The environmental impact of mink fur production

Report
Delft, January 2011

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Publication Data

Bibliographical data:
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The environmental impact of mink fur production
Delft, CE Delft, January 2011

Fur / Production / LCA / Clothing industry / Trade

Publication code: 11.2220.11

CE publications are available from www.cedelft.eu

Commissioned by: Bont voor Dieren, GAIA and LAV
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CE Delft's solutions are characterised in being politically feasible, technologically sound, economically prudent and socially equitable.

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Summary

Background

For decades, fur production has been a hotly debated issue in many Western countries. In the Netherlands and Belgium, this debate has focused on mink fur, the only type of fur produced in these countries. In Italy, mink fur is produced in relatively small quantities; here the debate involves fur use in fashion, mostly. Anti-fur associations point to animal welfare issues, including poor-quality living conditions and have ethical objections to mink being kept for their fur. The fur industry, for its part, considers fur production a 'green' agricultural activity, and cites the measures being taken to reduce CO_2 emissions and water and energy consumption. Fur is thus being positioned as an environmentally benign, 'natural' product.

Against this background a number of NGOs including the Dutch Bont voor Dieren, the Belgian GAIA (Global Action in the Interest of Animals) and the Italian Lega Antivivisezione (LAV) asked CE Delft to research the environmental impact of the fur production chain.

Life cycle assessment

CE Delft has performed a life cycle assessment (LCA) of fur production, thus to quantify the environmental impact of the various links in the production chain, "from chicken feed to piece of fur", so to speak. The analysis consists of two parts:

– Determining the impact of fur production with respect to 18 different environmental themes, providing insight into which phases of the fur production chain have the greatest impact.
– Comparison of the impact of fur with those of other common textiles: cotton, acrylic, polyester and wool, permitting environmental comparison between mink fur and other textiles.

The fur production chain

The fur chain is studied from the production of mink feed through to the production of 1 kilogram of fur for use in the fashion industry. More specifically, the following phases of the mink fur production chain have been investigated:

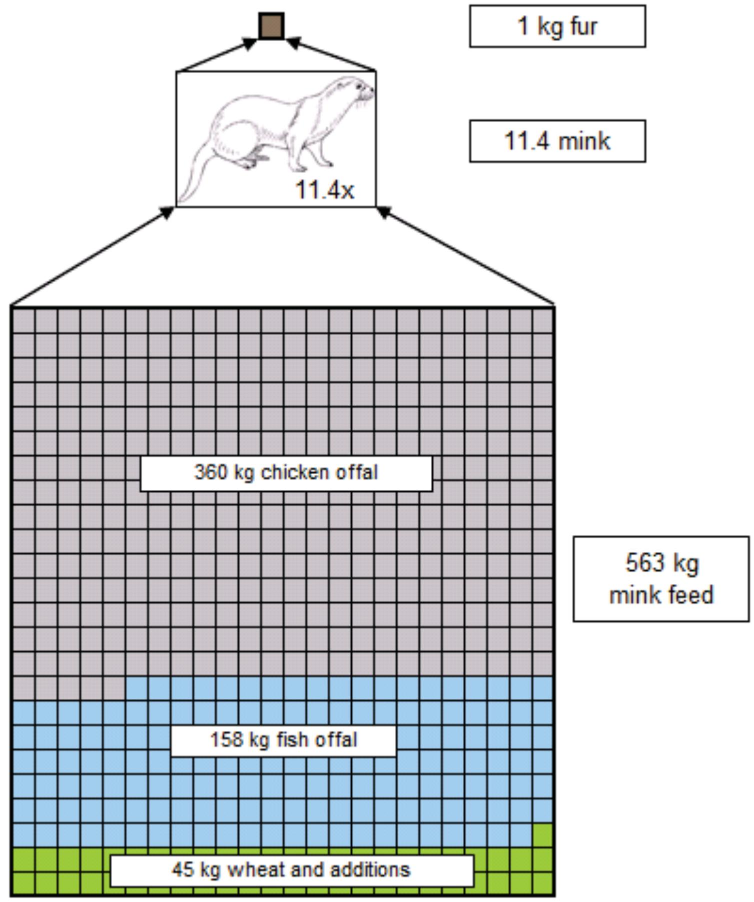
– *Mink feed production*: the feed consists of chicken and fish offal, supplemented with wheat flour and additives.
– *Mink keeping*: mink are bred for 7 to 8 months, after which they are pelted.
– *Pelting*: the pelt is removed from the carcass, cleaned and dried.
– *Auction*.
– *Fur treatment*: processes to transform the stiff pelt to fur (similar to leather processing), ready for further handling in the fashion industry.
– *Transportation*: between all the various phases there is transportation.

Each of these links in the production chain has been inventoried in as much detail as possible. However, data on certain aspects could not be found and in some cases scenarios have been drawn up, with the lowest scenario being used for analysis. The environmental impacts calculated in this study can thus be seen as minimum impacts; in all likelihood, the actual impacts will be greater. The analysis takes the Dutch mink farming practice as a starting point: of all the mink fur on the world market, 10% originates from Dutch mink farms, making the Netherlands the world's third-largest mink pelt-producing country. Given a limited variation between countries in the crucial parameters, such as

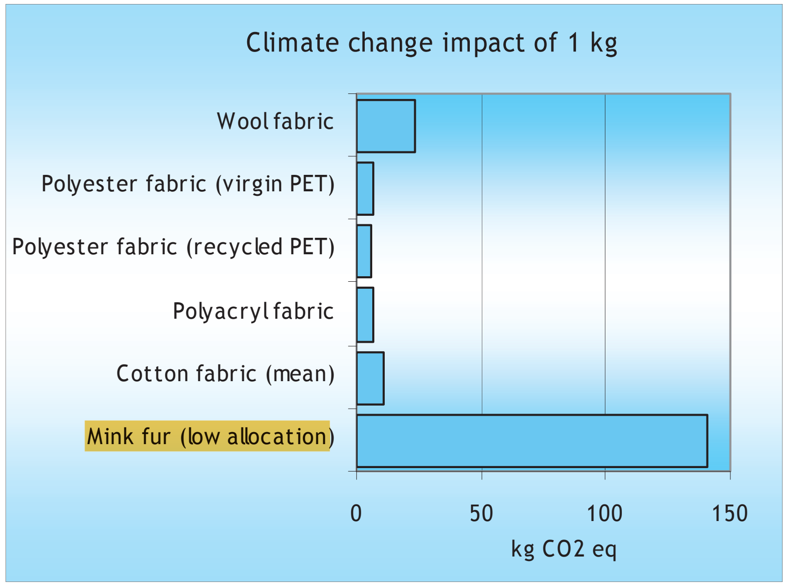
feed, results can be considered relevant for other European mink fur production.

Results

To produce 1 kg of fur requires 11.4 mink pelts, i.e. more than 11 animals. In the course of its lifetime, one mink eats almost 50 kg of feed (including the share of the mother animal), resulting in 563 kg of feed per kg of fur.



The feed consists mainly of offal, which is of low economic value and is therefore only assigned a small share of the environmental load of chicken or fish; as the meat fit for human consumption has the highest value, it is allocated the bulk of the environmental impact. Cultivation of the wheat also has an impact. Although the total environmental impact of 1 kg of mink feed is not particularly high, the 563 kilos required to produce 1 kg of fur knocks on considerably in the total environmental footprint of fur and for 14 of the 18 impacts studied feed is the predominant factor.



Compared with textiles, fur has a higher impact on 17 of the 18 environmental themes, including climate change, eutrophication and toxic emissions. In many cases fur scores markedly worse than textiles, with impacts a factor 2 to 28 higher, even when lower-bound values are taken for various links in the production chain. The exception is water depletion: on this impact cotton scores highest.

Other factors making a sizeable contribution to the overall environmental impact of mink fur are emissions of N_2O (nitrous oxide) and NH_3 (ammonia) from the mink manure. These emissions contribute mainly to acidification and particulate matter formation.

The climate change impact of 1 kg of mink fur is five times higher than that of the highest-scoring textile (wool). This is due both to the feed and to the N_2O emissions from the mink manure.

Samenvatting

Achtergrond

Bontproductie is al decennia lang een onderwerp van discussie in vele Westerse landen. In Nederland en België gaat het voornamelijk om de productie van nertsenbont, het enige type dat in deze landen geproduceerd wordt. In Italië wordt op relatief kleine schaal nertsenbont geproduceerd; het debat richt zich hier ook specifiek op het gebruik van bont in de mode-industrie. Anti-bontorganisaties wijzen op dieronvriendelijke leefomstandigheden en hebben ethische bezwaren tegen de nertsenhouderij. De bontindustrie werpt op dat de nertsenhouderij een groene, agrarische bezigheid is, en geeft aan dat maatregelen getroffen worden ter vermindering van uitstoot van CO_2. Bont wordt gepositioneerd als een milieuvriendelijk natuurproduct.
Een aantal maatschappelijke organisaties, waaronder het Nederlandse Bont voor Dieren, het Belgische Global Action in the interest of Animals (GAIA) en het Italiaanse Lega Antivivisezione (LAV), heeft CE Delft gevraagd om een analyse te doen naar de milieu-impact van de nertsenbontproductie.

Levenscyclusanalyse

CE Delft heeft een levenscyclusanalyse (LCA) uitgevoerd, waarmee de milieu-impact van verschillende fasen in de hele keten van nerstenbontproductie wordt berekend, ofwel “van voer tot lap bont”.
De analyse bevat twee onderdelen:

- Het bepalen van de impact van de bontproductie op 18 verschillende milieueffecten. Hiermee wordt inzicht verkregen over welke fasen in de bontketen de meeste impact veroorzaken.
- Het vergelijken van de impact van bont met die van de veelgebruikte textieltypen katoen, acryl, polyester en wol. Hierdoor is een milieukundige vergelijking mogelijk tussen nertsenbont en andere vezels.

Bontproductie: de keten

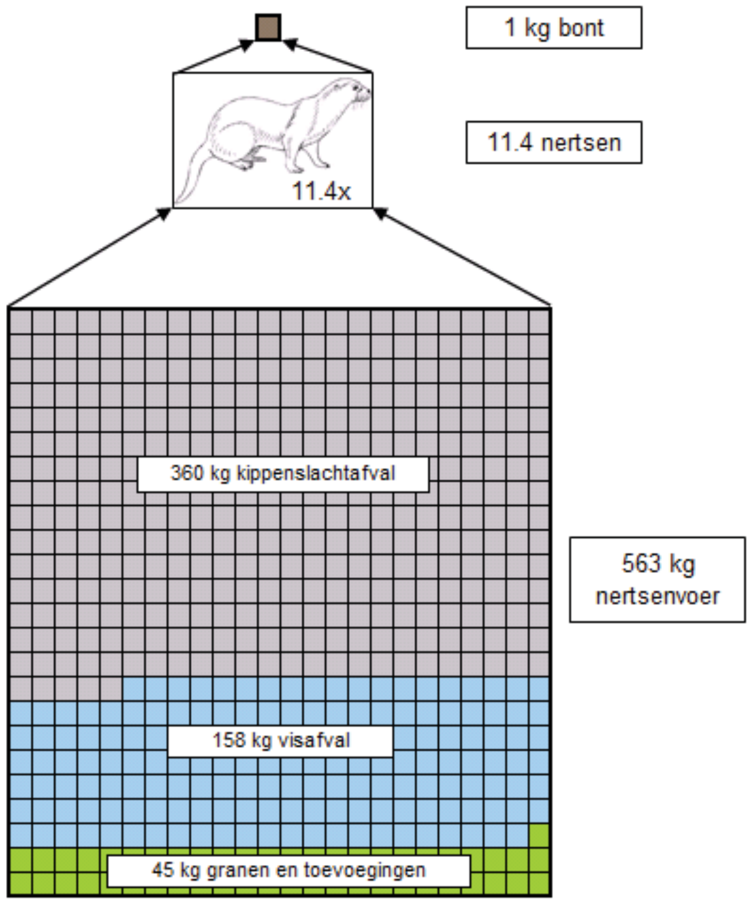
De keten is bestudeerd van productie van nertsenvoer tot aan productie van 1 kilo bont voor de mode-industrie. De nertsenbontproductie wordt gekarakteriseerd door de volgende ketenfasen:

- *Voedselproductie voor de nerts*: Nertsenvoer bevat kippen- en visslachtafval, aangevuld met meel (graanproduct) en voedingssupplementen.
- *Het fokken van de nerts*: Na zo’n 7 tot 8 maanden is de nerts volgroeid.
- *Pelzen:* De pels wordt van de gedode nerts verwijderd, schoongemaakt en gedroogd.
- Veiling.
- *Bontbewerking*: Dit zijn processen die, vergelijkbaar met leerlooien, de pels klaarmaken voor verwerking tot modeartikel.
- *Transport*: Tussen alle ketenstappen vindt transport plaats.

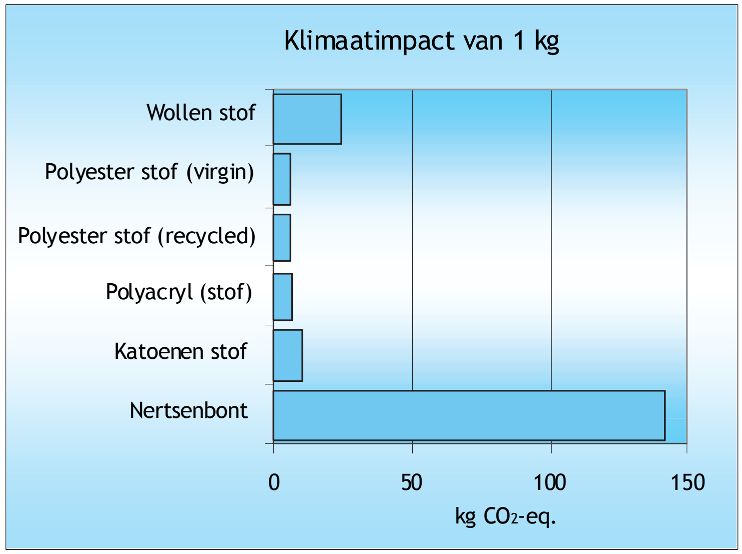
De fasen zijn zo goed mogelijk geïnventariseerd. Niet voor alle onderdelen van keten zijn data gevonden en in sommige gevallen zijn scenario’s opgesteld, waarbij de scenario’s met laagste waarden zijn geselecteerd voor analyse. Zo kunnen de berekende milieu-impacts gezien worden als minimale score: het is zeer waarschijnlijk dat werkelijke impact hoger ligt dan getoond in de studie. De milieukundige analyse neemt Nederlandse nertsenhouderij als uitgangspunt: 10% van het nertsenbont op de wereldmarkt is afkomstig van Nederlandse nertsenfokkerijen. Daarmee staat Nederland op de 3^e plek van de wereldranglijst. Omdat er tussen landen maar beperkte variatie is in de belangrijke parameters, zoals voer, zijn de resultaten echter ook relevant voor nertsenbont uit andere Europese landen.

Resultaten

Voor 1kilo bont zijn gemiddeld 11,4 nertsenpelzen nodig, dus de vachten van meer dan 11 dieren. Eén nerts eet bijna 50 kilo voer gedurende zijn leven (inclusief het aandeel voer voor het moederdier), wat neerkomt op 563 kilo voer voor 1 kilo bont.



Het voer bestaat grotendeels uit slachtafval, dat een lage economische waarde heeft. Daardoor wordt maar een klein deel van de milieu-impact toegerekend aan het slachtafval; het voor mensen eetbare deel neemt het grootste deel van de milieu-impact voor zijn rekening. De teelt van granen brengt ook milieu-impact met zich mee. De totale milieu-impact van 1 kg nertsenvoer is niet hoog, maar de 563 kilo voer per kilo bont draagt flink bij aan de totale milieu-impact van bont en is voor 14 van de 18 milieueffecten een bepalende factor.



In vergelijking met textiel heeft bont de hoogste impact voor 17 van de 18 berekende milieueffecten, waaronder klimaatverandering, vermesting, toxische emissies. De impacts van bont zijn een factor 2 tot 28 hoger, zelfs al worden voor diverse stappen in de bontketen de lage (ondergrens)waardes gebruikt. Alleen voor waterverbruik heeft bont niet de hoogste score, maar katoen.

Ook de N_2O-emmissie (stikstofoxide) en NH_3-emissie (ammoniak) afkomstig van de nertsenmest vormen een belangrijke factor bij de berekening van de milieu-impact. Deze stoffen dragen vooral bij aan de effecten verzuring en de vorming van fijn stof.

Het klimaateffect van 1 kilo bont is 5x zo hoog als de hoogste score voor ander textiel (wol). Dit komt door het voer en door de N_2O-emissie van mest.

Résumé

Contexte de l'étude

Depuis plusieurs dizaines d'années, la production de fourrure fait l'objet d'un débat intense dans de nombreux pays occidentaux. Aux Pays-Bas et en Belgique, les discussions se concentrent sur la peau de vison car il s'agit du seul type de fourrure produite dans ces deux pays. En Italie, la production de fourrure de vison est relativement faible, et le débat concerne surtout son utilisation dans le milieu de la mode. Les associations de défense animale attirent l'attention sur des questions relatives au bien-être animal, notamment sur les conditions de vie des animaux, et s'opposent pour des raisons éthiques à l'utilisation de visons pour la fourrure. L'industrie de la fourrure, de son côté, considère la production de celle-ci comme une activité agricole écologique, et invoque les mesures prises afin de réduire les émissions de CO_2 ainsi que la consommation d'eau et d'énergie. La fourrure est ainsi présentée comme un produit «naturel» et sain sur le plan environnemental.

En réaction à ce positionnement, les associations Bont voor Dieren (Pays-Bas), GAIA (Belgique) et la Lega Antivivisezione (LAV) (Italie), ont demandé à CE Delft de mener une étude sur l'impact environnemental de la chaîne de production de la fourrure.

Analyse du cycle de vie

CE Delft a effectué une analyse du cycle de vie (ACV) de la production de la fourrure, visant donc à quantifier l'impact environnemental de la chaîne de production et ses implications diverses ('de l'alimentation des poulets à l'étoffe de fourrure'). L'analyse se divise en deux parties:
- Étude de l'impact de la production de la fourrure à l'égard de 18 critères environnementaux, en déterminant les phases de la chaîne de production ayant le plus grand impact.
- Relevé des éléments permettant une comparaison entre l'impact environnemental de la fourrure de visons et celui d'autres textiles (le coton, l'acrylique, le polyester et la laine).

