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An Indonesian Pilot Project

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Jurisdictional approaches to High Conservation Value area designation using regulatory instruments: an Indonesian pilot project

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Agricultural expansion is the primary driver of tropical deforestation and ecological degradation. Certification schemes for sustainable agricultural supply chains, such that of the Roundtable on Sustainable Palm Oil (RSPO), seek to address this issue by identifying and protecting High Conservation Value (HCV) areas within concessions. Although RSPO certification of individual concessions has been beneficial, it has had limited efficacy in arresting systemic ecological degradation at larger scales. In response, certification at a regional, 'jurisdictional' scale concordant with local environmental regulation has been proposed as an alternative to conventional, piecemeal certification. Jurisdictional certification schemes require alignment with local legislation to ensure integration with governmental environmental and land-use planning; yet, questions of which legislation, and at which level of government, have remained unaddressed. Here, we report on a pilot jurisdictional RSPO certification scheme implemented by an Indonesian district, based on environmental carrying capacity assessments (ECCA) as legislated by the district government. Using the ECCA, we identified likely HCV areas across the district and considered their distributions with respect to three factors of feasible HCV management: (a) similarity with alternative HCV areas identified by a conventional HCV Screening method, (b) sensitivity to aspects of underlying legislation, and (c) scope for unilateral district-wide management. Likely HCV areas were generally similar between the ECCA and HCV Screening method, as each set spanned ~90% of the district. However, higher-confidence HCV areas according to the ECCA were much less extensive, at 51% of the district, and uniquely extensive across oil-palm concessions. HCV area designation was highly sensitive to the legislated parameters of the ECCA, namely, the selection and estimation of key ecosystem services. Potentially, subtle variations to ECCA implementation, such as those proposed by agro-industrial lobbyists, would significantly affect jurisdictional HCV designations. Finally, some three-quarters of all HCV areas and higher-confidence HCV areas designated by the ECCA fell outside of the exclusive administrative authority of the district government, being confined to agricultural zones. In politically-decentralised Indonesia, jurisdictional

HCV area management would therefore be narrowly confined to agricultural areas, or cooperation between district, provincial, and central governments would be essential to the protection of HCV areas generally across districts.

KEYWORDS

environmental assessment, HCV screening, sustainable oil palm, jurisdiction, ecosystem service

1 Introduction

Tropical biodiversity is besieged by many threats, including the over-exploitation of forests (Maxwell et al., 2016), hunting (Tilker et al., 2019), pollution (Hölker et al., 2010), fire (Kelly et al., 2020), climate change (Sintayehu, 2018), invasive species (Doherty et al., 2016), and habitat destruction (Hanski, 2011). In recent decades, increased global demand for agricultural and forest commodities has driven most tropical deforestation and ecological degradation (Gibbs et al., 2010; Hosonuma et al., 2012; Sloan and Sayer, 2015; Austin et al., 2017a; Austin et al., 2017b). In Indonesia, host to two global biodiversity hotspots (Sloan et al., 2014), the main drivers of deforestation since the early 2000s are the development of industrial-scale concessions for pulp and paper, timber, and especially oil-palm plantations (Carlson et al., 2013; Gaveau et al., 2014; Gaveau et al., 2016; Gaveau et al., 2022; Abood et al., 2015). This deforestation has had detrimental effects for ecosystem service provision, such as fire mitigation (Nikonovas et al., 2020), biodiversity (Sodhi et al., 2004; Edwards et al., 2010; Corlett, 2014), and water regulation (Casagrande et al., 2021).

Commodity-driven deforestation and environmental degradation in Indonesia has led to civil-society campaigns, such as global consumer boycotts, which have affected policies in countries importing Indonesian timber, palm oil, and other commodities (Lambin et al., 2018). For instance, in 2016 the European Union adopted the Forest Law Enforcement, Governance and Trade (FLEGT) regulations to exclusively import Indonesian timber that is certified as legally sourced (Tacconi, 2007; van Heeswijk and Turnhout, 2013). Commodity producers, in turn, have responded to such economic and regulatory pressures via various sustainable-production initiatives, such as corporate zero-deforestation pledges (Furumo and Lambin, 2020; Carodenuto and Buluran, 2021), fire-free production schemes (Carbon Conservation, 2017; Watts et al., 2019; Sloan et al., 2021), and commodity supply-chain certification schemes (Kadarusman and Herabadi, 2018). Supply-chain certification schemes, including the well-known Forest Stewardship Council (FSC) and the Roundtable on Sustainable Palm Oil (RSPO), entail the identification and protection of High Conservation Value (HCV) areas within otherwise productive concessions to avoid their unsustainable conversion. HCV areas are variously defined as host to high biodiversity, rare species and/or critical habitats, and/or as providing significant ecosystem services, and/or as having high socio-cultural importance to local communities (Edwards et al., 2011; Austin, et al., 2017).

The RSPO's Principles and Criteria guide member oil-palm growers in producing certifiable sustainable palm-oil production (RSPO, 2021a), including stipulating the identification and protection of HCV areas (e.g., Principle 7) (RSPO, 2018). Amongst various considerations covered by these Principles and Criteria, RSPO certification requires that HCV areas be identified by accredited third-party environmental consultants, both in existing concessions and those to be established. Thereafter, the individual concessionaire is charged with the monitoring and protection of its HCV areas in order to retain its RSPO certification. To date, the RSPO Principles and Criteria have been applied in 92 countries, including Indonesia, by far the world's foremost oil-palm producer (Statista Research Department, 2022). While current RSPO-certification practices have ostensibly lowered overall deforestation, they have proven less effective at reducing generalized ecological degradation, as with respect to biodiversity loss, burning, and peatland conversion (Ruysschaert and Salles, 2014; Azhar et al., 2015; Carlson et al., 2017; Morgans et al., 2018; Scriven et al., 2019). Amongst other shortcomings, RSPO Principles and Criteria implementation has been highly piecemeal. HCV areas have been identified at the level of individual concessions, culminating in ecologically and administratively disjointed conservation planning across the multiple concessions and forested areas within a given region (Runting et al., 2015; Sloan et al., 2019). More geographically and ecologically holistic approaches to HCV-area designation are necessary.

In response, the RSPO launched a new certification initiative in 2018, known as the Jurisdictional Approach (JA) (RSPO, 2021b). The JA seeks to scale the application of RSPO Principles and Criteria from the concession to a regional, 'jurisdictional' scale. In theory, the JA would entail a single designation of HCV areas across a given administrative jurisdiction[1], allowing for greater coordination amongst concessionaires and local governmental environmental regulators with respect to RSPO certification standards. Theoretical advantages of the JA include a greater total extent of Principles and Criteria implementation; regulatory support of market forces for sustainability; increased market access for producers by virtue of their 'collective certification' (Watts and Irawan, 2018), and economies of scale for financial and administrative aspects of HCV designation and RSPO compliance generally, particularly amongst smaller producers (RSPO 2021).

The JA to RSPO certification arguably necessitates that HCV designations are based on, or otherwise compatible with, local regulatory instruments. Thus, local governments would realise jurisdictional HCV designations or otherwise integrate them

1 According to RSPO (2021b, p. 8), a jurisdiction is defined as "a government administrative area where a system of laws is applied, it could mean a country, a state, a province, or a district, led by an authority that has the power or right to govern and to interpret and apply the law. Jurisdictions operate according to a set of regulations, which define the mandates and authorities in planning, budgeting and implementation of programmes and activities".

seamlessly with official land-use planning. This practicable aspect of the RSPO JA has been largely neglected to date. Indeed, recent guidelines for jurisdictional HCV Screening issued by the High Conservation Value Network (Watson, 2020) would effectively 'scale up' conventional RSPO HCV-assessment methods intended for concession-level application. While HCV Screening is potentially beneficial as an input to jurisdictional land-use planning, no means of integrating HCV Screening with Indonesian environmental planning are immediately apparent.

An alternative approach to jurisdictional HCV-area designation is to adapt existing environmental regulatory instruments to identify and protect HCV areas. Questions of which instrument, and at which administrative scale, have remain entirely unaddressed. In Indonesia, the jurisdiction with the authority to regulate agricultural commodity production is typically the district (*kabupaten*) (Irawan et al., 2019; Seymour et al., 2020). Amongst Indonesian districts, one regulatory instrument amenable to the JA is the Environmental Carrying Capacity Assessment (ECCA). Since 2009, Indonesian law[2] on Environmental Protection and Management requires all district and provincial authorities to undertake a detailed, spatially-explicitly, wall-to wall ECCA to ensure that planned socio-economic development (including agricultural expansion) will not adversely impact the provision of key ecosystem services (Watts and Irawan, 2018). Local governments must incorporate ECCA outputs into their environmental protection and management plans, medium-term development plans, and land-use/development plans to avoid or mitigate the negative ecological effects of development. To date, no more than 20% of district and provincial authorities have undertaken ECCAs.

