High ILUC-risk fuels review

Project results phase 1

July 11th 2022

Agenda

1. Policy Context
2. High ILUC determination
3. Global feedstock expansion
4. Productivity factors
5. Mapping of crop expansion into high carbon stock land
6. GHG emissions of crop expansion into high carbon stock land
7. Concluding remarks and next steps

The presenters of today

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Housekeeping:

- Please post questions in the **Chat/Questions box**. At the end of the presentation, there will be a central Q&A session to address the questions asked through the questions box.
- The slides and a summary of the Q&A will be distributed after the workshop.
- We welcome any remarks or feedback after the meeting by email to High.ILUC@Guidehouse.com
- **Please note this webinar will be recorded.**

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Policy context

Kitti Nyitrai

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High ILUC determination

Michèle Koper

The project on High ILUC-risk fuels

Project overview

- A review of all relevant aspects of the report on feedstock expansion such as:
  - Feedstock expansion shares in high-carbon stock land
  - GHG emissions related to feedstock expansion
  - Energy yield data
  - Note: Excluded from the project are a review of the formula and the threshold chosen, nor the concept of ILUC itself
- The following crops are covered by the study: *maize, palm oil, rapeseed, sunflower seed, soybean, sugar beet, sugar cane and wheat*
- The project will provide the European Commission with background information for their review of the feedstock expansion report.
- This webinar presents the results of phase 1 of the project, phase 2 is ongoing.

Indirect Land Use Change

Indirect Land-Use Change related to bioenergy:

- Occurs when the cultivation of crops for biofuels, bioliquids and biomass fuels displaces production of crops for food and feed purposes.
- Such additional demand increases the pressure on land and can lead to the extension of agricultural land into areas with high-carbon stock, such as forests, wetlands and peatland, causing additional GHG emissions

High ILUC-risk fuels:

Biofuels, bioliquids and biomass fuels produced from food and feed crops for which a significant expansion of the production area into land with high-carbon stock is observed.

- Consumption limited by a specific and gradually decreasing limit per Member State
- Feedstock Expansion Report (Delegated Regulation 2019/807) sets values to determine high ILUC-risk crops

Low ILUC-risk fuels:

Fuels produced in a way that mitigate ILUC emissions, either because they are the result of productivity increases or because they come from crops grown on abandoned, severely degraded or unused land.

- Exempted from the specific and gradually decreasing limit.
- Specific guidance on how low ILUC risk can be demonstrated

Determining High ILUC-risk feedstock

The criteria as set by Delegated Regulation 2019/807:

a) the average annual expansion of the global production area of the feedstock since 2008 is higher than 1 % and affects more than 100 000 hectares;

b) the share of such expansion into land with high-carbon stock is higher than 10 %, in accordance with the following formula:

$$x_{hcs} = \frac{x_f + 2{,}6\, x_p}{PF}$$

- X_{hcs} = share of expansion into land with high-carbon stock;
- X_f = share of expansion into forested land (Article 29(4)(b) and (c) of Directive (EU) 2018/2001
- X_p = share of expansion into peat- & wetlands (Article 29(4)(a) of Directive (EU) 2018/2001 including peatland);
- PF = productivity factor.

The feedstock expansion report as set up by JRC provided the resulting values and outcomes for these criteria. In this project we review the data on feedstock expansion related to determining high-ILUC (Article 7)

Review the data on feedstock expansion

Criteria determining high ILUC risk feedstock

- Average annual expansion > 1 % and > 100 000 ha
- Share of gross expansion into forested land
- Share of gross expansion into peat- & wetlands
- Productivity factors

Activities within our project

- Statistical analysis to calculate global annual net expansion per feedstock
- Mapping of expansion into high carbon stock land (global & regional)
- Calculation of energy yields per feedstock
- GHG emissions related to expansion in high carbon stock land
- Stakeholder consultation & review of latest scientific information

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Global feedstock expansion

Michèle Koper

Statistical Analysis

Definition – gross vs net expansion

When analyzing crop expansion statistics on a per country level, countries may see a decrease or increase in harvested area during the period in question

Global Net expansion shows expansion results when accounting for both countries where there has been an increase and a decrease in harvested area in 2019 compared to 2008. Global Net expansion is used to check the average annual expansion against the > 1 % and > 100 000 ha criteria for HILUC crops

Global Gross expansion shows expansion results when accounting only for the countries that experience an increase in harvested area in 2019 compared to 2008. Global Gross expansion is used to calculate the shares of expansion onto high carbon land (as we are interested in the extent to which agriculture expands into high carbon stock areas when the agricultural area is expanding)

Statistical analysis – global annual expansion

Methodology & main improvements

Applied Feedstock Expansion Report Methodology

Input data

- FAOStat : Area harvested & production volume per country per feedstock
- USDA-FAS: Global production volumes of palm oil

Sum global production volume (kt) and total **net** harvested areas (kha) for 2008 and 2019 per feedstock.

Calculate the annual net increase of production, annual net increase of area and total net & gross expansion of area

Implemented Methodology Improvements

Maize and soybeans multi-cropping Brazil: Multi-cropping of maize and soybeans played an important role over the past decades in Brazil. FAOStat harvested area data was replaced with planted area data from national statistics and to correct for double counting the 2nd maize harvest area was excluded

Palm oil fruit production in Indonesia and Malaysia: Area harvested as provided by FAOStat does not accurately represent area planted of this crop since palm is a perennial crop. FAOStat harvested area data was replaced with planted area data from national statistics data for Indonesia and Malaysia as these countries contribute to ~85% of the total palm oil fruit production in 2019

Statistical analysis – global annual expansion

Outcomes

- The crops with the highest annual net area increase between 2008-2019 are: oil palm fruit with 4.4%, soybeans with 2.0% and maize with 1.3%
- For wheat, the annual increase and total expansion in area are negative values. This is since these are **net expansion values,** meaning they include countries where there has been a decrease in harvested area in 2019 compared to 2008

Crop	Total production 2008 (kt)	Annual net increase of production 2008-2019 (%)	Harvested area 2008 (kha)	Harvested area 2019 (kha)	Annual net increase of harvested area 2008 to 2019 kha	Annual net increase of harvested area 2008 to 2019 %	Total net expansion 2008-2019 kha	Total gross expansion 2008-2019 kha*
Wheat	680,294	1.1%	222,130	215,902	-566	-0.3%	-6,228	10,658
Maize	829,792	3.0%	158,872	183,791	2,265	1.3%	24,919	36,883
Sugar cane	1,716,568	1.2%	24,092	26,777	244	1.0%	2,685	3,668
Sugar beet	221,199	2.1%	4,262	4,609	32	0.7%	348	745
Rapeseed	56,873	2.0%	30,093	34,031	358	1.1%	3,938	5,078
Oil palm	213,403	6.1%	17,950	28,914	997	4.4%	10,964	10,971
Soybeans	231,223	3.4%	96,448	120,496	2,186	2.0%	24,049	25,293
Sunflower seed	36,302	4.0%	25,331	27,369	185	0.7%	2,037	6,395

* Only including countries that experience an increase in area in the period 2008-2019

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Productivity Factors

Michèle Koper

Statistical analysis – Average Yield

Methodology & outcomes

Identify top 10 producing countries and their % contribution per feedstock

- Rank FAOstat crop production data for 2019 per country in descending order
- Calculate the % contribution to the top 10 countries' production

Identifying the annual crop yield of the top 10 producing countries

- Use FAOstat yield data on harvested area to obtain the average crop yield per year, per feedstock for the top 10 countries

Calculate the average crop yield per year

- Perform a weighted average calculation by multiplying the annual crop yield of a country with its % contribution in production per feedstock

