Potential impacts of a UK due diligence regulation on deforestation, land conversion, biodiversity and associated carbon emissions

Technical report

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Accompanying report

This report sets out research commissioned by WWF-UK carried out by the consultancies 3Keel and Environment Systems. The findings of this research are analysed and summarised in a separate report, which also includes recommendations to the UK government, companies, financial institutions and citizens:

WWF UK (2021). Due Negligence: Will a due diligence regulation on illegal deforestation delink UK supply chains from deforestation?

Available at: www.wwf.org.uk/what-we-do/due-negligence-report

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1 Introduction

Key Finding 1. A spatial analysis approach has been developed to assess the potential impacts of UK supply chains on deforestation, land conversion, biodiversity and associated greenhouse gas (GHG) emissions arising from projected land use change in Brazil and Indonesia. In the case of Brazil, this also included investigating legal compliance.

Key Finding 2. The study quantifies how much of those impacts would be legally allowed by producer country laws and identifies their locations.

Key Finding 3. The study makes use of publicly available spatial data in the analysis and highlights the challenges of using available data to determine the legality of potential deforestation and land conversion.

1.1 Background

WWF have been instrumental in raising the profile of the UK's contribution to deforestation, land conversion and other environmental and social impacts worldwide through its imports of agricultural and forest commodities[1]. As a consequence, the UK committed in 'A Green Future: our 25 Year Plan to Improve the Environment' to develop goals and actions for the UK, including that '*our consumption and impact on natural capital are sustainable, at home and overseas*'[2]. The government subsequently commissioned the Global Resource Initiative to propose a policy on how the UK might mitigate deforestation through commodity imports[3]. In 2020, the UK Government conducted a consultation on a proposed regulation that would require UK companies above a certain size to conduct due diligence to ensure that there is no illegal deforestation in their agricultural and forestry supply chains. Legality would be defined by producer country regulations.

However, legal deforestation and other types of land conversion – not covered in the proposed regulation – can potentially be widespread, causing significant biodiversity loss and greenhouse gas (GHG) emissions. In some contexts, it is even difficult to establish what is legal or illegal (e.g., where legal land uses and/or legal frameworks overlap and/or where there is a paucity of data to establish legality). This is likely to vary between both countries and commodities.

The study estimates the impacts of UK supply chains on deforestation, land conversion, biodiversity and associated GHG emissions arising from projected land use change in Brazil and Indonesia. It uses a spatial approach to understand, evidence and quantify the potential risks and impacts. The spatial study quantifies how much of those impacts would be legally allowed by producer country laws, identifies their locations and reports the total areas and associated GHG emissions and risks to biodiversity.

1.2 About this report

This technical report describes the spatial analysis and policy analysis that is summarised in the public summary report '*Due negligence: Will a due diligence regulation on illegal deforestation delink UK supply chains from deforestation?*' published in August 2021. It is intended to support that document by providing methodological details and some additional findings of the analyses.

The report focuses on the three main components of the analysis: a spatial explicit analysis of UK soy supply chains in Brazil, a spatial analysis of palm oil in Indonesia from areas of the country very likely to supply to the UK, and a detailed consideration of the key policy elements required to formulate an effective due diligence regulation that would be fit for purpose.

[1] WWF-UK and RSPB (2020). Riskier Business: the UK's overseas land footprint. https://www.wwf.org.uk/sites/default/files/2020-07/RiskierBusiness_July2020_V7_0.pdf
[2] HM Government (2018). A Green Future: our 25 Year Plan to Improve the Environment. https://www.gov.uk/government/publications/25-year-environment-plan
[3] Global Resource Initiative (2020). Final Recommendations Report https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/881395/global-resource-initiative.pdf

2 Potential deforestation associated with the UK's soy supply from Brazil

SUMMARY OF THE APPROACH

- The study makes use of publicly available spatial data in the analysis. It highlights the challenges of using data from the rural registration systems that support implementation of Brazil's Forest Code to determine the legality of potential deforestation/land conversion.
- The analysis is of the 133 municipalities known to be supplying soy directly to the UK.
- The spatial analysis used multiple datasets to identify areas of native vegetation that can potentially be deforested/converted legally and the impact of this.
- The key datasets are:

1. CAR – Registered parcel, Legal Reserves; protected land (APPs and Restricted Use Areas) – source: SICAR
2. Other nationally protected land areas (conservation units, indigenous lands, Quilombola land)
3. Vegetation types – that can be matched with different Forest definitions (e.g., FAO, Brazil definition)
4. Presence of soy on registered land
5. Harmonized global maps of above and below ground biomass carbon density (2020) for potential carbon emissions

2.1 Overview of the approach

The key legislation concerning private land use in Brazil is the Forest Code (Law no. 12.651). The Forest Code specifies that a certain proportion of each landholding must be retained as native habitat, with the proportion depending on the biome in which the landholding is present. The unit of our analysis was therefore individual landholdings, for which spatial analysis was used to assess the potential for legal deforestation and conversion.

Meetings were held with WWF Brazil, WWF-UK and their stakeholders for advice on the availability, quality and previous use of spatial data for deforestation and conversion, commodity sourcing and biodiversity impact assessment in Brazil. This helped identify a number of national datasets to support the analysis and interpretation.

2.2 Regulatory context

2.2.1 Native habitat

Key datasets to underpin analysis are those that determine whether land is protected from agricultural conversion or not and whether land is native habitat. In this study a distinction is made between natural forest and other types of natural vegetation to aid assessments of potential carbon emissions and biodiversity impacts.

2.2.1.1 Definition of types of native habitat

Forest: There are two definitions of forest that are relevant to the project.

1. The definition that is identified by the draft due diligence legislation uses the Food and Agriculture Organization (FAO) definition of forest[4]:
   - *"Land spanning >0.5 hectares with trees higher than 5 m and canopy cover >10%, or trees able to reach these thresholds in situ."*
2. The more commonly used definition of forest[5], provided by *Instituto Brasileiro de Geografia e Estatística* (IBGE) and widely used in Brazil in assessments of deforestation and land conversion is:

[4] Food and Agriculture Organization of the United Nations - FAO. Manual for integrated field data collection. FAO: Rome, Italy, 2012, 175p.;
[5] Instituto Brasileiro de Geografia e Estatística. Manual técnico da vegetação brasileira, 2nd ed., IBGE: Rio de Janeiro, Brazil, 2012

- *Trees with a height of more than 5m are considered to be forest, with defined forest types that include dense forest physiognomies (continuous crown cover), open forest types, seasonal forest, mixed ombrophylus (Atlantic) forest and mangrove areas*[6]

with the following forest types included:

- Ombrophilous Dense and Open Forest
- Mixed Ombrophylous Forest (Araucaria Forest)
- Evergreen Seasonal Forest
- Semidecidual Seasonal Forest (*Subcaducifolia* Tropical Forest)
- Decidual Seasonal Forest (Deciduous Tropical Forest)
- *Campinarana* Forest
- Forested Savannah (*Cerradão*)
- Forested Steppic Savannah
- Alluvial forests (*igapós*)
- Arboreal Mangrove Swamp (Pioneer Formation with riverine influence)
- *Buritizal* (Pioneer Formation with fluvial and/or lacustrine influence).

Natural land: In this study, references to natural land consists of any native vegetation classes defined as non-forest native formation in MAPBIOMAS.

Plantation forest is excluded from the definition of native habitat.

2.2.2 Protection of native habitat in Brazil

There are several legal designations/mechanisms in place in Brazil to afford protection against deforestation and conversion of native habitat, which can be broadly defined as:

- Indigenous lands
- Conservation units (national / state / local)
- *Quilombola* land
- Areas with protection afforded by the Forest code (see Section 2.2.3), namely Areas of Permanent Protection (APPs), Legal Reserves and Restricted Use Areas.

Whilst distinct in a legal or regulatory context, there are many occasions where each of these designations/mechanisms can overlap each other (i.e., cover the same area).

Unprotected native habitat is all remaining native habitat that is not covered by these measures.

On rural land that is not yet registered in Sistema Nacional de Cadastro Ambiental Rural (SICAR), deforestation or conversion can be considered as *de facto* illegal, as registering landholdings on the Cadastro Ambiental Rural (CAR) is mandatory under the Forest Code. Therefore, the study also assesses protected and unprotected forest and natural land on unregistered land.

2.2.3 The Forest Code

Brazil's Forest Code (Law no. 12.651) has been in force since 2012[7]. This Code introduced new instruments that, once effectively implemented, allow for better monitoring of land use which will be crucial in the combat against deforestation and in ensuring environmental compliance, as well as in attaining Brazil's goals with respect to the reduction of greenhouse gas emissions.

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[6] Forest (3.1): trees with a height of more than 5m are considered to be forest, including dense forest physiognomies (forest structure with dense forest (forest structure with continuous crown cover), open forest (forest structure with structure with different degrees of discontinuity of the upper cover, according to its type (with liana, bamboo, palm or sororoca), Seasonal Forest (forest structure with loss *of structure* with loss of the leaves of the upper strata during the unfavourable season (dry and cold) as well as the Mixed Ombrophylous (Atlantic) Forest) and mangrove areas.

[7] http://assets.wwf.org.uk/downloads/wwf_brazils_new_forest_code_guide_1.pdf

2.2.4 Implementing the Forest Code: SICAR

The mechanism designed to support the implementation of the Forest Code is the Sistema Nacional de Cadastro Ambiental Rural (National Rural Environmental Registry System or SICAR). SICAR provides an integrated database of georeferenced information for each property and its environmental situation. This system enables control, monitoring of environmental resources and strategic assessment to combat deforestation and conversion.

2.2.5 Land registration status

Implementation of the CAR is the responsibility of the Brazilian states. The public can access CAR data from the federal portal which holds SICAR data for 26 states and 5,570 municipalities. Many states have their own CAR system but whilst these will be more up to date, these are not available publicly.[8] States maintain "master" versions of the SICAR database on which administrative checks are made. These are periodically synchronised to update the central publicly available data source; however, the frequency of updates is not known. For example, it is known that, in some Brazilian States, the land registration process is at a more advanced stage than in others. In Mato Grosso and Acre, registration is high and the validation process well underway. In Rondônia, registration is good, whereas in many other States, registration and administrative checks are far from complete. The verification process has proceeded very slowly since 2019[9].

The CAR is mandatory for all rural properties. It involves the owner georeferencing the perimeter of their property, locating the remnants of native vegetation, APPs, areas of restricted use, consolidated areas and legal reserve areas. High resolution satellite images are provided to landowners to aid the registration process. The information submitted then undergoes a process of validation. There are five steps when registering a property[10]:

1. Property area: it is mandatory that landowners delineate the total area of their property.
2. Ground Cover: areas of the property made up of "Fallow Area", "Consolidated Area" and "Remnants of Native Vegetation".
3. Administrative Servitude: areas occupied by roads, other public works that cut through the interior of the rural property.
4. Areas of Permanent Protection (APP)/Restricted Use: a regulatory requirement defined in the Forest Code as being those destined to the protection of biological diversity associated with water springs water sources, relief and special areas of great environmental relevance. They may or may not be native vegetation.
5. Legal Reserve: a regulatory requirement to identify areas within the rural property that will be instituted voluntarily, temporarily or perpetually, for the conservation of natural resources.

[8] https://www.sciencedirect.com/science/article/pii/S0921800916308758
[9] WWF Brazil, *pers comm.*
[10] https://www.car.gov.br/manuais/ManualCAR.pdf

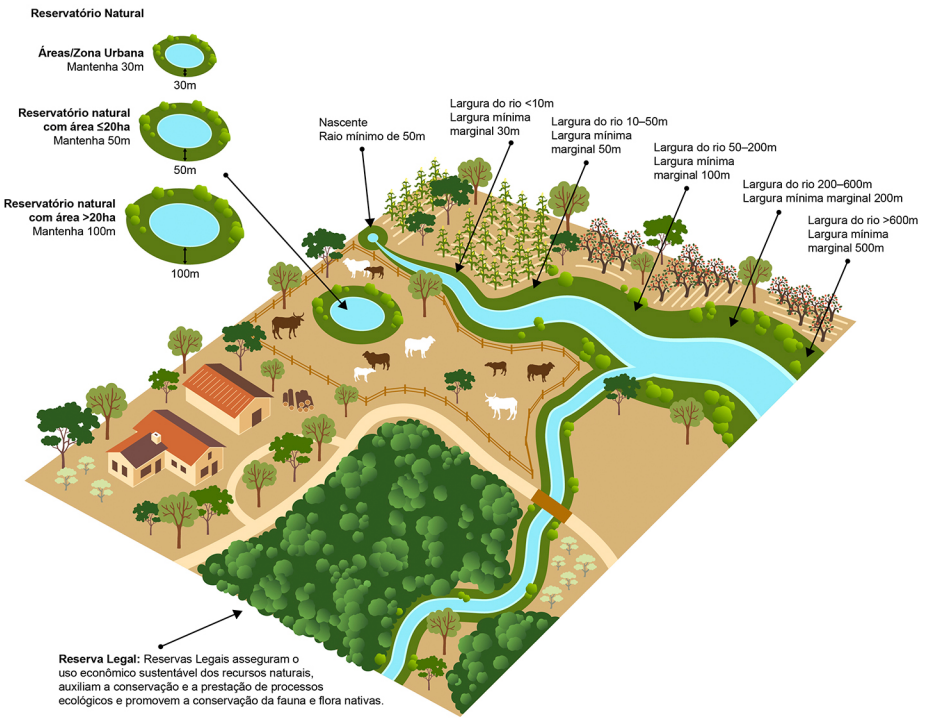


Figure 1: Areas of permanent protection (APPs) (source: WWF-Brazil) provides a representation of the types [11].

The legal requirement for the size of a legal reserve depends on where the property is located (Table 1).

Table 1: Legal Reserve Federal thresholds mandated by the Forest Code[12]

Land Use	Legal Amazon			Rest of Brazil
	Forest	Cerrado	Grasslands	
Legal Reserve	80%	35%	20%	20%
Productive Use	20%	65%	80%	80%

The Forest Code includes a number of specific regulations related to the CAR as follows:

- Landowners are required to participate in the SICAR (which was voluntary before 2012).
- Illegal deforestation carried out before 22nd of July 2008 might be pardoned if the landowner registers in the SICAR and in the state's Program for Environmental Regularisation.
- Landowners are allowed to count all APPs, such as forests along rivers and hillsides, as part of their Legal Reserve under certain conditions.
- The amount of required forest along rivers must range between 5 and 100 metres.
- Legal Reserve in forest regions of the Amazon can be reduced to 50% in states with more than 65% of its area occupied by protected areas or indigenous territories, and that have ZEE (Economic Ecological Zoning). In this case, the state can decide the size of the Legal Reserve.

2.2.6 Application of the regulatory context

A lack of information on the application of allowable variations in applying the Forest Code thresholds means that the study has known limitations.

2.2.6.1 Legally valid variations to thresholds

There are circumstances in which some states can reduce or increase the thresholds for Legal Reserves, however, no consolidated information summarising such changes could be found (*pers. comm*, WWF-Brazil). For example,

[11] WWF-Brazil (2015). Brazil's new Forest Code: A guide for decision-makers in supply chains and governments.
[12] WWF-Brazil (2015). Brazil's new Forest Code: A guide for decision-makers in supply chains and governments.

states that approved a ZEE can reduce their legal reserves, however it is thought that no state so far has ever approved a ZEE and effectively reduced its legal reserves.

Municipalities in the Legal Amazon can reduce their legal reserves when they have more than 50% of their areas covered by protected areas (conservation units, excluding APAs, and indigenous lands). Again, no consolidated table or information showing which municipalities effectively are making use of this legal provision could be found and it was beyond the study resources to check individually each state and municipality, their sustainability plans, etc.

The state of Tocantins adopts a 40% threshold for its *Cerrado* cover and Piauí does 30% because states constitutionally can approve and adopt environmental protection thresholds that are more protective than federal legislation. This has been applied in the analysis.

There are also adjustments that can be made for farm size[13], but it was beyond the study resources to source and apply these.

2.2.6.2 Identifying restoration and compensation land

Restoration: on a property is identified as Legal Reserve in SICAR and so is covered by the Legal Reserve dataset.

Compensation: Medium and large landowners and possessors (with areas larger than four fiscal modules[14]) who deforested more than what was allowed before July 22, 2008 are obligated to either restore their Legal Reserves on the property itself or via an "offset" through a compensation process in areas of equivalent size in the same biome. Compensation options include: a) the Environmental Reserve Quota (CRA, the acronym in Portuguese); b) a direct lease from another property owner; or c) a land purchase for or donation to the state or federal government of a private area. Small land holders are exempt from this obligation.

The CAR does not identify registered parcels that have compensation activity (commissioning / carrying out compensation). There will be natural vegetation that could be under compensation that will not show up as being protected in the SICAR. It could be protected already for example by being APP etc. Information was unavailable to determine whether native vegetation in any parcel is the result or restoration or compensation. It was also not possible to establish whether a registered parcel might be meeting Forest Code requirements through restoration and compensation activities on other holdings.

The SICAR is being further developed to link to another administrative system that deals with Forest Code "compensation mechanisms". These are not shown in SICAR, which means that there will be an underestimation of the amount of this land which cannot be located by this study.

2.2.6.3 Areas of Permanent Protection (APPs)

Landowners are allowed to count all APPs, such as forests along rivers and hillsides, as part of their Legal Reserve under certain conditions.

