WAVES
Indonesia

Synthesis Report:
Natural Capital Accounts and Policy in Indonesia

Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Program in Indonesia

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Abbreviations

ANS	Adjusted Net Savings
BAPPENAS	Ministry of National Development Planning (Badan Perencanaan Pembangunan Nasional)
BPS	Central Statistics Agency (Badan Pusat Statistic)
BRG	Peatland Restoration Agency (Badan Restorasi Gambut)
CWON	Changing Wealth of Nations
GHG	Greenhouse Gases
GOI	Government of Indonesia
I-WAVES	Indonesia WAVES
IIED	International Institute for Environment and Development
INDC	Intended Nationally Determined Contribution
NCA	Natural Capital Accounting
NDC	Nationally Determined Contribution
MASP	Ministry of Agrarian and Spatial Planning
MOEF	Ministry of Environment and Forestry
MOF	Ministry of Finance
REDD+	Reducing Emissions from Deforestation and forest Degradation
RPJMN	National Medium-Term Development Plan (Rencana Pembangunan Jangka Menengah)
SDG	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SEEA-AFF	System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries
SEEA-CF	System of Environmental-Economic Accounting Central Framework
SEEA-EEA	System of Environmental-Economic Accounting Experimental Ecosystem Accounts
SISNERLING	System for Integrated Environmental and Economic Accounts (Sistem Neraca Terintegrasi Ekonomi dan Lingkungan)
SNA	System of National Accounts
UN	United Nations
WAVES	Wealth Accounting and the Valuation of Ecosystem Services

Executive Summary

Indonesia is a diverse archipelago nation of more than 300 ethnic groups and has the largest economy in Southeast Asia. Indonesia has the world's fourth largest population, 10th largest economy in terms of purchasing power parity, the 14th largest in area and a member of the G-20. From 2000 to 2010, Indonesia sustained an average economic growth rate of about 6% owing it to a large extent to its rich natural asset base. Continuous growth has allowed the country to become a middle income country reducing the poverty rate from 70% in 1984 to less than 10% today. [1]

Development in Indonesia has resulted in reduced poverty but has been accompanied by significant pressure on natural capital, which is likely to threaten prospects for sustaining future growth. Indonesia's high economic growth relies largely on natural resources, with agriculture, forestry and fishing contributing 11.4% to GDP. Agriculture has mainly relied on expansion into new lands, particularly for oil palm, causing many environmental problems, including loss of forests (22 million ha between 1990 and 2014), reduced biodiversity and high carbon emissions (1,454 $MtCO_{2\text{-eq}}$ in 2016). The resulting air pollution from these emissions have caused serious health effects in Indonesia's population and recent estimates indicate that the total annual cost of premature deaths from air pollution is about 3.5% of Indonesia's GDP (2015).[2]

The Government of Indonesia has become increasingly aware of the overall importance of natural capital and is proactively addressing the challenges of managing it. Indonesia's National Medium-Term Development Plan (RPJMN) made a strong commitment to sustainable development.[3] The Government has also pledged to achieve the Sustainable Development Goals (SDGs), deliver on the country's Nationally Determined Contribution (NDC), and green Indonesia's growth trajectory. Crucial to reaching these targets is a credible and reliable natural capital accounting (NCA) system for assessing sustainability and resilience of country's economic growth model. [4]

Amongst the many actions the government is taking towards a sustainable growth pathway, three are of special relevance given their forward looking perspective and the policy impact they are having. These actions include: (a) development and strengthening of an Indonesian System of Environmental-Economic Accounts (SISNERLING) .[5] that can inform policy decisions, emphasizing the need to provide a better understanding of the relationship between the economy and the environment, (b) development of a comprehensive analysis on opportunities for low carbon development and green growth in collaboration

[1] Indonesia Systematic Country Diagnostic (World Bank, 2015) World Bank Data (World Bank: PovcalNet, n.d.), WB staff calculations World Bank Data (World Bank, 2018) Indonesia Country Partnership Framework (World Bank, 2015)

[2] Closing the Development Gap: Development Policy Review 2019 (Word Bank, 2019) These estimates do not include the burden of air pollution on Indonesia's neighbor countries. Measuring them will add accuracy and transparency to the estimations.

[3] Indonesia's economic planning follows a 20-year development plan, spanning from 2005 to 2025. It is segmented into 5-year medium-term plans, called the RPJMN (Rencana Pembangunan Jangka Menengah Nasional) each with different development priorities. The current medium-term development plan – the third phase of the long-term plan – runs from 2015 to 2020.

[4] The standard international agreed methodology to develop NCA is the System of Environmental-Economic Accounting (SEEA) which provides the basis for assessing the contribution of natural capital to the economy, and for evaluating the impacts of the economy to the environment.

[5] SEEA is the international agreed standard System of Environmental-Economic Accounting. Further information on this standard methodology in www.seea.un.org and is explained in more detailed later in this document.

with a broad alliance of partners, including the World Bank, and, (c) adoption of legislation on natural capital accounting as part of a broader set of recent policies and legislation.

The World Bank led Wealth Accounting and the Valuation of Ecosystem Services (WAVES) made important contributions on the three aspects mentioned above. These contributions, including the main findings of the accounts developed, are the focus of this Synthesis Report. Indonesia formalized in 2015 its association to WAVES, with the objective to introduce a systematic approach to NCA that could be institutionalized and that could inform policy dialogue, with a special focus on the national medium-term development plan (RPJMN). NCA implementation was developed through a National Steering and Technical Committee guided by a group of agencies led by the Ministry of Planning (BAPPENAS), the Statistical Agency (BPS), and the Ministry of Finance (MOF). Highlights from WAVES contributions include:

a. **The process of building the accounts to strengthen SISNERLING and the results obtained were useful to increase the recognition of natural capital as an important element in Indonesia's economic growth narrative.**[6] Under the WAVES Program new accounts were developed. Land cover accounts were developed at the national level, and land extent accounts were developed for Sumatra and Kalimantan. Feasibility of implementation and an initial pilot water account was developed for the Citarum Watershed. Ecosystem Accounts for Peatlands were developed for Sumatra and Kalimantan for three types of ecosystem services: provisioning services (timber, oil palm, biomass, and paddy production), regulating services (CO2 sequestration) and, cultural services (protected habitat). Some key findings from these accounts are extracted in this summary and detailed in the core part of the document.
b. **Comprehensive analysis of prospects of a low carbon economy allowed Indonesia's Government to understand ways to grow sustainably and reduce pressure to natural capital.** Bappenas, in cooperation with several development partners, including the World Bank, introduced the Low Carbon Development Initiative for Indonesia (LCDI) to explicitly incorporate GHG emissions reduction targets into the country's RPJMN 2020-2025, along with other interventions for preserving and restoring natural resources.[7] The research carried out under the LCDI built on previous work and expanded the analysis to develop forecasts using a systems approach.[8] Technical assistance under WAVES contributed to this approach and overall modelling exercise through development of natural capital methodologies, protocols, models and SEEA compliant data that were particularly useful to introduce and analyze carrying capacity, which is a concept that helps understand how growth could be constrained by the limits of natural capital stocks to provide ecosystem services (i.e. provisioning, regulating and cultural services). Arguably this represents one of the main contributions in terms of policy uptake, as this work underpins decisions that will be made in the next five-year policy cycle. One of the key findings of the LCDI report is that a low carbon growth path can deliver an average GDP growth rate of 6% annually until 2045. Through the sustainable utilization of its natural resources, and by reducing its carbon

[6] Indonesia has been using the System of Environmental-Economic Accounts (SEEA – or SISNERLING its acronym in Bahasa) for NCA for 30 years. See www.wavespartnership.org.
[7] Indonesia's nationally determined contributions (NDC) includes a unilateral reduction target of 29% (~2,869 $MtCO_{2\text{-}eq}$) below Business as Usual (BAU) emissions of Greenhouse gases (GHGs) by 2030, plus a conditional target of up to 41% reductions below BAU with sufficient international support. (Bappenas, 2019) It targets 2030 emissions of 2,037 $MtCO_{2\text{-}eq.}$ under the unconditional target and emissions as low as 1,693 MtCO2e under the conditional target. (WRI, 2017)
[8] World Bank Low Carbon Development: A paradigm Shift Towards a Green Economy in Indonesia (Bappenas, 2019)

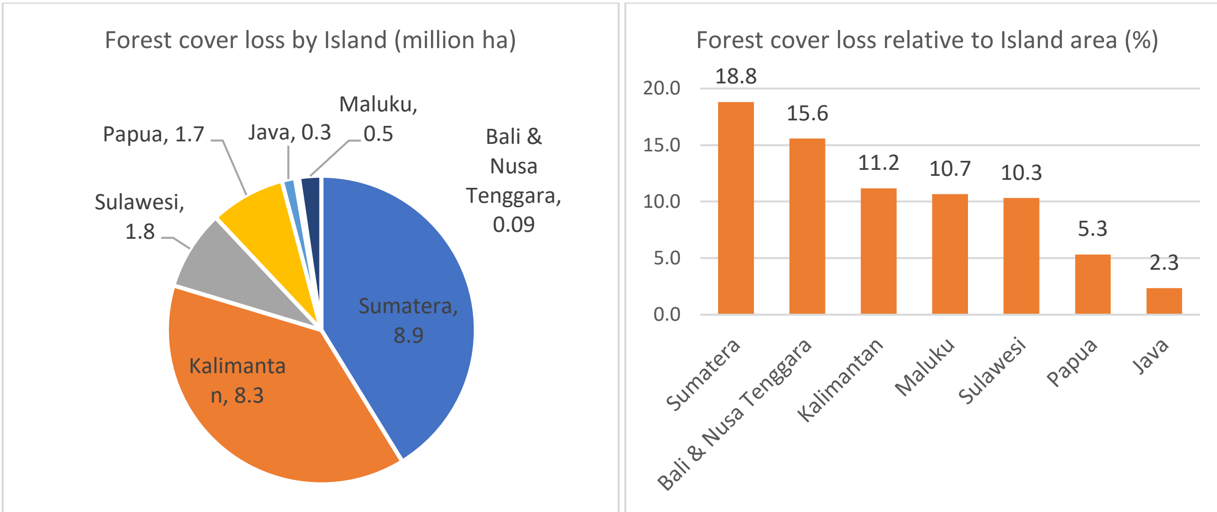
and energy intensity, Indonesia's total GHG emissions can fall by nearly 43% by 2030. This surpasses Indonesia's target in its national climate action plan, or Nationally Determined Contribution (NDC), presently set at 41% below baseline. In these scenarios, forested land is also predicted to expand, while fish stocks should remain stable, and peat degradation largely avoided. Investments totaling between US$ 14.6 billion to US$ 22.0 billion per year for the period 2020-2024, are required to realize such improvements. This is equivalent to between 1 and 1.7% of GDP: it compares well to Gross Fixed Capital Formation, which has been in the order of 30% of GDP over the last ten years.

c. **Accounts were institutionalized through innovative legislation as part of the broader legislation on natural capital and economic instruments.** Interagency coordination played a key role to WAVES effective support in Indonesia for setting the basis for institutionalization of the user-producer coordination mechanisms. Recognizing that good data are essential for evidence-based policy, the Government of Indonesia made improved information on natural capital legally mandated since 2009.[9] Building on this previous legislation, WAVES facilitated interagency collaboration on data and policy, largely owing to an institutionalized Steering Committee that led the Deputy Minister of Maritime and Natural Resource of Bappenas to issue a new Decree Number KEP.53/DEP.3/10/2017, replacing the previous Decree Number KEP.41/DEP.V/03/2016, on the establishment of the Coordinating Group for SISNERLING implementation. Furthermore, the engagement with BPS and other agencies informed the development of the draft strategic Plan for SEEA Implementation (SEEA Roadmap) which is a critical instrument for BPS to institutionalize accounts efforts. In the context of related legislation, WAVES' support to the Ministry of Finance (MOF) fed into policy dialogue towards the regulation on Fiscal Potential of Natural Resources, with the new draft regulation -still under discussion and not public- largely based on the WAVES Program lessons learned from other countries and as part of the capacity building activities developed with the MOF.

Land accounts developed under WAVES provided important insights on how forests and peatlands are threatened by agricultural expansion, particularly in Sumatra and Kalimantan. Indonesia lost about 22 million ha of natural forest between 1990 to 2014 and around 6 million ha of forest became perennial crop, mostly dominated by oil palm plantations but also acacia, mainly for pulp and paper production.[10] With an average annual loss of 1.5 million ha between 1990 to 2014, Sumatra and Kalimantan had the highest forest losses with 8.9 and 8.3 million ha of forests lost in the same period (Figure 1). The Island of Bali and Nusa Tenggara however had the highest forest cover loss with respect to their entire land area.