Here, for an Indonesian district piloting a JA to RSPO certification, we explore how, and how well, its ECCA may identify likely HCV areas compared to the conventional HCV Screening method currently advanced for jurisdictional applications. We adapted this district's ECCA to realise a jurisdictional HCV-area designation and then considered the distribution of resultant HCV areas in relation to three factors bearing on the feasibility of jurisdictional HCV-area management, namely, (1) the similarity of resultant HCV areas compared to HCV areas identified by the HCV Screening method, (2) the sensitivity of resultant HCV-area designations to the selection and estimation of ecosystem services as legislated by the ECCA, and (3) the scope for unilateral district-wide management of the HCV areas in the context of Indonesian political decentralization.

2 Materials and methods

2.1 Study area

Seruyan District of southern Central Kalimantan Province, Indonesia (Figure 1) is one of three jurisdictions selected globally for pilot implementation of the RSPO JA, alongside Sabah State, Malaysia and the whole of Ecuador. Encompassing 16,404 km^2, this district spans mostly lowlands, although undulating terrain covered with dense forest also occurs within its northern reaches. The central part of the district is mostly lowland oil-palm plantations on mineral soils, while the southern part is comprised by lowland forest, peat swamp forest, and mangrove, some of which fall within the Tanjung Puting National Park.

Deforestation and forest fragmentation have been expanding in Seruyan District since the early 1990s (Figure 1), mirroring trends for Kalimantan and Indonesia generally (Miettinen et al., 2016; Watts and Irawan, 2018; Watts et al., 2019). Since 1990, and particularly since 2000, after Indonesia's political decentralization, forest in the southern and central parts of the district declined by 4,822 km^2, or approximately 55% of the official Indonesian Forest Estate of the district as of 1990, due to logging and/or subsequent conversion to oil palm (Figure 1) (MoEF, 2019a). The district's forests are home to endangered species including Bornean orangutans, proboscis monkey, clouded leopard, and helmeted hornbill (Matsuda et al., 2009; Manduell et al., 2011; Cheyne et al., 2013), populations of which are scattered in forest fragments for which conservation is increasingly essential for species' viability (Gaston and Fuller, 2008). Biodiversity in Seruyan District is relatively understudied, compared to elsewhere in Kalimantan, which may undermine the scientific basis of potential conservation policies locally. In this context, Seruyan District declared its commitment to pilot the RSPO JA in 2015 and issued supporting regulations to initiate the process in 2016 (Watts and Irawan, 2018; Seymour et al., 2020).

2.2 Methodological overview

In collaboration with the government of Seruyan District, we adapted its recent ECCA for the district as a jurisdictional approach towards the identification of likely HCV areas. We then compared these HCV areas against those identified for the same district using conventional methods of the HCV Screening Method advanced by the HCV Network (Table 1). Additionally, we quantified the degree to which HCV areas according to the ECCA are dependent on particular ecological services surveyed by the ECCA and, therefore, are sensitive to the selection and/or estimation of such ecological services. Finally, we quantified the degree to which HCV areas according to the ECCA span areas under the exclusive authority of the district government versus other administrative levels of Indonesian government.

2.3 Environmental carrying capacity assessment (ECCA)

We worked with the Seruyan District Environmental Agency to conduct a district-wide ECCA following guidelines developed by the Ministry of Environment and Forestry (MoEF, 2019b). Of 18 ecosystem services prescribed by MoEF ECCA guidelines, the district's ECCA ultimately surveyed seven services deemed most relevant to sustainability planning and for which empirical observations were relatively confident, according to the Seruyan District government and following its consultation with the MoEF. The seven ecosystem services are: (i) food provisioning, (ii) water

2 National law 32/2009 on Environmental Protection and Management.

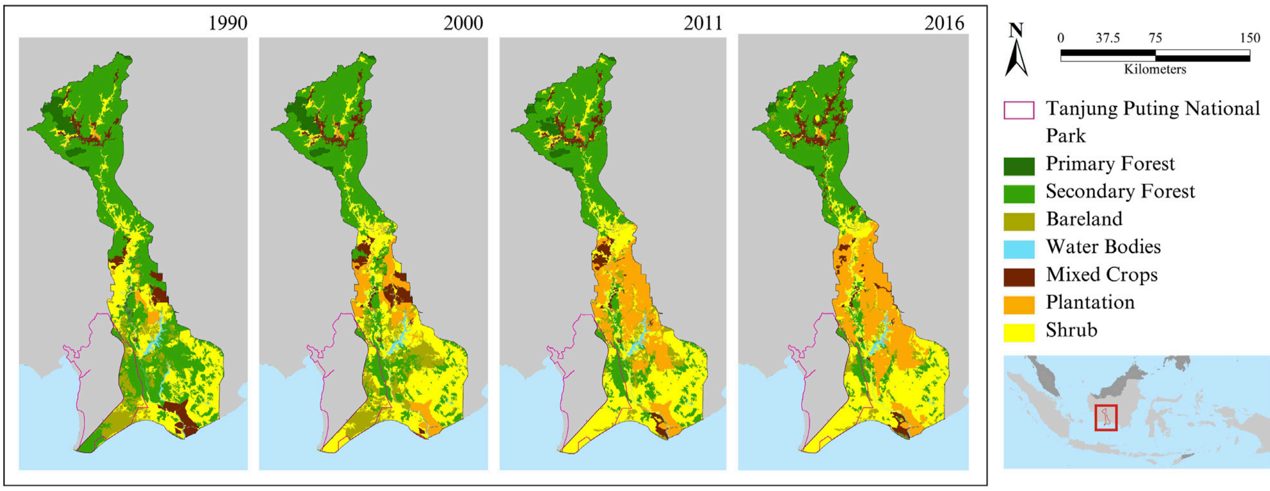

FIGURE 1
Land-use/cover change in Seruyan District, 1990—2016. Source: MoEF (2019a). Notes: Secondary forests according to Ministry of Environment and Forestry refers to any forested area that has been logged.

TABLE 1 A comparison the environmental carrying capacity assessment (ECCA) and HCV Screening method with regard to HCV identification.

	ECCA	HCV screening
Unit/level	Jurisdiction area (i.e., district or provincial administrative area)	Conventional HCV assessments focused on the concession level, while the HCV Screening focuses on a landscape or jurisdiction, to be defined as part of the screening exercise.
User	Government bodies (national and local level)	Government bodies, NGOs, donors, and investors, for example, to meet objectives of spatial planning, jurisdictional certification or supply chain risk management.
Regulation	Compulsory (Act 32/2009 on Environmental protection and management plan)	Voluntary; there is no regulation mandating HCV Screening
Data source	Guidelines and parameters are mostly from the Indonesian Ministry of Environment and Forestry (MoEF), including spatial data (landscape, natural vegetation, land cover). Non-spatial data can come from other sources (e.g., Seruyan District Statistic, expert consultation)	Spatial and non-spatial data, including socio-culture-economic and biodiversity data from disparate global datasets, reports, and publications from government bodies (e.g., MoEF, Geospatial Agency, spatial planning), NGOs, research institutions, and expert consultations.
Spatial resolution	Medium spatial resolution of input data (e.g., SPOT and Landsat satellite sensor processed as 1:250,000 scale); relatively high spatial detail or nuance in HCV-area designation	High to medium resolution of input data; relatively low spatial variation or nuance to HCV-area designations depending on the data available
Implementation	Desktop study, ideally alongside biodiversity survey and ground check	Desktop study—can be combined with targeted field work and consultation
HCV indicators	Indicators of likely HCV area are defined for the jurisdiction as a whole. The selection of ecosystem services for analysis, and the thresholds for their estimation, is guided by official regulation.	Indicators are static, typically presence/absence variables, and selected specifically for each HCV classes (HCV 1—6). Indicators selection reflects analyst judgement and data availability.
Outputs	Delineation of where HCV areas are relatively more or less likely to be present, by ecosystem service	Delineation of where HCV areas are relatively more or less likely to be present, by HCV class; summaries of HCV threats; overlay of HCV likelihood and threats to define 'HCV priority areas'
Post-analysis actions	Incorporate HCV assessment into regional development planning	Discuss screening result implications with stakeholders and determine next steps
Advantage	Regionally holistic; allows for gradations of HCV likelihood; backed by regulation to ensure protection and management at jurisdiction scale	Amenable to a wide range of data sources; flexible criteria for HCV-area designation
Disadvantage	Potential subjectivity in weighing and scoring variables of ecological integrity/threat; potential cullity to the inclusion or estimation of certain ecosystem services	Uncertain adoption by government development plans; inconsistent implementation between regions or contexts

provisioning, (iii) water regulation, (iv) climate regulation, (v) flood mitigation, (vi) landslide mitigation, and (vii) fire mitigation. Future ECCAs, either in Seryuan District or other districts, could well reflect a different set of the 18 prescribed ecosystem services, according to local priorities and analytical capacities.

