

GreenDelta

sustainability consulting + software

The MSDB in comparison to other databases

open openLCA LCA Conference, April 2025, Berlin

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GreenDelta GmbH

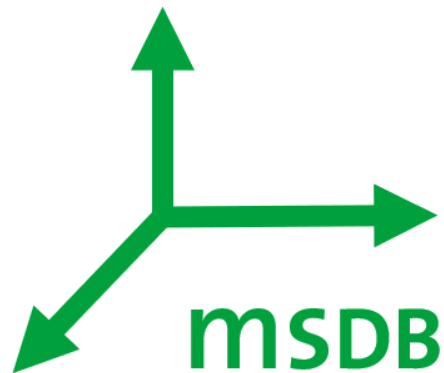
Topics

- **MSDB: what is it**
- **Status**
- **Difference to other databases**
- **Next steps**

MSDB, what is it

MSDB = massive sustainability database

1. Developed by GreenDelta in recent years, starting from a German research project “LCA data machine”
2. 500,000 datasets, global coverage, broad technological coverage
3. Unit process datasets



Approach: how to develop the MSDB?

1. **Combine top-down and bottom up**
2. **Model “atoms”, truly smallest information units, for important elements**
3. **Important elements are processes, flows, locations**
4. **Initial database not be in one of the existing reference systems (nomenclature and format) - ILCD, EcoSpold, etc., but agnostic, and can be exported in these**
5. **Creation of process data sets, and iteratively refine them**
6. **Where existing, use good, detailed models directly (transport, waste treatment, waste water treatment, etc.)**

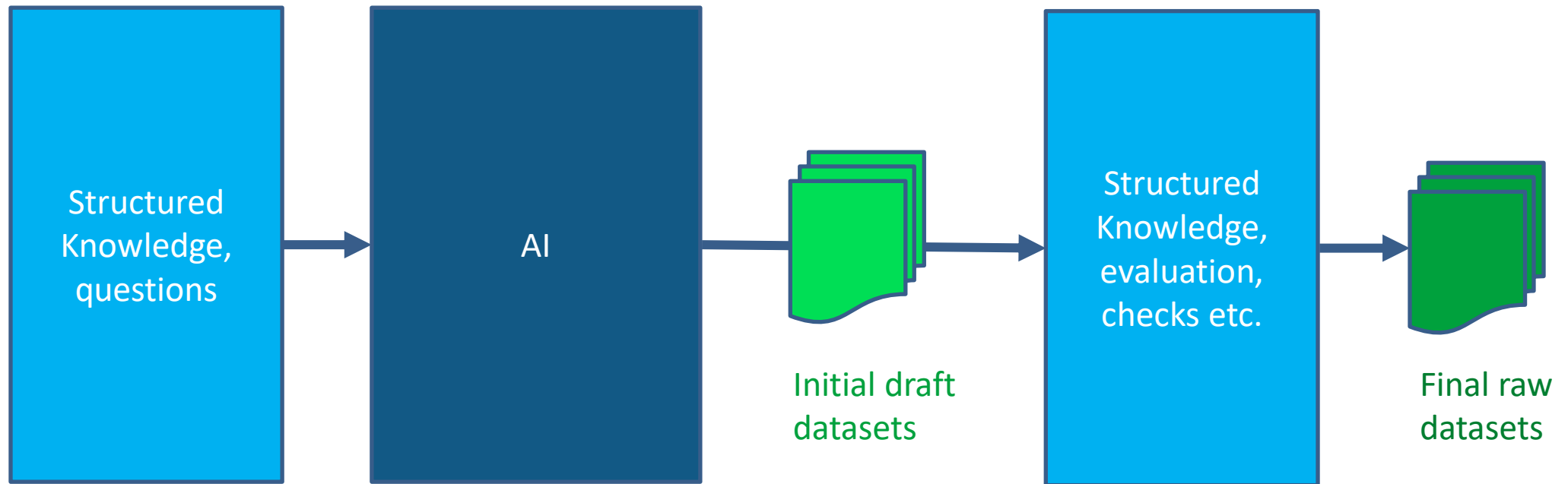
Approach: how to develop the MSDB?

