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Integrating relational and instrumental values of nature in planning land use for multiple ecosystem services (LUMENS): tools and process

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The recent reframing of global biodiversity policy from (unsuccessfully) dealing with 'underlying causes' to focusing on spatial allocations and planning implies renewed urgency of reconciling goal-oriented spatial planning of rights to use land and water with harmony-oriented 'co-production' by the relevant stakeholders. Current understanding of spatial and temporal variation in the balance between goal-oriented instrumental and harmony-oriented relational values of nature recognizes different decision-making styles. Taking Indonesia and Vietnam as examples, we explored how current tools and processes of land-use planning for multiple environmental services (LUMENS) deal with that balance, and what further steps may be needed to meet current expectations, across all sustainable development goals in a mega-diverse country with an export-oriented economy and its changing norms. So far, relational values are expressed primarily as stakeholder preferences through the 'co-production' process, consultations, and priority setting, while instrumental values and economic multipliers are formally presented.

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Introduction

Land use is socially constructed and contested in its meaning and values, while land-use change usually implies trade-offs between different benefits; land tenure and land-use claims are often unclear, overlapping, and contested and land users have multiple, sometimes conflicting, ideas of what social and environmental justice entails [1*]. Pan-tropical evidence on the ways agriculture drives deforestation suggests that, although most (90–99%) deforestation across the tropics in the period 2011–2015 was driven by agriculture, only 45–65% of deforested land became productive agriculture within a few years [2]. Elsewhere, land clearing rights or tolerated grabs, and the logging this allows or makes possible, may have prevailed. Plans and associated rights have favored specific stakeholders.

Coproduction of land-use planning, and clarifying rights to use land and water, is central to the recently adopted Global Biodiversity Framework [3*]. With 23 targets for 2030, the priority has shifted in its presentation from "dealing with generic drivers of biodiversity loss" (as in the Aichi targets for 2020) to spatial planning commitments. TARGET 1 "Ensure that all areas are under participatory integrated biodiversity inclusive spatial planning and/or effective management processes …" TARGET 2 "Ensure that by 2030 at least 30% of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration …", TARGET 3 "Ensure and enable that by 2030 at least 30% of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems…". Meeting these three targets, both in terms of spatial outcome and social–political process ('co-production' among stakeholders) will require a serious commitment, at various levels of governance systems, to improve land-use planning from "nice colourful maps to hang on the wall" while ticking of the boxes of meeting formal requirements, to becoming living 'boundary objects' in which stakeholders of spatially explicit rights to use land get sufficient guidance, while maintaining flexibility where feasible.

A systematic map [4] of differences in how 32 initiatives from six continents coproduce diverse outcomes for the sustainable development of ecosystems at local to global scales found variation in their purpose, understanding of power, approach to politics, and pathways to impact. A cluster analysis identified six modes of coproduction: (1) researching solutions; (2) empowering voices; (3) brokering power; (4) reframing power; (5) navigating differences; (6) reframing agency. Land-use planning, which operates within existing power networks, has a mixed track record, especially in preventing land degradation [5] or controlling the urban-agriculture interface in the Global South [6], depending on the legislative and governance context in which it has been applied.

The key questions for this study were:

A. What tools and processes can offer in reconciling plural values and the various sustainable development goals with spatial and socio-economic decisions?
B. Is there a need for a more robust representation, beyond instrumental values of nature, of relational values along with broader stakeholder involvement?
C. If so, how could processes and tools be adapted to achieve this?

We focus on our experiences applying such reconciliation process using one particular tool in Indonesia and Vietnam. The two Southeast Asian countries include all stages of empirical tropical forest transition curves [7], which elucidate the diversity of spatiotemporal dynamics of relationships between forest cover and development [8]. The discourse does not aim toward representativeness or sampling of cases nor reviewing range of tools. Nevertheless, the two case studies are not outliers with regard to forest transition stages, which may suggest that such process and tool are applicable to address a wide range of geographies.