[13] https://www.gov.br/incra/pt-br/acesso-a-informacao/indices_basicos_2013_por_municipio.pdf
[14] The size of a fiscal module is established by law and varies form one region to another between 20 hectares and 44 hectares.

2.3 Methodology

Summary of key spatial data used in the analysis

- TRASE data used to identify 133 soy sourcing municipalities for the UK, all of which are included in the analysis.
- SICAR data was chosen for the analysis of implementation of the Forest Code at the farm level even though administrative checks of the vast majority of the data are incomplete.
- The data used from SICAR was: land registration parcel, Legal Reserve Area, APPs and restricted use areas.
- A good quality national dataset of protected land (conservation areas, indigenous areas and *Quilombola* lands) was sourced to identify land with legal protection.
- MAPBIOMAS was used to identify native vegetation types and exclude non-native forest.
- *Harmonized global maps of above and belowground biomass carbon density* (2020) was used for calculating potential carbon emissions.
- The IUCN red list of species was used to assess risks to biodiversity.

Limitations of data used for the spatial analysis

Key Finding 1. Very few registered land parcels have had administrative checks.

Key Finding 2. information from the Forest Code is not, from the public dataset, demonstrating that the system is effectively implemented and is therefore likely to have substantial limitations for monitoring of land use, and by implication supporting a due diligence system.

Key Finding 3. The publicly available SICAR data may not be the most current dataset of land registration. More up to date datasets exist but were not available to the study.

Key Finding 4. The data to assess biodiversity impacts are very generalised (for biomes) as there were no data or indices available at a localised scale

Key Finding 5. The protected land layer excludes military land.

2.3.1 Key data requirements

In order to support a spatial assessment of due diligence system, the following information is required:

- UK soy-sourcing areas;
- Whether an area of native vegetation is subject to protection via a legal /regulatory system;
- Data to identify areas and types of natural vegetation.

2.4 Initial selection of datasets

Any due diligence system is likely to rely upon publicly available data and this was taken into account when deciding which data to use in the spatial analysis.

Following internet searches and meetings with WWF-UK and WWF-Brazil, the following spatial datasets were identified for review (Table 2). The datasets highlighted were not used in the analysis.

Table 2: Data reviewed for suitability for spatial analysis of a due diligence system.

Data	Source (date)	Comments
Administrative boundaries	Humanitarian Data Exchange & IBGE	Required for analysis of data outputs, including municipality, Legal Amazon (for application of the Forest Code) and State
Areas exporting soy to the UK.	TRASE (2019)	Sourcing: Selecting a sample of municipalities for inclusion. Includes Associated deforestation risk
SICAR (database of Cadastro Ambiental Rural)	Secretaria de Estado do Desenvolvimento Ambiental (April 2020)	Polygons of registered land parcels allow Forest Code provisions to be assessed. Not all farms are registered.
Biomes	IBGE	For application of the Forest Code at farm level
Consolidated "protected land" layer	Ministério do Meio Ambiente, FUNAI, Instituto Nacional de Colonização e Reforma Agrária	Conservation, *Quilombola* and indigenous lands with legal protection of land conversion of native vegetation)
Hansen/Global Forest Watch tree cover	Global Forest Watch (2019)	Presence of forest and % cover. Globally consistent dataset
MAPBIOMAS: Land cover	2019	Identifies 7 native vegetation types (forest / natural land) and land in soy production
PRODES: Forest loss / conversion	INPE (2020) [15]	Polygons showing native vegetation conversion
IUCN red list		Presence of endangered species
Forest Specialist Index		Point data biodiversity indices

2.5 Collation and review of spatial datasets

2.5.1 Administrative Boundaries

Although municipalities were chosen as the sampling units, being the administrative units for which two key datasets are compiled and sourced (SICAR and TRASE), two other administrative boundaries were required for the analysis; state boundaries and Amazônia Legal (Brazil's Legal Amazon).

State boundaries were sourced from the Humanitarian Data Exchange, an open humanitarian data sharing platform managed by the United Nations Office for the Coordination of Humanitarian Affairs. These boundaries are needed to make forest code assessments and for reporting purposes. Amazônia Legal was sourced from the Brazilian Institute of Geography and Statistics (Portuguese: Instituto Brasileiro de Geografia e Estatística - IBGE).

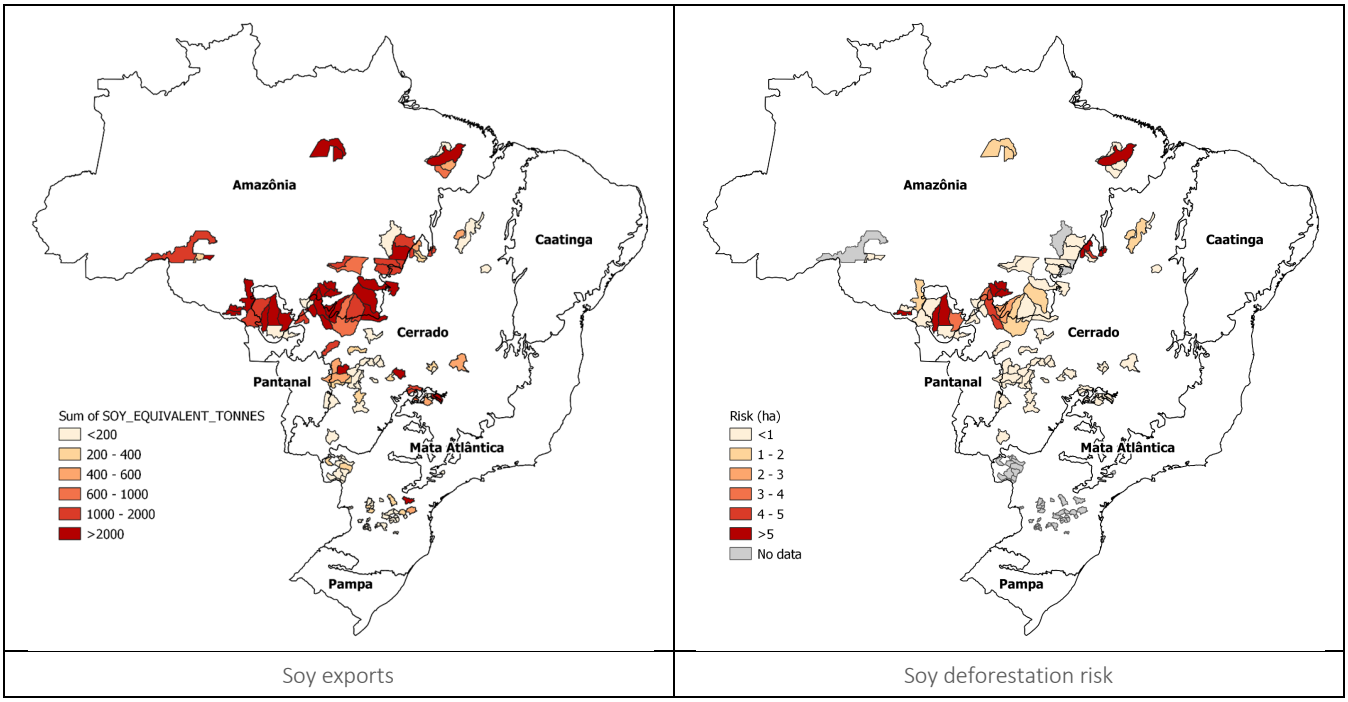
2.5.2 TRASE

The TRASE platform uses self-disclosed data from companies with customs, shipping, tax, logistics and other data to map the supply chains linking consumer countries, and traders, with places of production. All the municipalities supplying the UK directly with soy in 2018 (the most recent year for which data was available) were identified.[16]

There were 133 municipalities identified as being the source of soy exports to the UK (Figure 2) and all were included in the study.

The greatest volume of soy exports to the UK originates from Amazonia, which is also the area with the greatest known risk of deforestation arising from soy production (Figure 2). However, for many municipalities, particularly those in *Mata Atlantica*, there are no data on the levels of deforestation risk in the TRASE data (noting that the volumes from these areas directly supplying the UK are minimal).

[15] http://terrabrasilis.dpi.inpe.br/en/home-page/
[16] TRASE https://www.trase.earth/



Soy exports | Soy deforestation risk

Figure 2: Top soy-exporting municipalities to the UK and their associated risk.

2.5.3 Biomes

Biomes are required to make Forest Code assessments and to report the findings. A dataset of biome boundaries was sourced from IBGE.

2.5.4 Protected land

To enable clarity and to streamline the analysis, the legal designations/mechanisms discussed in Section 2.2.2 were divided into two categories (i.e., data layers, Figure 3) to identify:

1. Designated Safeguarded Areas (DSAs) - areas of land protected against deforestation and conversion of native habitat. Includes, although not limited to, indigenous lands, conservation units and APPs and restricted use areas.

2. Legal Reserves (LRs) - areas of native habitat within a rural property that are protected from land conversion upon which compliance to the Forest Code is assessed.

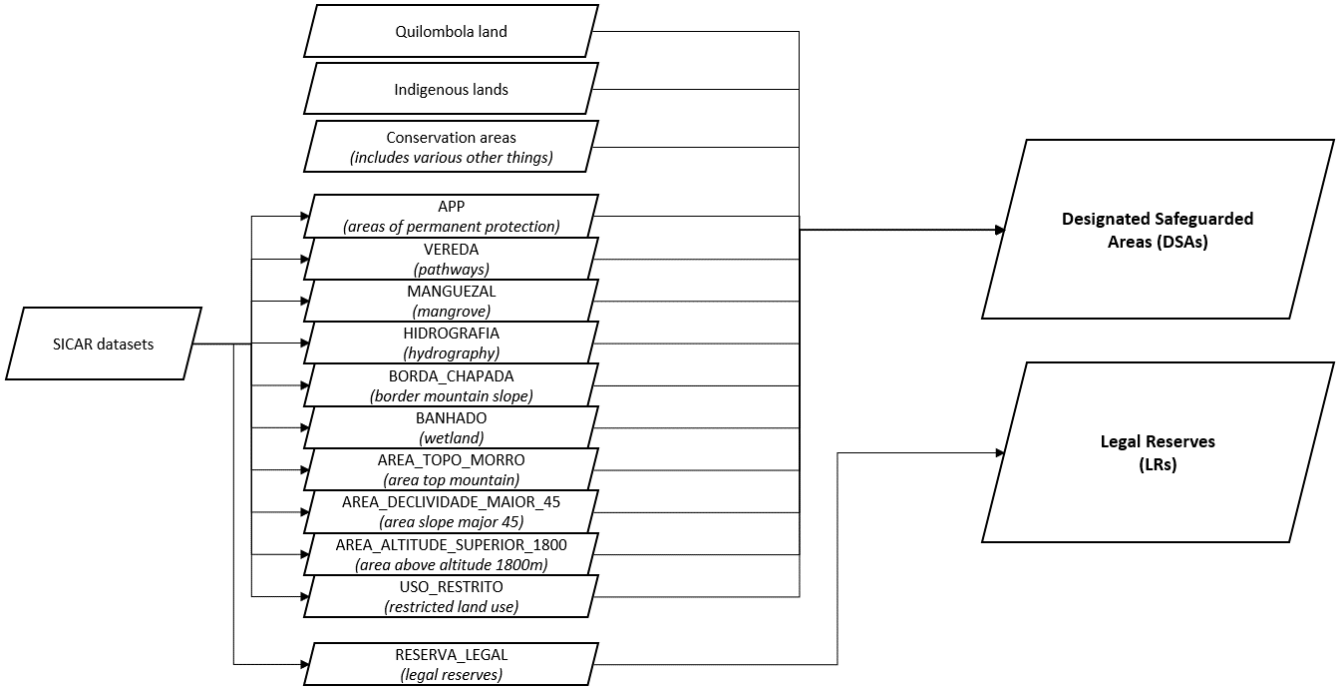


Figure 3: Designated Safeguarded Areas and Legal Reserves.

The data inputs to DSAs were sourced as follows:

- Conservation units (original source: Ministério do Meio Ambiente, (see Table 3)
- Indigenous lands (original source: FUNAI)
- *Quilombola* land (original source: Instituto Nacional de Colonização e Reforma Agrária)

Table 3: Brazil's national conservation unit database contains the following protected areas.

Full Protection	N°	Area (Km²)
Estação Ecológica	97	119,781
Monumento Natural	62	116,487
Parque Nacional / Estadual / Municipal	475	36,432
Refúgio de Vida Silvestre	77	6,637
Reserva Biológica	66	56,249
Sustainable use		
Floresta Nacional / Estadual / Municipal	108	314,009
Reserva Extrativista	95	156,217
Reserva de Desenvolvimento Sustentável	39	112,447
Reserva de Fauna	0	-
Área de Proteção Ambiental	375	1,298,968
Área de Relevante Interesse Ecológico	59	1,164
Reserva Particular do Patrimônio Natural	993	5,917
National Total	**4892**	**4,776,505**

Information on the location of military land was unavailable.

2.5.5 SICAR

There are multiple versions of the SICAR dataset that are maintained for administrative purposes and the publicly available dataset is not always the most up to date. There are also versions that have been downloaded and merged with other data, in some cases altering the boundaries to overcome conflicting boundary data to prepare datasets for policy analysis and research purposes.

A decision was made to use the publicly available SICAR data to reflect the fact that it is the system used to enact producer country laws (Forest Code) and that it is also the data most likely to be available to businesses needing to assess due diligence. In this respect, it is noted that there is no guide to explain the categories and derivation of the SICAR data and the interpretation of the dataset has been guided by data expertise in WWF-Brazil.

2.5.5.1 Assessing SICAR in test areas

To assess the status and quality of the CAR data and suitability of other datasets for the analysis, an initial test was made for three contrasting soy producing municipalities in the *Cerrado* and Amazon biomes (Table 4). In these municipalities there were high levels of land registration, high levels of forest loss in the 19-year period from 2000 to 2019 and variable proportions of forest and natural vegetation remaining.

Table 4: Characteristics of test sites.

	Sorriso	Tres Lagoas	Paragominas
Area of municipality (km^2)	9,300	10,200	19,300
Registered land (%)	93	93	88
Natural land (%)	24	19	52
Protected land (%)	25	17	49
Forest in 2019 (%)	22	8	47
Forest lost between 2000-2019 (%)	29	54	27

The status of checks on each registered parcel is tracked in SICAR (Table 5, column 1).

Table 5: Registration status recorded in SICAR.

SICAR status	Include	Status
Analysed without outstanding issues	Yes	Verified parcel
Awaiting analysis	Yes	indeterminate
Under analysis	Yes	indeterminate
Analysed, awaiting environmental regularisation (Law 12.651/12)	Yes (parcel will be monitored. Follow ups happening as found to be non-compliant)	Known issues (environmental)
Analysed with outstanding issues, awaiting submission of documents	Yes (non-compliant and not responding)	Known issues (environmental)
Analysed with outstanding issues, awaiting rectification and/or presentation of documents	Yes (registration not completed correctly)	Known issues (incomplete)
Cancelled by judicial decision	No (cancelled overlaps)	Treat as unregistered land
Cancelled by administrative decision	No (e.g., in conservation units.	Treat as unregistered land

Based on the SICAR it was decided to include all parcels in the analysis for assessment against the Forest Code, with the exception of those that that have been cancelled (Table 5). These were treated as unregistered land; having failed the administrative checks, any future land use change on the parcel in its current status would be illegal (as is the case for unregistered land).

Analysis of the three test areas revealed that most registered parcels are awaiting analysis or under analysis (Table 6).

Table 6: Distribution of registration SICAR statuses in three example municipalities.

Municipality	Status	Number of land parcels	Percentage
Sorriso	Awaiting analysis	1629	89.8%
	Analysed with outstanding issues, awaiting submission of documents	3	0.2%
	Analysed with outstanding issues, awaiting rectification	1	0.1%
	Analysed with outstanding issues, awaiting rectification and/or presentation of documents	1	0.1%
	Analysed without pending issues	45	2.5%
	Analysed, awaiting environmental regularisation (Law 12.651/12)	37	2.0%
	Cancelled by administrative decision	78	4.3%
	Cancelled by administrative decision	8	0.4%
	Cancelled by judicial decision	6	0.3%
	Under analysis	6	0.3%
Paragominas	Awaiting analysis	511	20.9%
	Analysed with outstanding issues, awaiting submission of documents	14	0.6%
	Analysed with outstanding issues, awaiting rectification	284	11.6%
	Analysed with outstanding issues, awaiting rectification and/or presentation of documents	514	21.1%
	Analysed without pending issues	97	4.0%
	Analysed, awaiting environmental regularisation (Law 12.651/12)	50	2.0%
	Analysed pending, awaiting the fulfilment of other restrictions	2	0.1%
	Cancelled by administrative decision	48	2.0%
	Under analysis	920	37.7%
Tres Lagoas	Awaiting analysis	1660	98.1%
	Cancelled by administrative decision	32	1.9%

This shows that, as yet, the information from the Forest Code is not, from the public dataset, demonstrating that the system is effectively implemented and is therefore likely to have substantial limitations for monitoring of land use, and by implication supporting a due diligence system.

2.5.5.1.1 Topology errors in SICAR

Topology expresses the spatial relationships between connecting or adjacent vector features (points, polylines and polygons). Since the majority of the SICAR data are user-submitted whereby individuals digitise their land parcels, topology errors are common.

