

TEXTILE AND BIODIVERSITY

Impacts and dependencies of the sector

Sectoral report

September 2026

Version 1.0

Version

Sectoral report, impacts and dependencies of the textile sector version 1.0, September 2026.

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Authors

Alejandra Rozas, Gabriel Robin, Mathieu Douziech (CDC Biodiversité)

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Summary for policymakers | Textile

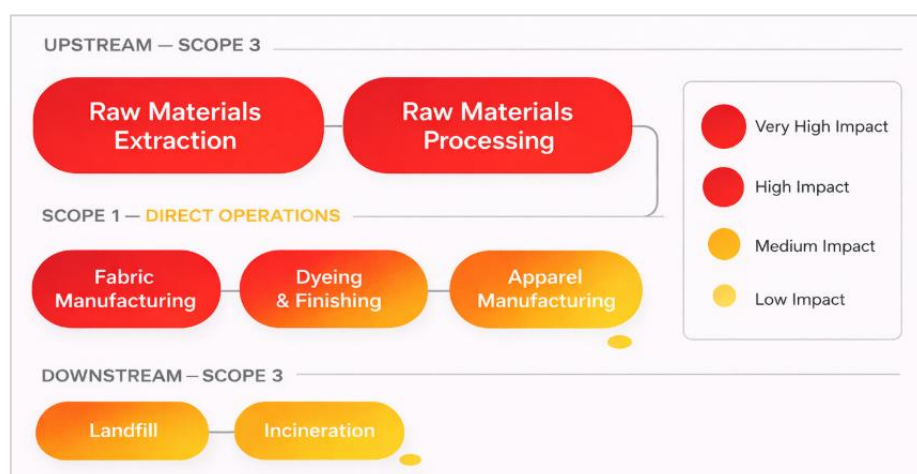
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ANALYSING THE IMPACTS OF THE TEXTILE SECTOR ON BIODIVERSITY

The relationship between biodiversity and business involves both **impacts** and **dependencies**. Organisations interact with biodiversity in two main ways: through their **reliance on ecosystem services**, and through the **impacts their activities** have on biodiversity. These interactions can create **risks** that affect operations, turnover, and profitability by influencing costs, sales, and even access to capital. When impacts and dependencies are high, they can amplify these risks for organisations, making them more vulnerable to disruptions and financial losses. Physical, transition, and systemic risks linked to biodiversity loss can also be transmitted to the financial sphere and, through contagion, spread throughout the wider financial system.

This analysis is designed to provide a **clearer understanding** of how the **sector interacts with biodiversity**. It highlights the main **impacts** and **dependencies**, as well as the potential **risks** and **opportunities** that may arise. It can therefore be useful not only for companies and financial institutions, but also for public authorities and anyone interested in gaining broader knowledge about biodiversity challenges. The findings are grounded in an extensive review of existing literature, combined with a quantitative assessment using the **Global Biodiversity Score**, a tool that measures biodiversity footprints. All detailed results and further findings are provided in a sectoral report.

KEY MESSAGES – A BIODIVERSITY IMPACT DRIVEN BY UPSTREAM ACTIVITIES



- The sector's impacts are **overwhelmingly driven by the upstream supply chain** (70-90% of the impact), due to the use of land and resource intensive inputs (natural and synthetic fibres, dyes, chemical auxiliaries).
- End-of-life management amplifies biodiversity pressures, as **landfilling and incineration** remain the dominant pathways while reuse and circular design offer the greatest mitigation potential.
- The heterogeneity of impacts across the value chain calls for **targeted strategies at each step**.

MAIN DRIVERS OF BIODIVERSITY LOSS



KEY TEXTILE MATERIALS — BIODIVERSITY IMPACT OVERVIEW

An analysis of four dominant textile fibres (together representing of 80% of global fibre production) was conducted. Natural fibres appear more impactful, but their impacts are more reducible—unlike synthetics, which face persistent challenges like fossil dependency, microplastic pollution, and limited recyclability.

MATERIAL	GLOBAL SHARE	DEGRADATION	TERRESTRIAL IMPACT	AQUATIC IMPACT	MAIN TERRESTRIAL DRIVER	MAIN AQUATIC DRIVER
COTTON	19%	20-50 cycles	HIGH	MEDIUM-HIGH	Land use (crop occupation)	Freshwater eutrophication
POLYESTER	59%	100-200 + cycles	MODERATE	MODERATE	Climate change (GHG emissions)	Ecotoxicity – freshwater
VISCOSE	6%	30-70 cycles	HIGH	HIGHEST	Land use (forest plantation)	Ecotoxicity – freshwater (organics)
POLYPROPYLENE	5%	80 – 150 cycles	LOW	LOW	Climate change (polymerization)	Minor contributions across categories

Source: GBS Product Tool / ecoinvent APOS 5 | Production phase only — excludes transport, retail & use | Global Biodiversity Score (MSA.km²)

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DEEP DIVE INTO THE SECTOR

KEY RESULTS ON DEPENDENCIES, IMPACTS, RISKS AND OPPORTUNITIES

IMPACTS

UPSTREAM VALUE CHAIN IS THE MAJOR DRIVER

The sector's greatest biodiversity impacts lie within its Scope 3 upstream suppliers, terrestrial and aquatic pressures representing between 70 and 99% of its total footprint across the value chain.

The four primary impact drivers are: **land use, climate change, water consumption and eutrophication.**

- Significant spatial pressures and pollution emissions linked to **agricultural and forestry activities** throughout the supply chain.
- Highest-impact materials: **cotton cultivation, leather production and synthetic fibre manufacturing.**
- Most critical processes: raw material growing, **dyeing, finishing and washing** operations.

DEPENDENCIES

WATER, A CRITICAL DEPENDENCY FOR THE SECTOR

The textile sector is intrinsically dependent on biodiversity. Water-related services are consistently critical across all subsectors: dyeing, finishing and washing operations require stable access to large volumes of clean water.

A dependency on biodiversity through the value chain

- Natural fibres (cotton, wool, cellulose) **rely directly on pollinators and living soils.**
- Manufacturing activities, due to intensive water uses and need for built-up infrastructures, rely heavily on the **supply and quality of water**, and climate related services such as flood control and storm remediation.
- **Solid waste remediation services**, are critical for incineration and landfill subsectors. As the ecosystems' natural capacity to decompose and assimilate materials is becoming overstretched, the sector is exposed to serious operational risks.

RISKS

WELL ESTABLISHED BIODIVERSITY RISKS

PHYSICAL RISKS

The sector is exposed to acute disruptions from ecosystem degradation due to its strong dependence on nature, such as cotton supply shocks driven by droughts or crop failures, as well as chronic declines in fibre quality as soils degrade and water basins become increasingly stressed over time.

TRANSITION RISKS

Transition risks arise as textile production practices face increasing regulatory, market and technological pressure: stricter due diligence on supply chains (e.g. sourcing of cotton and viscose), shifting consumer preferences away from fast fashion, and the need to invest in low-impact processes such as water-efficient dyeing and alternative fibres.

OPPORTUNITIES

NATURAL FIBRES AS A KEY LEVER

01 TRANSITION TO REGENERATIVE AGRICULTURE

Cotton, wool and cellulose are biologically derived fibres, meaning their production can shift toward agroecological systems that actively restore soil health, reduce synthetic inputs and rebuild ecosystem function, converting a major impact driver into an opportunity for nature recovery.

02 TEXTILE RECYCLING AS PRODUCTION DECOUPLING

Mechanical and chemical recycling reduce virgin raw material extraction, land use, water consumption and agricultural pollution. Designing for recyclability from the outset: mono-material construction, no mixed fibres is a prerequisite for viability at scale.

03 NATURE RISK IN PROCUREMENT & SUPPLIER ENGAGEMENT

Integrating nature risk assessments into procurement strategies and supplier engagement enables companies to systematically identify and act on the highest-impact points across their entire value chains.

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ENGAGING THE SECTOR: WHAT'S NEXT?

REDUCING BIODIVERSITY IMPACTS IN THE TEXTILE SECTOR REQUIRES ACTING PRIMARILY UPSTREAM IN THE VALUE CHAIN

Actions are ranked by priority level based on their position in the value chain and magnitude of biodiversity impact. Direct operations provide the most immediate leverage, followed by upstream supply chain interventions and downstream measures.

01 DIRECT OPERATIONS	Direct Operations Phase — <i>Highest immediate control & accountability</i> › Apply the mitigation hierarchy (avoid, reduce, restore, offset) to all site-level impacts, starting with eliminating unnecessary land take for new facilities › Conduct site-level biodiversity assessments to identify sensitive ecosystems near production sites and adapt operational footprint accordingly › Set internal biodiversity KPIs linked to operational decisions, including land occupation, water withdrawal, and chemical discharge at owned facilities
02 ENERGY USE DIRECT OPS	Energy Use for Direct Operations › Transition owned and operated facilities to 100% renewable energy (solar, wind, certified green electricity) to eliminate fossil-fuel-linked climate impacts on biodiversity › Conduct energy audits across all manufacturing sites to identify efficiency gains and reduce total energy consumption per unit of output › Engage key suppliers on renewable energy adoption, prioritising high-energy-intensity processes such as dyeing, finishing and synthetic fibre production
03 UPSTREAM PHASES	Upstream Phases — <i>Greatest leverage on biodiversity — raw material sourcing drives 70–80% of impacts</i> › Improve raw materials traceability (using certifications for example) to identify suppliers from high-risk locations › Prioritise the transition to regenerative or agroecological farming systems for natural fibres (e.g. Regenerative Organic Certified) — these offer a uniquely actionable lever to reduce impacts at source compared to synthetic alternatives › Enforce no-deforestation and no-conversion commitments across suppliers › Prioritise supply from basins exempt of water stress or require suppliers in water-stressed basins to adopt precision irrigation to reduce freshwater withdrawal
04 DOWNSTREAM PHASES	Downstream Phases › Integrate end-of-life recyclability criteria into product design to reduce virgin material demand and associated upstream pressures › Partner with certified sorters and recyclers to ensure post-consumer garments re-enter the material cycle

INDUSTRY BEST PRACTICES

Responsible Fibre Sourcing › Obtain GOTS, Better Cotton, FSC/PEFC or RCS certifications to verify responsible sourcing claims › Map full supply chain to Tier 3 level to identify biodiversity hotspots and deforestation-linked origins › Prioritise recycled or bio-based inputs where technical performance allows	Circular Design & End of Life › Design for disassembly using mono-material or easily separable blends to enable fibre-to-fibre recycling › Partner with certified sorters and recyclers to ensure post-consumer garments re-enter the material cycle › Apply Extended Producer Responsibility (EPR) frameworks and engage in take-back schemes	Measurement & Transparency › Use biodiversity footprinting to track impacts over the value chain and direct activities › Align reporting with TNFD and SBTN frameworks to meet regulatory expectations (CSRD, EU taxonomy) › Share supplier environmental data via collaborative platforms (e.g. Worldlee, Higg Index) to reduce duplicated audits
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A. Introduction: Global Context of the Textile Sector

The textile and apparel industry plays a significant role worldwide: according to the International Labour Organisation, more than 90 million people, predominantly women, are involved in the manufacture of garments, footwear, leather and textile products and the true number could be even higher due to underreporting in official statistics (ILO and International Labour Organization 2024). This underreporting is closely linked to informal and subcontracted employment arrangements, which often fall outside official monitoring systems. These informal arrangements expose workers to the sector's core social challenges like low wages, excessive hours, and unsafe conditions exacerbated by inadequate labour protections across producing countries (Women in Informal Employment: Globalizing and Organizing (WIEGO) 2025).

Beyond these social vulnerabilities, the sector also imposes severe environmental burdens throughout its value chain. The textile sector contributes between 2% and 8% of annual global greenhouse gas emissions, consumes an estimated 215 trillion litres of water per year, and accounts for approximately 9% of synthetic microfibre pollution reaching the oceans (Leal Filho et al. 2024). If current trends persist, global fibre production, already at a record 132 million tonnes in 2024, is projected to reach 169 million tonnes by 2030, with sector emissions having already risen 20% since 2019 (Materials Market Report 2025 n.d.). Natural fibres drive land degradation and water stress, while synthetics add fossil fuel dependency and microplastic pollution; despite growing awareness, recycled fibres represent only 7.6% of total production, with textile-to-textile recycling accounting for less than 1% of the global fibre market (Baloyi et al. 2024).

To address these interconnected social and environmental challenges, regulatory and voluntary initiatives are gaining momentum. The EU's 2022 Strategy for Sustainable and Circular Textiles, which entered into force in October 2025, introduces mandatory extended producer responsibility (EPR) schemes for textiles across all Member States, requiring producers to finance the collection, sorting, and recycling of their (European Commission 2022). Complementing this, UNEP's (2023) Global Roadmap targets net-zero emissions, reduced freshwater use and pollution, microplastic reduction, and circular business models across the textile value chain (United Nations Environment Programme 2023). In parallel, industry actors are updating their commitments: Inditex, for instance, has set a goal to source all textile fibres from lower-impact materials by 2030, with targets including 40% from conventional recycling, 25% from next-generation fibres, and 25% from organic or regenerative sources (Inditex 2025).

This report uses the Global Biodiversity Score (GBS) tool to assess biodiversity impacts across the textile value chain, from raw material cultivation and processing to downstream stages such as product

use, end-of-life management, and related emissions. Defined by NACE Rev. 2 Section C, the sector includes textiles, apparel, leather manufacturing, and upstream raw materials. The report quantifies and visualises the sector's biodiversity footprint using the GBS and provides an in-depth analysis of results. It focuses on the most common materials used in everyday textiles, adopting a standard T-shirt as a reference to facilitate intuitive comparison. Later sections analyse key materials like cotton, polyester, and viscose to highlight their respective contributions to the overall footprint and identify opportunities for reducing impacts through more responsible material choices and production practices.

