



ENDING TROPICAL DEFORESTATION: A STOCK-TAKE OF PROGRESS AND CHALLENGES

MINING GLOBAL FINANCIAL DATA TO INCREASE TRANSPARENCY AND REDUCE DRIVERS OF DEFORESTATION

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KEY POINTS

- The largest indirect drivers of deforestation are found in the global commodity and financial markets, but solutions to address these drivers have yet to be fully explored.
- There is a wealth of financial data and corporate governance information available that can be used to hold companies accountable to zero deforestation or other sustainable supply chain commitments and for activities linked to legal and illegal deforestation.
- Scaling up existing transparency solutions requires the financial community’s increased engagement to improve access to relevant data, improve capacity and automation of tools to analyze data, and better communicate the results in appropriate formats to appropriate audiences.

THE ISSUE

The climate and forest community has not yet harnessed the full power of the information age to create transparency in the global commodities markets. There exists a wealth of global financial data that can reveal the financial drivers of deforestation. Using the power of big data, forest champions—including indigenous peoples, business leaders, investors, policymakers, and law enforcement—can be empowered to find and draw attention to illegality and wrongdoing in commodities markets and supply chains. Additionally, companies can proactively use this information to reduce the material

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risk associated with deforestation and illegality in supply chains. Radical transparency techniques, in addition to illustrating overlaps in ownership structures and detecting instances of intentional overvaluation of assets, have been proven effective in holding companies to account for illegal or unethical activities and for violating zero-deforestation commitments. However, their full potential has yet to be unleashed.

WHY TRANSPARENT SUPPLY CHAINS ARE IMPORTANT TO FORESTS, CLIMATE CHANGE, AND DEVELOPMENT

The goals of the Paris Agreement cannot be met without reducing the greenhouse gas (GHG) emissions that result from deforestation and unsustainable land use. Recent studies show that the mitigation potential in the forest and land sectors could represent over one-third of the climate solution (Griscom et al. 2017). The impact of commercial and subsistence agriculture varies from country to country. However, agriculture is the largest direct driver of deforestation globally (Kissinger et al. 2012; Hosonuma et al. 2012), with commercial agriculture accounting for as much as 70 percent of deforestation in Latin America (FAO 2016), a significant proportion of which is illegal (Lawson 2014). A direct driver of deforestation can be, for example, a farmer clearing forest to plant crops, and the associated indirect driver is the market demand for those crops. As found in a study by Busch and Ferretti-Gallon (2017), forests are more likely to be cleared in locations where the economic returns to agriculture are higher. Government institutions responsible for implementing REDD+¹ strategies (forestry, environment, and/or agriculture departments, for example) generally have limited ability to affect indirect drivers of commodity-based deforestation, partly due to a lack of good governance and partly due to a scarcity of information about the companies whose supply chains begin in their jurisdictions.

There have been campaigns and corporate commitments to eliminate deforestation associated with the production of agricultural commodities, but there has been little to no measurable impact on national or global deforestation rates to date. Targeted, company-specific campaigns have achieved some success, but system-wide efforts—including voluntary international commitments such as those expressed in the goals of the New York Declaration on Forests (NYDF)—have not yet proved effective. One reason for this is that most of the commitments have

been made by companies that operate downstream in the supply chain, and few have traced their supply chains back up to the production level to assess the impact of the commodity production (Climate Focus 2016). Full traceability of supply chains can be particularly challenging for large, multinational companies with complex supply chains involving intermediary commodity buyers. Whether companies have full traceability of their supply chains or not, few have been held individually accountable by shareholders or other stakeholders to their commitments.

Another reason why we are not seeing the desired impact of corporate commitments to zero-deforestation is that the vast majority of financial markets do not differentiate between commodities based on their deforestation footprint or the sustainability of their production more broadly. For example, despite well-established certification schemes and major cocoa buyers' commitments to deforestation-free cocoa (Kroeger et al. 2017), there is no such commodity type listed on the world's stock exchanges, which limits the potential for a price premium. In fact, according to data from the Bloomberg Terminal analyzed by Climate Advisers in 2016, none of the more than 490 agriculture products that trade on exchanges globally are differentiated by transparency regarding their origination or certification. In other words, no exchange-traded agriculture commodity appears to have a certification or zero-deforestation premium; all certification and zero-deforestation-related products transact bilaterally, not on exchanges.

Companies prioritize action and investment in areas that affect their bottom line or represent a material risk, such as access to capital and legal compliance. Since 2010, total finance (private and public, international and domestic) for sustainable agriculture and forest management has amounted to about \$20 billion, which is minimal compared to the estimated \$777 billion for the land sector that is indifferent to forest and climate goals (Climate Focus 2017). Beyond the classic supply and demand justification, a noted cause for this disparity is the limited benefit that many companies (commodity buyers, producers, and independent investors) reap from investing in more sustainable or certified production systems. There is little reason for companies to make such investments if:

- i. it reduces their competitive advantage or market share; and
- ii. there is significant uncertainty around their ability to reap the reward; and/or

- iii. they do not suffer any significant repercussions or incur additional costs when they ignore or evade sustainable forest or agriculture management policies and regulations.

The latter problem can also take place in the company board room. Some companies have attempted to circumvent laws, regulations, or their own corporate social responsibility policies related to commodity production or trading through fraudulent financial accounting or shady corporate governance arrangements (see Box 1). Such practices artificially increase the value of converting forests to agriculture and other land uses, increasing the cost or limiting the effectiveness of forest conservation efforts. Lack of transparency in supply chains, and in corporate governance, makes it difficult to discover such illegal practices, and even more difficult to prosecute them.

