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Foreword

This report is prepared for by a team at the School of Economics and Business, Norwegian University of Life Sciences (NMBU). The report includes data publicly available by the end of May 2024, although news stories until the end of June 2024 have been included.

We are grateful for comments and critical inputs from David Gaveau (Nusantara Atlas), Liz Goldman (GFW, World Resources Institute) and seminar participants at the Rainforest Foundation Norway. We also thank the 32 resource persons in Indonesia that spend their valuable times in the interviews.

The assessments and views presented in the report are those of the authors.

The report is part of the BEDROCK project: https://bedrock-project.earth/

Ås, Norway, December 2024

Executive summary

Deforestation in Indonesia has declined sharply since 2015-2016. We use a combination of spatial land use change data, interviews with stakeholders and statistical analysis to explain this reduction.

The exact extent of the reduction in deforestation depends on the data set used, and the years or time periods compared, varying between 40% and 90%. A robust estimate is that deforestation has fallen by at least 50% since ca. 2016.

The decline is uneven across islands and provinces. The two main "deforestation islands" Kalimantan and Sumatra experienced a major decline, with a relatively larger decline in the former. The provinces with the largest absolute decline were Riau, South Sumatra and Central Kalimantan, followed by West and East Kalimantan.

In terms of commodities driving deforestation ("direct drivers"), palm oil is still the most important commodity (46% for 2018-2022, according to MapBiomas Indonesia data, compared to 55% for the period 2010-2017).

Pulp is on the rise as a deforestation driver, particularly in Kalimantan. In the three high deforestation provinces on that island, the demand for pulp was behind almost 1/3 of the natural forest conversion in 2022.

Mining for coal and valuable minerals such as nickel is also on the rise, with MBI data suggesting its share of national deforestation being 5.4% (2021-2022), compared to less than one (0.9%) for the 2010-2017 period. Mining is particularly important in Sulawesi, where it according to one estimate accounted for 30% of the deforestation in 2021-2022.

Five hypotheses are put forward to explain the reduction, related to public policies, private (corporate) policies, civil society pressure, commodity prices, and forest scarcity.

New public (government) policies have been a main reason for the decline. The moratorium of new permits of primary forest and peatlands in 2011 has had an impact, but also took time to produce an effect on the ground effect (in part as it was a ban on issuing *new* licences). Interviewees also stressed that better sectoral coordination related to the moratorium and other reforms has been key for the slowdown.

A second set of reforms relate to fire management and peatland protection, sparked by the devastating 2015 forest fires. The interviewees highlight this as a key policy reform by, for example, increasing the accountability of subnational government officials for fire management.

Results-based payments (RBP) or result-based contributions were central in the Letter of Intent between Indonesia and Norway in 2011 and in the new MoU of 2022, although the first payment was not made before in 2022. An RBP-based project of more than USD 100 million was approved by the Green Climate Fund in 2020. RBP has also been implemented at subnational level starting in East Kalimantan and Jambi with external donor support. Some

reports indicate positive results, although they are likely to be too location-specific and came too late to have had major impacts on the observed decline in national deforestation figures since 2016.

Private regulation such as certification and corporate pledges show promising signs with an increasing share of oil palm plantations being certified. Yet, breached are reported, and the forest encroachment factor (i.e., the share of new land being converted from forest) has not dropped as much as to be expected. Moreover, certification of pulp production and mining is lagging behind.

Civil society pressure has played a role in particularly two areas, although the exact role and contribution are hard to assess. First, CSOs are active actors on the policy arena, also to influence private sector initiatives and policies. Second, CSOs are important watchdogs for both implementation of public and private regulations and pledges. This has helped "bringing the forests to the court", as one interviewee observed.

Key commodity prices were relatively stable during the 2016-2020 period, and thus cannot explain much of the decline. Yet, no major increase in the prices of deforestation-risk commodities made the implementation of both public and private policies less costly (both for politicians and producers), and made violations of laws and regulations less profitable, increasing policy effectiveness.

The prices of coal and minerals such as gold and nickel have, however, increased steadily over the period. The nickel price quadrupled between 2016 and 2022. The increasing role of mining in deforestation can largely be explained by the high and increasing profitability, and demand is likely to grow steadily in the coming years due to the global energy transition.

The statistical analysis suggests that up to 1/3 of the reduction in deforestation can be explained by forest scarcity (forest transition). When a province hits ca. 40% forest cover, deforestation tend to decline.

While we conclude that all five hypotheses put forward are relevant to explain the recent decline in deforestation, we tentative conclude that public polices – in combination with a forest transition (scarcity) effect – has been the most important factors. Private policies show more mixed results. Behind the public and private policy changes, civil society has played a key role in policy reforms and in promoting more effective implementation though its watchdog role. Non-increasing agricultural commodity prices have made the implementation of forest conservation policies less costly.

Deforestation is still a profitable activity for land users and (sub)national governments, and forest conservation is a continuous battle, with future challenges emerging: the effectiveness of current policies may weakened over time, political priorities may change, prices of deforestation-risk commodities may rise, and the composition of direct drivers change – requiring a shift in the policy focus.

Recommendations

1. **Be ahead of the curve:** The forest transition suggests a natural development with decreasing deforestation in low forest cover regions (provinces) and increasing deforestation in high forest cover regions. The major future deforestation threats have moved eastwards in Indonesia. Mining is likely to be a key driver of deforestation in Sulawesi, while food estates, oil palm and pulpwood plantations in Papua are emerging as direct drivers in new deforestation hotspot.
2. **Incentives for high-forest, low-deforestation areas:** Much focus in the REDD+ discussion has been on reducing emissions from high-deforestation areas, and rightly so. Taking a more long-term view and preventing future increases in deforestation, mechanisms that incentivise the conservation of high-forest, low-deforestation areas are also needed, while noting the challenges of estimating additionality – particularly if carbon credits from these areas enter carbon trading.
3. **New deforestation-risk commodities:** The deforestation debate in Indonesia has traditionally focussed on timber logs and palm oil. Timber production is in decline, and the share of palm oil-driven deforestation is also declining, although oil palm cultivation is still the main immediate land use after forest clearing. Demand for biodiesel based on palm oil may make it maintain its role as the no. 1 deforestation-risk commodity. Pulp and mining (nickel) have increased its share of direct deforestation drivers, and with pricing of key minerals on the rise this pressure is likely to continue. Plans for large food estates is also likely to make it an increasingly important driver.
4. **The energy transition and deforestation:** The global energy transition has increased the demand for both renewable energy (palm oil and wood pellets) and minerals (such as nickel). Paradoxically, these also pose a threat to Indonesia's natural forests, and balancing these trade-offs remains a major challenge both for policy makers and advocacy groups.
5. **CSOs watchdog role important for effective implementation:** The private sector initiatives are commendable, but their impact hinges on their effective implementation. Clearing new forest land remains a profitable option from a business perspective, and without clear sanctions of violations (both formal and informal such as reputational risk) illegal and semi-illegal forest conversion is likely to continue.
6. **Better data on "other agriculture" commodities:** The share of "other agriculture" as a direct driver is increasing, yet this remains a black box in many data sets and analyses. More data on what constitutes this driver and their relative importance (including cocoa, coconut, coffee, rice, rubber sugar) are needed to design and implement targeted policies, also related to the EUDR.
7. **Transparency in data sets and their uses:** Several data sets on deforestation or tree cover loss are available, with quite different primary data sources and forest/deforestation definitions. This creates a wide range of figures, opening for cherry picking and selective uses. Full transparency on definition and data transformations is needed to enable better comparison and detect underlying trends.

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1 Introduction

Deforestation in Indonesia has declined sharply since ca. 2016. Why has this happened? Good policies, favourable economic conditions for forest conservation, forest scarcity, or good fortunes?

There are different claims put forward in the debate as to what has caused the decline, from the successful implementation of government policies, strong private sector commitment, advocacy by environmental conservation groups, market conditions, COVID19 and other factors (e.g., (Daemeter & Tropical Forest Alliance, 2021; Gaveau et al., 2022; Jong, 2021a)).

This report aims to shed light on why deforestation in Indonesia has been substantially reduced over the past few years. We will investigate a set of hypotheses on potential causes of this decline and assess the extent to which each can help explain the observed deforestation reduction. The hypotheses are split into two main categories: (1) new policies, and (2) structural and market changes.

Policies include both public and private ones, and are the direct actions taken by either the government or the private sector to limit deforestation. We further hypothesise that these changes are in part driven by civil society pressure. Public policies may also include the unintended effects of non-forest policies, such as infrastructure projects such as national strategic projects or the Omnibus (Job Creation) law aiming to stimulate economic activities during the COVID19 pandemic.

We analyse two structural and market changes: price trends of key deforestation-risk commodities, and forest scarcity as a driver of the deforestation slowdown (linked to the forest transition hypothesis). Other structural changes affecting forest loss are also conceivable, such as economic growth and urbanization, but we have not investigated these further.

The outline of the report follows the structure presented above. Chapter 2 presents the approach taken, details the hypotheses, and describes the data used. Chapter 3 presents the deforestation trends as shown by different data sets, and then disaggregate that by island and provinces, and by commodity. Chapter 4 gives an overview of key public and private policies and try to relate them to changes in deforestation. Chapter 5 looks at the commodity price changes, and test statistically the forest transition hypothesis about a scarcity-driven slowdown of deforestation. The final chapter synthesise the findings and conclude.

2 Approach, methods and data

2.1 Analytical approach and hypotheses

The deforestation literature distinguishes between causes of deforestation at different levels. A commonly used common deforestation framework to distinguish between causes of deforestation at three levels initially described by Kaimowitz & Angelsen (1998) and Angelsen & Kaimowitz, (1999): the direct drivers, the proximate (immediate) causes and the underlying causes. (Note that the terminology varying across studies, e.g., the term “driver” also being

used for underlying causes.) For our analysis, we use a slightly different categorization, and distinguish between explanations at three levels:

(i) The direct drivers of deforestation, i.e. the agents and the post-forest land uses. This will enable to identify which groups of "deforestation agents" have reduced deforestation-related activities, and where. The disaggregation of deforestation by agents/land uses and locations can help to establish a more direct link between changes in policies and deforestation.

(ii) The public and private policies, which can change the incentives and operating space for land users through new policies and their effective implementation.

(iii) The underlying market and structural changes, which in our case is limited to the study of two variables: market prices of key deforestation commodities, and forest scarcity.

The approach taken thus proceeds in three stages, as depicted in Figure 1 (from the centre and outwards): we first disaggregate and describe the changes in deforestation over the past few years, and then link these to changes in (i) policies and (ii) broader structural and market changes.

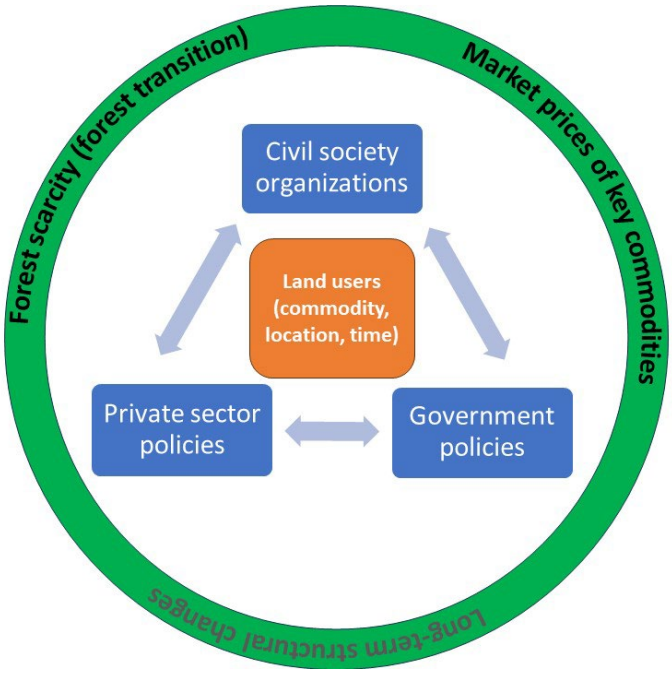

Figure 1: Three stages in the analytical approach of the study.

We explore the following factors (hypotheses) which may explain the recent decline in deforestation.

H1: Government policies: The Government of Indonesia (GoI) has issued several policies to halt the drivers of deforestation or create alternative source of income. These include: a permanent ban on issuing new permits to clear primary forests and peatlands; a moratorium on new oil palm plantation licenses; forest fire mitigation; a social forestry program; land rehabilitation; and increased enforcement against environmental violations (Daemeter &

Tropical Forest Alliance, 2021; Jong, 2021a). On the other hand, the GoI also enacted the Job Creation (Omnibus) law, which are relaxing environmental regulations and changing forest governance in Indonesia (Dwisatrio et al., 2023; Ramadhan et al., 2023). Furthermore, the GoI has strengthened the regulation on Indonesian Sustainable Palm Oil (ISPO) and Timber Legality and Sustainability Verification System (SVLK). Subnational governments are also more engaged with sustainability by issuing subnational regulations on sustainable plantation. These and other policies are discussed further in section 4.1.

H2: Private policies and industry action: The last decade has witnessed the rise of corporate self-regulation in the form of zero-deforestation commitment of the palm oil (and pulp and paper) companies (Dermawan et al., 2022b). In addition, there has been a steady increase of market uptake on certified products, which may drive higher sustainability-certified palm oil production (RSPO, 2023). These initiatives are discussed in section 4.2.

H3: Civil society pressure: Public and private policies are not created in a vacuum, but in a process where many actors participate, including civil society organizations (CSO). While civil society pressure on public policy reforms has been taking place for a long time, the last decade was marked by an increase in the direct interactions between companies and CSOs. This is particularly prominent for companies with zero-deforestation commitments, which seem more responsive to CSO criticism and their public reputation than the government (Dermawan et al., 2022a). These issues are discussed in section 4.3.

H4: Markets and commodity prices: Earlier studies attribute a significant role of oil palm expansion, and – in turn – how the palm oil price was correlated positively with oil palm plantation expansion and forest loss during the first two decades of this century (Gaveau et al., 2022). The COVID19 period, with skyrocketing palm oil prices, may suggest a break with this link. Commodity price changes are discussed in section 5.1.

H5: Forest scarcity and the forest transition: One plausible claim put forward in the debate is that in some high-deforestation locations, most of the forests may have gone and thus deforestation will by necessity slow down. More generally, the forest transition hypothesis suggests that other mechanisms also kick in when forest cover is reduced, including lower agricultural profitability and increased environmental concerns (e.g., Rudel et al., 2005a). This hypothesis is tested statistically in section 5.2.

2.2 Methods

The methods applied include: (i) non-systematic literature review, (ii) expert interviews in Indonesia, and (iii) statistical analysis of deforestation and other quantitative data. No single statistical analysis can estimate the relative merits of the above hypotheses. The approach is therefore to use a combination of methods to critically assess the validity of each of the explanatory factors (hypotheses) outlined above.

In the **literature review**, we looked at both the scientific literature (mainly journal articles), reports and other grey literature, policy documents and newspaper or online media articles. The purpose is to identify various explanations and trajectories of the deforestation decline, and to

map available supporting data. The literature review also serves as a means for process tracing of events (policies, corporate commitments, prices, and others) and also earlier assessments on the causes of the decline in deforestation.

We conducted semi-structured **expert interviews** with 32 respondents were selected to represent the diversity of actors, including government (national and subnational), private sector, donor community, and civil society organizations. We began by asking respondents for permission to record the conversation. Most declined so no transcripts are available, instead we took detailed notes that we used in the further analysis. We started with open-ended questions about what has driven the reduction of deforestation. If the respondents did not mention any specific factors, we asked for their assessment of specific policies under public discussion. We then classified the responses into those that supported the claims that a particular policy contributed to reducing deforestation and those that disagreed. The list of questions is included in Appendix 1.

We compared their responses with the available science evidence before we made our assessment about the likely impact of the specific policies. We classified impacts into low, moderate, and high. Our assessment of some having "low" (or "moderate") impact does not necessarily imply that these policies are "wrong" (in some sense); they may, for example, be lacking the scale to significantly reduce national deforestation rates (e.g., social forestry). In other cases, the policies may be "good on paper" but their implementation is failing.

The **statistical analyses of quantitative data** consist of three parts: First, in section 3 we use simple descriptive statistics to disaggregate the deforestation by year, location and post-forest land use (direct drivers). Second, in section 5.1 we look at simple correlations between commodity prices and commodity specific deforestation, to the extent those data are available. Third, in section 5.2 we test the forest transition hypothesis and use regression models to estimate to what degree the recent deforestation decline is due to a forest scarcity effect.

2.3 Data sources

Commonly used data sets for the analysis of forest loss in Indonesia are not coherent in their definitions of forest cover, forest (tree cover) loss and deforestation, which can lead to selective uses and different conclusions on the level and trends of deforestation. Moreover, the necessary information provided on, for example, forest definition and how data are processed is not always publicly available. This purpose of this report is, however, *not* to evaluate and compare different data sets and try to arrive at a best estimate of deforestation.

To ensure that the implications of our analysis are not sensitive to the choice of the data, we gathered five different data sets, all of which are displayed in Figure 3 and described in the following.

Global Forest Watch (GFW): Among the most widely used tools in the analysis of forest loss is the platform Global Forest Watch (GFW; https://www.globalforestwatch.org/) which provides data on tree cover loss from Hansen et al. (2013) and more recently also data primary forest loss from Turubanova et). GFW has global coverage for the years 2001-2023 and a

resolution of 30m at the Equator. Tree cover loss data has been used extensively but has the limitation of not distinguishing loss occurring in natural forests from tree cover changes in plantations or other land with tree cover, resulting in large differences when compared to the GFW primary forest loss data.[1] Throughout the report, we therefore refer to the primary forest loss data when mentioning GFW data.

Tropical Moist Forest (TMF): The more recently developed Tropical Moist Forest (TMF) data set of Vancutsem et al. (2021) does not operate with a canopy cover threshold to identify forest pixels but classifies pixels as *undisturbed* forest if they have not experienced disturbance events over the entire Landsat satellite image time series (https://forobs.jrc.ec.europa.eu/TMF). It is therefore less likely than GFW tree cover loss data to count forest plantations or afforested pixels as forest. TMF distinguishes disturbance into degradation and deforestation and also provides forest regrowth data for the period 1990-2022. The details of the differences have been well explained by GFW.[2]

MapBiomas Indonesia (MBI): A third data set used for the analysis was compiled by MapBiomas Indonesia (MBI, https://mapbiomas.nusantara.earth/). In contrast to TMF and GFW, MBI applies machine learning algorithms to 102 different spectral indices derived from 30m Landsat pixels. With the help of training data, the algorithm then distinguishes between a range of different land cover categories, such as forest, oil palm, wood pulp and other agriculture, with 95% of forest correctly detected and an overall accuracy of 75.3%. With the classification of land use, it is possible to track transitions from one land cover class to another and when they occurred. An important difference to TMF and GFW is thus that it classifies deforestation as the transition from forest to another land use category and not merely as the loss of forest as GFW and TMF do. The MBI data are available down to the *kabupaten* (district) level.

Nusantara Atlas: This map covers Equatorial Asia (Indonesia, Malaysia, Brunei) and includes data on deforestation and post-forest uses: oil palm, pulp-and-paper, mining and timber, making it suitable for analysis is direct drivers of deforestation. The maps combine "satellite images Planet/NICFI, Sentinel-2, Landsat, NOAA-20, S-NPP, Aqua and Terra), near-real-time deforestation alerts (RADD; GLAD), fire hotspots (VIIRS and MODIS) and rich cadastral information in one space" (https://nusantara-atlas.org/about/).

