

# Biodiversity footprint of companies

## summary report



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## summary report

This summary report is based on the Dutch report *Biodiversiteitsvoetafdruk bedrijven*

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## Biodiversity footprint of companies

Companies are becoming increasingly aware of their impact on biodiversity and natural capital. This may result from their implicit dependence on natural capital, from increasingly more critical consumers, or from the genuine concern of company managers and owners. Consequently, companies have an increasing need for tools to enable them to gain insight into their impact on biodiversity, and to measure and assess the effects of measures to limit this impact.

The Natural Captains project of the Platform Biodiversity, Ecosystems & Economy (Platform BEE) is stimulating companies to translate thinking and working with natural capital into tangible actions. This means making visible the impact of their activities on biodiversity and natural capital in terms of their biodiversity footprint. One way to assess a company's impact on biodiversity is to measure the biodiversity footprint of their current activities and possibly also to compare this footprint with that of alternative measures.

The previous Plansup study (van Rooij et al., 2016) adapted the GLOBIO biodiversity impact assessment method to determine the biodiversity impact of companies, and of their products and services. This biodiversity footprint method was tested in three case studies and has now been extended and applied to a further six case studies in the Natural Captains project. Based on these case studies, the method has been evaluated for wider application. To enable such wider application, a simplified Biodiversity Footprint Tool was developed in which the integrated impact of two pressure factors - land use and greenhouse gas emissions – can be uniformly determined. For more information about the Biodiversity Footprint Tool, see [www.naturalcapitaltoolkit.org/](http://www.naturalcapitaltoolkit.org/).

This summary report does not go into detail on the simplified Biodiversity Footprint Tool, but summarises the results of the six case studies. The summary does not include all assumptions and calculations but briefly describes the most notable results and conclusions of these case studies. A detailed report entitled

*Biodiversiteitsvoetafdruk van Bedrijven* (Arets et al., 2017) is available in Dutch, and the companies have the Excel spreadsheets with all calculations and assumptions.

### Method

The biodiversity footprint method used in the six case studies is derived from the GLOBIO model approach, which was developed by The Netherlands Environmental Assessment Agency (Planbureau voor de Leefomgeving, PBL) in cooperation with knowledge partners. The GLOBIO methodology comprises two models - one for determining terrestrial biodiversity (GLOBIO3; see Alkemade et al., 2009), and the other for determining the impact on freshwater biodiversity in rivers and lakes (GLOBIO-aquatic, see Janse et al., 2015). The GLOBIO biodiversity model is applied on global, regional and national scale to determine changes in biodiversity due to human impact. Biodiversity is not measured but derived

from the impact of a number of pressure factors on biodiversity. For each pressure factor, dose-response relationships have been developed based on meta-analyses of large numbers of scientific studies on biodiversity impacts. In general, the greater the pressure, the greater the biodiversity loss.

GLOBIO uses a relative biodiversity indicator, Mean Species Abundance of original species (MSA), representing the natural or original biodiversity of an area in a value in the range of 0 to 1. The MSA has a low value in areas where the pressure of a specific pressure factor is high.

The terrestrial GLOBIO3 model includes the following pressure factors: land use, infrastructure, fragmentation, climate change, and nitrogen deposition. The pressure factors in the GLOBIO aquatic model are upstream land use, nitrogen and phosphorus deposition from air and water, dams and water management, climate change, and fishing.

The biodiversity footprint method in this study is based on the GLOBIO model but does not include all pressure factors and is implemented on local scale. Moreover, in determining the biodiversity footprint, decrease in MSA is combined with the area (ha) on which the company has an impact.

### Company MSA and biodiversity footprint

An MSA of 1 indicates that an area is completely in its natural state. The nature is undisturbed and the species composition is similar to that in comparable areas without human interference. The species composition refers to the diversity of species in an area and to the numbers of individual species which is referred to as species abundance.

An MSA of 0.4 means that only 40% of the population remains of the nature in such areas (the natural reference), for example, as a consequence of pressure on nature due to company activities. In this case, company activities have led to a 60% loss of the natural reference, or an impact of 0.6. This is the difference between the MSA in the untouched site (which is always 1) and the MSA in a disturbed site (in this example, 0.4).

The extent of the area of impact (area) is also important. Thus, impact ( $1 - 0.4 = 0.6$ ) is multiplied by the area (ha) of the impact. If the area is 2 hectares, then the biodiversity footprint is:  $\text{Area (ha)} * (1 - \text{MSA}_{\text{area}}) = 2 * 0.6 = 1.2 \text{ MSA.ha}$ .

A higher MSA.ha means a larger footprint, for example, because the loss of natural reference species per hectare is high and/or the loss extends over a larger area.

By calculating the footprint for different situations, the impact of company measures can be calculated and compared.

The equation for determining the biodiversity footprint is:

$$\text{Footprint} = \Sigma(\text{ha area in use}_i * [1 - \text{MSA\_pressure factor}_i])$$

in which  $i$  = land use, climate change, water use and nitrogen and phosphorus emissions in water.

This equation is used to calculate a biodiversity footprint MSA.ha for a baseline and for different scenarios, enabling comparisons to be made. In addition to land use and climate change, this footprint study includes the impact of water use and of nitrogen and phosphorus emissions in water. The text box on the previous page explains how the MSA.ha unit is being calculated.

## Land use

Because of the direct relationship between land use and biodiversity, this pressure factor plays a key role in determining a company's or a product's impact on biodiversity. Land use can play a role in various parts of the production chain. This concerns, for example, land use for production of raw materials by suppliers and by the company itself, and also land use directly related to the company's own production processes (for example, plant site, storage facilities), and possibly land use associated with waste processing. Because the impact varies per land use type, each land use type is determined separately. Thus, the area and type of land use management in each part of the production chain has to be determined.

For a number of land use types, the GLOBIO3 framework MSA values are based on a dose-response relationship between land use type and biodiversity. For company related site locations (land in use for buildings, parking area etcetera), the MSA land use value is set at 0.05. This value means that for this type of land use only 5% of the original biodiversity remains and thus 95% has disappeared. The MSA values of the generic GLOBIO3 of land use classes are averaged. In reality, MSA values vary depending on land

use intensity (Alkemade et al. 2009). There may be large variations particularly for secondary forest and plantations, for instance because of differences in management, such as clear felling versus selective felling, rotation length, and species composition. MSA values can be determined or adjusted to differences in local conditions by using local expertise on the natural state of a land use type in a specific region.

In determining the land use area, it is important to consider whether the company is responsible for the total land use or whether the land has multiple uses. In the latter case, an economic allocation of the use should be applied in which a company is allocated only that part for which it is responsible.

## Climate

Greenhouse gas emissions contribute to climate change, which in turn has an impact on biodiversity. The climate-related dose response relationship used in GLOBIO3 shows the decrease in biodiversity (MSA) versus the increase in global mean temperature (see Arets et al., 2014). Thus, the contribution of greenhouse gas emissions to the mean global temperature has first to be determined. This requires insight into the greenhouse gas emissions of the company and its products for which the biodiversity footprint is to be determined. It concerns, for example, emissions from transport, energy and heating, and process emissions as well as emissions from agriculture and land use.

Because climate change has not only a local but also worldwide impact on biodiversity, the climate impact on MSA occurs worldwide in natural and semi-natural ecosystems. Thus, the MSA impact per ha is multiplied by the total global land area for ecosystems in natural and semi-natural state. This delivers emissions per kg in CO<sub>2</sub> equivalent, an MSA impact of  $3.29 \cdot 10^{-5}$  MSA.ha (see also, van Rooij et al., 2016).

## **Water abstraction**

In addition to the immediate impact on a location that is already discounted in the MSA impact for land use, water abstraction has an impact on nearby nature areas. The impact is largely local and depends on site conditions, such as groundwater table, soil types and vegetation response to potential changes in water availability. The effect of water abstraction on water availability also depends on the depth, length of period, and location of the water abstraction in relation to vulnerable nature areas. The impact is determined from the reduction in the Mean Spring Groundwater Level (MSL), which is a good measure of drought effects.

The first step in calculating the MSA for water abstraction is to determine the potential MSL without additional water abstraction and for the present situation with water abstraction by the company. In determining the potential MSL without water abstraction, use is made of soil maps, hydrological models and information from monitoring wells and relief maps.

