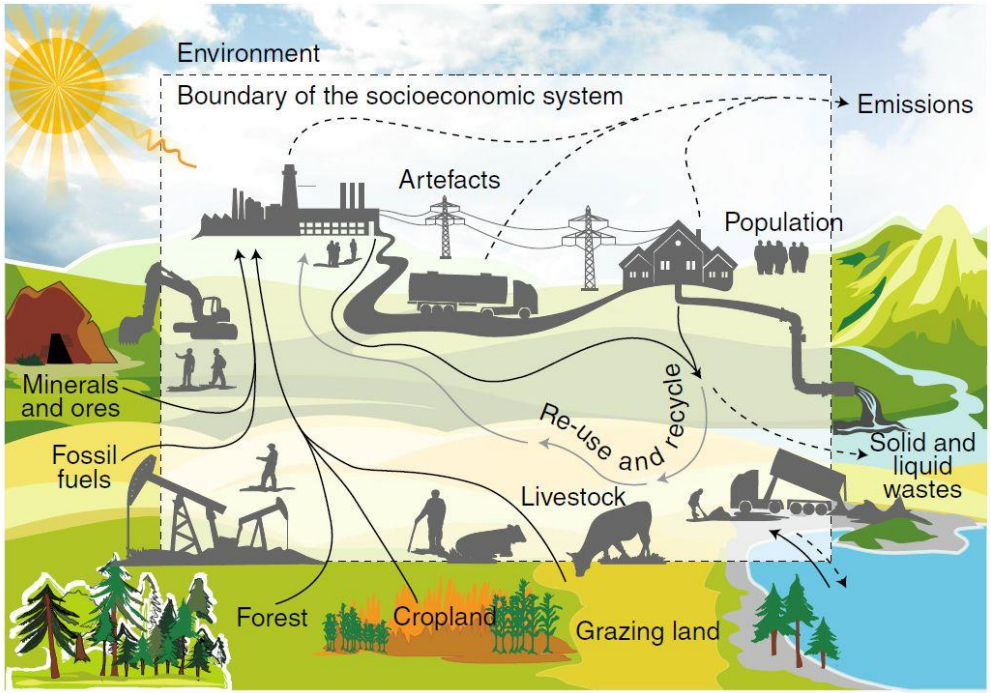
This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme(grant agreement No 741950).

Un Balance de Metabolismo Social
Universidad de Granada 2021

The global metabolic transition

Resource use and economic development during industrialization



Haberl *et al* 2019. *Nature Sustainability* 2, 173–184

Fridolin Krausmann

University of Natural Resources and Life Sciences Vienna
Institute of Social Ecology (SEC)

Overview

The agrarian-industrial metabolic transition: Empirical evidence

- Historic patterns: Japan 1878-2005: Growth and changes in the structure of material use.
- Global development of material stocks and flows 1900-2015.
- Global scenarios 2016-2050

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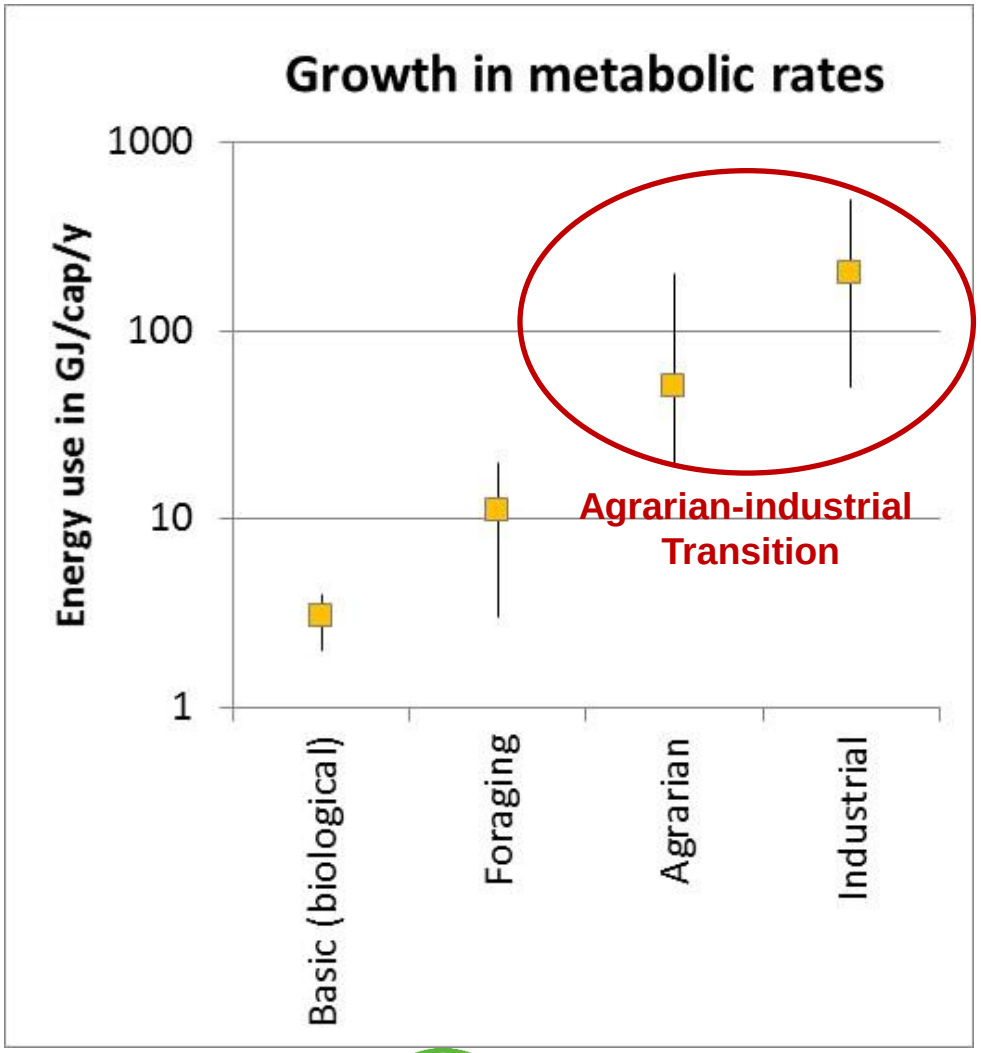
Human history - a history of increasing resource use

- We can distinguish major **metabolic regimes** with specific metabolic profiles: Distinct by **energy system** (energy source and conversion technology)
- **Metabolic rates (resource use per capita per year)** increase by one order of magnitude from one regime to another



