation are neither purely technical nor neutral. On the contrary, there is growing recognition that these types of decisions are both active and political (Gomez-Baggethún and Pérez-Ruiz 2011; Kallis et al. 2013; Phelps et al. 2014; Kenner 2014; Kull et al. 2015; Fig. 1), evidence of which can be found in the Indonesian legislation.

For example, the notable lack of recognition of cultural and amenity services, despite the high values attached by many indigenous and rural communities (e.g., Sodhi et al. 2009), likely reflects non-alignment of interests. As a result, many of the goods and services upon which people rely remain externalities, in spite of valuation efforts. While these types of goods and services are admittedly complex to integrate into mainstream legislation on ES valuation, "the key issues... relate to the questions of who holds the power to simplify complexity, how such simplifications are created, and by whom" (Martinez-Alier, 2008).

Nevertheless, legislation from both the Ministries of Finance and Environment appear to have made efforts to recognise a broader set of goods and services, with some specifically focused on local resource users, such as valuation of non-timber forest products and specifically medicinal plants (Table 4).

In contrast, much Indonesian still focuses narrowly on timber resources (Table 4) follows a long history of commercial timber extraction dating to the colonial era (Peluso 1991). This is particularly well reflected in the Central Statistic Bureau's narrow focus on the value of only specific valuable hardwoods. Similarly, the government revised the reference price of timber in 2012 (Table 7), long after the 2007 price was declared out of date. Recent development of carbon quantification and valuation approaches in Indonesia also been contested and politically charged (Astuti and McGregor 2015).

Despite several possible explanations, these decisions have significant impacts on taxation, trade-off analysis, and thus vested interests in the forest sector. For example, a timber reference price that also accounts for ecological values would taxation rates for the timber industry, which Indonesia continue to try and support. Expanded use of valuation to inform compensation following liability for environmental harm would potentially challenge established vested interests (Phelps et al. 2014). Indeed, any decision-making that affects land and resource distribution in Indonesia are uniquely politicised, long shaped by vested interests of political and military elite, related corruption and mismanagement, as increasingly the interest of local elite following

decentralization (see Ascher 1998; Smith et al. 2003; Barr et al. 2010).

Moreover, the political economy of natural resource use in Indonesia has revolved not only around private vested interests, but also resource and budget competition amongst government agencies (Ascher 1998; Barr et al. 2010). As a result, ES valuation and related methods are potential objectives for inter-agency disagreements, which may help to explain the diversity of approaches and lack of harmonization. The ambiguity surrounding ES valuation in Indonesia may actually be deliberate, as it is around resource jurisdictions and processes that enable resource grabbing (cf. Ho 2001).

6. Conclusion

Despite advances in environmental valuation theory and recent progress in various techniques to make it operational, there is a clear need for greater focus on the mechanics of how these are institutionalized, including government legislation, the associated governance dimension and the politics of valuation, especially if we are interested in overcoming the academic-practise gap.

One key implication from the existence of various methods of ecosystem service valuation, there is a need to have a clear and comprehensible legislation about how valuation is done. For this, some of existing regulations on ecosystem service valuation can be simplified and streamlined. Codification, while potentially reducing the barriers to accessing knowledge, can also reduce access where it is overly technical. Some of the reviewed legislation seems likely to have been consultant-driven and unlikely to be practical or accessible to the civil servants responsible for operationalising them.

There is clear need for a broader process to establish common objectives, approaches and methods, based on robust science, different stakeholder interests, cost and logistics. In this way, there is a need to simultaneously address technical, legal, scientific and political dimensions of valuation, while integrating it into broader efforts to strengthen natural resource and forest management. It is also important to take lessons on how these legislations are operationalized in order to evaluate and improve these legislations.

Valuation language, approach and methods not yet fixed, either in Indonesia or globally. This provides a valuable time to explore how they work and what improvements are needed. It appears that major barriers in Indonesia include a lack of training among decision-makers, as well as inadequate regulatory frameworks. Insights from valuation studies has not been able to disentangle the interplay among institutions, values and politics.

Also importantly, implementing a solid valuation of ecosystem services and developing national natural capital account need a substantial amount of budget. Whatever agencies that are mandated to conduct valuation or development of natural capital account should be equipped with the necessary budget to conduct their tasks. While valuation of ecosystem services may look trivial or academic exercise, it is increasingly gaining attention and policy momentum, for example during fire and haze in a number of provinces in Indonesia. It is important to ensure that the strong

presence in implementing stated objectives in Indonesia fail to materialize does not continue. With the decentralization swings back to the national and provincial level, this could open up opportunities for streamlining and standardizing valuation methods and implementation. In this way, it is expected there will be a growing recognition that valuation is, rather than a technical fix, part of a broader policy process imbued with the politics and power dynamics of both policy and knowledge production.

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Supplementary Online Information

Table S1. English-Indonesian translations of key terms, agency names, key valuation terms

Indonesian language terms	English translations or definition
Badan Perencanaan Pembangunan Nasional	Ministry of National Development Planning/ National Development Planning Agency
Kejaksaan Agung Republik Indonesia	Attorney General Office
Kepolisian Republik Indonesia	Indonesian National Police
Komisi Pemberantasan Korupsi	Corruption Eradication Commission
Badan Pemeriksa Keuangan	Supreme Audit Agency
Badan Pemeriksa Keuangan dan Pembangunan	Board of Finance and Development Supervision
BPS	Central Bureau of Statistics
Kementerian Kehutanan	Ministry of Forestry
Kementerian Pertanian	Ministry of Agriculture
Kementerian Keuangan	Ministry of Finance
Kuangan Negara	State Finance, defined in Law 17/2003 as “any right and obligation that has monetary value, including both goods and money that can be declared as ‘state-owned’ for the purpose of implementing the state’s rights and obligations”
Kerugian Negara	State Loss, defined in Law 1/2004 and Law 15/2006 as “reduction of money, securities, and goods in real and definite amount as a result of unlawful acts, either intentionally or negligently”
Provisi Sumber Daya Hutan	Forest Resource Rent Provision: a volume-based forest fee, which is calculated as a percentage of the reference price times the harvested forest product. The reference price is set up according to Ministry of Forestry Regulation.
Penerimaan Negara Bukan Pajak	Non Tax State Revenues
Sistem Neraca Terintegrasi Lingkungan dan Ekonomi	Integrated System of Environment and Economic Accounts is the Central Bureau of Statistics' system for tracking the stock of natural resources. Currently it covers timber.