## **Nitrogen and phosphorus emissions to water**

In addition to land use, greenhouse gas emissions and water abstraction, nitrogen and phosphorus emissions to water are key pressure factors on biodiversity that can be exerted by companies. For canals, rivers and lakes, the dose-response relationship between nitrogen or phosphorus concentration, and biodiversity is available from the GLOBIO aquatic methodology. This relationship is used to calculate the impact on aquatic biodiversity. The aquatic pressure factor is calculated separately and not added to other terrestrial pressure factors because of its deviating characteristic, for instance, variation in flow and depth. The method is described in this report but was not assessed in the current cases because the pressure factor was either not relevant or data were insufficient to

calculate the impact. However, the impact of these emissions was applied in the three cases in the earlier Plansup study (see van Rooij et al., 2016).

## **Scenarios**

Using these methods, the biodiversity footprint of various situations can be compared for the same functional unit, for example, for a certain quantity of semi-finished product or end product. The biodiversity footprint of the current situation without measures, referred to as the baseline, can be compared with the footprint of an alternative or future situation in which biodiversity friendly measures are implemented. Alternative production methods or the use of different raw materials can also be compared.

## **Case studies**

The methodology for determining the biodiversity footprint was applied in case studies of the six companies that participated in the Natural Captains project of the Platform BEE. In addition, the impact of water abstraction was incorporated in the Desso case study carried out earlier by van Rooij et al. (2016).

## **Results of the company case studies**

The key results of the companies that participated in the case studies are presented in Table 1.

## Overview of the company case studies Foreco

### **Foreco**

Biodiversity footprints of the use of three types of wood under different wood production systems as base material for bio-based impregnated NobelWood.

### **Moyee**

Difference in biodiversity footprint for coffee production under four scenarios:

- 1) Baseline with coffee beans from plantations;
- 2) All coffee beans from smallholders;
- 3) Effect of switching to total use of solar energy in coffee roasting;
- 4) Present situation but with transport of the total roasted bean production to the Netherlands by ship instead of by air.

### **Natural Plastics**

Difference in biodiversity footprint between traditional tree planting system in which two stakes are used per tree, and the Natural Plastics new Keepers system made from bio-based plastic from potato and maize residues.

### **Tony's Choclonely**

- 1) Difference in biodiversity footprint of a pure chocolate and a milk chocolate bar.
- 2) Difference in biodiversity footprint of production source of beans: low productive farmers and highly productive farmers.

### **Better Future Factory**

Biodiversity footprint of New Marble tile made from recycled PET bottles.

### **Schut papier**

Difference in biodiversity footprint of traditional paper and Valorise paper made from paper pulp and 30% biomass of residues from tomato plants.

### **Desso**

In determining the biodiversity footprint of Desso Dendermonde in van Rooij et al. (2016), water abstraction was found to be potentially a key factor. An additional case study was carried out in which the method for determining the footprint of water abstraction was tested.

Table 1

## Foreco

Since 1983, Foreco has been active in the wood sector. Foreco develops, produces and sells wood products for professional and consumer markets. Together with various other companies, Foreco offers high quality products, such as WaxedWood and NobelWood, for new building construction and renovation projects.

These products are used in cladding for building facades and as an alternative to tropical hardwood. To preserve the wood, it is impregnated in tanks with biopolymer made from the residue from sugar production (molasses) obtained from the Dominican Republic.

The biodiversity footprint is determined for three coniferous species that can be used as raw material for preserved NobelWood, which is a pinewood product preserved in a bio-based process. The three wood species are:

- Pine (*Pinus sylvestris*) from clear felling of semi-natural forest in South Germany;
- *Pinus radiata* from plantations in New Zealand;
- American pines (Southern Yellow pine, *Pinus spp.*) from semi-natural forests in North America.

The functional unit for the determination of the biodiversity footprint is 1000 m<sup>3</sup> sawn NobelWood per year.

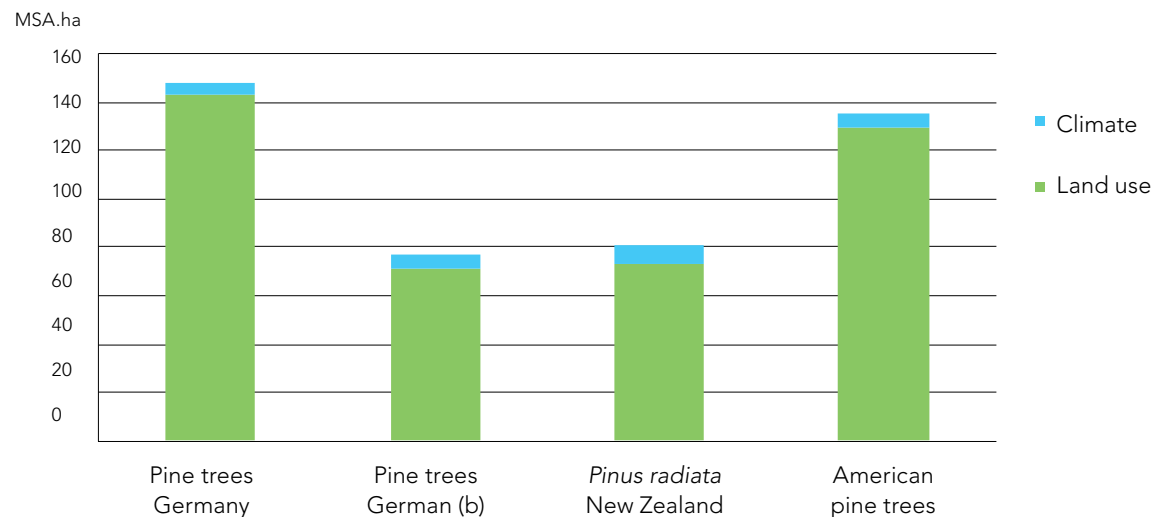


Figure 1 Biodiversity footprint of timber production systems in Germany, New Zealand and the United States, and a system in Germany taking into account other forest uses (b) for production of 1000 m<sup>3</sup> NobelWood.



Land use and climate related biodiversity footprint of the three pine species are presented in Figure 1. Because the wood preservation process on the Foreco site is the same for all three species, only the impact of raw material and transport is calculated. Because the forest stands are not irrigated, water use is not taken into account.

As Foreco did not have information about possible use of fertilisers in the *Pinus radiata* and American pine stands, the impact of nitrogen and phosphorus emissions to water was not included, and thus the aquatic footprint was not determined.

The impact of climate is considerably less than that of land use. In the calculations, it is assumed that emissions from local sawmills are the same for each wood species. The determining factor in climate impact is transport distance to Foreco and the type of transport.

The productivity of the wood production largely determines the size of the biodiversity footprint. The higher the productivity, the smaller the biodiversity footprint. The footprint of *Pinus radiata* is the smallest. When multiple use of the forest from which the wood is harvested is taken into account, the footprint for the German pinewood is considerably smaller. The economic outcome of hunting and recreation in the German forest reduces the footprint by half (see Figure 1, variant b).

## Moyee

Moyee supplies Fairchain coffee. The company does not wish to export or take away the added value of coffee bean roasting from the bean-producing countries but to share it with the local economy. So instead of exporting unroasted green beans, the coffee beans are roasted locally in a 50/50 enterprise with local entrepreneurs.

Currently, coffee beans are mainly sourced from a plantation in Ethiopia. This plantation is biologically managed but because the whole production chain is not organic certified, the coffee cannot be traded as organic coffee. In addition, a small proportion of the beans is sourced from smallholders around the plantation. However, the yield and quality of these beans are lower and beans cannot yet be directly purchased from the smallholders themselves (under Ethiopian law to protect smallholders). The beans are sent to a roaster in Addis Ababa in Ethiopia. Low quality beans are sold locally and export of the high quality beans is mandatory. The bean roaster is half owned by Moyee Coffee Nederland BV and the rest is in local hands. The roasted and packaged beans are exported to the Netherlands. The functional unit for calculating the biodiversity footprint is 100 kg roasted coffee beans exported to the Netherlands.

In the case study, the biodiversity footprint of the current situation is compared with that of three alternative scenarios. The baseline is the situation in which all beans are sourced from the present plantation. This is probably a good starting point for a situation in which Moyee works with its own plantation model. In the first scenario, the biodiversity footprint is calculated for all coffee beans sourced from smallholders.