La chaîne de production de la fourrure

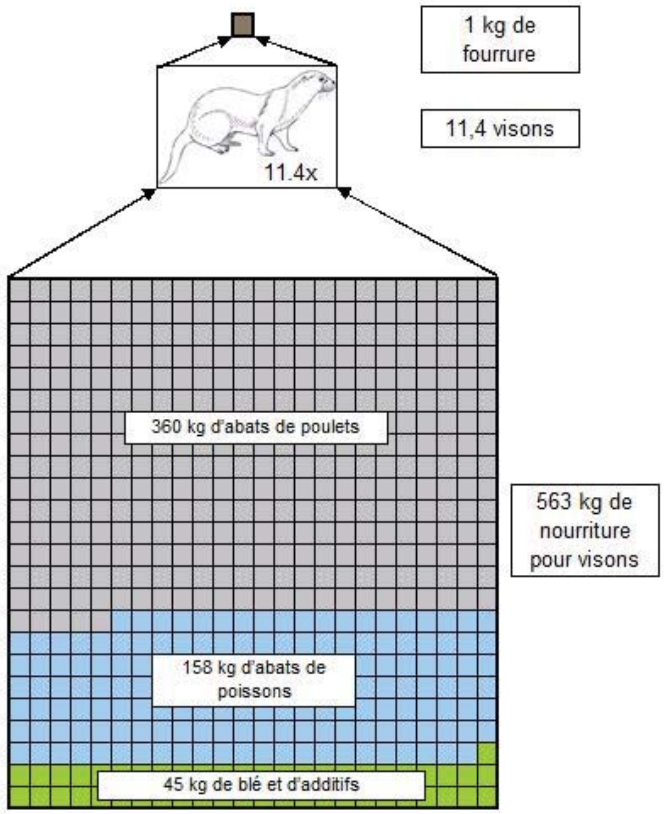
L'étude de la chaîne de la production s'étend de la nourriture des visons jusqu'à la production effective d'1 kilogramme de fourrure destinée à l'industrie de la mode. Plus spécifiquement, les phases de la production de fourrure de visons ayant fait l'objet d'une enquête sont les suivantes:
- Production de nourriture pour visons: la nourriture se compose d'abats de poulets et de poissons, avec ajout de farine de blé et d'additifs.
- Élevage des visons: les visons sont élevés sur une période de 7 à 8 mois, avant d'être écorchés.
- Écorchage: la peau est enlevée de la carcasse, nettoyée et séchée.
- Mise en vente
- Traitement de la fourrure: procédés de transformation de la peau brute (semblables aux procédés employés pour le traitement du cuir) en un produit prêt à l'emploi dans l'industrie de la mode.
- Transport: Facteur intervenant entre chaque étape de la production.

Chacun des paramètres entrant en jeu dans la chaîne de production a été examiné de façon la plus précise possible. Toutefois, certaines informations n'ont parfois pas pu être trouvées, Dans ces situations, plusieurs cas de figure ont été formulés, mais toujours avec la prise en compte des évaluations les plus basses dans l'analyse. Les impacts environnementaux calculés dans cette étude peuvent donc être considérés comme les chiffres minimums, et selon

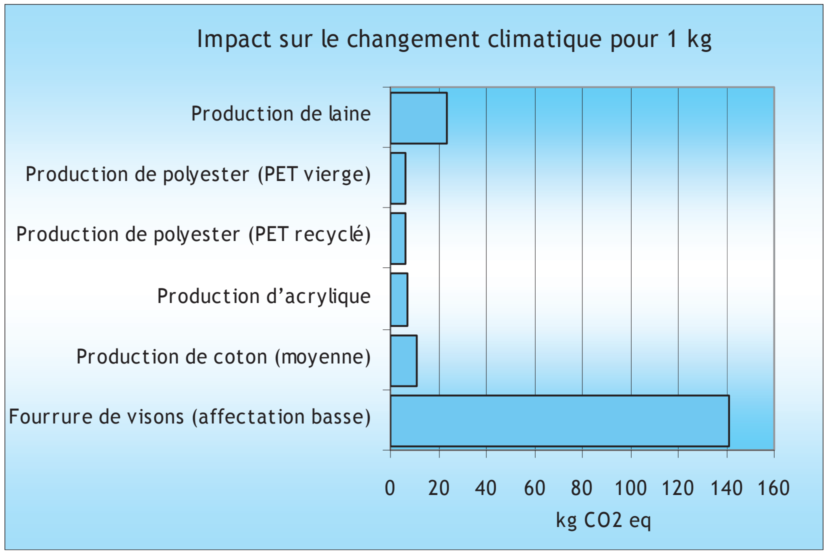
toute probabilité, les impacts réels sont plus importants. Cette analyse prend comme repère les pratiques de l'élevage de visons aux Pays-Bas: 10% de la fourrure de visons sur le marché mondial provient d'élevages néerlandais, faisant de ce pays le troisième plus grand producteur. La disparité dans les paramètres importants (comme la nourriture des animaux) étant limitée entre les pays, les résultats obtenus peuvent être considérés comme pertinents pour les autres pays européens producteurs de fourrure de visons.

Résultats

La production de 1 kg de fourrure requiert 11,4 peaux de visons, soit plus de 11 animaux. Au cours de sa vie, un vison consomme près de 50 kg de nourriture (part de la mère de l'animal comprise), ce qui représente donc 563 kg de nourriture par kilogramme de fourrure.



La nourriture se compose principalement d'abats, économiquement avantageux et donc responsables d'une part minime de la charge environnementale du poulet ou du poisson. La viande propre à la consommation humaine ayant un coût plus important, elle est considérée comme responsable de la majeure partie de l'impact environnemental. La culture du blé entre également en jeu. Bien que l'impact environnemental occasionné par la production d'1 kg de nourriture pour visons ne soit pas particulièrement élevé en soi, l'empreinte écologique globale de la fourrure est en fait considérablement alourdie par la quantité de nourriture requise pour 1 kg de fourrure: 563 kg. La nourriture est ainsi le facteur prédominent pour 14 des 18 critères étudiés.



Par rapport aux matières textiles, la fourrure a un impact plus important dans 17 des 18 critères environnementaux, ce qui comprend notamment le changement climatique, l'eutrophisation et les émissions toxiques. Dans de nombreux cas, l'effet de la production de la fourrure est nettement plus néfaste que le textile, avec un impact de 2 à 28 fois supérieur, même en prenant en compte des valeurs minimales pour plusieurs paramètres de la chaîne de production. La seule exception est la consommation en eau : la production de coton est la plus gourmande en la matière.

Les autres facteurs contribuant remarquablement à l'impact environnemental global sont les émissions de N_2O (Oxyde nitreux) et de NH_3 (ammoniac), provenant du lisier des visons. Ces émissions sont principalement responsables d'acidification et de formation de particules fines.
L'impact sur le changement climatique occasionné par la production d'1 kg de fourrure est cinq fois supérieur au textile le plus néfaste en la matière (la laine). En cause, les émissions de N_2O et le lisier des visons.

Riepilogo

Informazioni generali
Per diversi decenni la produzione di pellicce è stata argomento di accese discussioni in molti Paesi del mondo occidentale. Nei Paesi Bassi e in Belgio questo dibattito si è concentrato sulle pellicce di visone, l'unico tipo di pellicce prodotto in questi Paesi. In Italia le pellicce di visone vengono prodotte in quantità relativamente ridotte e in questo Paese il dibattito riguardo principalmente l'uso delle pellicce nel settore della moda. Le associazioni anti-pellicce mettono in evidenza i problemi relativi al benessere animale, incluse le condizioni scadenti in cui vengono tenuti gli animali, e sollevano obiezioni di tipo etico all'allevamento di visoni con il solo scopo di utilizzarli per la loro pelliccia. Da parte sua, l'industria delle pellicce considera la produzione di pellicce come un'attività a basso impatto ambientale e cita le diverse misure impiegate per ridurre le emissioni di CO_2 e il consumo di acqua ed energia. Per questo motivo le pellicce vengono considerate come un prodotto a basso impatto ambientale e "naturale".

Per contestare questo tipo di informazioni alcune organizzazioni non governative come l'olandese Bont voor Dieren, la belga GAIA (Azione globale per i diritti degli animali) e l'italiana LAV (Lega Anti Vivisezione) hanno chiesto a CE Delft di studiare l'impatto ambientale dell'industria di produzione delle pellicce.

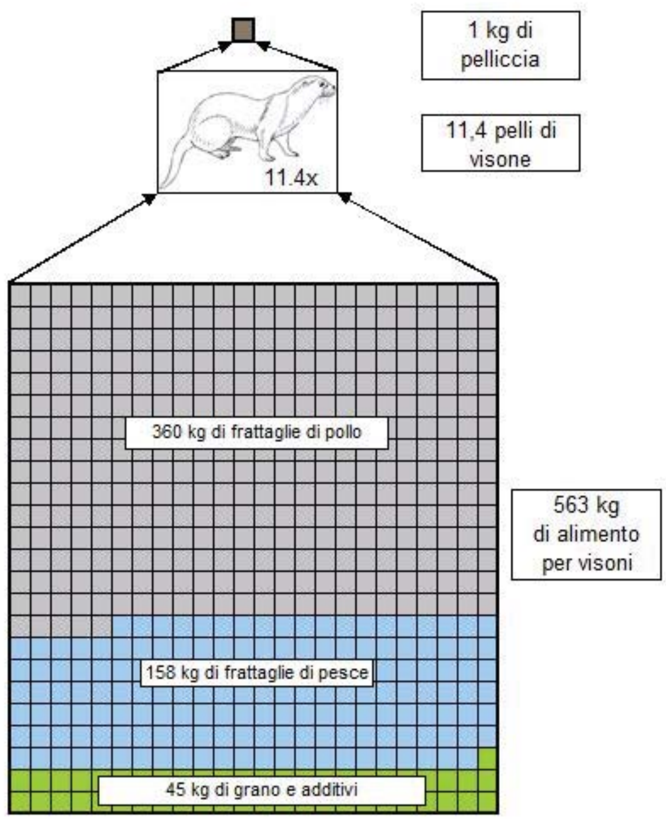
Analisi del ciclo di vita
CE Delft ha condotto un'analisi del ciclo di vita (LCA, life cycle assessment) della produzione di pellicce, al fine di quantificare l'impatto ambientale dei diversi anelli della catena produttiva, "dal mangime a base di pollame fino alla pelliccia finita". L'analisi era composta di due parti:
- Determinazione dell'impatto della produzione di pellicce in base a 18 diversi temi ambientali, fornendo informazioni su quali fasi della catena di produzione delle pellicce abbiano un impatto maggiore.
- Confronto dell'impatto della produzione di pellicce con l'impatto della produzione di altri prodotti tessili comuni, come cotone, acrilico, poliestere e lana, permettendo di conseguenza un confronto dal punto di vista ambientale tra le pellicce di visone e altri materiali tessili.

La catena di produzione delle pellicce
La catena di produzione delle pellicce viene studiata dalla produzione dell'alimento per i visoni fino alla produzione di 1 chilogrammo di pelliccia per l'uso nell'industria della moda. Più specificatamente, sono state esaminate le seguenti fasi riguardanti la catena di produzione delle pellicce di visone:
- *Produzione di alimento per visoni*: l'alimento consiste in frattaglie di pollo e pesce, integrate con farina di grano e additivi.
- *Allevamento dei visoni*: i visoni sono allevati per 7-8 mesi e quindi vengono abbattuti e scuoiati.
- *Scuoiamento*: la pelle viene rimossa dalla carcassa, viene pulita ed essiccata.
- *Vendita all'asta*.
- *Trattamento delle pellicce*: procedure per la trasformazione di pellami duri in pellicce (in modo simile alla lavorazione del cuoio), pronte per ulteriori lavorazioni nell'industria della moda.
- *Trasporto*: tra le diverse fasi del ciclo si inserisce il trasporto da un luogo all'altro.

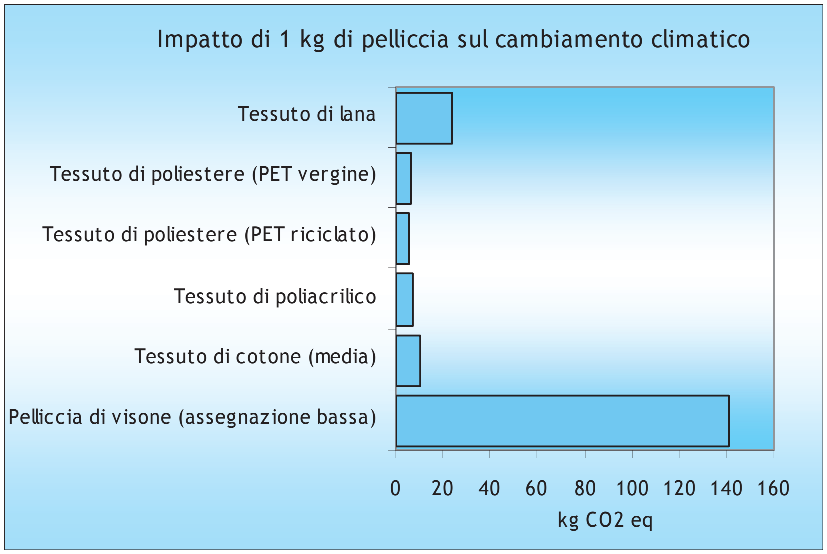
Ognuno di questi anelli della catena di produzione è stato esaminato nel modo più dettagliato possibile. Tuttavia, non è stato possibile trovare dati su alcuni aspetti in particolare e in alcune situazioni i dati sono stati estrapolati, utilizzando per l'analisi la situazione meno grave possibile. Gli impatti ambientali calcolati in questo studio possono essere di conseguenza considerati come impatti di livello minimo e molto probabilmente gli impatti reali sono molto più significativi. Come punto di partenza l'analisi ha impiegato la pratica di allevamento di visoni nei Paesi Bassi: di tutte le pellicce di visone presenti sul mercato mondiale, il 10% ha origine dagli allevamenti di visoni olandesi, rendendo così i Paesi Bassi il terzo Paese produttore di pelli di visone al mondo. Considerando una bassa variazione tra i diversi Paesi riguardo i principali parametri, come ad esempio l'alimento per visoni, i risultati possono essere considerati rilevanti anche per gli altri Paesi europei produttori di pellicce di visone.

Risultati

Per produrre 1 kg di pelliccia sono necessari 11,4 pelli di visone, ossia più di 11 animali. Nel corso della sua vita, un visone consuma quasi 50 kg di alimento (inclusa la parte assunta dalla madre), arrivando ad un totale di 563 kg di alimento per ogni kg di pelliccia.



L'alimento consiste principalmente in frattaglie, di basso valore economico, e a cui per questo motivo viene assegnata solo una piccola parte dell'impatto ambientale del pollo o del pesce. La carne utilizzata per il consumo umano possiede il valore più elevato e per questo le viene assegnato il valore totale dell'impatto ambientale. Anche la coltivazione del grano ha un impatto ambientale. Sebbene l'impatto ambientale totale di 1 kg di alimento per visoni non sia particolarmente elevato, i 563 chili necessari per produrre 1 kg di pellicce aumenta considerevolmente l'impronta ambientale totale delle pellicce e per 14 impatti dei 18 impatti studiati l'alimento rappresenta il fattore principale.



Rispetto ai tessuti, le pellicce hanno un maggiore impatto ambientale per 17 temi ambientali su 18, inclusi il cambiamento climatico, l'eutrofizzazione e le emissioni di sostanze tossiche. In molti casi le pellicce sono risultate marcatamente peggiori dei tessuti, con impatti da 2 a 28 volte più elevati, anche quando venivano considerati valori bassi per i diversi anelli della catena di produzione. L'unica eccezione è stato l'utilizzo di acqua: per questo impatto il cotone ha avuto il punteggio più alto.

Altri fattori che contribuiscono in modo ragguardevole all'impatto ambientale complessivo delle pellicce di visone comprendono le emissioni di N_2O (monossido di azoto) e NH_3 (ammoniaca) provenienti dalle deiezioni dei visoni. Queste emissioni contribuiscono principalmente all'acidificazione e alla formazione di materiale in sospensione.

L'impatto sul cambiamento climatico di 1 kg di pelliccia di visone è cinque volte superiore a quello del tessuto con punteggio maggiore (lana). Questo è dovuto sia alla alimentazione per i visoni che alle emissioni di N_2O delle deiezioni dei visoni.

1 Introduction

1.1 Background

Keeping animals for their fur is the subject of a broad public debate which has been going on for many years now. Naturally, the fur industry and anti-fur associations have opposing views, and each try to sway the debate with arguments and counter-arguments.

For anti-fur organisations the main issue is of an ethical nature: they object to mink keeping and killing animals for their fur, and focus on animal welfare and animal rights. The European Fur Breeders' Association (EFBA), for its part, regards fur farming as a 'green' agricultural activity and the fur industry recommends fur as being an environmentally sound natural product. According to its website, EFBA 'supports any decision that can reduce global emissions impacting on climate change' and points to the measures being taken to its reduce CO_2 emissions.

Several NGOs have expressed their doubts regarding the extent to which fur can be qualified as environmental friendly, among them the Dutch anti-fur campaigning group Bont voor Dieren, the Belgian GAIA (Global Action in the Interest of Animals) and the Italian Lega Antivivisezione (LAV). They commissioned CE Delft to conduct an analysis of the environmental impact of the fur trade.

CE Delft is an independent research and consultancy organisation specialised, among other things, in performing life cycle assessment (LCA). LCAs are performed for a wide range of clients, including companies, governments, NGOs and branch organisations. We agreed to perform an LCA on the fur production chain, inventorying the various steps and analysing their environmental impact as far as was possible, given data availability.

An LCA is an environmental analysis, not an analysis of sustainability. Sustainability comprises three dimensions: economic, ethical and environmental. As this is an LCA, however, ethical aspects are not under investigation and CE Delft wishes to remain objective in the pro- or anti-fur debate.

1.2 Focus

The focus of the present study is on fur from farmed animals, as these are the mainstay of the fur trade, accounting for some 85% of the industry's turnover (IFTF, 2010). The analysis takes the Dutch mink farming practice as a starting point: of all the mink fur on the world market, 10% originates from Dutch mink farms, making the Netherlands the world's third-largest mink pelt-producing country (EFBA, 2010b). European production in total contributes about 65% to the world production of mink pelts.

