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software / data / know-how

Social and environmental impacts of a T-shirt: A life cycle approach

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Content

- Who are we?
- What is Life Cycle Assessment (LCA) / social LCA?
- Case study: Cotton T-shirt
- Comparing different scenarios
- What to do with the results

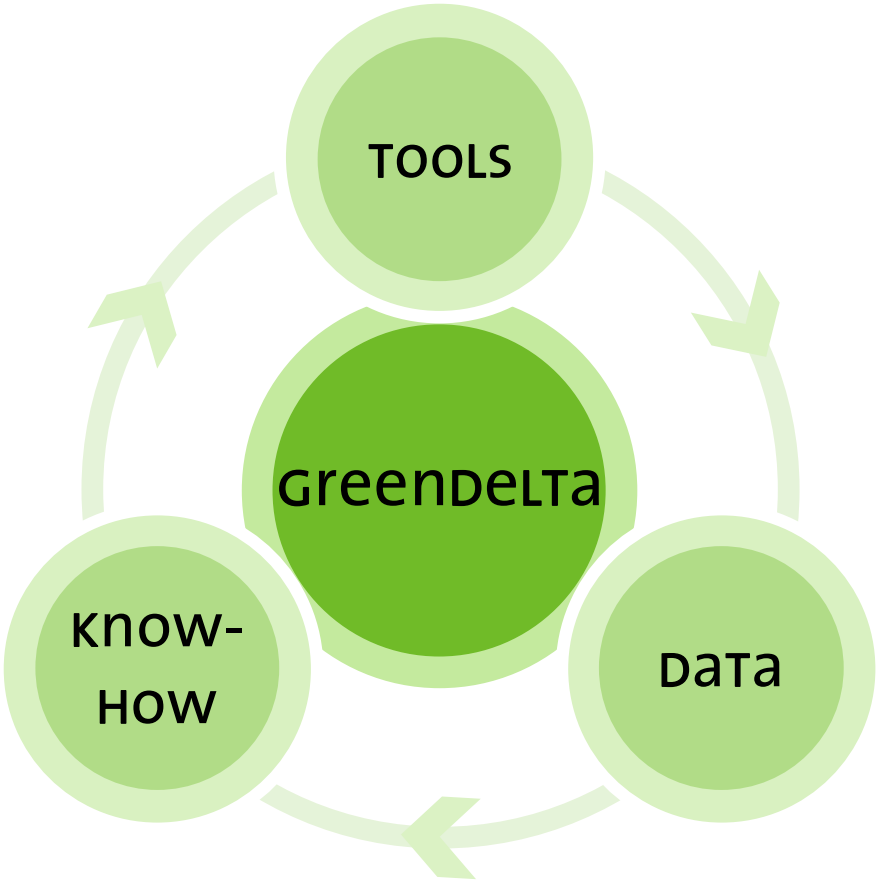
GreenDelta, Background

- Founded by Dr. Andreas Ciroth in 2004
- 10 employees (engineers, biologists, IT specialists, business administrators)
- Office in Berlin
- Business world-wide

GreenDelta, What we do

"The art of sustainability consulting"

- Sustainability research
- Life Cycle Assessments
- Databases
- Software for LCA and sustainability



GreenDelta, Projects I

CCL LABEL
YOUR GLOBAL PARTNER

LCA case studies for bottle labels

nano 3BIO

Product comparison of chitosan (biopolymer)

h_da
HOCHSCHULE DARMSTADT
UNIVERSITY OF APPLIED SCIENCES

Introducing LCA software in lectures

SCSglobal SERVICES
Setting the standard for sustainability™

Development of Life Cycle impact assessment feature

EPA
United States Environmental Protection Agency

Develop software for LCA

prosuite

Develop and implement methodology for sustainability assessment

GreenDelta, Projects II

PSILCA

Developing a global, transparent S-LCA database

L'ORÉAL

Advise for company sustainability metrics

Advise for company sustainability metrics and case study

Programmatorische federale Overheidsdienst Duurzame Ontwikkeling

Full, public social LCA and environmental LCA case study

BASF We create chemistry

Critical review of a method for S-LCA

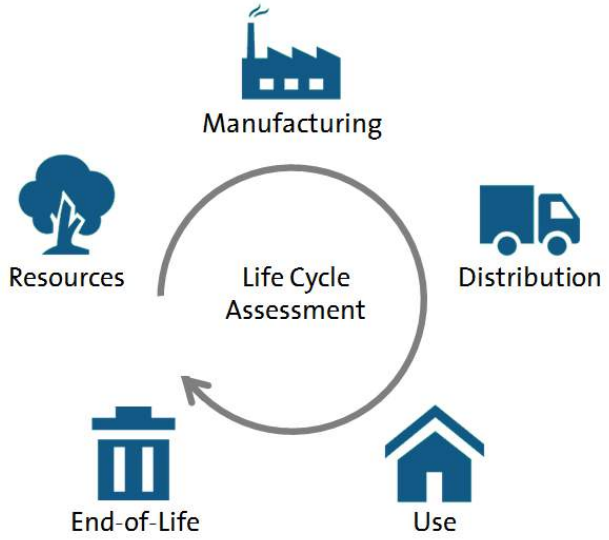
FCH FUNDACIÓN CHILE

Case studies, developing an indicator system for S-LCA

What is LCA / S-LCA

What is Life Cycle Assessment?

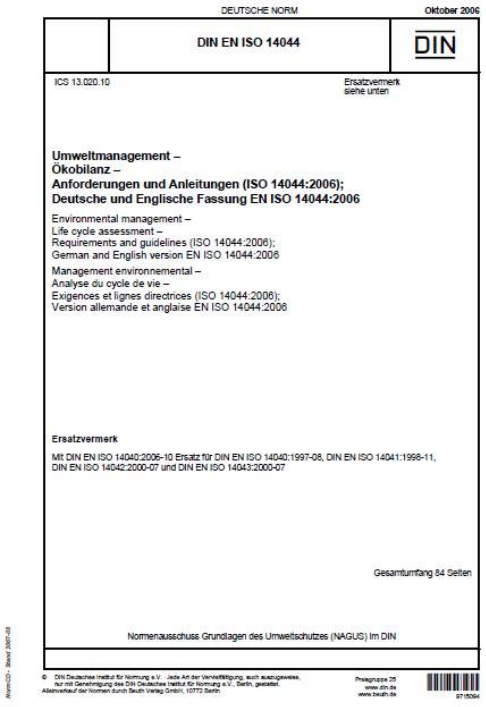
*Life Cycle Assessment is a technique for assessing the **environmental impacts** that occur during all stages of a product´s life cycle (from cradle-to-grave).*



- dates back to the early nineties
- covers approaches like **carbon and water footprints**

Life Cycle Assessment

- ISO 14040 and 14044 specify how to conduct an LCA study



DEUTSCHE NORM Oktober 2006

DIN EN ISO 14044

DIN

ICS 13.020.10

Ersatzvermerk siehe unten

Umweltmanagement –
Ökobilanz –
Anforderungen und Anleitungen (ISO 14044:2006);
Deutsche und Englische Fassung EN ISO 14044:2006

Environmental management –
Life cycle assessment –
Requirements and guidelines (ISO 14044:2006);
German and English version EN ISO 14044:2006

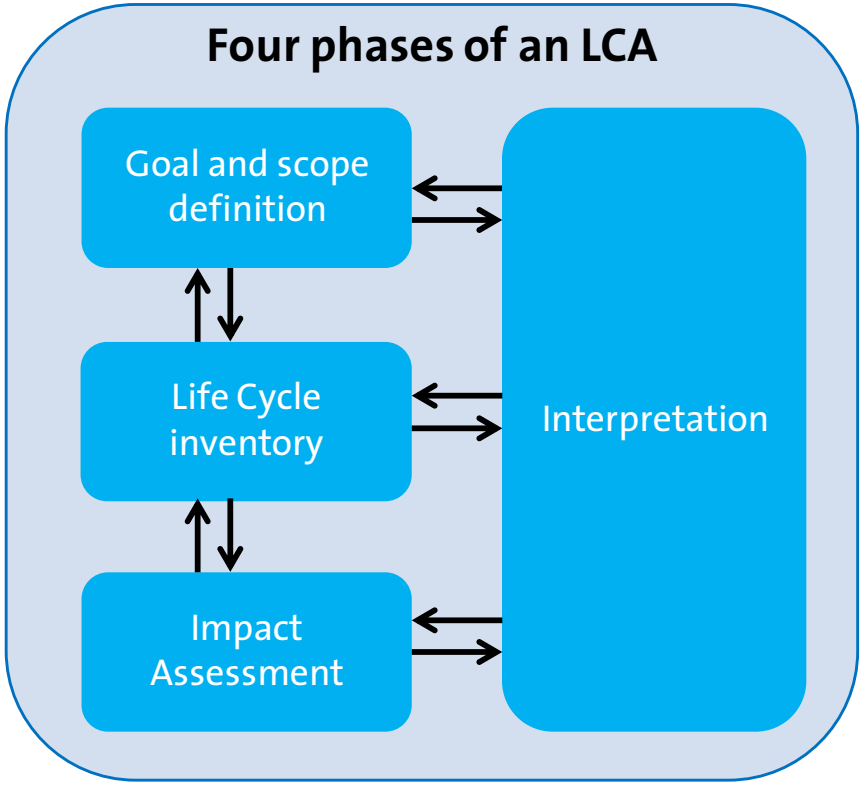
Management environnemental –
Analyse du cycle de vie –
Exigences et lignes directrices (ISO 14044:2006);
Version allemande et anglaise EN ISO 14044:2006

Ersatzvermerk

Mit DIN EN ISO 14040:2006-10 Ersatz für DIN EN ISO 14040:1997-08, DIN EN ISO 14041:1998-11, DIN EN ISO 14042:2000-07 und DIN EN ISO 14043:2000-07

Gesamtumfang 84 Seiten

Normenausschuss Grundlagen des Umweltschutzes (NAGUS) im DIN



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What is Social Life Cycle Assessment?

- Technique to assess **social and socio-economic aspects and impacts** along the entire life cycle of products and services

- Basic approach also defined by ISO 14040 and 14044

- In contrast to E-LCA **positive and negative aspects** are included

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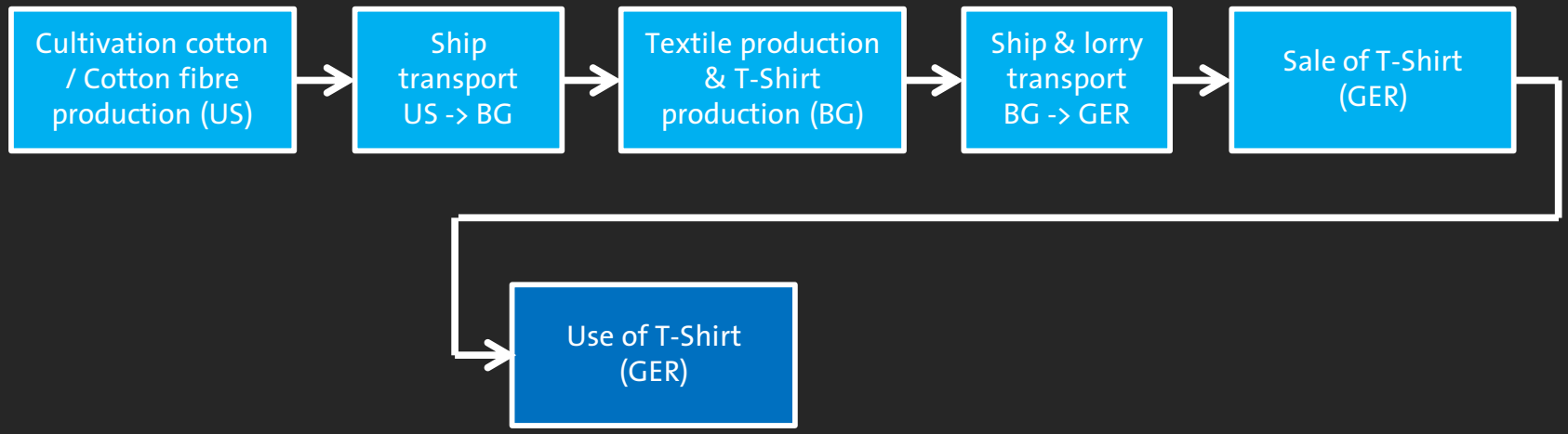
Social Life Cycle Assessment?

