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Supply Chain Intelligence: Actionable Risk Assessment of Brazilian Commodity Supply Chains Using Geospatial Data

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Supply Chain Intelligence: Actionable Risk Assessment of Brazilian Commodity Supply Chains Using Geospatial Data

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16 September 2025

Executive Summary: Geospatial data is transforming sustainability risk assessment in Financial Services. Driven by mandatory regulations such as the EU's CSRD and SFDR, alongside emerging standards such as TNFD, financial institutions must now monitor not just financial performance, but real-world environmental and social impacts across global supply chains.

This white paper showcases how geospatial data and asset-level geospatial analysis can be used as a support tool for supply chain impact monitoring. Specifically, we evaluate deforestation risks in Brazilian commodity supply chains. Using publicly available datasets and Google Earth Engine, we develop a reproducible risk scoring framework, applied to over 17,000 slaughterhouse facilities, tied to 9,854 companies, across Brazil.

This analysis:

- Quantifies deforestation exposure across 12 animal-based commodities at facility and company level.
- Creates actionable risk metrics for investors, lenders, and regulators.
- Aligns outputs with ESG disclosure frameworks, including CSRD, SFDR, TNFD, and the EUDR.
- Highlights high-risk companies and regions, providing clear signals for due diligence and sustainable finance strategy.

This paper is part of a broader move toward Earth Intelligent Finance, empowering financial actors to make faster, smarter, and more transparent sustainability decisions using geospatial insight.

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1. Introduction

The global push for transparency in Environmental, Social, and Governance (ESG) performance has reached a new level of urgency. For example, The European Union's Corporate Sustainability Reporting Directive (CSRD) mandates companies to disclose their impacts and dependencies under the principle of double materiality, evaluating both how sustainability issues affect their finances, and how their operations impact the environment and society.

For the Financial Services (FS) sector, this presents a growing challenge: traditional ESG analysis, often based on company self-reporting, annual filings, and third-party ratings, is no longer sufficient. These sources are often outdated, inconsistently formatted, lacking detail, or unverified. Timely, granular, and objective data is required, especially across supply chains where ESG risks are material but often hidden. Geospatial data offers a pathway to fill this gap. This paper builds on previous white papers introducing the European Sustainability Landscape and the role of geospatial data, to demonstrate how it can be used to support supply chain monitoring (Owens, 2025c, 2025a, 2025b).

By combining satellite data with asset-level datasets, financial institutions have the potential to assess environmental risks like deforestation, biodiversity loss, and water stress at the source. This enables FS firms to:

- **Perform** location-specific double materiality assessments
- **Evaluate** supply chain exposure to high-risk regions or practices
- **Monitor** progress with disclosure regulations such as CSRD, Taskforce for Nature-Related Financial Disclosures (TNFD), the EU Deforestation Regulation (EUDR) or the UK Forest Risk Commodity Regulation (UKFRC)
- **Verify** corporate ESG claims independently.

In this white paper, we demonstrate this approach by analysing Brazil's animal-based commodity supply chain, which is the primary driver of Amazon deforestation, using open-source datasets and scalable cloud-based tools. We focus on deforestation risk, but the methodology is extensible across sustainability topics, from water to pollution to ecosystem degradation. By doing so, we provide a blueprint for FS firms seeking to quickly, credibly, and cost-effectively operationalise sustainability analysis at the supply chain level.

2. Methodology

To demonstrate the practical application of geospatial data in financial sustainability analysis, we developed a replicable workflow that evaluates deforestation risk in Brazil's animal-based commodity supply chains. This section outlines the core data sources, assumptions, and processing methodology, with a particular focus on relevance to FS.

Asset Location Data

Robust location data is critical for supply chain-level risk assessment. While asset geolocation remains a challenge due to inconsistent disclosure and complex ownership structures, public and commercial datasets offer partial coverage.

For this study, we use a dataset of Brazilian slaughterhouses and related facilities (Trase, 2025). The dataset was cleaned to merge duplicate company names with small grammatical differences, accent differences or extra punctuation.[1]

We also discard facilities with no known ownership. The resulting dataset includes:

- 16,582 geolocated facilities (down from 17,869 in the original dataset, after removing those with no ownership details) across 2,691 municipalities and 26 states, plus one federal region;
- Classification across 12 commodities, as follows:
  1. Beef
  2. Chicken
  3. Dairy
  4. Egg
  5. Fish
  6. Goat
  7. Honey
  8. Inedible
  9. Lamb
  10. Pork
  11. Rabbit
  12. Unknown meat
- Ownership details for 9,854 companies, a reduction from 10,015 after cleaning for grammar, punctuation and accents within the name.

Figure 1 shows the distribution of the facilities dataset across the state borders. From the map, it is evident that there is a concentration of the slaughterhouses on the coastline, perhaps to accommodate international export, but there is coverage across all Brazilian states. While farm-level sourcing data would offer even greater precision, these facilities serve as practical proxies for upstream supply chains, especially in deforestation-sensitive sectors like beef.

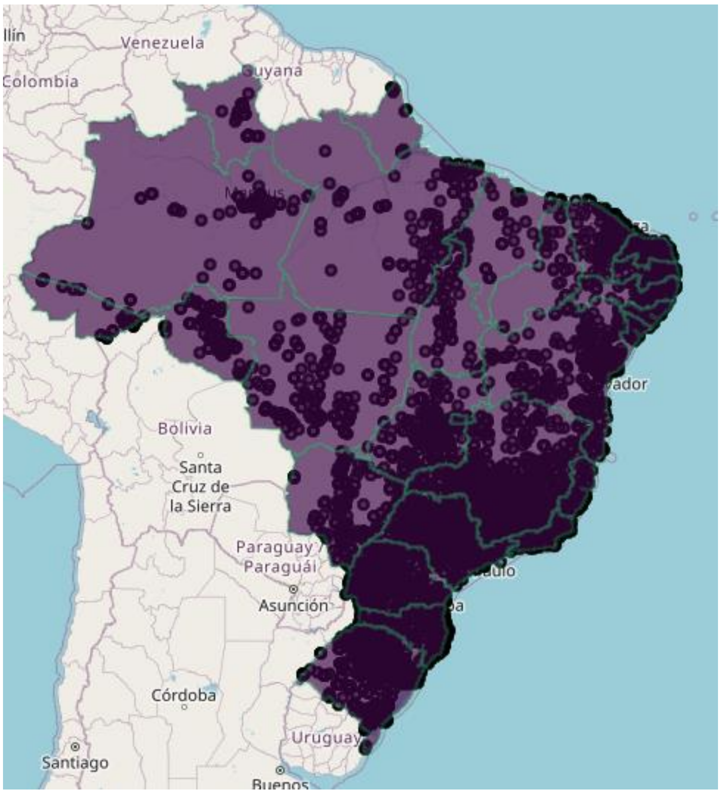

Figure 1 Brazilian Slaughterhouse locations.

[1] For example, corporate entity name *MANAÓS COMÉRCIO DE CARNES E CEREAIS LTDA* is merged with company name *MANAOS COMÉRCIO DE CARNES E CEREAIS LTDA*.