1.3 Aim

The aim of the project is to provide a picture of the overall environmental impact of the fur production, giving consideration to the entire chain of production. The analysis consists of two elements:

- determination of the environmental impact of fur;
- comparison of the environmental impact of fur with other types of textile.

The impact of 1 kg of fur has been determined for 18 categories of environmental impact, providing details on which aspects or phases of the fur production chain cause which environmental impacts. Owing to data gaps and the use of lower-bound scenarios, the results should be viewed as lower limits.

The environmental impacts of mink fur are compared with those of several common textiles: cotton, acryl and polyester (imitation fur) and wool. This provides insight into the relative performance of the fur production chain and helps answer the question whether fur can be qualified as 'environmentally friendly'.

1.4 Methodology

1.4.1 Life Cycle Assessment

To assess the environmental impacts of fur production, a life cycle assessment (LCA) was conducted. The goal was to model the fur production chain as accurately as possible and then assess the environmental impacts associated with each of the links.

LCA comprises a number of phases:

- establishing the goal and scope of the study;
- data inventory;
- modelling the fur production chain;
- impact assessment: quantification of environmental effects;
- interpretation.

All these phases are reported on in the present document, which is structured accordingly. This section discusses the main choices regarding methodology, goal and scope. Further background information on LCA is provided in Annex A.1.

For modelling the life cycle we made use of the LCA program SimaPro. This software is specifically designed for modelling life cycles and performing impact assessments. The program contains databases with substances, materials, processes and products, which can be used to create a model of the fur production chain. The substances, etc. reflect the inventoried inputs and outputs as well as possible. The Ecoinvent database was the principal database used, this being the most extensive and reliable available. To augment this data, some of the processes have been modelled on the basis of available literature data.

For assessing the impacts of the modelled fur production chain, the ReCiPe Midpoint method has been used. This method was developed in 2008 and is widely used for assessing emission-related impacts as well as land use. The method determines 18 environmental effects, among which:

- Emission-related:
  - climate change;
  - ozone layer depletion;
  - particulate formation;
  - human toxicity;
  - ecotoxicity;
  - acidification;
  - eutrophication of soil and water.
- Water consumption[1].
- Land use.

The full list and description of studied environmental impacts and more information on the ReCiPe Midpoint method is provided in Annex A.2.

Potential local environmental issues associated with fur production, such as odour and the risk of animal escapes (and their impact on local ecosystems) are not part of the quantitative approach. They do play a role in mink farming, however, and these issues will be addressed briefly in a qualitative manner.

1.4.2 Goal and scope definition

The goal of the study is to assess the life cycle environmental impacts of fur production. As a secondary goal, the impacts will be compared to the impacts of several common textile materials. This second goal will be discussed at the end of this section.

An attributional assessment has been made of the life cycle impacts of fur. This means that the results reflect the current, average impacts associated with 1 kg of mink fur as dictated by the goal. The results thus do not reflect the potential indirect consequences of significantly increasing or decreasing the scale of fur production.

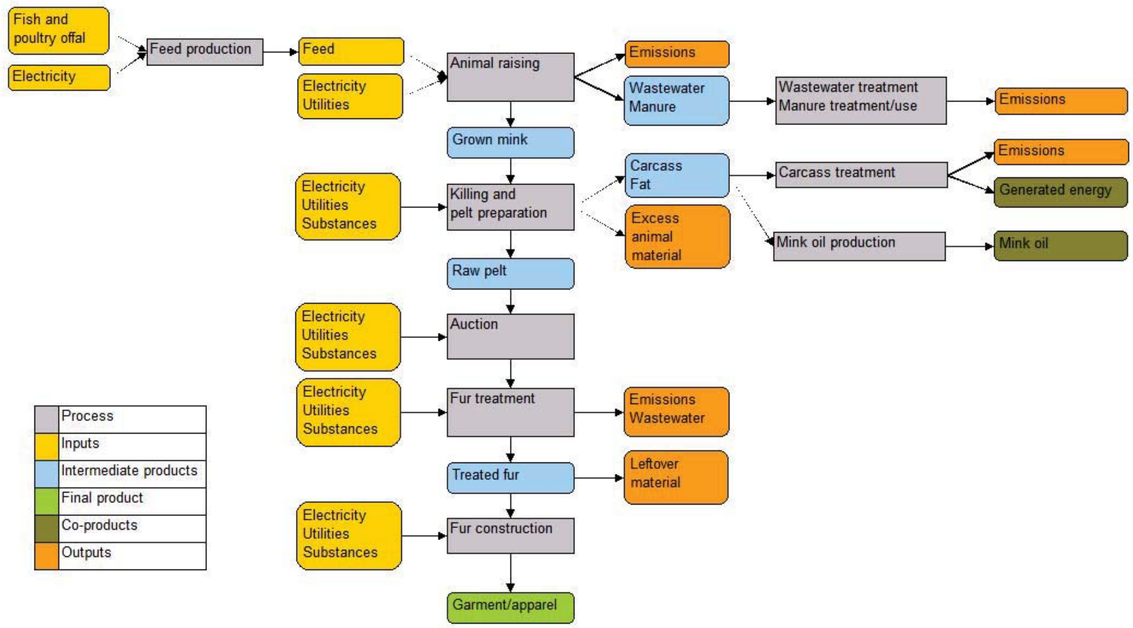
Allocation has been effectuated using the so-called cut-off approach (with farmland application of mink manure defined as being outside the fur farming system, for example) or by economic value (in the case of chicken and fish offal). Figure 1 shows the fur production chain up to the manufacture of a 1 kg patch of fur. Between each of the links in the chain are transportation steps. These are not shown in Figure 1, but have been included in the analysis.

Not included in the analysis are fabrication of apparel (coats, collars, etc.), product maintenance and characteristics of the final product (lifespan, insulating capacity). This is for the same reason of comparability.

Secondly, different fur products have different characteristics, making it hard to formulate assumptions about the likely properties of the final product.

[1] This concerns 'blue' water only and thus does not give a full water footprint as reported on e.g. waterfootprint.org.

Figure 1 System of the fur production chain



The goal was to fully map all the inputs and outputs of the fur production chain, in an endeavour to draw up a complete inventory. In practice, however, there proved to be many data gaps: not all the data required to map all the inputs and outputs is freely available. Some aspects could thus only be partially covered, while certain aspects were not covered at all, owing to lack of data or deliberate omission. Figure 2 shows the aspects that have and have not been taken into account in the analysis. Table 1 provides further details on the included and excluded aspects, as well as the reason for (partial) exclusion.

Figure 2 shows a change in system boundary: mink oil production now lies outside the system. In addition, manure treatment/use is also placed outside the system.

- We found no evidence that mink oil is produced out of minks, grown in The Netherlands. Besides, data on mink oil production is lacking, as well as data on the fat content of mink and conclusive data on mink oil value. If known, we could assign part of the environmental impacts up to mink killing and pelt preparation to the mink oil. Since we do not know what share to attribute to mink oil, though, we place mink oil production outside the system. This way we ignore the mink oil production and assume that the fur is responsible for the sum total of environmental effects.
  So there is no allocation to mink oil, which would lead to a lower environmental score for fur. At the other hand, fur is not assigned (part of) the additional burden associated with mink oil production and transportation to the oil production location.
- Mink manure is either used as fertilizer on farmland, or digested in a biogas plant. As data on biogas production are lacking, we assume the manure is used on farmland. The use of fertilizer is an input for the agricultural produce grown on the land, so these emissions are not part of the mink-keeping system.

Figure 2 System boundary and inputs/outputs actually investigated

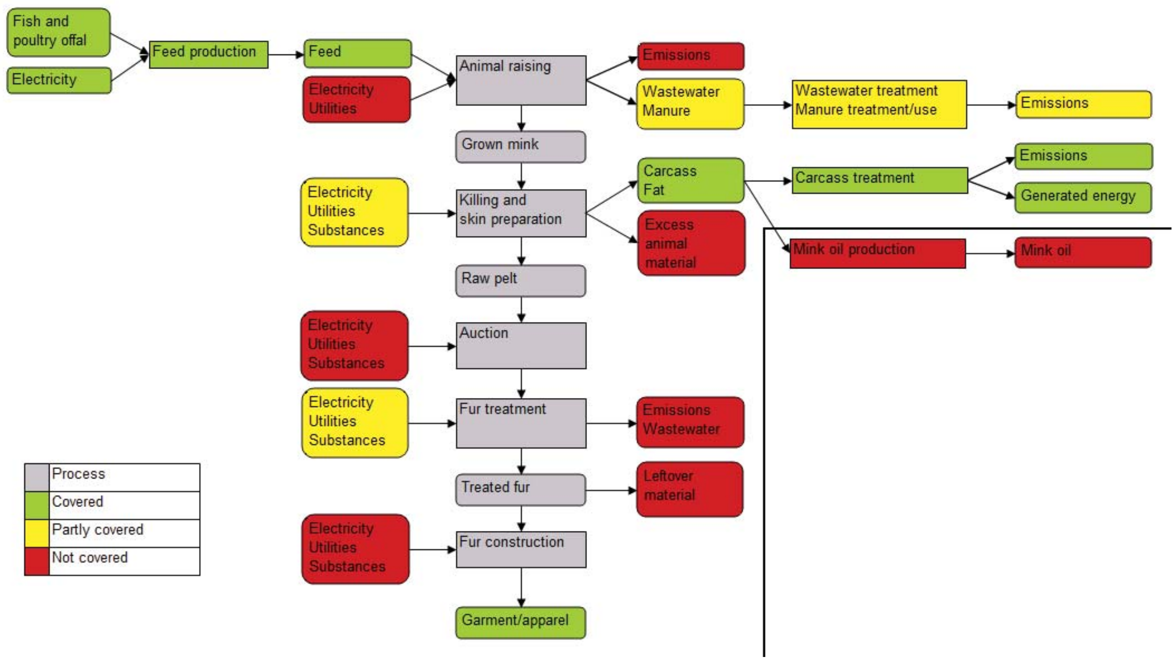


Table 1 Data availability and gaps in the model of the fur production chain

	Included	Excluded	Reason for exclusion
Feed production	Fish, meat and offal production Electricity for refrigeration		
Animal raising	Feed Use of straw Drinking water for minks	Electricity use of barns Water consumption for cleaning Emissions caused by utilities use	Lack of data Lack of data Lack of data
	Manure production Emissions due to manure	Wastewater and wastewater treatment Manure treatment and use	Lack of data Belongs to other system
Animal processing	Use of gas for killing Electricity for a number of machines	Electricity for a number of machines	Specifics for a number of machines are available
	Carcass treatment	Freezing of the carcass at farm Mink oil production	Lack of data Lack of data
Auction		All inputs	Deliberately omitted: minor influence anticipated
Fur treatment	Chemicals	Consumption of electricity, water and other utilities	Lack of data
		Wastewater	Lack of data
Fur construction	Electricity consumption		

	Included	Excluded	Reason for exclusion
Transportation	Indication of all transport steps from mink feed production to making of apparel		

Comparison with other textiles

The functional unit is 1 kg of mink fur or textile. This functional unit has been chosen to allow fair comparison with other fabrics with different properties. For example: the functionality of 1 m^2 cotton fabric differs from 1 m^2 fur, which makes them incomparable. Only fabrics with a certain area having the same functionality (like fur and fabricated synthetic fur) can be fairly compared. Van Dijk (2002) takes this approach: she selects a functional unit of 1 m^2 of fur, for comparison with 1 m^2 of synthetic fur. Synthetic fur, according to Van Dijk (2002), is made of 100% acryl (fibre and backing), or acrylic fibre with a cotton backing.
In this study, though, the aim is to compare fur with a wider range of common textiles (wool, polyester, etc.) for which 1 kg is a better functional unit for the intended comparison.

The following example shows that in this approach it is still possible to compare fake fur with real mink fur, as the density of the two is similar:
- density of fur: 670 g/m^2 (measurements, this study);
- density of fake fur: 693 g/m^2 (Van Dijk, 2002).

The composition of synthetic fur is (Van Dijk, 2002) is:
- 72% acrylic fibre;
- 28% cotton fabric.

The environmental impact of 1 m^2 synthetic fur can be calculated according to this data. The environmental impact of 1 kg fake fur is the score for cotton fabric x 0.72 + the score for polyacryl x 0.28.

2 The fur chain

This chapter starts out by providing some general information on the global mink market (Section 2.1) and an introductory review of the fur chain (Section 2.2). Section 2.3 presents the inventory data on the constituent links of the chain and the assumptions made in this study and discusses the remaining data gaps. The chapter concludes with the data inventory for production chains of the common textiles analysed for comparison (Section 2.4).

2.1 Mink fur production

Table 2 shows the ranking of mink-producing countries according to FCUSA (2010) and EFBA (2010b). The Netherlands ranks as the world's third-largest producer. Most mink farming takes place in Europe. In 2009, nearly 65% (30 million pelts) of global mink fur demand was supplied from European farms. The other main mink-producing countries are China, the USA, Canada and Russia. Within Europe, fur farming is concentrated mainly in the EU-15, principally Denmark, the Netherlands, Finland and Sweden (EFBA, 2010a; 2010b).

Table 2 Mink fur-producing countries

Country	FCUSA (2010): year 2010	EFBA (2010b): year 2009	Mink pelt production per year[2]
Denmark	27.7%	35.7%	14,000,000
China	23.8%	19.4%	12,000,000
Netherlands	9.5%	11.7%	4,500,000
Poland	8.5%		4,300,000
USA	6.7%	6%	3,400,000
Canada	4.4%	5.0%	2,200,000
Finland	4.0%	5.2%	2,100,000
Baltic states	2.8%		801,000
Russia	2.6%	4.5%	1,300,000
Sweden	2.0%	3.3%	1,200,000
Belarus	1.6%		800,000
Belgium			150,000
Italy			150,000
Other	6.4%	9.2%	3,200,000

[2] European data: EFBA (2010b); other: calculated and rounded according to FCUSA (2010) reporting a world pelt production of 50.48 pelts in 2010.

2.2 Description of steps and processes in the fur chain

Breeding mink

In the Netherlands, mink are bred in half-open or closed sheds, with each bitch having her own pen. The bitches give birth once a year, around April/May; the mother animal gives birth to 5 to 6 young a year (NFE), the average litter size being 5.5 (LEI, 2007). The young are bred and subsequently skinned in November or December (LEI, 2007 and USFCA).

The mink are kept in cages (with a maximum of two per cage) with one sleeping compartment (box) per mink, the minimum size of which is laid down by decree in the Netherlands (Dienstenrichtlijn PPE, 2009).

Table 3 **Minimum cage size and area per mink**

	Min. cage size:	Min. box size (1)	Min. box size (2)	Total for 2 mink	Total for 1 mink
Length (m)	0.85	0.2	0.2	1.25	0.63
Width (m)	0.3	0.2	0.2	0.7	0.35
Height (m)	0.45	0.15	0.15	0.75	0.38
Area (m)	0.255	0.04	0.04	0.875	0.44

Figure 3 **Cages and gutters**

Source: Jasopels catalogue.

Figure 4 **Mink cage with feed on top**

Source: Rond, 2008.

Manure

Manure is collected in gutters and removed or collected on belts and transported for storage in a manure pit. The manure may be treated to reduce its nitrogen and phosphorus content and/or dried. Whether as slurry or dried, the manure can be used as fertilizer on farmland or digested in a biogas plant. In the Netherlands there are a number of biogas plants processing poultry and mink manure (WUR, 2010). We were unable to find any indication of the split between processing in biogas plant and as fertilizer.

Feed

Feed is placed on top of the cage at least once a day (Dienstenrichtlijn PPE, 2009). Mink are fed by-products from the fishing and poultry industries (EFBA, NFE). Animal waste is processed to mink feed by feed manufacturers, who supplement the meat with wheat, minerals and vitamins. The processed feed is frozen using so-called plate freezers, which form large frozen slabs of meat. The meat is then cold-stored and transported in insulated trucks (Keizersberg diervoeders).

Figure 5 Feed production: plate freezing and storage

Plate freezing

Slabs of frozen feed

Cold storage

Source: Keizersberg diervoeders

Slaughter and carcass processing

The mink are killed on the farm (EFBA, LEI). The only FCUSA-approved method for slaughtering mink is by bottled gas: either pure carbon monoxide or carbon dioxide (FCUSA, AVMA guidelines on euthanasia). In the Netherlands the animals are placed via a lock in an airtight box, which is then filled with carbon monoxide (NFE).

Figure 6 **Gas box, for killing mink**

Source: Jasopels catalogue.

Mink oil is a co-product of fur production. The thick fatty layer under the mink skin is removed from the pelt when the animal is skinned and then rendered into mink oil. Mink oil is used in several medical and cosmetic products and for the conditioning and preservation of leather (Wikipedia, mink oil). It is not known whether mink fat is indeed removed at Dutch farms, since it is not mentioned at all in LEI (2007).

The carcass is frozen and then disposed of and incinerated by destruction companies (NFE). In the Netherlands the company Rendac takes care of collection and destruction. The end products, animal fats and meal, are used as a biofuel on-site and in power plants and cement kilns.

Skin preparation

Following slaughter, the mink are skinned and the pelts prepared for auction. To aid in these processes a wide range of machines are available. The skinning and preparation phases can be largely automated (Jasopels catalogue). There are two ways of skinning animals, known as ‘cased’ and ‘open’. All furs except beaver and badger are prepared in the former manner. After skinning, the pelt is fleshed (left-over muscle and fat are removed) and then placed inside out on a board for stretching and drying (Jasopelt catalogue). Drying the pelts takes three to four days (Belgian environmental permits).

Trade, auction

The majority of raw skins are sold through auction houses, often located close to producing areas (International Fur Trade Federation, IFTF). The world’s largest auction houses are in Copenhagen, Helsinki, St. Petersburg, Seattle and Toronto.

Further fur processing

Because of the preservation techniques used, the raw pelt is hard and dry. After auctioning, the raw fur is further processed in a process known as fur dressing to convert the skin into leather and render it suitable for use in garments. To obtain the desired look, the processed fur may be optionally dyed (BASF). Fur dressing is similar to leather production, but with conservation of the hairs (BASF).

Table 4 **Fur dressing processing steps**

Phase of fur dressing	Description
Soaking	Restoration of the dried collagen to approximately the water content it had in life and preparation of the skins for subsequent mechanical and chemical treatments (Kite and Thompson, 2005)
Washing	
Bleaching	Optional step for whitening the fur
Pickling	Prevents bacterial attack and contributes to hydrolytic breakdown of non-collagen material in the skin structure (Kite and Thompson, 2005)
Tanning	Conversion from skin to leather, rendering it resistant to decomposition
Water-repellent treatment (oiling)	Lubrication of the skin with oil

The main international centres for skin dressing and processing are in the Baltic States, Canada, China, France, Germany, Italy and Russia.