Ministry of Environment and Forestry (KLHK) data: Official data from the Ministry of Environment and Forestry (KLHK) data was used to compare the above-mentioned data to official statistics. The main difference to the other data sets is that the KLHK data employs a net deforestation approach, in which forest regrowth and forest plantations are subtracted from the area of forest loss (gross deforestation data are also available). It is only available at the aggregate country level, not as a geospatial data set, preventing a more detailed analysis. One

[1] Total forest loss has over the past years (since 2017) been roughly four times higher than the primary forest loss. See also https://www.globalforestwatch.org/dashboards/country/IDN/

[2] https://www.globalforestwatch.org/blog/data-and-tools/tree-cover-loss-and-tropical-moist-forest-data-compared/

should also note that the forest year is July-June, and not the calendar year as for the other data sets (e.g., the 2021 figure is for the period July 2020-June 2021). There are also different mapping units and definitions.[3]

To account for some of the differences across the forest loss data sets, especially when comparing GFW and TMF to MBI, we also use data on forest fires from Tyukavina et al. (2022). The data uses GFW data to filter out the pixels lost due to forest fire among all pixels identified as forest loss in GFW.

We critically examine the data underlying the reduction in deforestation to paint a more detailed and nuanced picture of the decline. For example, using the GFW data ("Hansen data" of tree cover loss based on Landsat images), most of the reduction from 2016 to 2017 was due to a reduction of fire-related forest loss.

Relatedly, one source of contradictory figures is the disaggregation of forest disturbance into deforestation and forest degradation in some data sets, but not in others. Also, it will be important when looking for explanatory factors to distinguish between what constitutes a long-term structural trend, and what are more recent deviations from that trend.

Finally, not all direct drivers are easy to detect. Most data sets identify plantations, such as oil palm. Nusantara Atlas also distinguish between industrial and smallholder oil palm, as well as pulpwood plantations and mining. Conversions to crops such as coffee and cocoa is more challenging to detect, particularly if grown extensively such as jungle rubber (*karet rakyat*) with rubber trees mixed with natural vegetation. MBI data uses, in addition to oil palm, the broad category of other agriculture, which includes a variety of crops (including rubber and cocoa).

Different data sources and forest (loss) and deforestation definitions is a source of confusion, but can also be a source of insights to better understand the different processes going on. It also calls for simplifications to communicate the main points. Thus, for example, for the purpose of report (explaining reduced deforestation), we may at times use the term "deforestation" when 'tree cover loss" or "forest loss" would have been more appropriate.

3 Disaggregation of deforestation

3.1 Deforestation over time

The figures for recent deforestation vary across data sets. Figure 2 compares net forest cover loss or deforestation across four data sets discussed in section 2.3. Although the decline in forest loss is visible in all data sets, it started already after 2011 according to MBI data while it started in 2015 in TMF and KLHK data, and 2016 in the GFW data.

[3] For details, see: Technical Blog: Indonesia Tree Cover Loss and National Deforestation Data Explained | WRI Indonesia (wri-indonesia.org)

Since its recent peak, deforestation has fallen by 69% according to GFW data (2016-2023) and by 79% according to TMF data (2015-2022). KHLK and MBI data show an even larger decline of 90% for both data sets (2015-2021 for KHLK, and 2011-2022 for MBI).

Deforestation fluctuates by year, and cherry picking the top year exaggerates the decline. A more representative figure is to compare a period before and after the change. Taking the average for the years 2010-2017 and 2020-2022, deforestation has dropped by 64% (GFW), 58% (TMF), 52% (KLHK) and 59% (MBI).[4] Taken together, we can conclude that deforestation has been reduced by at least 50% since ca. 2016.

Data from the Indonesian Ministry of Environment and Forestry (KLHK) is useful for comparison, while it should be noted that it is referring to net deforestation and forest cover include tree plantations.

In all data sets except MBI, deforestation has stabilized since 2020. At the time of finalizing this report, 2023 data are only available from GFW and Nusantara Atlas, both based on Landsat data. These suggest an increase from 2022, with an increase of 21% (GFW) and 34% (Nusantara Atlas) from 2022 to 2023. Reports suggest an increase in oil palm and pulp and paper driven deforestation in 2023, thus 2022 may represent a turning point.[5] These data also suggests that deforestation from plantation is also moving from Sumatra to Kalimantan and Papua. While the main purpose of this report is to explain the decline since 2016-2017, we discuss in Chapter 6 whether another turn point happened in 2022-2023.

The distinction between deforestation and forest degradation is important. TMF data allow to distinguish between the categories "undisturbed tropical moist forest", "degraded", "deforested" and "regrowth". Figure 3 shows the TMF trends in deforestation and degradation: they tend to move together (positively correlated, with a correlation coefficient of 0.64). Furthermore, for both variables we observe a sharp decline after 2015.

[4] Annual deforestation data represents both random fluctuations (due to fluctuations in factors such as weather end commodity prices) and medium-long term trends. The choice of periods is therefore a matter of discussion. We took a conservative approach and looked at the period up to 2017, to make the analysis less sensitive to random annual fluctuations.

[5] Nusantara Atlas | 2023 Marks a Surge in Palm Oil Expansion in Indonesia (nusantara-atlas.org) See also: Palm oil deforestation makes comeback in Indonesia after decade-long slump (mongabay.com)

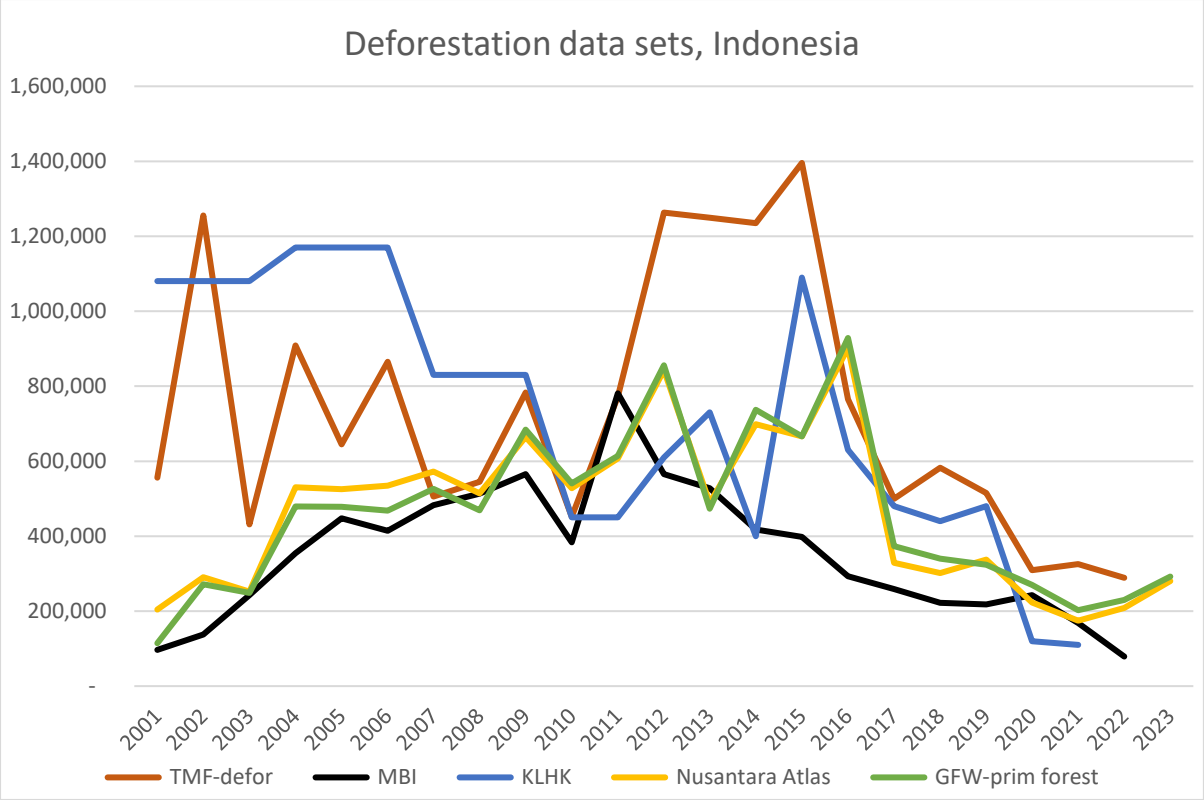

Figure 2: Deforestation (ha) in Indonesia, comparing different data sets.

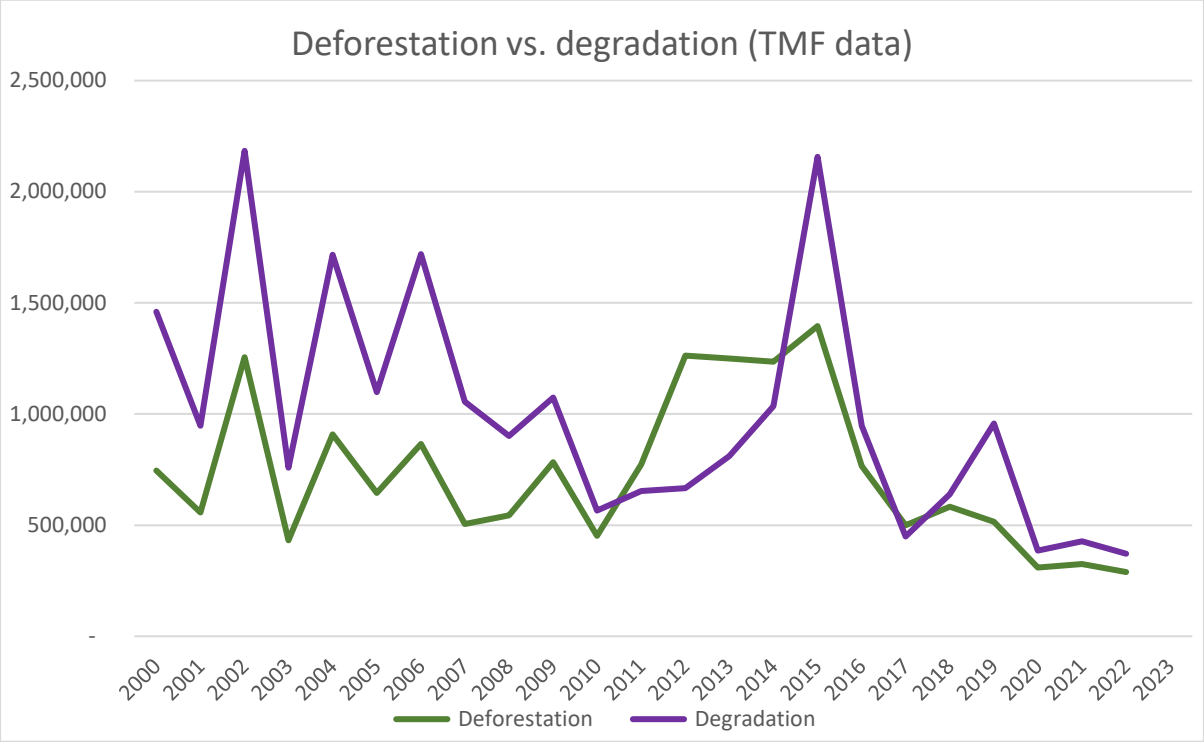

Figure 3: Deforestation and forest degradation (ha), 2000-2022. Source: TMF data.

3.2 Deforestation by location

The change in deforestation is uneven across islands and provinces, which makes it necessary to disaggregate numbers and identify which regions have driven the national level decline. We use mainly two data sets, the TMF and MBI. KLHK data are not publicly available at subnational level. We also supplement with some analysis using the Nusantara Atlas data.

3.2.1 Main islands

The changes in deforestation over time in the four main forest islands of Indonesia are depicted in Figure 4. Given that TMF deforestation is detected from disturbances in forest cover and MBI transitions from land use following forest loss, MBI likely does not account for fire-related loss. To account for this difference, we added fire loss from Tyukavina et al. (2022) to MBI forest conversion and find that fire correction makes the trends overall more comparable, with the exception of Sulawesi.

According to TMF data, the largest forest loss between 2000 and 2022 has occurred in Sumatra (11.4 Mha), followed by Kalimantan (7.7 Mha) and Sulawesi (1.9 Mha). To understand the noticeable gap between MBI and TMF data for the later island, we compare both figures with estimates from Supriatna et al. (2020) who find 2.1 Mha of forest loss between 2000 and 2017, confirming the TMF estimates. Besides mining and oil palm, they identify corn as a major commodity behind the loss in Sulawesi, frequently cultivated by smallholders who use the improved forest access created by logging activities. A hypothesis for the low deforestation estimates in MBI compared to TMF could then be that smallholder activities are not fully captured in the detection algorithms.

The trend analysis for the islands shows that the decline started earlier in Sumatra and Kalimantan compared to Sulawesi and Papua[6]. Although forest fires played an important role in the peak years around 2015, especially on Kalimantan and Sumatra, they do not explain all the observed increase, indicating that other factors also were important in explaining the surge and following decrease of deforestation.

The islands with the largest decline in 2021-2022, compared to the base period 2010-2017, were Sulawesi, with 81.2% reduction in 2021-2022, followed by Kalimantan with 69.7% reduction, whereas Sumatra deforestation levels remained comparatively high with “only” 55.8% reduction.

[6] We use the term “Papua” for the Indonesian part of the island of New Guinea, also referred to as Indonesian New Guina or Indonesian Papua. Similarly, “Kalimantan” refers to the Indonesian part of the island of Borneo.

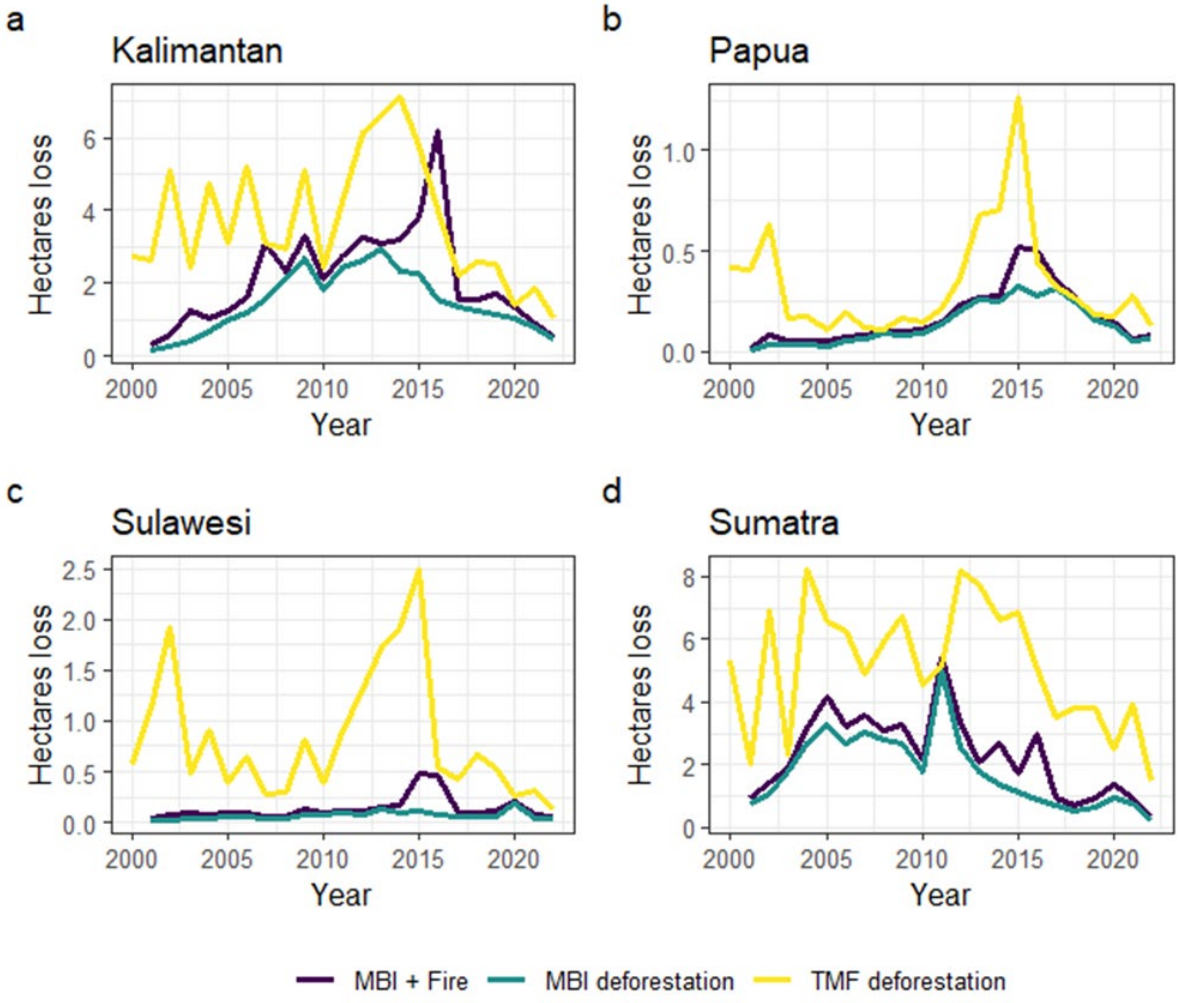

Figure 4: Deforestation on main islands for different data sets, 2000-2022. Sources: MBI, TMF, Tyukavina et al., (2022).

The two plots shown in Figure 5 picture the composition of deforestation across the major islands, based on the MBI and TMF data. The dominance of Sumatra and Kalimantan is clear, while the changes in their shares are not consistent between the two figures. Keeping in mind the specifics of the data described in Section 2.3, an explanation for the differences possibly lies in the type of deforested forest, since TMF deforestation specifically concerns previously undisturbed (old growth) forest whereas MBI's forest loss encompasses a much broader forest category.

Whereas TMF data depicts that most of the remaining undisturbed forest is lost in Sumatra, MBI data indicates Kalimantan as the major contributor to forest loss according to its specific forest categorisation. Despite the differences, both data sets show an increasing share for Sumatra and declining share for Kalimantan in recent years, suggesting that the deforestation drop in Kalimantan was more pronounced than in Sumatra.

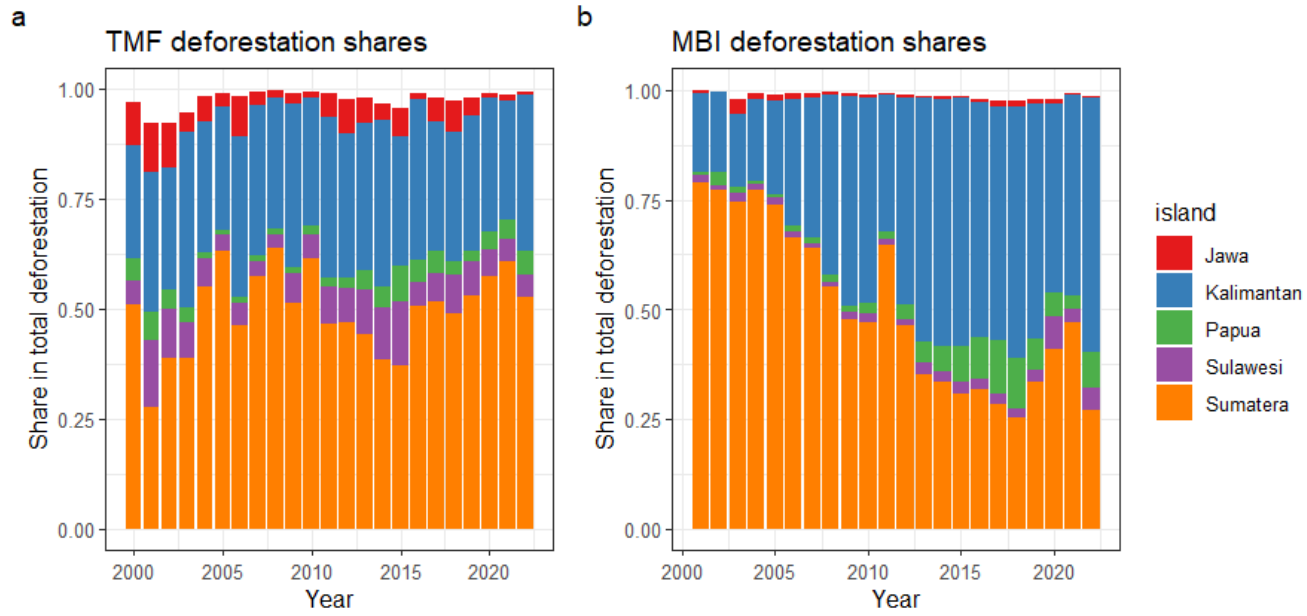

Figure 5: Deforestation 2001-2022 by island. Source: TMF and MBI data.