Calculate the average crop yield for the given period

- Average of the average crop yield per year

Use Average Yield as input for Productivity Factors

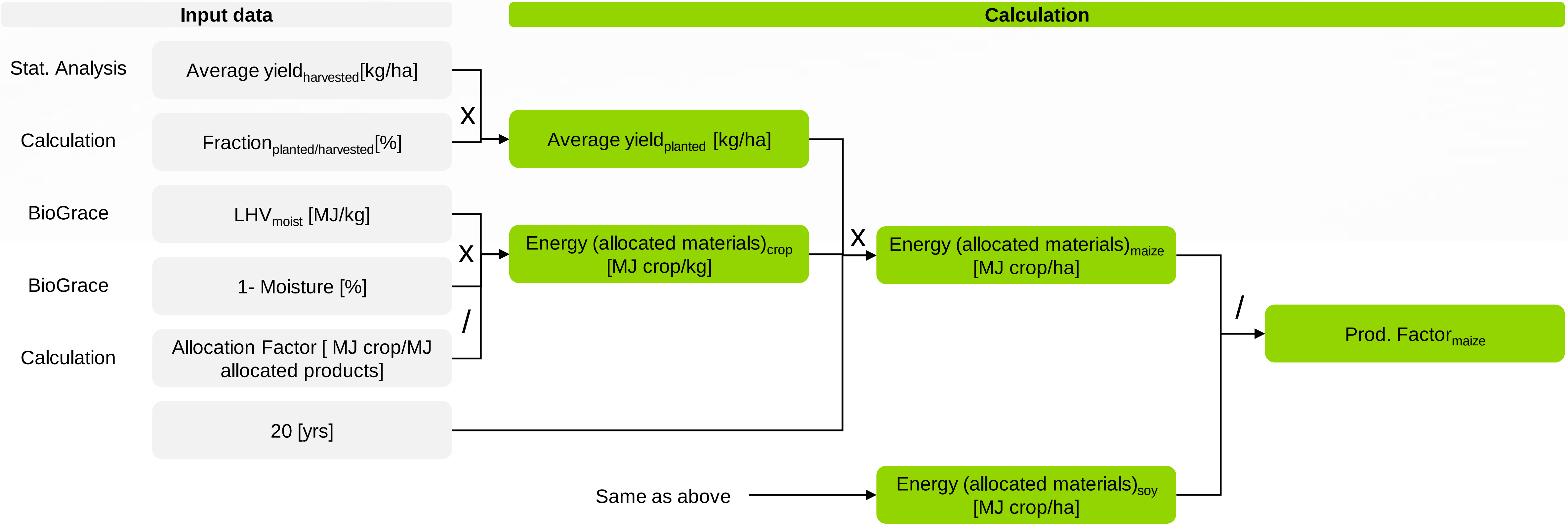
- See next slide

Average crop yield (kg/ha)

Year	Wheat	Maize	Sugar cane	Sugar beet	Rape seed	Oil palm	Soy beans	Sunflower
Average 2008-2017	3973	7524	73462	61302	2269	17158	2758	1832
Average 2008-2019	4018	7584	73845	61291	2253	17118	2803	1899

Productivity Factors

Methodology



Productivity Factors

Outcomes

- The resulting Productivity Factors are very similar to the ones presented in the original Feedstock Expansion Report

Crop	PF from Feedstock Expansion report 2008-2017	PF 2008-2019
Maize	1.7	2.0
Rapeseed	1	0.9
Soybeans	1	1.0
Sugar beet	3.2	3.2
Sugar cane	2.2	2.1
Sunflower	1	0.8
Wheat	1	0.9
Oil Palm	2.5	2.3

*Following the feedstock expansion report methodology, all PF are relative to soybean, which is set to 1

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Mapping of crop expansion into high carbon stock land

IIASA and GRAS

Global mapping of feedstock expansion

Introduction to the methodology

Mapping feedstock expansion in high carbon stock land

The aim of the exercise is to provide a global assessment of crop expansion into high carbon stock land

The eight crops focused on in this exercise are: Maize, oil palm, rapeseed, soybean, sugar beet, sugar cane, sunflower and wheat

A similar methodology as used in the report on feedstock expansion was applied in this project (starting from deforestation maps/trends). This because there are no annual global crop maps to track expansion patterns

Methodology and improvements

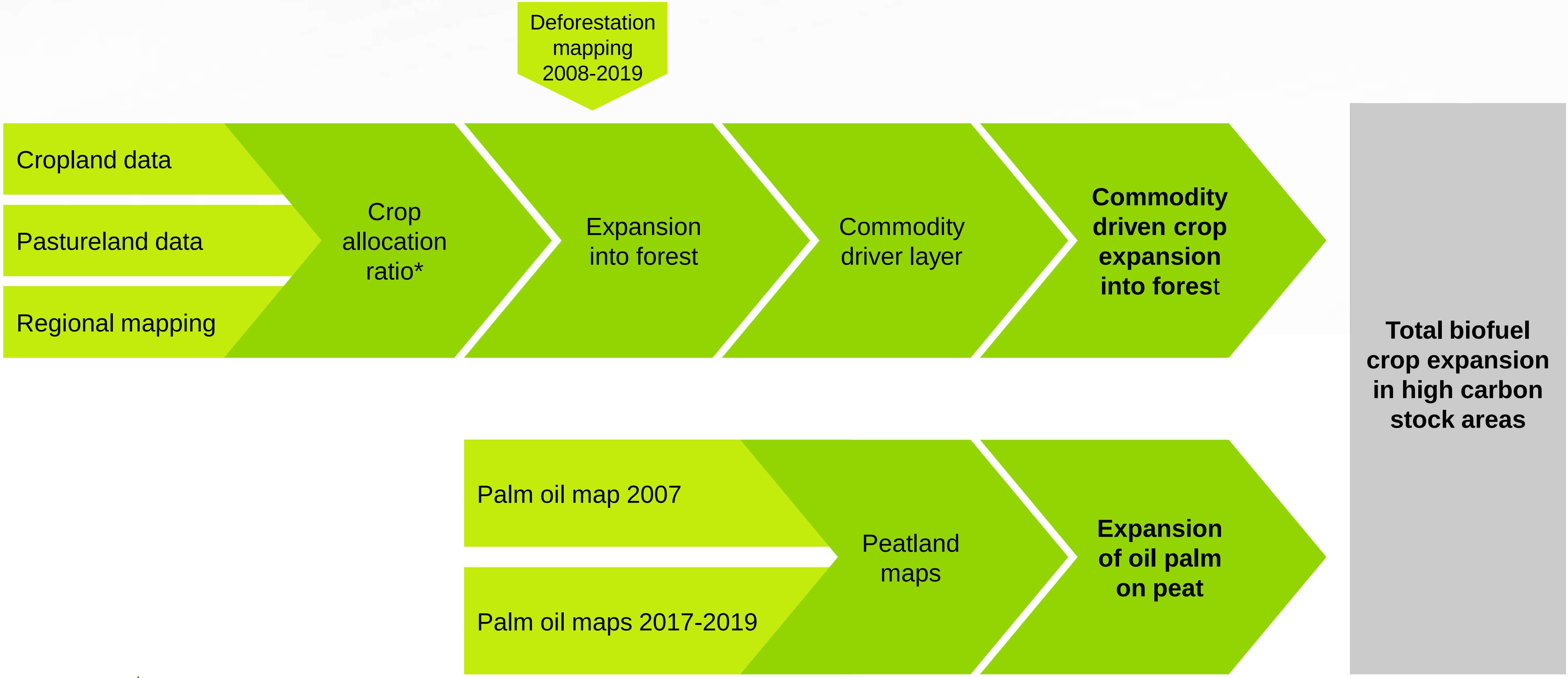
The methodology exists of two parts:

- Assessment of crop expansion on deforested areas.
- Assessment of crop expansion in peat areas

The main enhancement is the improved accuracy in 'hotspot' regions on crop expansion patterns by integrating results from regional satellite imagery mapping into the global map

Several other enhancements are the inclusion of more recent years, updating where available with more recent data sources and updating the drivers of deforestation data set (through a crowdsourcing campaign)

Summarizing methodology of mapping global crop expansion in high carbon stock areas



Global mapping: coarse and fine resolution

Starting point: Crop allocation method (JRC report):

$$\frac{MapSpam\ Crop\ X\ (2005)}{MapSPAM\ total\ crop\ area\ (2005)} \times \frac{Earthstat\ total\ crop\ area\ (2000)}{Earthstat\ total\ crop + pasture\ area\ (2000)} = \frac{Crop\ X}{crop + pasture} \text{ x }$$

