Food and Agriculture Organization of the United Nations

Forest monitoring for transparent commodity supply chains

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Rome, 2024

Required citation:

Neeff, T., Merle, C., D'Annunzio, R., O'Brien, V., Gill, G., Poultouchidou, A. and Fox, J. 2024. *Forest monitoring for transparent commodity supply chains.* Rome, FAO. https://doi.org/10.4060/cd3280en

ISBN 978-92-5-139378-9

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Acknowledgements

This paper was written by Till Neeff, Caroline Merle, Rémi D'Annunzio, Victoria O'Brien, Ghislaine Gill, Anatoli Poultouchidou and Julian Fox (Food and Agriculture Organization of the United Nations [FAO]). The authors would like to express their thanks to the following for their feedback: the team at FAO (Astrid Agostini, Bruno Cammaert, Ekaterina Krivonos, SimonRietbergen, Thomas Chalmers and Tomislav Ivancic); Laura Vary and Tina Schneider from the World Resources Institute (WRI); Pascal Ripplinger from the German Corporation for International Cooperation GmbH (GIZ); Adeline Dontenville from the European Forest Institute (EFI); Houria Djoudi from the Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF); and several officials of the Government of the United Kingdom of Great Britain and Northern Ireland.

This paper was developed by FAO through the AIM4Forests: Accelerating Innovative Monitoring for Forests programme, thanks to the financial support from the Department for Energy Security and Net Zero of the United Kingdom of Great Britain and Northern Ireland.

Abbreviations

EU	European Union
EUDR	EU Deforestation Regulation
FAO	Food and Agriculture Organization of the United Nations
FRC	forest risk commodity
OECD	Organisation for Economic Co-operation and Development
Whisp	What's in that plot?
UK	United Kingdom of Great Britain and Northern Ireland

Introduction

Over the last two decades, consumers have grown more aware of the environmental and social impacts of commodity production. Many companies have started to address those concerns by adopting codes of conduct or making public commitments to improve their business and sourcing practices (FAO, 2018). Some countries have complemented this voluntary approach with regulatory frameworks to strengthen and accelerate changes in business practices and ensure positive outcomes at scale. Obligations for due diligence, including rules on transparency and disclosure, have been imposed on supply chain actors. There has been a special focus on the risk of deforestation associated with the production of specific agricultural commodities that are traded internationally.

In late 2023, the European Union (EU) adopted Regulation 2023/1115 on Deforestation-free Products (EUDR),[1] which requires conducting due diligence to reduce the risk of deforestation, forest degradation and illegal production when placing specific agricultural products on the EU market or exporting those from the European Union. In May 2024, the European Union also adopted the Directive on Corporate Sustainability Due Diligence (CS3D),[2] which requires certain companies[3] in the European Union to introduce due diligence to identify, mitigate and prevent adverse social and environmental impacts in commodity supply chains. Following the adoption of Environment Act 2021 (Schedule 17 – Use of forest risk commodities in commercial activity),[4] the United Kingdom of Great Britain and Northern Ireland (UK) is expected to launch the Forest Risk Commodity (FRC) regime, which aims to avoid commodities from illegal production. A similar regulation is also being contemplated by the United States of America.[5]

For compliance with voluntary or regulatory due diligence requirements, companies need to enhance the transparency and traceability of commodity production and make arrangements for assessing production impacts (WRI and FAO, 2023). Forest monitoring solutions and datasets are needed for a risk assessment, notably regarding risks of deforestation and forest degradation, or lack of legality. The due diligence process will combine different types of data; geospatial information will be critical (as related to environmental impacts).

Relevant geospatial information is being collected and made available in several contexts. For example, the EUDR mentions the EU Observatory[6] generating information on the occurrence of deforestation and forest degradation from the Joint Research Centre (JRC). There are also many relevant sources of information other global data providers. And most importantly, countries maintain national forest monitoring systems, which respond to a country's data needs and have been tailored to its forests and ecosystems.

Deforestation-related regulations have created new demands towards countries' forest monitoring. Although current regulation directly targets the private sector, governments have the option to support due diligence efforts by providing datasets and setting standards. Data availability may translate into a competitive advantage for countries as commodity supply chains are restructured to comply with the new regulations. A collective effort between producers, other value chain actors and their governments can accelerate an adapted response to market sustainability requirements (FAO and World Bank, 2024). Facilitating access to relevant geospatial information, notably for smallholders, is key to reducing the risk of exclusion of those producers from international supply chains.

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1 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1115

2 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELLAR:56f26c57-055d-11ef-a251-01aa75ed71a1

3 This paper uses the terms "firm" and "company" interchangeably to refer to several types of supply chain actors, including also cooperatives and smallholders.

4 https://www.legislation.gov.uk/ukpga/2021/30/schedule/17/enacted

5 https://www.congress.gov/bill/117th-congress/senate-bill/2950

6 Recital 31 of the EUDR: https://forest-observatory.ec.europa.eu

The Food and Agriculture Organization of the United Nations (FAO) does not take a position on demand-side regulations; however, through this technical paper, the Organization is responding to country requests for support on the topic in the context of forest monitoring.

The publication originates in work that FAO undertook with several partner countries to explore geospatial information needs and how any apparent gaps could be addressed through forest monitoring. It begins by providing more background on relevant regulations, and then lays out the geospatial data needs, including an assessment framework, and provides information on how current country capacities can support emerging requirements. Finally, the paper identifies initial lessons learned from applying the assessment framework.

Background

Due diligence: identification, assessment and mitigation of risks

New regulations aim at minimizing the risk that commodity production could have caused deforestation or infringed local laws. For example, both the EUDR and UK FRC regime rely on due diligence as the process for ensuring compliance. In both contexts, due diligence is undertaken in three steps:

1. identification and characterization of the commodity;
2. risk assessment; and
3. risk mitigation.