Shifting perspectives on land multifunctionality

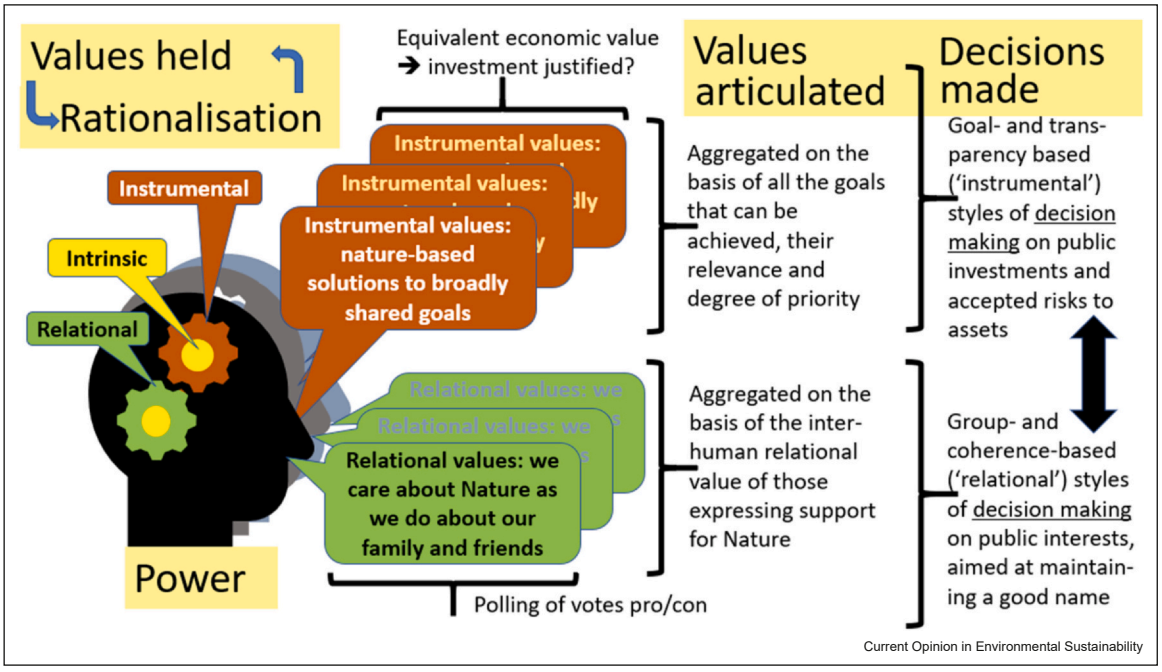
Land is important for many functions, as substrate for human activities (meeting geophysical criteria and acceptable flooding risk), use as production factor in primary production (agriculture, forestry, and aquaculture), as interface between rainfall (climate) and modulating water availability (hydrology), as protector from geohazards (including landslides, flash floods, and tsunami's), as habitat for biodiversity, as a place for human spirituality, or as 'sense of place' for cultural identity. Many of these functions can be expressed as 'instrumental' values (means to achieving goals, for example, Sustainable Development Goals [9]), but there is increasing recognition for 'relational' (harmony-oriented) values of nature as well (e.g. for the last two functions mentioned) [10]. These two types of values (and a further one that attributes 'intrinsic' values to nature and seeks rights-based recognition for nature's persistence), interact with two key approaches of public decision-making: goal-oriented and harmony-oriented [11,12] (Figure 1).

The balance between relational and instrumental values and modes of decision-making varies spatially (along with cultural traditions [13]) and temporally, along with political history and development processes. A recent synthesis [14] recognized four broad stages: I. People as part of nature, respecting the powers and spiritual values beyond its reach, II. Conquering and domesticating nature, replacing it by (agri)culture and emphasizing instrumental values (sanctioned by evolving religions), III. Natural resource management based on technology and multiple goals, and IV. Stewardship and common but differentiated responsibility for planetary health, including a rebound of spiritual and experiential values of nature. The primary track record of land-use planning is in stage III (coming out of stage II); the current challenge is to make it suitable for stage IV. Ecological corridor planning may operate at the transition of III–IV [15]. Export-oriented production of tropical commodities currently forces a transition from II to III, as part of 'green growth' planning [16,17].

