ANALYSE : GESTION ACTUELLE DES TERRES EXCAVÉES AU LUXEMBOURG, CONSÉQUENCES ET POSSIBLES ALTERNATIVES

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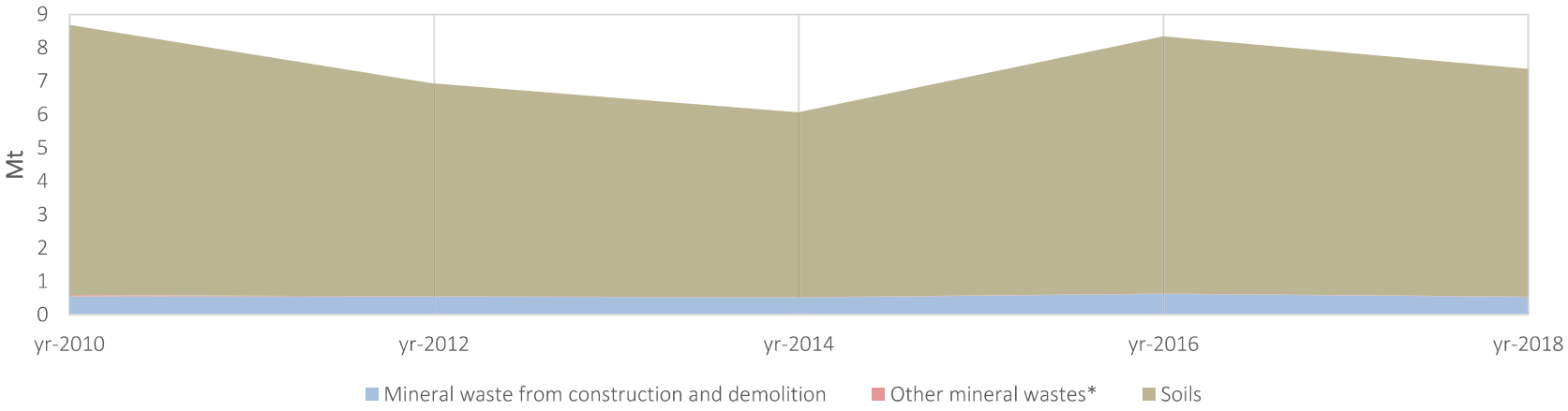
Problem of inert waste management in Luxembourg

CONTEXT

Trend of the inert waste production in Luxembourg (**on average: 7.5 Mt/year**)
Source of data: EUROSTAT (2022)



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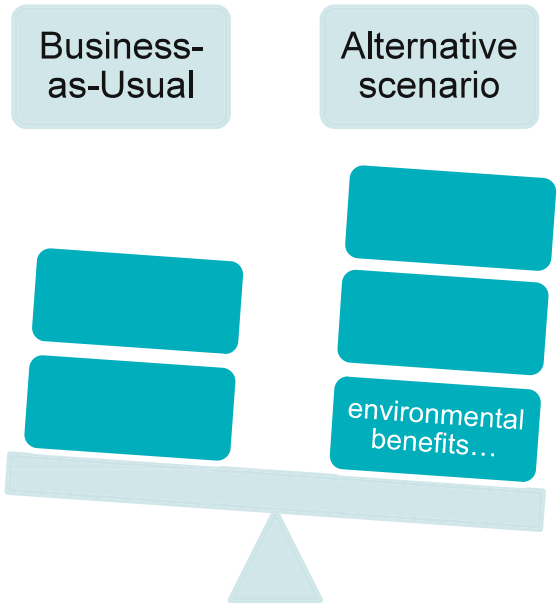
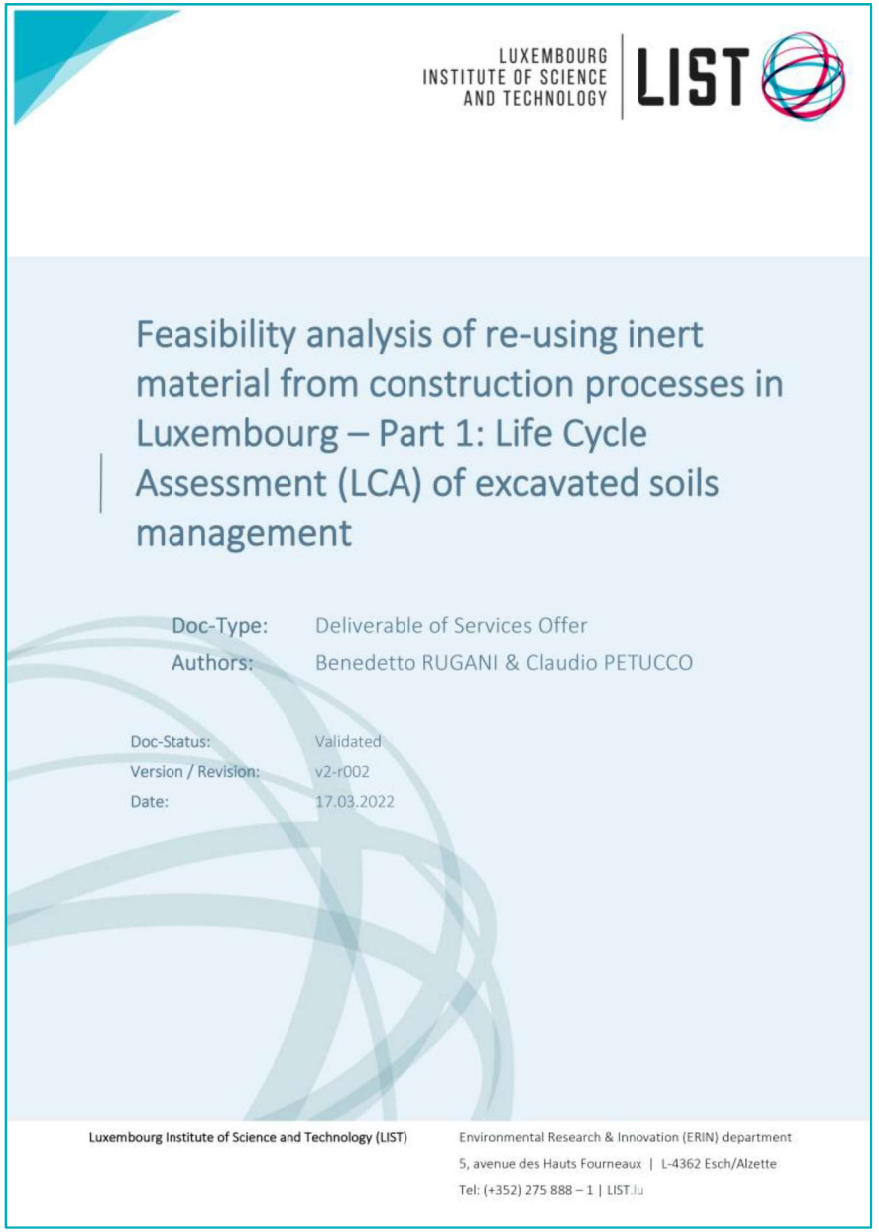
Environmental sustainability of excavated soils

GOAL OF THE STUDY

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Feasibility analysis of re-using inert material from construction processes in Luxembourg – Part 1: Life Cycle Assessment (LCA) of excavated soils management

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Authors: Benedetto RUGANI & Claudio PETUCCO

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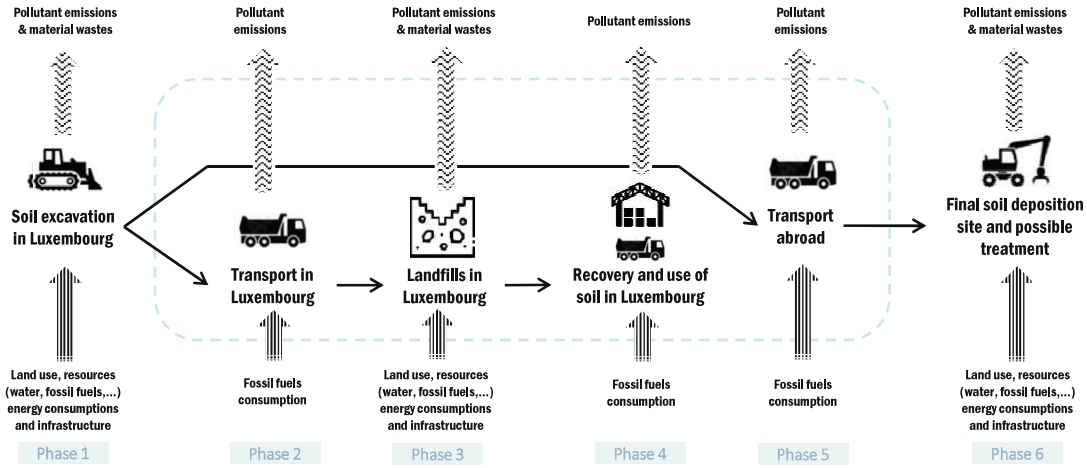
Environmental sustainability of excavated soils