- Impacts on different **stakeholders** are assessed, like *workers, local communities, consumers…*
- Impacts are grouped by different **categories** measured by several **indicators**

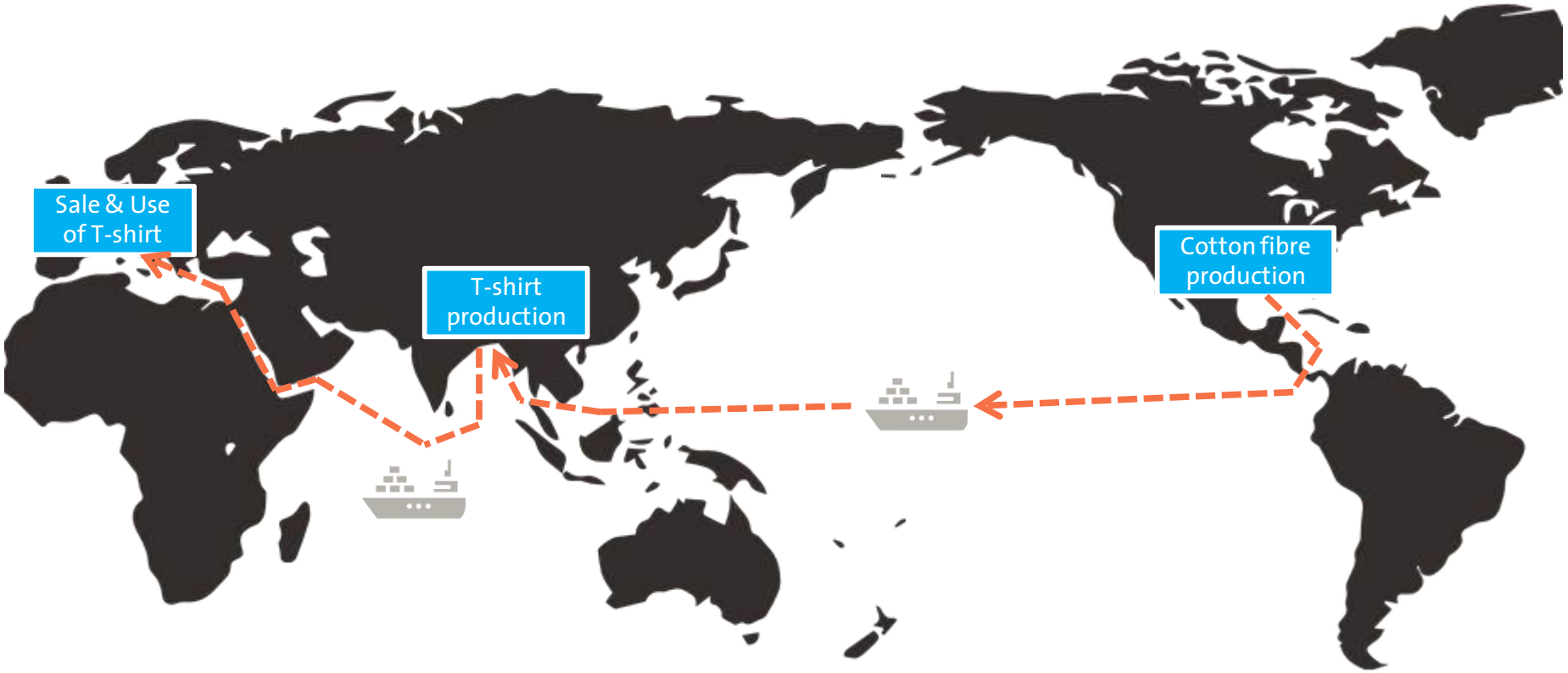
WORKERS	Fair salary	Living wage, per month
		Minimum wage, per month
		Sector average wage, per month
	Working time	Hours of work per employee, per day
		Hours of work per employee, per week
		Standard weekly hours
		Standard daily hours
	Discrimination	Occurrence of discrimination
		Women in the labour force
		Men in the labour force
		Gender wage gap
	Health and Safety	Accident rate at workplace
		Fatal accidents at workplace
		Occupational risks
		DALYs due to indoor and outdoor air and water pollution
		Presence of sufficient safety measures
		Workers affected by natural disasters

Case study: Cotton T-shirt

Life cycle of conventional cotton T-shirt



Production chain conventional cotton T-shirt



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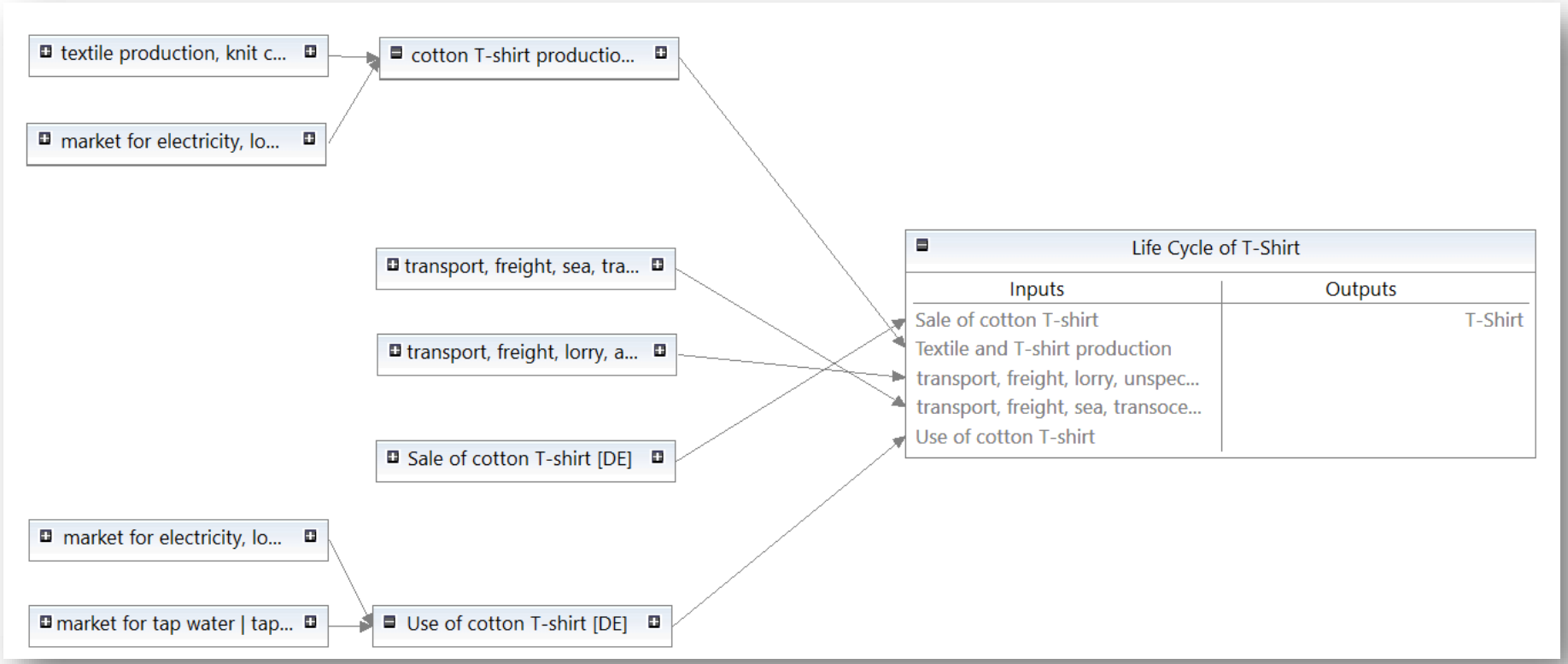
Case study assumptions

- Conventionally grown cotton
- Plain shirt without print
- Use phase of T-shirt: 5 years
- …
- Based on data from (literature) research, and databases for background system (ecoinvent and PSILCA)

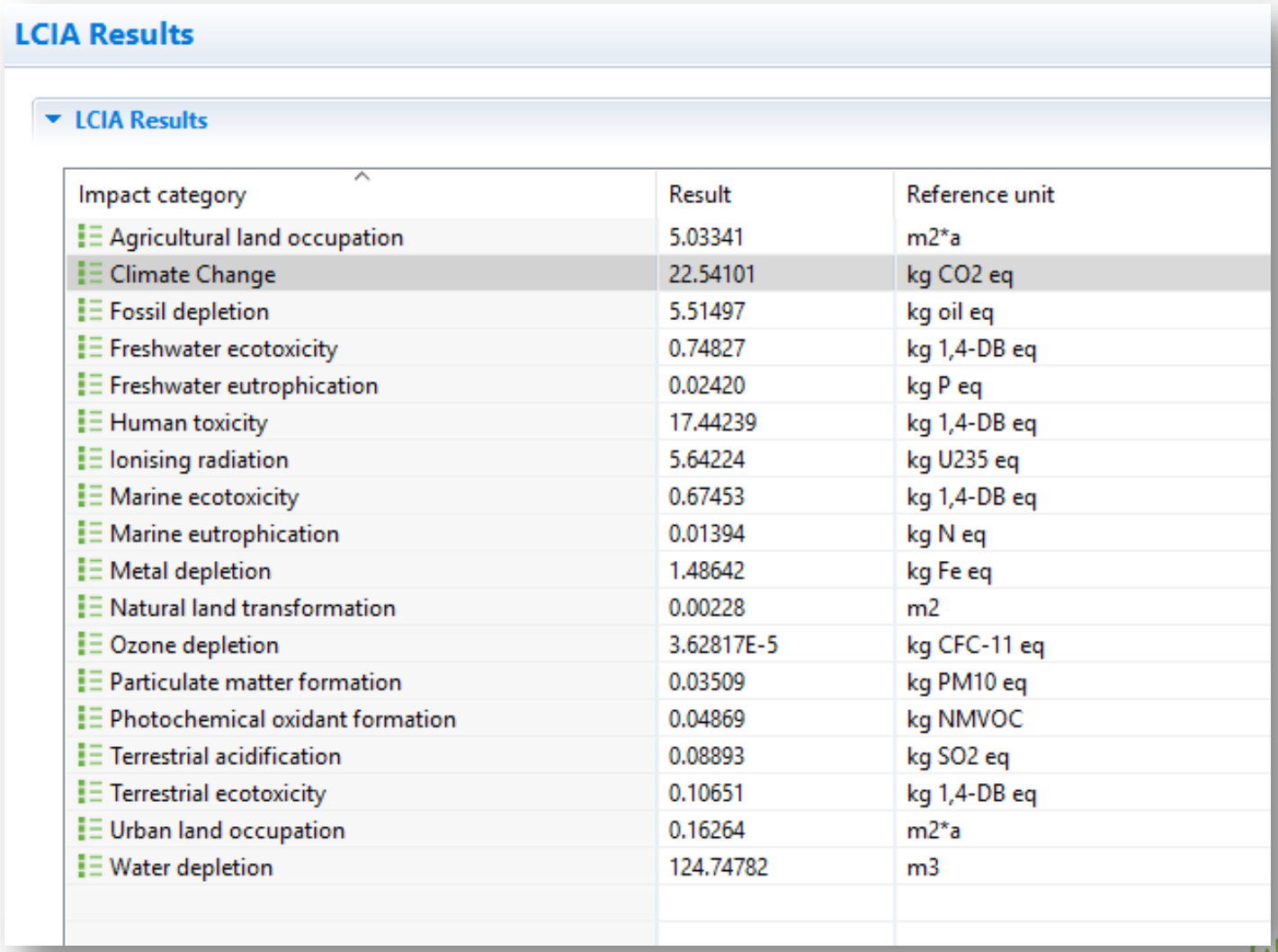
→ see **Appendix** (slide 50) for the references used

