GreenDelta

software / data / know-how

Hotspots analysis in LCA supported by novel visualisations

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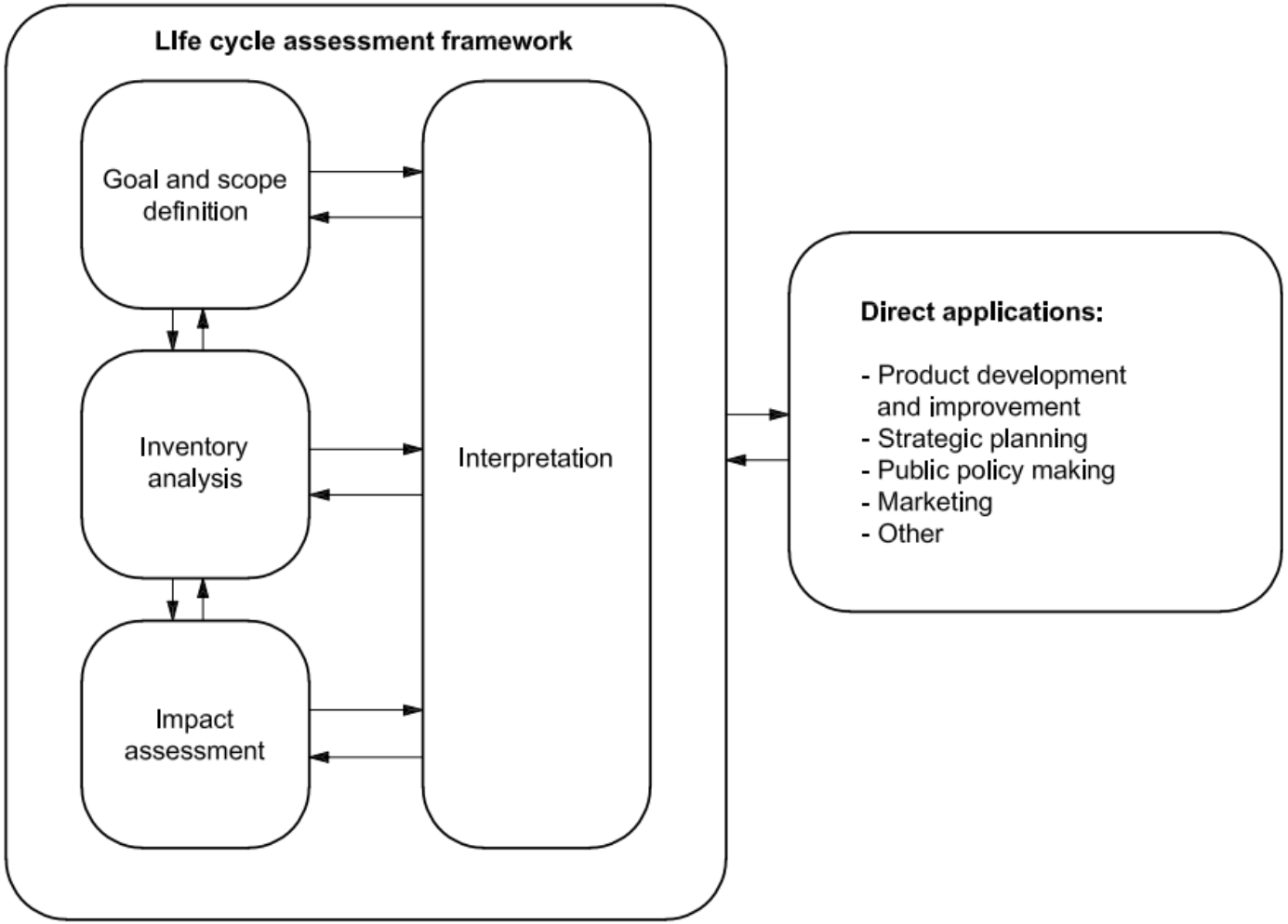
Presentation overview

1. Introduction: Interpretation and visualization in LCA, and hotspot analysis
2. Examples from one software and one case study
3. Discussion and outlook

Interpretation, visualisation, hot spot analysis

Interpretation: Basically, everything in LCA is about interpretation..



..and while facts and numbers are of course important outcomes and one input for interpretation, visualization is important

Inputs							Outputs					
Flow UUI	Flow	Category	Sub-categ	Unit	Result		Flow UUI	Flow	Category	Sub-categ	Unit	Result
5273eb9f-	electricity	3510:Elect	3510a: Ele	MJ	0		38a622c6-	1,4-Butan	air	high popu	kg	5.56E-10
45f50883-	electricity	351:Electr	3510:Elect	MJ	0		541a823c-	1-Pentanc	air	high popu	kg	3.99E-11
c296e5f8-	electricity	351:Electr	3510:Elect	MJ	0		8cbaa905-	1-Pentene	air	high popu	kg	3.01E-11
f9cc8f7f-e	electricity	351:Electr	3510:Elect	MJ	0		a0fec60d-	2-Aminop	air	high popu	kg	2.11E-12
ec9cf090-	electricity	351:Electr	3510:Elect	MJ	0		e2d860e3-	2-Methyl-	air	high popu	kg	1.01E-10
d9864d31-	electricity	351:Electr	3510:Elect	MJ	0		79a87f98-	2-Methyl-	air	high popu	kg	6.69E-15
510cd0bb-	electricity	351:Electr	3510:Elect	MJ	0		90d374f1-	2-Nitrobe	air	high popu	kg	3.39E-12
5b8064b0-	electricity	351:Electr	3510:Elect	MJ	0		cbf58f64-9	2-Propanc	air	high popu	kg	5.77E-06
7f57061d-	electricity	351:Electr	3510:Elect	MJ	0		99c07b66-	Acenaphtl	air	high popu	kg	1.16E-10
8e52d99d-	electricity	351:Electr	3510:Elect	MJ	0		5ad58fcc-	Acetaldeh	air	high popu	kg	1.75E-05
50f26bca-	electricity	351:Electr	3510:Elect	MJ	0		b9b68c0c-	Acetic aci	air	high popu	kg	0.000139
9c599317-	electricity	351:Electr	3510:Elect	MJ	0		1f130425-	Acetone	air	high popu	kg	2.08E-05
40481b41-	electricity	351:Electr	3510:Elect	MJ	0		7ed6dc0d-	Acrolein	air	high popu	kg	1.79E-08
862a8e99-	electricity	351:Electr	3510:Elect	MJ	0		42f51ad5-	Acrylic aci	air	high popu	kg	1.49E-08
3ed96bcd-	electricity	351:Electr	3510:Elect	MJ	0		d961f86b-	Aldehyde	air	high popu	kg	1.18E-05
51265f42-(	electricity	353:Steam	3530:Stea	MJ	0		6f0b8b7c-	Aluminiur	air	high popu	kg	0.000488
bccff4fd-9	electricity	382:Waste	3821:Treat	MJ	0		9990b51b-	Ammonia	air	high popu	kg	0.00402
01c12fca-a	Energy, gr	resource	biotic	MJ	67.01098		11f41c41-	Ammoniu	air	high popu	kg	1.14E-07
8842042d-	Energy, gr	resource	biotic	MJ	0.1405		79def65c-	Aniline	air	high popu	kg	9.88E-10
c5035ce2-	Peat, in gr	resource	biotic	kg	0.002634		48adac6a-	Anthranili	air	high popu	kg	2.48E-12
bac875f4-	Wood, ha	resource	biotic	m3	0.003261		3ea5684a-	Antimony	air	high popu	kg	8.68E-08
28528881-	Wood, pri	resource	biotic	m3	1.3E-05		f4d0a2c8-	Arsenic	air	high popu	kg	1.86E-06
b073ec00-	Wood, sof	resource	biotic	m3	0.002484		fd9a5a38-	Arsine	air	high popu	kg	1.74E-13
23e83c1f-(	Wood, un	resource	biotic	m3	5.59E-07		5ffb3576-	Barium	air	high popu	kg	5.76E-06
cc6a1abb-	Carbon di	resource	in air	kg	6.190301		fe65f7e4-(	Benzaldeh	air	high popu	kg	9.36E-09
57c71b25-	Energy, ki	resource	in air	MJ	5.618276		1bb6a502-	Benzene	air	high popu	kg	0.000338
a7ff17d4-(	Energy, sc	resource	in air	MJ	0.083155		9645e02f-	Benzene,	air	high popu	kg	1.24E-10
4602b501-	Krypton, i	resource	in air	kg	0.052993		7c09916a-	Benzene,	air	high popu	kg	1.57E-05
8bc65fca-5	Aluminiur	resource	in ground	kg	4.137302		1af44724-	Benzene,	air	high popu	kg	1.45E-09
6df9ea09-	Anhydrite	resource	in ground	kg	7.73E-06		c75dd699-	Benzene,	air	high popu	kg	3.65E-09
c13beafb-	Barite, 15	resource	in ground	kg	0.067885		2cbb504a-	Benzo(a)p	air	high popu	kg	1.68E-08
ac3a8914-	Basalt, in	resource	in ground	kg	0.623478		19e97bd6-	Beryllium	air	high popu	kg	5.99E-08
eead2933-	Borax, in g	resource	in ground	kg	0.034005		3e419ebc-	Boron	air	high popu	kg	2.23E-05
621b1cf1-5	Cadmium,	resource	in ground	kg	0.000556		0367c22a-	Boron trifl	air	high popu	kg	2.38E-15
600b1c44-	Calcium ca	resource	in ground	kg	21.60905		77c46f0e-(	Bromine	air	high popu	kg	3.12E-06