For each ecosystem service separately, the ECCA employed a spatially-explicit index to quantify the capacity of a given unit of land to sustain the ecosystem service. The index is defined by the weighted sum of scores for the classes of each of three categorial variables—*landscape type* (e.g., alluvial plain, peatland, karst hill, denuded mountain, etc.), *vegetation type* (e.g., lowland dipterocarps, limestone forest, mangrove, etc.), and *land cover type* (e.g., primary dryland forest, shrub, plantation, settlement, etc.), each observed spatially at 1:250,000 scale (GIA, 2016; MoEF, 2019a). Higher index scores denote a greater capacity for sustainable ecosystem service provision. Formally, the index, hereafter termed the Environmental Service Index (ESI_j) for a given ecosystem service *j,* is given by Eq. 1:

$$ESI_j = (w_s \times s_s) + (w_v \times s_v) + (w_c \times s_c) \quad (1)$$

where, for ecosystem service *j:*

$s_s, s_v, and\ s_c$ denote the scores for each class of the variables *landscape type*, *vegetation type*, and *land-cover type*, respectively, and

w_s, w_v, and w_c denote the weights for each class of the variables *landscape type*, *vegetation type*, and *land-cover type*, respectively.

Thus, for each ecosystem service *j* separately, scores and weights are combined to create one ESI_J index value for a given spatial unit of observation.

Scores reflect the influence of each class of each variable to provide environmental services generally. Each class of each variable has a different score of range 1–5, where 1 and 5 denote the lowest and highest capacity to provide environmental services, respectively. Unlike scores, weights for the classes of variables *vegetation type*, *landscape type*, and *landcover type* vary between the seven ecosystem services observed here. Variation amongst the weights serves to recognize the varying relative importance of one variable compared to another in the context of a given ecosystem service *j*. The sum of weights is equal to 1.

The *ESI* of Eq. 1 thus describes a non-denominational index of the potential for a given area to sustainably provide ecosystem service *j,* where the area in question is defined by the spatial intersection of the classes of the variables *landscape type, vegetation type*, and *land-cover type*. Supplementary Information S1 reports the scores and weights for each class of each variable for each of the seven ecosystem services considered here. Index values for ecosystem service *j* were subsequently classified into five classes of HCV-area likelihood: very low (1–1.8), low (1.81–2.6), moderate (2.61–3.4), high (3.41–4.2), and very high (4.21–5), where the threshold ESI_j values defining these classes reflected official guidance (MoEF, 2019b). HCV areas for Seruyan District are designated wherever *ESI* value was "high" or "very high" for a given ecosystem service *j*. Hereafter, HCV areas identified by either "high" or 'very high' *ESI* values are denoted as "higher confidence" HCV areas, and all other HCV areas are denoted as "lower confidence".

Scores and weights for each class of the three variables of Eq. 1 were initially determined by expert opinion gathered via a series of focus-group discussions. Experts consisted of principal environmental scientists of the Indonesian Institute of Science as well as local academics, all of whom have knowledge of and experience with environmental assessment and were involved in the development of the ECCA guidelines (MoEF, 2019b). Focus groups sought to ascribe scores and weights by consensus amongst participating experts. For a given ecosystem service, the experts discussed and determined scores and weights based on the role of a given class or variable in providing the ecosystem service. This approach sought to recognize the highly uneven potential for ecosystem service provision amongst the classes of a given variable. For instance, the ecosystem service of fire mitigation is minimal on degraded and cultivated lands, where most burning occurs (Ravi et al., 2009), and conversely it is maximal in closed-canopy forests, where burning is rare (Nikonovas et al., 2020). Similarly, the multi-variate nature of the *ESI* index allows for relatively nuanced determinations of HCV-area likelihood. For instance, whereas peatland generally burn extensively (Sloan et al., 2022), and so might merit a low score for fire mitigation, areas of primary peatswamp forest within peatland landscapes would still have a high mitigating effect (Nikonovas et al., 2020), increasing local fire-mitigation scores accordingly. Following the focus groups, the scores and weights were expressed cartographically to solicit feedback from a broader audience of government representatives, local academics, and environmental practitioners engaged with environmental assessments and ECCAs. Feedback typically entailed the affirmation of the original scores and weights; only rarely were they adjusted.

2.4 HCV screening

HCV Screening is a desktop analysis used to identify and prioritize potential HCV areas for protection at regional scales. First outlined in 2019 and then updated in 2020 by the HCV Network (Watson, 2020), HCV Screening adopts HCV assessment methods developed at the concession level (Areendran et al., 2020) but scales their application to the jurisdictional level. HCV Screening protocols therefore purport a more regionally holistic or consistent approach to HCV assessment than standard, concession-level assessments (Watson, 2020). Unlike HCV areas identified by the ECCA, HCV areas identified by HCV Screening are not based on land-use planning regulations particular to Seruyan District, notwithstanding an explicit recognition of legally protected areas or similar, such as national parks or designated production forests (Table 1). Also, in contrast to the ECCA, the HCV Screening method disaggregates the total HCV area into six thematic classes, labelled HCV 1 though to HCV 6 in Table 2, pertaining to endangered species, ecosystem services, and community needs, amongst other themes.

HCV Screening as realised here entailed a straightforward two-stage process. In the first stage, available secondary spatial data and contextual information (i.e., reports, published studies, official spatial data) pertaining to key indicators of HCV areas were compiled for each HCV thematic class (Table 3). For example, spatial data on remnant forest cover (MoEF, 2019a) and endangered orangutan sightings (Santika et al., 2017) were compiled and considered as indicators of the HCV 1 class (rare, threatened, endangered species) (Table 3). In this study, we consider only HCV thematic areas of classes HCV 1 through HCV 4 (Table 2),

TABLE 2 Six thematic classes of High Conservation Value as per the HCV Screening method.

Class		Description
HCV 1	Rare, threatened, endangered species	Concentrations of biological diversity, including endemic, rare, threatened, or endangered species
HCV 2	Landscape-level ecosystems	Large landscape-level ecosystems, ecosystem mosaics, and Intact Forest Landscapes (IFL), which contain viable populations of the great majority of naturally-occurring species
HCV 3	Rare, threatened, endangered ecosystems and habitats	Rare, threatened, or endangered ecosystems, habitats and refugia
HCV 4	Ecosystem services	Basic ecosystem services in critical situations, including protection of water catchments and control of erosion of vulnerable soils and slopes
HCV 5	Community needs	Sites and resources fundamental for satisfying the basic necessities of local communities or indigenous peoples (for livelihoods, health, nutrition, water, etc.)
HCV 6	Cultural values	Sites, resources, habitats and landscapes of global or national cultural, archaeological or historical significance, and/or of critical cultural, ecological, economic or religious/sacred importance for local communities or indigenous peoples

Source: Watson (2020).

which pertain exclusively to environmental conditions, since their remit corresponds most closely with that of the ECCA.

In the second stage, a threshold value/class was determined for each HCV indicator, based on the literature and/or expert opinion, to distinguish areas with higher versus lower likelihoods of HCV area (Table 3). For example, since remnant forest fragments >12,500 ha are deemed able to support viable populations of Borneo orangutans, fragments greater than this threshold were designated of a higher likelihood of HCV for the HCV 1 class, while those less than this threshold were designated as a lower likelihood of HCV (Watson, 2020). Indicator thresholds were typically described by a simple binary state, such as for (a) the presence or absence of a given indicator (e.g., a Ramsar site), (b) the occurrence of natural or non-natural vegetation of interest (e.g., wetlands, peatlands), or (c) by the presence or absence of a buffer distance around a feature of interest (e.g., rivers) (Table 3). For a given HCV thematic class as a whole (e.g., HCV 1), a higher likelihood of HCV area is said to occur when at least one HCV indicator is of a higher likelihood. Similarly, for all four HCV thematic classes considered here (i.e., HCV 1 through HCV 4), a HCV area is said to be of a higher likelihood when any indicator of any HCV class is of a higher likelihood. Hereafter, HCV areas identified as a 'higher likelihood' are denoted 'higher confidence' HCV areas, and otherwise as 'lower confidence' HCV areas, for consistency with the ECCA terminology.

2.5 Higher confidence HCV areas of the ECCA versus HCV screening

While the ECCA and HCV Screening methods both emphasise similar aspects of similar environmental features or conditions, e.g., intact forests, they clearly also differ in various respects, empirically, methodologically, and conceptually. Such differences between ECCA and HCV Screening would manifest as differences to the HCV areas identified by each methodology, perhaps especially with respect to higher-confidence HCV areas meant to prioritise jurisdictional vetting of potential HCV areas. At least two key differences between the ECCA and HCV Screening methods are apparent. First, HCV Screening explicitly prioritises areas that are nominally natural, intact, critical habitat, and/or biodiversity rich, whereas the ECCA does not. In this study, HCV Screening reflects distributions of threatened orangutans, as well as the presence of biodiversity-rich Ramsar sites and protected areas (Table 3). The current ECCA did not quantify biodiversity as an ecosystem service, though future ECCAs will likely do so. Second, the ECCA reflects a relatively wide range of ecosystem services and is relatively disposed to recognise their provision in human-modified, semi-natural landscapes, depending on the service. Fire mitigation and climate regulation, in particular, are afforded to moderate or high degrees by many modified landscapes, e.g., production forests, which might be discounted by HCV Screening for lack of strictly natural, intact forest. Higher-confidence HCV areas according to each method are compared directly in Section 3.

