ENV 501 / GR A3 30

Material Flow Analysis and resource management

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Laboratory on Human-Environment Relations in Urban Systems

Fall 2025

Last week

- EW-MFA: definitions
- Main material categories in EW-MFA
- EW-MFA indicators
- Data Sources
- How to perform an EW-MFA
- EW-MFA in the Swiss context: Guest speaker Florian Kohler, Federal Statistical Office (FSO)

Course outline

		8:15 - 9:00 and 9:15 - 10:00		13:15 - 14:00	14:15 - 15:00
Block I: EW-MFA global / national	W1 - Sep 11	Introduction to the course and general concepts	All	Exercise	Project
	W2 - Sep 18	EW – MFA and EW – MFA in the Swiss context	External Guest – Florian Kohler	Exercise	Project
	W3 – Sep 25	Examples of EW – MFA. Scaling EW-MFA to Cantons	MC	Exercise	Project
	W4 - Oct 02	Urban Metabolism and Circular Economy	FMC	Exercise	Project
Block II: MFA regional / urban	W5 - Oct 09	MFA method and the Stock-Flows-Service Nexus	CRB	Exercise	Project
	W6 - Oct 16	Dynamic MFA	CRB	Exercise	Project
	Oct 23	Autumn break			
	W7 - Oct 30	Applications of MFA – case study	External Guest – Guillaume Massard	Exercise	Project
	W8 - Nov 06	Input-Output Analysis and Material Flow Cost Accounting	External Guest – Vincent Moreau	Exercise	Project
	W9 - Nov 13	Spatial MFA	FMC	Exercise	Project
	W10 - Nov 20	Combined approaches: MFA + LCA; MFA + sociodemographics.	AS & FMC	Exercise	Project
Block III: Social sciences and public policy	W11 - Nov 27	Combined approaches: MFA + surveys; Quasi-dynamic MFA	GF & FMC	Exercise	Project
	W12 - Dec 04	Social metabolism	CRB	Past exam	Project
	W13 - Dec 11	Agent-based model	CRB, FMC, MAH, SLC	Project	Project
	W14 - Dec 18	Group Project Presentation	All	Project	Project

Content of lecture

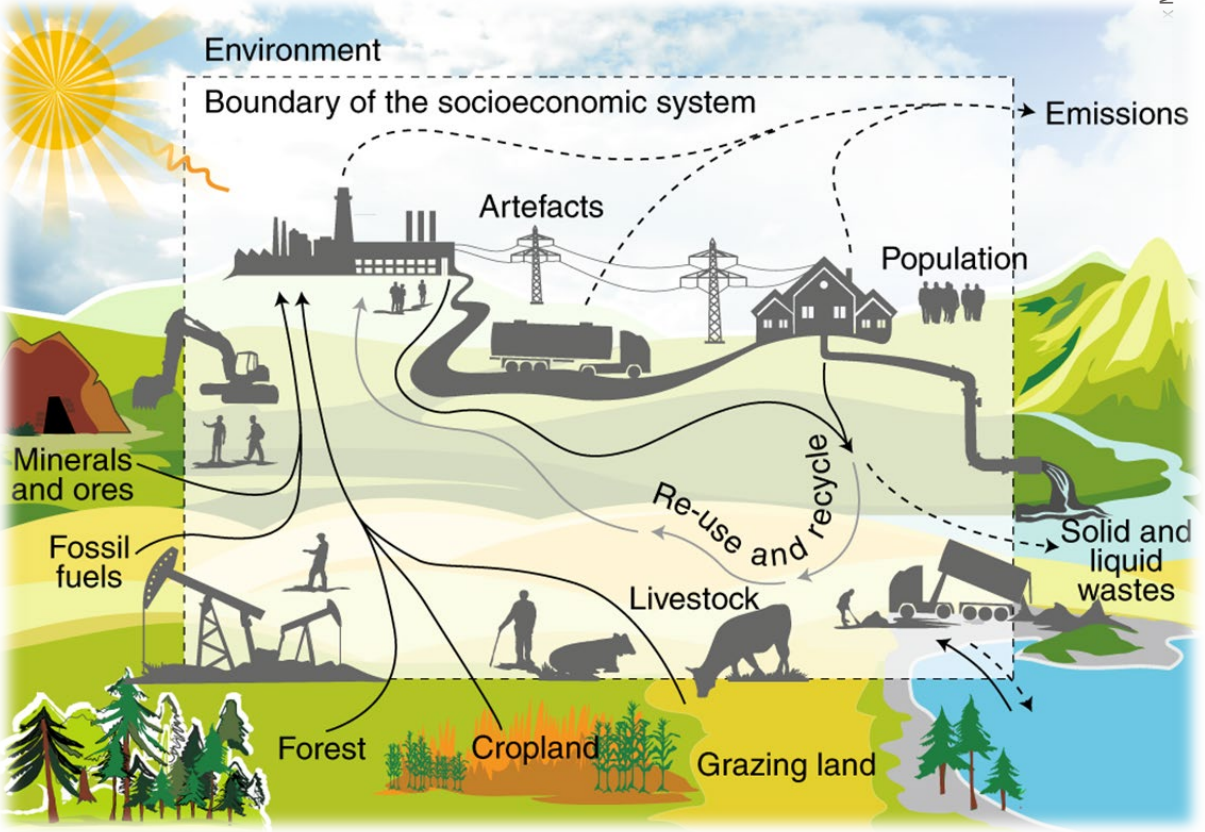
- EW-MFA in Switzerland: key indicators
- EW-MFA Cross-country comparisons
- EW-MFA and adaptability to other boundaries
- Example of Swiss Cantons
- Validation of methodology and insights

EW-MFA across the world

Cross-country comparisons

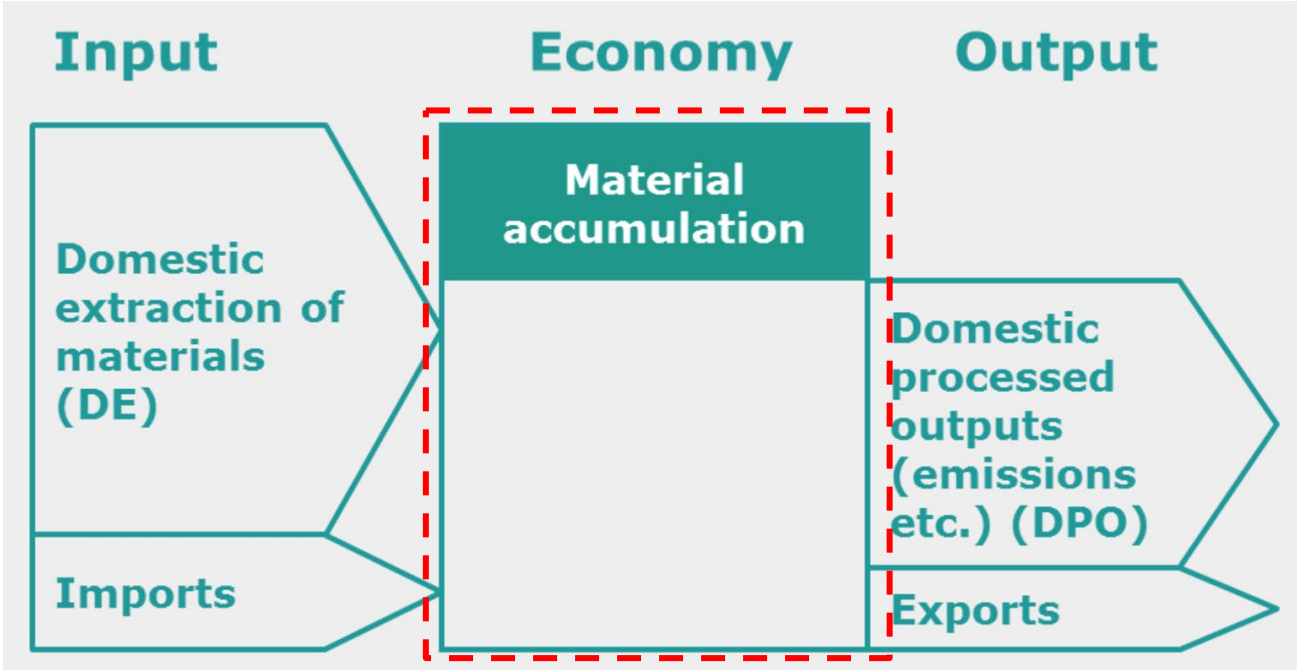
Economy-wide Material Flow Analysis (EW-MFA) (recap)

- Accounts for **all material flows** in **physical** terms
- **Interactions** of the domestic **economy** with the natural **environment** and the rest of the **world** economy
- Follows the principle of **mass conservation**



EW-MFA (recap)

Material inputs | Economy and Society | Material outputs



Material flows within the economy are not clearly represented in EW-MFA
Water and electricity flows are not represented as well

Source: Eurostat, 2018

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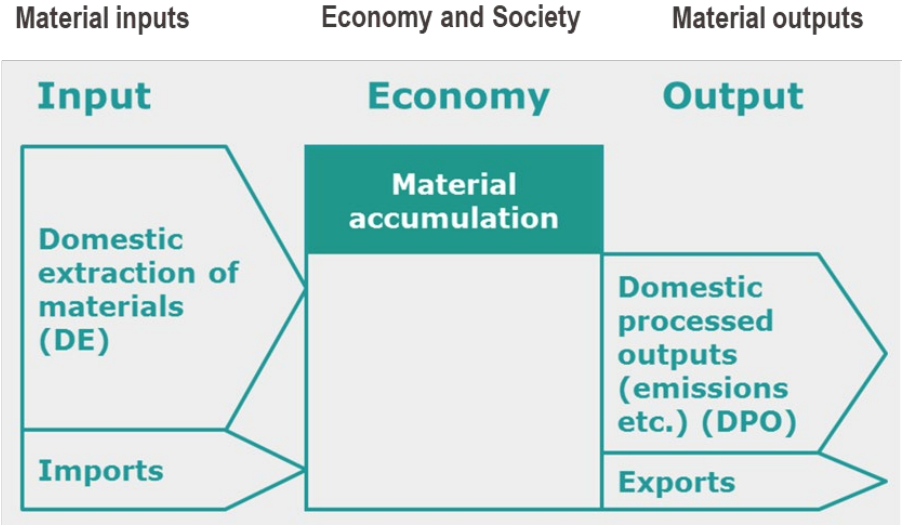
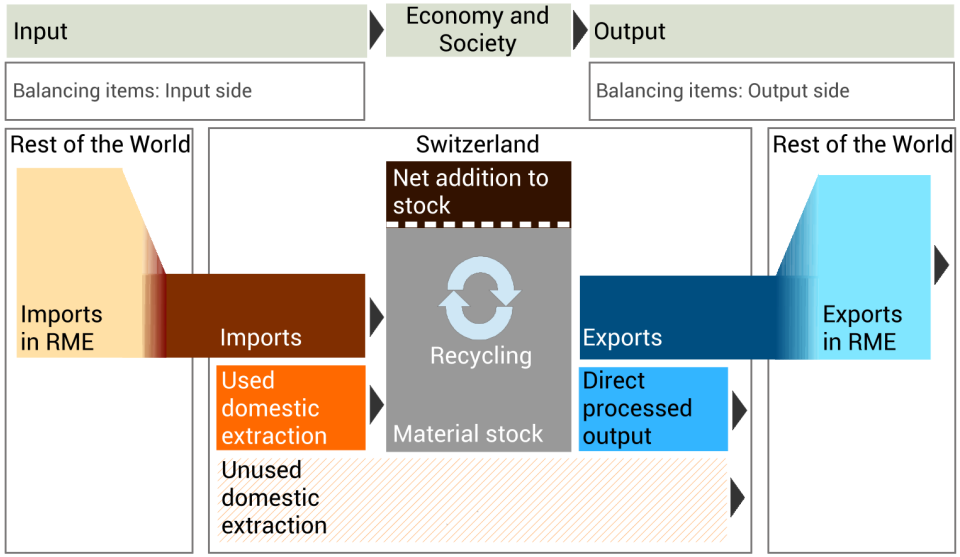
Switzerland EW-MFA indicators