Environmental Data Inputs

We combined two global, open-access datasets to assess forest loss and identify its likely causes:

Dataset	Purpose	Source
Hansen Global Forest Change v1.12 (2000–2024)	Forest loss detection at 30m resolution	(Hansen et al., 2013)
Drivers of Global Forest Loss (2001–2024)	Attribution of forest loss to key drivers (e.g. agriculture, fire) at 1km resolution	(Sims et al., 2025)

Table 1 Environmental Data Used for Analysis.

We mapped forest-loss at 30 m, but the "driver" layer (what likely caused the loss) exists only at 1 km. To combine them, every 30 m pixel inside a 1 km square inherits that square's dominant driver. This lets us show drivers alongside the finer 30 m loss map, but the driver labels still reflect 1 km patterns, not true local detail. Small, local losses can therefore be labelled with the wrong driver if their 1 km square is dominated by something else. This should be considered when interpreting the results, especially for applications requiring precise, pixel-level attribution of loss drivers.

Timeframe and Geographic Scope

We analysed forest loss from 2019 to 2024, capturing the pre- and post-cutoff period relevant to the EUDR. The cutoff date is 31 December 2020, and the regulation prohibits imports linked to deforestation after this date. The analysis was performed nationwide, with localised assessments around facility locations.

Supply Shed Definition

Each facility was assigned a 50km radial buffer to approximate its potential sourcing area ("supply shed"), a common geospatial approach for scalable environmental risk proxying in supply chain assessments. While actual sourcing distances may vary, this provides a scalable and conservative estimate across all commodities and regions[2]. Future refinements could incorporate commodity-specific sourcing models (that incorporate road infrastructure, travel times and food spoilage data, or other traceability data).

Risk Scoring Framework

Rather than attributing responsibility, we assess exposure through identification of company asset locations in high-risk regions. Specifically, each facility is assigned a composite risk score based on:

- Total forest loss area within the buffer;
- Proportion of forest loss caused by permanent agriculture (a proxy for systemic pressure);

[2] Discussion on relevant buffer zones for different commodities and their biodiversity impact: https://www.ibat-alliance.org/biodiversity-disclosure?locale=en

- Proportion of forest loss caused by wildfire;[3]
- Trend over time, indicating accelerating or declining risk.

All inputs were normalised using a linear scaling method before combination. The weightings presented in Table 2 are designed to emphasise systemic and worsening risks, reflecting the capacity of these drivers, forest loss, permanent agriculture, wildfire, and ongoing forest loss trends, to propagate adverse impacts throughout the region by intensifying interconnected vulnerabilities (e.g. large-scale forest loss reduces ecosystem resilience to fire) and amplifying the likelihood of future environmental degradation. Permanent agriculture and wildfire were selected as they are the primary drivers of deforestation within the region, as is demonstrated in Figure 3 and Figure 4:

Metric	**Weight (%)**
Forest Loss Area	40
Permanent Agriculture Share	20
Wildfire Share	20
Deforestation Trend Slope	20

Table 2 Risk Scoring Weighting.

It should be noted that, though the weights used here are selected primarily for illustrative purposes, this score can be recalibrated based on specific FS use cases. For example, insurers might prioritise trend volatility to calibrate their premiums for companies operating within the area.

3. Results & Financial Service Use CasesNational and State-Level Risk Overview

At the macro level, forest loss patterns provide early warning signals for systemic environmental risks. Between 2019–2024, we analyse forest loss and its dominant drivers across all Brazilian states and one federal region. Tree cover and tree loss are shown across all of Brazil for 2019 in Figure 2.

The state of Pará exhibited the highest forest loss, driven primarily by permanent agriculture, followed by wildfire (see Figure 3). This suggests ongoing land-use change linked to commodity expansion, a key signal for both regulatory attention and capital risk. Through 2019-2023, permanent agriculture was the primary driver of forest loss, whereas in 2024 it was wildfire (see Figure 4). The hottest year on record was recorded in 2024 (World Meteorological Organization, 2025), creating perfect fire conditions, with the primary cause being attributed to climate change, although events were more likely to occur due to El Niño (Otto *et al.*, 2024). This led to increased frequency and intensity of wildfires globally (Jones *et al.*, 2024). This analysis provides a starting point for FS institutions conducting regional risk scans, informing both portfolio screening and engagement strategies.

[3] (Sims *et al.*, 2025) define wildfire as tree cover loss due to fire with no visible human conversion or agricultural activity afterward. However, wildfires may start through human activities, accidental or deliberate.

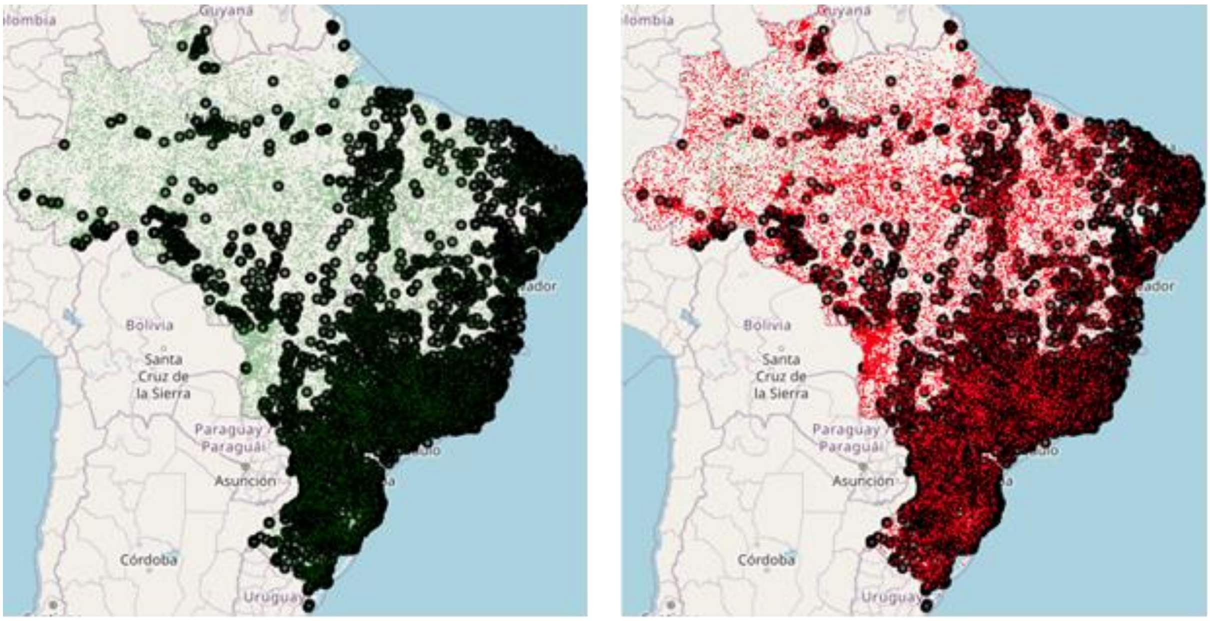

Figure 2 LHS – Facility locations and tree cover (green) as of 2019. RHS – Facility locations and tree loss (red) for the period of 2019-2024 inclusive.