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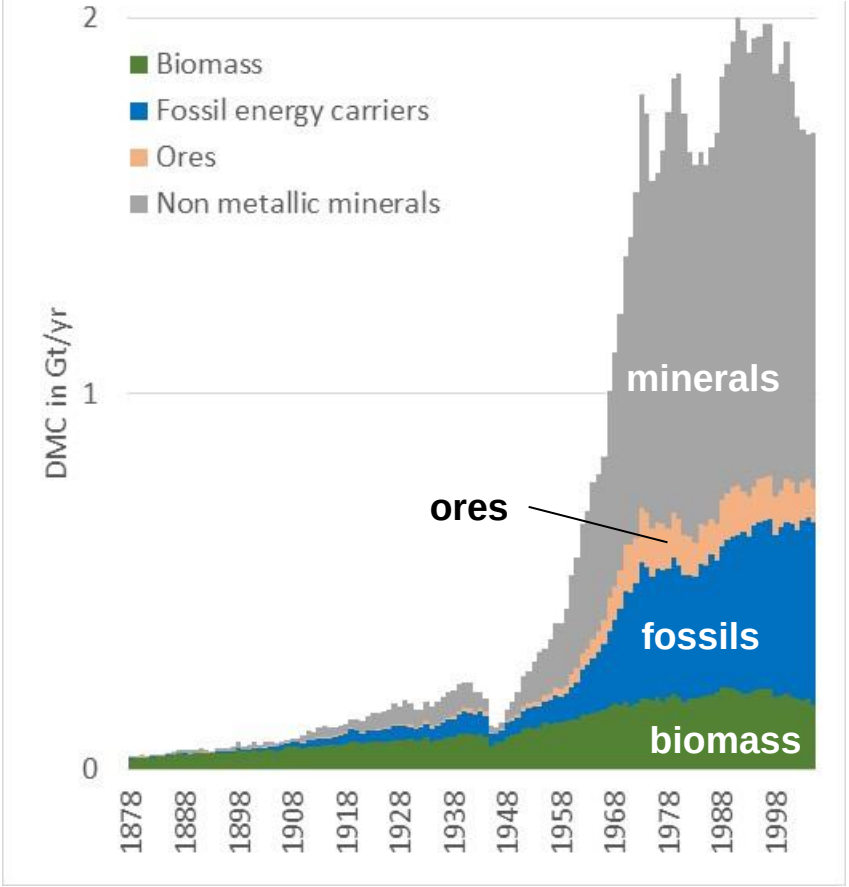
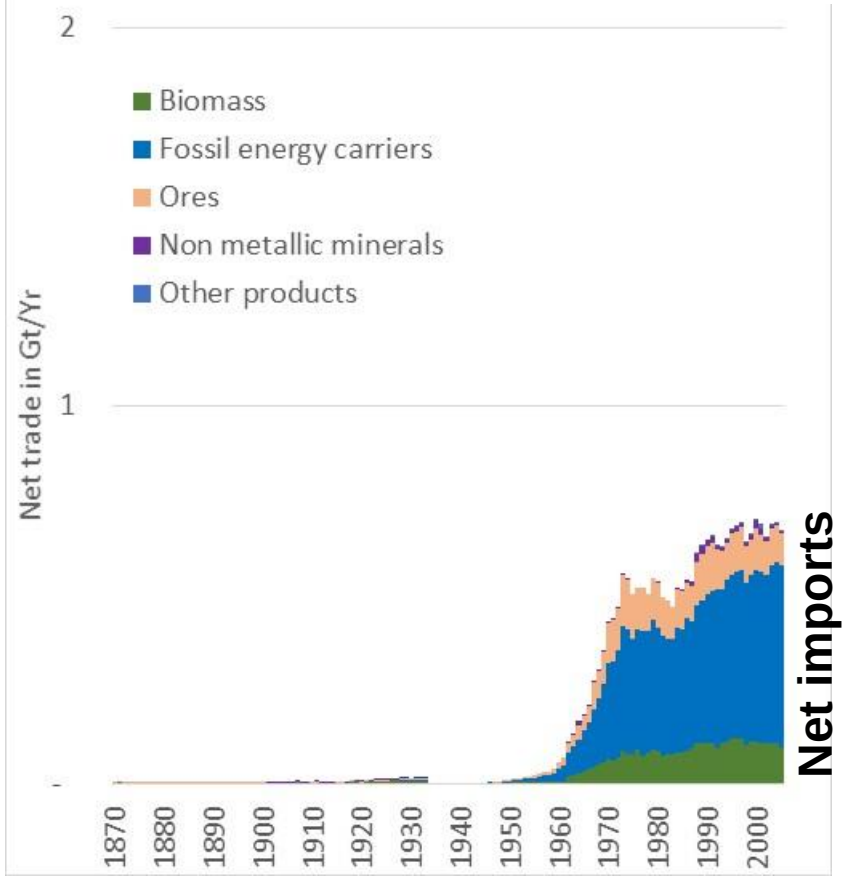
Longterm Perspective: Material Use in Industrial Economies: Japan 1878-2005

Material Consumption (DMC)



Physical Trade Balance (PTB)



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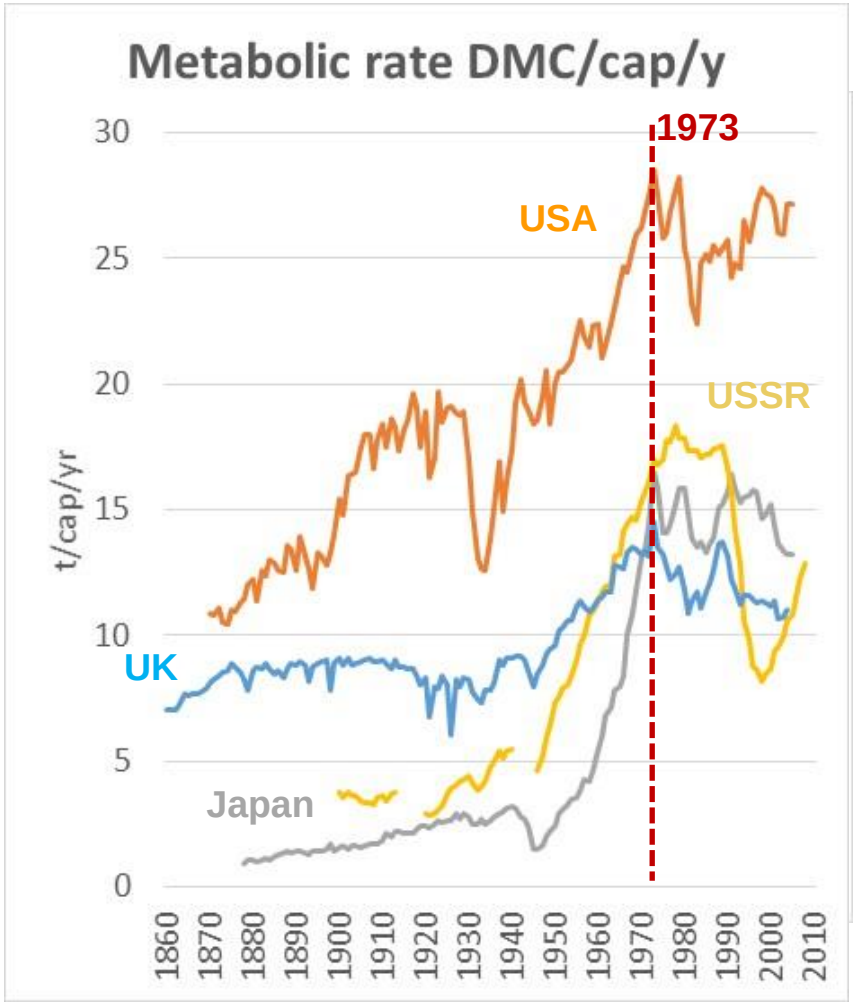
Emergence of the industrial metabolic profile



1. GROWTH

- Overall growth of DMC by up to two orders of magnitude.
- Mass production and consumerism accelerate physical growth post WWII: Per capita material use multiplies.
- 1970s syndrome: Growth slows down after oil price

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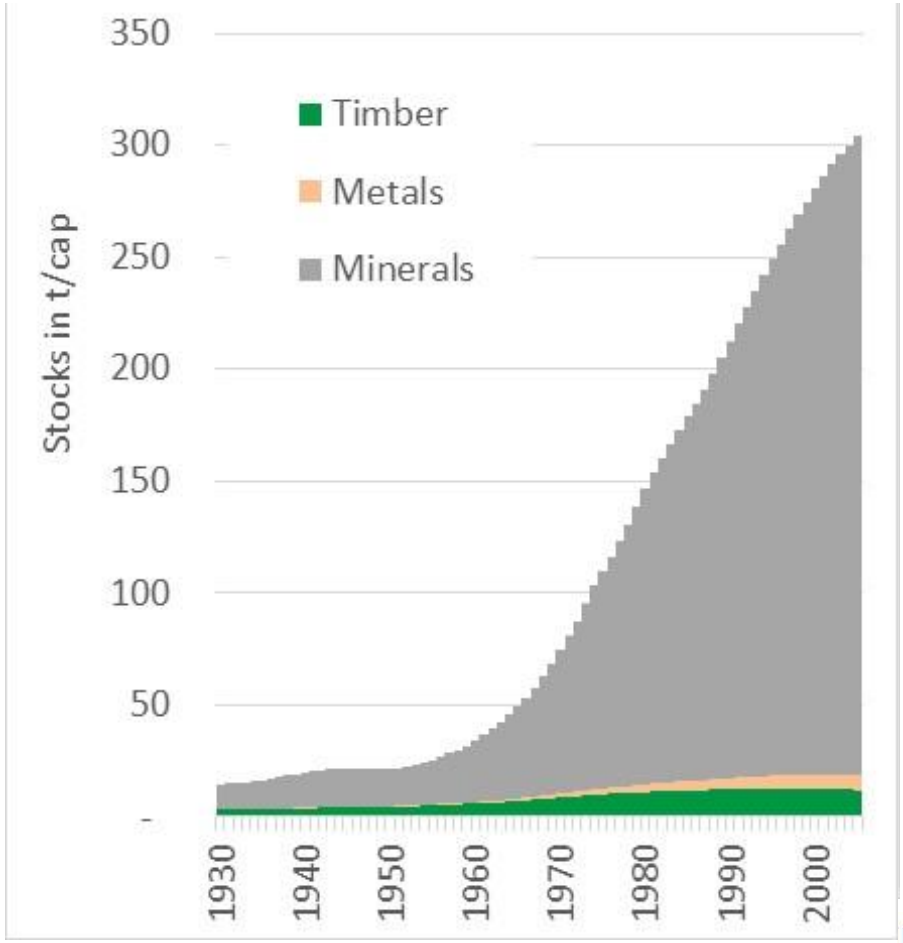
Emergence of the industrial metabolic profile

