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The impacts of deforestation on corporate business: addressing risks and harnessing opportunities in a changing landscape

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Introduction

The growing awareness on the part of institutions and consumers, about the environmental challenges of our time, has prompted companies to shed light on their involvement in adverse phenomena for the planet and the global economy such as climate change, desertification or ocean pollution. The latter include deforestation, which is becoming increasingly important in the socio-economic fabric because of its repercussions on both ecosystems and economic and social activities. Indeed, it contributes negatively to the increase in greenhouse gases as well as to the loss of biodiversity or the alteration of water and climate cycles, indirectly affecting the operations of many companies. Despite the numerous environmental and social impacts associated with deforestation, there are still a minority of companies that consider and manage these impacts within their business. However, regulatory pressure together with the latest agreements made by state leaders at COP26 do not allow companies to ignore the issue.

In many cases, deforestation is not perceived as a problem because its potential impacts on business activities are unknown. As a result, potential risks for companies are difficult to identify and, for the same reason, they fail to adequately manage them. At the same time, pressure from stakeholders and the new European deforestation regulation require companies to adapt to certain requirements, as well as clear and transparent communication with the outside world. As a result of these circumstances, this paper aims to answer the research question of analysing the impacts of deforestation on corporate business.

The objective of the research is to understand what the potential impacts of deforestation on business are and how they occur, so that possible risks can be identified. Then, depending on the analysis conducted to identify risks, guidelines are provided for the management and mitigation of these risks. There is a focus on those of a regulatory nature and how companies can comply with the new European regulation on deforestation. The importance of this research is found in its ability to link the environmental challenge of deforestation to the risks and opportunities for businesses.

Understanding and effectively managing these risks not only contributes to improving business operations, but also enables companies to align with new regulations and the growing expectations of transparency from stakeholders.

Firstly, companies need to understand the potential correlations between their activities and deforestation, to be able to define both areas and methods of intervention. Therefore, in the first part of the paper, a context analysis is conducted, aimed at describing the state of the art and highlighting the most common scenarios and circumstances in which the problem manifests itself for companies.

Next, the analysis focuses on the impacts of deforestation, moving from general considerations concerning the environment and society to the details of what affects businesses. The focus then shifts to specific economic sectors to highlight the concreteness of the observations made. Thus, it is shown how companies operating in sectors such as forestry, agriculture, energy or food production are directly exposed to the negative consequences of forest loss. The latter compromises the planet's ability to absorb CO2, accelerating global warming and reducing the availability of many natural resources produced in forests. This makes several economic sectors vulnerable and subject to price fluctuations or potential disruptions of business operations, destabilizing not only the individual company but the entire supply chain. Moreover, companies that are complicit in this phenomenon can suffer significant reputational damage, losing the trust of investors and consumers. Especially with the introduction of stringent regulations such as EU Regulation 2023/1115, companies risk financial penalties and trade restrictions if they do not comply with the requirements.

At the end of the analysis, the results of the research are discussed from a business perspective, identifying what the potential risks might be and how to manage them appropriately. Despite the presence of many risks, it is emphasized that effective management of deforestation can also offer opportunities. The adoption of sustainable practices can improve corporate reputation, attract more investors, open new market opportunities, and most importantly, help companies build more reliable supply chains, reducing natural resource risks and improving their ability to adapt to future regulations.

In conclusion, this thesis aims to provide an in-depth analysis of the issue, to support companies in managing deforestation-related risks and to help them navigate a rapidly changing regulatory and environmental environment while ensuring their economic resilience.

1 Literature Review

1.1 Deforestation in the current perspective of companies and institutions

The concept of sustainability encompasses numerous themes (environmental, social, governance, etc.), which, depending on the context, take on different relevance. One topic that is beginning to gain in importance among states, but especially among companies, concerns deforestation. This phenomenon is now evident in the eyes of many and the repercussions have become even more tangible for companies. One can identify multiple types of impacts on climate, biodiversity or the global economy, specifically the study will go into more detail about those directly/indirectly impacting corporate business. Several studies have highlighted the crucial role of forests in mitigating climate change through their ability to store carbon and regulate global water cycles(Harris et al. 2021). However, the continued destruction of forests undermines these benefits, contributing to rising greenhouse gas concentrations and altered climate patterns. According to the Intergovernmental Panel on Climate Change (IPCC), human activities have increased the concentration of greenhouse gases by 48% since pre-industrial times, leading to an increase in the global average temperature. Furthermore, the issue of deforestation is crucial to the pursuit of global climate and Net Zero targets for companies. Recently, the focus on the issue has been the statements of the Leaders of the states for COP 26, held in Glasgow in 2021, on forest and land use. During COP 24, held in 2018 in Poland, 2030 had been set as the target date to stop deforestation. As a function of this, stricter due diligence regulations had been envisaged at both European and non-EU levels.

In the business environment, many companies are exposed to risks from deforestation, especially those operating in sectors such as agriculture, forestry and energy. The latest report produced by Global Canopy shows that 40% of companies and financial institutions with the highest exposure to deforestation have not yet established specific policies to address this issue (Global Canopy, 2023). This gap indicates a significant lack of commitment to countering a major risk factor from a sustainability perspective, in all its dimensions (environmental, social and governance), as well as being a contentious issue between companies and local communities/governments. As also reported in recent studies conducted by the Carbon Disclosure Project (CDP) and the World Resources Institute (WRI), deforestation can lead to disruptions in the supply chain, increases in raw

material costs and potential market losses for companies that fail to adapt to rising sustainability expectations.

Another critical aspect highlighted in the literature concerns the impact of environmental regulations on business management, with many companies failing to comply with them. According to some studies, lack of transparency in supply chains and poor traceability of raw materials are crucial barriers to regulatory compliance (OECD-FAO 2020).

The current literature also emphasises the relevance of a systemic approach to managing deforestation, which includes not only companies but also governments and NGOs in a collective action. It is shown that collaboration between different stakeholders can lead to more effective results in conserving forests and promoting sustainable practices (Georg Kappen et al. 2020). Despite this, there remain significant challenges related to fragmented supply chains and lack of traceability that make it difficult to monitor and manage risks related to deforestation.

Although there has been progress, several research gaps remain. For example, there is a need for in-depth studies on the economic impact of deforestation on both businesses and markets, especially in developing countries. Related to this need is the search for strategies and practices to manage the potential risks to businesses associated with the phenomenon.

In conclusion, while awareness of the problem of deforestation is growing, business responses often remain fragmented and insufficient. In this paper, the path of analysis starts not with the identification of a target, but with the assessment of the current context to identify risks and opportunities. Consequently, measures and policies are proposed to manage these risks and ensure the long-term sustainability of business operations.

1.2 The importance and role of forests

A first point to focus on is the understanding of the relevance of forests to the global economy, as well as to climate change and biodiversity conservation. According to *Harris, N. L. et al.,* 2021 about half of the world's GDP depends on nature and its ecosystem services, where services are defined as all those activities that ecosystems provide to the environment such as, for example, the provision of water resources, pollution reduction, pollination, soil maintenance, wood and raw material supply. Within the same article further aspects are detailed that give an idea of the value created by

forests, among them we take as a key point the amount of CO2 absorbed by forests each year, which is about 7.6 billion tones (*Harris, N. L. et al.,2021)*. These aspects are not only important for the well-being of the planet, but also for the continuity, growth and development of businesses. In fact, most industries depend directly or indirectly on forests, among them forestry, agriculture and food, which are closely related to resource extraction and the ecosystems that make up the biosphere.

According to an article published by BCG[1](Boston Consulting Group) (Georg Kappen et al. 2020) biodiversity is crucial for the functioning of ecosystem services, specifically related to climate regulation, air purification and water filtration. Services whose value is estimated to be roughly equivalent to twice the world's annual GDP. The loss of these services could create major health risks for humans, threatening the existence of billions of people and degrading the planet's ability to sustain human life. Sectors such as chemicals, retail, and consumer goods still have hidden dependencies on forests within their supply chains. As nature, due to deforestation, begins to lose its ability to provide these services, companies could suffer major losses. As a further consequence, financial institutions also face risks, linked to stranded asset returns and limited opportunities for diversification. In the specific case of the Amazon rainforest, large-scale deforestation can mean major changes in local weather conditions and a drastic reduction in water availability.

Despite their value and potential threats, there is unfortunately a high loss of forests. Tropical regions, rich in biodiversity, lost about 110 billion of square meters (over 15 million football fields) of trees in the last year. This includes about 4 million hectares of natural forests that absorb 2.5 Gt [2] of CO_2 (equivalent to India's fossil fuel emissions in one year)(Mikaela Weisse, Elizabeth Goldman, e Sarah Carter, s.d.).

Several world powers had moved to try to curb this phenomenon, e.g. during COP 26 the commitment made by leaders was supported through the allocation of public and private funds amounting to almost USD 19.2 billion. An equally crucial aspect to be considered, beyond the allocation of funds, lies in the mode of action envisaged to counter the phenomenon. For this we refer to the Paris Agreement of 2016, where a programme aimed

[1] BCG is a US-based strategy consulting firm.
[2] Carbon dioxide emissions are measured in gigatonnes (Gt), where one gigaton corresponds to one billion metric tonnes (1 Gt = 1,000,000 tonnes).

at reducing emissions and deforestation was created, namely REDD+ (Reducing Emissions from Deforestation and Forest Degradation). This programme provides a financial incentive for countries to support specific activities (to reduce emissions) through the issuance of carbon credits and other financial mechanisms. The role of forests is not limited to that of carbon sinks; rather, in mitigating the impact of climate change, they are able to stem the spread of infectious diseases. Thus, a correlation is found between climate change and the geographical distribution of zoonotic disease vectors such as mosquitoes and other insects.

In addition, forests provide a refuge for biodiversity, promoting ecosystem stability and reducing threats to wildlife (primarily due to human actions). The lockdown period saw urban and peri-urban forests become essential spaces for maintaining human health through outdoor physical activity. These green spaces not only provided recreational opportunities, but also improved urban air quality, another important public health benefit, especially when respiratory viruses such as Sars-Cov-2 were a global threat. The importance of forests in providing ecosystem services that contribute directly and indirectly to human health has been recognized as essential to future pandemic prevention and response strategies. The value of forests, therefore, transcends their ecological role, placing them at the centre of public health and environmental sustainability policies.

1.3 Analysis of the current business scenario

Although many companies put a lot of emphasis on their tree planting programmes as reparation for their carbon debts, only a few are implementing concrete actions to eliminate deforestation, especially at the supply chain level. There is often a practice of creating a deceptively positive image of one's own company's environmental impact, which tends to be done by emphasizing minor initiatives or through vague language and green symbols in communication strategies. This practice, referred to as greenwashing, misleads consumers into believing that they are buying sustainable products or services even though there is no concrete commitment of the company to adopt sustainable practices. The first step in guiding a company to avoid actions that contribute to deforestation is to recognize the phenomenon and report on what is happening within the supply chain. Before even considering how to act, it should be understood in what ways and to what extent companies contribute to and are affected by deforestation. Among the determining factors is the supply chain, within which most deforestation occurs.

However, it is not a common practice to report in detail on the origins and manifestations of this phenomenon, as several reports testify. Among the best known and most in-depth, with reference to the topic of deforestation, is the CDP (Carbon Disclosure Project) report. This report states that out of a total of 1043 companies considered:

- Only 3% report data on deforestation that could be useful in assessing and tracking how they contribute to the phenomenon;
- Only 12% of them monitor, considering the entire value chain, their footprint on the phenomenon;
- Over 33% do not consider the phenomenon at the supply chain level and therefore do not report any data.

Therefore, the first step in the corporate environment is to initiate an internal investigation to verify and trace (especially through the supply chain) the link between companies and deforestation.

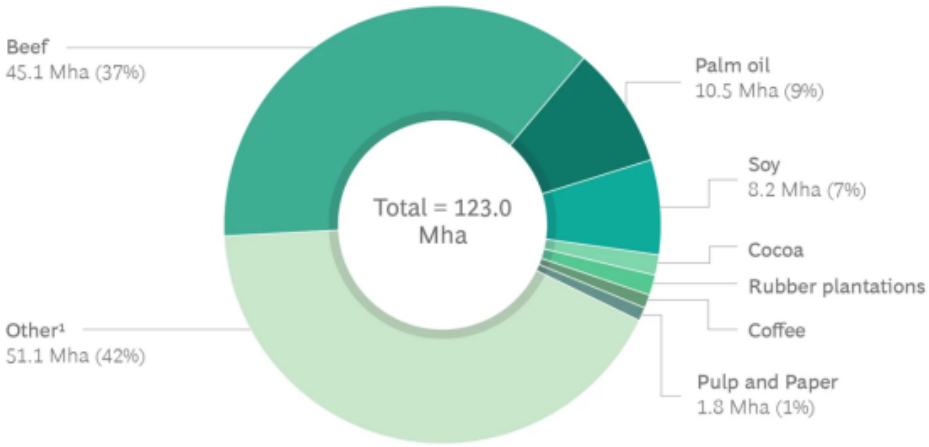
The following study carries out analysis and considerations from an international perspective; however, it must be emphasized that each Country is strongly influenced by local legislation. Several studies (including that of CDP) show a gap in proactivity between North American and European companies, due precisely to the lack of strong regulation on deforestation. According to the same report, only 1% of North American companies supported a rigorous assessment of forest-related risks and none of them provided financial or technical assistance to suppliers to reduce deforestation. At the same time, it is recognized in the US and Canada that there is a large presence of companies in sectors related to highly biodiversity-impacting activities such as soybean, palm oil, timber and cattle farming. Probably the remoteness of the company headquarters from the places where deforestation occurs makes this phenomenon less visible and less controllable for the companies themselves.

For the analysis of the current context in which the companies operate, it may be useful to evaluate certain aspects also reported in the BCG article, which introduces 3 key circumstances to be considered in the fight against deforestation and its impacts. These are considered as assumptions from which to develop a solution approach and reflect respectively: the impact of consumer companies, the factors for companies to intervene

in deforestation, and the structure of consumer companies. The 3 assumptions are detailed below:

1. Regarding the former, the graph below shows the values associated with the cultivation of beef, palm oil, soy and pulp and paper, which directly affect deforestation to the extent of 54%. Compared to the overall phenomenon, it can be said that 39% of global deforestation is associated with forestry and agriculture activities, which require the land to be cleared of forest areas. This means that with respect to events such as forest fires, agriculture has a permanent impact, taking away areas from the forest forever, while a fire, for example, does not exclude in the long term the planting of new trees on the affected land and thus the reconstitution of a forest area.

1. Agriculture-driven deforestation per commodity, 2001-2015, in millions of hectares (Mha)



Source: World Resource Institute

2. The second assumption to consider concerns the two factors that contribute to the interventionism of companies. These factors are time, since intervening in the short term has greater effects than intervening in the long term, and the various types of stakeholders that exert an influence on corporate decisions. As emphasized earlier in the paper, the starting point is the supply chain, as it represents the basis of corporate activities with which the risks of contributing to deforestation are associated. As such, an intervention in the supply chain

represents the first step necessary to be able to continue with further sustainability activities, such as reforestation or, more generally, the management and mitigation of impacts from deforestation. Companies that do not undertake activities to assess, manage and mitigate the risks of deforestation in the short term will find it more difficult in the future to manage the related impacts on their business, especially from a supply chain perspective. The other rather relevant factor is the stakeholders, who demand that companies stipulate and adopt sustainability policies and automatically integrate them into their corporate priorities. In fact, consumers are increasingly sensitive to environmental issues, favouring companies that demonstrate their commitment at the expense of others. Government and other institutions (such as the EU) through regulations and legislation provide incentives for companies to move in a more sustainable direction, including with respect to the issue of deforestation. Investors, as a third category of stakeholders, in most cases demand a certain level of ESG performance (which obviously includes actions with respect to forest management). Finally, employees themselves, according to a BCG survey, have a greater incentive to work for a company that considers the issue, while one in two say they do not want to work for one that ignores it.

3. Regarding structure, it can be stated that compared to suppliers, consumer companies are larger in size and operate in a less fragmented stage of the value chain. Hence, they not only have more resources and influence, but can involve many players in the industry and have the possibility to achieve significant results globally.

According to these three assumptions and based on the data in the CDP report, a collective approach is suggested, involving not only a set of companies but also public and private institutions, local authorities and NGOs. This type of approach is preferred as being more effective and the reasons for this lie in four key aspects:

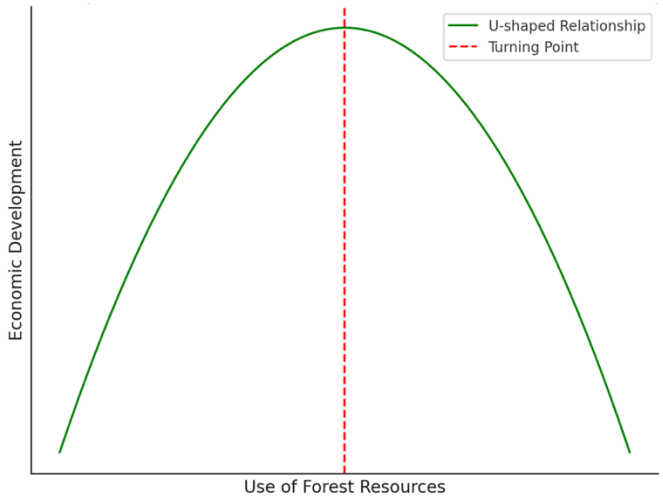
1. Possibility to act towards the same direction, without the need to align or wait for consensus from governments and industries;
2. Possibility of setting a common standard and preventing some companies from acting against environmental interests by promoting unfair competition practices to the detriment of environmental objectives;

3. Possibility of adopting a broader and more systemic approach, channelling resources and actions in each area instead of dispersing them indiscriminately. Contributing to a common cause more effectively than is feasible individually;
4. Establishing a roadmap and common action plans that foster the sharing of best practices and resources to make the final goal achievable.

