

SEI-PCS 'Indonesia wood pulp v3.0.0' documentation

Trase 'SEI-PCS Indonesia pulp v3.0.0' supply chain map: Data sources and methods

Trase maps supply chains for agricultural commodities, making it possible to link products and supply chain actors with specific areas of production, and associated sustainability risks and opportunities. It uses a generalised supply chain mapping approach called Spatially Explicit Information on Production to Consumption Systems (SEI-PCS) as the basis for this work (see Trase's [mapping manual](#) for more detail). This document describes the data and methods that Trase has used to map the supply chain for Indonesian wood pulp, using a model version called 'SEI-PCS Indonesia wood pulp v3.0.0'. This model represents a collaboration between experts at the Stockholm Environment Institute, Global Canopy, Auriga, Woods and Wayside International, and the Conservation Economics Lab at the University of California, Santa Barbara.

The supply chain map allocates pulp exports to each of Indonesia's pulp mills by integrating detailed industrial production and trade data. It also traces the flows of wood fibre to each pulp mill from individual pulpwood suppliers, which are grouped as industrial pulpwood plantations, community forests, natural forests, traders or wood chip mills outside Indonesia. Combined with spatial data detailing the boundaries of industrial pulpwood concessions, the supply chain map links pulp exports and domestic processing back to specific areas of pulpwood production. Table 1 provides an overview of key statistics for Indonesia's wood pulp industry during 2015-2019.

Table 1. Summary statistics for Indonesia's wood pulp industry, 2015-2019

	2015	2016	2017	2018	2019
Pulp production (million tonnes*)	6.79	7.18	8.32	8.84	9.10
Pulp exports (million tonnes*)	3.35	3.57	4.47	4.23	5.29
Wood supply (million cubic metres)	32.05	31.04	38.26	45.98	42.18
Number of active industrial pulpwood plantation suppliers	64	69	73	78	75
Number of pulp mills (exporters) in operation	5	5	6	6	6
Number of pulpwood mill/exporter groups	3	3	3	3	3
Number of importing companies	19	40	189	134	95
Number of importing countries **	7	13	27	30	19
Number of destination countries **	27	33	27	27	28
Percentage of pulp production processed domestically (%) ***	50	50	46	52	42

* = metric tons

** Importing country refers to the jurisdiction in which the importer of Indonesian pulp is located (as reported in the pulp trade data). Destination country refers to the country where the pulp is ultimately shipped and used for further processing (see section on pulp exports).

*** Percentage of pulp production processed domestically is an estimate calculated by subtracting reported exports from total production.

SEI-PCS Indonesia wood pulp v3.0.0 enhances our understanding of how a commodity's production and trade impacts the landscape. Whereas existing Trase models assign the production of raw material to administrative units (e.g. districts), the Indonesia pulp dataset is explicit about the concessions from which pulpwood, the raw input, is sourced. Based on this spatially explicit information, pulp trade can be directly linked to trends in a variety of land use and environmental indicators. Trase includes a selection of these indicators based on their relevance to assessing sustainability in the sector. These include: annual deforestation, deforestation for wood pulp, pulpwood species (*Acacia* and *Eucalyptus*) extent, peatlands, fire hotspots and burned areas. Details of the methodology and source for each of these land use characteristics are included below.

Table 2. Summary of indicators (2015 - 2019)

	2015	2016	2017	2018	2019
Total concession area of active, industrial suppliers (ha)*	4,459,931	4,690,825	4,851,232	4,831,750	4,656,527
Total percent of peat area (%)*	34.1	35.6	35.1	35.7	37.4
Total area planted with pulpwood species (ha)*	2,082,593	2,121,451	2,323,459	2,369,651	2,320,348
Total annual deforestation (ha)*	41,965	46,551	24,990	16,466	10,795
Total deforestation for wood pulp (ha)**	43,647	47,309	57,794	64,656	69,187
Total deforestation on peat (ha)*	18,547	21,644	8,778	4,280	4,797
Total number of fire hotspots*	13,987	4,386	4,286	5,104	9,169
Total burned area (ha)*	341,976	44,559	3,404	3,471	93,383

* Calculations are confined to areas of active industrial pulpwood concessions in each year