Materials accumulated in buildings, infrastructures & machinery



2. COMPOSITION

- Share of biomass declines from 90% to less than 30%.
- Fossil and mineral materials do not replace biomass but add on top of it.
- Share of materials used to build and maintain artefacts increases from 10% to 60%.
- Material-stocks (buildings, infrastructures, machinery) multiply from 10 to 300-500 t/cap.

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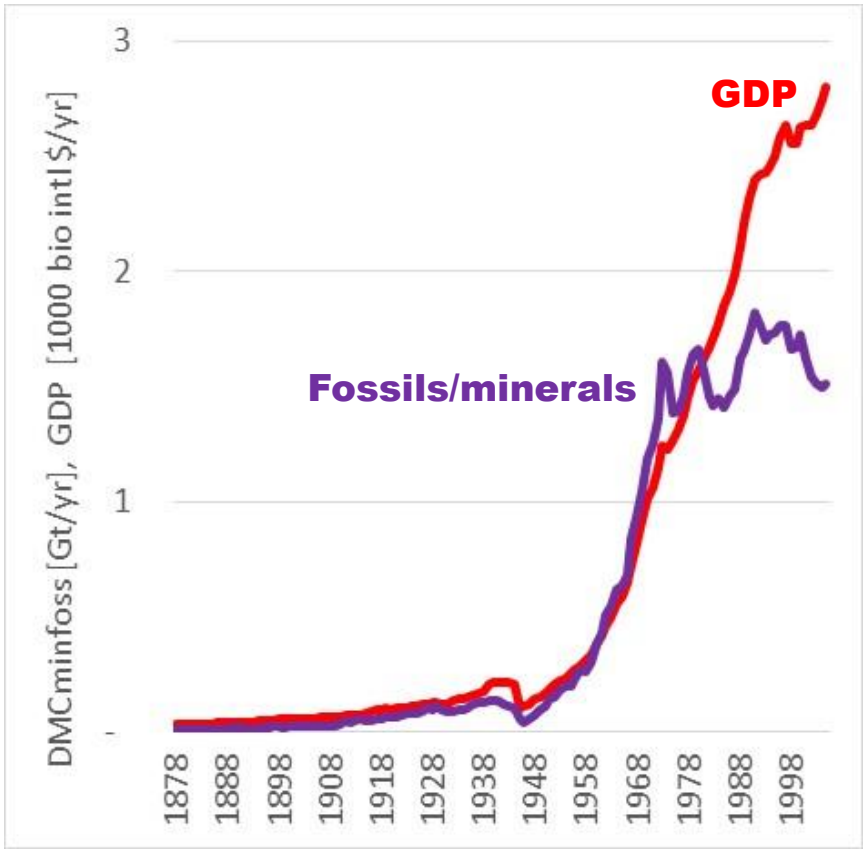
Material flows and economic development

Japan



3. DRIVERS

- Fossil/mineral materials are largely driven by GDP.
- With economic development: Relative decoupling of material use and GDP (partly due to externalization/trade)

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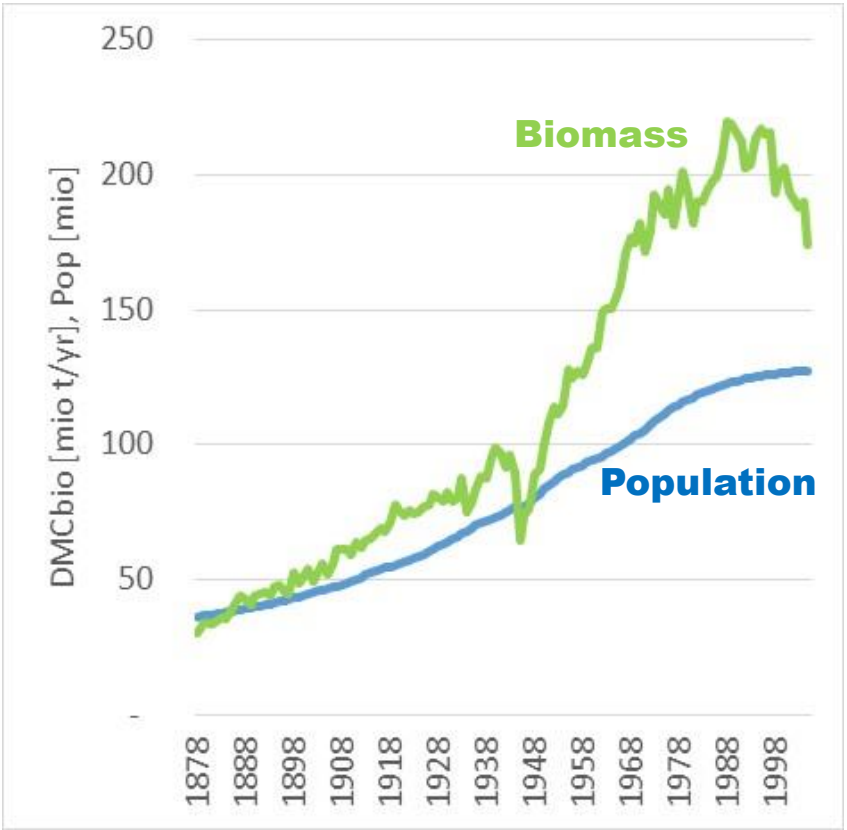
Material flows and economic development

Japan



3. DRIVERS

- Fossil/mineral materials are largely driven by GDP.
- With economic development: Relative decoupling of material use and GDP (partly due to externalization/trade)
- Biomass is initially driven by population, but increasingly accelerates over population
- Overall a shift from population towards affluence as driver of material use.