3.2.2 Provinces

The decline in deforestation varies greatly across provinces. Table 1 shows the decline in provinces with more than 1 Mha. Among the large deforestation provinces during the period 2010-2017 (> 100 000 ha), Riau and Kalimantan Barat (West Kalimantan) had a decline of ca. 60% in 2021-2022, while Sumatra Selatan (South Sumatra) and Kalimantan Tengah (Central Kalimantan) had an even larger drop of 73% and 80%, respectively. Furthermore, we note that Riau's two neighbouring provinces, Sumatra Barat (West Sumatra) and Jambi had much smaller reduction of 18-20%. The largest relative reductions are found in Sulawesi Utara (North Sulawesi), Sulawesi Selatan (South Sulawesi) and Maluku.

The Indonesian part of the island of Papua, which was recently divided into six provinces but here is aggregated into one, has seen comparably little deforestation over time, except for the peak year in 2015. Roughly 20% of TMF forest loss on Papua during 2015 was caused by fires (see Figure 4).

Province	Deforestation (ha)			Change (%) compared to 2010-17		Change (ha) compared to 2010-17	
	2010-17	2018-20	2021-22	2018-20	2021-22	2018-20	2021-22
Aceh	39 031	20 053	17 446	-49 %	-55 %	-18 977	-21 584
Bengkulu	18 246	12 408	8 732	-32 %	-52 %	-5 839	-9 514
Jambi	70 972	57 111	57 132	-20 %	-20 %	-13 861	-13 840
Kalimantan Barat	163 724	77 957	69 154	-52 %	-58 %	-85 767	-94 570
Kalimantan Selatan	33 152	14 318	5 911	-57 %	-82 %	-18 834	-27 241
Kalimantan Tengah	134 797	50 688	26 810	-62 %	-80 %	-84 109	-107 987
Kalimantan Timur	94 667	47 846	27 483	-49 %	-71 %	-46 821	-67 183
Maluku	8 839	2 214	976	-75 %	-89 %	-6 624	-7 863
Maluku Utara	8 892	2 110	2 457	-76 %	-72 %	-6 783	-6 435
Papua	56 367	18 887	20 891	-66 %	-63 %	-37 480	-35 477
Riau	180 311	101 280	72 260	-44 %	-60 %	-79 031	-108 051
Sulawesi Barat	13 636	7 191	4 769	-47 %	-65 %	-6 446	-8 868
Sulawesi Selatan	30 408	10 089	3 720	-67 %	-88 %	-20 319	-26 688
Sulawesi Tengah	40 609	15 433	8 527	-62 %	-79 %	-25 176	-32 082
Sulawesi Tenggara	20 092	7 622	3 746	-62 %	-81 %	-12 470	-16 345
Sulawesi Utara	8 879	3 945	1 142	-56 %	-87 %	-4 934	-7 737
Sumatra Barat	26 692	20 103	21 863	-25 %	-18 %	-6 589	-4 829
Sumatra Selatan	144 629	64 738	39 453	-55 %	-73 %	-79 891	-105 175
Sumatra Utara	71 846	42 010	33 088	-42 %	-54 %	-29 836	-38 757

Table 1: TMF deforestation in hectares for provinces with the highest forest cover (>1Mha). Source: TMF data.[7]

[7] For convenience, and due to changes in provincial border, Papua includes all the provinces on the Indonesian part of the island.

The absolute reduction shows a slightly different picture. Three provinces have reduced their deforestation by more than 100 000 ha: Riau, Kalimantan Tengah (Central Kalimantan) and Sumatra Selatan (South Sumatra). Large-scale reductions have also taken place in Kalimantan Barat (West Kalimantan) and Kalimantan Timur (East Kalimantan). The latter province is an interesting case, as it has been part of the World Bank's Forest Carbon Partnership Facility (FCPF). Under the FCPF, the Government of Indonesia and the World Bank agree to reduce 22 million CO_2 equivalent for the period of 2019-2024 (Forest Carbon Partnership Facility, 2022).[8] By December 2020, East Kalimantan had achieved emission reduction by 30.8 million tons of CO_2 equivalent. Subject to verification, the province successfully met the agreement within 1.5 years of the five-year plan and could opt to sell the additional 8.8 million tons of CO_2 equivalent (Forest Carbon Partnership Facility, 2022; Green Climate Fund, 2022).

Overall, we see highly varied patterns, with different trends among neighbouring provinces. We note a major decline in several of the Sulawesi provinces. The pattern in Sumatra is varied, with several provinces having small reductions. In Kalimantan the picture is more uniform, with the four major provinces having significant reductions (58-82%).

3.3 Deforestation-risk commodities (direct drivers)

3.3.1 Land use transitions

Given that the MBI data set displays the transition between different land cover categories from one year to the next, we use that to understand the commodities that drove deforestation and how they changed over the past two decades. The land cover categories encompass forest formation, oil palm, pulpwood, rice, mining, water, other agricultural land and other non-vegetated land (such as infrastructure). Unfortunately, the disaggregation is at a high scale, and, for example, rubber does not have its own category but is classified as "other agriculture". The classification of land cover in MBI data allows to reconstruct what area of each category is converted into something else each year and also into what it is converted. Figure 6 shows such flows for the four main islands, averaged over the time periods 2001-2009, 2010-2017 and 2018-2022. (NB: Note the different scales on the y-axis.) The corresponding figures are presented in Table 2.

For all islands, with the exception of Sulawesi, we observe a significant decline in the total land use transitions from the 2010-17 to the 2018-2022 period. For Sumatra, this is part of a longer trend (i.e., a decline also from the 2001-2009 period).

A second observation is that in Kalimantan and Papua, forest is the main "supplier" of new land in the land use transitions, while the category "Other agriculture" is a major supplier of land use transitions in Sulawesi and even more so Sumatra.

[8] The Emission Reductions Payment Agreement is available at the following link: https://www.forestcarbonpartnership.org/system/files/documents/FCPF%20Carbon%20Fund%20ERPA%20Tranche%20A%20&%20B.pdf

A third observation, we observe a change in the composition of post-forest land uses, as we summarize in section 3.4.

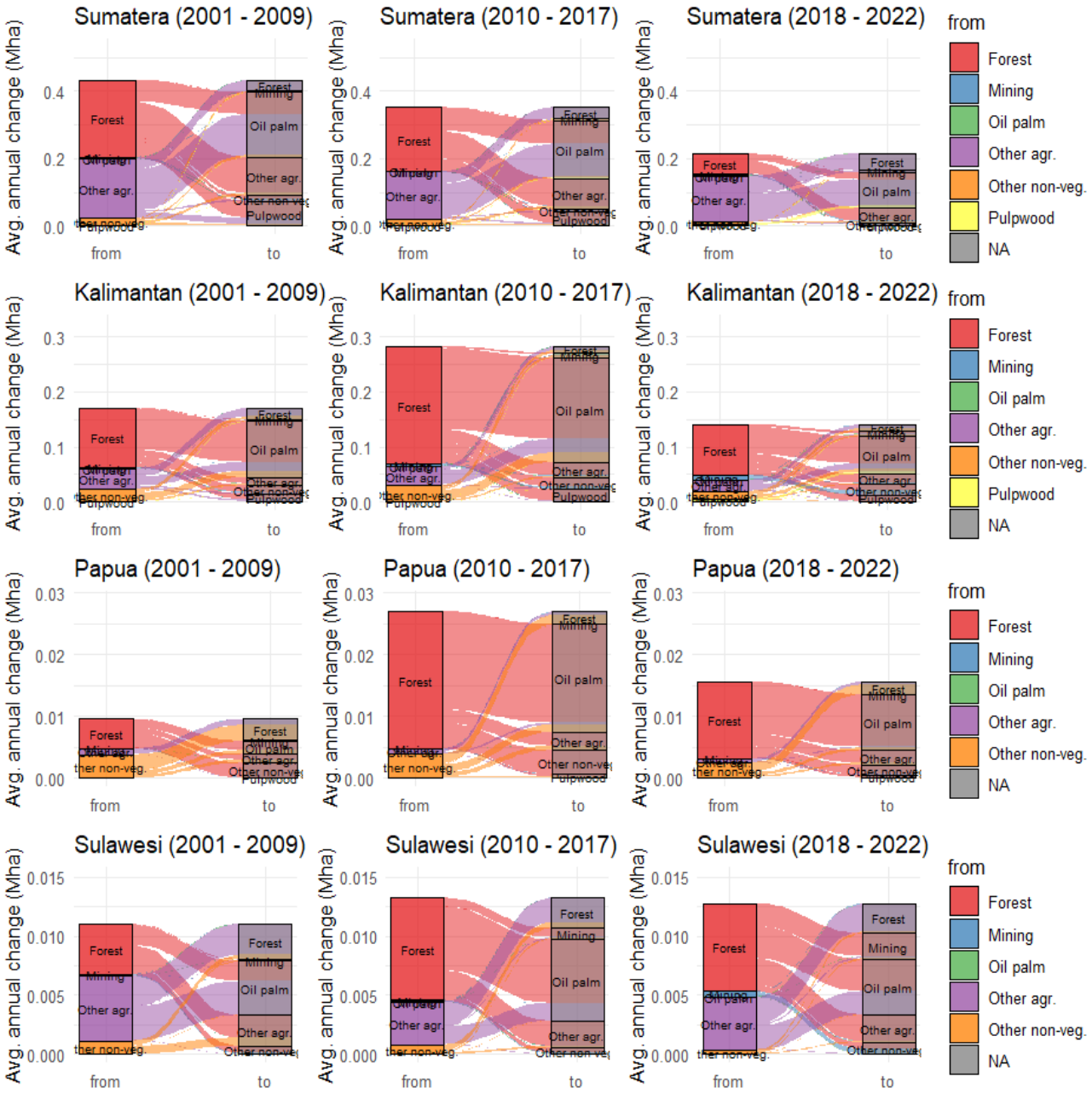

Figure 6: Land use transitions in the major islands. Source: MBI data.

Island	Category	2001-09 (ha)	2010-17 (ha)	2018-20 (ha)	2021-22 (ha)	2001-09 (pct. of 2010-17)	2018-20 (pct. of 2010-17)	2021-22 (pct. of 2010-17)
Kalimantan	Mining	969	3 258	4 339	4 844	29.7	133.2	148.7
	Oil palm	74 144	156 770	68 077	39 867	47.3	43.4	25.4
	Other agr.	11 367	24 662	22 256	12 574	46.1	90.3	51.0
	Pulpwood	8 812	22 324	18 914	4 507	39.5	84.7	20.2
Papua	Mining	5	1	1	4	973.1	109.6	732.7
	Oil palm	1 475	14 506	17 732	4 988	10.2	122.2	34.4
	Other agr.	874	2 238	2 701	1 252	39.1	120.7	55.9
	Pulpwood	67	317	510	242	21.1	161.2	76.5
Sulawesi	Mining	58	787	712	2 713	7.4	90.5	344.9
	Oil palm	1 716	5 949	936	4 090	28.9	15.7	68.7
	Other agr.	1 900	1 961	3 174	1 674	96.9	161.9	85.4
Sumatra	Mining	180	304	292	656	59.1	95.9	215.7
	Oil palm	64 270	78 815	6 677	30 204	81.6	8.5	38.3
	Other agr.	105 990	86 237	50 574	31 672	122.9	58.7	36.7
	Pulpwood	48 288	36 559	3 634	619	132.1	9.9	1.7
Total	Mining	1 212	4 350	5 343	8 217	27.9	122.8	188.9
	Oil palm	141 605	256 041	93 423	79 149	55.3	36.5	30.9
	Other agr.	120 131	115 098	78 705	47 171	104.4	68.4	41.0
	Pulpwood	57 166	59 200	23 058	5 368	96.6	39.0	9.1

Table 2: Post-forest land uses. Source: MBI data.

3.3.2 Forest encroachment factor

Forest loss due to the expansion of the cultivation area used for agricultural commodities can be decomposed into two factors:

*forest loss to crop ≡ total increase in area of crop * forest encroachment factor for crop*

where the "forest encroachment factor" is defined as the share of new cropland that is converted from forest. While some factors, such as crop prices, determine the overall demand for new cropland, other factors may influence the encroachment factor more directly, such as product certification and moratoriums. On the land supply side, the scarcity of forest will matter both for decisions on whether to intensify (increase yield) or extensify (increase land area), as well as the type of land to expand on (if an extensification strategy is chosen).

Table 3 presents the encroachment factors for oil palm and the category "Other agriculture", for different island and time periods. For oil palm, the encroachment factor varies significantly across islands. It has since 2010 remained above 90% in Papua, while it is lower in Kalimantan and Sulawesi, and the lowest in Sumatra. The encroachment factor also dropped significantly for Sumatra. However, a major drop in the extent of new oil palm in 2018-2020 in Sumatra made the aggregate encroachment factor for Indonesia increase in this period (higher share, while declining again in 2021-2022.

Oil palm	2001-2009	2010-2017	2018-2020	2021-2022
Kalimantan	72%	76%	76%	63%
Papua	68%	91%	93%	92%
Sulawesi	36%	75%	65%	53%
Sumatra	33%	40%	26%	18%
Indonesia	46%	60%	69%[9]	32%
Other agriculture	**2001-2009**	**2010-2017**	**2018-2020**	**2021-2022**
Kalimantan	40%	60%	51%	55%
Papua	56%	71%	72%	69%
Sulawesi	8%	12%	29%	28%
Sumatra	72%	70%	50%	53%
Indonesia	50%	55%	45%	45%

Table 3: Forest encroachment factors for oil palm and "other agriculture". Source: MBI data.

We also observe a decline in the encroachment factor for "Other agriculture" after 2017/2018, driven by a decline in both Kalimantan and Sumatra. The provincial differences are smaller than for oil palm.

The Nusantara Atlas data offers one additional direct driver of deforestation, namely forest conversion to pulp, and report three post-forest land uses: oil palm (split between smallholder and industrial), industrial pulp, and other land uses. The encroachment factors for oil palm for the three provinces with the highest deforestation in 2010-2017 in Sumatra (Riau, Jambi and South Sumatra) and Kalimantan (West, East and Central Kalimantan), as well as the overall for Indonesia, are reported in Table 4.

The absolute numbers are not comparable as the Nusantara Atlas data presented here only include the three largest "deforestation provinces" on each island, in addition to differences in definitions and raw data and processing. Yet the generally much lower encroachment factors for palm oil is notable for the Nusantara Atlas data.[10]

However, the main story emerging is similar for the two data sets. Compared to the previous period (2010-2017), total land expansion for oil palm declined substantially in 2018-2022, by at least 60 % depending on island and data set. Hence for Indonesia as a whole, the main cause of reduced expansion of oil palm into forest was the overall decline in the expansion of oil palm area. In Sumatra, is however, an exception: the reduced forest loss due to oil palm was due to a decline in the forest encroachment factor.

[9] The increase is due to a shift in the composition of oil palm driven deforestation between the islands, with Sumatra (low encroachment factor) reducing its share.

[10] We have not investigated further the reasons for the difference, beyond noting that different definitions, raw data and procedures are used in the two data sets.

	2001-2009	2010-2017	2018-2020	2021-2022
Kalimantan (3 main provinces)				
Total expansion of oil palm (ha/year)	191 114	266 439	76 703	41 536
Forest expansion of oil palm (ha/year)	51 732	85 233	26 141	9 252
Encroachment factor	27%	32%	34%	22%
Sumatra (3 main provinces)				
Total expansion of oil palm (ha/year)	166 276	113 335	28 255	18 323
Forest expansion of oil palm (ha/year)	61 773	35 120	1 684	1 474
Encroachment factor	37%	31%	6%	8%
Indonesia (all provinces)				
Total expansion of oil palm (ha/year)	468 019	505 103	144 450	76 532
Forest expansion of oil palm (ha/year)	153 270	175 858	42 614	19 220
Encroachment factor	33%	35%	30%	25%

Table 4: Forest encroachment factors for oil palm in Sumatra and Kalimantan: Source: Nusantara Atlas.

Looking at the encroachment factors in further details, Figure 7 displays the change in encroachment factors over time for industrial and smallholder oil palm, and for industrial pulpwood, for Indonesia (Nusantara Atlas data). First, the encroachment factor for smallholder oil palm has dropped since 2014 and been lower than the factor for industrial oil palm.[11] Smallholder deforestation made up ca. 24% of total oil palm deforestation over the period 2001-2023.

A second observation from the figure is that the encroachment factor for industrial pulpwood also has declined over the past decade and is now at around 20%.

[11] Note, however, that smallholder conversion to oil palm is harder to detect immediately by satellite, and it takes several years to get good data on that form of forest conversion.

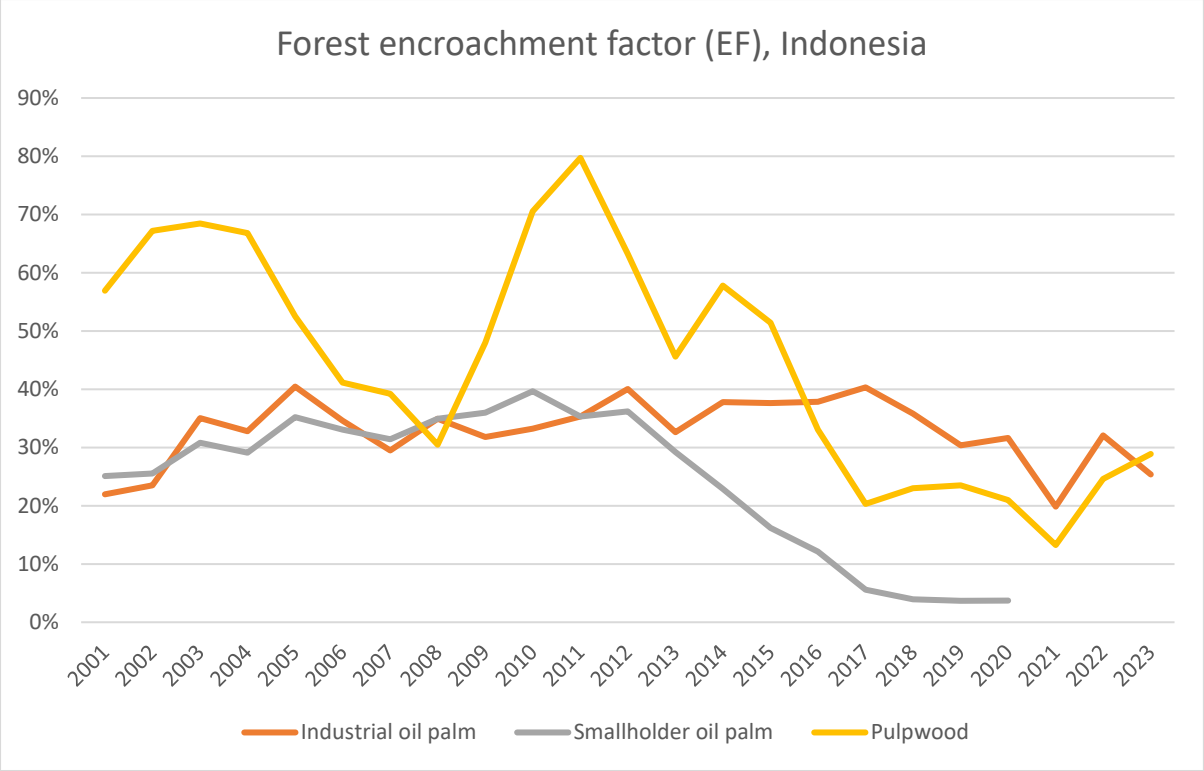

Figure 7: Forest encroachment factors for oil palm (industrial and smallholder) and industrial pulpwood. Source: Nusantara Atlas data.

