FASHION SECTOR FUTURE SCENARIOS: IMPACTS ON BIODIVERSITY, LAND, AND CARBON

REPORT

THE FASHION PACT

CONSERVATION INTERNATIONAL

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EXECUTIVE SUMMARY

Transforming the Fashion Sector with Nature is a two-year project funded by the Global Environment Facility (GEF) and co-executed by Conservation International, a GEF partner agency, and The Fashion Pact. By using world-class science, this project aims to better understand and mitigate the fashion industry's impact on biodiversity.

Under this project, six future scenario analyses were developed and conducted by [Conservation International](#) to examine the potential future nature impacts of the fashion sector based on certain sustainability decisions. These scenarios present potential future changes to agricultural production for regions that provide the raw materials for the fashion industry. The basis for the scenarios focuses on upstream changes in **production and land footprints for cotton, wool, and cashmere** at a global level. These scenarios were developed in the context of the [Science Based Targets for Nature](#) (SBTN) in order to provide perspective and future visioning for companies setting Science Based Targets for Nature targets.

The six future fashion sector scenarios are as follows:

(1) **Business as Usual**: Fashion sector continues with current commodity production trends;
(2) **Land Intensive**: Fashion sector increases and adds more land to produce raw materials;
(3) **Footprint reduction**: Fashion sector decreases the land under raw materials production;
(4) **Circular Economy**: Fashion sector implements circular economy principles through incorporating recycled materials, specifically for cotton;
(5) **Synthetic Substitution**: Fashion sector substitutes cotton for synthetics;
(6) **Nature Inclusive**: Fashion sector prioritizes reducing its footprint in areas that are important to biodiversity, carbon, and nature's contributions to people.

Based on these global scenarios, potential benefits and losses for biodiversity and carbon were measured for each material. These results can help guide ambitious and science-driven sector-level commitments and provide a view into setting science-based targets for nature to identify opportunities to strengthen actions and investments for biodiversity and nature-positive outcomes at a global level. The scenarios can help identify which sector-wide actions will result in the most positive nature outcomes and highlights which regions may be most important from a nature-standpoint for avoiding additional forest loss and conversion of natural ecosystems. It is important to note that these analyses took place at a global scale and do not consider more localized data and socio-economic impacts; thus, these results should only be considered in planning alongside additional local stakeholder information and data.

It is the intention of the author(s) to also submit the results of this scenario analysis for scientific publication. A [StoryMap](#) has also been created for those looking to examine the scenario results in greater detail.

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KEY FINDINGS AND RECOMMENDATIONS

It is the aim of this report to produce novel conservation science about how certain actions by the fashion sector can result in positive outcomes for nature. We encourage the private sector to apply these results to collective industry action that can drive change at scale and at a pace necessary to halt and reverse nature, climate, and biodiversity loss. There are several actions that can result in better outcomes for nature, including protecting existing habitats and nature ecosystems, more responsibly managing productive lands, and restoring degraded lands. This study highlights reducing land use in alignment with global frameworks for biodiversity.

- **Reducing land used for fashion commodities**, and aligning with SBTN's land reduction target, could greatly benefit biodiversity and carbon by improving habitats for hundreds of species.
    - When nature is prioritized, restoring 30% of cotton lands to natural vegetation **could improve the habitat of 233 threatened species** and allow for the sequestration of 0.37 Gt of CO_2.
    - Restoring 30% of wool lands and 30% of cashmere lands **could improve the habitat of 285 threatened species.**
    - **Reducing cotton production by 30% could return up to 89% of the cotton land footprint –** only 11% of the current land footprint is needed for 70% of cotton production. This indicates there is a high ability to integrate small amounts of circularity to easily meet SBTN land reduction and avoided conversion targets
- If the fashion sector continues with business as usual or, even worse, with expanding production to supply a growing virgin fiber need, there will be significant further negative impacts on biodiversity and nature such as species habitat loss, deforestation, and land degradation.

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INTRODUCTION

Fashion and Nature

Fashion and textiles are ubiquitous – everyone is affected by the processes within the fashion sector, from consumers to those who manage the farms from which materials are sourced, to clothing production and waste, including and the second-hand clothing market. In recent years, the fashion industry has rapidly grown, driven by consumer demand for frequently changing styles and fast fashion[1].

At the same time, the fashion industry is a driver of nature loss globally. Fashion has a basis in and dependance on nature – many fashion raw materials are produced on farms in a variety of vulnerable ecosystems around the world; dyes and factories are tightly linked to water resources; and people and livelihoods are both affected by and are affecting fashion supply chains. The raw materials that are the basis for the fashion industry are frequently associated with deforestation, rangeland degradation, ecosystem conversion, high water withdrawals, water pollution, and more[2]. How we use the land, specifically agriculture, is the largest driver of biodiversity loss and deforestation. As such, this report focuses on the land use of raw materials used for fashion[3]. Recently, the fashion sector has begun to meaningfully convene and coalesce on sustained and concerted actions to change their business-as-usual practices. Initiatives such as The Fashion Pact have brought together fashion companies to identify their shared sustainability challenges and take action toward becoming a more sustainable sector[4].

Strategic pathways forward for the sector are necessary to better understand the sector's largest impacts on nature and the largest potential beneficial changes it can make at a collective level to support and sustain nature into the future. **We developed 6 future-focused scenarios to model and measure the impact that this sector could have on nature.** This study provides science-based

[1] Niinimäki, Kirsi, "The Environmental Price of Fast Fashion."
[2] Niinimäki, Kirsi.
[3] IPBES, "Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services."
[4] The Fashion Pact, "The Fashion Pact: First Steps to Transform Our Industry."

analyses that demonstrate such benefits to nature that could occur if the fashion sector takes actions that reflect the scenarios presented here.

Commodity Category 1: Fashion & Textile Industry are Primary Driver of Commodity

Plant and animal fibers make up approximately 30% of global fibers used in the textile industry: cotton in particular accounts for 22% of this global fiber production[5]. While wool and cashmere account for a smaller percentage of global fiber, sheep and goats require extensive grazing land, and as such land use and management is crucial for addressing the biodiversity and carbon impacts of these commodities. However, the raw commodity sources of many fashion commodities are often not spatially mapped. Identifying specific land footprints of commodity sourcing for the fashion sector is necessary to better understand the sector's largest impacts on nature. The lack of spatially explicit data to identify fashion commodities required both creativity and proxy datasets; while the information presented here will be useful for the sector to better understand general regions for intervention and to illustrate the collective action of the fashion sector, the exact locations directly impacted by fashion sourcing need to be further refined. Due to these challenges, **we focused our efforts on mapping cotton, wool, and cashmere, the sourcing of which is largely driven by the fashion industry.**

Commodity Category 2: Other Fashion & Textile Industry Relevant Commodities

There are additional commodities relevant to the fashion sector that we did not model since the impacts and majority sourcing are driven by other sectors. These include leather (driven by the beef industry), man-made cellulosic (driven timber, paper, packaging), rubber (automotive sector), and synthetics (energy sector). For these commodities, it is still imperative to measure fashion sector impacts from sourcing these commodities through methods such as Science Based Targets Network (SBTN). Importantly, avoided conversion and reductions through incorporating recycled materials or by other means are going to be critically important for these commodities. Market signals such as these that are sent to industries driving production of commodities can motivate change. For example, the fashion industry could source all of their leather from no-deforestation, no-conversion areas that are sustainable rangeland managed systems, solely by shifting their sourcing practices due to the scale and size of the current cattle industry around the global. This commitment to sustainable sourcing could incentivize supply systems that are focused on non-conversion practices. Although the beef industry could continue to drive expanding cattle systems into forests and converted areas, efforts by the fashion sector to prioritize sustainable sourcing can still help drive collective action with regards to cattle, one of the largest drivers of deforestation. This type of action can represent the reality of most additional fashion relevant commodities and highlights the need for a collaborative multi-sector approach to move sustainability progress forward.

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[5] Textile Exchange, "Preferred Fiber Materials & Market Report."

Alignment with Global Frameworks

We designed scenarios in order to provide relevant information for stakeholders, and namely to help those in the fashion sector identify where they should focus on eliminating conversion and deforestation, helping identify where the industry can reduce its global footprint, and highlighting the best areas to target landscape engagement. The figure below shows the 3 targets that the SBTN Land Hub has delineated (Figure 1).

Figure 1. SBTN Land Hub Targets, v.0.3

These SBTN Land Hub Targets also align with the Global Targets for 2030[6], which include 23 action-oriented global targets. All three of the SBTN land targets apply to the Global Land Target 3 that specifically states the desire to "ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity."[7] As such, our contraction scenarios focus on a 30% land footprint reduction to align with this framework.

METHODS

To better understand the fashion sector's current and potential future impacts on nature, Conservation International conducted a variety of future-facing scenarios to examine what collective actions the fashion industry can take that lead to the most beneficial outcomes for carbon and biodiversity by 2030.