RME: Raw Material Equivalents

Source: Swiss Federal Statistical Office, 2018; Eurostat, 2018

Switzerland EW-MFA indicators

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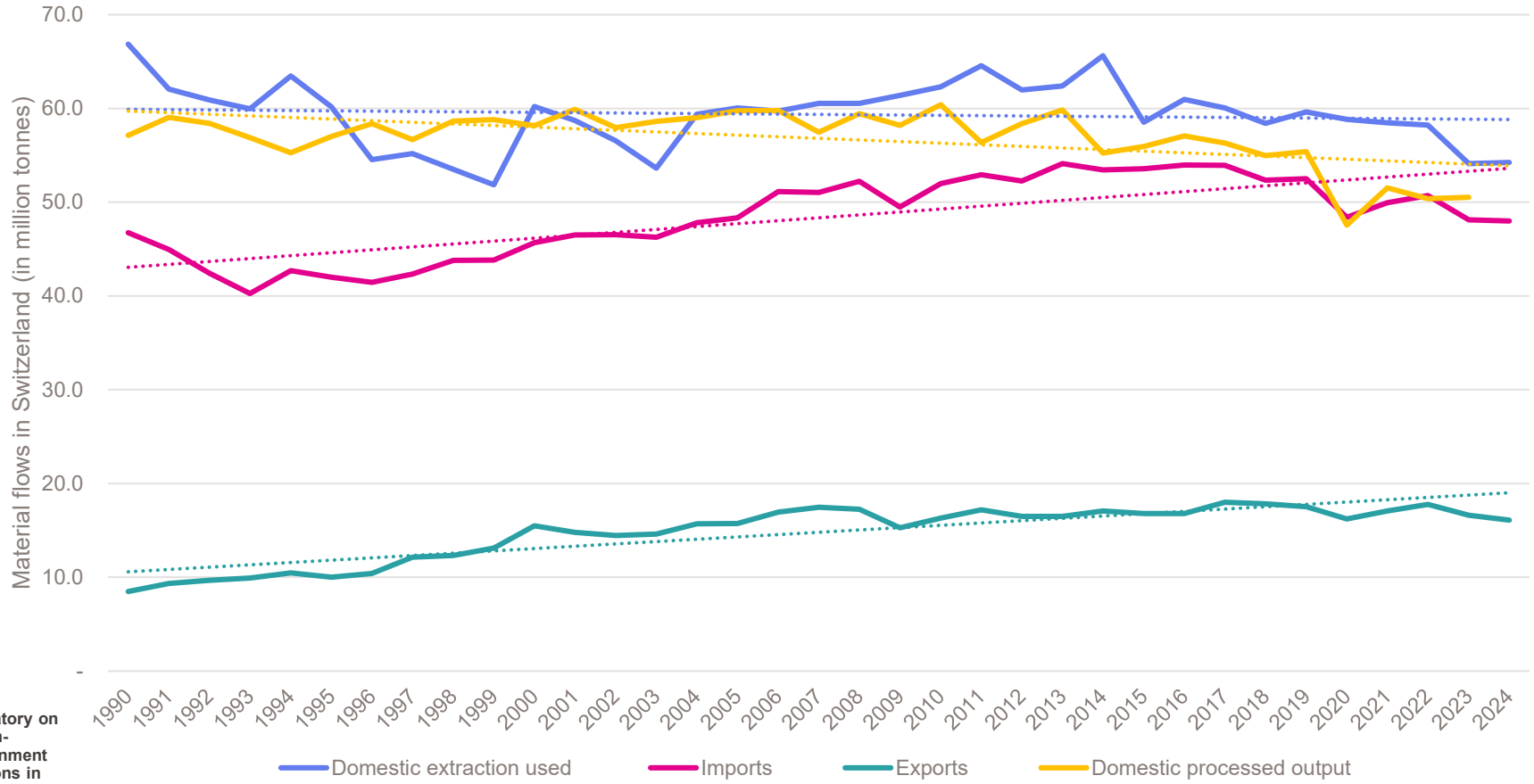
Material flows in Switzerland (in million tonnes)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024 1)
Domestic extraction used	62,4	65,6	58,5	61,0	60,1	58,4	59,6	58,8	58,5	58,2	54,1	54,2
Imports	54,1	53,4	53,6	54,0	53,9	52,3	52,5	48,4	49,9	50,7	48,1	48,0
Exports	16,5	17,1	16,8	16,8	18,0	17,8	17,5	16,2	17,1	17,8	16,6	16,1
Domestic processed output	59,8	55,2	55,9	57,1	56,3	55,0	55,4	47,6	51,5	50,4	50,5	
Emissions to air (%)	93,4	93,5	93,4	93,3	93,5	93,3	93,2	93,2	92,5	92,4	92,7	92,7
Emissions to water (%)	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Balancing items: input side	62,8	58,4	59,5	60,1	59,9	58,2	58,8	50,5	54,2	53,8	54,0	
Balancing items: output side	36,2	35,2	34,9	35,7	35,5	34,6	35,0	32,2	33,4	33,3	33,1	
Direct material input (DMI)	116,5	119,1	112,1	114,9	114,0	110,8	112,1	107,2	108,4	108,9	102,2	102,2
Domestic material consumption (DMC)	100,0	102,0	95,3	98,1	96,0	92,9	94,6	91,0	91,3	91,2	85,6	86,1
Net additions to stock (NAS)	66,8	69,9	64,0	65,5	64,0	61,6	63,0	61,7	60,6	61,4	56,0	
Circular material use	13,0	13,2	13,4	13,8	14,3	14,5	15,0	14,7	14,8	14,5	14,6	
Physical trade balance (PTB)	37,6	36,4	36,8	37,2	35,9	34,5	34,9	32,2	32,9	32,9	31,5	31,9

Source: Swiss Federal Statistical Office, 2025

Switzerland EW-MFA indicators



Source: Swiss Federal Statistical Office, 2025

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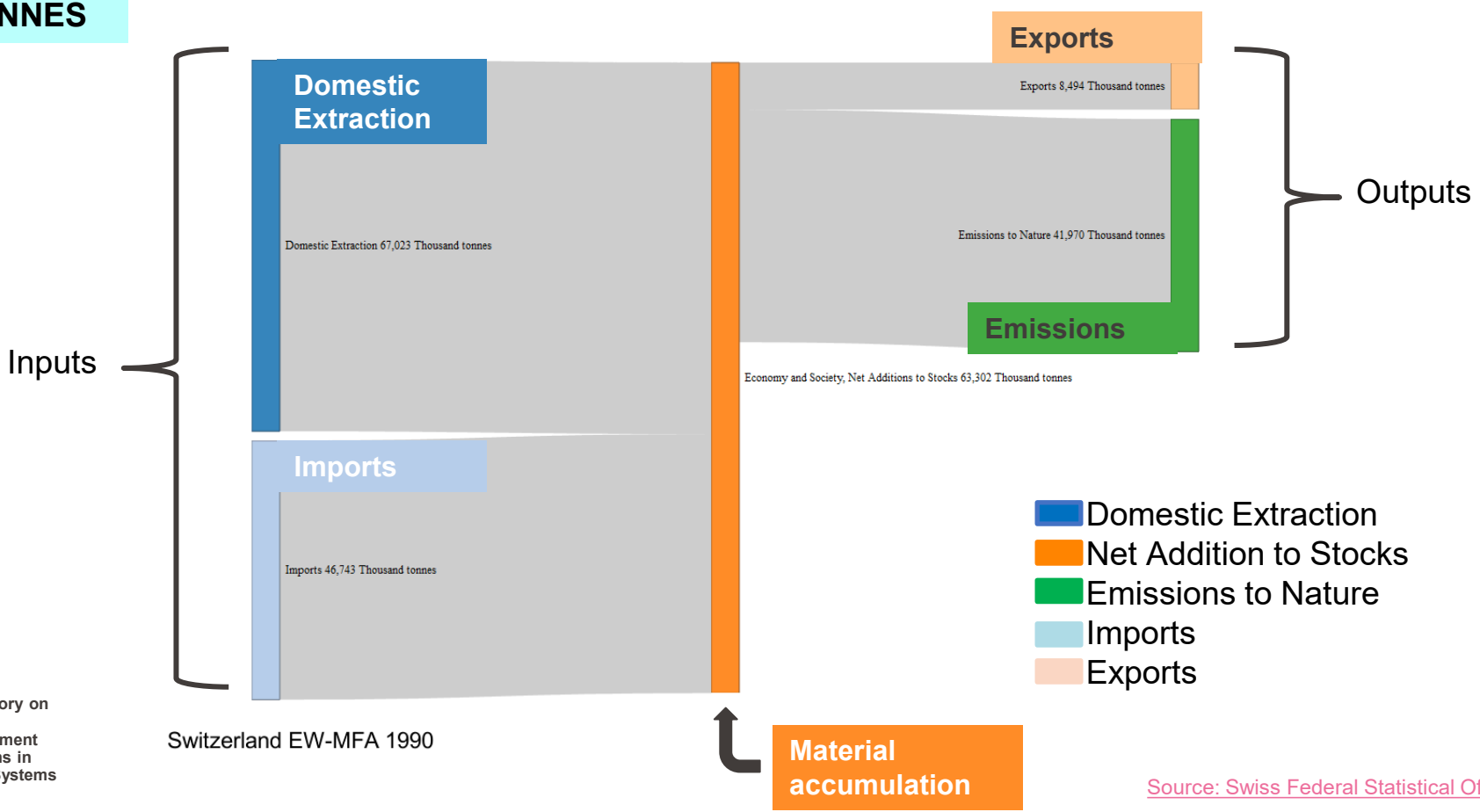
Switzerland EW-MFA indicators

TONNES



Switzerland EW-MFA 1990

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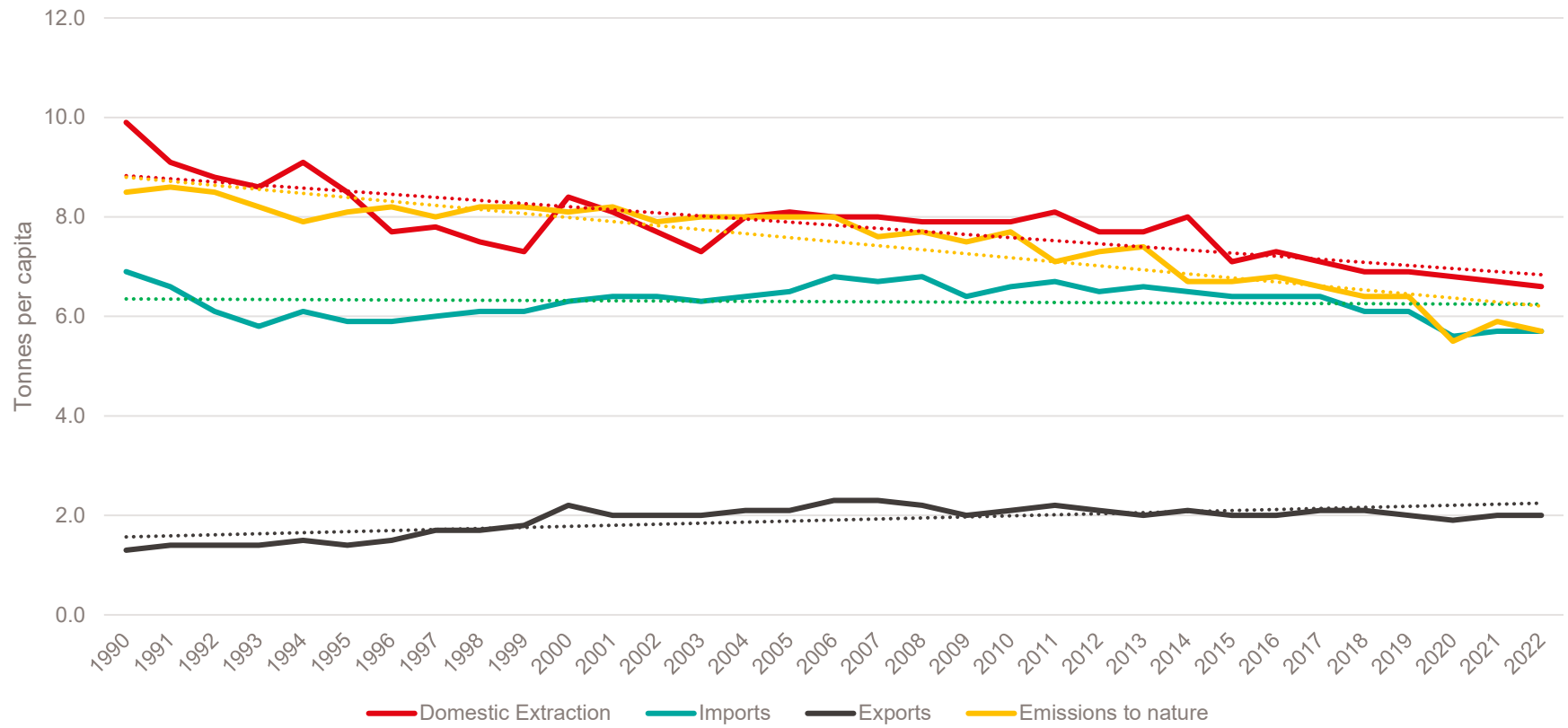
Source: Swiss Federal Statistical Office, 2025