At the same time, in 1998, the Indonesian Bank Restructuring Agency (IBRA) was empowered to address governance risks in the Indonesian economy, including the forest products sector specifically. While the IBRA was well-staffed and equipped, it lacked forestry and land-use expertise. The IBRA was also influenced by outside organizations with interests in maintaining the status quo. As a result, the IBRA exacerbated the problem instead of fixing it, as companies with poor records of performance in both governance and forest management were allowed to reestablish control over unprofitable forest product businesses and continue deforestation. These lessons are key to considering how governance transparency and related metrics are developed and deployed in a way that learns from previous activities (Setiono 2007).

How can companies be held to account for fraudulent financial accounting or corporate malfeasance? Use of corporate governance and financial data by human rights and environmental organizations and law enforcement can help ensure legality and compliance along supply chains by bringing to light real material risks that can impact a company's bottom line and valuation in the market. There is material risk if a product brand can be compromised by association with deforestation (and loss of wildlife habitat), as has been recently demonstrated at the company level. For example, in 2016 IOI Corporation was suspended from the Roundtable on Sustainable Palm Oil (RSPO) because of the alleged illegal deforestation of 11,750 hectares, which resulted in 26 corporate buyers ceasing buying palm oil from IOI. The company

Box 1 | How Accounting Fraud Can Drive Deforestation: A Palm Oil Example

Accounting fraud occurs when a company lies about the value of its assets—including land and plantation holdings—in order to overstate its financial strength. Why would a palm oil company do this? If the company has secured rights to operate in an area of forest land but does not have sufficient funds to clear the land and establish the plantation, it needs to get a short-term loan from a bank. However, the company's financial accounts may not be healthy enough to convince the bank to give them a loan with good terms (i.e., the full amount needed, at a low interest rate, with no collateral), or to loan to them at all.

In this case, the company decided to overvalue its palm oil assets in its financial accounting—for example, by valuing its plantations at double or more than their actual value. Then, on the exaggerated strength of the company's financial health, the company secures a bank loan to fund the conversion of its forested land to establish a palm oil plantation. Because the actual value of the land is insufficient to support the loan, the bank will eventually lose money, after the forests have been cleared and the plantations are not fully operational.

subsequently reported Q2 2016 losses of \$14.8 million (Chain Reaction Research 2016).

While environmental campaigns against companies have traditionally been viewed as reputational risks, the association of a company's products with deforestation can now be quantified as a material risk on both the supply and demand sides of a company's ledgers. A company's supply of an agricultural or other commodity may be cut off if its production relies on illegal deforestation or is curtailed by government policies that limit further production. On the demand side, a company that is found to be violating its own policies—such as No Deforestation, No Peat, No Exploitation (NDPE)—or a similar procurement policy by its buyers, and thereby violating shareholder and consumer trust, risks significant financial regulatory engagement. A well-documented example of such a case is when the London Stock Exchange delisted United Cacao as a result of the resignation of United Cacao's corporate advisor (United Cacao 2017a) following revelations of the company's association with illegal deforestation in the Peruvian Amazon (Collins 2015) and related unauthorized money transfers (United Cacao 2017b).

For “good” companies, greater overall transparency enables better risk management, which results in an increase in their value relative to “bad” companies that have yet to internalize the material risk of a supply chain associated with deforestation. Transparently managing, measuring, and monitoring these risks can also create a more inclusive development of the supply chain, as it will eliminate unfair competition and business practices that may favor only a small segment of society while hurting investors and citizens. Lastly, governments stand to gain from eliminating illegal deforestation from agriculture, as it generated losses of more than \$61 billion globally each year in the early 2000s (Blundell et al. 2018). In financial jargon, transparency enables better pricing of risk and return and where a company fits on the efficient frontier. In other words, without transparency, financial analysts will misprice deforestation risk, thereby increasing their likelihood to invest in companies that drive deforestation instead of investing in those working to stop it.

PROGRESS TOWARD MORE TRANSPARENT SUPPLY CHAINS

As of early 2018, more than 470 companies with commodity supply chains had made one or more commitments to address deforestation in their agricultural commodity supply chains; many committed to a target of zero deforestation by 2020. Other forest-related commitments were specific to individual commodities (e.g., deforestation-free soy or beef) or had different target years. But according to a 2018 assessment, just over half of those companies were reporting on their progress toward meeting the 2020 goal (Donofrio et al. 2018). Since 2012, there has been steady growth in both the numbers of companies making commitments (approx. 67 per year) and the number of forest-related commitments (approx. 120 per year) (NYDF Progress Assessment 2018). There was a notable increase in corporate supply chain commitments in 2014, the year that the NYDF was launched.

Over the last 10 years, there has been a significant increase in the number of organizations or initiatives dedicated to increasing transparency in commodity supply chains. This development has been facilitated by technological developments and associated financial support that have allowed new or improved access to various types of information, including geospatial data on land use and deforestation, trade data, corporate financial and governance data, and other relevant information. Data

mining is only as good as the analytical methods for which it is applied, and there has been important innovation in methods to associate different types of information to identify and quantify and publicly reveal indirect drivers of deforestation in commodity supply chains.