A further consideration concerns the territories most affected by deforestation, which are concentrated in developing countries. Within these, which often host the largest (tropical) forests, several drivers of deforestation can be identified. What emerges from a study on the correlation between economic development and deforestation (Siregar, Sentosa, e Satrianto, 2023), is particularly interesting in demonstrating the importance of the approach to the phenomenon by companies and institutions. Through a quantitative analysis, it is shown how the economic development of countries such as Indonesia and specifically the province of North Sumatra is closely dependent on institutional factors. Thus, contrary to popular belief, it is not exclusively natural or forest resources that drive economic growth. Rather, it is investment in human capital, in terms of improving health conditions and the quality of education, that underpins it. The result of the study is consistent with the idea that institutional factors have an impact on deforestation. Well-performing institutions can generate better environmental management through the implementation of effective public policies. It is inferred that a decrease in institutional quality leads to an increase in deforestation. In turn, forest resources do not contribute to economic development; on the contrary, their overexploitation can lead to environmental degradation that can hinder it.

The graph below briefly explains the relationship between Economic Development and Forest Resources.

2. *Relationship between Forest Resources and Economic Development*



Source: Own elaboration.

This aspect is crucial in identifying the best approach to follow to combat the phenomenon. Institutions, in this sense, play a key role by defining strict and transparent policies for the conservation of forests, incentivising business development through human capital incentives thus leading to an improvement in the welfare of communities and businesses while reducing deforestation.

1.4 ENI's approach

Companies, which today face the risks of deforestation, are better prepared to manage future regulations, as well as to preserve and increase cash flow, making them more attractive for long-term investments. One of the best-known companies in Italy that has adopted policies to combat deforestation is ENI. The latter has included deforestation among its other relevant sustainability issues. In general, Eni first set a series of targets, including the achievement of Net Zero in 2050. In detail, individual aspects are analysed in the long-term strategic plan drawn up by the company, which integrates sustainability into its business model. Within the plan, the goal is illustrated as net zero emissions scope 1 and 2 upstream to 2030. By 2050 it aims to achieve an -80% reduction in scope net emissions 1,2,3[3] related to the entire life cycle of energy products sold (*Ufficio Stampa ENI*, 18/11/2020). With respect to the impacts of deforestation, Eni focuses on emissions,

[3] Scope 1 are direct emissions controlled by the organisation, Scope 2 are indirect emissions related to the production of electricity, steam or heat. Scope 3 are indirect emissions from the organisation's value chain.

focusing its strategy on forest management with a view to climate change mitigation and the creation of an emissions offsetting system.

Eni's decarbonization strategy has forest conservation projects as its main driver. The latter, however, are part of a broader context of actions aimed at reducing emissions from industrial activities and offsetting emissions that cannot be abated with current technologies. In addition to these projects, further steps are planned such as the development of energy products from renewable and low-carbon sources (by waste and biomass).

Even before intervention policies are defined, the policies of BES[4], through which ENI identifies potential BES risks within the relevant macro-areas. For each of the macro-areas, following the identification of the risks and therefore of the relative impacts, the BES management model is proceeded with. The latter is structured in three steps: design and implementation of action plans and monitoring (BAP, Biodiversity Action Plan), application of the mitigation hierarchy, long-term collaboration.
ENI's interventions also focus on the sustainable development of communities and the conservation of biodiversity, and with this in mind, focus on tropical forests, especially those found in developing countries, which are given greater prominence internationally. The REDD+ projects that the company supports are aimed at reducing emissions and improving the natural storage capacity of CO2. They are associated with climate benefits, but also in terms of the social and economic well-being of local populations. Through these projects, ENI aims to generate carbon credits for each quantity of *carbon* not emitted into the atmosphere, a real compensation for carbon emissions that are difficult to abate with current technologies.

In support of its initiatives, ENI has declared the amounts of CO2 offset in the 2020[5] and provides an estimate of the targets it intends to achieve in 2024 and 2030. These statements help to numerically demonstrate the company's current commitment, as well as its adherence to high certification standards such as VCS (Verified Carbon Standards) and CCB (Climate Community & Biodiversity) to ensure the quality of the credits generated.

[4] ENI Policy on “Biodiversity and Ecosystem Services”.
[5] The declared value is 1.5 million tonnes of CO2.

1.5 Terna's approach

Terna is an example of another company in the Italian context that has mobilised itself through activities in favour of reforestation and biodiversity conservation. The "Biodotti" project was created with the intention of enhancing the microhabitats at the base of pylons to allow the movement of wildlife with a view to preserving and increasing biodiversity (Ufficio Stampa Terna, 2024). Simultaneous with this is the "Tiny Forest" project carried out by Terna in cooperation with the Italian Botanical Society, the aim of which is to create three plant communities. These communities will be cultivated using the method of Japanese botanist Akira Miyawaki, who is associated with a key role in CO2 absorption. The Miyawaki method takes its name from its creator and consists in reforesting certain areas according to intervention methods that imitate as much as possible what happens spontaneously in nature. Depending on the characteristics of the site, the tree species to be used are identified, collecting seeds in areas close to or with similar conditions to the intervention area. While these seeds are left to germinate in pots, the topsoil is recomposed by incorporating organic compost of various kinds. At a height of 30-50 cm, the pot-grown seedlings are placed in the topsoil while maintaining a high density. Finally, the surface is covered with natural mulch to prevent soil erosion and periodic weed control is carried out until the plants reach a height of 2/3 metres.(Raffaele Orrù e Alberico Bedini 2021). A key aspect to be considered in Terna's actions is the overall vision that drives the company's actions. In fact, the implementation of the latter project is not limited to the role of mitigating emissions but is part of a framework of interventions with multiple purposes, which contribute to both business and social-environmental goals. These interventions include:

- the creation of infrastructures in symbiosis with the landscape so as to reduce the visual impact as much as possible;
- the creation of forest areas in various Italian regions to mitigate the hydrogeological and soil erosion risk;
- the implementation of projects to contribute to the development of birdlife near power line supports.

One of the most interesting aspects of the "Tiny Forest" initiative is precisely the context in which reforestation is planned. The project's mission is precisely that of recreating forest areas within urban contexts, a somewhat challenging mission considering the

limited space and environmental conditions. However, the goal is valid and effective. In fact, through this initiative, the aim is to safeguard biodiversity in cities, but above all to mitigate climate change by capturing CO_2. Both would benefit citizens by improving air quality and providing green spaces that not only beautify the cityscape but also promote the psychophysical well-being of the community. Moreover, the way in which they are grown, i.e. the Japanese botanist's method, makes them, however small, quite efficient, as they can grow very fast and expand their CO_2 absorption capacity in a short time. These areas can become important educational and environmental awareness tools, involving local communities in the care and understanding of ecosystems.

Thus, it can be said that Terna's strategies for managing the impacts of deforestation focus on biodiversity conservation. Both the “Biodotti” and “Tiny Forest” projects reflect an integrated approach that combines biodiversity enhancement with carbon sequestration, contributing to climate change mitigation. In addition, the company's focus on urban contexts is emphasised in its efforts to minimise environmental risks related to soil erosion and hydrogeological risk, considering both socio-environmental and industrial impacts.

1.6 Most Affected Economic Sectors and Stages in the Value Chain

Generally, it is recognised that several sectors suffer negative impacts due to forest loss. Below is a list of some of them:

- Tourism: Several tourist destinations are such depending on the natural beauty and biodiversity of forests, consequently the negative impacts associated with forest degradation are reflected on the destinations themselves. For example, places such as the Bale Mountains National Park in Ethiopia attract tourists due to the presence of endemic species and forest landscapes. Deforestation poses a threat to these attractions, reducing the attractiveness and income of local economies heavily focused on the tourism sector(Welteji e Zerihun 2018).
- Fisheries and water resources: Deforestation can alter hydrological cycles, altering river flows, soil fertility and water quality, adversely affecting the availability of water for human, agricultural and industrial use. This can have direct effects on water-dependent sectors such as fisheries and agriculture. Deforestation practices that lead to increased soil erosion can increase sedimentation in watercourses, compromising

vital aquatic habitats for fisheries (https://www.worldwildlife.org/threats/deforestation-and-forest-degradation).

- Agriculture: The removal of forests can significantly alter local microclimates, which are essential for the cultivation of many crops. In addition, the loss of forests reduces soil fertility through erosion and degradation, forcing farmers to move and deforest additional areas to maintain production. For example, the cultivation of oil palms, a significant driver of deforestation, replaces large areas of tropical forest, altering ecosystems and reducing the capacity of the land to support future agricultural activities(Global Forest Review 2024).
- Textile sector**:** From the production phase of natural fibers, such as cotton, to the transformation processes, the consequences of deforestation compromise the quantity and quality of raw materials, generating delays and higher costs. In fact, the destruction of forests affects hydrological cycles, reducing the availability of water needed to irrigate crops, causing greater dependence on artificial irrigation, which in turn increases production costs and impacts the sustainability of agricultural operations.

These impacts demonstrate how deforestation can have cascading effects on various economic sectors, undermining their long-term stability and sustainability. An interesting aspect to investigate concerns the connection between where deforestation occurs and where it originated. The connection between the two can have several reasons at its origin, above all it can be linked to different business activities, which exploit certain areas for the supply of raw materials. Thus, the correlation with business activity is complex and multi-faceted, reflecting a global dynamic in which environmental impacts do not necessarily occur where a company does business. Companies, especially those with a global value chain, may contribute to deforestation in distant countries through their demand for raw materials. In many cases, production chains are developed from forest areas that are converted into agricultural land or areas for livestock farming. This tends to be attributed to the growing demand for the same raw materials. Such a relationship between business activity and relocated deforestation generates significant issues in terms of corporate environmental and social responsibility, here the analysis focuses on the reverse, i.e. how relocated deforestation can impact businesses. In the former case, steps have already been taken to track the actions of companies, trying to monitor their

ecological footprint through supply chain traceability, sustainability certifications, new regulations, innovation in production practices and the selection of certified suppliers. While tracking the impacts of deforestation on company business is more complicated due to the discrepancy between the areas where the phenomenon occurs and the location of the companies.

2 Empirical Analysis

2.1 Methodology

Compared to the literature introduced in the previous chapter, there is a gap inherent in the lack of consideration of the phenomenon of deforestation and its impacts on corporate business. Therefore, in the following paper, the objective will be to fill this gap and provide companies with the necessary tools to deal with the phenomenon. In this regard, the method of analysis includes several approaches, mainly a qualitative analysis of the collected data and reports is conducted. Starting from the latter, a value chain analysis is carried out, focusing on a specific industry, to understand how deforestation affects the various stages of the chain and identify critical points and potential vulnerabilities. The subsequent scenario analysis allows us to assess how different variables (regulations, climate change, etc.) might impact the business. Then, through a SWAT analysis, potential risks and opportunities for business related to the deforestation phenomenon are identified. Finally, in the discussion of the results, potential risk management measures are proposed following a materiality analysis to assess the relevance of the risks, together with the use of further frameworks/tools such as the Mitigation Hierarchy and ENCORE. The latter respectively deal with applying a hierarchical approach to risk management and mapping the dependencies of companies on ecosystem services, with the aim of developing strategies for risk mitigation and compensation.

Overall, the research is geared towards examining and describing the impacts of deforestation, linking existing theories and practices with available data and reports in order to formulate a set of tools and strategies to support companies in the proper management of deforestation-related risks, with a particular focus on compliance with regulatory requirements.

In addition, to formulate a set of tools and strategies to support companies in the proper management of deforestation-related risks in this paper, correlations between existing

theories and practices with available data and reports are assessed to address both current and future business requirements related to compliance with European deforestation regulations.

Data collection is based on reports from international organisations (e.g. CDP, WRI, FAO, OECD), European regulations and the consequent analysis of the regulatory environment as well as commonly used company policies.

Potential limitations of the following methodology are related to the dependence on secondary data, as a large part of the analysis is based on data and reports provided by international organisations or bodies. At the same time, there is uncertainty related to regulatory or political changes, which even if remote could alter scenario analyses that include current regulations and their potential developments.

2.2 Analysis of the impacts of deforestation: direct and indirect impacts.

In the following chapter, the impacts of deforestation will be examined, starting from a broader perspective encompassing the environmental sphere to a more specific view of socio-economic repercussions. In addition, the links between these two dimensions are outlined, defining the scope and incidence of potential impacts for business activities. The aim is to highlight how environmental dynamics can directly and indirectly influence the economic and operational environment of businesses.

2.2.1 Direct impacts: climate change

Carbon dioxide is the main greenhouse gas responsible for rising global temperatures. The removal of this gas from the atmosphere and its storage, through forests, are essential to mitigate climate change and regulate the climate. Forests act as a crucial link between the inorganic and biological worlds; they are efficient ecosystems that capture carbon from the air in the form of CO2, transform it into organic carbon in their structures and sequester it for long periods. The latest assessment report by the Intergovernmental Panel on Climate Change (IPCC) highlights the profound and negative impact of human activities on the Earth's climate. The use of fossil fuels (such as coal, oil and gas) and some industrial processes, such as cement and steel production, release large amounts of CO2 from both combustion and the chemical process of limestone calcination. These activities have increased the concentration of greenhouse gases by 48% since pre-industrial times, to such an extent that IPCC scientists have observed an increase in the

average temperature of the earth's atmosphere of about 1.1 °C from 1850(Ipcc 2022). This increase has generated significant climate changes visible all over the world, such as rising sea levels, melting glaciers, warming oceans, reduced agricultural production and an increase in the frequency, intensity and extent of extreme weather events: heat waves, prolonged droughts, torrential rains, hurricanes and cyclones, floods and storm surges. Climatologists have recorded numerous extreme events in recent years, including heat waves that killed hundreds of people in the United States and Canada, floods that devastated infrastructure in Germany, Belgium and China, and widespread fires in Siberia, the United States, Europe and the Mediterranean basin. It should be noted that numerous climate records have been broken since the beginning of 2023. For example, the first few days of July 2023 were the hottest ever recorded, with the global average temperature reaching its highest value since the beginning of measurements (17.23°C on 6 July 2023). (https://www.ipcc.ch/report/ar6/syr/)

In previous reports, the IPCC did not always attribute climate change as the direct cause of extreme weather events, however, in the latest edition, the Sixth Report, they stated with certainty that most extreme events in the past decade would be highly unlikely without climate change generated by human activities. With a temperature increase of 1.5 °C, many of the long-term effects of global warming, in particular changes in polar and alpine glacier extent and sea levels, will be unavoidable for centuries. Specifically, the Impacts, Adaptation and Vulnerability report identifies four main risk categories (risks of heatwaves on populations and ecosystems, risks to agricultural production, risks of water scarcity, risks caused by more frequent and intense flooding) for Europe, with each risk intensifying as global warming increases. If climate change adaptation measures remain poor, these risks become more severe, rising by 2°C instead of 1.5°C.

In the context of extreme climate change, deforestation contributes to amplifying these events because forests act as natural climate regulators. Their loss accelerates the cycle of natural disasters. In addition, industrial activities and the use of fossil fuels in general not only increase the concentration of CO2, but through deforestation rob the planet of a key element in the mitigation of emissions.

2.2.2 Direct impacts: disruption of the water cycle

In the water cycle, trees play a crucial role through the transpiration process, where they absorb water from the soil and then release it into the atmosphere. With the removal of trees, water vapour fluxes are significantly reduced, which can alter local climate regimes and consequently reduce precipitation. Their decrease causes direct effects in groundwater by affecting the availability of water for agriculture and human consumption. At the same time, soil with the removal of trees becomes more susceptible to erosion, which in intense weather events such as storms or hurricanes can cause increased surface runoff. The latter causes reduced infiltration and increased sedimentation in watercourses. A phenomenon that risks causing problems such as clogging of rivers and a decrease in water quality. In fact, with fewer obstacles such as forests, water can move more rapidly across the landscape, altering the natural cycles of rivers and increasing the frequency and intensity of flooding. The ultimate effects of flooding spill over to local communities, infrastructure and ecosystems. At the same time, surface runoff makes it more likely that contaminants such as pesticides and fertilisers will be carried into watercourses, acidifying and contaminating water quality even more.

2.2.3 Direct impacts: soil erosion.

Deforestation has a significant impact on the chemical, biological and physical properties of soil, with long-term consequences for the health of terrestrial ecosystems. The reduction of organic carbon and soil nutrients, such as nitrogen and phosphorous, is one of the direct consequences of deforestation. This depletion not only decreases soil fertility but also limits the availability of elements essential for plant growth and the sustainability of microbial life. In parallel, deforestation leads to a significant reduction in microbial biomass, which is essential for nutrient cycling and the decomposition of organic matter. The decrease in microbial activity directly affects the soil's ability to transform and recycle organic matter, making the soil less productive and less able to support natural vegetation. Removal of forest cover can lead to an increase in soil pH, moving it towards more alkaline conditions that can negatively affect mineral solubility and nutrient accessibility. Soil pH is crucial because it directly affects the availability of nutrients to plants. Many essential nutrients, such as iron, phosphorus and potassium, are only available within certain pH ranges and can become less soluble (and therefore less available to plants) if the pH shifts too far from these optimal ranges. Deforestation can

alter soil pH by increasing it, i.e. making it more alkaline, especially if the soil is exposed to intensive practices such as agriculture, which often involves fertilisers that can alter pH. This alteration of pH can affect plant growth and disturb the existing microbial balance.