Switzerland EW-MFA indicators



Source: Swiss Federal Statistical Office, 2024

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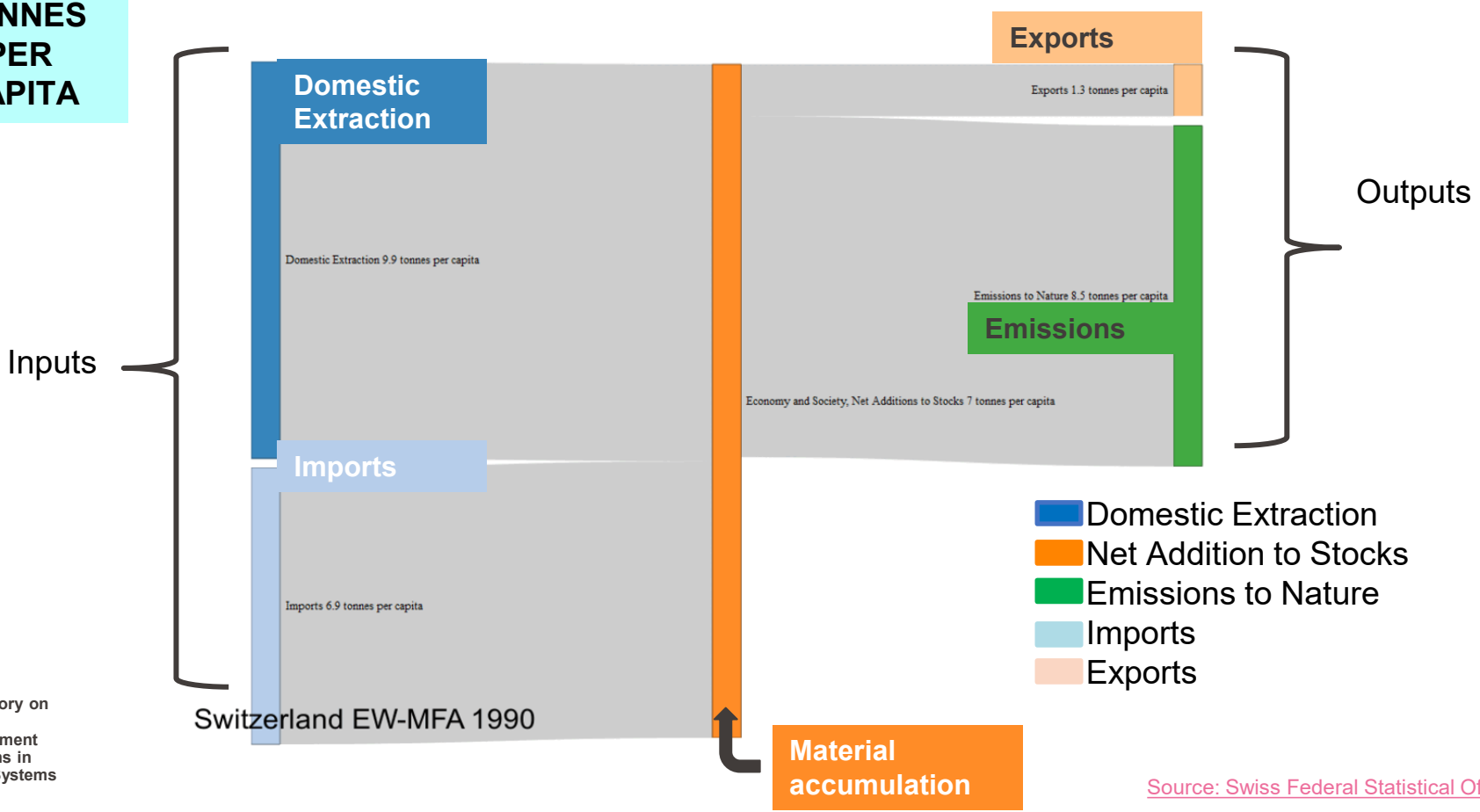
Switzerland EW-MFA indicators

TONNES PER CAPITA



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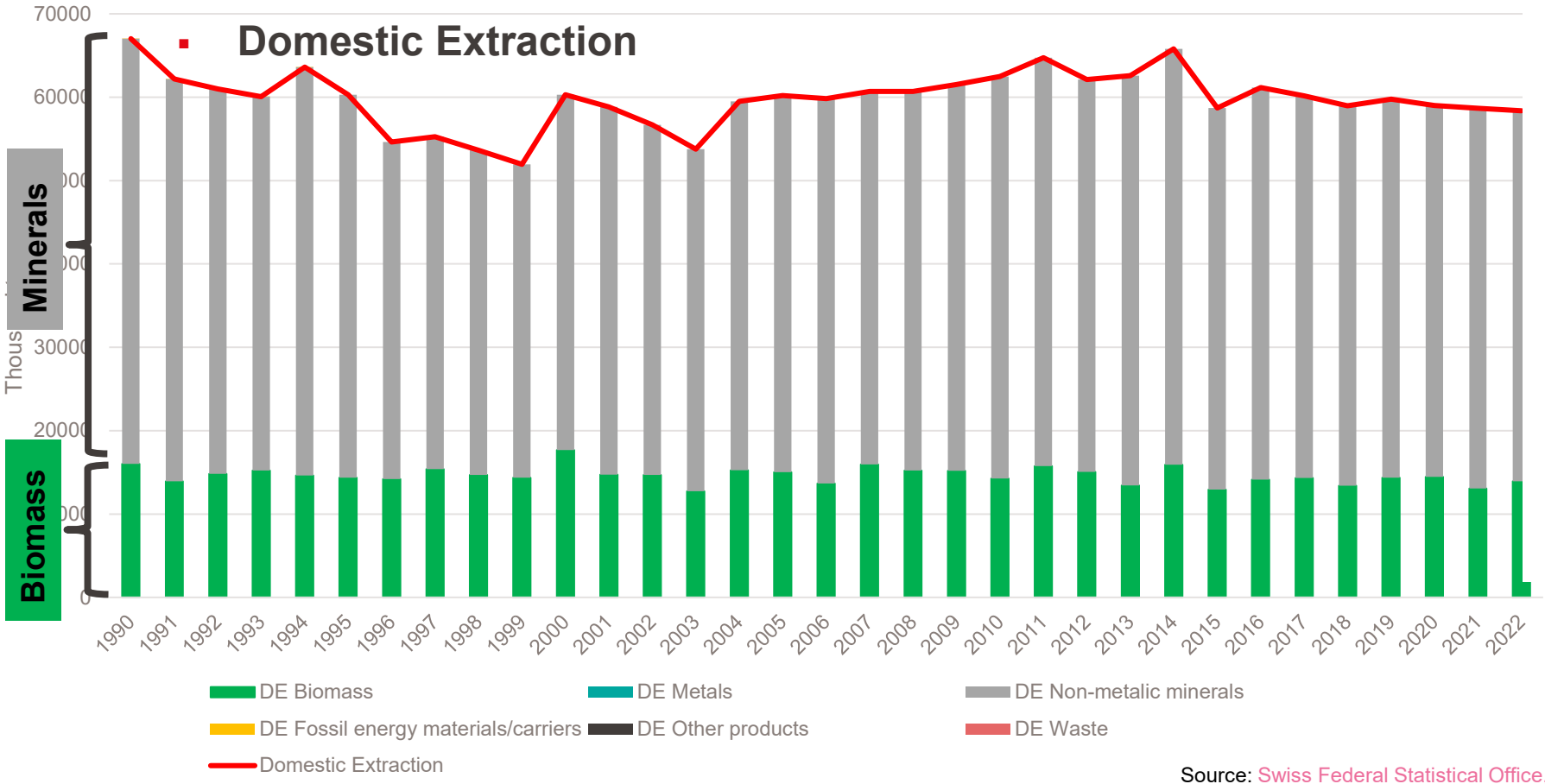
Source: Swiss Federal Statistical Office, 2025

Switzerland EW-MFA indicators



Source: Swiss Federal Statistical Office, 2024

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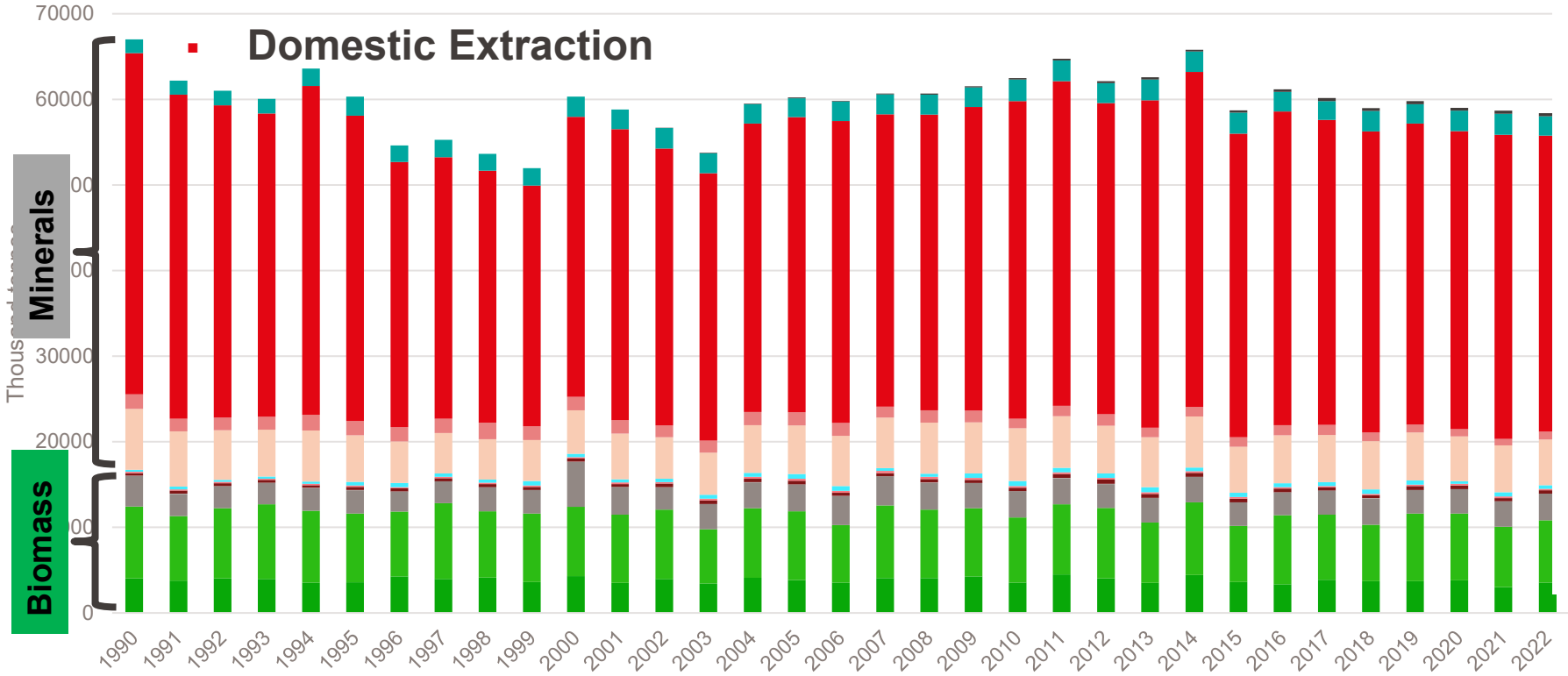
Switzerland EW-MFA indicators



Source: Swiss Federal Statistical Office, 2024

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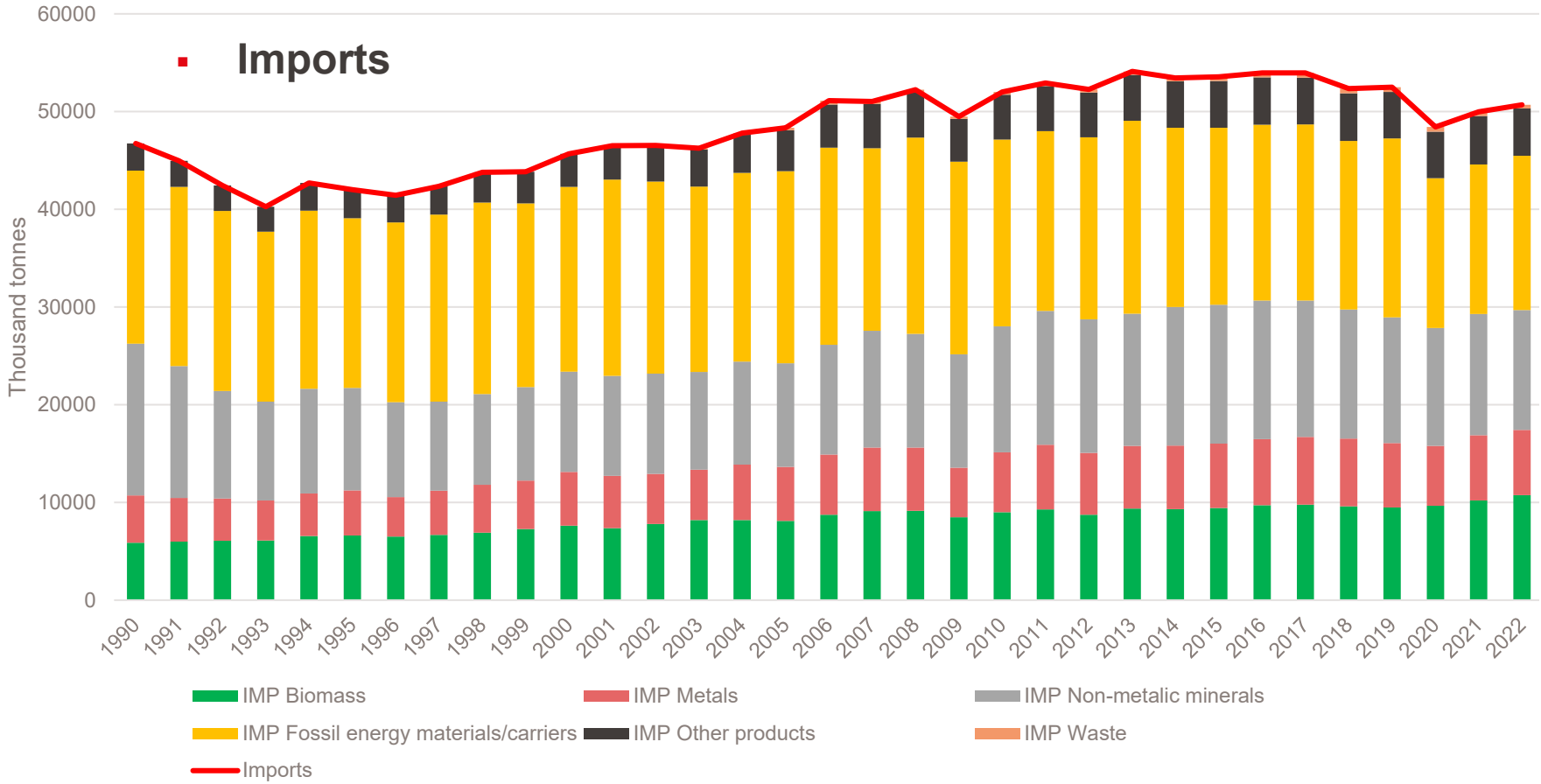
Switzerland EW-MFA indicators