The trend of declining oil palm forest conversion can also be seen when looking at the different post-forest land uses in Figure 8a. After a peak year in 2011, oil palm has continuously declined as a driver of deforestation and was even surpassed by "Other agriculture" as the most important post-forest land use in 2019 and 2020.

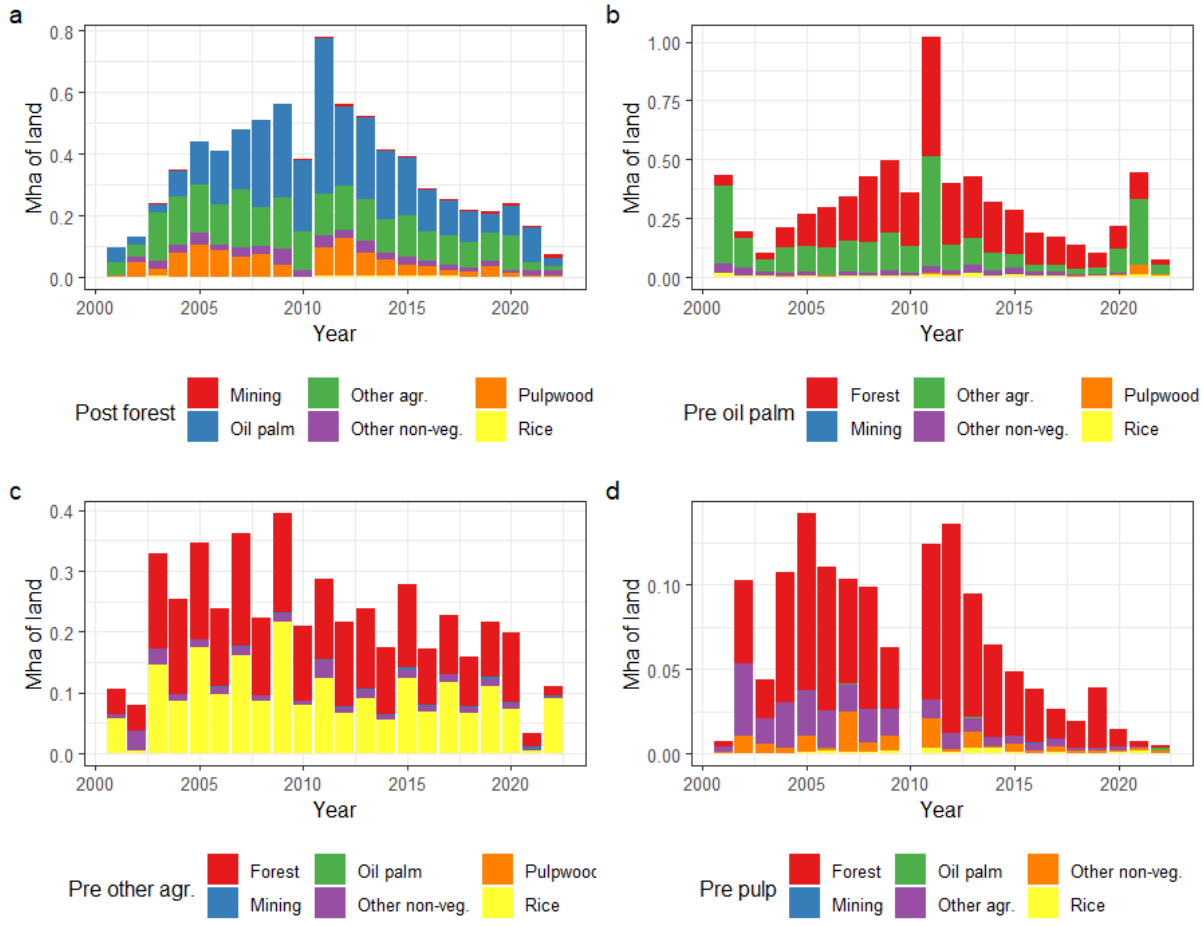

Figure 8: (a) Post-forest land uses, (b) pre oil palm land cover, (c) pre "Other agriculture" land cover and (d) pre pulpwood land cover, 2001-2020. Source: MBI data.

3.4 Synthesis of direct drivers

3.4.1 Oil palm driven deforestation slowed down, but still plays a major role

Historically, oil palm is the commodity most linked with deforestation in Indonesia. On Sumatra, oil palm driven deforestation has substantially declined when comparing 2010-2017 to 2018-2022 averages, and the highest share of new oil palm area in recent years was previously classified as "Other agriculture" land.

Although the share of previously forested land in new oil palm plantations is significantly higher in Kalimantan and Papua compared to Sumatra (at least using MBI data), the overall new palm oil area has declined in parallel with the decline in overall deforestation since the peak period 2010-2017. This is largely explained by a major decline in new oil palm areas, whereas the reduced share of new plantation areas from forest land (the forest encroachment factor) also played a role in Sumatra but not in Kalimantan. Looking at the whole country, and the previous land uses/cover of new oil palm areas, Figure 8b shows that the forest encroachment factor was relatively constant over the years of declining deforestation, again pointing to a general slowdown of the oil palm expansion as the main explanation, rather than the relatively less forest being converted to new oil palm plantations.

Despite the decline in new oil palm area, it is worth noting that all three islands have not seen substantial transformation of oil palm into other categories, suggesting that the net area of oil palm is still increasing.

3.4.2 The emergence of pulp wood as a deforestation driver

Starting around the beginning of the century, pulpwood has emerged as a major deforestation commodity in Indonesia. As Figure 8a and Figure 8d show, most of new pulp wood plantations are established on land that was previously forest. Most of the pulp wood deforestation occurred in Sumatra and Kalimantan, but with some significant differences (Figure 6). It is important to note, however, that the KLHK data does not consider pulpwood expansion as deforestation.

With an average of 48 288 ha between 2001 and 2009, Sumatra saw most of its forest loss from pulp wood in the first decade of the 20th century. In the 2010s, the area of new pulp wood declined significantly and even partly was converted into oil palm, especially in most recent years. In contrast, Kalimantan experienced most of the pulp wood expansion into forest area in the second decade of the 20th century. This dynamic has also been documented in other data sources[12].

3.4.3 Mining surging

Expanding mining activities (e.g., coal and nickel) are seen particularly in East Kalimantan and Sulawesi (Figure 6), although their share in country level forest loss remains low for now. However, it is important to note that the direct effects of mining on forests can be accompanied by large indirect effects, for instance from infrastructure development, and by simulating in-migration of mining workers and their families, that do not immediately show in post-forest land use figures (Giljum et al., 2022).

Mining activities are also increasing in Papua, much around Freeport (gold and copper) where most forest is gone, and therefore with less forest loss than elsewhere. There is a plan for a new mining site in Intan Jaya regency, which may pose risk for deforestation (Bashir, 2022).

A recent paper traces the land use footprints of nickel in Indonesia, with updated estimates of the direct land use change (dLUC) per ton of ore, and find the footprints to be ca. 20 times higher than previous studies found (Heijlen & Duhayon, 2024). Indonesia is by far the largest nickel producer, with close to half (48%) of the global production in 2023.[13]

Finally, one should note that while industrial mines are not hard to detect with remote sensing, artisanal mining is more difficult. Gold mining has a large artisanal sector, with a long tradition and occurs across the archipelago (Meutia et al., 2022).

[12] Nusantara Atlas | 2023 Deforestation by the Wood Pulp Industry in Indonesia Surges, Hits Record Highs in Kalimantan (nusantara-atlas.org). See also University of California Santa Barbara et al. (2023).
[13] https://mine.nridigital.com/mine_apr24/top-10-nickel-producing-countries-2023

4 Policy changes and the links to deforestation

Several studies and observers argue that the two major factors that have contributed to the decline of deforestation are public policies and industry actions (Jong, 2021a; Lee, 2023).

This section provides an overview of policies and measures to improve forest governance and reduce deforestation. We distinguish between public regulation, private regulation, and self-regulation. **Public regulation** refers to policies and measures developed or led by public authorities, including the judicial system in the public regulation domain. **Private regulation** refers to regulations that are formulated and implemented by the private sector and that govern the whole industry. Two relevant examples are the Forest Stewardship Council (FSC) timber certification and the Roundtable Sustainable Palm Oil (RSPO) certification systems. Finally, **self-regulation** refers to the policies or regulation made by an individual private sector actor or a collective of private sector actors. This may also include regulations made by indigenous people and local communities. However, we decided to discuss the issue on IPLC under the social forestry and the roles of civil society organizations' in reducing deforestation in Indonesia.

Table 5 provides a timeline of key policies within each of these three areas in Indonesia. These are discussed in more details in the following sections.

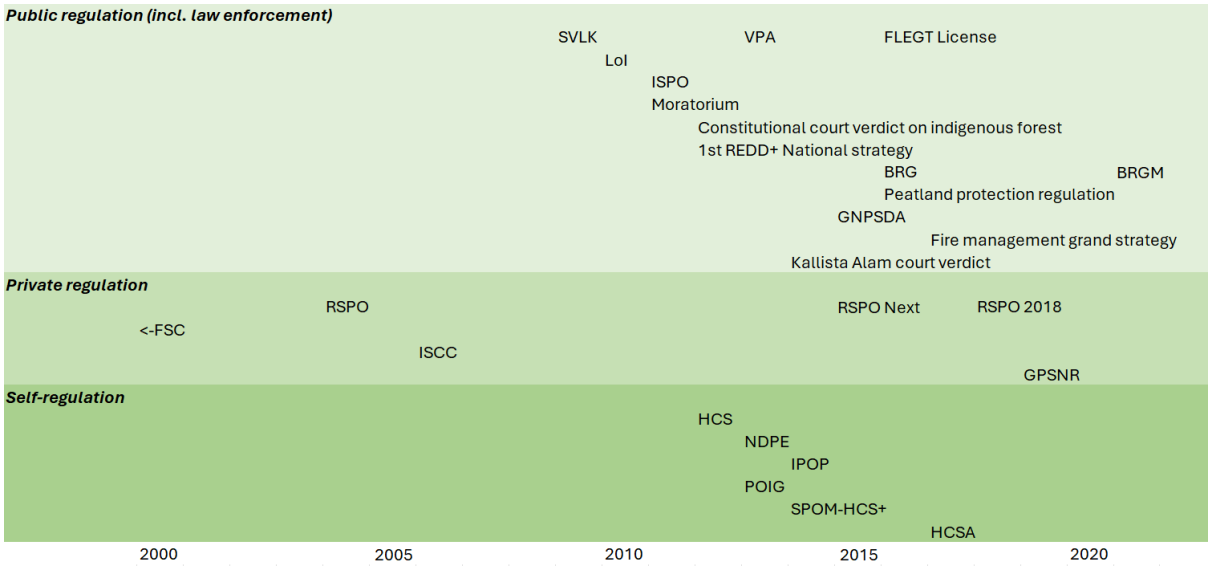

Table 5: Timeline of selected, key policies and measures.

4.1 Public policies

The Government of Indonesia (GoI) has issued a number of policies to reduce deforestation. These include: the 2011 moratorium of issuing new permits to clear primary forests and peatlands, which was made permanent in 2019; the 2018-2021 moratorium on new oil palm plantation licenses; forest fire mitigation; social forestry program; land restoration and rehabilitation; and increased enforcement against environmental violations (Jong, 2021a; Nugroho et al., 2023). The GoI has strengthened the regulation on Indonesian Sustainable Palm

Oil (ISPO) several times since it was issued in 2011, and the same applies to the Timber Legality and Sustainability Verification System (SVLK), which started in 2009.

Subnational governments have become increasingly more engaged with sustainable land use by issuing subnational regulations on sustainable plantation. There are concerns, however, that forest-related policies under the new Job Creation Law (Omnibus) would provide some legal grounds for increased deforestation or degradation. Most notably, the resolution for the problem of oil palm plantations' encroachment into the state forests has been criticized for not adequately addressing the problem.

We classified the public policies by level (national vs. subnational) and type, using the following classification:

1. **Moratorium**: key policies are the moratorium of new forest permits and moratorium of new oil palm plantation permits.
2. **Forest and peatland management and protection**: key policies are the establishment of forest management unit (Kesatuan Pengelolaan Hutan, KPH), peatland protection and restoration, and social forestry.
3. **Commodity certification**: key policies are the Timber Legality Verification System (Sistem Verifikasi Legalitas Kayu, now Sistem Verifikasi Legalitas dan Kelestarian, SVLK) and Indonesian Sustainable Palm Oil (ISPO),
4. **Result-based payment**: notable results-based payment arrangements are the ones partnered with the Green Climate Fund, Norwegian government at the national level, and agreements between multi donor funds coordinated by the World Bank at the provincial level.
5. **Law enforcement and integrated fire management**: law enforcement has been one of the strategic areas of the Ministry of Environment and Forestry. The last decade was marked with stronger implementation of the law enforcement approach to curb forestry-related offences. After the 2015 fire events, the GoI intensified the efforts for prevention, early detection, suppression and rehabilitation. These measures range from policy formulation, organizational strengthening, and law enforcement.

Table 6 provides summary of the evidence of the impact of these activities, and our assessment both in terms of likely impact and the strength of evidence for the stated impact.

Policies/Measures	Scientific evidence	Interviews	Our assessment
Moratorium primary forests and peatlands (2011)	• Moratorium has reduced deforestation. • Concessions in moratorium areas show lower deforestation than outside. • Displacement of deforestation outside moratorium areas.	• Moratorium provides a spatial restriction of primary forests and peatlands. • It strengthens the data and coordination among government offices at the national level. • It does not provide legal penalties for obstruction, requires	• Medium-high impact (medium-high evidence). Moratorium clarifies the border of primary forests and peatlands, based on which new permits were not issued. It took eight years before the policy was made permanent, reflecting

	• Moratorium map has been revised several times.	coordination with other agencies with different interest, and there are some exceptions, such as National Strategic Programmes.	the huge challenges to align maps of different ministries and national agencies. It also triggers deforestation outside moratorium area. It also has exemptions for existing permits and national strategic interests.
Moratorium oil palm permits (2018)	• Simulation shows potential impact to reduce deforestation. • No known study on the actual impact.	• It provides a spatial restriction but only applicable for new permits. • It requires coordination between authorities of state forest areas and areas for other uses, and between national and subnational governments. • Resolution of the oil palm encroachment into state forest is captured by the Job Creation Law, focusing more with administrative procedures.	• Low - moderate impact (low evidence). While it aims to take a similar pathway as the primary forest and peatland moratorium, coordination cost is high as it involves subnational government and palm oil companies, which generally are not willing to share their spatial data. Subnational governments have shown their willingness to revoke permits.
Forest management unit (KPH)	• KPHs has the potential to work as an intermediary among global, national, and local interests in reducing deforestation. • KPHs face capacity challenges and reduced roles after the Job Creation Law. • KPHs face challenge to deal with local conflicts	• Forest management unit provides on-the-ground support of policy implementation. • They face challenges in budgeting, staffing, and entrepreneurship.	• Low impact (medium evidence). While KPHs as organization have been formed, they lack capacity to implement their functions.
Peatland protection and restoration	• Serious attention from the Government of Indonesia esp. after 2015 fire event. • Creation of Peatland Restoration Agency and regulatory framework on peatland protection. • Canal blocking as a cost-effective peatland restoration • More preventive measures needed.	• Protecting and restoring peatlands reduce emissions significantly. • Government of Indonesia issued Regulations on peatland protection, established Peatland Restoration Agency, and prioritize several provinces for peatland restoration activities.	• Medium impact (medium-high evidence). Peatland restoration could reduce fires, which eventually reduce fire-driven deforestation.

Social forestry	• Potential reduction in village forest and production schemes • But forest loss at the starting point was high	• Show increased forest cover in Jambi and West Sumatra • Mainly through the sense of ownership and CSO facilitation	• Low impact (medium evidence). Some scattered success stories, but lack of scale.
Commodity certification	• Perception that deforestation has reduced with the introduction of SVLK. • Difficult to assess the impact of ISPO.	• SVLK requires actors to have good business process, including purchase and sales records. • The records include the origin of timber.	• Low impact (low evidence). SVLK is perceived to have contributed to reduce deforestation. ISPO does not prevent deforestation. Rigorous studies are required to assess actual impacts of commodity certification on deforestation.
Results-based payment	• Under the FCPF, East Kalimantan has reduced emission earlier than projected. • National level RBP (Norway, GCF) hard to assess	• It requires availability of data and presence of a functioning government-led multistakeholder process • RBP been "an icing on the cake".	• Medium impact (low-medium evidence). FCPF program in East Kalimantan has proved to be an achievement. The challenge is to scale out to other provinces. National level RBP one among several motivations for policy reforms.
Law enforcement	• Initially focus on encroachment, illegal logging, illegal wildlife trade, and fires • Use multidoor approach • Low deterrent effects and no losses have been restored	• Strengthened law enforcement, and the use of multidoor approach. • An increased number of civil courts for land and forest fire cases. • Fines do not materialize.	• Low impact (medium evidence). While enforcement efforts have been acknowledged, they give low deterrent effects and do not return the loss.
Integrated fire management	• See peatland restoration	• Commitment to look for permanent solutions to fires. • Increased coordination among national government agencies • Development of monitoring systems (i.e., Sipongi)	• Medium impact (high evidence). Fire prevention and suppression might have contributed to the reduced fire-driven deforestation.

Table 6: Overview of major public policies aimed at forest conservation.

4.1.1 Moratorium of new permits

There are two major policies related to land allocation that are considered to have provided major contributions to the decline of deforestation. The first is the moratorium of permits on primary forests and peatland, which started in 2011. The then-President Susilo Bambang

Yudhoyono signed the Presidential Instruction 10 of 2011 on 23. May 2011. The President instructed to take the necessary steps to support the postponement of issuing new licences for primary natural forest and peatland in conservation forests, protected forest, production forest (restricted production forest, regular permanent production forest, convertible production forest) and areas for other uses (*Area Penggunaan Lain*, APL). The GoI created the indicative moratorium map (known by its Indonesian abbreviation PIPPIB), which is updated every six months. President Joko Widodo made the moratorium permanent by signing the Presidential Instruction 5 of 2019 on 7. August 2019, aiming to protect 66.2 million ha of primary forests and peatlands (MoEF, 2022). The area was about 3 million ha lower than the initial PIPPIB figure of 69.1 million. One interviewee stressed that the reduction does not reflect the loss of forest, but rather the adjustments of permits data across ministries and levels of governments that took place between 2011 and 2019 when the moratorium was made permanent. The adjustments were conducted to find and verify existing permits and exclude them from the moratorium map.