** See below for definition of "deforestation for wood pulp"

Data and sources

Pulpwood supply

To document the flow of wood from suppliers to pulp mills, we constructed a supply chain map using data reported by Indonesia's six active pulp mills to Indonesia's Ministry of Environment and Forestry (MoEF) through official wood consumption reports. The MoEF requires all wood-based industries with a production capacity above 3,000 cubic metres (m³) per year to submit such reports, known as industrial wood supply plans (*Rencana Pemenuhan Bahan Baku Industri*, RPBBBI), on an annual basis (1). These reports provide detailed information on the pulpwood supply for each mill, including the names of suppliers, the types of supplier (industrial pulpwood plantations, community or natural forests, traders, and imports), and the volume of wood supplied in cubic metres.

During 2015-2019, approximately 87% of the pulp industry's wood supply was provided by forestry companies operating industrial wood fibre plantation (*Hutan Tanaman Industri*, HTI) concessions, which are licensed by the MoEF for periods of 42 to 100 years. The supply chain map links the wood consumed by individual pulp mills to the specific geographical areas covered by these HTI concessions to depict the spatial distribution of each mill's wood supply. To identify the locations of industrial pulpwood plantations, we used the HTI concession boundaries spatial dataset (known by its Indonesian acronym as IUPHHK-HTI) published by the MoEF in 2019 (2).

Other sources of wood supply include community suppliers, traders, and wood chips imported from abroad. The country of origin of the wood imports is provided in the results as it is represented on the RPBB wood consumption reports. In the case of imports from wood chip mills, it should be noted that the country of origin of the wood may be different than the country in which the wood chip mill is located. Community suppliers and traders are represented as aggregate amounts on a per province basis. Spatially explicit data on the location of community suppliers was not available at the time of publication, but it is expected to be included in future versions as wood from community suppliers represents an increasing portion of the pulp mills' wood supply, according to trends observed during 2015-2019.

Pulp production

Each mill's annual pulp production, disaggregated by wood pulp grade and reported in tonnes, was obtained primarily from the RPBB reports that each producer submitted to the MoEF. In some cases, corporate sustainability and annual reports were also used to determine the amounts of specific grades of pulp that particular mills produced.

Trade data

Data on export shipments of pulp from Indonesia was obtained from transaction-level trade data for 2015-2019. This data covers all exports of wood pulp from Indonesia under two Harmonised System (HS) codes, as defined in Table 3. The vast majority of pulp produced in Indonesia is Bleached Hardwood Kraft Pulp (BHKP), used primarily for making paper and paperboard, and is categorised under the HS Code 470329. Dissolving pulp, used in the production of textiles, is a relatively small but increasing proportion of Indonesia's pulp production, and is categorised under the HS Code 470200.

Table 3: Wood pulp products and HS codes relevant to Indonesia pulp exports

HS code	Product category
470329	Wood pulp; chemical wood pulp, soda or sulphate (other than dissolving grades), semi-bleached or bleached, of non-coniferous wood
470200	Wood pulp; chemical wood pulp, dissolving grades

We confirmed the consistency of the pulp export data with data from United Nations COMTRADE and Indonesia's Central Statistics Agency (*Badan Pusat Statistik*, or BPS), as shown in Table 4.¹ For dissolving pulp (HS code 470200), we only used export data from 2017-2019 as there were no significant exports under this HS code reported in the 2015 and 2016 data (3).² It should be noted that small sample shipments (< 150 kg net weight) were excluded from this data set in order to avoid skewing the data on shipments and importers.

¹ In 2018, an unusually large shipment over 500,000 tonnes was removed from the dataset since we were unable to verify the data with records in Indonesia's Timber Legality Verification System (SVLK).

² A study published in November 2020 documented an apparent profit shifting scheme in which dissolving pulp was actually exported from Indonesia in 2015-2016, but was reported as paper-grade pulp. See Forum Pajak Berkeadilan [Tax Justice Forum] et al. 2020. *Macao Money Machine*. <https://environmentalpaper.org/wp-content/uploads/2020/11/20201103-Macao-Money-Machine.pdf>

Unlike other commodities in Trase, the Indonesia wood pulp model differentiates import country from destination country. The import country refers to the jurisdiction in which the company purchasing the pulp directly from the Indonesian exporter is located (as reported in the pulp trade data). In many cases, however, this purchaser is a sales or marketing company located in a country that is different from the shipment's final destination after re-export. The destination country is the country where the pulp is ultimately shipped and used. Including this differentiation between import country and destination country in the supply chain map may provide increased transparency on invoicing practices and/or trans-shipment arrangements.