B. Methodology

B.1. Perimeter of the report on impacts and dependencies

B.1.1. Overview of the sector

The textile sector, as defined in this study, comprises the manufacture of textiles, wearing apparel, and leather and related products. It covers activities such as the preparation and spinning of textile fibres, the weaving and finishing of textiles, and the production of made-up textile articles, including household linen, blankets, and technical or industrial textiles. It also encompasses the conversion of these materials into final products through the manufacture of wearing apparel (*e.g.* tailored garments and knitwear) and leather goods (*e.g.* footwear, luggage, handbags, saddlery, and harnesses).

Although the cultivation of natural fibres falls under agriculture and the production of synthetic fibres is classified within chemical manufacturing, both stages are treated as upstream activities whose environmental pressures such as land occupation, water abstraction, and energy use are captured in the sectoral assessment. Finally, the perimeter includes waste management processes, notably the incineration and landfilling of textile waste, which represent key contributors to the sector's environmental footprint at end of life.

B.1.2. Perimeter based on official industrial classifications

The report's impact assessment covers the textile sector, focusing on production and waste treatment phases. It includes several EXIOBASE industries: "Manufacture of textiles (17)", "Manufacture of wearing apparel; dressing and dyeing of fur (18)", and "Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19)", as well as "Incineration of waste: Textiles" and "Landfill of waste: Textiles" within EXIOBASE's waste management group. In the NACE Rev. 2 ¹ classification, these correspond to Division 13 "Manufacture of textiles", Division 14 "Manufacture of wearing apparel", and Division 15 "Manufacture of leather and related products", while waste treatment

¹ Eurostat (2008). *NACE Rev. 2 – Statistical classification of economic activities in the European Community*. Publications Office of the European Union.

activities fall under Division 38 “Waste collection, treatment and disposal activities: materials recovery”. The study excludes all activities beyond incineration or landfill, such as retail², product use, or resale, and focuses solely on production, finishing, and end-of-life treatment, leaving other post-consumer or downstream phases outside its scope. This sectoral perimeter summarised in Figure 1 presents the correspondence between the selected EXIOBASE industries, their NACE Rev. 2 divisions, and the equivalent ISIC codes used to define the textile sector in this study.

² Retail sector already covered in: CDC Biodiversité (2025). *Technical annex Retail v1*. [Technical-annex_Retail_v1.pdf](#)

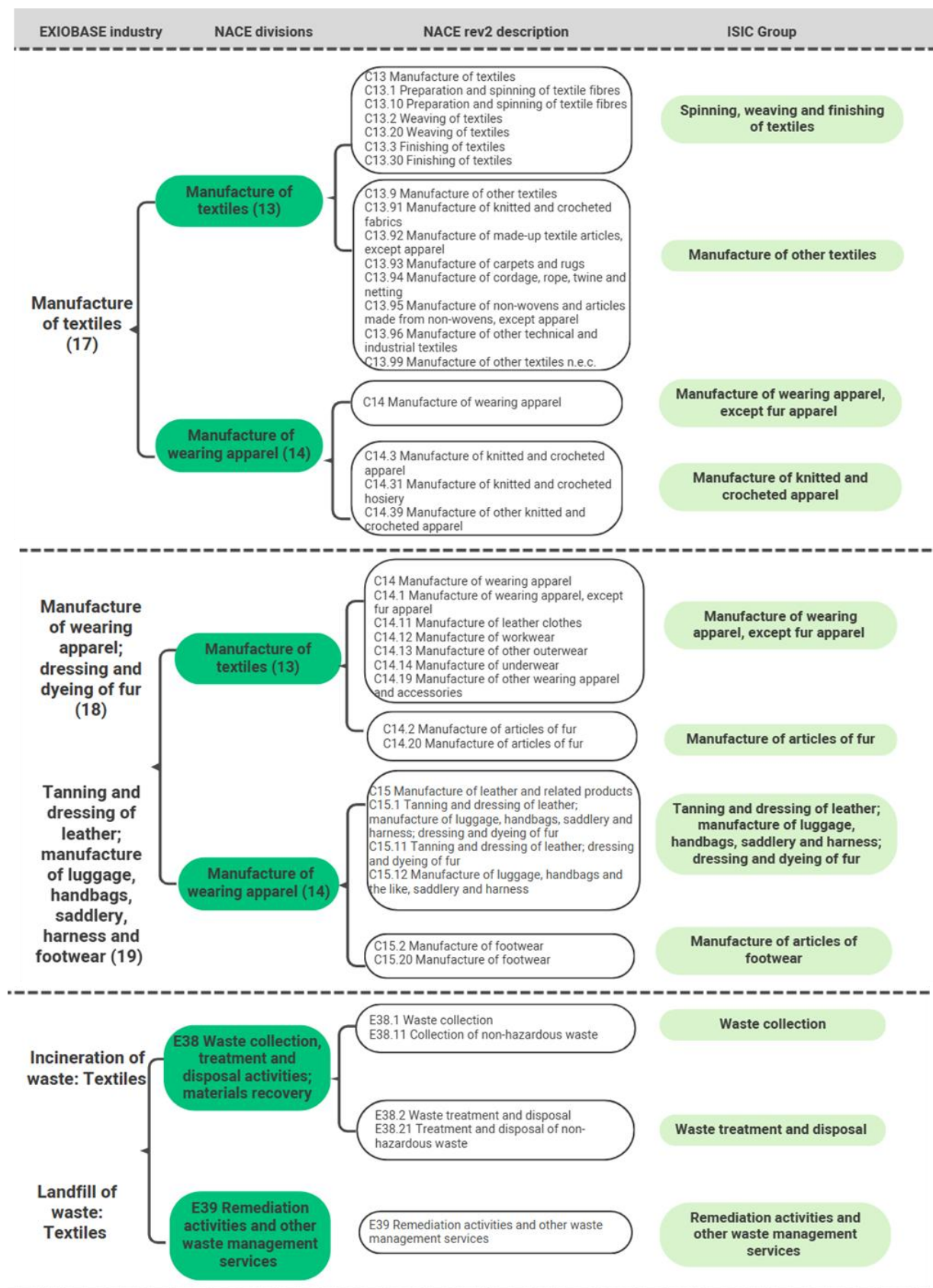


Figure 1- Correspondence between EXIOBASE, NACE and ISIC classifications for the Textile sector

Figure 1 provides a visual “correspondence map” linking the main textile-related sectors across EXIOBASE, NACE, and ISIC³ three widely used classification systems for economic activities. This mapping ensures that the same production and waste management processes are consistently identified across all data sources, supporting harmonised and precise sectoral boundary settings for the analysis. In this way, the environmental impact assessment is grounded in clearly defined activities and systematically excludes downstream phases such as retail, product use, or reuse, which are not captured in this study’s scope.

B.1.3 Scopes of the textile sector

The textile industry operates through a multi-stage value chain that transforms natural and synthetic raw materials into finished products, with each stage generating distinct environmental pressures on biodiversity. Fibres are produced, spun into yarns, converted into fabrics through weaving or knitting, and then treated in wet processing operations such as dyeing, finishing, and printing before garment assembly. The figure below summarises these stages and shows how they are allocated across upstream Scope 3, Scope 1, and downstream Scope 3.

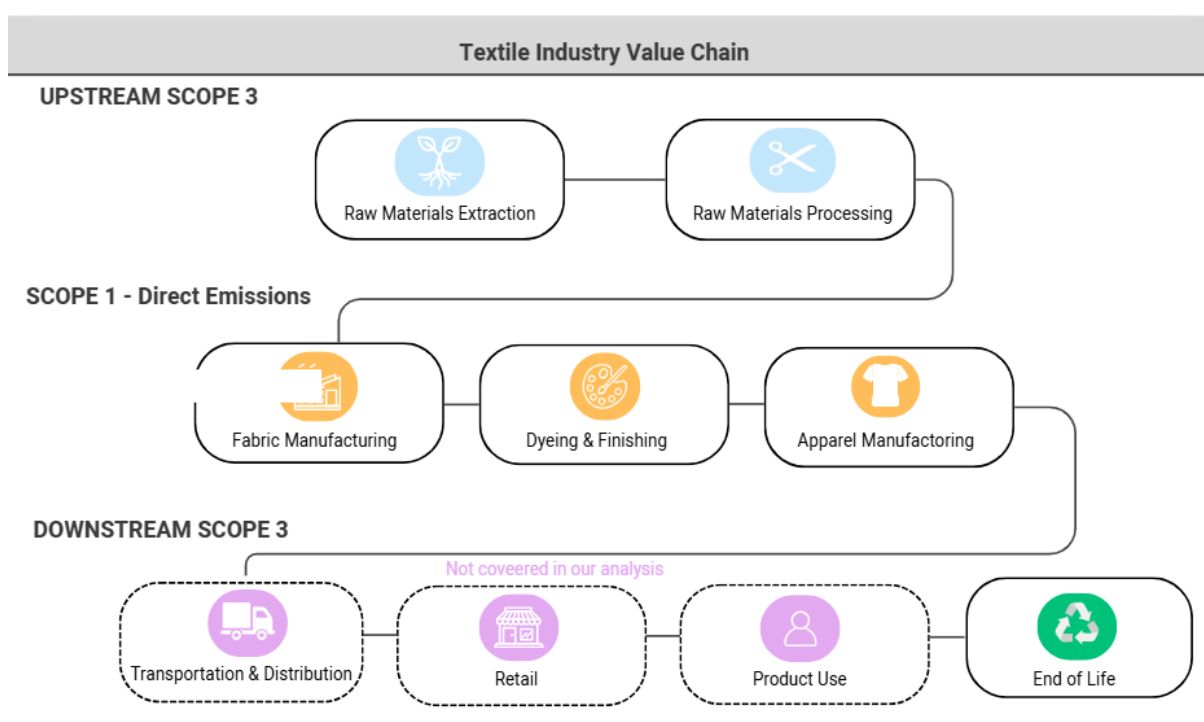


Figure 2: Value Chain of the Textile Sector: Analytical Scopes and Main Activities Considered in This Study

To assess these impacts systematically, this analysis applies the Greenhouse Gas Protocol (WRI/WBCSD, 2011) framework and EXIOBASE industry classifications, adopting a production-based accounting perspective. The assessment incorporates Scope 1 impacts from internal energy consumption, water use, and direct emissions; Scope 2 impacts from acquired electricity, steam, and cooling; upstream Scope 3 impacts related to raw material extraction and processing; and downstream

³ EXIOBASE v3: global industry model (163 sectors/200 products) used by Global Biodiversity Score (GBS). NACE Rev. 2: EU standard for economic sectors. ISIC Rev. 4: UN global standard adopted by MSCI and ENCORE for nature risks

Scope 3 impacts limited to waste management, including recycling, incineration, and landfilling. Transport, retail, and consumer use phases are excluded, as EXIOBASE allocates these to other sectors such as transportation services, retail trade, and household consumption.

Most results in the report are expressed in MSA.m²/kEUR of turnover. The impacts (MSA.m²) are divided by the turnover of the EXIOBASE industry group (kEUR). Please note that version 1.4.10 of the GBS uses 2011 turnover data from EXIOBASE 3.8. The geographical area covered by the report is the whole world.

Table 1 - Turnover of the EXIOBASE industry group included in the Textile sector (data obtained from GBS 1.4.10 and therefore from EXIOBASE, 2011) Table 1 below describes the share of the EXIOBASE industry group in the benchmark sector's turnover in 2011. According to EXIOBASE data, the **overall turnover of the textile sector was €1,926 billion**. Waste management activities related to textiles, such as incineration and landfilling, might be underestimated in these figures due to the prevalence of informal or illegal disposal practices, which are not fully traceable or captured in the data.

Table 1 - Turnover of the EXIOBASE industry group included in the Textile sector (data obtained from GBS 1.4.10 and therefore from EXIOBASE, 2011)

EXIOBASE industries	Turnover (MEUR)	Share in the textile sector's total turnover
Manufacture of textiles	1 000	53%
Manufacture of wearing apparel; dressing and dyeing of fur	610	32%
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	270	14%
Landfill of waste: Textiles	18	1%
Incineration of waste: Textiles	8	<1%
Total	1 900	100%

B.2. Global Biodiversity Score (GBS) in short

This section aims to remind the GBS main features to readers already familiar with it. For a more comprehensive introduction, readers are invited to refer to the GBS reports.

SOME DEFINITIONS AND CLARIFICATIONS

The GBS is a corporate **biodiversity footprint assessment tool**: it can be used to evaluate the **impact** or **footprint** of companies and investments on biodiversity. The results of assessments conducted with the GBS are expressed in the MSA.km² **unit** where MSA is the Mean Species Abundance, a **metric** expressed in % characterising the intactness of ecosystems. MSA values range from 0% to 100%, where 100% represents an undisturbed pristine ecosystem.

To break down impacts across the value chain and provide ways to avoid double-counting, the GBS uses the concept of **Scope**, or value chain boundary. **Scope 1** covers direct operations. Impacts occurring upstream are broken down into non-fuel energy generation which falls within **Scope 2**, and other purchases which fall within **upstream Scope 3**. Finally, downstream impacts belong to **downstream Scope 3**. Our previous reports (Publications | CDC Biodiversité) provide more details on this concept.

To account for impacts lasting beyond the period assessed, GBS results are further split into **additional gains/losses** – occurring within the period assessed and **accumulated negative** – persistent – impacts.

METHODOLOGY

To assess corporate biodiversity footprint, the main approach of the GBS is to link data on **economic activity** to **pressures on biodiversity** and to translate these pressures into **biodiversity impacts**. A **hybrid approach** is used to take advantage of data available at each step of the assessment. **Biodiversity Footprint Assessments** (BFA) use company specific data on purchases or related to pressures (such as land use changes or greenhouse gas emissions). In the absence of precise data, a default calculation **assesses impacts based on financial turnover data**.

To link activity, pressures and impacts, the GBS uses peer-reviewed tools such as EXIOBASE, an environmentally extended multi-regional input-output model, or GLOBIO, a model assessing the impact of various pressures on biodiversity intactness. Its underlying assumptions are transparent.