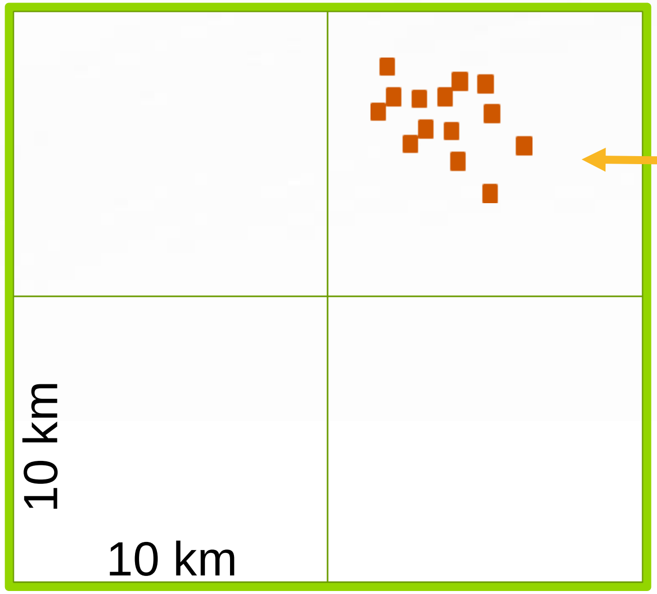
Commodity-driven tree loss ‘08-19 (in hectares)

Our improvements:

- Updated global crop maps and regional crop-driven tree loss estimations
  - MapSpam **2010** (instead of 2005) for all crops except:
    - **Soybean:** Global GEOGLAM (5 km resolution, 2015) for most of the world except:
      - GRAS crop-driven tree loss estimations (30 m resolution) in some provinces of Brazil, Argentina, Paraguay and Bolivia
    - **Oil palm**: GRAS crop-driven tree loss estimations (30 m resolution) in Southeast Asia and provinces of Cameroon
- IIASA **new commodity-driven forest loss layer**, based on Geo-Wiki crowdsourcing campaign

Global mapping: Layers employed

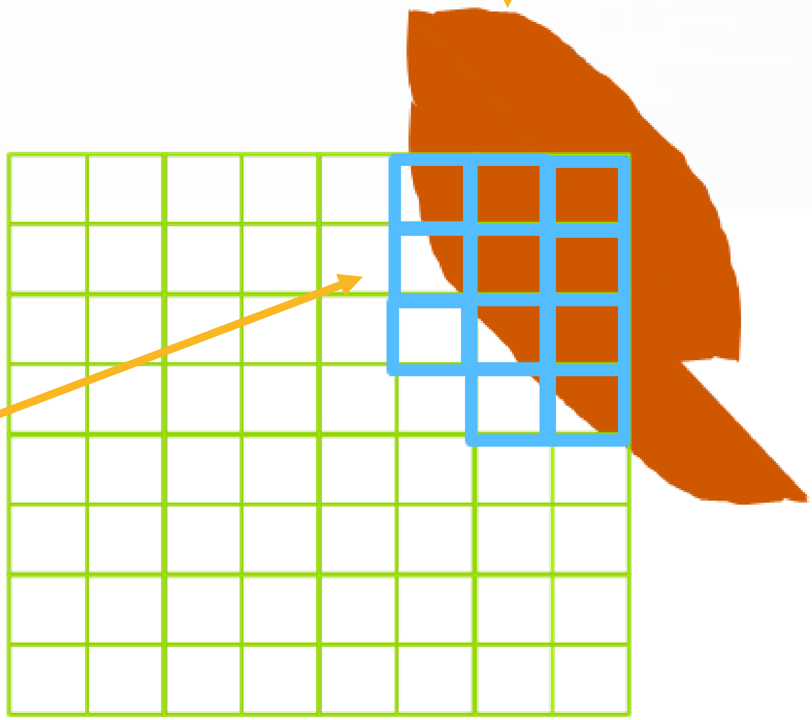
Base layer: MapSpam 2010 grid



Tree loss ha. summed up in each grid (Layer: GFW (30 m))

Crop proportions get allocated to the tree loss ha. (Layers: MapSpam, Geoglam, Earthstat)