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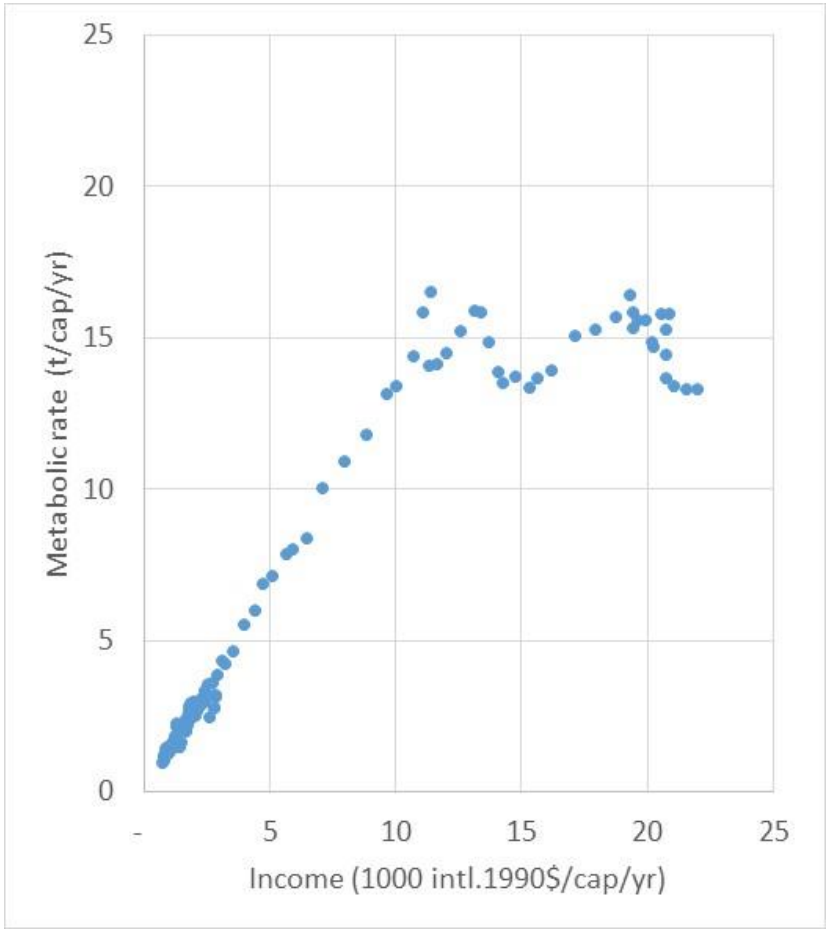
Material flows and economic development

Income vs. metabolic rate, Japan



4. DEMATERIALIZATION:

- Large improvements in material productivity (GDP / DMC) in particular after the 1970s in all industrial countries.
- Growth of material use with economic development.
- Stabilization of DMC at high income, but no continuous or significant decline in material

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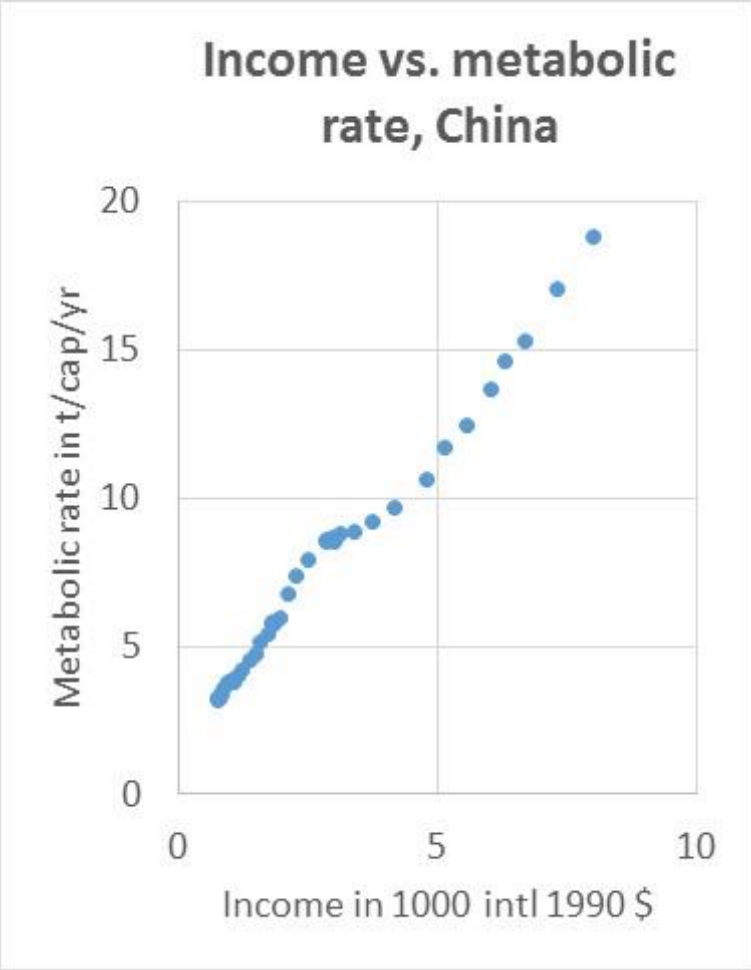
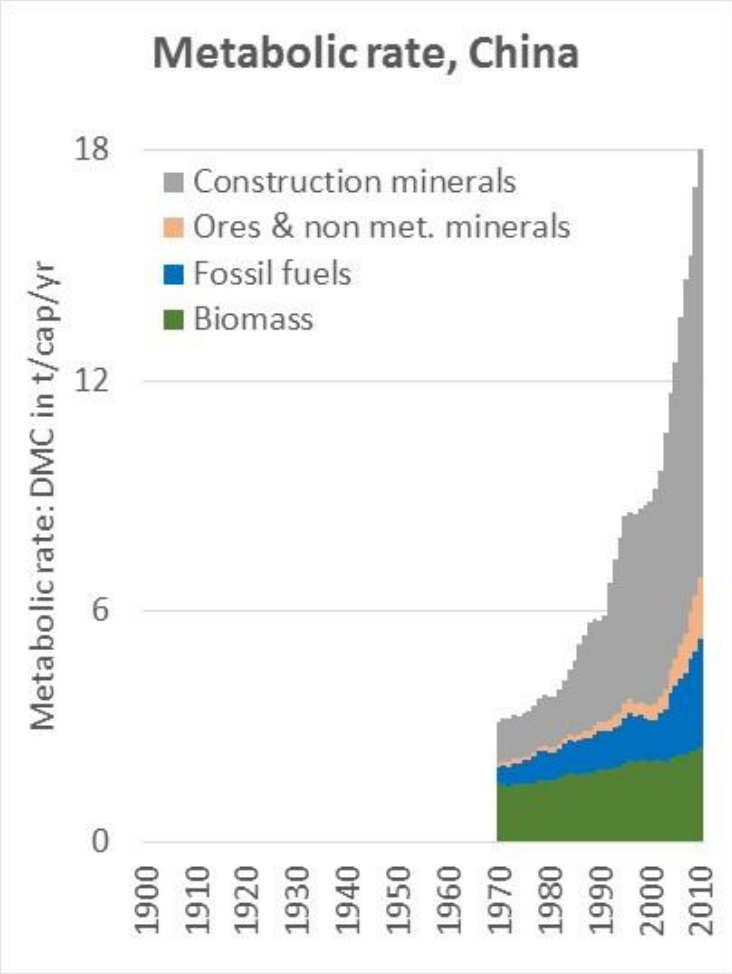
Do emerging economies follow the historic metabolic transition? China 1970-2010





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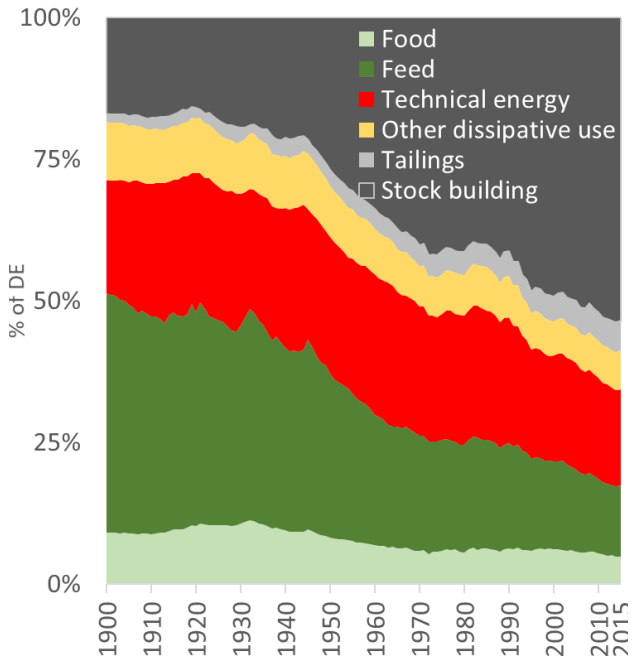
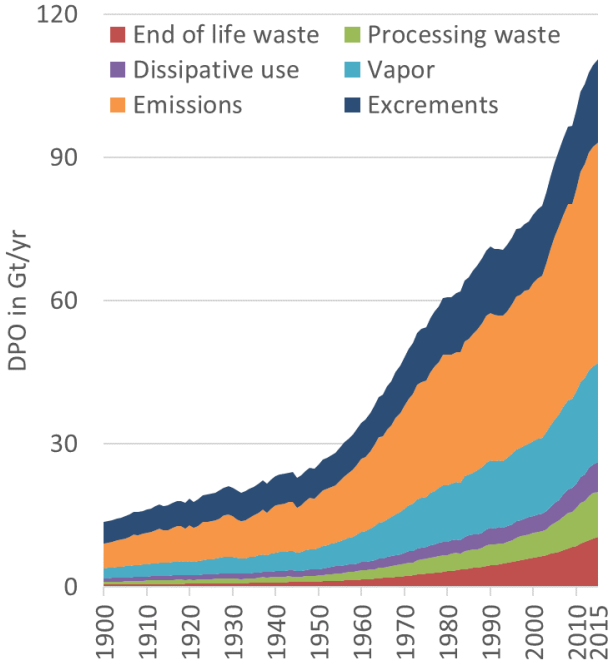
Global material flows 1900-2015