Start

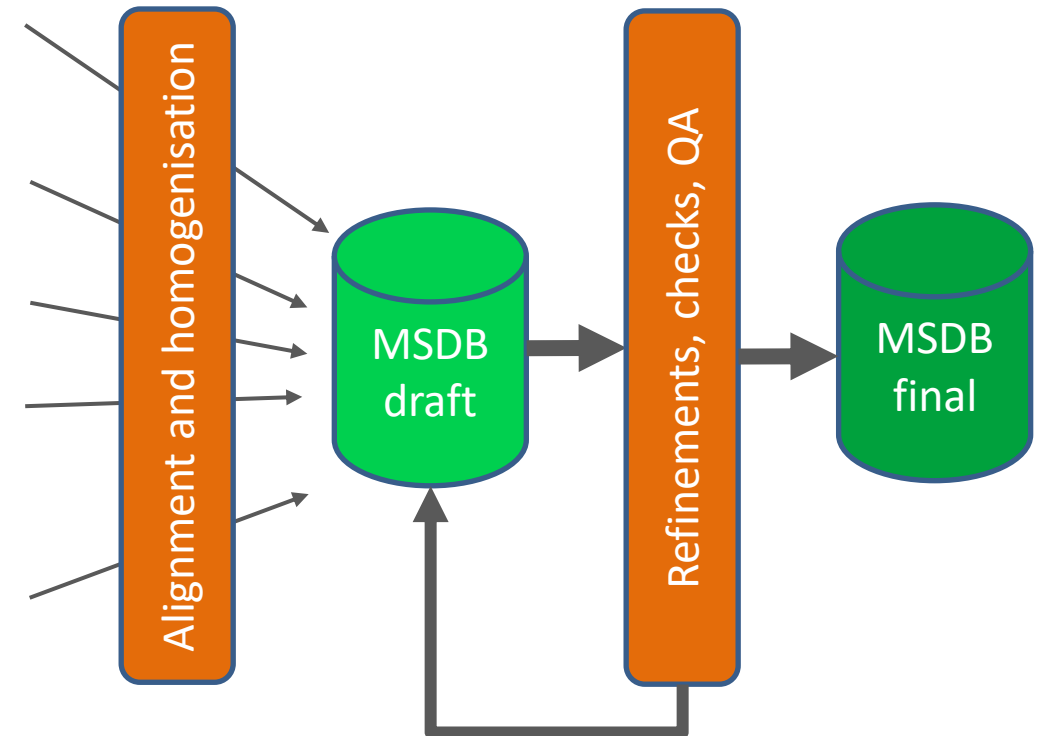
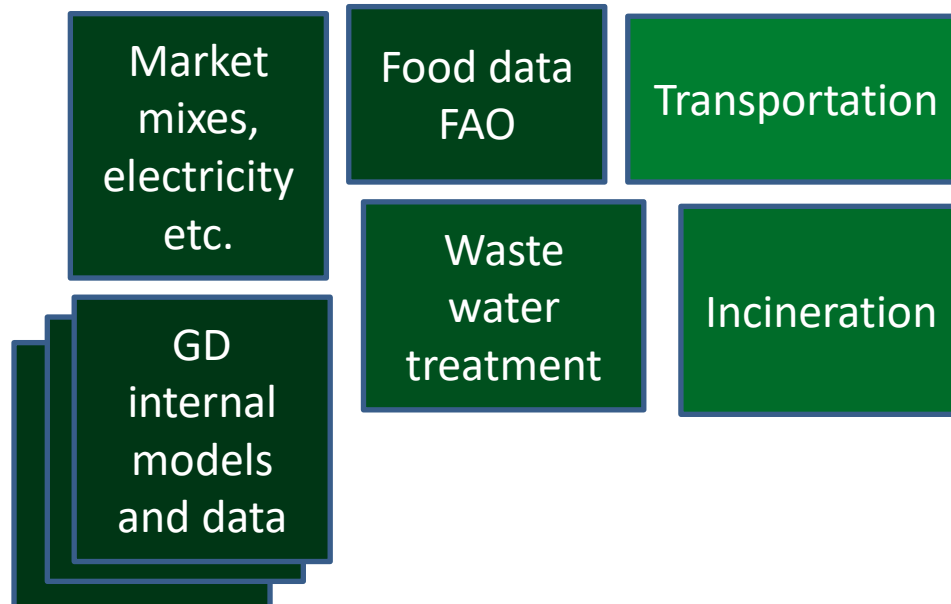
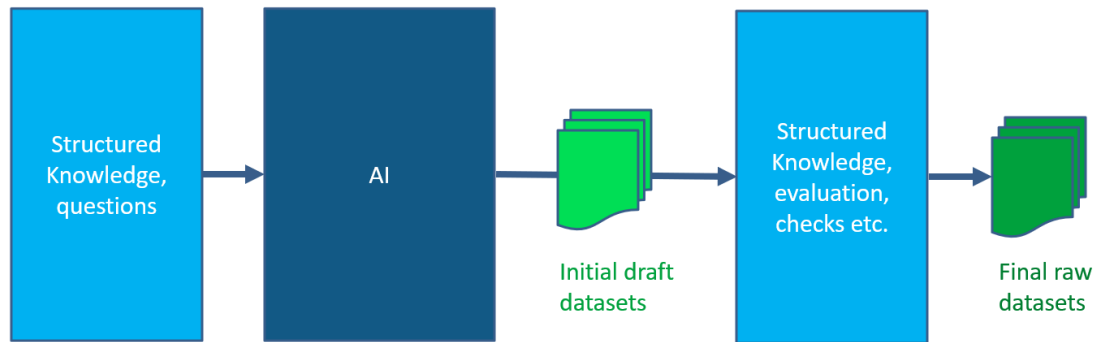
1. **Products in Combined Nomenclature, European Commission structure, but plain products and sectors (“atomic”)**
2. **Postulate datasets based on common knowledge + AI**
3. **Refine datasets based on internal and open source information (PRTR, Wikipedia, UN Food database, satellite images, ..)**
4. **Using reasoning and graph databases and models**
5. **Calculate data quality**
6. **..until satisfactory**

Dimensions are flows, processes, locations.

Approach: gated AI, for new datasets



Approach: entire database



Structure of the LCA database?

Dimensions are flows, processes, locations.

This creates a massive sustainability database with traceable quality.

We call it the MSDB.