Land-use planning for multifunctionality

Within the broader landscape governance, three main principles were coined: (i) negotiated solution among competing land uses through multiple stakeholders' participation; (ii) minimized trade-offs in multifunctional landscape among biodiversity, ecosystem services, food and livelihood security, and climate change; (iii) inclusivity that encompasses recognition of rights, context-specificity, awareness of power differences, and knowledge management [18]. Land-use planning for multifunctionality is no panacea — when taken as a standalone activity — but can be an essential part of a broader process of shifting development patterns into a more desirable direction, as long as power differences can be addressed by reference to higher-level goals. A recent analysis for East Kalimantan suggested that under unlimited development, zoning is effective, while under limited development it is not [19], suggesting that when land development policy can limit the types and extent of land and forest conversion, then spatial planning policy is not as instrumental in maintaining aboveground biomass and biodiversity as when land development policy does not regulate expansion and conversion toward intensive land uses. If indigenous groups, rural communities, small-scale farmers, pastoralists, women, and young people experience difficulties in accessing and using land and securing land rights, tweaking land-use planning as such will have little impact for them.

Figure 1



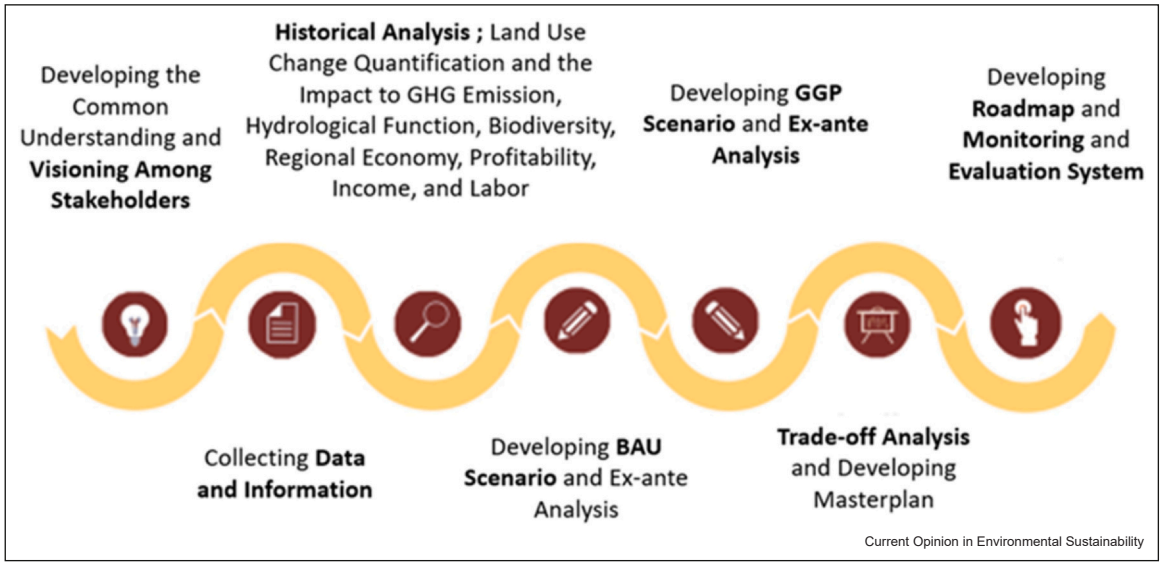
Instrumental (goal-oriented) and relational (harmony-oriented) values and rationalizations interact in the heads of people in the way they are articulated and the way decisions are made, for example, on public policy issues such as spatially explicit rights to use land and water.

Access to finance increasingly depends on documented legality of land use [20], while reality on the ground differs from maps, as evident from the 15–20% of Indonesia's oil palms that grow beyond where it is legally possible [21]. Facilitating legal access depends on the existence of legal pathways, sensitive land-use plans that allow right regimes to be used, and process-level support to vulnerable groups [22]. Effective land-use planning may also have to involve changes in water management, for example, to reduce fire risk in drained tropical peatlands [23]. In Indonesia, despite an abundance of studies of local perspectives on desirable spatial development, uptake in the formal spatial planning processes has been limited [24].