There are different types of topological errors, for example, polygon features can include gaps between polygon borders or overlapping polygon borders (Figure 4). Within the SICAR data, it is common to find minor discrepancies along parcel boundaries. No action was taken to correct these errors.

However, the APP data layer contained many topologically invalid features that needed to be cleaned. Over 3 million invalid features, such as polygons with no area, were removed from the APP data layer during cleaning. This

is a standard operation within GIS pre-processing and has no material effect APP layer while substantially speeding up subsequent data processing.

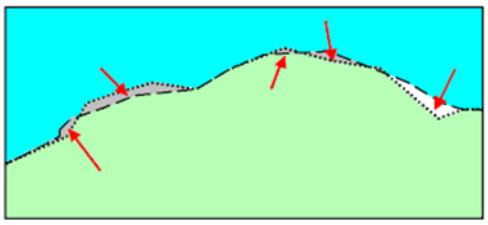


Figure 4: Examples of common topology errors.

2.5.5.1.2 Overlapping and duplicate claims

Overlapping and duplicated claim polygons were a significant problem both within individual Registered Land Parcel datasets and between neighbouring municipalities as Figure 5 illustrates. In this diagram the blue and pink areas represent neighbouring municipalities, and you can clearly see overlapping features both within and between the blue and pink polygons respectively.

The scale of this problem was evaluated for three test municipalities (Table 7), with this analysis showing that overlaps and duplicates could lead to substantially overestimating the real area of registered land. When assessing the status of native vegetation for parcels this would introduce significant double counting of at-risk vegetation. This problem is addressed during processing as section 2.7 outlines.

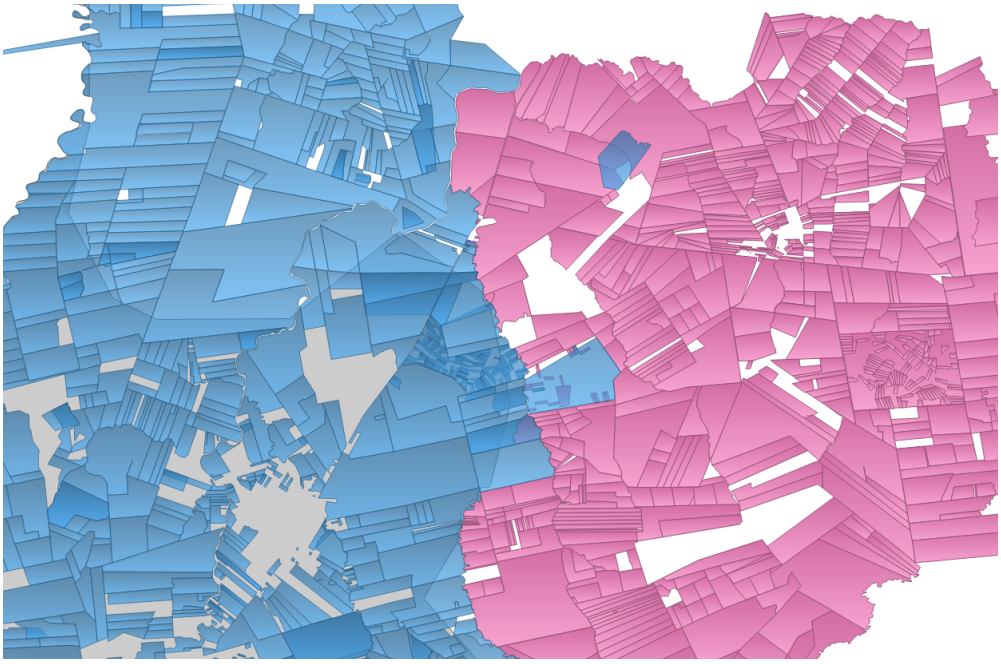


Figure 5: Examples of overlapping claims for an area of land.

In the test areas, these overlaps, ranged from 4% to 23% of all registered land (Table 7).

Table 7: Overlapping and duplicate claims in three test municipalities.

	Sorriso	Tres Lagoas	Paragominas
Registered land (km2)	8656	9488	16930
Overlapping areas (%)	12	4	23
Duplicates (%)	1	1	5
Cancelled areas (%)	7	2	9
Remaining topology errors (%)	6.4	3.5	14.5

Percentages are as a proportion of the total area of registered land. In the analysis, parcels falling outside a municipality were included in the analysis, parcels that fell outside Brazil were excluded. Duplicate geometries (e.g., exactly the same parcel being registered twice) were removed prior to the analysis

2.5.5.1.3 Protected land in SICAR

The SICAR comprises a wide range of self-declared, georeferenced data on rural properties and their preserved areas. Protected areas should comprise:

- Legal reserves
- APPs
- Restricted use areas
- Areas of "restricted use" land such as swamps and Pantanal plains that require special regimes of sustainable use are to be declared in the Restricted Use Areas layer in SICAR. The component areas of restricted use land (Table 8), such as mangrove or areas above 1800m are included as separate layers in SICAR datasets where they are present in a municipality. In some cases, these additional datasets are missing, the assumption being that the features are not present, data are not available or may not exist. Restricted use layers were merged into a single layer with APPs to be treated as protected land.

Table 8: Status of land within CAR.

SICAR Components (Portuguese)	English	Protected and included in the analysis (✓)
USO_RESTRITO	RESTRICTED_LAND_USE	✓
AREA_ALTITUDE_SUPERIOR_1800	AREA_ABOVE_ALTITUDE_1800	✓
AREA_DECLIVIDADE_MAIOR_45	AREA_SLOPE_MAJOR_45	✓
AREA_TOPO_MORRO	AREA_TOP_MOUNTAIN	✓
BANHADO	WETLAND	✓
BORDA_CHAPADA	BORDER_MOUNTAIN_SLOPE	✓
HIDROGRAFIA	HYDROGRAPHY	✓
MANGUEZAL	MANGROVE	✓
VEREDA	PATHWAYS	✓
APP	APP	✓
NASCENTE_OLHO_DAGUA	WATER_SPRING	Excluded as they are points
RESERVA_LEGAL	LEGAL_RESERVE	✓

APPs can overlap or be located within Legal Reserves. APPs can be assigned as Legal Reserve and there are many areas of APP that are Legal Reserves. Where APP is not also Legal Reserve it was assumed to be protected land that does not count towards the Forest Code legal reserve threshold.

Areas of compensation and restoration or areas of APPs that are not also identified as Legal Reserves cannot be identified by the study at this time as there is not an available dataset.

2.5.6 IMAFLORA

A "cleaned land" tenure data source was identified[17] which includes registered land parcels, however, this was not used because it utilises a hierarchy of datasets, which, if they overlapped, would cause the data registered in CAR to be overwritten with land boundary information from a range of other registers. As the Forest Code in Brazil is implemented solely via the data held within the CAR, such data amalgamation was deemed to diverge from the aims of the study which are directly related to the Forest Code.

2.5.7 Natural vegetation cover

In order to geographically model deforestation risk and enable reporting by vegetation type, an up-to-date and robust map of forest extent across Brazil was required. Three primary sources were considered:

- The Global Forest Change map (Hansen)[18]
- MAPBIOMAS landcover classification [19]
- PRODES deforestation/conversion data[20]

2.5.7.1 Global Forest Change – Hansen Tree cover data

Global Forest Change (GFC) is derived from a time series analysis of the Landsat archive, covering the period 2000-2019. It provides a global estimate of percentage tree cover at a ~30 metre resolution with a reported overall accuracy of 99.6%.[21] The presentation of tree cover as a percentage allows for the direct application the FAO definition of forest.

However, two key limitations of the data are that it does not differentiate plantations from natural woodland and it does not map the sparse savannah forest of the Cerrado with a high degree of consistency.

2.5.7.2 MAPBIOMAS

The MAPBIOMAS project is an initiative of the Climate Observatory and is produced by a collaborative network of co-creators made up of NGOs, universities and technology companies organized by biomes and cross-cutting themes. The product is a 30 metre resolution landcover / land use map covering the whole of Brazil for the period 1985-2019. Derived from the supervised classification of the Landsat archive in Google Earth Engine, the forest class has a reported overall accuracy of 92.41%.

The map provides a hierarchical classification which is compatible with both FAO and IBGE definitions of forest (see

Table 9 and Table 10). The MAPBIOMAS forest class includes old growth mature forest (i.e., >30-years old), early-stage forest (i.e., 5–15 years old), advanced secondary growth forest (i.e., 15- 30-years old), pristine forests that have not undergone anthropogenic conversion, savanna forest, mangroves and forest plantation.

The MAPBIOMAS classification can be used to map and quantify the extent of native vegetation and provides subtype granularity of both 'Forest' and 'Non-Forest' classes (

Table 9). It can also be used to exclude non-native forest from calculations of native forest areas.

Distinguishing vegetation types enables GHG impacts to be better understood.

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[17] Freitas, F. L. M.; Guidotti, V.; Sparovek, G.; Hamamura, C. Nota técnica: Malha fundiária do Brasil, v.1812. In: Atlas - A Geografia da Agropecuária Brasileira, 2018. Available at: www.imaflora.org/atlasagropecuario

[18] Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R. and Kommareddy, A., 2013. High-resolution global maps of 21st-century forest cover change. science, 342(6160), pp.850-853.

[19] Souza, C.M., Z Shimbo, J., Rosa, M.R., Parente, L.L., A Alencar, A., Rudorff, B.F., Hasenack, H., Matsumoto, M., G Ferreira, L., Souza-Filho, P.W. and de Oliveira, S.W., 2020. Reconstructing three decades of land use and land cover changes in brazilian biomes with landsat archive and earth engine. Remote Sensing, 12(17), p.2735.

[20] INPE, Projeto PRODES - Metodologia para o Cálculo da Taxa, Anual de Desmatamento na Amazônia Legal. Disponível em <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prode s/pdfs/metodologia_taxaprodes.pdf> Acesso em: 02 set. 2018.

[21] Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R. and Kommareddy, A., 2013. High-resolution global maps of 21st-century forest cover change. science, 342(6160), pp.850-853.

Furthermore, MAPBIOMAS contains a soy class that can be used to identify registered land parcels that grow soy. Parcels that contain five hectares or more of soy were classified as soy growing land parcels.

Table 9: MAPBIOMAS land-cover/land-use classes.

COLEÇÃO 5		ID	Hexadecimal code	COLOR
1. Floresta	**1. Forest**	1	129912	
1.1. Floresta Natural	1.1. Natural Forest	2	1F4423	
1.1.1. Formação Florestal	1.1.1. Forest Formation	3	006400	
1.1.2. Formação Savânica	1.1.2. Savanna Formation	4	32CD32	
1.1.3. Mangue	1.1.3. Mangrove	5	687537	
1.2. Floresta Plantada	1.2. Forest Plantation	9	935132	
2. Formação Natural não Florestal	**2. Non Forest Natural Formation**	10	BBFCAC	
2.1. Campo Alagado e Área Pantanosa	2.1. Wetland	11	45C2A5	
2.2. Formação Campestre	2.2. Grassland	12	B8AF4F	
2.3. Apicum	2.3. Salt Flat	32	968c46	
2.4. Afloramento Rochoso	2.4. Rocky Outcrop	29	#FF8C00	
2.5. Outras Formações não Florestais	2.5. Other non Forest Formations	13	BDB76B	
3. Agropecuária	**3. Farming**	14	FFFFB2	
3.1. Pastagem	3.1. Pasture	15	FFD966	
3.2. Agricultura	3.2. Agriculture	18	E974ED	
3.2.1. Lavoura Temporária	3.2.1. Temporary Crop	19	D5A6BD	
3.2.1.1. Soja	3.2.1.1. Soy bean	39	c59ff4	
3.2.1.2. Cana	3.2.1.2. Sugar Cane	20	C27BA0	
3.2.1.3. Outras Lavouras Temporárias	3.2.1.3. Other Temporary Crops	41	e787f8	
3.2.2. Lavoura Perene	3.2.2. Perennial Crop	36	f3b4f1	
3.3 Mosaico de Agricultura e Pastagem	3.3. Mosaic of Agriculture and Pasture	21	fff3bf	
4. Área não Vegetada	**4. Non vegetated area**	22	EA9999	
4.1. Praia e Duna	4.1. Beach and Dune	23	DD7E6B	
4.2. Infraestrutura Urbana	4.2. Urban Infrastructure	24	aa0000	
4.3. Mineração	4.3. Mining	30	af2a2a	
4.4. Outras Áreas não Vegetadas	4.4. Other Non Vegetated Areas	25	FF99FF	
5. Corpos D'água	5. Water	26	0000FF	
5.1. Rio, Lago e Oceano	5.1. River, Lake and Ocean	33	0000FF	
5.2. Aquicultura	5.2. Aquaculture	31	29EEE4	
6. Não Observado	6. Non Observed	27	D5D5E5	

It is important to note that Savanna Formations are mapped by MAPBIOMAS as Natural Forest, where there exist vegetation types with a predominance of tree species and with continuous canopy formation (Amazon biome) or a defined tree and shrub-herbaceous stratum (*Cerrado*) or small tree species, sparsely arranged in the shrub and herbaceous continuous vegetation (Pantanal, Table 9). This allowance for a shrub stratum means that some areas of 'Natural Forest' within MAPBIOMAS would be considered 'Other wooded lands' by FAO nomenclature.

Table 10: MAPBIOMAS, FAO, IBGE classification scheme alignments[22].

MAPBIOMAS	IGBE23	FAO24
Forest Formation	D, A, M, F, C, Sd, Td, Pma, Pfm	FEP, FEM, FDP, FDM, FSP, FSM
Savanna Formation	Sa, Sp, Sa, Sg, Td, Ta, Tp	WS, FDP, FSP
Mangrove	Pf	FEP, FEM

This means for FAO definition:

- Forest Formation in MAPBIOMAS: everything within it is included in the FAO definition of forest.
- Savanna Formation in MAPBIOMAS: it may contain areas which FAO define as Other Woodland.

This means for IBGE definition:

- Forest Formation in MAPBIOMAS: everything within it is included in the IBGE definition of forest.
- Savanna Formation in MAPBIOMAS: everything within it is included by the IBGE definition of the class "*cerrado*" which covers *cerrado* forest, woodland or parkland"

2.5.7.3 PRODES

The PRODES programme is a Brazilian government initiative with the aim of monitoring the conversion of natural vegetation (e.g., deforestation). Landsat and other satellites are used to classify images into forest, non-forest and deforested in the target year, previous deforestation, clouds, and water, this is then manually corrected by experts. The diverse source material and intensive human validation make PRODES the gold standard for forest loss estimates in Brazil. It should be noted that the product is an estimate of deforestation / loss of natural vegetation (not a national forest map. However, it can be combined with other datasets, such MAPBIOMAS or GFC to increase their accuracy.

This dataset can be used to make the native vegetation layer in MAPBIOMAS more current, but this was not done by the study as there was insufficient time to incorporate this analysis ahead of the delivery deadline.

2.5.7.4 SICAR natural land

The CAR dataset also contains information on the location of native vegetation as it pertains to land holdings. This was not used in the analysis.

2.6 Carbon storage and biodiversity impacts

2.6.1 Calculating above- and below-ground carbon storage

Four geospatial datasets were reviewed for their suitability to estimate the impact of deforestation and land conversion on forest and natural land in terms of potential carbon emissions (Table 11). The first of these, the Harmonized global maps of above and belowground biomass carbon density in the year 2010[25], was selected because it is a global dataset, of reasonable resolution, with both above and below ground biomass estimates. The preparation of this dataset and the processing steps undertaken to calculate the amount of stored carbon for at-risk parcels are outlined in section 2.7.3. Note that this data refers to carbon stored in the natural ecosystems – the actual emissions caused by conversion to other land uses would depend both on the way it was converted and the alternative land use.

[22] FAO (2012) classes: FEP, primary evergreen forest; FEM, secondary mature evergreen forest; FDP, primary deciduous forest; FDM, secondary mature deciduous forest; FSP, primary semi-deciduous forest; FSM, secondary mature semi-deciduous forest; WS, shrubs. IBGE (2012) classes: D, dense ombrophilous forest; A, open ombrophilous forest; M, mixed ombrophilous forest; F, semideciduous seasonal forest; C, deciduous seasonal forest; Sd, forested savanna; Td, forested steppe savanna; Pma, arboreal vegetation with marine influence (arboreal restinga); Pfm, mangrove; Sa, arboreal savanna; Sp, park savanna; Sg, woody grassy savanna; Ta, arboreal steppe savanna; Tp, park stepped savanna; Tg, woody grassy steppe savanna; E, steppe; Pmb, shrubby vegetation with marine influence (shrubby restinga); Pmh, herbaceous vegetation with marine influence (herbaceous restinga); Pfh, herbaceous vegetation with fluvial-marine influence; Pa, vegetation with fluvial and/or lacustrine influence.
[23] IBGE. Manual técnico da vegetação brasileira, 2nd ed., IBGE: Rio de Janeiro, Brazil, 2012. pp.157-160
[24] FAO. Manual for integrated field data collection. FAO: Rome, Italy, 2012, 175p
[25] Spawn, S.A., Sullivan, C.C., Lark, T.J. *et al.* (2020). Harmonized global maps of above and belowground biomass carbon density in the year 2010. *Sci Data* **7,** 112. https://doi.org/10.1038/s41597-020-0444-4

Table 11: Carbon datasets reviewed for use in the analysis

Dataset	Characteristics
Harmonized global maps of above and belowground biomass carbon (C) density in the year 2010[26]	• Woody, grassland, cropland and tundra biomass (aboveground C) and empirically modelled belowground C from landcover in Mg C/ha • Spatial resolution: 300 m • Base year is 2010, but the data was published recently (2020)
Aboveground Biomass Change for Amazon Basin, Mexico, and Pantropical Belt, 2003-2016[27]	• Pantropical belt bounded at N: 40 deg, S: 30 deg – cuts off a small fraction of SE Brazil in Rio Grande do Sul • Set contains specific data for Amazon Basin, but this would omit other biomes – data for 'Pantropical Belt' is likely more applicable • Spatial resolution: 500 m
Woods Hole Research Center Pantropical National Level Carbon Stock[28]	• Restricted to aboveground live woody biomass • Bounded at S: 21 deg – cuts off a section of SE Brazil (likely all within Mata Atlântica)
A new high-resolution nationwide aboveground carbon map for Brazil[29]	• National Land Use and Land Cover (LULC) data • Spatial resolution: 50 m

2.6.2 Biodiversity indices

2.6.2.1 IUCN Red List

The IUCN's searchable data set of plant and animal species was used, confining the search to the twelve States within which the municipalities that supply soy directly to the UK are found (Goiás, Maranhão, Mato Grosso, Mato Grosso Do Sul, Minas Gerais, Pará, Paraná, Piauí, Rondônia, Santa Catarina, São Paulo and Tocantins). The number of species in each threat category was enumerated[30].

