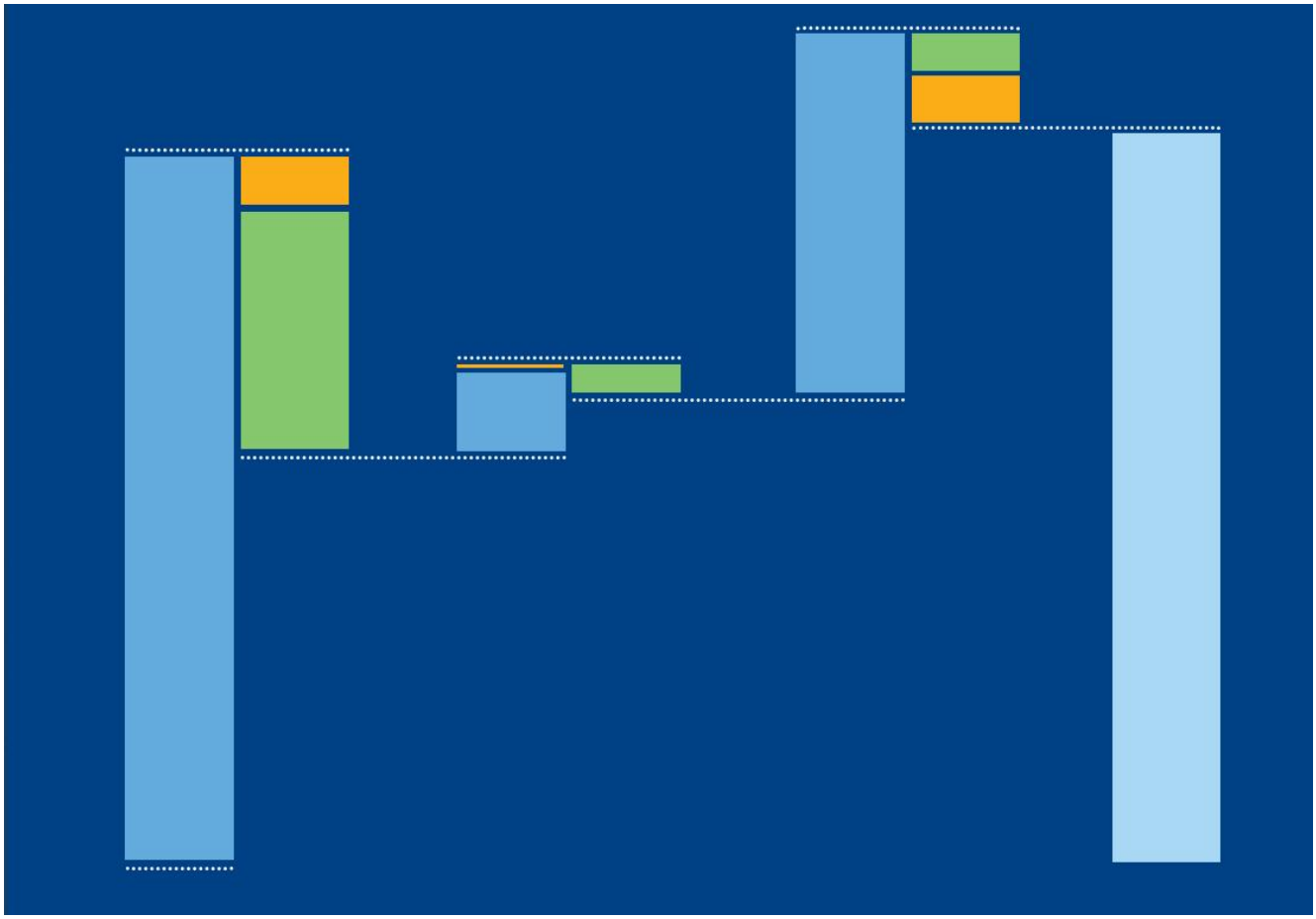
denkstatt
create sustainable value

METRO



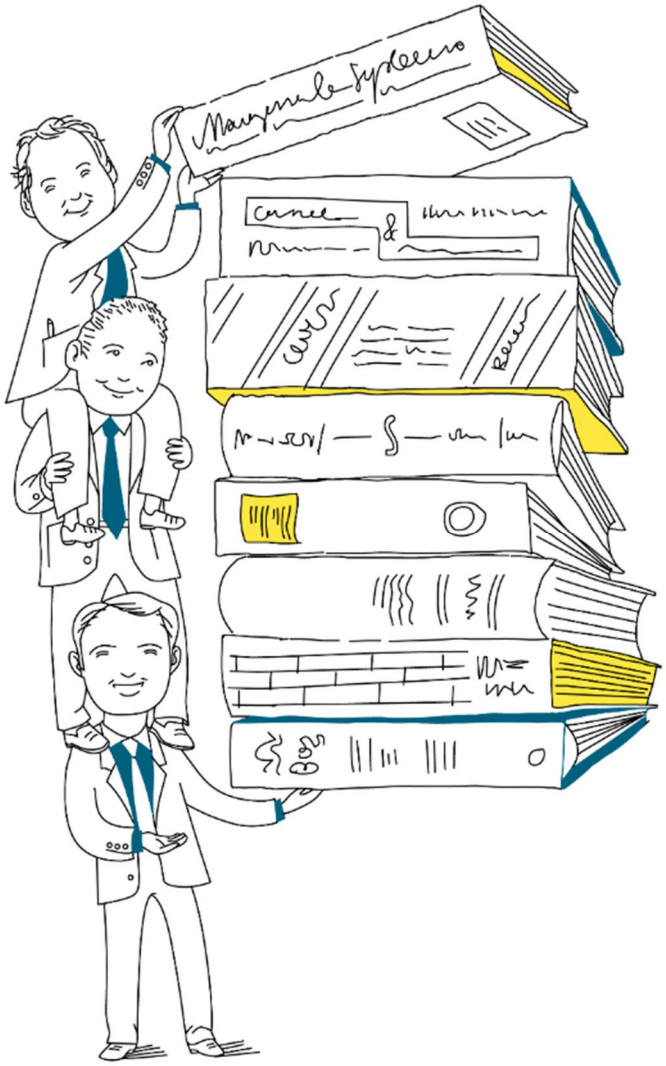
Sustainable Value Creation Method note

Appendix to the paper on SUSTAINABLE VALUE CREATION

Date: 2018-07-19

Client: Metro AG

A member of INOGEN



Editors: Ivan Paspaldzhiev, Florian Krautzer, Boyan Rashev, Willibald Kaltenbrunner

07.09.2018

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1. Methodology

The assessment outlined in the publication "SUSTAINABLE VALUE CREATION" by Metro AG (herein "METRO", referring to Metro AG's wholesale operations) seeks to assign a monetary value to the impact of METRO's activities and was conducted following the guidance of the Natural Capital and Social Capital Protocols. As per said guidance, the following sections breakdown the assessment methodology. This Method note aims to provide transparency behind the results of this assessment. It is to be understood as a detailed appendix to the paper aimed at the advanced reader, interested in specific methodological details of and data sources for the assessment.

1.1. Scope

It is typically recommended that impact valuation exercises cover at least a company's own controlled operations (as defined for financial reporting purposes) plus its direct suppliers. The present assessment seeks to go further and covers the activities along the entire value chain of METRO's wholesale operations in all 25 countries it operates in. This is divided into three parts:

- Upstream – the impacts due to activities induced by METRO's procurement of goods and services. These impacts are modelled three levels down, namely for 1) agriculture & raw materials production; 2) manufacturing & processing; 3) logistics. All additional economic activities such as production of fuels for energy used by the above industries is also included (see section 1.2.4.2).
- Own operations – the impacts due to the activities of METRO's stores, warehousing and auxiliary operations, as defined for financial and sustainability reporting purposes. In this assessment, this covers the activities of METRO Wholesale for financial year 2016/17. Corporate payments (i.e. value to stakeholders, creditors and governments) are an exception and represent METRO AG as a whole due to currently only being reported on a group level. Thus, positive economic value for Own operations can be seen as slightly overestimated.
- Downstream – the impacts due to activities induced by METRO's sales to wholesale customers. In the present study, this includes the HoReCa (hotels, retail and catering) and trader (reseller) sectors. Excluded is METRO's customer group "SCO" (professional service companies and organisations, such as offices and institutions). The rationale for exclusion is that it is not reasonable to link said customers' activities to the goods they purchase from METRO (such as office supplies).

The activities of Own operations are included based on primary data from METRO accounting on energy, fuel and resource usage, as well as economic activities. Activities Upstream and Downstream are included via input/output modelling, which relates payments (Upstream) and sales (Downstream) figures to environmental and social impacts. This is detailed in the following section.