In these analyses, we focused on fashion sector relevant commodities of which the majority is used by the fashion industry and which represent large purchase volumes. These commodities include cotton, wool, and cashmere. For cotton, we modeled both land-based and yield-based scenarios. For

[6] Convention on Biological Diversity, "2030 Targets and Guidance Notes."
[7] "SBTN Land: Supplementary Material."

wool and cashmere, all scenarios are land-based due to data constraints with matching yield with livestock density.

We developed 6 scenarios across two conceptual models: we started with an existing baseline then modeled future expansion and contraction (Figure 1). Each scenario provides a 'solution' as determined by Prioritizr[8], an R package that uses mixed integer linear programming to identify optimal solutions when given specific inputs and constraints. We used such inputs as biodiversity range-sized rarity richness[9], carbon potential[10], and Nature's Contribution to People (NCP)[11].

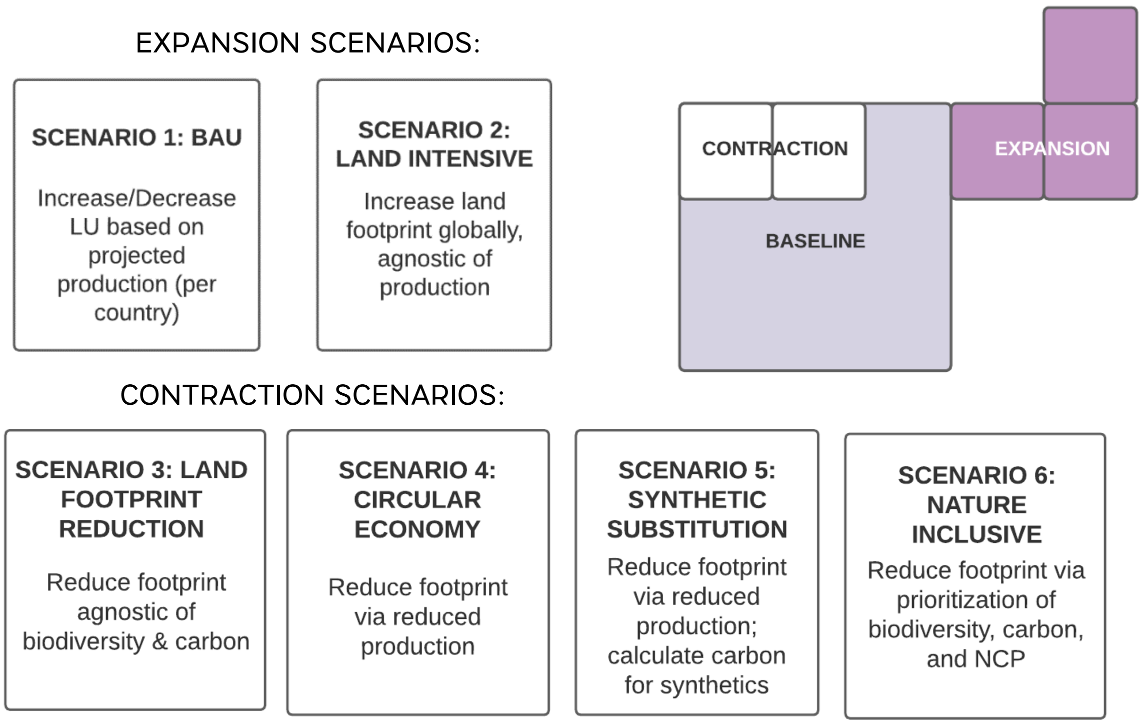

Figure 2. Scenarios modeled during analyses and a conceptual model to demonstrate the two main types of scenarios

We then measured the impacts of each solution to answer the question of how biodiversity, carbon, and NCP might be affected by changes in the land footprint for each commodity. In expansion scenarios, we expanded the current land footprint to answer the question: how harmful will impacts be if land use for fashion commodity production expands? For contraction, we asked where land footprint reduction, for example via restoration or more sustainable management practices, could be focused for the best returns on biodiversity and carbon.

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8 https://prioritizr.net/

9 "The IUCN Red List of Threatened Species"; "BirdLife Data Zone."

10 Hayek et al., "Carbon Opportunity Cost of Animal-Sourced Food Production on Land."

11 Chaplin-Kramer and Kennedy, "Local and Global Critical Natural Assets."

Every layer that we used to perform our analysis and models was projected to the Eckert IV equal area projection and aligned with a standard grid of 10 km per pixel. This helped create a uniform scale of analysis throughout each scenario.

Commodity Baselines

For cotton, we used the Spatial Allocation Production Model (SPAM) production layer to develop a global footprint for cotton production (Figure 2).[12] This initial production layer is provided in metric tons of cotton produced per pixel in 5-arc minute grid cells.

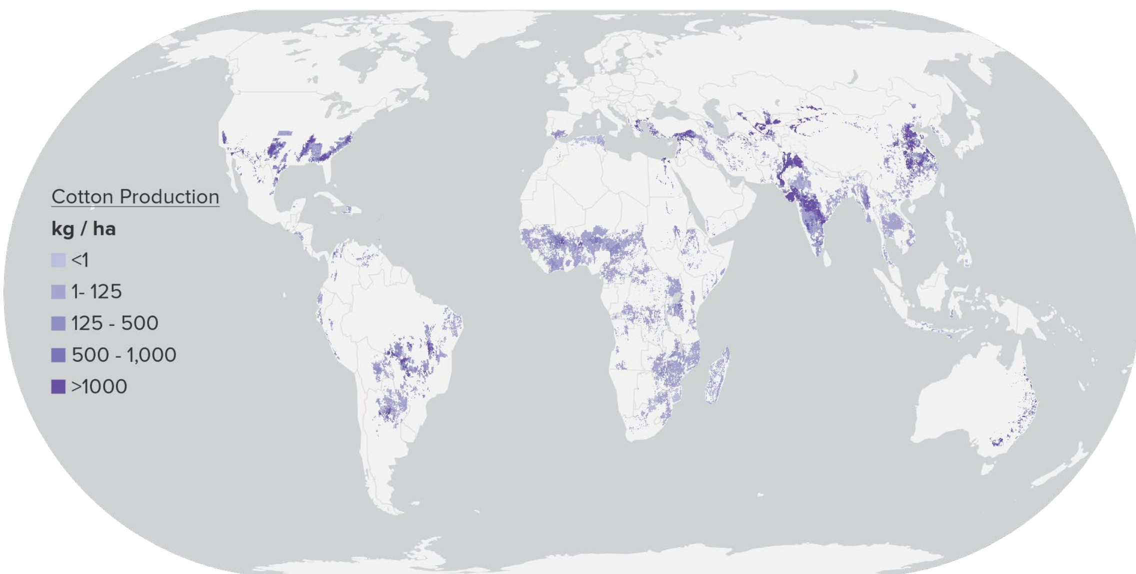

Figure 3. Cotton production baseline derived from SPAM

For cashmere and wool, because goats and sheep can often be used for other commodities such as meat or milk, we clipped the Gridded Livestock Density, v4, to specific cashmere and wool exporting countries to constrain our analysis to goats and sheep most likely to be used for cashmere and wool respectively.[13] For both goats and sheep, we thresholded the dasymetric method data to 10 to 2000 heads per km^2 based on methods from Strasbsurg[14] to eliminate extremely low-density values within the data. We then used FAOSTAT to gather country-level

[12] International Food Policy Research Institute (IFPRI), "Global Spatially-Disaggregated Crop Production Statistics Data for 2010 Version 2.0."
[13] FAO - UN, "GLW 4."
[14] Strassburg et al., "Global Priority Areas for Ecosystem Restoration."

exports of greasy wool[15] and the BACI international trade database derived from COMTRADE[16] to gather country-level exports for cashmere goat hair from 2015 through 2021. This constrained our analysis to countries most likely to use goats and sheep primarily for cashmere and wool respectively. Any country that contributed greater than 1% of total exports for any year within the time range of 2015 to 2021 was included in our analysis. For wool, this resulted in 19 countries for a total of 997 million hectares: China, Australia, New Zealand, Turkey, United Kingdom (UK), Morocco, Iran, Russia, South Africa, Pakistan, Argentina, Turkmenistan, India, Kazakhstan, Algeria, Uzbekistan, Uruguay, Indonesia, and Spain (Figure 4). For cashmere, this resulted in 9 countries and territories for a total of 349 million hectares: Mongolia, China, Mali, Italy, Afghanistan, Iran, UK, Hong Kong, Lesotho (Figure 5).