2.6.2.2 Forest Diversity Index

This dataset was explored and but not used because there were too few data points in Brazil.

2.7 Data processing

2.7.1 Identification of at-risk vegetation of legal conversion

A spatial analysis of registered land parcels was undertaken to identify natural vegetation that has no form of protection and is thus at risk of deforestation/conversion. In order for registered land to be counted as native vegetation on registered land with potential for legal deforestation and conversion the following three criteria need to be satisfied:

Criteria 1: the Legal Reserve (LR) area of the parcel meets or exceeds the % Forest Code threshold for the biome as shown in Table 12.

Criteria 2: the amount of native vegetation in the LR meets or exceeds the LR Forest Code threshold (i.e. if there has been deforestation/conversion within the LR that reduces the vegetation area in the LR to below the FC % cut-off then the registered parcel is non-compliant).

[26] Spawn, S.A., Sullivan, C.C., Lark, T.J. et al. Harmonized global maps of above and belowground biomass carbon density in the year 2010. Sci Data 7, 112 (2020). https://doi.org/10.1038/s41597-020-0444-4
[27] Baccini, A., W. Walker, L.E. Carvalho, M.K. Farina, K.K. Solvik, and D. Sulla-Menashe. 2021. Aboveground Biomass Change for Amazon Basin, Mexico, and Pantropical Belt, 2003-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1824
[28] Woods Hole Research Centre (July 23, 2019). Pantropical National Level Carbon Stock. https://data.amerigeoss.org/dataset/bb7e217f-021b-43d5-af3f-52bdf604bb1e
[29] Oskar Englund, Gerd Sparovek, Göran Berndes, Flavio Freitas, Jean P. Ometto, Pedro Valle De Carvalho E. Oliveira, Ciniro Costa Jr., David Lapola (2017). A new high-resolution nationwide aboveground carbon map for Brazil. https://doi.org/10.1002/geo2.45
[30] UCN Red List of Threatened Species https://www.iucnredlist.org/

Criteria 3: there is a remaining area of native vegetation outside the LRs that is not already safeguarded by another type of designated protection status, incl. APPs and types of restricted use areas.

Table 12: Forest Code environmental protection thresholds

Land Use	Legal Amazon			Rest of Brazil
	Forest	Cerrado[31]	Grasslands	
Legal Reserve	80%	35%	20%	20%
Productive Use	20%	65%	80%	80%

In order to evaluate these criteria on a per registered land parcel basis (parcel), a spatial analysis was undertaken that compared the parcels against a range of different layers as shown in Figure 6. This analysis required the following steps to be undertaken:

- Parcels were intersected with the Legal Reserves layer, allowing the area of Legal Reserve within each parcel to be quantified (Criteria 1).
- Parcels were intersected with a Designated Safeguarded Areas (DSA) layer that comprised of Conservation Units, Indigenous Lands, *Quilombola*, APP's, Restricted Use. For each parcel this allowed the exact area of land with no protection to be defined.
- The area of native vegetation was calculated for each parcel using a zonal statistics analysis of the MAPBIOMAS data. Natural vegetation was defined as natural forest and other non-forest native vegetation (in both cases including sub-types). For each parcel this allowed the area of natural vegetation within Legal Reserves (Criteria 2) and with no protection (Criteria 3) to be calculated.
- Parcels containing soy farms were identified using the MAPBIOMAS soy classification.
- Parcels that satisfied the three criteria outlined above were selected, and the areas of land not under DSA or Legal reserves were exported to a new layer.

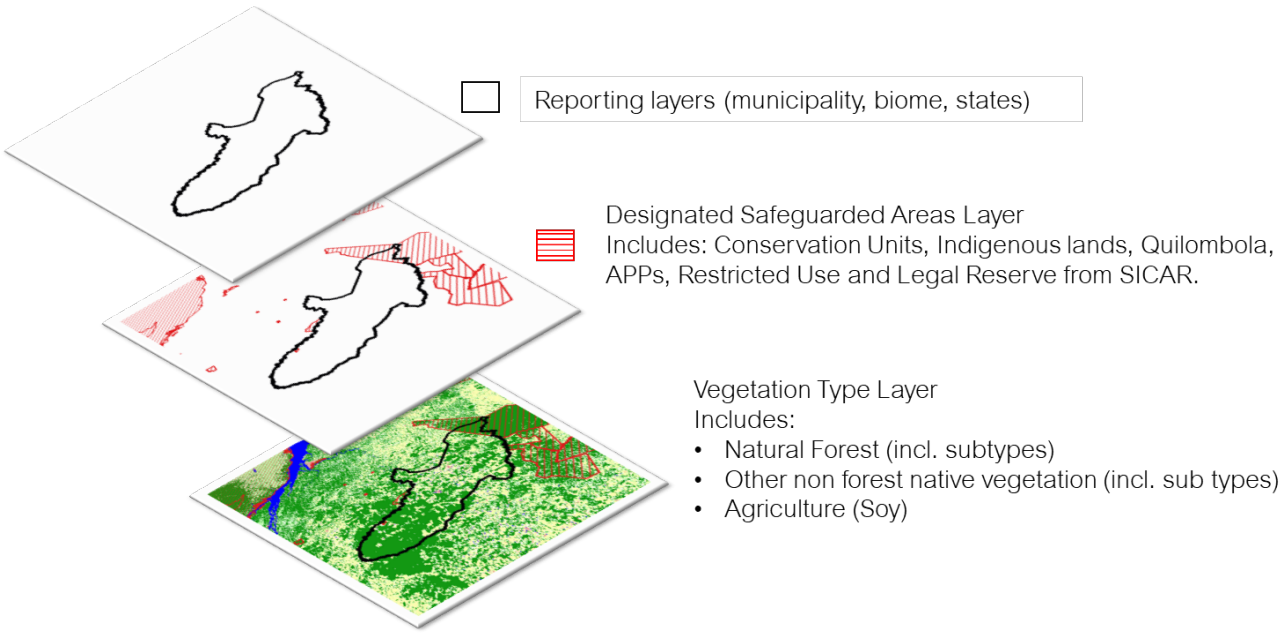

Figure 6: Spatial analysis layers

2.7.2 Removal of overlapping polygons

As outlined in section 2.5.5.1.2, there were numerous overlapping polygons within the Registered Land Parcels layer that would lead to double counting of at-risk vegetation unless accounted for. This was resolved by dissolving all overlapping and touching polygons within each biome to create a single, flat layer of at-risk land per biome.

[31] The States of Tocantins has a 40% threshold and Piauí 30%. Both are mostly in the *Cerrado* biome.

2.7.3 Calculation of natural vegetation area at risk and above and below ground carbon per biome

As outlined above, natural vegetation was defined as the MAPBIOMAS forest and other non-forest native vegetation, i.e., classes:

- 1-1-1-Forest Formation
- 1-1-2-SavannaFormation
- 1-1-3-Mangrove
- 2-1-Wetland
- 2-2-Grassland
- 2-3-Salt Flat
- 2-4-Rocky Outcrop
- 2-5-Other Non-Forest

Each of these classes was exported to a single binary raster at 30 metre resolution, creating 8 vegetation layers.

The carbon dataset used provides estimates of above- and below-ground carbon in tons per hectare are a 300 metre resolution. This was resampled to 30-m to match the MAPBIOMAS resolution and overlaid with each of vegetation layers to assign an appropriate carbon figure to each pixel in the 8 vegetation layers.

These datasets were then combined with the flattened at-risk polygons per biome described in section 2.7.2 using zonal statistics to calculate the following metrics for each polygon:

- Total area of each vegetation class in hectares.
- Average above and below-ground carbon per vegetation class. Note that this figure is only for the pixels of each class found within each polygon (i.e., it is a local rather than global average).
- For each at-risk polygon the total tons of carbon were calculated by multiplying total area of each vegetation class by the respective carbon figure. Finally, these values were summarised by biome.

2.8 Implications of the approach and data limitations on the analysis

There are particular strengths of the data and approach used in the analysis (Table 13).

Table 13: Strengths of the spatial analysis.

Strengths of the spatial analysis	Likely effect on analysis
Using SICAR data tests the ability of an analysis to apply local laws using publicly available data.	Provides a more granular analysis that can identify impacts at a more local scale. Demonstrates the feasibility and practicality of using a local system.
Uses a recent national vegetation map (MAPBIOMAS) with breakdown of forest and other native vegetation types.	Improved content. Allows distinction of risk to forest and other land use types such as natural grassland and the allocation of above- and below-ground carbon storage to these. Enables plantation forestry to be excluded from the analysis. Enables reporting for savannah vegetation. Enables registered land with soy to be identified
Having a spatial dataset of above and below ground carbon storage allows estimates of carbon storage to be derived for specific areas of native vegetation	Improved accuracy
Spatial approach	Enables data to be generated that is for all farms (including overlapping and duplicate claims) and a flat analysis (that accounts for the effects excluding overlapping and duplicate claims)

There are data gaps and data limitations in the analysis (Table 14). Those that stem from the vegetation and protected areas datasets and assessment of the implications are:

Table 14: Limitations of the spatial analysis.

Limitations and other findings of the spatial analysis	Likely effect on at risk areas	Effect on area at risk of legal deforestation
Data Gap: no data on military land in the protected land layer.	If this data were available, it would be likely to result in a reduced area of native habitat at risk of legal conversion.	Reduced area at risk of legal deforestation
Omission: There was insufficient time to incorporate the most recent deforestation and conversion data that is available from PRODES.	This data may indicate further forest and other natural vegetation loss, but the extent is unknown. It could reduce the number of registered parcels meeting LR thresholds by identifying areas of vegetation loss in LRs. This could take away some parcels that the study has identified as having native vegetation at risk of legal conversion	Probable reduction in area at risk of legal reforestation
Omission: The data to assess biodiversity impacts is very generalised as there were no data or indices available at a localised scale	Localised impact on biodiversity difficult to assess	
Omission: Analysis of effects of soy moratoria on the analysis	The municipalities selected include all of those that supply the UK directly, within and outside the areas of the soy moratorium. In theory this should lead to an overestimate of deforestation/conversion in our analysis, however, this may not be the case as (a) soy associated with deforestation/conversion from inside the moratorium area is exported directly to the UK (see TRASE) and (b) the very significant volume of soy that is imported indirectly or embedded within products will not necessarily be purchased by companies that explicitly adhere to the moratorium.	N/A (the moratorium is not a legal instrument)

Use of the SICAR land registration data, highlight some key difficulties of basing due diligence on local country laws and their associated regulatory systems (Table 15) in summary:

- establishing compliance with country legislation to demonstrate due diligence,
- relying on regulatory systems that are not yet embedded; in Brazil the data available is for the most part unverified.

Table 15: Use of Sistema Nacional de Cadastro Ambiental Rural (SICAR).

Findings from use of SICAR	Likely effect	Effect on area at risk of legal deforestation
Quantified in test areas: The very low numbers of administratively checked parcels in SICAR suggests that as yet, the information from the Forest Code is not, from the public dataset, demonstrating that the system is effectively implemented.	This introduces a large amount of uncertainty to the results of the study. This also means Brazil has substantial limitations for monitoring of land use using the Forest Code, and by implication supporting a due diligence system.	Unknown
Quantified: SICAR has many land registration claims that overlap, meaning that land is subject to claims originating from more than one registered parcel. An analysis was done to compensate for this issue in establishing above- and below-ground carbon storage	Overlapping claims on native vegetation at risk of legal conversion indicates demand for land, including land grabbing.	No effect on area at risk on the registered parcels but indicates uncertainty in claims of legality
Data Gap: Application of the Forest Code could not account for restoration and compensation land, except where restoration land has been assigned as Legal Reserve in the CAR data.	Areas of native vegetation identified as at risk of legal conversion may be compensation or restoration land	Increased area at risk of legal deforestation
Data Gap: Municipalities (esp. those in the Legal Amazon) have variations to the Forest Code requirements for Legal Reserve, for example as a result of decisions taken by ZEEs. These typically reduce the % LR requirements. No publicly available information could be sourced to identify these local variations.	Application of reduced Legal Reserve thresholds in the Legal Amazon could result in: more native vegetation being identified as being at risk of legal DD on farms that have been identified as meeting the threshold. an increase in the number of farms that the study identifies as meeting the LR threshold, and a consequent increase in native vegetation being identified as being at risk of conversion on those farms.	Potentially large reduction in area at risk of legal deforestation
APP can be Legal Reserves under certain conditions, and this is seen in the CAR. However, we cannot assume APP is Legal Reserve in cases where there is APP but no Legal Reserve. There were many parcels that contained APPs but no Legal Reserve. These would not be considered for native vegetation at risk of conversion because they do not meet the Legal Reserve threshold.	It is unclear what effect this may have. It may be a sign of the deficiency of the CAR data as we do not know why some parcels have APPs but no legal reserve in SICAR. A possible underestimate of land at risk as registered parcels	Unclear – effect could be substantial
Poor quality of the spatial data	Making use of the available data requires expertise and data processing facilities that are likely to be beyond those that many organisations required to deliver due diligence will have available.	Impractical to assess

2.9 Results

2.9.1 Output tables: all registered land, flat analysis

Five biomes were represented in the sample of 133 municipalities (Figure 2 and Table 16). Within these municipalities, there were 199,022 of registered land parcels.

Although included in the analysis, there were no occurrences of the following MAPBIOMAS vegetation types within the municipalities analysed:

- Mangroves
- Salt Flat
- Rocky outcrops
- Other Non-forest formations

Table 16: Biomes present within the areas of interest and whether they contain municipalities that directly export soy to the UK.

Location	Forest Code (LR allocation)	IBGE Biomes present (soy municipalities present: ✓)
Legal Amazon (Forest)	80%	Amazon ✓
Legal Amazon (*Cerrado*)	35%	*Cerrado* ✓
Legal Amazon (Grassland)	20%	Pantanal ✓
Elsewhere in Brazil	20%	Atlantic Forest ✓ *Cerrado* ✓ Pantanal ✓ *Caatinga*/Pampa (not present in sample)

Table 17: Area of native vegetation on registered land with potential for legal deforestation or conversion (km²).

Forest Code Legal Reserve % allocation based on location and biome		Native vegetation type (km²)				Total
		Forest formation	Savanna formation	Wetland	Grassland	
Legal Amazon[32]	Forest: 80% LR Amazon biome	1,572	14	0	30	1,616
	Cerrado: 35% LR *Cerrado* biome	2,295	6,869	0	2,209	11,374
	Grassland: 20% LR Pantanal biome	82	123	4	50	260
Elsewhere in Brazil	Forest: 20% LR Biome: Atlantic Forest	2,065	22	13	28	2,129
	Cerrado: 20% LR Biome *cerrado* extra	1,106	2,497	9	414	4,027
	Grassland: 20% LR Biome: Pantanal	115	155	28	855	1,152
Total		7,236	9,680	55	3,587	20,558

[32] The Legal Amazon covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, Amapá and Tocantins as well as the region west of longitude 44° W in the state of Maranhão.

Table 18: Amount of aboveground carbon within native vegetation on registered land with potential for legal deforestation and conversion.

Forest Code Legal Reserve allocation based on location and biome		Total Above Ground Carbon (tonne)				Total
		Forest formation	Savanna formation	Wetland	Grassland	
Legal Amazon[33]	Forest: 80% LR Amazon biome	140,628,554	407,122	0	592,566	141,628,243
	Cerrado: 35% LR *Cerrado* biome	136,623,229	165,602,289	9,871	11,855,371	314,090,760
	Grassland: 20% LR Pantanal biome	2,927,543	3,732,109	99,529	975,349	7,734,530
Elsewhere in Brazil	Forest: 20% LR Biome: Atlantic Forest	105,255,803	579,453	318,082	328,581	106,481,919
	Cerrado: 20% LR Biome *cerrado* extra	41,358,960	56,595,115	124,228	3,081,183	101,159,485
	Grassland: 20% LR Biome: Pantanal	3,501,764	3,208,798	349,642	5,269,376	12,329,580
Total		430,295,853	230,124,887	901,351	22,102,427	683,424,518

Table 19: Amount of belowground carbon within native vegetation on registered land with potential for legal deforestation and conversion.