1.2. Impact modelling & valuation

In terms of materiality, the assessment aimed to be extensive and include the fullest possible range of impacts for the three main impact dimensions – economic, social and environmental. All impacts are modelled bottom-up for individual METRO countries and aggregated for the final results presented in this document.

The following table summarises the included impact categories, the primary data from which they are derived, as well as the data sources for impact and valuation modelling.

Table 1: Summary of included impacts, as well as their data inputs and impact & valuation modelling data sources.

	Category	Impact	Data input	Impact modelling	Valuation
Upstream	Economic	Value to suppliers	Value of purchases from goods suppliers	-	World Input Output Database
		Value to contractors	Value of services purchased (e.g. consultancy)	-	World Input Output Database
		Value to service providers	Value of services purchased (e.g. maintenance, cleaning, waste management)	-	World Input Output Database
	Social	Social risk from exploitative labour	Value of purchases from goods suppliers	estell Model by Systain (based on EXIOBASE 2.2 and ILO)	Value of exploitative labour
	Environmental	Greenhouse gases	Value of purchases from goods suppliers Value of services purchased (e.g. consultancy) Value of services purchased (e.g. maintenance, cleaning, waste management)	EXIOBASE LC-IMPACT	Metro internal GHG price
		Air pollution			Damage to human health Damage to ecosystem health
		Water use			Damage to human health Damage to ecosystem health
		Water pollution		Ecoinvent v3.4 + ReCiPe2016	Damage to human health Damage to ecosystem health
		Land use		EXIOBASE LC-IMPACT	Damage to ecosystem health
Own Operations	Economic	Value to stakeholders	Distributed dividends	-	Taken 1:1
		Value to creditors	Paid interests	-	Taken 1:1
		Value to employees	Paid salaries	-	Taken 1:1
		Value to national and local government	Paid taxes and fees (incl. social security)	-	Taken 1:1
	Social	Value of employee training	Investments in training	-	Multiplied by employee turnover
		Health & Safety	Days lost due to accidents		Damage to human health
		Food donations	Value of food donated	Gustavsson *et al.* (2011) + ExternE (2008)	METRO value of a meal (MCC France)
		Other donations	Value of donations	-	Taken 1:1
	Environmental	Greenhouse gases	Metro GHG accounting (Scope 1, 2 and 3)	-	Metro internal GHG price
		Air pollution	Energy use (facilities), fuel use (logistics)	EMEP/EEA Inventory Guidebook, Tier 1 + LC-IMPACT	Damage to human health Damage to ecosystem health
		Water use	Water use (blue water)	LC-IMPACT	Damage to human health Damage to ecosystem health
		Water pollution	Water use (blue water)	Ecoinvent v3.4 + ReCiPe2016	Damage to human health Damage to ecosystem health
		Land use	Floor area of facilities + parking lots	LC-IMPACT	Value of grassland ecosystem services
Downstream	Economic	Value to clients	Value of sales to HoReCa and Traders	World Input Output Database (turnover)	World Input Output Database (share of employee compensation only)
	Social	Social risk from exploitative labour	Value of sales to HoReCa and Traders	Derived from *Upstream* + Vulnerable employment rate (ILO)	Value of exploitative labour
	Environmental	Greenhouse gases	Value of sales to HoReCa and Traders	EXIOBASE LC-IMPACT	Metro internal GHG price
		Air pollution			Damage to human health Damage to ecosystem health
		Water use			Damage to human health Damage to ecosystem health
		Water pollution		Ecoinvent v3.4 + ReCiPe2016	Damage to human health Damage to ecosystem health
		Land use		EXIOBASE LC-IMPACT	Damage to ecosystem health

1.2.1. Impact modelling

The impact modelling approach in this study has been developed with the aim of offering comprehensiveness while also limiting the different data sources and methods utilised, so as to narrow down the sources of uncertainty in the derived results.

For economic impacts, simple macroeconomic calculations are performed via the World Input Output Database[1] (see section 1.2.3).

[1] Timmer, M. *et al.* (2012). *The world input-output database (WIOD): contents, sources and methods* (No. 20120401). Institue for International and Development Economics.