The due diligence process starts with the need to collect data on the production process. Assessing deforestation risks needs geospatial information on the production sites (for example, geolocation of plots of production and presence of forests). For the EUDR, this is detailed in the articles dealing with the information to be used in the due diligence[7] and criteria to be considered when evaluating risk.[8] Assessing risks related to a lack of legality may also partly draw on geospatial data layers but will mainly require non-spatial data.

Based on such information, the risk assessment is then undertaken. According to FAO and the Organisation for Economic Co-operation and Development (OECD), risk is considered to be the likelihood of an impact, and should be assessed considering the scale, scope and irremediable aspects of the impact (FAO and OECD, 2023). Under a corporate due diligence process, risks are mostly assessed with a forward-looking perspective, as the priority is to avoid the occurrence of adverse impacts caused by the firm's activities or business relationships. The deforestation-related regulations have a slightly different approach and look only at the impacts that may have already occurred during the production process.

Companies undertaking due diligence will ultimately need to establish their own concept of risk assessment. For instance, they can qualify the risks within three tiers – red flags, yellow flags or acceptable risks – to be based on objective evidence (see Table 1 for an example).

[7] EUDR, Article 9.

[8] EUDR, Article 10.

Table 1. Examples of the three-tier categorization of risks in the context of deforestation-related regulations

	Deforestation	Lack of legality
	Geospatial datasets: Forest and commodity maps, deforestation monitoring	**Geospatial datasets:** Data layers on legal status (e.g. concession boundaries, protected area boundaries, ownership maps, territory boundaries of Indigenous Peoples)
Red flag: There is a serious/almost certain risk of non-compliance with the regulation and this risk may not be possible to mitigate	Production sites located in forest	Production sites fall into an officially designated protected area, if not allowing agricultural production
Yellow flag: There is a risk of non-compliance that deserves detailed assessment and mitigation measures	Production sites close to deforestation hotspots	Production sites fall into tenure regime, which requires prior consent
Acceptable risk: A specific risk of non-compliance cannot be associated with the production sites or supply chain actors	No forest in close vicinity of the production sites by the cut-off date and no nearby deforestation hotspots since the cut-off date	Production sites under status of agricultural production

Note: For the legality criterion, the assessment should be done for all relevant legislation, but the example is limited to some aspects of the legislation on land use.

Mitigation measures are needed if the risk is not considered acceptable.[9] In many cases, the risk can be reduced by gathering additional information on the circumstances of production and strengthening the flow of information through the chain of custody. The robustness of the assessment can be improved by enhancing the granularity of the information, or by crossing different sources of information and analysing their level of convergence. Collecting more information will often enable demonstrating that risks are acceptable, thereby preserving market access to the farms in question.

Scope of the due diligence process in key regulation

Although due diligence in key regulation follows the same basic steps, there could also be important differences regarding the scope of information requirements and risk assessments.

The risk assessment must align with the scope of the considered regulation and fit into the overall due diligence process that it lays out (Table 1). In the case of the EUDR, companies ("operators") gather the findings of the process in a due diligence statement, to be presented to EU competent authorities in charge of the compliance check. The due diligence statements – notably the plot boundaries – will be uploaded to the EUDR information system. Details on the structure of the EUDR information system need to emerge, but it is already clear that it will be a shared system among the competent authorities from all EU countries.

In the UK FRC regime, companies ("regulated persons") must, for each reporting period (annually), provide the relevant authority with a report on the actions taken to establish and implement a due diligence system in relation to each relevant commodity. The content, form and manner to submit the report will be determined in forthcoming guidance.

[9] EUDR, Article 11.

Table 2. Scope of risk assessment and due diligence process in key regulations

	EUDR	UK FRC regime
Commodities covered	Cattle, cocoa, coffee, oil palm, rubber, soy and wood, and some of their derived products*	Beef and leather, cocoa, palm oil, soy, and any derived products**, ***
Type of risk	Deforestation and forest degradation, lack of legality	Lack of legality, considering laws and regulations related to land use and ownership
Value chain stages	Risks at the production stage	Risks at the production stage
Trigger for due diligence	When placing and/or making available commodities on the EU market or exporting from the EU market	When using the forest risk commodities in UK commercial activity at any supply chain stage
Entity undertaking due diligence	"Operator": a natural or legal person who, during a commercial activity, places relevant products on the EU market or exports them from the EU market	"Regulated person": a natural or legal person with commercial activities in the United Kingdom of Great Britain and Northern Ireland that meets certain conditions on turnover, to be defined in forthcoming guidance
Acceptable risk level	Negligible or no risk	As low risk as reasonably practicable
Report on the due diligence	Due diligence statement to be collected in the EUDR information system (comprehensive information for the due diligence to be kept for five years)	Annual report on the due diligence system
Compliance checks	Competent authorities in EU countries check compliance on a sample basis	Competent authorities (to be defined in forthcoming guidance)

Notes: * Full list in Annex 1 of the EUDR.

** Timber products are separately subject to the UK Timber Regulations.

*** This is according to a declaration of the UK government in December 2023 (to be confirmed by forthcoming guidance).

In the case of the EUDR, the extent of due diligence changes according to the country of production based on its background risk profile.[10] The EU Commission is mandated to classify countries, or regions of countries, through a benchmarking process assessing the level of risk of deforestation. There are three categories: low risk, standard risk, and high risk. If the country of production is classified as low risk, the due diligence does not need to include risk assessment and risk mitigation measures (unless a risk of non-compliance is identified). The intensity of compliance checks by competent authorities also depends on the country benchmarking (there is no such country benchmarking for the UK FRC regime).

The differences in the scope of the due diligence process also entail differences in information requirements. The EUDR prescribes details and requests the due diligence to obtain "information that the relevant products are deforestation-free" and "produced in accordance with the relevant legislation of the country of production".[11] Specifically, information on plot boundaries always needs to be presented. With this, the EUDR already includes elements of a risk assessment (Step 2) among the information requirements (Step 1). For the UK FRC regime, detailed guidance is not yet available, but its scope is focused on legality, suggesting that geospatial information may play a smaller role.