In the long run, the aim of the GBS is to cover all biodiversity impacts across the value chain (including both upstream and downstream impacts). It currently covers direct operations and upstream impacts (cradle to gate) on terrestrial and aquatic (freshwater) biodiversity. The pressures covered are part of 4 out of the 5 pressures described by IPBES:

Land/sea change (IPBES):

- ➔ **Land use (LU)**: Impacts on natural habitat quality and quantity caused by a high level of pressure which prevents ecosystems from reverting towards more natural states
- ➔ **Wetland conversion (WC)**: Loss of aquatic ecosystems caused by the conversion and draining of wetlands for human purposes
- ➔ **Fragmentation of natural ecosystems (F)**: Reduction and subdivision of natural habitats and disappearance of ecological corridors
- ➔ **Human encroachment (E)**: Anthropogenic activities in otherwise natural areas (direct and indirect disturbance)

Climate change (IPBES):

- ➔ **Climate change (CC)**: The global mean temperature increase (GMTI) and the induced climate change modify the repartition areas of different biomes
- ➔ **Hydrological disturbance due to climate change (HD_{cc})**: Climate change can be the cause of the deviation of current river flows from the natural ones (changes in rainfall or evaporation)

Direct exploitation (IPBES):

- ➔ **Hydrological disturbance due to direct water use (HD_{water})**: Anthropogenic water abstraction can be the cause of the deviation of current river flows from the natural ones - this pressure is called "hydrological disturbance" in GLOBIO

Pollution (IPBES):

- ➔ **Atmospheric nitrogen deposition (N)**: Agricultural and industrial activities cause nitrogen emissions into the atmosphere, then nitrogen deposits on terrestrial ecosystems. When the critical load of the ecosystem is exceeded, the imbalance caused by additional nitrogen deposition harms ecological integrity
- ➔ **Land use in catchment of rivers (LUR) and wetlands (LUW)**: Watershed's upstream land use changes have an indirect negative impact on downstream water bodies. Land use type is indeed a good proxy for the nutrient emissions leaching from human activities to ecosystems
- ➔ **Freshwater eutrophication (FE)**: Human activities can lead to excess of nutrients leaching into water bodies and overstimulating algal and aquatic plant growth
- ➔ **Ecotoxicity (X)**: Ecotoxicity is the pressure caused by chemical substances on terrestrial or aquatic ecosystems (pesticides for example)

METRICS USED

To analyse the textile sector's biodiversity footprint, three key pressure metrics from the Global Biodiversity Score (GBS) developed by CDC Biodiversité are used: Terrestrial Accumulated Impacts, Terrestrial Additional Impacts, and Aquatic Accumulated Impacts. These metrics, expressed in MSA.km², enable a comprehensive assessment of accumulated long-term impacts and additional annual degradation across terrestrial and aquatic realms, disaggregated by value chain stages and underlying pressures such as land use, climate change, pollution, and hydrological disturbance.

Terrestrial Accumulated Impacts represent the total long-term biodiversity loss in terrestrial ecosystems (forests, grasslands, shrublands, agricultural lands) across the entire value chain, expressed in MSA.km². This static "stock" metric quantifies the cumulative reduction in Mean Species

Abundance (MSA) relative to pristine reference states, aggregating pressures including land occupation/conversion (LU), encroachment/fragmentation (E/F), climate change (CC), nitrogen deposition (N), and other pollution forms.

Terrestrial Additional Impacts represent the annual biodiversity loss in terrestrial ecosystems due to ongoing sector activities, expressed in MSA.km² per year. This dynamic "flow" metric captures yearly MSA declines from active pressures like those listed above, indicating the current rate of degradation rather than historical accumulation.

Aquatic Accumulated Impacts measure the total cumulative biodiversity loss in aquatic ecosystems (rivers, lakes, wetlands, coastal waters) linked to the value chain, expressed in MSA.km². This static metric integrates pressures such as hydrological disturbance/flow alteration (H), freshwater eutrophication (E), wetland conversion, and upstream catchment land use affecting water body integrity

The following sections present the results of impacts and dependencies of the sector obtained with the GBS.

C. Biodiversity and textile: analysing the impacts of the sector

C.1. Repartition of impacts through the value chain

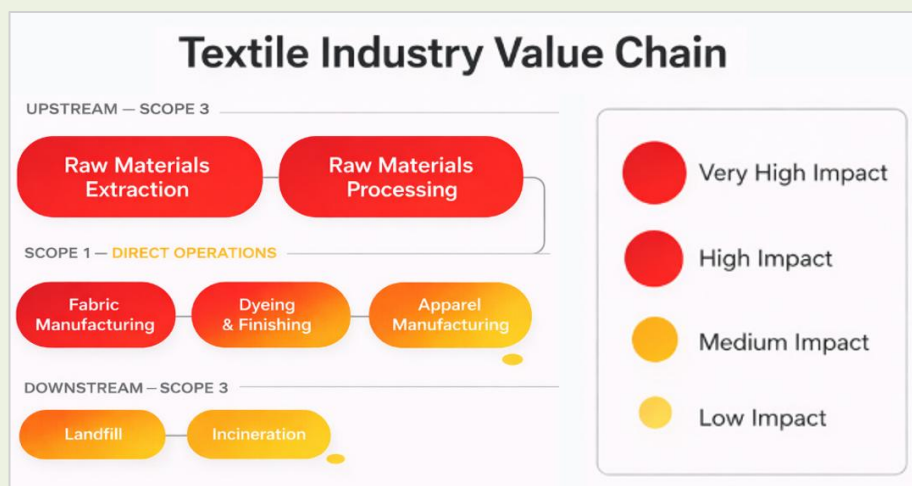
KEY MESSAGES

The textile, apparel, and leather sector's biodiversity footprint is overwhelmingly driven by **upstream supply chain activities**, though the distribution of impacts varies significantly across subsectors and tiers. For **textile and wearing apparel manufacturing**, most terrestrial and aquatic impacts (70–99%) originate **beyond direct operations**, particularly among **suppliers of suppliers**. This underscores the critical importance of **traceability** in the value chain, as the most significant pressures often lie deep in the upstream. In contrast, **tanning** presents a distinct profile: roughly **50% of upstream terrestrial impacts occur at Tier 1 (direct suppliers)**, offering more immediate levers for intervention and mitigation.

Direct operations (Scope 1) contribute marginally to the sector's overall biodiversity loss, but their role is notable in specific areas. **Terrestrial impacts** in direct operations are primarily tied to **greenhouse gas (GHG) emissions** from emission-intensive manufacturing processes. **Aquatic impacts** are limited but still present, particularly in **tanning**, where pollution pressures (e.g., chemical runoff) remain a concern.

In **waste management**, the distinction between terrestrial and aquatic impacts is equally nuanced. **Terrestrial impacts** (e.g., land occupation, on-site emissions) are concentrated in **Scope 1 (S1)**, particularly in landfill and incineration facilities. **Aquatic impacts**, however, are more closely linked to **upstream water treatment processes (S3)**, such as effluent discharge and water consumption.

This refined breakdown highlights the **heterogeneity of impacts** across the value chain and the need for **targeted strategies**—whether through deeper supply chain transparency, direct engagement with Tier 1 suppliers, or improved waste and water management practices.



The following sections examine the environmental pressures driving biodiversity impacts and present results by industry group to clarify the relative contribution of each sub-sector. The analysis decomposes the total footprint into three components: direct activities (Scope 1), tier 1 suppliers, and the rest of the value chain to avoid double counting and provide a clearer interpretation of where impacts occur. Aggregating all scopes without distinction would therefore lead to double counting of certain impacts (e.g., Scope 3 emissions from textile manufacturing may include Scope 1 emissions from its tanning suppliers). For this reason, the analysis is read industry by industry and contribution category, so that the role of direct operations, tier 1 suppliers, and the remaining value chain can be interpreted clearly without overstating the overall footprint. Biodiversity impacts are detailed across five sectors: textile manufacturing, apparel production, leather and fur processing, luggage and footwear manufacturing, and textile waste treatment (landfill and incineration). For each, the report illustrates contributions to additional and accumulated biodiversity impacts (in MSA.km²) and shows how impacts are distributed across tiers of the value chain.

Table 2 below presents an extract from Figure 1. It provides a concise overview of the sectoral perimeter, thus facilitating the interpretation of subsequent analyses by clearly defining the activities considered—textile, apparel, and leather manufacturing, as well as textile waste treatment (incineration and landfill). The table also illustrates the sectoral framework introduced in this section and confirms the exclusion of downstream processes, such as distribution, product use, and reuse.

Table 2 - Extract from Figure 1: Classification perimeter for the Textile sector

EXIOBASE industry	NACE Rev. 2 Division	ISIC Division	Included activities
Manufacture of textiles (17)	13 – Manufacture of textiles	13	Textile production
Manufacture of wearing apparel (18)	14 – Manufacture of wearing apparel	14	Garment manufacturing
Tanning & dressing of leather; footwear (19)	15 – Manufacture of leather and related products	15	Leather processing & footwear
Incineration of waste: Textiles	38 – Waste collection, treatment and disposal activities	38	End-of-life treatment
Landfill of waste: Textiles	38 – Waste collection, treatment and disposal activities	38	End-of-life treatment

The following calculations were performed using GBS version 1.4.10 in October 2025. The accumulated terrestrial impacts results include the component associated with Climate Change (CC) pressure, which

is not the case for all sectoral studies previously published since the accumulated impacts from the Climate Change pressure were only introduced starting from version 1.4.2 of the GBS.

When interpreting the results, particular attention should be paid to ecotoxicity, which captures the potential effects of chemical substances and pollutants on terrestrial and aquatic ecosystems. In this study, aquatic organic ecotoxicity is included in the aggregated biodiversity footprint, whereas metallic and organic terrestrial ecotoxicity are excluded from the total due to their high uncertainty. These terrestrial components are nevertheless reported separately to ensure transparency and to highlight potential areas of concern.

C.1.1. Impacts related to the Manufacture of textiles

KEY FINDINGS

The sector encompasses the transformation of raw fibres into yarns and fabrics through spinning, weaving, dyeing, and finishing processes. The analysis shows that most biodiversity impacts occur upstream in the value chain, mainly due to the **production of land- and resource-intensive inputs such as natural and synthetic fibres, dyes, and chemical auxiliaries**. These upstream uses of agricultural, petrochemical, and energy resources result in significant pressures on terrestrial and freshwater ecosystems. At the manufacturing stage, processes remain energy- and water-demanding, contributing to localised pressures through resource use and wastewater generation. Overall, the sector's biodiversity footprint is **primarily driven by indirect impacts linked to material and chemical supply chains** rather than by direct facility operations. Addressing these pressures requires improvements in fibre sourcing, chemical management, and resource efficiency across the textile value chain. However, the distribution of additional impacts along the value chain highlights actionable opportunities for near-term mitigation within manufacturing operations and first-tier suppliers.

Sector Definition and Scope

This industry encompasses **the transformation of raw fibres into textile materials and fabrics**. It includes the preparation and spinning of textile fibres both natural (such as cotton and wool) and synthetic (such as polyester and nylon) as well as the weaving of these fibres into fabrics. Finishing operations such as dyeing, printing, and coating are also included, as they provide colour and functional properties to textile materials.

The sector further covers the production of specialized textile products such as carpets and rugs, ropes and twine, technical and industrial textiles (*e.g.*, filters, reinforcement fabrics), and non-woven materials.

Note: This industry produces **intermediate textile goods** but does **not include** the manufacturing of final clothing or apparel products.

Biodiversity Impact Results

A) Terrestrial Accumulated Impacts

The analysis indicates that 71% of terrestrial biodiversity loss (490 000 MSA.km² out of a total of 690 000 MSA.km²) is attributable to upstream activities across the value chain, primarily linked to raw material extraction and the production of chemical inputs. This predominance of indirect impacts highlights that the main biodiversity pressures occur beyond direct manufacturing operations, emphasising the importance of addressing Scope 3 hotspots to achieve meaningful and systemic reductions in biodiversity loss.

Tier 1 suppliers account for 24% of total terrestrial biodiversity losses, reflecting the contribution of intermediate manufacturing processes such as yarn and fabric production, as well as finishing operations including dyeing and treatment. Direct manufacturing activities (Scope 1) contribute a comparatively small share approximately 5% of total losses (35 000 MSA.km²) mainly associated with the physical footprint of industrial facilities, process water use and discharge, and energy consumption for heat and electricity in textile operations.

Table 3 - Terrestrial Accumulated Biodiversity Impacts related to the Manufacture of Textiles by Impact Source (MSA.km²)

Impact Source	Accumulated impacts (MSA.km ²)	Distribution %
Value chain rest	490 000	 71%
Tier 1 suppliers	160 000	 24%
Direct (S1)	35 000	 5%
Total Terrestrial Accumulated Impacts: 690 000 MSA.km²		

B) Terrestrial Additional Impacts

Turning now to terrestrial additional impacts, a different distribution pattern emerges compared to accumulated losses. Additional impacts amount to a total of 4 000 MSA.km², revealing a more balanced contribution across the value chain. While the rest of the value chain remains the main source, accounting for 61% (3 000 MSA.km²), tier 1 suppliers represent 25% (1 300 MSA.km²), and direct manufacturing activities (Scope 1) contribute a notably higher share of 14% (700 MSA.km²) than in accumulated impacts.

Table 4 – Terrestrial Additional Biodiversity Impacts related to the Manufacture of Textiles by Impact Source (MSA.km²)

Impact Source	Additional Impacts (MSA.km ²)	Distribution %
Value chain rest	3 000	 61%

Tier 1 suppliers	1 300	 25%
Direct (S1)	700	 14%
Total Terrestrial Additional Impacts: 5 000 MSA.km²		

This distribution indicates that short-term biodiversity pressures are more closely linked to operational drivers, particularly energy use and process-related emissions occurring at and near the manufacturing stage. Unlike accumulated impacts largely driven by long-term structural factors such as land use change and upstream resource extraction, additional losses highlight actionable opportunities for near-term mitigation within manufacturing operations and first-tier suppliers.