[9] Law No.32/2009 on Environmental Protection and Management
[10] Indonesia Land Account (BPS, Forthcoming)

Figure 1. Indonesia: Forest cover loss by Island between 1990 and 2014
Million hectares and percentages



Source: Indonesia Land Account (BPS with WAVES Support)

Peatlands cover approximately 8% of Indonesia's land surface and are important for oil palm cultivation, one of the main agricultural commodities currently produced in Indonesia. Other agricultural products (provisioning services)[11] important to Indonesia's economy include timber and paddy production, and biomass production for pulp. Yet given the increasing scarcity of unused land, the pressure to convert peatland to cropland or plantation forestry areas are still expanding. The Ecosystem Account for Peatlands was divided in four main categories to analyze the state and trends of this critical ecosystem: extent accounts, conditions accounts, ecosystem services accounts and carbon accounts. The account compiled was limited to the best available information at the time and therefore some aspects relevant for these types of ecosystems were left out, for example some ecosystem services such as flood protection, forest fire prevention and hydrological services were not included.

The extent account for peatlands revealed that 52% of peat forests in Kalimantan and Sumatra have been converted to other types of land cover between 1900 and 2014. In both Sumatra and Kalimantan plantation areas and agricultural land expanded drastically during the same period. This led to increases in the production of plantation crops such as oil palm fruit, rubber and acacia. However, this changes also lead to various environmental impacts such as high carbon emissions, degraded peatlands, fire and smog formation with associated health impacts. Over time, agricultural activities will not be maintained because of soil subsidence in drained peatlands and subsequent flood risks.[12]

[11] Ecosystem services are the benefits that people derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems and which may include food, freshwater, timber, fibers, and medicinal plants; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes and which may include surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards; (iii) cultural services, which are the non- material benefits people obtain from ecosystems and which may include natural areas that are sacred sites and areas of importance for recreations and aesthetic enjoyment; and (iv) supporting services, which are the natural processes that maintain the other services and which may include soil formation, nutrient cycling and primary production (MEA).
[12] Indonesia Ecosystem Account for Peatlands (BPS, Forthcoming)

Three selected indicators (vegetation biomass, fire hotspots and water level) in the ecosystem condition account revealed an overall and increasing degradation of peatland ecosystems. Total dry biomass in Sumatra and Kalimantan peatlands decreased 35% and 27% respectively between 1990 and 2015. Around 91% (Sumatra) and 95% (Kalimantan) of total biomass in 1990 was stored in forests, but this number decreased to 46% and 76% respectively by 2015. The number of fires in forest plantation areas increased significantly from 1% to 18%, from 2006 to 2014 in Sumatra**.** The highest percentage of fires were in peatlands covered by wet shrubland. Even though the total area of peatlands in Sumatra is larger than in Kalimantan, the carbon emissions from Kalimantan peatlands were higher due to larger area burned each year. The cost of these fires was estimated to be in 2015 about 2% of Indonesia's GDP.[22] [13,14] Finally, the estimated groundwater level results showed that the annual average of water level in 2013 varied from 0-117 cm in Sumatra and from 0-96 cm in Kalimantan. These numbers are not entirely useful without a time series, but it showed the potential to construct this indicator and calls for investments on these type of data sets.

Oil palm plantation areas have expanded significantly and generated the highest monetary value in 2015, meanwhile timber production, CO2 sequestration, and protected land decreased over time. This was established through an ecosystem services account that tracked six main ecosystem services provided by Indonesian peatland, including the production of oil palm, biomass for pulp, paddy, timber, CO2 sequestration, and protected land as biodiversity habitat. However, in economic analyses of land use options in peatlands also externalities (such as health effects of peat fires and CO2 emissions) and the long-term forecasts of production need to be considered. The current and future increases in flood occurrence in peatlands due to soil subsidence are not yet included in the accounts, and this is a priority for further work, so the peat accounts can more meaningfully be used to advice policy makers.

Forest conversion and other land use changes in peatland lead to the decrease of carbon stored in vegetation. This was determined through the carbon account, used to monitor the change in carbon stocks and emissions (based on net carbon flux and peat fires) from peatlands. Around 31% of above ground carbon stocks in 1990 was lost by 2015 in Indonesian peatlands. Meanwhile, the total emissions from net carbon (CO2) flux in peatlands increased by 74% during the same period. Additionally, large parts of peatland were burned every year, resulting in more carbon emissions.

Peatland drainage led to CO_2 emissions which were most severe in Sumatra with Kalimantan close behind.[18] Peat drainage leading to atmospheric oxidation of organic carbon means that the net carbon (CO_2) emissions increased by 57% to 387 $MtCO_2$/year over a 25-year period. 32% of this total are from peatlands in Sumatra on degraded land and drained forest edges close to plantations, not areas currently supporting oil palm or plantation forestry (Table 1). As such, degraded land and drained forest edges abutting plantations areas should be a priority for rehabilitating peatlands as they would make a very large contribution to reducing global CO_2 emissions, without causing losses to crop production, provided that water flows in target areas were protected.

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[13] The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis Cost of Fire Paper (World Bank, 2016)
[14] It's important to note that these values were a one-shot estimation referring to 2015.

Table 1. Summary of carbon stocks and emissions in peatlands (Mt CO_2)

Source (Mt CO_2)	Island	1990	1995/1996	2000	2005/2006	2009/2010	2014/2015
Carbon stocks (vegetation)	Sumatra	2707	2585	2148	1980	1819	1770
	Kalimantan	2107	1862	1759	1702	1628	1533
CO_2 emissions (oxidation)[a]	Sumatra	131	146	178	195	225	272
	Kalimantan	91	94	95	99	108	115
CO_2 emissions (fire)[b]	Sumatra				318	183	286
	Kalimantan				386	325	324
Total		**5036**	**4687**	**4180**	**4680**	**4288**	**4300**

[a] = net carbon flux (excluding from peat fires)

[b] = from burnt peat (33-cm depth of burned peat for all types of LC)

Source: Indonesia Experimental Ecosystem Account

While WAVES has made important contributions in terms of account development, stakeholder engagement and initial policy impacts, there is still wide scope for fully mainstreaming natural capital in development planning and decision making. A key aspect is to demonstrate the full potential of the accounts to examine trade-offs faced when making development decisions, between the gains achieved by transforming natural capital into productive assets, and the losses associated with a reduction in the ecosystem services that natural capital delivers. This type of assessment requires additional modeling and monetary valuation of non-market services, not included in the scope of the WAVES Program. Land and ecosystem accounts show that peatlands would be a natural candidate for such a more in depth, forward looking analysis. [15]

[15] Indonesia has 45% of the world's tropical peatlands and it is estimated they are among the world's largest carbon pools, storing around 13.6 to 40 Gt of carbon (50-145 Gt on CO2), which is equivalent to 1.3 to 4 years of global emissions of CO2 from fossil fuel sources. An appraisal of Indonesia's immense peat carbon stock using national peatland maps: uncertainties and potential losses from conversion (Warren, Hergoualc'h, Kauffman, Murdiyarso, & Kolka, 2017)

1. Introduction

Indonesia is a diverse archipelago nation of more than 300 ethnic groups and has the largest economy in Southeast Asia as well as notable economic growth since overcoming the Asian financial crisis of the late 1990s.[16] Today, Indonesia is the world's fourth most populous nation, the world's 10th largest economy in terms of purchasing power parity, and a member of the G-20.[17] From 2000 to 2010, Indonesia has sustained an average economic growth rate of about 6%, driven largely by harnessing a variety of natural resources to propel the country forward as a middle-income economy.[44CPF] This growth has resulted in reducing the poverty rate from 70% in 1984 to less than 10% today.[18] Even though extreme poverty has declined dramatically, only 20% of Indonesians have joined the middles class.[19]

Long-term development is a process of accumulation and sound management of wealth, which is grounded in core stocks of capital – produced capital, natural capital, human capital and other forms of capital such as social capital.[20] This goes beyond measures like Gross Domestic Product (GDP), which is an important indicator of economic performance, but only looks at income and says nothing about wealth and assets that underlie this income. The whole portfolio of assets is relevant, but natural capital is particularly important for middle- and low-income countries. However, in several of these countries, natural capital is being depleted without any compensating investments in other forms of capital, leading to an overall decrease in wealth and a failure to improve standards of living among the poor.

Indonesia is a country reliant on natural capital and according to a recent World Bank report, more than 20% of Indonesia's share of total wealth is natural capital.[45CDP] These data come from global databases and may be an underestimation of the contribution of natural capital to total wealth, because agricultural and forest land degradation, including the loss of ecosystem services, are not captured in the wealth accounts at this time. The potential impacts of climate change are also not factored into valuation of natural capital. Critical natural capital like fisheries and water are not yet included in wealth accounts. Including these assets would increase national wealth, and, more importantly, make it possible to identify opportunities for growth through better management of natural capital.

Income related to natural capital is more than 27% of Indonesia's GDP, coming from natural resources, such as forests, rubber, oil and natural gas, minerals, palm products, and rich biodiversity that attracts nature-based tourism.[21] At the same time, Indonesia is the world's sixth-largest emitter of greenhouse gases, mainly due to conversion of its forests and carbon-rich peat lands to agricultural production. These shifts in land use have led to ecological and social consequences, such as sediment retention, water yield, carbon stock, and habitat quality.[22] Indonesia's rainforests—the world's third largest—are home to more

[16] Indonesia Systematic Country Diagnostic (World Bank, 2015)
[17] Indonesia Country Partnership Framework (World Bank, 2015)
[18] (World Bank: PovcalNet, n.d.), WB staff calculations
[19] Closing the Development Gap: Development Policy Review (Word Bank, 2019)
[20] Changing Wealth of Nations (Lange, Wodon, & Carey, 2018); Figure 1 in Annex 1 illustrates how these assets and capitals come together to form a measurement of total wealth which supports national income and the potential future prosperity and well-being of a country.
[21] WAVES Indonesia (World Bank: WAVES Partnership)
[22] Assessing Land Use Change and its Impact on Ecosystem Services in Northern Thailand (Arunyawat & Shrestha, 2016)

than 3,000 known species of animals, and 29,000 species of plants, and the livelihoods of 50-60 million people depend directly on these ecosystems.[23]

The Government of Indonesia prioritizes sustainable development in its planning framework and has a range of policy entry points in which natural capital plays an important role. The National Medium-Term Development Plan (RPJMN, 2015-2019) makes a strong commitment to sustainable development. The Government has also pledged to achieve the Sustainable Development Goals (SDGs), deliver on the country's Nationally Determined Contribution (NDC), and green Indonesia's growth trajectory. Crucial to reaching these targets is a credible and regularly updated information system that integrates information of different aspects of sustainable development (i.e. economic, social and environmental information) to assess sustainability and resilience of the country's economic growth.

Recognizing that good data are essential for evidence-based policy, the Government of Indonesia made improved information on natural capital legally mandated since 2009.[24] The implicit recognition of the importance of integrated environmental-economic information has a long history in Indonesia, implementation NCA based on the methodology of the System of Environmental-Economic Accounting (SEEA).[25] Since 1995, the Statistical Agency (BPS) has regularly a report on the System of Environmental-Economic Accounting - SEEA (SISNERLING for its Bahasa acronym). Although great efforts have been made, for SINSERLING to become a credible source of information, there are still data gaps and deficiencies that need to be addressed. the basic data and regularly updating this system of accounts, while developing more robust indicators sustainability will help to ensure that the government has the reliable information it needs to make evidenced based policy.

The World Bank led Wealth Accounting and the Valuation of Ecosystem Services Partnership (WAVES) worked with the Government from 2015 to 2019 to strengthen SISNERLING, focusing on land and ecosystem accounting.[26] The results and lessons learned of this long-term engagement are reported in this document, and the full body of work produced by WAVES will be made available online and provide input for future analysis. The report has five sections, including this introductory section. Section 2 provides information on the environmental and economic development in Indonesia, in context of wealth and natural capital, and how NCA has been embraced by the Government of Indonesia. Section 3 focuses on results from the developed natural capital accounts, while Section 4 reveals the impact of NCA in policy and planning and Section 5 describes the way forward. The references and annexes follow on from these sections.