Apparel manufacture

In Europe, important fur apparel manufacturing locations are Kastoria and Siatista and the surrounding area, in Greece. Here, the fur industry dominates the local economy (Pelsdieren.be; Wikipedia – Kastoria).

The steps of apparel manufacture are as follows (Connecticut Furs Inc.):
– selection of the number of furs needed for the desired design;
– slicing the skin into strips and sewing these together to make the designed pattern;
– soaking in water, stretching and drying, to match the form and design of the pattern;
– mounting additional parts, like closures.

Figure 7 **Piece of fur, composed of strips**

Source: Kite and Thompson, 2005.

2.3 Inventory

This section presents quantitative inventory data for each of the process steps and reports the assumptions made.

This study makes use of publically available sources for data on mink fur production. Various Dutch agencies provide information on mink-farming emissions and regulatory documents are available in the Netherlands.

For certain aspects of the life cycle multiple data sources are available, with conflicting information. For some aspects, assumptions have been made and a range of possible values calculated. It was opted to take the lowest values, to construct a conservative model of the fur production chain. The results of the environmental impact assessment will thus reflect the lower bound.

2.3.1 General: animal growth and fur yield

Mink fur density

The organisation Bont voor Dieren provided two fur samples, which were measured as having an average density of 673.6 g/m^2. In this study a rounded value of 670 g/m^2 was used.

Pelts per kg and m^2

Average sizes for female and male pelts were provided by the US importer and distributor Chichester, Inc. From this information the usable area of one pelt can be determined (Table 5). With the usable area and weight, it can be calculated how many pelts are needed for 1 kg and for 1 m^2 of fur (Table 6).

Table 5 **Calculation of usable pelt area**

Size of 1 pelt		Inch	mm	mm^2	m^2
Female	Length	21	533.4		
	Width, top	2.5	63.5		
	Width, bottom	4	101.6		
	Usable area			108,387	0.1084
Male	Length	24	609.6		
	Width, top	3	76.2		
	Width, bottom	5	127		
	Usable area			154,838	0.155

Table 6 **Calculations: pelts per kg and pelts per m^2**

	Mean	Female	Male	
Area of one pelt	0.1316	0.1084	0.1548	m^2
Weight of 1 m^2	670	670	670	g
Weight of 1 pelt	88.2	72.6	103.7	g
Number of pelts per kg	11.4	13.8	9.6	p
Number of pelts per m^2	7.6	9.2	6.5	p

Litter size

LEI (2007) states that the average litter size for mink (in the Netherlands) is 5.5.

2.3.2 Feed

Composition

Both LEI (2007) and Van Dijk (2002) report a distribution of feed components. The most recent figures of LEI have been selected, shown in Table 7. 'Other' represents flour and additives like vitamins and antibiotics. As the exact amounts and types of additives are unknown, as a simplification we have assumed that 'other' represents flour only.

Table 7 **Mink feed composition**

	Van Dijk, 2002 inventory	Van Dijk, 2002 modelled	LEI, 2007
Fish (offal)	20%	22.20%	28%
Chicken (offal)	70%	77.80%	64%
Other	10%		8%

Amount of feed

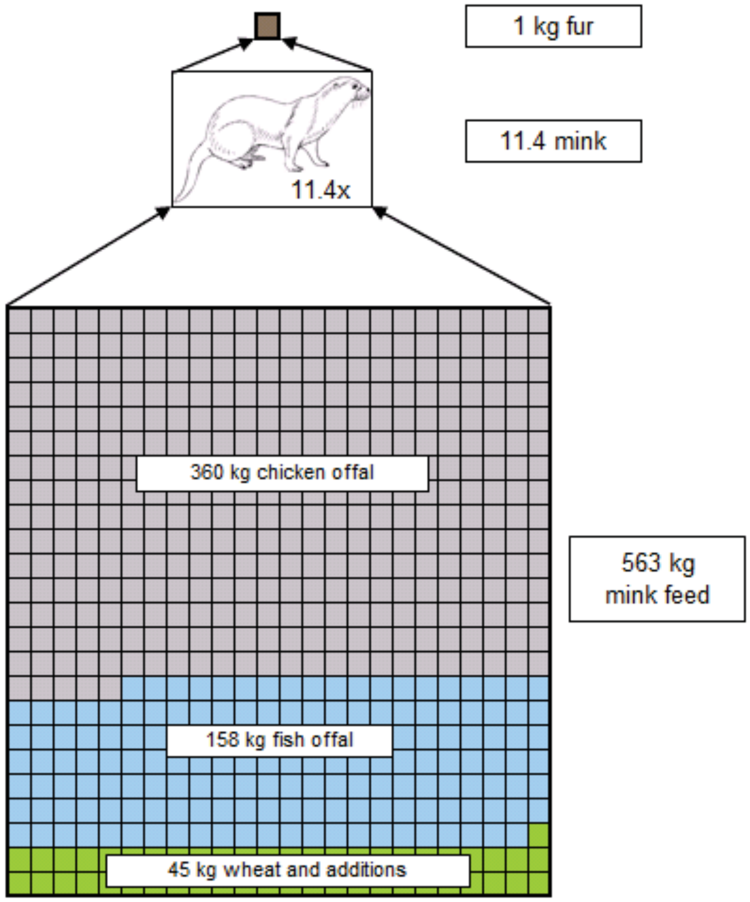
LEI (2007) indicates that the total amount of feed consumed by a mink during its lifetime is about 40 kg. This was checked using data from LEI and NFE. The calculated value has been used and taking into account the feed of the mother animal as well, the total amount of feed is closer to 50 kg than 40 kg.

Table 8 **Calculation: amount of feed**

Subject	Value
Mother animals in the Netherlands (year 2006; LEI, 2007)	700,000
Young per mother animal (LEI, 2007)	5.5
Total number of mink	4,550,000
Offal consumed annually by mink farms (NFE, 2010)	180,000 to 200,000 kg
Feed per mink per year	41.8 kg (mean)
Taking into account 1/5.5 of mother animal	49.4 kg

With a total of 49.4 kg feed per mink and 11.4 pelts per kg, the total amount of feed required for 1 kg of fur is 563 kg. Figure 8 shows the implications of this: large amounts of chicken offal, fish offal and wheat are required to produce 1 kg of mink fur. The need for 563 kg food for 1 kg fur means that fur is inefficiently produced.

Figure 8 **Food conversion**



Feed data

Table 9 **Source of background data used for modelling**

Meat type	Background data
Chicken	Data according to Blonk (2008) and CE (2010)
Fish	Data according to Blonk (2008) and CE (2010)
Flour	Ecoinvent database: wheat grain

Blonk (2008) provides the background data (inputs and outputs) used for modelling the breeding/raising of chickens, fish catch and processing. This data was previously used in another project carried out by CE Delft (CE, 2010).

Allocation

The mink feed consists largely of offal, which has an economic value. Based on the economic value of offal and the value of the main products (for human consumption), allocation factors were determined. An allocation factor indicates what part of the environmental impact is to be attributed to the meat for human consumption, and what part to offal.

Both Blonk (2008) and Van Dijk (2002) report allocation factors for offal, as shown in Table 10 and Table 11.

Table 10 Allocation factors for chicken waste

Chicken wastes	Type	Share of chicken (weight)	Allocation factor	Environmental load of 1 kg product compared with 1 kg chicken
Blonk, 2008	Organs and blood (not for human consumption) and waste products	0.29	1.7%	5.9%
Van Dijk, 2002	All wastes	0.336	1.78%	5.3%

Table 11 Allocation factors for fish waste

Fish wastes	Type	Share of chicken (weight)	Allocation factor	Environmental load of 1 kg product compared with 1 kg fish
Blonk, 2008	Salmon	0.36	0.05	14%
Van Dijk, 2002	Plaice	0.5	0.42	0.83%

While the allocation factors reported for chicken are very similar, those for fish differ a great deal. The choice of allocation factor makes a major difference to the overall result: the higher the allocation factor, the higher the environmental load per kg offal.

In this study we have chosen to calculate the lower bound of the environmental impact of fur production, to be sure that the values shown represent the lowest calculated values. It was therefore opted to take the following values:

- the environmental impact of 1 kg chicken offal is 5.3% of 1 kg chicken;
- the environmental impact of 1 kg fish offal is 0.83% of 1 kg fish.

Refrigeration of feed

Data was collected on the energy requirements of freezing the offal and keeping it frozen in a cold-storage room. Refrigeration of the offal prior to processing at feed-producing companies was not specifically taken into account.

Table 12 Data inventory for refrigeration of feed

Subject	Value	Source
Energy requirements, plate freezer	60 to 100 kWh/tonne feed	Duiven, 2002
Energy requirements, cold storage	30 to 50 kWh/m^3/year	Duiven, 2002
Density of meat	1,072 kg/m^3	Mean value of various meat products, according to Marcotte, 2008
Storage-room occupation	25 to 50%	Assumption
Chill duration	1 to 6 months	Assumption

The energy requirements of cold storage are expressed per m^3 of storage. The energy requirements per m^3 of food depend on the efficiency of using the storage room. It has been assumed that the storage room cannot be used to the full 100%, since space is needed for transportation and manoeuvring by forklift trucks. 50% has been assumed as an upper bound, with 25% arbitrarily taken as a lower bound, although a lower occupation rate is also possible. Chill duration is an unknown factor. Depending on the storage temperature, meat can be stored for over a year. It has here been assumed that the meat is frozen for 1 to 6 months.

Based on these data and assumptions, the energy requirements of freezing the feed and keeping it frozen were calculated. As assumptions regarding storage-room occupation and chill duration are of major influence on the results, two scenarios were run: one based on the lowest values, the other on the highest.

Table 13 Calculated energy requirements for 49.4 kg feed MJ

Energy requirements for 49.4 kg feed	Lower bound	Upper bound
Energy required for freezing the feed by plate freezers	3.0 MJ	4.9 MJ
Energy required for keeping the feed chilled in cold storage	0.2 MJ	4.6 MJ
Total energy required for freezing/cooling	3.2 MJ	9.5 MJ

Straw

Placing straw in the cage for the mink to use in the sleeping compartment is not obligatory by law but is done in practice. No data could be found on the exact amount of straw used for this purpose with mink and it was therefore assumed that each animal uses 2 kg straw in its lifetime. This figure may be low, but bearing in mind that not all farms probably use straw, it can be regarded as a suitable estimate for average mink farming.

2.3.3 Manure: emissions and use

During manure handling and storage, emissions occur. If handled correctly (manure collection in gutters, storage in containers), the manure will only cause emissions to air. Several studies and documents provide data on emissions from mink manure (Table 14) and these were used to establish emissions of methane, ammonia, N_2O and particulate matter (Table 15).

We were unable to find any indication of which share of the manure is used as fertilizer and what part is processed in a biogas plant. For this study, it is assumed that all manure is used as fertilizer.
When the manure is spread on farmland as fertilizer, there will be emissions to soil, water and air. These emissions have not been allocated to mink farming, however: the fertilizer is an input for the agricultural product grown on the land in question, so these emissions are not part of the mink-keeping system (they are outside the system boundaries). This approach to modelling the by-product manure is called ‘cut-off’.

WUR (2003) reports that in some years there was an imbalance between the input (in feed) and output (in manure) of N and P on mink farms: there was a surplus of N and P, and some N and P was unaccounted for. The imbalance fluctuates markedly from year to year and it is unclear whether the surplus leads to emissions to soil, water or air. Owing to these uncertainties, possible emissions due to minerals surpluses have not been taken into account in this study.

Table 14 Emission factors and other data used for calculating emissions

Subject	Value	Source
Methane emission factor (g CH_4/kg manure)	0.62	NIR, 2010
Ammonia emission factor (kg NH_3 per cage per year) - Open manure storage under cage - Daily manure removal to closed storage	 0.58 0.25	InfoMil[3]
N excretion per mother animal (kg/yr)	2.4	NIR, 2010
N excretion per mink (g/yr)	396	Calculated, assuming 5.5 young/mother animal and 1/5.5 share of mother animal
N emission factor	0.023	NIR, 2010
Annual PM_{10} emission per cage (g)	9	InfoMil
Manure production per mother animal (kg/yr)	103.7	NIR, 2010
Manure production per mink (kg/yr)	18.9	Calculated, assuming 5.5 young/mother animal and 1/5.5 share of mother animal

Table 15 Modelled emissions due to mink feed and manure

Category, source	Emission	Calculation	Value (g/lifetime)	Emission to
Manure management (NIR)	Methane emission	Em. factor * manure production	12	Air
Manure management (Infomil)	Ammonia emission	Emission factor/2 (2 mink per cage)	208	Air
Manure management (NIR)	N_2O emission	Em. factor * N excretion, converted to N_2O	16	Air
Animal management (WUR, 2003)	Particulate Matter < 10 µm	Emission factor/2 (2 mink per cage)	4.5	Air

2.3.4 Slaughter and carcass processing

Skinning

The Jasopels catalogue shows a large number of machines and tools for the fur industry, details of which are available on the company's website. Based on these specifics, the power requirements of a number of machines on which sufficient data are available were calculated. Machine usage will obviously differ from farm to farm: the machine park may be more or less comprehensive. The numbers are therefore merely indicative, to provide an idea of the order of magnitude of the environmental impact of the carcass processing phase. For details and calculations, see Annex B.

3 Website of the Ministry of Infrastructure and the Environment, Regulation on Ammonia and Cattle Farms, Main Category H: Fur-bearing animals.

Table 16 **Calculation of CO requirements for killing one mink**

Gas box	Value	Source
Box	~ 1 m^3	Jasopels catalogue
Gas	100% CO	NFE, 2010
Number of mink in box	30 to 50	Assumption
Density (room temperature, atmospheric pressure)	1.165 kg/m^3	Website: Engineering Toolbox
CO use per mink	0.02 to 0.04 kg	Calculated value

Table 17 **Electricity and air requirements per pelt**

Machine	Utility	Value per pelt	
Body drum	Electricity	36.3	kJ
	Compressed air, 8 bar	0.007	l
Skinning robot	Electricity	7.2	kJ
Fleshing machine	Electricity	461	kJ
	Compressed air, 8 bar	2	l
Drying	Electricity	817	kJ
	Compressed air, 4 bar	108	l
Total	Electricity use	1,321	kJ
	Compressed air use	110	l

Carcass disposal

The carcasses are collected and treated by Rendac. Data on the processing of carcasses by this firm are reported in CE (2008).

Table 18 **Utility use for carcass treatment by Rendac**

Utility	Value per kg carcass
Water use (m^3)	0.39 m^3
Energy (MJ, primary)	-2.37 MJ

Co-product: mink oil

We found no evidence that mink oil is produced out of minks, grown in The Netherlands. Therefore, in this study 100% of the modelled impacts have been allocated to the fur itself. Mink oil might be produced, however. As mentioned before, no conclusive data on mink oil value is found, but in this section we use consumer prices for mink oil to estimate the possible allocation to mink oil: part of the environmental impacts up to mink killing and pelt preparation gets attributed to the mink oil.

Unfortunately, no data on mink-oil production processes are available and data on yields and prices fluctuate and are from unofficial sources (websites, newspaper articles). Our first impression is that pure mink oil is expensive (consumer price), while yields are low. Based on available information, possible allocation factors for mink oil have been tentatively assessed here.

An article in the Wall Street Journal states that in 2008 the average mink pelt price was $ 66, a record: 36% higher than the 2007 price ($ 49 per pelt). Online, a number of mink oil products were found. The company Pure Mink Oil states that 3 to 10 ml of mink oil is obtained from one mink.

Table 19 **Mink oil value and yield**

Mink oil	Brand		Source
Production quantity		3 to 10 ml per mink	Pure mink oil
Price of end product	Sesbellot pure mink oil	$ 89 for 50 ml	Pure mink oil
	Touch of mink, pure oil	$ 57 for 56 g	Touch of mink
	Brand unknown	$ 36 for 56 g	Ebay

It should be noted that these are consumer prices, which will be much higher than the price of mink oil as a raw ingredient at the point of separation from fur and carcass. It is the raw material price at that stage which should properly be used for economic allocation. Based on the fact that in LEI (2007) no mention is made of financial income for mink farmers from mink oil sales, one may conclude that the income is negligible compared with that earned from fur.

Nevertheless, from this information prices have been calculated for 1 kg of fur and for 34 g and 114 g of mink oil. In each instance, a high and low scenario have been calculated.

Table 20 **Calculations: price per output**

Output of 11.4 minks		Price, high (US $)	Price, low
1 kg	Fur	11.4 * $ 66 = $ 752	11.4 * $ 49 = $ 557
34 g	Mink oil	34 * $ 89/0.05 = $ 61	34 * $ 36/0.056 = $ 22
114 g	Mink oil	114 * $ 89/0.05 = $ 203	114 * $ 36/0.05 = $ 73

Taking the highest and lowest values, the following two allocation scenarios were calculated.

Table 21 **Allocation scenario 1**

Outputs from 11.4 mink, low scenario for oil	Value ($)	Allocation factor
1 kg fur	752	97.2%
34 g oil	22	2.8%
Total value of outputs	774	

Table 22 **Allocation scenario 2**

Outputs from 11.4 mink, high scenario for oil	Value ($)	Allocation factor
1 kg fur	557	73%
114 g oil	203	27%
Total value of outputs	760	

In the case that mink fat is collected to produce mink oil, between 2.8 and 27% of all processes including killing and, partly, pelt preparation (see Figure 1) can be allocated to mink oil, according to these calculations. This 27% upper bound is interpreted as an absolute extreme, given that this is based, as stated, on consumer prices. Actual economic allocation may even be lower than 2.8%.

In the analysis we have therefore opted to allocate the full 100% of all impacts to fur. In the case that mink oil is indeed produced, this will introduce only a minor overestimate into the results.