Source: Swiss Federal Statistical Office, 2024

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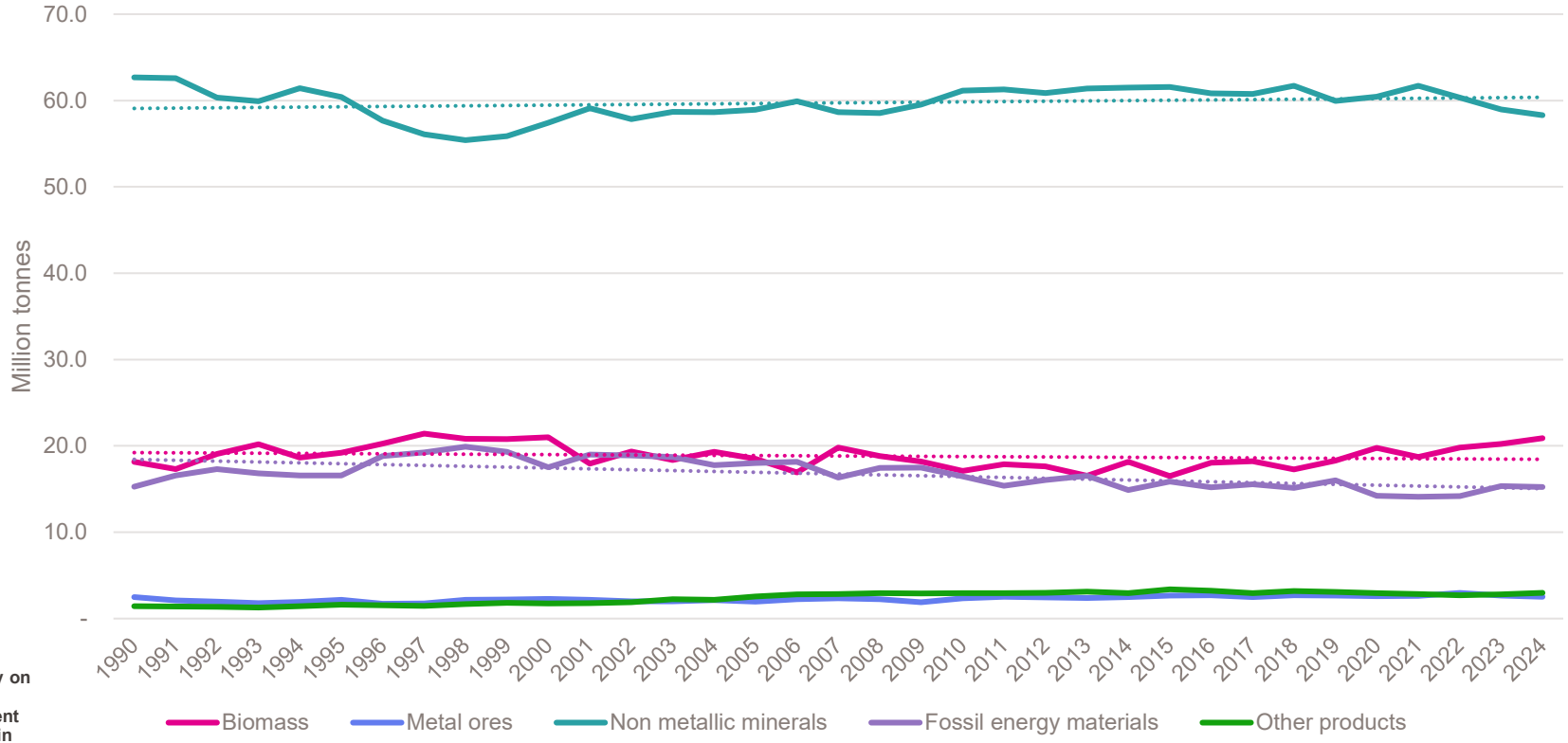
Domestic Material Consumption – Switzerland 1990-2024

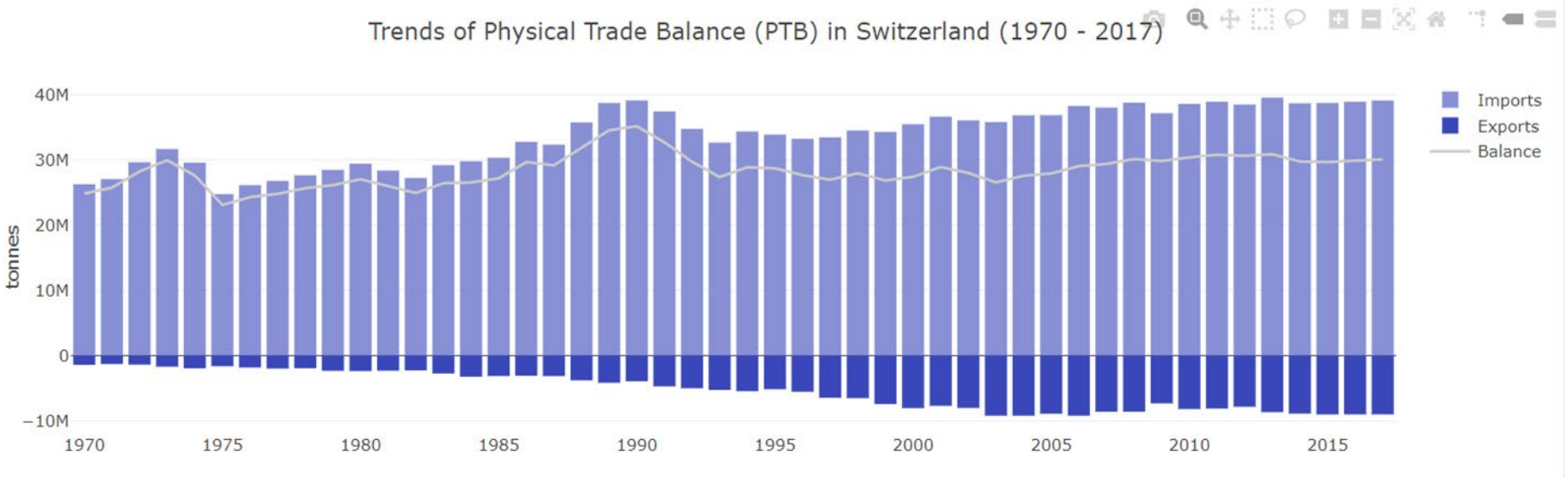


Source: Swiss Federal Statistical Office, 2024

Félix Martín del Campo, Hecher, Campfens

Physical Trade Balance - Switzerland 1970-2017

Is a country a physical net-importer or net-exporter of raw materials?



Source: Material Flow Analysis portal

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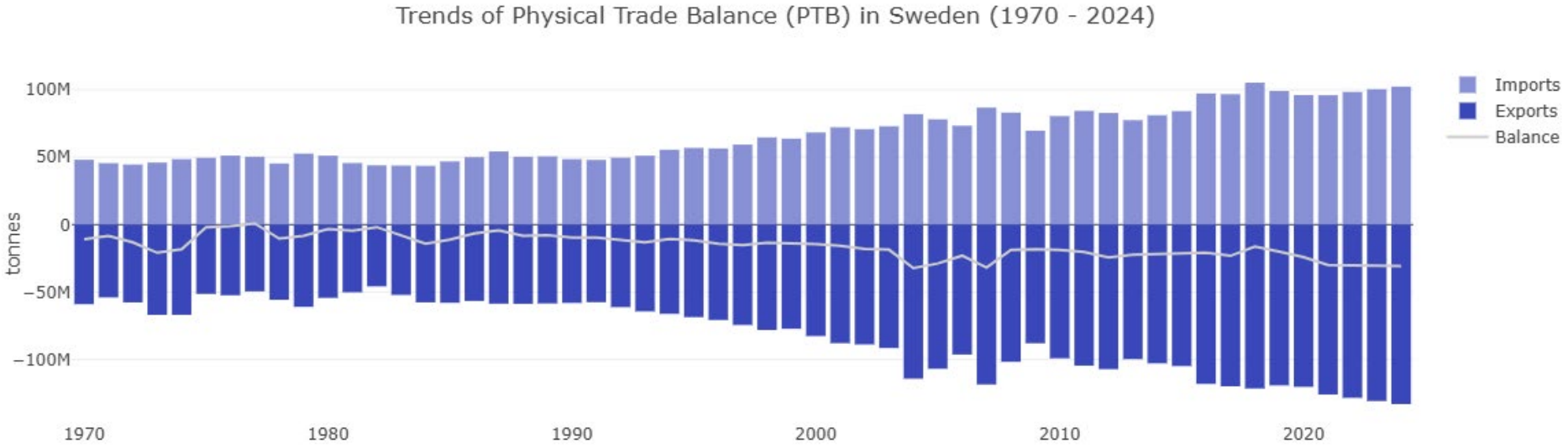
Physical Trade Balance - Sweden 1970-2024

Is a country a physical net-importer or net-exporter of raw materials?



Source: Material Flow Analysis portal

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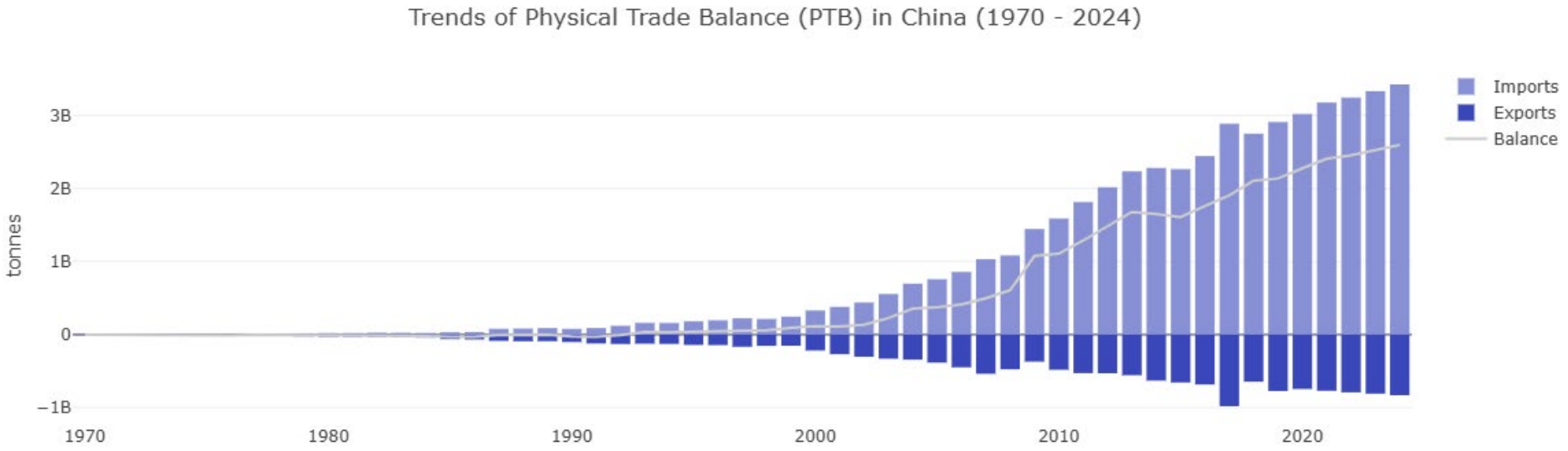
Physical Trade Balance – China 1970-2024

Is a country a physical net-importer or net-exporter of raw materials?