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[23] Forests and Landscapes in Indonesia: Data-driven analysis to support government and civil society actions for effective and equitable land-use in Indonesia.(World Resource Insitutute: Indonesia)

[24] Law No.32/2009 on Environmental Protection and Management

[25] SEEA Central Framework (UN et al., 2014); See Annex 2 for complete description of the SEEA methodology.

[26] See www.wavespartnership.org/en/indonesia

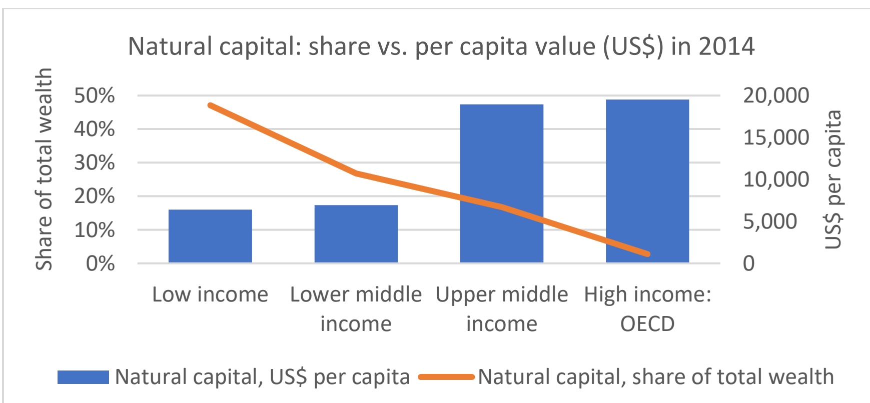
2. Environmental and Economic context in Indonesia

2.1. Wealth and natural capital

Measuring changes in wealth permits us to monitor the sustainability of development, an urgent concern for all countries today. GDP indicates whether a country's income is growing, whereas wealth indicates the prospects for maintaining that income and its growth over the long term. Income and wealth are complementary indicators and economic performance is best evaluated by monitoring the growth of both GDP and wealth. For example, when a country exploits its minerals the revenue from this is reflected in GDP, while the wealth accounts would show a decline in the value of natural capital.[27]

Natural capital[28] has historically been the largest component of wealth in countries at one point in their development, but the amount varies between countries and over time. Economies are largely developed around the relatively abundant forms of natural capital (e.g. forests, minerals, agricultural land) and investing the proceeds from this in other assets, such as produced capital, to foster development. Yet, in several countries, natural capital is being depleted without any corresponding investments in human capital (such as education or health) or produced capital (such as infrastructure), leading to an overall decrease in national wealth and a failure to improve standards of living among the poor. The opposite is happening, in general, in higher income countries. While the share of natural capital as a fraction of total wealth decreases, natural capital per capita increases (Figure 2).

Figure 2. Natural capital shares



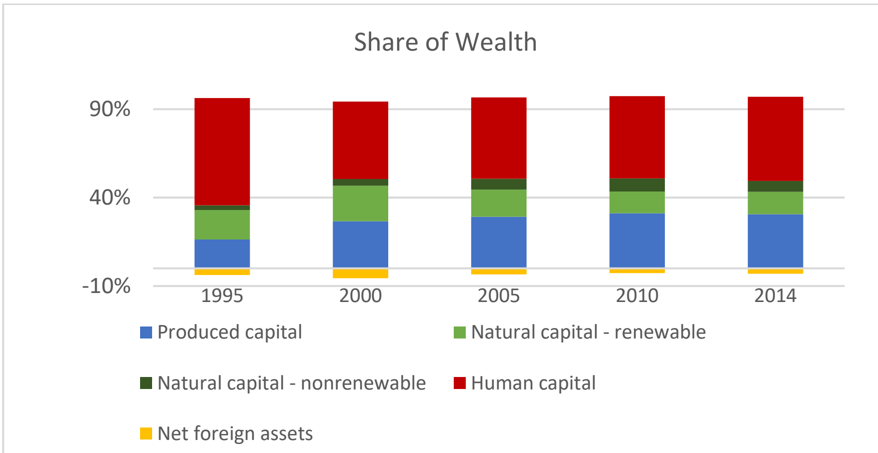
Source: CWON (Lange, Wodon, & Carey, 2018); Indonesia Wealth Account

Indonesia belongs to a group of 14 countries that remained lower middle-income over a 20-year period from 1995 to 2014.[29] Indonesia's wealth per capita expanded 42% during this time, outperforming lower middle-income countries globally. Indonesia's main component of wealth is human capital, which almost

[27] It also does not answer questions like: are income and growth sustainable? Will the same level of income be available for our children?
[28] Natural capital comprises of non-renewable (abiotic) and renewable (biotic) assets. Non-renewable natural capital includes subsoil assets such as fossil fuels, minerals, and metals; and renewable natural capital comprises of ecosystems assets and the ecosystems services they provide (i.e. the flow of goods and services, and the capacity to absorb emissions and waste, that are essential for human well-being).
[29] Compared to 32 countries that were lower middle-income in 1995 and developed to upper middle-income or higher by 2014.

doubled in this 20-year period (Figure 3a). While human capital grew quickly from 2000 to 2014, it declined from 1995 to 2000; possible factors include the Asian market crisis in the late 1990s, unemployment rate and fall in real wages. Additional, Indonesia's share of human capital decrease from 1995 to 2015, as a result of an increase in produced capital shares (Figure 5b)– which doubled in value from 1995 to 2014 (Figure 3a).[30] Nonrenewable natural capital shares increased from 3% to 7% of total wealth, and renewable natural capital declined from 18% to 13%, offsetting the total share on natural capital at a 1% decline in this 20-year period (Figure 3b).

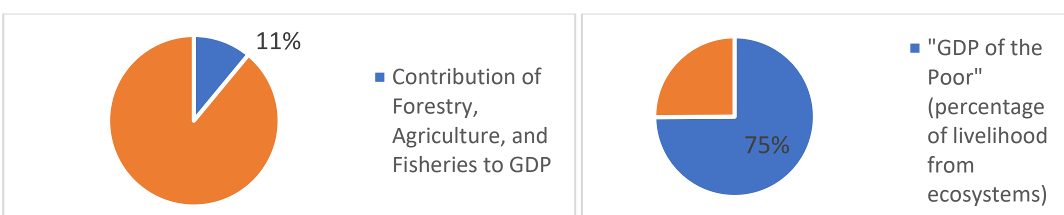
Figure 3. Shares of Wealth in Indonesia
Period: 1995 to 2014; Percent of the total



Source: Indonesia Wealth Account: (Lange, Wodon, & Carey, 2018)

The main natural resource-dependent sectors – agriculture, forestry and fisheries contributed 11.4% to GDP in 2005.[31] Many local communities, indigenous groups, and poor people in Indonesia are dependent on natural resources for employment and subsistence. Poverty can lead to degradation of natural capital – for example, reducing the services generated by ecosystems, and with a lack of investment resources, can lead to more poverty and thus creating a vicious circle.[58] 'GDP of the Poor' can show the dependence of poor people on natural resources and the links between ecosystems and poverty, which can be examined through the lenses of livelihoods, distribution, vulnerability and causality. The Economics of Ecosystems and Biodiversity (TEEB) initiative estimated that rural communities in Indonesia rely on ecosystem services for 75% their income (Figure 4).[58]

Figure 4. "GDP of the Poor": Dependence of the poor on ecosystems in Indonesia (2005)



Source: TEEB

[30] Changing Wealth of Nations (Lange, Wodon, & Carey, 2018)
[31] TEEB – The Economics of Ecosystems and Biodiversity for National and International Policy Makers (Brink, et al., 2009)

The agricultural industry has expanded into forested land, causing large-scale land use changes and leading to high emissions.[32] Since 2000, the main driver of land use change is oil palm and production tripled by 2014. Other types of plantations have also been planted, such as forests for fiber and pulp production, coffee, and cocoa, offering economic opportunities for settlers from Indonesia's remote outer islands. This expansion of plantations, into peatlands as well as logging of natural forest, has led to deforestation, degradation of lowlands and carbon emissions. The increased emissions since 2000 has led to Indonesia become the world's fourth largest emitter of greenhouse gases (GHG) in 2015[33] and the largest contributor of forest-based emissions.[34] According to Indonesia's First Biennial Update Report submitted to the UNFCCC in 2016, its total GHG emissions in 2012 were 1,454 million metric tons of carbon dioxide equivalent ($MtCO_{2\text{-eq}}$) for the three main GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrogen dioxide (N_2O).[35]

Pollution is an important environmental concern; the total annual cost of premature deaths from air pollution is 3.5% of Indonesia's GDP in 2015.[36] Environmental pollution causes significant economic losses in Indonesia and the burden affects the poor the most. Respiratory diseases cost up to USD 98 billion per year, causing 305 premature deaths/million people/year. [CDG] Treatment costs of non-communicable diseases from coal pollution equal to 40-80% of lower income group's annual expenditure. In addition, there is a loss of USD 3.2 billion of annual revenue from plastic bag pollution. [CDG] This includes fisheries, tourism, production cost of plastic, as well as cleanup costs.[CDG]

Adjusted net savings (ANS) was developed as an indicator to measure the real difference between production and consumption. ANS adjusts gross savings by taking into account investments in human capital, depreciation of fixed capital, depletion of natural resources, and damages caused by pollution. Figures for Indonesia show that although the indicator has been positive for the last few years, this driven by high rates of education investments, while natural capital is being depleted (Box 1).

Box 1. Macroeconomic Indicators: Adjusted Net Savings (ANS) in Indonesia [37]

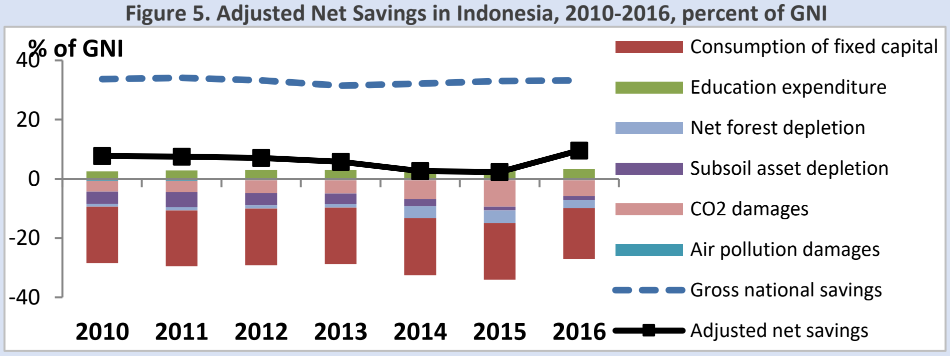
The WAVES program supported the Government of Indonesia in developing estimations for ANS, based on resource depletion, saving and investments**.** Truly comprehensive wealth accounting goes beyond the System of National Accounts (SNA), an international standard for measuring national income and savings, to include broader forms of wealth such as human capital and the benefits flowing from ecosystem services. The World Bank measures changes in wealth through adjusted net savings (ANS), which captures the real difference between production and consumption by including depreciation of fixed capital, as well as investment in human capital, depletion of natural resources, and damage from pollution. Positive ANS indicates an investment in the future—that a nation is accumulating the assets needed to build up its wealth and ensure its economic growth over the longer term. Years of negative saving, on the other hand, can be an indication of declining national wealth and unsustainable development.

While Indonesia's gross savings during this period are quite high, averaging 33% of GNI, the gap between gross savings and ANS is substantial, with an average ANS of 6%. ANS even dipped down to 2% in 2014 and 2015, indicating that Indonesia's national savings just barely covered the depreciation and depletion of its assets in those years. The main driver of Indonesia's low ANS is its significant consumption of fixed capital, averaging 19% of GNI. The second largest driver are damages from CO_2, especially due to emissions from peat fires and LULUCF (land use, land-use change, and forestry). These land use practices

[32] Indonesia Country Environmental Assessment (World Bank, 2009)
[33] Carbon Brief Country Profile: Indonesia (Carbon Brief, 2019)
[34] Forests and Landscapes in Indonesia: Data-driven analysis to support government and civil society actions for effective and equitable land-use in Indonesia. (World Resource Insitutute: Indonesia)
[35] Indonesia's First Biennial Update Report (Republic of Indonesia, 2015)
[36] Closing the Development Gap: Development Policy Review (Word Bank, 2019). These estimates do not include the burden of air pollution on Indonesia's neighbor countries. Measuring them will add accuracy and transparency to the estimations.
[37] Indonesia Wealth Account (World Bank, 2018)

also impact the estimates of net forest depletion, which averaged 2.2% during this period. Figure 5 shows Indonesia's ANS from 2010-2016, with the stacked bar columns illustrating the adjustments from gross national savings (blue dotted line) to arrive at ANS (black marked line).