2.3.5 Further fur processing

An attempt has been made to map the consumption of water, chemicals and other auxiliary materials during the fur-processing phase, as described in Section 2.2. Our main source of information was the '*BASF Pocketbook for the Leather Technologist'*, which devotes one chapter to fur processing. This includes a list and description of substances used in the individual phases of fur processing. For fur, the *Pocketbook* does not provide a list detailing the amounts of chemicals used in each phase, but it does do so for the processing of leather. The fur industry is closely related to the leather industry, the main difference being that the fur remains anchored in the leather and the operations are carried out in such a manner that the hair is not damaged (BASF, 2010). BASF (2010) lists chemicals for both fur and leather processing. It shows the types of chemicals used for both processes are similar. Since volumes of chemicals are not available for fur processes, the volumes of the Nappa leather manufacturing process are adopted. Nappa leather is soft leather, used among other things for clothing. Based on the description of the individual substances, the best-fitting Ecoinvent substance was selected for modelling the fur-processing phase.

In a recent study Krautter (2010) tested fur samples for a number of toxic substances, five of which were mink fur samples of differing origin. Four of the latter showed levels of formaldehyde exceeding the legal limit for this substance, as laid down in EU toy safety directives, and the maximum values currently set in key industry standards, for example (Krautter, 2010). Although chrome salts are used in fur dressing, the samples did not test positive for the toxic variant chrome VI.

Mean values for formaldehyde and two other substances found in the mink fur samples have been included in the model. Although other chemicals were also found in these samples, most of these are very specific and are not present in the Ecoinvent database. Therefore, only three substances have been modelled. Approximately 200 mg of chemicals are unaccounted for.

Since the levels of chemicals reported in (Krautter, 2010) pertain to the end product, it is likely that far larger amounts are used during the fur-dressing phase. In all likelihood, then, modelled consumption of chemicals and other substances represents a lower-bound estimate.

In the model, only the actual use of the chemicals has been factored in. Potential leakage to the environment (and effects thereof), atmospheric emissions of volatile substances and wastewater treatment have thus not been taken into account, because this type of data is unavailable.

Table 23 Modelled substances used in the fur-dressing phase, according to BASF, 2010

Fur-dressing phase	Mean amount (g/kg)	Name	Description	Selected substance, Ecoinvent
Soaking	10	Bascal	Aliphatic dicarboxylic acids, for acidic post-soaking	Polycarboxylates
Wetting	35	Eusapon S	Ethoxylated synthetic alcohol for wetting, dissolving and emulsifying grease	Ethoxylated alcohols, petrochemical
Bating	15	Basozym 1000	Organic enzymes in acid environment	Not in Ecoinvent, omitted
Tanning	100	Basyntan	Aluminium and chrome complex	50% Sodium dichromate 50% Aluminium sulphate
Fatliquoring	7	Lipoderm	Various anionic agents, based on: ester sulphite, lecithin, or biobased	Dimethyl sulphate
Washing	10	Soda		Soda, powder
Picking	10	Formic acid		Formic acid

Table 24 Modelled substances as found in fur, according to Krautter, 2010

Substance	Amount (mg)	Selected substance, Ecoinvent
Formaldehyde	0.38	Formaldehyde
2,2,4-Trimethylpentane	0.12	Dimethylpentane (as proxy)
Ethyl acetate	0.67	Ethyl acetate

2.3.6 Transportation

Data on the modes of transportation involved in various stages are lacking and assumptions therefore had to be made. It is uncertain, for instance, whether the pelts and finished fur are transported by ship or plane and where exactly the pelts are transported to. According to EFBA (2010b), Oslo seems to be Europe's main auction location, with 25 out of 30.1 million pelts auctioned here.

For further fur construction, four possible transportation scenarios were run:

1. Fur treatment and construction within Europe, transportation by truck and ship.
2. Fur treatment and construction within Europe, transportation by plane.
3. Fur treatment and construction overseas, transportation by ship.
4. Fur treatment and construction overseas, transportation by plane.

The assumed transport routes and distances for the four scenarios are shown in Table 25.

Table 25 **Transportation routes and distances**

Transport route	Location		Distance (km)				Source
	Scenario 1 and 2 (EU)	Scenario 3 and 4 (World)	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Offal to feed processing			75 (truck)				3 locations
Feed from processing to mink farm			50 (truck)				To 4 to 5 locations
Pelts from farm to auction location	To Oslo		1,250 (truck)				Googlemaps
Carcass to animal waste treatment	Farm to Rendac		100 (truck)				To 2 locations
Pelt from auction to processing	Oslo to Italy	Oslo to Hong Kong	2,500 (truck)	2,500 (plane)	18,848 (boat)	11,000 (plane)	Googlemaps, sea port distances
Pelt from processing to manufacturing	Italy to Greece	Hong Kong	1,000 (truck)	1,000 (plane)	50 (truck)	50 (truck)	Googlemaps

For transportation within the Netherlands, we made use of standardized distances by MERLAP, as available in CE (2007).

Table 26 **Standard distances**

Transport to	Distance (km)
Municipal waste incineration	40
Pellet generation	150
Cement kiln	150
1 location in the Netherlands	150
2 locations in the Netherlands	100
3 locations in the Netherlands	75
4/5 locations in the Netherlands	50

2.4 Textile production

In black, Table 27 shows the materials and processes used in modelling the textile production chain of cotton, acryl, polyester and wool. The grey phases have not been included in the analysis.

Table 27 **Life cycle of textile products**

Process	Process phases	Details
Raw materials	Production of fibre materials	Selected: cotton, poly-acryl, polyester (recycled and virgin PET), wool
Production	Production of fibre	Yarn spinning
	Construction of fabric	Weaving
	Pre-treatment	Cotton: scouring and bleaching Other: pre-treatment for dyeing
	Colouring	Disperse dyeing
	Finishing	Singeing and de-sizing
	Product assembly	
Packaging	Packaging	
Use	'SUCAM' : selection, use, care and maintenance	
Treatment	Post-user treatment	
Transportation	Transport	Transportation steps: 1 kg material from China to Europe (trans-oceanic freight) 1 kg processed material within Europe (truck)

3 Results

This chapter presents and discusses the results of the environmental impact analysis. It consists of three parts:

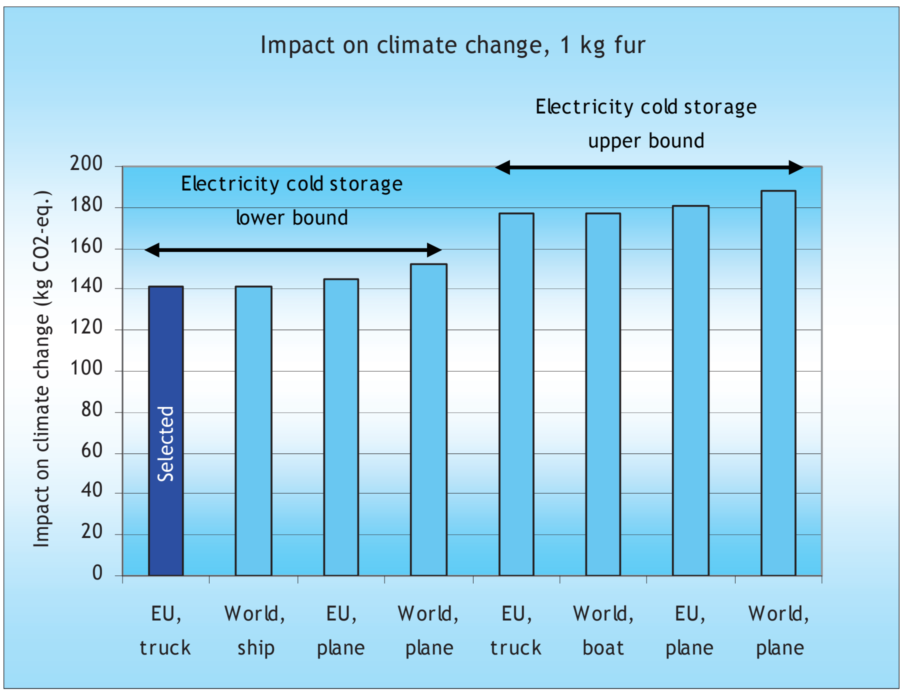
- Presentation of the results of environmental analysis of 1 kg of fur.
- Discussion of the results.
- Comparison with other types of textile.

3.1 Results

3.1.1 Upper and lower bounds

Figure 9 shows the impact of mink fur with respect to climate change (one of the 18 environmental effects under study) for eight different scenarios, based on the two scenarios for electricity for cold storage and the four scenarios for transportation. In Annex C.1 the scores on all 18 environmental impacts in each of the eight scenarios are reported.

Figure 9 **Impact on climate change in different scenarios, 1 kg fur**



As can be seen, taking the upper bound for electricity consumption increases the climate impact by about 1/3. The main reason for this large difference is that power consumption relates to a large volume of feed: all in all, 563 kg of feed is required to produce 1 kg of mink fur, all of which needs to be kept frozen.

Although transportation mode and distance also have a certain influence, relative to the total score this is only limited.

For further analysis and comparison with other textiles, the most modest scenario was taken, i.e. that representing the lower bound. In practice, therefore, the impact of fur production is most likely to be higher than the values shown in the bar chart.

Besides transportation and electricity for cooling, two other factors contribute to the statement that the impacts are most likely to be higher than reported:

1. A number of lifecycle aspects have not been included in this LCA, or only partially so. Such aspects as wastewater treatment and emissions associated with the use of volatile substances (fur treatment) will mean that aggregate environmental impacts are in fact higher.
2. The allocation factors adopted for mink feed are of pivotal importance: since 563 kg of feed is required for 1 kg of fur, it makes a huge difference what share of the environmental impact of chicken and fish is allocated to chicken and fish offal. In this study low allocation factors have been used. However, the fish allocation factor in particular may be higher, leading to higher environmental impacts.

On the other hand, there are two aspects that may reduce the overall environmental impact:

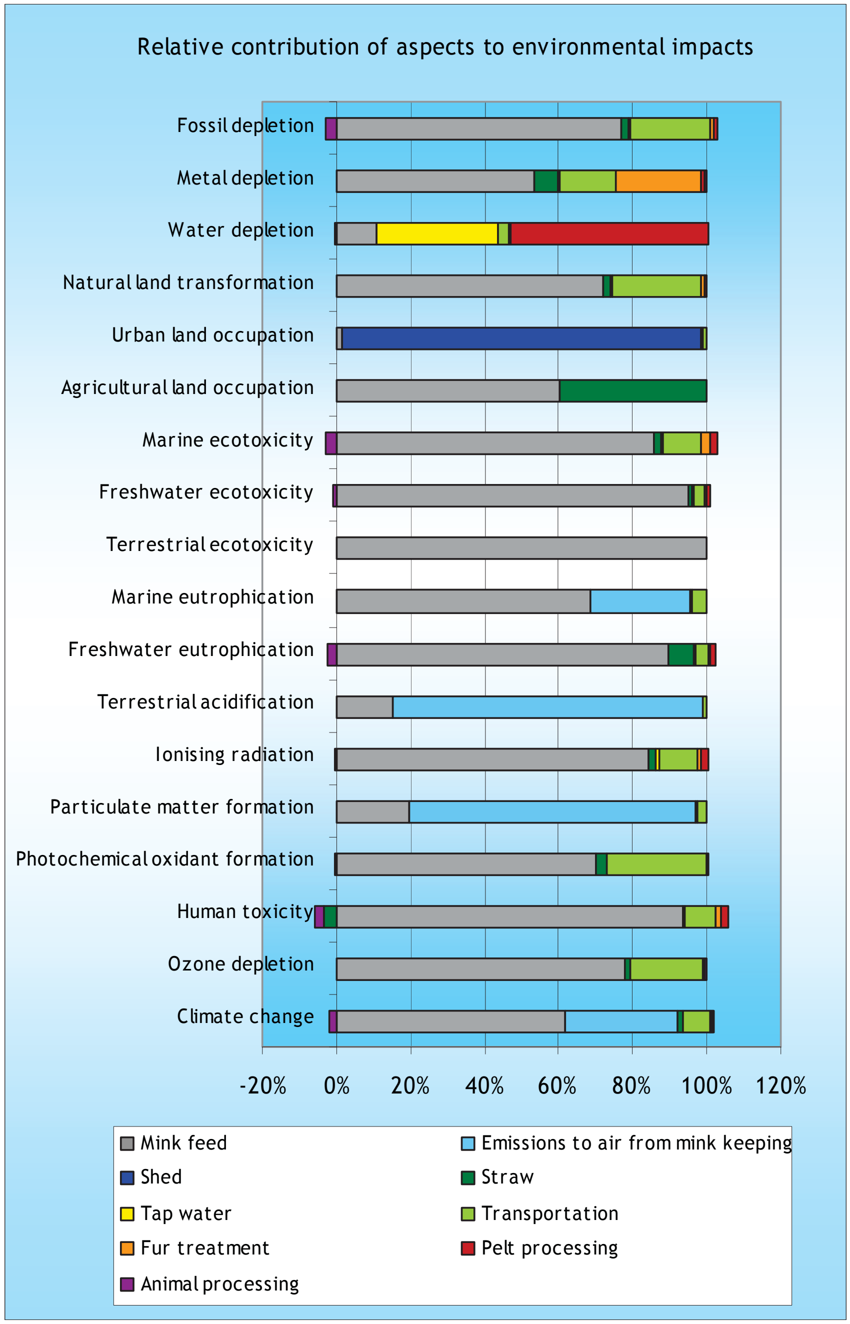
1. The allocation to mink oil has been set at 0%. In the case that no mink oil is produced out of Dutch minks, this is correct; in the case that mink oil is produced, this leads to a slight overestimation of results (see Section 2.3.4).
2. Biogas production from manure in a biogas unit has not been allowed for, with all manure assumed to be used as fertilizer, which lies outside the system boundaries. Biogas production may involve a modest environmental benefit.

In all likelihood the total overestimate is far less significant than the combined underestimates above, because of the low allocation factor for feed and the many omissions in the LCA.

3.1.2 Environmental impacts

Figure 10 shows the contribution of the various aspects of the mink fur life cycle to the 18 environmental impacts, as analysed using the ReCiPe Midpoint method. This bar chart applies to the ‘lower bound’ scenario (Figure 9). For the other scenarios, the shares of mink feed (grey) and transportation (light green) will be somewhat larger. In Annex C.2, the information in Figure 10 is shown in the form of pie charts.

Figure 10 **Relative contribution of life cycle aspects**



As can be seen, for most environmental impacts mink feed is the factor responsible for the greatest share. Again, this is because of the large quantity of feed required for 1 kg of fur (563 kg).

A number of impacts show a different pattern of contributions from the various life cycle aspects, being dominated by aspects other than mink feed, or by several aspects. Examples include those impacts related directly to a specifically modelled emission, such as terrestrial acidification or particulate matter formation.

Surprisingly, the ‘fur treatment’ phase, characterized by its use of chemicals, is not of much influence (see the fur treatment phase). This is because only the use of chemicals is modelled: volatile emissions and wastewater treatment were not included in this study, because these emissions are unknown to us. These emissions depend on how the chemicals are handled: emissions to air can be prevented or mitigated when air is filtered; wastewater treatment and proper treatment of sludge leads to smaller emissions as well. On the other hand, waste water treatment itself involves substance use and thus leads to an impact as well. Measures taken to prevent emissions differ per fur treatment facility. no data was found on volatile emissions and the degree of pollution of the wastewater.

Were this data available, it may well be the case that the fur treatment process would in fact prove more dominant on several environmental effects, like climate change, eco- and human toxicity and fossil depletion.

Mink feed

Since mink feed is a dominant aspect for most environmental impacts, we take a closer look at the underlying processes. For almost all environmental impacts, chicken offal is responsible for the greatest share of the environmental burden of mink feed. Fish does not contribute much, owing to the low allocation factor for fish offal (0.4%), as well as the relatively low emissions associated with the fish itself.

It is remarkable that flour (from wheat), which constitutes only about 8% of the total feed, is responsible for a (sometimes much) larger share of the environmental impact. This is due mainly to emissions to air and water and fertilizer use. This means the environmental impact will actually decrease if the minks are fed only offal. Were the minks to be put on an all-grain diet, the score on most environmental impacts would actually be higher than is currently the case. The overall environmental burden would be lowest if the feed consisted solely of fish offal.

Figure 11 shows the contribution of aspects to mink feed. Here, the conservative scenario for electricity consumption for refrigeration is shown However, electricity consumption may account for a relatively large share of the overall impact, when the other scenario is selected. This is not shown in the figure.