The database is prepared for openLCA initially (most powerful, our own software, widely used)

Combined nomenclature

- https://taxation-customs.ec.europa.eu/customs-4/calculation-customs-duties/customs-tariff/combined-nomenclature_en

2025, from <https://tulli.fi/en/statistics/combined-nomenclature-cn>

~ 16,000 categories

These are categories for products

cn_code	en
01	LIVE ANIMALS
0101	Live horses, asses, mules and hinnies
010121	Pure-bred breeding horses
01012100	Pure-bred breeding horses
010129	Live horses (excl. pure-bred for breeding)
01012910	Horses for slaughter
01012990	Live horses (excl. for slaughter, pure-bred for breeding)
010130	Live asses
01013000	Live asses
010190	Live mules and hinnies
01019000	Live mules and hinnies
0102	Live bovine animals
010221	Pure-bred cattle for breeding
01022110	Pure-bred breeding heifers "female bovines that have never calved"
01022130	Pure-bred breeding cows (excl. heifers)
01022190	Pure-bred cattle for breeding (excl. heifers and cows)
010229	Live cattle (excl. pure-bred for breeding)
01022905	Live cattle of the sub-genus Bibos or Poephagus (excl. pure-bred for breeding)
01022910	Live cattle of a weight <= 80 kg (excl. pure-bred for breeding)
01022921	Cattle of a weight > 80 kg but <= 160 kg, for slaughter
01022929	Live cattle of a weight > 80 kg but <= 160 kg (excl. for slaughter, pure-bred for breeding)
01022941	Cattle of a weight > 160 kg but <= 300 kg, for slaughter
01022949	Live cattle of a weight > 160 kg but <= 300 kg (excl. for slaughter, pure-bred for breeding)
01022951	Heifers "female bovines that have never calved" of a weight > 300 kg, for slaughter
01022959	Live heifers "female bovines that have never calved" of a weight > 300 kg (excl. for slaughter and pure-bred for breeding)
01022961	Cows of a weight > 300 kg, for slaughter (excl. heifers)
01022969	Live cows of a weight > 300 kg (excl. for slaughter and pure-bred for breeding and heifers)
01022991	Cattle of a weight > 300 kg, for slaughter (excl. heifers and cows)
01022999	Live cattle of a weight > 300 kg (excl. for slaughter, pure-bred for breeding and heifers and cows)
010231	Pure-bred buffalo for breeding
01023100	Pure-bred buffalo for breeding
010239	Live buffalo (excl. pure-bred for breeding)
01023910	Live domestic buffalo (excl. pure-bred for breeding)
01023990	Live buffalo (excl. domestic species and pure-bred for breeding)
010290	Live bovine animals (excl. cattle and buffalo)
01029020	Bovine pure-bred breeding animals (excl. cattle and buffalo)
01029091	Live domestic bovine animals (excl. cattle and buffalo and pure-bred for breeding)
01029099	Live bovine animals (excl. cattle, buffalo, pure-bred for breeding and domestic species)
0103	Live swine
010310	Pure-bred breeding swine
01031000	Pure-bred breeding swine
010391	Live pure-bred swine, weighing < 50 kg (excl. pure-bred for breeding)
01039110	Domestic swine, weighing < 50 kg (excl. pure-bred for breeding)
01039190	Live non-domestic swine, weighing < 50 kg
010392	Live pure-bred swine, weighing >= 50 kg (excl. pure-bred for breeding)
01039211	Live domestic sows, having farrowed at least once, weighing >= 160 kg (excl. pure-bred for breeding)
01039219	Live domestic swine, weighing >= 50 kg (excl. sows having farrowed at least once and weighing >= 160 kg, and those of other species)
01039290	Live non-domestic swine, weighing >= 50 kg
0104	Live sheep and goats
010410	Live sheep
01041010	Pure-bred sheep for breeding
01041030	Live lambs "sheep up to a year old" (excl. purebred breeding animals)
01041080	Live sheep (excl. lambs and pure-bred breeding animals)
010420	Live goats
01042010	Pure-bred breeding goats
01042090	Live goats (excl. pure-bred for breeding)
0105	Live poultry, "fowls of the species Gallus domesticus, ducks, geese, turkeys and guinea fowls"
010511	Live fowls of the species Gallus domesticus, weighing <= 185 g (excl. turkeys and guinea fowls)
01051111	Grandparent and parent female chicks of fowls of the species Gallus domesticus laying stocks of a weight of <= 185 g (excl. laying stocks of other species)
01051119	Grandparent and parent female chicks fowls of the species Gallus domesticus of a weight of <= 185 g (excl. laying stocks of other species)
01051191	Laying stock "fowls of the species Gallus domesticus" of a weight of <= 185 g (excl. grandparent and parent female chicks of other species)
01051199	Live fowls of the species Gallus domesticus of a weight of <= 185 g (excl. grandparent and parent female chicks and laying stocks of other species)
010512	Live domestic turkeys, weighing <= 185 g
01051200	Live domestic turkeys, weighing <= 185 g

Combined nomenclature

These are categories for products

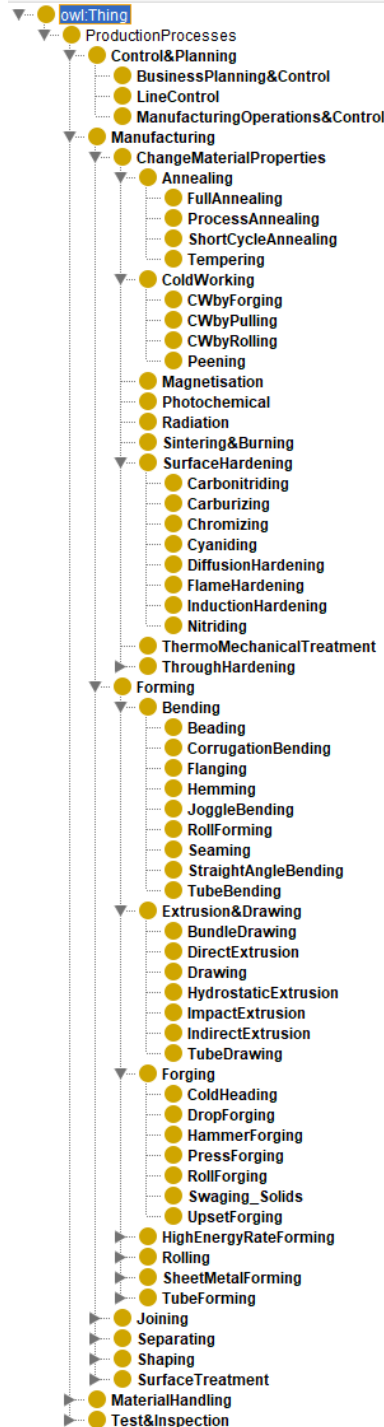
Processes?