Forest Code Legal Reserve allocation based on location and biome		Total Above Ground Carbon (tonne)				Total
		Forest formation	Savanna formation	Wetland	Grassland	
Legal Amazon[34]	Forest: 80% LR Amazon biome	33,781,974	181,354	0	0	33,963,328
	Cerrado: 35% LR *Cerrado* biome	42,425,448	149,401,233	6,076	50,021	191,882,779
	Grassland: 20% LR Pantanal biome	3,188,067	4,078,329	58,587	595,446	7,920,429
Elsewhere in Brazil	Forest: 20% LR Biome: Atlantic Forest	31,840,910	343,459	18,930	75,511	32,278,811
	Cerrado: 20% LR Biome *cerrado* extra	18,622,796	50,543,956	100,320	1,099,038	70,366,110
	Grassland: 20% LR Biome: Pantanal	3,460,286	5,121,648	339,259	10,276,566	19,197,759
Total		133,319,481	209,669,980	523,171	12,096,583	355,609,215

[33] The Legal Amazon covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, Amapá and Tocantins as well as the region west of longitude 44° W in the state of Maranhão

[34] The Legal Amazon covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, Amapá and Tocantins as well as the region west of longitude 44° W in the state of Maranhão

2.9.2 Output tables: all registered land containing soy, flat analysis

Table 20 provides the areas for each vegetation type within registered parcels that contain more than 5 hectares of soy in the MAPBIOMAS data.

Table 20: Area of native vegetation on registered land containing soy with potential for legal deforestation and conversion (km^2).

Forest Code Legal Reserve allocation based on location and biome		Native vegetation type (km^2)				Total
		Forest formation	Savanna formation	Wetland	Grassland	
Legal Amazon[35]	Forest: 80% LR Amazon biome	345	6	0	8	359
	Cerrado: 35% LR *Cerrado* biome	936	2,471	0	583	3,990
	Grassland: 20% LR Pantanal biome36	0	0	0	0	0
Elsewhere in Brazil	Forest: 20% LR Biome: Atlantic Forest	715	8	6	19	748
	Cerrado: 20% LR Biome *cerrado* extra	330	641	2	169	1142
	Grassland: 20% LR Biome: Pantanal	0	0	0	0	0
Total		2,325	3,126	8	780	6,239

Table 21: Amount of aboveground carbon stored in native vegetation on registered land containing soy with potential for legal deforestation/conversion.

Forest Code Legal Reserve allocation based on location and biome		Total Above Ground Carbon (tonnes)				Total
		Forest formation	Savanna formation	Wetland	Grassland	
Legal Amazon[37]	Forest: 80% LR Amazon biome	28,335,958	150,588	0	25,227	28,511,772
	Cerrado: 35% LR *Cerrado* biome	55,484,989	59,968,796	8,508	3,080,796	118,543,089
	Grassland: 20% LR Pantanal biome	0	0	0	0	0
Elsewhere in Brazil	Forest: 20% LR Biome: Atlantic Forest	34,790,332	203,258	110,555	168,655	35,272,800
	Cerrado: 20% LR Biome *cerrado extra*	10,861,133	13,338,565	7,090	1,044,493	25,251,281
	Grassland: 20% LR Biome: Pantanal	0	0	0	0	0
Total		129,472,412	73,661,207	126,152	4,319,171	207,578,942

[35] The Legal Amazon covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, Amapá and Tocantins as well as the region west of longitude 44° W in the state of Maranhão
[36] No areas of soy (>5 Ha) were found within Pantanal.
[37] The Legal Amazon covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, Amapá and Tocantins as well as the region west of longitude 44° W in the state of Maranhão

Table 22: Amount of belowground carbon stored in native vegetation on registered land containing soy with potential for legal deforestation and conversion.

Forest Code Legal Reserve allocation based on location and biome		Total Above Ground Carbon (tonnes)				Total
		Forest formation	Savanna formation	Wetland	Grassland	
Legal Amazon[38]	Forest: 80% LR Amazon biome	6,910,372	64,185	0	28,366	7,002,923
	Cerrado: 35% LR *Cerrado* biome	17,135,937	54,406,177	3,424	3,907,339	75,452,877
	Grassland: 20% LR Pantanal biome	0	0	0	0	0
Elsewhere in Brazil	Forest: 20% LR Biome: Atlantic Forest	10,676,717	111,862	67,019	138,244	10,993,842
	Cerrado: 20% LR Biome *cerrado* extra	4,929,460	11,787,279	9,003	1,190,178	17,915,920
	Grassland: 20% LR Biome: Pantanal	0	0	0	0	0
Total		39,652,486	66,369,502	79,446	5,264,127	111,365,562

2.9.3 Multiple claims on individual areas of native vegetation

In many cases, parcels of registered land overlapped. This means that, for an area on the ground, two or more registered parcels are making a claim on the same piece of land. An indication of the scale of this problem is outlined in Table 23.

Table 23: Area of that is within two or more registered land parcels that apply to native vegetation at risk of legal deforestation and conversion.

Biome	Overlaps Removed (km^2)	With Overlaps (km^2)	% Difference
Amazon	3,160	3,493	10.0%
Cerrado	52,713	65,847	22.2%
Mata Atlantica	11,335	11,665	2.9%
Pantanal	2,842	2,893	1.8%
Total	70,050	83,898	18.0%

From the figures, the area varies between biomes with the greatest percentage of multiple claims on native vegetation at risk of legal deforestation and conversion being found within the *Cerrado*.

2.10 Estimating the potential contribution of UK supply chains to future deforestation and conversion

2.10.1 Rates of deforestation and conversion attributable to UK supply chains 2021-2030

Loss of natural vegetation is highly variable over time in Brazil (Figure 7). Therefore, MAPBIOMAS data were used to generate two deforestation scenarios which were then used to estimate plausible potential deforestation and conversion rates between 2021 and 2030. The high conversion scenario took the mean of the three highest years (4,611,624 hectares per year, equivalent to 0.75% of the natural vegetation remaining in 2019 per year), with the medium scenario taking the median rate (2,831,675 hectares per year, equivalent to 0.44% of the natural

[38] The Legal Amazon covers the states of Acre, Pará, Amazonas, Roraima, Rondônia, Mato Grosso, Amapá and Tocantins as well as the region west of longitude 44° W in the state of Maranhão

vegetation remaining in 2019 per year). A lower scenario was considered highly unlikely given (a) the high and increasing rate in 2019, and (b) the various moves to deregulate environmental protection in Brazil.

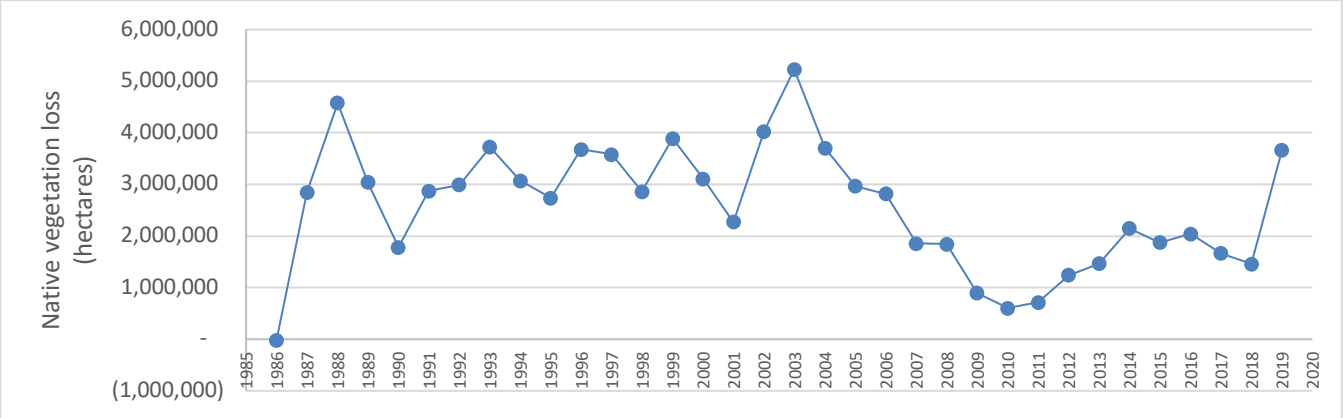

Figure 7: Loss of natural vegetation in Brazil 1986-2019 (Source: MAPBIOMAS)

A recent estimate of the extent of deforestation and conversion in Brazil attributed to UK soy supply chains was 2,130 hectares in 2017[39], or 0.13% of the natural vegetation loss recorded by MAPBIOMAS in that year. This proportion was applied to the Brazil-wide deforestation and conversion scenarios to generate the potential contribution of UK soy supply chains to deforestation and conversion between 2021 and 2030, resulting in a medium deforestation scenario of 36,329 hectares, and a high scenario of 59,165 hectares.

2.10.2 Levels of legal compliance

To estimate the likely proportion of legal and illegal deforestation associated with UK soy supply chains, we developed two legal compliance scenarios:

- Medium compliance: 21.5%. This is based on a Brazil-wide study of legality in soy, which concluded that 3.7 million hectares of 17.2 million hectares of soy planted on registered landholdings was illegal between 2016 and 2017[40].
- Low compliance: A study of deforestation in soy farms in one state, Mato Grosso, concluded that 95% of deforestation was illegal[41].

2.10.3 Estimated levels of legal and illegal deforestation and conversion associated with UK supply chains

The estimated area of deforestation and conversion associated with UK soy supply chains from Brazil was multiplied by the legal compliance scenarios to generate estimates of the extent of legal and illegal deforestation and conversion between 2021 and 2030 (Table 24).

Table 24: Area of natural vegetation conversion (hectares) attributable to UK soy supply chains under two deforestation scenarios and two legal compliance scenarios between 2021 and 2030.

	High deforestation		Medium deforestation	
	Legal	Illegal	Legal	Illegal
Medium compliance	42,072	17,093	28,518	7,811
Low compliance	2,680	56,485	1,816	34,513

[39] Croft, S., West, C., Harris, M., Otley, A. & Way, L. (2021). Towards indicators of the global environmental impacts of UK consumption: Embedded Deforestation. JNCC Report No. 681, JNCC, Peterborough, ISSN 0963-8091

[40] Rajão, R. et al. (2020). The rotten apples of Brazil's agribusiness. Science 17 Jul 2020: Vol. 369, Issue 6501, pp. 246-248. DOI: 10.1126/science.aba6646

[41] Vasconcelos, A. et al. (2020). Illegal deforestation and Brazilian soy exports: the case of Mato Grosso. TRASE, ICV & IMAFLORA.

The same scenarios were applied to the above and below ground carbon storage (see Table 21 and Table 22). These are given in Table 25.

Table 25: Estimated above and below ground carbon stored in vegetation at risk of conversion attributed to UK soy supply chains 2021-30 (tonnes)

	High deforestation		Medium Deforestation	
	Legal	Illegal	Legal	Illegal
Medium compliance	21,263,596	8,639,238	14,413,569	3,947,665
Low compliance	1,354,369	28,548,465	918,062	17,443,173

2.10.4 Threatened and endangered species

The number of species present in each threat category (see Section 2.6.2.1) in the twelve study states are given in Table 26.

Table 26: Number of species found in the 12 Brazilian states studied and their status according to the IUCN's Red List classification.

Category	**Number of species**
Critically Endangered	109
Data Deficient	308
Endangered	261
Least Concern	1369
Lower Risk/conservation dependent	17
Lower Risk/least concern	9
Lower Risk/near threatened	24
Near Threatened	116
Vulnerable	249
Grand Total	**2462**

3 Deforestation risk associated with palm oil from Indonesia

SUMMARY OF THE APPROACH
The legality of palm oil production could not be determined with the data available.
An alternative approach was developed to determine areas that have an elevated risk of illegality for palm oil production according to designated land use.
The analysis considered the whole of Sumatra and Kalimantan.
The spatial analysis used multiple datasets to identify where oil palm is grown and whether this is in line with the government plan of land allocation and protected land status.
The key datasets used were:

- Legal land use classification
- Protected land areas (National Parks, Nature Reserves etc.)
- Peatlands
- Location of oil palm plantations

3.1 Scope

Geographically, we focused on oil palm plantations in Sumatra and Kalimantan, areas of Indonesia that both supply significant volumes of palm oil to the UK, and which also have high rates of deforestation and land conversion[42].

3.2 Previous work

Meetings were held with WWF-UK and partners for advice on the availability and use of national datasets to support the analysis and interpretation. These highlighted that data on the location of oil palm concessions were incomplete; this is a major data gap for assessing the legality of palm oil production.

3.3 Regulatory context

Assessing the legality of deforestation and land conversion in Indonesia presents a different challenge to Brazil, for two reasons. Firstly, there are a plethora of legal instruments governing forest and other types of land conversion. Secondly, almost no information on legal compliance is available publicly. Consequently, our assessment of deforestation and conversion in Indonesia focuses on a subset of specific risks of illegal deforestation and conversion rather than assessing how much land might be converted in the future.

Indonesia's land area is divided into two basic classifications: Non-forest Estate (*Areal Penggunaan Lain*, APL) and Forest Estate (*Kawasan hutan*). APL is intended for activities such as agriculture and settlement, whereas cultivating oil palm on Forest Estate lands is illegal without a decree from the Ministry of Environment and Forestry for the forest estate to become recategorized. In addition to the land use designation, there are numerous other laws concerning the legality of conversion: at least twenty-two in Sumatra alone[43]. However, data on compliance with these various additional legal instruments is not publicly available.

Non-forest areas (APL) are intended for activities such as oil palm cultivation, and therefore plantations here have a lower risk of illegality on the basis of land use designation.

In addition to the land use designation, there are at least three legal instruments governing the conversion of peatlands to agriculture, including oil palm, in addition to the broader provisions governing forest conversion. These are: Permentan No.14/2009 concerning use of peatlands for oil palm plantation does not prohibit development of peatlands but restricts development only to areas that meet specified conditions, including a peat depth of less than 3 meters; Government Regulation No. 71/2014 Management and protection of peatlands; Presidential Instruction No. 8/2015 - Moratorium on new licenses in primary forests and peatlands. This decree

[42] TRASE https://www.trase.earth/
[43] NEPCon (2017). Palm Oil Risk Assessment: Indonesia – Sumatra. Version 1.2 I November 2017

was made permanent in 2019 and suspends the granting of new oil palm licenses in primary natural forest and peatlands.

The presence of three legal instruments, including an outright suspension of new oil palm permits, means that recent oil palm plantations on peatlands have an elevated risk of illegality. Legal or not, the detrimental impacts of converting peatlands, including significant greenhouse gas emissions and biodiversity loss, are disproportionately high. For this reason, we also assess the extent of oil palm plantations on peatland areas, irrespective of the land use designation of that peatland.

Finally, although most protected areas lie within the Forest Estate, we assess the extent of oil palm plantations in areas protected for nature conservation.

In summary, oil palm plantations within APL are less likely to be illegal based on land use designation, but any deforestation or conversion undertaken to create or expand those plantations may or may not be illegal. Oil palm plantations in Forest Estate (and peatlands or protected areas) are less likely to be legal and so can be considered to pose a greater risk of illegal deforestation or conversion. However, from publicly available data it is not possible to determine the actual legality of any deforestation or conversion that has been associated with a specific plantation or group of plantations.

3.4 Methodology

An elevated risk of deforestation or conversion was identified by locating areas of oil palm outside the nationally allocated zones that the Government has identified as suitable for oil palm production.

Summary of key spatial data used in this analysis
Two maps identifying land in oil palm production for 2017 and 2019.
The Indonesia legal classification: a national map of the protection status of the land in Indonesia – showing zones for different types of production and protected areas.
A supplementary dataset of protected land (conservation areas).
Peatland maps – as there are separate legal instruments beyond land use classification that restrict their use for agriculture.
The IUCN red list of species was used to assess biodiversity impacts.

3.4.1 Key data requirements

In order to support a spatial assessment of risk, the following information is required:

- Data to identify where oil palm is grown.
- Land use classification, which determines where protection status of land, which specifies where oil palm should and should not be grown without additional formal legal processes.
- Constraints maps that show where oil palm production would conflict with land designated for environmental purposes (conservation areas, peatlands).

3.5 Selection of datasets

3.5.1 Administrative Boundaries

These were sourced from the Humanitarian Data Exchange (Level 0 and Level 1), these being the country and provinces boundaries and were used to delineate the islands of Sumatra and Kalimantan.

3.5.2 Oil palm

Two datasets were used (both supported by scientific publications):

- The dataset produced by Danylo *et al.* (2021) showing the extent and age of oil palm plantations for the year 2017 across Southeast Asia using remote sensing[44]. This has a spatial resolution of 30 metres.

[44] Danylo, O., Pirker, J., Lemoine, G. *et al.* (2021). A map of the extent and year of detection of oil palm plantations in Indonesia, Malaysia and Thailand. Sci Data 8, 96. https://doi.org/10.1038/s41597-021-00867-1.

- A global dataset of oil palm extent created in late 2019 by Descals *et al*. (2021) as part of an ongoing programme[45]. This dataset identifies both large plantations and smallholder areas and has a spatial resolution of 10 metres.