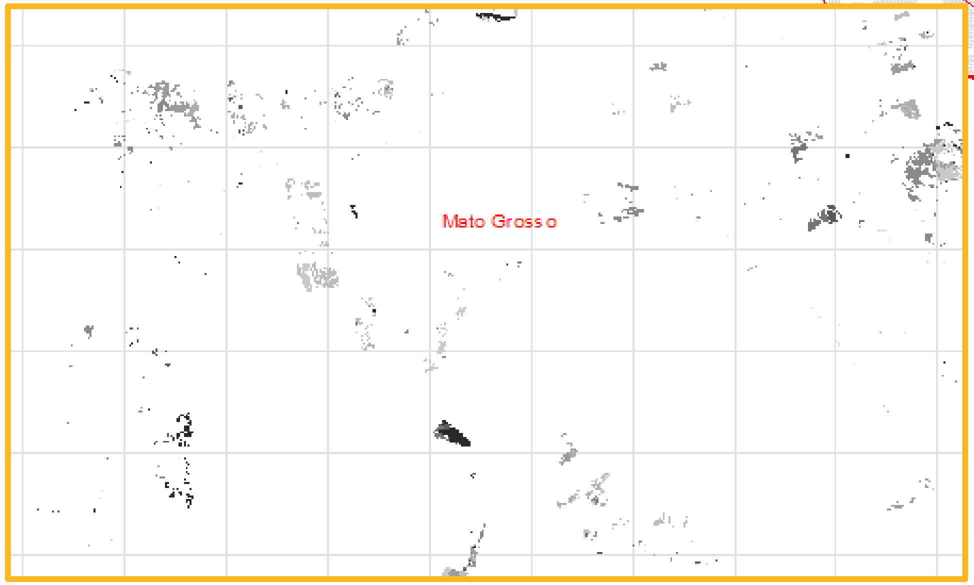
New commodity-driven forest loss layer

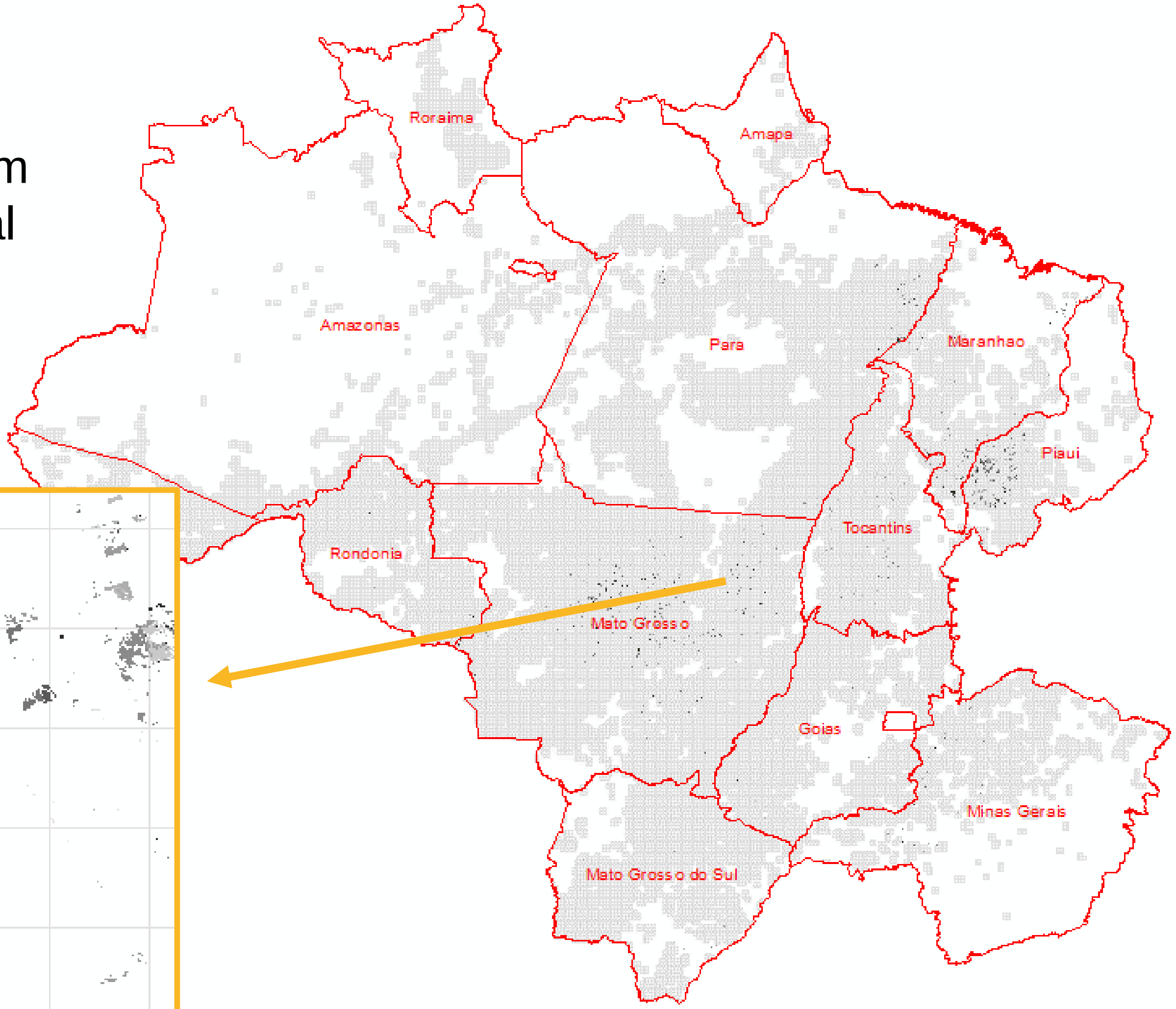


Grids to be summed up are selected if they touch the new commodity-driven forest loss layer

Global mapping: Integration of regional results

Crop-driven tree loss estimations (in ha.) from specific regions and crops replace the global maps in those areas

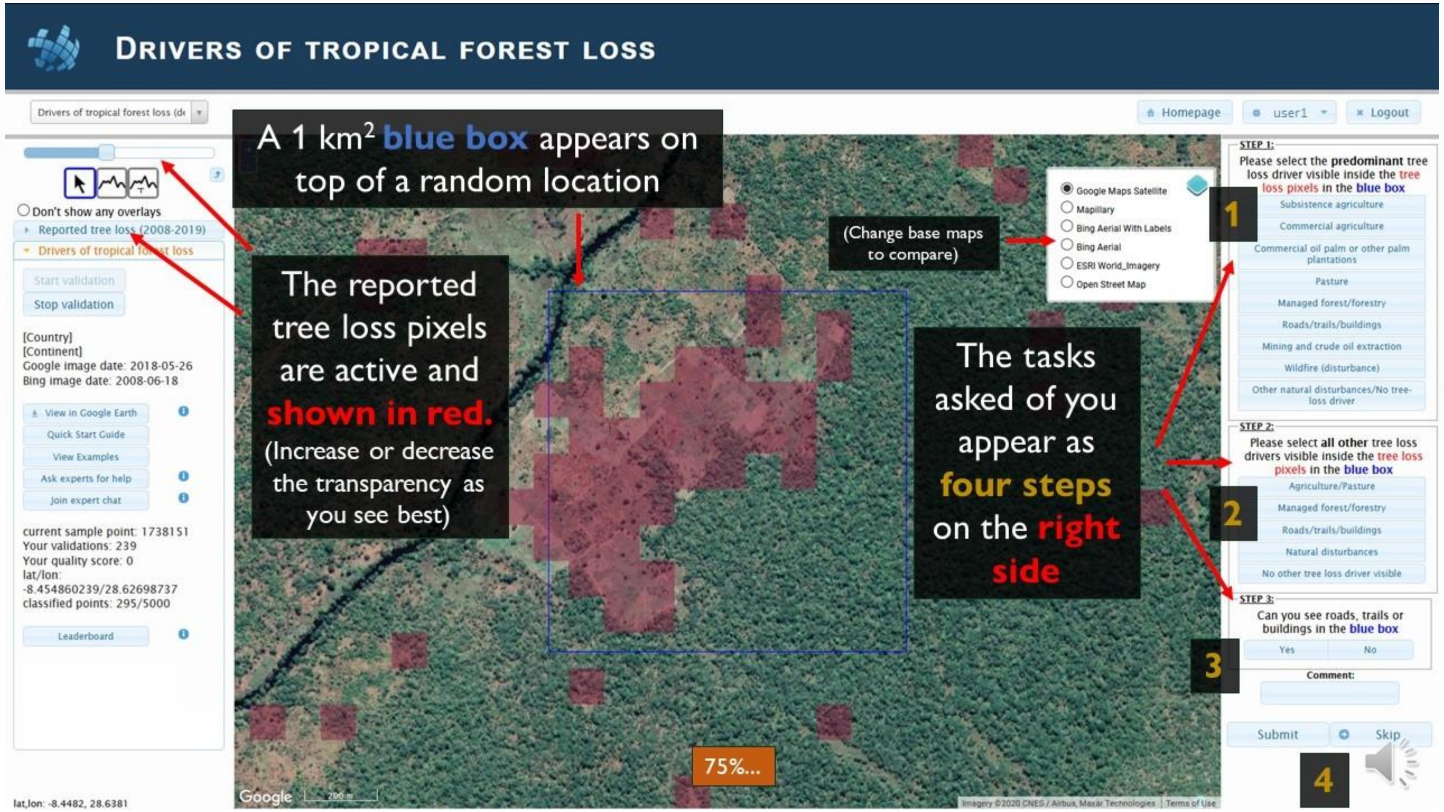




Crowdsourcing campaign

Improving the drivers of deforestation data set

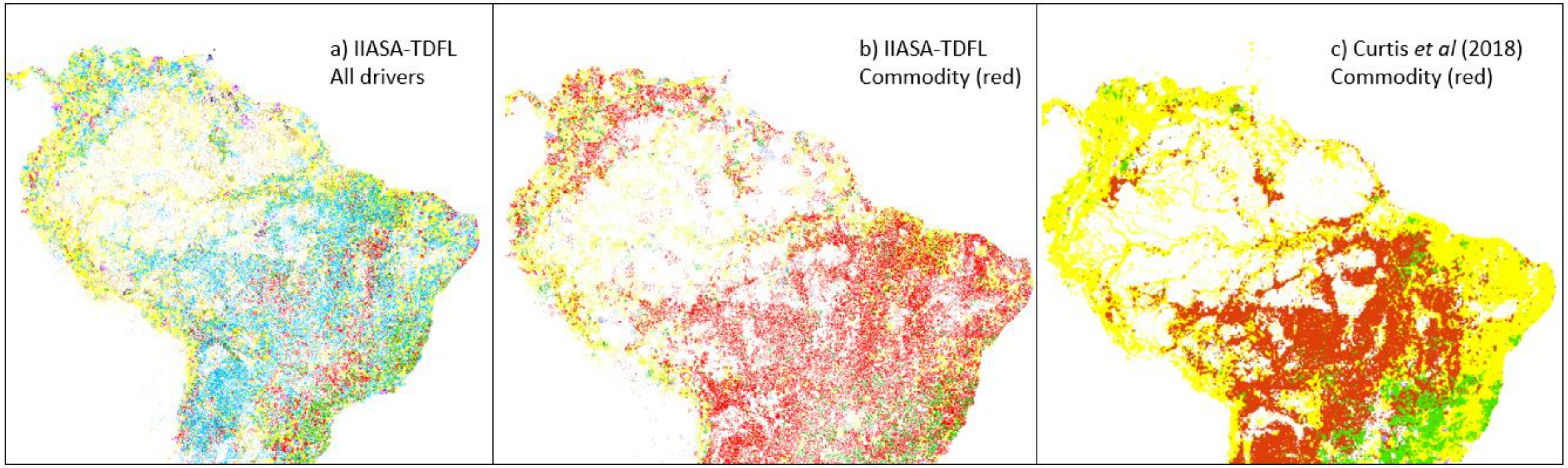
- Drivers of Tropical Forest Loss: A crowdsourcing campaign launched at the beginning of December 2020 **to refine the estimates of crop expansion into forested area**
- Identify the drivers of tropical forest loss -between 30 degrees of latitude north and south-
- Customized Geo-Wiki interface with an initial sample of 150,000 locations