[10] EUDR, Article 29.

[11] EUDR, Article 9.

Why should governments support company due diligence through forest monitoring?

In principle, the deforestation-related regulations focus on the private sector, which needs to undertake due diligence, and not on governments. However, governments of producer countries may have several reasons to engage and facilitate due diligence:

- Nationally produced data from national forest monitoring systems will often best reflect a country's ecosystems and land-use systems. By producing freely and easily accessible geospatial information, governments reduce the probability of inaccurate evaluation of the risk of deforestation based on the use of global geospatial datasets.
- Government datasets could be seen as more authoritative than datasets produced by supply chain actors or their service providers. Mostly, governments are not directly invested in trading commodities, which removes one potential source of perceived conflicts of interest. Moreover, government maps are often produced for the public and as part of international cooperation efforts, helping establish a better degree of transparency than in the private sector's proprietary geospatial datasets.
- A system operated by governments provides national scale and coverage and can support the most vulnerable actors: smallholders that have the least access to data and are the most at risk of losing access to markets. While larger companies could make their own arrangements for collecting necessary datasets, small- and medium-sized companies may often not be in the position to do so. The agribusinesses and traders buying their produce are required to undertake due diligence and may find it easier to simply exclude those farmers who are unable to provide requested information, rather than investing in collecting additional data. Even if companies moved to collect or create datasets, there would then be a risk of seeing the related costs reflected in the purchase prices offered to smallholder producers. Free access to authoritative government data could therefore remove a barrier for smallholders.
- Governments have an important role to play in clarifying land tenure, and information on farm boundaries is invariably relevant for claims and rights. Collecting plot boundary datasets creates risks of conflict, but also presents an opportunity to make progress towards clarifying tenure where governments engage in participatory processes.
- Finally, it is the role of governments to define legality. While the EUDR provides the applicable definitions surrounding deforestation, both the EUDR and the UK FRC regime refer to national relevant legislation to understand legality in commodity production. Only governments could credibly identify concrete criteria for establishing legality.

New frontiers for countries' forest monitoring

Geospatial information needs

Demand-side regulation will require the private sector to conduct due diligence on deforestation and forest degradation risks (for the EUDR), as well as legality (for the EUDR and UK FRC regime). The due diligence draws on data that the regulation either specifically requests or that are needed practically. Key geospatial information needs include a database of plot boundaries, forest and commodity maps, deforestation monitoring, and data layers on legal status (Table 3).

Under the EUDR, due diligence should be based on: product information (name, quantity, composition); origin (country, geolocation of specific plots of production) and conditions of production (absence of deforestation); the supply chain structure and functioning (including identification of all direct and indirect suppliers); and the legal context (to demonstrate compliance with applicable laws and regulations). Evidence of absence of deforestation will need to include data on commodity production sites and changes over time – often along with a forest cover and deforestation dataset. The evidence of legality will be based on a set of documents covering a country's legal requirements; they may often include spatial datasets.

Under the UK FRC regime, details on data needs will become clearer in forthcoming guidance and are expected to include common elements with EUDR requirements. Information on origin and chain of custody, along with evidence of legality, would usually need to be provided. However, more clarity needs to emerge on the needed level of detail regarding information on origin and whether it suffices to trace production to larger geographic areas such as regions or on the farm level, in which case a database of plot boundaries might be useful. A country's legal context will determine what data layers on legal status of production are needed. Some countries may legally restrict deforestation – forest and commodity maps as well as deforestation monitoring might then be needed.

While not formally requested under either the EUDR or the UK FRC regime, supply chain actors will need to establish a chain of custody to connect the information on origin with the products placed on the market. This could be done with a digital paper trail from production to market, included in a transactional database along the supply chain (a traceability system); this may be a practical necessity for the EUDR to identify individual production sites. For the UK FRC regime, more clarity on the need for a traceability system still needs to emerge.

Table 3. Geospatial datasets that play a role as evidence under new regulation on deforestation and legality of commodity production

Geospatial dataset	Information on origin and chain of custody	Evidence of absence of deforestation	Evidence of legality
Database of plot boundaries	Where a database of plot boundaries with unique identifier is available (e.g. a cadastre), it can facilitate identification of specific production sites for individual commodity batches.	Polygons of production sites can be overlaid with forest and commodity maps.	Polygons of production sites can be overlaid with data layers on legal status.
Forest and commodity maps	–	Where commodity maps indicate that production sites were already active before the cut-off date, the risk of deforestation is low.	–
Deforestation monitoring	–	Where production sites and deforestation hotspots are further away from each other, the risk of mixing compliant commodities with those produced on recently deforested areas is low.	–
Data layers on legal status	–	–	Where production sites do not fall into (e.g. areas with collective tenure arrangements or protected areas out of bounds for agricultural production), legality risks could be lower.

In addition to geospatial data needs for supporting company due diligence, country risk benchmarking (relevant for the case of EUDR[12]) could create further needs for forest monitoring, including on:

- rate of deforestation and forest degradation;
- rate of expansion of agriculture land for relevant commodities; and
- production trends of relevant commodities and products.

[12] EUDR, Article 29.

Assessment framework

This framework aims at evaluating how much relevant geospatial information for deforestation-related regulations is already existing at the country level. It represents a checklist that governments can use to assess the needs for additional developments of their national forest monitoring systems, including the conditions of accessibility, updating, and quality assurance processes. While there is more clarity on the EUDR, there are incomplete details regarding data requirements for the UK FRC regime.