Table 4: Comparison of Indonesia pulp export data from Customs, BPS and UN COMTRADE, 2015 – 2019

Year	Exports (tonnes)					
	Customs		BPS		UN COMTRADE	
	HS 470329	HS 470200	HS 470329	HS 470200	HS 470329	HS 470200
2015	3,352,263		3,399,357		3,399,357	
2016	3,571,258		3,532,960		3,531,959	
2017	4,324,924	140,905	4,450,773	140,410	4,451,896	140,409
2018	4,087,968	137,926	4,087,901	137,926	4,087,899	137,926
2019	4,590,558	695,330	4,590,676	695,330	3,944,303	431,110

Pulp processed in Indonesia

During the 2015-2019 period, we estimate that between 42% and 52% of Indonesia's pulp production was processed in Indonesia, i.e. not exported as pulp. These estimates were calculated by subtracting the annual reported pulp exports from the total pulp production reported by each mill to the MoEF in the RPBBi documents.

A substantial, but yet undetermined, portion of the pulp processed domestically was used to produce paper and paperboard products and, since 2019, viscose staple fibre, a portion of which were then exported as processed products. The current supply chain map represents these supply chains as being processed domestically, and does not track exports of downstream products.

Group affiliation

Companies were assigned group affiliation based on publicly available information including, but not limited to, corporate sustainability reports, audited financial documents (notably for public companies) and corporate registry documents from the Government of Indonesia. Group affiliation was determined based on ownership, management, nature of supply relationships and other criteria. For the purpose of this model, the pulp mills PT Toba Pulp Lestari Tbk and APRIL (comprising PT Riau Andalan Pulp & Paper and PT Intiguna Primatama) are treated as one group, as they are both controlled by the same beneficial owner, Sukanto

Tanoto and members of his family. This group is labelled, Royal Golden Eagle/Tanoto, and is sometimes shortened to Royal Golden Eagle, or RGE.³