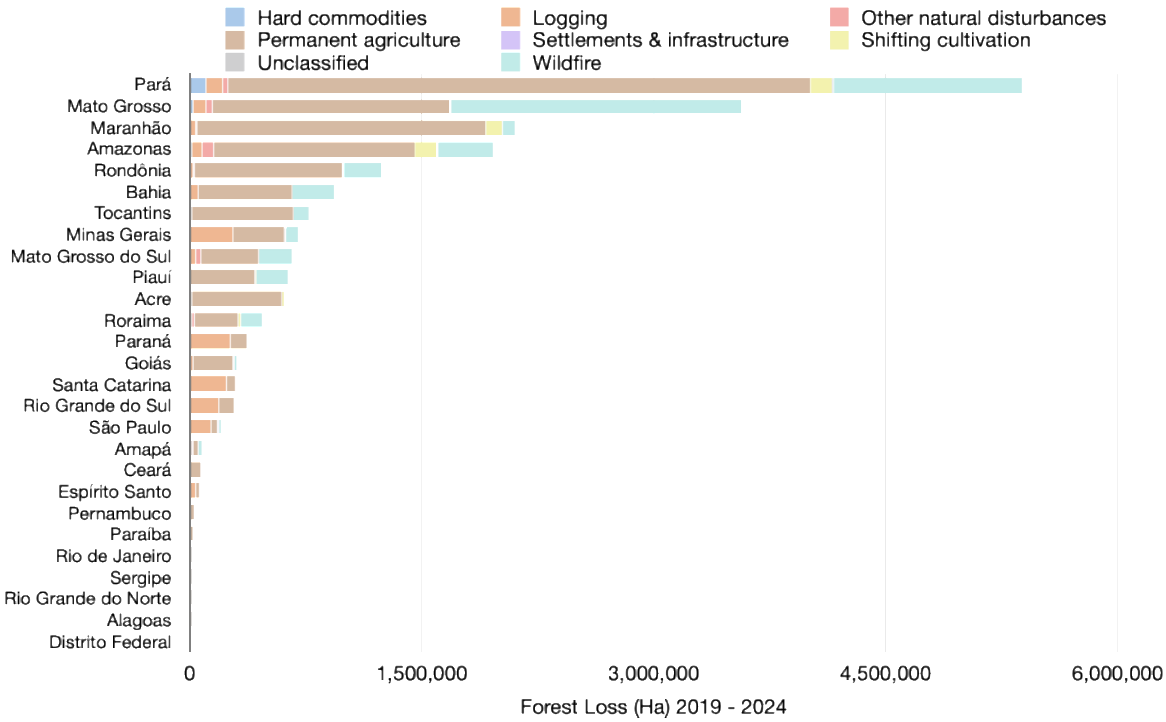

Figure 3 Forest Loss Drivers (2019 – 2024) for 26 Brazilian States and 1 Federal Region.

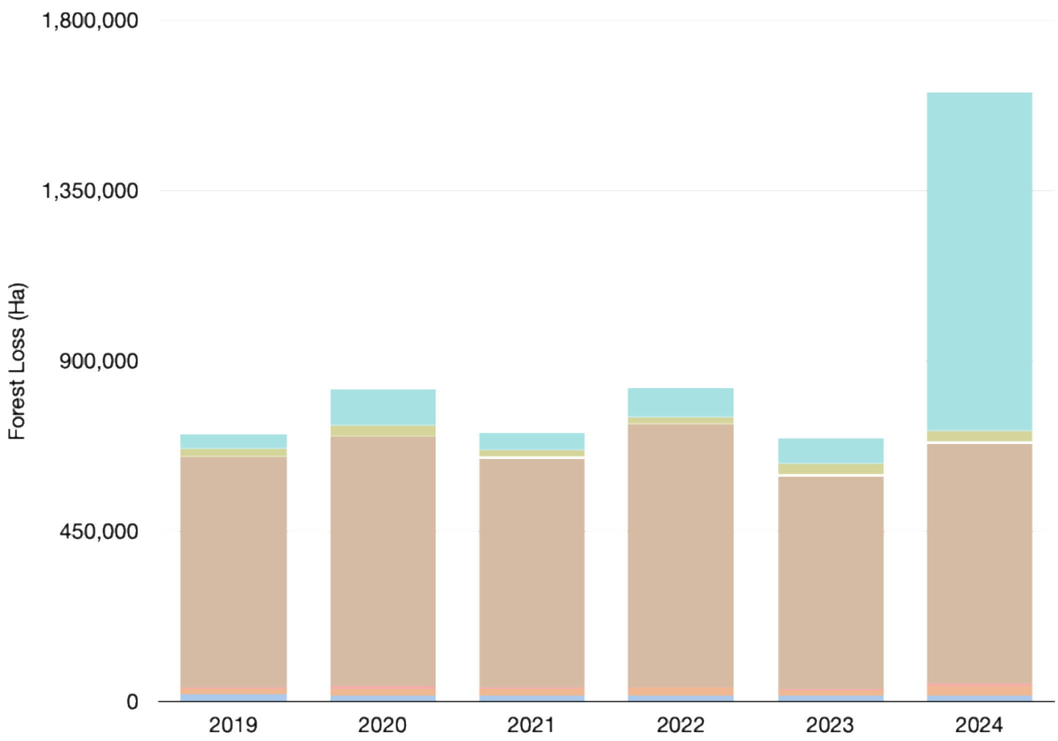

Figure 4 Para State Forest Loss by Drivers (2019 – 2024).

4. Company and Facility-Level Exposure Analysis

Using the 50km buffer approach and composite Risk Score (see Risk Scoring Framework), we assess over 17,000 facilities and calculate:

- Individual facility scores,
- Company-level aggregations, and
- Risk rankings by commodity.

From Figure 5, it is evident that most facilities exhibit low to medium risk scores (mean = 0.21), with a long right tail indicating a small set of very high-risk facilities. Percentile markers are included to guide interpretation thresholds. Using the percentiles defined in Figure 5, we can create risk categories, shown in Table 3.

Low	<25th percentile
Medium	<75th percentile
High	<95th percentile
Extreme	>95th percentile

Table 3 Risk category definition.

These risk categories can then be used to bin facilities by their risk category (see Figure 6), and visualised on a map (see Figure 7). Although the risk score is mathematically bounded between 0 and 1, the observed facility scores cluster below 0.5. Consequently, the 'extreme' bin reflects facilities with risk levels that are relatively higher compared to their peers, rather than in absolute terms across the full range.