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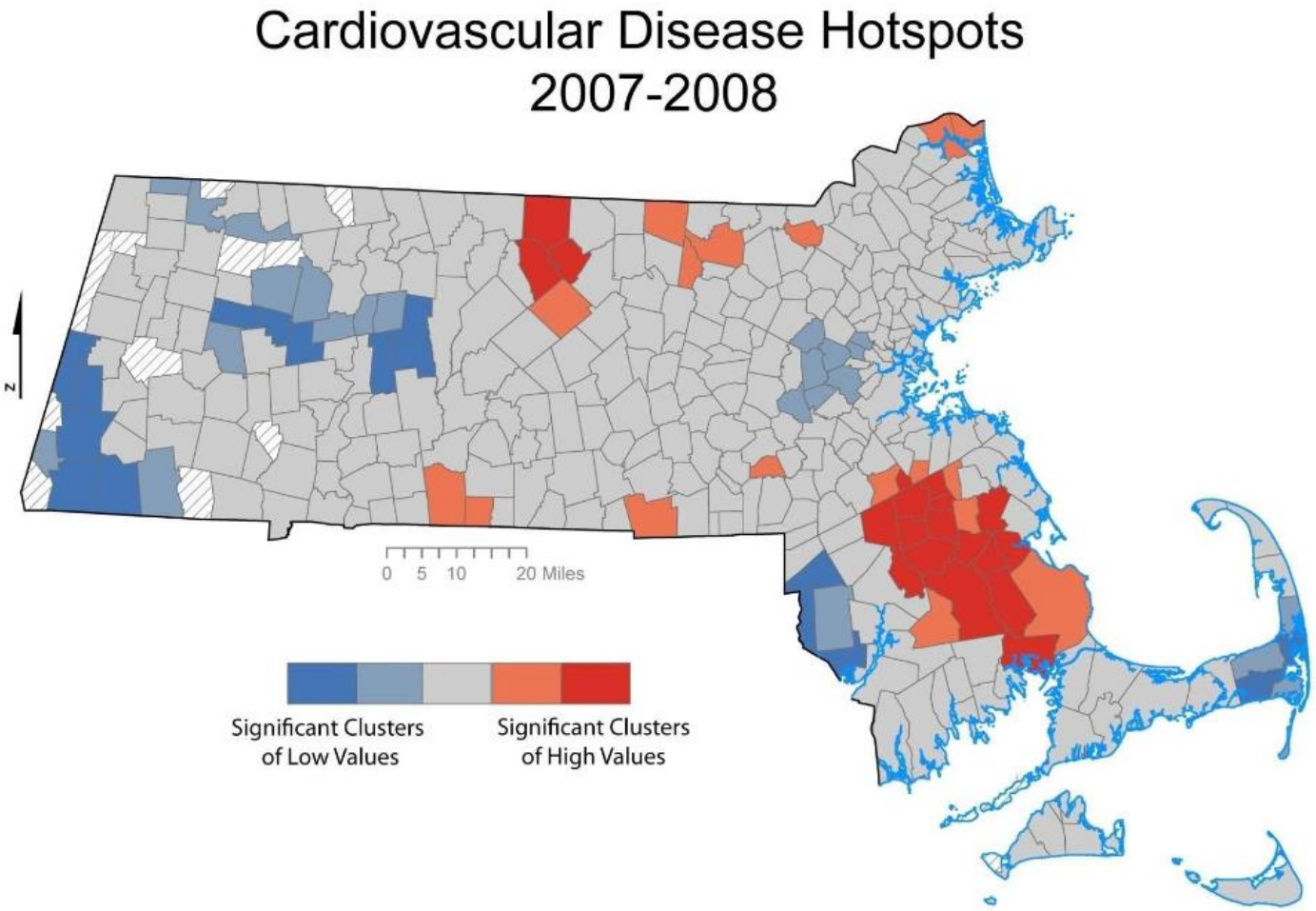
Hot spots, literally: Regions or areas of high concern



Children's Environmental Health Initiative: Hot Spot Analysis, https://www.cdc.gov/dhdsp/maps/GISX/training/module3/files/3_hotspot_analysis_module.PDF

Hot spots, more broadly: Abstract areas or points of high concern

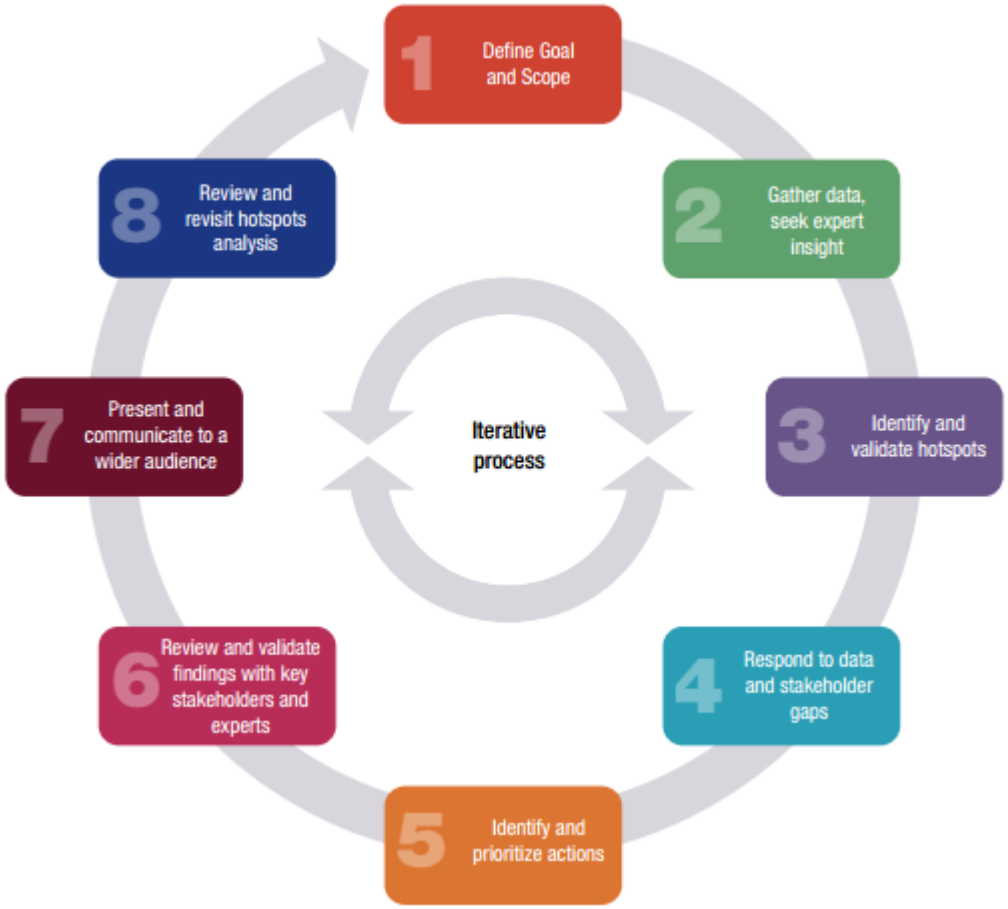
In statistics, hot-spot identification is a well-known problem with several possible techniques to be applied (typically, cluster analyses and similar),

In LCA and Sustainability Analyses, more simple approaches are used, and "hot spots" are typically points that contribute most

"The life cycle phase or phases with highest impact receive the highest value, whereas a stage with a low relevance is assigned a low value. The hot spots are determined by multiplying the value of the category and the value of the phase"

H. Rohn, M. Lukas, K. Bienge, J. Ansorge, C. Liedtke: The Hot Spot Analysis: Utilization as Customized Management Tool towards Sustainable Value Chains of Companies in the Food Sector, Agris, Vol IV Number 4, 2014

Hot spots, UNEP-SETAC, Hotspots Analysis flagship project 2017



UN Environment 2017: Hotspots Analysis: An overarching methodological framework and guidance for product and sector level application, p. 10

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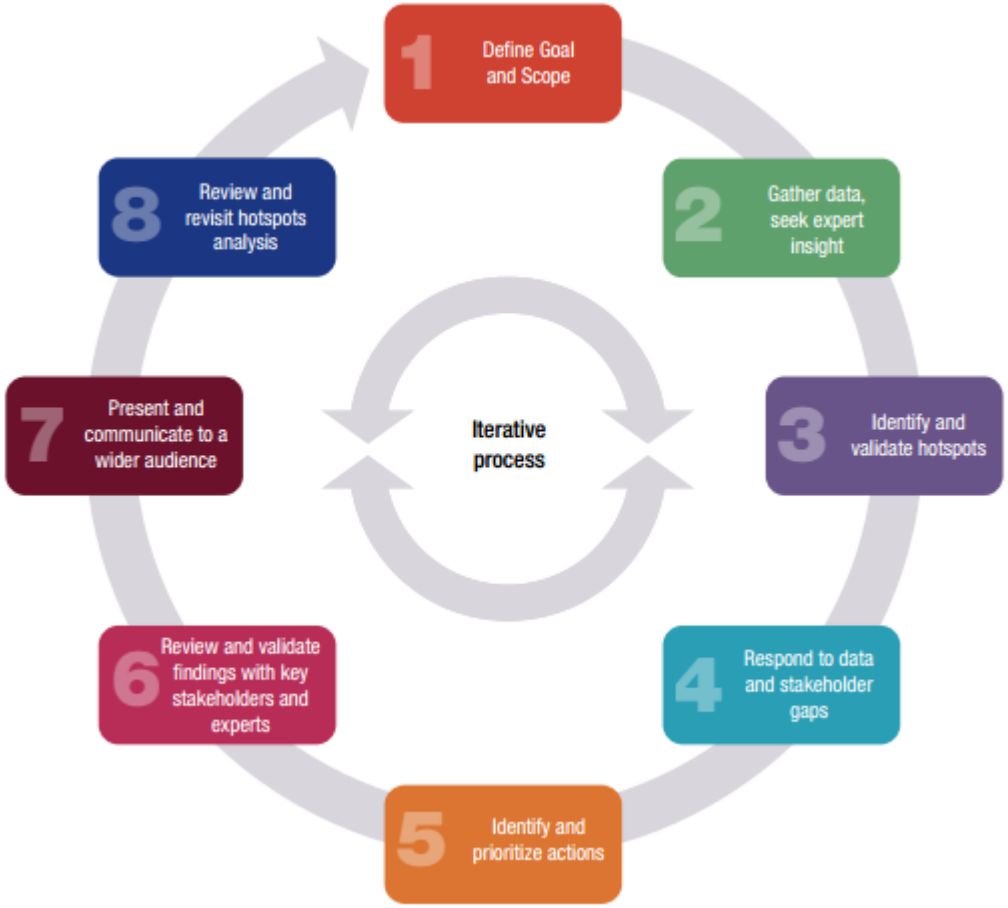
Hot spots, UNEP-SETAC, Hotspots Analysis flagship project 2017