Material extraction

Material use



Waste and emissions



Source: Krausmann et al. 2018

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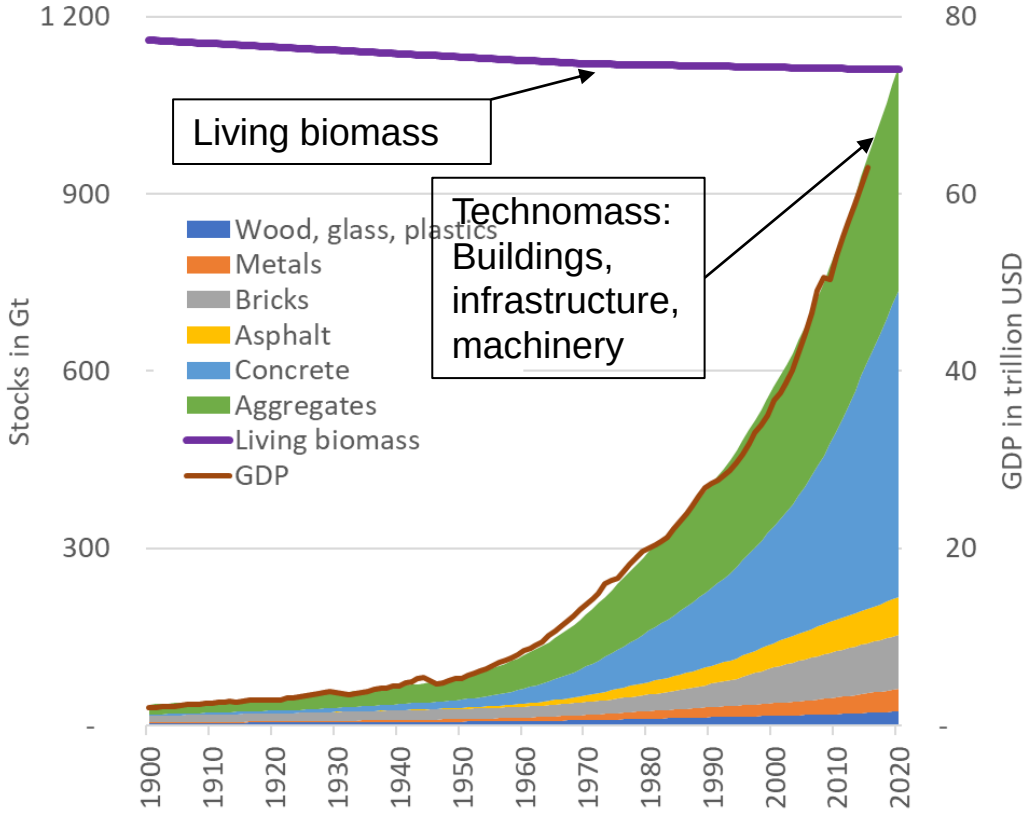
Materials accumulated in stocks of buildings, infrastructures and machinery

Global in-use stocks, living biomass and GDP



Stock-flow-service nexus:

- Global material stocks are growing with GDP
- The mass of technomass equals that of living biomass on the planet
- Building up, maintaining and using these stocks of buildings, infrastructures and machinery is a major driver for material and energy use.
- They shape social practices (including production and consumption), thereby creating path dependencies for future resource use

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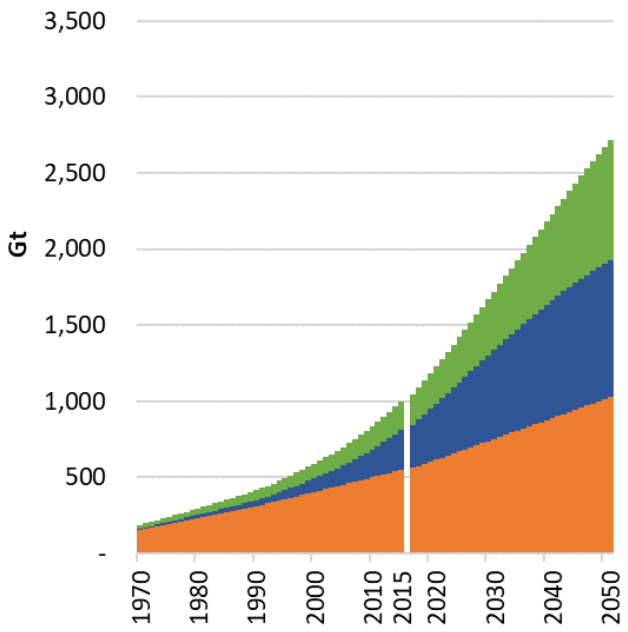
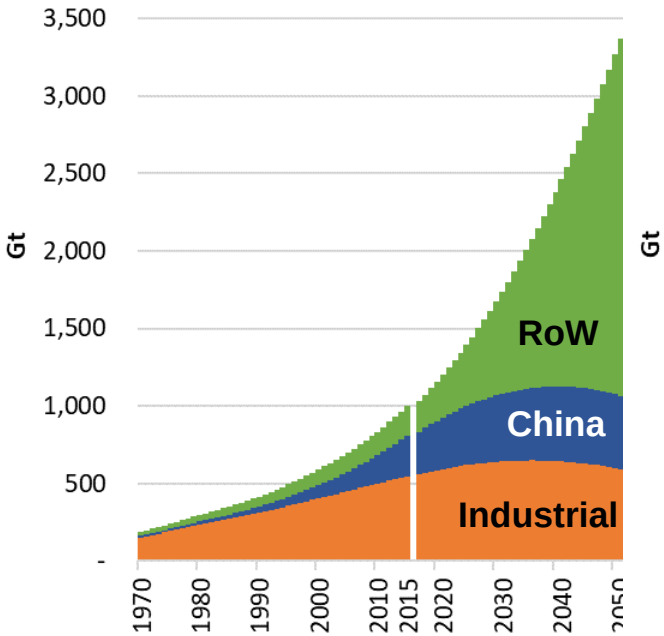
Scenario results: Development of global material stock 1970-2015-2050 in Gt

Business as usual$_{high}$



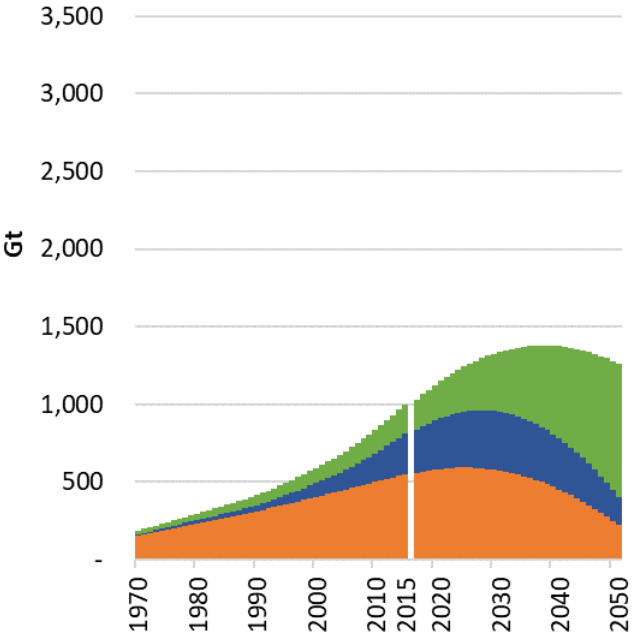
Stock growth based on GDP projections in the IPCC-SSP2 scenario