3 Results

3.1 HCV areas of the ECCA vs. HCV screening

The ECCA and HCV Screening methods produced very similar delineations of overall HCV area. Whereas the ECCA method classified 92% of Seruyan District as potential HCV area (Figure 2A), the HCV Screening method classified 87% as potential HCV area (Figure 2B). Both methods designated a common 87% of the district as HCV area (Figure 3A) and had a similarly high level of agreement across oil-palm and forestry concessions overall (Figures 4A, B). This strong agreement of overall HCV area between the two methods (Figure 3A) is due to the fact that, nominally, most of Seruyan District is HCV (Figure 2), including in many cleared and/or concession areas (Figures 4A–D). These results are consistent with a precautionary approach to initial HCV-area identification whereby designated HCV areas are ultimately validated as such, as via field visits, prior to their final adoption for jurisdictional land-use planning.

Forestry and agricultural concessions featured prominently in HCV-area designations. HCV areas designated by both the ECCA

TABLE 3 Indicators of HCV thematic classes HCV 1-4 and the likelihood of their presence (confidence classes) modified from HCV Screening guide (Watson, 2020) in Seruyan District.

HCV indicator	Higher confidence of HCV presence	Lower confidence of HCV presence	Data source
HCV 1—Rare, threatened, endangered species			
Protected areas (protected forest, conservation areas)	With natural forest cover	With no forest cover	Seruyan District Spatial Planning Regent of Seruyan Decree (2019)
Patch size of natural forest	≥ 12500 ha	> 250 ha and < 12500 ha	Official land-cover maps MoEF (2019a)
Orangutan population	Estimated > 200 orangutans within village administrative boundary with natural forest cover	Estimated > 200 orangutans within village area with non-forest natural vegetation	Orangutan population Santika et al. (2017); Land cover MoEF (2019a); Administration boundary GIA (2016)
Riparian area	1 km buffer of Seruyan River, or 100 m buffer of other rivers and lakes, with natural forest cover	1 km buffer of Seruyan River, or 100 m buffer of other rivers and lakes, with non-forest natural vegetation	River and lake map GIA (2016)
HCV 2—Landscape-level ecosystems			
Intact Forest Landscape (IFL)	Areas which qualify as IFL	Areas that are not IFL	Intact Forest Landscapes (https://intactforests.org/)
Ramsar sites	Ramsar wetland	Not Ramsar wetland	Ramsar Sites Information Services (https://rsis.ramsar.org/)
Wetlands	Wetlands with natural forest cover area (primary and secondary swamp forest)	Degraded wetlands	Official land-cover maps MoEF (2019a)
Production forest	With natural forest cover patches >100 ha	With natural forest cover patches <100 ha	Seruyan District Spatial Planning Regent of Seruyan Decree (2019)
HCV 3—Rare, threatened, endangered ecosystems and habitats			
Natural Forest	Covered by natural forest	Covered by non-natural forest cover (e.g., plantation)	Official land-cover maps MoEF (2019a)
Existing Mangrove	Intact/healthy mangroves	Degraded, fragmented mangroves	Official land-cover maps MoEF (2019a)
Swamp Area	Intact/healthy swamp area	Degraded, fragmented swamp	Official land-cover maps MoEF (2019a)
Peatland	With natural forest cover	Degraded/drained peatland	Peatland maps MoEF (2019a); Official land-cover maps MoEF (2019a)
HCV 4—Ecosystem services			
Wetlands	Intact/healthy wetlands	Fragmented, potentially polluted, wetlands	Official land-cover maps MoEF (2019a)
Steep slope areas	Slopes of > 40% with natural forest cover	Slopes of 25%–40% with natural forest cover	SRTM data Jarvis et al. (2018); Official land-cover maps MoEF (2019a)
Swamp areas	Present	Absent	Official land-cover maps MoEF (2019a)
River	River ≥ 50 m width, good water quality	River < 50 m width, polluted, suffering siltation	River map GIA (2016)
Lake	Permanent Lake	Seasonal Lake	Lake map GIA (2016)

and HCV Screening were extensive across the district's oil-palm, logging, and mining concessions (Figures 4A, B). Also, virtually all of the HCV areas identified by the ECCA but not HCV Screening (Figure 3B), comprising 5% of the district, are located within oil-palm concessions in central Seruyan District (Figure 4A). Similarly, virtually all of the higher-confidence HCV areas identified exclusively by the ECCA (Figure 3B) are located within the oil-palm concessions in central Seruyan District (Figure 4C). This concentration of HCV areas unique to the ECCA within oil-palm concessions (Figures 4A, C) is seemingly due exclusively to high *ESI* values for the fire mitigation (Figure 6G) and/or climate regulation (Figure 6D) ecosystem services, identified below as factors of disproportionate influence to the ECCA HCV-area delineation (Section 3.2).

The geography of HCV areas according to the ECCA poses political challenges for implementation or, indeed, opportunities for its derailment. The near ubiquity of all HCV areas across the district (Figure 2) and its concessions (Figures 4A, B) would likely prove excessively onerous and politically fraught for any land-use planning that would seek to recognise all such HCV areas. A validation of the nominal HCV areas prior to their official adoption would prove essential in this respect, both to cull the total HCV area and buttress any decision to conserve particular HCV areas. Further, in contrast

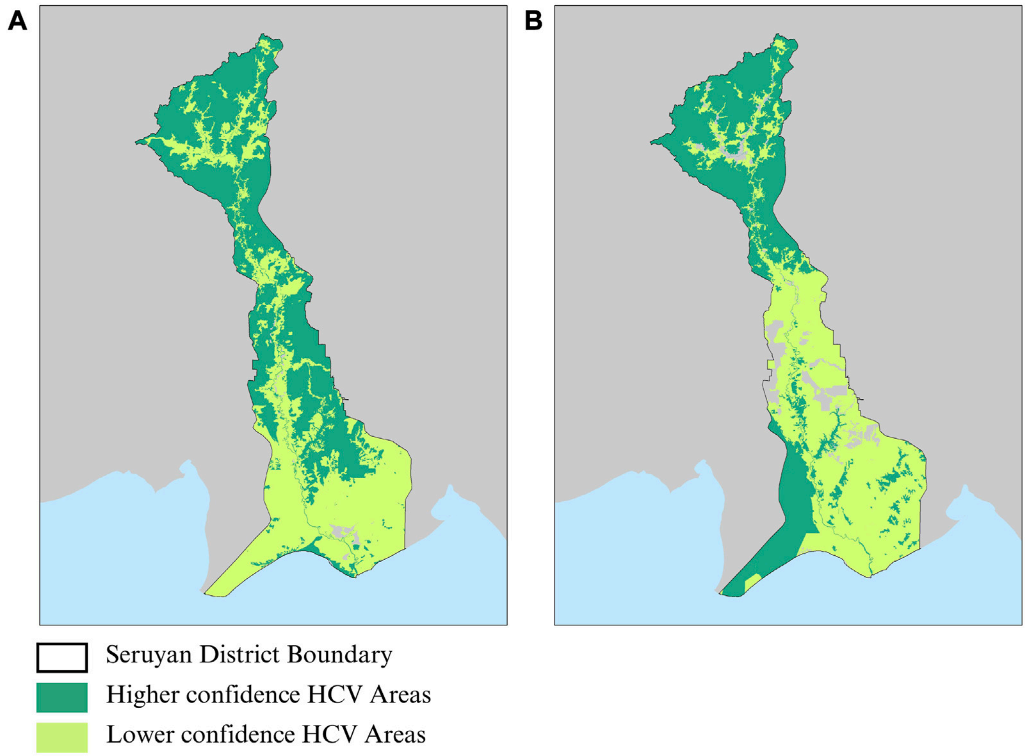

FIGURE 2
HCV areas of lower and higher confidence accord to **(A)** the Environmental Carrying Capacity Assessment and **(B)** HCV Screening.

to the ubiquity of all HCV areas (Figure 2), higher-confidence HCV areas exhibited much greater disagreement between the ECCA and HCV Screening methods (Figure 3), particularly within oil-palm concessions (Figures 4A, C). Although the ECCA and HCV Screening method both designated roughly half of the district as higher-confidence HCV area, at 51% and 42%, respectively, the proportion of these extents exclusive to a given method was appreciable, at 45% for the ECCA [all of which occurs in oil-palm concessions (Figure 4C)] and 35% for HCV Screening. The fact that these discrepancies are centered on oil-palm concessions could conceivably be exploited by vested interests seeking to challenge the basis of ECCA HCV areas. Once again, a validation of HCV areas would be essential to ensure politically feasible conservation.