Focus on the procedure rather than on hot spot detection (so far)



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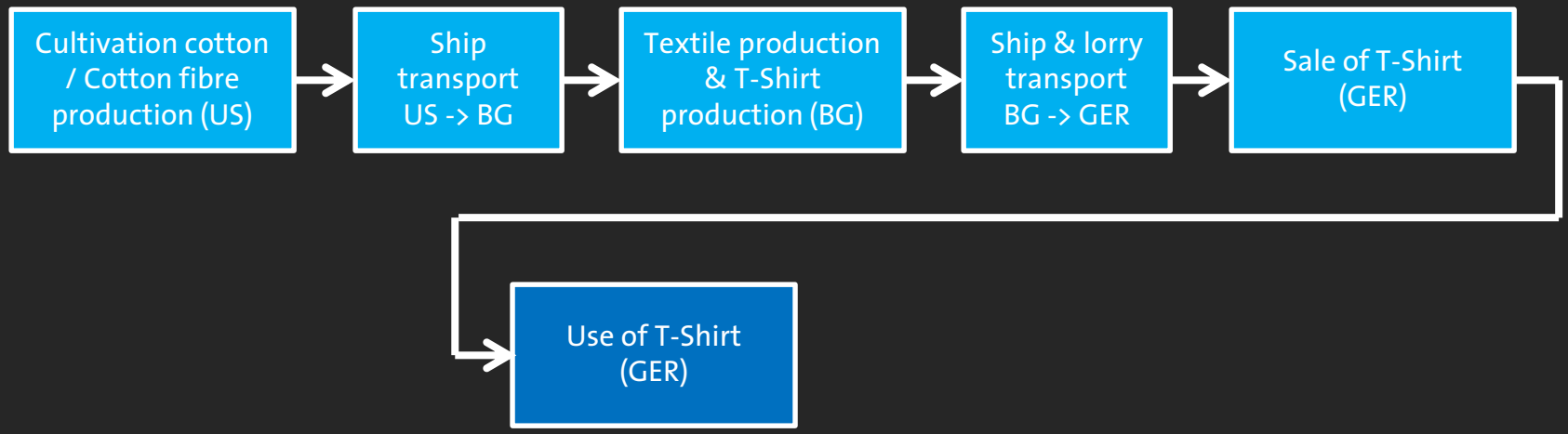
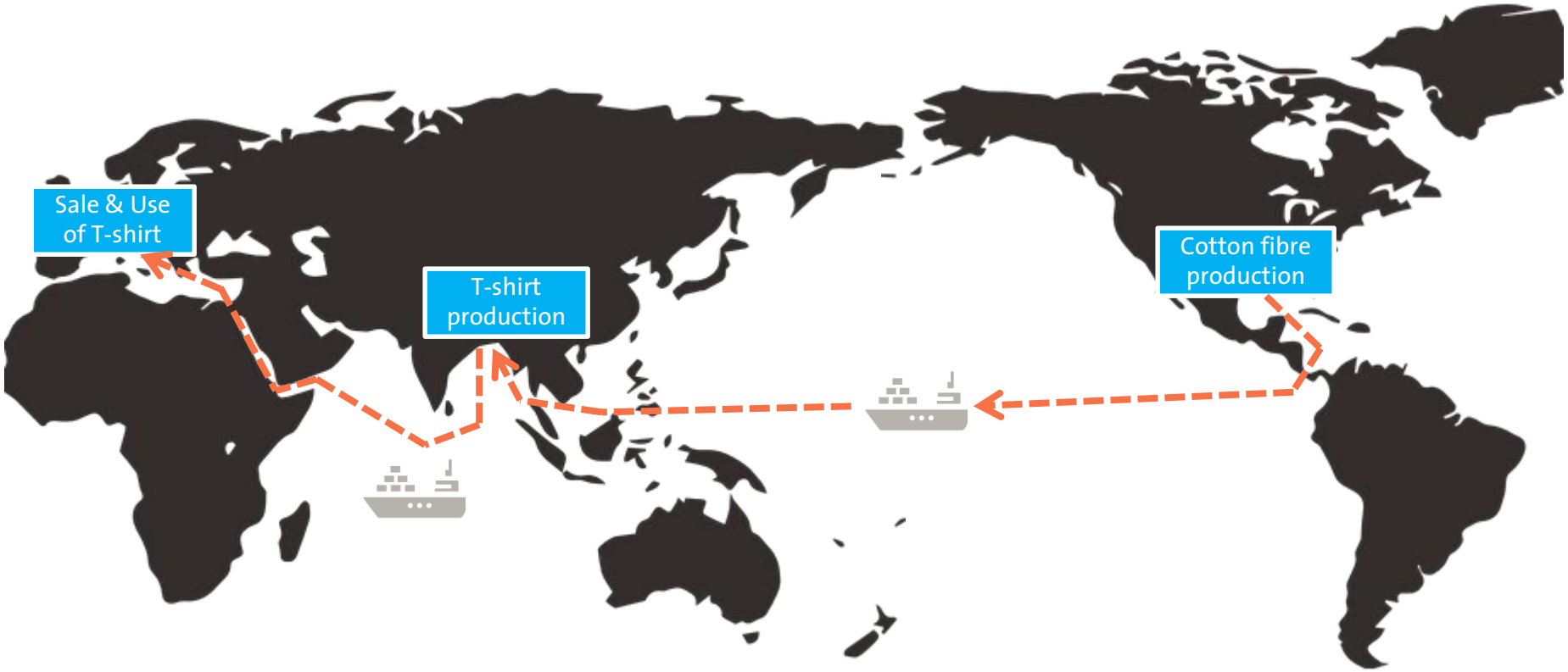
Case study: Cotton T-shirt