Global convergence$_{high}$



Global convergence of per capita stocks at the current level in industrialized countries

Global convergence$_{low}$



Global convergence of per capita stocks at the 1970 level in industrialized countries

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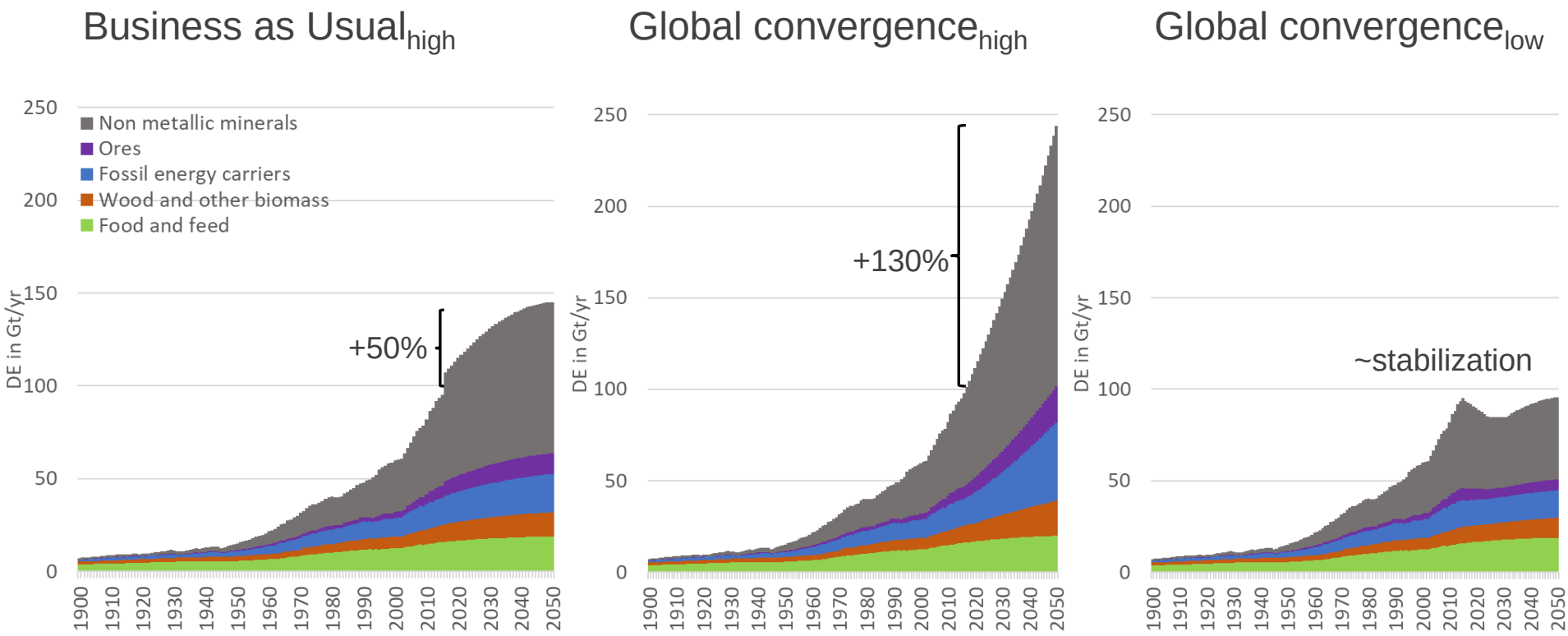
Scenario results: Development of global material extraction 1900-2015-2050 in Gt/yr



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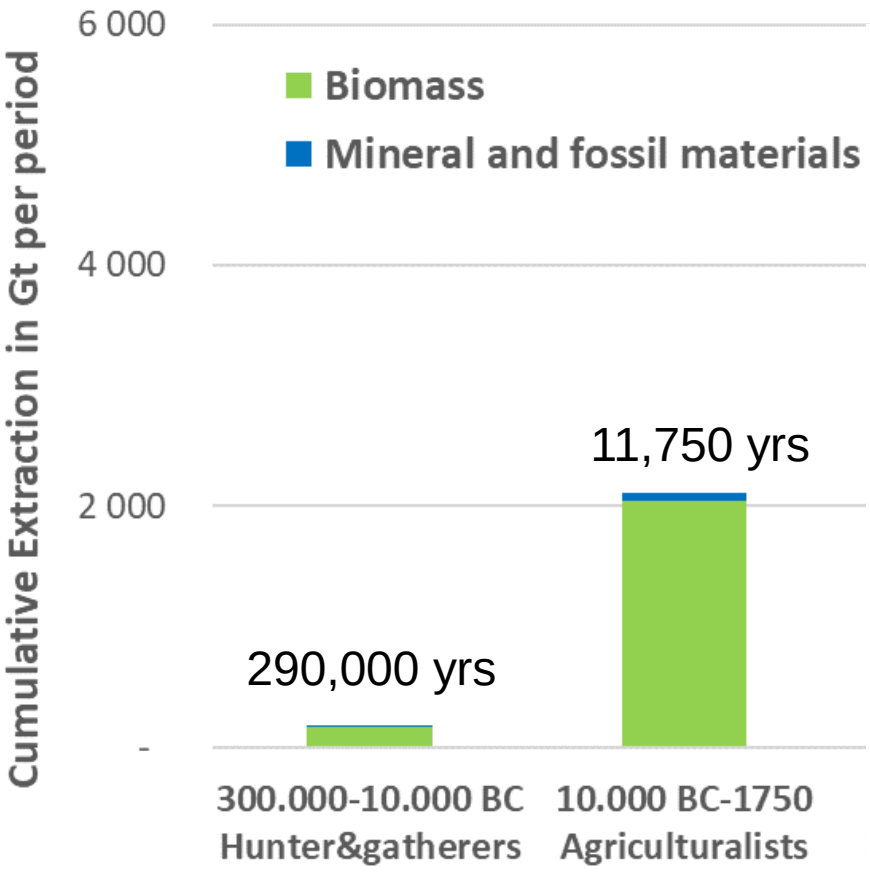
Cumulative material extraction across major socio-metabolic regimes