Source: Material Flow Analysis portal

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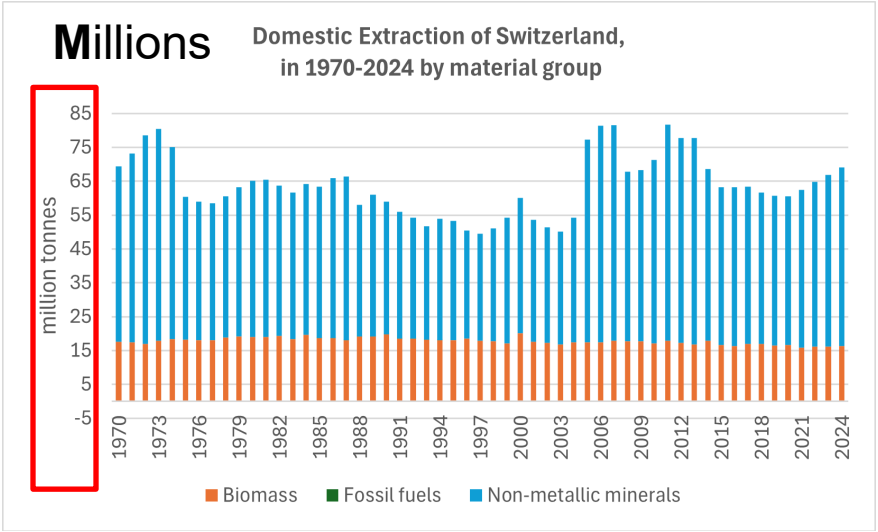
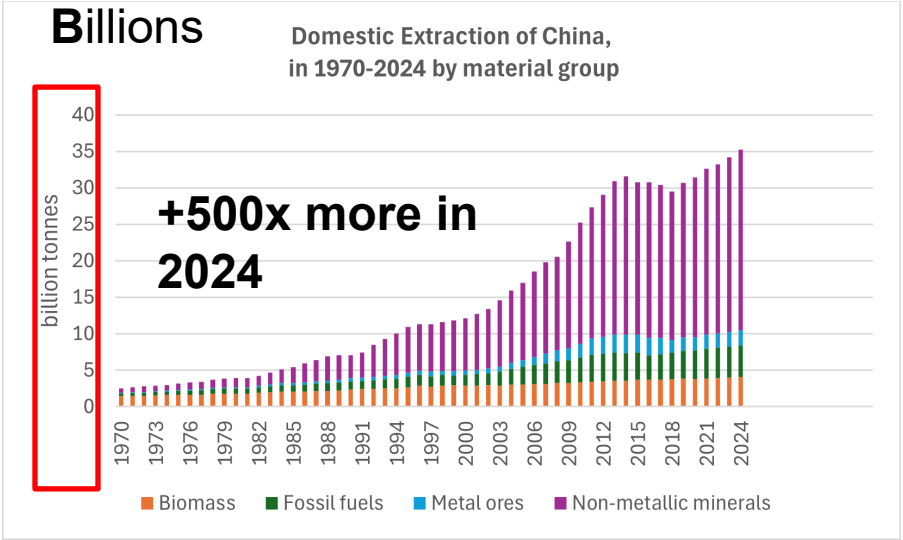
Domestic Material Extraction - Switzerland vs China 1970-2024





Source: International Resource Panel – Global Material Flows database

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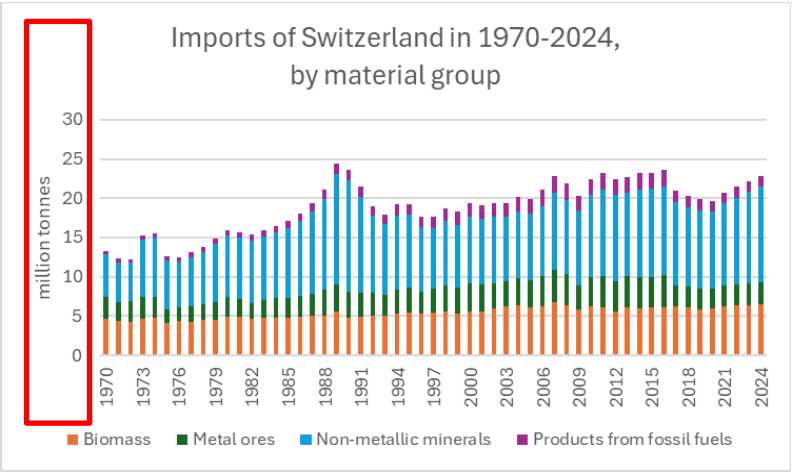
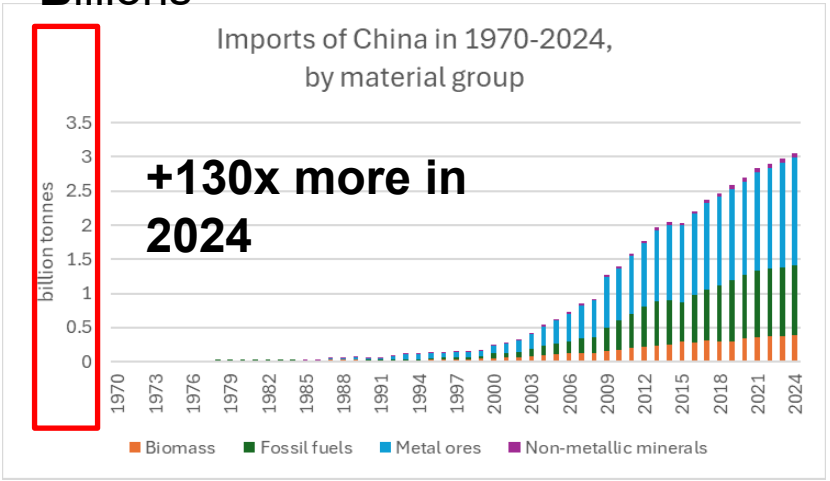
Imports – Switzerland vs China 1970-2024

Millions



Billions



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Source: International Resource Panel – Global Material Flows database

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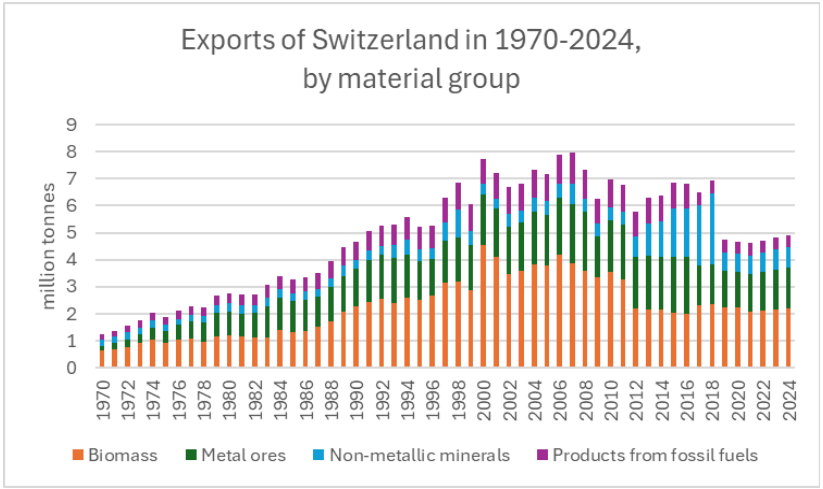
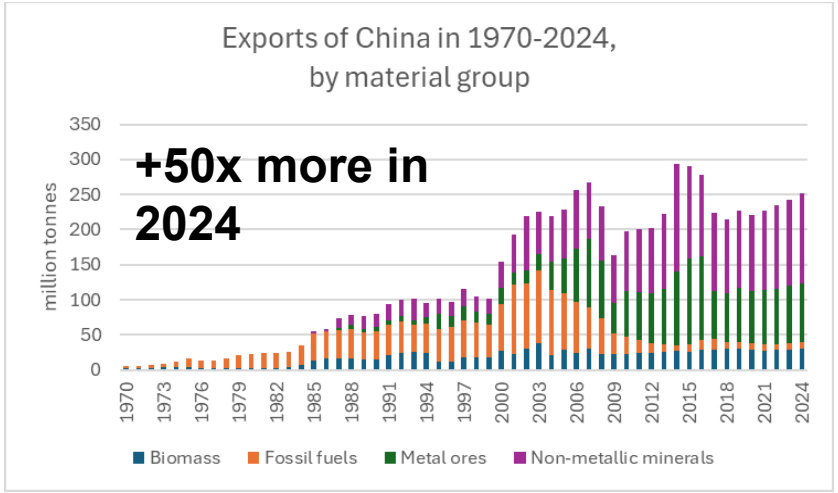
Exports – Switzerland vs China 1970-2024





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Source: International Resource Panel – Global Material Flows database

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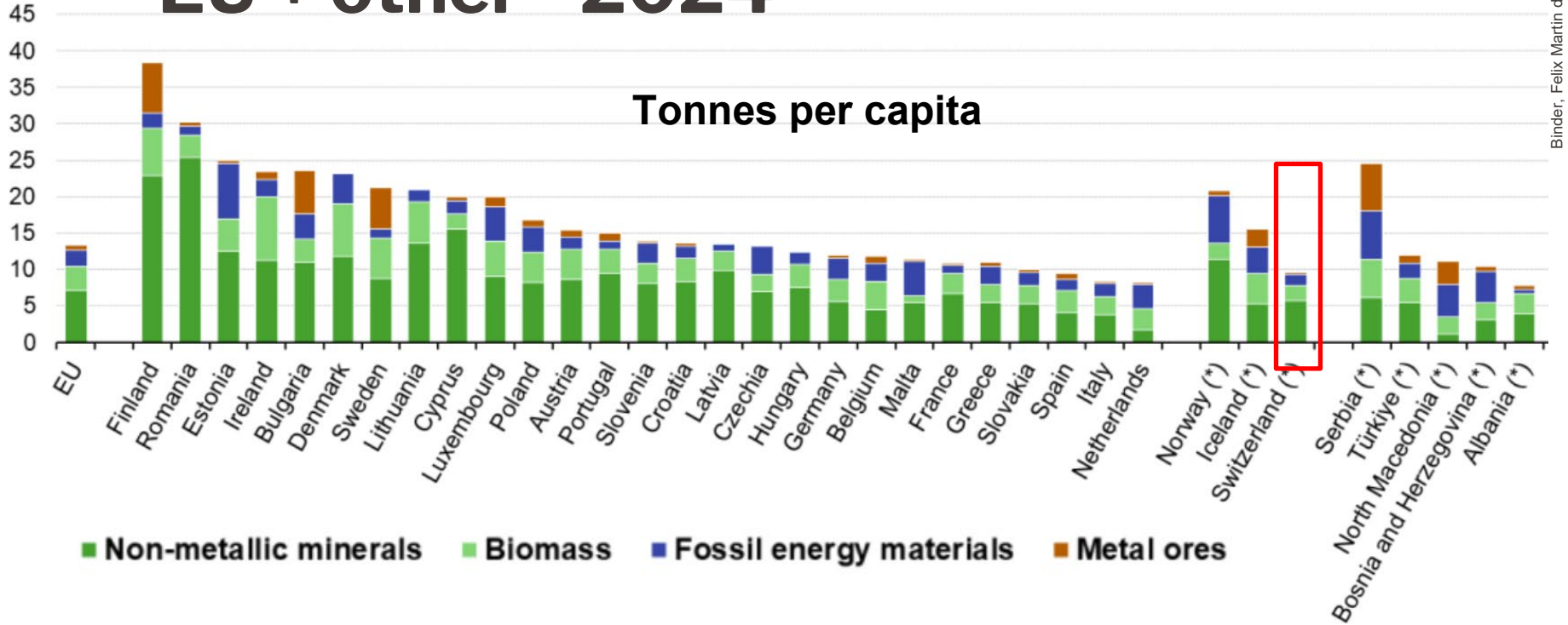
Domestic Material Consumption – EU + other - 2017

Source: Eurostat, 2018

Domestic Material Consumption – EU + other - 2024



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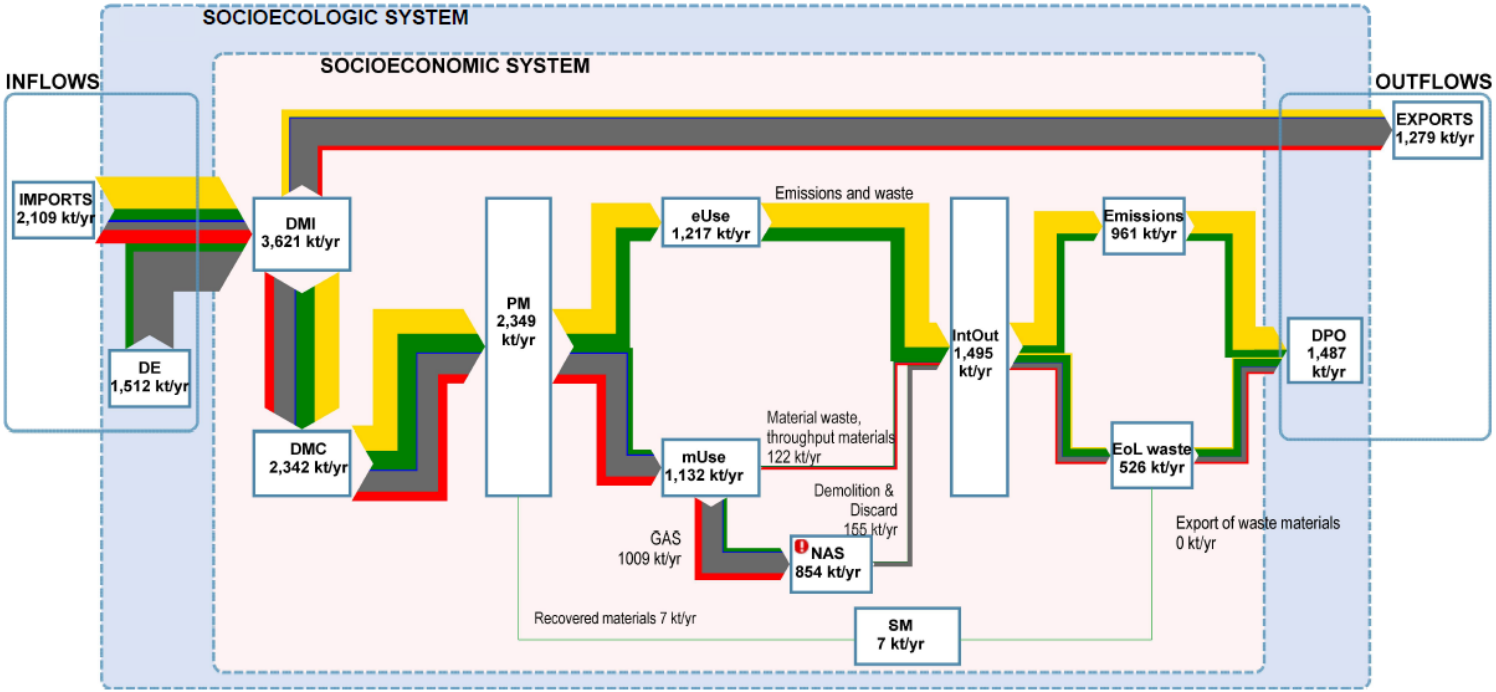
Source: Eurostat, 2024