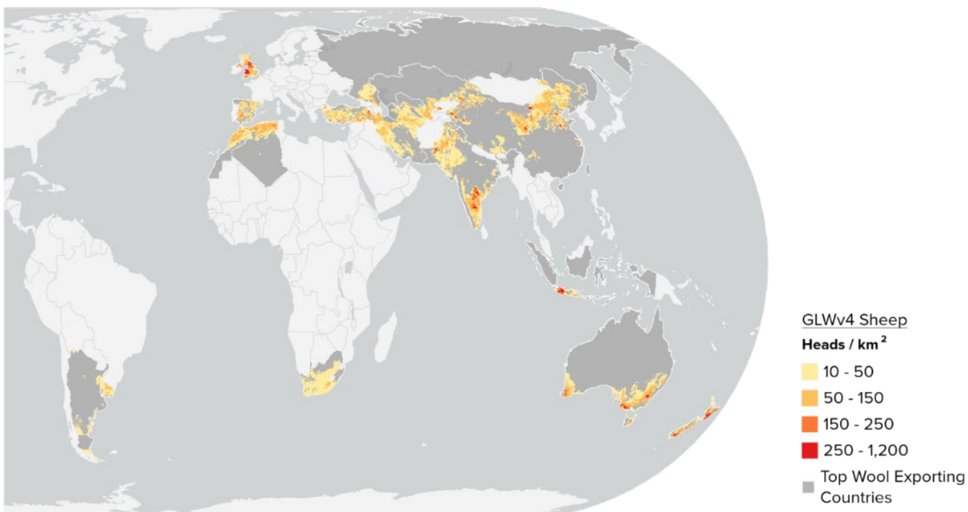

Figure 4. Wool production baseline derived from the Global Livestock of the World, Sheep, within wool-producing countries

[15] "FAOSTAT."
[16] "CEPII - BACI."

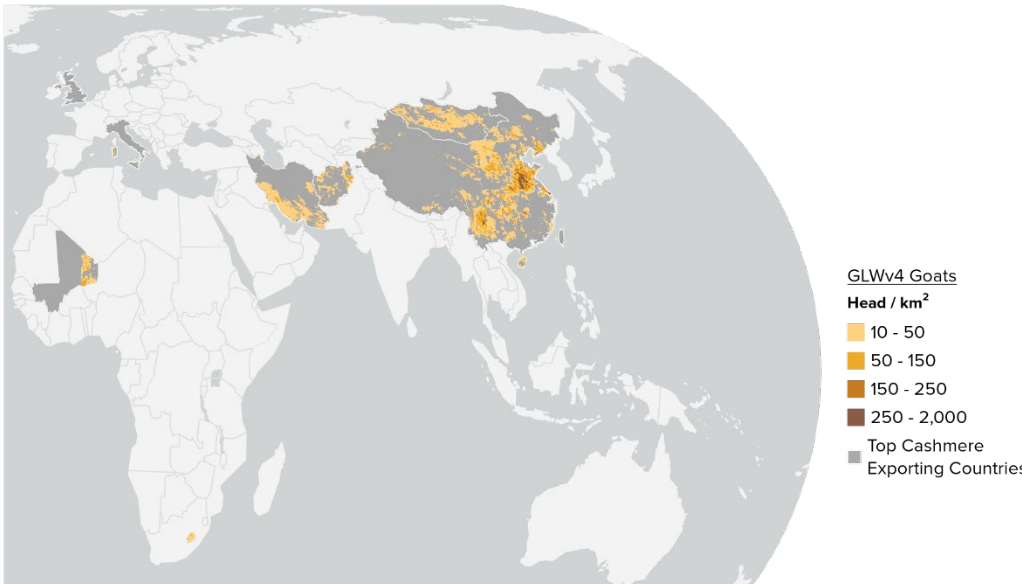

Figure 5. Cashmere production baseline derived from Global Livestock of the World, Goats, within cashmere-producing countries

Expansion Scenarios

In each expansion scenario, we considered the potential land which cotton, sheep, or goats could expand into. For cotton, we used a future climactic potential cotton layer from FAO GAEZ[17] along with distance to cotton in our baseline layer to constrain land to that which we deemed possible for expansion. Similarly, we used a distance to goat and sheep plus a Normalized Difference Vegetation Index (NDVI)[18] to prioritize land for expansion for sheep and goat grazing for the cashmere and wool scenarios. We thresholded the NDVI to the range that was found under the baseline footprint for each livestock to prioritize land that was most like that currently occupied. We also constrained the expansion to the countries already exporting cashmere and wool. For cotton, each expanded footprint was based only on the production potential and proximity to the baseline land footprint. For wool and cashmere, each expanded footprint was based only on NDVI and proximity to the baseline land footprint. This means that whether the expanded footprint was beneficial or harmful to biodiversity or if the biomass was carbon rich was not considered but was measured after as an impact.

Scenario 1) Business As Usual

This scenario presents a change in land use based on existing export patterns gathered from the trade data referenced earlier and assumes that these export patterns will continue. The change was calculated based on an average over 6 years of recent export data and represents one year of production. Percentages vary per country and commodity; the exact increase or decrease in export

[17] Fischer, *Global Agro-Ecological Zones v4 – Model Documentation*.
[18] Didan, "MOD13Q1 MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V006."

can be found in the Appendix (Table 12, Table 13, Table 14). This scenario includes both expansion and contraction methods because current export trends vary, showing that some countries have an increase in exports while others have a decrease in exports.

Scenario 2) Land Intensive

The land intensive scenario assumes land use for production increases across the board globally rather than potentially decreasing, as seen in Scenario 1. We present impacts representing a global 30% increase, as opposed to a 30% increase per country. For cotton, we considered two methods for increasing production: 1) increase the land footprint by 30%, and 2) increase potential yield by 30%. For potential yield, we used an agro-climatic potential cotton yield layer from FAO GAEZ[19]. For wool and cashmere, we expanded by 30% of the existing land footprint into the specific areas detailed in methods above.

Contraction Scenarios

In each contraction scenario (scenarios 3-6), we started with the existing commodity production and updated that land area based on the percentage of land or production to be removed based on the scenario. For most scenarios, we also incorporated data to reflect nature priorities, including biodiversity richness, carbon potential, and Nature's Contribution to People. We chose a 30% reduction to align with the previously mentioned global targets that promote land footprint reduction and landscape engagement.

Scenario 3) Land Footprint Reduction

This scenario explores a global land area reduction by 30% agnostic of biodiversity, carbon, and NCP. As such, this model represents a more randomized approach to land footprint reduction but does constrain the model to the existing production for cotton and density of sheep and goats for wool and cashmere respectively. In short, this scenario considers if the SBTN land reduction target was met but without prioritizing nature and does not attempt to reduce land use in areas most at risk.

Scenario 4) Circular Economy

The fashion industry has a large opportunity to recycle materials back into their products. Specific commodities such as cotton have a high potential opportunity for reuse and take up the most land of the fashion commodities examined.[20] Reuse of materials could help to reduce virgin materials that go into products and allow for the fashion sector to reduce the intensity of its land footprint, which is a key target for SBTN. This is an especially relevant opportunity and scenario given the

[19] Fischer, *Global Agro-Ecological Zones v4 – Model Documentation*.

[20] The Ellen Macarthur Foundation, "The Nature Imperative: How the Circular Economy Tackles Biodiversity Loss."

fashion industry's challenges with the end of life of a garment[21]. This scenario specifically applies to cotton production. Since data exists on cotton yield, we were able to consider reducing cotton's footprint by a certain production volume rather than by percentage of land footprint. Because spatially explicit production data was not available for wool and cashmere, we did not examine these commodities for Scenario 4.

Scenario 5) Synthetic Substitution

This scenario also only applies to cotton production to provide an adequate comparison for synthetic substitution. Given the fashion sector's increasing reliance on synthetic materials[22], we modeled these impacts as compared to natural fibers. In this scenario, we estimate the carbon equivalent of sourcing materials for synthetic clothing to compare the carbon emissions from synthetics with that of cotton production. We used data that estimates the CO_2 emissions that are produced when making a tonne of spun fiber for polyester and cotton[23]. It is difficult to compare cotton and polyester because the two materials have different technical and physical properties and occupy the market in different ways. For the purpose of this report, we have created a hypothetical scenario which assumes direct replacement of one fiber with another. As an additional consideration, we looked at the land-based carbon sequestered from reducing land under cotton production assuming using synthetic materials reduces the amount of carbon produced.

Scenario 6) Nature Inclusive

This scenario prioritizes biodiversity, carbon, and NCP by identifying important nature areas that can be prioritized for land use reductions, such as through restoration or more sustainable management. For each commodity, we removed 30% of the total land footprint and used biodiversity richness, carbon potential, and NCP within the model to select the areas of highest importance for nature to transition back to natural landscapes or remove from commodity production. As such, this scenario is named "nature inclusive" due to its inclusion of nature-based metrics (biodiversity, carbon, and NCP).

Impacts

We measured indicators of biodiversity, carbon, and forest cover for each scenario to understand the impacts of each and to offer a comparison to measure the magnitude of each solution.