The biodiversity footprint of the two types of production are compared in Figure 2. The footprint of smallholder coffee is about 1.5 times larger than that of coffee produced on more productive

plantations. The differences in coffee bean yield and impact are largely due to land use because the other process steps are the same.

As shown in Figure 3, air transport of the roasted beans has the largest climate-related impact in the present situation in the production chain.

In the second scenario, the impact of a total switch to solar energy for the roasting process is calculated. Sustainable solar energy replaces electricity, LPG and diesel in the coffee roasting. The impact of land use is the same as in the baseline situation. In the third scenario, the impact is determined of a switch from air to sea transport between Ethiopia and the Netherlands. In this situation,

land use is the same as in the baseline situation. The impact of these two scenarios is presented in Figure 4.

As shown in Figure 5 land use has a greater impact than does greenhouse gas emissions on the biodiversity footprint. The additional reduction in biodiversity footprint from use of solar energy and sea transport is relatively small. But these factors are very important in the reduction of the company's CO<sub>2</sub> emissions.

Because Moyee wants to strengthen the local economy to the benefit of smallholders, training on achieving a sustainable increase in productivity and reducing harvest losses will have the most positive impact on biodiversity.

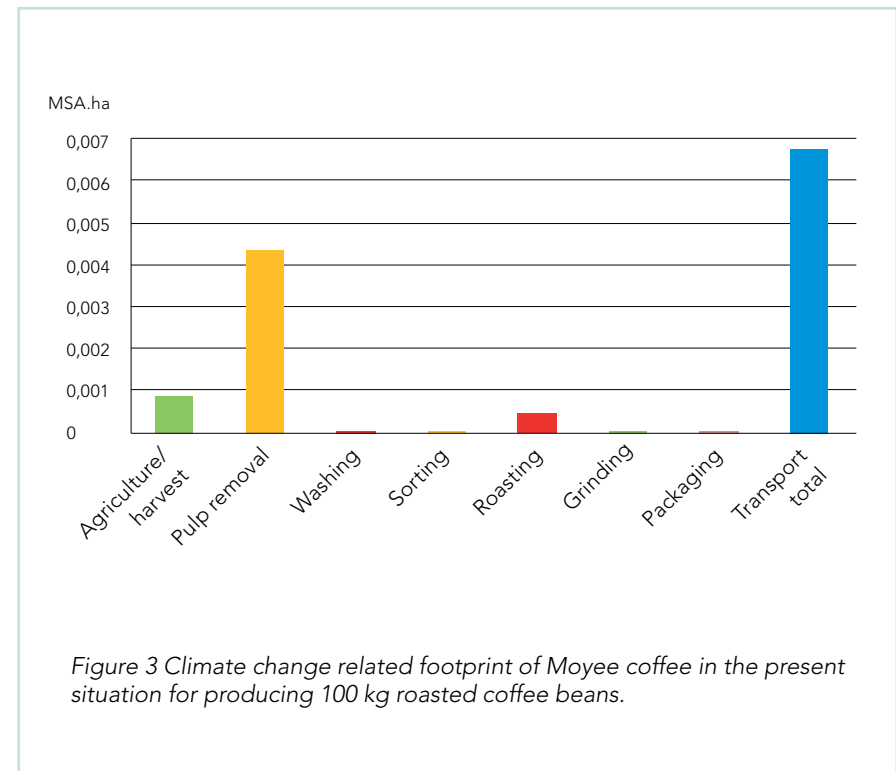
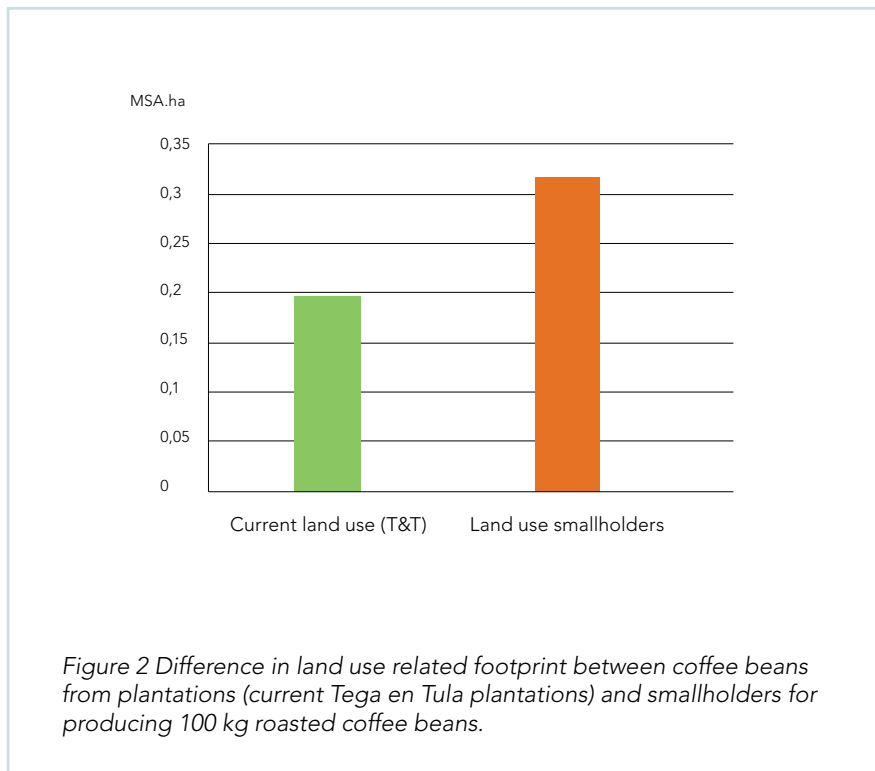


Figure 4  
Impact of sustainable solar energy for coffee bean roasting and sea transport on the climate impact.

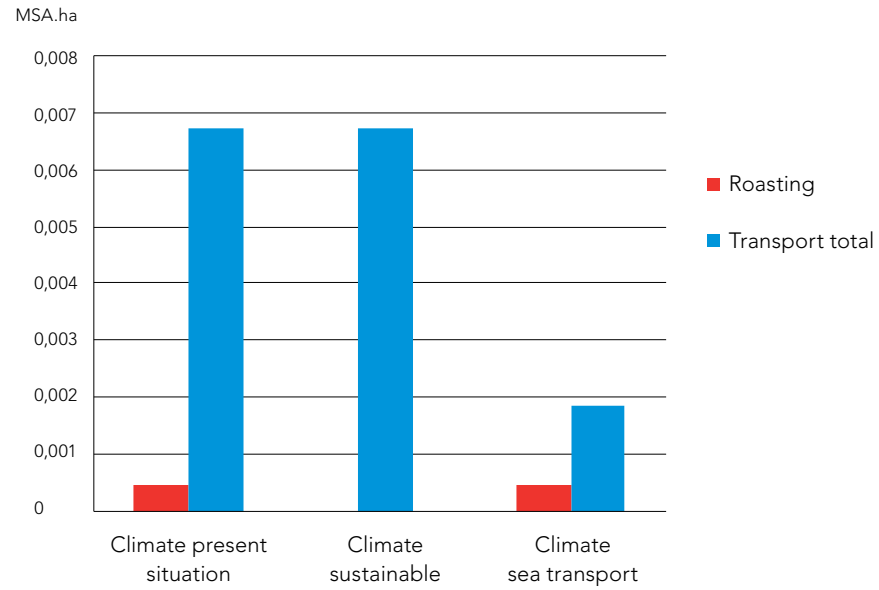
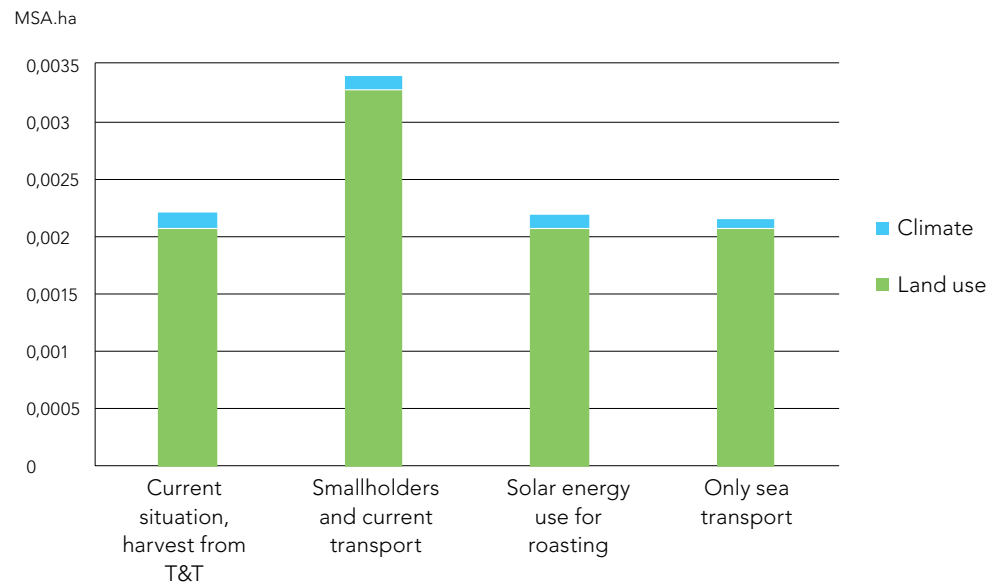


Figure 5  
Biodiversity footprint of 100 kg roasted coffee beans in the present situation (baseline) and the three scenarios based on climate and land use.