The assessment framework is available electronically as a Microsoft Excel tool.[13]

[13] Links to these resources are available on the FAO website: https://www.fao.org/in-action/aim4forests

Table 4. Assessment framework

	Database of plot boundaries	Forest and commodity maps	Deforestation monitoring	Data layers on legal status
Technical requirements	Is there a database of plot boundaries available (e.g. from a cadastre)? • Does it provide unique identifiers? • Is the spatial detail aligned with regulation?* • Does it include detail on farm age? • In absence of a cadastre, is there a workable technical approach available for collecting spatial boundaries?	Are there forest and commodity maps available meeting technical requirements? • Are there maps available for cut-off dates?** • Is the forest definition aligned?*** • Does the dataset adequately represent natural forests? ◦ Excluding agroforestry systems? ◦ Excluding forest plantations? ◦ Excluding other wooded land (crown cover <10%)? ◦ Adequately addressing temporary cover loss? • Does the dataset distinguish types of natural forest (primary forest, naturally regenerated forest, planted forest)?****	Is there deforestation monitoring available? • Are there data on the spatial patterns of deforestation (e.g. hotspots, maps, jurisdictional-scale statistics, alerts)? • Are there data on trends over time? • Is the forest definition and deforestation definition aligned? • Do the data adequately represent natural forest? • Is there information on drivers?	Are there spatially explicit data layers available on information relevant to the legal status? For example: • Production permits of individual commodities (concession boundaries, other types of production permits, managing planning)? • Land-use plans (gazetting of lands for certain commodities, protected area boundaries)? • Information on tenure (ownership, territories of Indigenous Peoples, collective ownership, other)? • Other?
Quality of datasets	Is the dataset of high technical quality? • Strong source of information? • Sufficient accuracy against high-quality reference data? • Application of geolocation standard? • Adequate spatial resolution? • Adequate updating process? • Demonstrated improvement above global geospatial datasets? • Independent verification?			Are there strong quality management processes in place for the individual data layers?
Accessibility of datasets	Is information accessible? • Is it public? • Is the access quick, easy and practical? • Are datasets well documented?			
Sustainability of datasets	Are there arrangements in place for ongoing updating and quality management of datasets?			

Notes: * For the EUDR, points for plots <4 ha and polygons for plots >4 ha.

** For the EUDR, December 2020.

*** For the EUDR and for UK FRC regime, the FAO definition.

**** For assessing degradation under the EUDR, which is only relevant for timber.

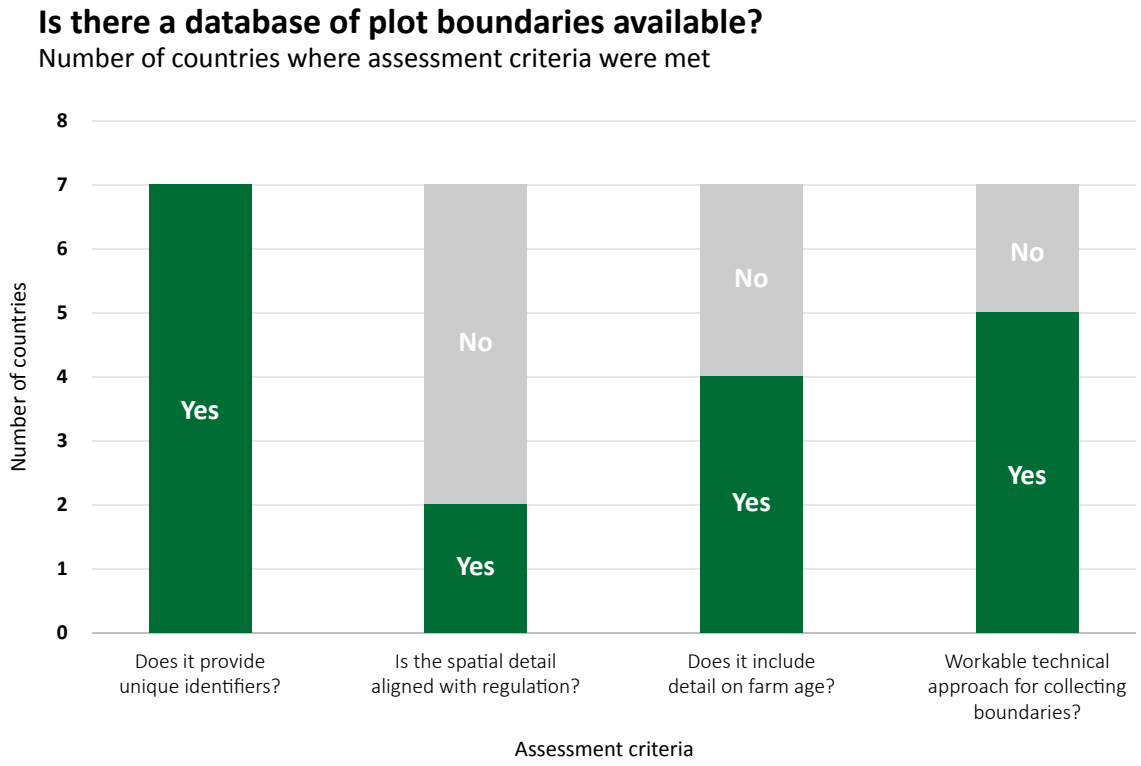
Current forest monitoring capabilities and new requirements

As of mid-2024, commodity producers and other supply chain actors around the world are preparing to meet the new requirements related to deforestation and legality, and governments are often providing support in this – not least through reviewing and improving forest monitoring systems. While some countries are already well prepared, capacity gaps are more important in others.

To gain an overview of country preparedness, FAO undertook a rapid survey, largely following the structure of the assessment framework laid out above. The survey was conducted as part of a South–South exchange convened by FAO, hosted by Peru, and attended by 66 participants, including 34 representatives (30 percent women) from seven Latin American countries: Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Honduras and Peru.