C) Aquatic Accumulated Impacts

Finally, the analysis turns to aquatic accumulated impacts, which exhibits an even stronger upstream dominance than terrestrial impacts. Total aquatic impacts associated with the Manufacture of Textiles amount to 37 000 MSA.km². Most of this impact originates from the rest of the value chain, where the production and treatment of fibres, dyes, chemical auxiliaries, and energy inputs take place.

Table 5 – Accumulated Aquatic Biodiversity Impacts related to the Manufacture of Textiles by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km²)	Distribution %
Value chain rest	29 000	 76%
Tier 1 suppliers	8 800	 24%
Direct (S1)	29	<1%
Total Aquatic Accumulated Impacts: 37 000 MSA.km²		

Tier 1 suppliers account for the remaining 24% (8 800 MSA.km²) of aquatic impacts, reflecting the intensive use of water and chemicals in textile finishing, dyeing, and fabric treatment processes. In contrast, direct manufacturing activities (Scope 1) contribute less than 1% (29 MSA.km²), indicating that aquatic biodiversity loss is overwhelmingly driven by upstream input production rather than by on-site water discharges at textile manufacturing facilities.

This concentration of impacts highlights water- and chemical-intensive upstream processes as critical leverage points for intervention, particularly through cleaner chemical substitution, improved wastewater treatment, and more sustainable sourcing of fibres and energy within the textile supply chain.

C.1.2. Impacts related to the Manufacture of wearing apparel, dressing and dyeing of fur

KEY FINDINGS

For this sector, accumulated biodiversity losses are largely driven by upstream activities, with the broader value chain including fibre cultivation, leather production, chemical use, and energy generation dominating both terrestrial and aquatic impacts. Tier 1 suppliers and direct operations contribute smaller shares, indicating that on-site garment manufacturing plays a limited role in long-term biodiversity loss. In contrast, additional losses show a more balanced distribution, with operational activities within factories and first-tier suppliers having a measurable influence on short-term terrestrial pressures. Aquatic impacts similarly exhibit strong upstream dependence, highlighting water- and chemical-intensive processes as the primary determinants of the sector's footprint. Overall, these findings confirm that the apparel sector's biodiversity pressures are **mainly inherited from upstream supply chains**, while short-term fluctuations reveal where immediate operational and supplier-related pressures are concentrated.

Sector Definition and Scope

This industry encompasses the **production of final clothing and apparel products from textile materials**. It includes the cutting, sewing, assembling, and finishing of garments such as shirts, trousers, dresses, coats, and outerwear, as well as the dressing and dyeing of fur.

The sector also covers finishing operations to enhance colour, durability, or functional properties of apparel, and the production of specialised items such as gloves, hats, scarves, and technical or protective clothing. Essentially, it transforms fabrics and textile materials into wearable products, adding value through assembly, tailoring, and finishing, but does not include the production of raw fibres or fabrics.

Biodiversity Impact Results

A) Terrestrial Accumulated Impacts

The results reveal a strong predominance of indirect pressures across the apparel value chain. Total accumulated terrestrial biodiversity loss associated with the Manufacture of Wearing Apparel sector amounts to 410 000 MSA.km². Of this total, 81% (330 000 MSA.km²) originates in the rest of the value chain, highlighting the sector's heavy reliance on upstream material- and chemical-intensive production processes.

Table 6 - Terrestrial Accumulated Biodiversity Impacts related to the Manufacture of wearing apparel, dressing and dyeing of fur by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ²)	Distribution %
Value chain rest	330 000	 81%
Tier 1 suppliers	54 000	 13%
Direct (S1)	26 000	 6%
Total Terrestrial Accumulated Impacts:		410 000 MSA.km²

Tier 1 suppliers contribute 13% of total accumulated terrestrial losses (54 000 MSA.km²), reflecting the environmental footprint of intermediate activities such as garment finishing, dyeing, and auxiliary processing prior to final assembly. Direct manufacturing activities (Scope 1) account for the remaining 6% (26 000 MSA.km²), primarily linked to the physical footprint of apparel factories, energy consumption for sewing and finishing operations, and process-related emissions.

As observed in the Manufacture of Textiles sector, long-term terrestrial biodiversity impacts in the apparel sector are also predominantly driven by upstream structural pressures embedded in material, chemical, and textile supply chains, rather than by direct on-site garment manufacturing. This similarity highlights the need to target Scope 3 hotspots particularly material sourcing and upstream processing when developing biodiversity mitigation strategies across the broader textile and apparel value chain.

B) Terrestrial Additional Impacts

Turning to terrestrial additional impacts, a different pattern emerges compared to accumulated losses. Total additional impacts for the apparel sector amount to 3,006 MSA.km. The rest of the value chain accounts for 66% (1,981 MSA.km²), Tier 1 suppliers contribute 17% (499 MSA.km²), and direct manufacturing activities (Scope 1) represent 18% (526 MSA.km²), reflecting a relatively higher share than in accumulated losses.

Table 7 - Terrestrial Additional Impacts related to the Manufacture of wearing apparel, dressing and dyeing of fur by Impact Source (MSA.km²)

Impact Source	Additional Impacts (MSA.km ²)	Distribution %
Value chain rest	2 000	 66%
Tier 1 suppliers	500	 17%
Direct (S1)	530	 18%
Total Terrestrial Additional Impacts:		3 000 MSA.km²

The relatively higher share of direct impacts compared to accumulated losses suggests that short-term pressures are more evenly distributed across manufacturing operations and first-tier suppliers, reflecting the contribution of operational activities alongside upstream processes.

C) Aquatic Accumulated Impacts

Turning to aquatic accumulated impacts, the analysis reveals a pronounced dominance of upstream supply chain contributions. Total aquatic losses for the apparel sector amount to 20 000 MSA.km². Of this total, 90% (18 000 MSA.km²) originate from the rest of the value chain, reflecting the significant influence of upstream processes such as fibre preparation, dyeing, chemical treatment, and wastewater management. Tier 1 suppliers account for 10% of aquatic impacts (2 000 MSA.km²), while direct manufacturing activities (Scope 1) contribute less than 1% (3 MSA.km²), indicating that on-site operations have a negligible direct effect on aquatic biodiversity.

Table 8 - Aquatic Accumulated Impacts related to the Manufacture of wearing apparel, dressing and dyeing of fur by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ²)	Distribution %
Value chain rest	18 000	 90%
Tier 1 suppliers	2 000	 10%
Direct (S1)	3	<1%
Total Aquatic Accumulated Impacts:		20 000 MSA.km²

C.1.3. Impacts related to the Tanning and dressing of leather, manufacture of luggage, handbags, saddlery, harness and footwear

KEY FINDINGS

In the tanning and leather goods sector, accumulated biodiversity losses are overwhelmingly driven by upstream activities, with **tier 1 suppliers particularly tanneries and leather producers emerging as the most critical hotspots**. Additional losses show a more balanced distribution across the value chain, indicating that **short-term pressures from operational activities** contribute alongside supplier-driven impacts. Aquatic and terrestrial losses alike underscore the sector's dependence on water- and chemical-intensive processes, highlighting that effective mitigation must target upstream production and sustainable sourcing rather than on-site operations alone. However, the fact that these impacts are concentrated in tier 1 of the upstream Scope 3 also presents an opportunity: engaging directly with tanneries and leather producers is more feasible than if the main pressures were located further upstream, facilitating collaboration and the implementation of more sustainable practices.

Sector Definition and Scope

This industry encompasses the **processing of raw hides and skins into finished leather products**, including tanning, dyeing, dressing, and finishing operations that enhance durability, appearance, and functional properties. It also includes the manufacture of leather goods and accessories, such as luggage, handbags, saddlery, harnesses, belts, and footwear.

The sector transforms raw animal hides into usable leather materials and final leather products, combining chemical and mechanical processes with skilled craftsmanship, but does not cover the production of raw hides or unrelated textile products. Essentially, it converts animal skins into finished leather items and value-added leather goods ready for consumer or industrial use.

Biodiversity Impact Results

A) Terrestrial Accumulated Impacts

Supplier-driven terrestrial losses dominate in the tanning and dressing of the leather sector. Total accumulated terrestrial biodiversity loss amounts to 510 000 MSA.km². Unlike apparel manufacturing, the largest share of impacts (55%, 280 000 MSA.km²) originates from Tier 1 suppliers, reflecting the high biodiversity pressures associated with input-intensive activities such as leather tanning and chemical treatments. The rest of the value chain contributes 43% (220 000 MSA.km²), while direct manufacturing operations (Scope 1) account for only 2% (9 600 MSA.km²), highlighting the limited role of on-site activities in cumulative terrestrial impacts. These results indicate that long-term biodiversity loss in this sector is strongly linked to upstream processes within first-tier suppliers rather than to direct manufacturing, emphasising the pivotal role of supply chain inputs in shaping the sector's terrestrial footprint.

Table 9 - Terrestrial Accumulated Impacts related to the Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ²)	Distribution %
Value chain rest	220 000	 43%
Tier 1 suppliers	280 000	 55%
Direct (S1)	9 600	 2%
Total Terrestrial Accumulated Impacts:		510 000 MSA.km²

B) Terrestrial Additional Impacts

On the other hand, short-term terrestrial pressures in the tanning and dressing sector are more evenly distributed across the value chain. Total additional terrestrial losses amount to 1,898 MSA.km². Half of these losses (50%, 950 MSA.km²) arise from the rest of the value chain, while Tier 1 suppliers contribute to 43% (820 MSA.km²), and direct manufacturing operations (Scope 1) account for 7% (128 MSA.km²). Compared to accumulated impacts, the more balanced distribution in additional losses indicates that short-term biodiversity pressures are shared between upstream suppliers and other stages of the production network, highlighting the influence of both immediate and broader supply chain activities on annual terrestrial biodiversity outcomes.

Table 10 - Terrestrial Additional Impacts related to the Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear by Impact Source (MSA.km²)

Impact Source	Additional Impacts (MSA.km ²)	Distribution %
Value chain rest	950	 50%
Tier 1 suppliers	820	 43%
Direct (S1)	130	 7%
Total Terrestrial Additional Impacts:		1 900 MSA.km²

C) Aquatic Accumulated Impacts

Aquatic impacts in the tanning and dressing of leather sector are almost entirely driven by supply chain activities. Total accumulated aquatic loss amounts to 27 000 MSA.km², with 99% stemming from upstream and downstream processes. Half of these losses (50%, 13 000 MSA.km²) are linked to the rest of the value chain, while Tier 1 suppliers contribute 49% (13 000 MSA.km²), reflecting the high water and chemical intensity of livestock production, tanning, chemical sourcing, and effluent management. Direct manufacturing operations (Scope 1) account for less than 1% (68 MSA.km²), indicating that on-site processes exert a minimal direct effect on aquatic biodiversity. Overall, these findings underscore the sector's strong dependence on water- and chemical-intensive inputs throughout its supply chain.

Table 11 - Aquatic Accumulated Impacts related to the Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear by Impact Source (MSA.km²)

Impact Source	Accumulated Loss (MSA.km ²)	Distribution %
Value chain rest	13 000	 50%
Tier 1 suppliers	13 000	 49%
Direct (S1)	68	<1%
Total Aquatic Accumulated Impacts:		27 000 MSA.km²

C.1.4. Impacts of textile waste disposal in landfills

KEY FINDINGS

For the textile waste landfill sector, terrestrial biodiversity losses are **highly site-dependent, with the majority generated by direct landfill operations**. This indicates that mitigation efforts can be most effective directly at landfill sites, for example through improved land management, emissions control, and optimised energy use. Upstream suppliers and the broader value chain contribute less to terrestrial impacts, but aquatic pressures remain largely indirect, arising from wastewater treatment and pollutant handling. Therefore, reducing aquatic impacts would require better management of supporting services and upstream processes, while on-site interventions remain the key leverage point for terrestrial biodiversity.

Sector Definition and Scope

This industry encompasses **remediation activities and the management of textile waste** through landfilling. It includes services that handle non-recoverable textile waste, ensure proper containment, and prevent environmental contamination.

The sector focuses on long-term storage and environmental protection, following regulatory standards for waste management. Essentially, it provides controlled disposal of textile waste that cannot be reused, recycled, or incinerated.

Biodiversity Impact Results

A) Terrestrial Accumulated Impacts

In the textile waste landfill sector, accumulated terrestrial biodiversity losses are highly site-dependent, with 81% of long-term impacts arising from direct landfill operations. This strong localisation of land-use pressures indicates that, despite the sector's overall smaller contribution compared with other value-chain stages, targeted, site-level interventions could have a substantial effect on reducing terrestrial biodiversity loss. Contributions from tier 1 suppliers and the broader value chain are minimal, emphasising that the ecological footprint of this sector is almost entirely driven by the physical presence and management of landfill sites.

Table 12 - Terrestrial Accumulated Impacts related to the Landfill of waste by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ²)	Distribution %
Value chain rest	3 000	■ 10%
Tier 1 suppliers	2 700	■ 9%
Direct (S1)	24 000	■■■■■ 81%
Total Terrestrial Accumulated Impacts:		29 000 MSA.km ²

B) Terrestrial Additional Impacts

With respect to additional impacts, the textile waste landfill sector exhibits a highly concentrated on-site footprint, with 89% of annual losses generated by direct landfill operations. Contributions from tier 1 suppliers and the broader value chain are minimal, reinforcing that operational practices at landfill sites are the primary driver of yearly terrestrial biodiversity loss and that targeted site-level management offers the most effective mitigation potential.