As climate change mitigation became a national commitment in many tropical countries with significant emissions from agriculture, forestry, and other land uses, the need for a negotiation-support tool to guide multiple stakeholder processes at subnational levels is evident. There is a wealth of land use/cover change modeling tools that can be used to guide the decision-making, some of them are (loosely) coupled with ecosystem impact valuation of ecosystem services. Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) (https://naturalcapitalproject.stanford.edu/software/invest) is one of the most widely used tools along this line. InVEST is a comprehensive tool for land-use planning at the landscape level under a reasonably uniform policy, regulation, and drivers of land use/cover changes as part of a jurisdictional area; it uses generalized proxies for 'ecosystem services', not based on local stakeholder understanding, values, and preferences. The trade-off of conservation development is often decided at jurisdictional level, referring and synergizing with the levels above and below. Integrating land use and development plans in a jurisdictional level is rarely conducted in tropical countries — while the aspiration exists, the knowledge base and tools are lacking. A scenario simulation tool, Land-Use Planning for Low-Emission Development Strategy (LUWES), a semi-spatially explicit tool, was developed and used in all provinces in Indonesia and piloted in Vietnam, Cameroon, and Peru [25]. In addressing green economy and green growth planning from land-use sector, LUWES evolved into LUMENS (Land-Use Planning for Multiple Environmental Services) that is fully spatially explicit, embraces beyond-carbon ecosystem services and biodiversity, embeds regional economy [26], and accommodates a wide range of conservation, development [27], and restoration scenarios [28,29].

LUMENS leads to a green growth plan (GGP), through the three principles of being inclusive, integrative, and informed. Tools were developed for use in supporting the negotiation process of land-use planning. The planning process for green growth with LUMENS involves seven main 'co-production' stages (Figure 2).

Figure 2



Seven coproduction stages in developing GGPs with Land-Use Planning for Environmental Services (LUMENS).

Except for stage 2 that is almost purely technical analysis but followed with dissemination and consultation, other stages are heavily multistakeholder processes. Across the whole stages, ideally a working group, formalized by the head of the jurisdiction (e.g. governor of the province), consistently represents the multistakeholder groups, consisting of relevant government agencies, private sectors, civil society organizations, representatives of indigenous groups, and local communities. When such a working group is not feasible to establish, the process needs to ensure the representativeness across stakeholder groups and retain the consistency of individual representatives.