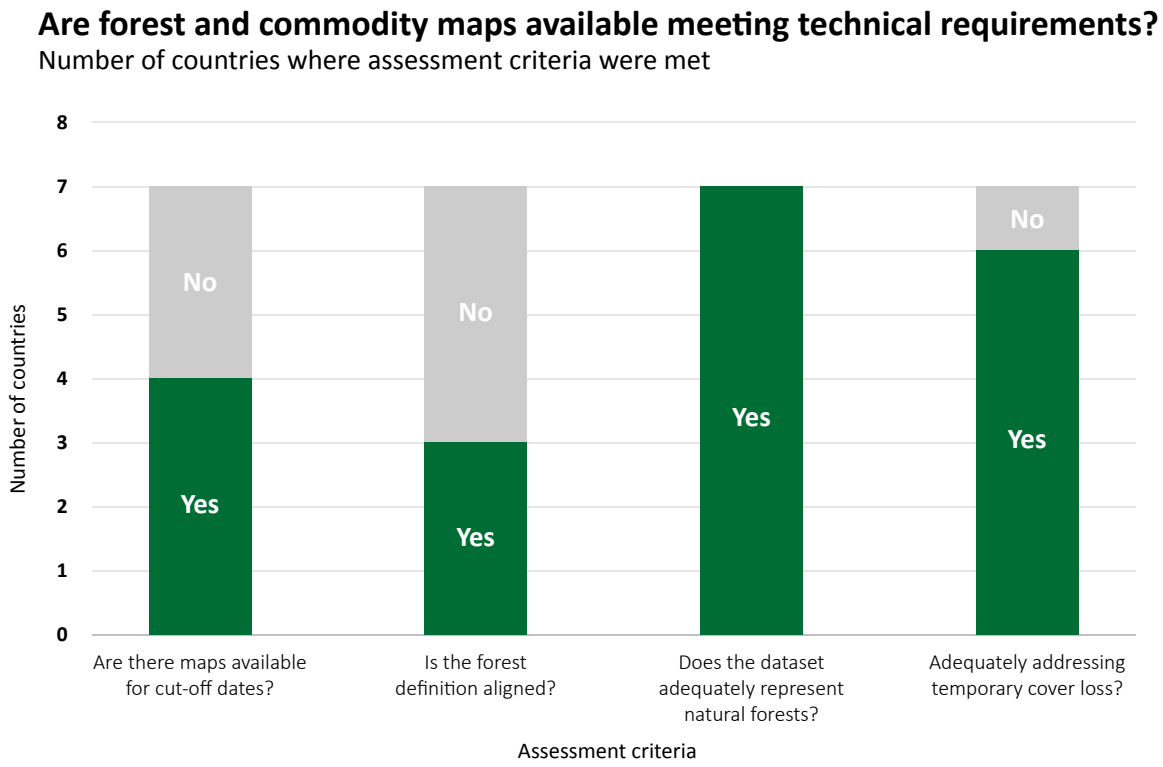
Most countries have existing datasets available (a database of plot boundaries, forest and commodity maps and deforestation monitoring); however, the survey results suggest that there is room to improve the alignment with the technical requirements of the EUDR and UK FRC regime. Regarding the database of plot boundaries, countries indicate gaps related to the level of detail of the spatial information, the farm age, cadastre coverage (partial coverage of the country; only specific production systems) (Figure 1). For forest and commodity maps to support due diligence, gaps need to be addressed related to reference year, forest definition and temporary loss of forest cover (Figure 2). To better align deforestation monitoring with the requirements, countries would need to adjust or complement data on deforestation patterns, long-term trends, and drivers of deforestation, as well as work to ensure that datasets adequately represent applicable forest definitions, also regarding natural forests (Figure 3).

Figure 1. Assessment results on database of plot boundaries



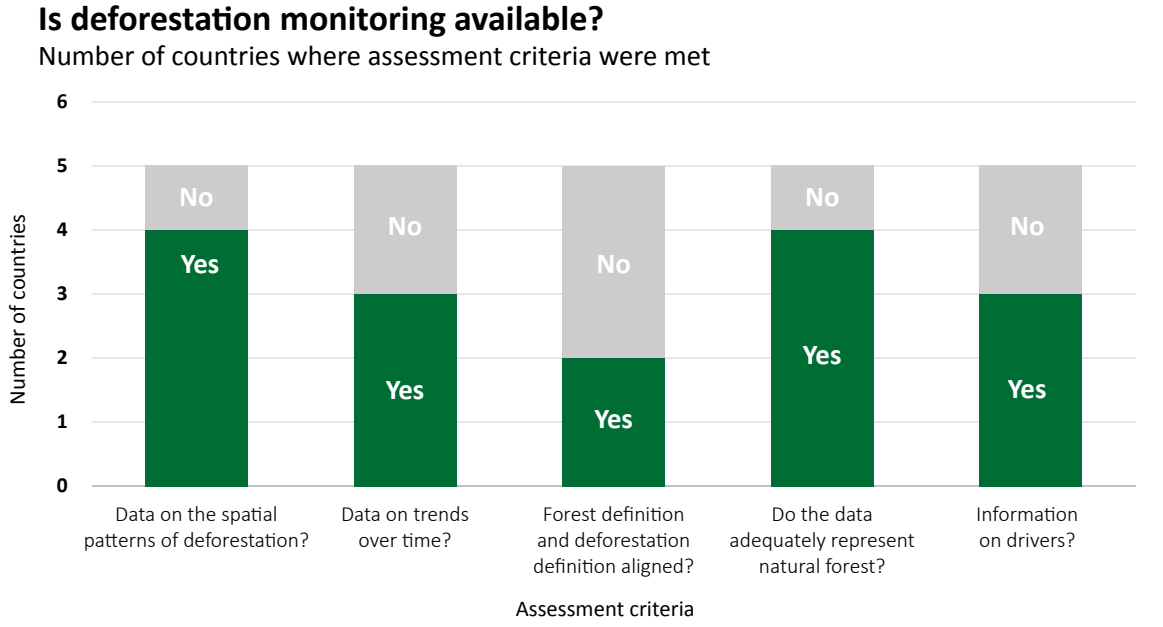
Source: Authors' own elaboration.

Figure 2. Assessment results on forest and commodity maps



Source: Authors' own elaboration.