According to some resource persons, the moratorium works in tandem with the One map policy that was initially developed during Mr. Yudhoyono's administration. Consistent with the One map policy's objectives, the moratorium's initial activity was to conduct inventory of primary forests and peatlands both inside and outside state forests. Since these areas are not only under the management of the Ministry of (Environment and) Forestry, it took several years before the synchronization process could be completed (interview 32).

Studies on the impact of the logging and peatland moratorium show that the policy may have reduced deforestation (Busch et al., 2015; Chen et al., 2019; Groom et al., 2022). Busch et al., (2015) simulate using 2000-2010 data, and concluded that should the moratorium have started in 2000, it would have been able to reduce the deforestation by 153–399 000 ha. Considering leakage (geographic displacement of deforestation to locations not covered by the moratorium), the reduction would have been 116–305 000 ha. Another study, using 2001-2017 data, indicated that there was a significant reduction of forest loss on the areas under moratorium, and concessions under moratorium were shown to have significantly lower forest loss than those outside the moratorium areas (Chen et al., 2019). A third study finds a small difference of dryland forest in forest loss between areas under and outside moratorium areas, although no difference in wetlands (Groom et al., 2022). Others claim that fire occurrences have been lower on the areas under moratorium (Lee, 2023, interview 28, 32).

In contrast, others claim that deforestation tends to increase in moratorium areas, where the annual deforestation was 97 000 ha in 2005-2011 and increased to 137 000 ha in 2012-2018 (Greenpeace Indonesia, 2019). Others have pointed to the risk of deforestation outside the areas under the moratorium (Leijten et al., 2021; Suwarno et al., 2018). There are also general concerns that some aspects make the moratorium may be less effective. The PIPPIB have been adjusted several times to accommodate the exceptions made explicit in the presidential instructions, which lies lower at the hierarchy of Indonesia's legislation (Greenpeace Indonesia, 2019; interview 15, 23). As such, there is no penalties if the instruction is neglected. Moreover,

since some of the primary forests and peatlands are located outside the state forest, the PIPPIB map must be developed and synchronized among the Ministry of Environment and Forestry, National Land Agency, and other national agencies. Finally, the moratorium contains some exceptions, such as existing permits and areas designated as national strategic programmes (Estherina & Sedayu, 2024).

The second main policy in this category is the moratorium of new oil palm plantation permits. On 19. September 2018, President Widodo signed the Presidential Instruction 8 of 2018 on the moratorium and evaluation of licensing of oil palm and improvement of oil palm plantation productivity. The moratorium aimed to improve the governance of the sustainable palm oil production in Indonesia and to resolve the problem of oil palm areas inside state forests and associated conflicts. One major area was to clarify which agency should be designated as the data manager for the oil palm, and the Directorate General of Estate Crops of the Ministry of Agriculture was assigned that role. More coordination was required since the data on land allocation, land use permit, and plantation business permit are managed by different levels of government agencies (interview 32). The moratorium was effective from 2018 until 2021.

The palm oil moratorium was part of a larger effort to solve challenges on the encroachment of oil palm plantations into the state forest areas, which the GoI responded by issuing the Presidential Regulation 88 of 2017 on the resolution of land control inside the state forest areas. Under the Job Creation law 6 of 2023[14], the 2017 Regulation was replaced by the Presidential Regulation 62 of 2023 on the acceleration of the implementation of agrarian reform. The 2023 Law contains two articles that provide the legal basis for palm oil plantations located in the state forest zone, at least temporarily (Muttaqien, 2023; Nababan, 2023). The article says that every person who carries out business activities that have been established and have permits in a forest area before the enactment of this Law and who has not fulfilled the requirements in accordance with the provisions of statutory regulations in the forestry sector, is obliged to complete the requirements no later than three years since this Law came into force (article 110a). NGOs are particularly concerned about the article because allowing palm oil companies in the state forest areas could backfire the progress made to resolve the oil palm encroachment into the state forest areas (Anonymous, 2023; Nurhadi Sucahyo, 2023; Siti Sadida Hafsyah, 2020; interview 3).

Several NGOs raised concerns about the decision to not extend the moratorium because they have seen some early outcomes of the moratorium, although several areas need improvements, such as law enforcement (Madani Berkelanjutan, 2021). In addition, at least in East Kalimantan, the Presidential Instruction is used as a guidance for provincial government to sort out issues related to palm oil land and permit and to develop sustainable palm oil regulations at the provincial level (interview 13, 21). While NGOs were largely concerned about the palm

[14] Job Creation Law was issued as Law 11 of 2020 on November 2, 2020. The Constitutional Court decided that the 2020 Law was conditionally unconstitutional. On November 3, 2021m, the Constitutional Court, through the Decision No.91/PUU-XVIII/2020 gave the Government of Indonesia and the Parliament two years to revise the Law. On December 30, 2022, the Government of Indonesia issued the Government Regulation in lieu of Law (Perpu) 2 of 2022, which was lifted as Law 6 of 2023.

oil permit moratorium ending in 2021, it was argued that it ended because the follow up or resolution of the oil palm permit issue was integrated into the Job Creation Law 6 of 2023 (interview 28). It was reported that more than 1 000 companies have plantations located in the state forest area (CNN Indonesia, 2023). While studies on the actual impacts of the Law on deforestation are not available (partly due to the Law being contested and re-issued in 2023), analyses point to several implications of the Law on forest governance and deforestation. For example, there are concerns that the Law has relaxed the need for ex-ante environmental impact assessment, centralized the approval and monitoring processes, and weakening strict liability stipulations (e.g., Sembiring et al., 2020). In addition, the Law has revoked the need to maintain a minimum of 30% of watersheds or island (Sunarto et al., 2021).

Studies evaluating the impacts of the palm oil moratorium on reducing deforestation are not available. One study, however, used a simulation to forecast that the large-scale oil palm moratorium could reduce deforestation by 28% and cut greenhouse gas emissions by 16% compared to a no-policy scenario for the period of 2010-2030 (Mosnier et al., 2017). Such simulation studies are useful to demonstrate the potential but may also fail to incorporate several implementation hurdles.

4.1.2 Forest and peatland management

Forest management units

Some interviewees argue that the establishment of Forest Management Units (Kesatuan Pengelolaan Hutan, KPH) is a policy that contributed significantly to reduced deforestation. While the idea of KPHs dates back to the pre-2000 era, it gained momentum after the issuance of the Government Regulation 6 of 2007 (interviews 3, 17). According to Indonesian forestry regulations, KPH was seen as a prerequisite to achieve sustainable forest management (Sahide et al., 2016). KPH was even seen as a response to tackle deforestation and forest degradation (Ramadhan et al., 2023). KPHs were established in 2009 after the issuance of the Minister of Forestry Regulation 6 of 2009 on the establishment of Forest Management Units, and Minister of Forestry Regulation 51 of 2010 on the determination of KPH areas throughout Indonesia and the establishment of model KPHs. KPH has become one of the government programmes with large donor support, including the German government (Marianne Scholte, 2019; interview 17). KPH aims to achieve sustainable forest management, and in that way also reduce the influence of palm oil as a driver of deforestation (Sahide et al., 2016). KPH has the potential to play an important role as intermediaries to achieve REDD+ targets, due to its capacity to connect national and international actors and local realities (Bae et al., 2014; Kim et al., 2016).

Despite the potential and strong donor support, KPHs would still need time to achieve its intended outcomes. First, KPHs are not equipped with sufficient human resources and budget for the operations, including the engagement with communities living in and around the management units (Bae et al., 2014; Kim et al., 2016; Scholte, 2019). Second, in the beginning KPH was designed as decentralized field-level forest management units, where they could operate as executor of forest management programs, including making contract with third parties on certain business aspects. However, under the 2023 Job Creation Law, the role of

KPH was reduced to focus only on facilitation without having executive decision power (Nugroho et al., 2023; Ramadhan et al., 2023). One implication is the reduced budget for KPHs, as they are more dependent on working with other government agencies such as the Watershed Management Agency (Balai Pengelolaan Daerah Aliran Sungai, BPDAS) and other agencies that have activities and programs located on areas under the facilitation of the KPHs. Third, being located at the site level, KPHs often have to allocate resources and time to manage and solve the issues related to land tenure and conflicts. Clarification on land boundary and tenure, including ownership, is frequently an issue in KPH areas (Budiningsih et al., 2022; Ichsan et al., 2021).

Peatland rehabilitation and restoration

Peatland has been well-recognized as a major pool of carbon. When converted to agriculture, it releases large amounts of carbon (Abrams et al., 2016; Ansari, 2011; Dohong et al., 2018). A major policy agenda of the GoI, after the huge fires in 2015, was to protect the country's peatlands. The agenda consists of establishing an organization that works specifically on peatland restoration, creating a regulatory framework on peatland protection, and undertake national and international collaborations on peatland restoration (Nugroho et al., 2023).

The GoI established the Peatland Restoration Agency (*Badan Restorasi Gambut*, BRG) in 2016. The mandate of the Agency was extended to include mangrove in 2021, hence the name becomes Peatland and Mangrove Restoration Agency (*Badan Restorasi Gambut dan Mangrove*, BRGM). The GoI adopts the 3R (rewetting, revegetation, and revitalization) approach to peatland restoration. Rewetting focuses on rewetting peatlands that have been drained by building canal blocking. Revegetation focuses on efforts to increase peatland vegetation cover. Revitalization refers to strengthen the capacity of communities or grass-root institutions, mainly at the village level (Badan Restorasi Gambut dan Mangrove, 2023). Some critics, however, mentioned that the 3R approach lack preventive measures such as Reduction of fire (hence 4R) (Harrison et al., 2020) and Reporting and monitoring (5R) (Terzano et al., 2022).

In the same year, the GoI also issued Government Regulation 57 of 2016 on peatland ecosystems protection and management. Under this framework, the GoI use peatland hydrological unit (*Kesatuan Hidrologis Gambut*, KHG) that defines peatland management areas into cultivation and protection purposes. KHG is expected to hold the expansion of plantations, mainly oil palm (interview 23). The GoI has established 865 KHGs covering 24.6 million ha. BRGM focuses its activities in priority provinces, which consist of 522 KHGs covering 12.9 million ha (Badan Restorasi Gambut dan Mangrove, 2023). The Ministry of Environment and Forestry also has strengthened its peatland-related units, by, for example, building several information systems that monitor fires (called *Sipongi*) and water table of peatland areas (*Simatag*) (interview 28).

In terms of restoration activities, BRGM collaborated with various stakeholders. They built 7,697 canal blockings in 746 villages of the seven priority provinces. BRGM also developed 2,147 hectares of revegetation plots. For the revitalization of livelihoods, BRGM has

established 1,246 packages of land-based, water-based, and ecosystem services-based activities. During 2020-2021, the number of hotspots in BRGM work area drops from 97 to 71, which is associated with the drop of burned area from 3,651 ha to 313 ha (Badan Restorasi Gambut dan Mangrove, 2023). In total, BRGM is mandated to restore 1.2 million hectares of degraded peatlands. By 2023, BRGM reported to have restored nearly 830,000 hectares through rewetting and revegetation (Badan Restorasi Gambut dan Mangrove, 2024). Similarly, reviews on peatland restoration in Indonesia shows the positive effect of canal blocking as a rewetting activity to reduce fires on peatland, and subsequently reduce peatland cover loss, making it a cost-effective measure to combat peatland fires (Kiely et al., 2021; Yuwati et al., 2021).

Social forestry

While social forestry has been one of the priority agendas of the Ministry of (Environment and) Forestry at least since Mr. Yudhoyono's administration, efforts to raise the profile of social forestry has been strengthened during the Widodo presidency. The administration sets out a target to allocate 12.7 million hectares of state forests for social forestry, equivalent to about 10% of the total areas of state forests. By 2022, the Ministry of Environment and Forestry has issued or established social forestry agreement of 5.3 million ha (Kementerian Lingkungan Hidup dan Kehutanan, 2023). One highlight is the clarification of schemes that fall as social forestry. The ministry issued a regulation that defines the different schemes of social forestry, that is indigenous or customary forest (*hutan adat*), community forestry (*hutan kemasyarakatan*), smallholder timber plantation (*hutan tanaman rakyat*), village forest (*hutan desa*) and forestry and environmental partnership (*kemitraan lingkungan*). Social forestry has a large potential for achieving reduced deforestation, insofar it was argued that forest rehabilitation through social forestry would be able to meet Indonesia's target for increasing carbon sequestration (interview 28).

Village forest has the potential to reduce deforestation (Gunawan et al., 2022; Santika et al., 2017, 2019; Wahyu et al., 2020). Village forests in Sumatra and Kalimantan have avoided deforestation, although in the longer term the performance depends on the type of forest function. Village forest reduces deforestation on areas allocated for watershed protection and limited timber extraction (Meijaard, 2017; Santika et al., 2017). However, an analysis of three schemes - village forests, community forestry, and community timber plantation –that cover 2.4 million ha found that schemes that aim at conservation tend to increase forest loss, and these aimed at production tend to reduce deforestation, although the reductions came from an initially higher forest loss (Kraus et al., 2021).

The performance of social forestry also depends on strong support from CSOs. In Jambi and West Sumatra, one analysis found that forest cover increased after the introduction of a social forestry scheme. While the forest cover under social forestry areas large recover through natural succession, it was argued that social forestry increases sense of ownership and responsibility of the agreement holders. They conduct patrol and adopt agroforestry systems in the areas allocated for cultivation (Yola Sastra, 2024; interview 7). While the cases in Jambi and West

Sumatra give some hope for the potential of the social forestry in reducing net deforestation, social forestry permits have been facing significant challenges in terms of flawed land administration processes, conflicting interests among local actors, and lack of institutional engagement beyond permitting process (Fisher et al., 2018). In addition, more small patches of forests under social forestry could lead to forest fragmentation (Gunawan et al., 2022). It is therefore too early to conclude on the nationwide impacts of these initiatives.

4.1.3 Mandatory verification and certification

There are two main products that are covered by mandatory verification or certification: timber and palm oil. Timber is regulated by the Timber Legality and Sustainability Verification (SVLK). For timber concessions, SVLK is supposed to be a stepping stone to achieve Sustainable Production Forest Management (PHPL) (Kosar et al., 2019). The SVLK is compatible with the EU Forest Law Enforcement Governance and Trade (FLEGT), and it became the first scheme in the world to issue FLEGT licenses (2016). According to the Ministry of Environment and Forestry's Information System on Legality and Sustainability (known as SILK), there are 3,983 SVLK-certified management units, both upstream and downstream, by April 2024.

The second commodity is palm oil. Indonesia is the first country that created mandatory sustainability certification for palm oil. The Indonesian Sustainable Palm Oil (ISPO) was created in 2011 and has since been strengthened both in terms of substance and legal backing. In terms of substance, ISPO was revised in 2015 and 2020. ISPO has also been legally strengthened from a ministerial regulation to a presidential regulation. By 2023, ISPO covered 4.2 million ha, of which 3.9 million ha were large-scale plantations. There are 707 certified companies and 79 smallholders (Antara, 2024). These figures translate to approximately 25% of the total oil palm area. 31% of the total oil palm plantation companies being ISPO-certified, while the share of smallholders is miniscule (79 among literally millions of small palm oil producers).

The deforestation reducing effect of both schemes remain understudied. One study shows that actors in Indonesia perceived SVLK to contribute to reduced deforestation, mainly through better implementation of forest management plan and the reduction of illegal logging (Goetghebuer et al., 2023; Tropical Forest Alliance & LPEM Universitas Indonesia, 2022). Another possible impact channel would be that having an SVLK certificate would mean the raw materials come from clear and recorded sources which follow the regulation of the Ministry of Environment and Forestry (Antara, 2020). In the case of ISPO, any impacts must also be seen in connection with private sustainability commitment or pledges. There are concerns, however, that certified companies do not necessarily carry out activities that conserve forests and comply to the national regulation. An example is a Greenpeace report which shows that over 200 ISPO-certified companies allegedly encroach state forest and therefore part of the problems being addressed by the moratorium of palm oil permits (Arumingtyas, 2021; Greenpeace Indonesia, 2021).

4.1.4 *Results-based payment*

One of the mitigation strategies of the Government of Indonesia (GoI) is to establish multi-bilateralism, that is, several bilateral relations under multilateral settings (Leony Aurora, 2012). One mechanism of bilateral agreement is results-based payments (RBP) as part of multilateral frameworks (Dwisatrio, 2021). RBP can be made for both the national and subnational levels. A major example of a national level RBP is the Letter of Intent between Indonesia and Norway in 2010, whereby Norway committed to pay USD 1 billion to Indonesia for verifiable emission reductions[15]. After discontent and disagreements on several issues (including delayed payments), Indonesia terminated the agreement in September 2021 (Jong, 2021b). A year later, in September 2022, however, Indonesia and Norway agreed to a new and modified agreement, where Norway would pay Indonesia to keep the forest standing, while still honouring the outstanding payment from the previous agreement (Jong, 2022). The first RBP payment of USD 56 million was made in 2022, for emissions reduction achieved in 2016-2017. In total, payments of USD 156 million have been made in 2022-2024 for the three forest years 2016-2019.

The Green Climate Fund (GCF) also approved in 2020 a project worth USD 103.8 million, based on emissions reductions achieved in the period 2014-2016. The money was disbursed in 2021, with UNDP as the accredited entity, and are to be used "to invest in activities that support the implementation of the country's national REDD+ action strategy (STRANAS). ... This includes working with key agencies at the national, provincial, and local levels to strengthen the development, coordination, and implementation of Indonesia's overall REDD+ architecture, as well as providing support to decentralised sustainable forest governance. This includes establishing forest management units and expanding implementation of the country's social forestry programme."[16]

RBP is also operational at the province level, where the central government select the province based on several criteria, including the political will of provincial government and a functioning multistakeholder process in place to support provincial government (interview 13, 23, 28). The Forest Carbon Partnership Facility (FCPF) is an example of a subnational RBP, in the form of an agreement between GoI and multiple donors coordinated by the World Bank. A FCPF grant agreement was initially signed in May 2011 and revised in November 2016. FCPF aims to contribute to the development of Indonesia's capacity to design a sound national REDD+ strategy, develop national and subnational reference scenarios and establish a forest monitoring and carbon accounting system, consistent with local, regional and national conditions and circumstances (Ministry of Environment and Forestry, 2023).

In East Kalimantan, one of the activities under the FCPF was the protection of forested areas outsize state forest zone. The size of the area is ca. 850 000 ha, with an aim to protect ca. 640 000 ha. Other activities included climate village program (Wiati et al., 2022). The achievement was noteworthy, as East Kalimantan managed to reduce emission beyond the target and earlier

[15] https://www.regjeringen.no/globalassets/upload/smk/vedlegg/2010/indonesia_avtale.pdf
[16] https://www.greenclimate.fund/project/fp130

than planned (Forest Carbon Partnership Facility, 2022; Green Climate Fund, 2022; interview 13, 26). However, the achievement is debated; deforestation remains high, and the impact of the carrots is questioned as the period for calculating results started not before 2019-2020 (interview 30). It is important to note that while emission reduction measurement was started in 2019, East Kalimantan issued and conducted several policies and programs that lead to its capacity to reduce emissions, started from the "Green East Kalimantan" ("Kaltim Green") as early as 2010. East Kalimantan is also a progressive province in terms of issuing a provincial sustainability regulation for the estate crop sector.