Life cycle of a conventional cotton T-shirt



Production chain conventional cotton T-shirt



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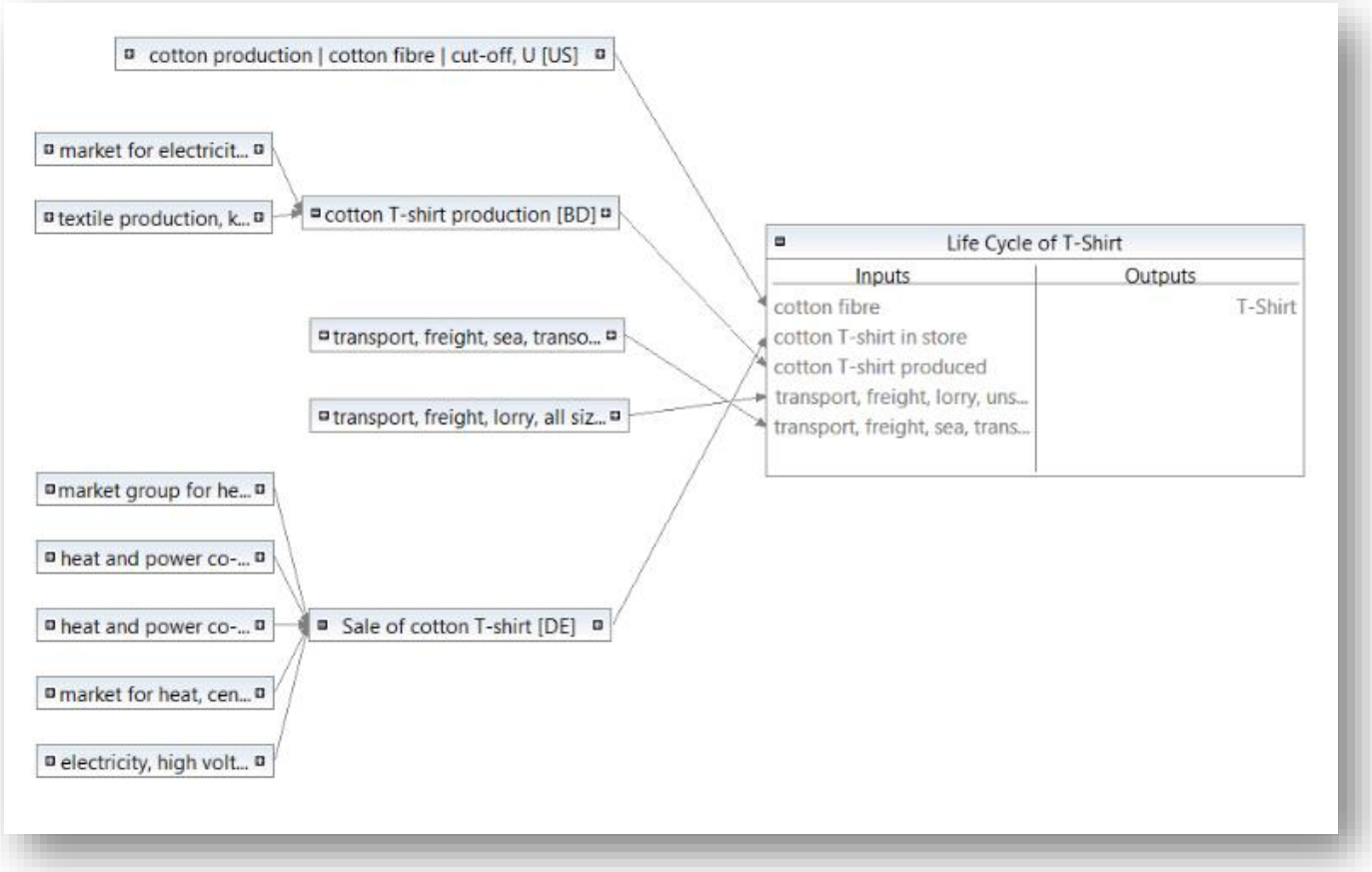
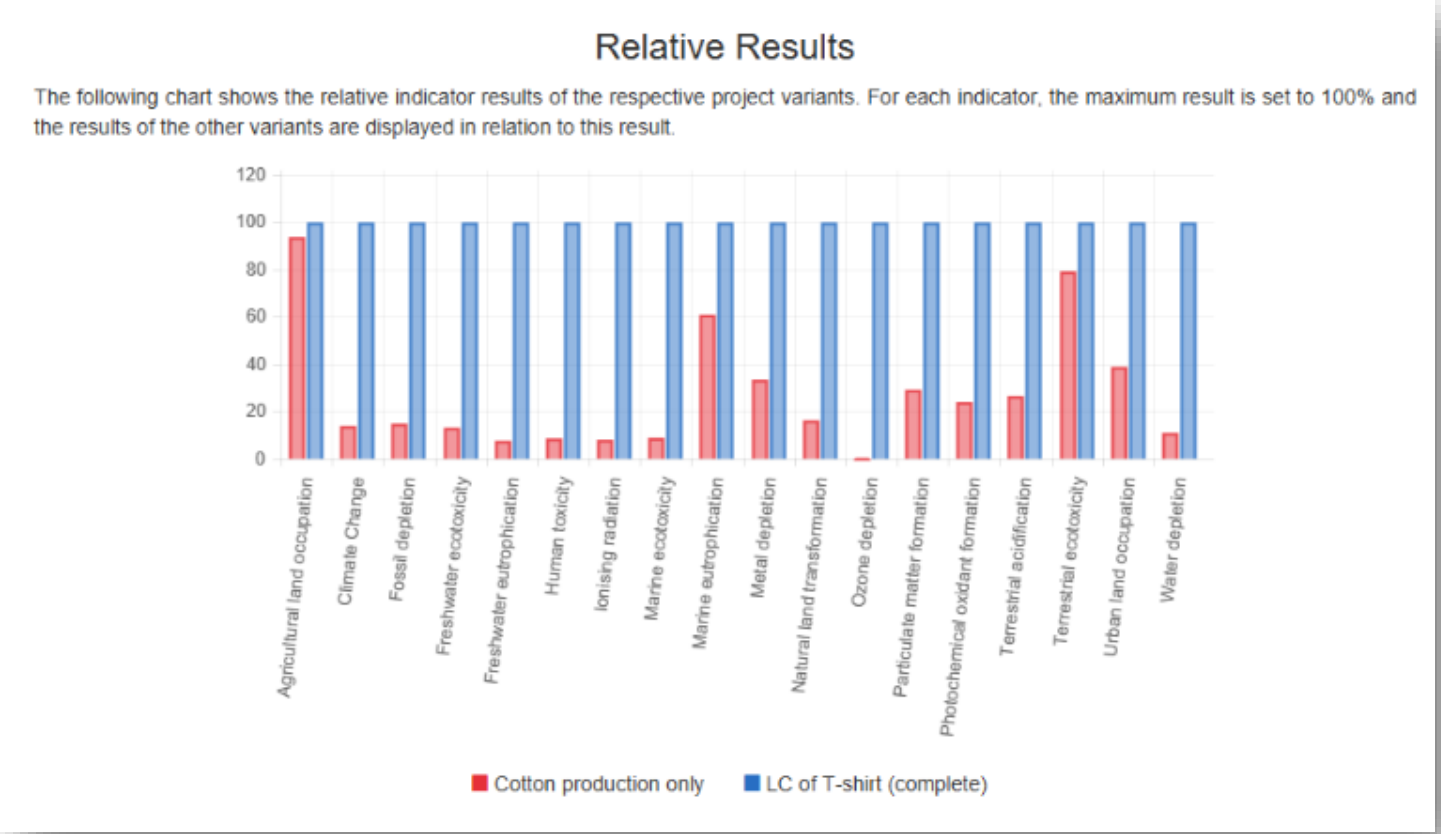
Life cycle for T-shirt, in software
model graph, in openLCA



Comparing impacts
bar chart, all ReCiPe midp. categories



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1st idea: Contribution tree
for detecting hot spots

- Turn the looped network of processes and flows into a tree
  - Cut-off loops and turn them into branches
  - Processes may appear several times
- Calculate the impact contribution for the elements in the tree
- Order by highest contribution

1st idea: Contribution tree

for detecting hot spots

Impact category: Fair Salary

Contribution	Process	Amount	Unit
100.00%	Retail of T-Shirt - DE	2.46115	FS med risk hours
95.37%	Production of T-Shirt - BD	2.34713	FS med risk hours
01.51%	Cotton farming and production - US	0.03728	FS med risk hours
01.31%	Textiles and Wearing Apparel - BD	0.03220	FS med risk hours
00.09%	Apparel manufacturing - MX	0.00210	FS med risk hours
00.05%	Education, Health and Other Services - BD	0.00120	FS med risk hours
00.03%	Hemp textiles - CN	0.00084	FS med risk hours
00.03%	Manufacture of wearing apparel; dressing and dyeing of fur - TR	0.00082	FS med risk hours
00.03%	Manufacture of Wearing Apparel - CN	0.00076	FS med risk hours
00.03%	Leather and footwear - BR	0.00063	FS med risk hours
00.03%	Manufacture of Wearing Apparel - ID	0.00063	FS med risk hours
00.02%	Manufacture of textiles - TR	0.00060	FS med risk hours
00.02%	Fiber fabrics - KR	0.00047	FS med risk hours
00.02%	Manufacture of transport equipment - MX	0.00041	FS med risk hours
00.02%	Manufacture of textile inputs - MX	0.00039	FS med risk hours
00.02%	Construction - BD	0.00038	FS med risk hours
00.02%	Textiles, textile products, leather and footwear - RU	0.00038	FS med risk hours
00.01%	Manufacture of leather and leather products - VN	0.00031	FS med risk hours
00.01%	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and foo...	0.00030	FS med risk hours
00.01%	Retail Trade - BD	0.00030	FS med risk hours
00.01%	Manufacture of wearing apparel; dressing and dyeing of fur - PL	0.00028	FS med risk hours
00.01%	Financial Intermediation and Business Activities - BD	0.00028	FS med risk hours
00.01%	Manufacture of wearing apparel; dressing and dyeing of fur - IT	0.00027	FS med risk hours
00.01%	Textiles, textile products, leather and footwear - CA	0.00022	FS med risk hours
00.01%	Manufacture of textile - IN	0.00020	FS med risk hours
00.01%	Manufacture of knitted fabrics and of knitted wearing apparel - AR	0.00020	FS med risk hours

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1st idea: Contribution tree

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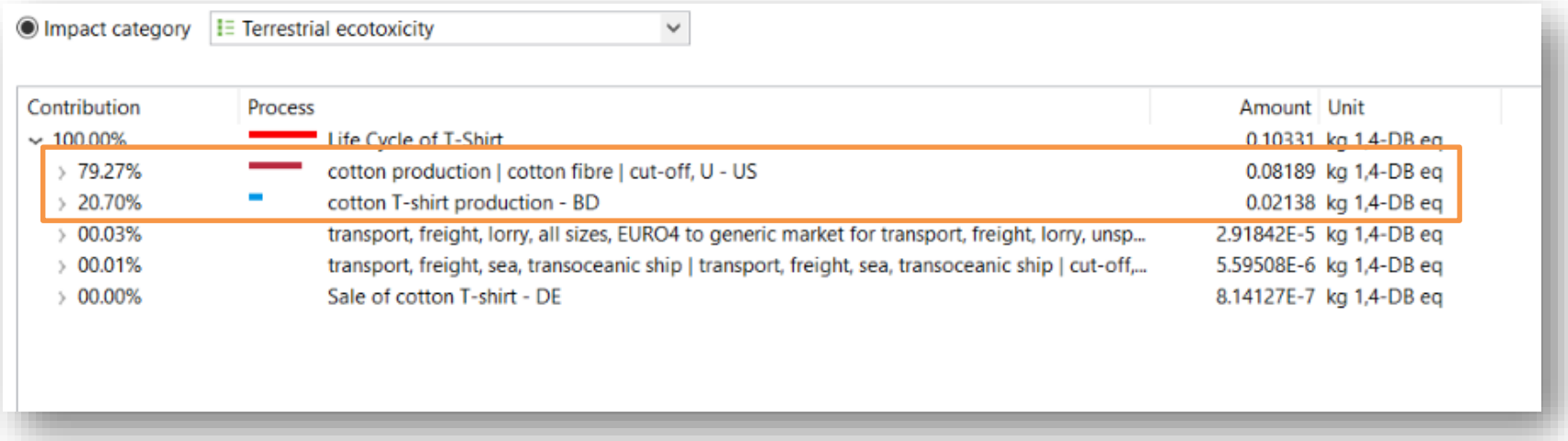
Social results

Contribution tree

impacts in a tree view



Environmental results

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Contribution tree, continued