- **Merged several classification systems from different domains, e.g. [1-3]**

[1] Daniel G.H. Sorensen, Thomas Ditlev Brunoe, Kjeld Nielsen, A classification scheme for production system processes, Procedia CIRP, Volume 72, 2018, Pages 609-614, ISSN 2212-8271, <https://doi.org/10.1016/j.procir.2018.03.021>.

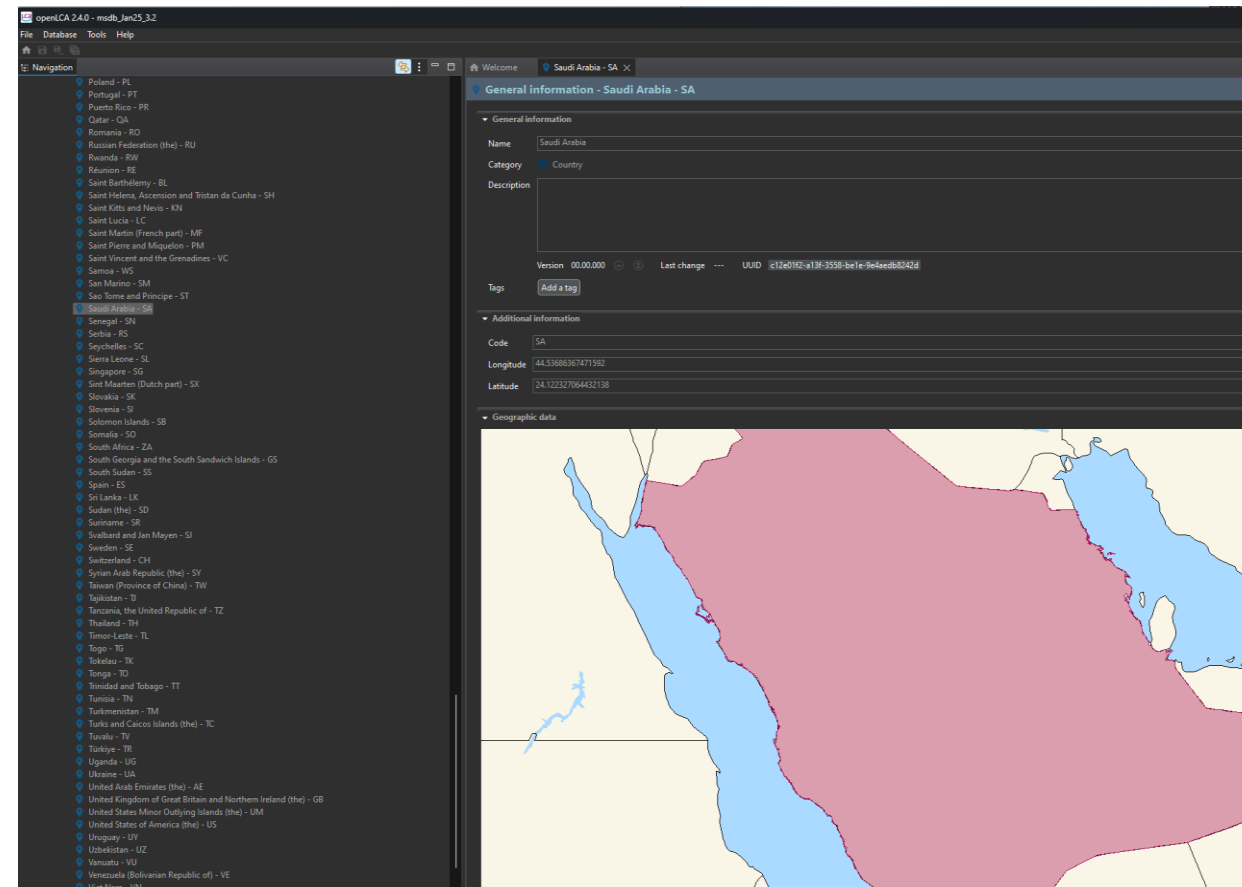
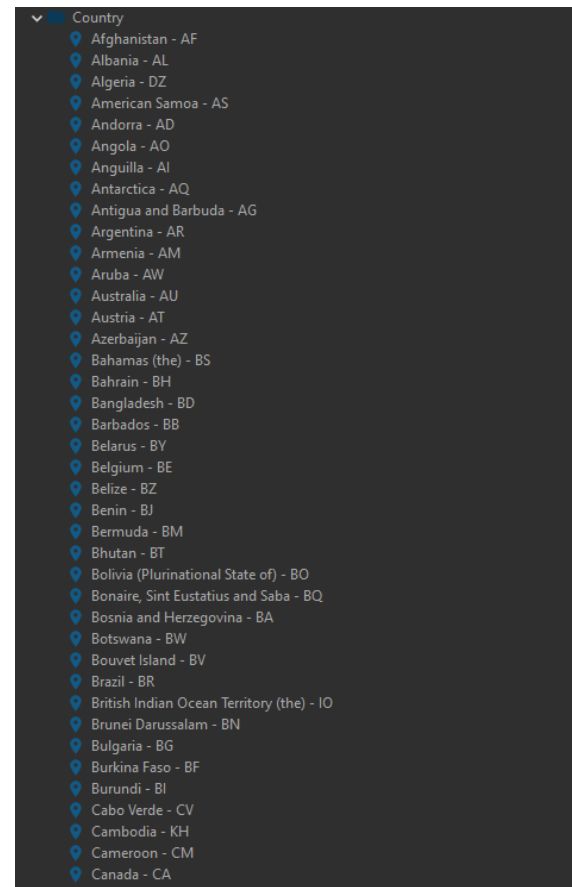
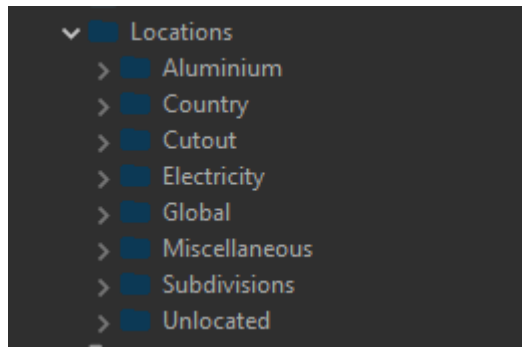
[2] R.A. Buswell, W.R. Leal da Silva, F.P. Bos, H.R. Schipper, D. Lowke, N. Hack, H. Kloft, V. Mechtcherine, T. Wangler, N. Roussel, A process classification framework for defining and describing Digital Fabrication with Concrete, Cement and Concrete Research, Volume 134, 2020, 106068, ISSN 0008-8846, <https://doi.org/10.1016/j.cemconres.2020.106068>.