For environmental impacts, impacts are ultimately transformed to:

- Damage to human health (in Disability-adjusted life-years; DALYs)
- Damage to ecosystem health (in Potentially disappeared fractions of species; PDFs)

With the exception of Own operations – Greenhouse gases (see section 1.2.4.1.1) and Own operations – Land use (see section 1.2.4.1.5), all impacts are modelled via country-specific impact factors from the LC-IMPACT FP7 project[2]. In brief, choice of impact factors from LC-IMPACT requires two value choices. First is factor calculation type – herein *averaged/linear* factors are used; these represent impacts due to larger changes in drivers and are more appropriate for aligning with the input/output modelling portion of this assessment. Second is the choice of time horizon and breadth of impacts. Herein e*xtended* impact factors are used – these include the widest possible range of impacts in the source methodology, including such that are further away in time and thus more uncertain. This larger uncertainty is deemed acceptable for ensuring that the calculated results are conservative and do not omit important impacts. See chapters 1.3 and 1.4 of the LC-IMPACT summary report[2] for more details.

Finally, social impacts are modelled via a collection of approaches for Own operations (see section 1.2.5.1) and via the concept of *social risk hours* for Upstream and Downstream scopes (see section 1.2.5.2).

1.2.2. Valuation

The following main valuation factors are used:

- Damage to human health - the Value of a Statistical Life-Year (VOLY) is used, taken to equal 69,750 EUR per DALY for 2016 (inflation-adjusted from 60,000 for 2005). This is the upper range of the values obtained by the EU-funded projects ExternE[3], CAFE[4] and NEEDS[5]. This value can be taken as representative for developed countries and is not adjusted for purchasing power in this study. If it were adjusted for purchasing power, the value of life would be lower for less developed (and thus poorer) countries, which is deemed ethically indefensible.
- Damage to ecosystem health – a value of 1.37 EUR per PDF is used (for Germany in 2016, adjusted from 2006), taken from the EU project NEEDS[6]. This value represents restoration costs for local ecosystem damages. However, biodiversity impacts are scale-dependent, which is why LC-IMPACT ecosystem impact factors model *globally-normalised* damages (see LC-IMPACT chapter 11[2] for more details). In order to align the NEEDS factor with LC-IMPACT, Koellner (2001)[7] is followed using land cover data for 2015 from the European Space Agency Climate Change Initiative[8]. NEEDS further provide valuation factors for EU25 used herein, with values for all non-represented METRO countries adjusted for purchasing power from the EU25 average.

[2] LC-IMPACT consortium. (2016). LC-IMPACT: A spatially differentiated life-cycle impact assessment approach Version 0.5, Summary report. Seventh Framework Programme, Project no: 243827
[3] Bickel, P. and Friedrich, R. eds. (2004). ExternE: externalities of energy: methodology 2005 update. EUR-OP.
[4] Hurley, F. *et al.* (2005). Methodology Paper (Volume 2) for Service Contract for carrying out cost-benefit analysis of air quality related issues, in particular in the clean air for Europe (CAFE) programme. *Methodology for the Cost-Benefit analysis for CAFE*, *2*, pp.1-159.
[5] Desaigues *et al.* (2006). Final report on the monetary valuation of mortality and morbidity risks from air pollution. *New Energy Externalities Developments for Sustainability (NEEDS).* Sixth framework programme, Project no: 502687
[6] Ott, W. *et al.* (2006). Assessment of biodiversity losses. NEEDS Deliverable D, 4.
[7] Koellner, T. (2001). Land Use in Product Life Cycles and its Consequences for Ecosystem Quality,University of St. Gallen, ETH Zürich, 2001.
[8] Bontemps, S. *et al.* (2013). Consistent global land cover maps for climate modelling communities: current achievements of the ESA's land cover CCI. In *Proceedings of the ESA Living Planet Symposium* (pp. 9-13).

- Greenhouse gas emissions – METRO's internal carbon price of 25 EUR/tonCO_2-eq is used. This is based on METRO's internal GHG accounting methodology.[9].
- Social risk Upstream and Downstream – a value of 2,745 EUR per social risk year (converted to hours) is used based on estimates for profits from exploitative labour from the International Labour Organisation[10]. The derivation of this value is detailed in section 1.2.5.2.

The following section details valuation for economic impacts, while social impacts and land use valuation for Own operations are described in section 1.2.5.1 and 1.2.4.1.5 respectively.