Deforestation also affects the quantity and quality of soil litter. Soil litter is composed of fallen leaves, twigs, fruit and other organic materials that are deposited on the forest floor. This litter is crucial to soil health because, as it decomposes, it releases nutrients that enrich the soil and feed the microbial diversity in the substrate, as well as helping to maintain soil moisture. Deforestation drastically reduces the amount of available litter, depleting the soil of vital nutrients and exposing it to increased erosion and degradation. A drastic decrease in soil biodiversity is another critical consequence. The "biota community" comprises all living organisms in the soil, including bacteria, fungi, insects, earthworms and other micro- and macro-fauna. These organisms play critical roles in nutrient cycling, decomposition of organic matter, soil structure and protection against plant pathogens. The biodiversity of this community is essential for the maintenance of ecological functions and ecosystem resilience. Deforestation can drastically reduce the diversity and abundance of these biota communities, compromising the essential functions of the soil and its ability to support plant as well as animal life (Zhou et al. 2021).

The cumulative impact of these changes not only renders soil incapable of supporting plant growth, but also undermines its ability to function as a sustainable reservoir of biodiversity and as a critical regulator of global carbon and nutrient cycles. Deforestation thus results in a series of mutually reinforcing negative effects, leading to far-reaching environmental degradation.

2.2.4 Direct impacts: biodiversity loss

Biodiversity, or biological diversity, represents the variety and complexity of life on a planet, including the genetic diversity within species, the diversity of the species themselves, and the diversity of the ecosystems in which these species live. It is a key component in the functioning of ecosystems, providing essential services such as air and water purification, climate control, plant pollination and waste decomposition.

Deforestation directly threatens biodiversity, mainly through the destruction of natural habitats. Forest habitats are among the most complex and biodiverse on the planet; they are home to more than half of the world's terrestrial species. When forests are cut down or degraded, the species that live in them lose their natural habitat and are often unable to survive in their new altered environment, leading to a decline in local biodiversity. This not only includes the loss of animal and plant species, but also of microorganisms and fungi that are essential for biogeochemical cycles, such as the carbon and nitrogen cycle. Furthermore, deforestation fragments the remaining forest ecosystems, creating small islands of habitat that cannot support the same amount of biodiversity as unbroken forests. Fragmentation reduces the ability of species to migrate and exchange gene pools, leading to a decrease in genetic diversity that may compromise the ability of populations to adapt to environmental changes or pathogens.

Biodiversity is critical to the stability and health of the planet's ecosystems, as they act as a buffer against extreme weather events, such as hurricanes and floods, stabilising the climate and absorbing large amounts of carbon, which is vital for moderating global warming. It also provides support to natural systems that deliver ecosystem services on which all life forms, including humans, depend (Etifor 2023). Forests, oceans, streams and grasslands cyclically manage large quantities of water, in turn regulating the climate and providing water resources for billions of people. Consequently, such habitats are more effective in filtering contaminants and providing clean water when they are healthier and more biodiverse. The loss of biodiversity due to deforestation can have cascading impacts on ecosystems. For example, the loss of a single key species can cause the disappearance or decline of many other species that depend on it for food, shelter or other ecological services. Furthermore, reduced biodiversity can reduce the resilience of ecosystems, making them more vulnerable to environmental stresses such as disease, exotic species invasions and climate change.

Finally, biodiversity is essential for communities living near forest areas. A variety of plants and animals ensures not only a balanced diet but also a safety net against the failure of individual crops or fish stocks. As an example, diversity of plant species allows farmers to select varieties resistant to specific pests or climatic conditions, reducing the risk of crop failure. Loss of biodiversity can lead to more vulnerable monocultures, increasing the risk of mass crop failure due to disease, pests or climate change, reducing the

availability of food for local communities. Besides the risk of causing imbalances in the diet of local inhabitants and cases of malnutrition, there is also the risk of exposure to zoonotic diseases. Indeed, habitat destruction resulting from deforestation tends to increase interactions between wildlife and humans, raising the risk of transmission of pathogens from animals to humans. These pose a problem for human populations, as they often lack natural resistance to these pathogens. Such an increase in interaction with wildlife facilitates the transmission of diseases such as yellow fever, Ebola and the Nipah virus. Especially in the aftermath of the Covid-19 pandemic, the global risks of zoonoses have been highlighted, emphasising the importance of maintaining natural ecosystems to reduce these risks.

2.2.5 Direct impacts: forest fragmentation and fire incidence

Forced land change is the conversion of forest land to agricultural, livestock or other areas by force. This means modifying the land and its conformation, fragmenting it into smaller, isolated portions. This process has several ecological implications; fragmentation reduces the available habitat for species, contributing to local extinction due to the reduced possibility of migration and genetic exchange. Species that cannot disperse become particularly vulnerable, as they cannot easily cross the middle ground between forest fragments. Near the edges, microclimatic changes such as higher temperatures and lower humidity often occur, which are additional barriers to species movement and increased tree mortality. In turn, fragmentation has led to increased human settlements that threaten the well-being of wildlife as well as exacerbating illegal logging.

Undergrowth fires, known as surface fires, usually occur when leaf litter and other biomass in the undergrowth catches fire. These fires, usually of low intensity, can have devastating effects on forest ecosystems. Their increase in frequency and intensity is linked to forest degradation, which leads to more combustible material and a reduction in undergrowth moisture. The combination of the loss of forest cover, which contributes to the vulnerability of the area during the dry season, and human activities, which risk introducing flammable elements, jeopardises the safety of forest territories. The spread of undergrowth fires generates a reduction in the biomass and carbon sequestration capacity of the forest, further exacerbating climate change. These fires tend to alter soil structure and vegetation composition, favouring the development of pioneer and weed species at the expense of native species. It is precisely the latter that suffer the loss of their habitat

and food sources. Sometimes, the spread of these fires can lead to the transformation of forests into savannah ecosystems, as is happening in the Amazon. This type of ecosystem is characterised by a combination of tall grasses and scattered shrubs, with temperatures tending to be high all year round and water availability varying between seasons. The frequency of fires changes the structure and composition, favouring the growth of fire-resistant grasses and shrubs, while reducing the recovery of tree species. All this results in a reduction in biodiversity, altered carbon and water cycles, as these areas have a significantly lower carbon sequestration capacity than forests. There are also negative consequences at the socioeconomic level, as these represent essential resources and ecosystem services for local communities. The loss of forests not only threatens the supply of timber and habitat for wildlife, but also risks destabilising the survival of communities, whose diet is closely related to the presence of the forests themselves.

2.2.6 Indirect impacts: business dependence on ecosystem services

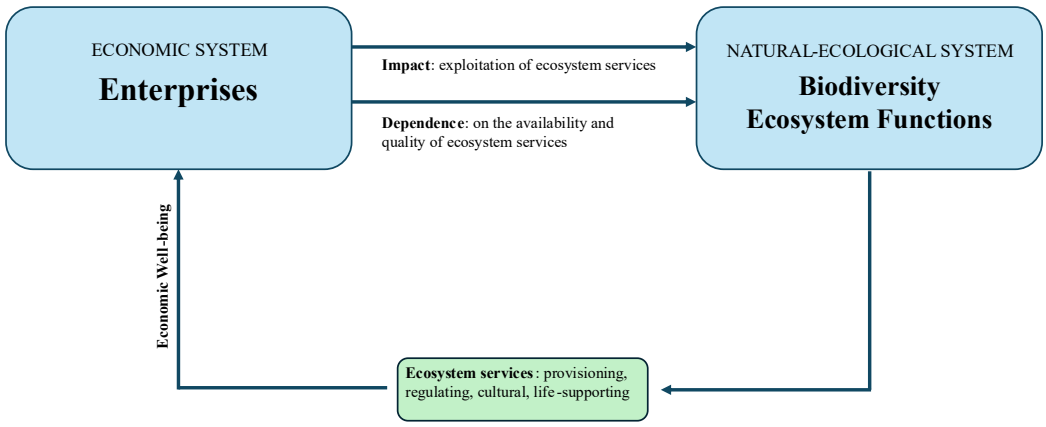
Ecosystems have a positive impact on human wellbeing and health, either directly through performing crucial functions such as water purification and the production of wood or food, or indirectly through functions such as climate regulation, pollination or soil formation. These functions and the associated benefits for humans are encapsulated within the concept of ecosystem services. Analysing these services and measuring/evaluating them allows the relationship between business and the environment to be explored from a new perspective, in order to determine the challenges that arise as the biosphere degrades. Ecosystems, due to their structure and the exchange processes between units, allow for the proper unfolding of nutrient cycles, which are essential for the replenishment of elements essential to life. These cycles require the presence of one element in particular, a victim of today's environmental crisis: biodiversity, which is essential for maintaining the vitality of ecosystems. (Carvalho, Cojoianu, e Ascui 2023) What follows the planet's loss of biodiversity is an increase in the fragility of ecosystems and a concomitant reduction in their resilience, making them no longer able to survive external stress situations. With respect to ecosystem services, four main categories can be identified:

- Supply/supply services: generate tangible goods such as food, water, fiber, wood, fuel and other raw materials;

- Regulatory services: such as climate, tidal, water quality, pollination and pest control;
- Cultural services: such as the use of nature for spiritual, aesthetic, recreational and educational purposes
- Life-support services: these include primary production such as nutrient cycling, decomposition and soil formation.

The services identified so far contribute to the wellbeing of individuals and the creation of value for businesses, which make use of them in various sectors such as, for example, agribusiness exploits pollination processes or climate regulation. In turn, fishing makes use of fishery resources, wood and paper production benefits from the raw materials provided by ecosystems, tourism exploits the value generated by seashores, coral reefs or forests. Considering this, changes in the use of eco-services, due to the environmental crisis, inevitably affect the operations of companies active in the various sectors. The consequence is a risk on business continuity and its economic-financial sustainability.

3. Correlation between the economic system and the ecological system



Source: Own elaboration.

The interaction between business functionality and access to services produced by the ecological system is strongly influenced by the health of the processes involved. Increasing fragility of ecosystems, loss of biodiversity, and reduction of ecological resilience may have a retroactive effect on enterprises and their value chains, leading to

new risks and new operational strategies. A potential example could be that of the 1990s in supply services, where the sudden disappearance of cod in the North Sea as a result of intensive and prolonged fishing, had an impact on companies such as Unilever, which used the raw material for fish sticks (Frey, Marco, Gusmerotti, Natalia, e Pogutz, Stefano 2018). This impact was reflected in higher raw material prices and risks to business continuity due to the scarcity of the resource. Hence the need for companies to search for new fish species to replace cod, as well as the introduction of a label and certification system for sustainable fishing such as the "Marine Stewardship Council".

2.2.7 Indirect impacts: socioeconomic implications of deforestation

In this section, the impacts of deforestation on the socioeconomic level will be discussed in general terms. These can manifest themselves along the entire value chain, but especially both in the vicinity of the companies themselves and in the territories upstream in the chain. In fact, especially in areas that are not predominantly forested, the presence of a forest is quite important in the climatic balance of the surrounding area. There are many circumstances that lead these territories to become the location of different enterprises: agricultural, food, energy, cosmetics, wood and paper production. The very need to increase the size of companies can lead to the removal of adjacent forests. The consequences of which are multiple and damaging:

- Worsening climatic conditions, with higher temperatures and altered rainfall patterns, which can require very expensive mitigation tools from businesses as well as undermining their productivity;
- Alteration of air and water quality, the effects of which spill over both into the human well-being of the people living/working in the affected areas and into production, which often benefits from the external conditions. In the case of hydroelectric power plants, the regulation of water flows is crucial for the operation of the power plant;
- Risk of natural disasters, which inevitably cause damage to nearby infrastructure and property.

Every sector, even those unrelated to the production of raw materials from forest land, benefits from the presence of forests located near business premises. Especially in urban contexts, where it is not easy to find green areas, they offer local communities a range of social benefits such as: psychological and physical well-being, recreational opportunities,

aesthetic and cultural value, property enhancement, tourism and local development. Therefore, the social impact of removing these areas, even if on a smaller scale, should not be underestimated. In addition to the environmental repercussions on the business, there is the risk of conflict with the local community, leading to significant economic and operational damage.

Most of the impacts identified so far have a direct or indirect repercussion on humans, especially for communities that have sprung up near a forest area, whose lifestyle and diet are closely related to the presence of a forest. Generally, in developing countries, the livelihoods of local communities depend on the forest, so the phenomenon of deforestation is likely to result in:

- Removal of communities, in the worst cases where a sufficient standard of living is no longer guaranteed;
- Destruction of the local economy, preventing typical hunting, fishing and forestry activities from taking place, contributing to the loss of essential resources and raw materials;
- Causing disease and worsening health conditions;
- Exploitation of local labour, becoming the only form of livelihood.

Local communities are generally among the most aggrieved parties when deforestation occurs. The power gap in the field between large corporations and local communities is large enough that the latter are unable to counter these phenomena. First, violations of civil/traditional rights of land ownership and use may occur against them. Still on the subject of rights, cases of exploitation are linked with informal/irregular forms of work and the lack of suitable health and safety conditions (Davide Pettenella e Mauro Masiero 2020).

Deforestation activities themselves negatively affect wellbeing and quality of life, due to the reduction of ecosystem services such as the lack of firewood or the lack of pollinating insects. Diseases may also be involved, which develop in contexts where vegetation is lacking and vectors for virus transmission are able to move more freely. This may be the case with the “Ebola” virus, where the destruction of rainforests has led wild animals, such as frugivorous bats, natural vectors of the virus, to come into more frequent contact with humans(Julie Mollins 2020). The conversion of forest land into agricultural land has

in the past led to internal migrations, with settlers moving to areas where labour was sought for the fields. These displacements frequently led to problems with access to basic sanitation, not guaranteeing adequate health conditions for the people. This thesis was amply supported in a 2007 article by the world rainforest movement (https://www.wrm.org.uy/bulletin-articles/central-africa-deforestation-brings-hivaids-to-indigenous-communities-mainly-women), that there has been an increase in cases of HIV infection among Cameroonian women as a result of the opening of forestry sites and the consequent influx of temporary workers.

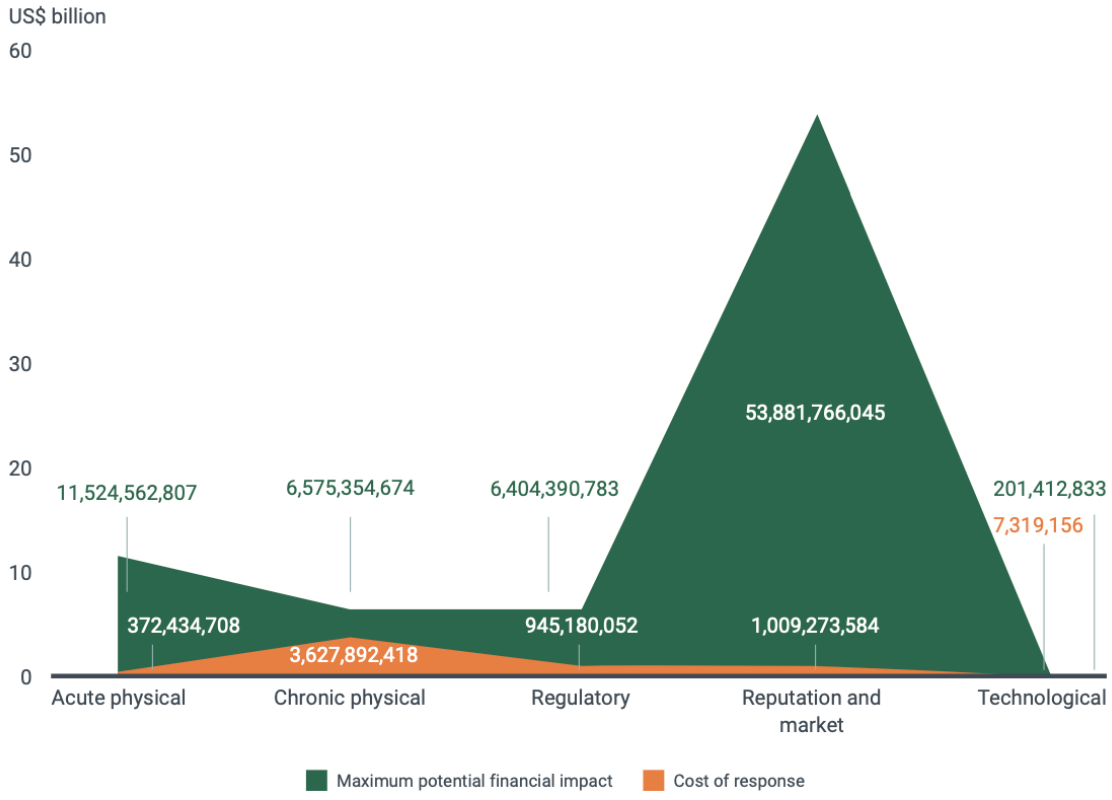
3 Results

Following the overview of the different impacts of deforestation, the following section will analyse the correlations between these and the potential risks for businesses, which may be systemic or non-linear, threatening the failure of individual sections as well as the entire economic system. Despite the scale of the phenomenon in terms of impacts, the rate of deforestation does not seem to be decreasing. To quantify the magnitude of the deforestation rate, one only must think that if it were to remain as it is, the Amazon rainforest would lose more than a quarter of its extension, turning into a non-forested ecosystem (CDP, 2023).

Within the CDP "Global Forest Report", forest-related risks are found in 2 out of 3 companies surveyed. The most significant element that emerges from the report is the total amount of the financial impact generated by forest-related risks, i.e. $78.6 billion. While the cost of mitigating the following risks is estimated at only USD 5.9 billion. The disparity between the two amounts is symptomatic of a failure to optimally manage following risks. In fact, most of the companies show that they either do not have appropriate tools for the identification of deforestation risks or do not have sufficiently elaborate tools to correctly quantify the financial impact of the risk. Of the interviewed companies, "23% do not include forest-related issues in their risk assessment and another 23% do not report risks because they have not yet assessed whether they are exposed to forest risks." (CDP, "*The forest transition: from risk to resilience*", 2023, pag. 19). The result is precisely an underestimation of measures to respond to and mitigate the following risks. Moreover, the latter are generally attributed to four different types of business risk: physical (acute and chronic), regulatory, reputational and technological. In the current

state of the art, companies that include deforestation in their risk assessment for a raw material have 84% of the risks associated with the individual material. However, the lack of consideration of the phenomenon and its immaturity in the assessment explain why only 54% of the companies, which find risks associated with deforestation, are able to quantify them. The following graph shows the financial amount of the mentioned risks and the cost of mitigating them.