These datasets were derived from satellite imagery and provide complete coverage of both islands. As they give slightly different results due to the different approaches used, they are used individually and in a combined data set (with duplication removed).

3.5.3 Indonesia legal classification

This layer shows the status of the land in Indonesia in 2015, according to the legal land use classification. There was limited metadata with the file. The data was sourced from Global Forest Watch[46] and the data with the nomenclature as follows:

- Convertible production forest (HPK)
- Limited production forest (HPT)
- Production forest (HP)
- Non-Forest (APL)
- 'Protected area' and 'Other': these together include conservations areas such as: game reserves, marine national park, marine nature recreations park, national park, national protected area, nature recreation park, nature reserves, wildlife reserves and other protected land.
- Water bodies

According to the land use classification system, oil palm production is limited to APL and cannot be grown in any of the other legal classification areas (i.e., the Forest Estate) without additional legal processes (e.g., reclassification of the area from Forest Estate to APL).

3.5.4 Protected land

Some additional areas of protected land were identified on the protected layer available from the World Database of Protected Areas (May 2021).

3.5.5 Peatlands

This layer shows the location of peatlands in Indonesia. The data was sourced from Global Forest Watch[47] with the source data originating from 2012 being from the Ministry of Agriculture[48].

3.5.6 Impacts on Biodiversity

3.5.6.1 International Union for Conservation of Nature (IUCN) Red List

The IUCN's searchable data set of plant and animal species was used, confining the search to Sumatra and Kalimantan. The number of species in each threat category was enumerated[49].

3.6 Data processing

3.6.1 Identification of vegetation at risk of legal conversion

The spatial analysis combined the data in the following way to identify land at elevated risk of illegal deforestation.

Step 1: Identify types of land at elevated risk of Illegal palm production (Table 27).

[45] Descals, A., Wich, S., Meijaard, E., Gaveau, D.L.A., Peedell, S. & Szantoi, Z. (2021). High-resolution global map of smallholder and industrial closed-canopy oil palm plantations. Earth Syst. Sci. Data, 13, 1211–1231, 2021. https://doi.org/10.5194/essd-13-1211-2021
[46] https://data.globalforestwatch.org/datasets/gfw::indonesia-legal-classification/about
[47] https://data.globalforestwatch.org/datasets/gfw::indonesia-peat-lands/about
[48] Indonesia: Ministry of Agriculture, 2012
[49] UCN Red List of Threatened Species https://www.iucnredlist.org/

Table 27: Land areas allocated to oil palm cultivation based used for this analysis

Dataset	Protected / Not legally allocated to oil palm production	Land allocated for oil palm production
World database of protected areas (WDPA)	Areas such as National Parks, Nature Reserves etc.	N/A
Indonesia legal classification (protection status of the land in Indonesia)	Limited production forest (HPT) Convertible production forest (HPK) Permanent production forest (HP) Protected area Other (including Protection Forest, *Hutan Lindung*)	Non forest estate (APL)
Peatlands	Peatlands	N/A

Step 2: Estimate areas of oil palm plantation with enhanced risk of being illegally deforested

This is based on maximum known extent of oil palm plantations and makes use of the two oil palm plantation maps:

- 2017 mapped extent of oil palm
- 2019 mapped extent of oil palm
- The maximum extent of oil palm in 2019 based on the combined data

Step 3: The oil palm maps were overlaid with the land classes given in Table 27 and the extent of oil palm plantations in each land class calculated.

3.7 Results

3.7.1 Extent of palm oil cultivation in Sumatra and Kalimantan

The combined oil palm maps from 2017 and 2019 suggest a total area of oil palm plantations of 4,530,200 hectares in Kalimantan and 7,802,600 hectares in Sumatra, 8% and 15% of the total land areas, respectively (Figure 8).

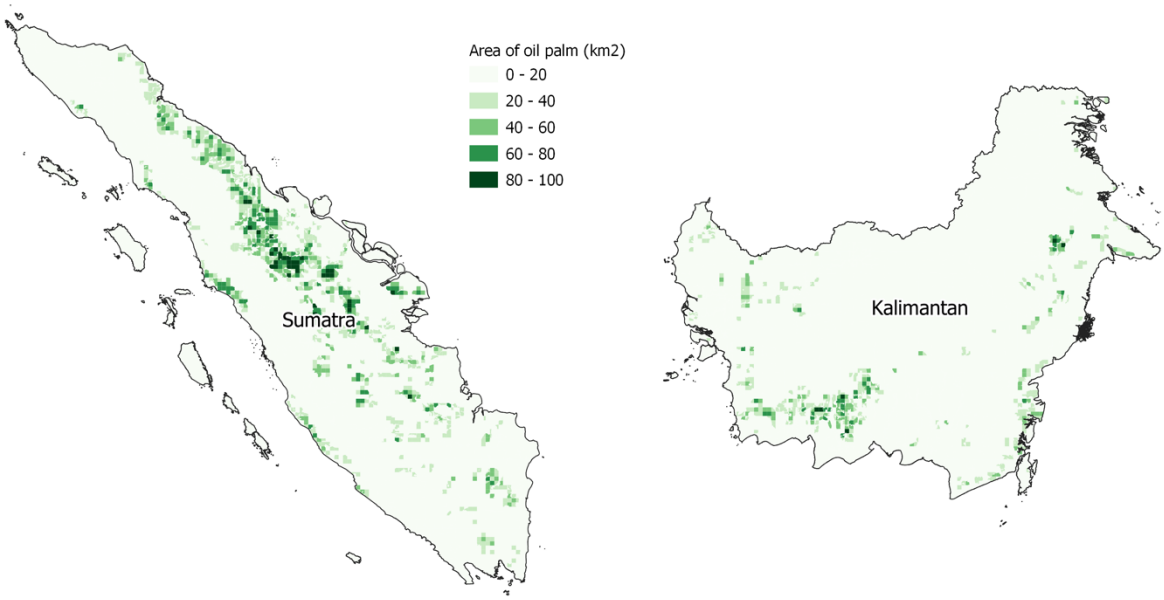

Figure 8: Density of oil palm plantations per 100 km² in Sumatra and Kalimantan

3.7.2 Output tables

The outputs provided will be estimates of the area of oil palm, separately reported for each of the following:

- oil palm on land that is not allocated for oil palm production,
- oil palm in protected areas,
- oil palm on peatland.

3.7.2.1 Breakdown of oil palm plantation area in land use designation class

Non-forest areas (APL) are intended for activities such as oil palm cultivation, and therefore plantations here have a lower risk of illegality on the basis of land use designation. A total of 3,071,000 hectares (68%) of the oil palm plantations in Kalimantan and 4,097,600 hectares in Sumatra (53%) are located within APL, where oil palm cultivation is legally allowed based on land use designation, but where additional licences are required to make deforestation that may have occurred in developing the plantation legally compliant. Data on these additional legal processes is not publicly available. It should also be noted that APL in parts of Indonesia still contains extensive natural forest.

Land areas where oil palm cultivation is less likely to be legal according to land use designation include plantations on peatlands, on areas that are not designated for palm oil plantations under Indonesia's spatial land use plans, and areas that are protected for nature conservation.

A total of 1,401,800 hectares (31%) of the oil palm plantations in Kalimantan and 3,522,000 hectares in Sumatra (45%) lie within land use designations where plantations are not permitted unless the land use designation has been formally changed after the land use plan used in our analysis, and where additional legal processes are still required to make deforestation legally compliant, data on which is not publicly available. This area therefore represents the proportion of oil palm plantations where there is an elevated risk that any deforestation and/or conversion that has occurred could be illegal, not that deforestation in these areas is necessarily illegal.

3.7.2.1.1 Sumatra

Legal designation		Area (hectares)	Area of oil palm (hectares)		
			2017	2019	2017 & 2019 (% of land use class that is oil palm)
Oil Palm allowed	APL	18,062,600	3,212,000	3,351,200	4,097,600 (23%)
Oil Palm not allowed	HP	6,699,700	540,200	606,700	694,400 (10%)
	HPT	3,892,000	450,800	550,500	602,200 (15%)
	HPK	5,343,100	1,838,000	1,932,500	2,225,400 (42%)
	Protected area[50]	8,959,200	124,500	127,200	165,600 (2%)
	Other	1,580,200	1,100	300	1,300 (0.1%)
	Water bodies	542,300	12,300	10,900	16,000 (3%)
TOTAL		45,079,000	6,178,900	6,579,400	7,802,600

3.7.2.1.2 Kalimantan

Legal classification class		Area (hectares)	Area of oil palm (hectares)		
			2017	2019	2017 & 2019 (% of land use class that is oil palm)
Oil Palm allowed	APL	13,911,400	1,962,400	2,901,400	3,071,000 (22%)
Oil Palm not allowed	HP	12,080,700	597,600	813,600	852,000 (7%)
	HPT	11,197,900	64,400	87,100	93,000 (1%)
	HPK	3,935,000	273,200	439,700	456,800 (12%)
	Protected area	11,893,100	40,300	43,400	56,100 (0.5%)
	Other	0	0	0	0 (0%)
	Water bodies	582,100	900	800	1,400 (0.2%)
TOTAL		53,600,300	2,938,900	4,286,000	4,530,200

[50] Note that the 'Protected Area' class is from the Global Forest Watch 'legal classification' data set and does not incorporate the WDPA data (see Section 3.7.2.2).

3.7.2.2 Incorporating additional protected area data

The WDPA contains additional areas of land that are not included in the land use designation 'Protected area' class. The table below takes this into account. The result is that by using this as a basis of legality, we found that a greater proportion of oil palm is being cultivated in areas where there is an elevated risk of illegality.

Location	Land status	Area (ha)	Area of oil palm (hectares)		
			2017	2019	2017 & 2019 (% of land use class that is oil palm)
Sumatra	All legal classifications where oil palm is not permitted to be cultivated and all other protected areas (from WDPA)	27,123,300	2,971,600	3,711,300	3,233,700 (12%)
	Remaining (APL not under WDPA)	17,955,700	3,207,300	4,091,200	3,345,700 (19%)
Kalimantan	All legal classifications where oil palm is not permitted to be cultivated and all other protected areas (from WDPA)	39,735,900	976,700	1,459,500	1,384,800 (3%)
	Remaining (APL not under WDPA)	13,864,400	1,962,200	3,070,700	2,901,200 (21%)

3.7.2.3 Peatland

A total of 404,300 hectares of oil palm plantations in Kalimantan are on peatland (8% of the total peatland area) with a further 1,216,000 hectares in Sumatra (19%). Conversion of peatland to oil palm cultivation may be legal if, for example, the area is located in APL, the original peat depth was less than three metres, and the conversion happened before the Presidential Instruction in 2015. However, the presence of three legal instruments, including an outright suspension of new oil palm plantation permits, means that recent oil palm plantations on peatlands have an elevated risk of illegality. Legal or not, the detrimental impacts of converting peatlands, including greenhouse gas emissions and biodiversity loss, are disproportionately high[51].

Total area of peatland in each location and the area of oil palm found within those areas.

Location	Area (hectares)	Area of oil palm (hectares)		
		2017	2019	2017 & 2019 (% of land use class that is oil palm)
Sumatra	6,344,300	857,100	1,034,100	1,216,000 (19%)
Kalimantan	4,922,900	242,200	386,000	404,300 (8%)

3.7.3 Threatened and endangered species

The number of species present in each threat IUCN Red List category (see Section 3.5.6.1) in Sumatra and Kalimantan are given in Table 28.

[51] Lucey, J., et al. (2014). Change in carbon stocks arising from land-use conversion to oil palm plantations: A science-for-policy paper for the Oil Palm Research-Policy Partnership Network

Table 28: Number of species in each IUCN Red List category in Sumatra and Kalimantan

Threat IUCN category	Number of species
Critically Endangered	130
Data Deficient	498
Endangered	269
Extinct in the Wild	3
Least Concern	1785
Lower Risk/conservation dependent	4
Lower Risk/least concern	24
Lower Risk/near threatened	44
Near Threatened	225
Vulnerable	389
Grand Total	**3371**

4 Policy analysis: A law to solve a problem

4.1 Methodology

For this policy analysis we evaluated the proposed wording of the commitment within the Environment Bill to develop deforestation due diligence regulation in the UK. We used Parliamentary debate reports and other resources published online. Additional insights were gathered through consultation with an expert in the subject. Existing deforestation commitments of companies – identified as the top five importers of soy and/or palm oil into the UK and Europe and the top eight food companies in the UK (based on revenue and market share) – were evaluated in terms of their scope based on the definition of deforestation used (Table 29).

4.1.1 What is being proposed

Within the Environment Bill, Schedule 16 contains a commitment to developing a deforestation due diligence regulation in the UK[52]. This would require large[53] businesses in the UK to ensure that any 'forest risk' commodities they use – defined as commodities associated with causing deforestation – have been produced legally, in accordance with local laws in producer countries. Businesses would have to take steps – undertake 'due diligence' – to provide proof that they have taken proportionate action to ensure that the products they are importing are not associated with illegal deforestation. Actors that do not comply would be subject to punishments such as fines.[54] The regulation is proposed to address the fact that there is currently no overarching legal requirement in the UK for businesses to ensure that the commodities they use have been produced in accordance with local laws, in this case related to deforestation.

In the proposed due diligence regulation wording, 'forest risk commodities' are defined as a commodity from a plant, animal or other living organism the production of which is, or may be, leading to the conversion of forest to agricultural use.[55] This does not include timber or timber products (Paragraph 1, Sub-paragraph (6)), which are covered by the UK Timber Regulations. It also does not apply to the use of a forest risk commodity where the commodity is a waste or is to be used to make renewable transport fuel (Paragraph 2, Sub-paragraph (7) and (8)).

In the proposed regulation wording, businesses would be required to prove that commodities have been produced in compliance with 'relevant local laws' determining legal deforestation. Relevant local laws are defined as any law which is 'having effect in the country or territory where the source organism was grown, raised or cultivated' and which relate to ownership or use of land.[56]

4.1.2 The proposed regulation: issues with intent

4.1.2.1 The focus on legality misses legal deforestation

The focus of the proposed regulation is on deforestation defined as illegal based on the local laws of the countries in which commodities are produced. Illegal deforestation is estimated to account for around half of deforestation globally.[57]

The extent of deforestation that occurs legally under local laws in producer countries is, therefore, significant (e.g., see analysis for Brazil, this document), with the attendant impacts on potential greenhouse gas emissions and biodiversity loss. Concerns over restricting the focus of the regulation to illegal deforestation have been

[52] UK Parliament (2021). Environment Bill: current version of the Bill as of 26 May 2021. Online [accessed 1st Jul 2021]: https://bills.parliament.uk/publications/41652/documents/310

[53] At the time of writing, the suggestion is that large companies would be defined as businesses which is meet at least two of the following: (a) annual turnover of more than £36 million, (b) balance sheet total of more than £18m (c) more than 250 employees.

[54] Defra (2020). Due diligence on forest risk commodities. Online [accessed 21st June 2021]: https://consult.defra.gov.uk/eu/due-diligence-on-forest-risk-commodities/

[55] UK Parliament. Environment Bill: Twenty Second sitting. Debated on Thursday 26 November 2020. Part 1: Requirements. Online [accessed 21st June 2021]: https://hansard.parliament.uk/Commons/2020-11-26/debates/e26dc624-6404-46fc-b756-ceb9e09954bb/EnvironmentBill(TwentySecondSitting)

[56] UK Parliament. Environment Bill: Twenty Second sitting. Debated on Thursday 26 November 2020. Online [last accessed 21st June 2021]: https://hansard.parliament.uk/Commons/2020-11-26/debates/e26dc624-6404-46fc-b756-ceb9e09954bb/EnvironmentBill(TwentySecondSitting)

[57] Global Witness (2021). Parliamentary briefing: Three Key Improvements Needed to UK Deforestation Law. Online [last accessed 21st June 2021]: https://www.globalwitness.org/en/campaigns/forests/parliamentary-briefing-three-key-improvements-needed-uk-deforestation-law/

raised by businesses, NGOs[58] and members of the House of Commons and House of Lords.[59] It could even prompt some governments into revising their laws to make more deforestation legal so it would become outside of the scope of the UK's due diligence regulation and restrictions.

Focusing only on illegality rather than all deforestation puts the UK government behind its own pledges; the commitments made by many major agri-food businesses; the recommendations of the Global Resource Initiative (GRI) Taskforce, and the guidelines of the Accountability Framework Initiative, which articulate a cessation of all deforestation associated with UK supply chains – not just illegal deforestation.[60]

4.1.2.2 Legality of deforestation is harder to prove than deforestation

The focus on legality makes implementation of a due diligence regulation - and its compliance by businesses - significantly more difficult; companies would first have to determine whether the production of commodities being imported had entailed forest clearance, and then determine whether that clearance was legal according to local laws.