Figure 11 Factors contributing to the environmental impacts of mink feed

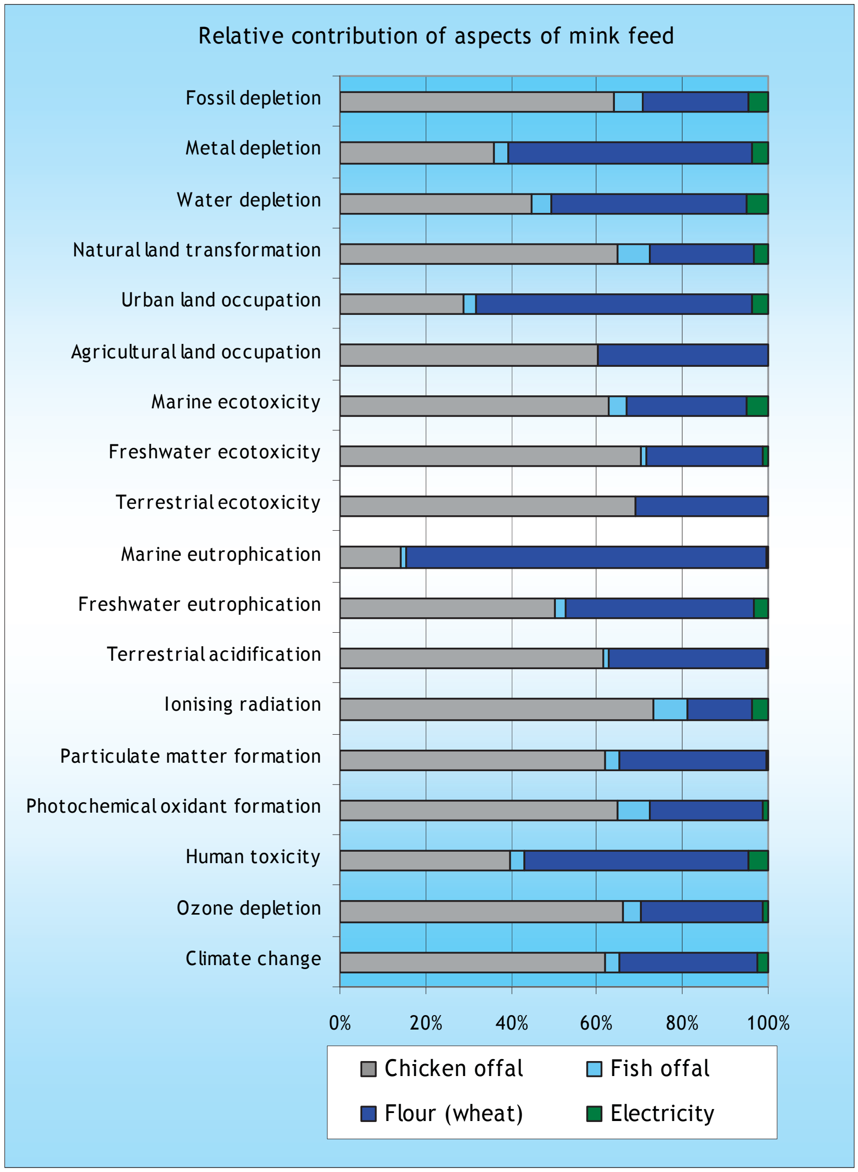
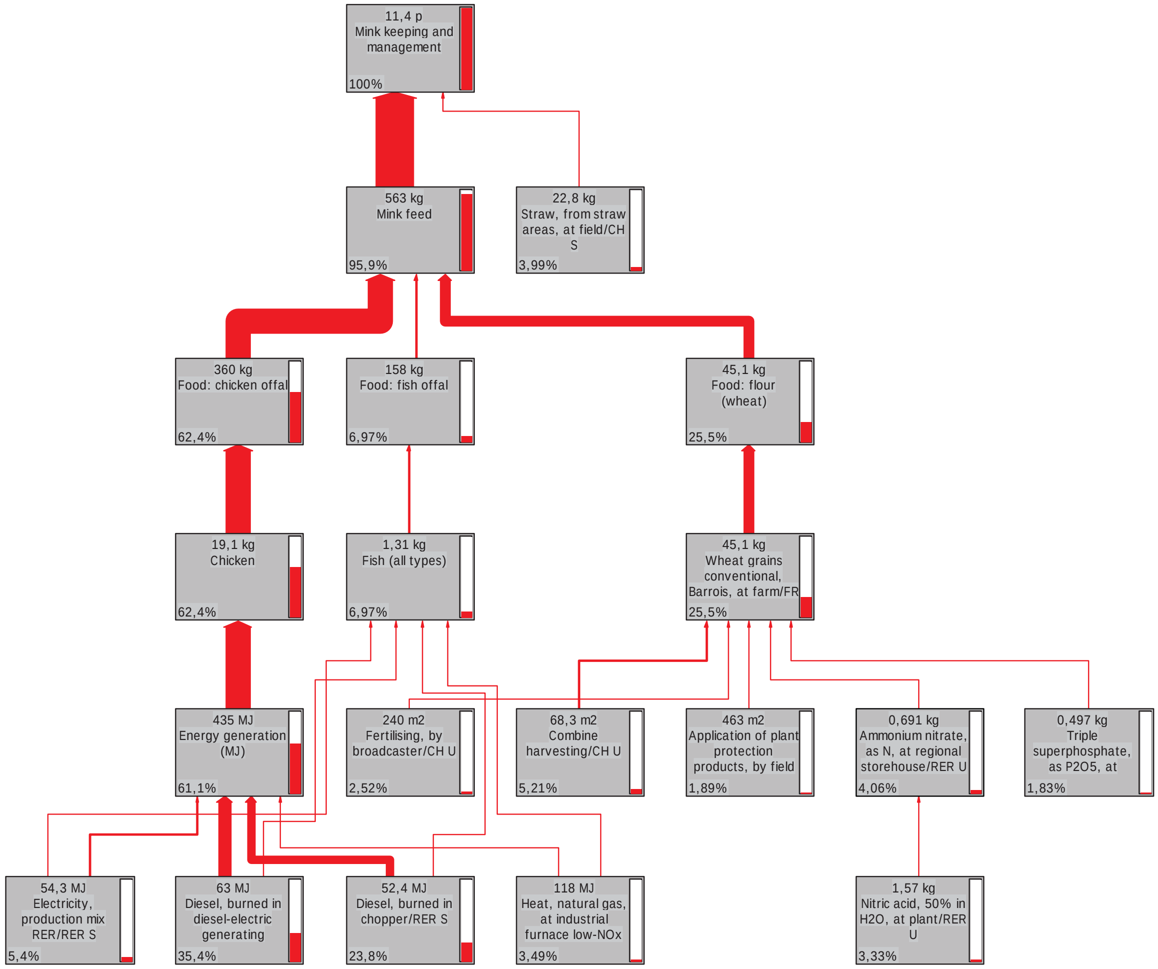


Figure 12 shows a flow chart of mink fur production. The large contribution of mink feed to the impact on climate change is immediately apparent.

Figure 12 Flow chart of climate change impact of mink feed



As already stated, a huge volume of feed is required to produce 1 kg of fur, with 11.4 mink needed for that fur, which has enormous impact on aggregate feed requirements.

If mink fur is compared with other animal products, for instance pork, we see that kilo for kilo far more feed is required. Blonk (2008), for example, reports that 3.1 kg feed is needed to produce 1 kg of pork. In the wider literature, feed conversion factors of 3 to 4 kg per kg pork are cited.

In mink feed, grains (for flour) are a direct ingredient. However, grains also constitute an indirect ingredient, via the chicken offal. The typical feed conversion factor for chickens is 2 kg feed per kg chicken, while 75% of chicken feed consists of grains and soy. Offal makes up 33.6% of the total weight of chicken (see Table 10) and 1.8% of the impact of chicken is allocated to chicken offal. All in all, then, there are 360 kg x 2 / 0.336 x 75% x 1/8% = *28 kg* of 'indirect crops' involved in producing 1 kg fur.

For the total crops required for 1 kg of fur, the conversion factor is over 70, in terms of input crops to output product (fur).

In terms of total feed input, the conversion factor is 563 (see Figure 12).

3.2 Discussion

3.2.1 Results compared with Van Dijk (2002)

In 2002, a study of the environmental impact of mink fur was performed by Van Dijk. The results of Van Dijk (2002) are compared with the results of this study.

There are a number of differences between the results of this study and those reported by Van Dijk (2002). This is due in the first place to Van Dijk adopting a functional unit of 1 m^2 rather than 1 kg, as used in this study. On our calculations, 1 kg fur corresponds to 1.5 m^2. For fair comparison, then, Van Dijk's results should be multiplied by 1.5.

Secondly, Van Dijk assumes 9 to 10 mink per m^2, whereas we calculate 7.6 mink per m^2 (or 9.2 female mink per m^2). This difference has consequences for the amount of feed per kg of fur and should lead to higher values in Van Dijk (2002) compared to this study (following multiplication by 1.5).

Table 28 **Assumptions in this study**

	Mean	Female	Male	
Number of pelts per kg	11.4	13.8	9.6	p
Number of pelts per m^2	7.6	9.2	6.5	p
Area of 1 kg	1.5	1.5	1.5	m^2

As for the results, Van Dijk (2002) reports substantial differences between mink fur and other fabrics, which is fully in line with the results of this study. The overall picture and conclusions are similar: fur gives rise to a higher environmental burden with respect to numerous environmental impacts.

There are differences, though, all of which can be explained by differences in the background data used. The processes used to model the fur production life cycle differ between the studies.

Climate change: Van Dijk (2002) calculates a substantially higher score for climate change than is found in this study. Van Dijk's climate change score accrues mainly from the N_2O and CO_2 emissions of chicken manure, attributable to chicken as part of the feed. In total, 74% of the climate change impact comes from the chicken in the mink feed. In the present study, chicken in mink feed is responsible for 20% of the total impact on climate change. A noticeable difference between the two scores is the high relative contribution of N_2O in the contribution of van Dijk (2002). As the amount of feed needed per year per mink, as well as the percentage of chicken in the feed, is similar in both studies, the discrepancy in contribution of N_2O to the total can only stem from differences in background modelling for the chicken production system. These differences cannot be traced in more detail from the literature sources. However, the data used here (Blonk, 2008) are considered most recent and consistent. It should be noted that the difference in scores cannot be interpreted as an improvement made since 2002 in the mink fur production, as there is no change in feed composition or feed quantity.
Aquatic ecotoxicity (freshwater): Van Dijk calculates a higher ecotoxicity score for non-fur fabric than for fur. This difference in results is due to differences in background data. Van Dijk takes into account the emissions of several substances to groundwater associated with cotton-fibre treatment, leading to high toxicity levels. The background data on textile production used in the

present study involve only very modest emissions to groundwater, as production takes place in a closed environment.

Aquatic ecotoxicity (marine): the absolute scores reported by Van Dijk are of a far greater order of magnitude (a factor 20,000 higher). The difference in results is again caused by differences in background data. Van Dijk models an emission to air of mercury at the production of acrylic fibres. Mercury does not feature in our background data on acrylic fibre and fabric production. The difference can be explained by dating: Van Dijk's background data originates from a Danish study, dated 1997; our background data is much more recent: the Ecoinvent database provides data on the raw materials and fibre production (European average, dated: 2009).

3.2.2 Other producing countries

This study focuses on mink fur production in the Netherlands. In several other European countries, including Italy and Belgium, mink fur is also produced and it is interesting to estimate to what extent our results remain valid in a wider context than Dutch mink farming alone.

Feed and N_2O emissions are the main aspects contributing to the scores on most environmental impacts (see Figure 10). Differences in these two aspects will therefore have most influence on the total environmental score.

The environmental impact of feed is determined by the type of feed (feed composition) and the allocation factors adopted for each of the feed ingredients; both of these may differ in other countries. In the case of N_2O emissions by the mink themselves, though, the situation is unlikely to vary much from country to country. Feed is thus the one aspect that needs investigating to pinpoint the greatest inter-country differences in environmental impact.

No exact data on feed composition was obtained for other countries. According to the Italian mink breeders' association (AIAV) and the Belgian fur federation (Belgische Bontfederatie), mink in Italy and Belgium are fed with meat and fish offal, together with cereals, as in the Netherlands. AIAV also reports that feed is refrigerated in much the same way as in the Netherlands (plate freezers). It is therefore to be expected that Dutch, Italian and Belgian feed composition and processing differ very little. The prices of offal and meat were not investigated. For further research this would be an advisable first step, along with determining the exact feed composition in the respective countries.

Apart from the question of feed, emissions from mink keeping may also differ in other countries because of different manure handling procedures, thus affecting the overall environmental impact. In this study it has been assumed that manure is removed through gutters and stored in a container; the assumption is therefore that emissions to soil and water are zero. If mink manure is stored not in containers but in farmyard piles, there will be emissions to soil and water due to leaching, increasing the scores for acidification and eutrophication.

3.3 Comparison with fabrics

On 17 of the 18 environmental impacts investigated, mink fur scores higher than other fabrics. In Annex C.3 the comparison of fur with these various other fabrics is reported individually for each environmental impact. As these charts clearly show, mink fur scores far higher than any of the fabrics with respect to all the impacts except water depletion.

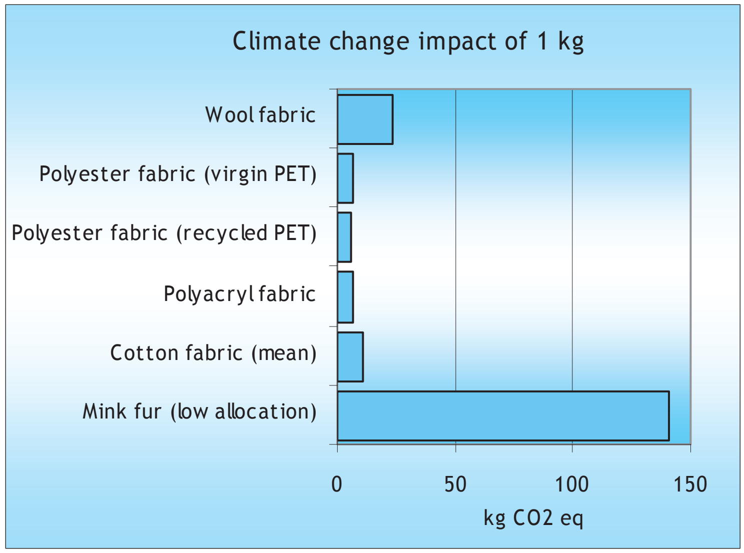
Considering that the values calculated in this study for fur represent a lower bound, the difference between 1 kg fur and 1 kg of other textile is likely to be even larger. It can be stated with certainty that fur is the least preferable option compared with common types of textile. Table 29 shows the relative difference between the scores of 1 kg mink fur and the closest score of the other textiles.

Table 29 Difference factor between mink fur and other textiles

Environmental impact	Reduction rate of impact of fur needed to match the highest score of the other textiles
Climate change	4.7
Ozone depletion	11.9
Human toxicity	3.4
Photochemical oxidant formation	28.1
Particulate matter formation	17.0
Ionising radiation	2.1
Terrestrial acidification	15.3
Freshwater eutrophication	5.2
Marine eutrophication	12.9
Terrestrial ecotoxicity	24.0
Freshwater ecotoxicity	2.6
Marine ecotoxicity	3.2
Agricultural land occupation	5.3
Urban land occupation	27.9
Natural land transformation	9.5
Water depletion	0.4
Metal depletion	6.8
Fossil depletion	6.5

Of the five other fabrics, wool and cotton fabric tend to score higher than the others on a number of environmental impacts. In the case of cotton this can generally be explained in terms of fertilizer inputs, irrigation, production processes and emissions to air and water. Wool has a higher scores compared to the synthetic fabrics, mainly because of the impacts associated with sheep keeping. Compared to fur, though, wool has lower scores. These lower scores are explained by the difference in diet. Because of its vegetarian diet (grass, soybean meal and corn), the meat of the sheep can be used as well, i.e. the wool is not the main output. According to the Ecoinvent process for wool, a sheep produces 4.2 kg of wool per year and 62.8 kg of meat (live weight) per year. The allocation factor for wool (economic allocation) is 22.8%.

Climate change



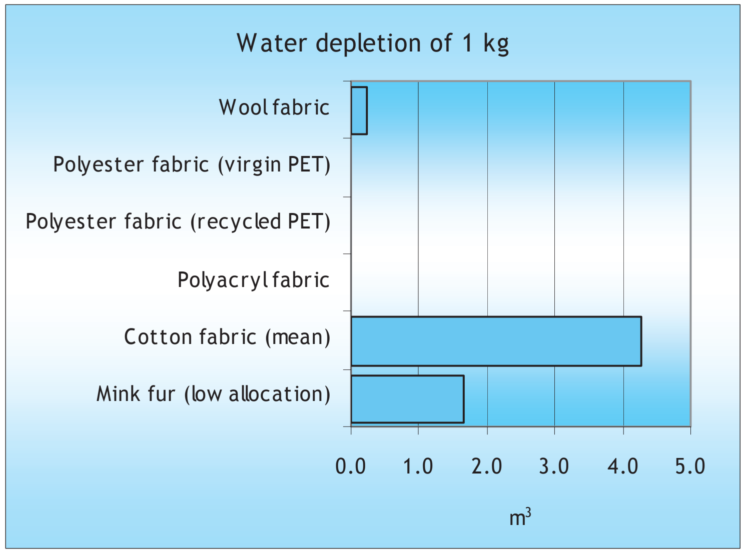
Climate change is the environmental impact on which there is currently greatest focus, since it is a global impact with known causes and visible consequences. The climate change impact of 1 kg of fur is far higher than that of the other textiles. As already mentioned, this is due mainly to the use of animal wastes as feed.

This impact is not only high compared with other textiles. There are not many raw materials scoring this high per kg on climate change: the score of mink fur is similar to that of materials involving high fuel consumption, or solvents for extraction (e.g. precious metals).

With an emission factor of about 110 kg CO_2 eq. per kg fur, the impact on climate change equals a car drive of over 1,250 km.[4]

[4] Based on EU emission standards (2008/2009): the CO_2 emission standard for cars is 140 g CO_2 per km.

Water depletion

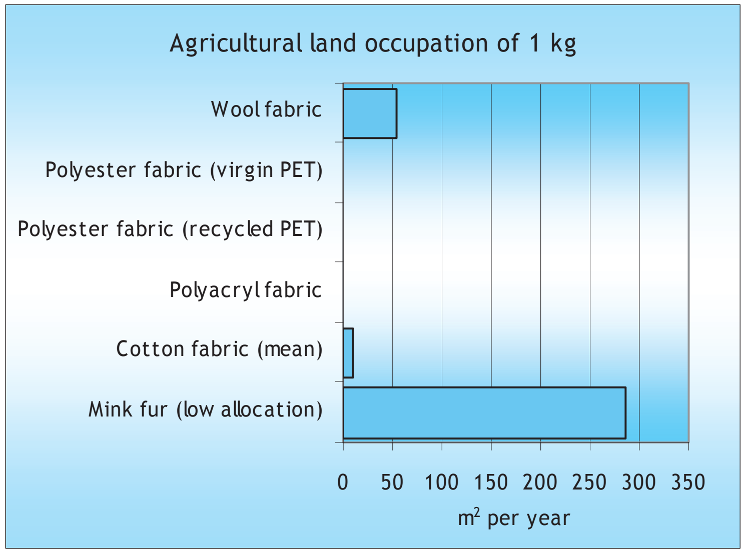


Water depletion is the only impact on which fur scores better than one of the fabrics, viz. cotton. The water depletion chart on the right only takes into account the water added by human activities, thus excluding rainwater.

The water requirements of 1 kg cotton are known to be high and in some countries the crops are heavily irrigated; in other countries irrigation is moderate. The value shown represents the mean of average cotton production in China and the USA.

The water requirements associated with 1 kg mink derive mainly from irrigation of the wheat for chicken feed. Not included are water use for the chickens, water use in the barn for cleaning and water use for fur treatment. Actual water consumption for 1 kg fur is therefore likely to be greater than shown.