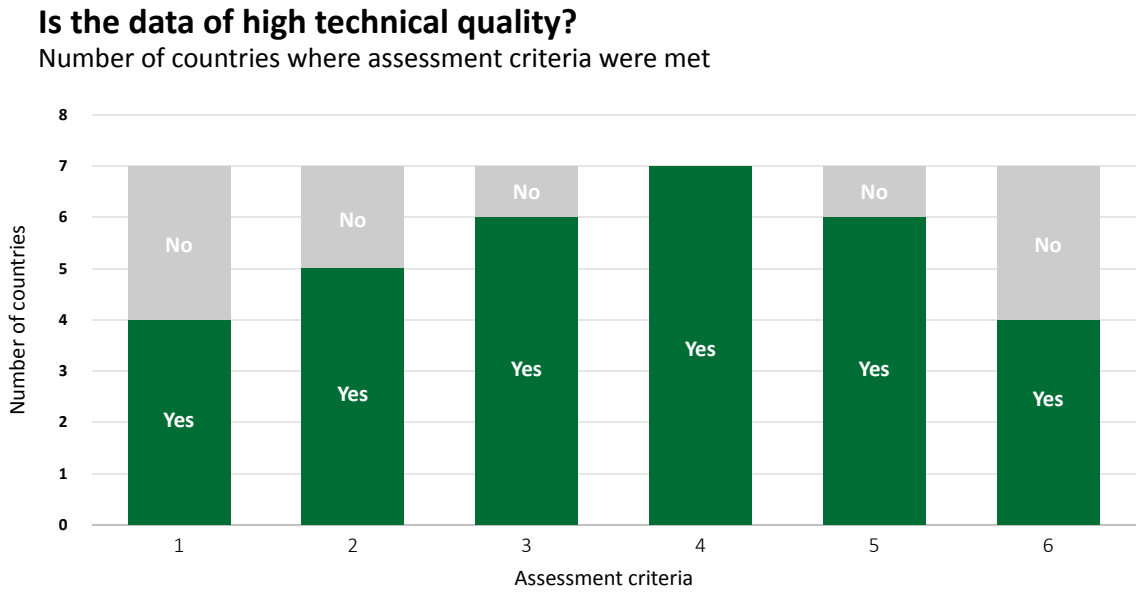
Figure 3. Assessment results on deforestation monitoring



Source: Authors' own elaboration.

While most countries have existing systems, there is still room to improve the quality of datasets (Figure 4). For example, regarding the forest and commodity maps, as well as the database of plot boundaries, several countries indicated that the updating frequency would need to be increased. There is also room for improvement regarding robust data sources for information on production sites. Several responses indicate only partial understanding of existing international datasets, notably those by the EU Observatory.

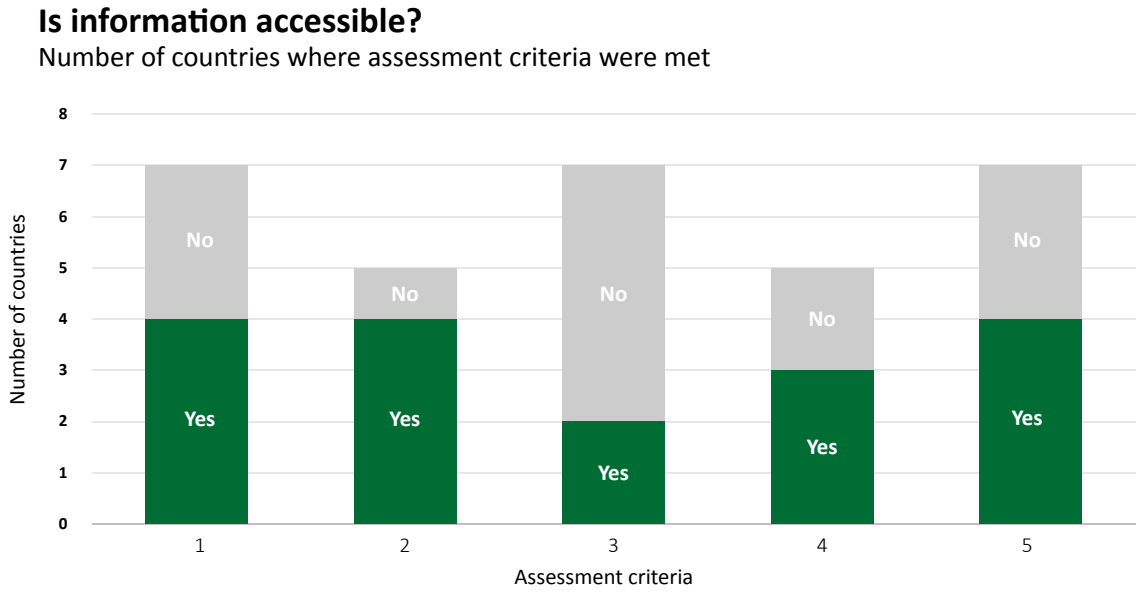
Figure 4. Assessment results on quality of datasets



Source: Authors' own elaboration.

A precondition for its use is the **accessibility of datasets**. The survey results for **deforestation monitoring** and **the database of plot boundaries** suggest that work is needed to make these datasets publicly available, more user friendly, and well documented (Figure 5).

Figure 5. Assessment results on accessibility of datasets



Source: Authors' own elaboration.

Clearly, the **sustainability** of **datasets** is essential, and the survey included an open question on arrangements for ongoing updating and quality management of datasets. While some countries have ongoing quality management and updating processes in place (for instance, a public, web-based, interoperable database with dashboard), other countries indicate that more work is needed to improve the updating frequency and other technical parameters (not yet continuous, not aligned with the cut-off dates), as well as the quality management of databases and maps.