Case study: Environmental impacts

Life Cycle of T-shirt, in software



Overall environmental results of T-shirt over complete life cycle

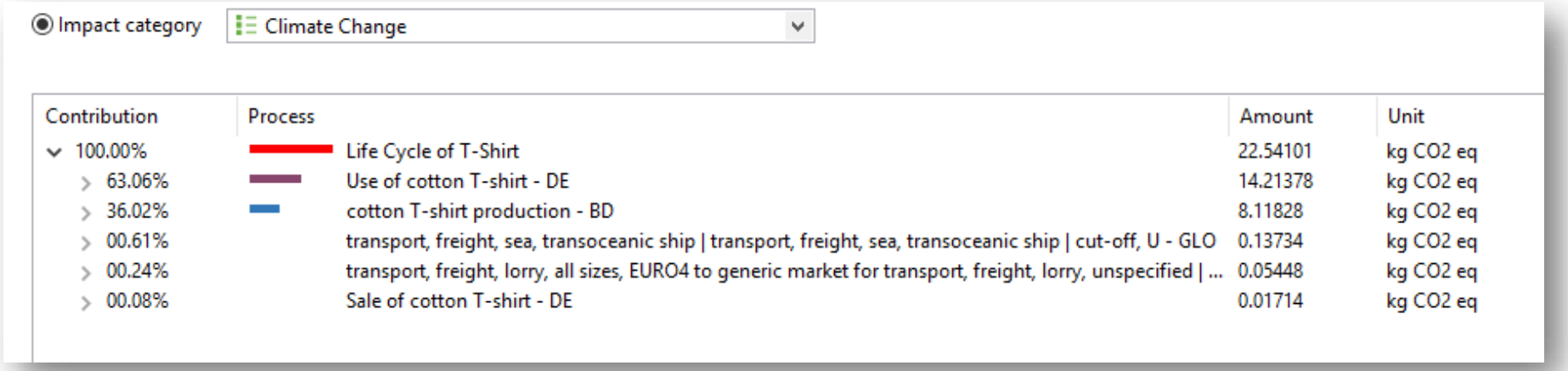


LCIA Results

LCIA Results

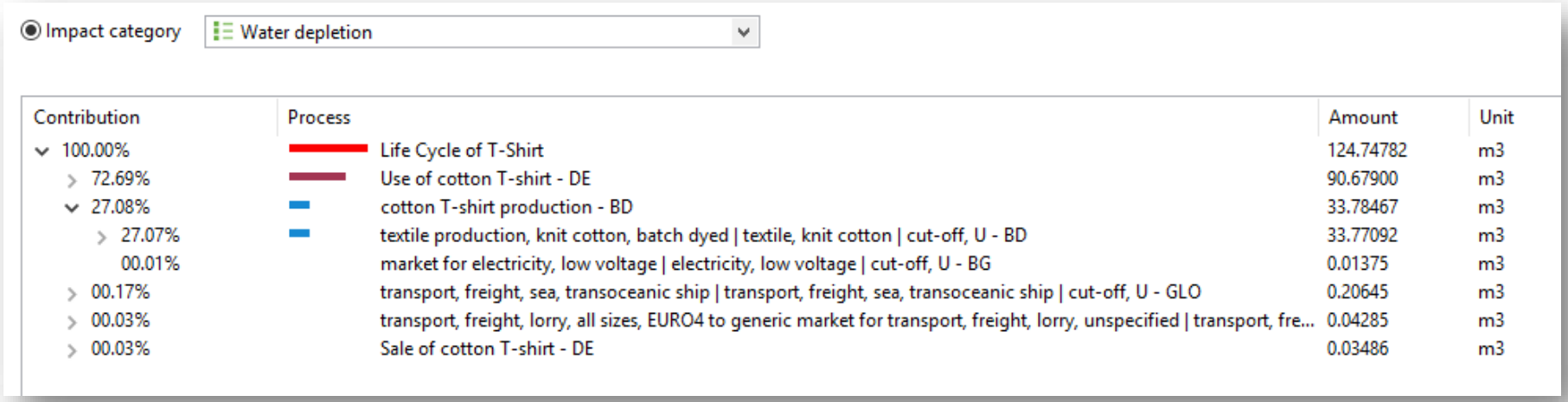
Impact category	Result	Reference unit
Agricultural land occupation	5.03341	m2*a
Climate Change	22.54101	kg CO2 eq
Fossil depletion	5.51497	kg oil eq
Freshwater ecotoxicity	0.74827	kg 1,4-DB eq
Freshwater eutrophication	0.02420	kg P eq
Human toxicity	17.44239	kg 1,4-DB eq
Ionising radiation	5.64224	kg U235 eq
Marine ecotoxicity	0.67453	kg 1,4-DB eq
Marine eutrophication	0.01394	kg N eq
Metal depletion	1.48642	kg Fe eq
Natural land transformation	0.00228	m2
Ozone depletion	3.62817E-5	kg CFC-11 eq
Particulate matter formation	0.03509	kg PM10 eq
Photochemical oxidant formation	0.04869	kg NMVOC
Terrestrial acidification	0.08893	kg SO2 eq
Terrestrial ecotoxicity	0.10651	kg 1,4-DB eq
Urban land occupation	0.16264	m2*a
Water depletion	124.74782	m3

Impacts on Climate Change, per life cycle stage



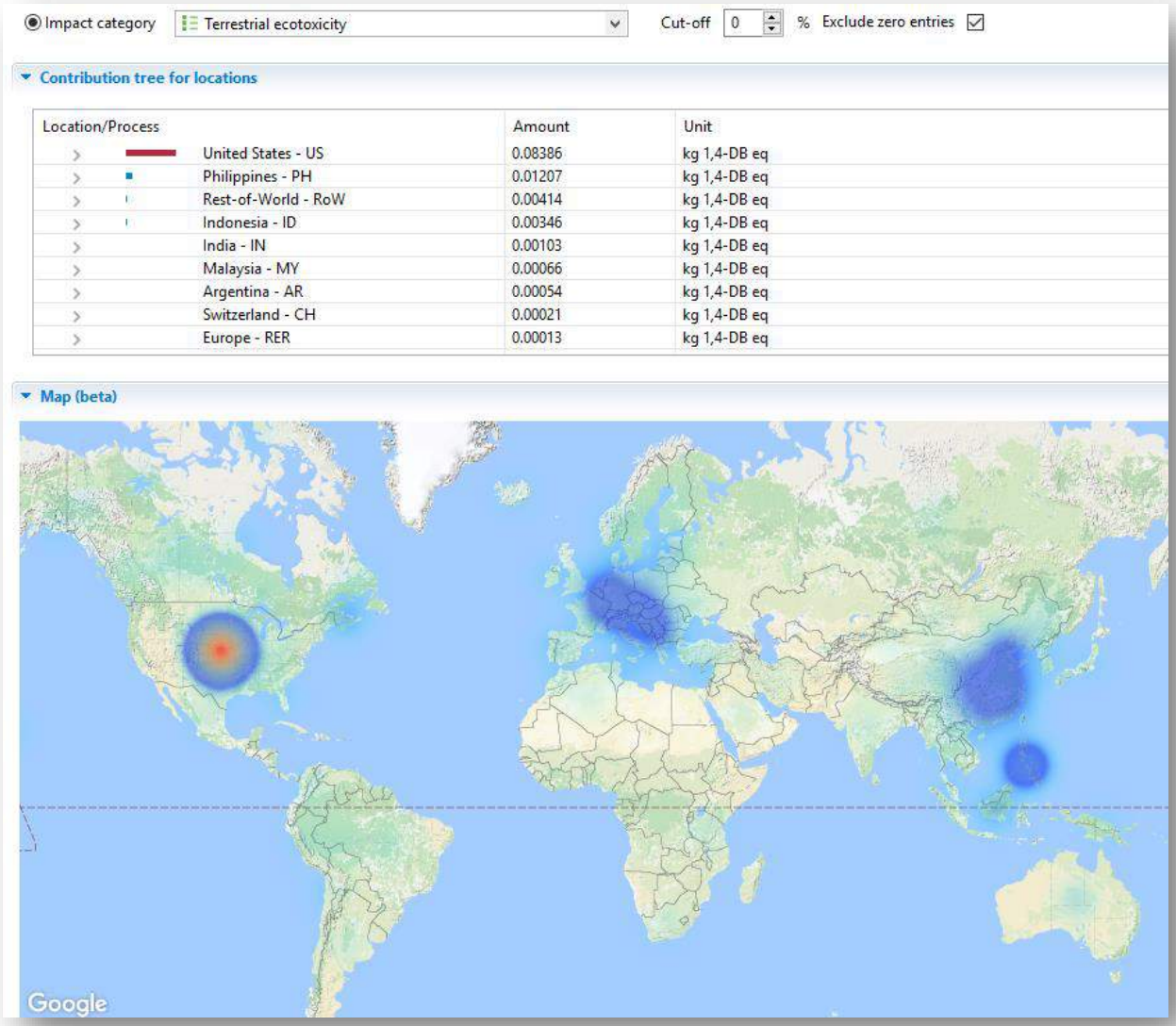
Contribution	Process	Amount	Unit
100.00%	Life Cycle of T-Shirt	22.54101	kg CO2 eq
63.06%	Use of cotton T-shirt - DE	14.21378	kg CO2 eq
36.02%	cotton T-shirt production - BD	8.11828	kg CO2 eq
00.61%	transport, freight, sea, transoceanic ship | transport, freight, sea, transoceanic ship | cut-off, U - GLO	0.13734	kg CO2 eq
00.24%	transport, freight, lorry, all sizes, EURO4 to generic market for transport, freight, lorry, unspecified | ...	0.05448	kg CO2 eq
00.08%	Sale of cotton T-shirt - DE	0.01714	kg CO2 eq

Impacts on Water depletion, per life cycle stage



Contribution	Process	Amount	Unit
100.00%	Life Cycle of T-Shirt	124.74782	m3
72.69%	Use of cotton T-shirt - DE	90.67900	m3
27.08%	cotton T-shirt production - BD	33.78467	m3
27.07%	textile production, knit cotton, batch dyed | textile, knit cotton | cut-off, U - BD	33.77092	m3
00.01%	market for electricity, low voltage | electricity, low voltage | cut-off, U - BG	0.01375	m3
00.17%	transport, freight, sea, transoceanic ship | transport, freight, sea, transoceanic ship | cut-off, U - GLO	0.20645	m3
00.03%	transport, freight, lorry, all sizes, EURO4 to generic market for transport, freight, lorry, unspecified | transport, fre...	0.04285	m3
00.03%	Sale of cotton T-shirt - DE	0.03486	m3

Localisation of impacts on Terrestrial ecotoxicity



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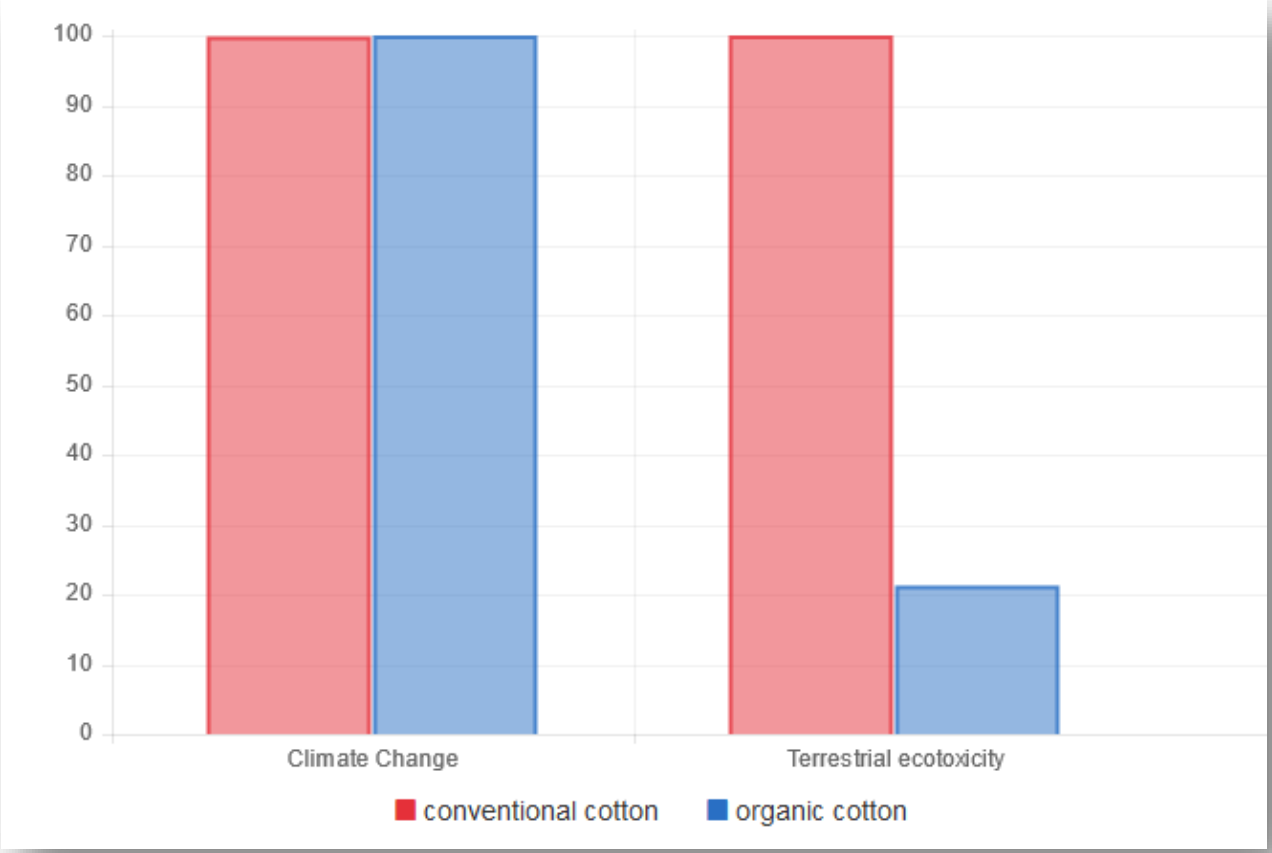
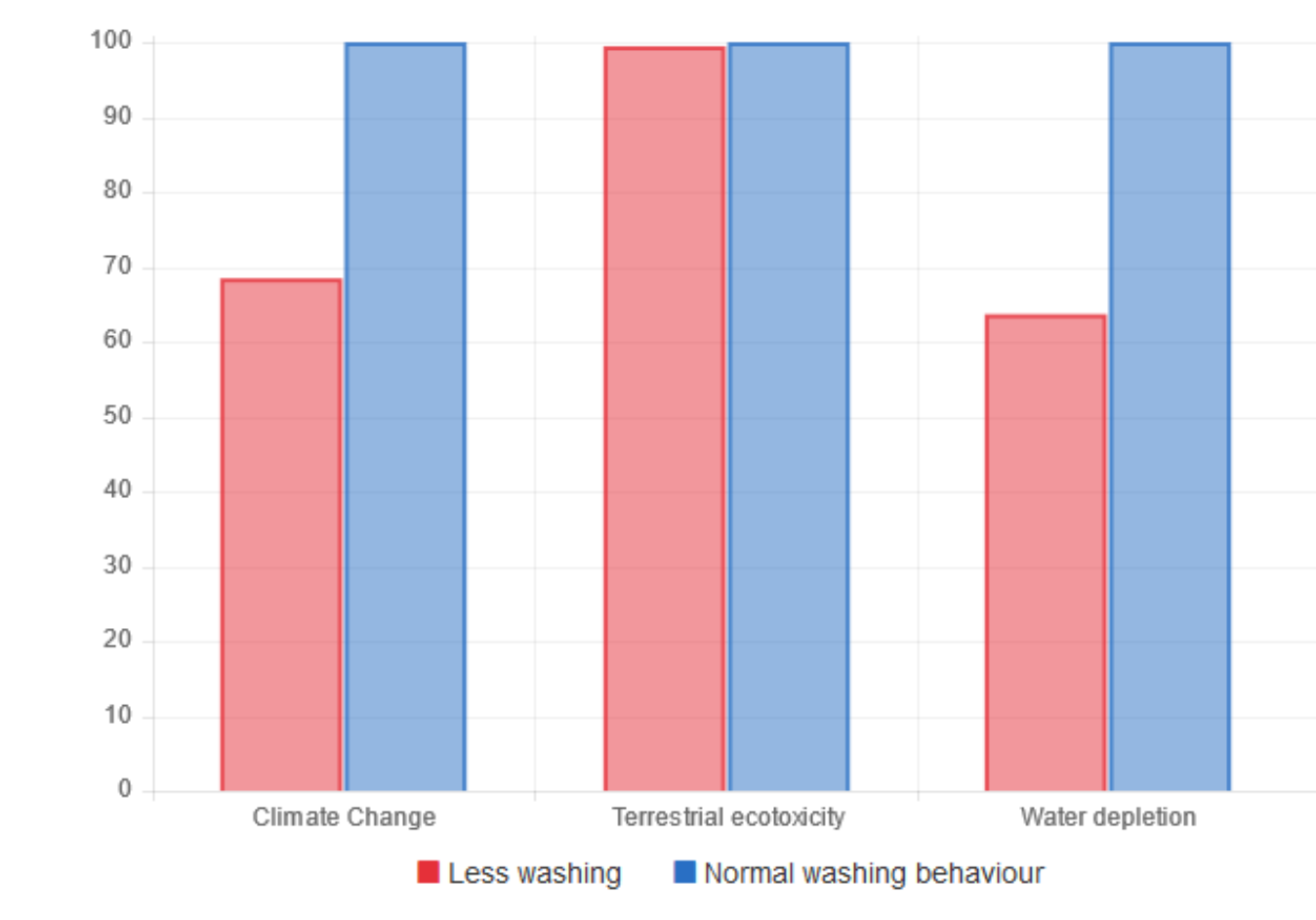
Comparing different scenarios