Where appropriate, adjustments for purchasing power and inflation (based on GDP deflators) are carried out via data from the World Bank World Development Indicators.

1.2.3. Economic impacts & value

1.2.3.1. Own operations

The economic value of activities in Own operations is the sum of:

- Value to shareholders – equivalent to distributed dividends
- Value to creditors – equivalent to paid interest
- Value to employees – equivalent to salaries paid
- Value to national and local government – summation of taxes and fees paid, as well as social security contributions (incl. health insurance)

An economic multiplier of 1 is assumed, which excludes any secondary economic "ripple effects" from the value transfer above. This can be seen as a conservative assumption. No additional impact and valuation modelling is performed.

1.2.3.2. Upstream

Upstream economic value is taken to be the summation of payments to METRO's suppliers of goods and services. This includes:

- Value to contractors – such as consultancy services
- Value to service providers – such as maintenance, cleaning and waste management
- Value to suppliers – divided via METRO's internal product classification into fresh food, ultra-fresh food, dry food, near-food and non-food suppliers

From a macroeconomic perspective, METRO's payments for goods and services are treated as contributing to gross output in the economy. Thus, no additional impact and valuation modelling is performed.

1.2.3.3. Downstream

Downstream economic value is taken as the salaries paid by wholesale customers (the HoReCa and trader sectors) induced by METRO sales.

These are derived in the impact modelling stage via country-specific socioeconomic accounts from the World Input Output Database (WIOD; version Feb 2018)[1]. From a macroeconomic perspective, the value of METRO sales is treated as intermediate inputs to customers' businesses. HoReCa customers are modelled via the

[9] Available at: https://www.metroag.de/~/assets/metro/documents/responsibility/metro-carbon-footprint-methodology_en.pdf [Accessed 3rd of July 2018]
[10] ILO., 2014. Profits of Poverty: The Economics of Forced Labour. International Labour Office.

"Accommodation and food service activities" sector, while traders are modelled as "Retail trade, except of motor vehicles and motorcycles". Customer turnover is calculated from intermediate inputs and is then multiplied by the share of sectoral employee compensation to gross output.

The result is *salaries paid by customers attributable to business with METRO.* In lay terms, customers purchase goods from METRO, which they then "consume" in order to create value. The portion of this value that is transferred to society is the value deemed to be induced by METRO. This portion is assumed to only be salaries paid - payments of taxes etc. are excluded as a conservative assumption, while the profits generated by customers are treated as "private" due to their business activities (i.e. they are their own personal profits and not attributable to METRO).

1.2.4. Environmental impacts & value

1.2.4.1. Own operations

1.2.4.1.1. Greenhouse gases

Greenhouse gas emissions for Own operations are modelled via METRO's internal GHG accounting methodology[9] and cover Scopes 1, 2 and 3 under the Greenhouse Gas Protocol. This notably does not include the emissions induced by METRO's product assortment, which is included separately in the Upstream scope (see section 1.2.4.2).

Emissions are valued via METRO's internal carbon price of 25 EUR per ton CO_2-equivalent.

1.2.4.1.2. Air pollution

Air pollution is modelled based on METRO primary data on fuel use for facilities and logistics, taking into account vehicle mixes. Included are emissions of PM2.5, NO_x, SO_x, NH_3 and NMVOCs. PM10 is converted to PM2.5 equivalent using a conversion factor of 65% - based a review of multiple studies and slightly higher than the 60% factor used in the notable "six cities study"[11] and by the World Health Organisation[12].

Fuel use for facilities[13] and transport[14] is done via the EMEP/EEA 2016 Inventory Guidebook. Tier 1 (most conservative) factors are used throughout, due to lack of more detailed data for Tier 2 assessment. This is notably the case for mix of EURO standards for external logistics. For facilities' use of district heating, the primary energy mix used for generating heat is obtained from International Energy Agency, with the EU28-average taken as representative throughout. Emissions from facilities' electricity use are modelled via the Ecoinvent v3.4 (Cut-off) *market for electricity, low voltage* dataset for individual countries.