Initial lessons learned from applying the assessment framework

During late-2023 and early-2024, the assessment framework was applied in several countries in an effort to think through how forest monitoring systems would need to evolve in order to best tailor to requirements. Such discussions took place or are scheduled to take place in Argentina, Botswana, Cameroon, Colombia, Costa Rica, Ecuador, Ghana, Peru, Uganda and Viet Nam. Recurrent issues include the following:

1. Mapping commodities could be equally important and potentially more difficult than mapping forest.
2. For forest maps, current datasets often do not match required forest definition and time frames, but it depends on the context how critical differences are.
3. Relying on any one dataset would be problematic for identifying forests and deforestation; rather, analysis should draw on the convergence of evidence from various sources.
4. Forest and land-use mapping can be centralized, but collecting information on plot boundaries requires fieldwork by many dispersed actors, including farmers, where it is hard to guarantee consistent high quality.
5. Information on forests and deforestation must be easily and publicly accessible to be of any relevance – and the simplest technical solutions to provide data access are often best.
6. More clarity is needed on how to safeguard privacy and property rights of data owners, especially where these are smallholders with limited agency.
7. Farm boundary datasets could take relevance for land tenure, creating risks of conflict among tenure holders, which need to be carefully managed.
8. Several institutions often need to effectively collaborate to produce the needed datasets on land use, forests and deforestation, making it necessary to draw up modalities for data sharing and collaboration.
9. Providing maps on forests, commodities and deforestation is not a once-off task but requires an ongoing mapping programme.
10. In many countries, new demands towards forest monitoring to generate datasets related to deforestation and commodity production still need additional funding.
11. Before upgrading forest monitoring approaches, countries need to carefully strategize because required investments could be significant.

Technical requirements

Mapping commodities could be equally important and potentially more difficult than mapping forest. Where it can be reliably established that areas were already production sites before the EUDR cut-off date of December 2020, these are, by definition, free of deforestation. But some types of croplands, especially crops like cocoa and coffee that grow under the shade of large trees, are very difficult to separate from forest lands. The FAO team worked with one country where the national forest monitoring system classified as much as 30 percent of cocoa farms as forest, unfairly and incorrectly disqualifying production from these farms as recent deforestation according to the EUDR definition.

For forest maps, current datasets often do not match required forest definition and time frames, but it depends on the context how critical differences are. The EUDR requires application of the FAO forest definition with a crown cover threshold of 10 percent and refers to the December 2020 cut-off date for defining deforestation. The FAO team worked with one country that had a forest cover map available for 2019 and 2021, but not for 2020, and where national datasets referred to a crown cover threshold of 15 percent, rather than 10 percent. Analysis quickly revealed that it would be best to also produce a 2020 map, but that existing datasets already provided a very good source of information. The analysis also revealed that differences in the crown cover threshold were inconsequential for tropical moist areas where commodities mostly grow, but made a significant difference for dry forest and savannah areas (which may render the crown cover thresholds a key issue chiefly for cattle or soy production).

Quality of datasets

Relying on any one dataset would be problematic for identifying forests and deforestation; rather, analysis should draw on the convergence of evidence from various sources. The availability of numerous publicly accessible satellite-derived maps detailing forest, land use and tree cover highlights a significant challenge: these products often show substantial differences, partly due to contradicting definitions and land-cover classification systems used. In addition, most of these datasets describe land cover, whereas the information on land use at the plot level is required by regulations. This means that single sources of geospatial data can only tell part of the whole story around any given plot of land.

Therefore, rather than relying on a single dataset, the various datasets should be used together to provide more nuanced, complementary details on a specific production site (or a whole landscape). Instead of relying on a single geospatial layer, the convergence of evidence from multiple layers can best contribute to understanding what has most probably occurred, reducing the impact of individual biases or errors present in any single piece of evidence. FAO and partners are developing the tool, "What is in that plot?" (Whisp) (see Box 1), a technical solution along with decision-making protocols that enables users to draw on the convergence of evidence to provide more insightful information for plots of land in the context of deforestation-related regulation (FAO, 2024).

Forest and land-use mapping can be centralized, but collecting information on plot boundaries requires fieldwork by many dispersed actors, including farmers, where it is hard to guarantee consistent high quality. The FAO team works with several countries where maps and land-use change statistics are compiled in a centralized data collection campaign for the country as a whole, implemented by specialized analysts working in a controlled environment. However, collecting information on polygons of production sites requires decentralized data collection. It is hard to guarantee the correct application of protocols for such datasets and ensure coherency and completeness.

Google, FAO and partners have worked to develop Open Foris Ground (see Box 1), a technical solution for collecting and aggregating data from potentially thousands of individual data collectors, notably smallholders. FAO is currently collaborating with several countries with the aim of supporting farmers in independently collecting coordinates while walking their boundaries.

Accessibility of datasets

Information on forests and deforestation must be easily and publicly accessible to be of any relevance – and the simplest technical solutions to provide data access are often best. Due diligence statements that confirm a negligible risk of deforestation will usually rely on several types of maps and data sources. Competent authorities will check the validity of claims on a sample basis and may decide to contrast those with available geospatial information. Only datasets that are easily accessible can be an effective basis for building claims and checking their validity.

Access need not be complicated. For instance, the FAO team works with several countries in Africa and Latin America that provide downloadable maps along with an authorization of general use, making the dataset easily accessible. FAO also works with another country, also in Latin America, considering providing data only on specific request and preventing data downloading, severely restricting the accessibility. It is not yet clear how all involved parties, including those verifying claims, could use those datasets.

There is a pressing need for user-friendly software applications tailored to the specific requirements in the context of EUDR and the UK FRC regime, such as for collecting plot boundaries for storing and analysing geospatial data. These technical solutions must prioritize interoperability to ensure seamless data access and sharing. For example, the Linux Foundation operates the AgStack Asset Registry to provide for such interoperability. AgStack provides public access to unique GeoIDs (codes for individual plots); the use of a standardized format ensures that platforms using GeoIDs are interoperable. The German Corporation for International Cooperation GmbH (GIZ) has developed INATrace, an open-source, freely available software programme for managing information on supply chains, which is interoperable with the AgStack Asset Registry.