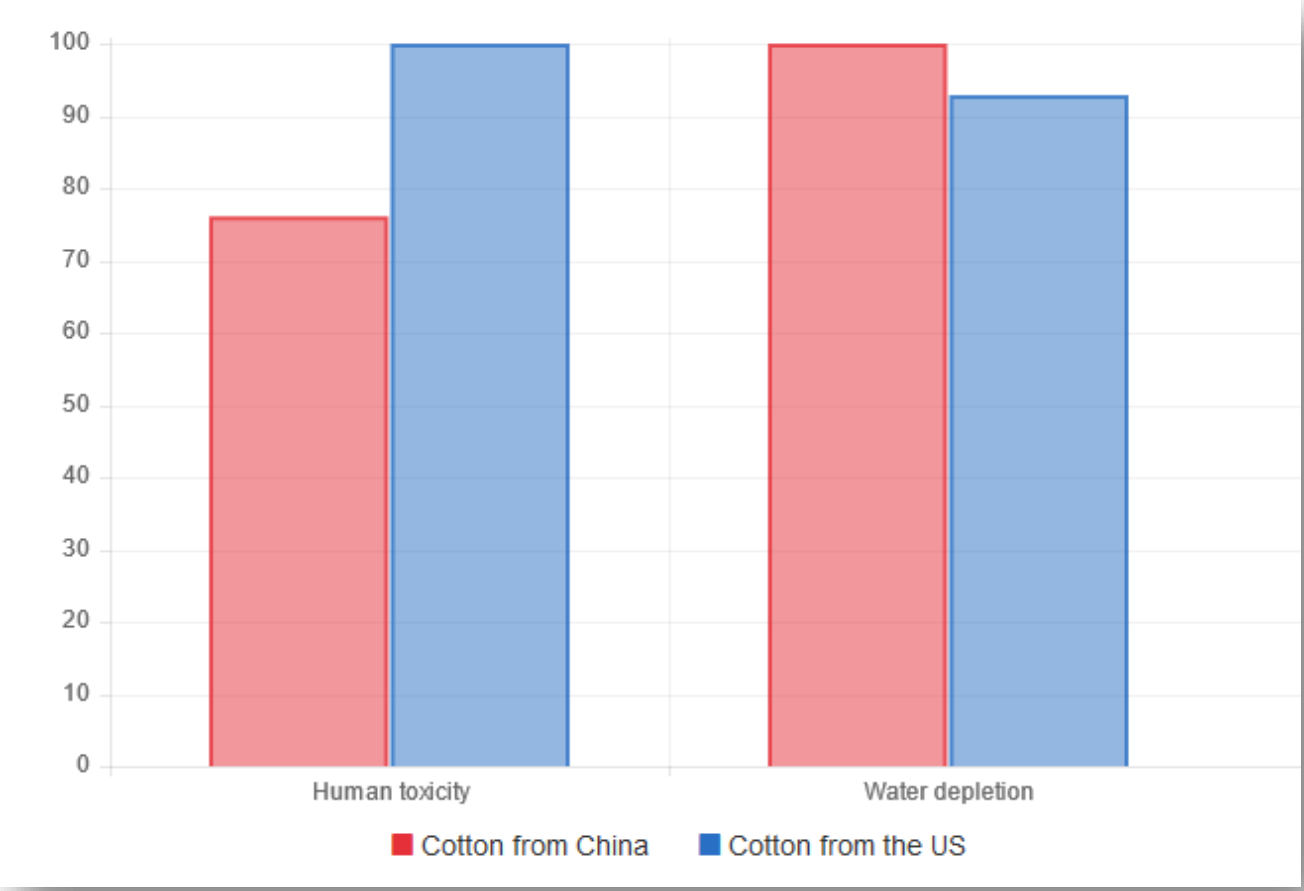
Conventional vs. organic cotton growing, both in US