4. Potential financial impact of reported forest-related risks and cost of response in US$.



Source: "The Forest Transition: from risk to resilience" (CDP, Global Forest report, 2023)

Although market and reputational risks emerge from the graph as the most relevant, the chronic physical risk associated with long-term environmental changes is considered the costliest to address. Another common factor in the sample of companies is the presence of risk drivers along the supply chain, demonstrating the importance of having monitoring and traceability systems in place for effective risk management.

3.1 Risks and Opportunities for businesses

3.1.1 Risks for businesses

The various impacts of deforestation dealt with so far are rather cross-cutting across many sectors, hence the need to be able to recognise, quantify and ensure business continuity. The companies that are affected by the effects of deforestation do not necessarily operate in the territories targeted by deforestation, rather the consequences cascade throughout the supply chain. In the upstream stages, the deforestation process by decreasing forest land contributes to the reduction of soil fertility, which particularly affects production capacity. The alteration of temperature and precipitation also manifests its effects in the subsequent stages, such as processing/drying, during which the quality of the raw material may decrease. Moreover, the effects can affect both companies and the market in general, as climate change not only tends to reduce production capacity but also to affect price changes on the stock exchange (as is the case for cocoa, discussed in more detail in the following paragraphs).

Changes in the capacity of an ecosystem to provide services affect the quality, availability and costs of inputs in different supply chains. The dependence of companies on nature and in particular on ecosystem services, which are endangered by deforestation, testifies to the correlation between the two systems and the relevance of the issue for corporate business. Different industries can be considered, for each service the relevant dependencies are given so that the scope of the issue is clear at a global level.

Water resources are a key element for:

- The beverage industry, as companies such as Coca-Cola and Nestlé are heavily dependent on the availability of high-quality freshwater sources for the production of their beverages. In the previous section, it was highlighted how ecosystem degradation and deforestation can compromise water availability and quality.
- Agriculture, since it not only requires a large availability of water but is also closely linked to it, making it a key variable in productivity.
- Soil fertility, it has been shown, depends on and can be affected by several factors. A worsening of it results in damage to the agricultural sector, which can impact the productivity of a soil over a long period of time. Climate regulation is an essential

ecosystem service for almost all sectors, as well as for human well-being. In particular, risks can be found in the:

- Energy sector, since renewable sources such as solar or hydropower, as a result of altered weather patterns and water flows, may compromise the ability to exploit these sources. According to the following article (https://www.enostra.it/news-eventi/che-futuro-ha-lidroelettrico-con-siccita-sempre-piu-frequenti/) production from hydropower has been on a downward trend for several years, while to meet the International Energy Agency's Net Zero by 2050 targets it would have to grow by 4% per year. In Italy alone, hydropower production is expected to decrease by 37% by 2022.
- Tourism industry, which attracts visitors mainly to exotic countries and tropical forests as long as they maintain their natural peculiarities. It is precisely the latter that are threatened by the consequences of deforestation, primarily climatic conditions and loss of biodiversity. As an example, the lack of water resources in Greece, whose islands attract millions of tourists, disproportionately amplifies the demand. (https://www.repubblica.it/viaggi/2024/07/15/news/grecia_estate_2024_siccita_turismo-423395982/)
- Real estate and construction sectors, as climate impacts can alter water flows and generate frequent floods, which in increasing cases damage infrastructure and housing. This leads to huge costs and long-term damage for the affected territories.

Forest resources are the basic building blocks for products:

- In the pharmaceutical industry, many drugs are created from wild plants and animals (aspirin, for example, contains “salicin”, which is a compound from willow bark), so the loss of biodiversity can jeopardise the production of the drugs themselves.
- In the wood and paper industry, the raw material can be lost due to uncontrolled deforestation, generating risks to business continuity and increased costs.

The problem lies precisely in the identification of risks for companies, which do not associate these dependencies with potential negative impacts, despite the fact that a large part of their turnover is closely linked to forest resources. This problem is also reflected in an earlier CDP report with respect to commodity dependencies. In the upper chart, the number of companies that declared the use of commodities with a high risk of

deforestation, such as wood, palm oil, soya, etc., is presented. While the lower chart shows the percentage of disclosures made on the individual commodity compared to the total, as well as the percentage of companies using the individual commodity compared to the total surveyed.

5. *Commodity disclosures by company through CDP's forests questionnaire in 2020 to 2023*

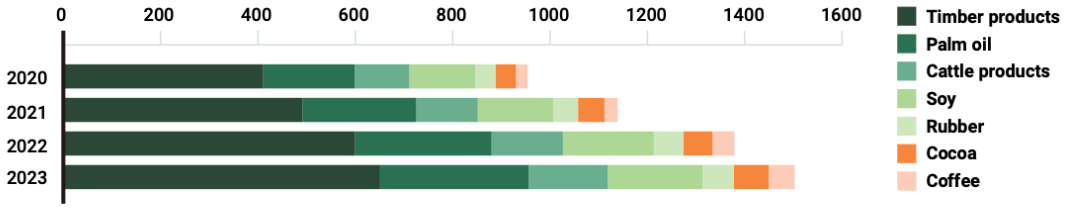


Table 1. Commodity disclosures and companies disclosing on each commodity

	Timber products	Palm oil	Soy	Cattle products	Cocoa	Rubber	Coffee
# of disclosures	650	304	194	162	71	64	53
% of disclosures	43.4%	20.3%	13.0%	10.8%	4.7%	4.3%	3.5%
% of companies disclosing on each commodity	73.8%	34.5%	22.0%	18.4%	8.1%	7.3%	6.0%

Source: CDP report 2024

Finally, the living conditions of local communities, who may be affected by deforestation and related adverse weather events, should not be underestimated. In particular, they suffer in terms of both health and the risk of livelihood loss. Indeed, the environmental consequences of deforestation can affect both the availability of food and the spread of disease, putting their health at risk. In addition, the negative effects on plantations/crops affect the quality of life of communities, which are economically dependent on these activities. For example, a drop in productivity would reduce the main source of economic livelihood of local communities, which for products such as cocoa, coffee, soya, palm oil, beef can directly affect the supply of the following goods, leaving part of the demand unsatisfied, increasing prices and reducing the operating margins of companies.

The following is a detailed description of the main risks identified for companies.

3.1.1.1 Reputational risks

The growing interest in the sustainability of production processes, on the part of consumers, companies and intermediaries in supply chains, is a critical factor in many markets. Failure to obtain certifications and the concomitant association with environmental degradation operations can lead to non-renewals/withdrawals of concessions for the use of environmental resources, as well as exclusion from tenders, with obvious economic and image damage. At the same time, a decline in quality due to the environmental repercussions of deforestation compromises both the operations and the reputation of a company. Indeed, the risk for companies supplying raw materials is that they will be excluded at the expense of suppliers with higher quality products, especially under the new regulations. The latter, as will be discussed in more detail in the next chapter, requires sustainability certifications (not to contribute to deforestation) and in their absence the company will be excluded from the market. Finally, a case that can arise is reputational damage for companies that exploit local communities. Cases have arisen in the past where companies have been sued by groups of individuals or communities who have suffered damages as a result of its activities. These class-action lawsuits result in high legal costs for the companies, as well as potential significant damages. One case in 2021 concerned Royal Dutch Shell, which was sued by a coalition of NGOs and local communities for liability in deforestation in Nigeria. The company's mining practices had caused environmental and health damage, costing it substantial financial compensation, reputational damage and negatively affecting investor confidence.(OECD-FAO 2020).

3.1.1.2 Market Risks

The decline in productivity in a geographical area, due to unsustainable management of raw materials, and particularly the victim of forced deforestation processes, has repercussions throughout the supply chain of a given raw material. Reduced availability can destabilise the entire market, also considering the price formulation mechanisms (e.g. the price of cocoa is set on the stock exchange). Furthermore, with respect to a given raw material, there may be several sectors involved (e.g. rubber is an important raw material for the automotive, textile and construction sectors), so that a shortage of the latter may leave a considerable portion of demand unsatisfied. The fluctuation between supply and demand, as well as uncertainty with regard to the future availability of the raw material, jeopardises not only the price setting mechanism but also the performance of companies,

especially, in the case of companies whose core business depends on the production of a raw material that is in short supply. Additional market risks arise for companies operating with non-certified suppliers, as regulations represent a barrier to entry for certain deforestation-related products. Outside of regulations, it must be considered that products from certified and environmentally sustainable brands are gaining increasing preference among consumers. Companies that can meet this demand can enter the market and expand their share at the expense of companies that are less sensitive to these issues.

Lastly, for companies whose products depend on raw materials or forest resources that are in danger of disappearing, there is a threat to business continuity, firstly, due to the price increase that may occur because of a drop in supply, and secondly, the reduction in margins may also spell the end of the trade.

3.1.1.3 Financial risks

The financial community has long included in its ratings the application of principles and indicators that consider the impacts and dependencies of the ecological system in corporate business. An increasing number of banks, insurance companies and investment funds rely on agencies specialising in rating and measurement services. Companies, which are exposed to damaged ecosystems or which impact ecosystems and biodiversity with hazardous activities, are subject to constant and thorough due diligence procedures. These can result in difficulties in accessing capital, higher capital costs and loss of investor confidence.

Companies that show little commitment to sustainable practices and a lack of consideration of deforestation in their operations are positioned in these cases. As a result, on the one hand they preclude themselves from approaching ESG (Environment, Social and Governance) investment funds, and on the other they struggle to find banks or other financial institutions willing to finance projects with a high risk of negative environmental impact. During the preliminary stages of a loan application, the company undergoes environmental due diligence, which is updated periodically during the life of the loan. This is a systematic process of assessing company practices in relation to sustainability and environmental impact, which considers:

- Sustainability policies, which are examined to understand how deforestation and ecosystems are managed;

- Certification and Standards, verifying commitment to and compliance with international environmental standards;
- Monitoring and Traceability, assessing the systems in place to track deforestation practices along the supply chain.

The absence of sound policies risks interfering with the granting of finance or increasing the interest rates charged due to perceived risk.

Investors usually carry out an analysis of the ESG scores of the companies they invest in to assess their ESG's risk exposure (Josh Brewer 2023). Specifically considered are:

- Environmental performance, thus assessing CO_2 emissions, land use and natural resource management;
- Corporate governance, analysing the measures taken for risk management and mitigation;
- Social initiatives, such as any commitments made to safeguard social communities and biodiversity;
- Regulatory compliance;
- Business Ethics.

In addition, scenario analysis and stress testing[6] are increasingly carried out to assess how different market conditions and regulations may affect the financial sustainability of companies. Thus, companies are subjected to the simulation of different scenarios to assess potential impacts (Kayan Patel 2022). For instance, are simulated:

- Impacts of climate change on resource availability and business operations;
- Impacts of environmental regulations on business processes and practices;
- Market risks associated with changes in commodity prices and consumer demand.

Consideration of the different factors above (sustainability policies, certifications, environmental performance, corporate governance) together with transparency and stakeholder engagement assessments help to identify financial vulnerabilities and inform investment and financing decisions. Therefore, companies need to take into account the

[6] Stress testing is a technique used by financial institutions to assess how certain stress scenarios affect the financial soundness of a company or investment portfolio. These scenarios simulate extreme conditions or events that could have a significant impact on financial markets and/or company operations.

aspects outlined above in order to obtain a good evaluation by investors/financiers and to avoid possible problems such as access to capital or loss of investors. Such problems can lead to a decline of the company, e.g. a group of institutional investors withdrawing their capital because of a failure to meet sustainability standards can negatively affect the share price and the resulting market value of the company.

In addition, increased ecological risks for companies operating in (risky) commodity production can lead to asset devaluation, e.g. in agriculture and food production. These are often referred to as "stranded assets", most of them related to regulatory risks, with respect to both deforestation and climate change. Restrictions that may be imposed through regulations, on land use or CO2 emissions, will threaten the use of these assets if they are found to be non-compliant and therefore unusable. In addition, risk factors and ecological pressures affect both physical assets (real estate and infrastructure) and operations for financial assets.

3.1.1.4 Insurability risk

Insurability risk refers to the difficulty for a company to obtain insurance cover due to the circumstances in which it operates, i.e. environmental conditions rather than the activities it carries out. In the context of deforestation, the risk arises for all those companies operating in sectors with a high environmental impact such as agriculture, forestry or natural resource extraction. Scenarios that may occur are:

- Increased insurance premiums, required by insurance companies to cover the increased risk associated with activities that contribute to deforestation. This is related to the fact that deforestation tends to amplify the frequency and intensity of extreme weather events;
- Exclusion of coverage if the perceived risk is too high or company policies do not conform to the sustainable management practices required by insurance companies;
- Additional costs for risk mitigation, necessary to meet insurance requirements and characterised by investments in advanced infrastructure, technology or certification.

3.1.1.5 Transition risk

Transition risk covers the challenges and uncertainties that companies face during the transition to a sustainable, zero-deforestation economy. This risk emerges as a result of regulatory, market and technology changes, which require new business models and investments. To align or implement sustainable practices, companies are required to adopt new strategies and operations, starting with the modification of production processes and including the structuring of supply chains. Sometimes, companies need greener infrastructure and technology, the investment of which requires significant capital, and those that fail to do so run the risk of losing competitiveness to companies that embrace sustainable innovation. These investments as well as other changes in business models are necessary in the face of international regulations and climate agreements, e.g. companies that fail to reduce their emissions may be subject to financial penalties or limitations on access to markets(Steven Cohen 2022).

3.1.1.6 Risk of climate policies

Considering the high impact attributed to deforestation on climate change, governments and institutions are expected to tighten climate policies and related emission controls. This means especially for regulated companies a rapid adaptation to these policies. Therefore, companies need to establish a strategy in the short term to comply with climate policies. Considering this, there is the cost of recent technologies to implement less emission-intensive solutions within the corporate infrastructure to be considered. However, these developing technologies could come with a high cost, especially for the first companies to use them, as well as the risk of obsolescence considering the novelty of the topic and the trend of technological progress. Following these considerations, emission permits are presented as alternative solutions. The latter are certificates that grant the holder the right to emit a specific quantity of greenhouse gases, measured in tonnes of carbon dioxide equivalent (tCO2e). The regulatory authority determines the total limit of emissible quantity, while companies obtain these permits partly for free and partly through an auction. (*https://www.reteclima.it/rischio-capitale-naturale-imprese-gestione/).*Holding these permits, especially if in excess of necessary quantities, exposes companies to risks stemming from: price volatility, regulatory uncertainty (changes in climate policy/availability of permits), and the emissions market. Thus, regulatory pressure on companies can translate into financial risks associated with the emissions market or investment in modern but expensive technologies.

A similar instrument but with different characteristics are options on REDD+, i.e. financial instruments that allow the holder to buy carbon credits from REDD+ projects at a set price by a certain date. However, as a risk management tool associated with uncertain climate policies, there is no certainty of benefits. Indeed, it may happen that carbon credit prices do not rise as expected and the company loses the premium paid for the option, or the effectiveness of REDD+ projects is not guaranteed. Being a different market than the emissions market, the carbon credit market can also be affected by price volatility and uncertainty. Thus, buying options or carbon credits in general is a temporary and alternative strategy to investing in emission reduction technologies, but with which additional financial risks are associated(OECD 2019).

The analysis addressed so far invites companies to recognise and accept interdependence to face upcoming challenges and improve the business-environment relationship. Awareness of the fact that the sustainability of a business over time is closely conditioned by the availability of ecoservices, and that these are at risk, should lead businesses to move in a new direction to safeguard resources and nature. Moving from a perception of ecosystem services as public goods with unlimited availability towards one of valorising and conserving them to improve business itself.