For Carbon, we estimated the amount of Manageable Carbon[24] loss for the expansion scenarios and Potential Carbon[25] that could be sequestered and restored for the contraction scenarios, since for expansion we wanted to measure the carbon that already exists, while for the contraction

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[21] Niinimäki, Kirsi, "The Environmental Price of Fast Fashion."
[22] Niinimäki, Kirsi.
[23] Cherrett et al., "Ecological Footprint and Water Analysis of Cotton, Hemp and Polyester."
[24] Noon et al., "Mapping the Irrecoverable Carbon in Earth's Ecosystems."
[25] Hayek et al., "Carbon Opportunity Cost of Animal-Sourced Food Production on Land."

scenarios we wanted to consider carbon that could exist if not suppressed by cropland. Manageable Carbon is defined as "carbon in terrestrial and coastal ecosystems that could experience an anthropogenic land-use conversion event." The Potential Carbon dataset estimates the carbon opportunity cost of animal-sourced food production on land. While this dataset is focused on animal-sourced food production, it includes cropland and pastureland while most other carbon potential datasets do not. This dataset specifically provides the tons of carbon per hectare suppressed by agriculture land producing animal feed and pastures.

With biodiversity, we reported any IUCN Red List[26] species where at least 20% of its habitat overlapped with a scenario. This provided a list of species for which a portion of their habitats were potentially threatened in the expansion scenarios or could have habitat improvement if cropland was returned to a natural ecosystem in the contraction scenarios.

To measure potential effects on deforestation, we took land covers 50, 60, 61, 62, 70, 71, 72, 80, 81, 82, and 90 from ESA CCI's 2015 Land Cover map[27] and overlaid this with the results of the expansion scenarios.

LIMITATIONS

As with any research, this report and analysis has limitations that users must understand to use the results appropriately.

- **Lack of reliable fashion-related data:** there is little to no spatially explicit data that maps exactly the origin of raw materials for fashion commodities. This required assumptions and approximations for commodity production information. While some country-level export data does exist for cashmere and wool, the relationship between landscape and animal-based commodities is more complicated than crop-based commodities such as cotton, and as such the wool and cashmere scenarios should be treated with more caution.
- **Only modeled commodities directly driven by the fashion sector:** We did not model leather, man-made cellulosic fibers, and rubber given that these commodities are largely driven by other sectors, and we provided recommendations and next steps for these commodities in the introduction.
- **Did not consider region-specific economic effects and relationships:** While we have methods and code to model more region-specific transformation, the analyses performed in this report are at a global scale and as such do not discuss stakeholder engagement and effects on economies dependent on cotton, wool, and cashmere; local input and data is likely needed for company-level planning.

[26] "The IUCN Red List of Threatened Species."
[27] Harper et al., "A 29-Year Time Series of Annual 300 m Resolution Plant-Functional-Type Maps for Climate Models."

- **Focus on low yield/low production areas**: While we do not necessarily wish to promote intensification of land practices, many of the scenarios resulted in solutions that highlighted areas where yield is low. While this can emphasize land that is important for industry action, these landscapes may already include sustainable practices.

FINDINGS AND RECOMMENDATIONS

We encourage the private sector to apply these results to collective industry action that can drive change at scale and at a pace necessary to halt and reverse nature, climate, and biodiversity loss.

- **Reducing land used for fashion commodities**, and aligning with SBTN's land reduction target, could greatly benefit biodiversity and carbon by improving habitats for thousands of species
    - When nature is prioritized, restoring 30% of cotton lands to natural vegetation **could improve the habitat of up to 233 threatened species** and allow for the sequestration of 0.37 Gt of CO_2.
    - Restoring 30% of wool lands and 30% of cashmere lands **could improve the habitat of up to 285 threatened species**
    - **Reducing cotton production by 30% could return up to 89% of the cotton land footprint** – only 11% of the current land footprint is needed for 70% of cotton production. This indicates there is a high ability to integrate small amounts of circularity to easily meet SBTN land reduction and avoided conversion targets
- If the fashion sector continues with business as usual or, even worse, with expanding production to supply a growing virgin fiber need, there will be massive negative impacts on biodiversity and nature such as species habitat loss, deforestation, and land degradation.

Maps for Scenarios 2 and 6 can be explored in greater detail in this StoryMap.

Scenario 1: Business As Usual

This scenario presents a change in land use based on existing export patterns gathered from the trade data referenced earlier and assumes that these export patterns will continue. Notable patterns of commodity production changes to meet business as usual practices show land under crop expansion in Central America, Central Asia, and land under crops reductions in southeast Asia (Figure 6). **With cotton, there is the potential to improve habitat for up to 487 threatened species but negatively impact the habitat for up to 1,661 threatened species (**Figure 9**).** While cashmere and wool don't show as stark numbers or differences, they may still negatively impact the habitats of 233 and 217 threatened species respectively.