Integrative analysis and circularity indicators

EW-MFA for The Bahamas in 2018 by Main Material Categories



DE: Domestic Extraction; **DMI**: Direct Material Input; **DMC**: Domestic Material Consumption; **PM**: Processed Materials; **mUse** & **eUSe**: Material & Energy use; **GAS**: Gross Addition to Stocks; **IntOut**: Interim Outputs; **SM**: Secondary Materials (recycling); **EoL**: End-of-life waste; **DPO**: Domestic Processed Output

Source: Martin del Campo et al., 2023

EW-MFA: Pro's and con's

Advantages

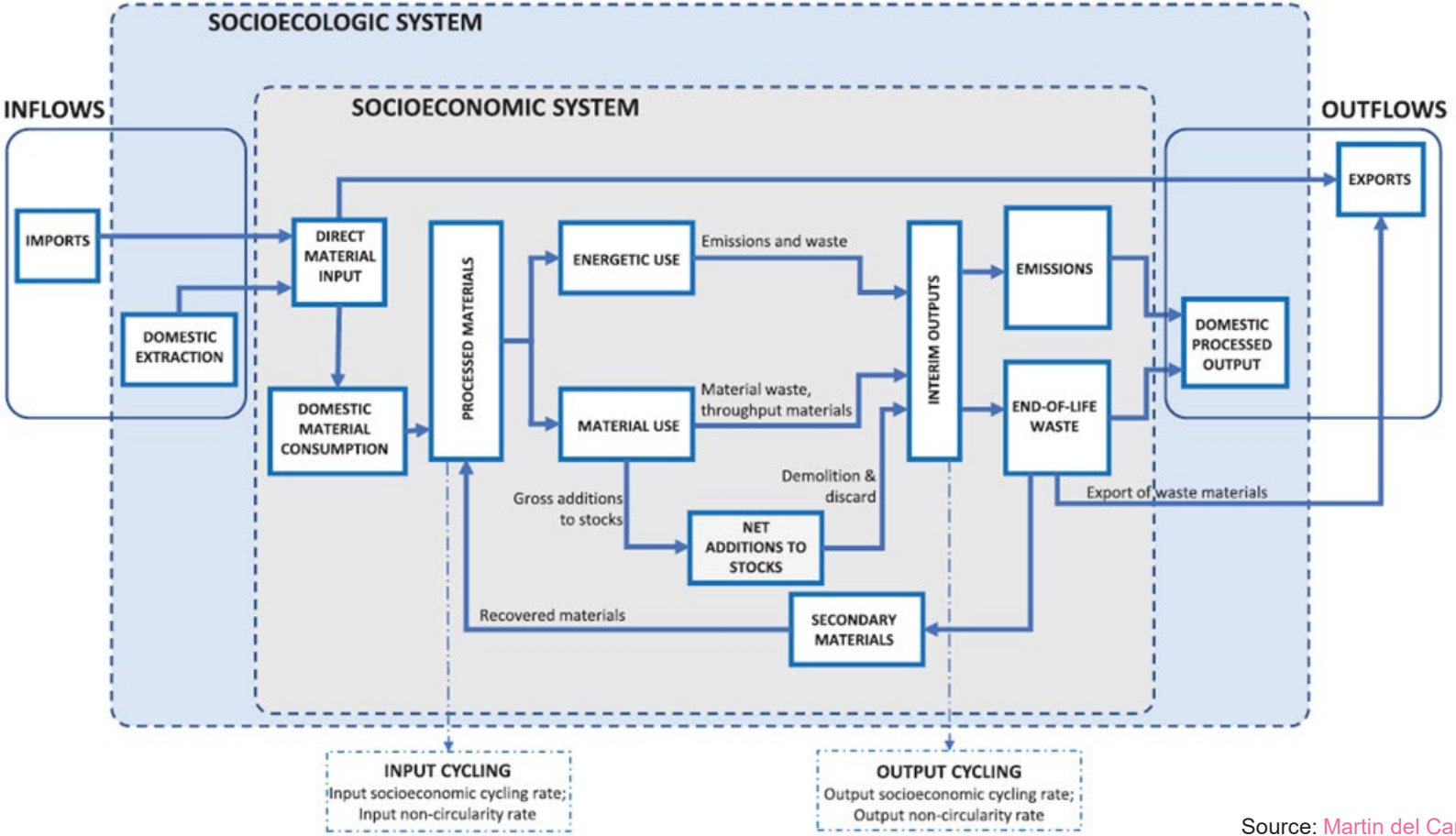
- Trend representation within countries
- Identification of proportions and hotspots
- Comparative analysis across countries/regions
- Development of physical indicators which can be set in relation to economic indicators
- Monitoring and assessment of overarching policy goals (e.g. SDGs)

Disadvantages

- Difficulties in explaining trends
- Difficulties in deriving causalities
- **None of the indicators show the full picture if considered individually**

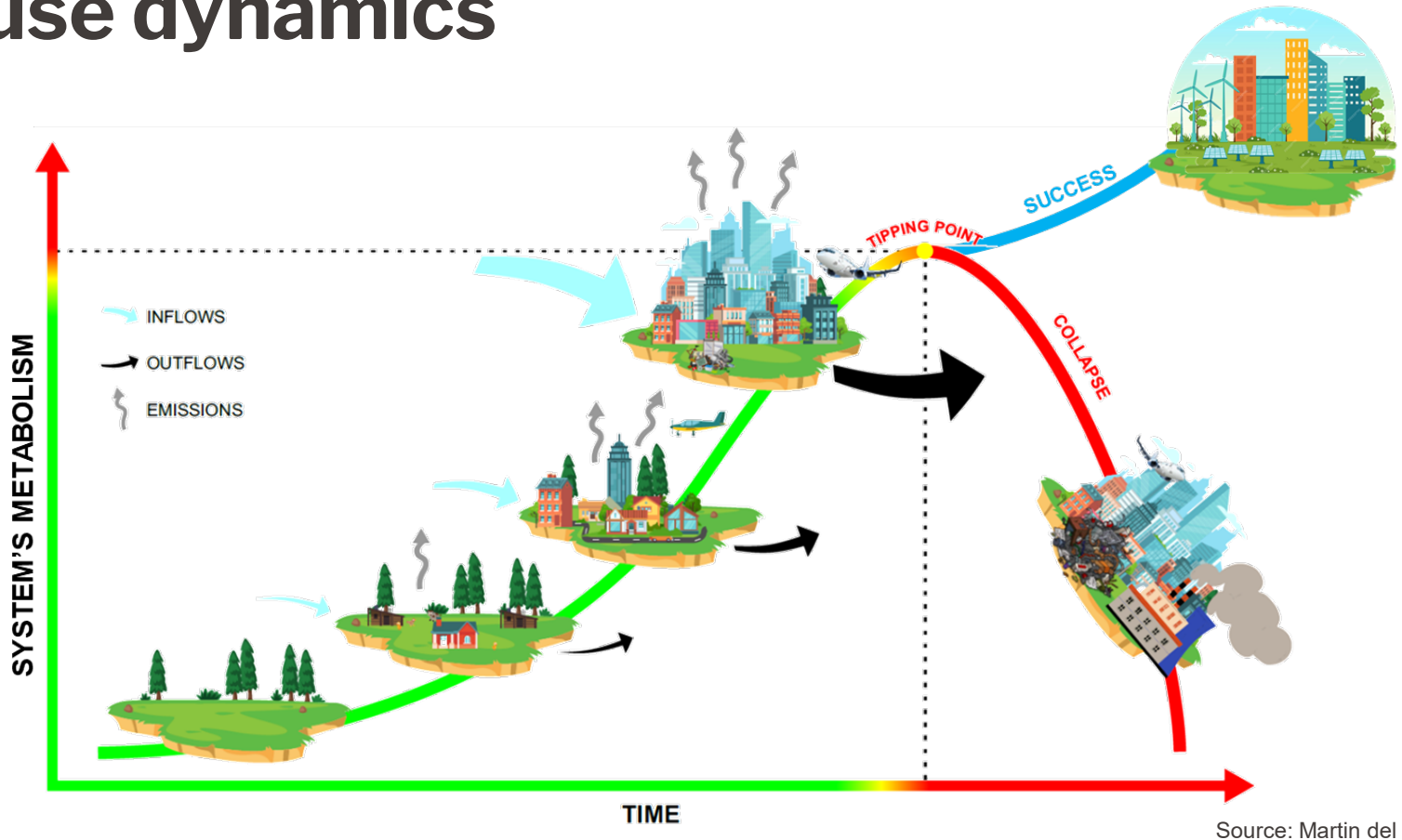
EW-MFA and adaptability to other boundaries

EW-MFA (recap)



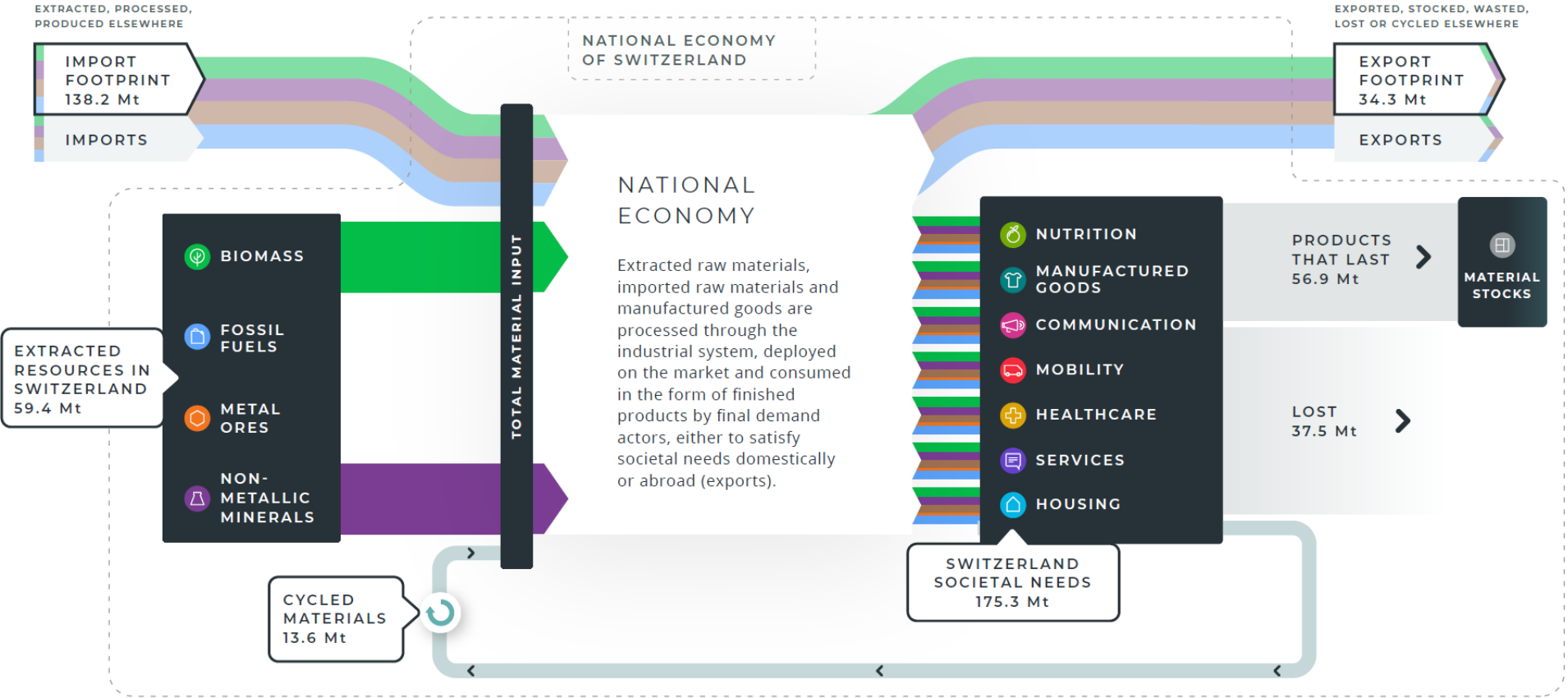
Source: Martin del Campo et al., 2023

Relevance of resource-use dynamics



Source: Martin del Campo, 2023

EW-MFA for Switzerland in 2022



Source: Circle Economy, 2023

Swiss administrative boundaries

Country

Cantons (26)

Source: Office Fédéral de la statistique (au 1.1.2018). https://www.bfs.admin.ch/bfs/en/home/services/geostat/swiss-federal-statistics-geodata.html

Regionalization of EW-MFA

- **Importance**
  - Tailors analysis to local conditions and resource flows
  - Enhances policy relevance by focusing on regional dynamics
- **Methodological Approach**:
  - Collect regional data on domestic extraction, imports, exports, and emissions.
  - Use sub-national boundaries for detailed insights into material flows.
- **Benefits**
  - Identifies regional strengths and weaknesses in resource use
  - Facilitates targeted interventions and policies for sustainable development
  - Allows comparison and benchmarking