[3] McCabe, W.L, Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw-Hill Book Co, 2005



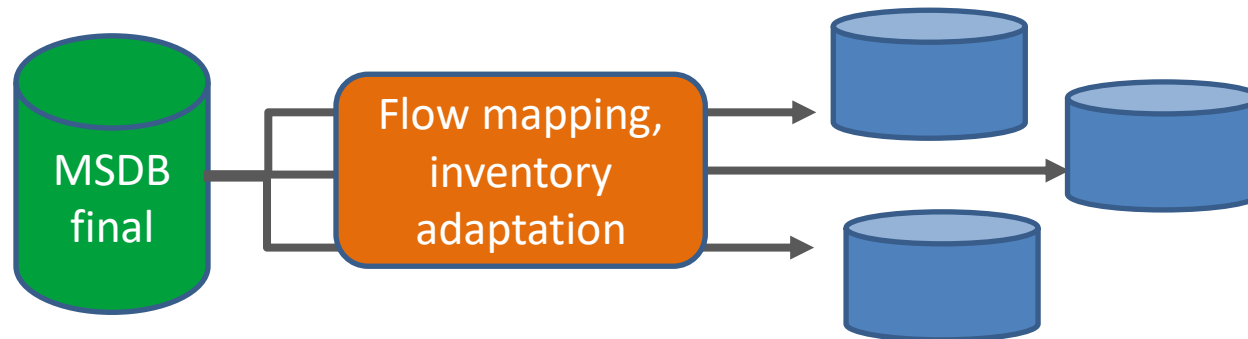
Locations

- For now, the default openLCA locations, but extendable; each with long lat and GeoJSON information



And the entire database

- Created in openLCA now, with “gated AI”.
- Works well, we are finetuning (setup, data sources, routines...)
- 500,000 processes systems work in openLCA (!)
- Database itself is agnostic to specific flow reference systems, modelling methods (allocation, end of life, ...) to maximise application possibilities
- Conversion to specific reference systems and modelling rules via Graph database (typedb)¹