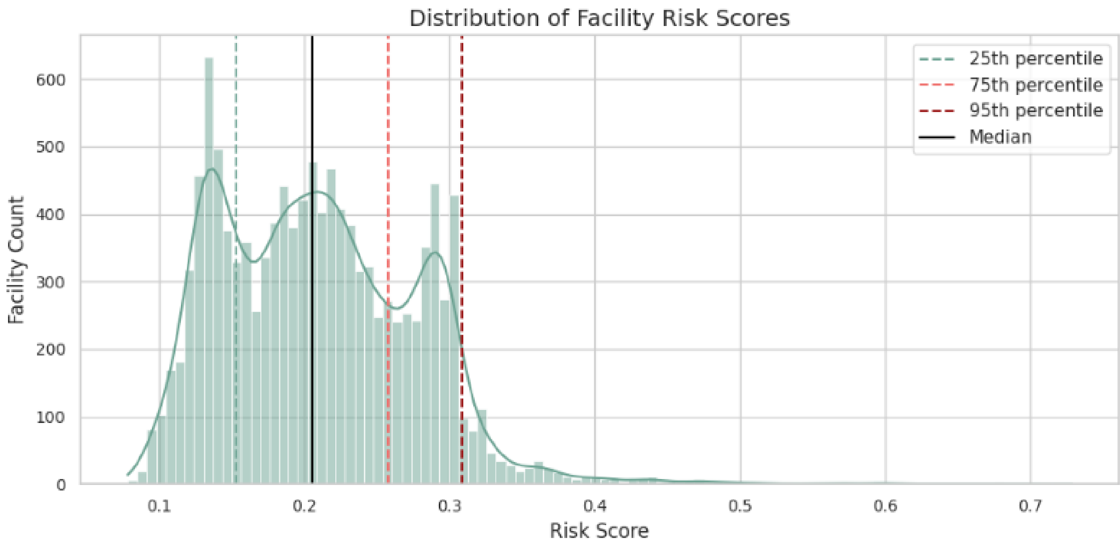

Figure 5 Facility Risk Score Distribution full dataset for 2019-2024.

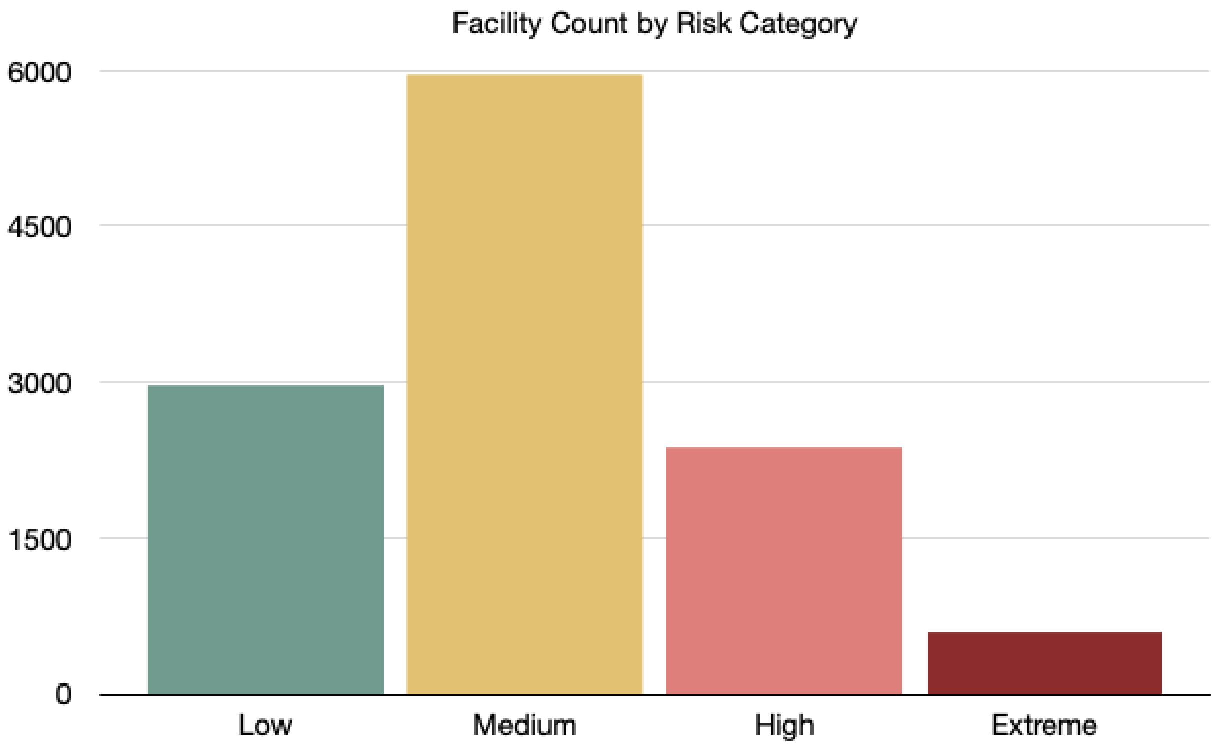

Figure 6 Facility Count by Risk Category, analysed for the period of 2019-2024.

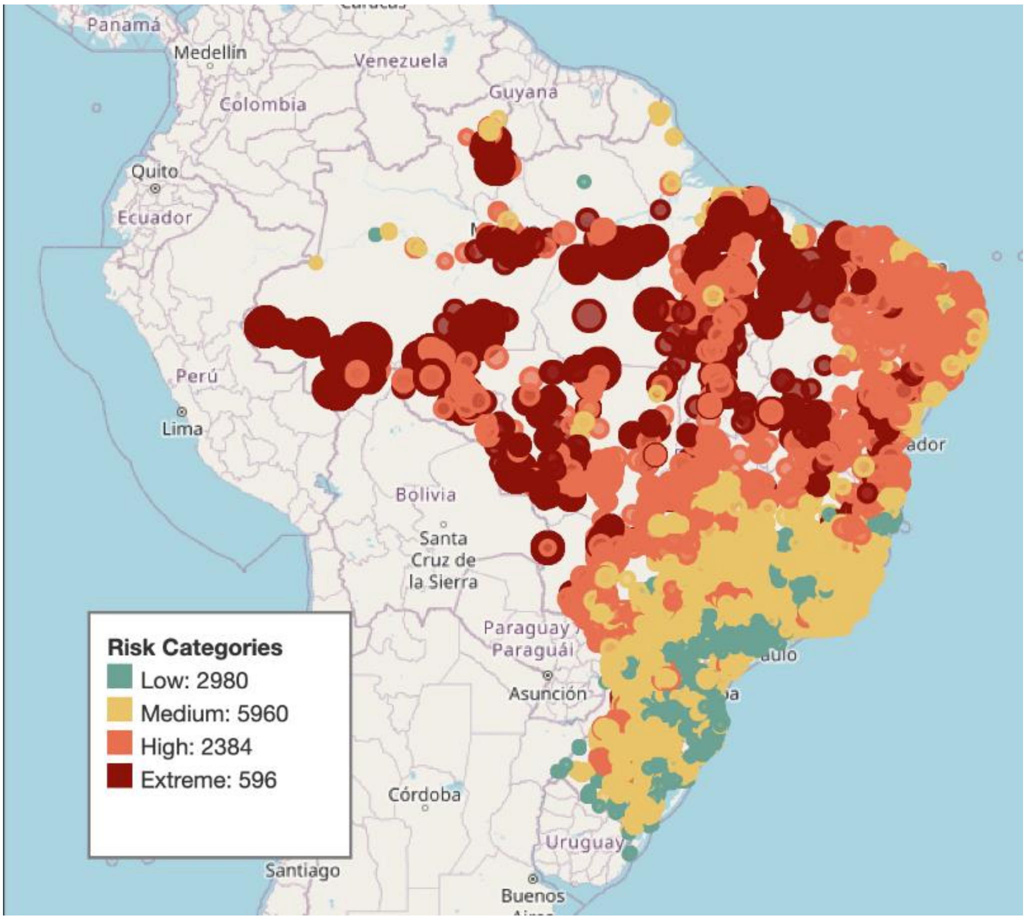

Figure 7 Colour-coded risk score for the period of 2019-2024.