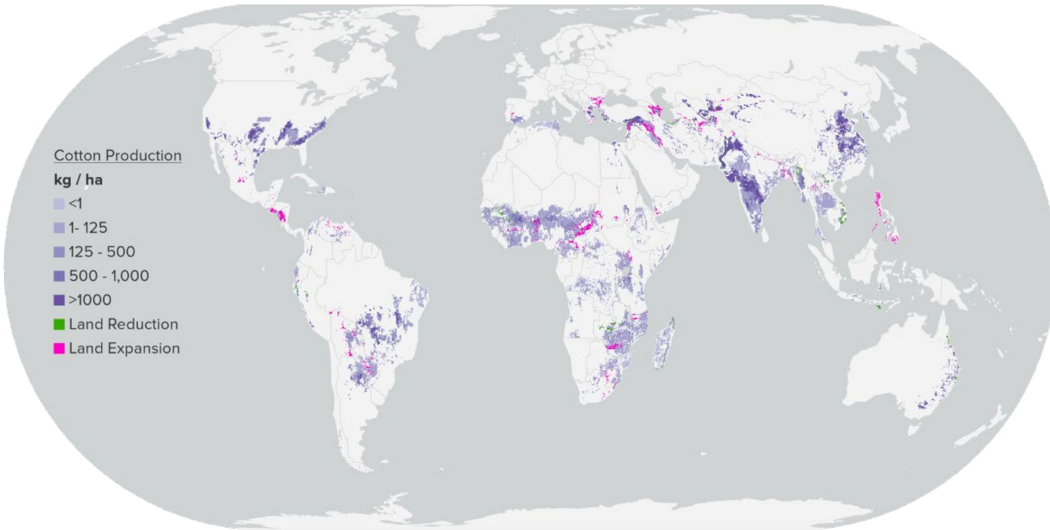


Figure 6. Map of cotton under Scenario 1, Business As Usual

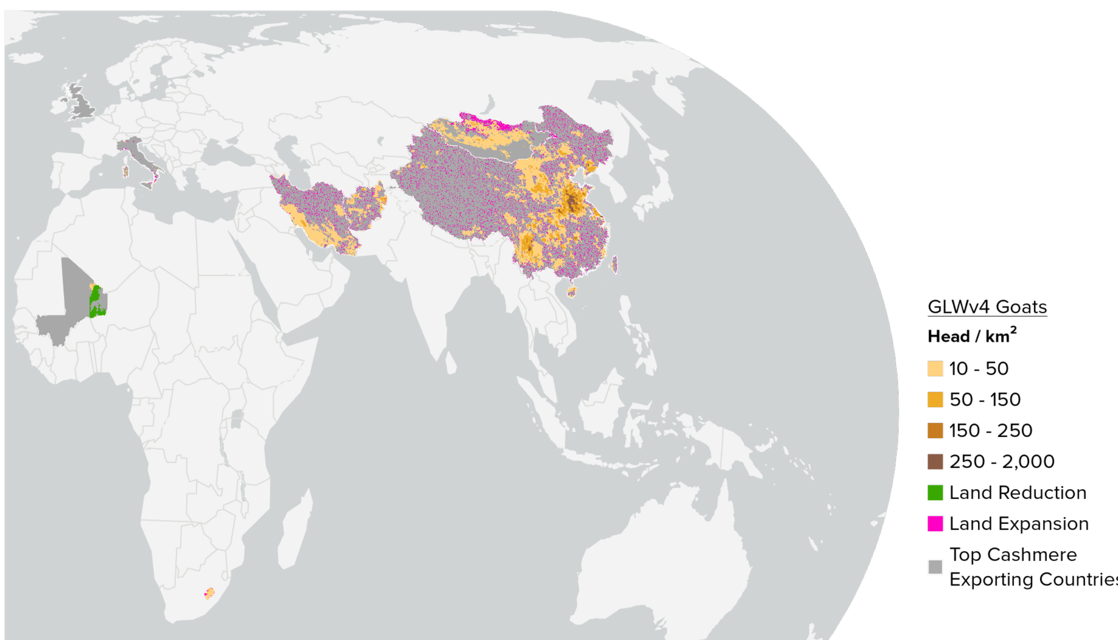


Figure 7. Map of cashmere under Scenario 1, Business As Usual

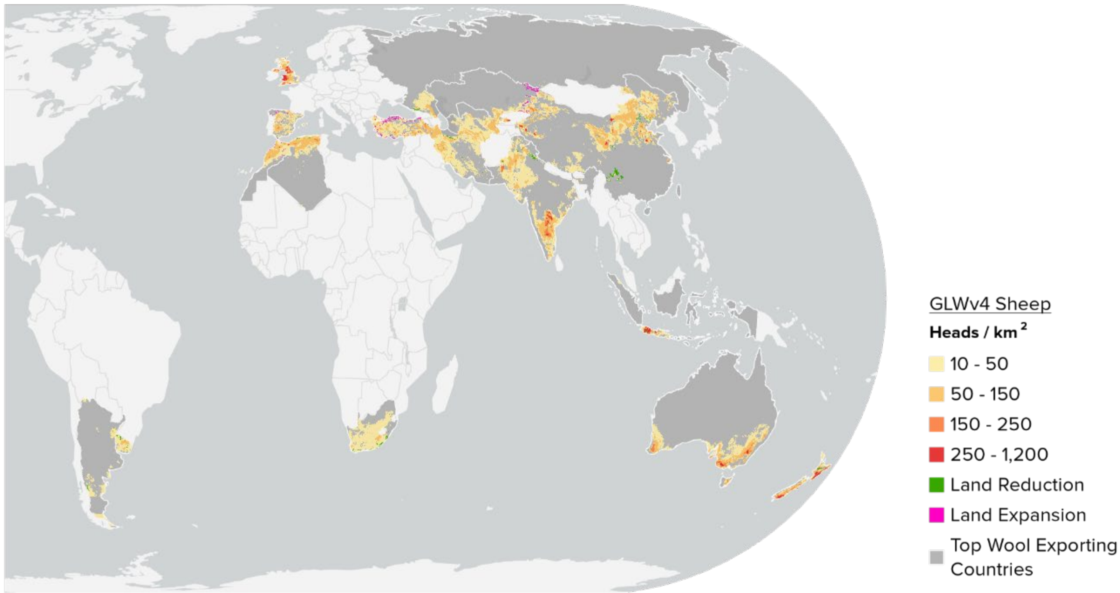
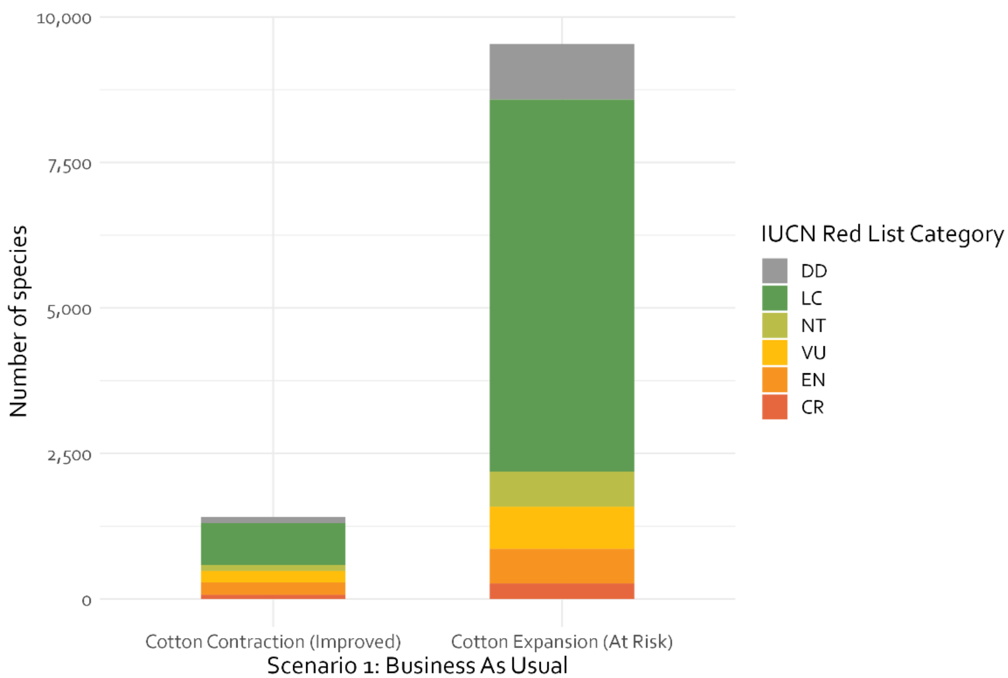
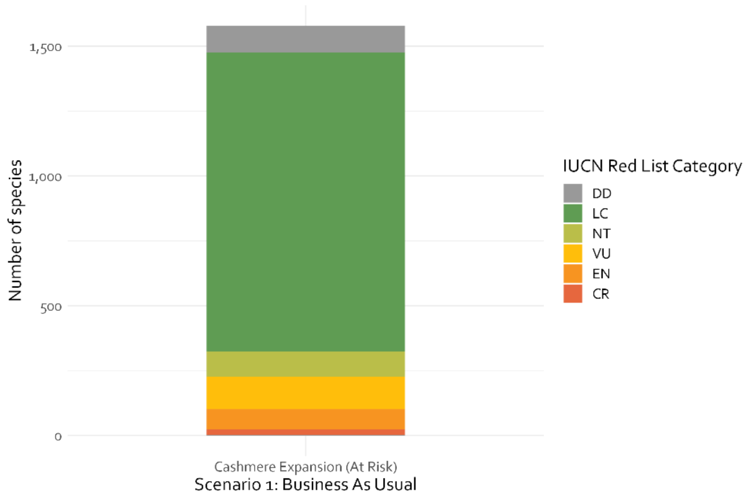
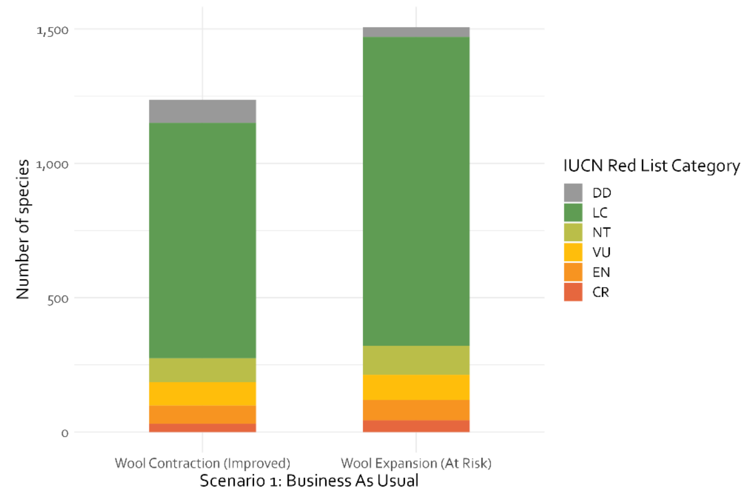


Figure 8. Map of wool under Scenario 1, Business As Usual







Scenario 2: Land Intensive

The land intensive scenario assumes land use for production increases across the board globally rather than potentially decreasing, as seen in Scenario 1. This scenario shows where expansion occurs if 30% more land was needed for cotton, wool, and cashmere production for fashion in the future (Table 1, Table 2, Table 3). The impacts of this scenario are especially stark, with large areas of potential expansion taking place in the USA, Spain, and Argentina (Figure 10). There is a potential for 54.6 million hectares of forest loss if cotton's land footprint were to expand by 30%, or 270 million hectares.