Figure 5. Adjusted Net Savings in Indonesia, 2010-2016, percent of GNI



Source: World Bank staff calculations, based on data from World Bank's World Development Indicators and Indonesia data sources (SISNERLING)

2.2. Current policy responses

The Government of Indonesia is aware of the overall importance of natural capital and it has adopted legislation on NCA and economic instruments. The government regulation on Environmental Economic Instruments (PP IELH) no. 46/2017 was initiated by the MoEF and sets out a framework for environmental economic instruments. This includes instruments of development planning and economic activities, which mandates Central Statistics Agency (BPS) to prepare natural capital accounts and a depletion adjusted GDP (i.e. GDP that accounts for the depletion of natural). The regulation includes funding, incentives and/or disincentives, to provide a reward for any party that preserves and protects the environment; on the other hand, punishment/liability for any party that causes pollution or damage to the environment. It is hoped that the implementation of PP 46/2017 will create a better balance between the utilization of natural resources and environmental protection and management.

Recently, important progress has been made on the climate front, with the Nationally Determine Contribution (NDCs) and with the Low Carbon Development report. The Government of Indonesia has committed to reduce GHG emissions by 29% by 2030 relative to business as usual, and up to 41% with international support.[38] This commitment was made through a Presidential Decree No. 61 on the National Action Plan for Reducing Emissions of Greenhouse Gases, under the coordination of Bappenas. This plan aims to provide: a clear overview of GHG emission reduction achievements; an evaluation of the strengths and weaknesses of national efforts to address climate change; and producing valuable insights and guidance for developing and implementing future national climate policy. Issues of green development are also included in Indonesia's National Medium-Term Development Plan (RPJMN) for 2020-, where government places great emphasis on three: food, water and energy security. This plan is expected to drive Indonesia toward a greener and more inclusive economic growth by promoting sustainable development and resilient growth.

[38] Indonesia's NDC projects its 2030 BAU emissions to be approximately 2,869 MtCO2e. It targets 2030 emissions of 2,037 MtCO2e under the unconditional target and emissions as low as 1,693 MtCO2e under the conditional target. (WRI, 2017)

The Ministry of Planning, Bappenas, in cooperation with several development partners, has formulated a Low Carbon Development Plan for Indonesia that captures social, economic and environmental dynamics. The novelty of this plan is that it uses a systemic approach.[39] Specifically, the impact of socio-economic development on the environment is quantified first, and then the impact of environmental degradation (including resource scarcity and reduction of ecosystem services) on economic performance is estimated. In practice, this means the plan considers the fact that economic activity requires the use of natural resources and generates pollution. Consumption of natural resources also leads to resource scarcity and may results in higher commodity prices and possibly reduced access to resources. Pollution in turn, can lead to health impacts, resulting in reduced labor productivity and increased health costs. In both cases, both businesses and households experience negative impacts, with the latter, and especially lower income families, being affected the most. It utilizes this information to achieve Indonesia's NDCs.

An important component of the climate agenda being promoted by the Government relates to the restoration and conservation of lowland areas. A renewed effort began in September 2015 with the Ministry of Environment and Forestry (MoEF) establishing an ad hoc Task Force to lead the national emergency response to fire and haze reduction. In November 2015, the President committed to creating a Peatland Restoration Agency (BRG), establishing a moratorium on all new concessions on peatlands and prohibited any clearance and drainage on previously issued concessions for peatlands. Through the BRG, the Government has committed to the restoration of at least 2 million hectares of peatland. A range of activities to support this commitment have been initiated, including mapping peatland and inventory landscapes (hydrological units), in order to; (i) reclassification of land use for protected and cultivated functions (re-zonation), (ii) private sector partnership, direction and promoting cooperation in peatland restoration, (iii) construction and maintenance of peatland rewetting infrastructure, (iv) conflict resolution over peatland tenure and land use, and the promotion of community based/participatory restoration actions.[40] The efforts to restore peatlands along with the zoning restrictions and management of peatlands, are intended to lay the foundations for reducing the risk of future haze from fires in peatlands. Policies administered to achieve Indonesia's NDC are encouraging in their commitment towards REDD+[41] and peatland restoration targets. 87% of emissions targets are expected to be achieved through REDD with 95% of reductions from forest and peatland policies alone. Significant efforts are being made to improve land governance with the One Map Initiative, the REDD+ policy and strategy.

The WAVES work has provided important inputs in support of these government efforts, including through the land and peat accounts, support to the dynamic system modeling, and initial valuation of peatland ecosystem services. These are discussed in the ensuing sections of the report.

2.3. Institutionalization of NCA in Indonesia

The Government of Indonesia, including key relevant ministries, are collectively working on strengthening the scope, use and methodology of natural capital accounting. BPS has been developing

[39] Systemic in this context means that policy interventions are assessed against dimensions of development (social, economic and environmental), across sectors, for all stakeholders, over time and in space (e.g. for different provinces). For example, see: (Li et. al., 2012)

[40] BRG's Roadmap for Peatland Restoration (BRG, 2016)

[41] REDD - Reducing emissions from deforestation and forest degradation

annual asset accounts for forest resources, minerals and energy using the SEEA 1993 framework. In addition to the range of environmental and sustainable development indicators produced by BPS, other institutions have produced their own statistics and data. MoEF developed the Environmental Quality Index and the UKP4[42] developed the OneMap and OneData.[43] The OneMap Program aims to develop a generally agreed land cover, use and ownership data system that is aligned with the Spatial Planning Law (Law No.26/2006). OneData aims to enhance data governance by promoting common standards for data and metadata, as well as establishing a single data portal.

BPS has produced SINSERLING Accounts since 1995 including accounts for forests, energy, emissions and minerals. The World Bank led Wealth Accounting and the Valuation of Ecosystem Services Partnership (WAVES) worked with Indonesian Government from 2015 to 2019 to strengthen SISNERLING, focusing on land and ecosystem accounting. The collaboration with WAVES and the steering committee and technical teams formed as part of this helped to align SISNERLING accounts to the SEEA 2012 through a formalized data protocol and inter-ministerial data infrastructure. This allowed the production land and ecosystems accounts with a special focus on peat ecosystems. Further details on this collaboration are described in Box 2.

SISNERLING and NCA methodology as well as a conceptual roadmap support harmonizing of guidelines embedded in current Indonesian legal frameworks for conducting natural capital assessments. Indonesian ministries have different guidelines for conducting land valuations with varied levels of emphasis and comprehensiveness. MoEF Regulation No 15/2012 for valuation of forests covers forest ecosystem services and their values more extensively, including extractive, non-extractive, environmental impacts, biodiversity services and social and cultural value. The Ministry of Finance (MoF) Regulation No. 98/ PMK.06/2010 focuses on providing commercial valuations, upon request. It does not consider the capital value forest flora and fauna for areas beyond timber values (i.e. non-timber products and services) The MoF intends to update guidelines for the valuation of natural resources.

Box 2. Overview of WAVES-supported activities in Indonesia

Indonesia formalized its association with the World Bank led WAVES Global Partnership in 2015, with the objective to introduce a systematic approach to NCA that could inform policy dialogue, with a special focus on the national medium-term development plan (RPJMN). WAVES has been supporting development of data, policy, and process around NCA in Indonesia: consisting in the development of natural capital accounts (land and selected ecosystem services in peatlands), illustrations of accounts use and policy applications (policy block), and stakeholder engagement and capacity building (process block).

The WAVES program in Indonesia focused on four areas of work:

a) Improving the Indonesian SEEA (SISNERLING) coverage and data quality. WAVES supported better monitoring of how Indonesia's natural assets are used at an aggregate level. Central to this effort was raising awareness of measures such as Comprehensive Wealth Accounts and Adjusted Net Savings (ANS).
b) Establishing SEEA-based national accounts for land and ecosystems. This included development of land cover accounts at national level, ecosystem extent accounts for Sumatra and Kalimantan, as well as ecosystem accounts for peatlands also for the same two islands.
c) Developing feasibility and guidelines for SEEA-based water accounts at the watershed level, piloting initial accounts for the Citarum River Basin.
d) Integrating data into natural capital accounts, WAVES helped to inform different development processes, particularly the RPJMN, NDC strategic planning, and the country's long-term development vision.

[42] Presidential Delivery Unit for Development Monitoring and Oversight (officially called UKP-PPP)
[43] Indonesia Feasibility Assessment Report (World Bank, 2015)

NCA implementation was developed through a National Steering and Technical Committee (NCS) guided by a group of agencies led by the Planning Agency (Bappenas), the Statistical Agency (BPS), and the Ministry of Finance (MOF). The NSC played a key role as a coordination entity to facilitate and strengthen existing mechanisms of interaction among key stakeholders.

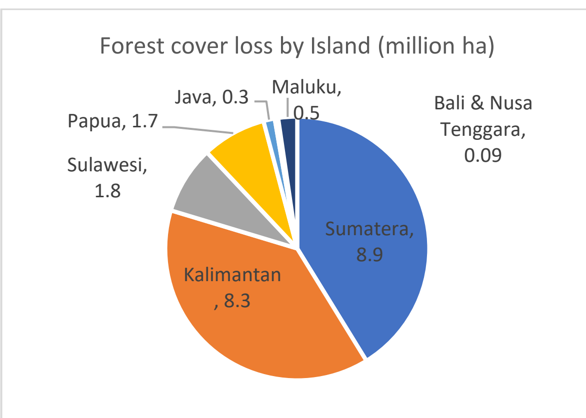
3. Land and ecosystem accounting

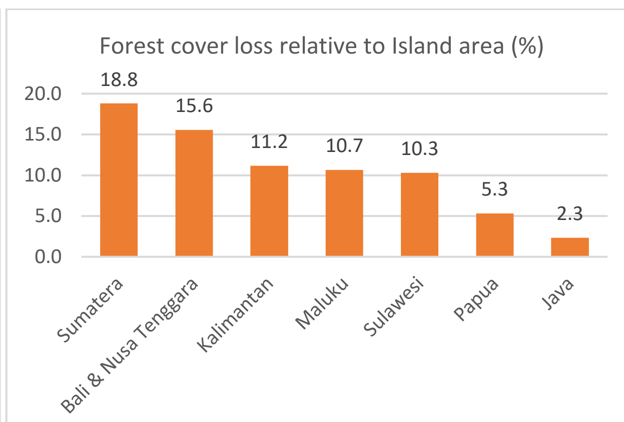
Shifts in land use have ecological and social consequences that are a critical to Indonesia's pledge to a low carbon economy. Indonesia's forests are home to thousands of plant and animal species, and 50-60 million Indonesians depend directly on the forests for their livelihoods. Land use changes are the highest contributor to emissions in Indonesia, making up 88% of emissions. By 2030, the land use sector (REDD and agriculture) is expected to represent more than half of the country's aggregate emission reduction target (17% of the 29% targeted reductions).[44]

An accounting approach was used to identify trends in land use changes and examine possible impacts of future land use changes in Indonesia.[45] Land accounts contribute to the implementation of Law No. 26/2006 on Spatial Planning, by helping institutionalize classification standards for land cover and land use, and support community empowerment and rural development.

The land account found that the highest rate of land use change is to forest cover. [46] Indonesia lost about 22 million ha of its natural forests between 1990 2014, with an average annual rate of 1.5 million ha (Figure 6). The highest rate of change in forest cover took place from 1996 to 2000, in which 9 million ha of natural forests converted to other land cover types (an average rate of 2.2 million ha/year). The rate of forest cover loss has been slowly declining since 2000. The Island of Bali and Nusa Tenggara had the highest forest cover loss in relation to its entire land area, compared to other islands. The highest rate of change took place from 1996 to 2000, when 9 million ha of natural forest was lost.