Use Cases for Financial Services Stakeholder

This analysis supports a wide range of FS stakeholders who are increasingly required to integrate environmental risk into decision-making — whether for regulatory compliance, financial risk management, or sustainability-led strategy. Based on these stakeholders, we introduce three personas and present the data in a way that may be useful to the challenges they face.

Asset Managers & ESG Investors

Persona: Sustainability teams within investment firms or ESG analysts at asset managers operating Article 8/9 funds under the SFDR[4]. Their goal is to demonstrate that their portfolios are aligned with ESG criteria, particularly when it comes to principal adverse impacts (PAIs) such as deforestation or ecosystem loss.

Their challenge: Most ESG data is self-reported, inconsistent, and aggregated at the company level, making it difficult to compare holdings or conduct supply chain-level risk analysis.

What they need from geospatial data:

- Comparability across companies and commodities;
- Quantification of exposure to deforestation or high-risk sourcing zones;

[4] The Sustainable Finance Disclosure Regulation: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2088

- Aggregation to fund- or company-level for financial decision-making and reporting;
- Auditability to back claims in regulatory filings.

How this analysis helps:

Using over 17,000 facilities across Brazil, each assigned a composite forest loss risk score, we enable direct comparison across companies, commodities, and regions.

Figure 8 presents the top 20 companies, ranked by average risk score across their operational facilities, highlighting those whose operational footprint is concentrated in high-risk areas.

Figure 9 shows the top 20 companies by total cumulative risk score across the sample period, giving a broader picture of their environmental exposure. This may be useful for impact investing in respect of divestment decisions. This is broadly in line with their facility count, confirming more generally that companies with larger operations will have larger risk exposure.

Investors can use this data to prioritise engagement with high-risk firms, to screen and adjust holdings to reduce exposure to unsustainable practices, and to provide verifiable evidence of ESG integration in line with regulatory requirements under SFDR Article 8 and Article 9.

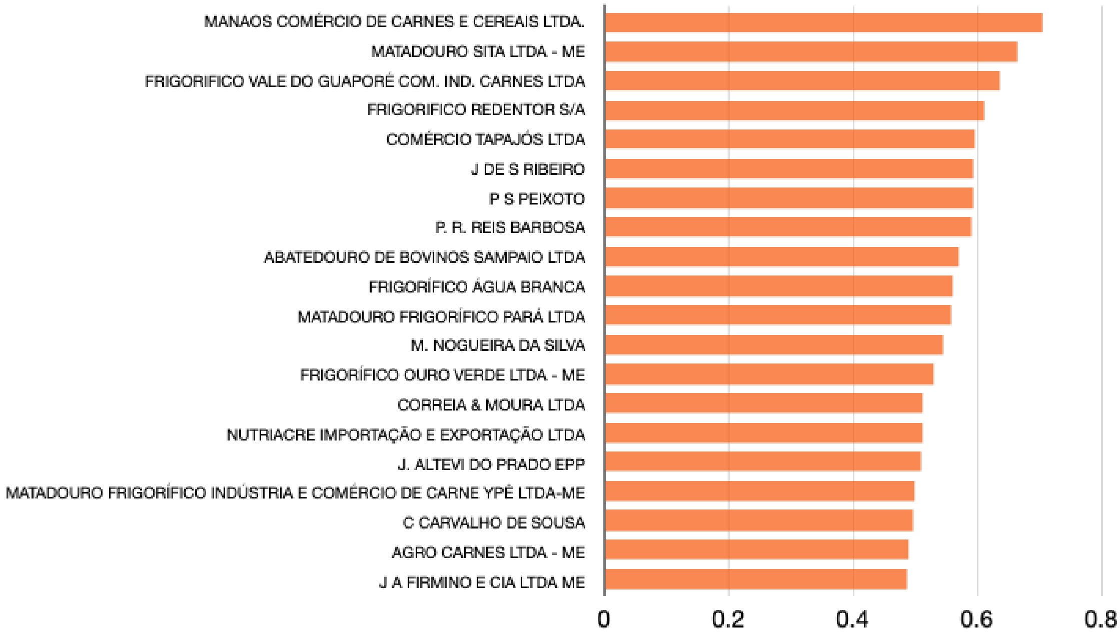

Figure 8 Top 20 Companies by Average Risk Score across their facilities for 2019-2024.

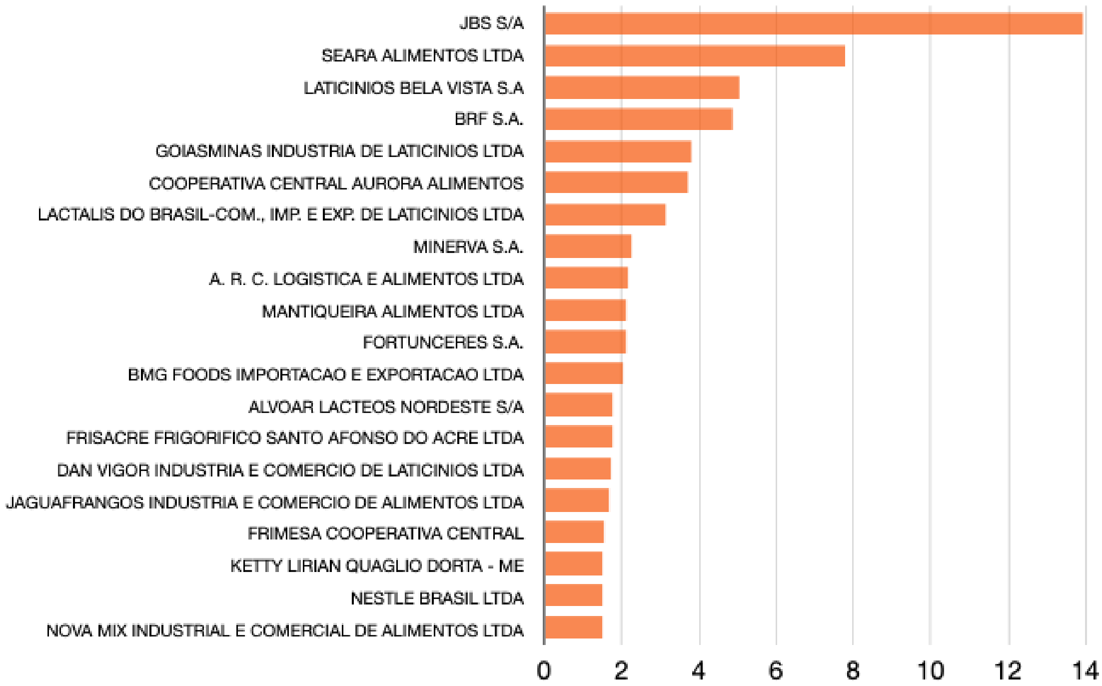

Figure 9 Top 20 Companies by Cumulative Risk Score for 2019-2024.