Mills and ports

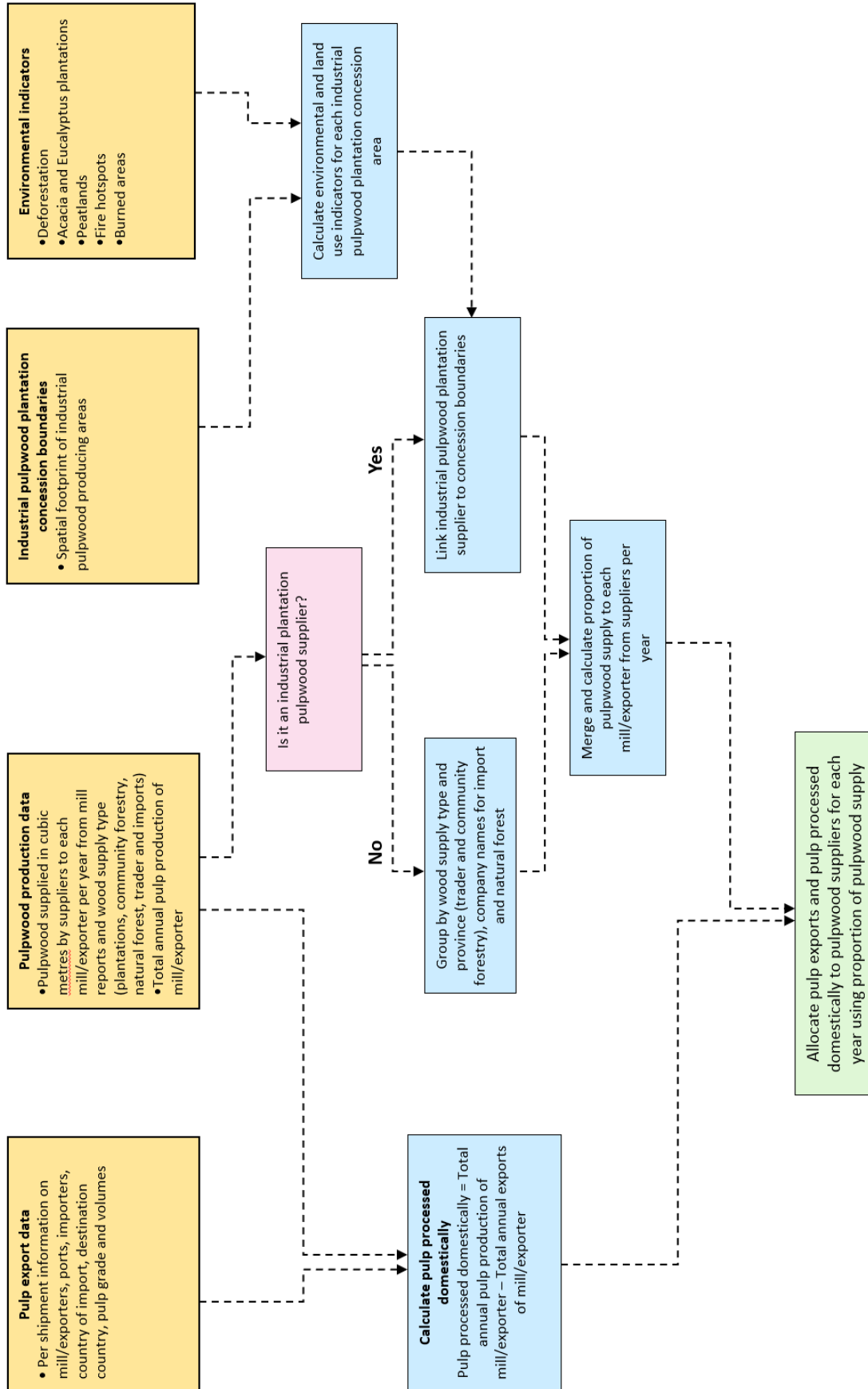
The pulp mill capacity data is from the RPBB mill consumption reports and is generally consistent with production capacity numbers included in the major producers' sustainability reports. The group affiliation of each of Indonesia's six pulp mills were identified using publicly available information. The Royal Golden Eagle/Tanoto Group's Kerinci mill complex in Riau Province includes pulp production lines owned by two companies: PT Riau Andalan Pulp & Paper and PT Intiguna Primatama. In this model, the Kerinci mill complex is treated as one mill and referred to as APRIL.

SEI-PCS implementation

For each year, the input datasets provide information on (a) customs data detailing the mill that supplies each export shipment; (b) production data detailing the volume of wood sourced from each wood supplier by each mill; and (c) concession boundaries detailing the spatial location of industrial pulpwood suppliers. SEI-PCS combines these datasets through two primary steps. First, we estimate the annual volume of pulp that is processed domestically by calculating the difference between each mill's total annual pulp production and the volume of pulp exported by each mill. Second, we calculate the proportion of each mill's total wood supply coming from each pulpwood supplier. Finally, we use these proportions to estimate the amount of wood coming from each supplier that is embedded within each export shipment, or within each mill's production destined for further domestic processing. As an example, assume a mill has two suppliers, PT A and PT B. PT A supplies 4,000 m³ of pulpwood, PT B supplies 1,000 m³ of pulpwood, and the mill produces 1,000 tons of pulp. In this case, the total pulp produced by the mill in that year is allocated across suppliers in proportion to each supplier's share of the mill's total pulpwood supply. As a result, PT A is estimated to contribute wood for 800 tons of pulp ($1,000 \times 0.8$), while PT B is estimated to contribute wood for 200 tons of pulp ($1,000 \times 0.2$).