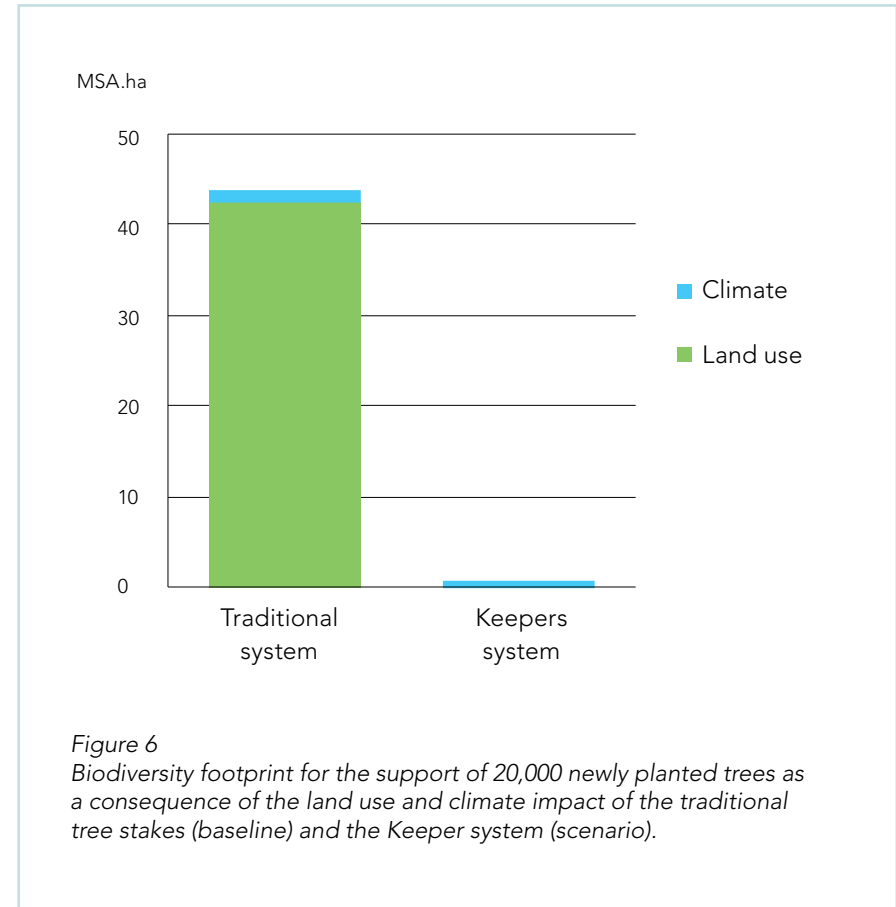
## Natural Plastics

Natural Plastics specialises in a tree planting system that uses bio-based material, called the Keeper system, as an alternative to wood tree stakes to support planted trees. The Keeper system anchors the planted trees in place with bio-based pegs attached to a bio-based rope attached to the root clod mesh. This provides an alternative to the tree stakes and eliminates the need to fell trees for tree planting systems. In addition, the system eliminates the need for the synthetic rubber tree ties traditionally used to attach the wood stakes to the trees.

The difference in biodiversity footprint between the traditional and the Keeper tree planting systems is determined. The functional unit is tree-planting material for planting 20,000 trees a year.

In the traditional tree planting system, wood production for the tree stakes appear to have the greatest impact on land use. It is assumed that the tree stakes are made of spruce from forests in the Baltic or East Europe. The synthetic rubber tree ties are based on raw oil extracted from the sea. The land area for the production of these ties is very small and thus is not included in the footprint calculation. Also, land use for the production of steel nails from mines is not considered significant because the area for the production of these nails is very small compared to that required for wood production. To determine the climate impact, data from a life cycle analysis were used (BECO, 2013).

In the Keeper system, the raw material for pegs is potato residue, and maize residue is used for the rope ties. Nothing is paid for these residue materials, and thus according to the economic allocation principle, the land use for potato and maize production does not need to be included in the footprint calculation. The footprint for the traditional tree planting system is 56 times larger



*Figure 6*  
Biodiversity footprint for the support of 20,000 newly planted trees as a consequence of the land use and climate impact of the traditional tree stakes (baseline) and the Keeper system (scenario).

than that for the Keeper system (see Figure 6). The difference could be smaller in the future if the company has to pay for the residue materials. In that case, the economic share of the land use for potato and maize cultivation needs to be included in the footprint calculation.

## Tony's Choclonely

Tony's Choclonely (TC) sells 'slave-free' chocolate bars based on cacao beans produced in Ghana and Ivory Coast. Tony's social mission comprises five principles of cooperation:

1. Pay a fair price
2. Follow the cacao bean
3. Improve quality and productivity together
4. Farmers stand strong together
5. In for the long haul

Natural capital is second priority to this mission. In this case, the difference in the footprint of milk versus pure chocolate is investigated in two cacao bean productivity systems. The footprints are calculated for the current mean productivity of cacao producers (low productivity) and for the situation in which farmers produce under more or less ideal circumstances with the right knowledge and production means (high productivity). Tony's expectation is that cacao bean productivity could increase to 800 kg/ha/y. The footprint of the paper and aluminium wrapping is not

included because it is the same for both bars. The functional unit is the production of 180 g chocolate bar.

The largest proportion of land use is for cacao production (see Table 2). Because the low productivity farmers produce less cacao per ha, more land is needed to produce a chocolate bar than for cacao from high productivity farmers. The current low productivity farmers supplying cacao to Tony's produce on average 450 kg/ha/y.

For the calculation, it is assumed that half of the sugar required is cane sugar from Mauritius and half is beet sugar from the Netherlands and Germany. Because of the higher productivity, beet sugar production requires less land area than that required for cane sugar production. In the production of milk chocolate bars, grassland in Germany is also required for the production of milk powder. The relative impact per land use type is given in Figure 7.

Greenhouse gas emissions are based on information per chocolate bar from a life cycle analysis conducted by True Price. Emissions are

Item	Land use (m <sup>2</sup> )		
	per kg component	per milk chocolate bar	per pure chocolate bar
Cacao low productive farmers (m <sup>2</sup> )	31,75	1,94	4,17
Cacao high productive farmers (m <sup>2</sup> )	17,86	1,09	2,35
Cane sugar (50% per bar) (m <sup>2</sup> )	0,75	0,03	0,02
Beet sugar (50% per bar) (m <sup>2</sup> )	1,20	0,05	0,03
Milk powder (grassland) (m <sup>2</sup> )	9,54	0,40	-
Milk (feed) (m <sup>2</sup> )	2,10	0,09	-

Table 2

Land use in m<sup>2</sup> per kg component and per 180 g bar of milk chocolate and of pure chocolate. It is assumed that each bar is made of 50% beet sugar and 50% cane sugar.