Thanks to a recent proliferation of transparency tools produced by public interest groups, stakeholders now have unprecedented access to information about the links between deforestation and commodity supply chains. The initiatives vary by analytical perspective or starting point (e.g., from international commodity buyer or from location of production), by scope of company or commodity covered, and by scope and source of data (including geographical, trade, financial, and governance data). Consider the following examples:

- Global Canopy Programme and Stockholm Environment Institute have created the Trase tool to track trade flows in commodity supply chains (see Figure 1).
- The World Resources Institute has added a Commodities section to its Global Forest Watch tool (GFW Pro) that companies can use to analyze the impact of their commodity sourcing on forests. GFW Pro is planning to extend this application so the finance sector can conduct similar analyses.
- The Forest Trust’s Transparency Hub and the Supply Change Initiative are examples of initiatives that focus on providing information and assessment of companies’ progress in meeting their commitments to responsible and sustainable supply chains.
- There are also supply chain transparency initiatives that assess and rank companies based on their transparency—for example, the Sustainability Policy Transparency Toolkit (SPOTT) and/or on their policies to address deforestation risk (such as the Forest 500 ranking).

While some of these initiatives are in the early stages of development and application, they are contributing to a significant increase in supply chain transparency, providing valuable information to a variety of stakeholders, and beginning to demonstrate impact. The impacts can be seen in the advocacy choices of environmental and human rights campaigners, which can influence some consumers’ behavior based on experience in other sectors and product types (Bask et al. 2013). The impact on companies can be seen in their increasing interest in acquiring more information about the goods

they buy, in order to reduce risk and uncertainty, and their engagement with technology companies to find ways to reduce the cost of tracing supply chains (Stahl 2017; Provenance Team 2017).

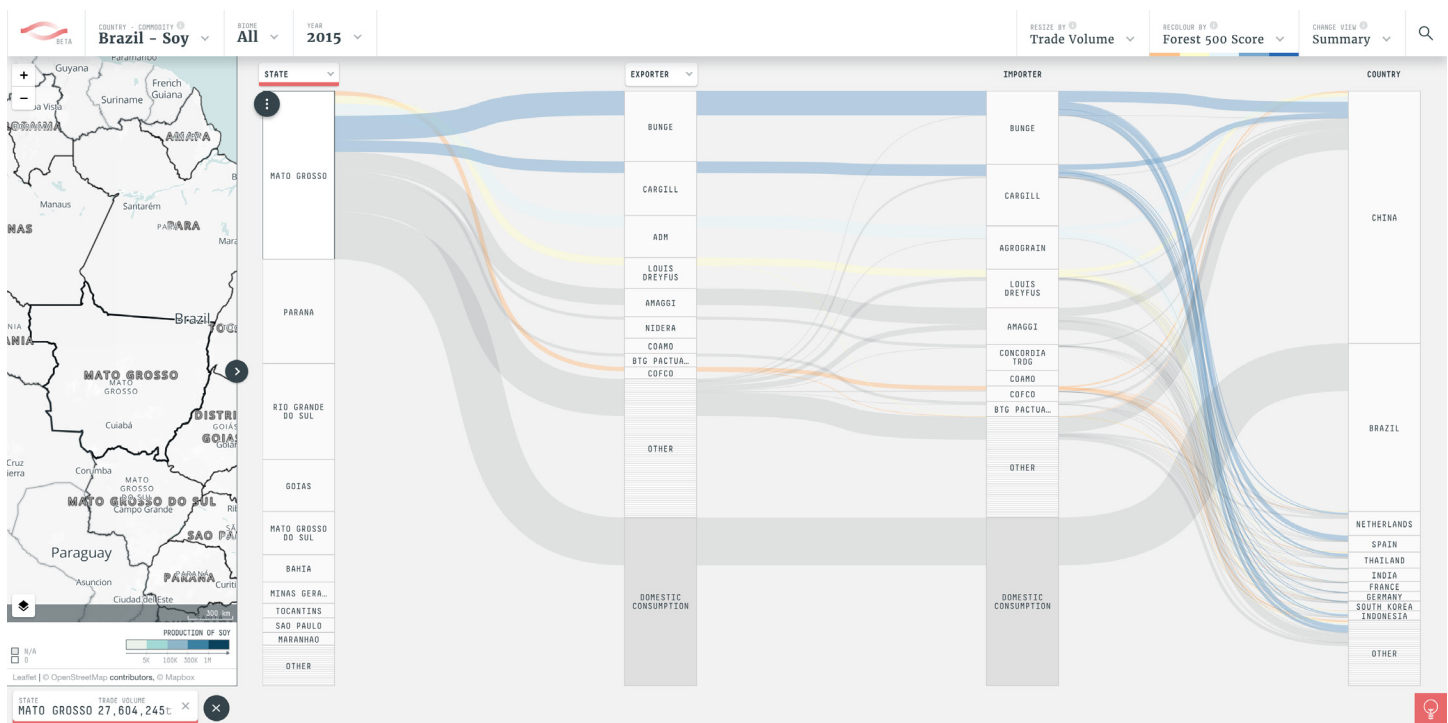
MATERIAL RISKS OF POOR ENVIRONMENTAL AND SOCIAL PERFORMANCE

Activist groups such as Greenpeace and Rainforest Action Network have often relied on supply chain information to create reputational risk as a way to hold companies accountable for their impacts on forests. Advocacy campaigns that link companies to deforestation may tarnish brands and affect sales if they are able to elicit a reaction from informed consumers—noting, however, that reputational risk is generally greater for consumer-facing companies (like Kellogg or Unilever) than for commodity traders (like Cargill or Bunge). This campaign approach has been effective in convincing major international commodity buyers to commit to better practices. For example, commitments made by members of the Consumer Goods Forum to achieve zero net deforestation

by 2020 in key commodity sectors increased by 22 percent in 2016 alone (Wensing and Van der Wekken 2017). However, reputational risk is not always enough to encourage a company to improve its practices, particularly for intermediary commodity traders that have little direct exposure to consumers and for those operating in markets where consumers are less likely to change their purchasing behavior based on environmental concerns. Responsive actions by companies could include:

- changing directors, executives, and board members;
- incorporating these risks into the risk governance structure;
- revising and/or enhancing measuring, managing, monitoring practices;
- enforcing procurement or investment policies;
- changing suppliers; and/or
- taking other actions that would minimize financially material risk.

Figure 1 | Soy Trade Flows from Mato Grosso



Notes: This screenshot from Trase shows soy trade flows (by volume) from Mato Grosso, Brazil, with an overlay of companies' Forest 500 scores.

Source: Trase 2015.

Organizations working at the intersection of finance and sustainable supply chains have recognized the potential of combining multiple data types to ensure accountability for sustainable supply chain commitments and, furthermore, to internalize material financial risk. These data types include deforestation monitoring, chain-of-custody and trade data, and corporate financial and governance data. Internalizing financially material risks relies on enforcement by external stakeholders, which is why increased transparency can be a powerful driver of behavioral change amongst poorly performing companies. To help explain how these data types translate into financially material risk, Table 1 describes eight categories of risk within agricultural supply chains, and offers examples of each.² While the transparency initiatives described earlier can reveal or lead to reputational risk, financial transparency initiatives like Chain Reaction Research combine multiple and seemingly disparate types of information in their analyses. This helps to provide more information about companies' exposure to all five risk categories associated with environmental and social impacts of their commodity business.

MONITORING CORPORATE GOVERNANCE: A CASE STUDY OF INDONESIA'S PALM OIL INDUSTRY

Governance is a key element of whether citizens have trust and confidence in companies and markets. The Organisation for Economic Co-operation and Development (OECD) defines corporate governance as “a set of relationships between a company’s management, its board, its shareholders and other stakeholders. Corporate governance also provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance are determined” (OECD 2015, 9).

Analyzing corporate governance data can reveal three forms of interlocking executives—occurring when a director, executive, or board member serves on more than one board or is employed by more than one company:

1. Amongst direct competitors, which enables access to material non-public information and trade secrets; offers the ability to coordinate to defend illegal deforestation; and raises the potential for cartel behavior.
2. Amongst suppliers and buyers, which creates conflicts of interest as these individuals can

manipulate prices and have access to material non-public information regarding business expansion strategies.

3. Amongst a company and its regulator and investors, which creates numerous conflicts of interest. It is common for jurisdictions to make it illegal for a director, executive, or board member to serve or be employed by two or more corporations that are competitors or that buy and sell to each other. For example, in the United States, this behavior is regulated under the Clayton Antitrust Act of 1914; Indonesia’s 1999 Ban on Monopolistic Practices and Unfair Business Competition also serves this function.

Transparent governance data can enable improved analysis of the link between deforestation risks and companies that transact in related commodities. For example, as reported by Change Reaction Research (2018b), in April 2018, Citigroup canceled its loans and exited its relationship with Indofood Agri Resources and its related companies that derive revenue from palm oil ingredients production and trade, while continuing its line of credit to Indofood Agri Resources for short-term trade finance related to non-palm oil commodities. Likewise, in January 2018, Pepsi Co announced it had suspended relationships with Indofood Agri Resources and related companies (Chain Reaction Research 2018a). Both announcements were influenced by the availability of transparent governance data (covering issues regarding land, provenance, and human rights) and by pressure from civil society for greater transparency (Chain Reaction Research 2017a). Over the period of April 2013 to April 2018, Indofood Agri Resources share price decreased 75 percent.

In researching corporate governance in the Indonesian palm oil sector (Chain Reaction Research 2017a) using data from the Bloomberg Terminal and other sources, it was found that a major family-owned conglomerate was the majority owner of six publicly traded companies that had interlocking boards, executives, and directors, and which may have been functioning as a single company in direct violation of Indonesian laws. Minimally, through interlocking executive positions, these companies appeared to at least be in violation of Indonesia’s Competition Law. If true, these legal violations or unethical business practices bred unfair competition and alleged illegal collusion regarding deforestation-related behavior, resulting in undue profits to the company at a financial and environmental cost to the Indonesian public and a risk to investors.