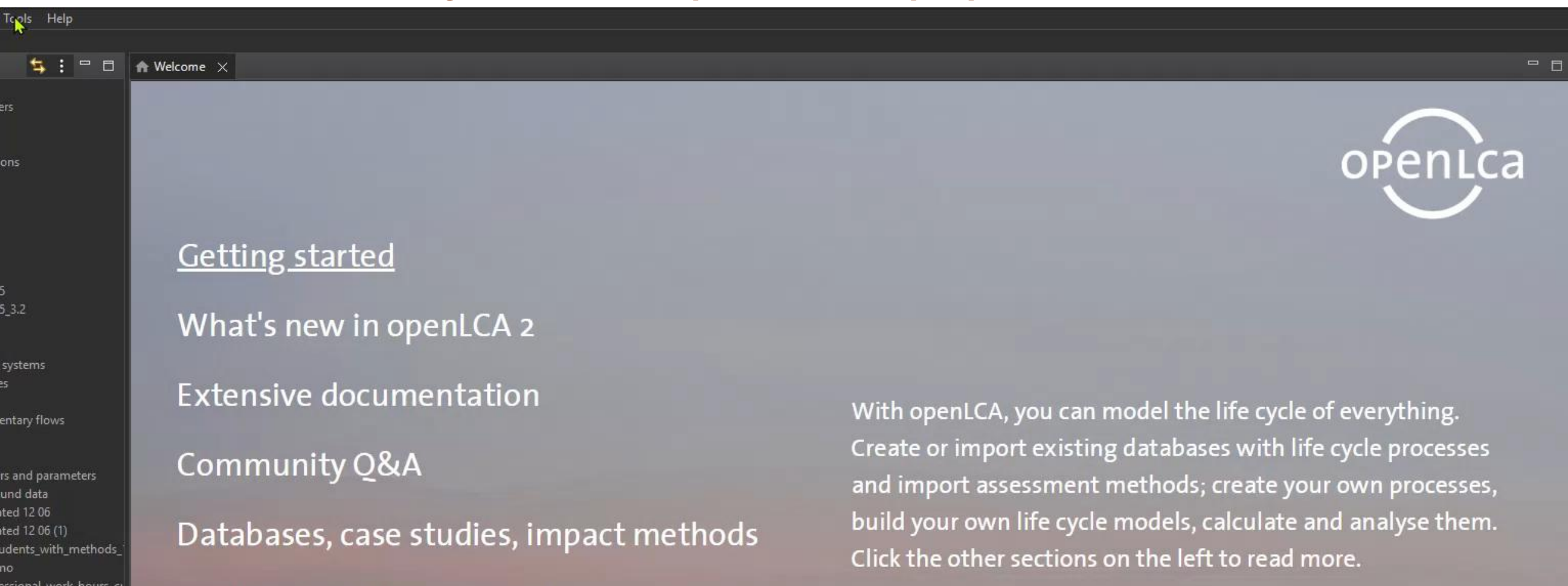
MSDB, comparison to other databases

MSDB, comparison to other databases

1. (it is not released yet, but soon)
2. 500,000 datasets – much larger than other databases
3. The database is
 1. A database (!)
 2. An answering machine, able to provide datasets for any requested product
 3. A system that can be trained for specific sectors, locations, ...
 4. An LCA assistant in openLCA

MSDB, the LCA assistant

The LCA assistant is just a tool in openLCA that proposes datasets.



MSDB, a modular treatment of infrastructure

- **Machines are not directly allocated to the process but this contribution is driven by capacity, lifetime, utilization, and can thus be configured. Sources are provided.**
- **We will provide default values**

E.g., PCB production

```
},
"machines": [
  {
    "name": "Automatic PCB Etching Machine",
    "lifetime": "7 years",
    "utilization": "90%",
    "capacity": "500 piece/hour",
    "description": "This machine performs the chemical etching process to remove unwanted copper from the PCB design data, creating the circuit traces.",
    "source": "[1] - Flex Circuit Solutions - Automatic PCB Etching Machines: [https://flexcircuitsolutions.com/automatic-pcb-etching-machines/](https://flexcircuitsolutions.com/automatic-pcb-etching-machines/)"
  },
  {
    "name": "Pick and Place Machine",
    "lifetime": "6 years",
    "utilization": "85%",
    "capacity": "300 piece/hour",
    "description": "This machine accurately places electronic components onto the PCB based on the fabrication order. It uses robotic arms for precise placement.",
    "source": "[2] - Panasonic - Pick and Place Machines: [https://www.panasonic.com/us/en/solutions/industrial-automation/pick-place-machines](https://www.panasonic.com/us/en/solutions/industrial-automation/pick-place-machines)"
  },
  {
    "name": "Laminator",
    "lifetime": "10 years",
    "utilization": "75%",
    "capacity": "1000 piece/hour (overall production line)",
    "description": "This machine applies a layer of resin or other material to the PCB to improve its mechanical strength and solderability.",
    "source": "[3] - SMT Global - PCB Laminators: [https://www.smtglobal.com/pcb-laminators](https://www.smtglobal.com/pcb-laminators)"
  },
  {
    "name": "Screen Printer",
    "lifetime": "5 years",
    "utilization": "95%",
    "capacity": "400 piece/hour",
    "description": "This machine applies solder paste onto the PCB, which is the necessary material for surface mount technology (SMT) soldering.",
    "source": "[4] - Henkel - Screen Printing Machines: [https://www.henkel.com/en/solutions/electronics/screen-printing](https://www.henkel.com/en/solutions/electronics/screen-printing)"
  }
]
```

MSDB compared to IO databases

(such as exiobase,
for example)

Inputs/Outputs - Kerosene - DK

Inputs

Flow	Category	Amount	Unit	its/Revenues	Uncertainty	Avoided was	Provider	Data quality	Location
Air transport services (62) - FR	Product flows/Air transport se...	2.35530	EUR 20...		none				
Air transport services (62) - GR	Product flows/Air transport se...	0.23422	EUR 20...		none				
Air transport services (62) - HR	Product flows/Air transport se...	0.04475	EUR 20...		none				
Air transport services (62) - HU	Product flows/Air transport se...	0.37885	EUR 20...		none				
Air transport services (62) - IE	Product flows/Air transport se...	2.58431	EUR 20...		none				
Air transport services (62) - IT	Product flows/Air transport se...	0.25939	EUR 20...		none				
Air transport services (62) - LT	Product flows/Air transport se...	0.09119	EUR 20...		none				
Air transport services (62) - LU	Product flows/Air transport se...	0.18964	EUR 20...		none				
Air transport services (62) - LV	Product flows/Air transport se...	0.06492	EUR 20...		none				
Air transport services (62) - MT	Product flows/Air transport se...	0.06258	EUR 20...		none				
Air transport services (62) - NL	Product flows/Air transport se...	2.62976	EUR 20...		none				
Air transport services (62) - PL	Product flows/Air transport se...	0.16762	EUR 20...		none				
Air transport services (62) - PT	Product flows/Air transport se...	0.60979	EUR 20...		none				
Air transport services (62) - RO	Product flows/Air transport se...	0.07049	EUR 20...		none				
Air transport services (62) - SE	Product flows/Air transport se...	11.15230	EUR 20...		none				