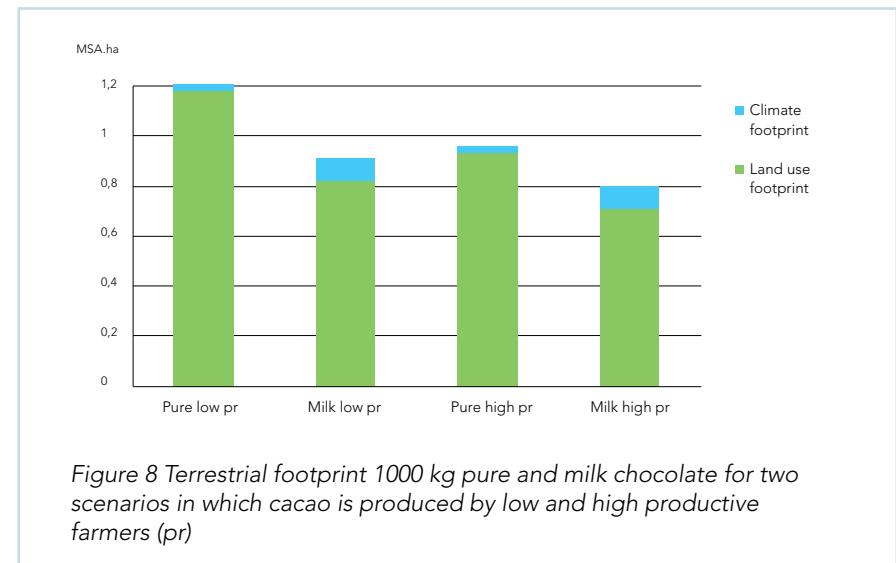
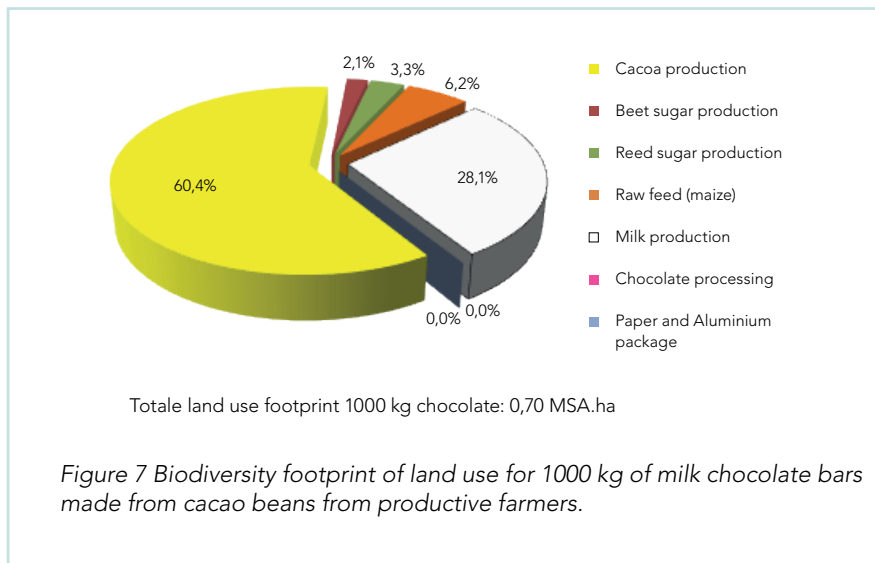
given for cacao cultivation, sugar production, milk production and for chocolate manufacture. While the greenhouse gas emissions comprise only a small proportion of the total footprint, CO<sub>2</sub> emissions were 350% higher for a milk chocolate bar than for a pure chocolate bar. This is important with regard to reducing climate-related emissions.

As cacao is grown in high rainfall areas with an abundance of water, water use for cacao cultivation is not a pressure factor. Water is required for washing the beans and to a lesser extent in processing the liquid chocolate in Belgium. But as sufficient data were not available, the impact is not taken up in the calculation of the biodiversity footprint. Further, little fertiliser is used by the productive farmers. The low productivity farmers sometimes use manure from their cattle on their cacao trees. As these are small quantities, it is assumed that the impact of nitrogen and phosphorus emissions in the surrounding water is also small.

An overview of the total biodiversity footprint for the various scenarios is presented in Figure 8. While milk production is the

largest contributor to the climate impact, a milk chocolate bar made of cacao from high productive farmers has the smallest footprint and the pure chocolate bar made of cacao from low productive farmers has the largest. The impact of climate is relatively small because land use is by far the largest contributing factor to the footprint of both types of chocolate bars. More efficient cacao production reduces the relative impact of land use but increases that of climate. Although climate impact on biodiversity is relatively low, it may be a goal to reduce the company's carbon footprint.

Just as in the case of Moyee coffee, training of low productivity farmers directed to increasing their productivity has the largest positive impact on the footprint. Tony's states that with the right know-how and means, a farmer can achieve production of 800 kg/ha. Further, the higher the cacao content in a chocolate bar, the higher the biodiversity footprint. In addition, use of more beet sugar instead of cane sugar would have a slight positive impact on the footprint.



## Better Future Factory

Better Future Factory (BFF) offers design and technical engineering for high quality products made from recycled raw materials that must also have a positive long-term impact. The company makes 3D printer wire from recycled drinking cups. In addition, 'New Marble' tiles are made from used PET bottles. This is done in cooperation with sheltered workshops and a company that shreds the PET bottles. The New Marble tiles are made from residue material that is easier to process than ceramics.

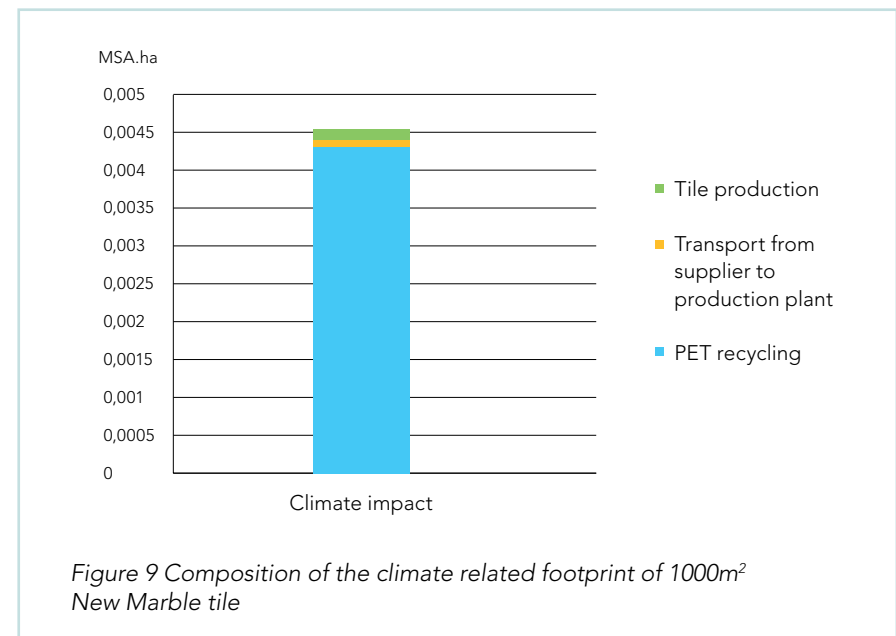
It was originally intended to compare the New Marble tile with a standard ceramic tile. Because the company has insufficient information to calculate a standard ceramic tile, only the biodiversity footprint of the New Marble is determined. This is done for a functional unit of 1000 m<sup>2</sup> tiles per year.

The New Marble tile is produced from recycled PET bottles, for which the raw material is oil extracted from the sea and thus its land use is limited. Because a cost price is paid for the flakes made from discarded PET bottles (about € 800 per 1000 kg), the proportion of the land area used to produce and store the PET bottles could be determined (economic allocation of the land use). This requires the mean cost price of the PET bottles but Better Future Factory does not have the data. To this must be added the area for the production of the PET flakes. About 20 m<sup>2</sup> land is used to produce the New Marble tile and 10 m<sup>2</sup> for storage. The expected lifetime of the tile is 15 years. Discarded tiles are recycled to produce the flakes for the production of new tiles. Thus, land use for waste processing does not have to be added. Not all data on land use were available and therefore the impact by land use is not calculated. However, the indication is that land use for tile production is relatively limited and consequently the land use related footprint is also small.

To determine the climate impact, a life cycle analysis (Shen et al., 2010) is used to obtain data on recycling PET bottles. In addition, there are emissions from the transport of the PET material and for the manufacture of the solar panels to fire the ovens in which the tiles are made. The contribution of various components in the production chain to the climate impact is given in Figure 9.

As little water is used in tile production and nitrogen and phosphorus are not emitted to water, these pressure factors are not included in the analysis.