Banks, Lenders, and Underwriters

Persona: ESG risk teams within commercial banks or underwriters offering sustainability-linked loans. They must assess whether borrowers present reputational, financial, or regulatory risk linked to environmental impacts.

Their challenge: Lenders often rely on borrower claims and ESG scores that lack spatial resolution. This makes it difficult to assess whether a company's facilities operate in deforestation-prone zones, a key risk for sectors like agriculture or food processing.

What they need from geospatial data:

- Objective exposure data at facility or regional level;
- Trend metrics to assess how risk is changing over time;
- Risk flags to embed into loan covenants or underwriting thresholds;
- Portfolio screening to identify companies with hidden supply chain risks.

How this analysis helps:

Referring back to Figure 5, which shows the distribution of risk scores across all facilities, it can be seen that the long right-hand tail identifies a small subset of facilities with extreme risk. This allows banks to flag borrowers who may be exposed to future regulatory tightening or reputational risk. Leveraging this distribution, in Table 3, we defined risk thresholds (Low to Extreme) which lenders can use as input into loan structuring. This may include, for example, setting higher rates or more stringent ESG conditions for companies with facilities above the 95th percentile.

Our scoring framework includes a trend component, capturing whether deforestation is increasing or decreasing over time around each facility. This provides interesting temporal insights. The risk score can be calculated on a yearly basis for the period of study, to identify those companies/facilities that are improving or worsening against past performance as is shown in Table 4 for the top 20 companies with the highest average risk score over the analysis period. Cells are colour coded to show reduced risk (green) or increased risk (red) compared to the previous year. Across the population of companies, this can help identify potential movements between risk thresholds, which could trigger sustainability-linked loan covenants. Figure 9 again, helps contextualise whether a borrower operates at scale (due to correlation with total facilities), which is important when assessing whether high risk is systemic or isolated. By integrating this analysis into credit risk scoring or ESG due diligence, banks can better align lending practices with environmental sustainability targets and avoid greenwashing allegations.

Company	**Year**					
	2019	2020	2021	2022	2023	2024
RAQUEL FEITOSA FONTES	0.677	0.358	0.399	0.402	0.453	0.407
MATADOURO SITA LTDA - ME	0.675	0.510	0.567	0.650	0.613	0.601
MANAÓS COMÉRCIO DE CARNES E CEREAIS LTDA	0.655	0.506	0.695	0.696	0.534	0.661
COMÉRCIO TAPAJÓS LTDA	0.644	0.458	0.499	0.617	0.503	0.478
MATADOURO FRIGORÍFICO INDÚSTRIA E COMÉRCIO DE CARNE YPÊ LTDA-ME	0.641	0.376	0.422	0.423	0.486	0.422
FRIGORIFICO VALE DO GUAPORÉ COM. IND. CARNES LTDA	0.579	0.558	0.526	0.473	0.419	0.791
Grand Total	0.548	0.441	0.508	0.530	0.546	0.506
MATADOURO FRIGORÍFICO PARÁ LTDA	0.545	0.428	0.492	0.491	0.671	0.458
FRIGORÍFICO ÁGUA BRANCA	0.540	0.430	0.507	0.497	0.680	0.459
M. NOGUEIRA DA SILVA	0.516	0.425	0.536	0.546	0.446	0.502
J DE S RIBEIRO	0.515	0.436	0.516	0.613	0.759	0.464
P S PEIXOTO	0.514	0.436	0.515	0.613	0.757	0.465
P. R. REIS BARBOSA	0.513	0.435	0.513	0.611	0.756	0.464
FRIGORIFICO REDENTOR S/A	0.512	0.508	0.532	0.537	0.501	0.732
FRIGORÍFICO OURO VERDE LTDA - ME	0.502	0.428	0.460	0.452	0.518	0.499
C CARVALHO DE SOUSA	0.499	0.381	0.494	0.544	0.421	0.392
ABATEDOURO DE BOVINOS SAMPAIO LTDA	0.493	0.542	0.498	0.481	0.446	0.637
J. ALTEVI DO PRADO EPP	0.493	0.428	0.518	0.470	0.479	0.373
NUTRIACRE IMPORTAÇÃO E EXPORTAÇÃO LTDA	0.486	0.400	0.513	0.500	0.466	0.442
CORREIA & MOURA LTDA	0.486	0.399	0.514	0.500	0.466	0.442
AGRO CARNES LTDA - ME	0.475	0.384	0.443	0.481	0.549	0.426

Table 4 Temporal risk profile of the top 20 companies (2019–2024) based on average forest loss risk score per year. Red indicates increased risk compared to previous year. Green indicates reduced risk compared to previous year.

Regulators, Watchdogs & Auditors

Persona: Entities responsible for enforcing ESG disclosure regulations, including CSRD, EUDR, and TNFD-aligned frameworks. This includes sustainability audit firms, national regulators, and non-profit environmental watchdogs.

Their challenge: Disclosures are often voluntary, unverifiable, or lack spatial evidence. Regulators need a way to objectively verify claims, prioritise investigations, and flag inconsistencies.

What they need from geospatial data:

- Objective validation of reported impacts;
- Flagging of outliers: companies whose exposure is inconsistent with their disclosures;
- Support for prioritisation of investigations or enforcement;
- Cross-referencing across regulations (e.g. CSRD double materiality and EUDR cut-off compliance).

How this analysis helps:

Geospatial analysis provides external, timestamped evidence that can validate or challenge sustainability claims.

Figure 9 assists in the identification of companies with the largest environmental footprint, regardless of whether they have disclosed it. Figure 10 further contextualises risk by showing the primary forest loss drivers around each commodity. For example, if a company claims to source responsibly, but operates in zones dominated by permanent agriculture-driven forest loss, this might warrant scrutiny.