Impact category: Terrestrial ecotoxicity

Contribution	Process	Amount	Unit
100.00%	Life Cycle of T-Shirt	0.10331	kg 1,4-DB eq
79.27%	cotton production | cotton fibre | cut-off, U - US	0.08189	kg 1,4-DB eq
20.70%	cotton T-shirt production - BD	0.02138	kg 1,4-DB eq
20.70%	textile production, knit cotton, batch dyed | textile, knit cotton | cut-off, U - BD	0.02138	kg 1,4-DB eq
19.63%	market for fatty acid | fatty acid | cut-off, U - GLO	0.02028	kg 1,4-DB eq
00.75%	market for deinking emulsion, in paper production | deinking emulsion, in paper production | cut-off, U - GLO	0.00078	kg 1,4-DB eq
00.21%	market for electricity, low voltage | electricity, low voltage | cut-off, U - BG	0.00021	kg 1,4-DB eq
00.04%	market for cyanuric chloride | cyanuric chloride | cut-off, U - GLO	3.82844E-5	kg 1,4-DB eq
00.03%	market for ethoxylated alcohol (AE7) | ethoxylated alcohol (AE7) | cut-off, U - GLO	2.90727E-5	kg 1,4-DB eq
00.01%	market for steam, in chemical industry | steam, in chemical industry | cut-off, U - GLO	1.17778E-5	kg 1,4-DB eq
00.01%	market for sodium sulfate, anhydrite | sodium sulfate, anhydrite | cut-off, U - RoW	1.00140E-5	kg 1,4-DB eq
00.01%	market for wastewater, average | wastewater, average | cut-off, U - RoW	5.23973E-6	kg 1,4-DB eq
00.00%	market for tetrafluoroethylene | tetrafluoroethylene | cut-off, U - GLO	3.75874E-6	kg 1,4-DB eq
00.00%	market for sodium chloride, powder | sodium chloride, powder | cut-off, U - GLO	2.60558E-6	kg 1,4-DB eq
00.00%	market for wastewater, average | wastewater, average | cut-off, U - Europe without Switzerland	2.49078E-6	kg 1,4-DB eq
00.00%	market group for heat, central or small-scale, natural gas | heat, central or small-scale, natural gas | cut-off, U - GLO	2.37775E-6	kg 1,4-DB eq
00.00%	market for waste textile, soiled | waste textile, soiled | cut-off, U - GLO	2.31477E-6	kg 1,4-DB eq
00.00%	market for soda ash, light, crystalline, heptahydrate | soda ash, light, crystalline, heptahydrate | cut-off, U - GLO	1.98378E-6	kg 1,4-DB eq
00.00%	market group for tap water | tap water | cut-off, U - GLO	1.33585E-6	kg 1,4-DB eq
00.00%	market for sodium sulfate, anhydrite | sodium sulfate, anhydrite | cut-off, U - RER	8.72377E-7	kg 1,4-DB eq
00.00%	market for urea formaldehyde resin | urea formaldehyde resin | cut-off, U - GLO	7.51376E-7	kg 1,4-DB eq
00.00%	market for sodium dithionite, anhydrous | sodium dithionite, anhydrous | cut-off, U - GLO	7.02269E-7	kg 1,4-DB eq
00.00%	market for sodium hydroxide, without water, in 50% solution state | sodium hydroxide, without water, in 50% solution state | c...	6.44354E-7	kg 1,4-DB eq
00.00%	market for citric acid | citric acid | cut-off, U - GLO	5.39245E-7	kg 1,4-DB eq
00.00%	market for hydrogen peroxide, without water, in 50% solution state | hydrogen peroxide, without water, in 50% solution state ...	3.05224E-7	kg 1,4-DB eq
00.00%	market for wastewater, average | wastewater, average | cut-off, U - CH	1.99062E-7	kg 1,4-DB eq
00.00%	market for acetic acid, without water, in 98% solution state | acetic acid, without water, in 98% solution state | cut-off, U - GLO	1.93641E-7	kg 1,4-DB eq
00.00%	market for anthraquinone | anthraquinone | cut-off, U - GLO	1.68343E-7	kg 1,4-DB eq
00.00%	market for polycarboxylates, 40% active substance | polycarboxylates, 40% active substance | cut-off, U - GLO	1.29350E-7	kg 1,4-DB eq
00.00%	market for sulfuric acid | sulfuric acid | cut-off, U - GLO	1.02022E-7	kg 1,4-DB eq
00.00%	market for nitrogen fertiliser, as N | nitrogen fertiliser, as N | cut-off, U - GLO	3.78856E-8	kg 1,4-DB eq
00.00%	market for polyethylene, low density, granulate | polyethylene, low density, granulate | cut-off, U - GLO	1.60992E-8	kg 1,4-DB eq
00.00%	market group for heat, central or small-scale, other than natural gas | heat, central or small-scale, other than natural gas | cut-...	1.21321E-8	kg 1,4-DB eq
00.00%	market for acrylic acid | acrylic acid | cut-off, U - GLO	4.01758E-9	kg 1,4-DB eq
00.00%	market for electricity, low voltage | electricity, low voltage | cut-off, U - IN	1.13032E-7	kg 1,4-DB eq
00.03%	transport, freight, lorry, all sizes, EURO4 to generic market for transport, freight, lorry, unspecified | transport, freight, lorry, uns...	2.91842E-5	kg 1,4-DB eq
00.01%	transport, freight, sea, transoceanic ship | transport, freight, sea, transoceanic ship | cut-off, U - GLO	5.59508E-6	kg 1,4-DB eq
00.00%	Sale of cotton T-shirt - DE	8.14127E-7	kg 1,4-DB eq

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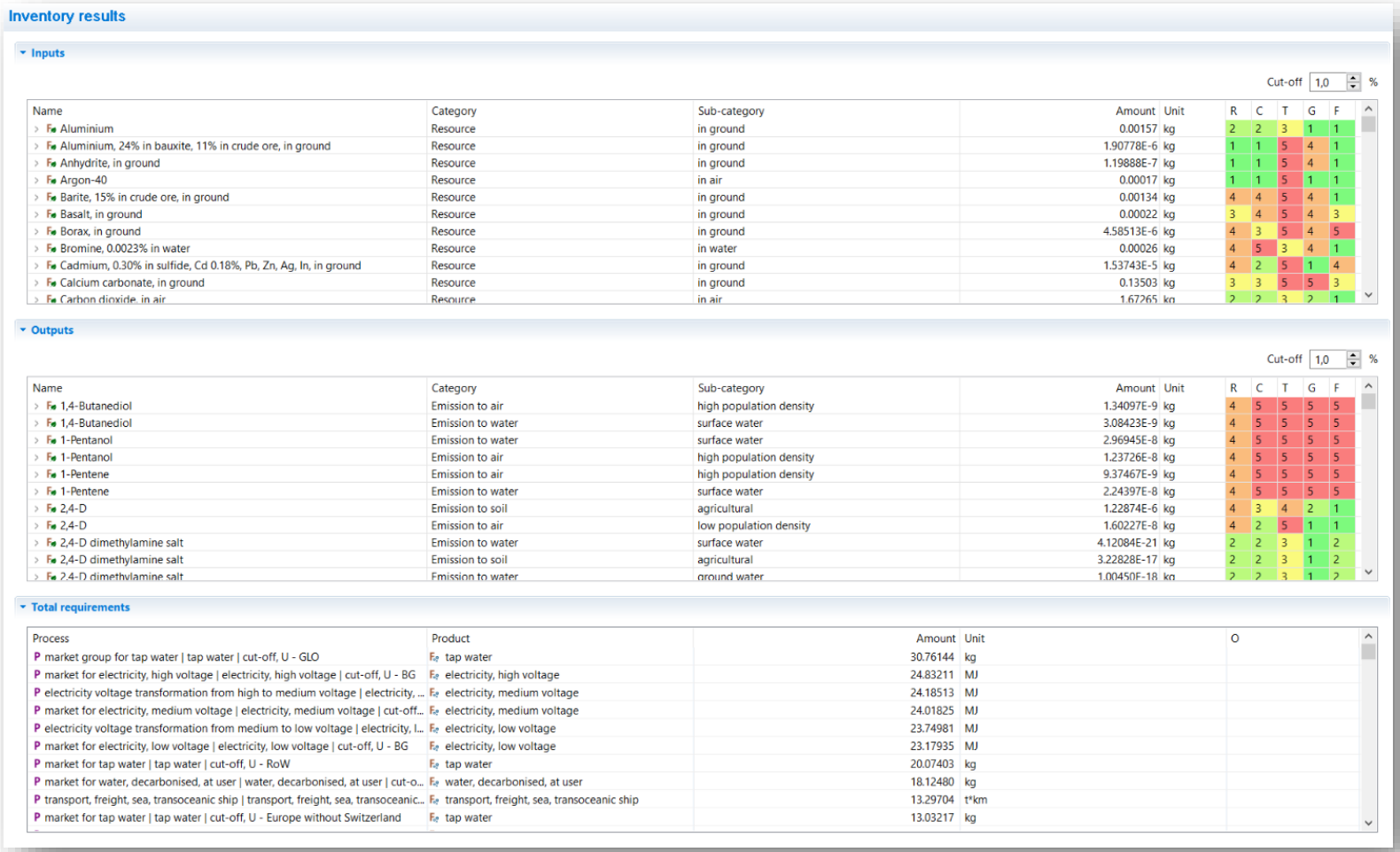
2nd idea: A life cycle model combines (typically) processes of various quality

- How stable is the information about the most contributing elements, the hot spots?
  - Hot spot and weak quality -> rather improve the quality?
  - Hot spot and good quality -> take action?
- Would it be possible to show the data quality together with LCA results?
- Better for the interpretation (and in the end decision support)

LCIA results of T-shirt over its life cycle

LCI incl. data quality



Inventory results

Inputs

Cut-off 1,0 %

Name	Category	Sub-category	Amount	Unit	R	C	T	G	F
Aluminium	Resource	in ground	0.00157	kg	2	2	3	1	1
Aluminium, 24% in bauxite, 11% in crude ore, in ground	Resource	in ground	1.90778E-6	kg	1	1	5	4	1
Anhydrite, in ground	Resource	in ground	1.19888E-7	kg	1	1	5	4	1
Argon-40	Resource	in air	0.00017	kg	1	1	5	1	1
Barite, 15% in crude ore, in ground	Resource	in ground	0.00134	kg	4	4	5	4	1
Basalt, in ground	Resource	in ground	0.00022	kg	3	4	5	4	3
Borax, in ground	Resource	in ground	4.58513E-6	kg	4	3	5	4	5
Bromine, 0.0023% in water	Resource	in water	0.00026	kg	4	5	3	4	1
Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn, Ag, In, in ground	Resource	in ground	1.53743E-5	kg	4	2	5	1	4
Calcium carbonate, in ground	Resource	in ground	0.13503	kg	3	3	5	5	3
Carbon dioxide, in air	Resource	in air	1.67265	kg	2	2	3	2	1