Although there was not sufficient information on the impact of land use, the footprint is expected to be largely determined by climate-related emissions. The largest proportion of the emissions is related to the recycling of PET bottles, with only a small contribution from tile production and transport.



## Schut Papier

Schut Papier is a relative small paper production company. A wide range of paper types between 55 to 600 g/m<sup>2</sup> is produced from a varied range of fibres including cellulose, flax, cotton, sugar cane and cloth waste. Schut also uses plant residues from greenhouse horticulture as raw material, which is a major step to the paper production from non-wood fibres. In the production of Valorise paper, a maximum of 30% virgin paper pulp from wood is replaced with fibres from tomato stalks obtained from greenhouse horticulture.

The biodiversity footprints of traditional 250 g paper and 250 g Valorise paper are calculated and compared. The production unit of 1000 kg/y per roll is also used as the functional unit for the calculation.

Some of the data were obtained from a life cycle analysis (Meesters and Keijsers, 2016) carried out for Schut Papier. Virgin paper pulp comes mainly from Chile and is produced from *Pinus radiata* grown at 24 m<sup>3</sup>/ha/yr (Arets et al, 2011).

According to Meesters and Keijsers (2016), production of 540 tonne paper requires 530 tonne virgin paper pulp, while production of the same quantity of Valorise paper requires 380 tonne paper pulp. For 1000 kg of traditional paper, 981 kg pulp is required and for 1000 kg Valorise paper, 703 kg. Based on 3.5 m<sup>3</sup> wood per tonne pulp, 1000 kg traditional paper requires 3.44 m<sup>3</sup> wood and the same quantity of Valorise paper requires 2.46 m<sup>3</sup> wood. Based on these data and the production of *Pinus radiata*, 0.14 ha plantation is needed to produce 1 tonne traditional paper, and 0.10 ha to produce 1 tonne Valorise paper. Because there are no costs for the tomato stalk residue, land use for tomato cultivation according to the economic allocation is not included for the Valorise paper. The MSA\_land use value for the high productive radiata plantations amounts to 0.2, according to GLOBIO3 dose-response relationship.

The land-related biodiversity footprint is equal to  $0.14 * (1 - 0.2) = 0.11$  MSA.ha for 1 tonne traditional paper and  $0.10 * (1 - 0.2) = 0.08$  MSA.ha for 1 tonne Valorise paper.

An overview of greenhouse gas emissions from plantation management, pulp production, and paper production is presented in Table 3. These can be determined on the basis of the quantity of wood, pulp and paper, and related emissions per unit of production. The emission values for pulp are based on the assumption that pulp production is 50% chemical processing and 50% mechanical processing.

Transport emissions are calculated on the basis of road transport from the pulp plant to the sea in Chile, sea transport of the pulp to the Port of Rotterdam, and road transport from the port to Schut. For the Valorise paper, there are additional transport emissions of the glasshouse residues to Schut. The total transport emissions for traditional paper are calculated at 208 kg CO<sub>2</sub> and for Valorise paper at 168 kg CO<sub>2</sub>. This emission is in addition to the emissions set out in Table 3.

The impact of water use is also calculated. According to Meesters and Keijsers (2016), production of 540 tonne traditional paper uses 12,533 tonne water (23.2 m<sup>3</sup> water per 1000 kg paper) and the production of the same quantity of Valorise paper requires 12,079 tonne water (22.4 m<sup>3</sup> water per 1000 kg paper). The biodiversity impact of water use on the surrounding stream-valley natural area is based on the change in the mean spring groundwater level (MSL) in the areas. In addition to precipitation and soil factors, the total water use is important in calculating the impact of water abstraction on the MSL. The effect was modelled and calculated for the case that groundwater extraction by Schut Papier would reduce by 3.6% if traditional paper production was replaced totally by production of Valorise paper.



Schut Papier extracts groundwater at a depth of 80 m. To establish the effect of reducing water abstraction, it is important to look at the soil. Between the borehole and the surface, two clay layers in the sand reduce the effect of reducing water abstraction. The effect on the groundwater table, and thus on the spring groundwater table is very limited, even in the immediate surroundings of the source. This is estimated to be only a few millimetres which has no effect on plant species and thus on the MSA. Because the impact of water use for the time being can only be calculated for water use in the Netherlands, the impact of water use for pulp production and plantation is not included.

Schut Papier expects no difference in nitrogen and phosphorus emissions to water in the production of traditional and Valorise paper. Thus, this pressure factor is not included in the analysis. The footprints for land use and for climate per process component are presented in Figure 10. This indicates that land use is the main contributing factor to the biodiversity footprint, followed by the climate impact of pulp production and then by paper production. Switching from traditional to Valorise paper reduces the footprint by 22%. Because production of Valorise paper requires less pulp, the potential impact of water abstraction in Chile would also be less.

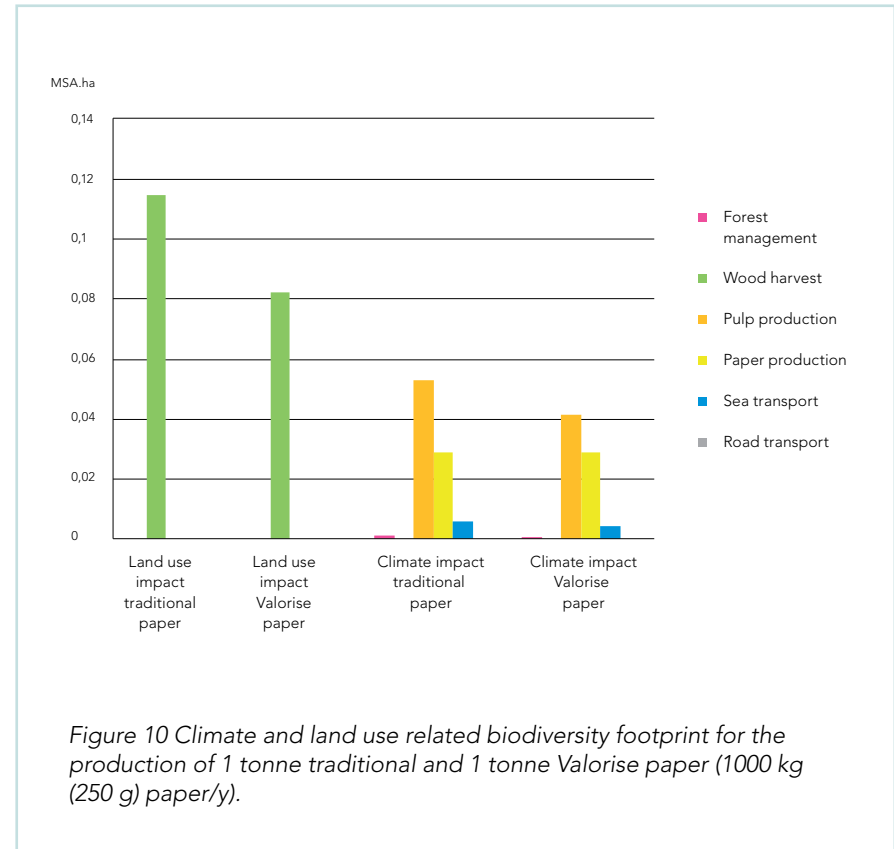


Table 3  
CO<sub>2</sub> emissions from plantation management, pulp production and paper production in the production of traditional and Valorise paper

	Emission factor	Traditional paper	Valorise paper
Weight paper pulp per tonne paper (kg)		981	703
Volume wood in pulp per tonne paper (m <sup>3</sup> )		3,44	2,46
Weight glasshouse residue per tonne paper (kg)			1083
CO <sub>2</sub> plantation management for wood (kg)	8,3 kg CO <sub>2</sub> /m <sup>3</sup> hout	28,5	20,4
CO <sub>2</sub> pulp production (kg)	1,63 kg CO <sub>2</sub> /kg pulp	1600	1147
CO <sub>2</sub> paper production (kg)	0,867 kg CO <sub>2</sub> /kg papier	876	876
CO <sub>2</sub> glasshouse residues	0,105 kg CO <sub>2</sub> /kg residu	0	114
CO <sub>2</sub> total process (kg CO <sub>2</sub> )		2495	2148

## Desso - water use impact

Desso is part of the Tarket Group and supplies high quality carpet tiles and wall-to-wall carpet. Desso operates on the Cradle to Cradle principle. The company is located in Waalwijk, the Netherlands, and in Dendermonde, Belgium. In the previous biodiversity footprint study (van Rooij et al., 2016), the biodiversity footprint was determined for carpet production in 2012 and for 2020 for which the effect of the measures in the Desso Cradle to Cradle Roadmap: Vision 2020 were calculated. The footprint was calculated for the pressure factors of land use, greenhouse gas emissions and emissions to water. On one of Desso's production sites a substantial amount of water is pumped near the Denderbellebroek nature area in Belgium. Thus, the impact of water use by Desso Dendermonde on biodiversity is determined in the present study for the situation in 2012 and for a scenario in which no water is abstracted.