Examples of applications, lessons learned, and evaluation of achievements

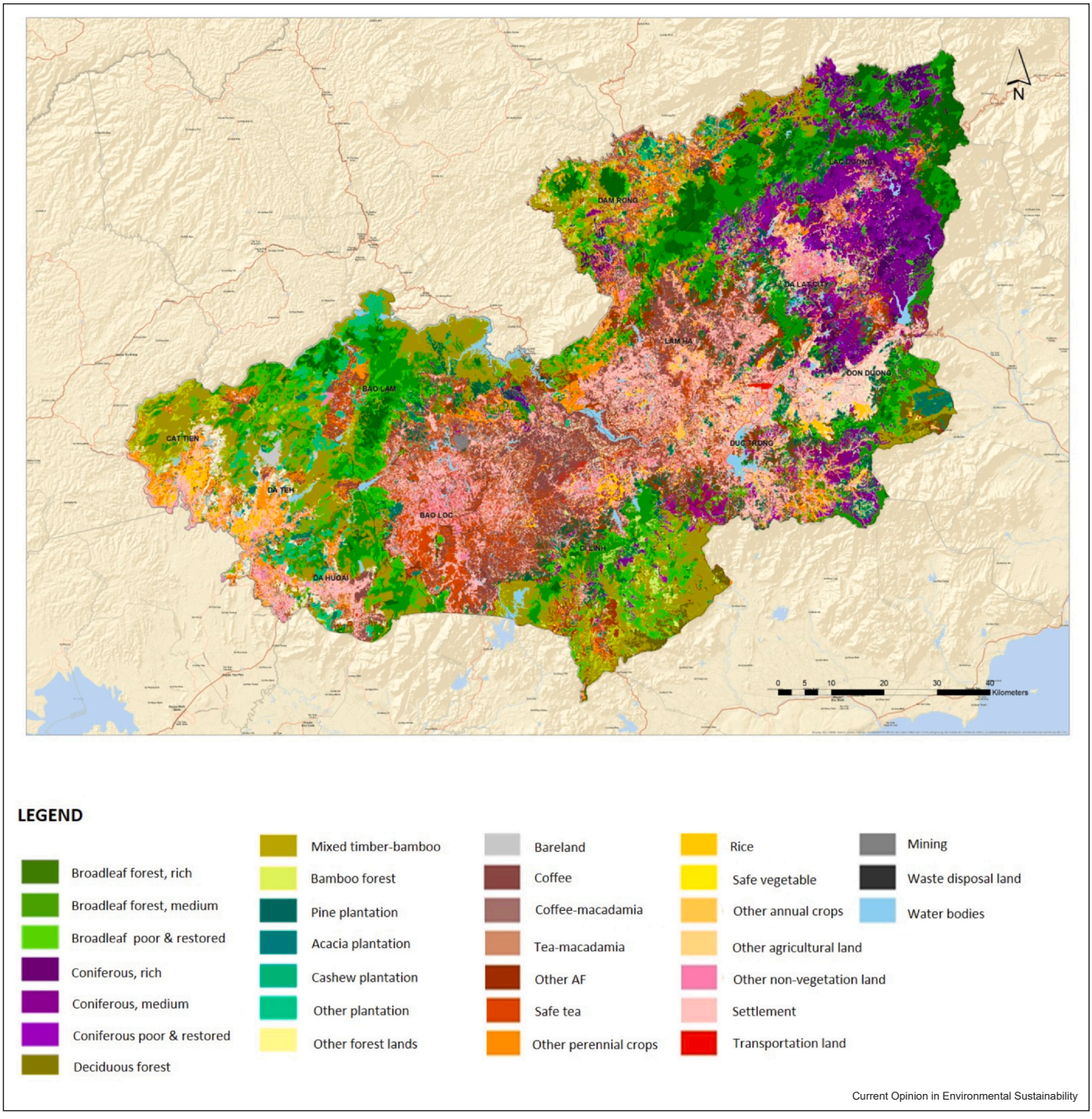
Green Growth Action Plan for Lam Dong Province (Vietnam)

The Green Growth Action Plan (GGAP) of Lam Dong province (Central Highlands region, Vietnam) [30] articulates spatial plus economic plans for strong economic growth in an improved and sustainable environment. Plans are to maintain a gross regional domestic product growth of 8–9% until 2030, but with a structural transformation from agriculture to services and industry as dominant sectors after 2030. The province's industrial sector will need to focus on developing processing and downstream industries using local raw materials and developing a handicraft industry for tourism. The service sector needs to support the production and market value chain of agricultural products that meet the export standard, strengthened by product branding. A vision of Lam Dong as a major tourist center in the region and the country, can drive optimal, responsible use of natural resources.

The GGAP outlines nine key strategies that complement and enrich the priorities in the province's existing strategies. The GGAP strategies were developed and assessed using LUMENS framework [31,32]. The province's most recent (2015–2020) planning on, for example, land use, settlement and transportation network, and other existing spatial information, is used to model ecological and economic processes in all assessed land-based and related sectors. For the energy sector, the Long-range Energy Alternatives Planning model was used to track energy consumption and production in all sectors. A generic river hydrology model [33,34] was used to assess the impact of land-based measures on watershed functions. A projected land-use map for the year 2030 using LUMENS and GGAP measures over 2021–2030 is one of the key outputs from the assessment (Figure 3).