3.1.2 Correlation with the finance sector

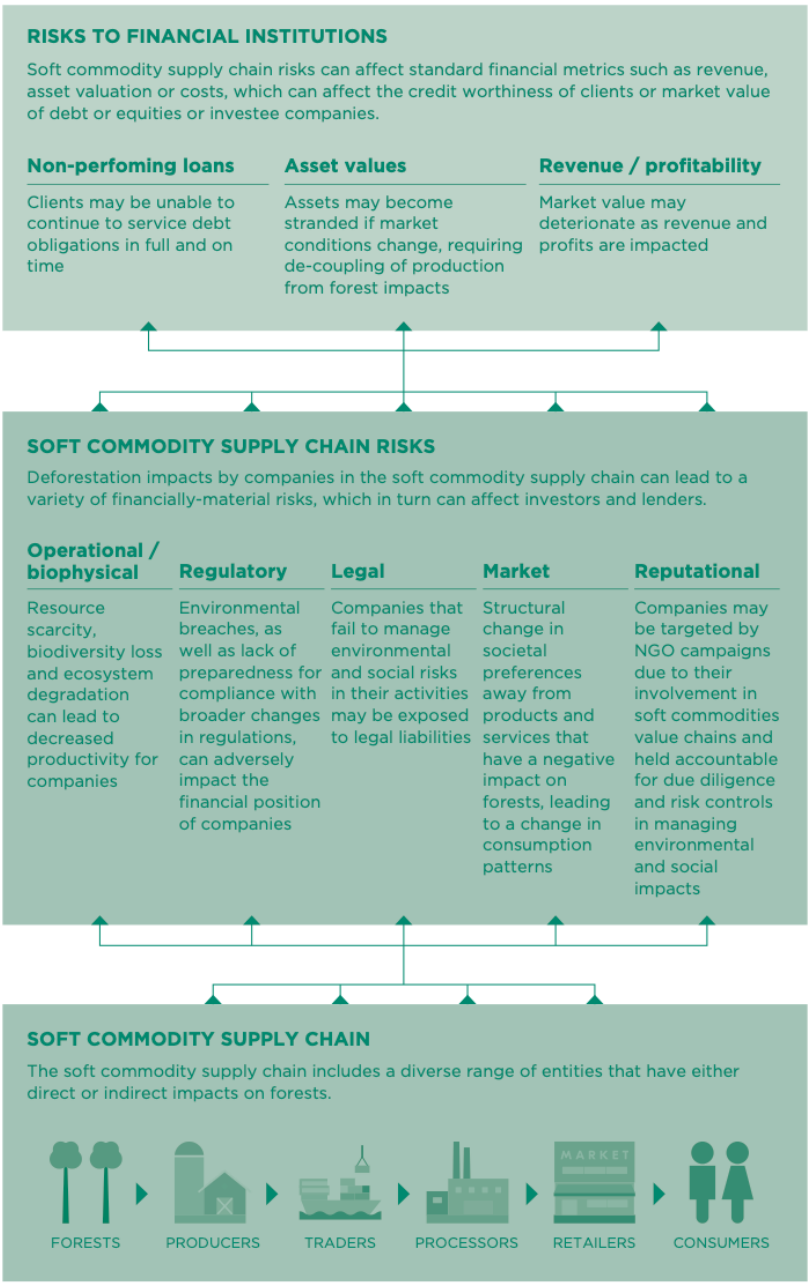
Identifying deforestation risks is as important a practice for companies as it is for financial institutions. Indeed, the latter are required to limit their exposure to risk by monitoring their financing/investment in companies and trying to provide them with better tools to hedge against the same risks as well as avoid them. The commitment of these institutions should be greater so that a concrete result can be achieved in the short term. This starts with providing risk identification tools that are effective throughout the supply chain, identifying possible impacts and dependencies on ecosystem services, and finally implementing mitigation strategies for the risks tracked.

The role played by financial institutions was further explored in Global Canopy's "Forest 500 report", which tracks the 500 most influential entities in the forest sector. Despite failing to meet targets for eliminating deforestation from their portfolios, institutions such as JP Morgan, Bank of America and Mitsubishi UFJ provided USD 72 billion for 25 companies that had not yet made any commitment to deforestation. In view of the crucial role played by institutions, an attempt is being made to draw a guideline for risk

management not only for companies but also for the latter. In particular, the "Forest 500 report" outlines a roadmap, containing the different steps to achieve the goal of eliminating deforestation as well as related human rights violations. The first step requires the official recognition of deforestation as a business risk and consequently the need to work together to manage it. The next step involves the implementation of a strict policy towards the major risks associated with the individual product (commodity/raw material). This policy must consider the related human rights, as well as those of workers, and avoid any form of abuse or violence against forests, natural resources and local communities. In addition, it is required to demonstrate a risk exposure assessment of customers prior to entry into the company, while publishing a non-compliance policy. The next steps require continued commitment to the first two steps, i.e. the monitoring and involvement of those directly involved in responding to the risk, as well as the constant collection of data and evidence from risk assessment activities. Now, there are no institutions that have passed step two of the policy implementation; this is the data that it is hoped to improve in order to reach the final step of removing deforestation as a business risk. One aspect to consider is the significance of the risk for the financial institutions themselves, which suffer from non-performing loans, devaluation of assets or loss of confidence of investors and consumers. Below, the chart summarises the correlation between the different players and the manifestations of risk for both companies operating in soft commodities[7] supply chains and financial institutions.

[7] Soft commodities are defined as non-durable agricultural products, which are cultivated not extracted. They include commodities such as cocoa, coffee, sugar, cotton, soya, palm oil; unlike hard commodities (such as metals and energy resources), soft commodities are affected by seasonal growth cycles and climatic/biological variables.

4. The impact of finance flow on forests and the risk created for financial institutions



Source: CDP 2020

3.1.3 Business Opportunities in the Preservation of Natural Capital and Ecoservices

On the one hand, the phenomenon of deforestation entails risks for companies operating in the affected sectors, but on the other hand it generates opportunities for both existing companies and new ones to enter the market. Indeed, it opens up the possibility for new

companies to enter the market to provide innovative solutions that meet the growing need for sustainability. More so, considering the presence of numerous funding programmes and guarantee funds dedicated to start-ups and new companies developing green technologies and conservation projects. Many companies have undertaken a series of investments in reforestation or habitat conservation projects, opening up the possibility for third-party companies to purchase certificates and related services to comply with specific regulations and stakeholder expectations.

For existing companies, there is the possibility of reducing the risk associated with deforestation and climate change by investing in sustainability and forest conservation. At the same time, there are opportunities to improve sustainability practices to enhance corporate reputation, attract investors and consumers.

3.1.3.1 Sustainability certificates

Companies can obtain sustainability certificates to improve their corporate image and enhance their reputation. By investing in sustainable practices and certifications, there is the possibility of continuing to operate in the market, differentiating oneself and attracting a larger customer base. Obtaining certifications such as FSC (Forest Stewardship Council) and Rainforest Alliance, which are recognised globally, enhances companies' credibility in international markets. Likewise, it offers access to more sensitive markets, allowing companies to differentiate themselves and reduce the regulatory risk associated with non-compliance. Indeed, obtaining certifications such as the RSPO (Roundtable on Sustainable Palm Oil) in the first place requires adherence to criteria such as the protection of forests and the reduction of environmental impact, aligning corporate interests with new European regulatory requirements. Especially for companies dealing with raw materials commonly associated with deforestation, having such certifications can confer several competitive advantages.

3.1.3.2 Carbon credits

The carbon credit market becomes a place where companies can access by investing in reforestation and conservation projects that issue certified carbon credits. These credits can be traded with other companies that need to offset their carbon emissions. New companies can enter the market to provide carbon credit management and certification services, while existing ones can reduce their carbon footprint and improve their reputation for sustainability. Currently, there are already two examples of organisations

facilitating the generation and trading of carbon credits, namely South Pole and Verra. In practice, companies invest in reforestation or forest conservation projects, which are certified by bodies such as South Pole that verify the actual reduction or sequestration of CO2 emissions. Every tonne of CO2 avoided or absorbed through these projects generates a carbon credit, which can be sold on the market to other companies, who, unable to reduce their emissions, are willing to buy it. In this way, the company that has invested in the reforestation project can obtain a direct economic return and at the same time improve its reputation.

3.1.3.3 Partnerships with large companies

For companies offering reforestation services, implementation of sustainable practices or conservation of ecosystems, the possibility of collaborating with large companies is opening up. The latter often seek specialised partners to improve the sustainability of their supply chains. These partnerships benefit both parties: on the one hand, they improve the sustainability shortcomings of large companies; on the other hand, they foster the growth and recognition of innovative companies through partnerships with established and renowned companies. Companies such as Nestlé and L'Oréal collaborate with specialised bodies to implement sustainable sourcing practices. For example, L'Oréal has developed the "L'Oréal for the Future" programme that includes ambitious goals such as the conservation of ecosystems. In particular, the French brand within its supply chain works with RSPO-certified suppliers to ensure that the palm oil used in its products comes from sustainable sources.

3.1.3.4 Technological innovations

Technological innovations represent an important opportunity for companies, enabling them to proactively address environmental challenges, such as deforestation, and turn them into a competitive advantage. Some companies specialise in using advanced technologies such as drones, artificial intelligence and blockchain to provide services to companies that want to improve their transparency and effectiveness in raw material procurement processes or forest conservation projects. Tentree[8] uses blockchain technology to track and verify their reforestation efforts. Indeed, this technology allows companies to track the origin of raw materials and ensure that they are derived from sustainable sources unrelated to deforestation. Through real-time monitoring and

[8] Sustainable clothing company that commits to planting a certain number of trees for every article sold.

immutable recording of transactions, companies can identify any risks related to deforestation at an early stage. In addition, there are initiatives such as the reforestation hub, developed by The Nature Conservancy and American Forests, which use these technologies to map reforestation opportunities in the US, identifying the most suitable areas for new forestry projects.

At the same time, a company that implements advanced technological practices not only reduces its ecological footprint, but also gains a competitive advantage over peers by using technology as a marketing and corporate reputation tool. The use of blockchain, for example, allows companies to demonstrate to consumers and investors the transparency of their supply chains by attracting greater trust and access to new markets. Finally, blockchain reduces operational costs by improving efficiency and minimising fraud or discrepancies along the supply chain, providing an additional advantage over technologically backward peers.

3.1.3.5 Loans and guarantee funds

Further opportunities arise for new and existing enterprises, which through participation in sustainable projects have easier access to guarantee funds or financing. These funds offer financial support to reduce risk and encourage sustainable agricultural practices. L'agri3 Fund[9] provides loans to support sustainable agriculture projects. In general, the growing interest in investing in projects that promote sustainability and environmental regeneration has led to the development of markets, such as the green bond market, which issued over USD 500 billion in 2021, demonstrating the steady growth (Kayan Patel 2022). Green bonds are debt instruments issued by companies, governments or financial institutions to raise capital to finance projects with positive environmental impacts. Companies committed to combating deforestation can use green bonds to raise long-term funds on favourable terms. Indeed, in addition to reputational benefits, such funds allow companies to finance deforestation mitigation projects leading to long-term operational savings through sustainable management of natural resources. At the same time, these projects can create new sources of income, such as the sale of carbon credits generated by reforestation initiatives. Global interest in sustainable investments is steadily growing

[9] International fund to catalyse private financial resources for forest protection and sustainable agriculture.

and these instruments allow companies to access capital that would not have been available through traditional financing channels.

3.1.4 Policies to directly counter deforestation

The Intergovernmental Panel on Climate Change (IPCC) in its latest report, in addition to urging a halt to the construction of new coal-fired power plants and the development of new fossil fuel deposits, emphasises for all sectors the numerous opportunities for intensified climate action that could reduce greenhouse gas emissions by half by 2030. Referring to forests, agriculture and other land uses, it reaffirms the potential to contribute significantly to the reduction of greenhouse gas emissions and to the removal of CO2. The IPCC emphasises that mitigation response strategies can benefit biodiversity, support adaptation to climate change and secure resources for livelihoods, food, water and timber. Among the many adaptation and mitigation options to be pursued in the short term are agro-forestry, biodiversity and ecosystem connectivity management, forest-based adaptation, reduced conversion and restoration of natural ecosystems, and afforestation. Forest-based adaptation includes sustainable forest management, reforestation and afforestation.

3.1.4.1 Reforestation and Afforestation

Both practices are regulated by a set of systems including carbon credit markets, certification standards and international regulations. The aim is to ensure the sustainability of activities, especially through internationally recognised certification standards such as FSC or VCS. Subsequently, the same international regulations take care of regulating and incentivising them, as witnessed by the Kyoto Protocol and the Paris Agreement (2015). The latter considers reforestation as the main strategy to achieve emission reduction targets. While the Kyoto Protocol allowed countries and companies to finance reforestation and afforestation projects to generate carbon credits, through the introduction of the Clean Development Mechanism (CDM). Finally, it is regulated markets, such as the European Union Emissions Trading Scheme (EU ETS), that provide economic incentives for the sale of credits generated by reforestation or afforestation projects.

The process of replanting trees in an area where the forest has been degraded, damaged or destroyed is called ‘reforestation’. An area that has been degraded as a result of human

activities such as agriculture, logging or fires undergoes a process to restore the original forest ecosystem, improve soil quality, contribute to climate change mitigation and increase biodiversity. The objectives and benefits of this process are manifold while the only challenge is to make the soil suitable again for forestry development by clearing it of any invasive species.

Afforestation, on the other hand, involves planting trees in areas where there was previously no forest cover, i.e. grassland, dry land or abandoned farmland. The objectives are similar to those of reforestation, with the difference that the process can be more complicated due to environmental conditions. In fact, growing a forest will require a studied selection of tree species appropriate for the environment as well as a proper arrangement in relation to the existing vegetation.

3.1.4.2 Agroforestry

Agroforestry is defined by the Association for Temperate Agroforestry (AFTA) as an "intensive land management system that optimises the benefits from the biological interaction created when trees and/or shrubs are deliberately combined with cultivated fields and/or livestock" (https://www.aftaweb.org/about/what-is-agroforestry.html). Beyond this definition, it can be said to be a practice of growing trees, fields and livestock in the same area, the interaction of which generates ecosystem benefits and services. This practice aims to reconcile different purposes such as: growing trees for the production of raw materials and timber, increasing agricultural production and protecting the ecosystem (Nair et al. 2009). These are complemented by additional cumulative benefits of agroforestry:

- Soil and water conservation through trees that improve water retention and reduce surface runoff, helping to maintain soil fertility and protect water resources;
- Carbon sequestration stimulated by vegetation helps mitigate climate change and reduce the environmental impact of agricultural activities;
- Diversification of income through the combination of different production activities enables businesses to diversify their sources of income and reduce the economic risk associated with a single activity;

The improvement of biodiversity through the creation of habitats for various animal and plant species, preserving the well-being of local ecosystems.

Therefore, agroforestry is considered a practice that:

- Has the intention of structurally combining trees, crops and livestock to manage them in unison;
- Intensively manages these aspects to ensure good productive and protective capacity;
- Actively exploit the biological and physical interactions between the different components to increase productivity and environmental conservation benefits.

This system is adopted with the aim of diversifying production and earnings while providing ecosystem services. Despite this, in some areas the slash and burn [10] contributing to environmental degradation. In these cases, agroforestry systems reflect a viable alternative to mitigate climate change and recover land, contributing to food security and ecosystem restoration. To implement agroforestry in businesses, one must first identify suitable areas, i.e. those where it can be effective depending on climatic conditions, soil and crop or livestock needs. This is followed by careful planning for the integration of trees with crops and livestock in a functional system, selecting the appropriate species and the best arrangement. In addition, the adoption of responsible policies by companies towards local communities can generate additional benefits beyond those of reputation. Businesses, through the inclusion of local communities in activities such as agroforestry, can improve their living conditions and socio-economic well-being, while contributing to corporate interests. For these reasons, it is important to involve and educate local communities, who can contribute to and benefit from increased productivity. Today, such practices by companies determine not only the reputation of a company but also their ESG score, attracting investors as well as consumers.

Agroforestry practices are many and varied; the most developed ones are listed below:

- Alley Cropping is the cultivation of different species on the same field using the shade created by rows of trees. It generally consists of the cultivation of food, fodder or medicinal plants;

[10] This is a mobile agricultural method, where farmers move around frequently, which consists of cutting and burning plants in a forest to create a cultivable field. The felled vegetation (slash) is allowed to dry out and then burnt to release nutrients into the soil. However, after a few years, the productivity of the soil is lost due to the depletion of nutrients.

- Forest Farming, horticultural species, medicinal or ornamental plants are grown in the lower layers of forests to optimise both timber production and the fields below;
- Silvopasture, i.e. the creation of an integrated system with the cultivation of fodder plants and grazing animals in the middle of a tree plantation, to provide both shade and better fodder quality.

3.1.5 Risk and Opportunity management tools: Encore, AFI, Mitigation Hierarchy

After outlining what risks companies face due to deforestation, the following section looks at some tools and strategies for effective risk management. Given the global significance of environmental impact considerations, alliances have emerged between organisations such as the Natural Capital Finance Alliance (NCFA), an initiative from the financial sector that aims to provide expertise, information and tools for managing crucial natural capital issues for financial institutions. In particular, the relevant subject matter shared by financial institutions and companies concerns the risk management process. As part of a larger project such as the "Advancing Environmental Risk Management" (European Food Safety Authority (EFSA) et al. 2022) organisations such as Global Canopy and UNEP FI (United Nations Environment Programme Finance Initiative) have developed tools to help companies recognise and assess their exposure to risks. The most popular tool is known as ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure), which aims to help companies understand the link between different economic sectors and nature by analysing the dependencies and impacts of one on the other. Consequently, by identifying the relative risks and opportunities linking natural capital to business activities. (https://www.unepfi.org/themes/ecosystems/whats-next-for-financial-institutions-and-nature-related-risk/). In detail, this tool allows companies:

- Risk materiality assessment: companies conduct materiality assessments to identify which aspects of biodiversity are most relevant to their operations. Materiality is determined by considering both the potential impact on business performance and the importance to stakeholders.
- Classification of dependency risks: companies classify biodiversity dependency risks according to the type of ecosystem service on which they depend. Encore can be useful at the industry level, as once a certain risk area is identified, it simplifies the process for companies operating in the industry.

- Recognition of dependencies: first and foremost, companies assess dependency based on the contribution of ecosystem services to their operations.
- Risk management: by identifying and classifying dependency risks, companies integrate their risk management, developing more accurate mitigation and sustainable resource management strategies.