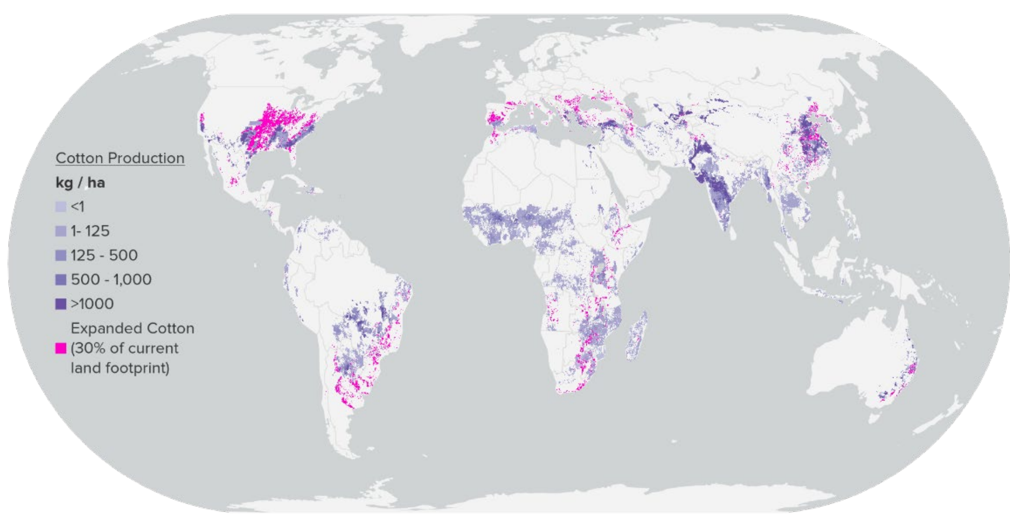


Figure 10. Cotton under Scenario 2, Land Intensive – 30% Land Expansion

Table 1. Species whose habitats could be at risk by a 30% cotton land footprint expansion:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	13	73
Endangered (EN)	37	
Vulnerable (VU)	23	
Near Threatened (NT)	32	
Least Concern (LC)	134	Total:
Data Deficient (DD)	35	274

Table 2. Species whose habitats could be at risk by a 30% cashmere land footprint expansion:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	0	6
Endangered (EN)	3	
Vulnerable (VU)	3	
Near Threatened (NT)	1	
Least Concern (LC)	3	Total:
Data Deficient (DD)	2	12

Table 3. Species whose habitats could be at risk by a 30% wool land footprint expansion:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	19	129
Endangered (EN)	55	
Vulnerable (VU)	55	
Near Threatened (NT)	35	
Least Concern (LC)	206	Total:
Data Deficient (DD)	54	424

Scenario 3: Land Footprint Reduction

This scenario explores a global land area reduction by 30% agnostic of biodiversity, carbon, and NCP. Biodiversity and carbon were not incorporated into the Prioritizr model to remove any bias toward selecting land with lower biodiversity and carbon (which is done in Scenario 6). Because only cotton production values were used to prioritize land selected for reductions, this solution prioritized land with lower yield while reaching the 30% footprint reduction target. This means that low-productivity lands were preferentially removed, which is illustrated below in Madagascar, southeast Asia, and across most cotton-producing areas of Africa (Figure 11).

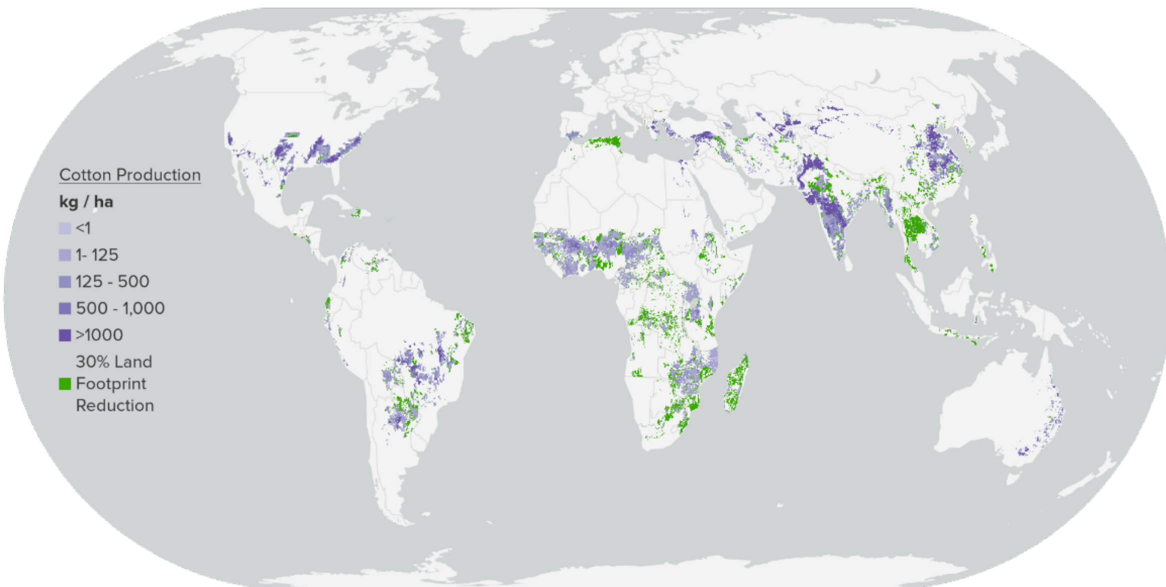


Figure 11. Cotton under Scenario 3, Land Footprint Reduction agnostic of biodiversity, carbon, and NCP

Table 4. Species whose habitats could be improved by a 30% cotton land footprint reduction agnostic of biodiversity, carbon, and NCP:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	111	620
Endangered (EN)	276	
Vulnerable (VU)	233	
Near Threatened (NT)	128	
Least Concern (LC)	739	Total:
Data Deficient (DD)	162	1649

Table 5. Species whose habitats could be improved by a 30% cashmere land footprint reduction agnostic of biodiversity, carbon, and NCP

<table>
<tr><th>IUCN Red List Category</th><th>Species Count</th><th></th></tr>
<tr><td>Critically Endangered (CR)</td><td>2</td><td rowspan="3">14</td></tr>
<tr><td>Endangered (EN)</td><td>8</td></tr>
<tr><td>Vulnerable (VU)</td><td>4</td></tr>
<tr><td>Near Threatened (NT)</td><td>3</td><td></td></tr>
<tr><td>Least Concern (LC)</td><td>25</td><td>Total:</td></tr>
<tr><td>Data Deficient (DD)</td><td>13</td><td>55</td></tr>
</table>

Table 6. Species whose habitats could be improved by a 30% wool land footprint reduction agnostic of biodiversity, carbon, and NCP

<table>
<tr><th>IUCN Red List Category</th><th>Species Count</th><th></th></tr>
<tr><td>Critically Endangered (CR)</td><td>13</td><td rowspan="3">64</td></tr>
<tr><td>Endangered (EN)</td><td>24</td></tr>
<tr><td>Vulnerable (VU)</td><td>27</td></tr>
<tr><td>Near Threatened (NT)</td><td>26</td><td></td></tr>
<tr><td>Least Concern (LC)</td><td>210</td><td>Total:</td></tr>
<tr><td>Data Deficient (DD)</td><td>25</td><td>325</td></tr>
</table>

Scenario 4: Circular Economy

There is a significant potential benefit to decrease the commodity land footprint given how much of the land is low yield through promoting circular economy to make up for that cotton supply gap. There is approximately 30 million tonnes of cotton produced each year according to the FAO; by reducing cotton's production by 30%, the scenario showed an 89% decrease in land footprint. In other words, only 11% of the current cotton land footprint is needed for approximately 70% of cotton production. With incorporating of recycled cotton materials into garments, we can lower the need for cotton production. In this scenario, total global cotton produced was reduced by 30% of volume according to SPAM. As shown below, this scenario showed a significant reduction in land footprint as compared to the other scenarios, in large part due to large areas of land with low yield (Figure 12). While this could seem to highlight high intensity farms as a benefit, it should moreso emphasize the importance of a circular economy helping to ease land demands within the fashion sector.

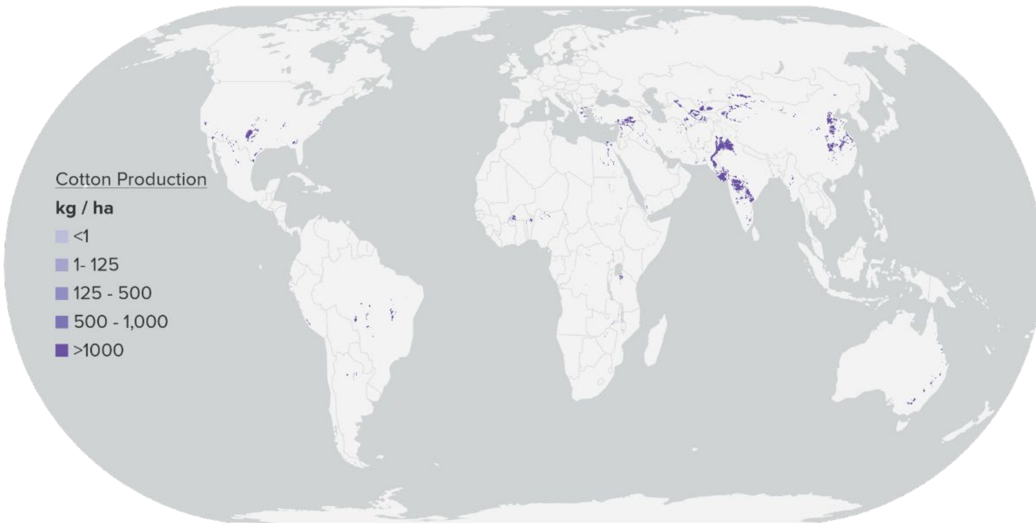


Figure 12. Cotton under Scenario 4, Circular Economy, 30% reduction of volume of cotton production