The Green Growth planning process emphasizes 'instrumental values', but in involving local stakeholders, a diversity of 'relational values' surfaced in the iterative planning process, including attachment to place and perceived identity as an inherent value rather than as separate 'map' layers. Local communities were involved at all stages from the discussion of planning units, conservation-development scenarios, and *ex ante* impacts; and the negotiation of 'best'-selected scenarios. Using LUMENS, a study in northwest montane region of Vietnam also shows that the lack of participation and recognition of local land-use practices affects the success

Figure 3



Lam Dong's projected land covers for the year 2030 with green growth implementation.
Source: Ref. [30].

of the implementation of land-use plan, payment for forest environmental services, and the nationally determined contributions [35]. Moreover, co-investment in environmental stewardship through voluntary contracts can complement 'rights-based' land-use planning [36], as recently explored for Central Vietnam [37*].

Green Growth Planning for three Indonesia's provinces

Indonesia's lowland is vast, densely populated, and highly degraded. Lowland management needs to be integrated into a broader jurisdictional approach of GGP that focuses on the specific contexts of lowland landscapes by integrating land-use plans with development

plans to facilitate the achievement of a number of objectives, including (1) sustainable economic growth; (2) inclusive and equitable growth; (3) economic, social, and environmental resilience; (4) healthy and productive ecosystems in ecosystem service provisions; and (5) reduction of greenhouse gas emissions [38]. The coproduction of a GGP is preceded by stakeholder mapping and a series of meetings. In three provinces with significant lowland areas in Indonesia (South Sumatra, Jambi, and Papua), participants from multistakeholder groups were in agreement and stated that the GGP outcomes are aligned with the GGP at the national level and to the SDGs (Sustainable Development Goals), with a common focus on sustainable improvements to people's livelihoods, including socio-economic resilience, healthy and productive ecosystems, and reduction of greenhouse gas emissions.

While many of the expected outcomes are common across the provinces, the specific characteristics of each region also subtly influence the expected outcomes. For example, unlike the other two provinces, Papua emphasizes the achievement of equality and equity for indigenous Papuans, which clearly shows strong relational values. During the process, no distinction was made explicitly between instrumental and relational values in formulating the intervention types. Even though in most discussions most aspirations are highly relates to instrumental values, there are interventions such as social forestry and customary land conflict resolution and also no-go areas for plantation expansion that have stronger embedded relational values than instrumental values compared with others. The cultural and broader social context also reflected well with a difference across provinces (Table 1).

The Green Growth (GG) intervention maps for three provinces show ranges of interventions based on the location/spatial activities of the GGP. The GG interventions in the lowland areas of the three provinces display both commonalities and differences, according to their respective development stages and local contexts. Because of the scarcity of land in the Sumatran provinces, measures to increase productivity per unit area, rather than to expand the use of land for cultivation, are promoted. Yet, the wide extent of degraded land, makes restoration through agroforestry practices a promising option [42].

By contrast, Papua's inhabitants are scattered across a vast forest landscape. Agroforestry is also a good option here, albeit for different reasons than in the Sumatran provinces. In Papua, a system with a higher return to labor is much needed due to labor scarcity. All provinces must achieve and improve geographical alignment between infrastructure (production, processing, and distribution) within the existing farming systems on suitable lands. In all cases, farmers need better access to land, which may be facilitated either through social forestry and/or agrarian reform in the Sumatran provinces or through measures to resolve conflicts between the government and customary law in Papua, where they relate to lands as their mothers.

Discussion and way forward

LUMENS, as a negotiation-support framework, integrates a participatory process of multiple stakeholders with a technical tool for achieving green growth through multifunctional land uses. The participatory process encompasses the development of common targets and indicators, strategy and intervention (including land-use) scenarios, and selection of 'best' scenarios with regard to the achievement of green growth targets while maintaining ecosystem services and biodiversity. Such effective conservation of biodiversity and related ecosystem services will require approaches at the landscape scale [43]. Resilience to climate change becomes an increasingly pressing issue to achieve green growth, so that buffering capacity of the watershed is crucial. LUMENS encompasses hydrological function in its *ex ante* simulation. The model performed well in annual timescale, but precision is less at finer timescales. INVEST faced similar problems in its water balance modules [44,45], while scale-dependent sediment

Table 1

Various GGP intervention types in three Indonesian provinces and their degree of importance according to local stakeholders [39–41].