³ See *Macao Money Machine* for details on common beneficial ownership of PT Toba Pulp Lestari Tbk and APRIL's operating companies. <https://environmentalpaper.org/wp-content/uploads/2020/11/20201103-Macao-Money-Machine.pdf>

Figure 1: Decision tree describing how SEI-PCS Indonesia v3.0.0 allocates pulp exports to pulpwood suppliers



Sustainability indicators

Planted area

SEI-PCS Indonesia wood pulp v3.0.0 includes data detailing the total area of industrial pulpwood plantations within pulp concessions based on data from Gaveau et al (in review) (4). Gaveau et al. mapped annual expansion of industrial pulpwood plantations, most commonly acacia (*Acacia mangium* and *Acacia crassiparva*) by visually inspecting an annual time-series of cloud-free Landsat composites from 2000 to 2019. They also referenced indicative maps of pulpwood concessions and reviewed various online and press reports to further identify the location of these plantations. The boundaries of the plantations were delineated using the scale 1:50,000 according to expert photointerpretation. Beyond the spectral information from the satellites, the visual interpretation also considered the structure of the landscape. Pulpwood plantations show long linear or rectangular shapes usually detected close to harvesting trails with less density than observed for other forestry agriculture such as palm oil plantations. The final planted area detected by Gaveau et al. includes areas recently harvested, immature and mature stands and failed plantations. This dataset does not report scattered community plantations, which are more difficult to detect with remote sensing data.

Deforestation

Annual deforestation maps (30 metre resolution; 2001-2019) were created by combining multiple remotely sensed datasets. First, we identified all locations that begin the year 2000 as primary forests as classified by Margono et al., 2014 (5) (Please note that the MoEF has classified some of these “primary” forests as “secondary” forests that have been impacted by selective timber harvesting). Looking within these primary forest pixels, the Trase team assigned the timing of deforestation using the most recent annual Tree Cover Loss dataset (v1.7) from the University of Maryland (Hansen et al., 2013)(6). This dataset assigns the year of pixel-level forest loss events by determining when pixels with tree cover experience a stand-replacement event, as indicated by a time-series of Landsat imagery.

Two different estimates of deforestation are provided on the Trase platform, so that users can assess pulp producers' ongoing compliance with sustainability commitments as well as the commodity's longer-term contribution to forest loss:

Annual Deforestation estimates how much deforestation has taken place within the entire area of a concession for a specific year between 2015 and 2019. Users access this data by selecting “Edit Map Layers” on the bottom-left of the screen below the map.

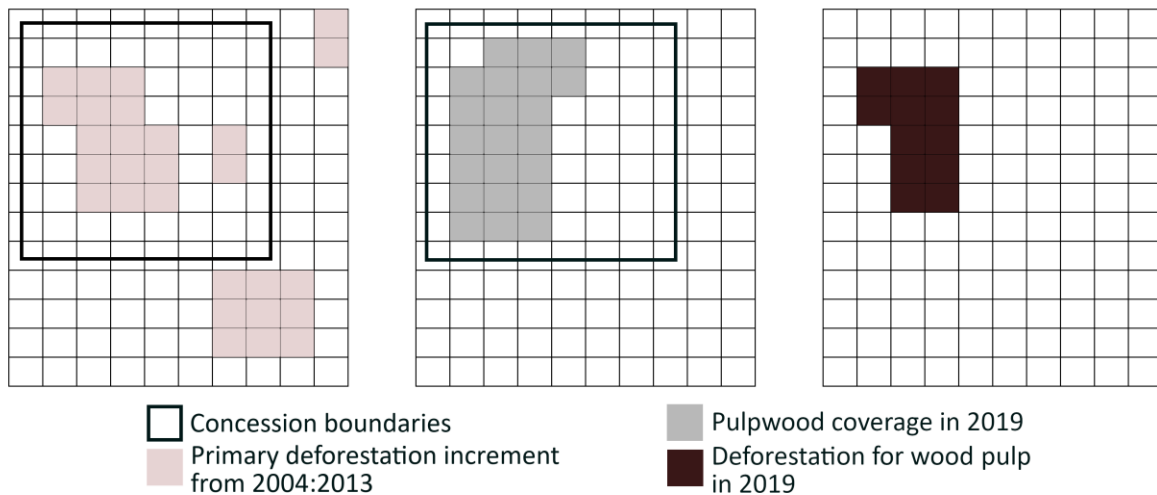
Users interested in assessing compliance with zero-deforestation commitments are encouraged to focus upon this Annual Deforestation metric since it identifies the total amount of deforestation occurring inside a concession within a specific year.