Outputs

Flow	Category	Amount	Unit	its/Revenues	Uncertainty	Avoided pro	Provider	Data quality	Location	Description
Kerosene - DK	Product flows/Kerosene	1.00000E6	EUR 2...		none					
As - combustion - air	../Emissions to air	0.00178	kg		none					
As - non combustion ...	../Emissions to air	3.39966E-5	kg		none					
As - non combustion ...	../Emissions to air	0.00020	kg		none					
As - non combustion ...	../Emissions to air	4.28990E-6	kg		none					
As - non combustion ...	../Emissions to air	0.00129	kg		none					
Benzo(a)pyrene - com...	../Emissions to air	0.01948	kg		none					
Benzo(b)fluoranthene...	../Emissions to air	0.02526	kg		none					
Benzo(k)fluoranthene ...	../Emissions to air	0.01016	kg		none					
Cd - combustion - air	../Emissions to air	0.00096	kg		none					
Cd - non combustion ...	../Emissions to air	1.88870E-7	kg		none					
Cd - non combustion ...	../Emissions to air	4.38478E-5	kg		none					
Cd - non combustion ...	../Emissions to air	1.11375E-8	kg		none					
Cd - non combustion ...	../Emissions to air	5.71987E-5	kg		none					
Cd - non combustion ...	../Emissions to air	3.45219E-5	kg		none					
CH4 - combustion - air	../Emissions to air	47.57258	kg		none					

General information Inputs/Outputs Documentation Parameters Allocation Social aspects Direct impacts Additional properties

MSDB compared to IO databases

(such as exiobase, for example)

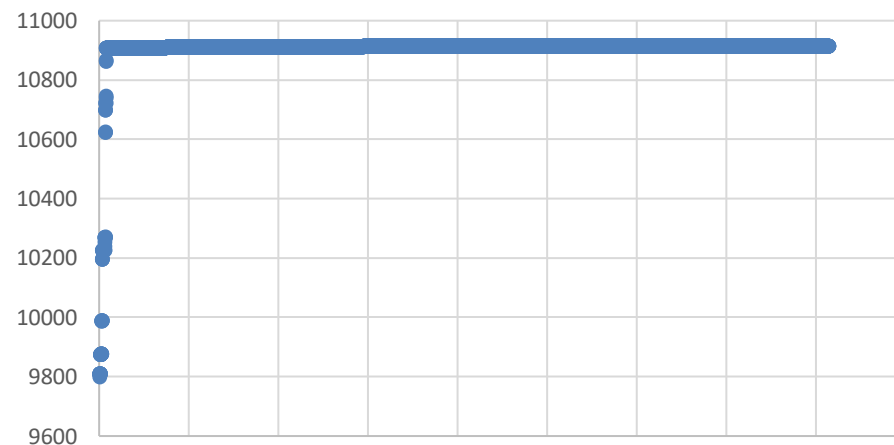
	exiobase 382, pxp	MSDB
process dataset size (flows)	10,912	3-35
Locations	global, 49	569
Datasets	8,148	500,000
Documentation on dataset level	none (!)	on dataset and flow level
Flexibility	none but several versions available	adjustable

MSDB compared to IO databases

(such as exiobase, for example)

	exiobase 382, pxp	MSDB
process dataset size (flows)	10,912	3-35
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Datasets	8,148	500,000
Documentation on dataset level	none (!)	on dataset and flow level
Flexibility	none but several versions available	adjustable

number of flows in datasets, exiobase 382



MSDB compared to LCA unit process databases

(such as Agribalyse, for example)

Inputs/Outputs - Avocado oil, at oil mill - FR											
Inputs											
Flow	Category	Amount	Unit	its/Revenues	Uncertainty	Avoided was	Provider	Data quality	Location	Description	
⚙️ Avocado {GLO} prod...	material/Others/Adapte...	7.09000	kg		none					Average e...	
⚙️ Electricity, low voltag...	energy/Others/Copied f...	0.08200	kWh		none					Electricity ...	
⚙️ Oil mill construction ...	material/Others/Copied ...	1.11000E-9	Item(s)		none					Calculatio...	
✅ Water, well, FR	Resources/in ground	0.00069	m3		none					10-20% of...	
Outputs											
Flow	Category	Amount	Unit	its/Revenues	Uncertainty	Avoided pro	Provider	Data quality	Location	Description	
⚙️ Avocado oil, at oil mil...	material/Agricultural/P...	1.00000	kg		none					Average ...	
⚙️ Avocado peel, at oil ...	material/Agricultural/Pl...	1.06000	kg		none	☐				Average e...	
⚙️ Avocado stone, at oil ...	material/Agricultural/Pl...	1.42000	kg		none	☐				Average e...	
⚙️ Avocado, residual pul...	material/Agricultural/Pl...	3.61000	kg		none	☐				Average e...	
🗑️ Wastewater, average ...	waste treatment/Others...	0.00069	m3		none					Wastewat...	