Crowdsourcing campaign – Results

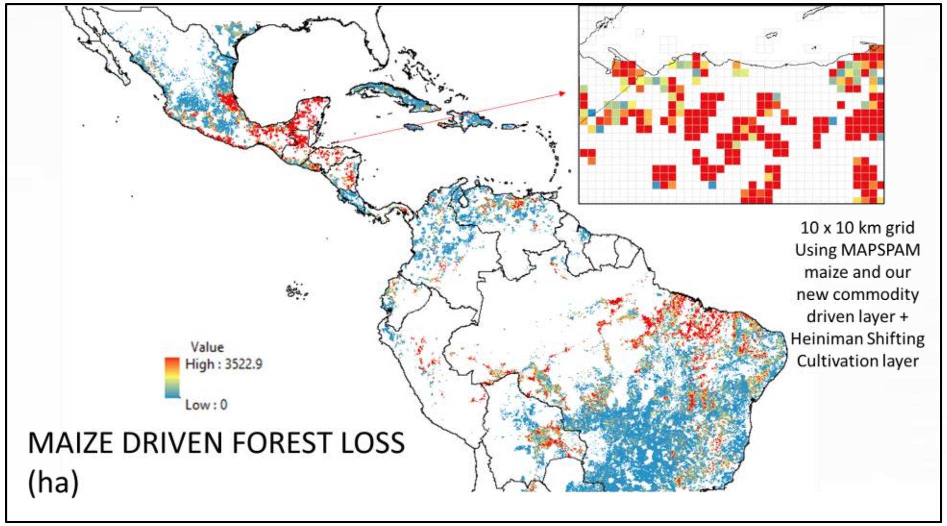
Improving the drivers of deforestation data set

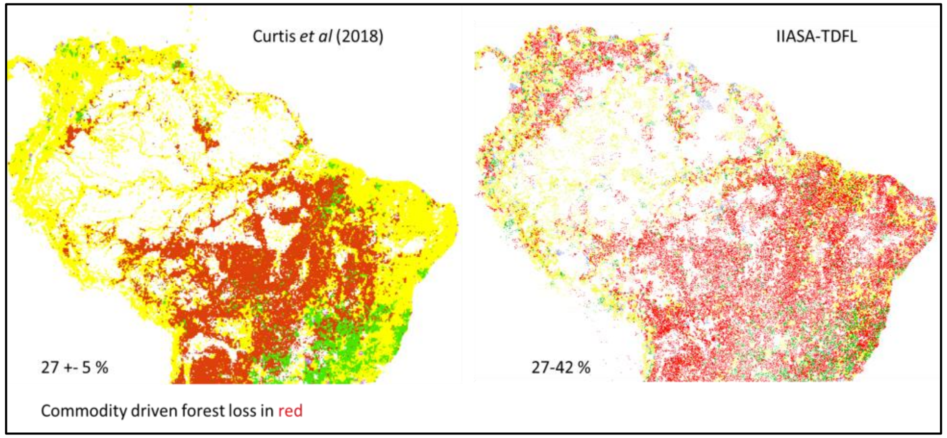
- A total of 58 participants from several countries produced over **400,000 validations of approximately 120,000 locations** distributed randomly across the world, each location being validated at least by three different participants.
- The **IIASA commodity-driven forest loss layer** was created by using four predominant drivers: 1) commercial agriculture, 2) commercial oil palm and other palm plantations, 3) mining and crude oil extraction, and 4) pasture



Conclusions global mapping

- The updated crop maps provide a better picture of recent developments and crop patterns (by using updated maps as well as the combination with the regional mapping).
- The commodity-driver layer employed is an improved version of the previous feedstock expansion report and can be further refined by e.g., including subsistence agriculture or employing the actual pixel distribution of the tree loss or thresholds instead of the whole grid.
- Total oil palm expansion on peatland has strongly improved by the use of regional mapping for Indonesia and Malaysia





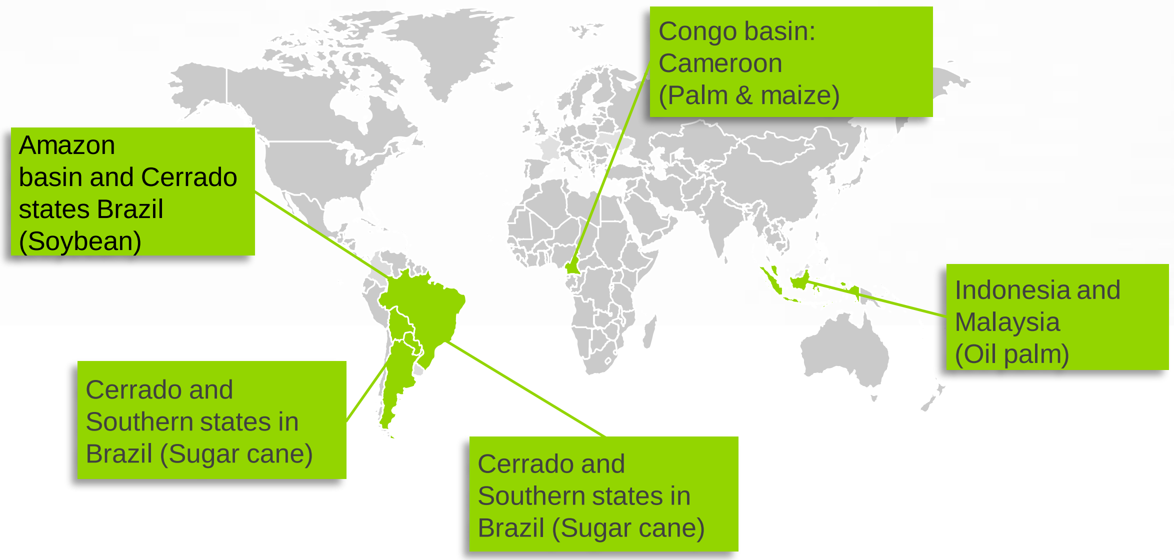
Detailed mapping of selection of ‘hotspot’ regions

To increase detail and certainty level of assessments

In selecting the regions for the regional mapping, we used the following criteria:

- Regions where majority of deforestation takes place based on results of the statistics and the initial global deforestation maps
- Main production regions for those crops associated with expansion based on results of the statistics
- Main production regions of crops for which the regions are associated with deforestation based on results of the statistics and the initial global deforestation maps
- Insights from the literature review
- Practical expertise from the project team

Selected regions



Regional mapping of feedstock expansion methodology

Indonesia and Malaysia (Oil palm)

- Mapped the main palm regions: Borneo, Sumatra and Peninsular Malaysia
- ALOS PALSAR and NDVI time series check each pixel marked as tree cover loss by Hansen et al (2019) and classified it into replanting or no replanting (deforestation)

Amazon basin and Cerrado states in Brazil (Soybean)

- 12 major soybeans states: Acre, Amapá, Amazonas , Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Rondônia, Roraima and Tocantins
- Soybean crop mapping methodology is based on using satellite imagery time series

Cerrado and Southern states in Brazil (Sugar cane)