[11] Dockery DW, Pope CA, 3rd. Acute respiratory effects of particulate air-pollution. *Annual Review of Public Health.* 1994; 15:107-132.
[12] World Health Organization, 2016. Ambient air pollution: A global assessment of exposure and burden of disease.
[13] 1.A.4 Small combustion, Commercial stationary installations. 1.A.1 Energy industries, Public electricity and heat production is used for emissions from district heating
[14] 1.A.3.b.i-iv Road Transport

Emissions are converted to impacts via country-specific LC-IMPACT factors (see chapters 5, 6 and 7 therein[2]) as follows:

	PM2.5	NO_x	SO_x	NH_3	NMVOCs	Impacts
Particulate matter formation	X	X	X	X		Human health
Photochemical ozone formation		X			X	Both human and ecosystem health
Terrestrial acidification		X	X	X		Ecosystem health

Table 2: Air quality impacts included in the present assessment, based on LC-IMPACT factors.

Valuation is performed via the Value of a statistical life for human health damage and ecosystem restoration costs for ecosystem damage (see section 1.2.2 for details).

1.2.4.1.3. Water use

Water use is included via primary data for each individual METRO country, as collected for sustainability reporting purposes. Only consumptive water use is included; green water use is excluded from the project scope due to lack of data. Water use (in m^3) is converted to impacts via country-specific LC-IMPACT factors for damage of water stress on human health (due to malnutrition), as well as on ecosystem health (damage to aquatic and riparian habitats). See chapter 12 in LC-IMPACT for more details[2]. Valuation is performed via the Value of a statistical life for human health damage and ecosystem restoration costs for ecosystem damage (see section 1.2.2 for details).

1.2.4.1.4. Water pollution

Water pollution impacts are modelled based on water use via the Ecoinvent v3.4 *market for wastewater* (Cut-off) dataset, used in three geographical versions:

Dataset available geography	Use
CH (Switzerland)	Germany
Europe, without Switzerland	Rest of Europe
RoW (Rest of World)	All other Metro countries

Table 3: Geographic differentiation used for the Ecoinvent market for wastewater dataset.

The ReCiPe impact method is used, with impacts included being:

- Damage to human health from cancerogenic and non-cancerogenic toxicity
- Damage to ecosystem health from freshwater and marine toxicity and eutrophication

ReCiPe midpoint impacts are converted to DALY and PDF respectively following the recommendations of the method's original authors[15].

It is currently assumed that 100% of water used is treated due to inability to model untreated water via Ecoinvent. 100% treatment may not necessarily be the case especially for developing countries, which is why the approach used herein likely underestimates water pollution impacts. Valuation is performed via the Value of a statistical life for human health damage and ecosystem restoration costs for ecosystem damage (see section 1.2.2 for details).

1.2.4.1.5. Land use

Land use is included based on METRO primary data for area used for floors and parking lots for facilities in individual countries. Land use impacts for Own operations are directly converted to value based on the global average value of ecosystem services from grasslands[16], taken as representative for Germany and purchasing-power-parity (PPP) adjusted between countries.

This is chosen instead of using the LC-IMPACT method as in Upstream & Downstream modelling. The LC-IMPACT factor for land occupation on urban land in Germany is averaged over urban lands where antecedent land uses may have been different unrepresentative land use types such as forests or wetlands, while METRO's land occupation (for stores and warehouses) can safely be assumed to only occur on lands with grasslands as the antecedent land use. Using the LC-IMPACT method otherwise leads to impacts that are several orders of magnitude larger than any other category for Own impacts, which is deemed to be unrealistic.

1.2.4.2. Upstream & Downstream

Upstream and Downstream impacts are included via the Estell model by Systain (based on the EXIOBASE[17] input/output model version 2.2). In brief, EXIOBASE provides a "snapshot" of the trade linkages in the global economy, allowing for linking economic activities (METRO payments or sales) to impacts induced by business with METRO.

For Upstream impacts, the origin of goods purchased by METRO is modelled via the average consumption share of the EXIOBASE "Hotels & restaurants" sector in individual METRO countries. Upstream results include the impacts of 1) agriculture & raw materials production; 2) manufacturing & processing; 3) logistics, as well as all additional economic activities induced, such activities due to the use and production of fuels used by the agricultural sector.

Downstream impacts are included via customer turnover (see section 1.2.3.3), modelling the HoReCa sector as "Hotels and restaurants" in EXIOBASE and the traders sector as "Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods".

As opposed to Downstream economic impacts (where only a portion of customers' impacts are attributed to METRO; see section 1.2.3.3), the full environmental impact of customers Downstream is attributed to METRO.