Outputs

Cut-off 1,0 %

Name	Category	Sub-category	Amount	Unit	R	C	T	G	F
1,4-Butanediol	Emission to air	high population density	1.34097E-9	kg	4	5	5	5	5
1,4-Butanediol	Emission to water	surface water	3.08423E-9	kg	4	5	5	5	5
1-Pentanol	Emission to water	surface water	2.96945E-8	kg	4	5	5	5	5
1-Pentanol	Emission to air	high population density	1.23726E-8	kg	4	5	5	5	5
1-Pentene	Emission to air	high population density	9.37467E-9	kg	4	5	5	5	5
1-Pentene	Emission to water	surface water	2.24397E-8	kg	4	5	5	5	5
2,4-D	Emission to soil	agricultural	1.22874E-6	kg	4	3	4	2	1
2,4-D	Emission to air	low population density	1.60227E-8	kg	4	2	5	1	1
2,4-D dimethylamine salt	Emission to water	surface water	4.12084E-21	kg	2	2	3	1	2
2,4-D dimethylamine salt	Emission to soil	agricultural	3.22828E-17	kg	2	2	3	1	2
2,4-D dimethylamine salt	Emission to water	ground water	1.00450E-18	kg	2	2	3	1	2

Total requirements

Process	Product	Amount	Unit	O
market group for tap water | tap water | cut-off, U - GLO	tap water	30.76144	kg	
market for electricity, high voltage | electricity, high voltage | cut-off, U - BG	electricity, high voltage	24.83211	MJ	
electricity voltage transformation from high to medium voltage | electricity, ...	electricity, medium voltage	24.18513	MJ	
market for electricity, medium voltage | electricity, medium voltage | cut-off...	electricity, medium voltage	24.01825	MJ	
electricity voltage transformation from medium to low voltage | electricity, l...	electricity, low voltage	23.74981	MJ	
market for electricity, low voltage | electricity, low voltage | cut-off, U - BG	electricity, low voltage	23.17935	MJ	
market for tap water | tap water | cut-off, U - RoW	tap water	20.07403	kg	
market for water, decarbonised, at user | water, decarbonised, at user | cut-o...	water, decarbonised, at user	18.12480	kg	
transport, freight, sea, transoceanic ship | transport, freight, sea, transoceanic...	transport, freight, sea, transoceanic ship	13.29704	t*km	
market for tap water | tap water | cut-off, U - Europe without Switzerland	tap water	13.03217	kg	

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Data quality indicators: e.g., ecoinvent

	1	2	3	4	5	Add score
Reliability	Verified data based on measurements	Verified data partly based on assumptions or non-verified data based on measurements	Non-verified data partly based on qualified estimates	Qualified estimate (e.g. by industrial expert)	Non-qualified estimates	Remove indicator
Completeness	Representative data from all sites relevant for the market considered, over and adequate period to even out normal fluctuations	Representative data from > 50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from only some sites (<< 50%) relevant for the market considered or > 50% of sites but from shorter periods	Representative data from only one site relevant for the market considered or some sites but from shorter periods	Representativeness unknown or data from a small number of sites and from shorter periods	Remove indicator
Temporal correlation	Less than 3 years of difference to the time period of the data set	Less than 6 years of difference to the time period of the data set	Less than 10 years of difference to the time period of the data set	Less than 15 years of difference to the time period of the data set	Age of data unknown or more than 15 years of difference to the time period of the data set	Remove indicator
Geographical correlation	Data from area under study	Average data from larger area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown or distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)	Remove indicator
Further technological correlation	Data from enterprises, processes and materials under study	Data from processes and materials under study (i.e. identical technology) but from different enterprises	Data from processes and materials under study but from different technology	Data on related processes or materials	Data on related processes on laboratory scale or from different technology	Remove indicator
Add indicator	Remove score	Remove score	Remove score	Remove score	Remove score	

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LCIA results of T-shirt over its life cycle

midpoint results incl. data quality

Impact analysis

Subgroup by processes ☑ Cut-off 1,0 %

Name	Impact result	Unit	R	C	T	G	F
Agricultural land occupation	3.62792	m2*a	2	2	3	2	1
Climate Change	8.30101	kg CO2 eq	3	2	3	3	1
Fossil depletion	1.86288	kg oil eq	1	1	5	2	1
Freshwater ecotoxicity	0.30429	kg 1,4-DB eq	1	1	3	1	1
Freshwater eutrophication	0.01066	kg P eq	1	1	3	1	1
Human toxicity	7.00543	kg 1,4-DB eq	1	1	3	1	1
Ionising radiation	2.07923	kg U235 eq	1	1	5	2	1
Marine ecotoxicity	0.26555	kg 1,4-DB eq	1	1	3	1	1
Marine eutrophication	0.00960	kg N eq	2	2	3	2	1
Metal depletion	0.19450	kg Fe eq	2	2	5	2	1
Natural land transformation	0.00083	m2	3	2	5	3	1
Ozone depletion	3.51681E-5	kg CFC-11 eq	4	3	5	4	1
Particulate matter formation	0.01476	kg PM10 eq	3	2	3	2	2
Photochemical oxidant formation	0.01826	kg NMVOC	2	2	3	2	2
Terrestrial acidification	0.04457	kg SO2 eq	3	2	3	2	1
Terrestrial ecotoxicity	0.10331	kg 1,4-DB eq	2	2	3	2	1
Urban land occupation	0.04379	m2*a	2	2	5	3	2
Water depletion	33.96675	m3	1	1	4	5	1

LCIA results of T-shirt over its life cycle
midpoint results by process and flow

Impact analysis

Subgroup by processes ☑ Cut-off 0,1 %

Name	Category	Inventory result	Impact factor	Impact result	Unit	R	C	T	G	F
Water depletion				33.96675	m3	1	1	4	5	1
Climate Change				8.30101	kg CO2 eq	3	2	3	3	1
Human toxicity				7.00543	kg 1,4-DB eq	1	1	3	1	1
Agricultural land occupation				3.62792	m2*a	2	2	3	2	1
Ionising radiation				2.07923	kg U235 eq	1	1	5	2	1
Fossil depletion				1.86288	kg oil eq	1	1	5	2	1
Freshwater ecotoxicity				0.30429	kg 1,4-DB eq	1	1	3	1	1
Marine ecotoxicity				0.26555	kg 1,4-DB eq	1	1	3	1	1
Metal depletion				0.19450	kg Fe eq	2	2	5	2	1
Terrestrial ecotoxicity				0.10331	kg 1,4-DB eq	2	2	3	2	1
P cotton production | cotton fibre | cut-off, U - US	0 cotton T-Shirt			0.08181	kg 1,4-DB eq	2	2	3	2	1
F Cypermethrin	Emission to soil / agricultural	4.63088E-6 kg	1.12498E4 kg 1,4-DB eq/kg	0.05210	kg 1,4-DB eq	2	2	3	2	1
F Aldicarb	Emission to soil / agricultural	0.00011 kg	234.95062 kg 1,4-DB eq/kg	0.02471	kg 1,4-DB eq	2	2	3	2	1
F Fipronil	Emission to soil / agricultural	3.43087E-5 kg	77.13804 kg 1,4-DB eq/kg	0.00265	kg 1,4-DB eq	2	2	3	2	1
F Chlorpyrifos	Emission to soil / agricultural	8.11717E-5 kg	17.55499 kg 1,4-DB eq/kg	0.00142	kg 1,4-DB eq	2	2	3	2	1
P coconut production, dehusked | coconut, dehusked |	012:Growing of perennial crops / 0126:Gro...			0.01206	kg 1,4-DB eq	2	2	3	1	1
P coconut production, dehusked | coconut, dehusked |	012:Growing of perennial crops / 0126:Gro...			0.00320	kg 1,4-DB eq	2	2	3	1	1
P coconut production, dehusked | coconut, dehusked |	012:Growing of perennial crops / 0126:Gro...			0.00283	kg 1,4-DB eq	2	2	3	5	1
Terrestrial acidification				0.04457	kg SO2 eq	3	2	3	2	1
Urban land occupation				0.04379	m2*a	2	2	5	3	2
Photochemical oxidant formation				0.01826	kg NMVOC	2	2	3	2	2
Particulate matter formation				0.01476	kg PM10 eq	3	2	3	2	2
Freshwater eutrophication				0.01066	kg P eq	1	1	3	1	1
Marine eutrophication				0.00960	kg N eq	2	2	3	2	1
Natural land transformation				0.00083	m2	3	2	5	3	1
Ozone depletion				3.51681E-5	kg CFC-11 eq	4	3	5	4	1

LCIA results of T-shirt over its life cycle

Top 5 process contrib. incl. data quality

Child Labour, total		0.26482	CL med risk hours	5	4	5	4	5
International migrant workers (in the sector/ site)		1.23938	IMW med risk hours	1	1	2	1	1
Cotton farming and production - US	T-Shirt	1.09755	IMW med risk hours	1	1	2	1	1
Production of T-Shirt - BD	T-Shirt	0.11293	IMW med risk hours	5	5	5	5	5
Retail of T-Shirt - DE	T-Shirt	0.00567	IMW med risk hours	5	5	5	5	5
Transport - MY	Malaysia / Commodities	0.00402	IMW med risk hours	2	3	5	1	2
Transport - BD	Bangladesh / Industries	0.00388	IMW med risk hours	5	5	5	5	5
Textiles and Wearing Apparel - BD	Bangladesh / Industries	0.00289	IMW med risk hours	5	5	5	5	5
Fiber, yarn, and thread mills - US	USA / Industries	0.00050	IMW med risk hours	5	5	5	5	5
Broadwoven fabric mills - US	USA / Industries	0.00041	IMW med risk hours	5	5	5	5	5
Research and development - DE	Germany / Commodities	0.00038	IMW med risk hours	5	5	5	5	5
Spinning - TH	Thailand / Commodities	0.00032	IMW med risk hours	2	3	5	1	2
Artificial and synthetic fibers and filaments manuf	USA / Commodities	0.00032	IMW med risk hours	5	5	5	5	5