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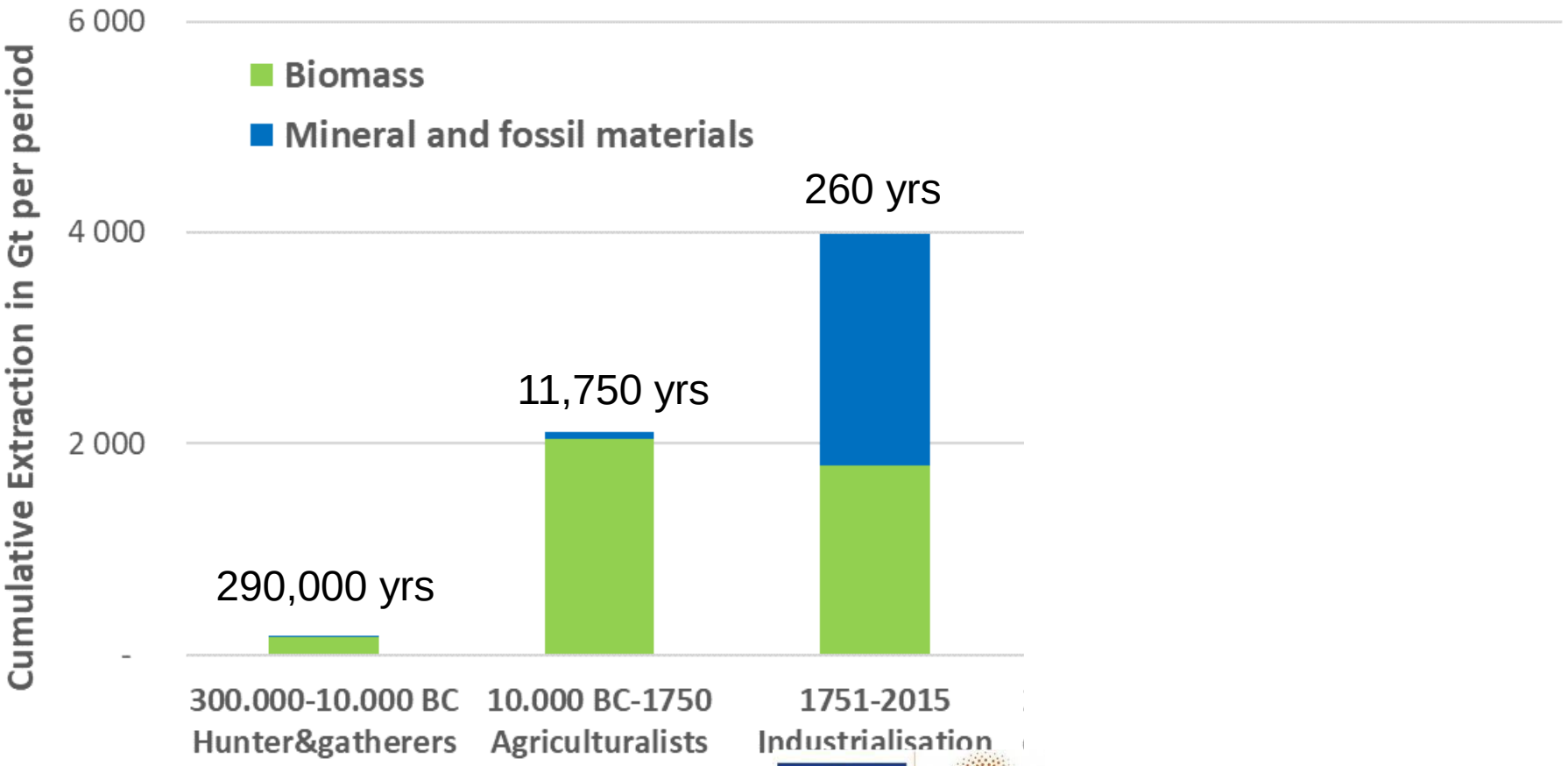
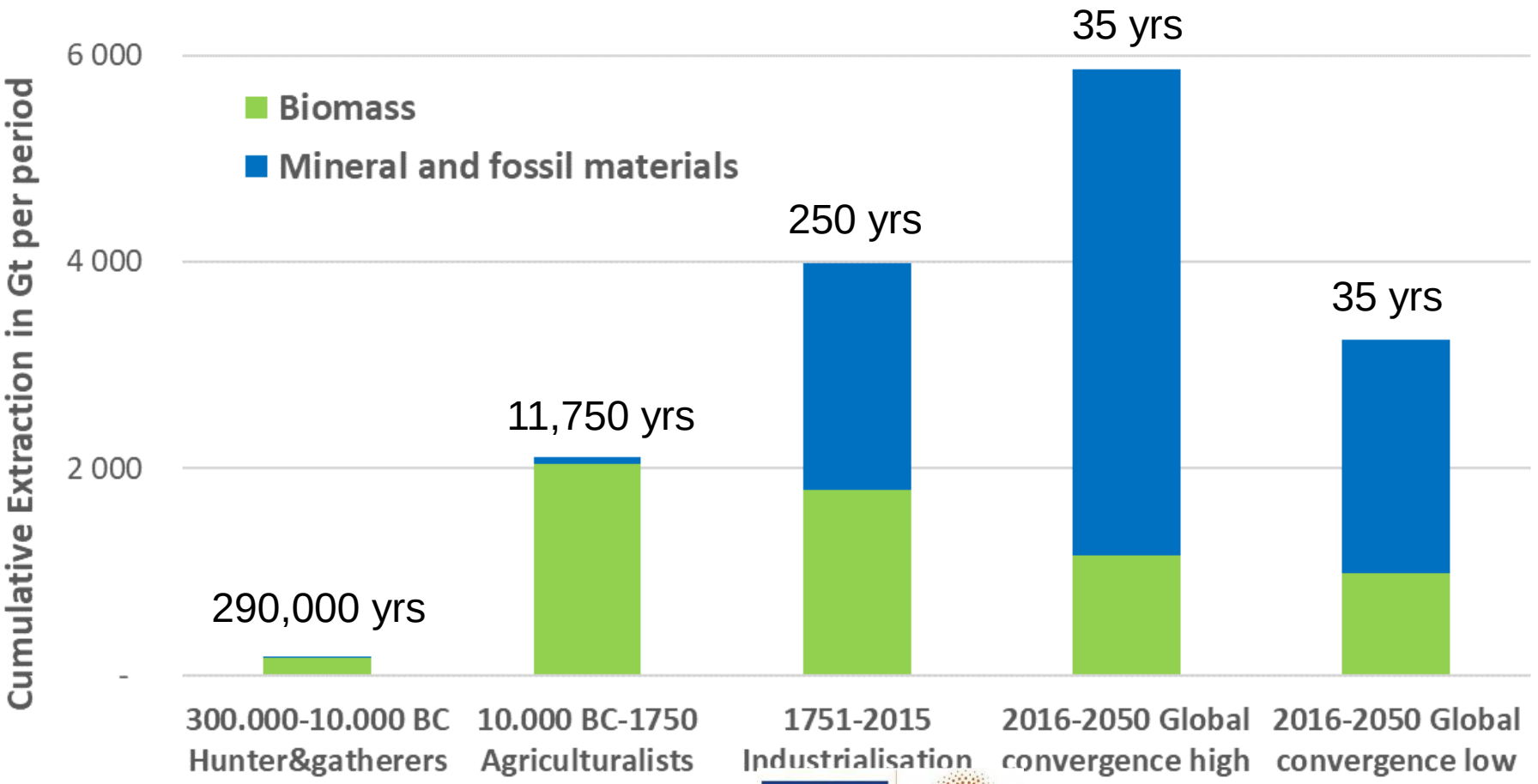


Cumulative material extraction across major socio-metabolic regimes



Concluding remarks

Strategies of a more efficient resource use are important, e.g.,

- Circular Economy: Keep materials longer in the system by increasing life time of stocks, reuse and re-manufacturing; end of life recycling, increasing energy efficiency of service provision from stocks, decarbonize the energy system.

But a radical downsizing of the global social metabolism to remain within planetary boundaries requires a

- transformation towards an economy and way of life based on a lower level of material stocks. How much material structures and corresponding services are required for a good life and well being? -> see e.g., debate about decent living standards, sustainable de-growth...

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Thank you!

Sources:

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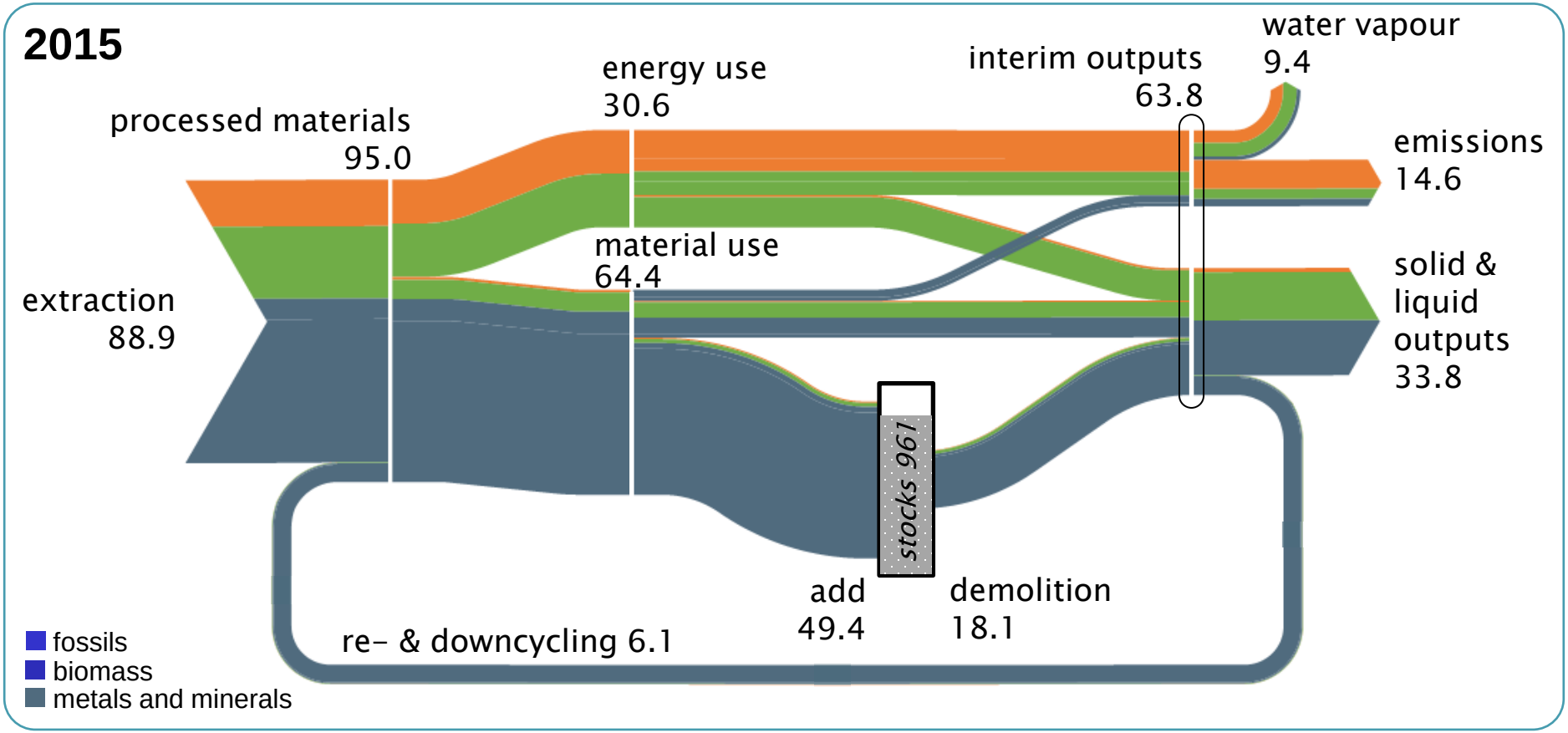
Global material flows in 2015:
The circularity rate is still very low: 6% at the input and 10% at the output side



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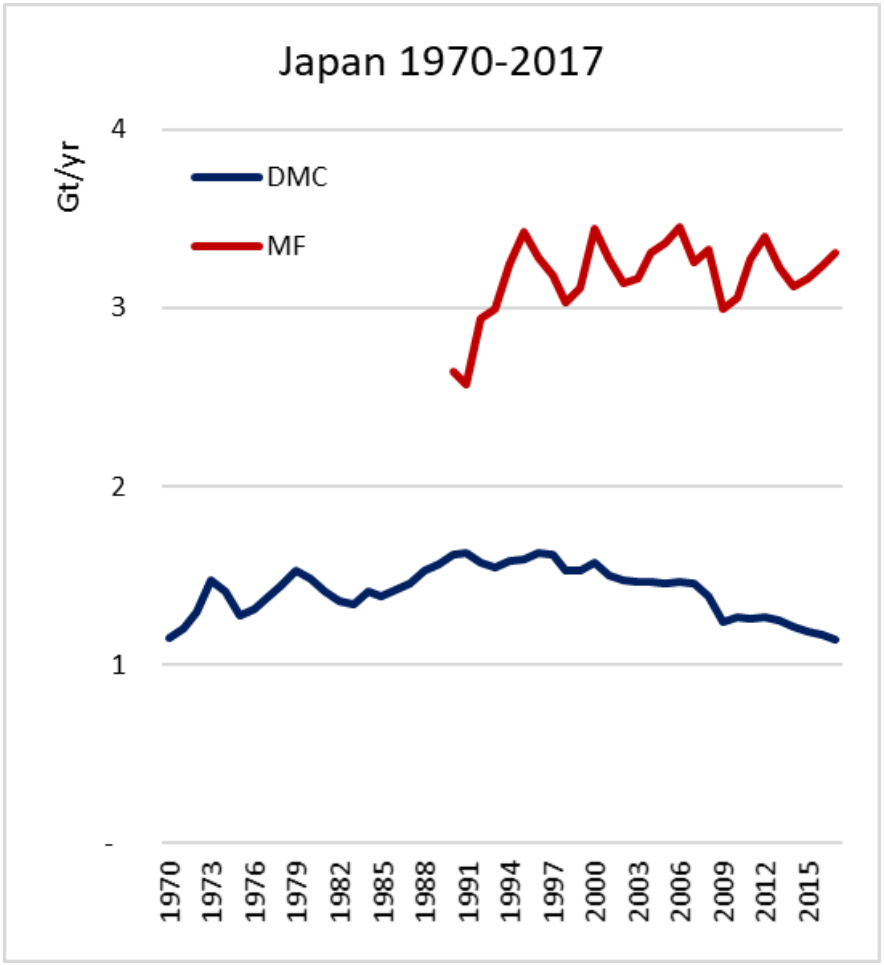
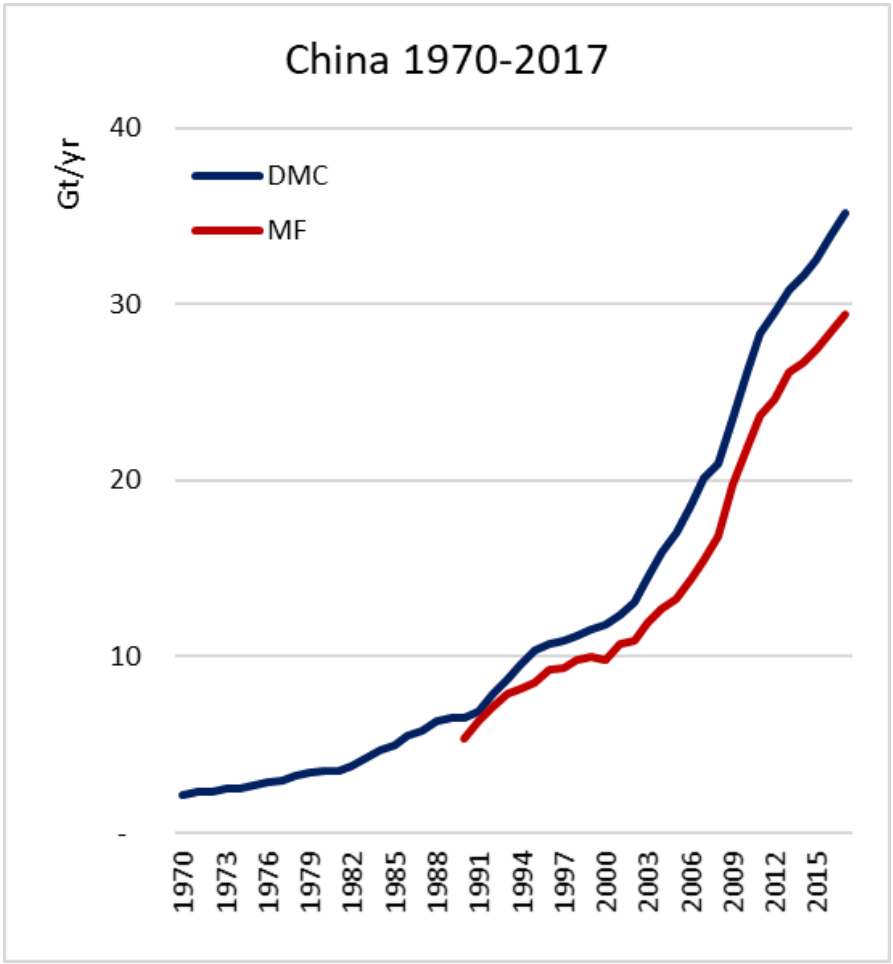
Material consumption (DMC) vs. Material Footprint (MF)





Source: IRP-UNEP MateriL Flow Database 2021

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