Deforestation for wood pulp estimates how much deforestation is associated with the establishment of each supplier's pulpwood plantations that are harvested for a particular year of exports, accounting for deforestation that occurred between 2001 and 2013 (depending on year of export). Users access this data by selecting “Change Units” on the top-right bar of the screen.

Users interested in assessing to what extent pulp exports during the period 2015-2019 were associated with deforestation for different actors within the plantation footprint are encouraged to focus on the Deforestation for Wood Pulp metric. The metric differs from “annual deforestation” both in its spatial focus and the referenced time period. Rather than looking across the entirety of a pulp concession, deforestation for wood pulp only calculates deforestation within pixels that are eventually converted to pulp plantations according to Gaveau et al. (Figure 2: Illustration of the spatial assignment of deforestation for wood pulp in a given concession boundary).

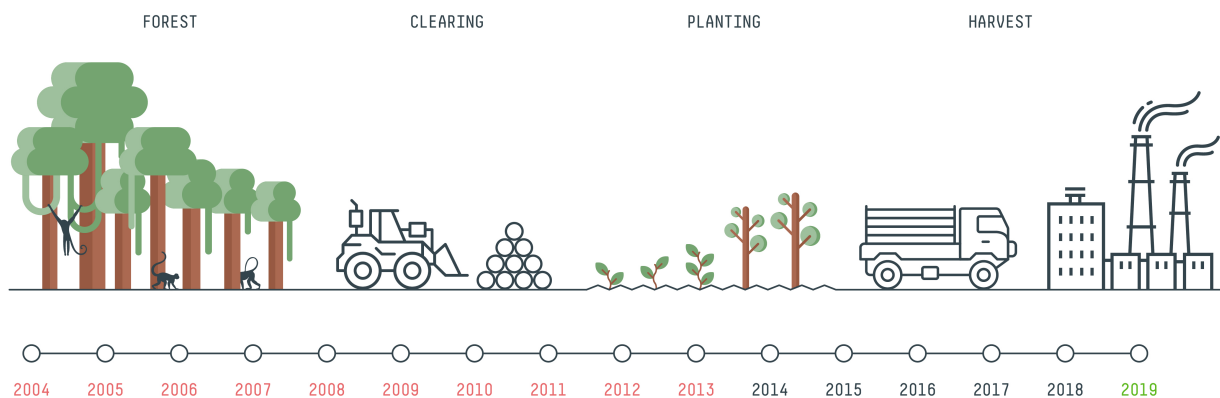
Deforestation for wood pulp is a retrospective estimate of deforestation, aggregating deforestation across a pre-specified allocation period connected to producing the pulp that was exported during 2015 to 2019 (Figure 3: Deforestation and pulpwood maps used to calculate deforestation for wood pulp between 2015 and 2019). This estimate is necessarily conservative as it is limited to areas developed for plantations whereas the deforestation impacts can expand beyond the planted area to other parts of the concession or even outside concession boundaries.

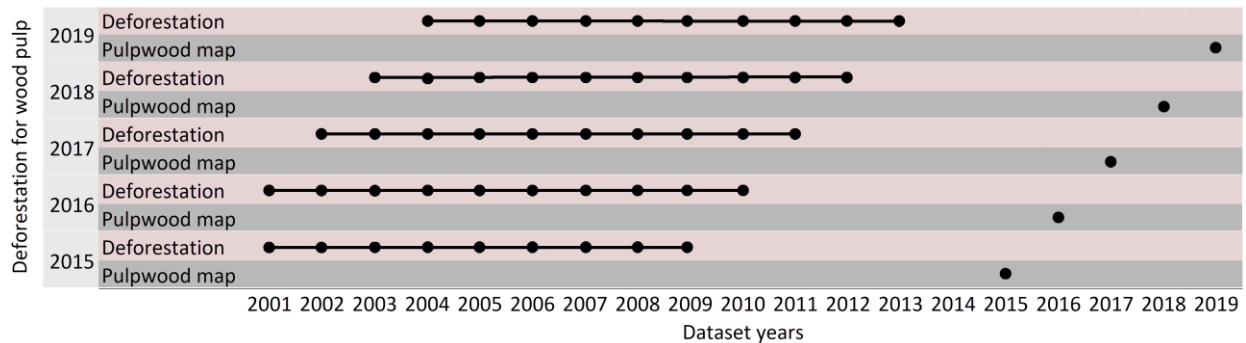
Figure 2: Illustration of the spatial assignment of deforestation for wood pulp in a given concession boundary