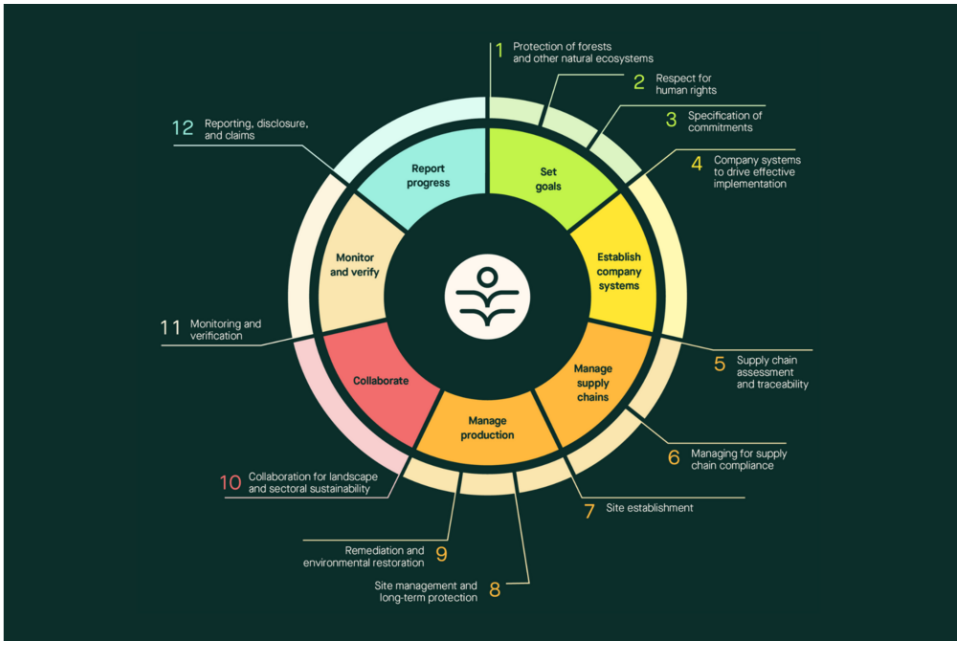
As a function of a more detailed risk analysis, companies can develop more effective and targeted biodiversity policies. In the context of the following paper, whose focus is on deforestation, Encore's analysis provides further food for thought by identifying points of contact between sectors such as agriculture and forestry and their dependence on forest raw materials. Furthermore, as highlighted in the previous section, the loss of biodiversity associated with deforestation also constitutes a risk for industries that depend on certain ecosystem services. Thus, this tool (Encore) can map the dependencies and impacts of industries on nature, through a database that includes over 167 economic sectors and about 21 ecosystem services. With respect to the functionalities present in the tool and the purpose of the research, the functionalities for businesses to manage the impacts of deforestation are discussed below:

- Impact assessment: allows companies to identify the areas most at risk;
- The sectoral risk analysis: facilitates the risk mapping process by identifying existing linkages between specific sectors (including suppliers) and natural capital;
- The association of risks to impacts: considerations of natural capital impacts to companies are directly translated into economic risks to companies;
- The presentation of strategies: once economic risks are identified, mitigation and adaptation strategies are associated with them, proposed based on sectors;
- The support of reporting and communication: provides support in the drafting of the sustainability report, introduces the topics of natural capital risks and possible actions to meet regulatory requirements such as the Task-force on Nature-related Financial Disclosure[11].

[11] This task force is a global initiative to develop and disseminate a framework for the disclosure of nature-related financial information. It is designed to help companies and investors identify, assess and manage nature-related risks and opportunities.

About reporting, tools similar to Encore have been developed, such as the Accountability Framework Initiative (AFI), which is a guide for companies to demonstrate their ethical commitments with regard to deforestation, ecosystem conversion and human rights in supply chains. This type of tool facilitates companies to transparently report on their supply chains (sourcing of raw materials) and respect for human rights. In fact, the AFI establishes 12 core principles to guide companies in eliminating deforestation, also covering respect for human rights, supply chain traceability and collaboration for sustainability at sector and landscape level. For the effective implementation of the principles in companies, resources such as e-learning platforms, practical guides, webinars and case studies are provided by the AFI.

5. Accountability Framework: Core Principles



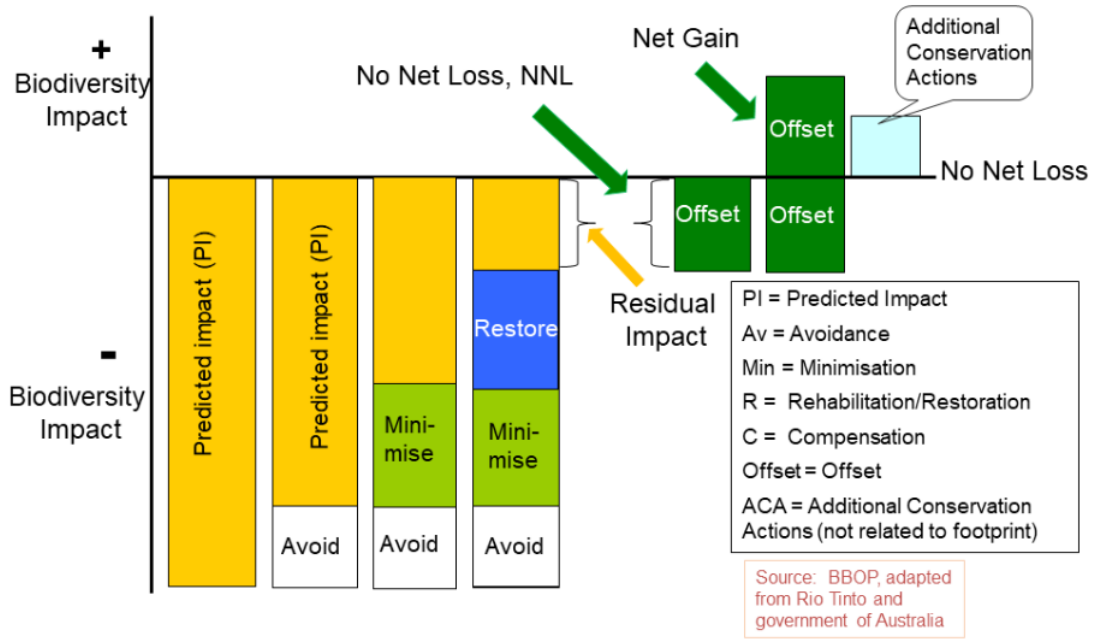
Source: https://accountability-framework.org/use-the-accountability-framework/core-principles/

Along the same lines is another international initiative that aims to develop and promote global standards for biodiversity offsets. The latter called the "Business and Biodiversity Offsets Programme" (BBOP) was launched in 2004 and is supported by a coalition of companies, NGOs and financial institutions. The tool below is called "Mitigation Hierarchy" and is an approach for managing risks and impacts on biodiversity. The matrix contains a sequence of actions to progressively reduce damage, giving priority to avoiding

negative impacts and compensating for unavoidable ones. The 4 main steps of the matrix are:

- Avoid damage to biodiversity from the outset;
- Minimise negative impacts with sustainable practices;
- Restore damage by bringing the environment as close as possible to its original condition;
- Compensate for residual impacts by creating equivalent benefits for biodiversity elsewhere

6. *Mitigation Hierarchy*



Source: https://www.forest-trends.org/bbop/bbop-key-concepts/mitigation-hierarchy/

Finally, cooperation between companies must be considered as a further tool to support them. CDP with its reporting continues to emphasise the importance of disclosure as a tool for achieving zero net emissions targets and monitoring progress. It is crucial to disclose information to avoid greenwashing and keep track of what has been done and what is still needed to meet the targets set by the Paris Agreement. In the CDP 2023 report, the companies on the best in class "A list" are those with the most accurate documentation of their environmental impacts and the most proactive in nature and

climate mitigation. Thus, it is precisely the disclosure of their actions that provides a cue and a guide for other companies. In addition to voluntary disclosure, there is now mandatory disclosure following the enactment of new European regulations.

3.1.6 The impact of deforestation on the cocoa industry

Against the analysis of risks and opportunities in general for businesses, an in-depth analysis of the cocoa sector is proposed below. This provides a concrete example of how deforestation affects a specific supply chain, demonstrating both the extent of the phenomenon and the complexity of the risks described above. The cacao tree is a rather delicate plant, which grows in the shade of sunlight and in very humid areas. It needs, therefore, abundant rainfall and temperatures between 25° and 35°. For these reasons, the cocoa tree generally grows in the shade of other trees and takes about five years to start bearing fruit. Traditional cocoa varieties (the Amazons and Amelonado) have recently given way to new hybrid varieties, which have greater resistance to the sun and higher yields in the short term. (Etifor 2021).

Because of these characteristics, the areas allocated to cocoa cultivation have increased considerably, thanks also to the slash and burn technique of virgin forests, leading consequently to a depletion of biodiversity and soil fertility. All this has led to a peak deforestation rate in forest reserves in 2020, as witnessed by an investigation by The Guardian (Ruth Maclean, 2017), which illustrated the situation in Côte d'Ivoire where entire villages of farmers occupy illegally protected areas while the police collect bribes for not reporting such infringements.

The cocoa beans contained inside the flowers are harvested by hand by the producers, usually small farmers, with tools like a machete or “cocoa iron”. They are then freed from the white mucilage around the seed and the fermentation and drying processes begin. At the end of these, the seeds take the form of whole or broken beans, which represent the final output to be exported. So, while we have billions of end consumers globally, we also have considerably fewer small farmers in developing countries. In the global cocoa market, these two factions are managed by a few international players (trading companies) that handle both distribution and processing, together with other small and medium-sized traders. In this market, the World Economic Forum attributes more than 80% of the revenues of the cocoa supply chain to the large producers, while small farmers

receive no more than 6.6%. From these figures, it is clear why conflicts often arise between multinationals and local communities, which are not always guaranteed the same rights as workers in developed countries.

Moreover, in this type of supply chain it is rather complicated to ensure that the cocoa exported is not produced in deforestation-prone areas. Above all, because of the convenience for local traders to buy cocoa beans from small farmers, who are used to operating in protected reserves and national parks. Illegal cocoa beans are then mixed with legal ones during the various stages of the supply chain. The result of this process is the creation of products that include illegal cocoa, without being able to trace it back easily.

3.1.6.1 The cocoa market

Closely linked to the deforestation phenomenon is the turnover associated with the cocoa market, which has a decisive influence on the actions of companies and farmers. The global market value of cocoa is estimated at around 21.1 billion dollars, with an annual growth rate of 4.5 %.(https://www.marketsandmarkets.com/Market-Reports/cocoa-chocolate-market-226179290.html). Production is dominated by a few major countries:

- Ivory Coast: world's largest producer, holding about 30%;
- Ghana: holds about 20%;
- Indonesia: holds about 6%.

While in terms of chocolate consumption, Europe is the main player with an average annual consumption of 6 kg per capita (significantly higher than the global figure of 0.9 kg). The reason behind this is the presence of major manufacturers such as Nestlé, Mondelez International, Ferrero and Lindt&Sprüngli. This has made Europe the world's number one region in terms of industrial demand for beans, making it in turn the number one region in terms of cocoa processing and export (https://www.expertmarketresearch.com/reports/cocoa-market).

The negative implications of deforestation emerge from several studies, which document a loss of about 26% of forests in Côte d'Ivoire, between 2000 and 2019, due to cocoa production.(https://worldcocoafoundation.org/focus-areas/reverse-deforestation)

Italian imports alone caused an average annual loss of about 1222 hectares of forest, ranking 6th among European economies with the greatest impact on deforestation associated with cocoa production.

To better understand the industrial dynamics related to cocoa, two crucial aspects must be considered: the small number of international players (resulting in a sort of oligopoly), and the determination of the price of cocoa, which does not primarily involve the producer but takes place on the stock exchange and may be influenced by climatic and/or socio-political factors. Thus, small producers do not have the means to reach the market and influence the price but are forced to accept the conditions set by intermediaries in an arbitrary manner.

The current context can be analysed in the light of this evidence. The price of cocoa has increased by 100% since 2022, there are several causes, but deforestation is certainly among them. Indeed, the latter has contributed, along with other climatic factors, to the reduction of production capacity in several African countries following severe droughts and the spread of diseases among the plants. Further causes include speculation by Edge funds, which have been betting upwards on the market value by buying futures (contracts that bind holders to buy cocoa in the future at a price set today and higher than at the time of purchase). Through this manoeuvre, companies hedge against risk and at the same time secure their supply of raw material. However, this price increase does not benefit African farmers, as cocoa is currently sold at the prices set a year ago at national level. In fact, the price increase for farmers is expected to start in October 2024. (*https://www.corriere.it/economia/finanza/24_febbraio_19/cacao-perche-il-prezzo-e-al-nuovo-record-la-scommessa-da-8-miliardi-dei-fondi-speculativi-1c45bc7e-77e7-4458-8d57-12986e9edxlk.shtml?refresh_ce>).*

In addition, among the causes of the price increase is the new EU regulation against deforestation. The implications of which will be discussed in more detail in the last part of the following paper, but in the meantime one can reflect on the need for traceability of the raw material and its associated costs. These can be borne by three distinct actors

- on the final consumer, who should recognise the value of forest conservation and be willing to pay more for the product;
- on producers, who should bear the costs and reduce their profit margin;

- on small farmers, worsening the socio-economic conditions in which they already find themselves.

With respect to the last circumstance, i.e. burdening small farmers, there are further considerations to be made. In fact, this could create the risk of a "double market" if some farmers decide not to adapt to European standards. The latter rather than comply and ensure sustainability standards could continue to supply their products (contributing to deforestation) to markets with less stringent regulations such as China and/or Indonesia. Thus, the regulatory intent to combat deforestation may prove partially or completely ineffective. Especially in producer countries such as Côte d'Ivoire and Ghana, new plantations result in the loss of habitat for wildlife, leading to a decrease in biodiversity and an increase in CO2 emissions. The loss of forest land itself reduces soil fertility, which is a key element in ensuring the health of plantations. Consequently, the latter become more vulnerable and prone to diseases and pests. In turn, the climate changes as a function of the loss of forest areas, altering temperature and precipitation, key factors for the good productivity of plantations.

3.1.6.2 The impact of deforestation on the cocoa supply chain

The very expansion of plantations, at the expense of forests, can damage and endanger production. This is compromised by several factors as a consequence of deforestation:

- Soil fertility, severely threatened by the removal of forests, which compromises the soil's ability to retain the water and nutrients needed for cocoa cultivation;
- The loss of biodiversity, mainly due to the disappearance of natural habitats, in addition to putting animal and plant species at risk, affects the resilience of agricultural ecosystems, compromising their sustainability in the medium to long term;
- Exposure to pests and diseases, closely related to the loss of biodiversity, directly affects production capacity;
- Climatic conditions, which tend to result in higher temperatures and irregular rainfall, are responsible for affecting the harvest not only of cocoa plantations but also of others in adjacent areas;
- Political and social instability, in fact deforestation can provoke conflicts between farmers and local communities. The latter are very often victims of the violation of

their rights, losing access to the natural resources on which their livelihood depends. In turn, the economic conditions afforded to local farmers are not always ethically sound, just as workers' rights are not in line with international labour standards. Especially in developing countries, there is a violation of these rights as well as a worsening of health conditions due to the reduction in air, water and food quality associated with the destruction of forests.

Primary production, i.e. cultivation, is undoubtedly the stage in the value chain where the greatest impacts of deforestation occur. It is precisely because the primary consequences of deforestation (soil erosion, loss of biodiversity and climate deterioration) are poured on it. However, these do not only affect the production phase, rather the harvesting and processing phase is the direct consequence of degraded cultivation. Indeed, the quality of cocoa beans can be compromised by the loss of nutrients in the soil, causing either a deficit in production capacity or a drop in the value of the final product. At the same time, deforestation alters local watersheds, reducing the availability of water needed for cocoa processing. This can negatively affect fermentation and drying processes, which are crucial for the development of cocoa flavour. Due to these effects in both cocoa cultivation and processing, large investments are required from companies to compensate for the damage of deforestation, in particular:

- Advanced irrigation systems: as a result of altered natural water cycles, state-of-the-art systems are needed to ensure good soil fertility;
- Soil protection systems: to compensate for the reduced fertility as well as the vulnerability of the soil, investments in infrastructure such as agricultural terraces and vegetation barriers, as well as in products and fertilisers, are necessary;
- Maintenance and implementation of road infrastructures: climatic conditions worsened by deforestation can affect cultivated areas and their accessibility in no small measure.

Especially the third point deserves special consideration. In sectors such as cocoa where the value chain is highly fragmented globally, it is crucial to maintain good control over the downstream stages. Logistics plays a key role in avoiding delays and inefficiencies that can lead to substantial economic damage at the distribution stage. Generating potential additional costs, a deterioration in product quality and increased carbon

emissions due to transport. Also, in the downstream stages of the value chain, traceability and sustainability certifications are a key issue following the enactment of the new European regulation.

The difficulty of enforcing sustainable agricultural practices in areas suffering from deforestation makes it more complex to obtain sustainability certifications such as Fairtrade and Rainforest Alliance, which are crucial to access European and North American markets. To a regulatory discourse can be added one concerning the sustainability of production, which risks being compromised by the inferior quality of cocoa beans. The latter can affect the production of high-quality chocolate by requiring additional processes to improve the final product, increasing production costs and reducing profit margins.

3.2 The European approach to deforestation and the new regulatory framework

The overview of companies in environmental strategies, as well as the need to combine economic and social-environmental objectives, can be seen as an example of an ideal approach to achieving ambitious goals. A similar attitude has been shown by the European Union, which recently passed a new law on the nature restoration[12](European Commission, June 2024)[13]. In a broader perspective, the latter can be seen as complementary to the more recent "anti-deforestation" law to introduce a more effective approach to sustainability in EU territories. The urgent need to address climate change and declining biodiversity has led to the enactment of a very ambitious intervention, not only to safeguard the environment, but also to redirect consumption and production practices towards greater sustainability. The Nature Restoration Act aims to reverse the decline of biodiversity through binding targets for the restoration of degraded ecosystems and the conservation of natural habitats in Europe. This is part of the Green Deal commitments and recognises the complex interdependence between ecosystem health, biodiversity and human well-being. Although focused on specific aspects of the ecological crisis, both laws share a common basis, namely the adoption of a systemic and integrated approach to environmental conservation. The complementarity of the two laws lies in their ability to simultaneously address the causes and effects of biodiversity loss

[12] Law called "Nature Restoration"
[13] Law approved on 17 June 2024 in Luxembourg Council

and deforestation, recognising the central role of terrestrial and marine ecosystems in maintaining climate stability and providing essential ecosystem services.