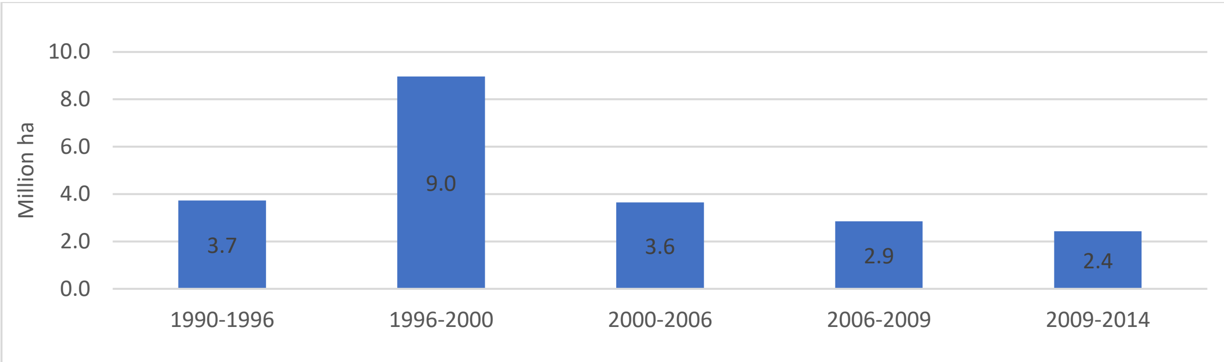
Figure 6a). Forest cover loss by island (million ha) & relative to island size (%) since 1990





[44] GHG emission cost curves DNPI, (McKinsey & Company, 2015)
[45] The land account presents a clear overview of land cover change (between 22 land cover classes) that has taken place in Indonesia from 1990 up to 2015. It is based on government data only (Ministry of Environment and Forestry - MOEF).
[46] Land Account for Indonesia: Forthcoming publication by BPS, supported by WAVES. (BPS, Forthcoming)

Figure 7. Forest cover loss by accounting period (million ha)

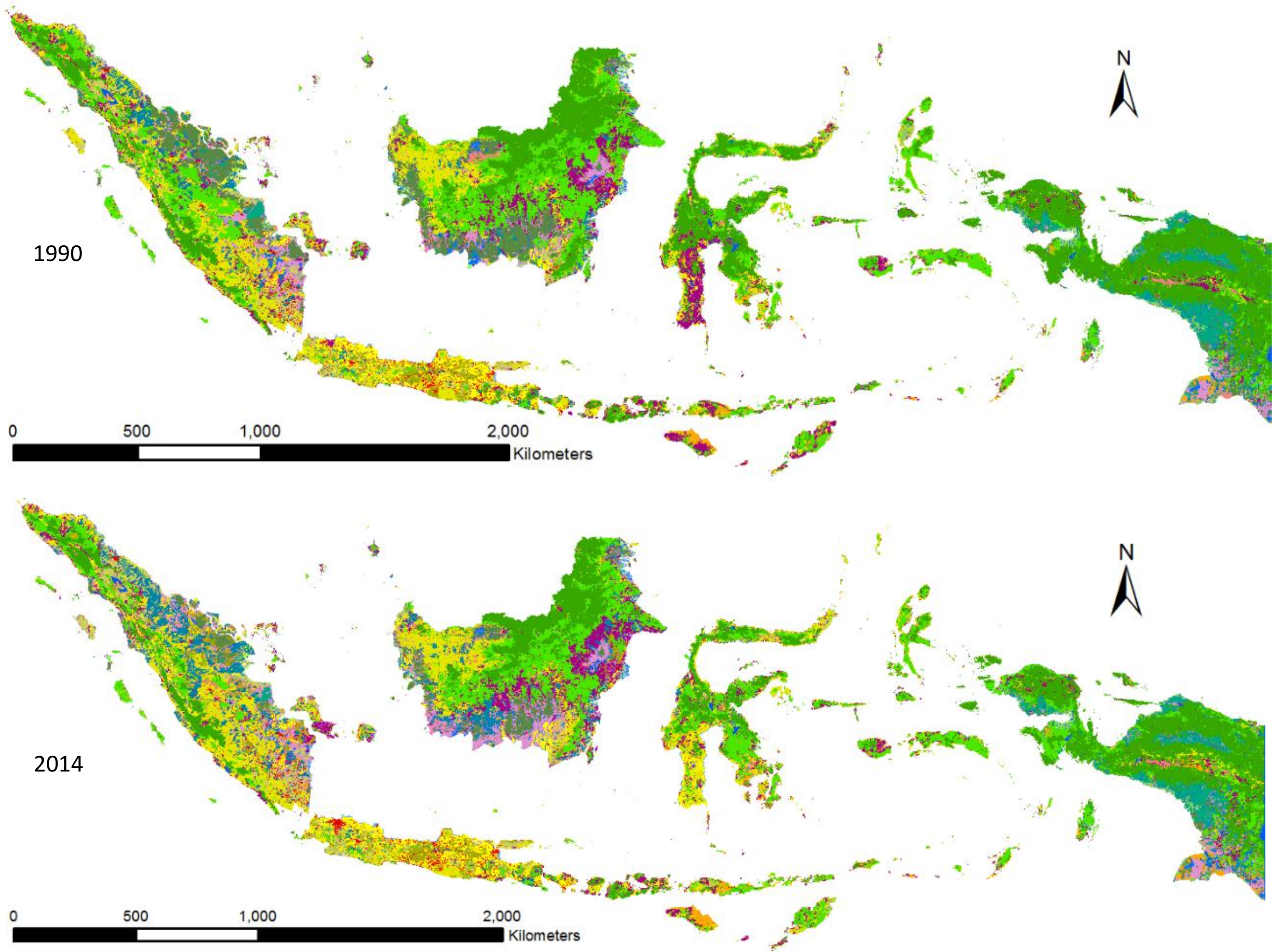


Source: Land Account for Indonesia: (BPS, Forthcoming)

The expansion of perennial crops occurred at the expense of forest land. Perennial crops, dominated by oil palm plantations, rapidly expanded from 1990 to 2014, with additional area of 6 million ha. About 60% of the additional perennial crop areas were forested in 1990.

Land cover change varied in different island groups. In Sumatra, there were major transformations from forest land to plantation forestry (such as acacia) and perennial crops (such as oil palm), starting in the early 1990s. The largest conversion of Indonesian forest during 1990 to 2014 took place in Sumatra (about 8.9 million ha). In Kalimantan, about 8.3 million ha of forests were converted to other land cover types in the same period. However, the change started somewhat later, and appears to be ongoing. In Sulawesi and Papua, conversion of forests increased sharply from 1996 to 2000, slowing down after 2006. In Sulawesi, there is an increase of shrubby dry cultivation land cover, of about 2 million ha during 1990 to 2014. Java, Bali and Nusa Tenggara, and Maluku experienced a relatively low levels of forest conversion, less than 600 thousand ha. However, the conversion of forests is still the main driver of land cover change. Other major land cover changes during this timeframe were the expansion of settlement areas (in Java, about 230 thousand ha) and the conversion agricultural areas (in Bali and Nusa Tenggara, about 500 thousand ha).

Figure 8. Land cover map of Indonesia in (a) 1990 and (b) 2014



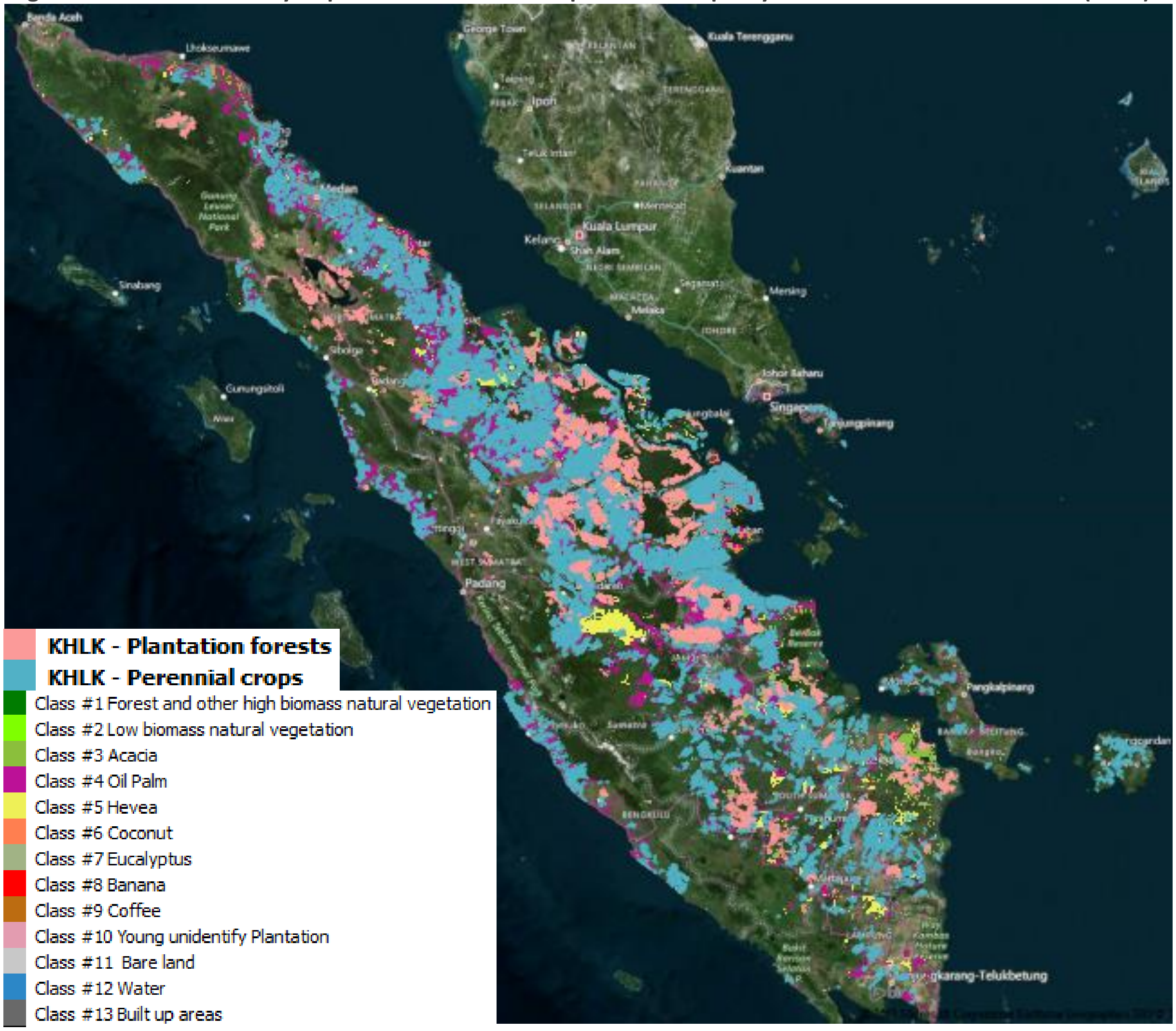
Source: Land Account for Indonesia: (BPS, Forthcoming)

A specific element of the land extent account[47] differentiated and successfully mapped the land cover classes of *Perennial crops* and *Plantation forests* into the different crop and forestry tree species.[48] For the perennial crop class, the differentiation between oil palm, *hevea*, coffee, banana, coconut and cacao plantations were investigated, while for the plantation forest class the acacia and eucalyptus plantations were analyzed. These crops were identified by the Government due to their importance to economic and revenue for the country. It is important to know where these crops are grown for land use planning and management, inclusive growth and dealing with sustainability concerns (Figure 9).

In Sumatra and Kalimantan, oil palm is the dominant perennial crop, followed by hevea. The dominant plantation forest crop in both islands is acacia (mainly for pulp and paper production), followed by eucalyptus. The young/unidentified plantations class represents some 8.3% of the total perennial crops and plantation forests area in Sumatra. This is related to the rotation period of oil palm (typically around 25 years) and acacia (typically around 4 years). In Kalimantan, around 0.1% of land is identified as young/unidentified plantation. This is related to the more recent land conversion to plantations in Kalimantan: few plantations have reached the end of their productive life span. As illustrated by Figure 9, significant areas were classified with algorithms as plantations outside the perennial crops and forest plantations land cover layers.[49]

[47] Based on the extent account, which provides further insights in the types of crops grown in Indonesia, particularly in perennial cropping and plantation forestry systems.
[48] This exercise has been conducted with a land cover map of 2014/15 and satellite imagery from 2016. Such exercises were not previously possible, but now are with the support of advanced remote sensing methods.
[49] However, as no accuracy assessment was carried out outside the perennial crops and forest plantations land cover layers, these figures should be taken with caution.