Strategy	GGP intervention	South Sumatra	Jambi	Papua
Access to land for improving livelihood capitals	Social forestry and partnerships	+++	++	+
	Proposed agrarian reform	++		+
	Reconciliation of land/conflict resolution of customary land	+	+	+++
Land use and infrastructure	Reallocation of land uses	+++	++	++
	No-go for plantation expansion	++		+++
Sublandscape restoration	Priority restoration of peat, including fire management	++	+++	
Application of good agricultural practices (GAP)	Restoration and revitalization with good agricultural/agroforestry practice of alternative commodities	+++	+++	++
	Intensification of existing crops and fishery	++	+++	+++
	Commercial plantation revitalization (GAP-based)	+++	++	+
	Intensification of paddy rice	++	+++	

delivery ratios are uncertain. In terms of the participatory process, spatially explicit, agent-based models that try to predict responses of land users to proposed policies [46–48] potentially embrace both instrumental and relational values, but it is impractical to be applied in a wide, jurisdictional scale. Overall, reducing arbitrariness in planning can benefit from evolving one-off analyses to participatory decision-making [49].

Addressing environmental governance issues at multiple levels is needed [35,37], of which spatial planning is an important part, but not sufficient as such [50*]. Elsewhere, strategies (bylaws, boundary demarcation, community action plan, and conflict resolution) used to enhance adherence to participatory village land-use plans had mixed success [51]. In coastal zones in China, pressure of increased demands sparked spatially explicit ecosystem service quantification [52], discussed in terms of intersectoral coordination. The initial lack of coordination on China's Loess Plateau [53], was turned around with success by the governments' grain for green program to induce a land cover transition toward restoration of functions.

In most decision- and negotiation-support tools, relational values of nature are much less articulated and reflected in land-use planning for green growth than instrumental values, with variation rooted in broader social and cultural contexts. LUMENS as software has not been geared and designed to cater to relational values per se and also the process specifically has been guiding multistakeholders more toward instrumental values rather than explicitly accommodative toward relational values. While more tailored to fill in the gaps of the available technical and negotiation tools within the suite of government regulations and policies, LUMENS has not been designed to distinguish, address, and integrate relational values into consideration. However, as a framework, through its three central principles of inclusive, integrative, and informed, LUMENS steps heavily rely on the process that is aware, sensitive, responsive, and transformative toward relational values, especially in forested areas inhabited by marginalized groups, indigenous population, and local communities. Some study also shows that empirically relational and instrumental values are hard to differentiate [54]. Options-by-contexts principle [36] is necessary to be held, especially in light of the four stages of relational–instrumental value balance in decision-making.

A framework of tools and participatory process in balancing instrumental and relational values can coproduce spatial land-use planning for multifunctional landscape management through joint formulation of an explicit target of biodiversity and ecosystem service conservation and maintenance, go and no-go principles in zoning, and conservation-development scenarios; and negotiation process of the 'best' scenario considering all *ex ante* impacts across social, economic, and ecosystem indicators. Further, integration between landscape and seascape management and restoration will address the first three targets of the Global Biodiversity Framework and contribute to SDG when rights are being properly recognized, and the multilevel governance systems are strengthened.

Transformative governance of complex biodiversity–climate–society interactions will need to build multifunctional interventions, achieve integration and innovation across scales, build coalitions of support, use equitable approaches, and target positive social tipping dynamics [55,56]. Coproduction of usable knowledge may depend on how it combines context-based, pluralistic, goal-oriented, and interactive processes [57*]. Finally, acknowledging the importance of spatial tools for inclusive landscape governance, research agenda should be revamped to address a broader application domain, find innovative ways to allow participations, and create and use new technologies [17].

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Given the role as Guest Editor, Meine van Noordwijk had no involvement in the peer review of the article and has no access to information regarding its peer-review. Full responsibility for the editorial process of this article was delegated to Erika Speelman.

Data Availability

The authors do not have permission to share data.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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