Table 1 | Categories of Financially Material Risks within Agricultural Supply Chains

RISK	GUIDING DEFINITION	EXAMPLE
Business	Short-term tactical business losses that can occur if a company does not understand its market.	<ul style="list-style-type: none"> ■ A company loses market share because it is selling deforestation-linked commodities and some of its buyers change their consumer preferences.
Strategic	Long-term strategic business losses and ultimately bankruptcy if a company does not understand its competitive position.	<ul style="list-style-type: none"> ■ A company loses its ability to function as a viable, sustainable business when all of its revenue is linked to deforestation while none of its buyers want to purchase deforestation-linked commodities.
Market	The potential that market prices will adversely impact a company's financial position as it relates to its deforestation-linked commodities.	<ul style="list-style-type: none"> ■ Losses that occur when a company's equity price drops, its commodity sales do not occur as forecasted, interest rates on its debt fluctuate, and currency costs are incurred due to deforestation-linked commodities.
Credit	The risk that a firm associated with deforestation will incur default risk, credit spread risk, down-grade risk, and ultimately bankruptcy.	<ul style="list-style-type: none"> ■ The loss that a firm incurs if it or its trading partners—whether buyers or suppliers—are unable to make payments in a timely fashion, resulting in payment default, widening of credit spreads used in their loans, downgrade of their credit rating, and ultimately, bankruptcy.
Liquidity	The financial risk that for a certain period of time a given financial asset, security, or commodity cannot be traded quickly enough in the market without impacting the market price.	<ul style="list-style-type: none"> ■ The financial loss incurred if institutions are unable to sell their agriculture goods or assets related to deforestation in a timely fashion.
Reputation	The risk that adverse publicity regarding a company's business practices and associations, whether accurate or not, will damage confidence in the integrity of the institution or a loss in revenue; increased operating, capital, or regulatory costs; or destruction of shareholder value.	<ul style="list-style-type: none"> ■ Brand equity impacts from negative publicity, consumer concerns, or advocacy campaigns. ■ Damage to brand equity due to conflicts over scarce resources or environmental or social issues highlighted in advocacy campaigns. ■ Financial damage from the described reputational risk impacts.
Legal/Regulatory	<p>Violation of current regulations/legislation and lack of preparedness for compliance with broader changes in regulations.</p> <p>The risk of legal sanctions stemming from a company's failure to comply with laws, regulations, rules, related self-regulatory organization standards, and codes of conduct.</p>	<ul style="list-style-type: none"> ■ Penalties or fines due to violations of regulations within supply chains. ■ Failure to anticipate future government action such as taxes, incentives, duties, and tariffs that impact ability to conduct commerce. ■ Compliance costs due to violations of financial, environmental, labor, and corporate governance guidelines. ■ Legal actions or sanctions for failure to address negative environmental or labor rights impacts.
Operational	<p>Potential losses resulting from external physical events and management's failure to plan for and mitigate these events.</p> <p>Potential losses resulting from risk of a change in value caused by the fact that actual losses, incurred for inadequate or failed internal processes, people, and systems, or from external events (including legal risk), differ from the expected losses.</p>	<ul style="list-style-type: none"> ■ Reduced primary crop or livestock production. ■ Higher transport costs to haul imports longer distances. ■ Stranded assets due to shifting production zones. ■ Negatives from fraudulent staff, manager, and executive behavior.

Source: GARP.

Moving from theory to practice, from recognizing the potential to actively mining and curating these complex and seemingly disparate types of information, collaborations have developed pilot approaches in several different commodities and regions. To illustrate the approach and impact of these innovative financial transparency initiatives, three examples are illustrated here.

Table 2 | **Moving from theory to practice: examples of applied financial transparency**

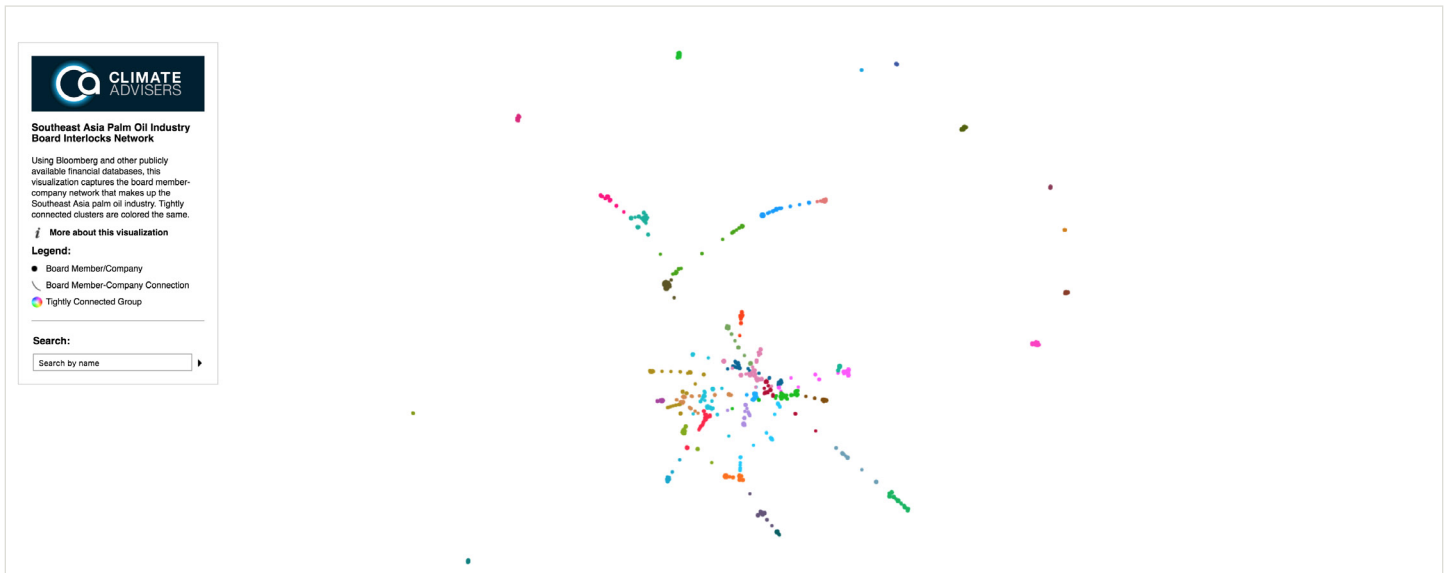
EXAMPLE I	
Investigators	Climate Advisers, in collaboration with Client Earth, and including conversations with several law enforcement, human rights, environmental, and financial data organizations
Country of focus	Brazil
Commodity	Soy
Main data type, methodology	Financial and governance information, including ownership structures, areas of operation, and influence and political connections of Brazilian companies in the soy sector
Findings	<ul style="list-style-type: none"> ■ Possible violations of labeling laws for soy exported to Germany <ul style="list-style-type: none"> □ A Brazilian soy producer sold to a European buyer over \$30 million worth of soy produced in the Amazon biome, when both companies claim to have no Amazon-based soy ■ Soy exported to Norway for feed may have been tied to forced labor as defined by the 2014 Protocol to the 1930 ILO Forced Labor Convention ■ Possible links to Brazilian money laundering
Communication strategy	Findings presented by Client Earth directly to the European buyer
Impact	<ul style="list-style-type: none"> ■ European company has begun direct engagement with NGO to help ensure its supply chain policies are followed ■ European company issued new and updated public policy that commodities it purchases from Brazil are zero-deforestation ■ Legal advisers to EU Commission are engaged with regional and national authorities to review effectiveness of labeling laws. Mislabeling the origin of products as zero-deforestation when they are, in fact, linked to deforestation is a violation of EU advertising and business laws ■ Public exposure alleged corporate malfeasance related to deforestation increased scrutiny of supply chain controls and verification process