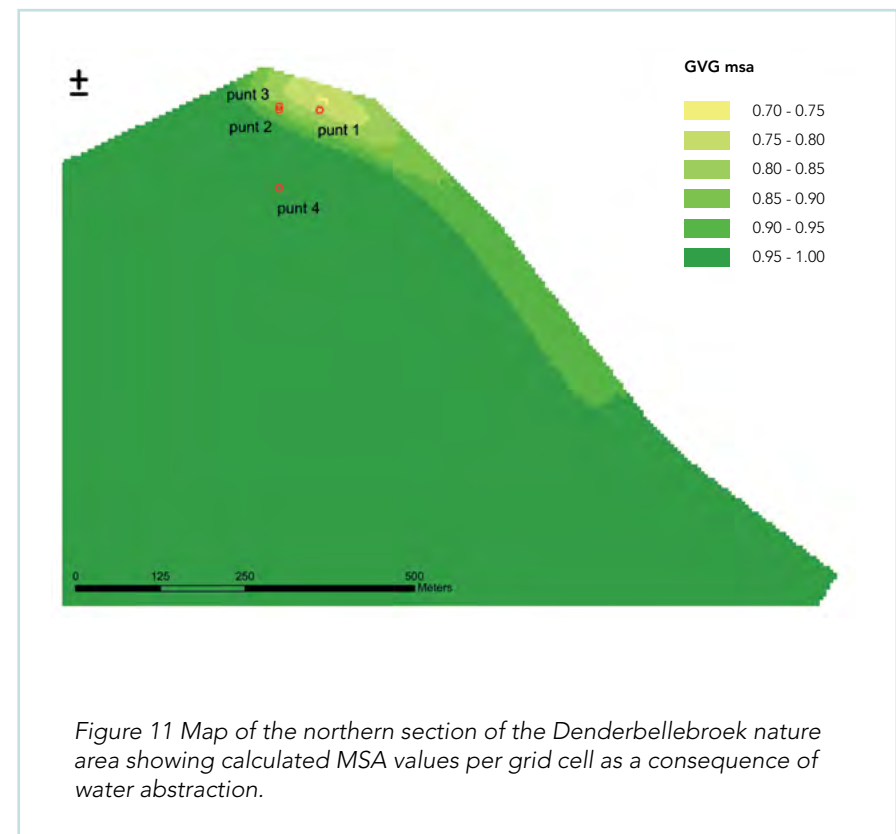
The north-east part of the nature area is most affected, and thus for this part of the study, the effect on the potential plant species is considered. Four of the boreholes in the area to monitor the groundwater table were selected with a difference in groundwater table.

On the basis of the measurements, the present mean spring groundwater table is calculated. To calculate the effect of not abstracting water, use was made of a soil map, hydrologic model calculations (Patyn, 2011), boreholes and a contour map.

The number of species that could be present under the current water abstraction is higher than under the original, wetter conditions. However, only some of the species under the situation without water abstraction are present in the current situation with water abstraction by Desso. Thus, the MSA shows a decrease for a few boreholes (Figure 11). For the situation without water abstraction, the number of potential species present reduces to a

quarter. The relationship between the change in MSL and MSA is determined using regression analysis based on data from the four boreholes.

Per 25 m<sup>2</sup> grid cell, the biodiversity impact 1-MSA is determined and multiplied by the area. The sum of these values for the whole area gives the biodiversity footprint in MSA.ha. The total area is 148.5 ha, of which 94% is not affected (1-MSA = 0). The biodiversity footprint for the rest of the area is 0.64 MSA.ha. Water abstraction contributes only 0.007% of the total Desso biodiversity footprint (8,960 MSA.ha for climate and land use).



## Nature restoration in the Netherlands

Nature restoration is not included in GLOBIO even though this is an important aspect for companies wanting to achieve higher nature state in an area of low biodiversity. A hypothetical case is included in which agricultural land is converted to nature. In this case, only options are examined to determine the changing impact of land use for nature development.

The case for testing a new nature recovery methodology comprises comparing the land use-related biodiversity footprint of an area of 30 ha agriculture land (baseline) and the reduction of this footprint by gradual conversion to 30 ha nature area. Nature development occurs in conformity with local natural species. Because the conversion from agriculture area to a nature area is a long-term process in which the nature values develop, the biodiversity footprint is determined at two time points: one year after conversion and after a period of 25 years.

The functional unit is 30 ha land. The biodiversity footprint for the agriculture area is determined only for the specific area and not the impact of other agricultural activities in which this 30 ha of agricultural land plays a role.

For the calculations, the assumption is made that previously intensive agricultural area (MSA = 0.1) is converted using applicable initial nature restoration measures, such as, loosening the soil, planning and seeding with local tree and plant species, and restoration of the original drainage. It is assumed that disturbance caused by these management measures in the first years does not lead to a reduction in the already low MSA value. It is not known how long it will take to achieve the undisturbed natural reference state in terms of structure and species composition. Thus, it is assumed that after implementation of the management measures, 70% of the area will achieve a natural state after 25 years (MSA=0.7).

This value is not directly underpinned by the GLOBIO3 method, because nature recovery and the time factor are not explicitly included. The restoration time also depends, for example, on the intended plant and animal species and other local site factors. Thus, an MSA value of 0.7 should be seen as an initial expert estimate. For simplicity, the development of the MSA in this natural restoration process is determined with the aid of a linear equation. To establish the exact MSA change in nature restoration, additional research has to be carried out from which the dose-response relationships can be defined per restoration year.

### Conversion of an intensive agricultural area to a nature area: year 1

In the first year of converting an area of intensive agriculture to a nature area, nature has only had a very short period to develop. The MSA of the area is then increased from 0.1 to 0.124 and the biodiversity footprint is  $30 * (1 - 0.124) = 26.3$  MSA.ha (Figure 12).

### Conversion of an intensive agriculture area to a nature area: year 25

It is assumed that the MSA of the area achieves the value of 0.7 after 25 years. This reduces the footprint on the area after 25 years nature development to  $30 * (1 - 0.7) = 9$  MSA.ha (Figure 13).

The biodiversity footprint is expected to decrease significantly over a period of 25 years. Further development to complete restoration is expected to progress at an increasingly slower rate because the Netherlands is highly populated and various pressure factors are always present near or at the location.

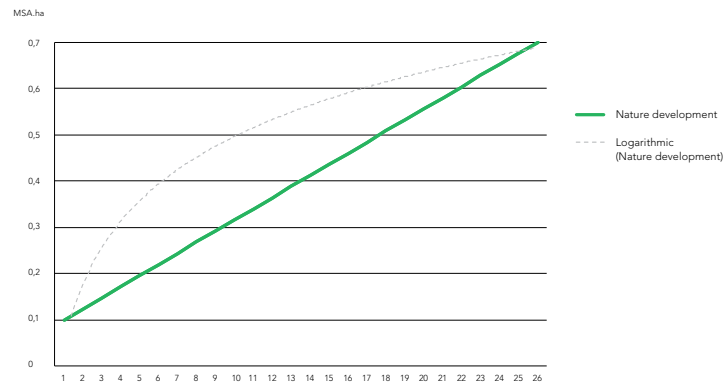


Figure 12 Proposed MSA development for the conversion of intensive agricultural area to nature area without disturbance. The grey broken line illustrates a logarithmic progression in the increase but this is not used in the analysis

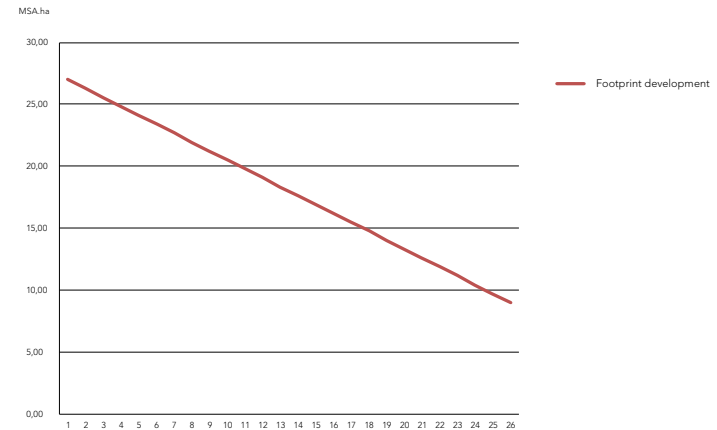


Figure 13 Land use related footprint during conversion of intensive agricultural area to undisturbed nature area.