Washing behaviour: 28 instead of 55 times/year

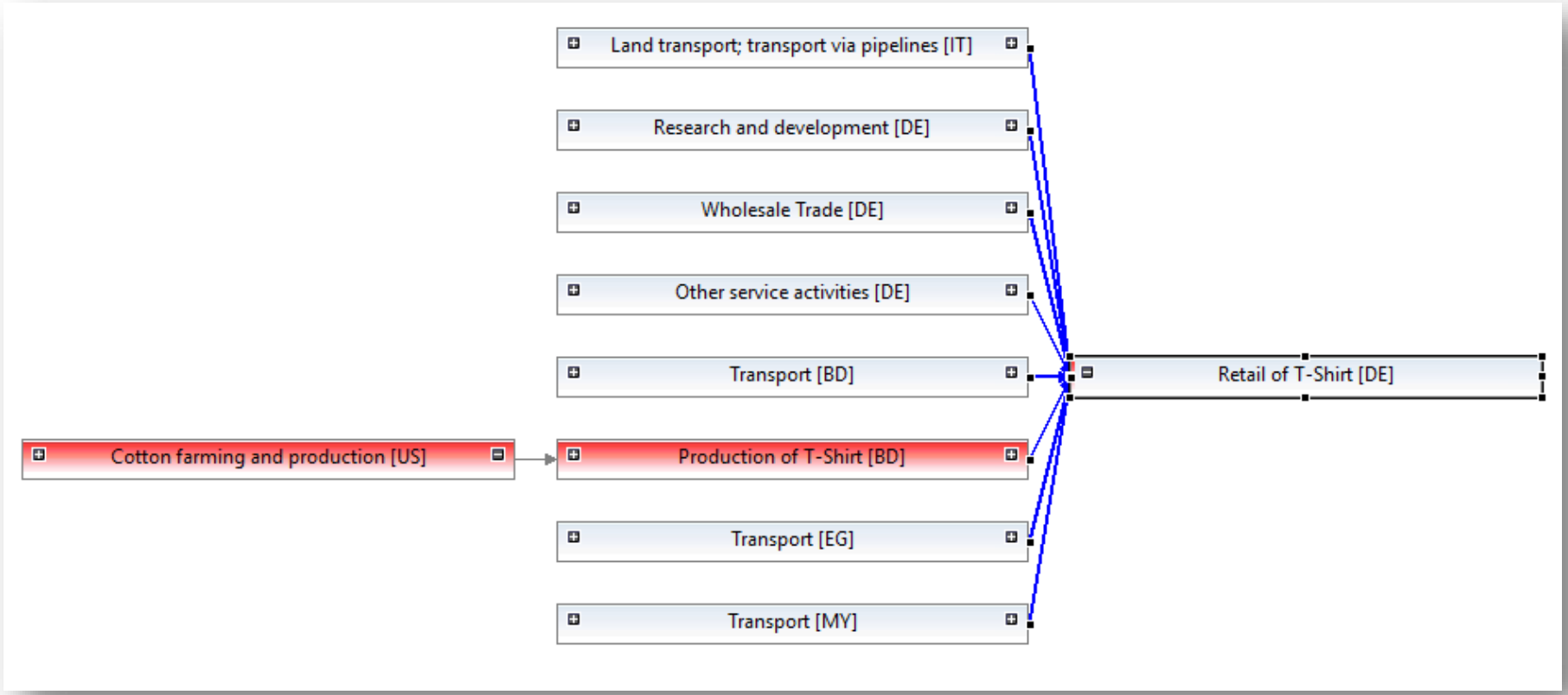


Cotton growing in the US vs. in China



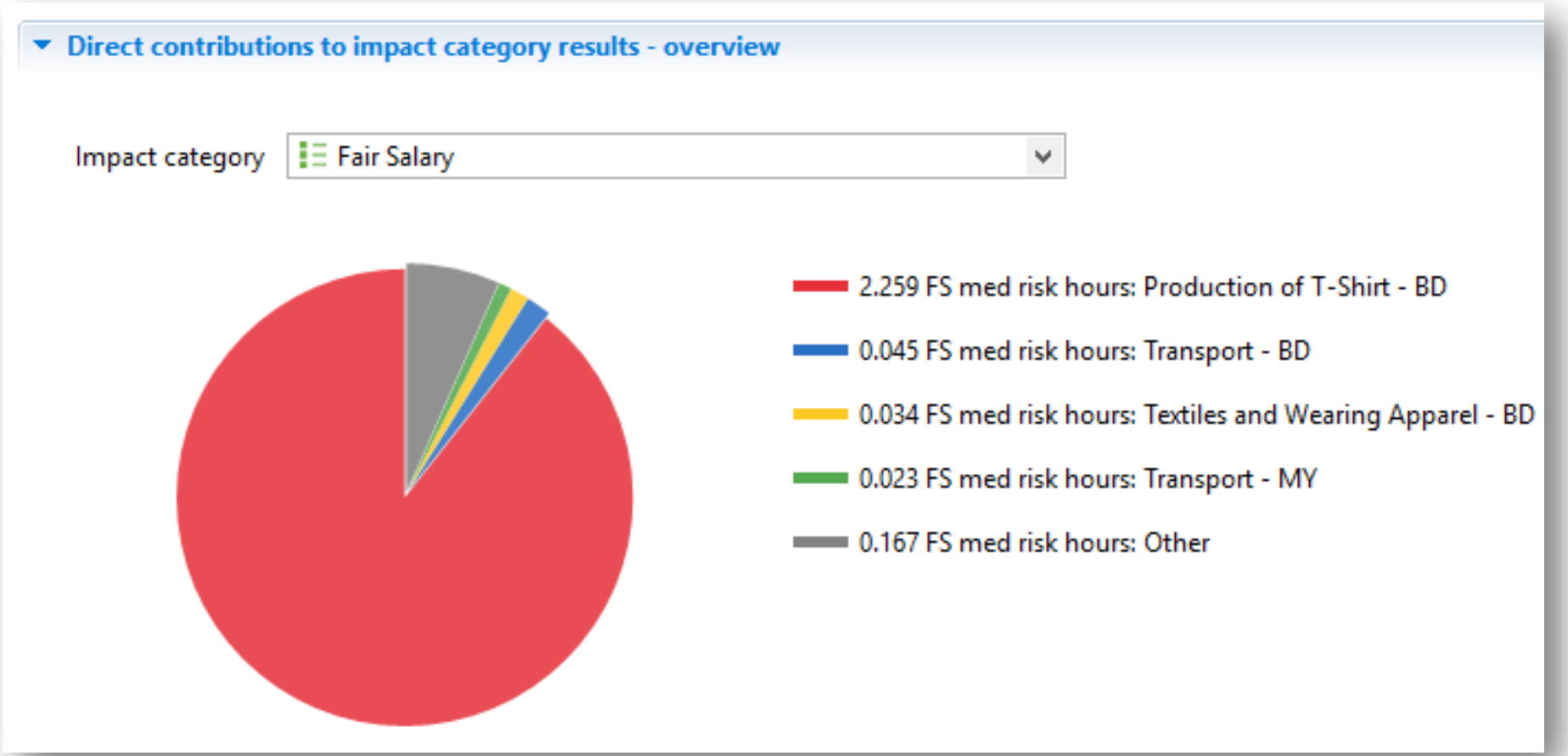
Case study: Social impacts

Foreground system for the S-LCA



Direct process contributions to the risk of unfair salaries

- Without calculating process upstream chains



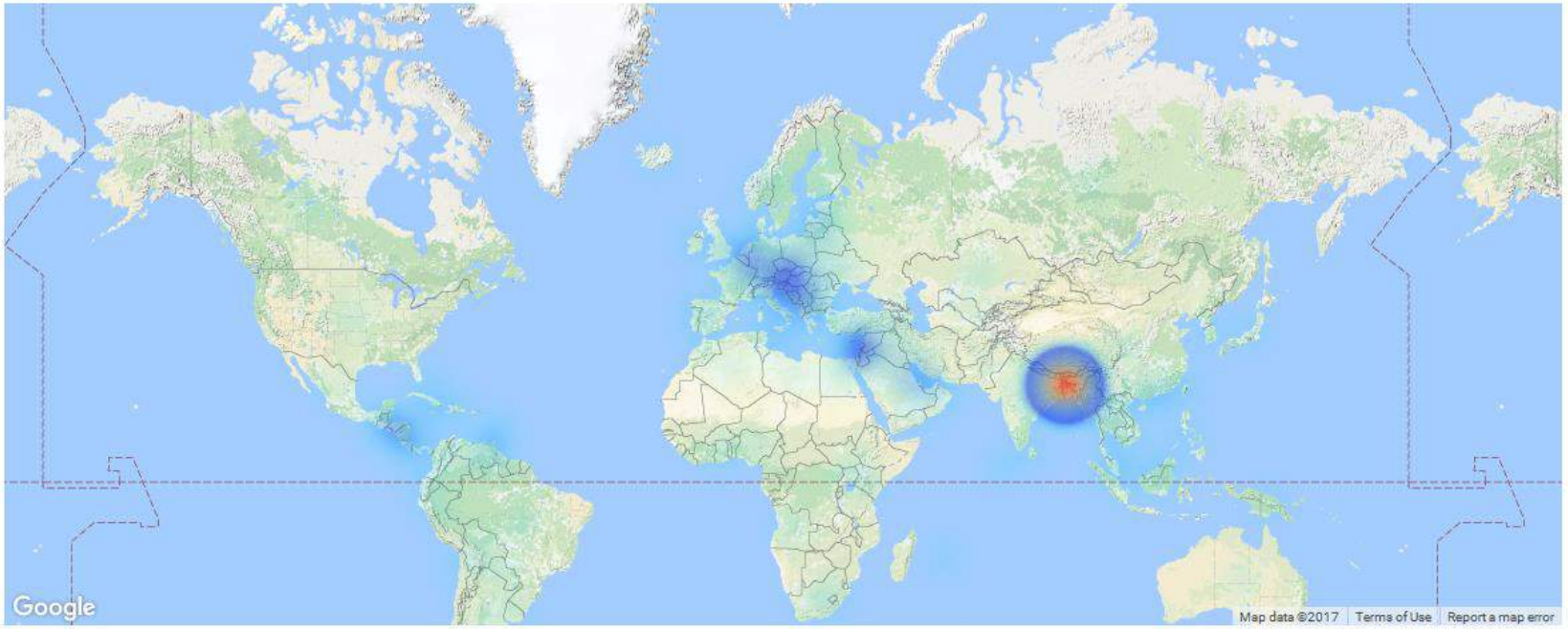
Social hotspots (countries) regarding the risk of unfair salaries

Impact category: Fair Salary | Cut-off: 0 % | Exclude zero entries

Contribution tree for locations

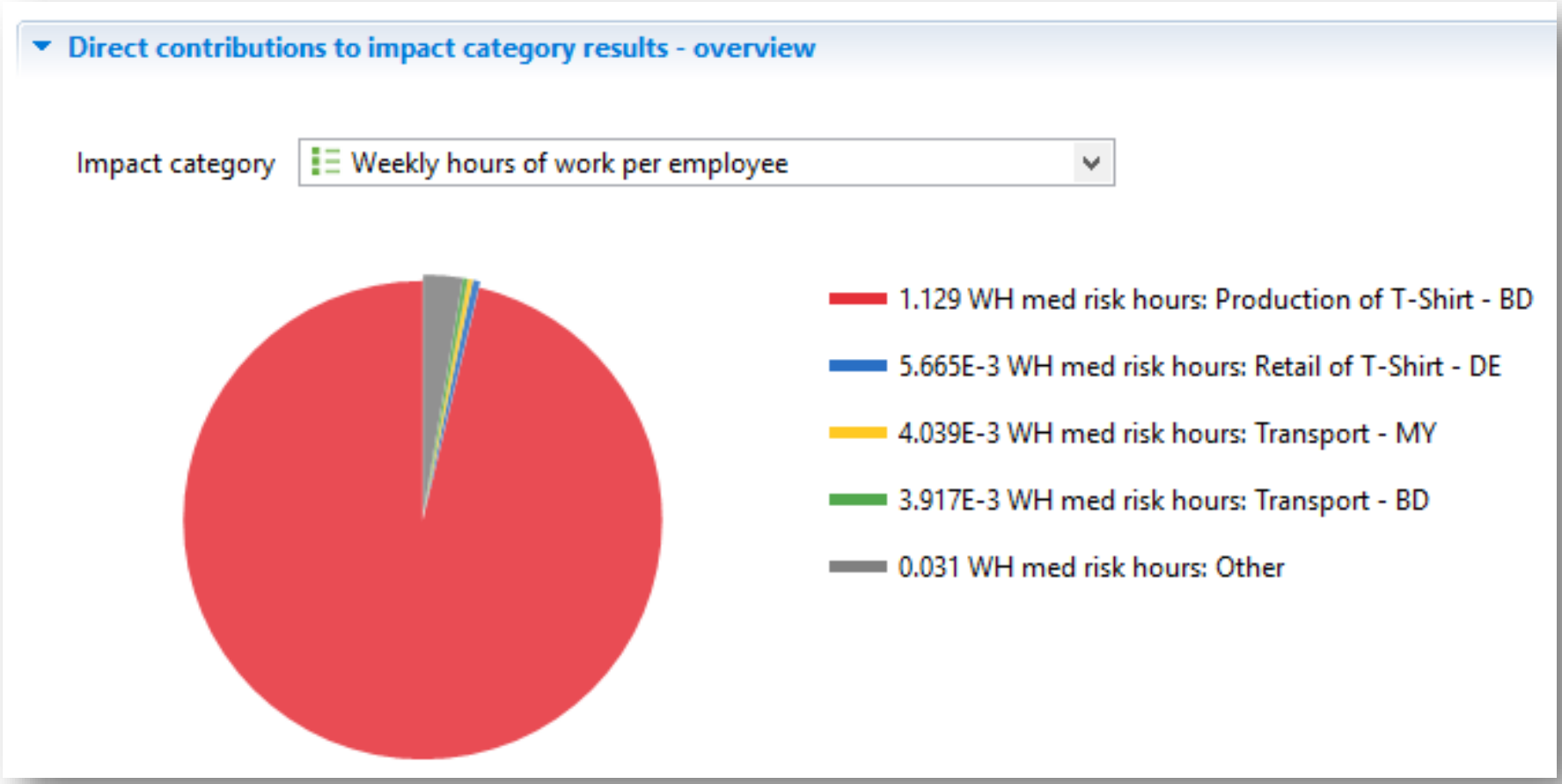
Location/Process	Amount	Unit
Bangladesh - BD	2.35886	FS med risk hours
Malaysia - MY	0.03013	FS med risk hours
China - CN	0.02598	FS med risk hours
Germany - DE	0.02453	FS med risk hours
United States - US	0.02226	FS med risk hours
Mexico - MX	0.02006	FS med risk hours
India - IN	0.01317	FS med risk hours
Egypt - EG	0.00352	FS med risk hours
Argentina - AR	0.00277	FS med risk hours

Map (beta)



Direct process contributions to the risk of overtime

- Without calculating process upstream chains



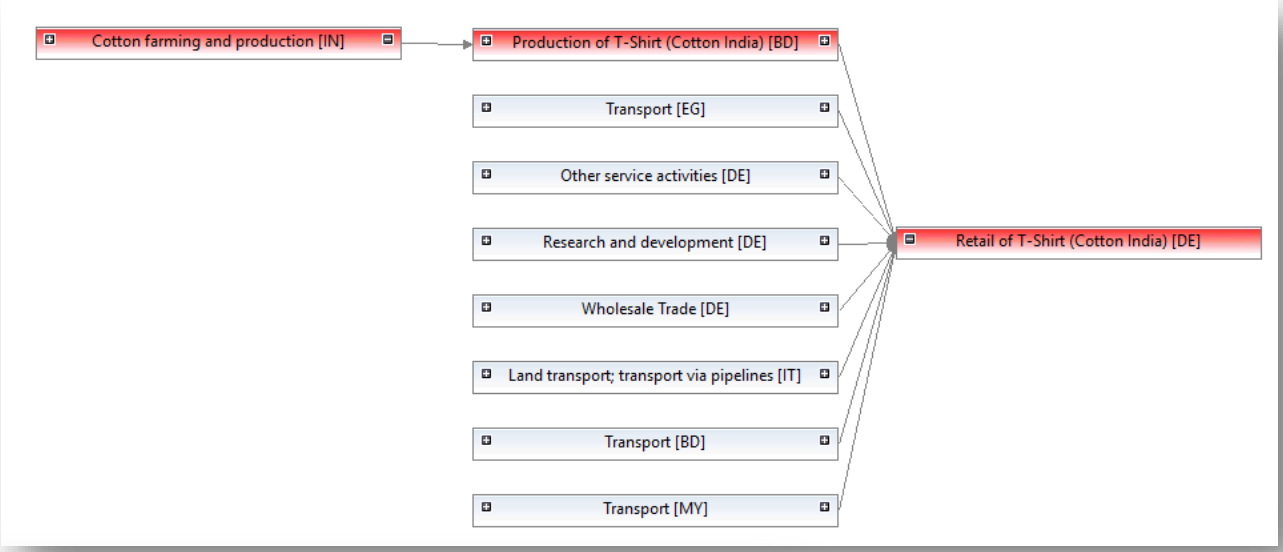
Sun burst diagram for the risk of overtime