Table 2 | Moving from theory to practice: examples of applied financial transparency (cont'd)

EXAMPLE II	
Investigators	Climate Advisers and Auriga, with initial support from the Erb Institute at the University of Michigan, followed by conversations with several law enforcement, human rights, environmental, and financial data organizations
Country of focus	Indonesia
Commodity	Palm oil
Main data type, methodology	Survey of financial and governance information, including ownership structures, areas of operation (concessions), and influence and political connections of 15 companies in the palm oil sector
Findings	<ul style="list-style-type: none"> ■ All companies surveyed frequently and repeatedly violated the 1999 Ban on Monopolistic Practices and Unfair Business Competition (also known as the Competition Law) ■ None of the companies surveyed transparently adhere to or comply with the 2014 Plantation Law regarding limits to hectare ownership ■ Only 20 percent of the total number of concessions owned by the companies surveyed adhere to Indonesian Sustainable Palm Oil (ISPO) system regulations ■ Only 15 percent of those concessions that have peatlands comply with Indonesia's peatland regulations, which are important tools within the suite of Indonesian laws and policies that can be used to prevent deforestation
Communication strategy	<ul style="list-style-type: none"> ■ Briefed the Corruption Eradication Commission, high-level actors at relevant ministries, and law enforcement ■ Findings shared with key local publications, elite global media ■ Pursuing coverage of multiple individual corporate stories, as well as globally focused "trend" agenda-setting stories ■ Positive engagement with Thomson Reuters, <i>New York Times</i>, <i>Forbes</i>, <i>Tempo</i>, and <i>Fortune</i>
Impact	<ul style="list-style-type: none"> ■ Raised awareness with government and law enforcement ■ Awaiting policy or legal action
EXAMPLE III	
Investigators	Climate Advisers, financial accountants, and the Environmental Investigation Agency
Country of focus	Indonesia
Commodity	Palm oil
Main data type, methodology	Financial and governance information, including financial accounting analysis of Noble Group's financial statements, their ownership structures, areas of operation, and influence and political connections
Findings	Noble Group overvalued their palm oil assets by about \$60 million ^a
Communication strategy	Direct discussions with Noble Group on their valuation
Impact	Noble Group decreased the valuation of their palm oil assets by about \$60 million after being presented with the financial analysis, which resulted in limiting the available financing, opportunity for, and attractiveness of converting more forests on its 70,000-hectare concessions to agricultural land

Sources: a. Thoumi 2017; Noble Group 2017.

Figure 2 | Sector-Level Map of Southeast Asian Palm Oil Industry Executive Interlocks



Note: For illustrative purposes only.

Source: Leetaru and Thoumi 2017. Data derived from publicly available sources as of Q2 2016 and may contain errors.

Climate Advisers conducted a review of corporate governance (the results of which were published by the CFA Institute) of the 70 largest agriculture companies that are publicly traded in Indonesia, Malaysia, and Singapore. The total dataset overlaid 2,500 estimated executive interlocks and 7,300 institutional investor positions, and included over 100,000 individual data points. Within this review process, from an analysis of publicly available information on 19 companies listed on the Jakarta Agriculture Index, two companies stand out above the 17 other companies. For these two companies, there were at least 34 cases of potential infractions under Indonesia’s 1999 Competition Law, which represented 61 percent of the potential legal violations found over all 19 companies. These legal violations occur when executives, directors, and board members in one of their companies held executive positions in other firms with which that company trades palm oil, directly or indirectly.