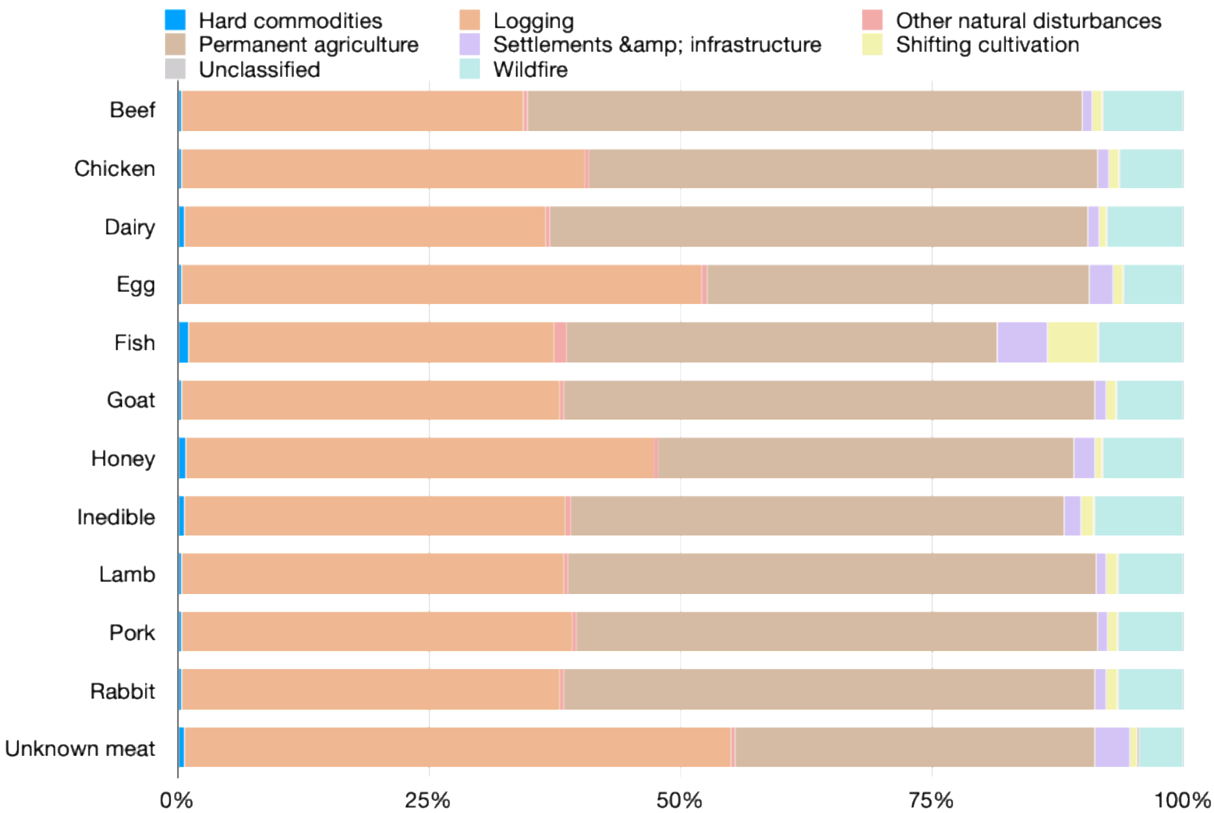

Figure 10 Forest Loss Impact Driver Split per Commodity for 2019-2024.

Figure 11 presents risk distribution by commodity, potentially highlighting systemic issues. For example, beef-related facilities show wider interquartile risk ranges and more outliers, suggesting targeted regulatory focus is warranted. This approach allows regulators to adopt a risk-based monitoring strategy, prioritising investigations, targeting audits, and building evidence for enforcement.

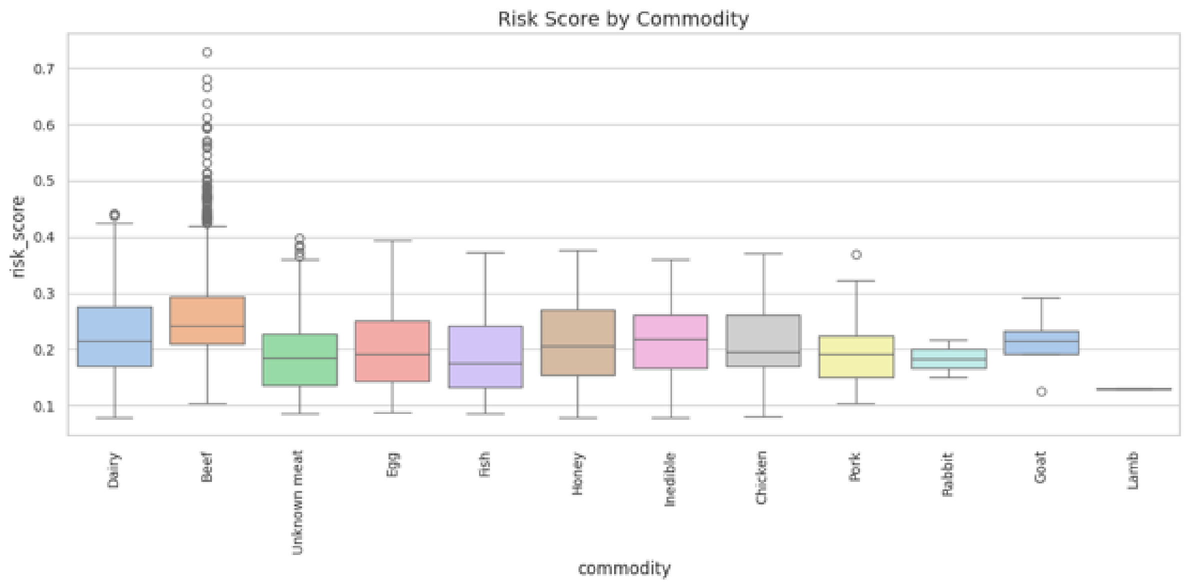

Figure 11 Risk Score Distribution split by Commodity for 2019-2024.

5. Key Insights & Strategic Recommendations

The geospatial risk assessment approach proposed in this study offers both immediate insights, and long-term opportunities for FS institutions seeking to enhance ESG intelligence, meet regulatory demands, and reduce exposure to environmental risk.

Key Insights

Deforestation Risk Is Spatially and Driver Concentrated

The state of Pará (Figure 3) ranks as the highest-risk region for forest loss from 2019 to 2024, with permanent agriculture driving most losses over the period. However, in 2024, wildfire emerged as the primary driver (Figure 4, reflecting a climate change-related shift consistent with regional climate stress trends observed in Amazon studies (Jones *et al.*, 2024; World Meteorological Organization, 2025) and reported in the annual review by the Monitoring of the Andes Amazon Program[5]. This pattern highlights both spatial and temporal deforestation hotspots, enabling FS actors to geographically target high-risk zones for screening and reporting.

This case study demonstrates how applied earth intelligence can identify evolving risk drivers and their implications for supply

[5] https://maaproject.kinsta.cloud/?html2pdf=https://www.maapprogram.org/amazon-deforestation-fire-hotspots-2024/&media=print

chain resilience. These insights are broadly applicable to other regions and commodities, though results here are specific to Pará and relevant sectors.

Commodity-Specific Risk Patterns Highlighted by Beef Example

While beef-linked facilities show higher median and more volatile risk scores (Figure 11), indicating disproportionate exposure, this reflects a broader pattern across commodity sub-sectors where risk profiles differ. Beef serves as a clear example of the need for commodity-specific risk modelling in portfolios, credit evaluations, and regulatory reviews.

Most Facilities Are Low Risk, but a Small Minority Drive Extreme Impact

Figure 5 reveals a long-tailed risk score distribution focused effectively within a ~ score range, where most facilities fall into low to medium risk categories. A small minority in the upper tail account for extreme environmental exposure. These facilities and their owning companies should be prioritised by FS due diligence and regulatory interventions to mitigate systemic impact.

Company-Level Aggregation Reveals Hidden Exposure

Figure 8 and Figure 9 show that companies with apparently low average risk may hold significant cumulative exposure due to their scale or number of moderate-risk facilities, underscoring the importance of portfolio-wide risk aggregation and double materiality assessments.