Table 13 - Terrestrial Additional Impacts related to the Landfill of waste by Impact Source (MSA.km²)

Impact Source	Additional Impacts (MSA.km ²)	Distribution %
Value chain rest	25	 5%
Tier 1 suppliers	32	 6%
Direct (S1)	480	 89%
Total Terrestrial Additional Impacts:		520 MSA.km²

C) Aquatic Accumulated Impacts

With respect to accumulated aquatic losses, the textile waste landfill sector is overwhelmingly influenced by upstream and external activities, with 96% of impacts originating outside direct operations. The broader value chain, particularly wastewater management and treatment services associated with landfill operations, accounts for many of these losses, while tier 1 suppliers contribute a smaller but notable share. Direct on-site operations have a minimal effect, indicating that aquatic biodiversity pressures are largely indirect, highlighting the importance of managing supply chain inputs and external services to reduce freshwater ecosystem impacts.

Table 14 - Aquatic Accumulated Impacts related to the Landfill of waste by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ²)	Distribution %
Value chain rest	190	 56%
Tier 1 suppliers	130	 40%
Direct (S1)	13	 4%
Total Aquatic Accumulated Impacts:		330 MSA.km²

C.1.5. Impacts associated with the incineration of textile waste

KEY FINDINGS

The biodiversity footprint of textile waste incineration is characterised by a clear contrast between terrestrial and aquatic impacts. Terrestrial losses, both accumulated and additional, are **overwhelmingly operation-centred**, with direct on-site incineration activities dominating the footprint, reflecting that terrestrial pressures primarily arise from emissions, energy use, and process management within the plants. In contrast, **aquatic impacts are largely indirect**, driven by upstream and external processes such as residual material handling and energy inputs, with minimal contribution from on-site operations. This distribution underscores that while mitigation of terrestrial biodiversity loss depends mainly on optimising on-site processes, addressing aquatic impacts requires attention to upstream supply chain activities, highlighting the sector's dual dependence on operational efficiency and the broader value chain.

Sector Definition and Scope

This industry specifically **covers incineration treatment of textile waste**, converting non-hazardous post-consumer textiles into energy through controlled combustion while capturing emissions to meet environmental regulations. It also includes limited materials recovery from incineration residues. Unlike circular economy approaches (recycling/reuse), this focuses on safe end-of-life disposal—preventing open dumping, methane emissions from landfills, and leachate pollution by transforming waste into recoverable heat/electricity or inert ash.

Biodiversity Impact Results

A) Terrestrial Accumulated Impacts

For the incineration of textile waste, accumulated terrestrial biodiversity losses are predominantly driven by direct operations, with 76% of long-term impacts arising from on-site incineration activities. Contributions from tier 1 suppliers and the broader value chain are relatively minor, reflecting that the sector's biodiversity footprint is largely operation-centred, with a large contribution to the climate change pressure through large GHG emissions linked to incineration operations.

Table 15 - Terrestrial Accumulated Impacts related to incineration of waste by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ²)	Distribution %
Value chain rest	780	 16%
Tier 1 suppliers	400	 8%
Direct (S1)	3 800	 76%
Total Terrestrial Accumulated Impacts:		5 000 MSA.km²

B) Terrestrial Additional Impacts

Results show that both accumulated and additional terrestrial losses are overwhelmingly operation-centred, with 76% of long-term and 88% of annual additional impacts arising from direct on-site activities. Tier 1 suppliers and the rest of the value chain contribute minimally, highlighting that land-based pressures are primarily driven by emissions, energy use, and process activities within the incineration plants themselves, making on-site optimization the main lever for reducing terrestrial biodiversity loss.

Table 16 - Terrestrial Additional Impacts related to incineration of waste by Impact Source (MSA.km²)

Impact Source	Additional Impacts (MSA.km ²)	Distribution %
Value chain rest	5	 6%
Tier 1 suppliers	6	 7%
Direct (S1)	77	 87%
Total Terrestrial Additional Impacts:		88 MSA.km²

C) Aquatic Accumulated Impacts

Compared with terrestrial impacts, aquatic biodiversity losses in the textile waste incineration sector are predominantly indirect, with 84% of accumulated losses originating from upstream and external processes such as residual material handling and energy inputs. Tier 1 suppliers contribute 16%, while direct operations have a negligible share, indicating that freshwater ecosystem pressures are largely driven by the broader value chain rather than on-site incineration activities. This contrasts with the operation-centred terrestrial footprint, highlighting that mitigation strategies for aquatic impacts need to consider upstream and supply chain processes rather than focusing solely on the incineration plants themselves.

Table 17 - Aquatic Accumulated Impacts related to incineration of waste by Impact Source (MSA.km²)

Impact Source	Accumulated Impacts (MSA.km ² /)	Distribution %
Value chain rest	42	 84%
Tier 1 suppliers	8	 16%
Direct (S1)	<1	<1%
Total Aquatic Accumulated Impacts:		50 MSA.km²

C.1.6. Synthesis of impacts across the textile sector

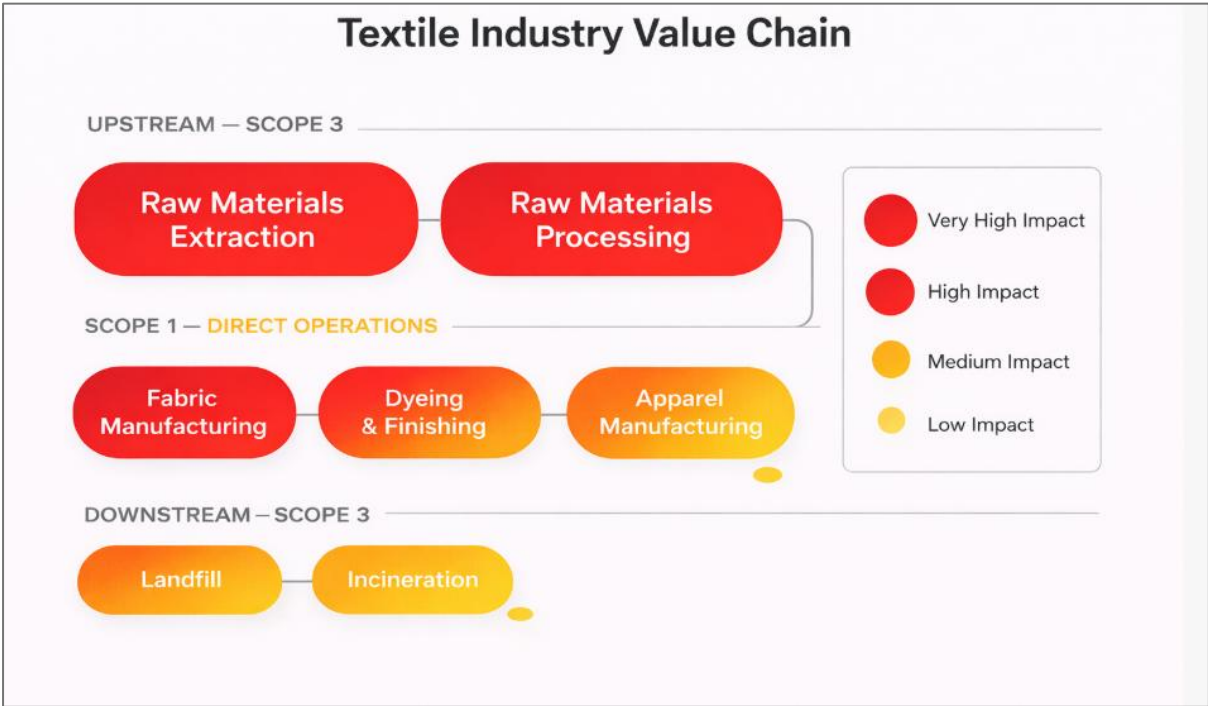


Figure 3: Overview of the Textile Sector Value Chain and Impact Assessment Scopes

This figure synthesises how terrestrial and aquatic biodiversity losses are distributed across sectors and value chain tiers, showing that upstream activities systematically dominate accumulated impacts in production-oriented sectors such as textiles, apparel, and tanning, while direct site level operations play a relatively larger role in waste treatment activities. This visual helps to quickly identify where the main biodiversity hotspots lie for each sector across different tiers of the value chain through a color-coded heat map approach.

The disaggregated values in the table below confirm this pattern quantitatively: production-oriented sectors (Manufacture of Textiles, Wearing Apparel, and Tanning & Dressing of Leather) consistently show 70-99% of accumulated impacts concentrated in upstream stages, reflecting the dominance of raw material extraction and chemical production in shaping their biodiversity footprint. Conversely, waste-management sectors (Landfill and Incineration) exhibit an inverted distribution, with 40-89% of terrestrial impacts arising from direct operations due to land occupation and facility-level emissions. This sectoral bifurcation underscores that effective mitigation strategies must be tailored to impact location: supply chain engagement for production sectors versus site-specific operational improvements for waste management.

Table 18: Synthesis of Biodiversity Impacts Across Textile Subsectors by Supply Chain Scope in MSA.km²

	Manufacture of Textiles	Manufacture of Wearing Apparel	Tanning & Dressing of Leather	Landfill of Waste: Textiles	Incineration of Waste: Textiles
UPSTREAM	Terrestrial Accumulated Impacts				
	490 000	330 000	220 000	2 900	780
	Terrestrial Additional Impacts				
	3 000	2000	950	25	5
	Aquatic Accumulated Impacts				
	29 000	18 000	13 000	190	42
Tier 1 SUPPLIERS	Terrestrial Accumulated Impacts				
	160 000	54 000	280 000	2 700	3 800
	Terrestrial Additional Impacts				
	1 300	500	820	32	77
	Aquatic Accumulated Impacts				
	8 800	2 000	13 000	480	8
SCOPE 1	Terrestrial Accumulated Impacts				
	35 000	26 000	9 600	24 000	3 800
	Terrestrial Additional Impacts				
	690	530	130	480	77
	Aquatic Accumulated Impacts				
	29	3	68	13	<1

C.2. Breaking down the impacts by pressures

The following sections present the biodiversity impact intensities of the textile sector, beginning with Scope 1 impacts examined by environmental pressure, followed by tier 1 upstream suppliers, and concluding with impacts from the rest of the value chain from more distant upstream stages. Impact intensities are expressed in MSA.m²/kEUR calculated by dividing absolute impacts (MSA.m²) by sectoral turnover to enable consistent comparison across industries and scopes. Results are disaggregated by environmental pressure, including climate change (CC), encroachment (E), fragmentation (F), freshwater eutrophication (FE), hydrological disturbances (HD), land use (LU), land use in catchment of wetlands (LUW), land use in catchment of rivers (LUR), atmospheric nitrogen deposition (N), and wetland conversion (WC). These impact intensities reveal priority areas for biodiversity risk mitigation across the textile value chain. Methodological details are provided in the general appendices (CDC Biodiversité 2021).

A) Scope 1 – Direct Operations

In this context, Scope 1 refers to the direct impacts generated by textile manufacturing activities in line with the GHG Protocol definition of Scope 1 as direct emissions from owned or controlled sources (*e.g.* onsite fuel combustion, process emissions and fugitive emissions). The results of the impact intensities are expressed in MSA.m²/kEUR and are disaggregated by pressure type and environmental realm, enabling the identification of where direct operational impacts are most concentrated.

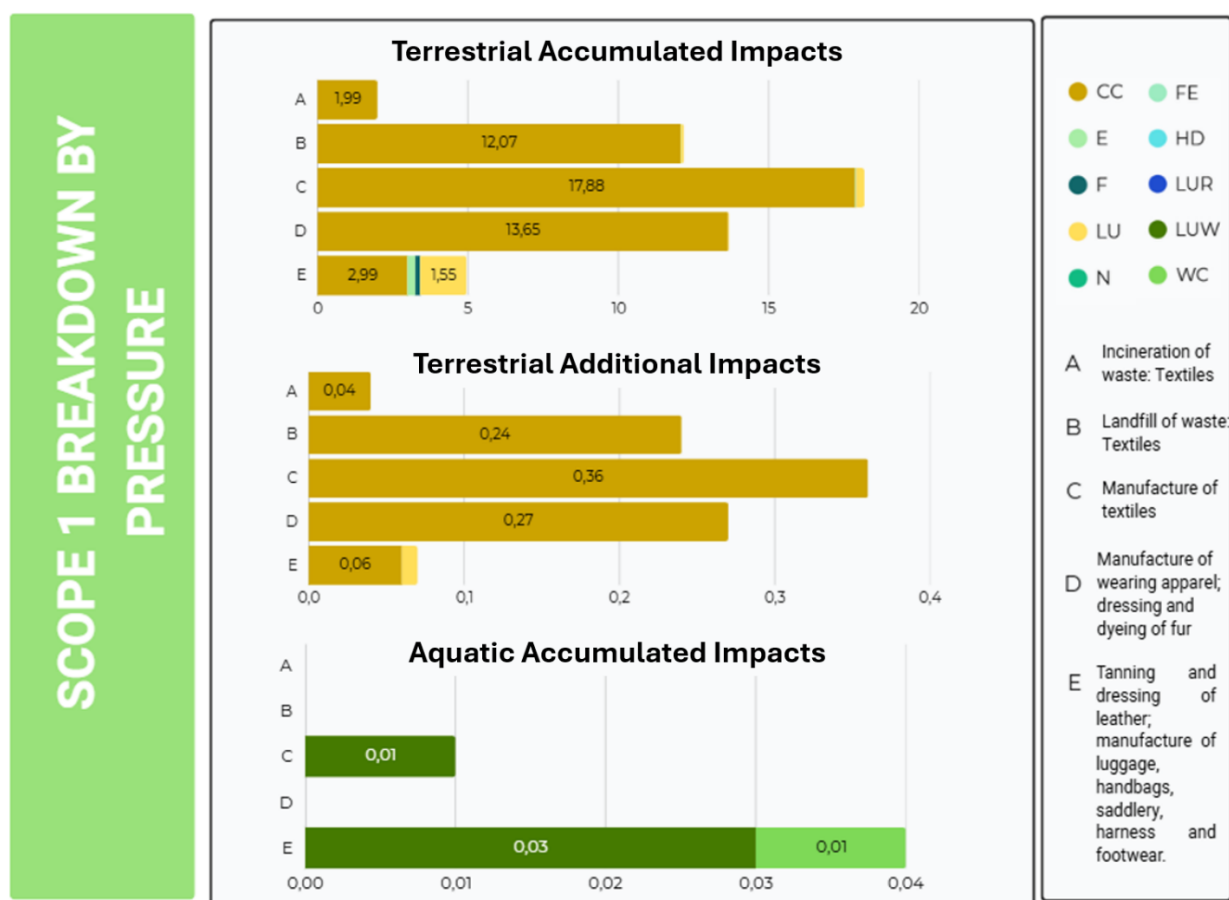


Figure 4: Scope 1 Biodiversity Impacts Breakdown by Pressure Across Textile Subsectors (MSA.m²/kEUR)

Results show that for terrestrial pressures, the bulk of the Scope 1 footprint is linked to climate change impacts from manufacturing and waste operations. As shown in the top panel, "Manufacture of textiles" displays the highest intensity at 18 MSA.m²/kEUR for CC, followed by "Manufacture of wearing apparel; dressing and dyeing of fur" at 14 MSA.m²/kEUR. "Landfill of waste: Textiles" also contributes significantly at 12 MSA.m²/kEUR for CC, indicating that direct GHG emissions from production facilities and waste disposal generate substantial long-term biodiversity impacts. "Incineration of waste: Textiles (A)" shows lower but still notable impacts (2 MSA.m²/kEUR), while "Tanning and dressing of leather (E)" displays a more diversified pressure profile with contributions from both climate change (1.4) and land use (E: 1.55).