Assessing the impact of national level RBPs is inherently difficult. One approach is to "follow the money" and investigate the impact of the imitated projects. The GCF support was designated for specific activities, while the Norwegian contribution is not. However, a major aim of RBP is to induce policy reforms that reduce emissions from tropical forest. This boils down to tracing down policy decisions, and the impact of those decisions. As discussed in section 6.2.1, the promise of RBP from Norway and other actors is one among several factors that may explain Indonesian forest policy reforms since ca. 2010, but we are not aware of any detailed scientific studies on RBP's role relative to other factors.

4.1.5 Law enforcement and integrated fire management

One important change in recent years has been the strengthening of law enforcement. As one interviewee puts it, "forests has been brought into the courts" (interview 17). Together with the independent monitoring, law enforcement officers successfully reveal illegal timber and wildlife trade, including timber originating from forest-rich regions such as Papua. Furthermore, enforcement by the government has led to prosecution of actors using fire to clear the land. The trigger was the successful prosecution of a palm oil company, Kalista Alam, who was found to have burned forests in Aceh for oil palm plantations. After this, the GoI has been building court cases against companies allegedly burning forests and peatlands. While the big and publicised cases involve companies, there are also cases when individuals are brought to the legal system for using fire.

In terms of fire management, one important policy feature was the inclusion of fire prevention and early suppression as the key performance indicators of high-ranking officers at the subnational level. The President threatens to remove officials from the position of provincial head of military and police if they failed to prevent and manage fires (interview 5, 10, 15, 24, 25). The firefighting was carried out in a coordinated manner, led by the fire brigade of the Ministry of Environment and Forestry (known as *Manggala Agni*) (interview 28).

4.2 Private sector (industry-initiated) policies and measures

Private regulation, which refers to industry-wide standards initiated by the industry, have been in place since the early 2000s for timber and palm oil. There has been a steady increase of market uptake and production of certified palm oil (RSPO 2022). The uptake of certified timber, such as through the FSC and PEFC schemes, is also increasing.

Certification may contribute to reduced deforestation through increasing the areas under certified production and by limiting expansion into forested areas. The oil palm area under RSPO certification in Indonesia rose from 1.5 million ha in 2015 to 2.4 million ha in 2022. Meanwhile, the certified forest area was 3.2 million (FSC) and 4.8 million ha (PEFC). In addition, RSPO certification has adopted zero deforestation in the latest (2018) version of its principles and criteria. The introduction was not new, since RSPO introduced RSPO NEXT in 2015 – an upgrade of RSPO that included zero deforestation as an element of sustainable palm oil certification. RSPO and its members also work to implement and develop partnerships with other members to ensure sustainable palm oil production. Moreover, one of the elements of the principles and criteria is continuous improvement, which push the adopters to keep improving their achievements and report them on a regular basis. Finally, by allowing the participation of third-party monitoring systems that are acknowledged by the certification body, certification adopters will not be able to clear the forest without being noticed (interview 8).

Studies on the impact of RSPO point to the potential of RSPO certification in reducing deforestation. One study indicates that certification lowered deforestation from a counterfactual of 9.8% to 6.6% per year (Carlson et al., 2018). A similar study shows that RSPO-certified companies also perform better in dealing with fires when the likelihood of fires is low, although it is not case when the likelihood of fires is high (Cattau et al. 2016). A study on the impact of sustainable oil palm certification found that certification significantly reduced deforestation among certified plantations, but not fire or peatland clearance (Carlson et al., 2018). As a result, certified plantations retained more forest compared to when the letter of intent was issued. Deforestation reductions were particularly large within primary forests, areas targeted for protection by the principles and criteria of sustainable palm oil. In addition, certification was mostly adopted in older plantations that do not contain much forest left. Moreover, adoption of certification is more impactful in Kalimantan than Sumatra (interview 4, 7, 13). However, it would require adoption by more oil palm plantations to have a large impact on the reduction of forest loss (Carlson et al., 2018; Cattau et al., 2016). In terms of spillovers, a study in Kalimantan found that RSPO certification reduces forest clearance in state forest areas, but there is a tendency to increase forest clearance in forested areas outside state forest zone (Heilmayr et al., 2020).

FSC certification in Indonesia is facing a harsh reality as the timber industries in Indonesia (except pulp and paper) are declining. Several factors have contributed to the decline, including low productivity, old machinery, and declining international timber prices. They also operate in less favourable policy environment. A log export ban that has been imposed since 2001 to reduce the illegal logging, and this has also pushed down the Indonesian log price far below the global market prices. The domestic log price is at the level of the cost of production, making the logging business not profitable (interview 9). Overall, this development has most likely had a positive impact on forest conservation.

Furthermore, timber certification also has yielded positive results. Between 2000 and 2008, FSC certification (and the general decline of the sector) reduced aggregate deforestation (Miteva et al., 2015).

The last decade has witnessed the rise of corporate self-regulation in the form of zero deforestation commitment of the palm oil producers (Dermawan et al., 2022b). Despite being sustainability-certified, these companies pledge towards no deforestation in producing palm oil and timber, together with other commitments to not clear peatlands and not exploit local communities.[17] Palm oil and pulp and paper producers pledge for no-deforestation, no-peatland, and no-exploitation (NDPE) policies, sometimes with different names. There are some early signs that corporate NDPE policies might yield their intended outcomes in reducing deforestation (AidEnvironment, 2021; Heilmayr & Benedict, 2022).

Despite the progress, it is important to note two major risks. First, even companies with sustainability certificates and zero deforestation commitments can allegedly breach their commitments. Several reports mention that while at the aggregate level there are positive indications of industry actions (TheTreeMap, 2023), companies with certification or zero deforestation commitments are found to violate their commitments (TheTreeMap, 2023). Some of the challenges include ensuring that the indirect suppliers (suppliers of the companies that supply to the companies with NDPE policies (Dermawan et al., 2022a). Second, while deforestation related to industrial oil palm has decreased in Sumatra and Kalimantan, there is a recent increase in deforestation in Papua (Jong, 2024; TheTreeMap, 2023). For example, Asia Pulp and Paper, one of the largest pulp and paper producers in Indonesia, has PEFC certification but have been disassociated with FSC.

Policies/Measures	Scientific evidence	Interviews	Our assessment
Certification	• Potentially positive outcomes	• Increased area under certification and strengthened standard	• Low-medium impact (medium evidence). Promising outcomes, but slow progress of uptake
Corporate self-regulation	• Early assessment shows positive outcomes	• Strong monitoring by CSOs contributed to better practices	• Medium-high impact (low evidence). Promising outcomes albeit early and need to reach a critical mass of companies NDPE commitment.
CSO actions	• CSOs play several roles, from becoming watchdog to facilitating changes in the ground	• CSOs play advocacy and collaboration with other actors	• Medium impact (low evidence). The role is indirect, i.e., aiming to change the behaviour of other actors.

Table 7: Overview of major private sector and civil society policies and actions aimed at forest conservation.

[17] RSPO initially adopted zero deforestation as an upgrade through RSPO NEXT in 2015. In 2018, RSPO adopted zero deforestation in the 2018 Principles and Criteria. Before 2018, RSPO certified companies adopted zero deforestation in their own pledges or sustainability policies.

4.3 Civil society organizations' (CSOs) actions

While civil society pressure has been taking place for as long as forest/timber concessions and oil palm plantations have existed, the last decade has been marked by an increase of direct interactions between companies and civil society organizations (Hapsari, 2018; Samnuzulsari et al., 2021). This is particularly prominent for companies with zero-deforestation commitments, which have been more responsive to CSO criticism and their public reputation than the government (Dermawan et al. 2022).

CSOs play various roles in shaping the reduction of deforestation in Indonesia. First, they act as watchdogs: they observe the private sector practices by both using remote sensing tools and on-the-ground monitoring and provide sufficient data to criticising to them if laws or commitments are not breached (interview 13). One of the famous cases is the action of Greenpeace that resulted with the termination of contract between Nestle and a major Indonesian palm oil producer (Tabacek, 2010). In addition, reports by CSOs that show land clearing practices by palm oil and pulp and paper companies become important monitoring tools. Similarly, CSOs play an important role in monitoring public policy, one example being on the progress of the moratorium of permits on primary forest and peatlands (interview 28, 32).

Second, CSOs collaborate with private sectors. An example is the development of the High Carbon Stock approach between Golden-Agri Resources, PT Smart, Tropical Forest Trust, and Greenpeace (Golden-Agri Resources et al., 2012). Another example is the creation of Palm Oil Innovation Group (POIG), where several CSOs have become members of the initiative. While such collaboration in some cases might be in conflict with the public watchdog role, it is also argued that the collaboration does not necessarily weaken the role of CSOs in monitoring the practices of the companies (Dermawan et al., 2022a).

Third, CSOs provide support to the government both bilaterally and under a multistakeholder process (Seymour et al., 2020). They played an important in strengthening REDD+ regulatory framework at the national level, in particular the safeguards that include free, prior, and informed consent (FPIC). The support of the CSOs to the implementation of a results-based payment in East Kalimantan under the Forest Carbon Partnership Facility is an example, where CSOs pushed for the establishment of the Provincial Council of Climate Change (Forest Carbon Partnership Facility, 2015). Another example of CSO support is their involvement in the Sustainable District Association (*Lingkar Temu Kabupaten Lestari*, LTKL), where they support district governments to develop the implementation strategy and connect with other partners.

Finally, NGOs collaborate with community-based organizations to develop activities that aim to reduce fires and reduce deforestation, and to facilitate the smallholders and farmer groups in implanting social forestry programs. For example, WARSI works with communities who have social forestry agreements in Jambi and West Sumatera to develop programme, provide assistance, and monitor progress, although their role in the formal policy processes remain small (Purwanto, 2015; Rahayu et al., 2023).

4.4 Linking policy changes to deforestation changes on the ground

Various public and private regulations and their implementations have played a role in the recent reduction of deforestation in Indonesia. Some of the policies and measures are developed or formulated at the national level with subnational implementation, while others focus on specific jurisdictions or territories.

First, our interviewees consider peatland protection and integrated fire management relatively to have made a major contribution to reducing deforestation in Indonesia. Fire-related deforestation has declined sharply after the 2015 fires. It is important to note that while the government issued specific policies to protect peatlands, the role of companies in their NDPE commitment should also be underscored. The spatial scope of peatland protection measures may overlap between public and private policies, for example, the BRGM's priority areas cover seven provinces which are also the location of several major palm oil and pulp and paper companies and associated plantations.

Second, despite the analyses which support the claim that moratorium reduces deforestation, respondents are divergent on the contribution of moratorium of primary forest and peatlands in reducing deforestation. Without legal sanctions and an evaluation framework, some argued, the contribution of moratorium of permits on primary forests and peatlands is not convincing. At the same time, the impact of the moratorium cannot be seen only from the halt in new permits; it also triggered collaboration across national government agencies to build and harmonize data on primary forests and peatlands and clarify existing rights over these lands.

Third, RBP is an important mechanism in reducing deforestation in Indonesia. Nationally, Indonesia has successfully reduced its emissions from the reference level. At the subnational level, RBP has performed well in East Kalimantan, and there is a similar optimism in Jambi. While subnational RBPs show some promises, it would need time for other provinces to be able to participate in such schemes. There is a major gap between the situation in the provinces and what is needed for a working RBP in terms of commitment of subnational leadership, availability of data to measure the baseline and emission reduction targets, and a working multistakeholder process where private sector and CSO can contribute meaningfully.

Fourth, the impact of certification and corporate self-regulation hinge on the capacity of third-party actors to monitor potential breaches by the companies. While forest and palm oil certification schemes have audit and surveillance mechanism to ensure compliance, they are conducted on a periodic basis. Day-to-day monitoring has mainly been the role of the CSOs.

Fifth, although CSOs' actions do not directly reduce deforestation, their roles in advocacy, monitoring, and facilitating with other stakeholders are important in the efforts to reduce deforestation in Indonesia. Their strengths lie in the broad networks, flexibility of operation, and being less bureaucratic. They keep up with the latest tools to monitor the practices of private sector actors to ensure early warning of illegal operations.

Finally, the role of donor programmes and international cooperation has also been also important, through the support to the Government of Indonesia in implementing the policies.

They do so by filling the gap and provide assistance to meet capacity needs of both agencies at the national and subnational levels.

5 Linking changes to broader economic and ecological changes

5.1 Commodity prices and economic fluctuations

Earlier studies attribute a significant role of oil palm expansion in the deforestation in Indonesia, and – in turn – how the palm oil price was correlated positively with oil palm plantation expansion and forest loss until the COVID19 period (Gaveau et al. (2022). The COVID19 period, with skyrocketing palm oil prices but no increase in the expansion of palm oil into natural forests, may suggest a break with this link, although one can argue that the COVID-period was special, and we are likely to return to the positive link in the future.

The relationship between commodity prices and area expansion is complicated by several factors. Establishing a perennial crop represents an investment for decades, where the harvesting starts after several years (typically 3-4 years after establishment for coffee and palm oil, and 6-7 years for rubber). Hence what matters for the investment decision is the *expected* future prices, and expectations are influenced by current level and trend in the commodity price, expected changes in government policies, etc.

Expansion of agricultural land has been the dominant driver of deforestation, but mining has come to play an increasingly important role (cf. section 3). We look at each set of prices in turn.

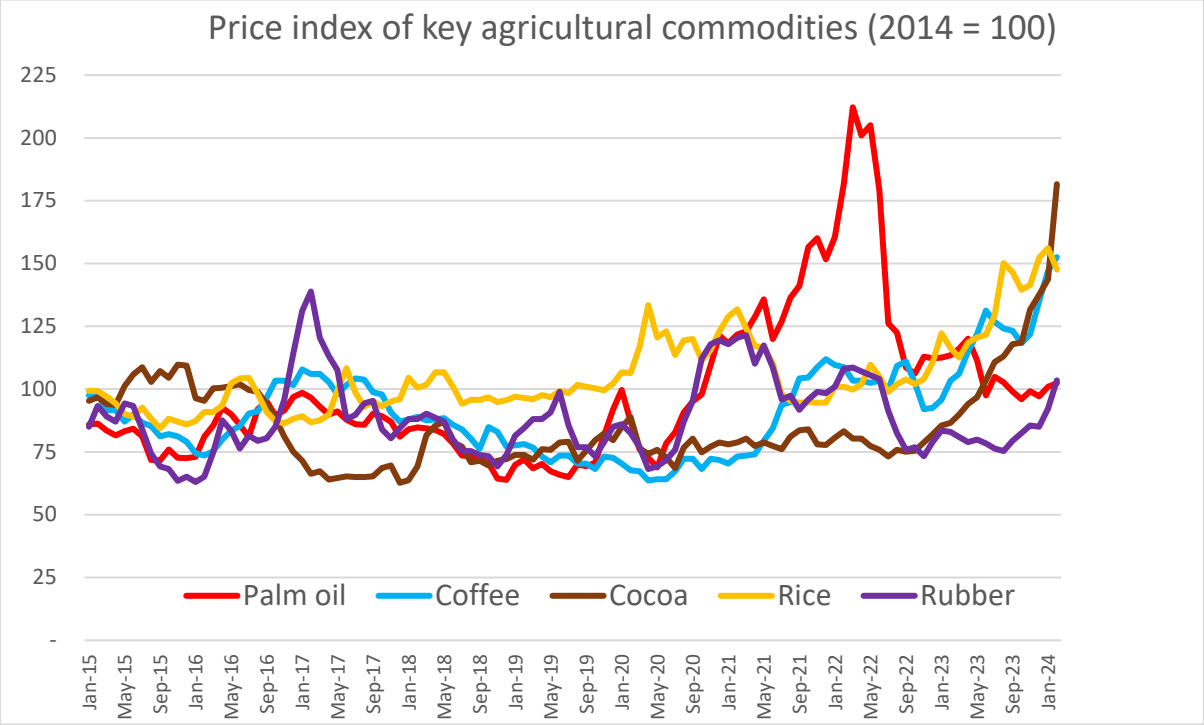

Figure 9: Price index of key agricultural commodities (average price in 2014 = 100). Source: indexmundi.com[18]

[18] Prices are global market prices at key international trading spots. For details, see indexmundi.com

Figure 9 shows the global market price index since 2014 for five key agricultural commodities. First, and most relevant to this study, there is no general decline in key agricultural commodities involved in deforestation during this period (2014-2023). However, looking at the subperiod pre-2020, in which most of the decline in deforestation took place, we observed at the price of four of the five commodities (not rice) were substantially lower compared to their 2014 level (in 2019, about 3/4 of their 2014 level).

After the outbreak of COVID19 (March 2020), there has been a general increase in food and beverage prices, although the price of the main food commodity (rice) stabilized and was back to 2014 level before a new increase after the war in Ukraine started in February 2022.

Coffee and cocoa prices have followed similar trajectories and have for much of the period been below 2014 levels but have risen recently – in part due to production challenges in other parts of the world. The global price of rubber has fluctuated, with no clear trend over the period.

In contrast, the price of palm oil tripled between May 2000 and May 2022. This was however, temporarily, and prices are by early 2024 back to the level ten years ago. The relationship between oil palm expansion into forests is depicted in Figure 10. No firm conclusions can be drawn, but it appears that the strong association between palm oil prices and expansion previously observed (Gaveau et al., 2021) has been weakened. The MDI data show an increase on oil palm driven deforestation from 2020, but still at relatively low levels. The drop in 2022 and the simultaneous peak in palm oil prices do, however, suggest that other factors than the price also play a critical role. The Nusantara Atlas data show a slightly different trend, with an increase since 2021. Overall, one may hypothesise that the recent surge (2023) observed in palm oil area can be related to the price hikes in 2020-2022, which may have formed the expectations about palm oil still being a profitable crop (or possibly even more profitable than in the past) (interviews 3, 8, 14).

Government policies play an important role to modify the impact of global market price fluctuations. When the price dropped in early 2020, Indonesian producers were compensated for the early price drop with a USD 195 million subsidy from the government.[19] Then, in early 2022 when the price skyrocketed, the government introduced an export ban on palm oil which created an excess supply, which eventually brought prices down domestically.[20] This domestic market obligation (DMO) has since been relaxed, but is still operational: producers must sell 20% of their production volume through the DMO mechanism.[21]

The prices used in the figures are nominal US dollars. The exchange rate IDR/USD has been gradually increasing, from passing the 13 000 mark in March 2015 to ca. 15 500 by the end of 2023. Keeping other factors constant, this represents a close to 20% increase in export prices

[19] https://news.mongabay.com/2020/07/indonesia-subsidy-palm-oil-biodiesel-producers-smallholders-b30/
[20] https://www.esmmagazine.com/features/why-are-palm-oil-prices-declining-analysis-206480
[21] https://www.thestar.com.my/business/business-news/2023/11/02/indonesia-to-continue-palm-oil-domestic-market-obligation-policy-into-2024

measured in Rupiah. Thus, the pre-2020 decline in agricultural commodity prices (in USD) is smaller when measured in Rupiah.