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[15] Huijbregts, M.A. *et al.* (2017). ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. *The International Journal of Life Cycle Assessment*, *22*(2), pp.138-147.
[16] De Groot, R. *et al.* (2012). Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem services*, *1*(1), pp.50-61.
[17] Wood, R. *et al.* (2014). Global sustainability accounting—developing EXIOBASE for multi-regional footprint analysis. *Sustainability*, *7*(1), pp.138-163.

This is because while economic impacts are partially internalised by customers, environmental impacts are externalities and thus not internalised.

The same emissions/resource usages are modelled as used in Own operations and the same conversions to human and ecosystem health damage via LC-IMPACT are performed. Land use is also modelled via LC-IMPACT (in contrast to Own operations) and includes damage to biodiversity due to urban land occupation (see chapter 11 in LC-IMPACT for more details[2]).

1.2.5. Social impacts & value

1.2.5.1. Own operations

1.2.5.1.1. Employee training

The value of employee training to society is taken to be the portion of investment in staff training multiplied by staff turnover. This is calculated separately for individual METRO countries. The rationale for this is that trained employees leaving the company represent a transfer of value to society.

1.2.5.1.2. Health & Safety

Health & Safety impacts are included based on primary data on reported days lost due to workplace incidents for individual METRO countries. Time lost is treated as a damage to human health (in DALYs) and is valued via the Value of a statistical life-year (see section 1.2.2).

1.2.5.1.3. Food donations

Food donations are valued as an avoided cost of food purchases for donation recipients. Primary data on *value* of food donated is used for individual METRO countries. Modelling is performed as follows:

1. Value of donations is converted to amount of food donated in kilograms via the average price of food donated (1.29 EUR/kg for METRO Germany, adjusted for PPP for other countries)
2. Of the amount donated, a portion is assumed to be food wasted by end-consumers. Food waste factors are derived via coefficients of food waste percentages at the end-consumer stage for different food groups and geographic regions based on data from the FAO[18]. Food waste factors are averages of the FAO coefficients, weighted by shares of turnover for different food groups for individual METRO countries.
3. The value of food wasted is modelled as a landfill externality from the EXIOPOL[19] EU project (0.012 EUR/kg for EU25)
4. The value of the food not gone to waste is modelled via METRO data for the average value of a meal (1.52 EUR/500g meal for METRO France)
5. Subtracting the value of food wasted from 4. yields the end-value of food donations.

1.2.5.1.4. Other donations

Other donations are treated as in economic value for Own operations (taken 1:1). It should be acknowledged that "Other" donations may have different impacts (both larger or smaller) than simply the amount of money that is donated based on the type of donation, but this has currently not been modelled.

[18] Gustavsson, J. *et al.* (2011). Global Food Losses and Food Waste– Extent, Causes and Prevention. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
[19] EXIOPOL, 2009. Final report on waste management externalities in EU25. DELIVERABLE DII.5.B-2, p. 29

1.2.5.2. Upstream & downstream

1.2.5.2.1. Impact modelling

Impact modelling Upstream and Downstream in the value chain is done via the concept of *social risk hours*. In brief, these represent the amount of working time an individual person spends at risk of exploitative labour practices, covering:

- Child labour and forced labour
- Occupational Health & Safety
- Working time violations
- Unfair compensation
- Discrimination
- Lack of freedom of association (access to unionisation)

Upstream, social risk is modelled based on ILO data via the *Estell* model, giving amount of time spent exposed to social risk for individual METRO countries. *Estell* uses economic accounts from EXIOBASE and herein follows the same procedure as for input/output modelling in section 1.2.4.2.

Downstream, social risk is obtained via social risk factors (social risk hours per EUR of turnover) derived from total social risk hours and total turnover for individual METRO countries. Upstream social risk is aggregated along the entire METRO supply chain (in different countries), while Downstream activities of customers can safely be assumed to only occur in the country in which METRO goods are purchased. Thus, some adjustment is necessary. The social risk factors obtained are adjusted based on a coefficient of vulnerable employment in individual METRO countries, representing the ratio of vulnerable employment in a country compared to the global average (for 2017). This coefficient allows for adjusting social risk upward for countries with higher vulnerability than the global average and adjusting downward for countries with lower vulnerability. Data on country vulnerable employment is obtained from the International Labour Organisation's World Employment and Social Outlook database.