Table 7. Species whose habitats could be improved by a 30% cotton production reduction

IUCN Red List Category	Species Count	
Critically Endangered (CR)	189	1055
Endangered (EN)	433	
Vulnerable (VU)	433	
Near Threatened (NT)	279	
Least Concern (LC)	2019	Total:
Data Deficient (DD)	380	3733

Scenario 5: Synthetic Substitution

This scenario also only applies to cotton production to provide an adequate comparison for synthetic substitution. The footprint is identical to Scenario 4, but the impacts are calculated differently as synthetics are petroleum based and not crop based. In this report, we are primarily focusing on the impacts of land use for production on biodiversity and carbon. With respect to land use, cotton can have a harmful environmental footprint. Cotton production requires a substantial amount of land and water, often relying on irrigation in water-scarce areas and on chemical inputs like pesticides and herbicides. With our focus on the often-harmful environmental impacts of production landscapes, it may seem beneficial to mitigate impacts transitioning from land-intensive, natural fibers like cotton to less land-intensive, synthetic fibers like polyester. However, the production of both natural and synthetic fibers has negative impacts on the environment and climate, and even in rigorous life cycle assessments it is not clear that one form of production is "better" than the other.[28]

Although not nearly as large as cotton, the land footprint for polyester is not zero; mining for the coal and petroleum that create polyester can destroy natural habitats and requires water and chemical inputs. Further, energy requirements for synthetic fiber production are high, with polyester requiring up to ten times more energy than cotton production and producing up to four times more CO_2 emissions.[29] The emissions from production vary depending on the fuel mix; for example, regions that use more renewable energies will have lower emissions than those reliant on fossil fuels for their electricity. However, polyester will always require oil, meaning that even if polyester production were entirely fueled by renewable energy sources, it cannot be sustained indefinitely.

We used the below numbers from an Stockholm Environmental Institute Report for emission factors (9.52 and 5.90 values in Table 8)[30] for various fibers. We did not see consensus across sources, so we used these values to exemplify this scenario, knowing that different emissions factors may be more relevant in specific production systems.

Table 8. Kg of CO_2 emissions per ton of spun fiber, comparing synthetic and cotton fiber

KG of CO2 emissions per ton of spun fiber:			
	crop cultivation	fiber production	TOTAL
polyester USA	0.00	9.52	9.52
cotton, conventional, USA	4.20	1.70	5.90
hemp, conventional	1.90	2.15	4.05
cotton, organic, India	2.00	1.80	3.80
cotton, organic, USA	0.90	1.45	2.35

With 30% cotton tons globally swapped out for synthetic fiber, if we assume a 1:1 tons of fiber equivalence, we would remove approximately 9 million metric tons of cotton (FAO) and replace with that exact same amount of synthetic fibers. To produce 9 million metric tons of synthetic fiber would release 32,580,000 MT CO_2 (0.032 GT CO_2).

When comparing maximum carbon potentially sequestered by removing cotton land under current production, you could maximally sequester 0.864 GT CO_2. Biodiversity benefits show a potential improvement of the habitats of 1055 threatened species.

[28] Muthu, "12 - Comparative Life Cycle Assessment of Natural and Man-Made Textiles."
[29] Cherrett et al., "Ecological Footprint and Water Analysis of Cotton, Hemp and Polyester."
[30] Cherrett et al.

We note that there is a temporal disconnect with emissions from synthetics, which are immediately, and maximum potential carbon sequestration which can take. We also cannot compare biodiversity benefits directly with carbon benefits.

Scenario 6: Nature Inclusive

This scenario prioritizes biodiversity, carbon, and NCP by identifying important nature areas that can be prioritized for land use reductions, such as through restoration or more sustainable management. This scenario should be most closely compared to Scenario 3, which is a similar footprint method reduction scenario that does not prioritize biodiversity, carbon, and NCP. Scenario 6, alternatively, does prioritize biodiversity, carbon, and NCP, and as such, with this strategic nature planning, the return on the environmental impacts is greater and is considered nature inclusive**. With cotton, we see 233 threatened species with the potential for an improved habitat; with cashmere and wool these numbers are 78 and 207 respectively (**Table 10,Table 11**)**. Compared to Scenario 3, where 30% land was reduced but biodiversity and carbon was not prioritized, the number species whose habitats could be improved doubles for wool and quadruples for cashmere (Table 5, Table 6).

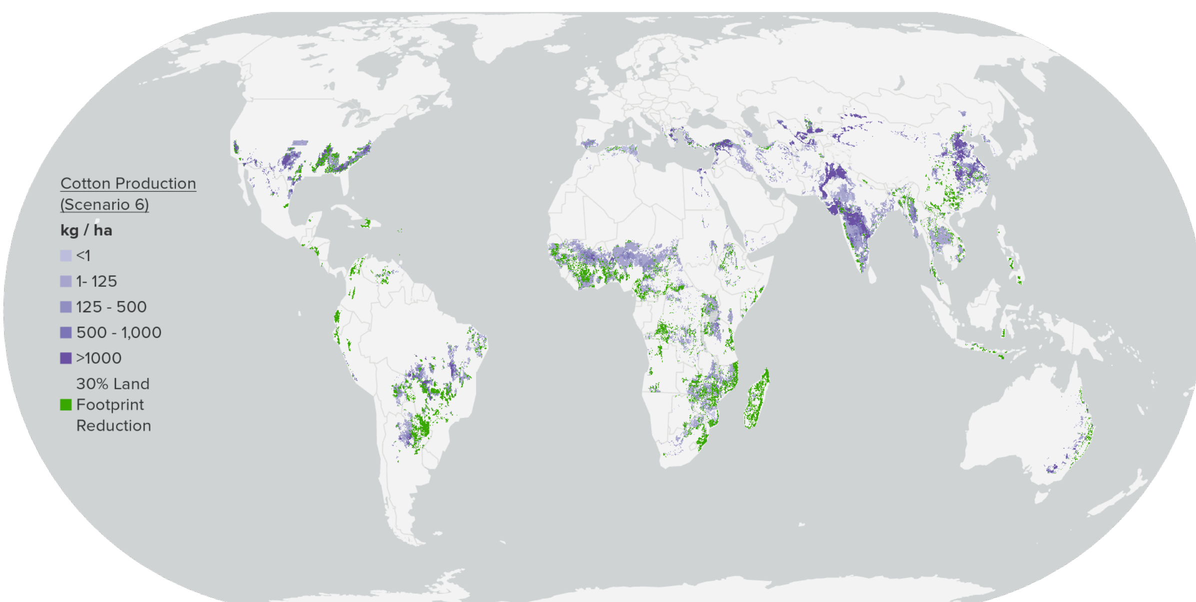


Figure 13. Map of cotton production footprint under Scenario 6

Table 9. Species whose habitats could be improved by a 30% cotton land footprint reduction when biodiversity, carbon, and NCP is prioritized:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	23	233
Endangered (EN)	82	
Vulnerable (VU)	128	
Near Threatened (NT)	100	
Least Concern (LC)	1194	Total:
Data Deficient (DD)	106	1633

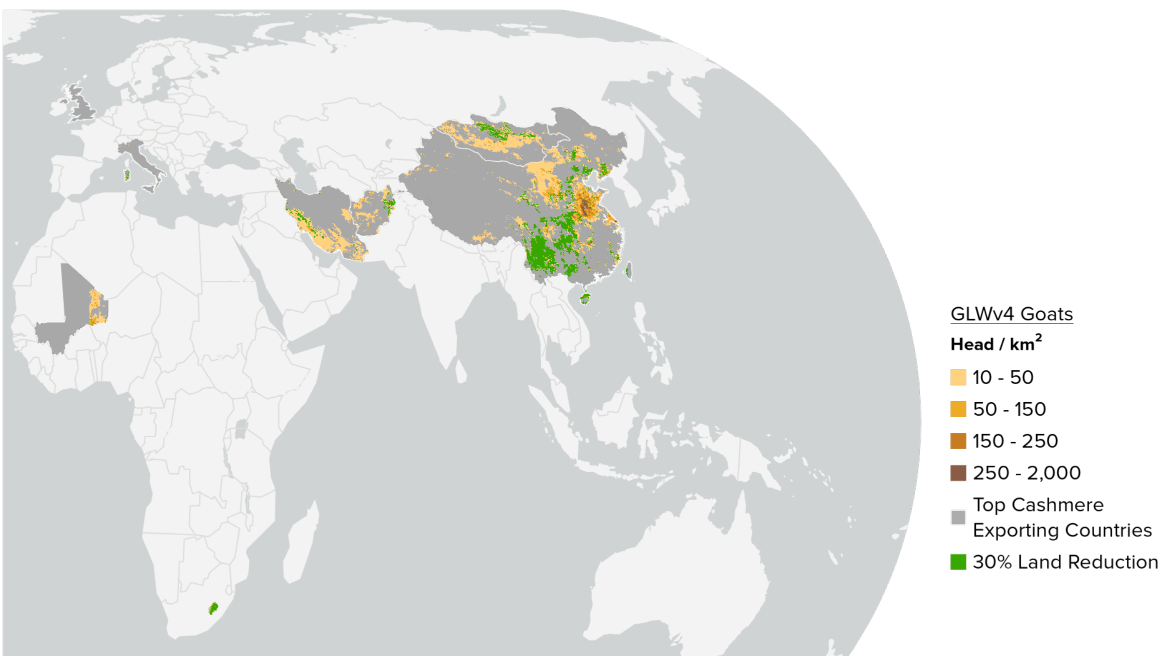


Figure 14. Map of cashmere footprint under Scenario 6

Table 10. Species whose habitats could be improved by a 30% cashmere land footprint reduction when biodiversity, carbon, and NCP is prioritized:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	7	78
Endangered (EN)	34	
Vulnerable (VU)	37	
Near Threatened (NT)	26	
Least Concern (LC)	229	Total:
Data Deficient (DD)	27	360