The middle panel shows that terrestrial additional losses are considerably lower across all activities, ranging from 0.04 to 0.36 MSA.m²/kEUR. "Manufacture of textiles" again shows the highest value (0.36), followed by "Landfill of waste: Textiles" (0.24) and "Manufacture of wearing apparel; dressing and dyeing of fur" (0.27), reflecting short-term operational impacts that are significantly smaller than accumulated losses.

The bottom panel demonstrates that aquatic accumulated pressures remain negligible across most activities, with losses under 0.04 MSA.m²/kEUR. Only "Tanning and dressing of leather" shows a visible aquatic impact (0.01 MSA.m²/kEUR), highlighting that the textile industry's Scope 1 biodiversity footprint is predominantly terrestrial rather than aquatic, and primarily accumulated (long-term) rather than additional (short-term).

Note: The absence of visible bars for certain pressures/activities in the charts does not indicate zero impact; values may be present but too small to display at this scale.

B) Tier 1 – Direct suppliers

Tier 1 captures biodiversity impacts from immediate upstream suppliers to textile, apparel, and leather manufacturers—primarily energy providers (electricity, steam for dyeing/drying), chemical suppliers (dyes, finishing agents), and waste pre-processors, all just outside company gates and expressed as MSA.km²/kEUR by pressure type.

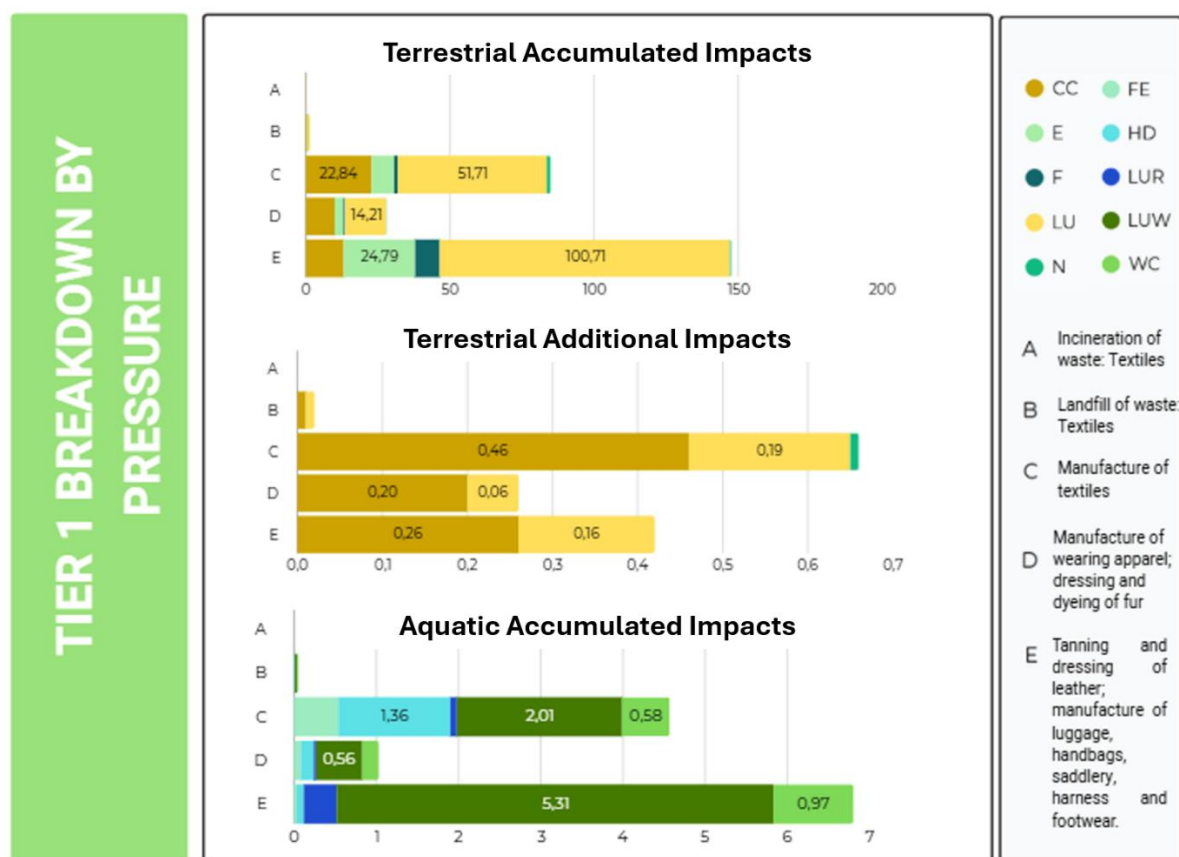


Figure 5: Tier 1 Biodiversity Loss Breakdown by pressure Across Textile Subsectors (MSA.m²/KEUR)

Tier 1 results indicate that manufacturing activities overwhelmingly dominate the biodiversity footprint across all pressure categories.

In terrestrial accumulated pressures, the Tanning and dressing of leather sector stands out as the largest contributor, reaching 100.71 MSA·km²/KEUR for land use (LU) and 24.79 for encroachment (E), largely driven by livestock feed demand. The Manufacture of textiles sector follows with considerable impacts – 22.86 for climate change (CC), 51.71 for land use, and 7.78 for encroachment reflecting its energy- and chemical-intensive processes. The Manufacture of wearing apparel shows moderate values (14.21 for both LU and CC), while waste management activities remain marginal (below 1.0 across all pressures).

For terrestrial additional losses, similar patterns can be observed but with substantially lower magnitudes. Textile manufacturing leads again (0.49 MSA·km²/KEUR), confirming that long-term accumulated impacts far outweigh short-term operational effects.

In aquatic accumulated pressures, the dominance of manufacturing persists. Leather processing ranks highest, with 5.31 MSA·km²/KEUR for freshwater eutrophication (FE) and 0.97 for hydrological disturbance (HD), followed by textile manufacturing (1.36 for FE and 2.09 for HD). Waste-related impacts remain negligible (below 0.1).

C) Value Chain Rest – Upstream Stages

In this context, value chain rest captures the biodiversity impacts associated with the more distant upstream stages of the textile value chain, that is, suppliers beyond Tier 1 that provide inputs to the direct suppliers of textile, apparel, and leather manufacturers. Impact intensities are expressed in MSA·m²/kEUR and are disaggregated by pressure type and realm, allowing the identification of where impacts concentrate in the deeper tiers of the supply chain.

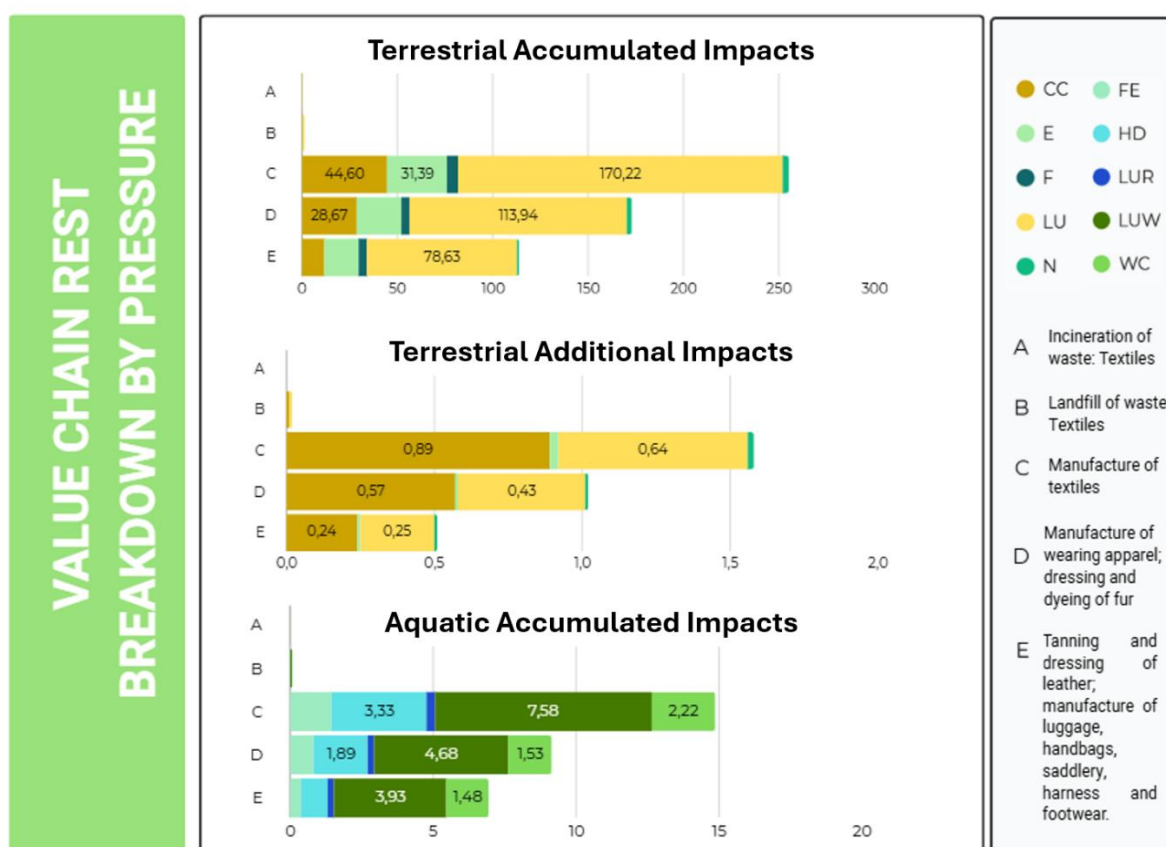


Figure 6: Tier 1 Biodiversity Loss Breakdown by pressure Across Textile Subsectors (MSA.m²/kEUR)

For terrestrial pressures (Climate change, Encroachment, Fragmentation, Land use, Nitrogen deposition), the value chain rest footprint is concentrated in the furthest upstream stages—raw material extraction and primary processing. "Manufacture of textiles" and "Manufacture of wearing apparel; dressing and dyeing of fur" display the highest intensities, driven not by manufacturing itself but by their deep supply chains. Natural fibre production (cotton, wool, linen) is dominated by land use and nitrogen deposition from agricultural cultivation and fertilizer application.

Chemical fibres (polyester, nylon, acrylic) generate higher climate change and ecotoxicity impacts from energy-intensive petrochemical extraction and synthetic polymer production. "Tanning and dressing of leather" contributes substantially through livestock grazing and chemical-intensive tanning, while textile waste management activities show minor contributions.

In the aquatic realm (Freshwater eutrophication, Hydrological disturbance, Land use in catchment of rivers, Land use in catchment of wetlands, Wetland conversion), textiles and apparel again dominate. Land use in catchment of rivers and Land use in catchment of wetlands reflect habitat conversion from agricultural expansion and water infrastructure (dams, irrigation systems), while water consumption is driven by cotton irrigation, textile processing, and the water footprint of energy generation embedded in chemical fibre supply chains. Together, these pressures underscore how upstream resource extraction—not downstream manufacturing or waste management—drives most biodiversity impacts in the rest of the value chain.

D. The impacts of raw materials: comparing the four most common textile fibres

KEY MESSAGES

The results reveal that **no fibre category is without significant biodiversity consequences**, though the nature and location of their impacts differ fundamentally. Natural and semi-synthetic fibres such as cotton and viscose generate the highest overall impacts: cotton leads in terrestrial biodiversity loss through the continuous occupation of irrigated monocultures, habitat fragmentation, and pesticide-driven ecotoxicity, while viscose tops aquatic losses as the chemical dissolution of wood pulp using CS₂ and NaOH releases organic and metal pollutants into freshwater systems, further compounded by plantation-based land use. On the other hand, synthetic fibres like polyester and polypropylene show comparatively lower ecosystem-specific impacts, but their footprints are dominated by climate change from fossil-fuel-intensive polymerisation, shifting biodiversity pressure toward harder-to-mitigate atmospheric pathways rather than eliminating it. Critically, **this does not make synthetics a preferable alternative**—natural fibres' impacts can be substantially reduced through proven measures discussed later (e.g., organic/Better Cotton initiatives cutting pesticides by up to 50-70%, sustainable viscose certifications minimising deforestation), whereas synthetics face persistent, long-lasting challenges like fossil dependency, microplastic pollution accumulating in oceans for centuries, and limited recyclability, rendering their mitigation more complex and less reversible.