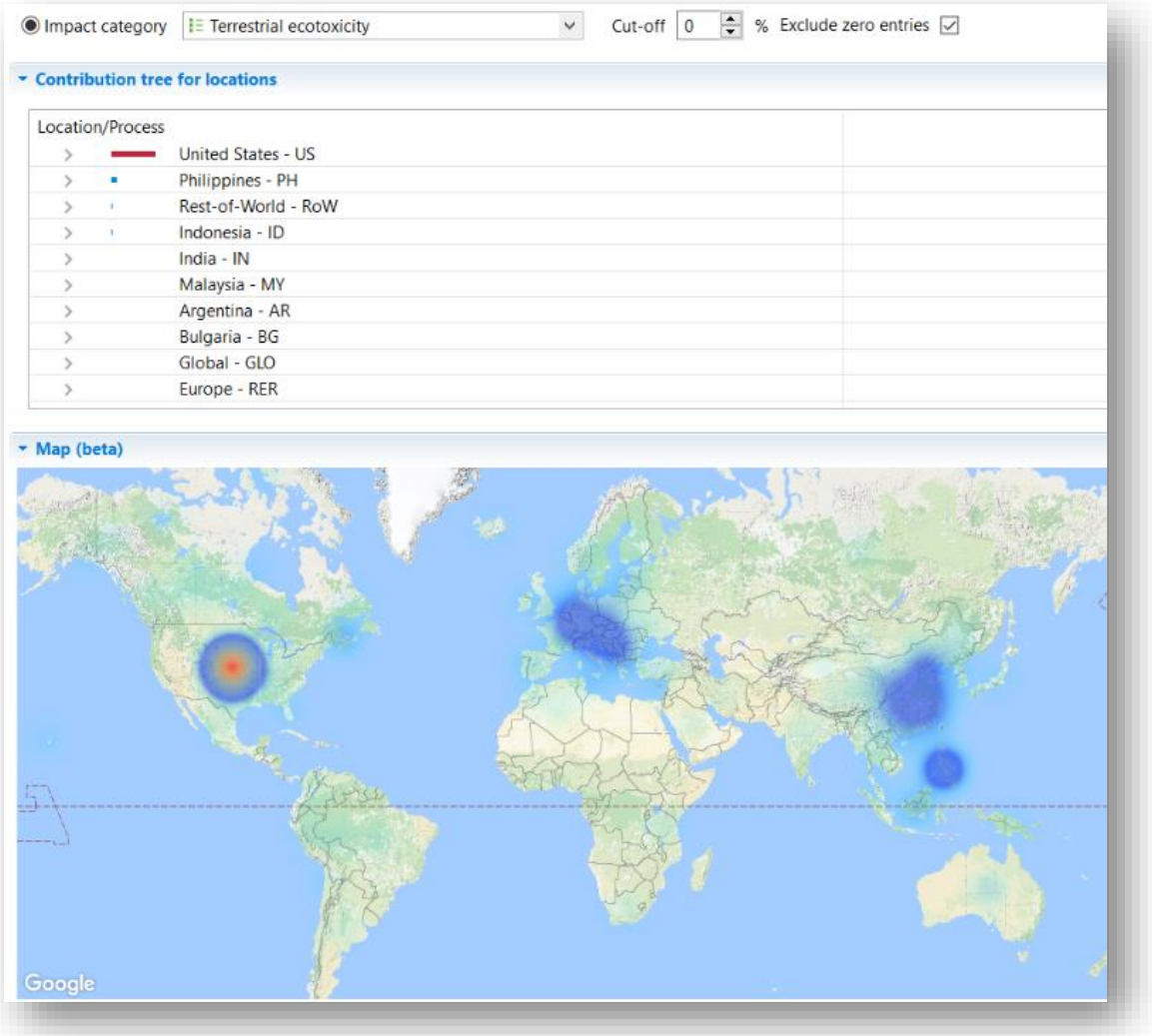
LCIA results of T-shirt over its life cycle

Top 5 process contrib. incl. data quality

Weekly hours of work per employee				1.16380	WH med risk hours	1	1	1	1	1
Production of T-Shirt - BD	T-Shirt			1.12928	WH med risk hours	1	1	1	1	1
Retail of T-Shirt - DE	T-Shirt			0.00567	WH med risk hours	2	1	2	1	3
Transport - MY	Malaysia / Commodities			0.00402	WH med risk hours	2	1	2	1	3
Transport - BD	Bangladesh / Industries			0.00388	WH med risk hours	2	5	4	4	4
Textiles and Wearing Apparel - BD	Bangladesh / Industries			0.00289	WH med risk hours	2	5	4	4	4
Fiber, yarn, and thread mills - US	USA / Industries			0.00101	WH med risk hours	2	5	2	1	4
Broadwoven fabric mills - US	USA / Industries			0.00082	WH med risk hours	2	5	2	1	4
Research and development - DE	Germany / Commodities			0.00076	WH med risk hours	2	1	2	1	3
Cotton farming and production - US	T-Shirt			0.00057	WH med risk hours	2	5	2	1	4
Fiber, yarn, and thread mills - US	USA / Commodities			0.00047	WH med risk hours	2	5	2	1	4
Broadwoven fabric mills - US	USA / Commodities			0.00045	WH med risk hours	2	5	2	1	4
Other service activities - DE	Germany / Commodities			0.00042	WH med risk hours	2	1	2	1	1
Transport - EG	Egypt / Industries			0.00041	WH med risk hours	2	1	2	1	3

Idea: Localisation of „impact causes“

map view



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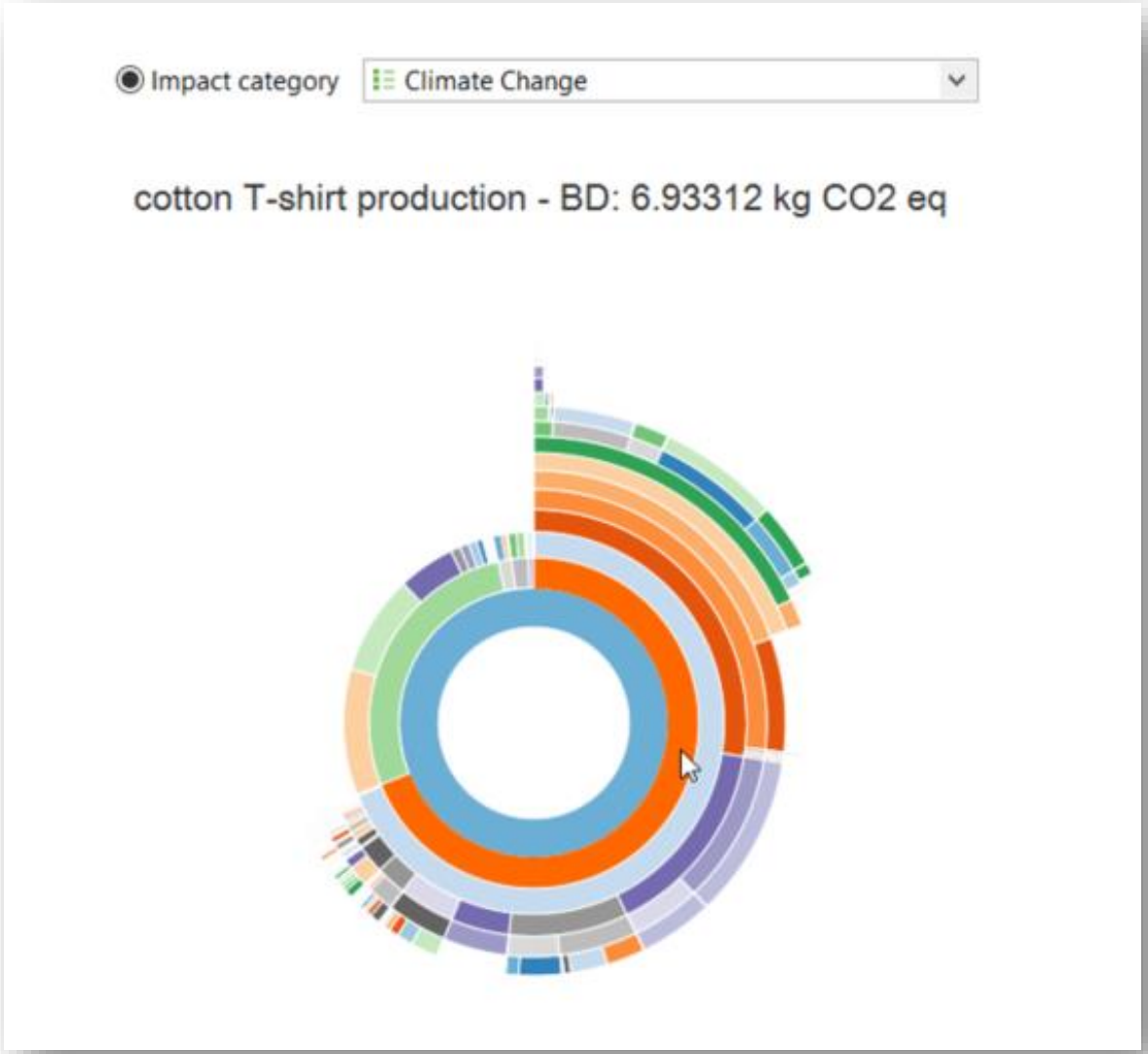
Idea: Displaying impacts in a network in a more compressed way