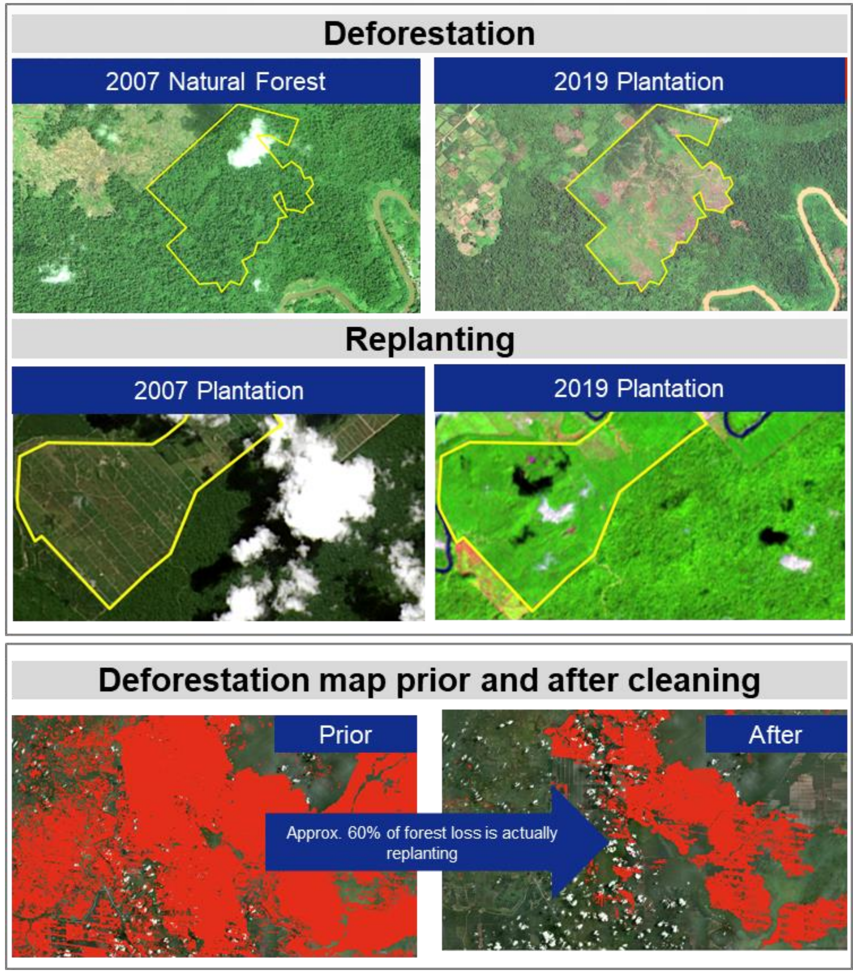
- Sugar cane areas were mapped using Landsat timeseries imagery. The ground truthing data were collected visually by GRAS. TWDTW method was used for the classification.

Gran Chaco region in Paraguay, Bolivia and Argentina (Soybean)

- Western and northern states of Paraguay, the south of Bolivia and the Chaco region in northern Argentina

Congo basin: Cameroon (Palm and maize)

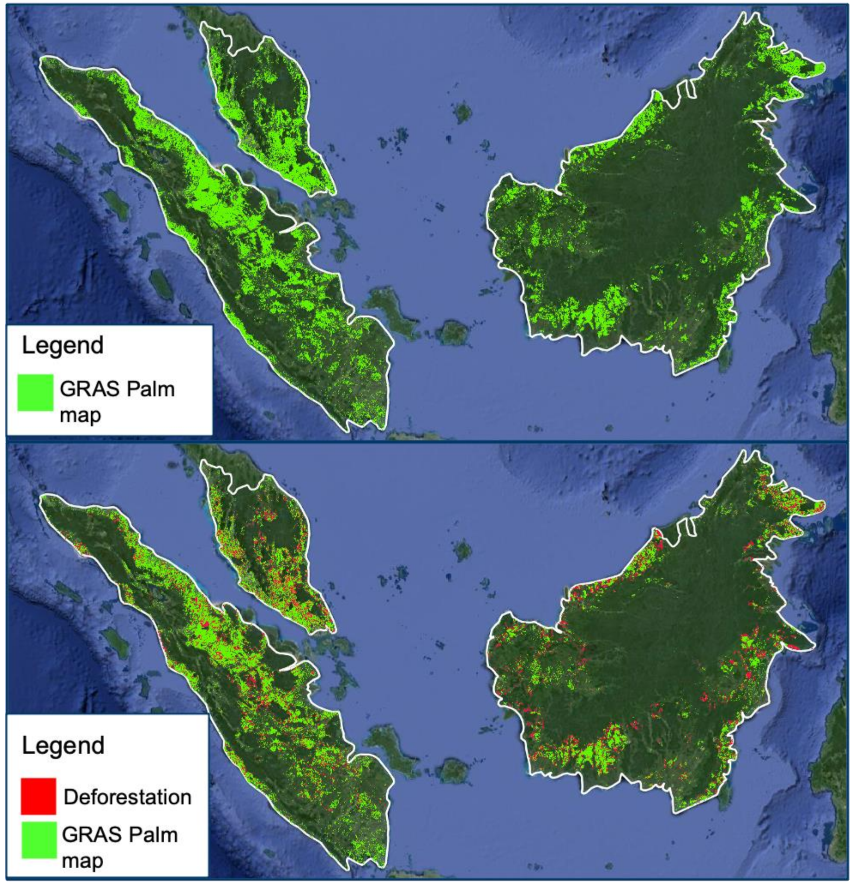
- Five main countries: Cameroon, Central African Republic, Congo, Democratic Republic of Congo (DRC) and Gabon



Example results regional mapping 1

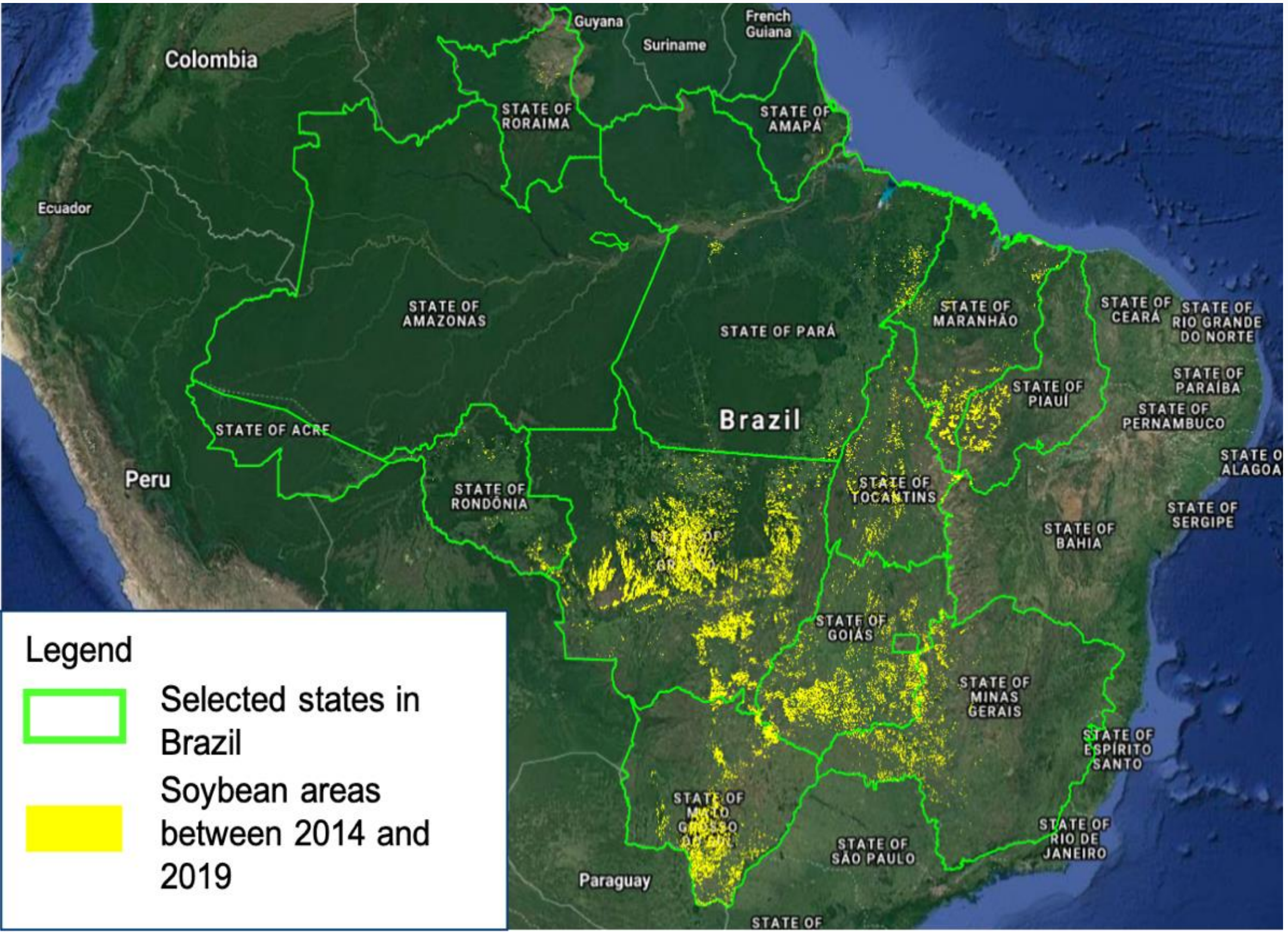
Indonesia and Malaysia (Oil palm)