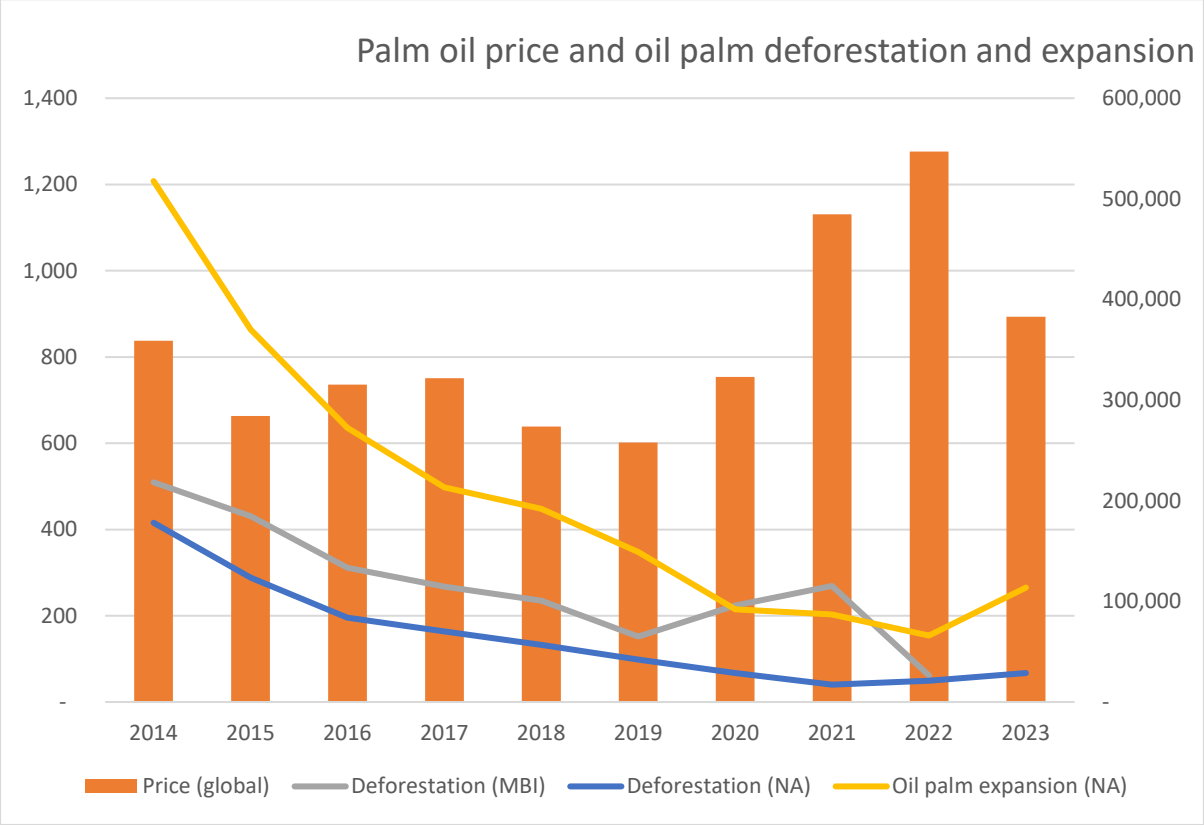

Figure 10: Palm oil prices and deforestation due to palm oil expansion: Source: indexmundi.com, MBI and Nusantara Atlas (NA).
Note: first y-axis is price, while the second y-axis is ha (deforestation and total expansion of oil palm into forests and other land).

No other country loses more forest due to industrial mining than Indonesia. During the first two decades of this century, 58.2% of the forest lost globally to industrial mining occurred in Indonesia, amounting to 190 098 ha (Giljum et al., 2022). Coal mining in Kalimantan was the main source behind this figure.

In addition to coal, key minerals include nickel, copper and gold in the mining industry of Indonesia. Figure 11 shows the price trends for these commodities. The most striking development is the spike in coal prices, a result of the energy shortage after the Russian invasion of Ukraine in February 2022. By early 2024, coal prices are, however, back to a more normal level.

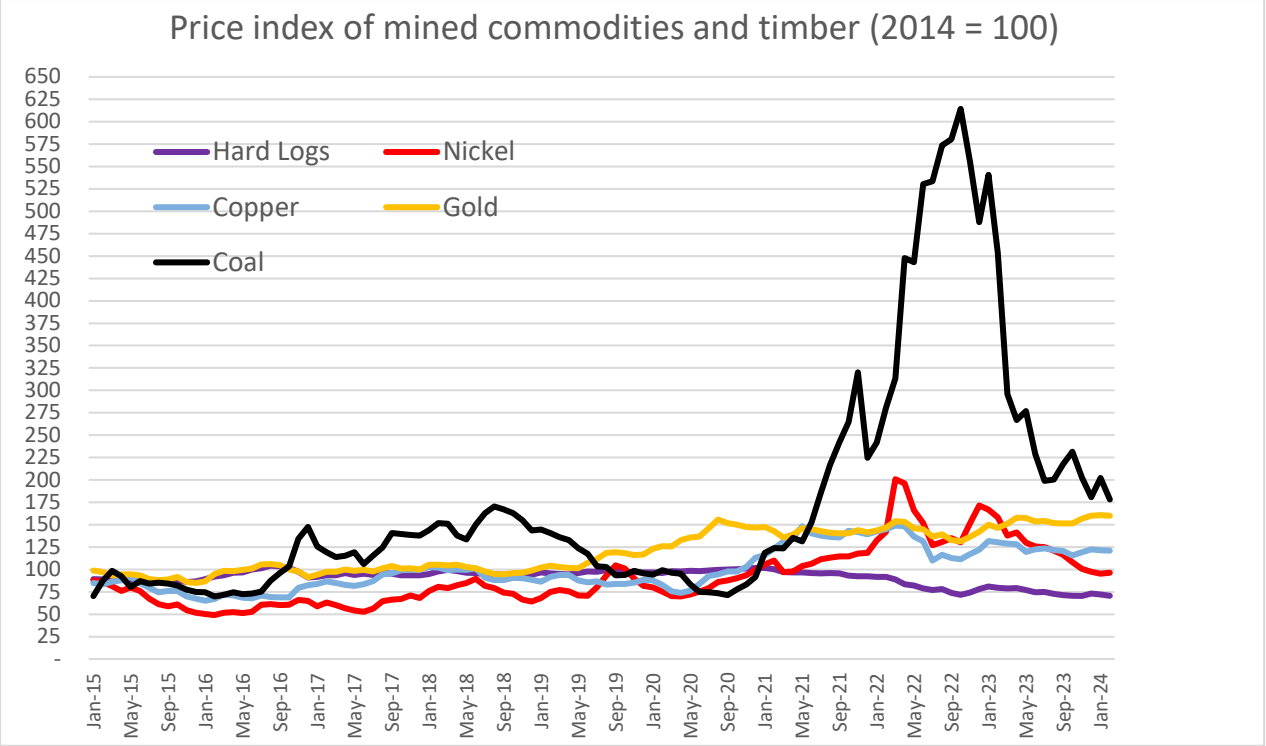

Figure 11: Price index of key minerals, coal and timber (average price in 2014 = 100). Data source: indexmundi.com

The price of the three minerals included have shown an increasing trend since 2016. Since its low in February 2016, the price of nickel quadrupled by March 2022, but has since dropped again by more than 50%. Gold prices have shown a steadier increase and are by early 2024 about 50% higher than the 2014 level. The same net increase is true for copper, although the price fluctuations have been higher.

Timber (hard logs) prices are also pictured in the figure, and we observe no major change until 2020, after which the price has dropped by ca. 30% (January 2021 to end 2023).

Overall, minerals and coal have witnessed a steady increase in its price for the period of study, unlike agricultural commodities which saw a decline until 2020 and an increase afterwards. This is consistent with the finding of section 3: mining has in recent years assumed a bigger role as a direct driver of deforestation.

5.2 Forest scarcity

5.2.1 The forest transition

The Forest Transition (FT) theory predicts that forest cover undergoes a stylized trajectory of change, from an initial stable state through a period of accelerating rate of decline, to decelerating decline, and stabilization and partial recovery (Figure 12) (Wolfersberger et al., 2015). The theory is often used to explain and predict deforestation trends but is also criticized for its deterministic prescriptions and weak empirical foundations (Perz, 2007). Note that there are two important turning points in the FT trajectory: when the *deforestation rate* starts to

decline (shifts from accelerating to decelerating deforestation), and when deforestation ends and reforestation starts (deforestation shifts from positive to negative).[22]

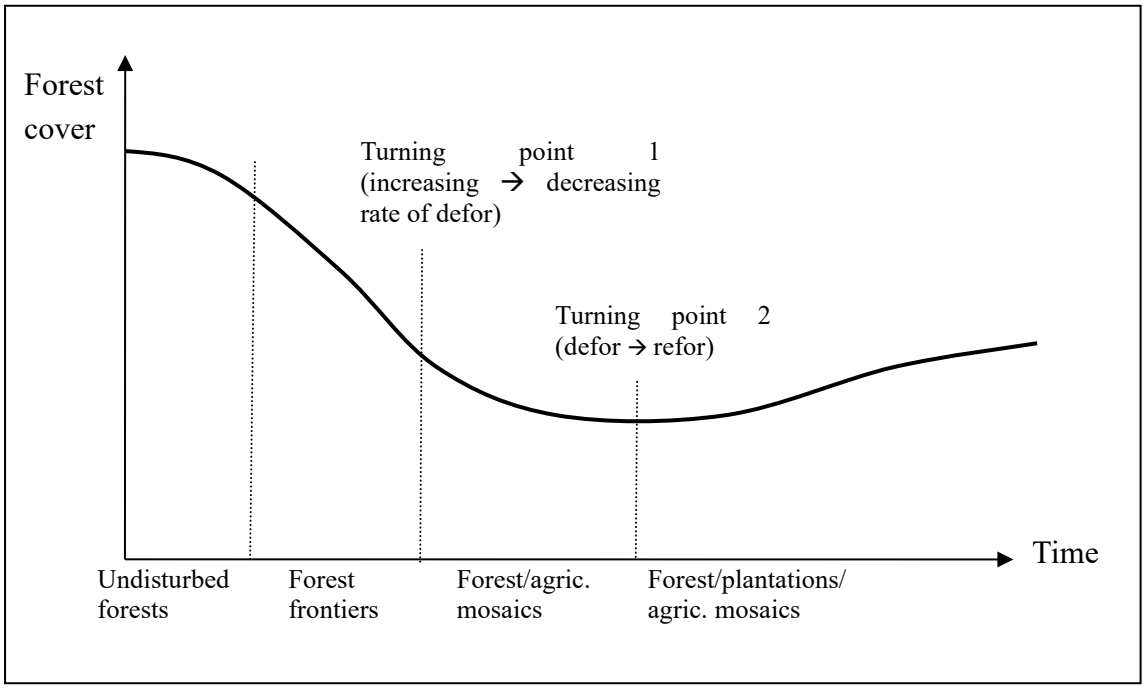

Figure 12: Stylised scheme of the forest transition.

The FT can be linked to different but interrelated factors. One of the main explanations put forward in the literature is the forest scarcity hypothesis: as forest cover declines, forest loss inevitably decreases simply by the fact that less forest is left to be cleared. Increasing scarcity of forest reduces the supply of forest products and hence leads to higher value of the forest that is left, making conversion less profitable and even partly reverses it (Angelsen & Rudel, 2013; Barbier et al., 2010; Rudel et al., 2005).

The second main explanation in the FT literature is linked to stages of economic development. With increasing demand for food and other agricultural commodities, forest is first transformed into agricultural area, before urbanisation and decreasing agricultural employment halt agricultural expansion (Rudel et al., 2005).

5.2.2 Regression model

If the FT theory plays a role in explaining the decline in forest loss in Indonesia, we would thus expect that it has mostly dropped in regions where: (i) forest cover has approached or surpassed the first turning point, or where (ii) economic development has led to lower agricultural dependency.

We use a panel regression model of the following form:

$$floss_{i,t} = \beta_1 fcover_{i,t} + \beta_2 fcover^2{}_{i,t} + \beta_3 covariates_{i,t} + \gamma year_t$$

[22] In mathematical terms, if we consider forest cover to be a function of time, the first turning point is when the second derivative changes sign, while the second turning point is when the first derivative changes sign.

The variables $floss_{i,t}$ and $fcover_{i,t}$ are forest loss and forest cover calculated as the share of land in province i and year t, and γ are year fixed effects to control for time trends that are common across provinces. We include squared terms to test for the hypothesised bell-shaped relationship between deforestation and forest cover. As an indicator of economic development, we used expenditures per capita (also including a squared term to allow for non-linearity), the agricultural employment share, and population density. All of these are provided by the Indonesian Database for Policy and Economic Research, accessed through the World Bank data portal.[23]

	TMF			MBI		
	(1)	(2)	(3)	(4)	(5)	(6)
Forest cover	0.0346***	0.0351***	0.0307**	0.0099*	0.0104*	0.0079+
	(0.008)	(0.0061)	(0.0099)	(0.0040)	(0.0039)	(0.0046)
Forest cover squared	-0.043***	-0.0430***	-0.044***	-0.0106*	-0.0111*	-0.0117*
	(0.009)	(0.0074)	(0.010)	(0.0046)	(0.0043)	(0.0049)
Expenditure per capita		2.4e-08	4.0e-08*		1.8e-08	3.0e-08+
		(1.6e-08)	(1.8e-08)		(1.3e-08)	(1.6e-08)
Expenditure per capita squared		-9.7e-15	-1.6e-14+		-6.3e-15	-1.1e-14
		(6.5e-15)	(7.7e-15)		(5.7e-15)	(7.4e-15)
Agric. employment share			0.0081			0.0061
			(0.0048)			(0.0040)
Population density			-0.00035			-0.00020
			(0.00022)			(0.00014)
FT turning point (% forest cover)	0.405	0.407	0.349	0.466	0.465	0.335
Observations	660	602	500	616	544	488
R^2	0.381	0.424	0.490	0.137	0.224	0.352
Std. Errors	by: province	by: province	by: province	by: province	by: province	by: province
Fixed Effects: year	X	X	X	X	X	X

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 8: Panel regression model results for deforestation as a share of land.

Regression results with both TMF and MBI data are shown in Table 8. The results indicate the existence of a forest scarcity effect, where forest loss first increases with forest cover, but decreases once a turning point has been reached. Using only forest cover and squared forest cover as covariates, the model can explain 38% and 14% of the variation in deforestation for TMF and MBI data, respectively (columns (1) and (4)). With all variables included, our model explains 49% of the variation in forest loss for TMF data and 35% for MBI data.

Depending on the model specification, the turning point was located between 35% and 43% forest cover according to TMF data and between 34% and 47% for MBI data. The forest scarcity effect remains significant also when socio-economic variables were added, such as expenditure per capita in columns (2) and (5), or agricultural employment share and population density in columns (3) and (6). It therefore appears that the forest scarcity effect dominated over the economic development effect in Indonesia.

[23] https://databank.worldbank.org/source/indonesia-database-for-policy-and-economic-research/preview/on

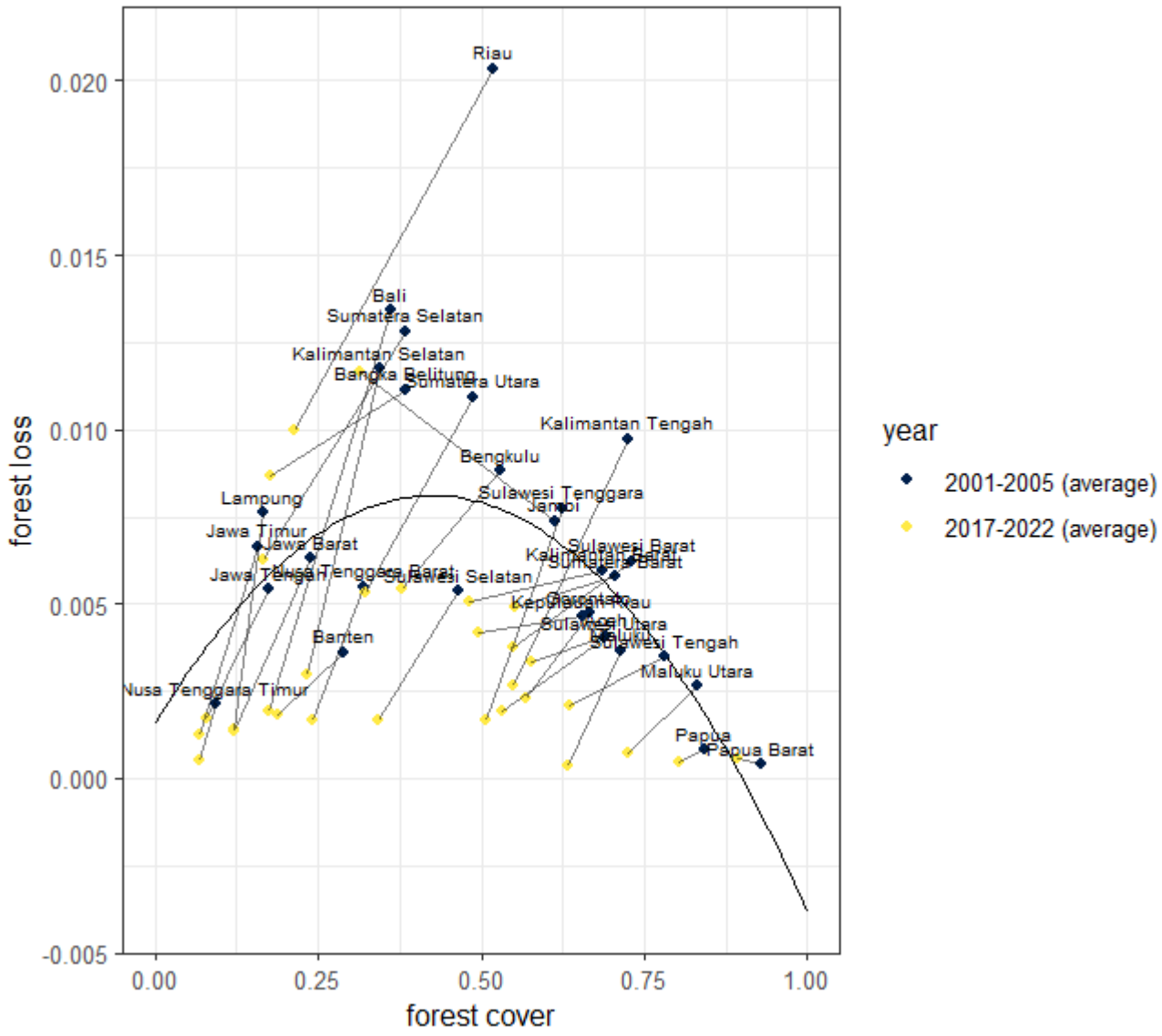

Figure 13: Forest transition curve for model (1). Province trajectories are plotted for average deforestation and average forest cover (TMF data).

We further investigated the trajectory of each province along the forest transition curve for the forest scarcity turning point of 41% as indicated in model (1) in Table 8, i.e., the first turning point of Figure 12. We find that many provinces' forest cover indeed declined towards the turning point threshold and beyond (Figure 13, Table 8). Comparing average deforestation for the years 2001-2005 and the post-peak years 2017-2022, the only provinces with increasing rates of forest loss over the considered time interval were initially located on the right side of the turning point. Among the provinces with the highest forest cover decline are Jambi and Riau, as shown by the distance between the blue and the yellow points along the x-axis (cf. section 3.2.2). Whereas Jambi has moved beyond the forest transition turning point and shown an increase in forest loss between the two time periods, Riau was located close to the turning point in the 2000-2005 period with extremely high deforestation but has seen a substantial reduction in forest loss since then. A general observation is that provinces to the left of the

curve appear to have experienced a stronger reduction of deforestation rates and a lower loss in forest cover between the time periods considered.