As shown in Figure 2, revelations of this network of corporate interlocks (Leetaru and Thoumi 2017) signaled to the market that these firms—which form part of a family of companies—were capable of manipulating the Indonesian capital markets to their advantage (Forest Trends 2018). At moderate resolution, Figure 2 reveals the interconnected nature of boards, not including overlapping executives and directors, of 12 different companies. Groups of investors and companies that are

more connected than the rest of the network have the same randomly assigned color, and node size is based on the node’s relative “importance” as determined using Google’s PageRank algorithm.

Clustered companies tend to indicate opportunities for collusion and cartel behavior; the more interconnected the boards, the closer the companies. This represents a clear concentration of power between companies, access to material non-public information, potential for cartel behavior, and possible violation of anti-trust legislation. In contrast, the same analysis of the remaining Singapore publicly traded palm oil companies found only two instances in which a company was interlocked with a publicly traded firm with which it trades palm oil, directly or indirectly.

Overall, applying big data analytics—where big data is defined as datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze (Manyika et al. 2011)—to transparency within the Indonesian palm oil sector had significant results. It revealed details of a network through which this family of companies appeared to be using beneficial ownership, revenue sharing agreements, and interlocking directorships to circumvent Indonesian laws or ethical business norms, while contributing to documented human rights abuses and deforestation concerns (Chain Reaction

Research 2017b, 2018a). As a result of the interlocking relationships, these companies' executives lacked independence and objectivity to work 100 percent of the time for their shareholders and had multiple conflicts of interest, some of which may represent violations of Indonesian law.

REMAINING CHALLENGES

To date, most of the progress achieved by various civil society initiatives targeting the linkages between commodity supply chains and deforestation has affected targeted companies' reputations—for example, through the use of rankings and by revealing geographical associations of supply chains with deforestation. More recently, as the examples shared here demonstrate, there has also been progress made in methods that combine various data sources and visualize the analytical results in a way that translates commodity-based drivers of deforestation into material risk and impact for companies and investors. Given the scale of these trials, these successes have affected only a small fraction of the problem similar to the scale of their trial size. Yet it is clear that new methods or systems and additional categories of financial data are needed to scale up impact and result in companies valuing and internalizing material risk on a regular basis.

There remain many challenges to enabling full transparency and ensuring accountability in global commodity supply chains. Improving access to, and analysis of, big data can help companies meet their commitments to zero-deforestation commodity supply chains and manage associated risk, and can help regulators and independent organizations hold these companies accountable.

The forest and climate policy communities are familiar with various tools and technologies for monitoring deforestation and tracking trade in deforestation-related commodities. However, this community has been largely unaware of the wealth of seemingly unrelated financial data that can reveal further detail on supply chains, help to explain the indirect drivers of deforestation, and be used to hold companies accountable to policy commitments and laws. Increasing awareness of data sources such as Bloomberg Terminal and Thomson Reuters Eikon, and increasing understanding of how they can be employed to monitor commodity supply chains, could significantly scale up success in reducing these drivers of deforestation. Access to existing data is

also a challenge, particularly to the nongovernmental organization (NGO) and public sectors, as the cost of such proprietary data can be prohibitive. For instance, while the Bloomberg Terminal has a public website that provides basic company information, similar to Thomson Reuters Eikon, the vast majority of their governance and financial data that would add value to supply chain research is only available with a costly subscription (ranging from \$1,200 to \$2,500 per month).

Even if environmental organizations are aware of these aforementioned data sources and have access to them, they generally lack the capital market skills and transactional background to efficiently and effectively analyze the data to reveal the facts and story that will impact corporate behavior. Until internal capacity is built, environmental organizations must rely on partnerships with financial analysts who are experts in financial data and who can make the data comprehensible for use in campaigns, policy development, corporate decision-making, and enforcement.

For example, visualization of big data analytics can produce powerful results, yet it is laborious, expensive, and can quickly become out of date. The relationship maps of palm oil companies and investors from a recent article published by the CFA Institute (Leetaru and Thoumi 2017) whose 130,000 charter holders drive ethical financial best practices globally—demonstrate the interconnectedness of the industry. For example, it is now possible to map interlocking board, executive, and management positions across direct competitors, peers, suppliers, and buyers so as to demonstrate collusion and access to material non-public information that materially impacts deforestation-related risks (Leetaru and Thoumi 2017). However, directorships are generally for one- to three-year terms, therefore confidence in the results decreases over time. Also, companies' supply chain relationships can change frequently.

While this type of analysis and visualization is currently labor intensive, future automation of these methods could address the timeliness issue and provide the resulting information in a format tailored to the needs of the various stakeholders—to environmental organizations for targeted campaigns, to governments for policy development and enforcement, and to companies and investors for improving assessment, valuation, and mitigation of environmental and legal risk associated with commodity supply chains. The technology to do this exists, but access to proprietary data for such an automated use

requires commercial terms to be negotiated with the data providers. Given the potential of this type of analytics to reduce risk and improve resilience in the market, and to increase public policy benefit, both global and local, the owners of these data platforms should look for solutions that will support greater transparency in this area—perhaps by making more of the relevant data available free of charge to the public, or by partnering with transparency organizations or NGOs as an intermediary to curate the data, and/or through government funding arrangements. The evolution of access to Landsat global land imagery, from sensitive government property to commercial property to global public good, may offer some lessons in this regard.