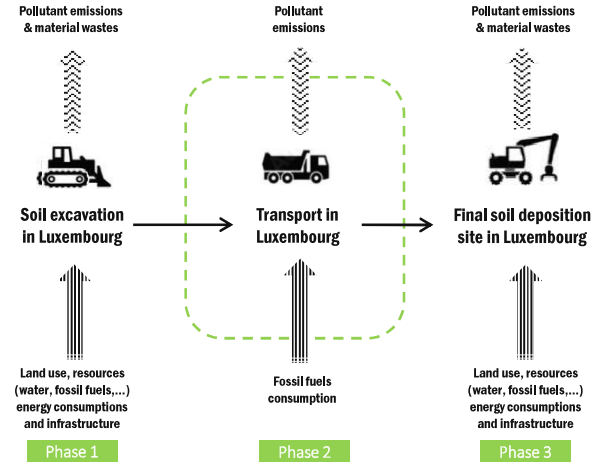
SPECIFIC OBJECTIVES

I. to characterize the prevalent (**business-as-usual**) management of excavated soils from construction and public works in Luxembourg: **analysis of material flows**

II. to evaluate the environmental impacts derived from current practices of prevalent management of excavated soils in Luxembourg: **life cycle assessment (LCA)**

III. to compare these impacts with those (positive and negative) associated with an alternative management system that would ideally **re-use the whole amount of excavated soils** in Luxembourg





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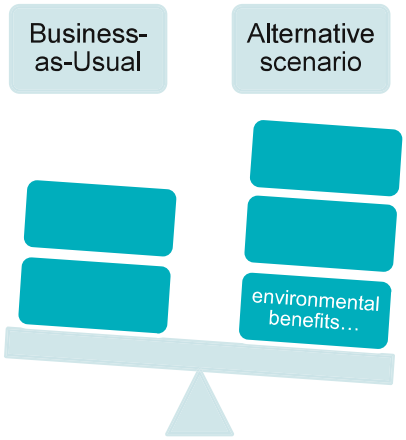
Hypothesis

ALTERNATIVE SYSTEM MORE SUSTAINABLE THAN BUSINESS-AS-USUAL



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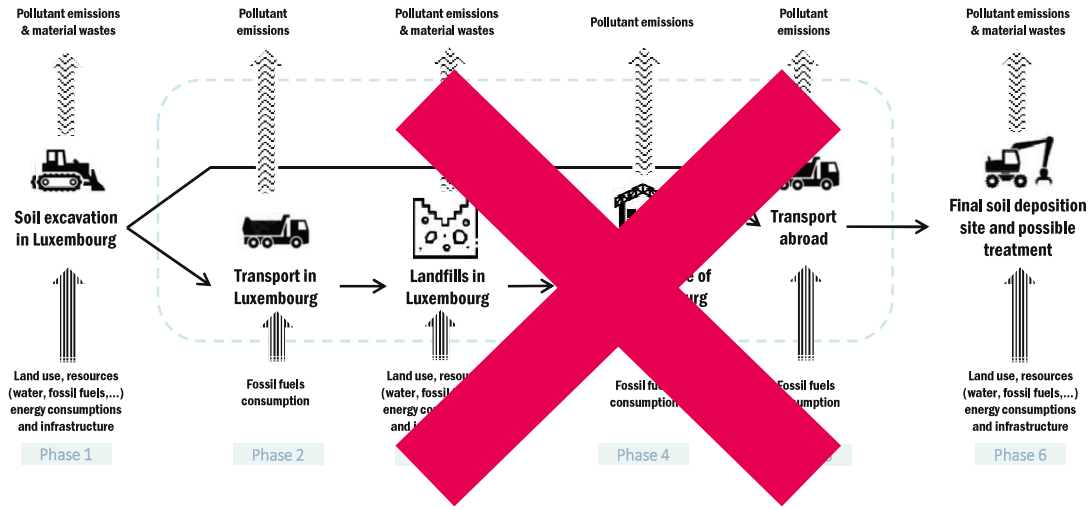

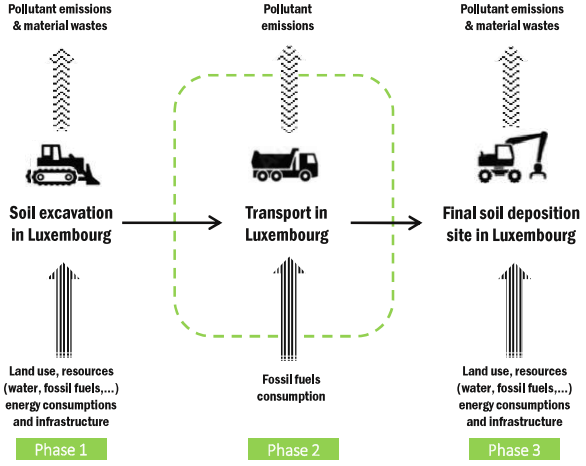

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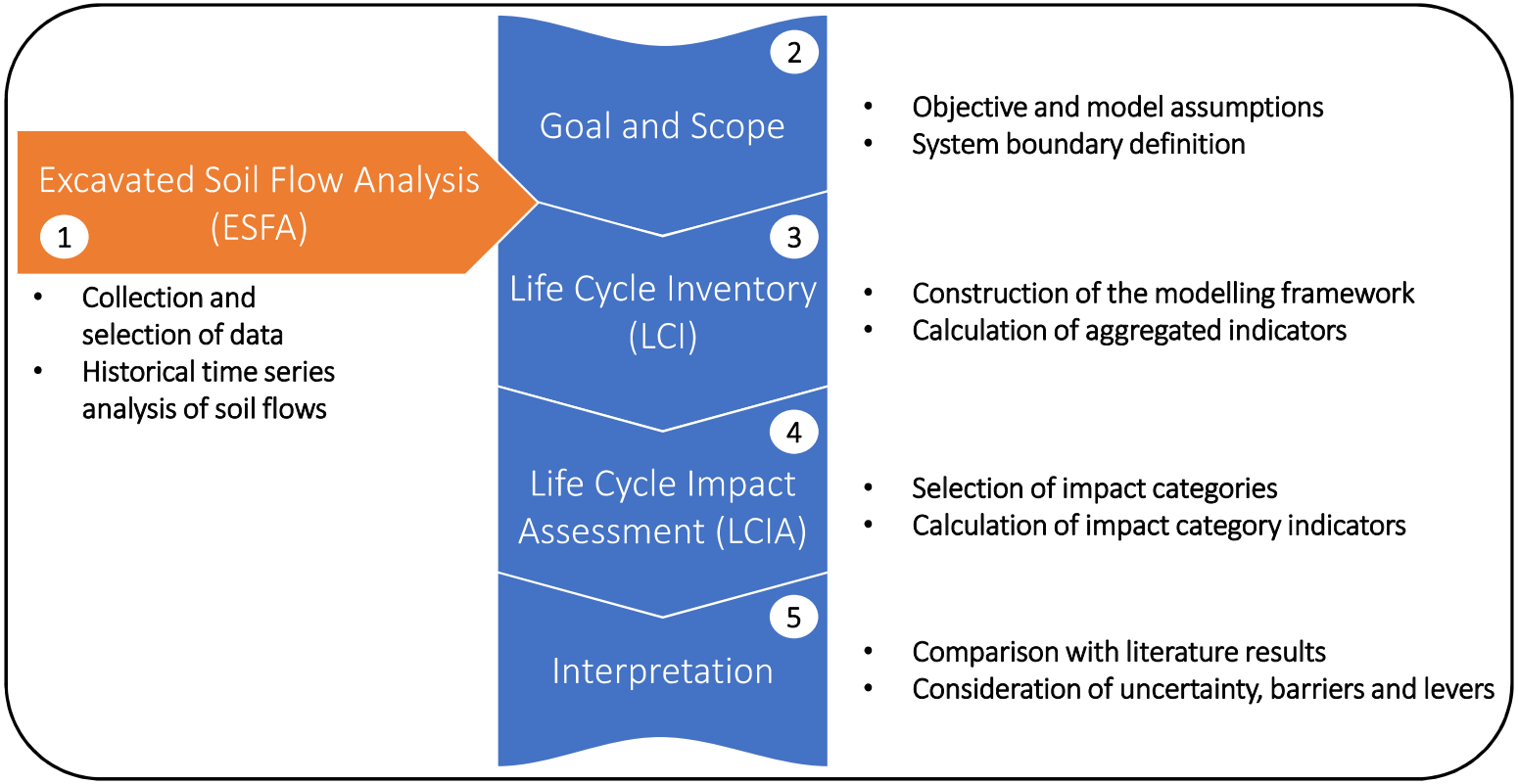
Environmental sustainability of excavated soils

METHODOLOGICAL STEPS



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Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG: DATA COLLECTION PROCESS

Data source(s):

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Environnement, du Climat et du Développement durable
Administration de l'environnement

STATEC
Institut national de la statistique et des études économiques

Time reference: 2010-2021 (complete and comparable coverage: 2016-2019)

Categories of data flows:

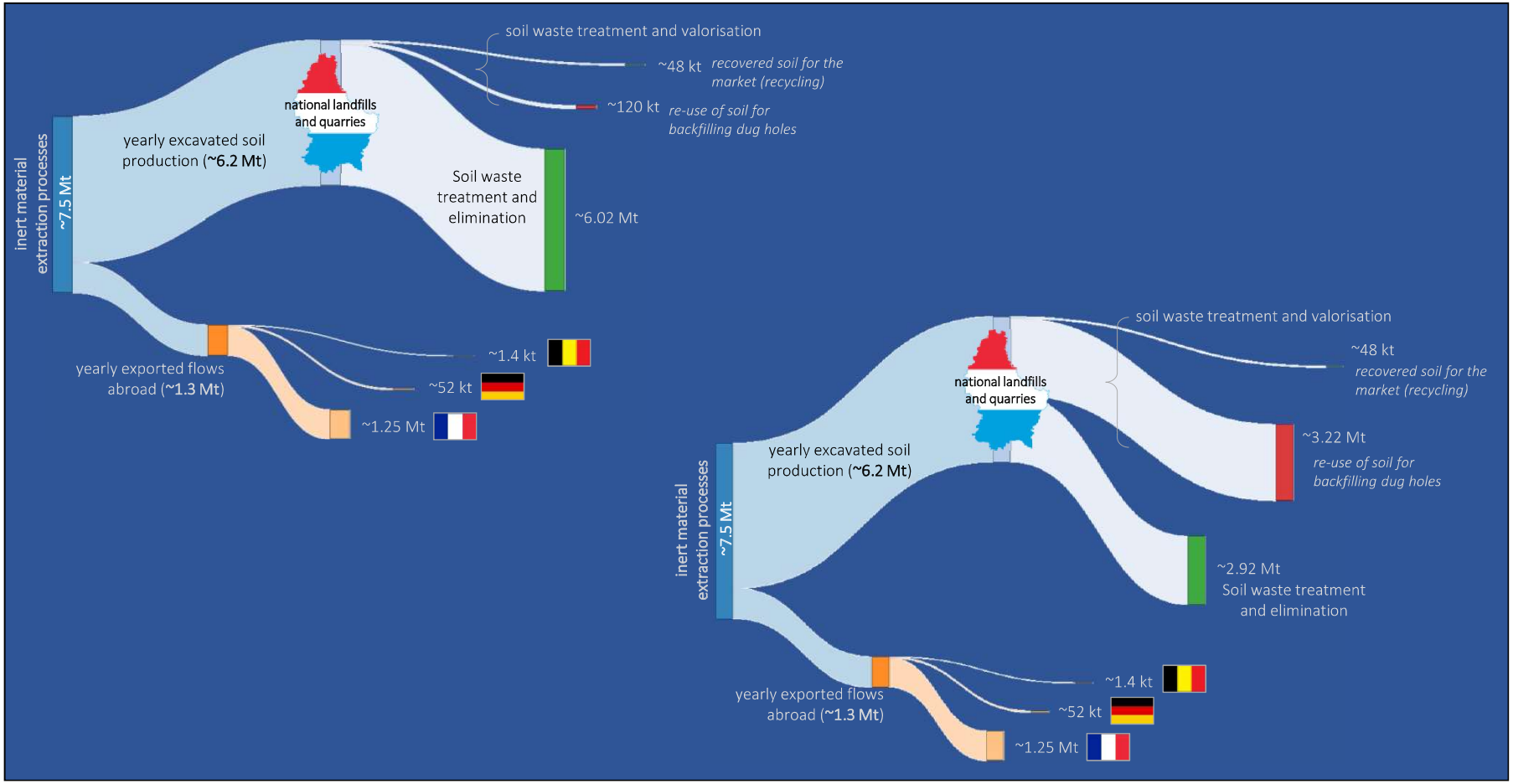
NACE sector producing waste materials
Total amount of each soil waste exported from Luxembourgish landfills (in kt)
Exported waste per destination country (kt)
Exported waste per type of material (kt)
Exported waste per type of treatment at destination (in kt)

LIST

Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG

Summary of results: nr. 2 possible interpretations



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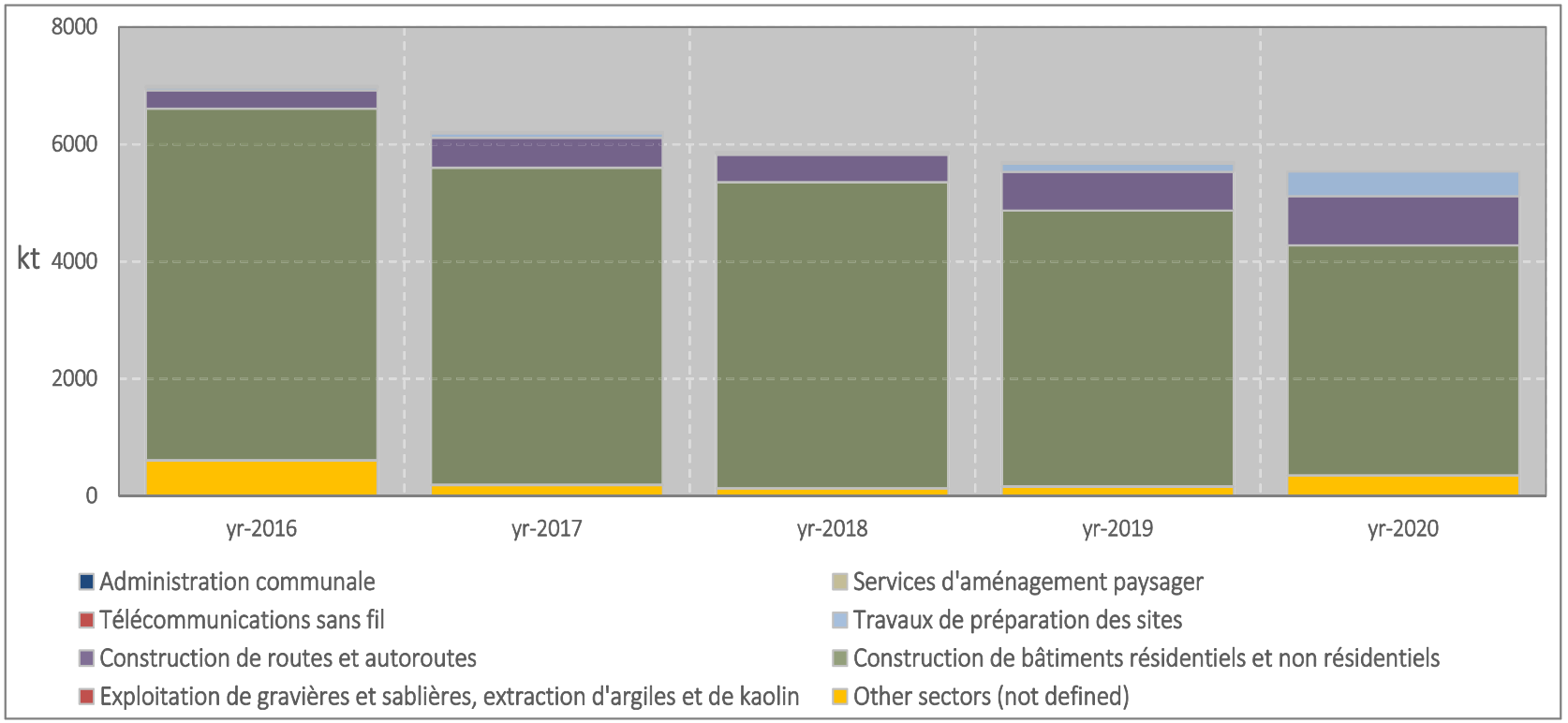
Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG

Excavated soil waste annually produced by economic sector in Luxembourg



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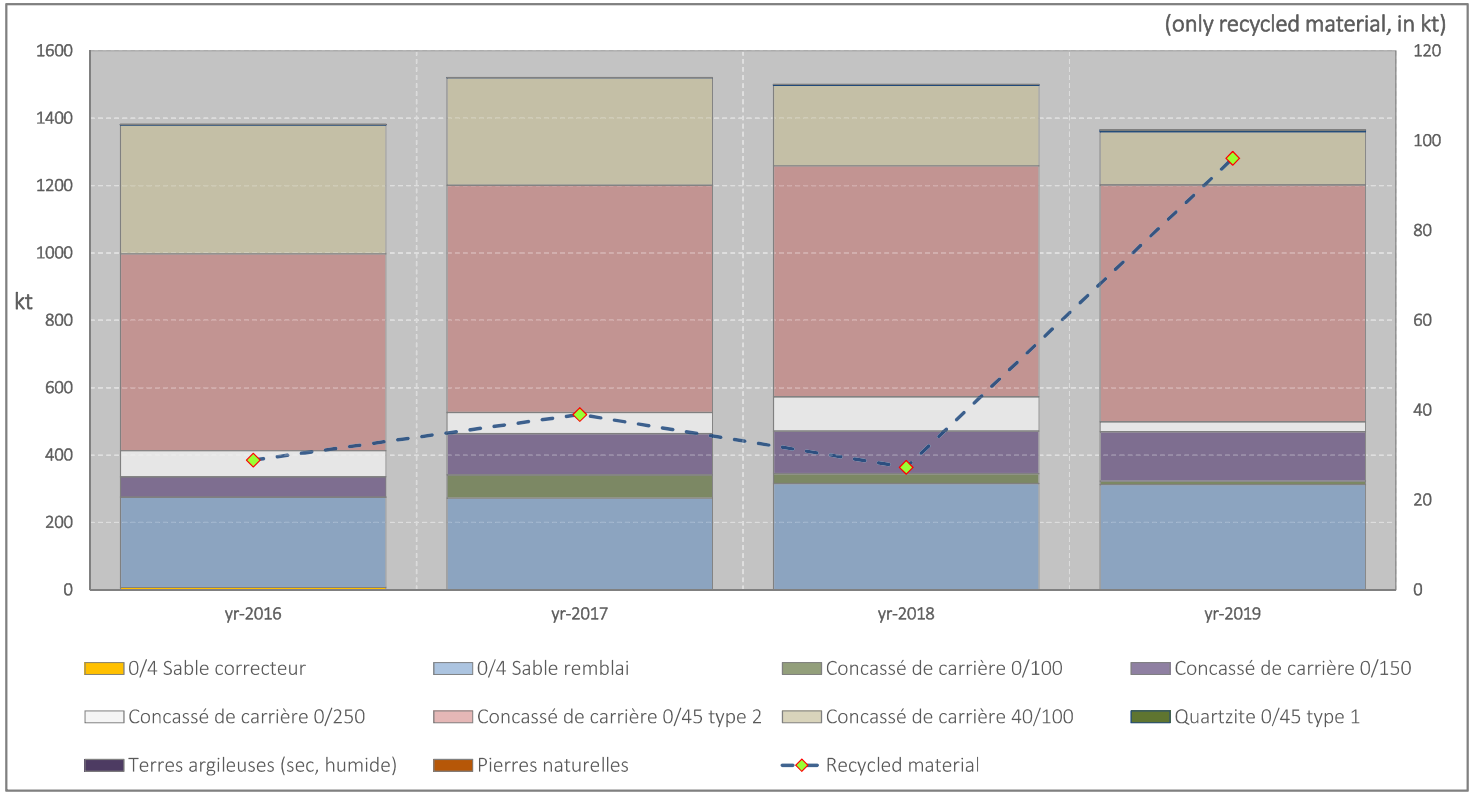
Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG

Typology and amount of excavated soil material waste moved out from Luxembourgish landfills and quarries



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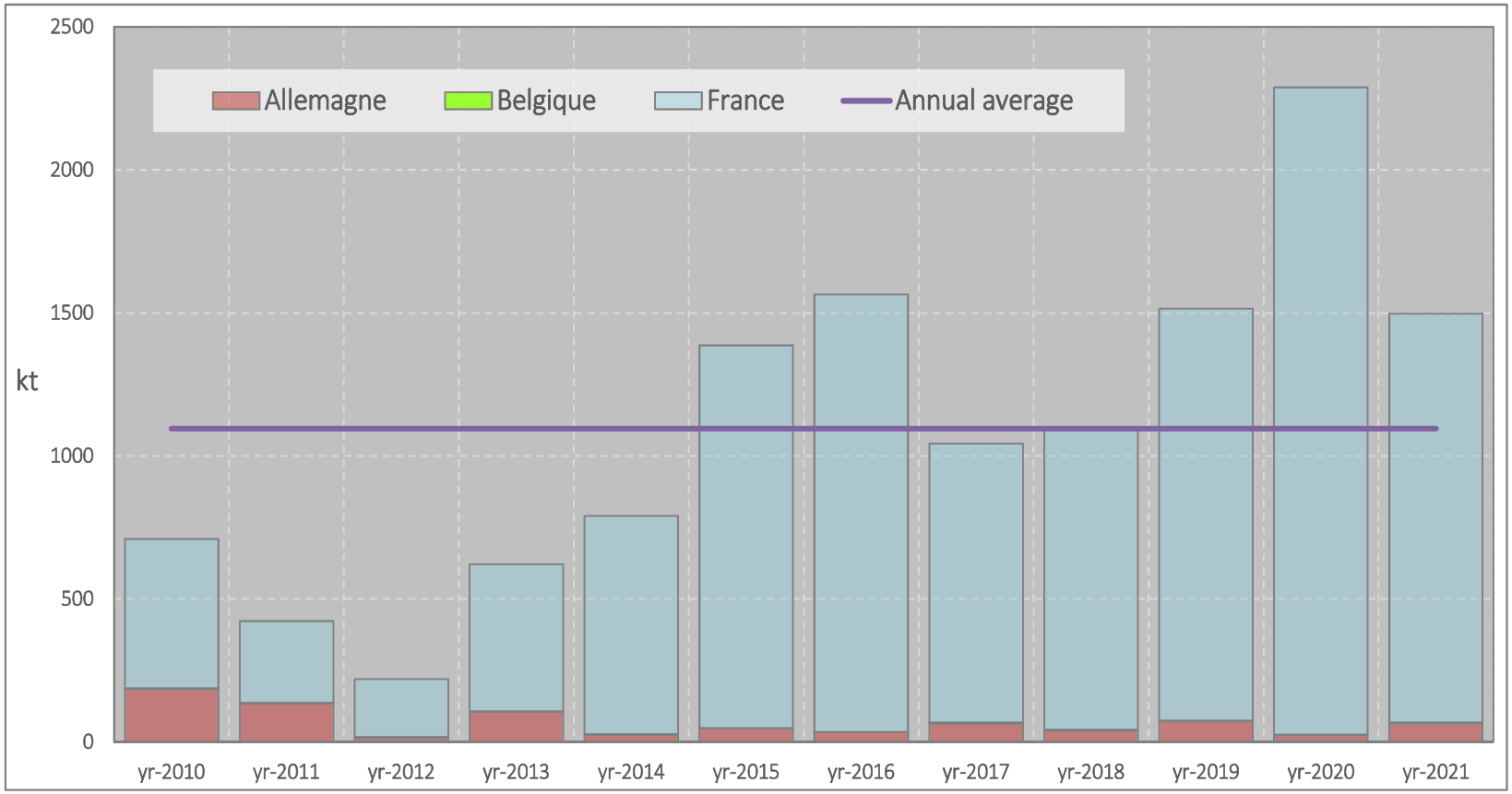
Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG

Total yearly exported soil inert waste per destination country



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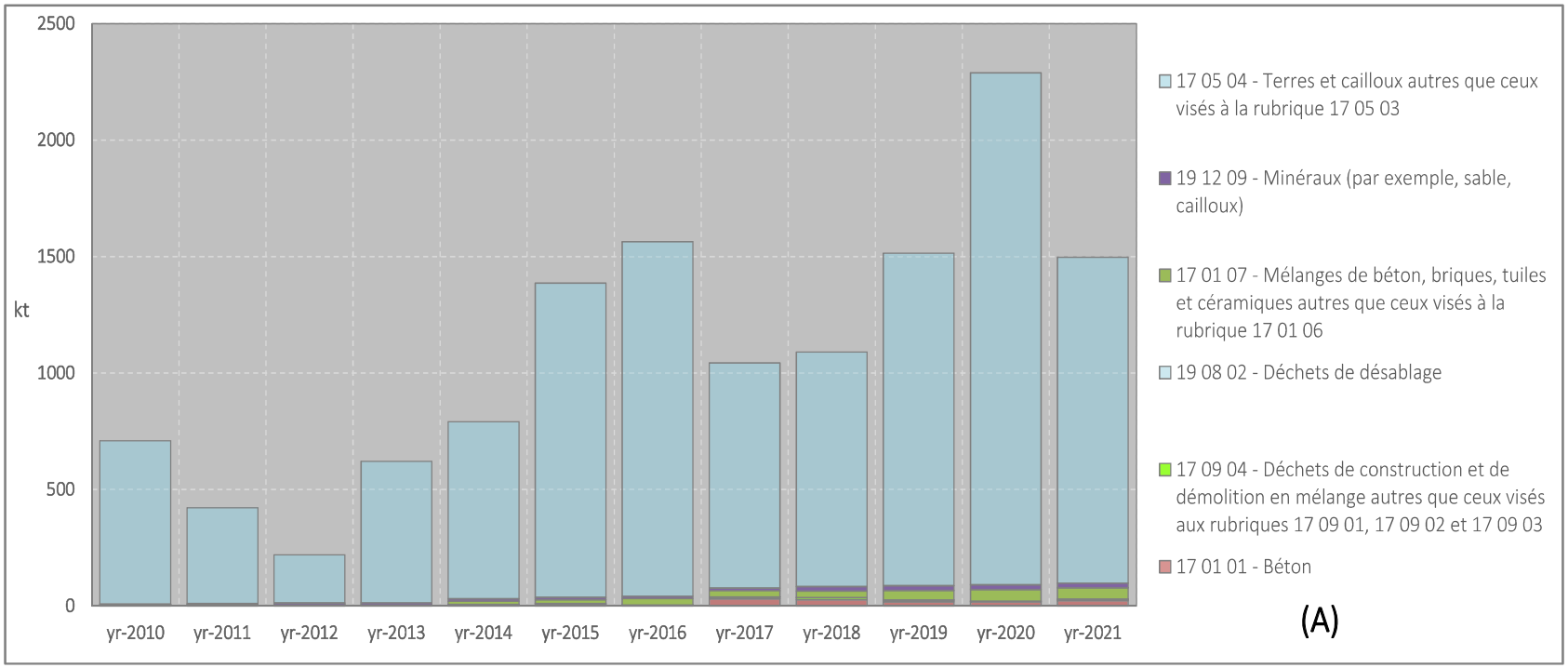
Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG

(A) Yearly exported soil waste from Luxembourg per type of material; (B) yearly amount of waste per type of treatment at destination (in France, Germany or Belgium)



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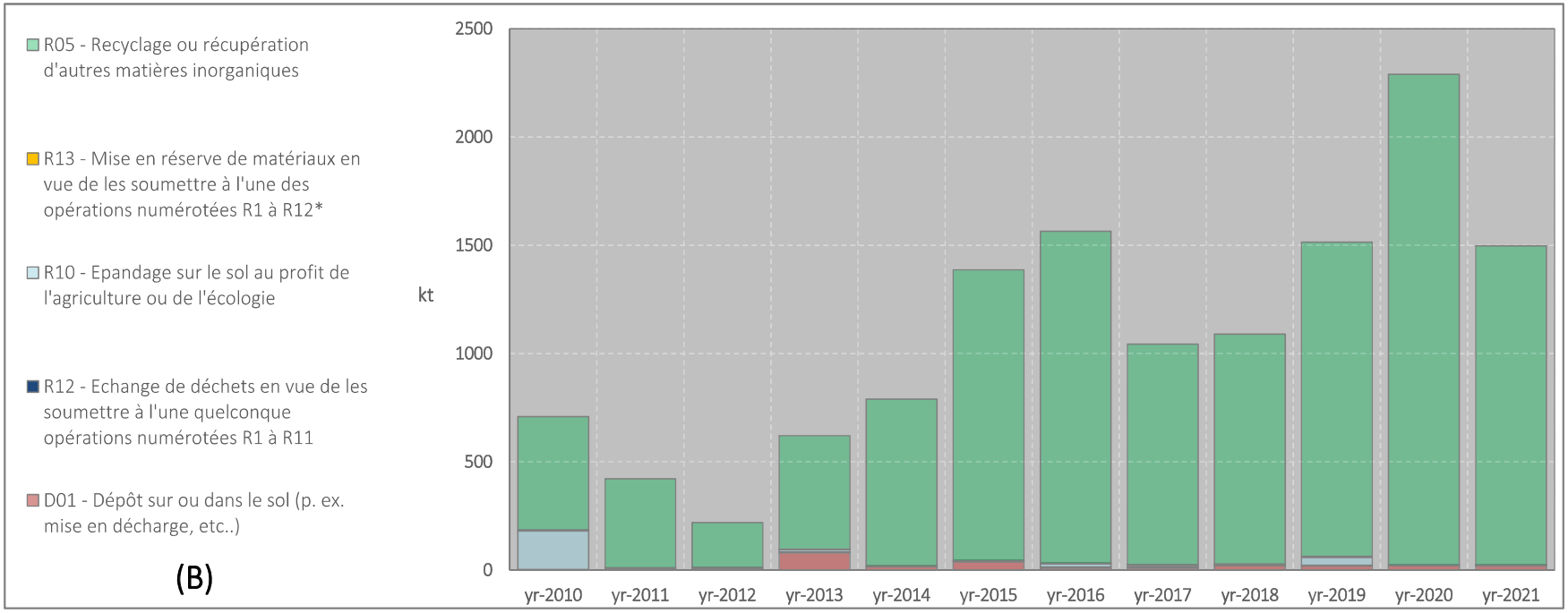

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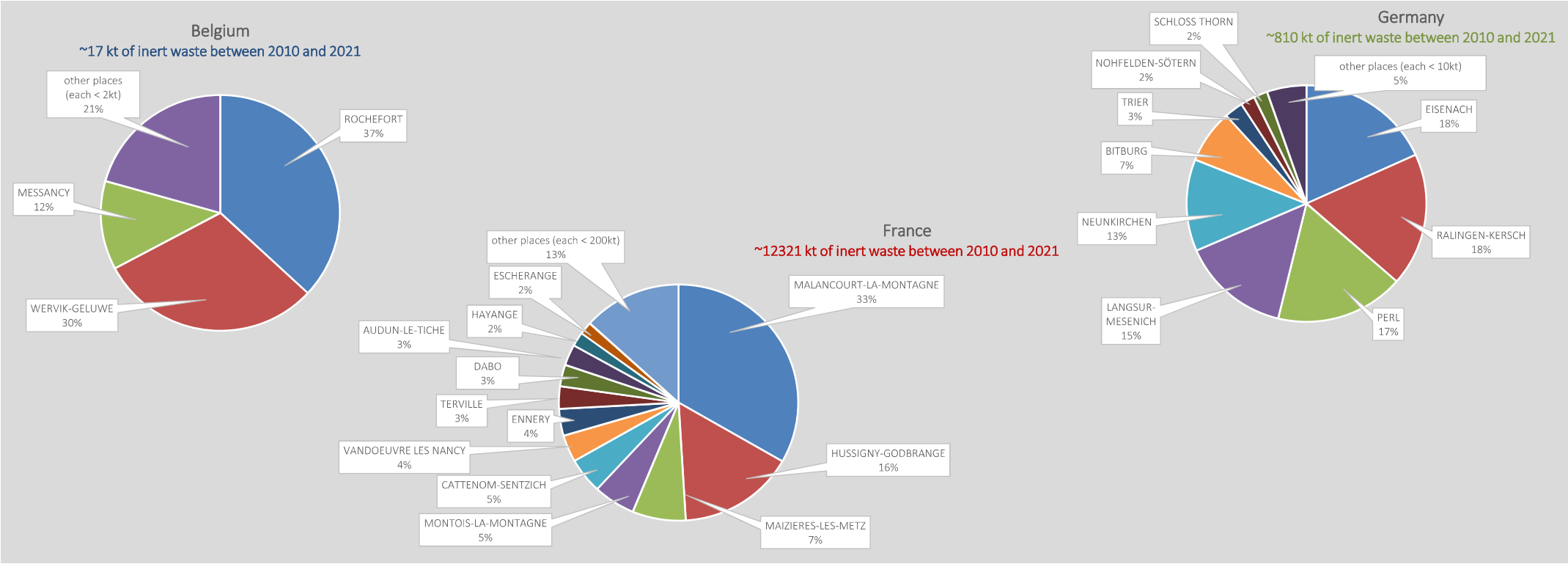
Material Flows Analysis

INPUT/OUTPUT FLOWS OF EXCAVATED SOIL IN LUXEMBOURG

Distribution of soil inert waste per treatment location abroad (~75 locations in total)*



* Locations that received less than 2 kt of soil (in Belgium), 10 kt (in Germany) and 200 kt (in France) over the timeframe 2010-2021 are not shown for simplicity, but their value contributes to the total value of the aggregated item “other places” on every pie

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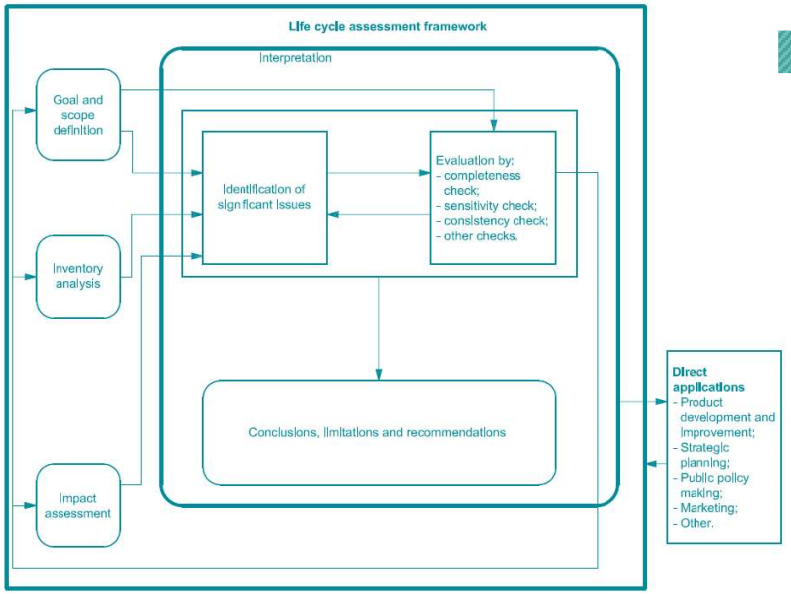
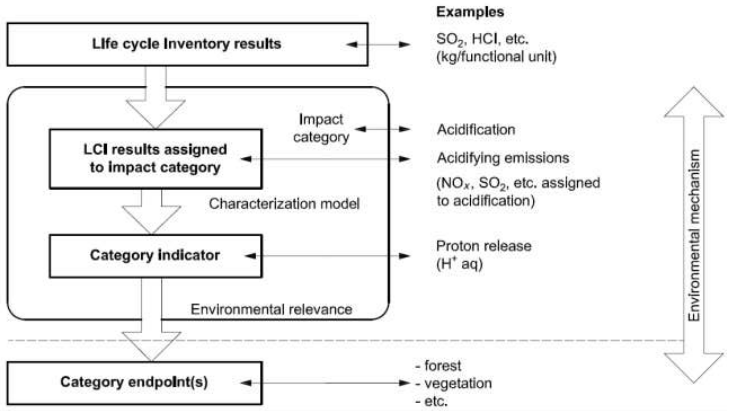
Life Cycle Assessment (LCA)