MSDB compared to LCA databases

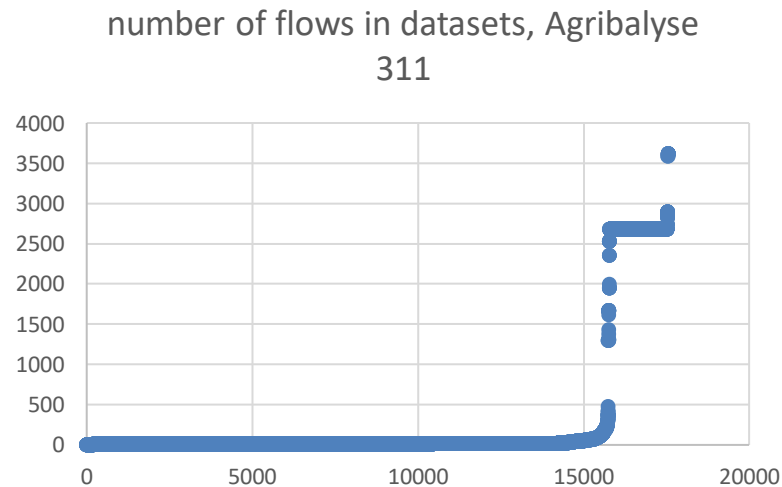
(such as Agribalyse, for example)

	Agribalyse 311	MSDB
process dataset size (flows)	1-3622	3-35
Locations	570	569
Datasets	17.557	500.000
Documentation on dataset level	on dataset and flow level	on dataset and flow level
Flexibility	adjustable apart from system processes	adjustable

MSDB compared to LCA databases

(such as Agribalyse, for example)

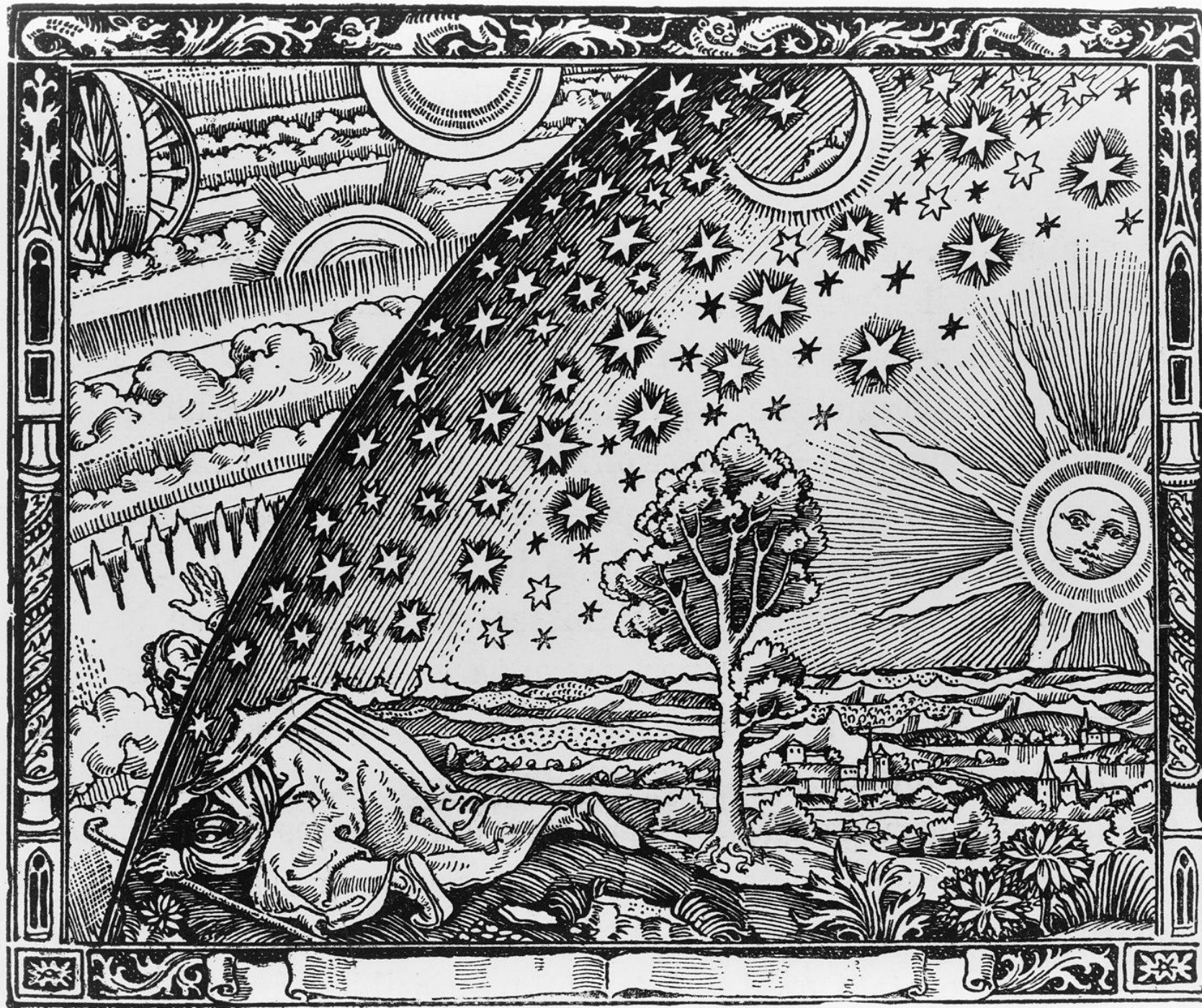
	Agribalyse 311	MSDB
process dataset size (flows)	1-3622	3-35
Locations	570	569
Datasets	17.557	500.000
Documentation on dataset level	on dataset and flow level	on dataset and flow level
Flexibility	adjustable apart from system processes	adjustable



MSDB, next steps

Next steps

- **Deliver first version, spring 2025**
- **Put the database for tests**
 - **in projects**
 - **with external experts**
- **Document and explain**



Camille
Flammarion:
L'atmosphère.
Météorologie
populaire. Paris
1888, p. 163.

greenDELTA

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sustainability consulting + software



Thank you!

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