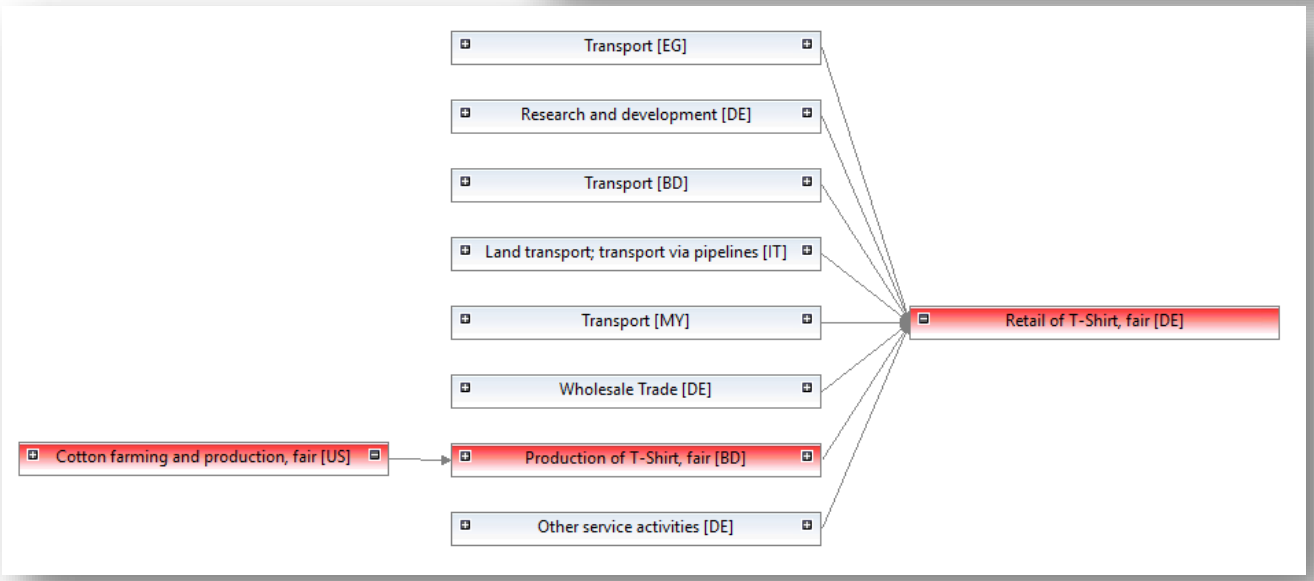
- Including process upstream chains

Comparing different scenarios

Foreground systems for other scenarios

Scenario 2: cotton from India





Scenario 3: „fair“ T-shirt

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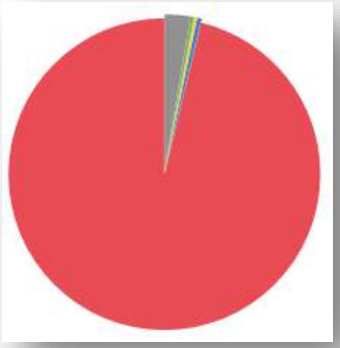
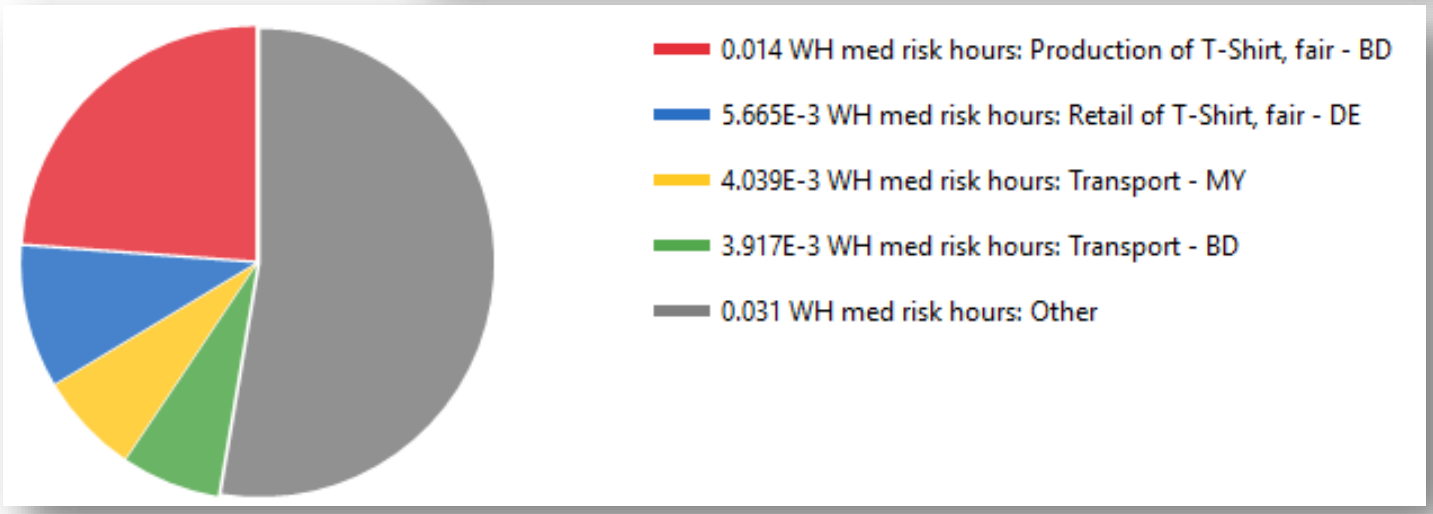
Direct process contributions to the risk of overtime

Scenario 1



Scenario 2:
cotton from India



Scenario 3: „fair“ T-shirt

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Social hotspots regarding the risk of unfair salaries

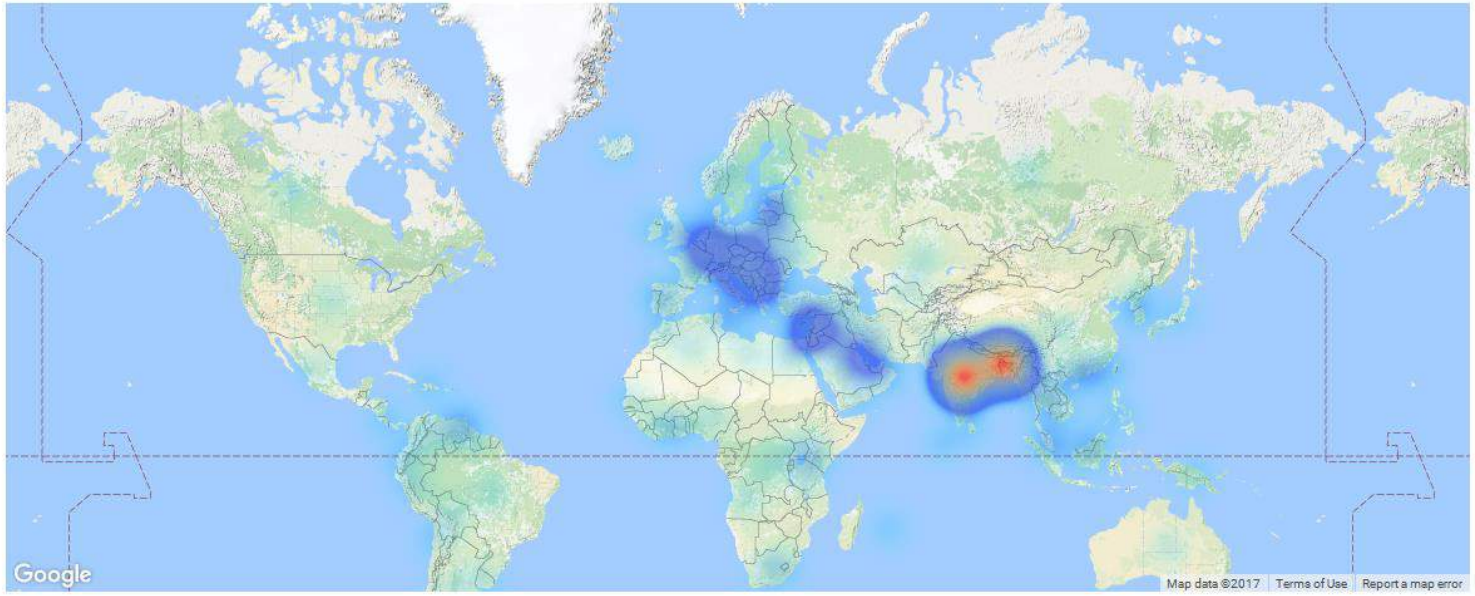
Scenario 1

Impact category: Fair Salary Cut-off: 0 % Exclude zero entries

Contribution tree for locations

Location/Process	Amount	Unit
India - IN	2.38670	FS med risk hours
Bangladesh - BD	2.35898	FS med risk hours
Malaysia - MY	0.03007	FS med risk hours
Germany - DE	0.02450	FS med risk hours
China - CN	0.01114	FS med risk hours
Mexico - MX	0.00494	FS med risk hours
Egypt - EG	0.00352	FS med risk hours
Turkey - TR	0.00245	FS med risk hours
Italy - IT	0.00205	FS med risk hours

Map (beta)



Scenario 2:
cotton from India

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Social hotspots regarding the risk of unfair salaries

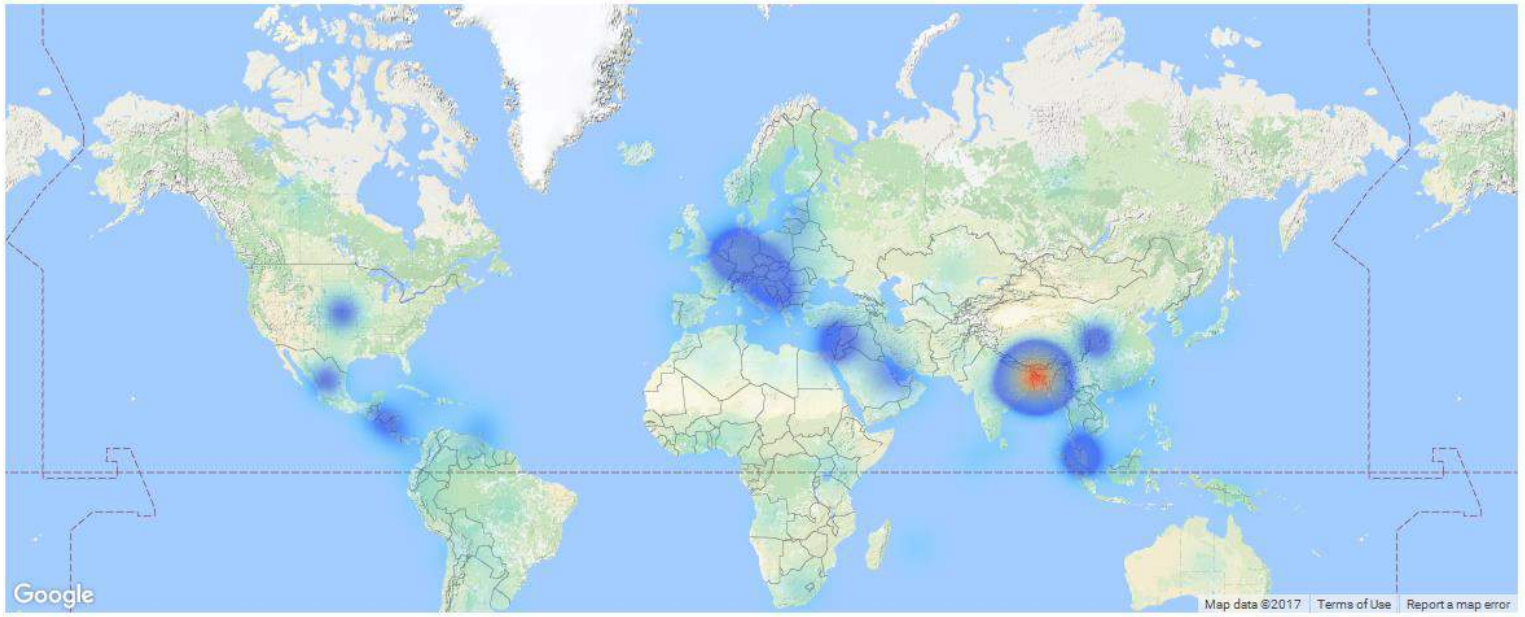
Scenario 1

Impact category: Fair Salary | Cut-off: 0 % | Exclude zero entries

Contribution tree for locations

Location/Process	Amount	Unit
Bangladesh - BD	0.27988	FS med risk hours
Malaysia - MY	0.03013	FS med risk hours
China - CN	0.02598	FS med risk hours
Germany - DE	0.02453	FS med risk hours
United States - US	0.02226	FS med risk hours
Mexico - MX	0.02006	FS med risk hours
India - IN	0.01317	FS med risk hours
Egypt - EG	0.00352	FS med risk hours
Argentina - AR	0.00277	FS med risk hours

Map (beta)



Scenario 2:
Fair T-shirt

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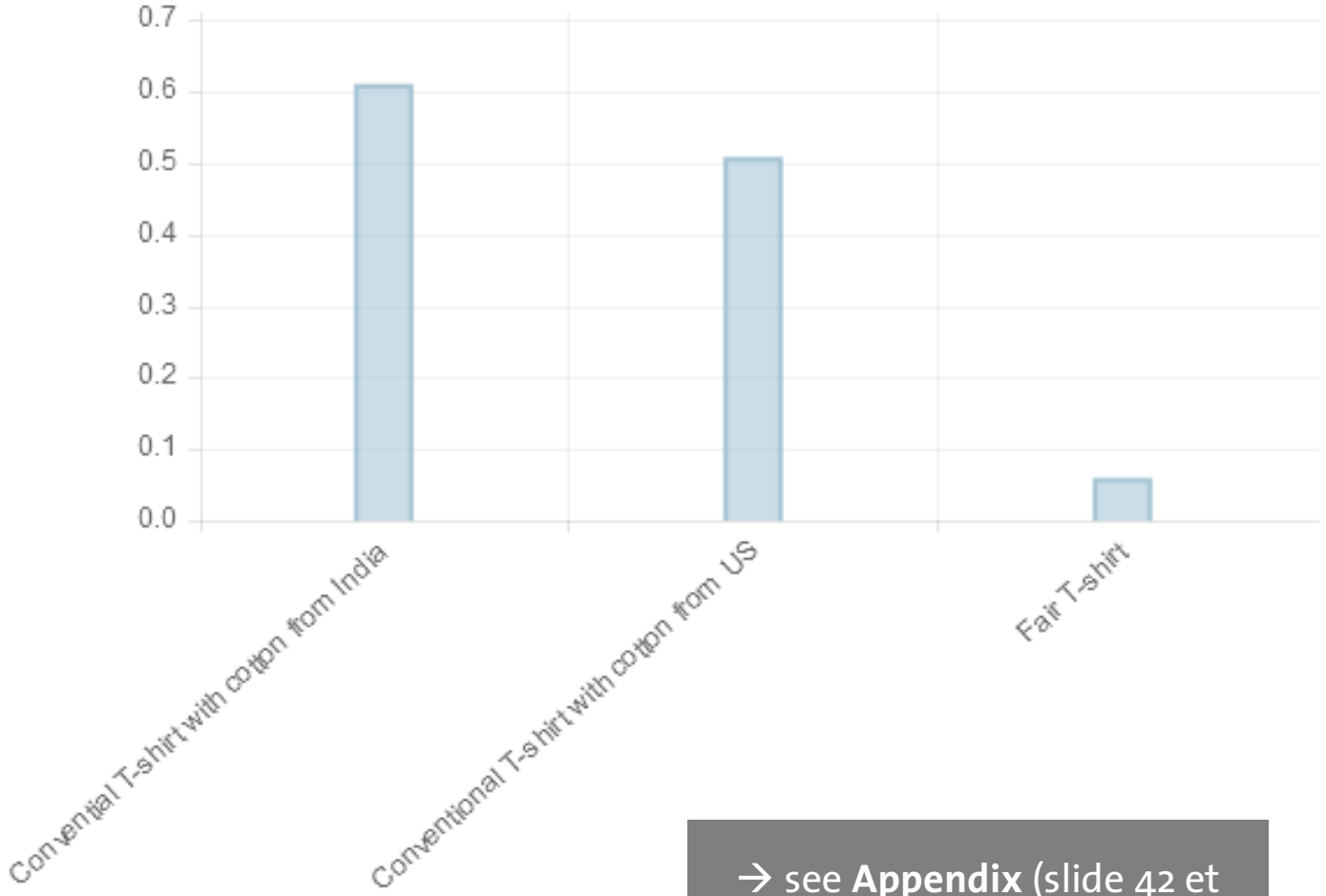
Comparison of the total risk of Non-fatal accidents