Geospatial ESG Analysis Is Fast, Scalable, and Modular

The complete analytics pipeline was completed in approximately two days using Google Earth Engine and a Google Colab Notebook, including coding, data processing, and visualisation. The analysis is scalable to global analyses subject to data availability. This adaptability enables rapid application to new regions (e.g., Indonesia), commodity types (e.g., palm oil), additional ESG metrics (e.g., water stress), and relevant regulatory frameworks (e.g., CSRD, TNFD).

Strategic Recommendations by Stakeholder

The key insights can be summarised into the following action table per stakeholder detailed in the *Use Cases for Financial Services Stakeholder* section, detailing how FS can integrate geospatial data into their current workflows.

Stakeholder	Action
Asset Managers	Integrate geospatial ESG screening into pre-investment and ongoing risk analysis. Use commodity- and geography-specific thresholds to prioritise engagement or divestment.
Banks / Lenders	Include facility-level deforestation exposure in ESG lending criteria. Use percentile thresholds to inform pricing or trigger enhanced due diligence.
Regulators / Auditors	Adopt geospatial datasets as part of disclosure verification under CSRD, EUDR, and TNFD. Focus audit activity on high cumulative-risk companies operating in agriculture-driven loss zones.

Table 5 Strategic Recommendations by Stakeholder.

6. Regulatory Alignment

The geospatial analysis directly supports alignment with emerging global sustainability disclosure regulations. By offering objective, spatially granular, and time-specific insights, it provides a credible and scalable solution for FS institutions to meet mandatory ESG obligations.

CSRD - Corporate Sustainability Reporting Directive (EU)

Under CSRD, companies must report on their double materiality, disclosing both:

- Financial materiality (how sustainability risks affect the business);
- Impact materiality (how the business affects people and the environment).

This analysis supports both dimensions:

- By identifying high-risk regions of operation (e.g. Pará), it helps assess business risk exposure;
- With further analysis, forest loss could be linked to specific facilities and commodities, revealing the company's environmental footprint.

Relevant European Sustainability Reporting Standards (ESRS) sustainability topics, which underpin the CSRD, that this analysis can support, include:

ESRS Section	**Example Datapoint Related to Deforestation**	
E4-1	Transition plan on biodiversity and ecosystems	Transition plan time-bound targets to halt/restore forest loss
E4-2	Policies related to biodiversity and ecosystems	Existence and coverage of zero-deforestation commitments/policies
E4-3	Actions and resources related to biodiversity and ecosystems	Actions to avoid, minimize, restore or offset deforestation; resources allocated; prioritization process; timeline and stakeholder engagement
E4-4	Targets related to biodiversity and ecosystems	Measurable, time-bound targets to reduce/halt deforestation, restore or protect forest area, sourcing targets; baseline and progress reporting
E4-5	Impact metrics related to biodiversity and ecosystems change	Hectares of forest area deforested/converted, restored or protected
		% of raw materials from certified deforestation-free sources
		# / area of production sites in deforestation-risk regions
E1-6	Gross Scopes 1, 2, 3 and Total GHG emissions	GHG emissions/removals due to forest loss (LULUCF)
ESRS 2, IRO-1, SBM-3	Description of the process to identify and assess material impacts, risks and opportunities	Description of business risks due to deforestation, e.g. regulatory, reputational, supply chain

Table 6 Relevant CSRD sustainability topics that this analysis supports.

EUDR – EU Deforestation-Free Regulation

The EUDR prohibits the import of certain commodities (e.g. soy, beef, palm oil) if they are linked to deforestation or forest degradation after 31 December 2020. This analysis has demonstrated how to:

- Detect forest loss within facility supply sheds (50km buffer),
- Identify whether deforestation occurred after the legal cutoff date, and,
- Attribute loss to drivers like permanent agriculture, a key flag under the EUDR.

Financial institutions can use this analysis to assess whether clients or investees are at compliance risk with EUDR due diligence obligations, This is particularly true for lending, trade finance, or equity exposure to agriculture-linked sectors.

SFDR

Asset managers offering Article 8 and 9 funds must report on Principal Adverse Impacts (PAIs) such as:

> *"Exposure to companies involved in deforestation, through its disclosure of Indicator 15 in Table 2: "Share of investments in companies without a policy to address deforestation."*

This analysis supports SFDR disclosures by:

- Quantifying deforestation risk scores at company and facility level, and testing of deforestation policies that are in place,
- Linking scores to specific commodities, which can feed into PAI reporting templates,
- Providing auditable, externally verifiable data that strengthens fund-level ESG claims.

TNFD

TNFD encourages organisations to assess nature-related risks and dependencies, using the LEAP framework:

- Locate: Identify geographies where activities interact with nature;
- Evaluate: Assess dependencies and impacts;
- Assess: Analyse material risks to business and stakeholders;
- Prepare: Develop responses and disclosures.

This geospatial pipeline operationalises LEAP by:

- Locating facilities and mapping their surrounding ecosystems,
- Evaluating exposure to ecosystem degradation (e.g. deforestation),
- Enabling materiality assessment across companies, commodities, and jurisdictions.

This analysis provides a foundation for nature-related risk disclosures and early TNFD adoption, ahead of likely regulatory codification.

UK Sustainability Standards and Global Frameworks

While the UK SRS (Sustainability Reporting Standards) are still emerging, they are expected to align closely with CSRD and TNFD. Additionally, this methodology complements global standards such as:

- ISSB IFRS S1/S2: Climate and sustainability-related risk disclosures,
- CDP Forests Questionnaire: Scope 1–3 land-use change data,
- GRI 304/(101): Direct driver assessment, Habitat conversion/ reduction of species assessments.

7. Conclusion

This white paper demonstrates that geospatial data is not only viable but essential for modern sustainability risk assessment across global supply chains. It shows how open datasets can be leveraged to determine environmental risk metrics, specifically forest loss, for corporations operating within or near affected areas. The resulting metrics offer tangible insights for investors, lenders, auditors, and regulators by delivering greater granularity, objectivity, and auditability than traditional ESG data sources often provide.

Regulators are increasingly shifting from voluntary disclosures to mandatory, location-based reporting frameworks such as CSRD, EUDR, and TNFD. At the same time, market demands for accountability continue to rise, particularly for high-impact commodities like beef, as demonstrated throughout this analysis. Advancements in data availability and analytical tools now make such rigorous assessments possible at scale, with transparency, efficiency, and affordability.

Looking ahead, FS organisations are encouraged to start integrating spatial ESG metrics into their internal risk systems, investment decision frameworks, and ESG dashboards. Facility-level risk scores can be valuable for informing engagements, shaping loan conditions, and guiding portfolio screening processes. Furthermore, collaboration with data providers, researchers, and audit partners will be critical to ensure alignment with evolving sustainability standards including CSRD, SFDR, and TNFD. Preparing for future ESG expectations will also require extending the methodology beyond forest loss to incorporate metrics related to water, biodiversity, and ecosystem dependencies.

This work is part of a broader Supply Chain Intelligence initiative, where financial decision-making is increasingly informed by geospatial data. For organisations interested in applying this methodology or exploring similar approaches tailored to their own portfolios, regions, or asset classes, engagement with the authors is welcomed.

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