Nature Restoration legislation aims to establish a legal framework for the restoration of damaged ecosystems and the conservation of biodiversity in member states, as their loss compromises services such as air and water purification, soil fertility and climate regulation. Furthermore, the synergy between the two laws is highlighted in the drive towards greater environmental responsibility on the part of companies and the involvement of member states in the development of national strategies and action plans. The dual legislative dimension underlines the importance of a collective and transnational commitment to addressing environmental challenges.

As reported by (www.isprambiente.gov.it) regarding the Nature Restoration Law, EU countries must restore at least 30 per cent of habitats in poor condition by 2030, 60 per cent by 2040 and 90 per cent by 2050. The objectives of the law also include restoring at least 25.000 km of rivers and ensuring no loss (in terms of area) of urban green spaces and urban tree cover (Federico De Girolamo 2024). In addition, it must be ensured that restored areas are not at risk of deteriorating again, and therefore national restoration plans must be adopted, containing objectives and ways to achieve them. These measures were taken following a study by the European Environment Agency, which revealed that 81% of habitats, the natural environments in which an animal or plant lives, in EU territories have an inadequate (45%) or poor (36%) conservation status. Added to these figures is the negative trend of deteriorating natural habitats, so far affecting about 36% of those in the EU, but the percentage is increasing. The objectives of the law are not limited to improving biodiversity, but also to improving climate conditions and food safety. Each member country will have to draw up its own national nature restoration plan, detailing the ways and means to achieve the goals. They will be supported by the scientific community in deciding which habitats to prioritise in their interventions, taking into account key indicators for overall health.

So, while the Nature Restoration Law covers a wide range of ecological objectives with multi-stakeholder engagement, the EU Regulation 2023/1115 (“anti-deforestation”) focuses on a more circumscribed and business-oriented action, with a specific focus on reducing deforestation associated with traded goods.

3.2.1 Overview of EU Regulation 2023/1115

Ultimately, the following section explores the issue of deforestation considering the new European regulation and its implications for business. The current context shows a growing awareness on the part of institutions and citizens of the importance of forests for the maintenance of ecosystems and their contribution to global climate stability. Despite the crucial role they play, deforestation continues to pose a significant threat, not only to the environment but also to the economic sustainability of businesses. The impacts of deforestation ripple throughout the value chain, affecting multiple sectors and entailing environmental, social and financial risks.

The adoption of the new EU Regulation 2023/1115 is an integral part of the sustainability policies promoted by the European Union and represents an evolution from the previous EU Regulation 995/2010, known as the "Timber Regulation" or EUTR. The main objective of the new regulation is to minimise the EU's contribution to global deforestation and forest degradation by improving the sustainability of supply chains for raw materials and products that impact forest ecosystems. EU Regulation 2023/1115 introduces several novelties compared to the Wood Regulation, which focused mainly on timber and timber products, aiming to prevent the placing on the market of products made through the illegal felling of trees. Furthermore, for companies that fell under its scope, the EUTR provided:

- Due diligence obligations thus the gathering of information about the timber to ensure its compliance with the laws of the Country of origin, as well as assessing and mitigating the risks of illegality;
- Accountability of operators, who are responsible for the supply chain and thus the traceability of timber, i.e. the legality of sources;
- Independent monitoring bodies, whose purpose is to monitor and assist operators in fulfilling their due diligence obligations.

With respect to the following points, the new regulation envisages, firstly, the extension of the scope to include other critical raw materials such as cattle, cocoa, coffee, palm oil, rubber and soya. Thus, covering a wider range of products that contribute to deforestation. Further innovations are reflected in: a digital due diligence declaration required from companies, to facilitate transparency and related controls; the adaptation to more stringent requirements; and the creation of a country benchmarking system.

These new aspects addressed in the regulation are part of an overall vision of the European community, which aims to:

- Reducing deforestation, by acting on companies but especially on supply chains and ensuring that products placed on the market do not contribute to deforestation;
- Mitigating greenhouse gas emissions, deforestation being one of its causes. The EU can act indirectly, limiting the phenomenon and thus reducing emissions from forest destruction;
- Preserve Biodiversity, as forests are crucial habitats for a wide range of animal and plant species;
- Promoting Sustainability, through the promotion of sustainable production and procurement practices among European companies. This not only contributes to environmental well-being but also to greater social responsibility.

3.2.1.1 Timeframe and transitional regime

The Regulation is scheduled to enter into force on 30 December 2024, with obligations that will apply to all operators and traders from this date. However, a transitional regime is provided for small and medium-sized enterprises (SMEs) that use assets other than those already subject to the EUTR and established before 31 December 2020. In relation to these SMEs, compliance with the obligations will be postponed until 30 June 2025, giving them a longer adaptation period to comply with the new rules (Gazzetta Ufficiale dell'Unione Europea 2023).

The Timber Regulation will continue to apply until 31 December 2027 for all timber products, after which date the new EUDR will take over, ensuring a smooth and orderly transition to the new regulatory regime.

During the transition period, the competent authorities of the Member States will be in charge of verifying the compliance of companies with the requirements of the new regulation, applying fines and other corrective measures in case of violations.

3.2.1.2 Figures involved in the UE Regulation

The two main categories of economic actors involved in the implementation of the regulation are operators and traders, the former being the entities that first place raw materials or products associated with deforestation on the EU market. This category includes producers, processors and importers, ranging from large companies to micro-

enterprises, which, regardless of their size, must comply with the same basic obligations. Traders include all those who make products made available on the market by a trader, i.e. wholesalers, distributors and retailers. The latter can be either small traders with limited resources, such as SMEs, or large traders with significant influence on the supply chain.

Operators' main obligations include: implementation of a due diligence system, risk assessment and mitigation, due diligence documentation and declaration, review and update. Operators must maintain accurate documentation and submit a due diligence declaration of product compliance before placing them on the market. This declaration must be available to competent and customs authorities for inspection. In addition, regular review and updating of the due diligence system is required to ensure its continued effectiveness. This system requires the collection of detailed information on suppliers and sources of raw materials, including the Country of production and geolocation coordinates of production plots. Next, a risk assessment must be carried out to determine whether the raw materials or products are associated with deforestation or forest degradation. If a risk is identified, measures must be taken to mitigate it to a negligible level.

Traders, on the other hand, have an obligation to collect and store information, as well as to declare compliance. Only large traders, thus not SMEs, are required to adopt a due diligence system similar to that of traders. While for all regardless of size, annual reporting on due diligence practices and ensuring that products distributed comply with the regulation's standards is required. The collection and preservation of information is necessary to demonstrate the compliance of products with the regulation's standards and must include details on suppliers, facilitating monitoring by competent authorities.

3.2.1.3 Tasks of Member States and Authorities

Another category of actors affected by the regulation are the Member States and the competent authorities, establishing for each the requirements for their designation, functioning and responsibilities in ensuring compliance with the regulation. Member States must ensure that competent authorities have the necessary powers to fulfil their obligations, including the possibility to: carry out inspections, request information from operators and traders, and take corrective measures in the event of non-compliance.

Indeed, it is among their priorities to continuously monitor the compliance of the actors involved, starting with the analysis of due diligence statements and performing risk-based checks. Furthermore, to prevent possible circumvention of the regulation, they must exchange information with the Commission and the authorities of the other Member States regarding significant changes in the pattern of trade in the products concerned.

The European Commission is delegated the task of carrying out a comparative Country assessment, which is important to help companies and authorities identify risk countries and make informed decisions on the management of supply chains. Specifically, this assessment system aims to rank countries according to the risk of imported raw materials contributing to deforestation. Countries are then classified into three risk categories: high risk, low risk and standard risk. Depending on the classification, there is a level of due diligence companies must perform on imported products, so if we have high-risk countries, there will be more rigorous and detailed due diligence than is required for low-risk countries. Country evaluation criteria include the rate of deforestation and forest degradation, the rate of expansion of agricultural land for the commodities concerned, and trends in the production of these products and commodities. The system provides for the possibility of periodic review and updating of the list of countries and their risk classifications to reflect changes in forest management policies and practices.

To ensure harmonised application of the regulation, cooperation between the competent authorities of member states is encouraged, such as mutual assistance during investigations and controls. As well as cooperation and technical assistance is requested from operators and traders, to help them comply with the requirements of the regulation. Especially for SMEs, which may have fewer resources at their disposal, it is important to guide them in the implementation of due diligence systems and in the adoption of tools to support the collection and management of information. Finally, the commission is responsible for setting up and managing a centralised information system that facilitates the submission of due diligence declarations by operators and traders, as well as supporting authorities in monitoring and enforcing the regulation. This system must be accessible to competent authorities and customs and must promote transparency as well as the sharing of commercially non-sensitive information with the public (Gazzetta Ufficiale dell'Unione Europea 2023).

Thus, while operators and traders have specific transparency obligations, the authorities have the task of monitoring the compliance of operators and traders. In particular, the former are responsible for publishing annual due diligence reports, which include:

- Information on measures taken for risk assessment,
- Data and results on controls carried out along the supply chain,
- A description of the information collection procedures and criteria used for risk assessment.

Finally, they ensure that this information is publicly available, promoting transparency in their operations and supply chains.

With regard to authorities, these are designated by the European Commission, through an updated list with names, addresses and contact details, to ensure transparency and facilitate communication with stakeholders(Gazzetta Ufficiale dell'Unione Europea 2023). There are two key activities that authorities are required to perform:

- Data collection and publication, ensuring that commercially non-sensitive data is made available to the public in an open format. In addition, information collected during controls must be accessible to interested parties for compliance assessment.
- Co-operation and exchange of information with authorities in other member states, as well as with the European Commission, to co-ordinate monitoring activities and ensure harmonised application of the regulation throughout the European Union.

Information management and public participation, implying the creation of an information system that allows the public to access data on the compliance of raw materials and products, as well as promoting the participation of consumers, NGOs and other entities in assessing and monitoring the practices of operators and traders.

3.2.1.4 Integration with other European directives

Regulation (EU) 2023/1115 integrates with other EU legislation to create a coherent and comprehensive legal framework, which addresses various aspects of environmental sustainability, human rights protection and transparency in supply chains. Among the main regulations that make up the framework are:

- The European Climate Regulation (EU Regulation 2021/1119) which defines how to achieve climate neutrality by 2050 and the reduction of greenhouse gas emissions by

55% by 2030. The Deforestation Regulation contributes to these goals by reducing deforestation and preserving so-called carbon sinks.

- The CSRD (Corporate Sustainability Reporting Directive), introduced to improve transparency of environmental, social and governance (ESG) information, obliges all companies with a turnover of more than EUR 40 million to report in detail on ESG issues and to use reporting standards[14].
- The Regulation on Sustainability Reporting in the Financial Services Sector (EU Regulation 2019/2088), which requires financial market participants to disclose how they integrate sustainability risks into their decision-making processes, together with the Deforestation Regulation ensure that commodities and financed products meet sustainability standards without contributing to deforestation.

3.2.2 Implications of the UE Regulation for companies

In recent years, many investors have made their investment choices considering sectors and companies particularly affected by deforestation. Evaluating the resulting financial implications and how to manage the risks arising from deforestation. Therefore, it is crucial for companies to improve their approach to these issues, also in view of the changes brought about by the European regulation. Indeed, the latter has a significant impact on a company's business, to the point of affecting a company's operations in the European market. In the following section, the implications of Regulation 2023/1115 on companies are outlined, so that one can understand both the extent of the impact and the potential risks one faces.

The need to comply with the new regulation foreshadows several changes for many companies, in some cases drastic due to their size or the sector in which they operate. Indeed, raw materials that fall under the scope of the European regulations are often brought into Europe by operators working in developing countries. In these cases, complying with the requirements requires a large economic effort and more, especially in sectors such as cocoa or coffee, whose first actors in the supply chain are small local farmers, who do not have advanced skills or government support.

[14] The standards in question are the European Sustainability Reporting Standards (ESRS) developed to harmonise information at European level and improve comparability between companies

Despite the difficulties that many operators/traders may face. in complying with the regulation, it is necessary to comply by the date of entry into force (30/12/2024) to avoid incurring additional types of risks due to the regulation. The new regulation requires companies to invest in appropriate equipment (such as geolocation software) for the traceability of raw materials. This, for companies, means: increasing the marginal costs associated with such investments, if they already have such equipment; otherwise, facing significant new costs. Translating these additional costs into operational risks associated with the implementation of traceability systems and leading to:

- Technical Difficulties: enterprises have to implement advanced traceability systems, which require specific technical skills and significant investment in technology;
- High Costs: the costs associated with collecting and managing traceability data, including the costs of upgrading IT infrastructure, can be difficult for small and medium-sized enterprises. Just as they can be for larger ones with a complex and globalised network.

Further aspects are related to the timing and resources required for the activities required by the regulation:

- Continuous monitoring of agricultural practices and regulatory compliance requires additional human and financial resources;
- Hiring new highly specialised staff and training them in the use of new technologies and compliance procedures entails additional costs and time.

Companies that have not planned for such incremental investments may face an even greater financial risk, as in the current macroeconomic environment there is a tendency to reduce the capital allocation budget for these purposes.(https://www.janushenderson.com/it-it/advisor/article/deforestation-rising-up-the-corporate-and-investor-agenda/). This is especially relevant for consumer companies, which are already under pressure due to inflation and international political scenarios (e.g. Russia-Ukraine conflict).

In general, the delay or difficulty in ensuring compliance with the regulation can generate risks for corporate business, related to corporate image and corporate social responsibility. In particular, one must consider:

- Public perception: companies that fail to demonstrate the sustainability of their operations may suffer damage to their public image and lose consumer trust;
- Stakeholder relations: non-compliance can undermine relations with stakeholders, including investors, customers and business partners, reducing their trust in the company;
- Human rights protection: companies must ensure that agricultural practices respect human and labour rights, including the prevention of forced and child labour;
- Social responsibility: requires the promotion of socially responsible practices along the supply chain to avoid criticism and social sanctions.

Another potential issue associated with the new regulation is the risk of violating the rights of local communities. Indeed, where small farmers fail to comply with EU regulations, they may move to marginal areas to seek new land for cultivation. In turn, favouring the expansion of large-scale agriculture at the expense of local communities and indigenous peoples' land would exacerbate land conflicts and undermine rights to food and shelter. The lack of specific protections for land tenure rights and the principle of free, prior and informed consent in the EU regulation could institutionalise land eviction by increasing human rights risks.

The primary purpose of the EUDR is the regulation of companies operating in the European market, hence non-compliance entails several market risks. In particular:

- Market exclusion: non-compliance means exclusion from the EU market, thus losing a significant share of the global market;
- Loss of competitiveness: compliant companies may use their compliance as a competitive advantage, leaving behind those that fail to comply. In turn, this creates the risk of small companies no longer operating in the EU market, leading them to turn to other markets without disrupting the deforestation process or worsening the conditions of small farmers in developing countries;

- As a result of increased costs to operate in a compliant manner, there is a risk of sourcing raw materials at a higher price or in smaller quantities, affecting the supply for consumers. Who may look for cheaper alternatives.

At the same time, companies must be able to manage their relationships with suppliers in the light of the European regulations in such a way as to ensure operations during the compliance period. For this reason, it is important to manage relationships with other parties in the supply chain in a timely manner, avoiding supply risks:

- Logistical complications: the need to ensure that all suppliers are compliant with regulations can complicate supply chain management. Exclusion of a particular supplier in view of the lack of requirements may cause inconvenience in the search for a replacement;
- Supply disruptions: non-compliance of key suppliers may cause interruptions in the supply of raw materials, negatively affecting production and business operations.

A further issue arises depending on enforcement in individual states, especially against companies, which are subject to different types of sanctions. These include fines proportionate to the environmental damage and the value of the raw materials/products involved, the maximum amount of which can be up to 4 per cent of the company's total annual turnover at European level. In addition to fines, companies may also face the confiscation of non-compliant products or the proceeds generated from their sale. As for temporary measures, they risk exclusion for up to 12 months from public procurement procedures and access to public funding. At the same time, there is a temporary ban on the entry or export of raw materials/products to the EU market in the event of serious or repeated infringements. In addition, there is the possibility of immediate corrective measures for non-compliant companies such as: cease-and-desist orders, withdrawal of non-compliant products from the market, obligations to implement risk mitigation and prevention measures. These can be accompanied by ancillary measures, such as the obligation for companies to participate in training programmes on environmental compliance and due diligence, as well as the obligation to finance environmental restoration initiatives or support local communities affected by deforestation.

Finally, the regulation provides for the mandatory publication of sanctions and measures taken against non-compliant companies, as a deterrent for other companies and as an incentive for greater responsibility(Gazzetta Ufficiale dell'Unione Europea 2023).

Considering what has been discussed, it is evident that Regulation 2023/1115 represents a turning point for companies, which are required to address their environmental responsibilities through a more transparent system and due diligence mechanisms. This means that in addition to the need to comply with the legal provisions, companies must also integrate processes for constant monitoring of their supply chains. The latter also offer opportunities to improve natural capital management and reduce regulatory and reputational risks. The next section goes into detail about the due diligence system, describing how it supports companies in proactively managing critical issues related to deforestation.