→ see **Appendix** (slide 42 et seqq.) for further comparisons

What to do with the results

Benefits of LCA

- Transparent overview of environmental and social impacts over the entire life cycle, including use (and disposal) phase
- Identification of weaknesses and optimization potential of the investigated product
  - Uncover unexpected hotspots
- Efficient way to assess the entire life of a product

What to do with the results

- Compare different options of products and services→ for decision making in product development or improvement
- To compare and benchmark suppliers
- As a basis for certification and labelling
- As a basis for CSR
- Marketing

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software / data / know-how

Thank you!

Contact

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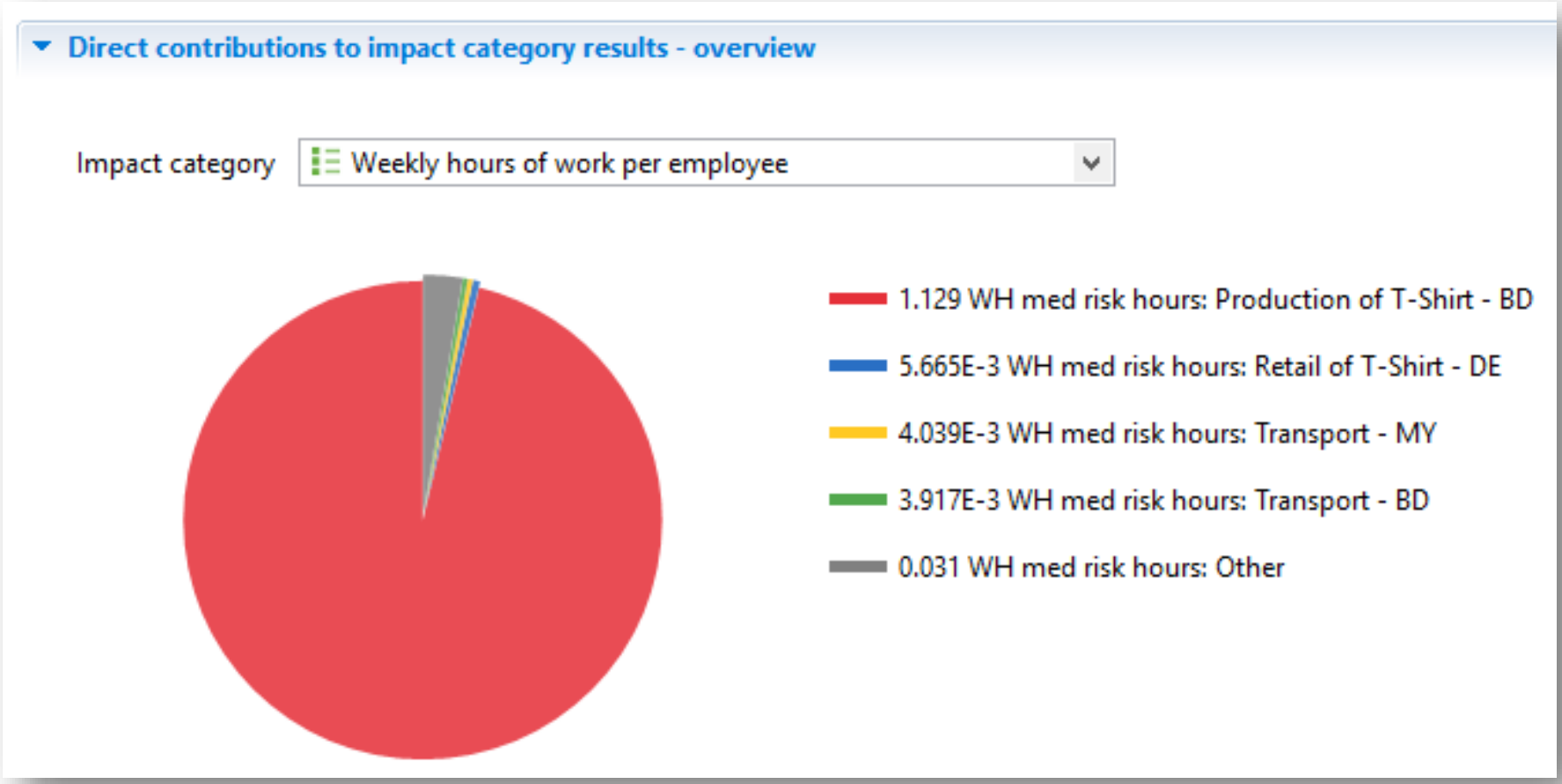
Muellerstrasse 135, 13349 Berlin
www.greendelta.com

Appendix 1: Further comparisons of S-LCA scenarios

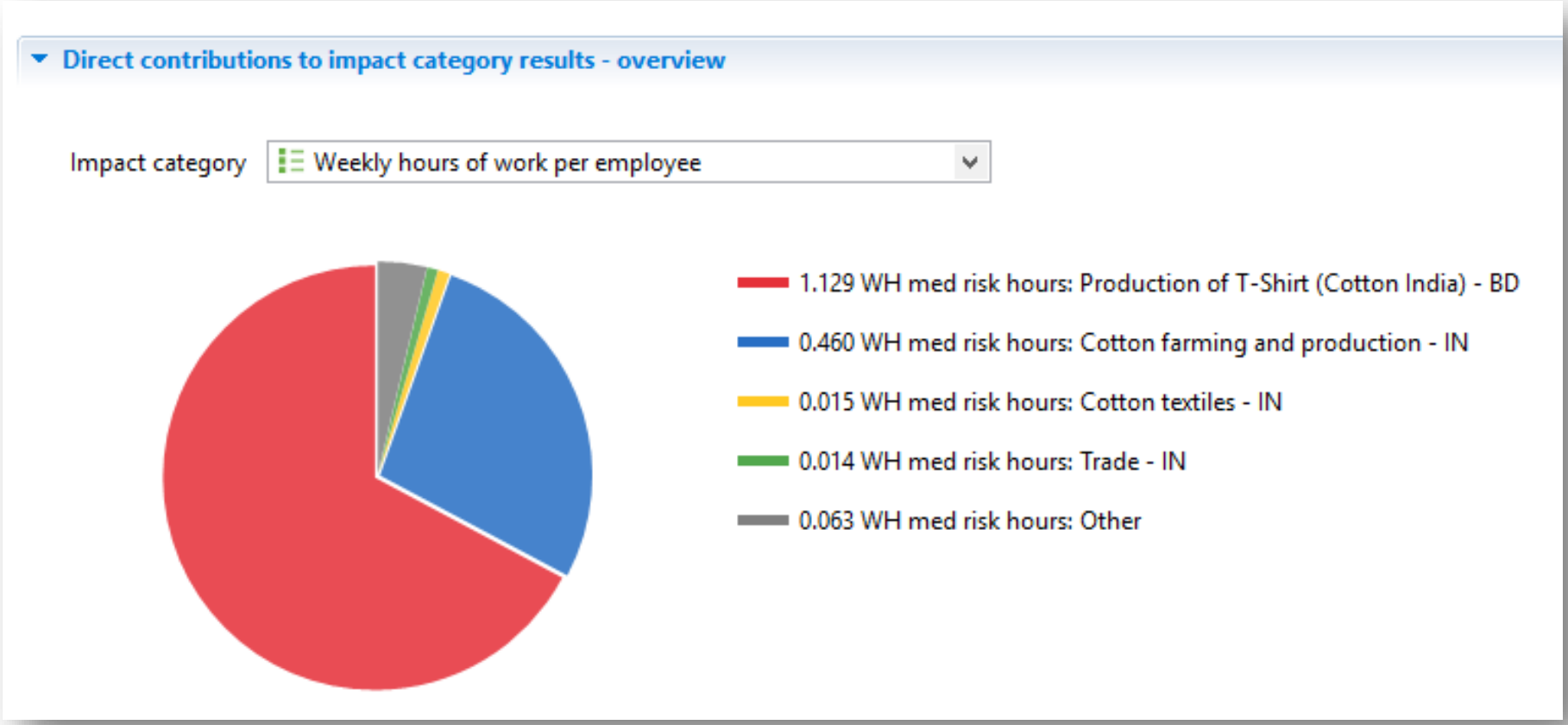
Direct process contributions to the risk of overtime

- Scenario 1: Cotton from US



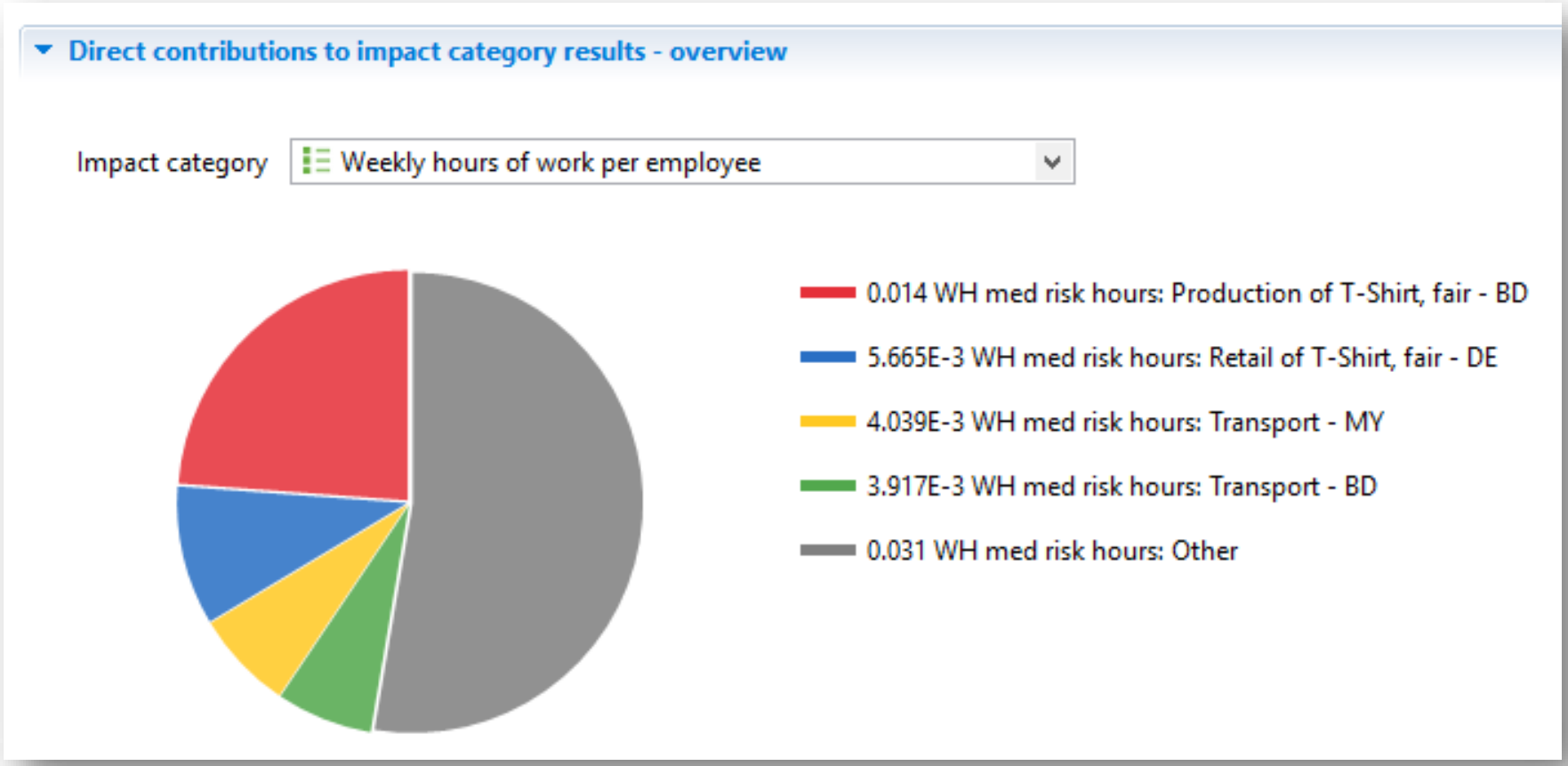
Direct process contributions to the risk of overtime