EVIDENCE GAPS AND AREAS OF CONTROVERSY

Applying big data analytics to the challenge of increasing transparency in commodity supply chains is a recent development, with some institutional efforts beginning in 2015 that contributed to the results presented in this paper. There is now a limited yet compelling clear evidence base that supports the theory of change. This has been demonstrated in a cost-effective, efficient, and replicable manner revealing potential violations of anti-monopoly laws by publicly traded palm oil companies. At the sector level, there has yet to be an assessment of the impact of greater transparency in commodity supply chains in terms of reducing deforestation rates, though they have begun to occur at the company level, as in the Noble Group case discussed in Example III of Table 2. However, proxy indicators—such as number of verified sustainable supply chains and number of reported cases of corporate malfeasance—could be monitored alongside deforestation rates to assess impact.

To date, this big data analytics approach has relied heavily on corporate financial and governance information about publicly traded companies, where regular, public reporting is required by law and financial regulatory authorities.

Private companies (from multinationals to smallholders) are also part of the global commodities market and thereby potentially associated with deforestation. As private companies are only required to report basic information, generally for tax and licensing purposes, they represent a constraint on the objective of full transparency of supply chains. This constraint can be reduced through pressure or conditions imposed by publicly listed companies that purchase commodities from the privately held companies.

This approach can demonstrate—as it has in test cases—corporate malfeasance, including violations of laws, regulations, or internal corporate policy or procedures. Companies themselves, investors (including banks), governments (including financial regulators and government-related sovereign wealth funds, pensions funds, and investment funds), and civil society can all act on this information in different ways. Investors and governments may receive this analysis yet decide to not act on it for any number of reasons. For instance, Indonesia’s Corruption Eradication Commission received analysis of the interlocking of many of Indonesia’s palm oil companies, and, according to a report by the Gecko Project and Mongabay (2017), the agency has been examining the legal compliance of plantation companies across the country, but no case has yet been brought to court.

The Indonesia example highlights the importance of developing ways by which the findings of these analyses can be used effectively within the context of any political economy. Local NGOs could use this data to help authorities develop a case for prosecution, but doing so in jurisdictions with significant levels of corruption could also be dangerous if powerful actors feel threatened. In such circumstances, increased transparency can upset the status quo, which may not be politically convenient or desirable for powerful actors. Transparency is a means to an end, not the end itself. If the information is not acted upon, the risks may not become financially material.

CONCLUSIONS AND NEXT STEPS

The impact of this type of transparency on forests will be two-fold. First, and most directly, it will provide important new information and options to help forest champions inside and outside of government fight corruption and illegality in Indonesia, Brazil, and elsewhere. Second, understanding diverse business relationships among commodity companies will have a positive upstream impact by allowing consumer goods companies, responsible investors, and other forest champions in consumer countries to reward (with their purchasing power) and finance downstream companies that are doing the right thing.

The movement to create transparency about corporate relationships in the agricultural commodities business is growing. The movement is currently at the same stage of development as the science of analyzing earth observation satellite data was in 2010. A few highly trained, well-funded experts and organizations with the capacity to manually sort through the data teamed up with some institutions developing automation trials and spent two years undertaking iterative analysis to draw key lessons learned. The work is accurate and powerful yet time consuming, expensive, laborious, and quickly out of date. Just as Global Forest Watch and similar efforts made it possible for anyone in the world to track deforestation in real time, accurately, and virtually for free, we need to automate big data analytics in the same manner.

Next steps include:

- Secure financial institution leadership from institutions that have expertise in governance risks analytics, combined with stakeholder input, to develop a set of overarching yet simple governance metrics useful to financial decision-makers that reflect the governance risks associated with deforestation.
- Partner with financial data holders to determine how public interest groups may have access to select categories of relevant data for key sectors of the economy involved in deforestation-linked supply chains.
- Partner with public authorities at national and local levels to build legal cases for prosecution.

- Conduct more “manual,” targeted analyses of companies with and without forest commitments and significant deforestation risk in their supply chains, or target companies by location of interest.
- Build an automated system of radical transparency for commodity supply chains, globally.

Based on progress to date, and the impact of the latest innovations, the potential to scale up impact in reducing the commodity drivers of deforestation (including from illegal activity) is very promising and growing rapidly, particularly as it aligns with corporate leadership on zero-deforestation pledges. Current trajectories of progress without these innovations are not enough to reach company commitments and global deforestation goals. What is needed is to increase impact, to hold companies accountable to commitments, and to get all companies to treat deforestation as a material risk. Once we can connect changes in forest cover in specific places to individual companies and downstream actors in the supply chain, and can overlay their ownership structures and demonstrate the inter-relationships among these companies, we can expect an exponentially increased impact in transforming the global agricultural commodities business to one that is friendlier to forests and the climate.

ABBREVIATIONS

FAO	Food and Agriculture Organization
GHG	greenhouse gas
IBRA	Indonesian Bank Restructuring Agency
ISPO	Indonesian Sustainable Palm Oil
NDPE	No Deforestation, No Peat, No Exploitation
NGO	nongovernmental organization
NYDF	New York Declaration on Forests
OECD	Organisation for Economic Co-operation and Development
RSPO	Roundtable on Sustainable Palm Oil
SPOTT	Sustainability Policy Transparency Toolkit

ENDNOTES

1. REDD+ refers to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks.
2. Global Association of Risk Professionals, <https://www.garp.org/#!/frm/study-materials>.

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