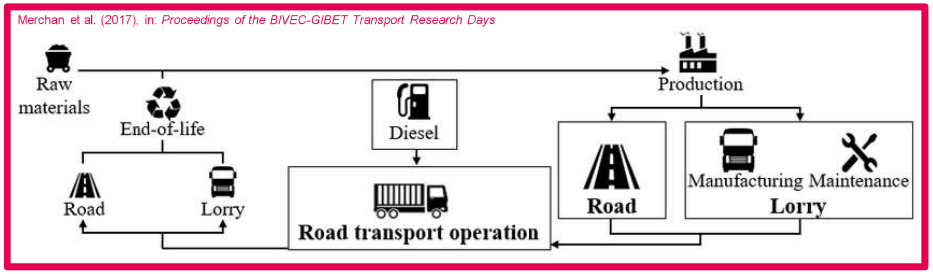
ENVIRONMENTAL IMPACT ANALYSIS: THE "LCA" METHOD

ISO 14044:2006(E)

INTERNATIONAL STANDARD







Term	Example
Impact category	Climate change
LCI results	Amount of a greenhouse gas per functional unit
Characterization model	Baseline model of 100 years of the Intergovernmental Panel on Climate Change
Category indicator	Infrared radiative forcing (W/m^2)
Characterization factor	Global warming potential (GWP_{100}) for each greenhouse gas (kg CO_2-equivalents/kg gas)
Category indicator result	Kilograms of CO_2-equivalents per functional unit
Category endpoints	Coral reefs, forests, crops
Environmental relevance	Infrared radiative forcing is a proxy for potential effects on the climate, depending on the integrated atmospheric heat adsorption caused by emissions and the distribution over time of the heat absorption

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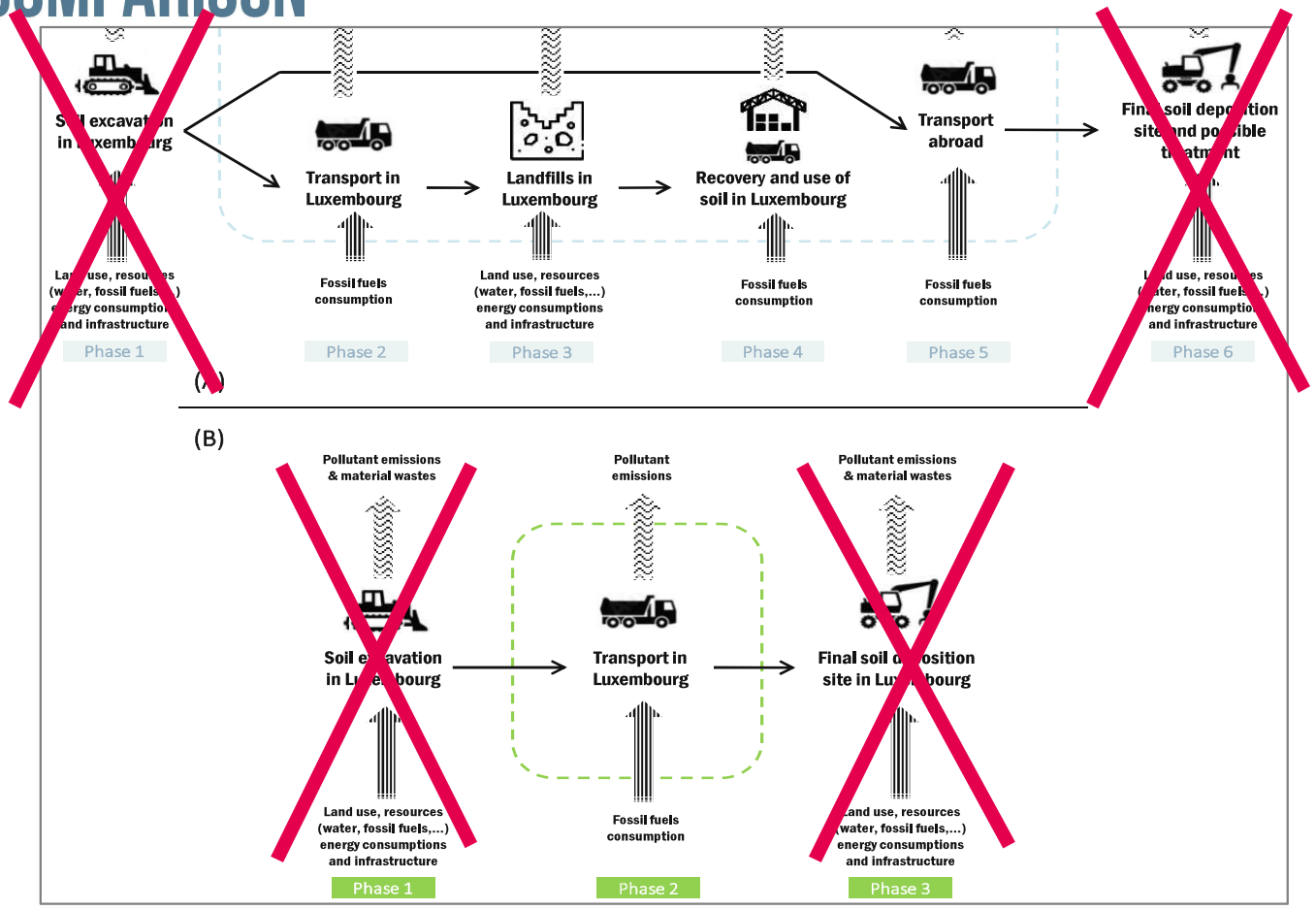
Life Cycle Assessment (LCA)

ASSUMPTIONS FOR MODELS COMPARISON



Life Cycle Assessment (LCA)

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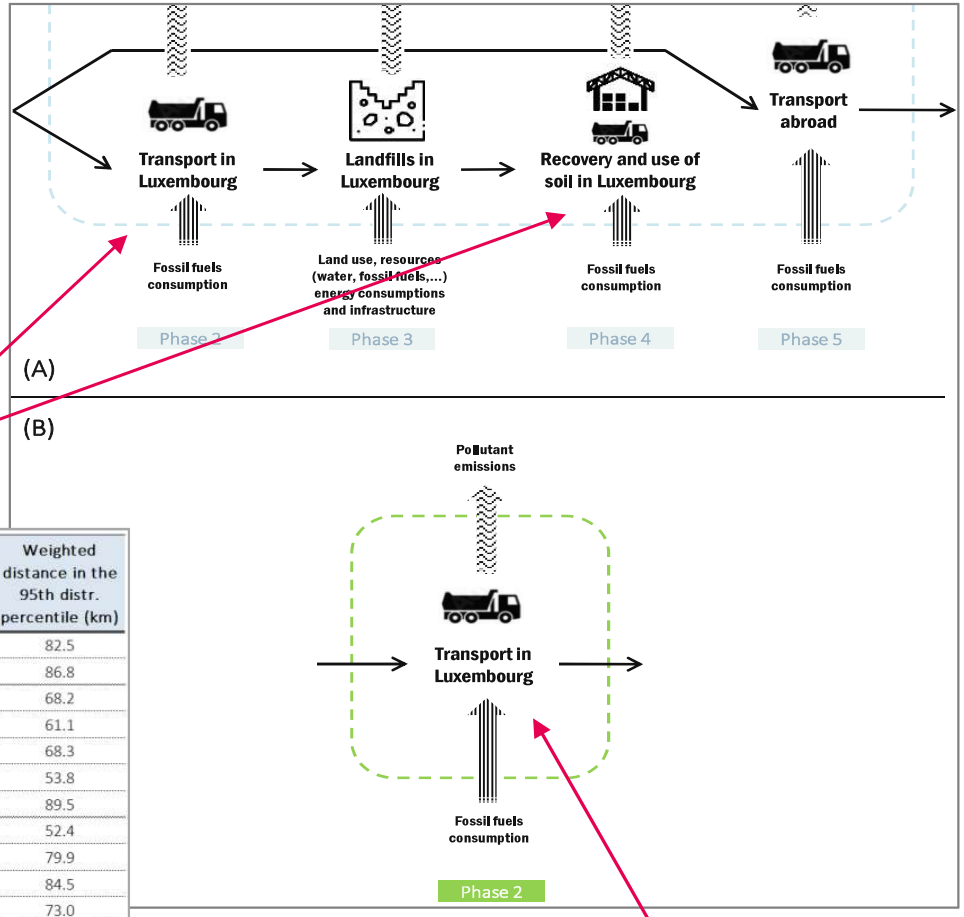

Calculated **average**, **minimum** and **maximum** distances for the business-as-usual scenario of soil transportation in Luxembourg