3.2 HCV areas of the ECCA by ecosystem service and bioregion

The ECCA underlying HCV-area designations is highly sensitive to 'capture' by a single ecosystem service and/or the estimation of its *ESI*, as indicated by marked dissimilarities between the frequency distributions and geographies of *ESI* values amongst the seven surveyed ecosystem service. In general, the capacity for ecosystem-services provision was greater in the northern, forested, upland region of the district than in its relatively deforested central and southern lowlands (Figures 5, 6), which are dominated by oil palm (Figure 4A). However, the ecosystem services of climate regulation, and especially fire mitigation, were notable exceptions to this geographical pattern, given their near-ubiquitous "high" and "very high" *ESI* values, respectively (Figures 6D, G; Figure 7). Correspondingly, these two ecosystem services alone would account for 84%–93% of the total HCV area estimated for the district by the ECCA (Figure 2A). Similarly, the frequency distributions of the five *ESI* classes ranging from "very low" to "very high" vary drastically between the seven ecosystem services considered by the ECCA (Figure 7). Whereas only 3%–18% of Seruyan District would merit HCV-area designation on the basis of *ESI* values for water regulation, water provision, or food provision, some 65%–93% of the district would merit HCV-area designation on the basis of *ESI* values for the remaining ecosystem services, again especially climate regulation (84%) and fire mitigation (93%) (Figure 7).

The near ubiquity of high and very high *ESI* values for climate regulation and fire mitigation are not necessarily suggestive of an imprecise or 'exaggerated' *ESI* estimation. Indeed, there is no reason to expect comparable geographies or frequency distributions of *ESI* values across the ecosystem services within any jurisdiction. Amongst the seven ecosystem services considered here, large discrepancies in their frequency distributions and geographies do however underscore how a single ecosystem service with near-ubiquitously higher *ESI* values (e.g., Figure 6G) may alone underlie HCV-area designations across an entire jurisdiction (Figure 2A). Such

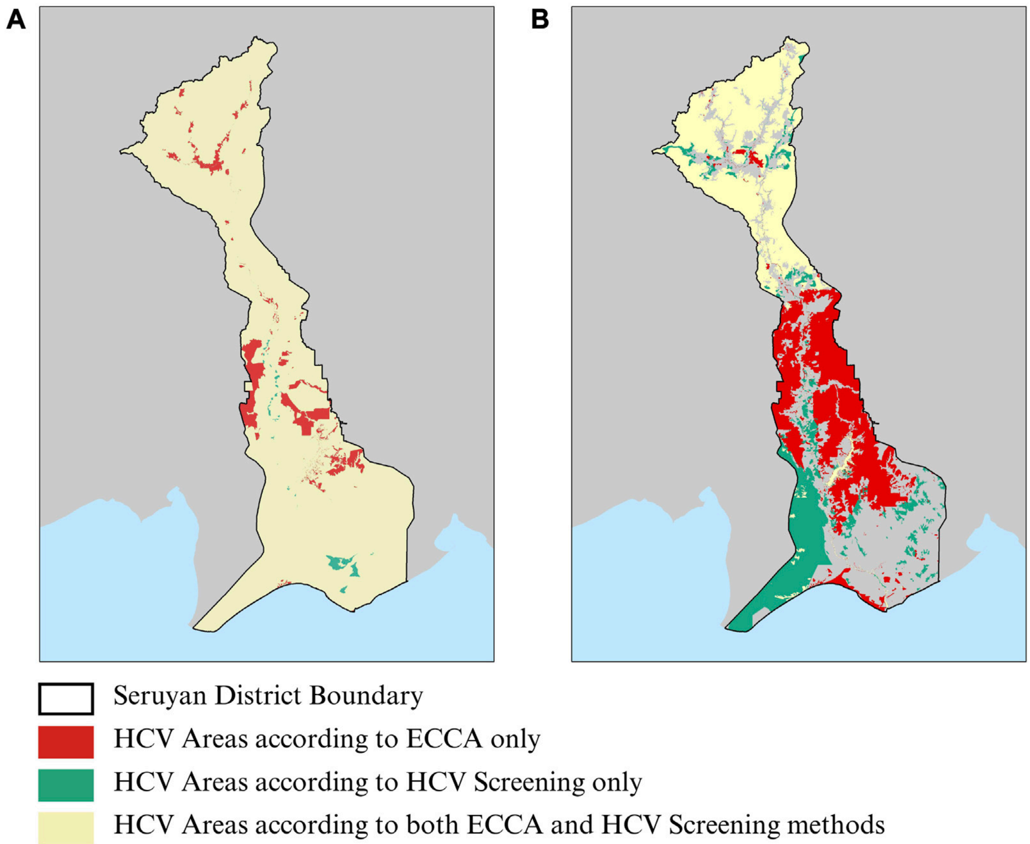

FIGURE 3
Agreement of HCV areas identified by either the Environmental Carrying Capacity Assessment or the HCV Screening method, for **(A)** all HCV areas and **(B)** higher confidence HCV areas.

an outcome is equally possible for HCV Screening, provided discrepancies amongst its four HCV thematic classes, but is not apparent here (Figure 8). Such a case of "capture" by a relative few ecosystem services would still be in keeping with the precautionary principles of HCV designation (Areendran et al., 2020), but would also drastically increase the potential for subtle but significant manipulations of the parameters of the ECCA by vested economic or political interests.

3.3 Jurisdictional authority for HCV-area management

HCV-area designation according to the ECCA or similar jurisdictional approaches to commodity supply-chain certification are challenged by spatial disagreements between HCV areas and the administrative authority of local government. In Indonesia, district-level governments have exclusive jurisdiction over lands legally designated for agricultural or similar non-forestry land uses outside the official Forest Estate. Hence, the Seruyan District government would have jurisdiction over HCV areas within its oil-palm concessions, and areas of potential oil-palm concessions, which by law are granted on lands outside of the Forest Estate. The district government would have no jurisdiction over HCV areas within logging concessions, or potential logging concessions, as these concessions are granted within the Forest Estate.

Of the total HCV area designated by the ECCA in Seruyan District (Figure 2A), only 22% falls under the immediate and sole administrative authority of the district government (Table 4). Such areas are relatively devoid of intact forest cover and disproportionately orientated towards agricultural concessions, as expected. The remaining 68% and 9% of nominal HCV areas fall under the administrative jurisdictions of the provincial and national governments, respectively (Table 4). These areas are relatively forested and encompass forest concessions. ECCA areas falling under national jurisdiction occur within nature reserves and protected areas, e.g., national parks, which are managed by the national Ministry of Environment and Forestry. HCV areas under provincial jurisdiction similarly occur within forests legally designated for protection, production, or conversion that here are presumed to have operational forest management units, i.e., community-minded cooperative forest management administrations (Sahide et al., 2016a). While these areas of legally designated forest use are originally under the jurisdiction of the national Ministry of Environment and Forestry, authority over forest management units devolves to a supervisory provincial government.