Figure 13 gives a better indication of the location of different provinces along the different forest scarcity turning points estimated in Table 8. Considering the implied turning point of model (1) of 41%, eight provinces (Jambi, Riau, Bengkulu, Sumatra Utara, Sulawesi Selatan, Bali, Bangka Belitung and Sumatra) have moved from the right to the left side of the turning point between 2001 and 2022. Another ten provinces were already below the forest scarcity threshold in 2002.

Riau is an extreme province, in the sense that the deforestation rate in 2001-2005 was much higher than the estimated FT curve suggests. The 2017-2022 deforestation is still above that curve, but the huge decline observed between the periods can be seen as Riau becoming a more "normal" province.

Table 9 shows the forest cover and forest cover loss across the archipelago, sorted by forest cover in 2002 (forest share of total land). The FT theory predicts increasing rates of deforestation for high forest provinces, while medium-low forest cover provinces should experience a decline in the rate of deforestation. More generally, the higher the forest cover, the higher the expected increase in the deforestation rate.

In the first category of very high forest cover provinces, the deforestation rate increased by 1.6 percentage points (pp). In line with FT predictions, the rate of deforestation in the medium forest cover group, was reduced by 2.8 pp, but with large variations within the group.

Overall, the analysis of the forest transition suggests that a forest scarcity effect has been a significant factor in the reduction of forest loss in Indonesia over the past decade. Assuming there is a forest cover turning point from which deforestation rates decline as forests get scarce, we showed that several provinces have surpassed this critical point in recent years and seen reduction in forest loss thereafter. However, as a very stylised theory, it is prudent to be cautious about the predictive power of the forest transition and to interpret the results in the context of the actual ecological, socioeconomic and political situation in each province.

Category/Province	TMF cover 2002	TMF cover 2012	TMF cover 2022	Change 2002-2012 (pp)	Change 2012-2022 (pp)	Change 2002-2022 (pp)	Change in def rates between 1. and 2. period
Very high forest cover							
Papua Barat	93.0%	91.5%	89.0%	-1.5%	-2.6%	-4.1%	-1.1%
Papua	84.3%	82.7%	79.7%	-1.6%	-3.0%	-4.6%	-1.4%
Maluku Utara	82.9%	78.5%	71.8%	-4.4%	-6.7%	-11.1%	-2.3%
Category average	*86.7%*	*84.3%*	*80.2%*	*-2.5%*	*-4.1%*	*-6.6%*	***-1.6%***
High forest cover							
Sulawesi Tengah	78.9%	71.7%	62.7%	-7.2%	-9.0%	-16.2%	-1.8%
Sulawesi Barat	74.3%	62.9%	53.5%	-11.5%	-9.4%	-20.8%	2.1%
Kalimantan Tengah	73.9%	61.7%	53.8%	-12.3%	-7.9%	-20.2%	4.4%
Maluku	71.6%	67.9%	62.8%	-3.7%	-5.1%	-8.8%	-1.3%
Sumatra Barat	71.3%	61.4%	53.8%	-10.0%	-7.5%	-17.5%	2.4%
Kalimantan Barat	69.8%	56.1%	46.9%	-13.8%	-9.2%	-22.9%	4.6%
Aceh	69.7%	62.8%	56.7%	-6.9%	-6.1%	-13.0%	0.8%
Sulawesi Utara	68.5%	63.9%	52.4%	-4.6%	-11.5%	-16.1%	-6.9%
Gorontalo	66.8%	63.1%	56.3%	-3.7%	-6.8%	-10.4%	-3.1%
Kepulauan Riau	66.4%	58.2%	48.3%	-8.3%	-9.9%	-18.1%	-1.6%
Sulawesi Tenggara	63.4%	56.5%	49.3%	-6.9%	-7.2%	-14.1%	-0.2%
Jambi	62.6%	44.0%	29.0%	-18.6%	-15.0%	-33.6%	3.7%
Category average	*69.8%*	*60.8%*	*52.1%*	*-9.0%*	*-8.7%*	*-17.6%*	***0.3%***
Medium forest cover							
Riau	54.0%	30.1%	20.2%	-23.9%	-9.9%	-33.8%	14.0%
Bengkulu	53.6%	43.7%	36.5%	-9.9%	-7.2%	-17.1%	2.8%
Sumatra Utara	49.9%	37.8%	31.2%	-12.2%	-6.5%	-18.7%	5.6%
Sulawesi Selatan	47.2%	39.9%	33.2%	-7.3%	-6.7%	-14.0%	0.6%
Bangka Belitung	39.4%	26.6%	15.6%	-12.8%	-11.1%	-23.8%	1.7%
Sumatra Selatan	39.3%	24.7%	15.0%	-14.7%	-9.7%	-24.3%	5.0%
Bali	36.3%	27.8%	16.5%	-8.5%	-11.3%	-19.8%	-2.8%
Kalimantan Selatan	35.1%	28.2%	22.2%	-6.9%	-6.0%	-12.9%	0.8%
Nusa Tenggara Barat	32.4%	29.3%	23.5%	-3.1%	-5.8%	-8.9%	-2.7%
Category average	*43.0%*	*32.0%*	*23.8%*	*-11.0%*	*-8.2%*	*-19.3%*	***2.8%***
Low forest cover							
Banten	28.9%	23.4%	17.4%	-5.5%	-6.1%	-11.6%	-0.6%
Jawa Barat	24.2%	17.2%	10.4%	-7.0%	-6.7%	-13.7%	0.2%
Jawa Tengah	17.5%	12.4%	7.1%	-5.1%	-5.2%	-10.3%	-0.1%
Lampung	16.6%	13.5%	11.2%	-3.1%	-2.3%	-5.4%	0.8%
Jawa Timur	16.0%	10.8%	6.2%	-5.2%	-4.7%	-9.8%	0.5%
Nusa Tenggara Timur	9.7%	8.0%	6.4%	-1.6%	-1.7%	-3.3%	0.0%
Category average	*18.8%*	*14.2%*	*9.8%*	*-4.6%*	*-4.4%*	*-9.0%*	***0.1%***

Table 9: Forest cover (reduction) by province for the years 2002, 2012 and 2022. Kalimantan Utara and Kalimantan Timur are not included in the table, since Kalimantan Utara was only created in 2012 when it split off Kalimantan Timur to form a new province. Source: TMF data.

6 Discussion and conclusions

The starting question was: "Why has deforestation in Indonesia declined over the past few years?". There is no straightforward method to answer such a complex question, and the approach has been to build an evidence base and develop a coherent story by decomposing deforestation figures (year, location and direct driver), through interviews, and by statistical analysis. While such a triangulation is the most viable approach, there are several challenges. First, the data do not tell one uniform story. As seen in section 3, the numbers on the level of deforestation and its direct drivers differ considerably, due to different definitions, methods and primary data sources. Second, there is no single, best approach to trace impacts. This was exemplified by the interviewees on the impacts of the moratorium. Some stressed how the moratorium has – or has not – changed economic incentives though new "sticks and carrots" (including legal enforcement and punishments). Others stressed the process, and how the moratorium can change values and attitudes, and also has stimulated a process for better coordination across different sectors and level of government.

6.1 What has happened?

Deforestation in Indonesia has dropped by at least 50% since 2016. Although forest loss to fires has been extraordinarily high in the years before the drop, this alone is not sufficient to explain the trend. The reduction has occurred for most provinces and direct drivers, suggesting that national policies and structural changes has been a major factor, more than commodity-specific ones (commodity prices, certification, etc.). Yet there are major differences across provinces, with some (previously) high-deforestation provinces having reduced deforestation by up to 80%.

An interesting regional pattern is observed for the forest encroachment factor (EF) for different commodities - the share of land new agricultural land that is from forest conversion. The reduction in the EF for Sumatra is noteworthy, while it has remained relatively stable for Kalimantan.

There has, however, been some marked changes over time in the direct drivers of deforestation, i.e., the commodities that are produced on the land after the trees have been removed. Palm oil still is the single most important commodity, and the MBI data suggest that 46% of the post-forest uses during 2018-2022 was for oil palm, compared to 55% during 2010-2017. At the same time, the encroachment factor of palm oil has declined in recent years, i.e., a smaller share of the newly established oil palm is on previously forest land. This is true particularly in Sumatra. For Indonesia, however, the main factor is reduced oil palm expansion into any forms of land, while reduced encroachment factor comes second.

Several reports suggest that pulpwood is on the rise as a direct driver, although MBI data does not support that claim. Nusantara Atlas data does, however, point to a major increase in Kalimantan (and a move in pulp-driven deforestation from Sumatra to Kalimantan). In the three high-deforestation provinces of Kalimantan, pulp made up 29% of the deforestation in 2022.

Mineral mining is another direct driver, although the overall share remains relatively low. According to MBI data, mining was responsible for 3.4% of the deforestation in Indonesia for the 2018-2022 period, up from 0.9% in the 2010-2017 period (with a much higher share in the last two years (2021-2022): 5.4%). Mining is particularly important in Sulawesi, where it accounted for 30% of the deforestation in 2021-2022, compared to 8% during 2010-2017.

The expansion of other agricultural commodities, such as rubber, is not as easy to identify, as detailed data is missing and challenges exist in distinguishing, for example, jungle rubber from forests with remote sensing methods. The share of land categorised as "Other agricultural land" has, however, increased between the latest periods (MBI data).

Finally, timber production seems to play a decreasing role, for reasons discussed below.

6.2 The hypotheses

We put forward five possible explanations (hypotheses) of the decline, and we review each of them in turn.

6.2.1 H1: Government policies

Public policy reforms take time to have an impact on the ground. The reduction of deforestation over the last few years is the result of policies and measures that were enacted much earlier. Several events led to major policy reforms during the decade of 2010-2020.

In 2007, Indonesia hosted COP13 of UNFCCC, where REDD+ was officially adopted and became part of the Bali Road Map, and thus a main element of the international climate mitigation agenda. As the COP13 host, also Indonesia played a major role in the follow up work.

In May 2010, Norway and Indonesia signed a Letter of Intent, in which Norway pledged up to USD 1 billion as payment for reduced emissions. A key result of the agreement was the moratorium of 2011. The impact of that (and the later additions) is still debated. Scholarly studies lend some support to the moratorium having a positive conservation effect, although the effect size is limited compared to the commitments. An important side effect of the moratorium has been more coordination across sectoral ministries and levels of government, also part of the One map initiative.

In 2015, massive forest fires and resulting haze in Indonesia and its neighbours, which by some estimates caused about 100 000 premature deaths due to the smoke exposure.[24] It caused major domestic concerns and put fire management and peatland protection at the top of the political agenda. Several important policy measures where implemented, and the interviewees highlights this among the most important policies in explaining the deforestation reduction.

Other policy initiatives include schemes for results-based payment and social forestry. An overall assessment of these is lacking, but we conjecture that these have been important in the

[24] https://seas.harvard.edu/news/2016/09/smoke-2015-indonesian-fires-may-have-caused-100000-premature-deaths#:~:text=Schools%20and%20businesses%20closed%2C%20planes,Indonesia%2C%20Malaysia%2C%20and%20Singapore.

locations where implemented. RBP has worked in East Kalimantan and potentially Jambi. Similarly, village forest shows its capacity to reduce deforestation. However, our assessment is that they have had more limited impact on national deforestation rates.

6.2.2 H2: Private policies and industry action

The story of private sector forest initiatives and their impacts is a mixed one. The area under certification, at least for oil palm, has increased, and a few studies suggest a positive forest impact of certification schemes and pledges. However, if fully implemented, we should have seen a sharp decline in the forest encroachment factors, something which only can be observed for Sumatra and is more likely to be due to a forest scarcity effect (see below).

Much of the certification debate and initiatives has focused on palm oil. For timber, pulp, companies can apply FSC or PEFC certification, yet it is not widespread. In particular, the large conglomerate Sinar Mas (which includes the subsidiary Asia Pulp & Paper), despite having adopted PEFC certification, are still working to end its disassociation with FSC.

Since the last decade, palm oil and pulp and paper companies have increased their commitment to eliminate deforestation from their supply chains by issuing NDPE policies. There are early signs that the pledges have produced some reduction in deforestation, but companies with NDPE policies still face challenges in ensuring that smallholders and indirect suppliers comply to their NDPE policies.

6.2.3 H3: Civil society pressure

Civil society organizations (CSOs) play an indirect but important role by influencing public policy makers and corporate actors. The role and impact are harder to assess, as one has to track specific policy creation and implementation processes.

CSO plays an important role in several areas. First, they are active actors on the policy arena. What is noteworthy in Indonesia is that this has not been limited to public policies, but there are several examples of their role in private sector initiatives. Second, CSO are important watchdogs for both implementation of public and private regulations and pledges. Several such breaches have been brought to public attention and in some cases ended up in the courts. Finally, CSO work locally in the implementation of specific projects, with potentially significant positive impacts locally, but most likely insufficient in numbers and coverage to affect national deforestation rates significantly.

6.2.4 H4: Markets and prices of deforestation-risk commodities

Several commodities are involved in the deforestation process. Overall, prices of key deforestation-risk commodities were relatively stable during the 2016-2020 period, while some have increased during the pandemic (2020-2022) and also after 2022 as a result of the war in Ukraine.

Changing commodity prices were not a driver behind the reduced deforestation. Nevertheless, we conjecture that stable price of key commodities made implementing both public and private policies less costly for politicians and producers, which also improved policy effectiveness.

There are two noteworthy exceptions to this overall picture. First, timber (log) prices in the global market have been declining, and although the log export ban (since 2001) does not make this a direct outlet for Indonesian producers, they do indirectly affect the profitability of Indonesian timber production.

In contrast, the prices of minerals such as gold and nickel have increased steadily over the period, with the nickel price quadrupled between 2016 and 2022. The increasing role of mining in deforestation has already been noted and can largely be explained by the high and increasing profitability (and exceptions about future scarcity). Global nickel demand is, according to IEA, expected to grow by 65% (or even more in a sustainable development scenario) during this decade[25], putting a growing pressure on Indonesian forests. Nickel and other minerals are key ingredients in the green transition, but producers such as EV makers lack adequate policies to ensure deforestation-free supply chains.[26]

6.2.5 H5: Forest scarcity and the forest transition

The forest transition theory predicts that deforestation will slow down as forest become scarcer. We tested this in a regression model and estimated the turning point where the deforestation *rate* (as share of total land area, not forest area) starts declining. Depending on data set and model specification, we find the turning point to be between 34 and 47%, with 40% as reasonable point estimate. This suggest that as provinces are approaching a forest cover of 40%, the deforestation rate starts to slow down.

Our analysis suggest that this natural forest transition (scarcity) effect may explain up to 1/3 of the decline in deforestation. Riau stands out as the province where the largest drop in the deforestation rate. On the other hand, the forest transition theory also predicts that the deforestation may increase in the high forest cover provinces, mainly located in Eastern Indonesia (Sulawesi, Papua).

6.3 Concluding remarks

We put forward five different potential explanations (hypotheses) for the decline in deforestation. Among the five, we tentative conclude that public polices - in combination with a forest transition (scarcity) effect – has been the most important factors. Private policies show more mixed results, although certification schemes – and the recent tightening of them – are commendable and moves in the right direction. Behind the public and private policy changes, civil society has played a key role in policy reforms and in promoting more effective implementation though its watchdog role. Non-increasing commodity prices has made the implementation of forest conservation less costly.

Yet, there is a real chance that we are witnessing a trend shift from 2023, as there are clear signs of increasing deforestation. GFW data show a 21% increase in deforestation from 2022

[25] https://www.iea.org/data-and-statistics/charts/total-nickel-demand-by-sector-and-scenario-2020-2040
[26] EV mineral supply chains: manufacturers lack adequate biodiversity and deforestation policies. – The Rainforest Foundation (regnskog.no)

to 2023. Nusantara Atlas data suggest an increase in both oil palm (36% up)[27] and pulpwood plantations (15% up)[28], and mining is likely to continue its rise.[29]

Deforestation continues because - for land users/owners, and (sub)national governments - the forest land converted to agriculture or other purposes, or the resources located in forests (timber, minerals) are more worth than standing forests. Forest conservation is a continuous battle. That policies have worked in the past does not guarantee that they will work in the future. Forest users may find loopholes and ways to bypass laws and regulations when profitable opportunities exist. The prices of deforestation-risk commodities may start on an upward trend again, increasing profitability of agricultural expansion further. The composition of deforestation-risk commodities changes, as seen with the diminishing role of timber logging while pulp plantations and mining for valuable minerals have assumed a greater role. This requires a shift in the policy focus.

Moving forward, deforestation risks also could also come from other "national strategic programs", since they are exempted from the moratorium of primary forests and peatlands. One notable program is food estate. Given the land where the food estate program takes place may have variable land suitability, it is likely that the productivity level of food crops is lower than under more suitable land. Past programs such as the Mega Rice Project in late 1990s and subsequent programs such as Merauke Integrated Food and Energy Estate, where forests and peatlands have gone, and the expected food crop production did not materialize have provided important lessons to ensure that food estates are not established at the expense of forest loss.

[27] https://nusantara-atlas.org/2023-marks-a-surge-in-palm-oil-expansion-in-indonesia/

[28] https://nusantara-atlas.org/2023-deforestation-by-the-wood-pulp-industry-in-indonesia-surges-hits-record-highs-in-kalimantan/

[29] Nusantara Atlas | Indonesia's Mining Crossroads: New Map Unveils Opportunities for Environmental Monitoring (nusantara-atlas.org)

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Annex 1: Interview guide

Resource persons were selected based on the information obtained in the literature review, as well as representatives for a diversity of actors in the field: government (national and subnational), private sector, donor community, and civil society organizations. We started asking the resource persons with open questions on the trends, policies, and measures. For each policy and measure, we asked more detailed information on the characteristics of the policies and measures that may contribute to the reduction of deforestation. In some interview sessions, we focus on certain policies that we found in the literature review.

Most of the 32 resource persons interviewed requested to remain anonymous, and we have therefore not included the names and affiliations. The guiding questions were:

0. Introduction
    a. Introducing the interviewer, its organizational affiliation, and the project.
    b. Respondents may answer the questions partly without any consequences.
    c. Permission to record the audio only for research purposes. No recording if the resource person does not approve.
1. General
    a. Describe about you and your organization.
    b. Describe how you or your organization are related to the analysis of deforestation trends in Indonesia (policymaker, business, analyst, campaign, observer, etc).
2. Deforestation trends
    a. Explain what you understand about the trend of deforestation in the last 5 years, and in the longer term.
    b. Explain what you understand about the commodity, location, type of land use, and magnitude (size).
    c. Explain how you know that deforestation has decreased in the last few years.
3. Factors that contribute to the reduction of deforestation.
    a. Explain what public policies, programs, and measures that you think have contributed to the reduction of deforestation.
    b. For each public policy, how has the policy contributed to the reduction of deforestation?
    c. Explain what private actions that you think have contributed to the reduction of deforestation.
    d. For each private action, how has the action contributed to the reduction of deforestation?
    e. What are the roles of civil society organizations in reducing deforestation? To what extent they contribute to the reduction of deforestation?
    f. What are the roles of other stakeholders (e.g donor programs) in reducing deforestation? To what extent they contribute to the reduction of deforestation?
    g. To what extent the emergence of customary forest contributes to the reduction of deforestation?
    h. What other factors that you think may contribute to the reduction of deforestation? How did these factors play out?
4. Do you think the deforestation reduction will continue? What are the risk factors that may increase deforestation in the future?