Figure 9. Sumatra: Overlay of plantation forests and perennial crops layers on land use classification (2015)[50]



Source: Land Account for Indonesia: (BPS, Forthcoming)

The expansion of the agriculture occurred mainly in peatlands. Indonesia has 45 percent of the world's tropical peatlands, the largest share worldwide.[51] Peat is comprised of accumulated organic material, which forms domes and acts as natural reservoir of water and carbon, providing a variety of ecosystem goods and services important for the economy and well-being. This includes farming of agriculture products (food), medicinal and ornamental plants, and timber and non-timber forest products, among other.[52] It is estimated that the tropical peatlands of Indonesia are one of the world's largest carbon pools, storing around 13.6 to 40.5 Gt of carbon (50-145 Gt on CO_2), which is equivalent to 1.3 to 4 years of global

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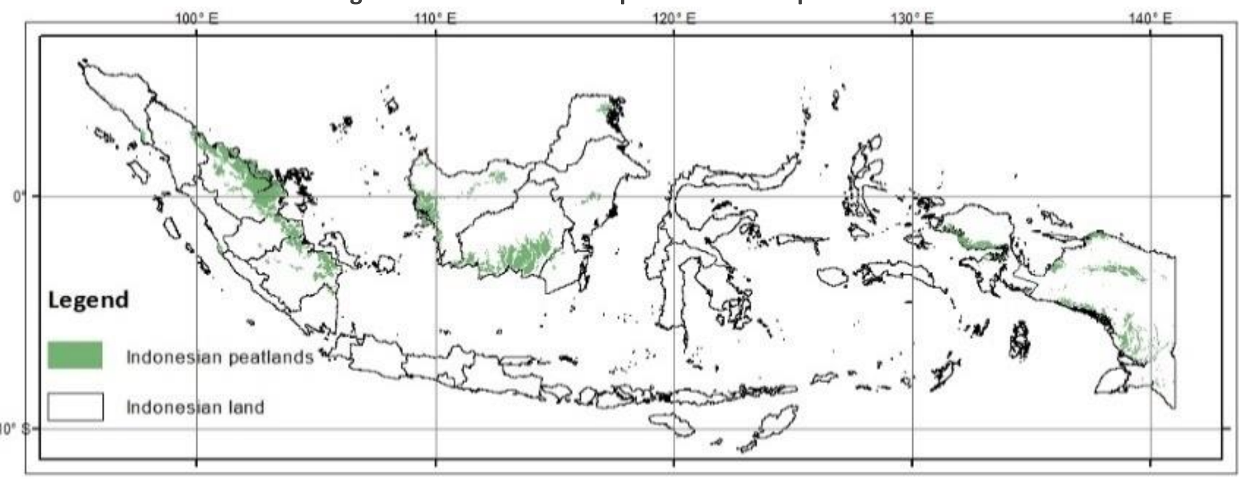
[50] Areas appearing in green (acacia), pink (hevea) and purple (oil palm) correspond to plantations not included in the plantation forests and perennial crops layers.

[51] Implementing Peatland Restoration in Indonesia: Technical Policies, Interventions and Recent Progress (Dohong, 2018)

[52] The economic value of peatlands resources within the Central Kalimantan Peatland Project in Indonesia (Beukering , Schaafsma, Davies , & Oskolokaite , 2008)

emissions of CO_2 from fossil fuel sources.[53] Peatlands also have spiritual, historical and cultural value. It's important to note that the ecosystem accounts are partial, and largely include resource rents for ecosystem goods and crops, rather than some of the harder-to-quantify regulating and cultural ecosystem services. Peatlands cover approximately 8% of Indonesia's land surface (15 Mha) and are mainly found in the three biggest islands of Sumatra (43%), Kalimantan (32%), and Papua (25%),[54] see Figure 10. An ecosystem account was developed to monitor the changes of peat ecosystems and economic activities concerning their physical and monetary values.[55]

Figure 10. Distribution map of Indonesian peatlands



Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

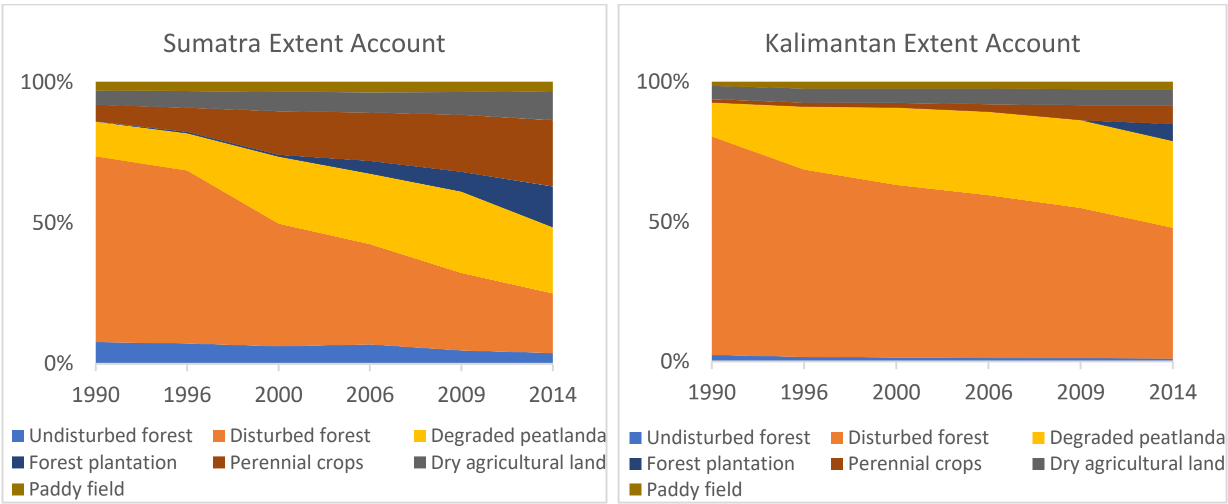
The BRG has been tasked to restore 2.5 million ha of peatlands by 2020 with the primary aim to reduce the risk of fires. To date 260,000 ha of peatlands have been restored. To restore the hydrology of degraded peatland ecosystems, and hence avoid fires in peatlands, the BRG also designates peatland zones for protection and cultivation, reviews permit and licenses for management or concessions over peatlands which fail to control degradation and/or fire and strengthens coordination, policy formulation and implementation across the government.[56] More effective peatland mapping could help resolve conflict over land use and tenure of land reform.

54% of peat forests have been converted to other land use in Sumatra and Kalimantan between 1990 and 2015 (Figure 11). This includes rich ecosystems of lowland forest, mangroves, which were converted to support agriculture activities, more recently - industrial plantations. As of 2015, about 40% of peatlands are under concession (5.4 Mha), where 57% has already been developed and oil palm has the greatest coverage of developed land with 1.6 Mha.[57] The remaining 43% of peatlands under peatlands are not developed and 1.4 Mha of peat forest is still standing under concession, which is at risk for conversion and current fires. Of the remaining peatland forest under concession, Kalimantan and pulpwood plantations contribute the largest share. Only 5% of oil palm concessions in Sumatra is still forest, while

[53] An appraisal of Indonesia's immense peat carbon stock using national peatland maps: uncertainties and potential losses from conversion (Warren, Hergoualc'h, Kauffman, Murdiyarso, & Kolka, 2017)
[54] Ecosystem account for peatlands Indonesia: Forthcoming publication by BPS, supported by WAVES. (BPS, Forthcoming)
[55] Ecosystem account is based on the Indonesian governments (MOEF) land cover map.
[56] BRG's Roadmap for Peatland Restoration (BRG, 2016)
[57] Effective Peatland Management – a preliminary fact base (McKinsey & Company, 2015)

in Kalimantan the share is 30%. As of 2015, 17% (0.3 million ha) of pulpwood plantations in Sumatra still has forest (estimated before the fires that occurred later that year), and 49% in Kalimantan. Overall, concessions have been utilized in a higher degree in Sumatra and the next wave of development can be expected in Kalimantan. About 60% (7.9 Mha) of peatlands are not under concession, hereof 43% (3.4 Mha) ha is already developed, where smallholders make up the largest share with 70% of this land, and oil palm contributes 28%.[58]

Figure 11. Ecosystem extent account of peatlands in Sumatra and Kalimantan



Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

The ecosystem account revealed that Sumatra has more carbon stored (as vegetation) in peatlands than Sumatra. In 1990, carbon stored as vegetation (biomass) in Sumatra and Kalimantan was estimated to be 4.8 Gt of CO2-eq. and declined by 31% in 2015, as a result of deforestation and land use changes, Figure 12.[59] This reduction was noticeable in every province in Indonesia. Warren et. al. assessed that carbon stored in peatland soil in Indonesia exceeds the estimated carbon stock of above and belowground biomass (21.6 Gt C) by 30%. The study estimated that Sumatra's peat soil store up to 19.5 Gt of carbon and Kalimantan about 12.4 Gt, depending on peat depth.[60]

The potential damages from a decrease of carbon stocks in peatlands are much greater and the cost of damage were estimated, using social cost of carbon as a proxy of the unit price of the stock .[61] Based on the social cost of carbon (SCC), which measure the long-term damage done by of CO_2 emissions in a given year, the peatlands of both islands were valued at USD 115 Billion (3% discount rate) or USD 35 Billion (5% discount rate) in 1990. By 2014/2015, the value decreased by 31% for both discount rates, as seen in **Error! Reference source not found.**Figure 12b. The estimated cost of damages from carbon stock loss during this period was about USD 36 Billion (3% discount rate) or UDS 11 Billion (5% discount rate).

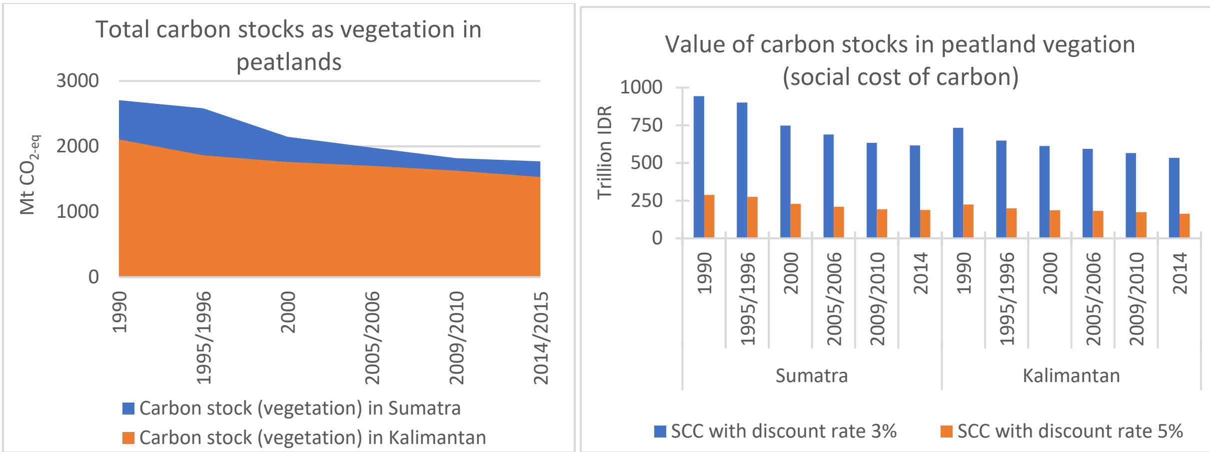
[58] Effective Peatland Management – a preliminary fact base (McKinsey & Company, 2015)

[59] Estimated biomass is the product of total area of each LC type and the sum of dry biomass of tree and dead organic matter. Dry tree biomass consists of aboveground and belowground biomass, and dead dry matter is the sum of litter biomass and woody debris biomass. Also used to estimate vegetation carbon content together with carbon fraction values.

[60] (Warren, Hergoualc'h, Kauffman, Murdiyarso, & Kolka, 2017)

[61] In this analysis, the monetary value is based on a marginal social damage cost technique, the social cost of carbon (SCC).

Figure 12. Carbon stocks as vegetation and social cost of carbon stocks as vegetation in peatlands



Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

The impacts of drainage and CO_2 emissions were most severe in Sumatra, and Kalimantan is mirroring Sumatra's path. As a result of peat drainage exposing organic carbon into the atmospheric oxidation, the net carbon (CO_2) flux increased by 57% to 387 MtCO_2/year over a 25-year period (Table 2).[62] Around 70% of emissions were released from Sumatran peatlands alone. Total CO_2 emissions from perennial crops in peatlands increased over time in both islands, and emissions from forest plantations in Sumatra.