sun burst



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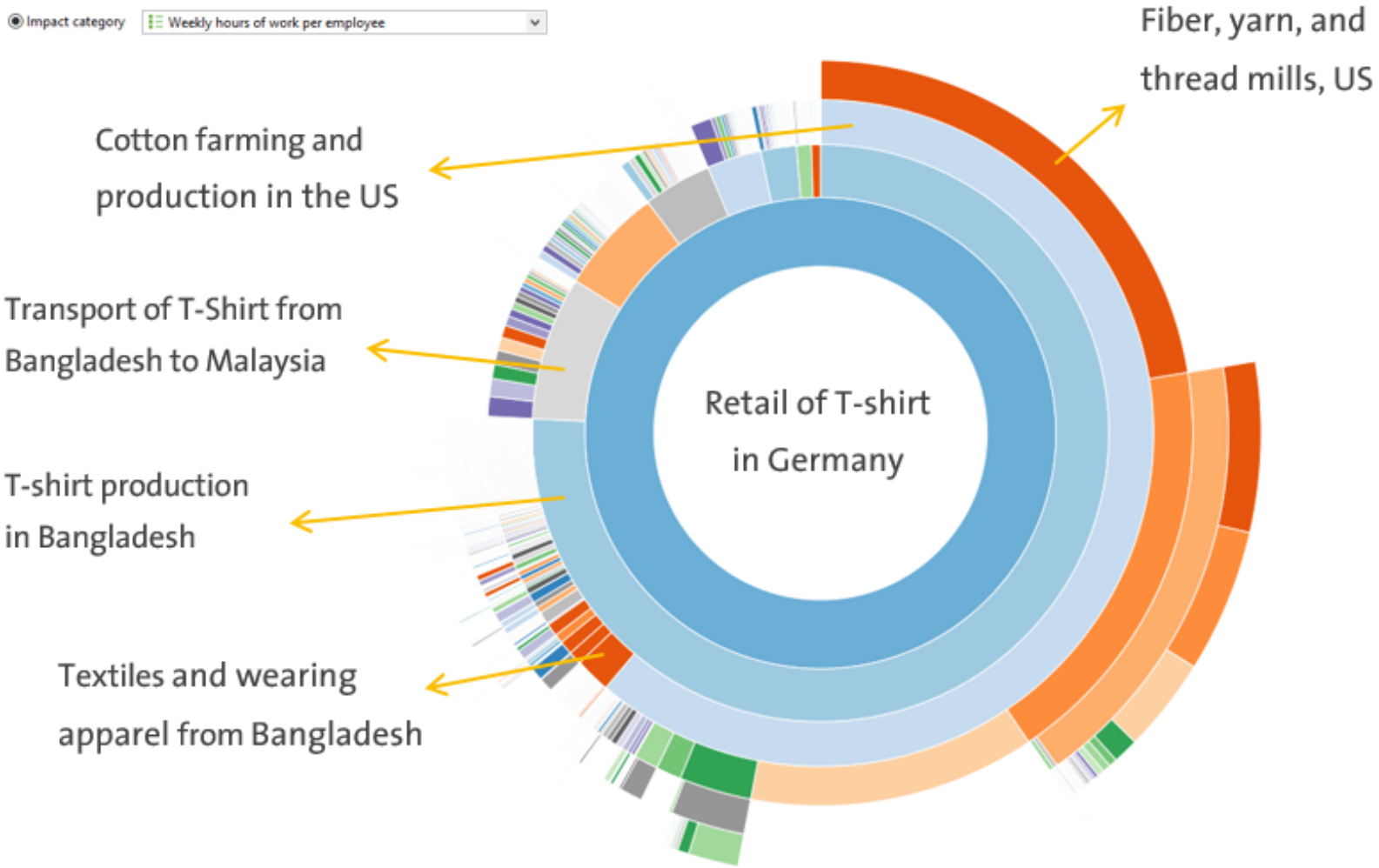
Displaying impacts
sun burst

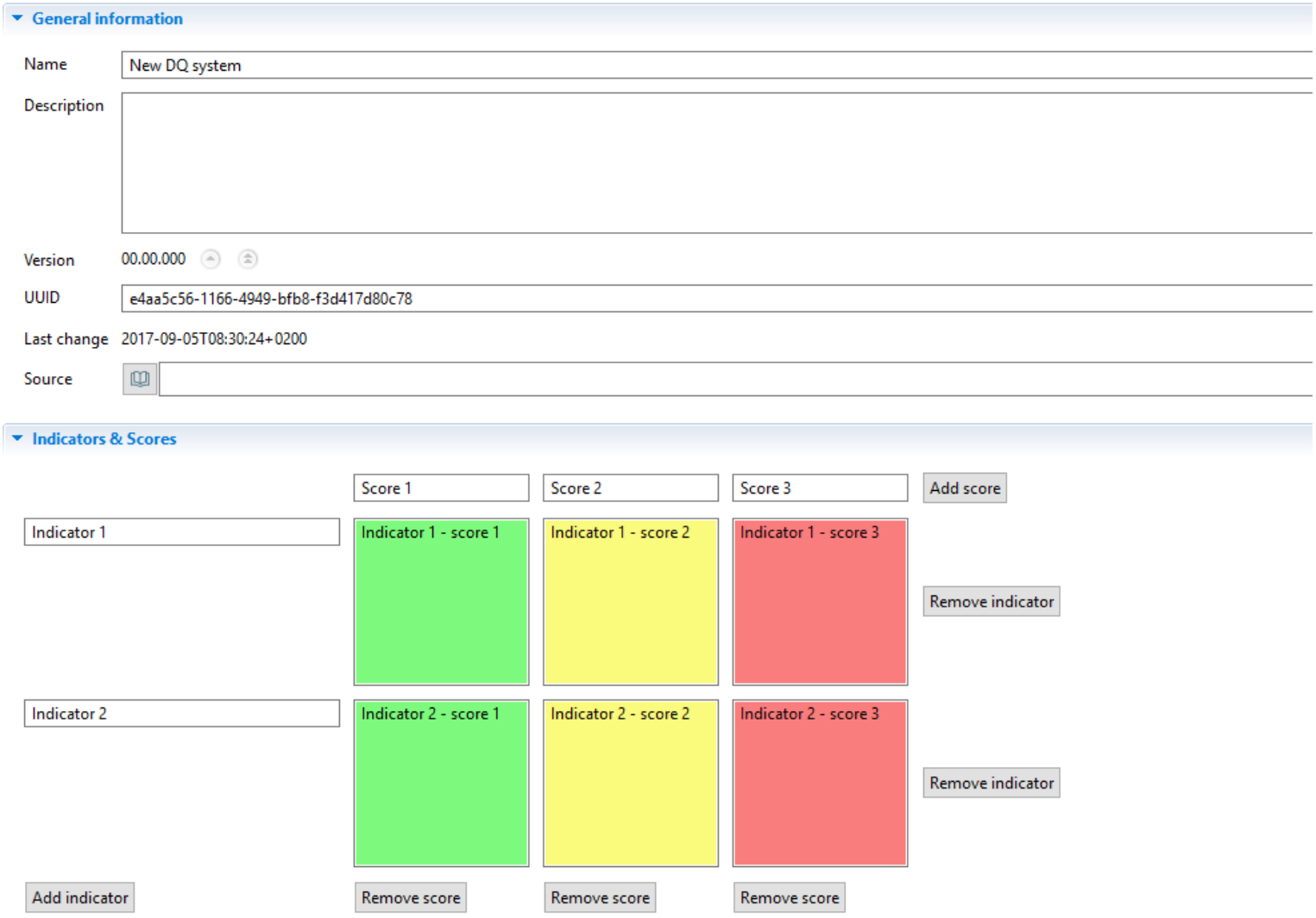


Summary, Outlook and discussion

Summary

- I have shown a way to visualize contributions in LCA case studies and product systems using an ordered “contribution tree” view
- This view is useful for detecting hot spots
- Adding the data quality of processes in the product system to the results is useful for interpretation since it helps to understand how reliable the information is
- Maps, and sun burst charts, are further useful for understanding the product results
- All these elements are available in openLCA 1.6

Outlook & discussion: However..



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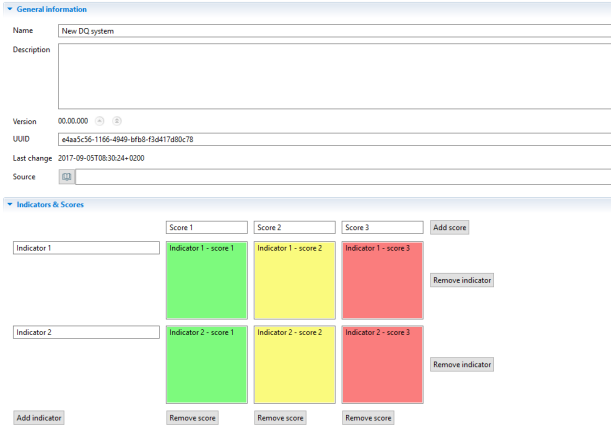
Outlook & discussion: However..



- There are several DQ systems proposed (ecoinvent, ecoinvent modified, PEF, ..)
- Existing DQ systems change
- This has an effect on the DQ results obviously
- But in the end is probably comparable to LCIA methods

Outlook & discussion

Overall, we are probably just at a starting point in LCA visualisation & hot spot analysis:

- Systematic hot spot analysis?
- Display of large results so that users (of various background, also non-LCA) understand, tiered approaches
- Information for the modeler (unused flows, ..) and for the "end user"
- Smart combination of various dimensions
- Learning from other disciplines (biogenetics, e.g.)

→ *We invite tool developers and users to discuss and exchange, and potentially collaborate, on LCA visualisation.*

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sustainability consulting + software

Merci!

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