Reduction in the extent of forest (and other natural vegetation) can be monitored remotely in near real time, anywhere in the world. However, establishing whether those changes are legal requires additional information on permits. In the case of Brazil, a country with unusually high levels of public information, compliance with some aspects of the laws governing forest and native vegetation conversion can be established (see analysis for Brazil in this document). In most countries, however, establishing that a deforestation event is legal would require a paper trail of documents that are not in the public domain, would need verification of authenticity, and verification of compliance. Depending on the complexity of local regulations governing forest conversion, this paper trail could run into scores of documents for each production location. Experiences from the EU Timber Regulation (EUTR) have shown that it is difficult to prove the illegal origin of products to the degree required for conviction or punishment.[61]

4.1.2.3 'Relevant local laws' relate to land ownership, not land clearance

In the current wording of the Bill, 'relevant local laws' are defined as those that relate to use and ownership of land. This creates three major issues. Firstly, the law is intended to eliminate illegal deforestation from UK supply chains. By using local laws based on land ownership, rather than those that may exist governing forest clearance and habitat conversion, it assumes a proxy relationship between legal ownership of land and legality of forest clearance on that land. The issue with this is demonstrated by proposed changes to local laws in Brazil, discussed in 4.1.2.4 below. Secondly, by referring to local laws on land ownership the Bill side-lines - and could therefore undermine – local environmental laws that may already exist to control forest clearance. Finally, it is often difficult for smallholder producers to provide evidence of land ownership and they risk being unfairly penalised by a regulation that relies on this[62]. This is important, as a significant proportion of palm oil and almost all cocoa traded internationally is produced by smallholders.

4.1.2.4 Complexity and changeability of local laws

Ensuring that commodities have been produced in compliance with local deforestation laws as would be required under the proposed regulation wording entails several intractable challenges. Firstly, the number and complexity of local laws defining what is legal or illegal deforestation is considerable. For example, there are no fewer than twenty-two regulations relating to forest conversion in Sumatra, which is one of the main palm oil producing

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[58] Global Witness (2021). Parliamentary briefing: Three Key Improvements Needed to UK Deforestation Law. Online [last accessed 21st June 2021]: https://www.globalwitness.org/en/campaigns/forests/parliamentary-briefing-three-key-improvements-needed-uk-deforestation-law/

[59] UK Parliament (2021). Environment Bill. Volume 812: debated on Monday 7 June 2021. Spoken contribution from Lord Randall of Uxbridge. Online [last accessed 21st June 2021]: https://hansard.parliament.uk/Lords/2021-06-07/debates/6E1FE4FF-613D-44D6-8668-C8468E87D916/EnvironmentBill?highlight=environment%20bill#contribution-5F4175BE-1936-4B10-AEBA-9511C9D5C73E

[60] For example: Retail Soy Group (2020). Letter to The Rt Hon George Eustice MP Secretary of State for Environment, Food and Rural Affairs Ref: Role of due diligence requirements in addressing global deforestation. 5th October 2020. Online [accessed 21st June 2021]: https://www.retailsoygroup.org/wp-content/uploads/2020/10/Letter-on-due-diligence-consultation_final.pdf

[61] Brack & Ozinga (2020). Enforcing due diligence legislation 'plus'. Online [last accessed 21st June 2021]: https://www.fern.org/publications-insight/enforcing-due-diligence-legislation-plus-2230/

[62] C. Brandi, T. Cabani, C. Hosang, S. Schirmbeck, L. Westermann, H. Wiese (2015). Sustainability standards for palm oil: challenges for smallholder certification under the RSPO J. Environ. Dev., 24 (3), pp. 292-314 and L.S. Prokopy, K. Floress, D. Klotthor-Weinkauf, A. Baumgart-Getz (2018). Determinants of agricultural best management practice adoption: evidence from the literature J. Soil Water Conserv., 63 (5) (2008), pp. 300-311

areas within Indonesia.[63] Ensuring that production complies with all of these laws on the ground is highly complex and collecting evidence of this is made almost impossible by a lack of traceability and transparency, in particular from middle supply chain actors[64].

Local laws are also subject to change which will - due to the fact that the proposed due diligence regulation is based on compliance with local laws - alter the scope and strength of the regulation. Recent and ongoing changes to laws in Brazil provide an illustrative example; in May 2021, the lower chamber in Brazil approved a law which significantly weakens the licensing requirements for several environmentally damaging activities, including large-scale agriculture.[65] Additionally, a bill currently passing through the Brazilian senate would effectively grant an amnesty to actors responsible for past illegal occupation of public lands and grant these actors land rights, effectively legitimising, legalising and rewarding those behind land clearance that occurred up until as recently as 2018.[66,67] A due diligence regulation based on local legality would approve imports that were produced in line with these two legal changes.

4.1.2.5 Exclusion of non-forest natural habitats

In a document produced by the Department for Environment Food & Rural Affairs (Defra) for a public consultation (25th August to 5th October 2020) on the due diligence regulation, the proposed scope was that 'relevant local laws' would include those that '*protect natural forests and other natural ecosystems from being converted into agricultural land*'[68]. However, the wording of the proposed regulation as of the Twenty Second sitting of the Environment Bill in November 2020 specifically states; "*the regulations may specify a local law only if it relates to the prevention of forest being converted to agricultural use*." (2(5)) and elsewhere in the proposed wording, forest is defined as "*an area of land of more than 0.5 hectares with a tree canopy cover of at least 10% (excluding trees planted for the purpose of producing timber or other commodities)*"(1(4)).[69] This wording has been retained through subsequent readings and amendments of the Bill to date.

With the current wording, the regulation does not cover the conversion of ecosystems other than forest. This leaves vast areas of natural and semi-natural habitat, and the considerable biodiversity and carbon stored within them, vulnerable to conversion. The current wording also makes it possible that conversion to land uses other than agricultural use would not be covered by the regulation which means that land that passes through an intermediate use – for example plantation forestry or the production of tree crops, which are not included as 'forest risk commodities' in this regulation – before being converted for agricultural use would also not be covered.

Our analysis confirms the risk of significant of conversion of non-forest natural ecosystems. In Brazil, nearly half of the remaining natural vegetation area in Brazil that could potentially be legally converted under current laws is *Cerrado* - a highly biodiverse savanna habitat that supports around 30% of Brazil's biodiversity (and 5% of the world's total animal and plant species) including around 30 endemic bird species and several threatened

[63] NEPCon (2017). Palm Oil Risk Assessment: Indonesia – Sumatra. Version 1.2 l November 2017

[64] Traceability is better for a few particular forest risk commodities and geographies (e.g. soy in the Brazilian Amazon) but, in general, there is a lack of publicly-available data at sufficient resolution to allow tracing of sourcing back to specific parcels of land and to link this with relevant local laws in order to assess whether production meets local legal requirements. See, for example: Gardner *et al.* (2019). Transparency and sustainability in global commodity supply chains. World Development. 121, 163-177. https://doi.org/10.1016/j.worlddev.2018.05.025; zu Ermgassen et al. (2020). Using supply chain data to monitor zero deforestation commitments: an assessment of progress in the Brazilian soy sector. Environmental Research Letters. 15. https://doi.org/10.1088/1748-9326/ab6497; Linda JL. Veldhuizen, Ken E. Giller, Peter Oosterveer, Inge D. Brouwer, Sander Janssen, Hannah HE. van Zanten, M.A. Slingerland (2020). The Missing Middle: Connected action on agriculture and nutrition across global, national and local levels to achieve Sustainable Development Goal 2, Global Food Security, Volume 24, 100336, ISSN 2211-9124, https://doi.org/10.1016/j.gfs.2019.100336

[65] Observatorio do Clima. Câmara aprova "mãe de todas as boiadas", o fim do licenciamento. Online [last accessed 21st June 2021]: https://www.oc.eco.br/camara-aprova-mae-de-todas-as-boiadas-o-fim-do-licenciamento/

[66] WWF Brasil (2021). Policy Brief: Legislative package supported by Bolsonaro government will undermine the Paris Agreement. Online [last accessed 21st June 2021]: https://www.wwf.org.uk/sites/default/files/2021-04/Policy%20Brief%20-%20The%20Bolsonaro%20Government%27s%20Undermining%20of%20the%20Paris%20Agreement%20-%20April%202021.pdf

[67] WWF Brasil (2020). Brazilian National Congress can grant amnesty to large public lands invaders. Online: https://www.wwf.org.br/informacoes/english/?75342/Brazilian-National-Congress-can-grant-amnesty-to-large-public-lands-invaders

[68] Defra, August 2020, Due diligence on forest risk commodities: Consultation document. Online [last accessed 9th June 2021]: https://consult.defra.gov.uk/eu/due-diligence-on-forest-risk-commodities/supporting_documents/duediligenceconsultationdocument.pdf

[69] UK Parliament. Environment Bill: Twenty Second sitting. Debated on Thursday 26 November 2020. Online [last accessed 21st June 2021]: https://hansard.parliament.uk/Commons/2020-11-26/debates/e26dc624-6404-46fc-b756-ceb9e09954bb/EnvironmentBill(TwentySecondSitting)

mammals which are primarily found in the *Cerrado*, including the maned wolf, Giant Anteater and Giant Armadillo.[70,71]

Moreover, the focus on forests (and illegality) is significantly less ambitious than the existing commitments of many leading companies that use forest and ecosystem-risk commodities in the UK. We analysed the deforestation policies of twenty-three major companies that use palm oil and soy (Table 29). The companies include seven of these are the largest importers of palm oil and/or soy into the EU and UK by volume, according to proprietary data (palm oil) and TRASE analysis of UK imports (soy). They are represented in order of ranking for UK imports in Table 29, (noting that Cargill is amongst the largest imported of both commodities, hence placed first). The analysis also included the eight largest food manufacturers and eight largest retailers in the UK (given in order of market share). Seven of the companies assessed (30%), including Bunge and AAK, had a commitment to eliminate either conversion of all ecosystems or conversion of any natural forest from their supply chains. A further 11 (48%) had commitments to eliminate net deforestation or conversion of specific types of forest (e.g., High Conservation Value Forest) from their supply chains. Five companies had no public commitment to eliminate deforestation from their supply chains. In addition, the British Retail Consortium - which represents over 170 businesses - called for Defra to make the proposed due diligence regulation more comprehensive and include 'other natural ecosystems' as well as forests.[72]

Moreover, the focus on illegality sets a lower threshold than existing government commitments, including the Sustainable Development Goals, the Paris Agreement, the Aichi Biodiversity Targets, the New York Declaration on Forests, the Amsterdam Declaration and the Leaders' Pledge for Nature.

[70] WWF (2015). The 'big five' of the Cerrado. Online [last accessed 21st June 2021]: https://www.wwf.org.br/?50242/The-Big-Five-of-the-Cerrado
[71] Conservation International (2021). Cerrado – Species. Online [last accessed 21st June 2021]: https://www.cepf.net/our-work/biodiversity-hotspots/cerrado/species
[72] BRC (2020). Defra Mandatory Due Diligence Consultation Template. Online [last accessed 21st June 2021]: https://brc.org.uk/media/676065/defra-mandatory-due-diligence-consultation-v3.docx

Table 29: Analysis of the deforestation and conversion policies of major UK and EU importers of soy and palm oil, and major UK food manufacturers and retailers.

	Supply chain role			Type of deforestation policy			Ecosystem scope of deforestation policy					
Company	**Top 8 EU/UK Importer**	**Top 8 UK food manufacturer**	**Top 8 UK retailer**	**Global timebound commitment**	**Sectoral timebound commitment**	**Aim/policy (not timebound)**	**a) All ecosystem conversion**	**b) Natural forest conversion**	**c) No clearance of a category of forest (typically HCV)**	**c) Net deforestation (incl. credit purchase)**	**d) Net deforestation (incl. credit purchase) of a category of forest**	**e) No public commitment**
Cargill	Palm oil and soy					x		x				
Bunge	Soy			x			x					
Amaggi	Soy					x	x					
Louis Dreyfus	Soy					x		x				
Sime Darby	Palm oil					x		x				
AAK	Palm oil			x			x					
Stepan	Palm oil					x			x			
Associated British Foods		x										x
Boparan Holdings		x										x
Arla Foods		x							x			
Greencore Convenience Foods		x		x				x				
Muller UK and Ireland		x										x
Coca-Cola Enterprises		x										x
Bakkavor		x				x			x			
Mondelez UK		x										x
Tesco			x		x					x		
Sainsbury's			x		x					x		
Asda			x		x					x		
Morrison's			x		x				x			
Aldi South			x		x					x		
Coop			x		x					x		
Lidl			x		x					x		
Waitrose (John Lewis Partnership)			x		x					x		

4.1.2.6 Insufficient transparency and traceability in supply chains

Deforestation and conversion are place-based processes. Conducting due diligence on deforestation in supply chains therefore requires accurate information on the provenance of supplies. That information also has to be up to date, as sourcing locations are not static.

In supply chains where provenance is part of the value of the product – such as boutique coffee or chocolate – this presents less of a problem, as sourcing is often known and stable. However, the majority of the volume of most forest-risk commodities do not have such short, direct and stable supply chains, meaning that without further disclosure, it is rarely possible to trace all forest-risk commodities back to the area of land on which they were produced.

For example, a major importer of Brazilian soy to the UK knows the origins of 70% of the volume to farm level, but buy the remaining 30% on the spot market, from origins unknown. Similarly, palm oil is typically bought on the spot market at each stage – fresh fruit bunches, crude palm oil, refined palm oil and derivatives – and mixed with material from known sources.[73] Full traceability is therefore difficult to achieve without further disclosure which presents a fundamental barrier for downstream buyers to proving, firstly, whether a specific product or batch of raw materials has caused deforestation and, secondly, whether that deforestation was legal or illegal.

The implications for a company carrying out due diligence are either to reform the way that supply chains work specifically for the UK market to make them fully traceable from farm to shop or rely on independent certification and verified fully segregated or identity preserved supply chains. Both of these options are costly and the second may not even be feasible for some commodities due to insufficient supply or inadequacy of some schemes to demonstrate that the product is deforestation and conversion-free. A third potential option would be for UK companies to move their sourcing away from places where the risk of illegality is deemed to be high. The latter would remove any positive UK influence on sustainability in those countries – including a market for smallholder suppliers – with the commodities sold to markets where deforestation is of low concern. In addition, the way that supply chains respond to the UK regulation will also critically depend on the direction of due diligence legislation being developed in the EU and the US; if UK, EU and US regulations are harmonised, their combined market size has the potential to encourage reform of existing supply chains to foster more sustainable practices, which may reduce the tendency for companies to simply move sourcing away from high-risk places.

4.1.3 Issues related to policy design, implementation and enforcement

The design of any due diligence regulation is crucial to its impact. The interpretation of what is meant by ‘due diligence’, the scope of liable actors, the requirements of actors including expectations around traceability, sanctions or incentives for actors, and the measuring and enforcement of compliance will determine the overall impact of a due diligence regulation. Much of the detail of this will be defined in secondary legislation, which is not yet formulated, but the broad parameters will be shaped by the wording of the primary regulation and it is therefore critical to consider how the regulation will be implemented during the development of its text.

4.1.3.1 Definition of due diligence

There are different models of ‘due diligence’ and the design and implementation of due diligence legislation will fundamentally depend on what definition is applied. The two main models of due diligence in the current debate are: i) due diligence as a market obligation, and, ii) due diligence as a process of ongoing corporate improvement.

The first definition frames due diligence as a process that must be carried out before a product can be placed on the market. This requires actors to investigate the actions of the businesses they are sourcing from to ensure that they are meeting certain standards and requirements. If an actor does not carry out this assessment, they can be prosecuted. This approach is particularly common in the finance sector and also underpins the EU Timber Regulation and EU Conflict Minerals Regulation which require companies to carry out due diligence to ensure they are not placing illegal timber or conflict minerals on the EU market. Companies must gather information from their supply chain, using this to assess the risk of the occurrence of illegal or unsustainable activities

[73] Personal communications between the lead author and staff of companies producing and importing palm oil and soy to the UK.

according to defined criteria, and take actions to mitigate this risk. Due diligence legislation using this definition excludes certain products from the market. It commonly applies only to 'first importers' or 'first placers' who first bring the product into a market in the jurisdiction to which the regulation applies, rather than other actors in the supply chain.

In the second model, due diligence is a continuous process of improvement. This is the interpretation enshrined in guidelines including the United Nations (UN) Guiding Principles on Business and Human Rights agreed in 2011 and the Organisation for Economic Cooperation and Development (OECD) Due Diligence Guidance for Responsible Business Conduct from 2018. It is also adopted in the Food and Agricultural Organisation (FAO) Guidance for Responsible Agricultural Supply Chains published in 2016. In this model of due diligence, supply chain actors are required to identify and avoid or address adverse impacts occurring as a result of their own operations, their business relationships and/or through their supply chains. Due diligence is framed as a dynamic and ongoing process of improvement of supply chains by the corporations involved in them. Businesses must identify the risks in their supply chains and progressively address them, starting with the most critical. This interpretation of due diligence underpins laws including the French Corporate Duty of Vigilance (Devoir de Vigilance) law.

Both models of due diligence have value, but both also have weaknesses.

A law based on due diligence as market compliance may not foster broad and ongoing improvement of the supply chain. There is a risk that instead of working to address issues linked to their suppliers, actors simply drop suppliers that cannot demonstrate compliance. This may unfairly affect smaller suppliers for whom the bureaucratic burden of proving compliance is proportionately higher. By restricting due diligence to particular products and access to the market, this definition also potentially restricts the scope of the companies liable under the law. For example, obligations under the EU Timber Regulation are only placed on companies which first place a product on the market. As a consequence, products are sometimes imported first to a shell company or an EU country with weaker enforcement which results in a loophole allowing illegal timber products to enter the market[74].