Site	Average distance (km)	Min distance (km)	Max distance (km)	% remaining capacity*	Weighted average distance (km)	Weighted distance in the 5th distr. percentile (km)	Weighted median distance (km)	Weighted distance in the 95th distr. percentile (km)
Hosingen	54.9	0.8	96.3	3%	57.9	17.3	64.8	82.5
Nothum	59.2	0.0	102.2	0%	61.1	20.5	68.6	86.8
Folkendange	42.8	5.8	82.0	1%	45.9	10.5	49.9	68.2
Colmar-Berg	38.1	1.9	75.0	12%	41.0	9.0	43.4	61.1
Folschette	47.6	6.4	90.7	13%	49.2	25.1	50.0	68.3
Brouch	33.4	5.1	67.6	31%	36.1	14.2	37.4	53.8
Moersdorf	56.0	6.2	101.7	4%	57.5	31.5	58.8	89.5
Bridel	24.5	1.2	62.7	12%	25.4	9.2	24.8	52.4
Gadderscheier	33.3	0.1	105.6	0%	30.9	1.8	23.1	79.9
Mondercange	30.1	3.2	121.1	4%	28.4	4.8	17.9	84.5
Altwies	32.8	5.2	83.3	19%	32.7	12.0	29.8	73.0
Schwebsange	48.8	11.1	110.5	1%	48.4	23.3	43.0	100.0
*Aggregated figures***	41.8	0.0	121.1	100%	**38.1**	**10.5**	36.5	**67.7**

* Based on the absolute figures (in m^3) included in Table 1 for the year 2020; this information has been used to obtain the weighted figures
** Figures in bold have been used as reference distances to calculate the impacts due to transportation in the business-as-usual scenario

Calculated **minimum** distance of **8.8** km, and **maximum** distance of **26.5** km

Life Cycle Assessment (LCA)

SUMMARY OF LIFE CYCLE INVENTORY RESULTS:

BUSINESS AS USUAL-SCENARIO

Category of environmental stressor	Unit	Score per FU (1 ton of soil)	Contribution by Phase ($_{BAU}$ -model)					
			Phase 2	Phase 3	Phase 4	Phase 5_BE	Phase 5_DE	Phase 5_FR
Natural resource extractions and land use								
Raw materials (minerals, metals and fossil fuels), total	kg	1.04E+02	7%	90%	0%	0%	0%	3%
Natural gas	m^3	3.76E-01	33%	53%	0%	0%	0%	13%
Water	m^3	1.07E+01	43%	41%	0%	0%	1%	16%
Wooden biomass	m^3	6.09E-05	40%	36%	0%	0%	1%	23%
Energy from renewable sources	MJ	4.93E+00	23%	20%	0%	0%	2%	54%
Land use changes (transformation from)	m^2	2.59E-01	2%	13%	0%	0%	3%	81%
Land use changes (transformation to)	m^2	2.59E-01	2%	13%	0%	0%	3%	81%
Land use (occupation)	m^2a	1.62E+00	20%	58%	0%	0%	1%	21%
Volume of land (repositories)	m^3	8.95E-07	37%	48%	0%	0%	0%	14%
Volume of land (repositories), annual	m^3a	6.40E-02	31%	39%	0%	0%	1%	28%
Air pollution								
Radioactive substances emitted to air, total	Bq	1.38E+05	50%	36%	1%	0%	0%	13%
Pollutant emissions released to air, total	kg	1.10E+01	45%	37%	0%	0%	1%	16%
Water vapour	m^3	2.11E-02	39%	41%	0%	0%	1%	19%
Waste heat	MJ	2.40E+00	38%	51%	0%	0%	0%	10%
Water pollution								
Radioactive substances emitted in water, total	Bq	2.78E+03	42%	40%	0%	0%	1%	16%
Pollutant emissions to water, total	kg	5.27E-01	38%	48%	0%	0%	0%	13%
Water discharges	m^3	1.05E+01	43%	40%	0%	0%	1%	16%
Waste heat	MJ	5.72E-01	47%	38%	1%	0%	0%	14%
Soil pollution								
Release of pollutants in soils, total	kg	1.71E-02	39%	55%	0%	0%	0%	6%
Waste heat	MJ	2.53E-03	36%	47%	0%	0%	1%	15%

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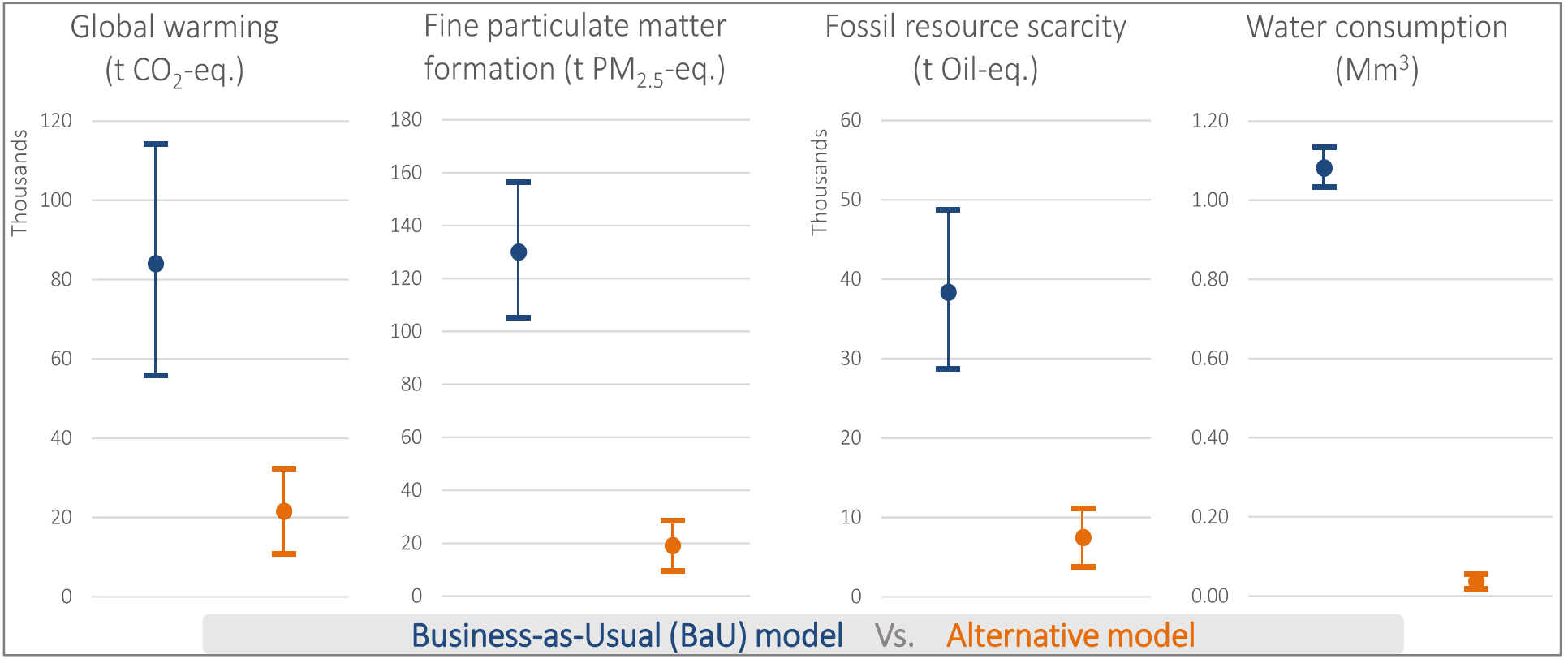
Life Cycle Assessment (LCA)

SUMMARY OF LIFE CYCLE IMPACT ASSESSMENT RESULTS



Comparison of the variability ranges (between *min* and *max* amounts) of each **environmental impact associated with the annual management of soil waste in Luxembourg** (life cycle of excavated soil). For the BAU-model, average data for the timeframe 2016-2019 are displayed.