Regionalization of EW-MFA: Challenges

- **Data Availability**
  - Limited access to region-specific data (imports/exports)
  - Need for harmonization across sub-national databases
- **Methodological Consistency**
  - Ensuring uniformity in data collection and analysis methods
  - Adapting national methodologies to local contexts without losing accuracy
  - Balancing granularity with data reliability and availability.
- **Policy Integration**
  - Aligning regional findings with national policies and objectives
  - Bridging the gap between local and national governance structures
- **Stakeholder Engagement**
  - Involving local authorities and communities in data collection and interpretation
  - Ensuring that policies are responsive to regional needs and contexts

Example in Swiss Cantons

Application in Switzerland

Cleaner and Responsible Consumption 10 (2023) 100127

Contents lists available at ScienceDirect

Cleaner and Responsible Consumption

journal homepage: www.journals.elsevier.com/cleaner-and-responsible-consumption

Streamlining the regionalization of economy-wide material flow accounts (EW-MFA): The case of swiss cantons

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Steps

- Data Collection process
- Down-scaling the data on a cantonal scale
- Results by canton
- Final remarks

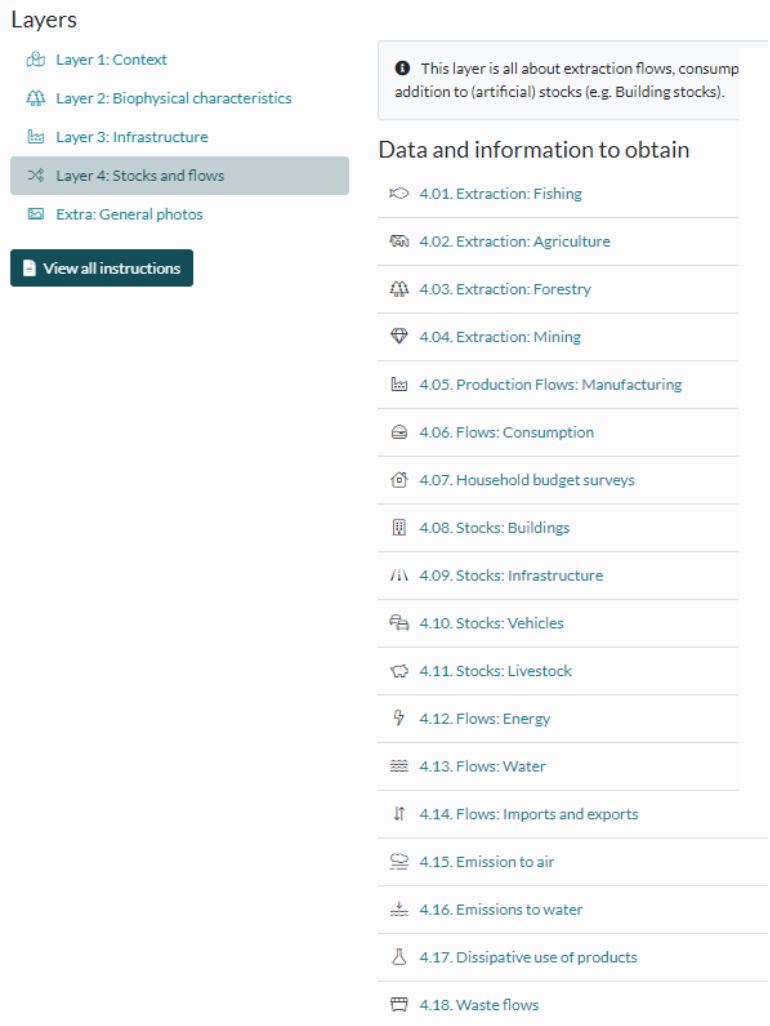
Source: Wiedmann et al. (2023)

Data collection process

- **Gathering data following the EW-MFA questionnaires**
  - Domestic Extraction (DE)
  - Import
  - Export
  - Domestic Processed Output (DPO)

- **Data storage**
  - Metabolism of City (MoC) Data Hub
  - Spreadsheet (Excel)
  - List of contacted people

- EW-MFA Handbook 2018



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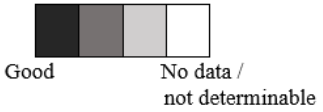
Available data

- Available data considering MoC Data Hub layers
- To fill in an EW-MFA questionnaire
  - Different sources
  - Transform metrics
  - Downscaling



		Lausanne City			Vaud Canton			Geneva City			Geneva Canton		
	Data Quality	A	F	OA	A	F	OA	A	F	OA	A	F	OA
1. Context	Boundaries, Economic activities, Population & Policies												
2. Biophysical	Soil, Vegetation, Biodiversity, Water, Climate & Minerals												
3. Infrastructure	Land use, Networks, Services, Manufacturing sites, Transports…												
4. Stocks & Flows	Natural extraction												
	Consumption, budget surveys												
	Stocks: Buildings, Infrastructure												
	Stocks: Vehicles												
	Stocks: Livestock												
	Flows: Energy												
	Flows: Water												
	Flows: Imports & Exports												
	Emissions (air, water, products)												
	Waste flows												

Matrix representing the collected data by availability and quality.
A: Availability; F: Format; OA: Open Access

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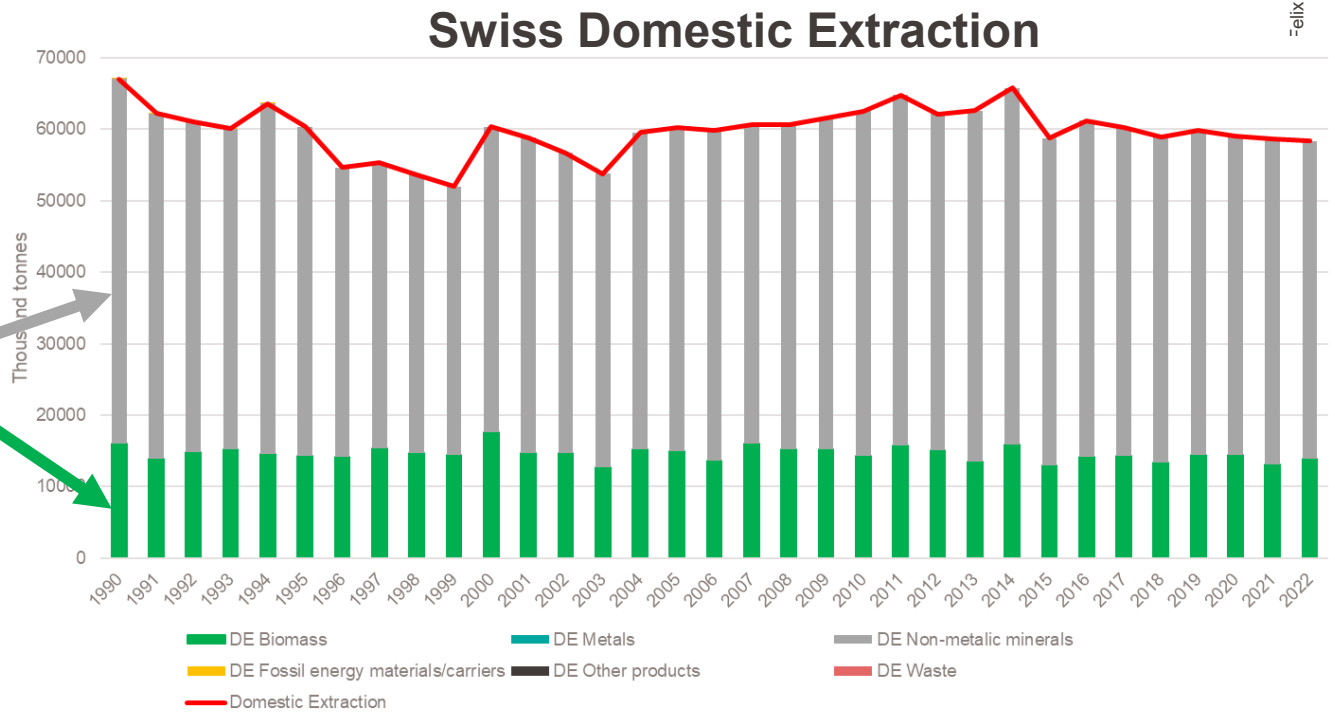
Domestic Extraction (DE)

- Fossil energy materials / carriers
- Biomass
- Metals
- Minerals



Source: Swiss Federal Statistical Office, 2024

DE – Biomass (Crops)

Crops, fodder crops and residues

- Utilised Agricultural Area (UAA) classification 3, FSO
- Swiss biomass production
  - DE Switzerland, FSO
  - Fruits (UAA), wine and beetroots production, FOAG
  - Crops and milk production, yield factors - regional and cantonal level, USP
  - Vegetables production (request data, available for main porducer cantons), SZG CCM CSO

Crops

Mass production per canton $= Primary\ data$

$$= \frac{Cantonal\ UAA}{Swiss\ UAA} \times Swiss\ Production$$

$$= Cantonal\ UAA \times Yield\ factor$$

Wine [hl → tons]

Tons of wine = $(Primary\ data\ [hl]/0.8)/10$

DE – Biomass (Wood & Wild life)

Wood

- Wood harvest in Switzerland by Canton [m^3], FSO

Wild life

- Fish statistics per canton, BAFU – Bundesamt für Umwelt
- Hunting statistics per canton, BAFU – Bundesamt für Umwelt
- Hunting statistics per canton, FSO

Wood [m^3 → tons]

1. For sawlogs and veneer logs, a 10% extra volume need to be added in order to account for bark.
2. A Swiss factor is applied to convert the volume in mass: 0.52 t/m^3 for hardwood, and 0.68 t/m^3 for softwood.

Wild life

Hunting, is it allowed in Switzerland?
Conversion factor number of head to weight in EW-MFA Handbook

DE – Minerals data sources & calculations

Data sources

- Cantonal Statistical Office (VD – STATVD, GE – OCSTAT)
- Cantonal department of the territory (DGE-GEODE Vaud, DSPE-GESDEC Genève)

Transform metrics

- Usually from m^3 → tons
  - Specific factors from Cantonal department
  - EW-MFA Handbook

Image: La carrière d'Holcim à Eclépens (VD)

Imports & Exports

- Fossil energy materials / carriers
- Biomass
- Metals
- Minerals
- Other products
- Wastes imp/exp for final treatment

NST code		MF code
1	Products of agriculture, hunting, and forestry; fish and other fishing products	MF1
2	Coal and lignite; crude petroleum and natural gas	MF4
3	Metal ores and other mining and quarrying products; peat; uranium and thorium	MF2
4	Food products, beverages and tobacco	MF1
5	Textiles and textile products; leather and leather products	MF1
6	plaiting materials; pulp, paper and paper products; printed matter and recorded media	MF1
7	Coke and refined petroleum products	MF4
8	Chemicals, chemical products, and man-made fibers; rubber and plastic products ; nuclear fuel	MF4
9	Other non metallic mineral products	MF3
10	Basic metals; fabricated metal products, except machinery and equipment	MF2
11	Machinery and equipment n.e.c.; office machinery and computers; electrical machinery and apparatus n.e.c.; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	MF2
12	Transport equipment	MF2
13	Furniture; other manufactured goods n.e.c.	MF5
14	Secondary raw materials; municipal wastes and other wastes	MF6
15	Mail, parcels	MF5
16	Equipment and material utilized in the transport of goods	MF5
17	Goods moved in the course of household and office removals; baggage and articles accompanying travellers; motor vehicles being moved for repair; other non market goods n.e.c.	MF5
18	Grouped goods: a mixture of types of goods which are transported together	MF5
19	Unidentifiable goods: goods which for any reason cannot be identified and therefore cannot be assigned to groups 01-16.	MF5
20	Other goods n.e.c.	MF5
21	Unknown	MF5

Imports & Exports - Road

Road transport

- Swiss Heavy Vehicles (yearly survey)
  - Eurostat, road transport by NST 2007 code for NUTS 3 regions (equals to swiss cantons): Loading → Exported ; Unloading → Imported
  - Swiss Heavy Vehicle survey by main Swiss regions – FSO

- Foreign Heavy Vehicles (every 5 years) - FSO
  - Complete missing years by liner regression
  - Data aggregated by main Swiss regions – downscaling→

$$\frac{Eurostat\ data\ NUTS\ 3}{FSO\ data\ SHV\ Survey\ by\ main\ Swiss\ regions}$$ or

$$\frac{Eurostat\ data\ NUTS\ 3}{Aggregation\ Eurostat\ data\ of\ Cantons\ coposing\ your\ main\ region}$$

- Swiss Light Vehicles (every 10 years) - FSO
  - Complete missing years by linear regression or Swiss trends of goods transported
  - Allocation to NST 2007 code by considering the share of other surveys

Imports & Exports - Rail

- Cantonal statistics by mean of transport (often aggregated and considering only foreign exchanges)
- Eurostat dataset import from abroad to Swiss main regions
- HSG study intra-regional trades of goods by rail. Share compared to Swiss Heavy Vehicles survey.