Previous analyses revealed that raw material production drives most biodiversity impacts in the textile sector, particularly through upstream Scope 3 activities such as fibre cultivation and synthetic processing. To better understand these pressures, this focus examines the four dominant textile fibres polyester, cotton, viscose, and polypropylene which together represent over 80% of global fibre production. Using the GBS Product Tool,⁴ we quantify the specific biodiversity footprints of each fibre and identify their impacts across terrestrial and aquatic ecosystems. Building on these insights, this focus combined with findings from workshops and literature reviews will support the identification of

⁴ The *GBS Product Tool* is a biodiversity impact assessment tool developed by CDC Biodiversité under the Global Biodiversity Score (GBS) framework. It quantifies product-level biodiversity impacts across the life cycle, expressed in MSA-km² (Mean Species Abundance). Source: CDC Biodiversité, *Global Biodiversity Score – Methodological Framework*.

the most effective strategies to reduce impacts and help clarify how each material contributes differently to biodiversity loss.

D.1. Methodology

The methodology relied on the GBS Product Tool – a dedicated module of the Global Biodiversity Score (GBS) – to compute biodiversity impacts of textile products, expressed in MSA.km² (Mean Species Abundance × km²), by translating life cycle assessment (LCA) data into biodiversity impacts.

Data from the ecoinvent database were used to evaluate the biodiversity impacts associated with the main textile fibres: polyester, cotton, viscose, and polypropylene.

The results are expressed in MSA.km² and are first analysed per kilogram of fibre produced to ensure comparability between materials. In a second step, these impacts are scaled to the average weight of a standard T-shirt (size M, 200 g), allowing the comparison of biodiversity impacts at the product level.

Recent global fibre market data identify polyester, cotton and man-made cellulosic fibres such as viscose as the main fibres used in textile production by weight. In 2024, polyester accounted for about 59% of global fibre output, while cotton represented around 19% of the market; together with viscose and other MMCFs,⁵ these core materials make up roughly 80–85% of total fibre production and are the primary components of everyday garments such as T-shirts.

Table 19: Global fibre consumption by market share (2025) (source: Textile Exchange)

Material	Global Share (2025)
Polyester	59%
Cotton	19%
Viscose	6%
Polypropylene	5%

Polyester

The leading synthetic fibre in textile production. Primarily polyethylene terephthalate (PET), it forms through polymerization of petroleum-derived ethylene glycol and terephthalic acid, then melt-spun into continuous, high-strength filaments. These fibres exhibit low moisture absorption (0.4%), exceptional tensile strength, quick drying, and resistance to abrasion, stretching, and mold ideal for performance driven applications (Asfand, Petraitiene, and Daukantiene 2024). China produces over 65% of global

⁵ MMCF (Man-Made Cellulosic Fibres) refers to regenerated cellulose fibres such as viscose, modal, and lyocell, produced from wood pulp or other plant-based feedstocks through chemical processing. Source: Textile Exchange, *Preferred Fibre & Materials Market Report*.

polyester supply, underpinned by its vertically integrated petrochemical capacity and continuous investment in new production infrastructure (Textile Exchange 2025).

Widely used in sportswear base layers, durable shirts/pants blends, outerwear linings, upholstery, and recycled bottle-to-fleece jackets. Its blend with cotton or elastane enhances garment longevity while balancing comfort and cost for uniforms, activewear, and every day.

Cotton

Natural fibre, harvested from *Gossypium* plant bolls and processed into short staple fibres (20-50 mm) with oval cross-section and breathable lumen structure. Renowned for 8-10% moisture absorption, hypoallergenic softness, excellent dye affinity, and thermoregulation, it excels in skin-contact garments (Basyigit, Kuyucak, and Coskun 2024). Major producers like India, China, US, Pakistan rely on irrigated monocultures (International Cotton Advisory Committee 2024).

Essential for t-shirts, underwear, jeans, towels, bedsheets, and casual wear due to everyday comfort. Organic/Better Cotton variants preserve performance while addressing environmental concerns, maintaining its staple role in versatile apparel.

Viscose

Functions as a regenerated cellulosic, dissolving wood pulp (eucalyptus/beech) in carbon disulfide/NaOH to extrude silk-mimicking filaments with 11-13% moisture regain, fluid drape, sheen, and breathability (Karlsson Gedda et al. 2024). Production concentrates in Indonesia, China, India amid pulp plantation debates. Offers premium hand-feel at accessible cost.

Excels in flowing dresses, blouses, lingerie, scarves, linings, and summer apparel where elegance matters. Bridges natural comfort with synthetic uniformity, popular in fast fashion and mid-range garments seeking luxury aesthetics.

Polypropylene

Emerges as lightweight thermoplastic from propylene polymerization via Ziegler-Natta catalysts, yielding 0.9 g/cm³ density fibres with superior moisture-wicking, chemical/UV resistance, and wet-strength retention (Hossain et al. 2024). China leads manufacturing for technical applications.

Applied in sport base layers, thermal socks/underwear, nonwovens (masks/filters), geotextiles, ropes, upholstery, and industrial bags. Non-absorbent hygiene properties suit performance/protective gear where rapid evaporation prevents bacterial growth.

D.2. Analysis of the impact per tonne

Terrestrial accumulated impacts

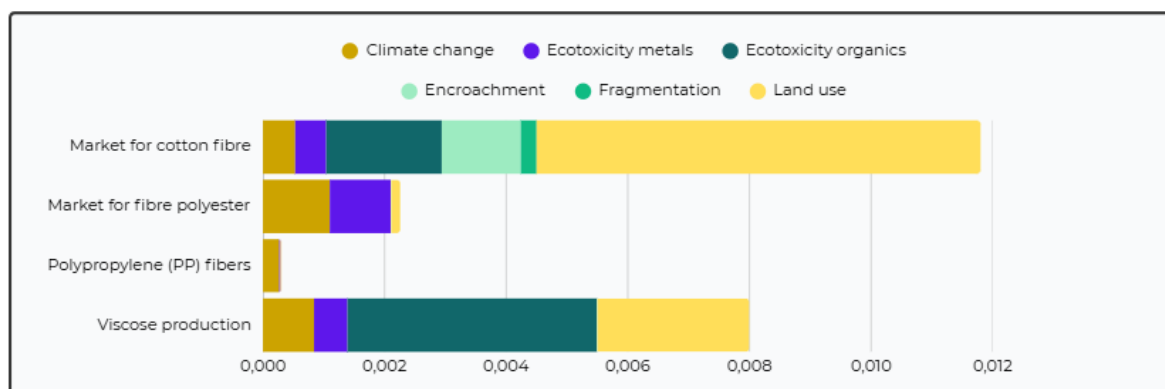


Figure 7: Terrestrial cumulated impacts by Key Textile Material (MSA.km²/t)

Across the four materials assessed, cotton fibre holds the highest terrestrial accumulated impact. As a natural fibre harvested from *Gossypium* bolls, cotton production is inherently land-dependent, relying on extensive irrigated monocultures particularly in India, China, the US, and Pakistan, where intensive farming practices keep the land under constant pressure, limiting opportunities for biodiversity to recover. This pressure is intensified by edge fragmentation and by organic ecotoxicity from heavy pesticide and herbicide use. Viscose shows the second highest impact, driven by wood-pulp sourcing from eucalyptus and beech plantations which are heavily human impacted forests generating high land-use impacts, and by chemical dissolution with carbon disulfide (CS₂) and sodium hydroxide, which generates ecotoxicity affecting soils and terrestrial systems. Polyester, produced via polymerisation of petroleum-derived intermediates, exerts a moderate impact mainly through climate change and metal ecotoxicity, reflecting its energy-intensive synthesis and use of metal catalysts; its land-use pressure remains minimal. Likewise, polypropylene (PP) from propylene polymerisation displays the lowest terrestrial loss, dominated by climate impacts and negligible land occupation.

Terrestrial additional biodiversity losses on terrestrial ecosystems

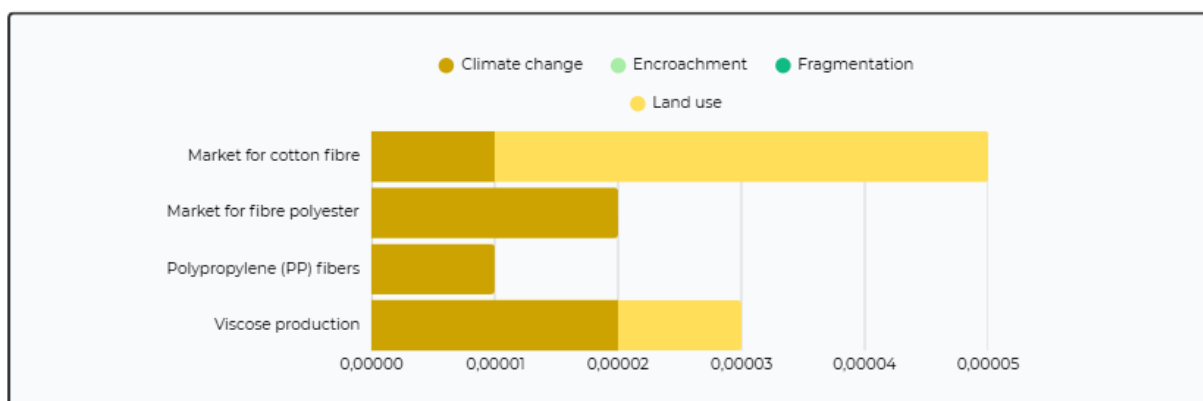


Figure 8: Terrestrial Biodiversity additional losses by Key Textile Material (MSA.km²/t)

This part focuses on terrestrial additional impacts. This perspective shows new losses related to necessary changes of state in the ecosystems to maintain or increase production. Cotton fibre has once again the highest footprint cotton fibre again shows the highest terrestrial loss, driven almost entirely by land use. As a land-intensive crop reliant on irrigated monocultures, cotton exerts sustained pressure through the continuous occupation and management of farmland—capturing the statistical, yearly impacts of cropland expansion rather than a single land-conversion event. Polyester and viscose display intermediate additional impacts with distinct profiles: polyester’s footprint stems almost exclusively from climate change, reflecting the fossil-fuel-intensive polymerisation of ethylene glycol and terephthalic acid, while viscose combines moderate climate and land-use pressures from energy-demanding pulp dissolution and plantation forestry. Polypropylene (PP) records the lowest additional impact, primarily from climate change linked to high-temperature propylene polymerisation, consistent with its negligible land demand as a fully synthetic fibre.

Taken together, this perspective reinforces the same underlying pattern observed for accumulated loss: land-based fibres like cotton maintain continuous terrestrial pressure through persistent land occupation, while synthetics shift that burden toward climate-related pathways driven by fossil energy use.

Aquatic accumulated impacts

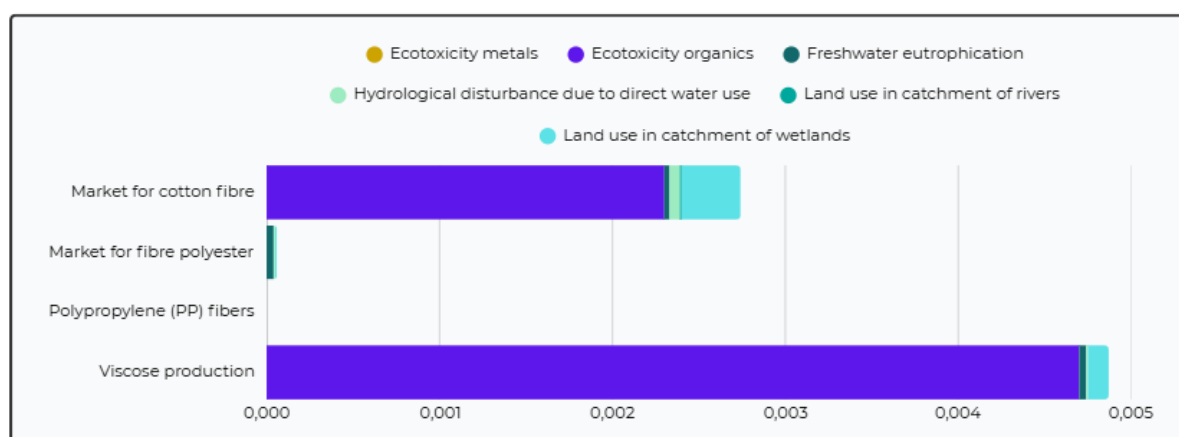


Figure 9: Aquatic cumulated Impacts by Key Textile Material (MSA.km²/t)

Extending the analysis to aquatic ecosystems, the accumulated impacts reveal a distinct pattern across materials. Viscose exhibits the highest overall aquatic impact, largely driven by ecotoxicity from organic and metal pollutants released during the chemical dissolution of wood pulp using compounds such as carbon disulfide and sodium hydroxide. These emissions, together with nutrient loads and land-use pressures in water catchments, contribute to the degradation of river and wetland ecosystems. Cotton follows with substantial aquatic pressures arising from multiple sources: nutrient emissions from cropland within water catchments, ecotoxicity linked to pesticide use and chemical treatments during fibre processing, and high water demand from both irrigation and processing stages. In contrast, polyester and polypropylene (PP) display comparatively lower aquatic losses within this assessment scope, reflecting their limited water and land dependency and the predominance of ecotoxic impacts during dyeing, finishing, and polymerisation stages. It is important to note, however, that this indicator does not capture physical impacts such as microplastic release, which could substantially alter the relative burden of synthetic fibres in aquatic environments.

D.3. Biodiversity footprint comparison of 200g T-Shirts

To enable a fair comparison between a medium-sized 200 g T-shirt made from different textile fibres, the following table presents an overview of four materials cotton, polyester, viscose, and polypropylene. The assessment combines the results discussed above with additional data sources to provide a concise overview of their relative performance across key impact categories, including biodiversity footprint, ocean pollution, longevity, recyclability, and biodegradability.