- An updated palm map was created for Sumatra, Borneo and Peninsular Malaysia based on satellite imagery for the period 2008 - 2019
- Specific effort was made to further refine the deforestation map as to remove any replanting of plantations incorrectly listed as deforestation
- To get a perspective on the effect of replanting within the palm areas, 7.13 Mha of Hansen's tree loss (2008-2019) overlaps with current palm areas. About 50% of the tree loss was mapped by GRAS as replanting activities (3.59 Mha). The remaining 3.54 Mha are mapped by GRAS as actual deforestation
- Please note that the values mentioned above, are before the overlay with the drivers of deforestation (done after integration with the global map)



Example results regional mapping 2

Amazon basin & Cerrado states in Brazil (Soybeans)



- The soybean maps created had an accuracy of over 90% for the 12 mapped states and an agreement with the Brazilian agricultural statistics of >90%
- GRAS has created a combined map of all areas that are marked as soybean in any year between 2014 and 2019 (see left)
- The deforestation map shows a declining trend up until 2019, possibly caused by deforested areas being converted first to pasture for a few years

Results global feedstock expansion

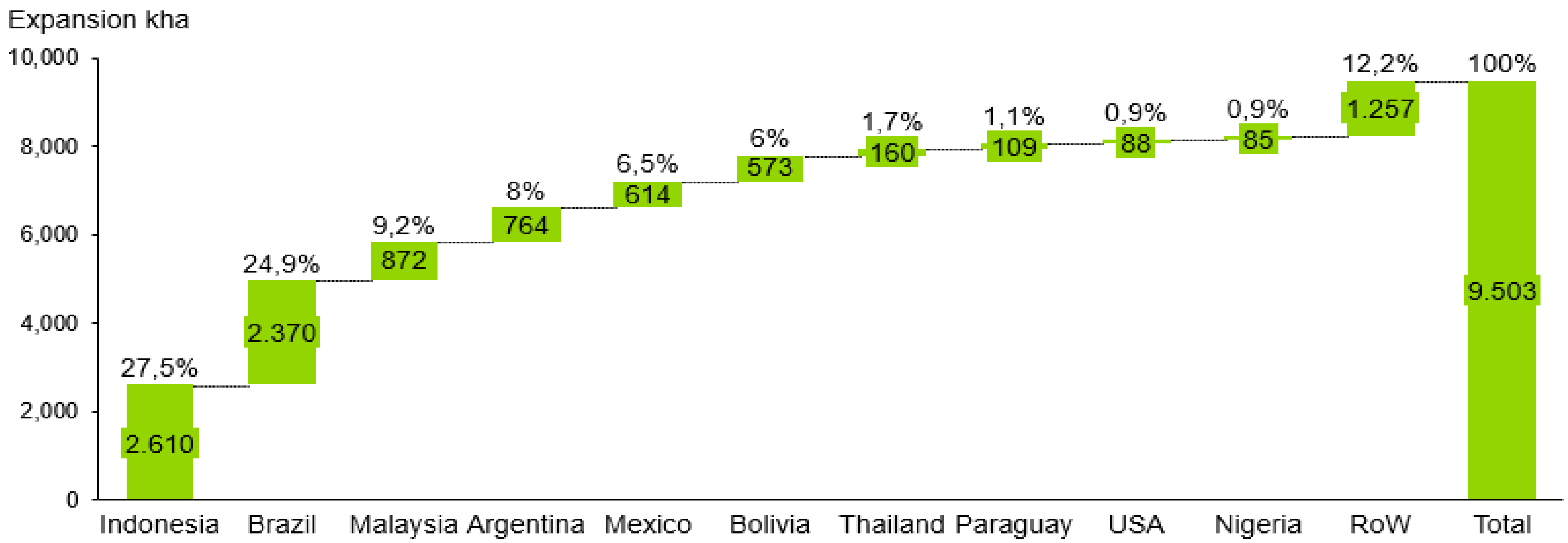
Integrated global mapping results for all eight crops

Crop	Increase of planted area (2008-2019) (kha)	Expansion into forest area (kha)	Expansion on peatland (kha)	Share of expansion forest	Share of expansion peat
Wheat	10,658	314	0	3%	0%
Maize	36,883	2,486	0	7%	0%
Sugar cane	3,668	495	0	14%	0%
Sugar beet	745	1	0	0%	0%
Rapeseed	5,078	64	0	1%	0%
Oil, palm	10,971	3,422	1,055	31%	10%
Soybeans	25,293	2,400	0	9%	0%
Sunflower	6,395	133	0	2%	0%

- Combining the global map with the regional mapping results
- Multi-cropping in Brazil might have led to an overestimation of maize expansion as we assigned an equal burden to soy and maize in such systems
- Compared to the feedstock expansion report, the analysis shows a reduction in expansion into high carbon stock land for palm oil (both in absolute numbers as well as share)
- It additionally shows an increase in the share as well as absolute expansion of soybeans into high carbon stock land
- Please note that this table does not include the application of the productivity factor, but the full expansion results

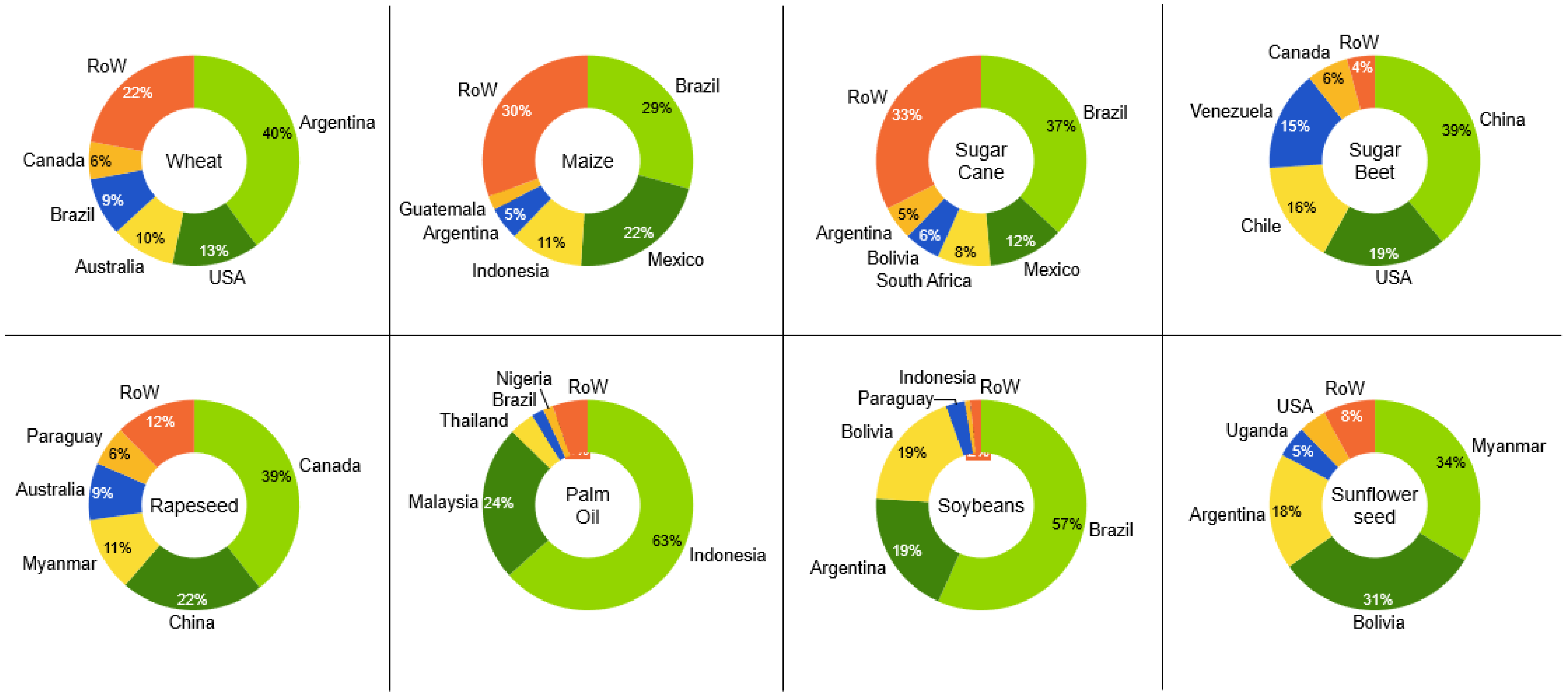
Reflections on global feedstock expansion results