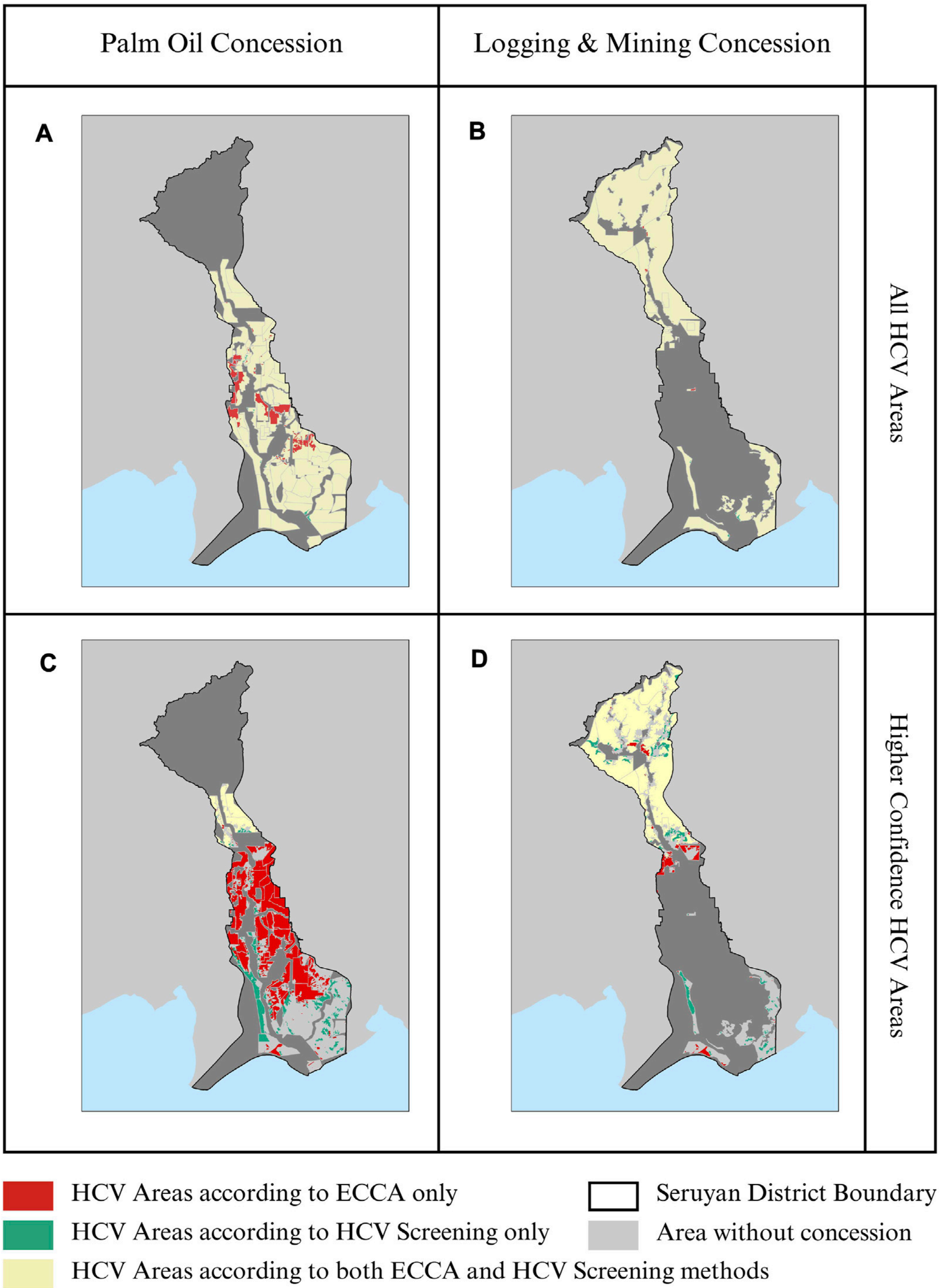

FIGURE 4
HCV area distribution within concessions, by method of HCV identification and HCV confidence class: All HCV area within palm-oil concessions **(A)**, All HCV area within logging and mining concessions **(B)**, Higher confidence HCV area within palm-oil concessions **(C)**, Higher confidence HCV area within logging and mining concessions **(D)**.

In summary, the Seruyan District government would have exclusive authority to recognize HCV areas within its oil-palm production zones, but would have little to no authority in other, relatively forested, and often adjacent conservation and forestry zones, which host 72% of higher-confidence HCV areas across the district (Table 4; Figure 2A; Figures 4A, C). Such uneven jurisdictional geography in relation to forest extent and concession type would necessitate inter-governmental cooperation for truly district-wide, coordinated HCV management.

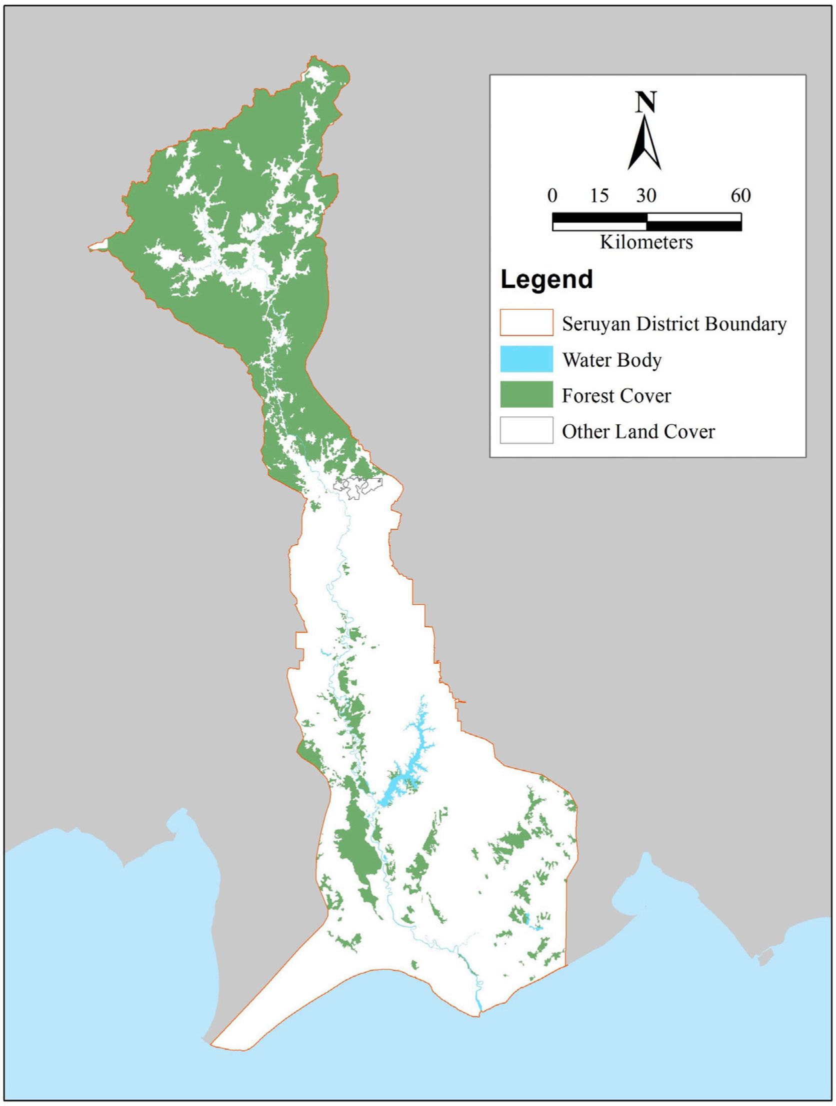

FIGURE 5
Forest cover in Seruyan District. Source: MoEF (2019a).

4 Discussion

4.1 Jurisdictional approaches and certifiably sustainable commodity supply chains

Protecting the world's remaining natural terrestrial ecosystems requires halting deforestation and degradation caused largely by agricultural commodity supply chains (Austin et al., 2017a; 2017b; Garrett et al., 2019). Current approaches to reducing commodity-driven deforestation focus on identifying sites of deforestation, linking these to 'downstream' agents in supply chains (e.g., mills, exporters), and documenting how international companies further downstream in the supply chain are connected to these sites and agents (Gardner et al., 2019). Companies implicated by supply chains can either choose to improve the environmental standards of their upstream suppliers, or they can exclude suppliers with environmentally destructive practices (Lambin et al., 2018). Commodity certification schemes, such as RSPO, offer pathways for companies to improve the sustainability of production while offering assurances to buyers regarding which companies to patronize (Loconto and Fouilleux, 2014; DeFries et al., 2017; Lambin and Thorlakson, 2018).

Notwithstanding well-established supply chain certification schemes for certain commodities, such as timbers, there remains appreciable variation in scheme effectiveness among commodities and regions (Seymour and Harris, 2019), and commodity-driven tropical deforestation apparently remains undiminished overall (Curtis et al., 2018). Reasons given for the apparent ineffectiveness of current supply chain certification models are largely economic. They include the limited adoption of certification schemes due to limited markets for certified products (Tayleur et al., 2018; Tayleur et al., 2017); a low marginal price increment for certified commodities, especially at the farm gate (VanWey and Richards, 2014; Tey et al., 2020); and low demand for certified commodities among key buyer countries, especially China and India (Schleifer and Sun, 2018). Political and