- Scenario 2: Cotton from India



Direct process contributions to the risk of overtime

- Scenario 3: “Fair” T-shirt

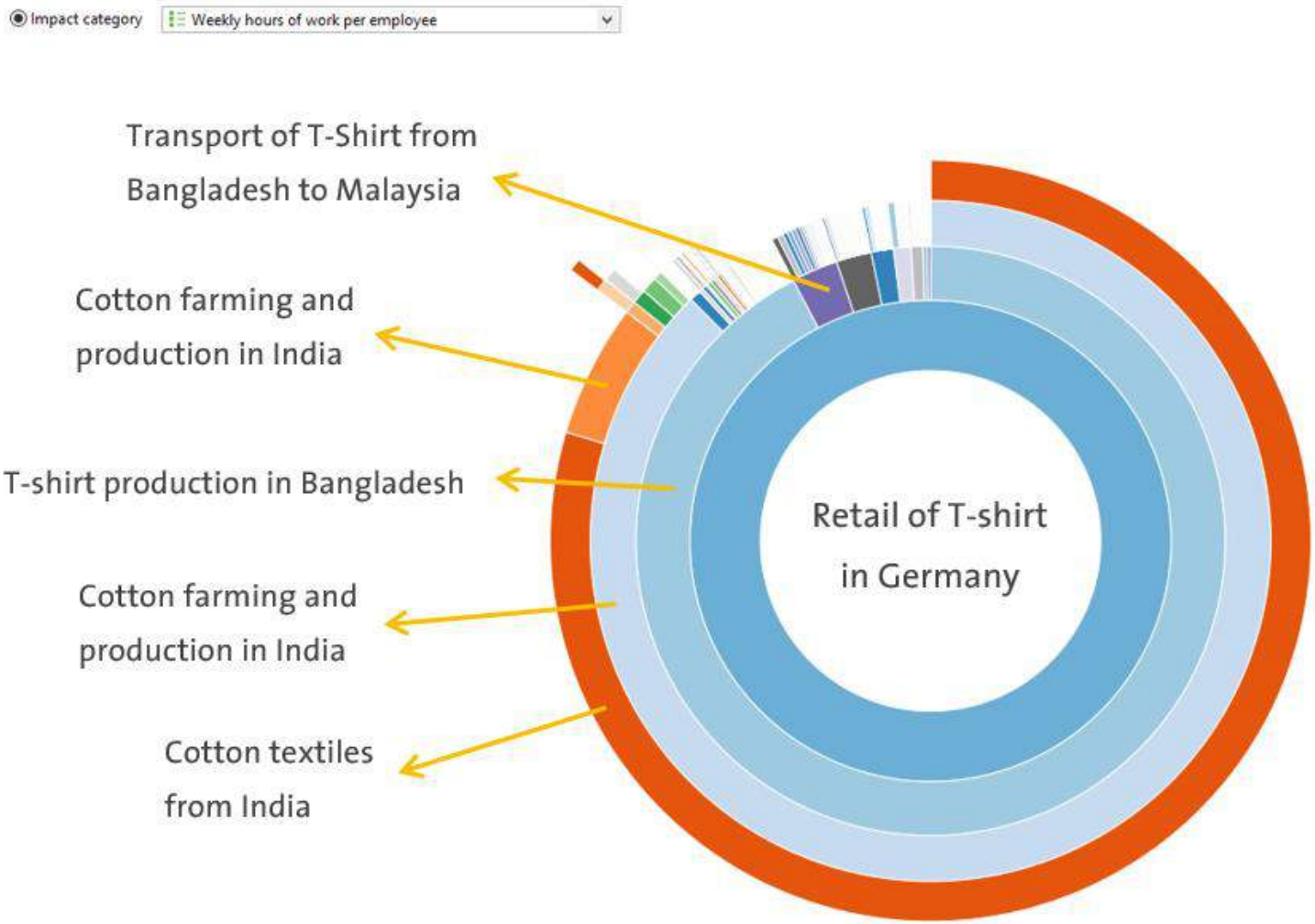


Sun burst diagram for the risk of overtime

- Scenario 1: Cotton from US

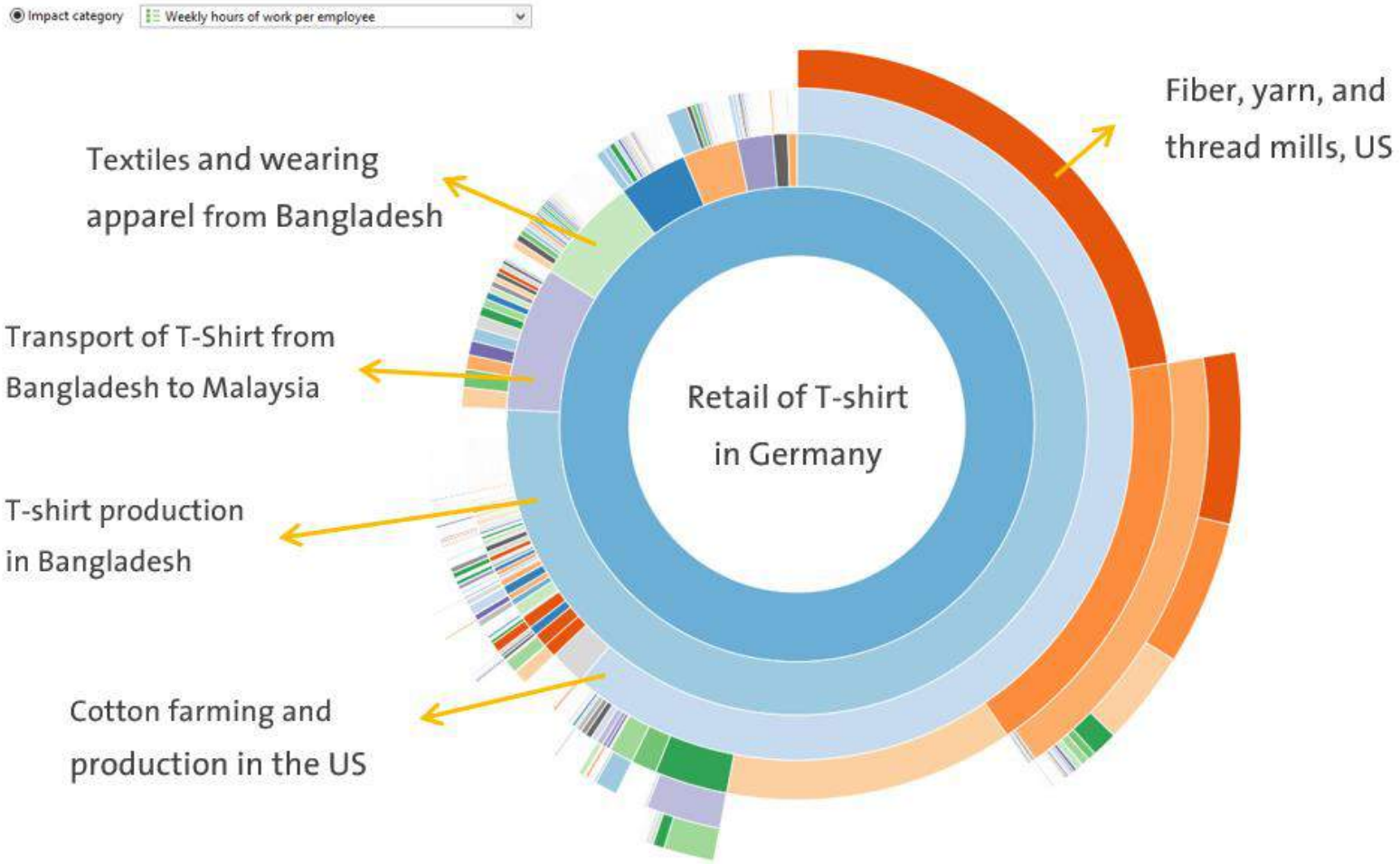
Sun burst diagram for the risk of overtime

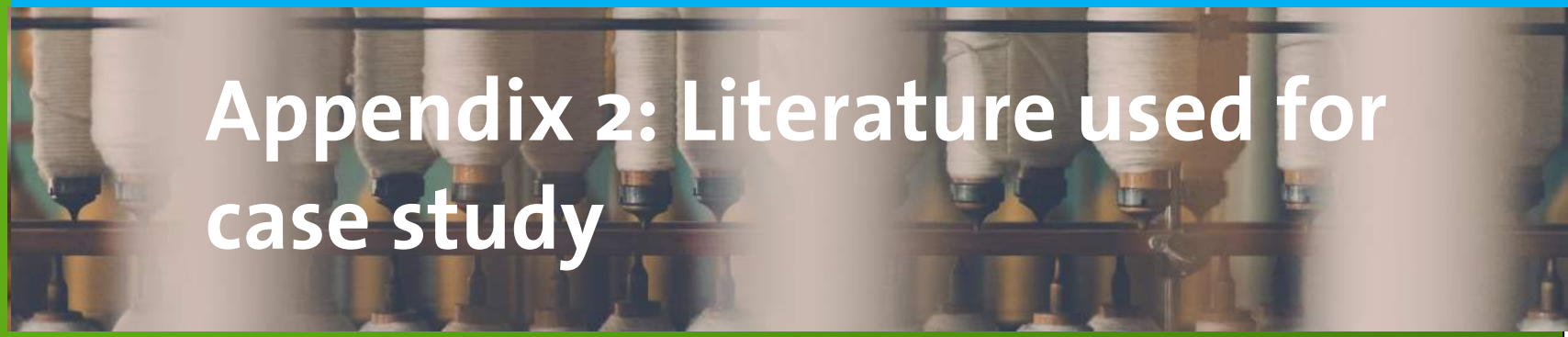
- Scenario 2: Cotton from India



Sun burst diagram for the risk of overtime

- Scenario 3: “Fair” T-shirt





Appendix 2: Literature used for case study

- Transportation route, weight of T-shirt, prices of components and processes, working conditions in production sites:
Uchatius, W. (2010): *Das Welthemd*. In Zeit Online. http://www.zeit.de/2010/51/Billige-T-Shirts/seite-2 (last access: 25/01/2017)

- Assumptions from organic cotton production:
Murugesh Babu, K., Selvadass, M. (2013): *Life Cycle Assessment for Cultivation of Conventional and Organic Seed Cotton fibres*. In: International Journal of Research in Environmental Science and Technology. ISSN 2249–9695.

- Cotton yield:
National Cotton Council of America (2016): *Cotton Production Costs and Returns: United States*.
http://www.cotton.org/econ/cropinfo/costsreturns/usa.cfm (last access: 25/01/2017)

- Electricity consumption of sewing machine:
Stromverbrauch im Haushalt (2016): *Nähmaschinen – Stromverbrauch*. http://www.stromverbrauch-haushalt.de/naehmaschine-berechnen.html (last access: 25/01/20017)

- Water consumption of washing machine:
Waschmaschine.net (2017): *Wasserverbrauch einer Waschmaschine*. http://www.waschmaschine.net/wasserverbrauch/ (last access: 25/01/2017)

- Electricity consumption of washing machine, Number of washing cycles per year:
Stromverbrauch info (2017): *Stromverbrauch von Waschmaschinen* http://www.stromverbrauchinfo.de/stromverbrauch-waschmaschinen.php (last access: 25/01/2017)

- Definitions for S-LCA:
Benoit, C. et al. (2009): UNEP/SETAC Life Cycle Initiative: *Guidelines for social life cycle assessment of products*.
http://www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines_sLCA.pdf (last access: 25/01/2017)

- Wages in Bangladesh, Price breakdown of a T-shirt:
Deutscher Gewerkschaftsbund Bezirk Nord (2014): *Made in Hell. Textilproduktion in Bangladesch*. http://sh-nordwest.dgb.de/++co++c324b84c-6b1c-11e4-8538-52540023ef1a/#3 (last access: 25/01/2017)

- Wages in Bangladesh:
Clean Clothes Campaign (2013): *Bangladesh Minimum Wage*. https://cleanclothes.org/livingwage/bangladesh-minimum-wage (last access: 25/01/2017)

- World map (slide 14): https://pixabay.com/de/karte-der-welt-internationale-1042847/ (last access: 25/01/2017)