Land use

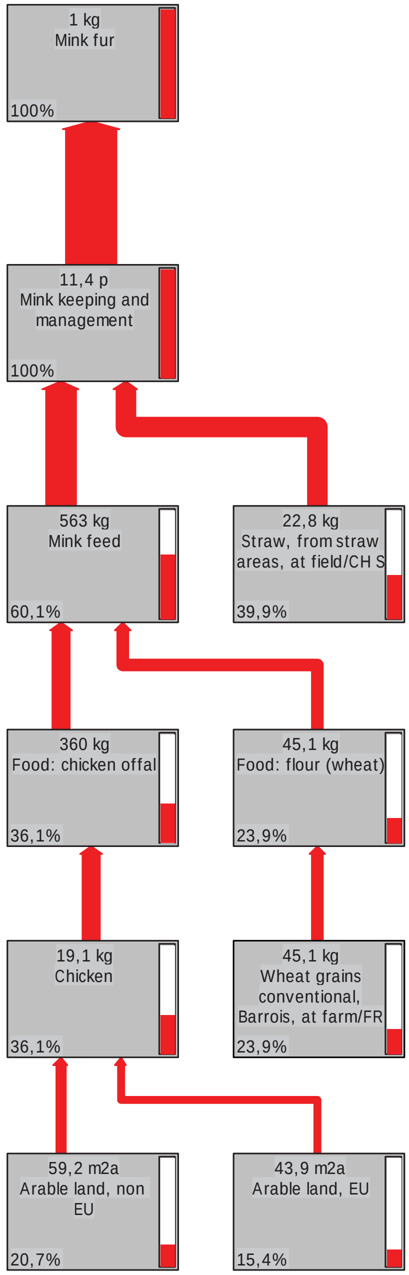


For land occupation, fur scores far higher than the other textiles. Further details are provided in Annex D.2:

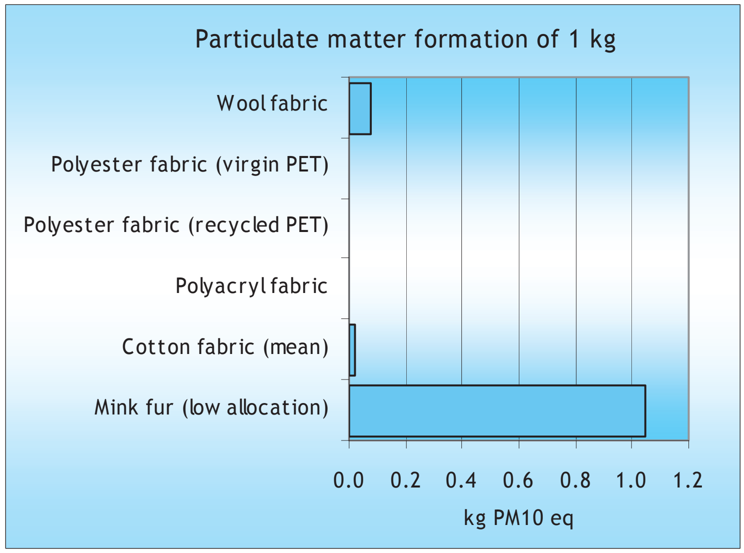
- 45 kg of wheat is required per year, for which a total of 68 m^2 land is needed;
- to meet the annual feed requirements of the chickens (corn, soy, grains) 103 m^2 is needed.

The use of straw is optional; in this study it has been assumed that an average of 2 kg of straw per mink is used. If straw is not taken into account, land occupation will be 172 m^2.

Figure 13 Flow chart: agricultural land occupation



Air quality



Two environmental impacts affect (local) air quality: particulate matter (PM) formation and photochemical oxidant formation. On both of these, fur scores far higher than the other textiles. Here, the results for PM formation are shown; the results for photochemical oxidant formation are available in Annex D.3.

80% of the PM formed originates from the NH_3 emissions from manure. Though PM formation for 1 kg cotton may seem low, the production of 1 kg of cotton scores higher on this count than 1 kg of mink feed.

Transportation and the large volume of feed account for the high score on photochemical oxidant formation and explain the difference between mink fur and the other textiles.

Non-quantifiable aspects

The fur production chain also entails certain non-quantifiable impacts. Although these are not part of this study, we mention them briefly.

Odour

Odour is an aspect of air quality that cannot be assessed very well in a general sense as it depends on the local situation whether people will experience nuisance from odour or not. The mink themselves, the manure and the feed all have a typical smell (NFE). In many countries, legislation sets a minimum distance from mink farms to the built environment, depending on the size of the farm (total number of animals and mother animals) and the type of surroundings.

Escape of minks to the wild

The Belgian Research Institute for Nature and Forests (INBO, 2010) concludes that the American mink is an invasive species in Europe, a territorial predator which competes with native species like the otter, muskrat and the marten. Being domesticated does not lead to reduced predator impact, but possibly even the contrary (‘hyper-predation’). Because of competition with other species and hybridisation with European mink (genetic impact), there is a real threat of biodiversity loss in case of escape or liberation.

Animal welfare

Animal welfare is not part of most environmental analysis yet, but is an issue that should not be neglected. In fur production, animals are mostly carnivores and thus several animal husbandry systems are involved in the life cycle, with various potential animal welfare issues.

Much has already been written on this subject, by a wide variety of organisations. In the Netherlands, minimum standards for keeping mink are in place (Dienstenrichtlijn PPE, 2009). In Belgium, no minimum standards are determined by law; regulations for killing the mink are in place, only.
It is very much a personal issue whether or not one finds it offensive for humans to keep wild animals under conditions differing from their natural habitat.

4 Conclusions

4.1 Main conclusions

The study in general

Data used for the analysis is retrieved from public sources. Information on mink farming in the Netherlands was available from a variety of agencies and regulatory documents. To model the fur lifecycle, most phases are approximated, based on available data. Some data gaps remain in the inventory.

On issues on which there was uncertainty, several scenarios were established and the scenario with the lowest environmental impact taken. The main data gaps leading to underestimation of the overall environmental impact are wastewater treatment (both at mink farms and during fur treatment) and emissions of the volatile substances used in fur treatment.

Two aspects that have not been taken into account in the study will involve environmental benefits. Allocation to mink oil has been set at 0% and all mink manure is assumed to be used as fertilizer, with no consideration being given to the scope for biogas production.

It is a near certainty that the underestimates associated with data gaps and the conservative approach will outweigh the overestimates.

Interpretation of results

In terms of fur output, feed conversion is highly inefficient: to produce 1 kg of mink fur requires 563 kg of feed. It is due above all to this volume of feed that 1 kg of fur has such a relatively large environmental footprint, despite the fact that only very minor environmental impacts are associated with one kg of feed. Fur production is analysed on 18 environmental impacts, among which impact to climate change, eutrophication, particulate matter formation, ozone depletion, toxicity, land occupation and fossil depletion.

On 17 of the 18 environmental impacts studied, 1 kg of mink fur scores worse than 1 kg of other textiles. Only in the case of water depletion does fur have a lower score, but the water used to produce the chicken feed (grains, etc.) was not included in the mink life cycle, and the water requirements of cotton growing are notoriously high.

Even in a conservative approach, the environmental impacts of 1 kg fur (apart from water depletion) are a factor 2 to 28 times higher than those of common textiles. This is a very clear and consistent result, with indicator categories all pointing in the same direction. In this situation, in LCA practice it is preferred not to ‘weigh’ the environmental categories into one single overall score as this step always requires a subjective weighting scheme.

Mink feed is the main contributor to 14 of the 18 environmental impacts studied. Besides feed, N_2O and NH_3 emissions from mink manure make a noticeable contribution to several environmental impacts. The use of chemicals (for fur treatment) makes only a limited contribution to overall environmental impact, but it should be noted that emissions could not be modelled and the effects are thus underestimated.

Applicability of results

The analysis is based on data for Dutch mink farming. Data collection proved to be very time consuming and thus detailed comparison with systems in other European countries such as Belgium and Italy was not feasible. However, results can be considered representative for a wider range of European industry due to the determining influence of impacts associated with feed. As long as feed quantity and composition are similar, the results will be similar as well. Other results should be expected for different feeding or manure management regimes.

4.2 Further work

A core issue with respect to mink keeping is the ethics of captive mink breeding and animal welfare. A full sustainability assessment should encompass all three pillars of sustainability, i.e. economic, social and environmental aspects, which would include animal welfare. This study addresses only quantifiable environmental aspects. Although the results of the comparison with typical textiles give a clear picture, a completer picture of impacts and their relative contribution to the total would be desirable. The results of this study give lower limits to true impacts of fur due to several data gaps.

Further work could also be done to assess in more detail difference between systems (countries) as well as animal types. Other common fur animals are fox, (finn)raccoon and chinchilla, for some of which there is also significant production in European countries.

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Annex A Methodological background

A.1 LCA

Figure 14 Schematic view of life cycle phases

The goal of life cycle assessment is to quantify the environmental impacts caused by products and activities during their entire life cycle, from raw materials extraction via usage through to the waste phase, or in other words 'from cradle to grave'.

LCA is used to compare (product) alternatives and provide insight into their production chains. Besides this kind of 'comparative' LCA, the methodology can also be used to obtain an absolute figure for environmental performance, which is used for the eco-labelling of products. The latter practice is subject to strict rules for execution (ISO14001, PAS 2050).

LCA has been widely incorporated into decision- and policy-making processes in industry, government agencies and NGOs alike.

A life cycle assessment study comprises the following sequence of phases:
- determination of goal and scope;
- data inventory;
- modelling of the production chain;
- impact assessment: quantification of environmental impacts;
- interpretation.

Determining the goal and scope of the study includes the 'what' and 'for whom' questions: what functional unit is to be studied, and what system boundaries are to adopted? The question 'for whom' will determine choices regarding the data inventory, the impact assessment method and the reporting of the results.

For modelling and impact assessment a variety of tools are available. We made use of the Simapro software, which contains databases of life cycle information on a wide range of materials and processes as well as an array of methods for calculating impacts. Using this software, it is possible to:
– model all the inputs and outputs of the life cycle, by selecting existing materials and processes;
– create user-defined processes for use in the model;
– perform impact assessments of the full life cycle, or phases thereof, using different methods;
– create graphs for interpretation.

For the purpose of this project we used the ReCiPe 'Midpoint method', as explained in the next section.

A.2 Environmental impacts: the ReCiPe Midpoint method

After completing the inventory, the environmental result is calculated. This primary result is a long list of emissions, raw material requirements and other relevant aspects (see the left-hand column of Table 30). To help interpret this list, impact assessment methods are available.

In this study we used the ReCiPe impact assessment method, the successor to the frequently used Eco-indicator 99 and CML2 methods.

The ReCipe method converts the long list of inventory results to understandable indicators. The method offers three levels of impact assessment:
– midpoint level (18 environmental impacts);
– endpoint level (3 indicators);
– one single indicator.

In this study, impacts are reported at the midpoint level.

Table 30 **Schematic overview of ReCiPe midpoint and endpoint impact categories**

LCI results	Midpoint	Normalization	Endpoint	Single indicator
Long list of emissions and substances: Raw materials Land use CO_2 VOS P SO_2 NO_x CFC Cd DDT etc.	Ozone depletion	DALY	Damage to human health (DALY)	Single indicator, obtained by weighting the three endpoints
	Human toxicity	DALY		
	Ionising radiation	DALY		
	Photochemical oxidant formation	DALY		
	Particulate matter formation	DALY		
	Climate change	Human Health: DALY		
		Ecosystems: species*yr	Damage to ecosystems (species*yr)	
	Terrestrial acidification	species*yr		
	Terrestrial ecotoxicity	species*yr		
	Urban land occupation	species*yr		
	Agricultural land occupation	species*yr		
	Marine ecotoxicity	species*yr		
	Freshwater eutrophication	species*yr		
	Freshwater ecotoxicity	species*yr		
	Minerals depletion	$	Resource depletion ($)	
	Fossil depletion	$		
	Marine eutrophication	-	-	-
	Water depletion	-	-	-

Table 31 shows the midpoints and the units in which they are expressed.

Table 31 **Midpoint indicators and their units**

Midpoint impact categories	Unit
Climate change	kg CO_2-eq. to air
Ozone depletion	kg CFC-11-eq. to air
Terrestrial acidification	kg SO_2-eq. to air
Freshwater eutrophication	kg P-eq. to freshwater
Marine eutrophication	kg N-eq.to freshwater
Human toxicity	kg 14 DCB-eq. to urban air
Photochemical oxidant formation	kg NMVOC-eq. to air
Particulate matter formation	kg PM_{10}-eq. to air
Terrestrial ecotoxicity	kg 14 DCB-eq. to soil
Freshwater ecotoxicity	kg 14 DCB-eq. to freshwater
Marine ecotoxicity	kg 14 DCB-eq. to marine water
Ionising radiation	kg U_{235}-eq. to air
Agricultural land occupation	m^2 * yr
Urban land occupation	m^2 * yr
Water depletion	m^2
Minerals depletion	kg Fe-eq.
Fossil depletion	kg oil-eq.

Description of environmental impacts (midpoint level)

Climate change
The impact category 'climate change' refers to the reinforced greenhouse effect: a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, among which carbon dioxide (CO_2), methane (CH4) and N_2O. As a result, the temperature is higher than it would be if direct heating by solar radiation were the only warming mechanism. The effect is calculated according to IPCC standards with a 100 year time horizon.

Ozone layer depletion
Most atmospheric ozone is found at an altitude of around 15-30 kilometres and this part of the atmosphere is therefore known as the ozone layer. This layer absorbs much of the damaging ultraviolet radiation emitted by the sun. The ozone layer is depleted by a variety of gases, including chlorofluorocarbons (CFCs), resulting in a decline of layer thickness. The reduction is greatest in spring, but at most locations levels are almost back to normal by autumn.

Acidification, terrestrial
Acidification of soils (and water) is a consequence of air pollutant emissions by factories, agricultural activities, power stations and vehicles. These acidifying emissions include sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and volatile organic compounds (VOC), which are transported via the atmosphere or the water cycle and end up in soils. This is referred to as acid deposition. By way of foliage and root systems these substances penetrate trees and other plants, making them more susceptible to disease. Acid deposition also causes damage to lakes and rivers, ultimately harming the wildlife that lives or drinks there, because of elevated acid and aluminium concentrations.

Eutrophication, freshwater
Eutrophication is the term used for elevated nutrient concentrations in water in particular. In biology it is used to refer to the phenomenon of certain species exhibiting strong growth and/or reproduction following addition of a nutrient surplus, generally leading to a sharp decline in species richness, i.e. loss of biodiversity. Eutrophication may occur, for example, in freshwater bodies subject to fertiliser run-off, particularly nitrogen and phosphate deriving from manure, slurry and artificial fertilisers from farming activities. The result is pronounced 'algal bloom', recognisable as dark-coloured water masses with an unpleasant smell. Eutrophication can lead to hypoxia, a deficiency of oxygen in the water.

Human toxicity
The impact category 'human toxicity' covers emissions to air, water and soils that result (ultimately) in damage to human health. In calculating toxicity, the environmental persistence (fate) of the substance and its accumulation in the human food chain (exposure) are taken into account as well as its toxicity (impacts).

Ecotoxicity, terrestrial, freshwater and marine
The impact category 'ecotoxicity' covers emissions to air, water and soils that result (ultimately) in damage to the ecosystems in soils, freshwater and marine waters.

Photochemical oxidant formation

Photochemical oxidant formation, or smog (a combination of the words 'smoke' and 'fog'), is a form of air pollution involving mist polluted by smoke and exhaust fumes, which may in certain periods suddenly increase in severity, with potential consequences for human health. The substances of greatest influence on smog formation are ozone and airborne particulates and, to a lesser extent, nitrogen dioxide and sulphur dioxide.

Particulate matter formation

Particulate matter (PM) refers to airborne particulates with a diameter of less than 10 micrometres. It consists of particles of varying size, origin and chemical composition. When inhaled, PM causes health damage. In people with respiratory disorders and cardiac problems, chronic exposure to airborne particulates aggravates the symptoms, while in children it hampers development of the lung function. The standards for particulate levels are currently exceeded at numerous locations in Europe, particularly along busy roads.

Ionising radiation

Ionising radiation results from the decay of radioactive atoms like those of uranium-235, krypton-85 and iodine-129. There are two types of ionising radiation: particle-type radiation (alpha radiation, beta radiation, neutrons, protons) and high-energy electromagnetic radiation (X-rays, gamma radiation). Ionising radiation can damage DNA and cause a variety of cancers.

Land use, agricultural and urban

The impact category 'land use' refers to the damage to ecosystems associated with the effects of human land occupation over a certain period of time.

Depletion, minerals and fossil

Consumption of mineral resources and fossil fuels has been weighted using a factor that increases in magnitude as the resource in question becomes scarcer and its concentration declines.

Annex B Inventory details

B.1 Specifications of machines used for mink processing

Body drum		
Specifications	Electricity	3 x 400 Volt, 3.7 A
	Air consumption	0.05 l/min, 8 bar
	Operating time	3 to 24 min.
	Capacity	100 males, 120 females
Calculations	Mean capacity	110 minks/ 15 minutes
	3*400*3.7 =	4,440 J/s
	4,440*15*60 =	4.0 MJ per 110 pelt
	4.0/110	36.3 kJ per pelt
	0.05*15/110	0.0068 l compressed air per pelt

Skinning robot		
Specifications	Electricity	3 x 400 Volt, 0.3 A
	Operating time	20 sec.
Calculations	3*400*0.3 =	360 W
	360*20 =	7.2 kJ per pelt

Fleshing machine		
Specifications	Electricity	3 x 400 Volt, 32 A
	Air consumption	10 l/min, 8 bar
	Max. capacity	300 pelts per hour
Calculations	3*400*32 =	38,400 W
	38,400*60s*60min/300	461 kJ per pelt
	10*60/300	2 l per pelt

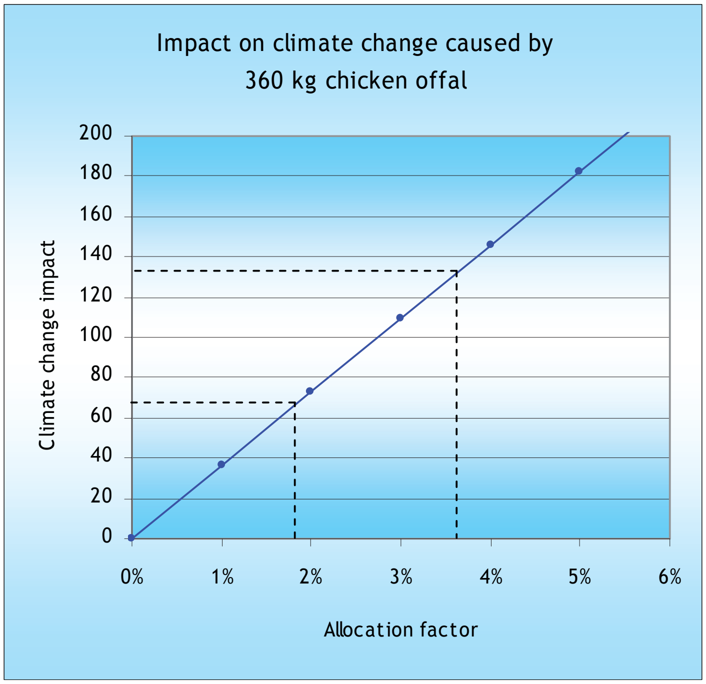
Drying		
Specifications	Electricity	400 Volt, 63 A
	Drying time	3 days
	Dehumidifying	15 g water/skin/day
	Air quantity	4,000 to 20,000 l/h, 4 bar
	Capacity	8,000 pelts (mean)
Calculations	400*63 =	25,200 W
	25,200*60s*60min*24u*3days/8,000 =	817 kJ per pelt
	Mean air consumption	12,000 l/h
	12,000*24u*3days/8,000	108 l per pelt

Annex C Influence of allocation factor

C.1 Impact on climate change according to allocation factor

The choice for allocation factor has a large influence on the environmental impact which is assigned to offal. This is illustrated in Figure 15 for the share of chicken offal in mink feed. Feed for 1 mink feed (563 kg) contains around 360 kg of chicken offal.
In this study, an allocation factor of 1.8% is taken, a low estimate.