3.2.3 The due diligence system

EU Regulation 2023/1115 imposes a stringent due diligence system on companies dealing with commodities that are at risk of deforestation. This must be designed to ensure that products imported, exported and marketed in the EU are not associated with deforestation and forest degradation. To be effective, this process must be well structured and integrated into business operations. Taking the case of a company operating in the cocoa sector, first and foremost it is required to prepare a detailed collection of information on the origin of cocoa. This includes the identification of GPS coordinates of plantations, verification of land ownership documents and an analysis of the farming practices adopted by the producers. In relation to the land identified by GPS, verifications should ascertain that it has not been involved in deforestation processes after the cut-off date established by the regulation. Verifications should also take into account the local context of the production areas, including local laws, land rights and the socio-economic conditions of local communities. For example, if a cocoa farmers' cooperative in Ghana is located in an area with weak enforcement of land tenure laws, the company will need to take additional measures to verify the legality of production. Then, using the information gathered, the companies can identify potential deforestation risks. They then ascertain that there has been no legal or illegal deforestation, forest degradation or conversion of forest areas for agricultural use. Once the risks have been identified, they must be classified according to their severity and likelihood, so as to focus the companies' efforts on the risks that require

significant or urgent action. To intervene with mitigation strategies, it would be advisable for companies to implement them in collaboration with suppliers, especially in cases where technical support or the adoption of advanced technologies is required (Berning e Sotirov 2023). Furthermore, it is very important for both suppliers and companies further down the supply chain to obtain internationally recognised sustainability certifications such as FSC or Rainforest Alliance. This reduces the risk of deforestation, improves transparency and trust, and potentially attracts additional consumers.

A crucial aspect of the due diligence system is regular monitoring and verification. Regular audits and independent verification are required to ensure that the mitigation measures taken are effective and that practices throughout the chain comply with sustainability standards. Indeed, audits help to identify any problems and take timely corrective action, ensuring ongoing compliance. In addition, companies must promote corporate social responsibility initiatives that support local communities and improve their socio-economic conditions. This can include community development projects, such as building agricultural infrastructure, schools or health clinics. Such initiatives not only improve the quality of life of local communities, but also reduce pressure on deforestation by offering sustainable alternatives for livelihoods.

3.2.3.1 Traceability tools

Among the main tools identified for the creation of an effective and transparent due diligence system are traceability platforms. These systems need to collect geolocalised data, such as the GPS coordinates of each plot of land used for production, ensure transparency of information on suppliers and farming practices. Interoperability of systems is crucial, allowing the integration of data from different existing platforms and infrastructures, while data security must be ensured to protect sensitive information collected along the supply chain.

The operation of an effective traceability system consists of several key steps. First, data is collected by advanced technologies such as blockchain, IoT(Internet or Things) sensors and GIS (Geographic Information System)[15] which provide detailed information on soils, farming practices and raw material movements. This data is then verified and validated

[15] IoT sensors are devices that collect data from their surroundings and transmit them through the Internet. GIS are systems designed to capture, store, manipulate, analyse, manage and present geographical and spatial data.

through periodic audits and field inspections. Continuous monitoring of activities is essential to ensure that farming practices do not contribute to deforestation. Finally, the system must be able to generate detailed reports documenting regulatory compliance of the sustainable practices adopted.

The implementation of these systems presents several difficulties, one of the main problems being the high costs involved in adopting advanced technology and training staff. To overcome this, companies can collaborate with other companies and governments to share costs and resources or seek grants and funding from international organisations. Another challenge is the interoperability of systems, which can be complex due to the need to integrate different standards and platforms. Adopting common standards for data collection and management, using collaborative platforms such as the Digital Integration of Agricultural Supply Chains Alliance (DIASCA[16]), can facilitate this process.

Protecting the privacy of data collected along the supply chain is another critical issue; companies need to implement advanced IT security measures and develop clear policies for data management and sharing, ensuring that information is only used with appropriate consent. Furthermore, the complexity of supply chains, which often involve many intermediaries, can make traceability management difficult. Detailed mapping of each step in the chain and collaboration with local organisations and farmers can improve transparency and traceability. Such systems are now crucial in several sectors, from the food industry to the fashion industry. Some examples of systems adopted in the coffee industry are given below (Claudina Padilla-Quiñonez, et al. 2023):

- Trazar-Agro is a system developed by OIRSA[17], implemented by the Ministry of Agriculture and Livestock in Honduras. This instrument integrates registers of individuals, establishments, operators and means of transport involved in agricultural and livestock activities. It currently serves over six thousand registered farmers.

[16] It means the use of digital technologies to improve the efficiency, transparency and traceability of the entire agricultural supply chain.
[17] Organismo Internacional Regional de Sanidad Agropecuaria, an international organisation dedicated to agro-protection in the Central American region.

- INATrace supported by the GIZ PROCAMBIO II[18], it aims to establish transparent agricultural supply chains globally. It uses blockchain technology to track coffee from production to final packaging, promoting price transparency and fair compensation in the supply chain.
- GrainChain is a technology startup that uses a blockchain and IoT enabled platform to manage pre and post-harvest processes. It facilitates the monitoring and recording of crucial events in the coffee value chain, such as harvesting, transportation, storage and sale.

Compared to these systems, data privacy and interoperability are key elements in the management of tracked information. GrainChain and INATrace ensure the protection of user data by committing not to share, rent or sell information without user consent. INATrace allows the upload of a data sharing agreement signed by all stakeholders involved. Regarding interoperability, Trazar-Agro can interoperate with SAP, while INATrace is evolving through an alliance with DIASCA and GrainChain offers integration capabilities with third-party systems, sensors and existing IT infrastructures.

For the coffee industry, traceability systems offer significant advantages for EUDR compliance:

- They enable the registration of information needed for due diligence, e.g. INATrace is developing a specific module to verify the origin of deforestation-free products.
- They improve the transparency of supply chains, allowing consumers to access detailed information on the coffee route.
- They offer training and technical support, facilitating the adoption of digital technologies by farmers and improving their farming practices.

3.2.3.2 Potential critical issues to be addressed

At the same time, these systems present potential difficulties in terms of economics as the magnitude of the costs associated with the transition from the pilot phase to the large-scale implementation of digital technologies cannot be estimated, representing an obstacle especially for small manufacturers. In this sense, companies have to take an active role in

[18] It is a German international cooperation company working in various fields such as sustainable development, environmental protection. One of its initiatives in Central America is procambio II, a programme that aims to promote the sustainable management of natural resources and climate change mitigation.

providing resources and training so that manufacturers can comply with regulations, effectively increasing their operating costs. In addition, the adoption of these systems requires investment in technology, staff training and infrastructure for data collection and management. In terms of information flow, current traceability initiatives focus on the forward flow of information in the supply chain, with limited availability of feedback information, INATrace, for example, is developing a feedback function from end consumers, but it is unclear whether this information will reach producers. Furthermore, companies must ensure that they protect sensitive data collected along the supply chain by ensuring that information is not shared without appropriate consent. Companies are required to ensure that systems can integrate with other existing platforms and infrastructures to facilitate data management and analysis. As was also reported for the examples above, interoperability can be technically complex and costly, as platforms may use different standards, making it difficult to synchronise data between systems.

The European Cocoa Association (ECA), with a view to the best possible implementation of the following regulation within the cocoa industry, points out some critical points regarding the specific sector. Indeed, due to the complexity of the supply chain, in particular due to inefficient transport systems and infrastructure, a significant amount of cocoa beans and products exported to Europe risk not complying with traceability requirements. This is because the cultivation and processing of the beans is largely done by small local farmers who do not have the necessary tools to trace the origin of each crop. Given also the local economy of small-scale farmers, it becomes difficult to imagine that they will be able to equip themselves with them, so support is needed from both the companies operating along the supply chain and the local government. What they need is a national system of traceability and farm registration, preventing farmers from bearing the burden of compliance, which would inevitably lead to their exclusion from exporting to European markets. Besides the government, companies can also contribute through direct business relationships with local farmers and cooperatives. The ECA reports cases of companies that have mapped farms and introduced digital traceability systems in parts of their supply chain, but the goal should be integration with all actors in the chain, thus including intermediaries, domestic exporters, trade houses, terminal exchanges. The risk foreshadowed, through a failure of the above-mentioned institutions to support farmers, is that of domestic and cross-border smuggling or even the expansion of deforestation. In

the latter case, the conversion of additional forest land to crops other than cocoa is envisaged.

The reasons behind the difficulties to comply lie in: low levels of education, limited financial resources, land management problems due to unclear rights and insecurity of tenure, limited access to information, low degree of organisation and risk-averse attitudes towards sustainable management systems that require long-term commitments.

Small farmers risk being excluded from the value chain due to the complexity of implementing traceability systems, as EU operators tend to shorten and simplify supply chains, reducing the number of smallholders and sourcing raw materials from larger farms. This could reduce transaction costs for companies, but at the same time exclude more small farmers from the supply chain. In turn, these small farmers could generate further deforestation as a result of the loss of livelihoods. Due to the limited number of alternative income opportunities.

3.2.4 Criticality Management Guide

According to the implications for small farmers, presented in the previous paragraph, through the analysis of the paper (Zhunusova et al. 2022) some corrective actions were highlighted to curb potential short- to medium-term bottlenecks related to the implementation of Regulation (EU) 2023/1115. In particular, a system of incentives and support aimed at small farmers and companies in producing regions could reduce transaction costs. For example, through the establishment of unions or cooperatives, improving access to credit and providing the means to undertake structural changes in their farming systems. Although facilitating access to credit is complicated in view of the lack of collateral, implementing policies to improve collateral such as issuing title deeds and formal property rights could facilitate the process.

3.2.4.1 Risk mitigation

Given the adjustments required, potential guidelines to support companies in complying with the new European directive are outlined below. Once the risk assessment has been completed, companies are required to develop and implement mitigation strategies to reduce the identified risks to acceptable levels. The first step recommended to address this type of situation is the upstream preparation of an action plan, in line with the overall

strategy. Therefore, the definition of mitigation and contingency plans by management figures (such as a Chief Sustainability Officer) is recommended.

- Risk Mitigation Plan: a document that describes the specific actions the company intends to take to mitigate the risks identified during the assessment. This plan should include deadlines, responsibilities and allocated resources;
- Contingency Plan: a plan that describes the emergency actions to be taken in the event of the identification of unforeseen risks or incidents of non-compliance. This plan should ensure that the company can respond quickly and minimise negative impacts.

Through the following discussion of the different tools, potential strategies that a company can adopt are listed:

- Advanced traceability, as highlighted above, includes the use of technologies such as blockchain to track the origin of raw materials;
- Collaboration with suppliers, companies need to ensure supplier compliance with the standards dictated by the regulation and at the same time can collaborate through the provision of training and technical support. In the case of small cocoa farmers, knowledge on agroforestry could be passed on to integrate crops with trees in order to also improve biodiversity;
- Sustainability certifications are encouraged, especially those that are recognised globally, so as to be able to prove the origin of the products. In particular, collaboration with producer cooperatives is encouraged to obtain certifications, guaranteeing operability in the European market;
- Regular audits and verifications, the conduct of which helps to monitor the effectiveness of risk measures taken. Ensuring standard-compliant practices throughout the supply chain, as well as timely and targeted interventions towards identified risks;
- Corporate Social Responsibility initiatives, which have the dual purpose of supporting the local community, reducing pressure on deforestation and improving the image and operations of the company carrying it out. One can think, for example, of investments in local infrastructures that facilitate the transport of people as well as that of goods, increasing the company's time and logistics systems;

- Involvement of stakeholders, i.e. local communities as well as non-governmental organisations and other interested parties in decision-making processes related to forest management. Such involvement ensures that company policies respect the rights of local communities and contribute to forest conservation;
- Attestation of responsibilities by defining specific responsibilities within the company. Managers are responsible for ensuring that due diligence policies are implemented and followed correctly. Operating personnel need training and awareness-raising on sustainability objectives and traceability procedures. In addition, companies can collaborate with external consultants and independent audits to ensure an impartial and objective assessment of their practices.

Furthermore, it is crucial to structure a due diligence system that is flexible and adaptable so that it can react quickly to changes in market conditions or regulatory requirements.

3.2.4.2 Strategies and support roles for businesses

Given the multiple requirements that companies have to fulfil, as well as the potential figures to be entrusted with the various tasks, it is crucial to provide them with a set of actions that can facilitate compliance. This is because a company's primary objective is to maintain both its operations and profitability, hence the need to help it implement the various systems (such as due diligence) as effectively and efficiently as possible.

As a basis, companies are advised to develop training programmes to make all internal staff aware of the need for collaboration and effectiveness. Therefore, they are potentially useful:

- Training programmes: develop and implement training programmes for staff and suppliers. These programmes should cover regulatory requirements, sustainability best practices, use of traceability technologies and due diligence procedures.
- Workshops and Seminars: organise regular workshops and seminars to update staff and suppliers on the latest regulatory requirements and advanced risk management techniques.
- Integration of Management Systems:

- Environmental Management Systems (EMS): integrate due diligence requirements into the Environmental Management System (ISO 14001), ensuring a structured and systematic approach to environmental risk management;
- Quality Management Systems (QMS): use a Quality Management System (ISO 9001) to monitor and continuously improve due diligence processes.

Also, with a view to stakeholder involvement, both internal and external, it is essential to define clear company policies. Below are some examples:

- Sustainability Policy: a document outlining the company's commitments to environmental sustainability, including managing natural resources, reducing deforestation and respecting the rights of local communities;
- Due Diligence Manual: a detailed guide describing due diligence procedures, including information gathering, risk assessment, mitigation and monitoring processes. This manual should be updated regularly to reflect best practices and regulatory changes.

In addition to what has been suggested so far, there are additional supporting documents that can facilitate relationships with suppliers, monitoring bodies and external auditors. To this end, the adoption of documentation that defines in advance the subject matter and scope of action of the parties in the contract can simplify business operations and overall efficiency. Hence, the list of potential contracts to be defined ex ante:

- Supply Contracts: contracts must include specific clauses requiring suppliers to comply with the company's sustainability standards and due diligence policies;
- Supplier Code of Conduct: a document that sets out the company's standards and expectations in terms of sustainable practices and social responsibility, which suppliers must accept and follow;
- Internal Audit Reports: documents that report the results of internal audits, highlighting areas of compliance and those requiring improvement. These reports must include recommendations for corrective action;

- External Verification Reports: reports provided by independent auditors verifying the effectiveness of the mitigation measures taken and compliance with regulations;
- Due Diligence Statements: documents that the company must submit to the relevant authorities to demonstrate compliance with due diligence requirements. These statements must include details of risk assessments, mitigation measures taken and audit results;
- Sustainability Reports: periodic publications that communicate to stakeholders the company's progress in terms of sustainability, including the results of Corporate Social Responsibility initiatives, certifications obtained and deforestation mitigation measures.

At the same time, an effective system requires the collaboration of different professional figures, the ones most suitable in the context outlined so far are listed below:

- Chief Sustainability Officer (CSO) responsible for the company's overall sustainability strategy, including compliance with environmental regulations. He/she is responsible for defining the sustainability policy, overseeing the implementation of the due diligence system and monitoring progress;
- Compliace Officer whose task is to ensure compliance of the company's operations, ensuring compliance with laws and regulations such as 2023/1115;
- Supply Chain Manager manages the chain and ensures the traceability of products, works with suppliers and verifies the origin of raw materials:
- Risk Analyst deals with the identification and assessment of risks by analysing data.
- CSR specialist for the promotion of CSR initiatives;
- Internal Auditor conducts internal audits to ensure compliance, plans and evaluates the effectiveness of mitigation measures.

The compliance plan as well as each group policy needs to be integrated with the business plan, so that there is no disconnect between the operations and sustainability management.

Conclusion

The following paper dealt with the phenomenon of deforestation with a specific focus on the risk it poses not only to the environment but also to businesses. An attempt has been made to answer the research question by analysing the types of impacts it generates and how these affect businesses. From the discussion it emerges that deforestation has several direct impacts such as the reduction of forest resources or the increase in greenhouse gas emissions, which deteriorate both the ecosystem and business operations. This challenges not only individual companies but entire global supply chains, creating an unstable economic environment and crises within entire economic sectors. The correlation between deforestation and business is also underlined in the light of indirect impacts, which undermine services such as climate regulation, the water cycle or soil fertility that are essential for the performance of many business activities. In fact, these factors negatively affect both primary sectors such as agriculture and forestry as well as secondary and tertiary sectors, resulting in disruptions in supply chains and increased business vulnerability.

Despite its magnitude and wide scope, there is little recognition of the phenomenon by many enterprises. The problem that emerged from the discussion is related not only to the identification but above all to the assessment of risks, highlighted by the fact that many companies do not have an adequate mitigation strategy. Hence the need to focus on how multiple impacts translate into business risks. As demonstrated throughout this thesis, the destruction of forests has an immediate impact on resource availability and local ecosystems, compromising the very operations of companies and the integrity of supply chains. In addition to operational risks, deforestation has several additional impacts. For example, there are financial risks, related to commodity price volatility, reputational risks, due to the focus of investors and consumers on sustainable practices, and regulatory risks, due to recent regulations to combat deforestation. Especially at the European level, EU Regulation 2023/1115 represents a turning point in the fight against deforestation, offering a more structured regulatory framework for the promotion of sustainable business practices. The Regulation introduces new responsibilities for companies, which must adopt due diligence processes throughout the supply chain and ensure that their activities do not contribute to deforestation. This approach not only promotes forest conservation

but creates a culture of transparency by making it difficult for companies to ignore the risks of deforestation without consequences.

At the same time, complying with the new regulations poses significant challenges for companies, which is why compliance guidelines have been outlined in the paper. It defines the relevant aspects of the EU Regulation and the potential challenges for companies, related to the adoption of traceability systems, stricter certification standards and the implantation of a rigorous due diligence system. In addition to the requirements of the EU Regulation, risk mitigation strategies and tools, such as the AFI Framework, were proposed to help companies manage their supply chains. Furthermore, along with the adoption of key tools such as the implementation of due diligence, reforestation and conservation strategies have been described that, combined with the creation of carbon credits, can generate new economic opportunities. From this perspective, the proactive management of deforestation-related risks becomes an opportunity to strengthen corporate resilience and gain a competitive advantage in an increasingly sustainability-conscious environment.

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