## Biodiversity Footprint Tool

The Platform BEE commissioned the development of a simple web version of the GLOBIO based biodiversity footprint method. This web tool can be used as a first step in establishing a company's or a product's impact on biodiversity.

The tool takes account of the two major pressure factors - land use and greenhouse gas emissions. It can be used to measure the impact of the present and future annual production of a product,

of a product group, and of the whole company. This impact is based on available company data, with the focus on raw material suppliers, intermediate products, and the production process. Comparison of present and future or alternative footprints can give an indication of the effectiveness of future company measures in reducing their impact on biodiversity. The tool will be available in 2017 on the following websites: [www.naturalcaptains.nl](http://www.naturalcaptains.nl) and [www.naturalcapitaltoolkit.org](http://www.naturalcapitaltoolkit.org).

## General conclusions

### Data availability

The case studies relied on information and data available from the companies. It was not the intention of the project to carry out additional life cycle inventories and analyses.

The greatest biodiversity impact of most companies results from land use and greenhouse gas emissions from the production of raw materials and during the production process. Thus, the availability of these data is a decisive factor in determining their biodiversity footprint. In a number of cases, the company had information from life cycle analysis for the baseline situation, but often insight and information about possible alternatives were not available and had to be obtained from other sources. Thus, assumptions and expert estimates were made to provide the data required.

In general, the impacts of land use could be determined for the components in the production chain of products of agriculture and forestry origin. By using the limited information available from the company and productivity data from the literature, an estimate could be made in most cases of the area of a specific land use category required for a contribution to the functional unit.

Information about greenhouse gas emissions was available in most cases from a life cycle analysis or the company's own overviews. In a number of cases, data on, for example, transport distances and energy use could be converted to greenhouse gas emissions using standard emission factors.

### Robustness of the results

To determine the robustness of the results, the analyses were also carried out with the ReCiPe model. This method is based on life cycle analysis (LCA), which delivers another biodiversity footprint indicator. The ReCiPe method is less able to distinguish between

land use systems and to include local conditions in the analysis. Yet, trends and conclusions based on ReCiPe calculations are largely in line with the results based on the GLOBIO method. Thus, it can be concluded that GLOBIO3 results are reasonably robust and do not depend only on the method used.

Measuring the biodiversity impact was not a matter of course for all companies. Greenhouse gas emissions were often available or relatively easy to determine or estimate. But insight into the contribution of land use, for example as the consequence of the use of raw materials, was not so readily available. In these cases, a brief analysis was made for the company's biodiversity footprint for the baseline situation. Then, the impact of possible or actual measures that could be implemented was made rather ad hoc or by comparison with other similar products. The method is also, and perhaps better used, for a longer period to gain more insight into possible alternatives and the data required to measure performance and to gain more insight.

### Conclusions based on the case studies

In most cases, land use plays a dominant role in the total biodiversity footprint. These are chiefly cases where wood (Foreco, Natural Plastics) and agricultural products (Moyee, Tony's Choclonely) play a key role. The hypothetical case of agriculture conversion to nature gives an indication of how to calculate the gradual restoration of nature. Measures to reduce greenhouse gas emissions are generally easier to implement, but the case studies also show that in most cases only a limited part of the biodiversity footprint could be reduced with such measures.

Water use only has an impact on biodiversity if it leads to lowering of the groundwater table in nearby nature areas. The impact of water abstraction is measured in two case studies and appears to

be very limited. It is estimated that this is also the case for the other case studies. Key factors are the local geo-hydrological conditions in the soil and the site of the borehole sources in relation to nature areas. In addition, relatively large quantities of water need to be abstracted before there is a significant impact on the surrounding nature area.

The results indicate that land-related productivity is a key factor in the size of the biodiversity footprint. As productivity doubles, the area needed for the same production is reduced by half. The reverse is the case for more extensive land use that requires a larger area. According to the biodiversity footprint equation ( $\text{Area} \cdot [1 - \text{MSA}]$ ) both the required area and the biodiversity quality of the area in terms of MSA determine the land use related biodiversity footprint. A higher land use intensity of a piece of land implies in general a higher productivity but at the same time a reduction of the remaining biodiversity within that land. The outcome of the equation will show if a reduction of area as a result of an increase in productivity will lead to a decrease of the footprint (in MSA.ha) or not.

Not all pressure factors are included in the footprint method but those included together cover the major part of the impact of Dutch companies on biodiversity. Based on the generic dose-response relationships in the present GLOBIO model, it is not yet possible to include the impacts of very specific nature friendly measures or of very extensive land use. The GLOBIO model also has no specific relationships for multiple land use and nature restoration. In the biodiversity footprint method used in this study, a number of solutions are provided and applied, but additional research is required to verify the assumptions and make adjustments if required.

### **Response of companies**

Just about all companies who worked on the case studies have stated that the results have led to new insights into their biodiversity

impact. As expected, in most cases the biodiversity footprint decreased in the proposed alternative situations in comparison with the present situation.

Some captains confused in the first instance the concept of biodiversity and natural capital. Biodiversity is only part of nature capital and the footprint method does not take account of aspects, such as sustainability and human risk. However, biodiversity is a good indicator of the capacity of an ecosystem to deliver the services (natural capital) on which companies depend. Most captains were not well aware of the company processes that had the most impact on biodiversity. This led to some surprising results for some companies.

After the previous study the management of Desso carpets was surprised that wool, which is only a relatively small proportion of the total raw materials used, plays a major role in their footprint. A key variable is whether there is multiple land use, not only in terms of meat production but also whether sheep contribute to nature management and conservation.

For Foreco, there was a surprise that wood from extensively managed semi-natural forest can lead to a higher footprint than wood from intensive plantations. By including shared use of semi-natural forest in the calculation, the footprint decreased. This principle is now better recognised by the management, and has also resulted in improved understanding of the data required for this type of assessment.

In the first instance, Natural Plastics was surprised that there is a footprint component if the use of company waste has to be paid for. Company waste is increasingly being considered to be valuable residue material and when demand increases, this material can become a production objective with its own footprint.

Better Future Factory could only calculate the footprint for a new tile made from recycled material because there was not sufficient impact-related information available for the alternative ceramic tile. During the completion of this footprint study, the company management stated that an additional life cycle analysis was being carried out.

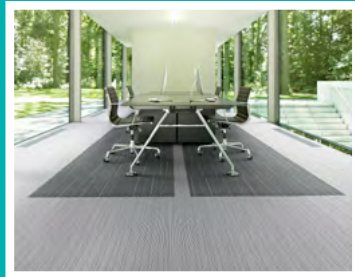
For Tony's Chocolonely, the welfare of the cocoa farmers is a top priority. With training, these smallholders can improve their productivity, which will have a beneficial effect in terms of income and biodiversity footprint.

This was also the case for Moyee. This company was surprised that a switch in coffee transport from air to sea makes a relatively small contribution to reducing their biodiversity footprint. However, the switch plays an important role in reducing the company's greenhouse gas emissions. Rise in sea level and changing rainfall patterns affect people whereby climate gets relatively more attention in politics and the media. Reducing emissions is also a goal for Moyee and for many other companies as well.

Schut papier and Desso were relieved that water use contributes very little to their footprint.

Based on the results and feedback from the companies, it can be concluded that GLOBIO-based company footprints can help companies to:

- Gain insight into the pressure factors and company processes that make the largest contribution to their biodiversity footprint taking into account local conditions;
- Determine the difference in footprint between the present and an alternative or future situation;
- Calculate the effectiveness of biodiversity friendly measures.





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