Table 20: Material Overview of a 200 g T-shirt

IMPACT CATEGORY	COTTON	POLYESTER	VISCOSE	POLYPROPYLENE (PP)
GBS BIODIVERSITY FOOTPRINT – Production Phase Impacts (MSA.km²)				
BIODIVERSITY IMPACT <i>Relative footprint per 200g T-shirt</i>	Terrestrial HIGH Aquatic MED-HIGH Overall Score: HIGHEST	Terrestrial MODERATE Aquatic MODERATE Overall Score: MODERATE	Terrestrial HIGH Aquatic HIGHEST Overall Score: HIGH	Terrestrial LOW Aquatic LOW Overall Score: LOWEST
MAIN DRIVERS	MAIN TERRESTRIAL DRIVER Land use (crop occupation) MAIN AQUATIC DRIVER Freshwater eutrophication	MAIN TERRESTRIAL DRIVER Climate change (GHG emissions) MAIN AQUATIC DRIVER Ecotoxicity – freshwater (organics)	MAIN TERRESTRIAL DRIVER Land use (forest plantation) MAIN AQUATIC DRIVER Ecotoxicity – freshwater (organics)	MAIN TERRESTRIAL DRIVER Climate change (polymerization) MAIN AQUATIC DRIVER Minor contribution across categories
OCEAN POLLUTION				
MARINE MICROPLASTIC RELEASE <i>Fibres released per 50 washes</i>	0.5 – 1 million fibres BIODEGRADABLE Natural fibres – low environmental persistence <i>Source: Akyildiz et al., Environ. Pollut. 357 (2024); Wang et al., Environ. Sci. Technol. (2023)</i>	10 – 17 million fibres SYNTHETIC MICROPLASTICS Persists hundreds of years in marine environment <i>Source: Changing Markets Foundation, Spinning Greenwash (2025); UNRIC, Cost of Polyester (2024)</i>	0.5 – 2 million fibres SEMI-SYNTHETIC Degrades slowly; variable persistence <i>Source: Gliaudelyte et al., Text. Res. J. (2024); Hazlehurst et al., Front. Environ. Sci. (2024)</i>	5 – 10 million fibres SYNTHETIC MICROPLASTICS Persists hundreds of years in environment <i>Source: Akyildiz et al., Environ. Pollut. 357 (2024); Hossain et al., J. Clean. Prod. (2024)</i>

IMPACT CATEGORY	COTTON	POLYESTER	VISCOSE	POLYPROPYLENE (PP)
LONGEVITY & END OF LIFE				
DURABILITY <i>(Wash cycles)</i>	20 – 50 cycles Durability  LOW High lint shedding; short garment lifespan <i>Source: Zambrano et al., Mar. Pollut. Bull. (2023); Better Cotton Initiative LCA Update (2024)</i>	100 – 200+ cycles Durability  VERY HIGH Excellent tensile strength retention <i>Source: Carbonfact, Carbon Footprint of Polyester (2025); Textile Exchange Materials Market Report (2024)</i>	30 – 70 cycles Durability  MODERATE Vulnerable to chemical reshaping <i>Source: Fang et al., Sci. Total Environ. (2025); Asia Pacific Rayon (2024)</i>	80 – 150 cycles Durability  HIGH Superior abrasion resistance <i>Source: Traxler et al., Resour. Conserv. Recycl. (2024); Hossain et al., J. Clean. Prod. (2024)</i>
RECYCLABILITY	1 mechanical cycle Recyclability  VERY LOW Severe fibre breakage limits reuse <i>Source: Colucci et al., Sci. Total Environ. (2025); Better Cotton Initiative LCA Update (2024)</i>	1 – 3 cycles Recyclability  LOW Downcycling with quality loss each pass <i>Source: Andini et al., Science Advances (2024); Pinheiro et al., ScienceDirect (2025)</i>	1 chemical cycle Recyclability  LOW Limited closed-loop options available <i>Source: Fang et al., Sci. Total Environ. (2025); Textile Exchange Biodiversity Analysis (2023)</i>	2 – 5 mechanical cycles Recyclability  MODERATE Best mechanical recyclability of synthetics <i>Source: Traxler et al., Resour. Conserv. Recycl. (2024); Textile Exchange Materials Market Report (2024)</i>
BIODEGRADABILITY	HOME COMPOSTABLE 5–6 months in soil <i>Source: Cotton Inc. Natural Resource Survey (2024); CottonToday (2025)</i>	NON-BIODEGRADABLE Persists indefinitely in environment <i>Source: UNRIC, Cost of Polyester (2024); Pinheiro et al., ScienceDirect (2025)</i>	INDUSTRIAL COMPOSTABLE 1–5 months under industrial conditions <i>Source: Fang et al., Sci. Total Environ. (2025); Textile Exchange Biodiversity Landscape Analysis (2023)</i>	NON-BIODEGRADABLE Persists for decades in soil & water <i>Source: Traxler et al., Resour. Conserv. Recycl. (2024); Hossain et al., J. Clean. Prod. (2024)</i>

E. Impact reduction actions

E.1. Dealing with the end of life of textile products

At the global scale, end-of-life management of textile materials remains dominated by landfilling and incineration, both of which contribute to biodiversity loss through land occupation, leachate contamination, and air emissions affecting surrounding ecosystems. Although recent advances in mechanical, chemical, and biological recycling technologies show promising potential to enhance material circularity, large-scale deployment remains limited due to high costs and scalability barriers. Consequently, landfill and incineration continue to serve as the dominant baseline for evaluating waste management practices, underscoring the need for more sustainable and ecologically beneficial end-of-life pathways (Tang et al., 2023).

In Europe, this global trend persists, with around 85% of textile waste still ending as landfill or incinerated. The EU Directive 2018/851 mandates separate collection across all member states by 2025, aiming to advance circularity and reduce the sector's ecological footprint. Digitalization and advanced sorting technologies could enable up to 60% reuse, 35% fibre recycling, and 5% chemical recycling, yet such practices remain largely manual and small-scale. Strengthening policy measures such as Extended Producer Responsibility (EPR) is therefore critical to expand recycling infrastructure and mitigate the biodiversity pressures linked to raw material extraction (Wojnowska-Baryła, Bernat, and Zaborowska 2022)

Life Cycle Assessment (LCA) evidence indicates a clear environmental hierarchy in end-of-life options. Reuse consistently achieves the highest environmental benefit, as extending product lifespans directly reduces the need for new fibre production major drivers of land conversion and ecosystem degradation. Mechanical recycling follows, lowering impacts by substituting virgin material demand, though results depend on yield and substitution efficiency (Abagnato, Rigamonti, and Grosso 2024). Incineration remains economically competitive only under low carbon-pricing contexts, but it contributes to air pollution and resource loss, while landfill consistently represents the least desirable scenario for both environmental and biodiversity outcomes (Solis et al. 2024).

Yet recycling alone cannot be regarded as a comprehensive solution. While increased recycling rates may modestly reduce climate impacts, their biodiversity co-benefits are context-dependent and limited by energy demand and the residual need for virgin inputs. For instance, a 10% rise in recycling rates can slightly lower water deprivation (~3%) but may not translate into proportional gains for biodiversity (Sandin, Lidfeldt, and Nellström 2025). This highlights the need for a systemic approach integrating circular design, responsible consumption, and effective waste management to address the upstream drivers of biodiversity loss linked to textile production and disposal.

E.2. Actions to reduce the impacts through the textile value chain

Reduction actions need be tailored to the value chain step the will take place in. The following table proposes a list of actions to reduce the impacts of each step of the textile value chain, based on the on the results of this report.

01 DIRECT OPERATIONS	Direct Operations Phase — <i>Highest immediate control & accountability</i> › Apply the mitigation hierarchy (avoid, reduce, restore, offset) to all site-level impacts, starting with eliminating unnecessary land take for new facilities › Conduct site-level biodiversity assessments to identify sensitive ecosystems near production sites and adapt operational footprint accordingly › Set internal biodiversity KPIs linked to operational decisions, including land occupation, water withdrawal, and chemical discharge at owned facilities
02 ENERGY USE DIRECT OPS	Energy Use for Direct Operations › Transition owned and operated facilities to 100% renewable energy (solar, wind, certified green electricity) to eliminate fossil-fuel-linked climate impacts on biodiversity › Conduct energy audits across all manufacturing sites to identify efficiency gains and reduce total energy consumption per unit of output › Engage key suppliers on renewable energy adoption, prioritising high-energy-intensity processes such as dyeing, finishing and synthetic fibre production
03 UPSTREAM PHASES	Upstream Phases — <i>Greatest leverage on biodiversity — raw material sourcing drives 70–80% of impacts</i> › Improve raw materials traceability (using certifications for example) to identify suppliers from high-risk locations › Prioritise the transition to regenerative or agroecological farming systems for natural fibres (e.g. Regenerative Organic Certified) — these offer a uniquely actionable lever to reduce impacts at source compared to synthetic alternatives › Enforce no-deforestation and no-conversion commitments across suppliers › Prioritise supply from basins exempt of water stress or require suppliers in water-stressed basins to adopt precision irrigation to reduce freshwater withdrawal
04 DOWNSTREAM PHASE	Downstream Phase › Integrate end-of-life recyclability criteria into product design to reduce virgin material demand and associated upstream pressures › Partner with certified sorters and recyclers to ensure post-consumer garments re-enter the material cycle

F. The textile sector's dependencies to biodiversity

KEY MESSAGES

The textile sector shows critical dependencies on ecosystem services concentrated in two main areas. Scope 1 operations depend heavily on **water-related services** (supply, flow regulation, climate regulation at 60% each) and demonstrate extremely high dependency on **solid waste remediation** (49-100%), particularly for waste incineration and landfill activities. Textile Manufacturing also shows critical dependency on knowledge-based services (education, science, research). Upstream Scope 3 dependencies appear lower when aggregated but reveal medium reliance on **water services** (47-51%) and **protective services** including flood control, storm mitigation, and soil retention (45-50%). **Overall, the sector's operational continuity is vulnerable to ecosystem decline**, with risks concentrated in water availability, waste assimilation capacity, and climate stability throughout the value chain.

Since version 1.4.10 of the GBS, the version 2 of ENCORE is used for the dependencies analysis. Now, this database includes cultural services and thus relies on 25 ecosystem services (against 21 for the first version).

Critical dependencies are situations where a specific industrial activity is highly dependent on one ecosystem service, indicating significant relationships between industry and the natural environment that may create vulnerabilities in both natural and economic systems. The table below examines these critical dependencies across 49 global regions under Scope 1 (direct operations), encompassing the 27 European Union member states. 17 major global economies (United Kingdom, United States, Japan, China, Canada, South Korea, Brazil, India, Mexico, Russian Federation, Australia, Switzerland, Turkey, Taiwan, Norway, Indonesia, and South Africa), and 5 regional aggregates (Rest of World Asia and Pacific, America, Europe, Africa, and Middle East)

The results obtained are that three out of five of the textile industry activities demonstrate critical dependencies on ecosystem services: Textile Manufacturing exhibits critical dependency on education, scientific, and research services (critical score: 1) across all regions, suggesting heavy reliance on knowledge-based ecosystem services for innovation, quality control, and sustainable practices development. Both Textile Waste Incineration and Textile Waste Landfill show critical dependencies on solid waste remediation services (critical score: 1 each), directly impacting the ecosystem's capacity to process, manage, decompose, and assimilate textile waste materials through combustion and natural degradation processes respectively. In contrast, Apparel Manufacturing and Leather &

Footwear production show no significant critical dependencies (critical score: 0 across all regions), indicating that the textile industry's environmental footprint is concentrated primarily in manufacturing operations and end-of-life waste management.

F.1. Scope 1 Dependencies Analyses

According to Figure 10 below, Scope 1 of the textile sector exhibits dependencies on ecosystem services across all subsectors, with particularly marked patterns in water- and waste-related services. All subsectors show consistent dependencies on water supply, water flow regulation, and global climate regulation (each at 60%), confirming the textile industry's status as one of the most water-intensive manufacturing sectors. Dyeing, finishing, and washing require stable access to large volumes of clean water, so rivers, wetlands, and vegetated watersheds are essential in regulating flows and maintaining water quality that underpins textile production.

The most critical finding in the heatmap is the very high to extremely high dependency on solid waste remediation, ranging from 49% to 100% and reaching its maximum in subsectors dealing with incineration and landfill of textiles. This pattern reflects the sector's substantial generation of solid waste—such as fibre offcuts, fabric scraps, chemical residues, and end-of-life products—and its complete reliance on natural decomposition processes. Soil microorganisms and other decomposer communities provide an irreplaceable service by breaking down these materials. If ecosystem health declines or waste volumes surpass natural processing capacity, the sector would face serious constraints in waste management, heightened operational risks, and rising treatment and disposal costs.



Figure 10: Scope 1 average dependency scores of the Textile sector. Source: GBS 1.4.10, May 2025, Alejandra Rozas

F.2. Upstream Scope 3 Dependencies Analyses

We now turn to Scope 3 dependencies, which capture indirect vulnerabilities throughout the supply chain.

Figure 11 shows that, on average, upstream (Scope 3) activities in the textile sector appear to have only a low dependence on ecosystem services. This is mainly because many different types of companies and processes are grouped together in Scope 3, so their dependencies are averaged and “diluted”, which hides the strong dependencies that some specific activities may have.

However, the figure also shows a clear medium dependence on several water-related services: water flow regulation (51%) and water supply (47%), as well as on protection services such as flood control (50%), storm mitigation (50%) and soil and sediment retention (45%). This means that upstream processes like growing fibres, producing chemicals, and transforming materials need ecosystems to provide steady water, protect facilities from extreme weather, and keep soils stable, otherwise production can be disrupted or damaged.

In short, the average scores suggest limited direct dependency when all upstream activities are considered together, but many parts of the textile supply chain still rely strongly on healthy ecosystems to function reliably.



Figure 11: Upstream Scope 3 average dependency scores of the Textile sector Source: GBS 1.4.10, May 2025, Alejandra Rozas

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