More clarity is needed on how to safeguard privacy and property rights of data owners, especially where these are smallholders with limited agency. Plot boundaries count among the required datasets and refer directly to the business dealings of farmers, often smallholders. In a context of lacking information on the geolocation of plots of production, it is often agribusinesses or traders that take the lead to collect this

information, including the smallholder farms that they purchase from. However, in the absence of a clear legal framework or proper guidelines on data governance, there is a risk that companies do not request appropriate and informed consent of farmers for information on their farms to be included in their future due diligence statement. This information may also remain as a private asset of the company which undertook the collection of boundaries, limiting the capacity of farmers and their organizations to engage with other potential clients. In discussion with FAO, several governments have expressed concerns about the risk of the unfaithful use of geolocation information, disconnected from actual provenance of commodities, creating possible reputational risks for the country.

Farm boundary datasets could take relevance for land tenure, creating risks of conflict among tenure holders, which need to be carefully managed. This is particularly true in contexts of land tenure insecurity, ambiguity, or where formal and informal tenure rights overlap. Especially where governments are involved in data collection, the datasets could help cement tenure claims, with potential for conflicts. Building datasets on plot boundaries in those situations could face significant hurdles and may require purposeful communication, participatory processes and clear consent from involved parties. These processes may take time and could be resource intensive but are necessary to avoid unrealistic expectations, conflict and potential inequitable exclusion based on factors like gender or ethnicity.

Sustainability of datasets

Several institutions often need to effectively collaborate to produce the needed datasets on land use, forests and deforestation, making it necessary to draw up modalities for data sharing and collaboration. In most countries that the FAO team works with, the national forest monitoring system is operated by the country's forest service, often largely in response to international reporting needs (not least in the context of efforts to reduce deforestation and related greenhouse gas emissions). In response to demand-side requirements related to deforestation impacts of agricultural supply chains, such forest information needs to be combined with information on commodity mapping and plot boundaries, which is often held by agencies overseeing agricultural activities.

For example, the FAO team works with one African country where the agency overseeing cocoa production maintains a detailed producer database with polygons of production sites, but the agency overseeing forests holds information on forest and deforestation. While it is clear that both agencies need to work together to enable forest monitoring that effectively supports the private sector in meeting reporting requirements, the collaboration modalities need detailed discussion and potentially a formalized framework. Providing relevant information for checking the legality criteria may require even more cross-institutional collaboration.

Providing maps on forests, commodities and deforestation is not a once-off task but requires an ongoing mapping programme. Most obviously, an ongoing mapping programme is needed to generate updated deforestation information over time, which could inform risk assessments. In addition, an ongoing mapping programme for developing the forest mask is needed to generate annual updates to a whole time series of forest maps, including but not limited to the specific cut-off dates in regulation. Discussions between the technical teams, FAO, and one African country highlighted three reasons for this in the context of the EUDR: a December-2020 forest map needs continuous maintenance and improvement; generating an initial forest map might be simple, but data needs will evolve; and an updated, high-quality forest mask is needed on an ongoing basis for detecting deforestation patterns over time.

In many countries, new demands towards forest monitoring to generate datasets related to deforestation and commodity production still need additional funding. Countries first aim to leverage existing datasets and existing data collection campaigns, but gaps are usually significant – not least because the requirements in deforestation-related regulation are quite particular. Often, domestic resources are rather tight and cannot easily or quickly be accessed. In recent years, it has become common practice to use project-based international funding for forest monitoring, often related to an interest in measuring and reporting on greenhouse gas emissions from deforestation. But this cannot easily be repurposed for the context of commodity production, and donors have only made available modest international resources for data collection to support the EUDR and UK FRC regime. Countries that FAO works with combine several strategies to fund data collection and management, mixing domestic and international sources; one country even aims to cover costs by charging the private sector for data access. In most cases, however, sustainable funding strategies for data collection have not yet been developed.

Before upgrading forest monitoring approaches, countries need to carefully strategize because required investments could be significant. Before anything else, countries need to collect information on a range of agricultural and forestry commodities, their production systems, and supply chains (production areas, degree of consolidation and role of smallholders, principal actors and lead firms, export countries), as well as aspects related to sustainability (contribution to deforestation and others). Countries then need to identify the commodities of principal interest (for example, because they fall under the scope of demand-side regulation, because of significant value, volumes and areas, and because of significant export to regulated markets). Having this information available can prepare the basis for a more targeted assessment of geospatial datasets. The framework presented in this paper has already proven useful to a group of countries in arriving at a strategy towards strengthening forest monitoring.

Box 1. Two FAO tools to manage geospatial data on environmental impacts of commodity production

The tool, Open Foris Ground, serves to collect coordinates of plot boundaries in the field and generate polygons. It is designed to compile plot boundaries from numerous data collectors, including smallholders. The resulting polygons are automatically included in the AgStack Registry.

The tool, "What's in that plot?" (Whisp), extracts information from a series of spatial datasets for a set of plots of land (i.e. farms). The polygons are drawn from the AgStack Registry. The analysis results in a table showing, for each plot of land, information on the spatial datasets (e.g. presence of forest cover, deforestation, agricultural commodities and others).

	Open Foris Ground	Whisp
Purpose	To collect coordinates on plots of lands (i.e. plot boundaries).	To assess deforestation and forest degradation risk at the plot level.
Target users	Smallholders and cooperatives. Designed for non-technical users with little to no special training.	Governments and private sector, including cooperatives.
Components	Web-application for survey design and management* and smartphone application for map-based, structured data collection.	Whisp application programming interface (API) for processing databases** and customizable notebook for adapting the process and data layers.
Availablity	The code is publicly available on GitHub*** and can be inspected, reproduced and adapted.	The code is publicly available on GitHub,**** and can be inspected, reproduced and adapted
Developer	Google and the Food and Agriculture Organization of the United Nations (FAO).	FAO.

Notes: * https://ground.openforis.org

** https://whisp.openforis.org

*** https://github.com/openforis/ground-platform

**** https://github.com/forestdatapartnership/whisp

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With the financial support of:

UK Government

ISBN 978-92-5-139378-9

CD3280EN/1/11.24