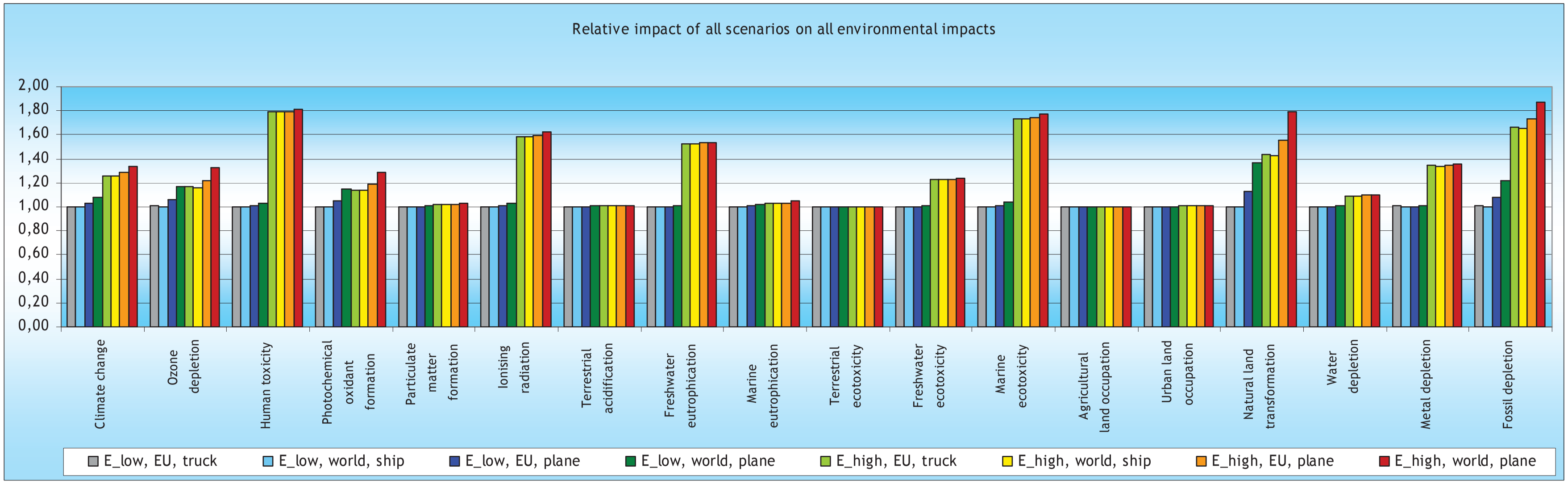
Figure 15 Relation between impact on climate change and allocation factor for chicken offal



Annex D Detailed results

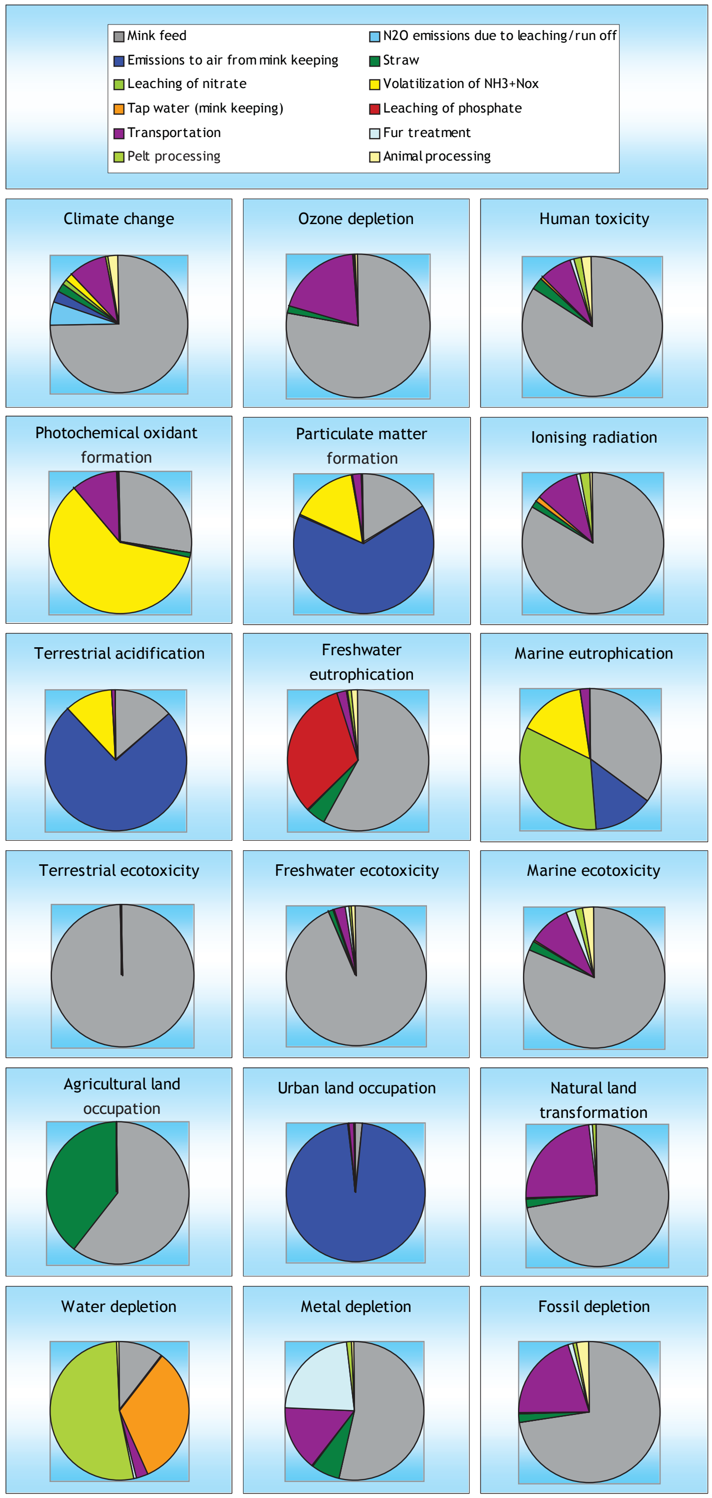
D.1 Relative impact scenarios

Figure 16 All scenarios: relative scores per environmental impact category



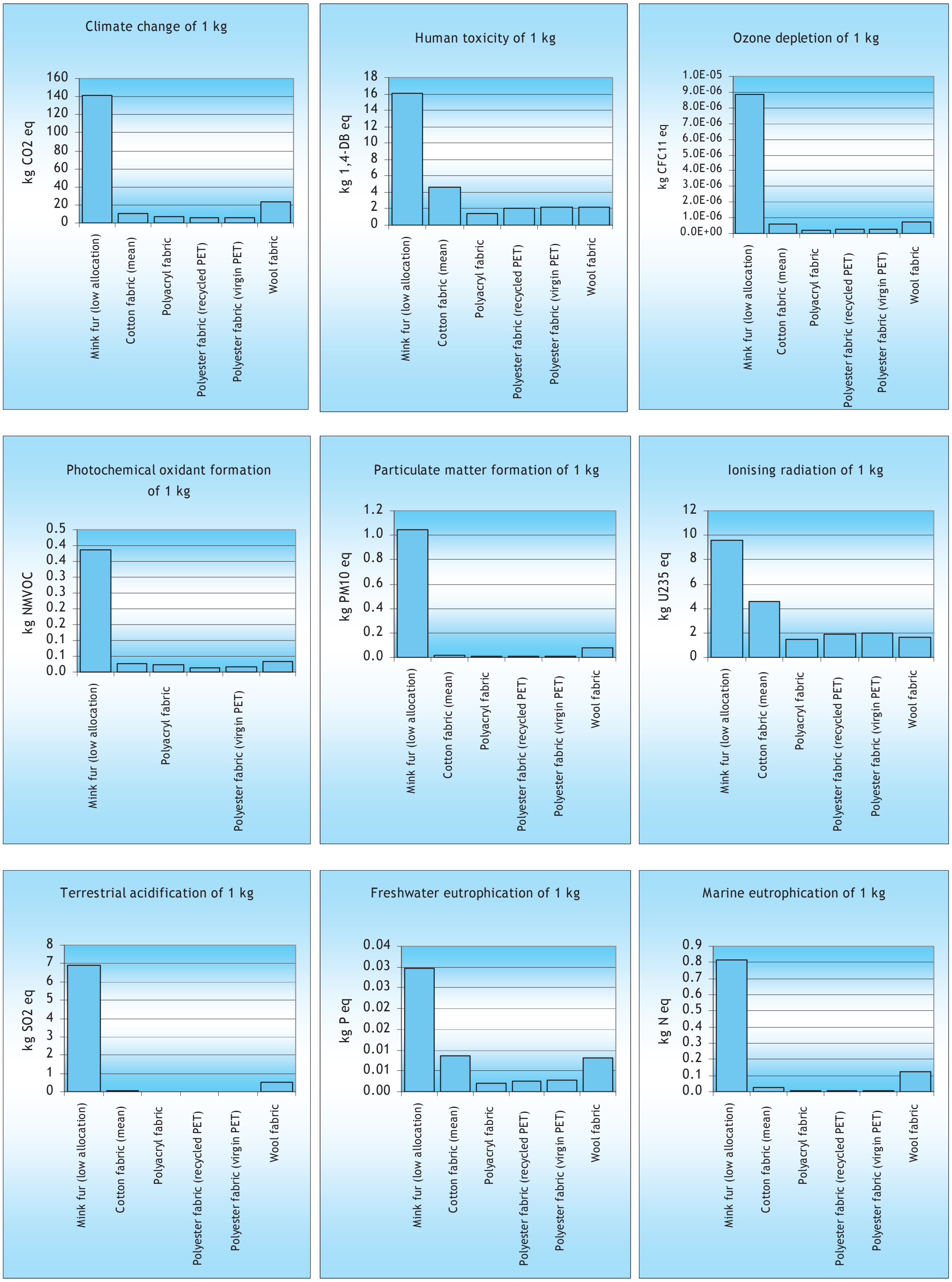
D.2 Fur production chain

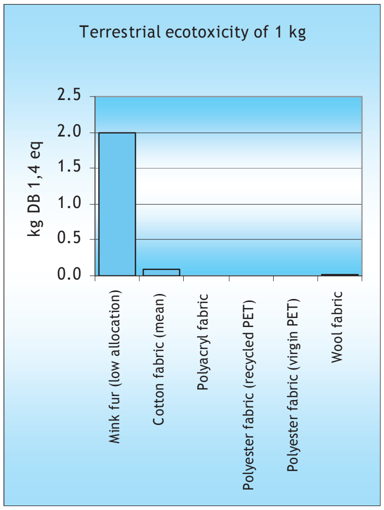
Figure 17 Relative contribution of aspects of fur production chain to environmental impacts

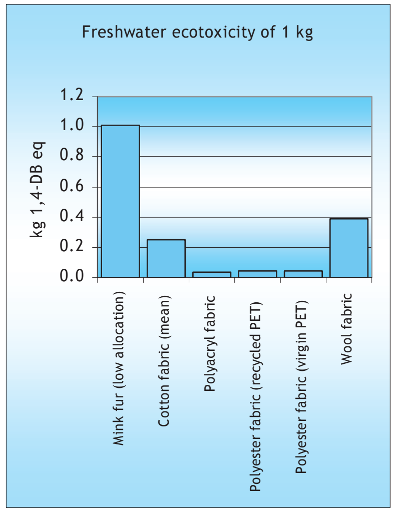


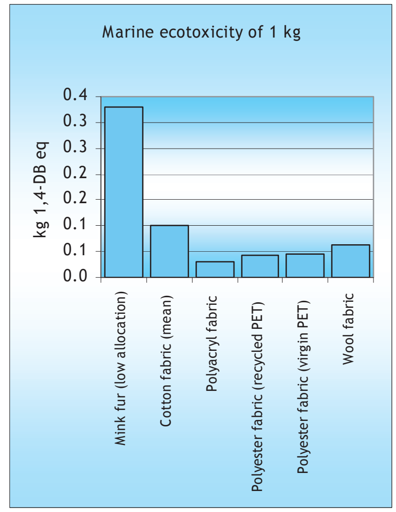
D.3 Comparison, all impacts

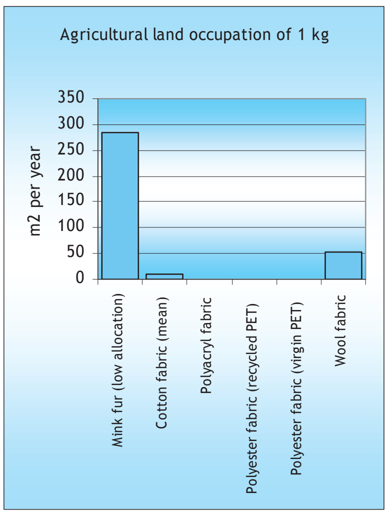
Figure 18 Comparison of mink fur production with other textiles

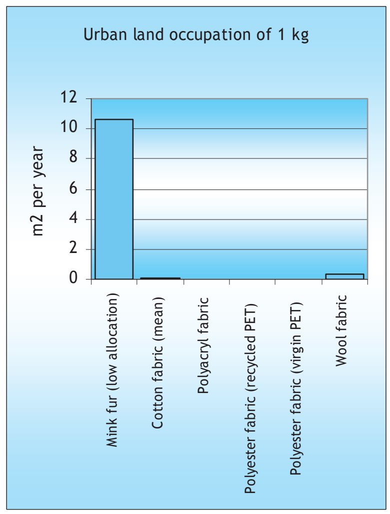


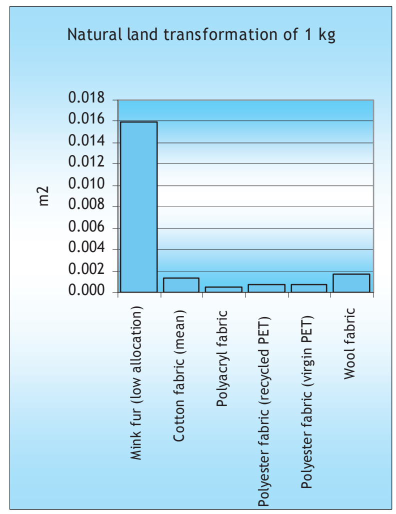

Terrestrial ecotoxicity of 1 kg
kg DB 1,4 eq
2.5
2.0
1.5
1.0
0.5
0.0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric

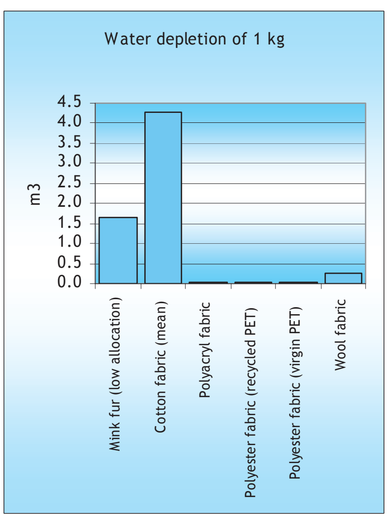

Freshwater ecotoxicity of 1 kg
kg 1,4-DB eq
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric

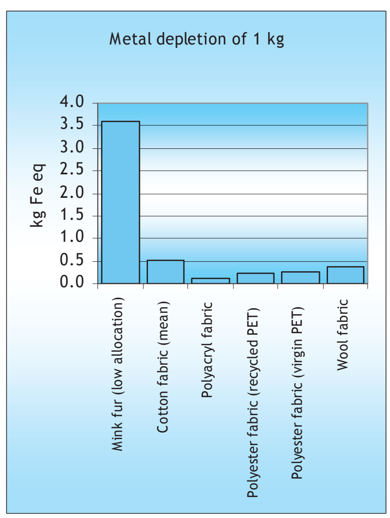

Marine ecotoxicity of 1 kg
kg 1,4-DB eq
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric

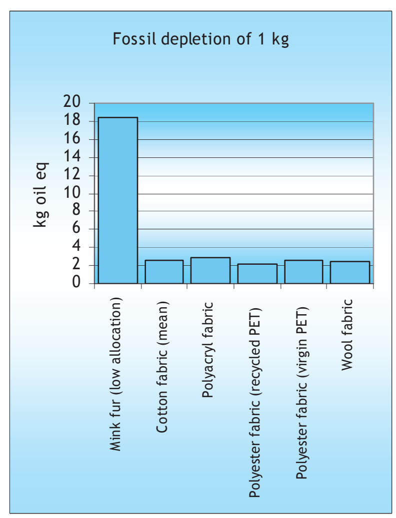

Agricultural land occupation of 1 kg
m2 per year
350
300
250
200
150
100
50
0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric


Urban land occupation of 1 kg
m2 per year
12
10
8
6
4
2
0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric


Natural land transformation of 1 kg
m2
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric


Water depletion of 1 kg
m3
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric


Metal depletion of 1 kg
kg Fe eq
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric


Fossil depletion of 1 kg
kg oil eq
20
18
16
14
12
10
8
6
4
2
0
Mink fur (low allocation)
Cotton fabric (mean)
Polyacryl fabric
Polyester fabric (recycled PET)
Polyester fabric (virgin PET)
Wool fabric