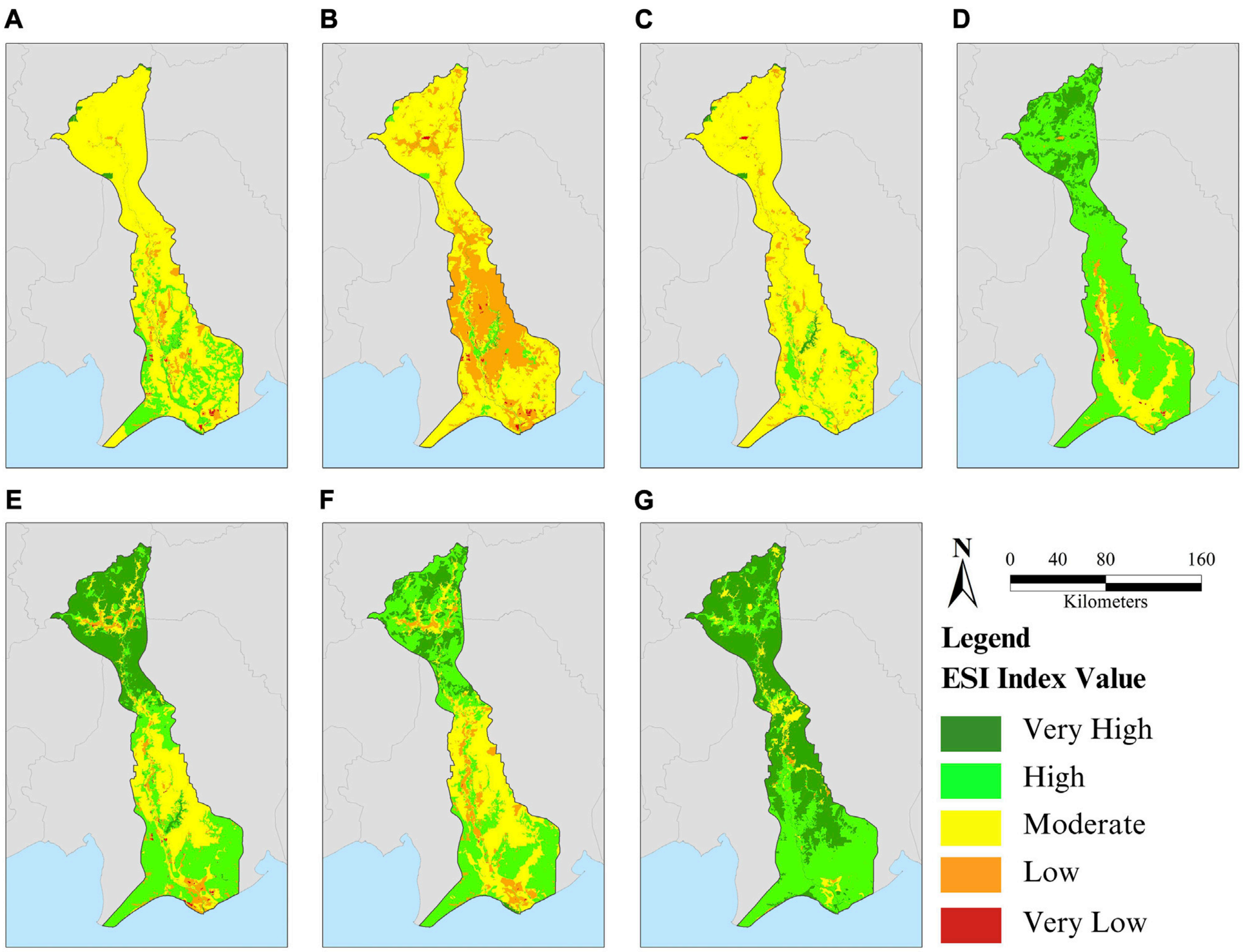

FIGURE 6
Environmental carrying capacity assessment results in Seruyan District with respect to the geography of seven ecosystem services: **(A)** water provisioning, **(B)** food provisioning, **(C)** water regulation, **(D)** climate regulation, **(E)** flood mitigation, **(F)** landslide mitigation, and **(G)** fire mitigation.

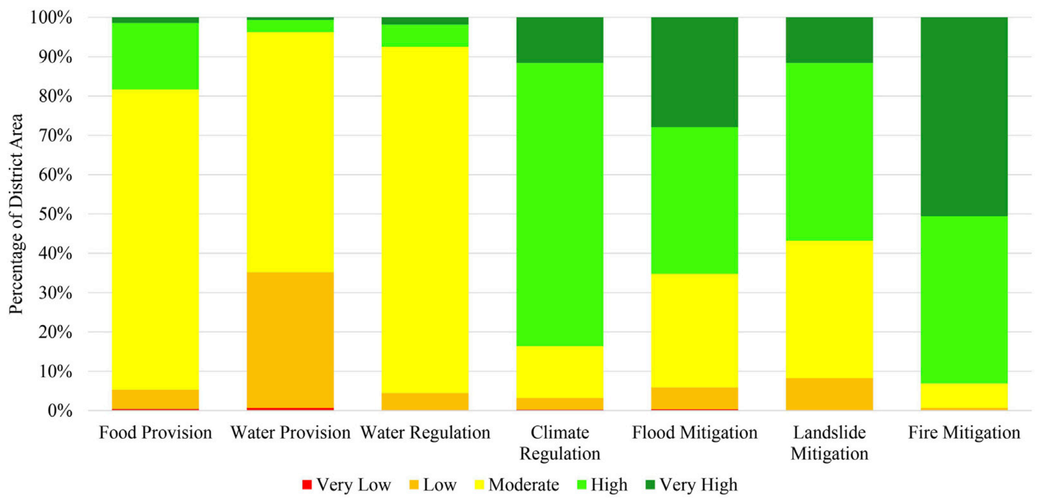

FIGURE 7
Environmental carrying capacity assessment results in Seruyan District with respect to the frequency distribution of carrying capacities for seven ecosystem services.

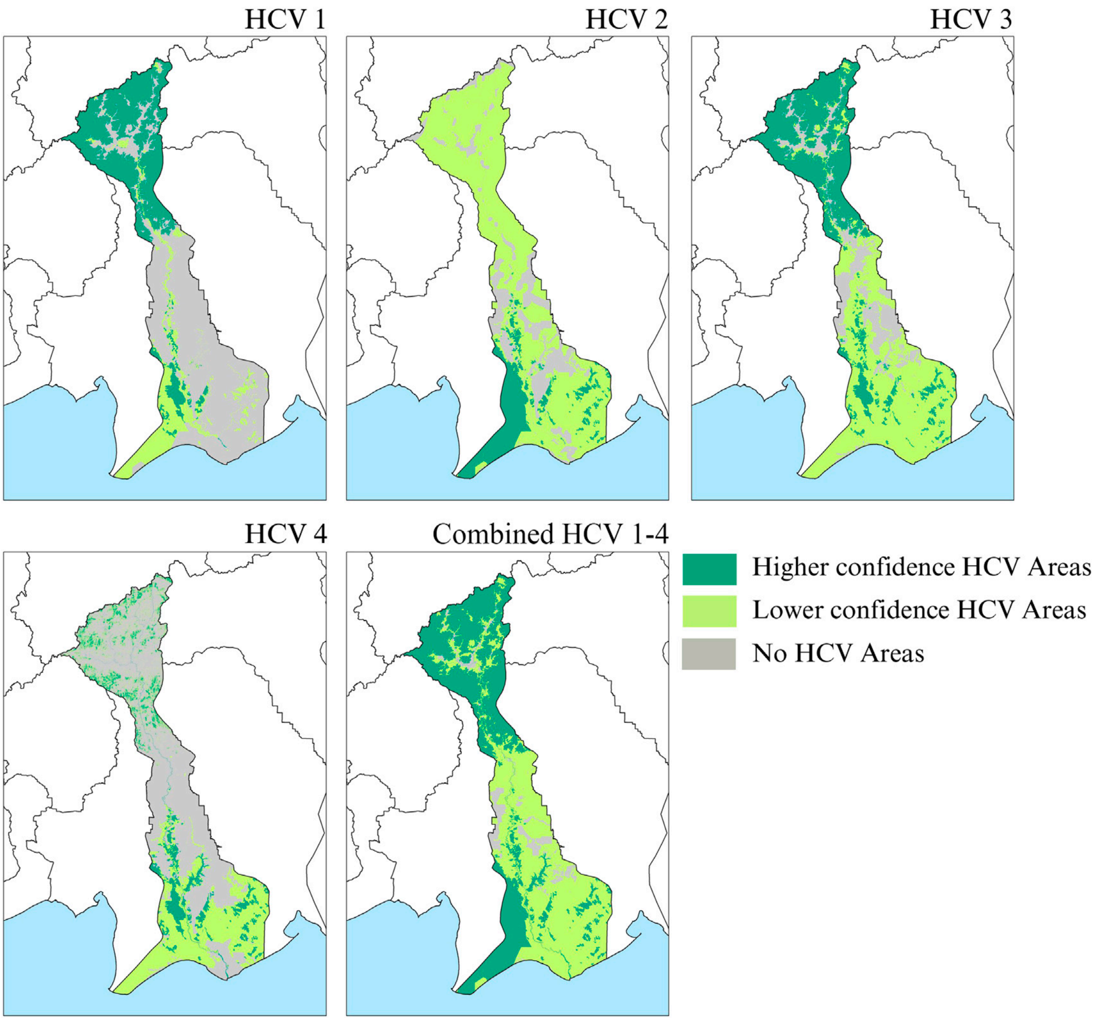

FIGURE 8
The distribution of the four HCV thematic classes of HCV Screening in Seruyan District, individually (HCV 1, HCV 2, HCV 3, HCV 4) and combined (HCV 1–4), by HCV confidence. Notes: Areas of classes HCV 1-4 by HCV confidence level are reported in Supplementary Information S4.

TABLE 4 HCV area identified by the ECCA, by level of government with jurisdiction over the HCV area.

Governmental level	Percentage of HCV area in Seruyan district		
	Lower confidence HCV	*Higher confidence HCV*	*Total HCV*
District	8.0	14.2	22.2
Provincial	31.5	36.6	68.0
National	8.6	0.4	9.0

corporate marketing initiatives are however arguably shifting such economic factors. Consumer countries, especially in Europe, have begun introducing regulatory requirements intended to prevent unsustainable commodities from entering their markets (Sellare et al., 2022). Similarly, in response to consumers' perceived weaknesses of certification schemes, their environmental criteria have sometimes been made more stringent, as when the RSPO introduced no-deforestation and no-exploitation commitments for peatlands in 2018 (Jong, 2018). Such political and corporate initiatives are still nascent, and their impact on the demand for certified, sustainable commodities remains unknown.