Table 2. Total CO_2 sequestration and emissions (from oxidation) in Indonesian peatlands 1990-2015

Indicator	Peatlands of	Mt CO_2/year					
		1990	1995/1996	2000	2005/2006	2009/2010	2014/2015
Sequestration	Sumatra	9	9	7	8	5	4
	Kalimantan	2	2	1	1	1	1
Emissions	Sumatra	-140	-155	-185	-202	-230	-276
	Kalimantan	-93	-96	-96	-100	-109	-116
Total	Sumatra	-131	-146	-178	-195	-225	-272
	Kalimantan	-91	-94	-95	-99	-108	-115

Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

32% of carbon emissions from peatlands in Sumatra were from degraded land and drained forest edges close to plantations. In 2015, around 34% of CO_2 emissions in Kalimantan's peatlands were from drained forests and 20% from degraded lands (Figure 13). Degraded land and drained forest edges close to plantations areas should be a priority for rehabilitating peatlands since this could make a very large contribution to reducing global CO_2 emissions without causing losses to crop production. Based on the social cost of carbon, the estimated cost of damages of carbon emissions released due to oxidation in peatlands in 1990 was around 77 Trillion IDR (3% disocunt rate,~ USD 5 Billion) or 23.6 Trillion IDR (5% disouct rate, ~ USD 1.6 Billion) in total, see Figure 13b. In 2014/2015, the cost increased by 74% as the total emission went up.

[62] Total net carbon flux was estimated as the sum of carbon sequestration (positive value) and carbon emission (negative value) multiplied by the total area for every type of land cover. Estimated values include emissions from drainage, but not peat fires.

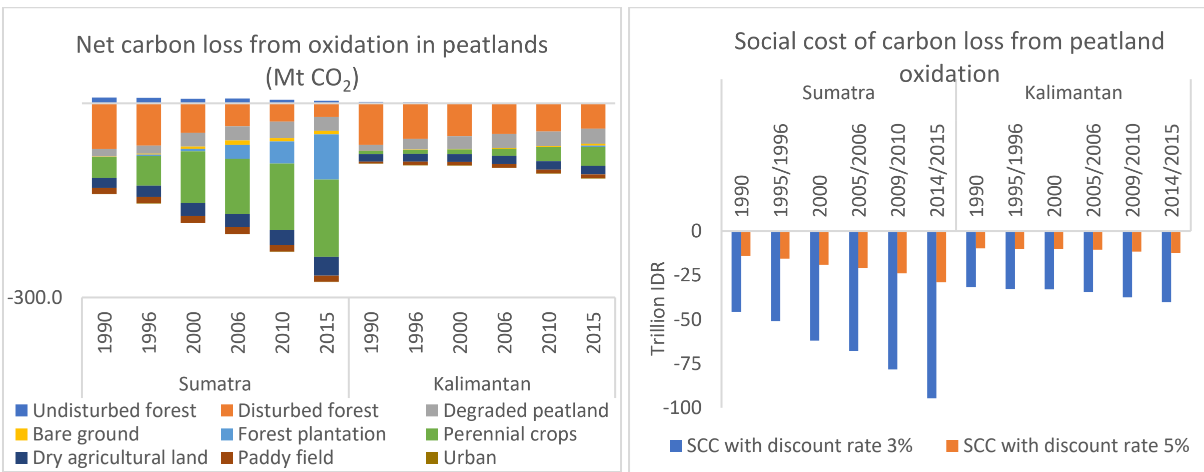
Table 3. Summary of carbon emissions in peatlands (Mt CO_2)

Source (Mt CO_2)	Island	1990	1995/1996	2000	2005/2006	2009/2010	2014/2015
Carbon stocks (vegetation)	Sumatra	2707	2585	2148	1980	1819	1770
	Kalimantan	2107	1862	1759	1702	1628	1533
CO_2 emissions (oxidation)[a]	Sumatra	131	146	178	195	225	272
	Kalimantan	91	94	95	99	108	115
CO_2 emissions (fire)[b]	Sumatra				318	183	286
	Kalimantan				386	325	324
Total		**5036**	**4687**	**4180**	**4680**	**4288**	**4300**

[a] = net carbon flux: CO_2 sequestration and emissions from oxidation (excluding from peat fires)

[b] = from burnt peat (33-cm depth of burned peat for all types of LC)

Figure 13. (a) Net carbon loss from oxidation (b) Social cost of carbon loss from peatland oxidation



Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

In Sumatra, the total area of forest plantation burnt increased significantly, from 1% to 18%, between 2006 and 2014.[63] The largest area of fire was in peatlands covered by wet shrubs. Carbon emissions from peat fires were substantial and were much higher than net carbon flux.[64] Even though the total area of peatlands in Sumatra is larger than in Kalimantan, the results show that the carbon emissions from Kalimantan peatlands were higher due to larger amounts of burnt area each year (Figure 14). Similar to fire distribution, the highest emissions were from wet shrubs. High carbon emissions from burnt peat cause substantial economic losses. Based on the social cost of carbon, this cost was estimated at 184-256 Trillion IDR (3% discount rate, ~ USD 11-15 Billion) or 56-78 Trillion IDR (~USD 5-8 Billion with a 5% discount rate) each year in both islands.

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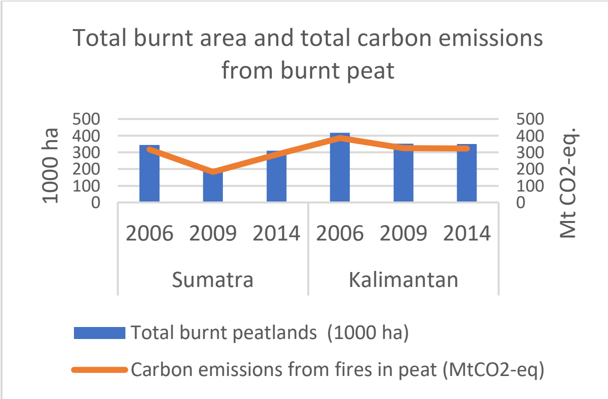
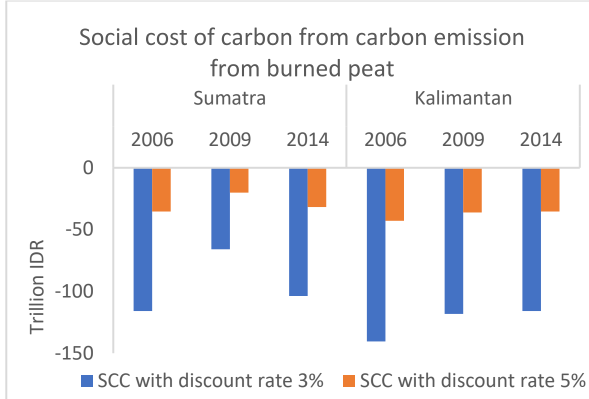
[63] Number of fires in peat areas were detected from MODIS collection 6 near real-time fire data from Fire Information for Resource Management System, NASA, extracted using ArcMap.

[64] Carbon emissions from peat fires were estimated from the emission of burned scar in peatlands, whereas the total carbon emission is estimated as the sum of burned area multiplied with the mass of fuel available for combustion per area, the combustion factor, and the CO_2 emission factor.

Figure 14. Carbon emissions and social cost of carbon from total burnt peatlands





Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

The cost of fire is estimated to be the equivalent of about 2% of Indonesia's 2015 GDP, rising to 19% of GDP by 2033[65] due to climate change.[66] In 2015, the estimated economic cost of fire to Indonesia (USD 16 billion) was larger than the estimated value added from Indonesia's gross palm oil exports (USD 8 billion in 2014)[67] and the value added from the country's entire 2014 palm oil production (USD 12 billion). While not all fires are set to clear land for oil palm, it is a large driver of land conversion.

Subsidence in peatlands is estimated to be 1.5m for the first 5 years of drainage, with half of this subsidence occurring in the first year and continuing at the rate of 5 cm per year after 5 years.[68] Peatland forests act as a buffer, storing and gradually releasing water, providing an effective defense against storms and coastal flooding. In their place, plantation areas and agricultural lands have expanded, requiring drainage to enhance agricultural productivity and improve accessibility of the terrain. Over time, an increase of subsidence will occur, leading to flowing, which severely hampers agricultural productivity in peatlands. Flooding is worse in Sumatra, which is the most advanced in terms of land use conversion to agriculture from peatland. This is evident by the fact that drainage depth in 2013 was up to 117 cm in Sumatra and up to 96 cm in Kalimantan (Figure 15). The deepest drainage was in the areas of perennial crop, plantation forest, bare land and degraded peat swamp forest in the distance less than 500 m from those areas. The deepest drainage was in north-eastern parts of Sumatra. [69]

[65] Indonesia will suffer from losses and damages associated with climate change and the degradation of natural resources without a Green Planning and Budgeting Strategy, or BUA policies. This is likely to reduce economic growth from the target levels of 7% to 3.5% by 2050, with a 2.5% drop caused by damage and loss form climate change and a 1.0% drop caused by degrading natural resources. This reduction in GDP growth will increase progressively, as climate change takes hold and natural resources are even more degraded. As a result, total GDP under BAU policy will be a 6% lower by 2020 and 19% lower by 2033. (MoF, 2015)

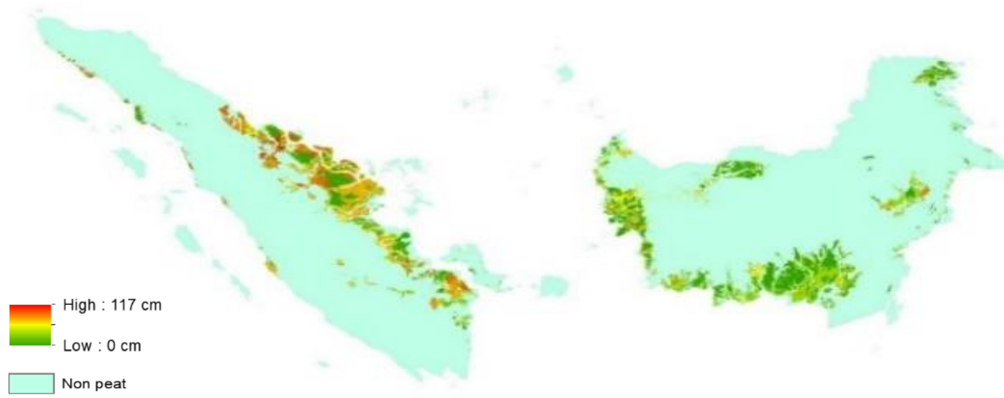
[66] The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis (World Bank, 2016)

[67] Based on a gross export value of USD 17.5 billion in 2014 and total palm oil production value of USD 25.5 billion (IDR 302.5 trillion) multiplied by the palm oil industry value added share 0.556 of total palm oil output taken from the Indonesian 2008 Input-Output table. Data sources: Food and Agriculture Organization, Indonesian Palm Oil Producers Association, and Indonesian Ministry of Agriculture.

[68] Subsidence and carbon loss in drained tropical peatlands (Hooijer, et al., 2012)

[69] Water table depth was obtained using Kriging interpolation and lookup tables. It's important to note that this location does not correspond to the deepest peatland area. (Warren, Hergoualc'h, Kauffman, Murdiyarso, & Kolka, 2017)

Figure 15. Estimated water level map of Sumatra and Kalimantan peatlands in 2013.



Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

Peatland conversion has been driven by timber and more recently oil palm production, but peatlands also harbor significant levels of biodiversity and carbon sequestration. Table 2 shows the physical flows of benefits provided by Indonesian peatlands to people and economy in Sumatra and Kalimantan It is estimated that 32 Mt of fresh fruit bunches of oil palm were produced in 2014/2015, triple the total produced in 2000. It is also evident that in both islands, timber production (Table 4) and its monetary value (Figure 16) decreased over this 15-year period. Some rare wildlife species are only found in Indonesian peatlands, and includes the Sumatran tigers and Sumatran orangutans, sun bears, tapirs, and white-winged swans.[70]

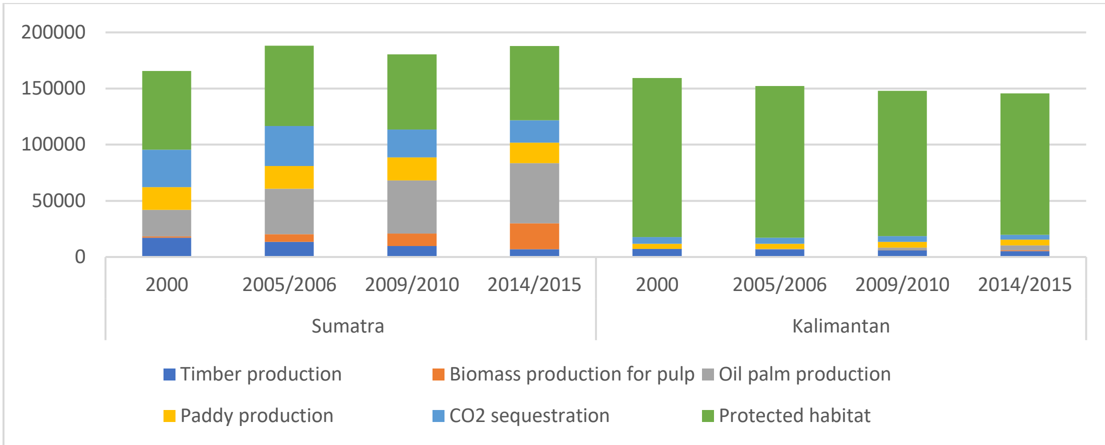
Table 4. Physical value of ecosystem services provided by Indonesian peatlands

	Sumatra				Kalimantan				Total
	2000	2005/2006	2009/2010	2014/2015	2000	2005/2006	2009/2010	2014/2015	
Timber production (1000 m^3/yr)	1,893	1,482	1,094	777	794	741	666	576	8,023
Biomass production for pulp (1000 t/yr)	1,011	5,503	8,833	18,161	0	2	24	624	34,158
Oil palm production (1000 t/yr)	10,389	16,837	20,242	23,635	14	2,185	4,282	8,022	58,606
Paddy production (1000 t/yr)	620	625	627	561	192	196	214	214	3,249
CO_2 sequestration (1000 t CO2yr)	7,175	7,629	5,337	4,282	1,299	1,182	1,099	958	28,961
Protected habitat (1000 ha)	442	451	423	416	892	851	816	794	5,085

Source: Ecosystem account for peatlands Indonesia: (BPS, Forthcoming)

70 (Pantau Gambut, n.d.)

Figure 16. Monetary value of ecosystem services provided by peatlands (USD Trillion)



4. Impact of NCA in policy and planning

With NCA it is now better understood that economic strategies yield a variety of costs that were previously not well captured. With the Low Carbon Development Plan, and its underlying work of NCA, it is now possible to estimate the value of the hidden flows, specifically for resource depletion (energy) and for ecosystem services (water and air pollution). This allows for the development of a more holistic development strategy, one that generates values across industries (agriculture, forestry, tourism), economic actors (households, businesses and government), dimensions of development (social, economic and environmental), as well as over time (for the short, medium and longer term). The goal is not to optimize performance for one dimension, but maximize the outcomes across all indicators of performance, in a fair and just manner.

Experts estimate that externalities cost the economy 1% to 1.5% of GDP every year, and this impact will grow over time.[71] Money is already being spent to reduce externalities (e.g. water treatment and purification), and money could be saved and used more effectively under a Low Carbon Development strategy. With Low Carbon interventions, particularly targeting land and energy use, GDP growth averages 6.0% between 2018 and 2050, 0.7% higher than in the baseline scenario.[59] At the same time, net job creation is forecasted, leading to reduced unemployment. Further, emissions are projected to decline by 31.9% and up to 44.8% in 2030 respectively in a fair and a more ambitious scenario. Finally, forest land is forecasted to expand, fish stock to remain stable, and peat degradation will be largely avoided. Such forecasting indicate that it may well be possible to design a strategy that delivers for all economic actors, present and future, in a sustainable way.

Investments are required to realize such improvements, totaling 1% of GDP in the fair scenario and 1.7% of GDP in the ambitious scenario (or 2.8% and 6.3% of total investment respectively).[LCDI] On the other hand, the returns are much higher, with the gain in GDP being close to 6 times higher than the investment required (taking a societal perspective) and additional government revenues reaching the same level as the investment (taking a government perspective).

[71] Low Carbon Development: A Paradigm Shift Towards Green Economy in Indonesia (Bappenas, 2019)

Various methodologies have been employed in the studies that underlie the Low Carbon Development strategy. These include the use of natural capital accounts using the SEEA framework, to classify and quantify the physical use of natural resource and ecosystem services; economic valuation techniques to value of ecosystem services; macroeconomic models for forecasting economic performance, and systems engineering approaches for analyzing the energy industry. The key word for this work is “knowledge integration”, performed using Systems Thinking, and quantified with a methodology called System Dynamics.[72] This has allowed a comprehensive assessment to be carried out that, despite not being all encompassing, has allowed Bappenas to identify and anticipate new challenges, and uncover new opportunities.

It is hoped that Low Carbon Development strategy can serve as a map or GPS, not only showing the direction (e.g. north), but allowing decision makers to visualize the path, obtain precise instructions on what turns to take, considering desired targets and making use of reliable forecasts for the outcomes of our actions. This could be used as a map to consider performance across all dimensions of development, economic sectors, economic actors, time and space.

Systematic development of NCA has helped strengthen institutional foundations and processes to deliver across national and regional initiatives and mandates. The land accounts support the establishment of monitoring frameworks for fiscal incentives, or for payment for results program, like the carbon finance programs. The land accounts also feed into the OneMap and OneData policies as well as providing basic information for development of other SEEA accounts such as the ecosystem extent account, ecosystem services supply and use accounts, and carbon and biodiversity thematic accounts.

could distinguish and discuss a) impacts already made; b) further use of the information already generated; c) additional policy uses which would require extensions/ expansion of the analysis)

5. The Way Forward

A key result of the Indonesia WAVES program is that it generated information which supports the on-going preparation of the RPJMN 2020-2024 and Indonesia 2045 long-term plan. The accounts and other data generated provide information to support the potential fiscal report for Ministry of Finance. It is noted that fiscal policy in the context of NCA plays two roles: (i) identifying opportunities for raising additional revenues for the state, and (ii) using taxation to correct for market failures, such as externalities that are not priced in the market, leading to inefficient outcomes. An example of this is the use of carbon taxation to raise the cost of CO_2 emissions.

The accounts provide critical information that can be used to support development of forest policy. The land and timber accounts were used for assessing the forestry sector and understanding deforestation patterns to better target and prioritize forest management. These accounts could support defining spatial areas for biodiversity conservation, agricultural production, and payment for ecosystem services. All of

[72] *Systems thinking* is a method of studying the dynamic behavior of a complex system considering the systems approach, i.e. considering the entire system rather than in isolation, and *system dynamics* is a tool or a field of knowledge for understanding the change and complexity over time of a dynamic system. (Bala B.K., 2017)

this information will be used for improving community livelihoods as well as for looking at risks to economy due to fire or price changes and hence lost or stranded assets in oil palm, rubber, acacia etc.

While current linkages between NCA and policy remain challenging,[73] there are several opportunities for using the valuations in accounting for both forest and non-forest lands. Valuation is not currently used in the designation and function of forest areas, as stated in Government Regulation No. 104 of 2015. However, with better linkage of NCA to the mid-term development plan towards RPJMN 2020-24, Government of Indonesia 2045 vision, SDG vision, strategic environmental assessments provide opportunities to assist in several areas, including:

Law/Regulation No. and Name	Description	Key agency/body of government responsible
Law No. 32/2009 on Environmental Protection and Management (UUPPLH 32/2009)[74]	Requires an inventory of all-natural resources and calls on all departments to develop economic instruments, including appropriate environmental economic accounting.	Ministry of Environment and Forestry
Law No. 26/2006 on Spatial Planning (UUPR 26/2007)	Help institutionalize classification standards for land cover and utilization.	BAPPENAS
Regulation No. 46/2017 (PP 46/2017) on Environmental Economic Instruments for Environmental Management	Requires the government to link macroeconomic policy with natural assets through adjusted net savings and Green GDP estimates and establish a payment for ecosystem services	Coordinating Ministry of Economic Affairs, Deputy for Coordination of Energy, Natural Resources and Environmental Management
Regulation No. 46/2016	Integrate climate change targets into the country's development agenda.	BAPPENAS
Bandung's regulation PERDA 6/2011*	Environmental management and protection, land utilization/management (including permits), Monitoring, Reporting, Verification tool (including environmental licenses), environmental economic instruments (incentives/disincentives), payment for ecosystem services; Requires the set of database, spatial information, and economic instruments/tools to do implement the mandate	Bandung City Government
Gorontalo's regulation 4/2016*		Gorontalo City Government
Padang's regional regulation 8/2015*		Padang City Government
West Kalimantan's provincial regulation 3/2014*	Environmental Impact Analysis, law enforcement/compensation, land utilization/management (including permits), Monitoring, Reporting, Verification tool (including environmental licenses); Requires: spatial information and planning.	West Kalimantan Regional Government
West Java Provincial Regulation 5/2015	Management of natural capital, including inventorisation, building the database/account, spatial planning, and economic valuation on natural capital, payment for ecosystem services; Requires the set of database, spatial information,	West Java Regional Government

[73] (Berghöfer , et al., 2016)
[74] See http://extwprlegs1.fao.org/docs/pdf/ins97643.pdf

	and economic instruments/tools to do implement the mandate.	
West Java Provincial Regulation 1/2012	Environmental Impact Analysis, law enforcement/compensation, land utilization/management (including permits), Monitoring, Reporting, Verification tool (including environmental licenses); Requires: spatial information and planning.	West Java Regional Government

* Regional government regulations that require data to feed into natural accounting exercises for assessing carrying capacity, cost benefit analysis, spatial planning and environmental management.

WAVES made important contributions in terms of account development, stakeholder engagement and initial policy impacts, there is however wide scope for fully mainstreaming natural capital in development planning and decision making. A key aspect is to demonstrate the full potential of the accounts to examine trade-offs faced when making development decisions, between the gains achieved by transforming natural capital into productive assets, and the losses associated with a reduction in the ecosystem services that natural capital delivers. This type of assessment requires additional modeling and monetary valuation of non-market services, not included in the scope of the WAVES Program. Land and ecosystem accounts show that peatlands would be a natural candidate for such a more in depth, forward looking analysis. The work on peatlands provides a data and methodological framework to further assess costs and benefits, including general economic equilibrium effects, of alternative options of managing peatlands in Kalimantan, Sumatra and Papua. This could be done through the analysis of different policy interventions to incentivize sustainable peatland management options, i.e. options that can ensure the sustained delivery of provisioning services without affecting the ability of peatland to deliver regulating ecosystem services (including forest fire prevention, flood protection, carbon storage and biodiversity conservation).

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Annex

All Annexes and intermediate technical reports (which served as inputs to this report) can be accessed through the following links:

Name	Link
Account 1 – Ecosystems	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EmZ-qqenc3NOuAtqQbH_ICABizJ0NsYVm8hTzmczz1e-HQ?e=InyRjF
Account 2 – Land	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EgY1fEjZe81AhAUSMUkpA3kBCoG_US6-pVElLsN03eH0kg?e=Yd0xxx
Account 3 – Water	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EvJvx95y9r1HmhnHFk30ZQQBqpHwUgcll6llU3eFOmaNkw?e=RqyE1D
Account 4 – Wealth	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/ElV_WqfG_rZBmwfk_SNyz3kBvA7tvg9Jdv4rcHZ5-BFFhw?e=bMuQBU
Briefs - Comms	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EhXNfHu0XIFPgKrKtAe9Q8kBTvA-Q3F9LCjyJzBLNpJDxA?e=VAZCXO
Capacity Building	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EoJUPwn9B5VCpO-Rw7m_QKsB7ipZktvIcEHkdJmjDpiLSQ?e=3lhhKm
Carrying Capacity- V2045 Model	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EmlNoKWyGoxFilZVnbtPH7kBUFG2A9y44PgXs33fOfppXQ?e=kCvvSY
Country Reports	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EmYlvLq3_fxFrT_ZwRfQkEABAXIYqTfphXUh-SLO_1B6wg?e=7oXDbl
Data Protocol	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/EoFbTqECSslMtfQcCsbUebkBTBk9QS9xI0MVNqr-M2Bm3A?e=AKFFt1
Feasibility Assessment	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/Eu_IqK9i9zRDtabS6jOrFCYByXChegZz0sld2USRIbIL-w?e=ssdpSE
SEEA-SISNGERLING Report	https://worldbankgroup-my.sharepoint.com/:f:/g/personal/jpcastaneda_worldbank_org/Eu3qA8UNdZ5Mu3fPLJ60k4wBwPWG_dDkua-dqMDps2LhLg?e=s4vWXc