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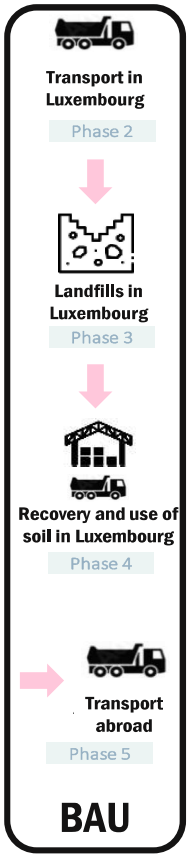
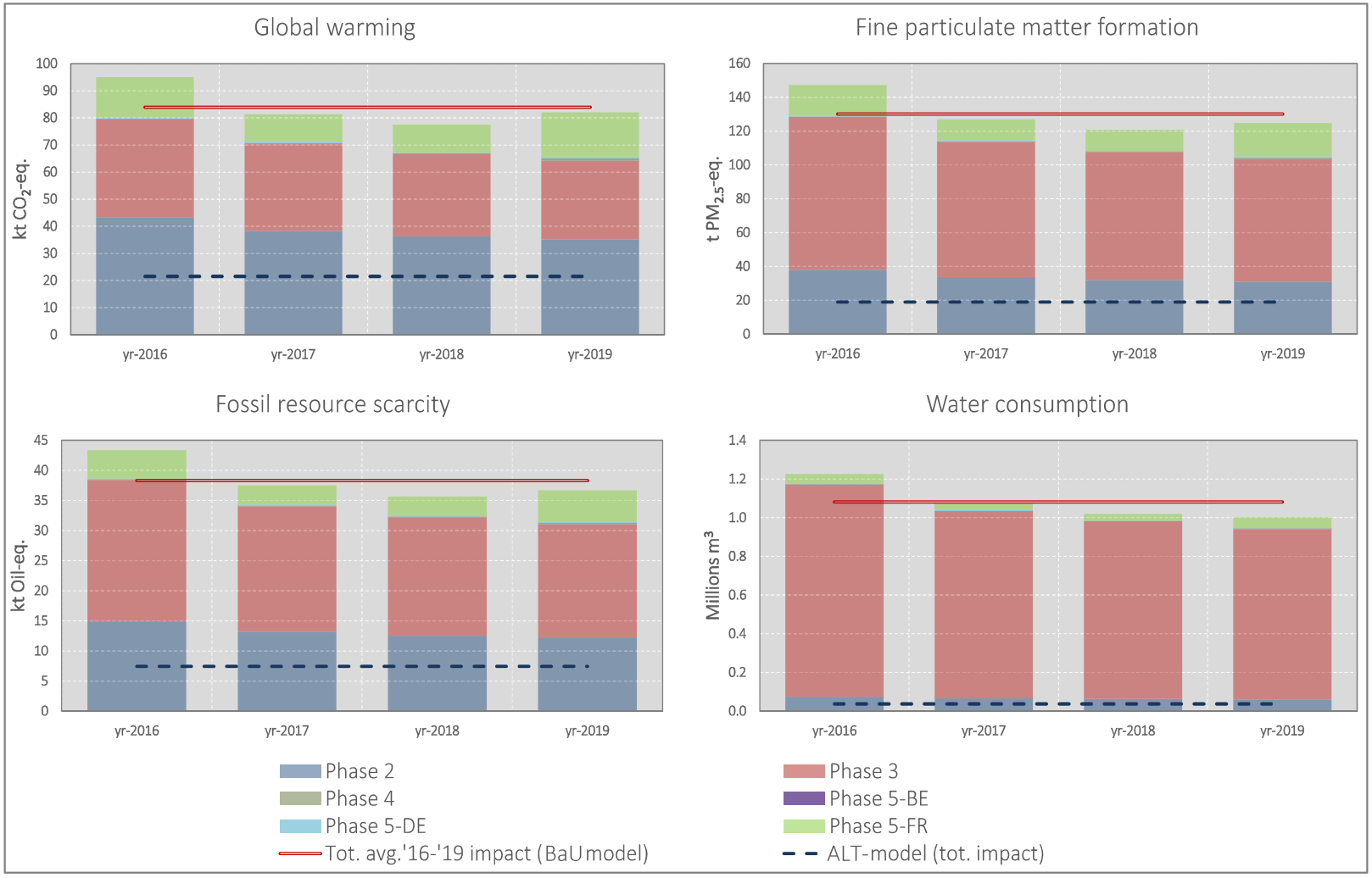
Life Cycle Assessment (LCA)

SUMMARY OF LIFE CYCLE IMPACT ASSESSMENT RESULTS





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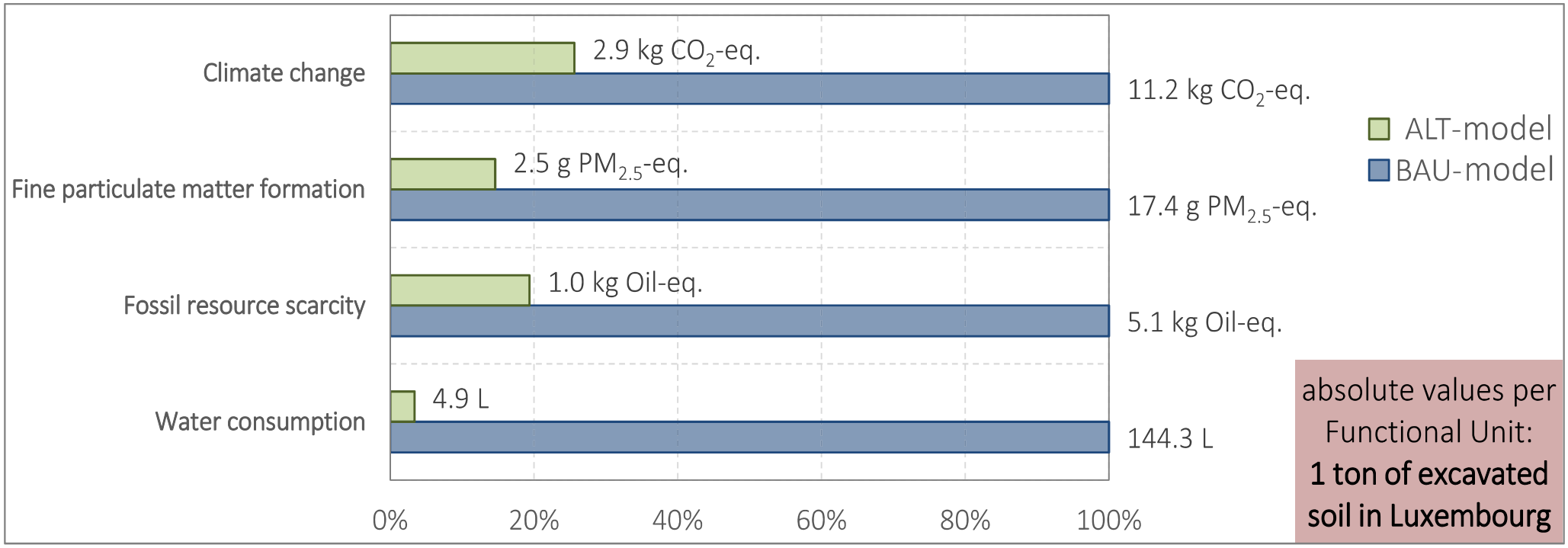
Life Cycle Assessment (LCA)

SUMMARY OF LIFE CYCLE IMPACT ASSESSMENT RESULTS



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CONCLUDING REMARKS

- **Around 7.5 Mt of excavated soil waste are produced annually in Luxembourg ➔ ~12 t per capita**, an amount which is **~4 times higher than the EU average** (one of the highest amounts in Europe) ➔ at the current rate of disposal of inert waste (~5 Mt per year), all the national sites will be saturated and not be able to host additional soil by 2030

- **~11 kg CO_2-eq. per ton of soil landfilled or exported abroad are emitted** due to transport processes and other land- and backfilling activities; **between ~25% to 47% of the impact is associated with the transportation in lorries** from the **construction and excavation sites to the landfill areas in Luxembourg ➔** when considering the shortest distances (i.e., 10.5 km), a high relative contribution to the impact is also associated with the transportation from Luxembourg to other destinations abroad (mainly in France)

- **Environmental impacts associated with alternative management scenarios for the recovery and re-use of the excavated soil waste may considerably decrease when compared to the abovementioned business-as-usual situations**, e.g., potential reductions of the carbon footprint (i.e., impact on global warming) in between ~72% to ~77% would be achieved if the excavated soil material were all collected and transported in areas not farer than ~27 to ~9 km, respectively

- Confirming previous hypotheses and qualitative observations, **the re-use of excavated soil with alternative local nature-based solution and restoration projects can help**:
  - **reducing the environmental footprint** associated with the supply-chain of inert waste
  - **preventing and mitigating the problem of overexploitation of landfills and quarries** in Luxembourg
  - **hampering issues associated with severe traffic jumps**, optimizing the logistics and avoiding time loss by the lorries

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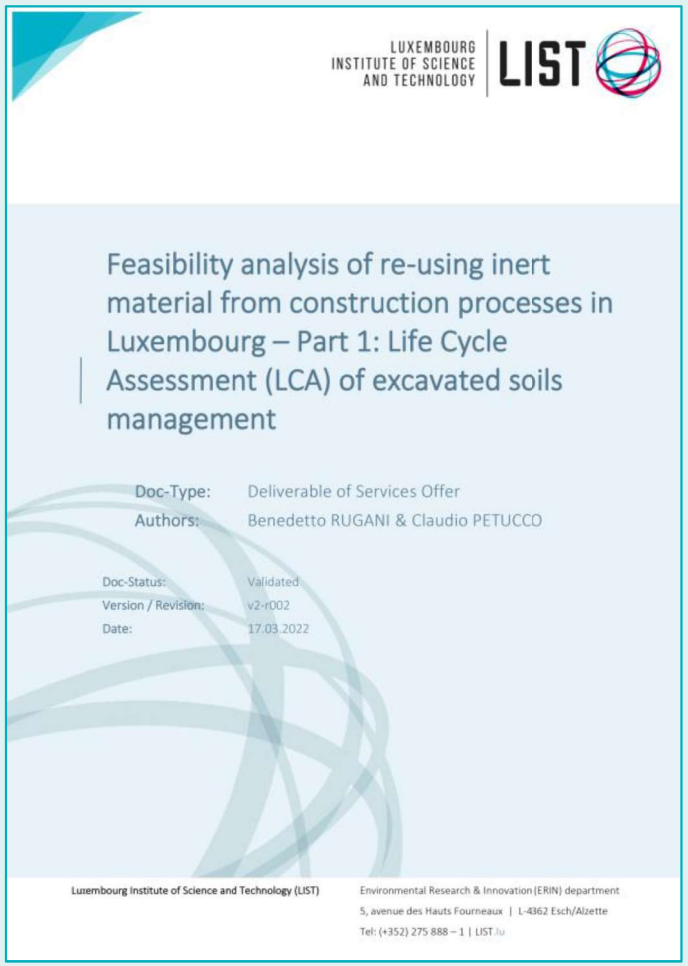

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