- There are six countries responsible for ~84% of the total expansion area of cropland into high carbon stock land
- More than half of the total expansion of biofuel crops into high carbon stock land is found in the tropical rainforest. The tropical climate zone has a share of 98% in total cropland expansion (the remainder in temperate forests or mountainous forests).



Reflections on global feedstock expansion results

The three crops with the highest expansion area are palm oil, maize, and soybeans



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GHG emissions of crop expansion into high carbon stock land

Michèle Koper

Total carbon stock change

Land converted to cropland

Annual CO_2-C and non-CO_2 emissions from burning of drained organic soils

Excluded,

Annual non-CO_2 emissions from burning biomass

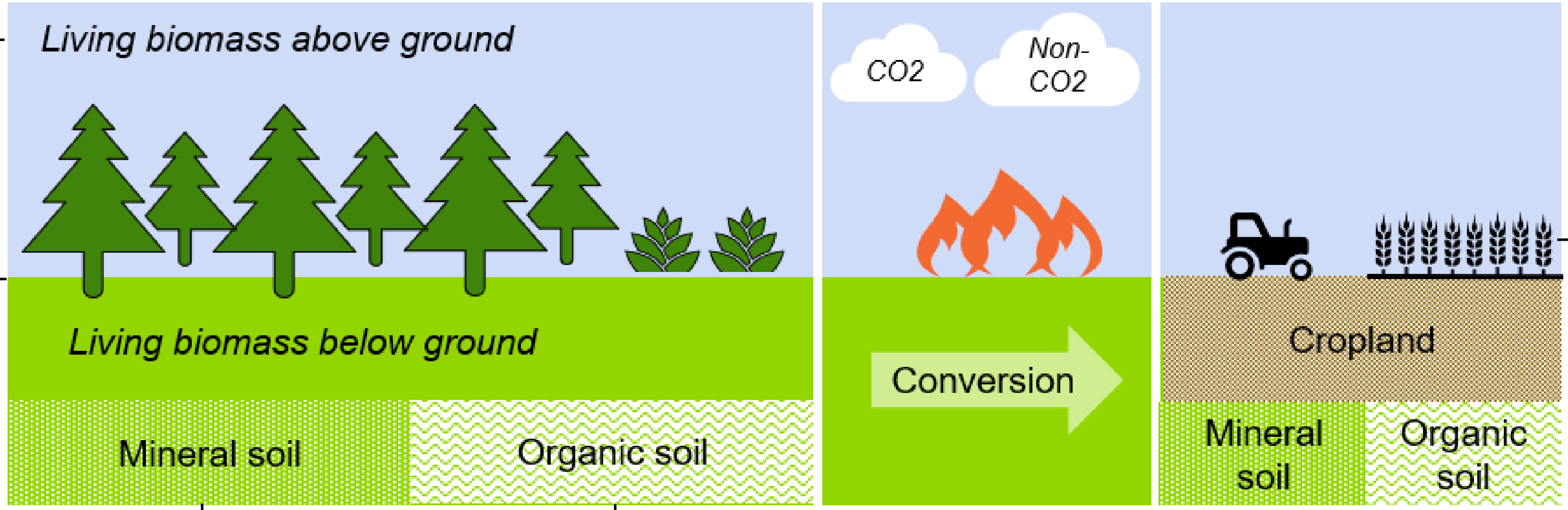
Excluded,

C stock of living biomass (below and above ground)

Included

C stock of dead organic matter

Included



(If relevant)
C stock of living biomass (below and above ground)

Included

C stock of mineral soils in land converted to cropland

Included

Net annual flux of on-site and off-site CO2 and non-CO2 emissions by drained organic soils.

Included

GHG Calculations

Main outcomes & learnings

Crop	GHG emission factor [tCO2/yr/ha]	Share of total expansion area of all crops [ha]
Oil, palm	28.3	38%
Soybeans	20.1	25%
Maize	22.3	26%
Sugar cane	20.5	5%
Wheat	16.7	3%
Sunflower seed	17.4	1%
Rapeseed	17.8	1%
Sugar beet	24.8	0.01%

- For all crops, except palm oil, most emissions (>85%) are caused by the removal of living biomass and dead organic matter
- For palm oil ~55% of the GHG emissions is due to emissions from expansion on peatlands
- The weighted average for all eight crops is 24 tCO2/ha/yr, higher than the 19.6 tCO2/ha/yr presented in the feedstock expansion report
- Main reasons are the consideration of climate zones and inclusion of the emissions from soil carbon, below ground biomass and dead organic matter

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Concluding remarks & next steps

Final results

Determining High ILUC crops

- Based on the results from our analysis for the period 2009-2019, palm oil would be classified as high-ILUC risk feedstock
- Soy comes very close to the 10% threshold (9.5%)

Crop	Share expansion on high carbon land	Average annual expansion (kha)	Average annual expansion (%)
Wheat	3.3%	-566	-0.3%
Maize	3.4%	2,265	1.3%
Sugar cane	6.5%	244	1.0%
Sugar beet	0.1%	32	0.7%
Rapeseed	1.3%	358	1.1%
Oil, palm	24.3%	997	4.4%
Soybeans	9.5%	2,186	2.0%
Sunflower	2.6%	185	0.7%

Concluding remarks and next steps

- Based on the results from our analysis 2009-2019, palm oil would be classified as high-ILUC risk feedstock. Soy comes very close to the 10% threshold (9.5%).
- The results of this analysis are based on the latest available scientific data and several improvements compared to the first feedstock expansion report (e.g. combining global and regional mapping).
- Furthermore, in the ongoing phase 2 we have further enhanced the mapping and expanded the timeframe, for example by:
  - Adding 2020 as year (and exploring trends in more recent years in more detail)
  - Further improvements to the statistical analysis
  - Further improvements to the maps (e.g. additional improvements on the drivers layer, improving the 2007 palm map for the peat estimates)

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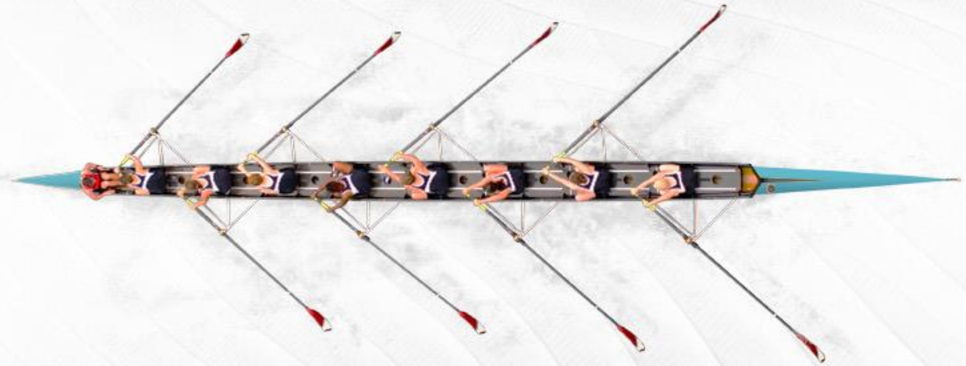
Are there any questions?

Thank you for your attention



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