in 1000 t nach von	Genfersee-region	Espace Mittelland	Nordwest-schweiz	Zürich	Ostschweiz	Zentral-schweiz	Tessin	Total
Genferseeregion	35761	6492	1239	673	636	522	188	**45510**
Strasse	94%	76%	44%	30%	27%	55%	16%	**88%**
Schiene	6%	24%	56%	70%	73%	45%	84%	**12%**
Espace Mittelland	5195	63984	5077	1717	2610	3337	463	**82382**
Strasse	80%	97%	83%	59%	71%	84%	39%	**93%**
Schiene	20%	3%	17%	41%	29%	16%	61%	**7%**
Nordwestschweiz	1848	7316	33704	3646	2511	4603	802	**54430**
Strasse	56%	88%	98%	78%	65%	87%	38%	**90%**
Schiene	44%	12%	2%	22%	35%	13%	62%	**10%**
Zürich	377	1155	2581	26454	3659	2544	630	**37398**
Strasse	49%	76%	94%	97%	74%	78%	19%	**91%**
Schiene	51%	24%	6%	3%	26%	22%	81%	**9%**
Ostschweiz	454	1561	1604	3811	40202	1400	348	**49379**
Strasse	49%	74%	83%	93%	98%	86%	94%	**96%**
Schiene	51%	26%	17%	7%	2%	14%	6%	**4%**
Zentralschweiz	342	2096	2048	2023	1007	26677	333	**34527**
Strasse	70%	97%	95%	90%	86%	99%	59%	**97%**
Schiene	30%	3%	5%	10%	14%	1%	41%	**3%**
Tessin	46	392	589	189	252	344	9625	**11438**
Strasse	35%	42%	19%	43%	88%	77%	>99%	**91%**
Schiene	65%	58%	81%	57%	12%	23%	<1%	**9%**
Total	**44021**	**82995**	**46842**	**38513**	**50877**	**39427**	**12388**	**315064**
Strasse	**90%**	**94%**	**93%**	**91%**	**92%**	**94%**	**87%**	**92%**
Schiene	**10%**	**6%**	**7%**	**9%**	**8%**	**6%**	**13%**	**8%**

Anteil Strasse >50% Anteil Schiene >50%

Tabelle 6: Modalsplit (Strasse vs. Schiene) in und zwischen den Grossregionen in 1000 t im Jahr 2014
(Quellen: SBB Infrastruktur (2015): Schienengüterverkehr der Schweiz 2014, BFS (2016): Gütertransporterhebung 2014)

HSG Logistikmarktstudie supplied by CFF Infrastructures in 2021

Domestic Processed Output (DPO)

- Emissions to air
- Waste
- Emissions to water
- Dissipative use of products
- Dissipative losses

DPO – Emissions to air

Activity data

- Cantonal statistics office (energy consumption, industries present on the territory, number of cars and fuel consumption)
- Cantonal department of energy

GHG and other pollutant gas emissions factors

- National Inventory Report (FOEN)
- Informative Inventory Report (FOEN)

Livestock emissions factor

- IPCC Report 2006 (Dong et al.)

Emissions to air of HFCs, PFCs, SF6, Heavy Metals, and POPs, were downscaled from the Swiss EW-MFA based on Per Capita numbers

DPO - Waste

- Cantonal statistical office
- Cantonal department of geology and soils usually in charge of waste management
  - What is interesting for you? Type of waste and disposal method

Source: Pixabay.com

DPO – Emissions to water

- Based on the waste water treatment plant reports
  - Know which plants you have in your region
  - Analysis of water released into the environment

- MF4.01 Dissipative use of organic fertiliser, 5% of it considered in MF 3.04 Other substances and organic materials

Paramètres	Unité	Concentrations			Rendements en %	
		Entrée	Sortie			
			Traitée	Traitée + Déversé	Traitée	Traitée + Déversé
Matières en suspension	mg/l		10			
DBO_5	mg O_2/l	182	8	12	95.8	93.3
DCO		395	35	46	91.5	88.4
Carbone organique total	mg C/l	101				
Carbone organique dissous			10		90.0	
Phosphore ortho	mg P/l		0.11			
Phosphore total		5.09	0.35	0.51	93.1	90.0
Ammonium	mg N/l	24.30	14.79			
Nitrate + nitrite			9.33			

Bilan de l'épuration Vaudois en 2019
Annexe E2 - Capacités et résultats 2019 de la "STEP vaudoise"

Binder, Felix Martin del Campo

DPO – Dissipative use of products and dissipative losses

- Organic fertiliser: $Number\ of\ livestock\ (FSO) \times manure\ production\ factor$ (EW – MFA Handbook 2018)
- Mineral fertiliser, Pesticide, Seeds: $Swiss\ DPO \times \frac{Cantonal\ UAA}{Swiss\ UAA}$
- Sewage sludge: illegal environmental dumping since 2008
- Compost, Solvents: $Swiss\ DPO \times \frac{Cantonal\ population}{Swiss\ population}$
- Salt, Dissipative losses: $Swiss\ DPO \times \frac{Cantonal\ Impermeable\ surface}{Swiss\ Impermeable\ surface}$

EW-MFA (Canton) results

Canton Vaud EW-MFA indicators in thousands of tons											
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DE	5255	5217	5239	5508	5260	5075	5285	4972	4986	5061	4892
IMP	25069	27067	22607	23158	26309	23629	26678	29676	27794	30429	32684
EXP	25917	26674	21107	23280	26530	23135	27436	28239	25459	28162	29665
DPO	4413	4406	4518	4223	4306	4448	4130	4139	4200	4105	3985
DMI	30323	32283	27846	28666	31569	28704	31963	34648	32780	35490	37575
DMC	4406	5609	6739	5386	5039	5568	4527	6409	7322	7328	7910
PTB	655	2192	2911	1138	1360	1271	1037	2616	3524	3658	4383
Canton Geneva EW-MFA indicators in thousands of tons											
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DE	1123	1124	1120	1129	1123	1112	1126	1111	1162	1252	1239
IMP	12046	11486	10801	11377	12738	11403	10803	11264	9945	10746	9314
EXP	11027	10127	10180	10699	12464	11125	10988	11355	10420	10048	9127
DPO	2075	2023	2084	1842	1886	1886	1636	1704	1684	1696	1612
DMI	13169	12609	11921	12505	13861	12515	11928	12374	11107	11999	10553
DMC	2142	2482	1741	1807	1397	1390	940	1019	687	1950	1426
PTB	1019	1358	621	678	274	278	-186	-91	-475	698	187
Swiss EW-MFA indicators in thousands of tons (FSO data)											
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DE	60708	61623	62899	64979	62203	63405	65571	60150	60922	60528	59733
IMP	52168	49423	51957	52876	52234	54072	53383	53506	53914	53953	52339
EXP	17256	15275	16297	17163	16462	16477	17044	16770	16804	17974	17780
DPO	59565	58294	60507	56536	58527	59947	55385	55997	57121	56555	55218
DMI	112875	111047	114855	117855	114436	117477	118954	113656	114837	114482	112072
DMC	95619	95771	98558	100692	97974	101000	101910	96886	98033	96508	94292
PTB	34912	34148	35659	35713	35772	37595	36339	36736	37111	35980	34559

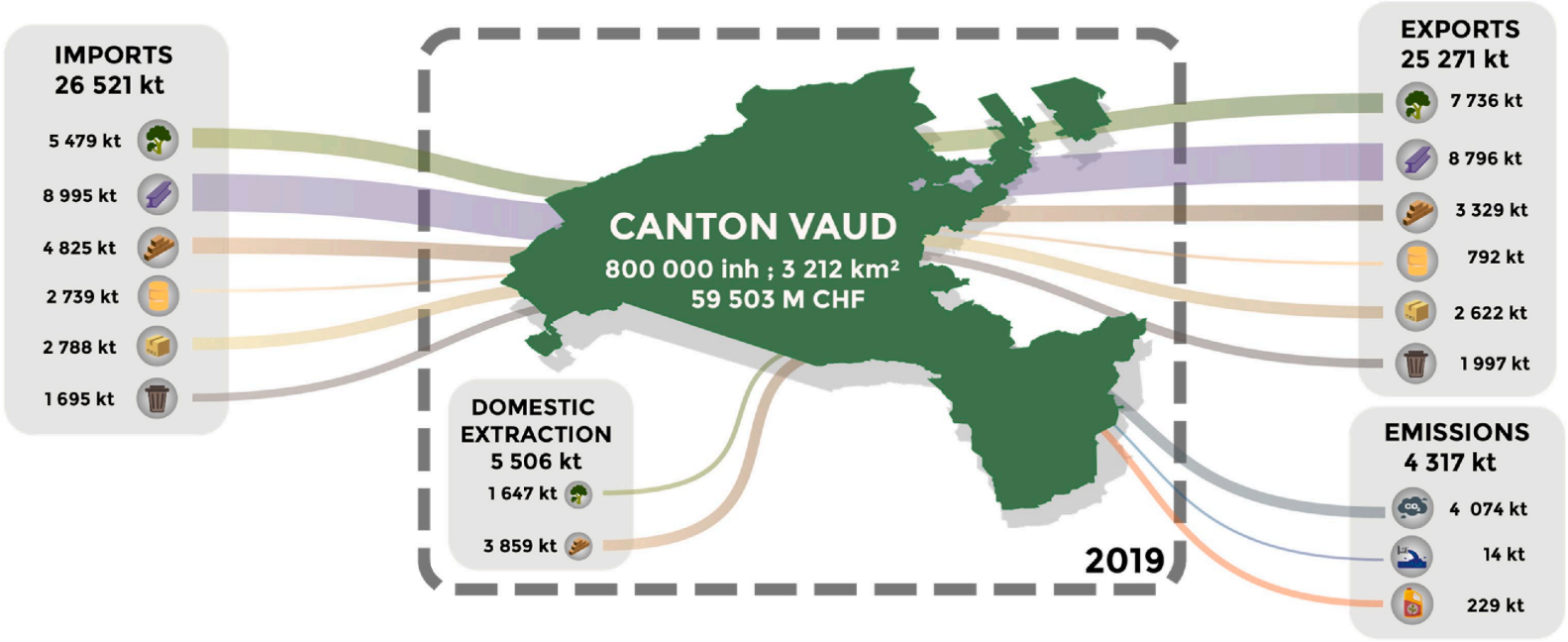
- Other indicators:

Indicator	*Method*
DMI	DE + IMP
DMC	DMI – EXP
PTB	IMP – EXP

Canton Vaud EW-MFA indicators in tons per capita											
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DE	7.8	7.6	7.5	7.7	7.2	6.9	7.1	6.5	6.4	6.4	6.2
IMP	37.3	39.3	32.2	32.5	36.2	32.2	35.6	39.0	35.9	38.8	41.2
EXP	38.6	38.8	30.1	32.6	36.5	31.5	36.6	37.1	32.9	35.9	37.4
DPO	6.6	6.4	6.4	5.9	5.9	6.1	5.5	5.4	5.4	5.2	5.0
DMI	45.1	46.9	39.7	40.2	43.5	39.1	42.7	45.5	42.4	45.2	47.4
DMC	6.6	8.2	9.6	7.6	6.9	7.6	6.0	8.4	9.5	9.4	10.0
PTB	13.5	14.6	8.9	11.0	9.3	12.0	14.4	13.2	12.1	17.8	14.8
Canton Geneva EW-MFA indicators in tons per capita											
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DE	2.6	2.5	2.5	2.5	2.4	2.4	2.4	2.3	2.4	2.6	2.5
IMP	27.5	25.7	23.8	24.9	27.7	24.6	23.0	23.6	20.5	22.0	18.8
EXP	25.2	27.7	22.5	23.4	27.1	24.0	23.4	23.8	21.5	20.5	18.4
DPO	4.7	4.5	4.6	4.0	4.1	4.1	3.5	3.6	3.5	3.5	3.3
DMI	30.1	28.3	26.3	27.3	30.1	27.0	25.4	25.9	22.9	24.5	21.3
DMC	4.9	5.6	3.8	3.9	3.0	3.0	2.0	2.1	1.4	4.0	2.9
PTB	2.3	3.0	1.4	1.5	0.6	0.6	-0.4	-0.2	-1.0	1.4	0.4
Swiss EW-MFA indicators in tons per capita (FSO data)											
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DE	8.0	7.9	8.0	8.2	7.7	7.8	8.0	7.2	7.2	7.1	7.0
IMP	6.8	6.3	6.6	6.6	6.5	6.6	6.5	6.4	6.4	6.4	6.1
EXP	2.2	2.0	2.1	2.2	2.1	2.0	2.1	2.0	2.0	2.1	2.1
DPO	7.7	7.5	7.7	7.1	7.3	7.4	6.7	6.7	6.8	6.7	6.5
DMI	14.7	14.3	14.6	14.8	14.2	14.4	14.4	13.6	13.6	13.5	13.1
DMC	12.4	12.3	12.5	12.7	12.2	12.4	12.4	11.6	11.6	11.4	11.0
PTB	4.5	4.4	4.5	4.5	4.5	4.6	4.4	4.4	4.4	4.2	4.0

EW-MFA questionnaires in figshare

EW-MFA Canton Vaud in 2019



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• Laboratory on Human-Environment Relations in Urban Systems

Legend

- Biomass
- Metal ores
- Non-metallic minerals
- Fossil energy carriers
- Other products
- Waste for final treatment
- Emissions to air
- Emissions to water
- Dissipative use of products

Limits of this study

- Data accuracy and metric conversion
  - Limited data on import and export flows
    - Consequently DMI, DMC and PTB
- Need of improvement of environmental monitoring

Remarks

- Overview of resources needs / environmental pressure
- Dig further in different flows to…
  - Circularize flows
  - Implement local flows
  - Developing new policies
  - Implement mitigation strategies
- Improvement of environmental monitoring techniques and data availability

Thank you for your attention!