To define this allocation period, we assume that a typical pulpwood rotation lasts five years based on common industry knowledge. Therefore, we assume that a minimum of six years elapse after a deforestation event before the first pulpwood harvest from the plantation that was subsequently established, and we exclude this lag from the allocation period. For example, when calculating deforestation for wood pulp produced in the year 2019, clearing that occurred between 2014 and 2019 is not counted.

Figure 3: Deforestation and pulpwood maps used to calculate deforestation for wood pulp between 2015 and 2019





Selecting a start date for the allocation period is challenging. How far back in time should deforestation be attributed to a commodity's production? In forested landscapes, all areas of commodity production were once under natural forest. However, the work of Trase is focused primarily on estimating recent deforestation that contributed to the expansion and production of a commodity for a given year of harvest and export. To achieve that purpose, the time period of two harvest rotations was selected. The final deforestation estimate for pulp exports is derived from calculating the average annual deforestation over a period of 10 years (i.e. equivalent to two harvest rotations) leading up to the first year pulpwood plantations were detected. As an example of this approach, the deforestation for wood pulp exported in 2019 is the total area of the pulpwood plantations that overlap the deforestation that occurred between 2004 to 2013 divided by ten (to produce an annual estimate). The only exception occurs in assigning deforestation for wood pulp produced and exported in 2015, for which the area is divided by nine due to the lack of data on deforestation in 2000.

Trase continuously reviews its methodologies to estimate deforestation in the context of user needs and may add other metrics in future versions of the model.

Fire hotspots and burned areas

SEI-PCS Indonesia wood pulp v3.0.0 includes estimates of fire hotspots and burned areas. For the fire hotspots, the model incorporates data from NASA's Fire Information for Resource Management System (FIRMS) (7). All confidence levels of hotspots are included in the analysis. While this data is sufficient for viewing trends across suppliers and years, sites like Global Forest Watch Fire can provide more detailed analyses in terms of viewing different confidence thresholds. To estimate the area burned within each concession, we rely upon the Burned Area dataset from MoEF (8), which can be downloaded via publicly-accessible links on the Ministry's website.

Peatlands

SEI-PCS Indonesia wood pulp v3.0.0 includes three different indicators of peatland area and loss. The first, called "Peat area", is simply the total amount of peatlands located inside pulp concessions. The second, called "Pulpwood plantations on peat", is the net area of peatlands in pulp concessions that have been planted with pulpwood species, i.e. a subset of the first peatlands indicator, as defined by Gaveau et al. The third is called "Deforestation on peat" and estimates annual deforestation occurring on peatlands. For all three metrics, Trase identifies peatlands using Indonesia's official peat map, which was produced by the Indonesian Center for Agricultural Land Resources Research and Development within the Ministry of Agriculture 2011 (9).

Data download

Available from the download function on the Trase platform and at [http://resources.trase.earth/data/Trase Indonesia Wood Pulp V 3 0 0.xlsx](http://resources.trase.earth/data/Trase_Indonesia_Wood_Pulp_V_3_0_0.xlsx)

Changes to previous version(s)

Version	Publication date	Changes
3.0.0	February 2021	NA – this is first version.

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Annex: Glossary

Term	Definition	Example
Asset	In the context of Trase, a physical or material resource owned by a business or an economic entity that relates to the production, storage or processing of a commodity.	Pulp mill, concession.
HS code	Unique code from the Harmonised System (HS) which describes the nature of the products being traded internationally.	HS 470200: Wood pulp; chemical wood pulp, dissolving grades
Logistics	Activities related to the production, storage, processing, transport, trade, etc., of commodities in supply chains.	Pulpwood plantation management, pulp production, shipping.
Node	Jurisdiction, asset, trader or country representing a point of aggregation or transfer of a commodity through its supply chain.	Wood supplier, pulp mill, importer company, destination country.
Supply chain	Sequence of nodes linking a location of production to a country of import and/or destination country.	

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