1.2.5.2.2. Valuation

Valuation is performed via ILO data[10] on profits from exploitative labour for different geographic regions. A weighted average value of 2,745 EUR per work-year is used (PPP-adjusted between countries), being a mix between values for the two sectors estimated by the ILO - the "Agriculture'' sector and a more generic "Construction, manufacturing, mining and utilities" sector (called "Other" herein). The value per year is converted to an hourly figure based on the productive hours in a year (assuming a 40-hour work week multiplied by 52 weeks).

The rationale behind this is that the value business generates from exploitative labour is a value that is "lost" to society, as it is value based on unsustainable use of human capital.

For determining the mix between the two ILO sectors, assumptions have been made on the contribution of each sector to the production of products in METRO's product groups:

Product group	Product group shares	Agriculture	Other	Value (EUR/social risk year)
Fresh Food	16.8%	50%	50%	2,577
Ultra fresh food	21.1%	90%	10%	1,927
Dry food	40.2%	25%	75%	2,983
Near food	9.0%	10%	90%	3,226
Non Food	12.9%	10%	90%	3,226

Table 4: Assumptions on shares in goods production and weighted value assigned for profits from exploitative labour.

The logic behind shares assumptions is one of assigning a higher percentage contribution of "Agriculture" to more "fresh" product groups, due to these having less associated processing activities. As the source value for the "Other" sector is higher, attributing more "Agriculture" to food production leads to a smaller number for value of exploitative labour.

1.3. Key limitations:

The following are seen as the most major limitations of the study approach:

- Upstream and Downstream GHG emissions from refrigerants (such as HFCs) are excluded due to lack of data in EXIOBASE. This likely leads to underestimating GHG emissions in the value chain.
- The water pollution methodology is based on the strong assumption of 100% treated waste water which is likely not true especially for developing countries. This likely leads to underestimating the effects of water pollution.
- Valuation of social risk hours requires multiple value choices which may lead to inflation of uncertainty
- Health & Safety impacts in Own operations are suspected to be underestimated due to suspected inconsistent reporting of H&S data between METRO countries.
- Air pollution modelling for the Own operations vehicle fleet does not consider emissions standards due to lack of data for vehicle standards in external logistics transport for different countries.

2. Appendix: Data sources

[1] Timmer, M. *et al.* (2012). *The world input-output database (WIOD): contents, sources and methods* (No. 20120401). Institue for International and Development Economics.

[2] LC-IMPACT consortium. (2016). LC-IMPACT: A spatially differentiated life-cycle impact assessment approach Version 0.5, Summary report. Seventh Framework Programme, Project no: 243827

[3] Bickel, P. and Friedrich, R. eds. (2004). ExternE: externalities of energy: methodology 2005 update. EUR-OP.

[4] Hurley, F. *et al.* (2005). Methodology Paper (Volume 2) for Service Contract for carrying out cost-benefit analysis of air quality related issues, in particular in the clean air for Europe (CAFE) programme. *Methodology for the Cost-Benefit analysis for CAFE*, *2*, pp.1-159.

[5] Desaigues *et al.* (2006). Final report on the monetary valuation of mortality and morbidity risks from air pollution. *New Energy Externalities Developments for Sustainability (NEEDS).* Sixth framework programme, Project no: 502687

[6] Ott, W. *et al.* (2006). Assessment of biodiversity losses. NEEDS Deliverable D, 4.

[7] Koellner, T. (2001). Land Use in Product Life Cycles and its Consequences for Ecosystem Quality,University of St. Gallen, ETH Zürich, 2001.

[8] Bontemps, S. *et al.* (2013). Consistent global land cover maps for climate modelling communities: current achievements of the ESA's land cover CCI. In *Proceedings of the ESA Living Planet Symposium* (pp. 9-13).

[9] Available at: https://www.metroag.de/~/assets/metro/documents/responsibility/metro-carbon-footprint-methodology_en.pdf [Accessed 3rd of July 2018]

[10] ILO., 2014. Profits of Poverty: The Economics of Forced Labour. International Labour Office.

[11] Dockery DW, Pope CA, 3rd. Acute respiratory effects of particulate air-pollution. *Annual Review of Public Health.* 1994; 15:107-132.

[12] World Health Organization, 2016. Ambient air pollution: A global assessment of exposure and burden of disease.

[13] 1.A.4 Small combustion, Commercial stationary installations. 1.A.1 Energy industries, Public electricity and heat production is used for emissions from district heating

[14] 1.A.3.b.i-iv Road Transport

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