Jurisdictional approaches to certifying commodity production have been proposed as a relatively environmentally stringent and economically efficient means of reducing commodity-driven deforestation. Underpinning this approach is the fact that local governments, supported by multi-stakeholder industry groups (e.g., the RSPO), have the authority, means, and interest to reduce commodity-driven deforestation (Busch and Amarjargal, 2020; Boshoven et al., 2021; Essen and Lambin, 2021). Initially promoted in Latin America with a focus on soy and cattle (Nepstad et al., 2014; Nepstad et al., 2013), jurisdictional approaches to sustainable commodity production have proliferated globally and now encompass a range of commodities, including palm oil, cocoa, timber, and pulp and paper (Seymour et al., 2020; Essen and Lambin, 2021). The resultant plurality of jurisdictional approaches and commodities means that there is no single standard for measuring the soundness of jurisdictional approaches and, consequently, whether commodities sourced from certified regions can credibly be deemed to be sustainable. This is in contrast to conventional, non-jurisdictional supply chain certification schemes whereby principles, criteria, and indicators for sustainable production at a given site are explicitly delineated, often by multi-stakeholder groups such as the RSPO or the Forest Stewardship Council (Loconto and Fouilleux, 2014).

Our findings demonstrate that a careful adoption of an existing regulatory instrument, here the ECCA, to scale the principles and criteria of supply-chain certification schemes (RSPO, 2021a), can produce results similar to current best-practice approaches to this same end, namely, HCV Screening (Watson, 2020). Although the ECCA regulatory instrument focused on one element of the RSPO Principles and Criteria, namely, the identification and protection of HCV areas (Areendran et al., 2020), a similar approach is conceivably possible for other environmental, social, and governmental aspects of these principles and criteria (Pacheco et al., 2020). The legality and legitimacy of the ECCA, and its alignment with official land-use planning and environmental-management processes, increase the likelihood that HCV areas will be officially adopted and efficiently protected. This process of transitioning from an ECCA to vetted, protected HCV areas is not exact, nor even assured, however. Below we identify several factors contributing to uncertain or inefficacious transitions.

4.2 Transitioning from regulatory instrument to HCV area

In a given jurisdiction, a regulatory instrument adapted to support jurisdictional supply-chain certification may well have been originally designed for very different purposes and so may prove to be of limited relevance to HCV identification *per se*. In the case of the ECCA, it is based on a supply-and-demand approach to ecosystem-service assessment, whereby environmental carrying capacity is said to be exceeded when the estimated supply for ecosystem services exceeds the estimated demand (Świąder et al., 2020a; Nepstad et al., 2020b). In contrast, the HCV Screening approach focused on HCV areas defined from a conservation perspective, supplemented with consideration of land use and potential threats to habitat (Senior et al., 2015; Areendran et al., 2020). Despite these methodological differences, the ECCA provided results similar to those of the HCV Screening in terms of overall HCV area, notwithstanding discrepancies observed amongst higher-confidence HCV areas. The similarity of overall HCV areas may simply reflect the fact that each method designated the vast majority of our study district as HCV area (Figure 2), which may not be the case elsewhere or for other regulatory instruments. Further, in the case of our ECCA, the extensiveness with which it designated HCV areas was highly dependent on the particular selection and/or estimation of ecosystem services, of which two alone (fire mitigation and climate regulation) could account for nearly all HCV areas (Figure 6).

A further consideration for the transition from regulatory instrument to HCV area is, obviously, the administrative scale of the regulatory instrument. Indonesia provides an illustrative example regarding sustainable oil-palm certification. An Indonesian regulatory instrument seemingly more aligned with HCV designation than the ECCA is the Essential Ecosystem Areas (EEA) instrument, which seeks to identify and protect important ecosystems outside conventional conservation areas (Sahide et al., 2020). The EEA instrument falls under the authority of the federal Indonesian Ministry of Environment and Forestry, with management devolved to provincial governments, such that district governments have neither authority for EEA designation nor management (Steni, 2021). Consequently, although thematically aligned with HCV conservation, EEAs cannot be used for oil-palm certification at the district level, at least not directly, despite oil-palm concessions being granted and managed by district governments. Land-use planning (i.e., spatial planning laws) and similar district-level instruments, including ECCAs, do however allow district governments to designate Strategic Environmental Areas (SEAs) that are similar to EEAs. The utility of SEAs and EEAs for HCV designation merits consideration in the future.

Finally, the choice of regulatory instrument must consider that the instrument, or its administration, may not grant jurisdictional authority over many of the HCV areas that the instrument would ultimately designate. In the case of the ECCA in Seruyan District, 77% of the total HCV area identified (Figure 2A) fell within the Indonesian Forest Estate, the administration of which is beyond the authority of the district government (Brockhaus et al., 2012; Sahide et al., 2016b). Ironically, the management of only those HCV areas falling under the jurisdiction of the district government would likely engender the same critiques of disjointed, piecemeal conservation as levelled previously against conventional RSPO certification realized at the concession scale. Although district governments cannot directly manage most forests and protected areas, they can support forest and habitat integrity through the creation of buffer zones (Jotikapukkana et al., 2010) and ecological corridors (van Noordwijk et al., 2012). Perhaps especially in Indonesia, where environmental governance is relatively decentralised and closely reflects the geography of forest resources, a major challenge for any jurisdictional approach to HCV identification is whether a local government has the authority to manage designated HCV areas and, if not, whether intergovernmental cooperation is likely to be effective.

5 Conclusion

A jurisdictional approach to the certification of sustainable palm oil supply chains aims to apply RSPO principles and criteria for sustainable production at the scale of local governmental environmental regulation and planning. To ensure compliance with these principles and criteria, High Conservation Value (HCV) areas must be identified and protected across the jurisdiction, at least in areas eligible for oil-palm production, ideally seamlessly with environmental planning. Here, for an Indonesian district piloting jurisdictional approaches to RSPO certification, we adopted its Environmental Carrying Capacity Assessment (ECCA) to illustrate how, and how well, an existing regulatory instrument may identify likely HCV areas compared to the conventional HCV Screening method currently recommended for jurisdictional certification (Watson, 2020). Such use of existing regulatory instruments for HCV-area designation aspires to correct for key shortcomings of conventional RSPO certification, including its piecemeal implementation and poor integration with the local environmental regulation.

Our results indicate that the overall HCV-area designation according to the ECCA is geographically virtually equivalent to that based on HCV Screening. For each method, HCV areas spanned virtually the entire district, underscoring how initial HCV delineations require vetting and validation prior to official adoption, and how any ambitious adoption of all HCV areas would likely prove impracticable. In contrast, higher-confidence HCV areas according to the ECCA spanned roughly half of the district, were largely discrepant from higher-confidence HCV areas of the HCV Screening method, and uniquely spanned oil-palm concessions.

The Seruyan District government has exclusive authority over ~40% of all high-confidence HCV areas, which occur within zones of current or potential oil-palm production. The remaining ~60% of higher-confidence HCV areas designated by the ECCA occurred outside the exclusive authority of the district government, in zones designated for conservation of forestry. Intergovernmental cooperation may therefore prove essential to truly district-wide, comprehensive HCV-area delineation and management.

HCV areas according to the ECCA are sensitive to the selection of ecosystem services surveyed, and to the estimation of their provision (i.e., the *ESI*). Indeed, the very set of ecosystem services surveyed by an ECCA is at least somewhat flexible according to local development priorities and analytical capacities. The selection and estimation of ecosystem services should therefore be highly transparent, and ideally aligned with sustainability certification standards, such as those of the RSPO. The sensitivity and flexibility of ECCA HCV-area designations, as well as their ubiquity or discrepancies noted above, may invite challenges by vested interests seeking to influence HCV-area designations.

We stress that our results are particular to the ECCA conducted for Seruyan district. Our finding would likely vary given a different selection of ecosystem services and/or changes to geographic and politico-legal context. Future research on jurisdictional HCV-area delineation for RSPO certification should therefore quantify the implications of variation to (a) the selection of ecosystem services inherent to an ECCA, (b) the land-cover geography of Indonesian districts implementing a JA, and (c) political-legal contexts of land-use planning, as between the three RSPO JA pilot projects underway in Sabah, Ecuador, and Indonesia.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding authors.

Author contributions

MP and SS shared the same contribution including conceptualization, data curation, formal analysis, methodology, validation, writing original draft, review and editing. JW involved in developing research concept, supervision, and writing the manuscript. SI and JL contributed in writing original draft, while KP provided help in data curation, formal analysis, and methodology. CW contributed in software and visualization. EW involved in methodology, manuscript review and editing, while NU in project administration and software. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2023.1226070/full#supplementary-material

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