Where due diligence is framed as an ongoing improvement, there is a risk of the emphasis becoming focused on companies showing evidence of assessing and identifying the risks in their supply chains, rather than tangible actions to address these. It is critical that any due diligence legislation not only requires evidence that companies are conducting due diligence assessments of their supply chains, but also that they are taking action to address the risks and tracking the impacts of the actions they take. Another risk with this definition of due diligence which relates to improving the supply chain as a whole is that the burden to address issues may become diffused among the various supply chain actors, with the result that no one takes any action. It also makes the process of evaluating whether a company has undertaken sufficient due diligence more complicated as the company may argue that certain issues are within the remit of other actors and that it is not (yet) able to affect these. Companies can therefore claim that they are working towards making improvements without actually doing so. This can make impactful enforcement of due diligence legislation based on ongoing improvement difficult; it can be nearly impossible to sanction bad actors and easy for companies to appear compliant without taking tangible action.

How due diligence is defined has fundamental implications for the requirements that will be made of business covered under the regulation and how these will be enforced. It is critical that for a functioning and effective due diligence regulation, the definition of due diligence and the details of the legislation design are aligned.

4.1.3.2 Enforcement

An effective due diligence law crucially relies on effective enforcement.

The challenges posed by a limited supply chain traceability and transparency and the difficultly of evidencing legal or illegal deforestation were briefly discussed above. These issues are fundamental to the effective enforcement of a due diligence regulation. Of particular relevance to the focus of this report, and the current proposed

[74] Brack & Ozinga (2020). Enforcing due diligence legislation 'plus'. Online [last accessed 21st June 2021]: https://www.fern.org/publications-insight/enforcing-due-diligence-legislation-plus-2230/

wording of the UK due diligence regulation, is the distinction between legal and illegal deforestation. The difference between the two is often defined by numerous and complex local laws, and requires ground-truthing which is rarely possible given the sheer number of producers involved in most forest and agricultural commodity supply chains, and the difficulty of tracing a product back to a specific producer. This challenge is illustrated by experiences of enforcing the EU Timber Regulation; it has proven difficult to prove illegality of timber supply to the level needed for a conviction and penalty. This significantly weakens enforcement and impact of the regulation.

Furthermore, a due diligence law defined based on illegal deforestation according to local laws critically relies on local enforcement of laws within producer countries. There are challenges with this; for example, 95% of the deforestation that took place on soy farms in the Mato Grosso state of Brazil between 2012 and 2017 was illegal under Brazilian regulations because necessary licenses to convert were not in place. This demonstrates that even where local laws exist to prevent illegal deforestation and/or conversion, they are not always effectively enforced.[75] Supply chain actors have relatively little power to directly influence the enforcement of in-country laws.

In order to prevent activities that lead to deforestation or habitat conversion, the penalties for infringement of the due diligence regulation must be appropriately dissuasive. In other words, the severity of the penalty and risk it represents for offenders must have a genuinely deterrent effect by being economically risky.[76]

To date, most discussion of penalties has been framed around monetary fines. However, if fines are to be used, they must be scaled to the economic size of the actor in question and sufficiently large to be genuinely dissuasive. If fines are too low, they effectively become an absorbable cost of infringement for large businesses and disproportionately penalise small businesses. This has been the case with the EU Timber Regulation where fines administered under the regulation have been found to be too small to deter illegal activity[77].

Particularly if a model of due diligence as continuous improvement is used – which, unless wording of the regulation is strong, risks that companies may get away with reporting efforts towards identifying and addressing risk rather than taking action to address them – penalties for infringement must be harsh. In other words, if the requirement on a business is to provide evidence of efforts to improve towards eliminating deforestation risks and impacts, if they are then found to be supporting activities that contribute to deforestation, the punishment must be severe.

A more effective alternative to fines could be measures of 'supply chain disruption'. An example of this is the US Tariffs Act which grants significant powers to the US Customs and Border Protection Agency to block products from import to the US if there is evidence of a risk that they have been produced using forced labour. Companies are then required to undertake an audit of their activities and systems and to prove that their goods are free from forced labour.[78] This process can last months or years and, in some cases, can shut down whole sectors. For example, in 2019, the Customs and Border Protection Agency blocked all imports of tobacco from Malawi due to risks it was being produced using child or forced labour[79]. A due diligence law in the UK would benefit from a similarly strong instrument to require companies to provide evidence that their imports had not contributed to

[75] Vasconcelos, Bernasconi et al, (2020). Illegal deforestation and Brazilian soy exports: the case of Mato Grosso. TRASE. Online [last accessed 21st June 2021]: https://resources.trase.earth/documents/issuebriefs/TraseIssueBrief4_EN.pdf

[76] Client Earth (2018). National EUTR penalties: are they sufficiently effective, proportionate and dissuasive?. Online [last accessed 21st June 2021]: https://www.documents.clientearth.org/wp-content/uploads/library/2018-03-01-national-eutr-penalties-are-they-sufficiently-effective-proportionate-and-dissuasive-ce-en.pdf

[77] Client Earth (2018). National EUTR penalties: are they sufficiently effective, proportionate and dissuasive?. Online [last accessed 21st June 2021]: https://www.documents.clientearth.org/wp-content/uploads/library/2018-03-01-national-eutr-penalties-are-they-sufficiently-effective-proportionate-and-dissuasive-ce-en.pdf

[78] Saunders, J. 2020. Meaningful supply chain legislation: Lessons from the US Tariffs Act for regulating the trade in forest risk commodities. Online [last accessed 21st June 2021]: https://www.forest-trends.org/blog/meaningful-supply-chain-legislation-lessons-from-the-us-tariffs-act-for-demand-for-regulating-the-trade-in-forest-risk-commodities/

[79] Saunders, J. 2020. Meaningful supply chain legislation: Lessons from the US Tariffs Act for regulating the trade in forest risk commodities. Online [last accessed 21st June 2021]: https://www.forest-trends.org/blog/meaningful-supply-chain-legislation-lessons-from-the-us-tariffs-act-for-demand-for-regulating-the-trade-in-forest-risk-commodities/

deforestation or habitat conversion, with similarly disruptive penalties such as a suspension of authorisation to trade.[80]

Enforcement of penalties will require sufficient resources and ideally, a due diligence regulation should have a dedicated court to assess cases, as is the case for EU Timber Regulation in the Netherlands, where they are heard by specialist courts[81].

In addition to criminal prosecution in courts, civil sanctions would also be valuable in enforcement of a due diligence regulation. Criminal sanctions assessed in a court tend to comprise fines or prison sentences and require a significant degree of evidence to prove 'beyond reasonable doubt' that a crime has been committed. Experience from the EUTR is that it is very difficult to prove non-compliance to this degree, which has resulted in very few convictions being made under the regulation[82].

In contrast, the evidence burden for civil sanctions is much lighter; it must be proved on the 'balance of probability' that a violation has occurred. The punishments are also broader, for example requiring actors to carry out specific actions, and it is easier to scale punishments to the size of the actor than it is for more rigid criminal sanctions. Examples of civil sanctions include Stop Notices which are injunctions that prevent actors from continuing with business activities. For example, a Stop Notice that prevents an actor being able to take a product to sale will subject them to economic costs and reputational damage from being unable to fulfil contracts, paying to store unsold stock and ongoing uncertainty. The disruptive impact of such measures can be more effectively dissuasive than a fine.

4.1.3.3 Scope of companies covered and requirements for different actors

The scope of actors obligated to meet the requirements of any due diligence legislation will have critical implications for its impact.

In part, this will relate to which due diligence model is adopted (see 4.1.3.1, above); a law based on due diligence as a market access obligation places the responsibility of due diligence mainly or solely on the 'first placer' company introducing a product to a market. The restriction of the EU Timber Regulation to obligations for 'first placer' companies is considered a critical weakness as it has resulted in some cases in products being imported to 'shell companies' or EU countries with weaker enforcement before being traded onwards.[83]

An alternative is to extend the obligation of compliance to all actors in a supply chain, regardless of their role. This has the advantage of creating the possibility for actors to collaborate towards improvements along the supply chain. However, there is also the risk that responsibility becomes dissipated, with the result that no one actor takes responsibility for ensuring action is taken.

This approach requires a clear definition of which companies are in scope. This is commonly done based on criteria related to the size of the company. Factors include the number of employees, as in the French Devoir de Vigilance law which covers companies with more than 5,000 employees in France or 10,000 employees worldwide.[84] Other criteria include volume of product handled and annual turnover, which have the advantage that they better reflect the scale of a company's activity and the size of its resources which may more closely reflect their relative role in the production and trade of commodities as well as the capacity to implement, and provide evidence for meeting, regulation requirements. The current wording of the UK due diligence regulation implies that companies will be defined based on turnover, which is due to be specified in regulations made by the

[80] Client Earth (2018). National EUTR penalties: are they sufficiently effective, proportionate and dissuasive?. Online [last accessed 21st June 2021]: https://www.documents.clientearth.org/wp-content/uploads/library/2018-03-01-national-eutr-penalties-are-they-sufficiently-effective-proportionate-and-dissuasive-ce-en.pdf

[81] Brack & Ozinga (2020). Enforcing due diligence legislation 'plus'. Online [last accessed 21st June 2021]: https://www.fern.org/publications-insight/enforcing-due-diligence-legislation-plus-2230/

[82] Brack & Ozinga (2020). Enforcing due diligence legislation 'plus'. Online [last accessed 21st June 2021]: https://www.fern.org/publications-insight/enforcing-due-diligence-legislation-plus-2230/

[83] Brack & Ozinga (2020). Enforcing due diligence legislation 'plus'. Online [last accessed 21st June 2021]: https://www.fern.org/publications-insight/enforcing-due-diligence-legislation-plus-2230/

[84] Assent Compliance LTd (2021). What Is the French Corporate Duty of Vigilance Law?. Online [last accessed 21st June 2021]: https://www.assentcompliance.com/assentu/resources/article/french-corporate-duty-of-vigilance-law/

Secretary of State.[85] The exact threshold is still under debate but is likely to be made complementary to the Companies Act 2006 which defines large companies as those with turnover exceeding £36million[86]. The criteria used to define the businesses in scope should ensure that as large a proportion of businesses involved in the UK forest risk commodity supply chains as possible, ideally at least 80% of businesses that trade the commodity[87].

There is debate around the optimum inclusion of small companies in a due diligence regulation. The burden of investing in a due diligence system and complying with requirements will be proportionately higher for small companies. However, simply excluding small actors risks creating loopholes for businesses that do not need to comply with the due diligence regulation. In addition, some small businesses want the requirements to apply to them and their similar-sized competitors to avoid a scenario where businesses that invest in systems and practices to comply with due diligence are undercut by competitors who do not have such standards in place.[88]

A possible solution to the dual challenges of responsibility being dissipated amongst supply chain actors and small companies falling outside of the regulation scope is for the responsibility for meeting due diligence requirements to be targeted at large 'bottle-neck' actors in the supply chain. These large actors would have a larger burden of proof to show that they comply with due diligence regulation whilst small 'downstream' actors would only have to show that they have sourced from one of these actors that has been assessed to be meeting the requirements of the regulation. This can be achieved by adding a risk assessment criterion to the regulation requirements in which actors assess whether a commodity has passed through a regulated company in the supply chain before reaching them. If the answer is yes, they would only need to collect basic information and identify the company in question to show that the commodity had low risk of contributing to illegal deforestation.

The exact requirements placed on the actors covered by the regulation will depend on the model of due diligence used (see 4.1.3.1 above). In either case, an effective regulation would both require actors to prove they have a due diligence system in place and explicitly prohibit the use of commodities that have contributed to deforestation. Requirements should also extend beyond simply requiring traceability or certification of supply as the link between traceable or certified volumes and deforestation-free production is often not robust.

The need for different requirements for different types and sizes of actor along the supply chain creates complexity for a due diligence regulation designed in this way and will critically require the requirements for each business to be as clear and detailed as possible.

4.1.3.4 Scope of 'forest risk commodities'

The scope of the commodities covered under the due diligence regulation is yet to be defined. The Explanatory Notes for the Environment Bill as of 26th May 2021 state that the list of commodities 'likely to be considered for inclusion' includes beef, cocoa, leather, palm oil, rubber and soya. The final list of commodities to be included is due to be defined by the Secretary of State in secondary legislation at a later date.[89] The scope of forest risk commodities covered by the due diligence regulation will crucially determine its impact. To maximise its effectiveness, the scope must be as broad as possible and include all commodities driving deforestation and habitat conversion. One Lord providing spoken contribution during a debate of the Environment Bill on June 7th 2021 voiced concern that beef may not be included.[90] This would constitute a significant weakening of the regulation as cattle ranching is one of the leading causes of deforestation and conversion globally, causing the loss of an estimated 3 million hectares of deforestation annually between 2001-2015.[91] Beef production is a main

[85] UK Parliament (2020). Environment Bill: Explanatory notes. Online [last accessed 21st June 2021]: https://bills.parliament.uk/publications/41652/documents/310
[86] UK Government (2006). Companies Act 2006. Online [accessed 1st July 2021]: https://www.legislation.gov.uk/ukpga/2006/46/contents
[87] As-yet unpublished analyses by the consultancy Efeca assess the impact of different criteria and thresholds for the due diligence regulation on the proportion of forest risk supply chain actors that would be in scope for compliance.
[88] Personal communication from the owner of a small timber product company to the main author
[89] UK Parliament (2020). Environment Bill: Explanatory notes. Online [last accessed 21st June 2021]: https://bills.parliament.uk/publications/41685/documents/327
[90] UK Parliament (2021). Environment Bill. Volume 812: debated on Monday 7 June 2021. Spoken contribution from Lord Randall of Uxbridge. Online [last accessed 21st June 2021]: https://hansard.parliament.uk/Lords/2021-06-07/debates/6E1FE4FF-613D-44D6-8668-C8468E87D916/EnvironmentBill?highlight=environment%20bill#contribution-5F4175BE-1936-4B10-AEBA-9511C9D5C73E
[91] Goldman, E. et al., (2020). Estimating the role of seven commodities in agriculture-linked deforestation: oil palm, soy, cattle, wood fiber, cocoa, coffee, and rubber. Technical Note. Washington, DC: World Resources Institute. https://files.wri.org/d8/s3fs-public/estimating-role-seven-commodities-agriculture-linked-deforestation.pdf

driver of deforestation in Brazil where around 14% of the UK's annual imports of beef came from between 2016 and 2018.[92]

The current regulation wording also states that commodities to be used for sustainable transport fuel are not included in its scope. The Explanatory Notes state that this is to avoid overlap with the Renewable Transport Fuel Obligations Order 2007 (S.I. 2007/3072)[93]. Significant volumes of soy and palm oil – two major drivers of deforestation globally – will therefore be beyond the scope of the due diligence regulation if current wording is agreed. It must be ensured that these volumes are adequately captured in the Renewable Transport Fuel Obligations Order and do not fall through a gap between the two pieces of legislation. This is not a major issue at the moment, as little of the biodiesel feedstock used in the UK derives from soy oil or palm oil, however, changes in the UK's biodiesel feedstock use in the future could make this a significant omission.

4.1.4 What would a good due diligence law look like?

Based on the analysis above, we have identified a few weaknesses in the existing wording of the due diligence regulation in the Environment Bill. These findings indicate that a good Due Diligence law should meet the following principles:

- The model of 'due diligence' should be clearly defined - i.e., is it a process that must occur before an action or transaction takes place (e.g. as in EUTR) or a framework for measuring continuous improvement (e.g. as in OECD due diligence guidelines) - and regulation must be designed to match this;
- In the case of due diligence as ongoing improvement, criteria or benchmarking must be clearly defined to allow an assessment of whether companies are undertaking sufficient due diligence and truly making progress towards eliminating supply chain risks, otherwise it will be impossible to sanction companies that violate the regulation;
- Punishments for non-compliance must be effectively dissuasive - the impact of the regulation must be reviewed, and the punishments evaluated and adjusted if they are not proving effective. A combination of criminal and civil sanctions may be most effective;
- The scope should cover all deforestation, not just illegal deforestation; a single standard or definition of deforestation should be defined and should draw on international standards such as the AFi definitions, and apply to all UK sourcing;[94]
- The scope should cover conversion of all natural ecosystems, and not be confined to forests (see Section 2.9, above)
- Penalties should comprise 'supply chain disruption' and not just fines as these may represent an absorbable cost for large businesses allowing them to continue violating the due diligence law;[95]
- The scope of companies liable to comply with the regulation must cover a majority of the actors in the UK forest risk commodity supply chains;
- The scope of commodities covered by the regulation should be as wide as possible, and encompass all of the main drivers of deforestation and habitat conversion;
- The criteria for businesses in scope under the regulation and the specific requirements for each type of business must be made as clear and as detailed as possible.

[92] WWF-UK and RSPB (2020). Riskier Business: the UK's overseas land footprint. https://www.wwf.org.uk/sites/default/files/2020-07/RiskierBusiness_July2020_V7_0.pdf

[93] UK Parliament (2020). Environment Bill: Explanatory notes. Online [last accessed 21st June 2021]: https://bills.parliament.uk/publications/41685/documents/327

[94] Global Witness (2021). Parliamentary briefing: Three Key Improvements Needed to UK Deforestation Law. Online [last accessed 21st June 2021]: https://www.globalwitness.org/en/campaigns/forests/parliamentary-briefing-three-key-improvements-needed-uk-deforestation-law/

[95] Earthsight (2020). Eight reasons proposed UK law won't stop consumption driving global deforestation. Online [last accessed 21st June 2021]: https://www.earthsight.org.uk/news/analysis-eight-reasons-uk-due-diligence-law-wont-stop-consumption-driving-global-deforestation