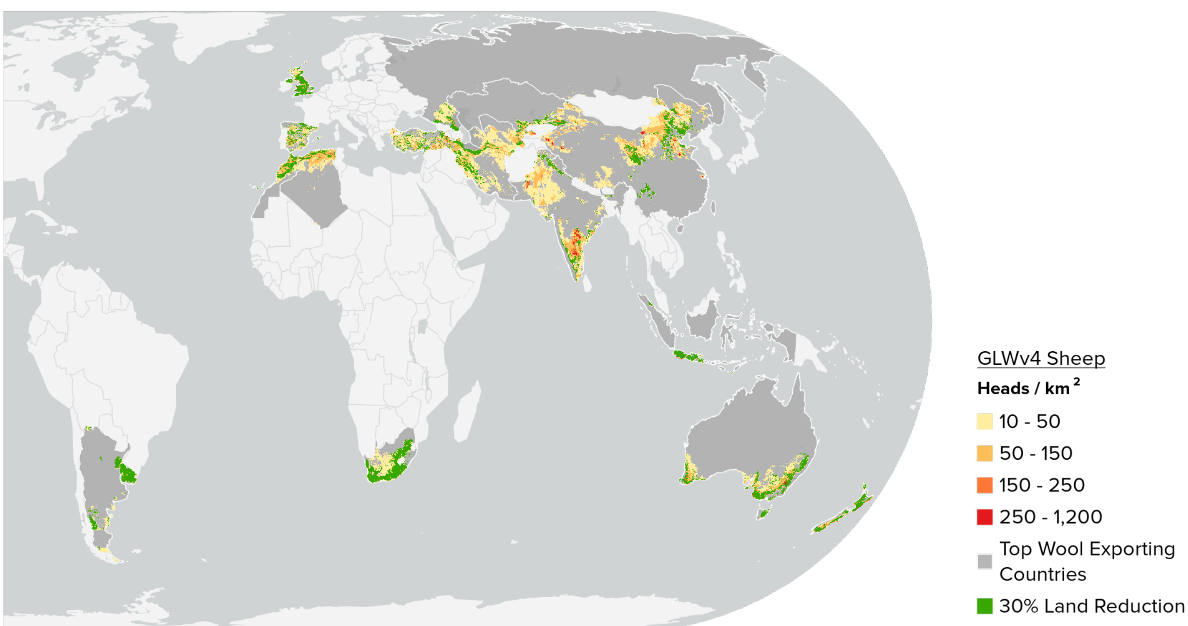


Figure 15. Map of wool footprint under Scenario 6

Table 11. Species whose habitats could be improved by a 30% wool land footprint reduction when biodiversity, carbon, and NCP is prioritized:

IUCN Red List Category	Species Count	
Critically Endangered (CR)	44	
Endangered (EN)	83	207
Vulnerable (VU)	80	
Near Threatened (NT)	89	
Least Concern (LC)	577	Total:
Data Deficient (DD)	74	947

CONCLUSION AND NEXT STEPS

While these scenarios represent various options for a future landscape for fashion, it is important to emphasize that these are **global scenarios** that show the benefits from **collective action**. These scenarios are informative in how the fashion sector could transition to supporting nature through key steps such as further integration of recycled materials through circular economy. These scenarios also showcase the dire consequences if the fashion industry continues on their current business as usual or expansion trajectories, which would result in potentially irrecoverable negative impacts to species and land carbon emissions. With any actions that are undertaken by the industry based on sector shifts, it is imperative that companies understand their supply chain, know more specifically where they are sourcing raw materials (given the outsized impact of raw material production on biodiversity compared to other tiers of the supply chain), and work locally to collaborate with communities who are directly engaged on the land. Despite international commitments to end deforestation, forest loss is still increasing.[31] When countries and the private sector work together, the power of the collective via the Fashion Pact and other pre-competitive platforms and initiatives can counteract negative trends in the industry. We encourage the private sector to apply these results to collective industry action that can drive change at scale and at a pace necessary to halt and reverse nature, climate, and biodiversity loss.

A StoryMap has been created for those looking to examine the scenario results in greater detail.

[31] "The Latest Analysis on Global Forests & Tree Cover Loss | Global Forest Review."

APPENDIX

Table 12. Cotton average percentage of export value change from 2015 to 2020 per country

Country	Continent	Avg % Change Cotton Export (2015 - 2020)
Afghanistan	Asia	13%
Albania	Europe	-2%
Algeria	Africa	2%
Angola	Africa	15%
Antigua and Barbuda	North America	-4%
Argentina	South America	5%
Australia	Australia	-7%
Azerbaijan	Asia	73%
Bangladesh	Asia	17%
Benin	Africa	26%
Bolivia	South America	33%
Botswana	Africa	-2%
Brazil	South America	13%
Bulgaria	Europe	28%
Burkina Faso	Africa	3%
Burundi	Africa	-12%
Cameroon	Africa	8%
Central African Republic	Africa	15%
Chad	Africa	68%
China	Asia	1%
Colombia	South America	2%
Congo DRC	Africa	1%
Costa Rica	North America	0%
Côte d'Ivoire	Africa	9%
Ecuador	South America	1%
Egypt	Africa	14%

El Salvador	North America	71%
Ethiopia	Africa	7%
Ghana	Africa	1%
Greece	Europe	11%
Guatemala	North America	3%
Guinea	Africa	1%
Haiti	North America	0%
Honduras	North America	0%
India	Asia	5%
Indonesia	Asia	-20%
Iran	Asia	-6%
Iraq	Asia	113%
Israel	Asia	-20%
Kazakhstan	Asia	4%
Kenya	Africa	-4%
Kyrgyzstan	Asia	12%
Laos	Asia	4%
Madagascar	Africa	-4%
Malawi	Africa	-1%
Mali	Africa	-13%
Mexico	North America	12%
Morocco	Africa	0%
Mozambique	Africa	11%
Myanmar	Asia	-13%
Nepal	Asia	3%
Nicaragua	North America	33%
Niger	Africa	0%
Nigeria	Africa	0%
Pakistan	Asia	-6%
Paraguay	South America	18%
Peru	South America	-20%

Philippines	Asia	63%
Senegal	Africa	-4%
Somalia	Africa	0%
South Africa	Africa	18%
South Korea	Asia	0%
Spain	Africa	3%
Sudan	Africa	28%
Syria	Asia	13%
Tajikistan	Asia	3%
Tanzania	Africa	0%
Thailand	Asia	7%
Togo	Africa	1%
Tunisia	Africa	-1%
Turkiye	Asia	-7%
Turkmenistan	Asia	19%
Uganda	Africa	11%
United States	North America	5%
Uzbekistan	Asia	-5%
Venezuela	South America	14%
Vietnam	Asia	-40%
Yemen	Asia	6%
Zambia	Africa	-14%
Zimbabwe	Africa	31%

Table 13. Average percent change of cashmere export from 2015 to 2021

Country	Avg % Change Cashmere Export (2015 - 2021)
Mali	-89%
Italy	3%
Mongolia	9%
China	13%
Afghanistan	21%
Iran	23%
Lesotho	28%
United Kingdom	44%

Table 14. Average percent change of wool export from 2015 to 2021

Country	Avg % Change Wool Export (2015 - 2021)
Algeria	-2%
Argentina	-2%
Australia	0%
China	-2%
India	-1%
Indonesia	-2%
Iran	-1%
Kazakhstan	1%
Morocco	1%
New Zealand	-3%
Pakistan	0%
Russian Federation	-2%
South Africa	-3%
Canarias	1%
Spain	1%
Turkey	6%
Turkmenistan	0%
United Kingdom	0%
Uruguay	-4%
Uzbekistan	0%

For additional questions regarding this report, please contact fashion@conservation.org