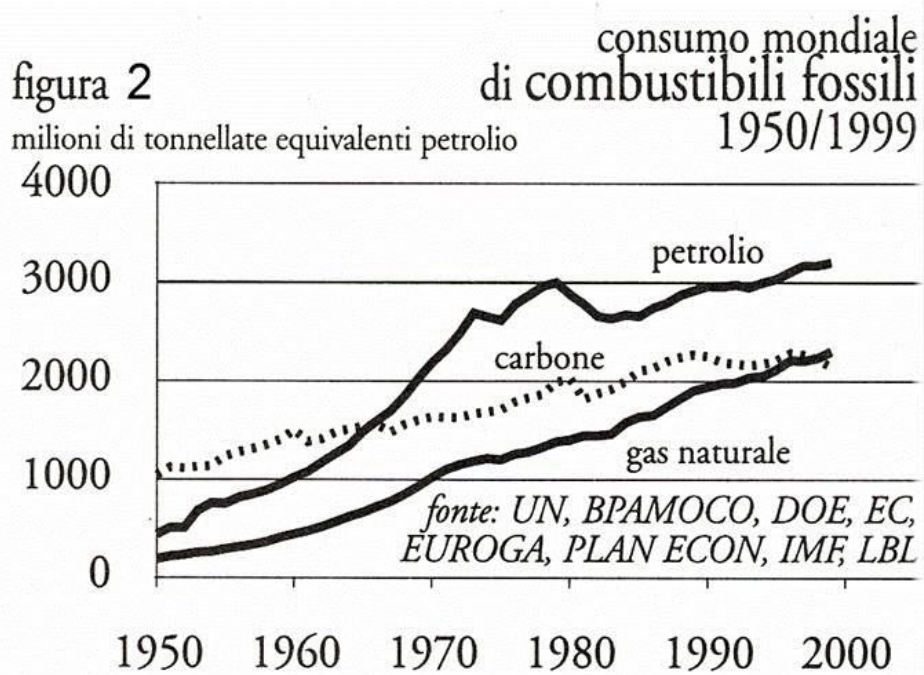


... Materia

Nicholas Georgescu Roegen (1906-1994)

"Matter matters too"

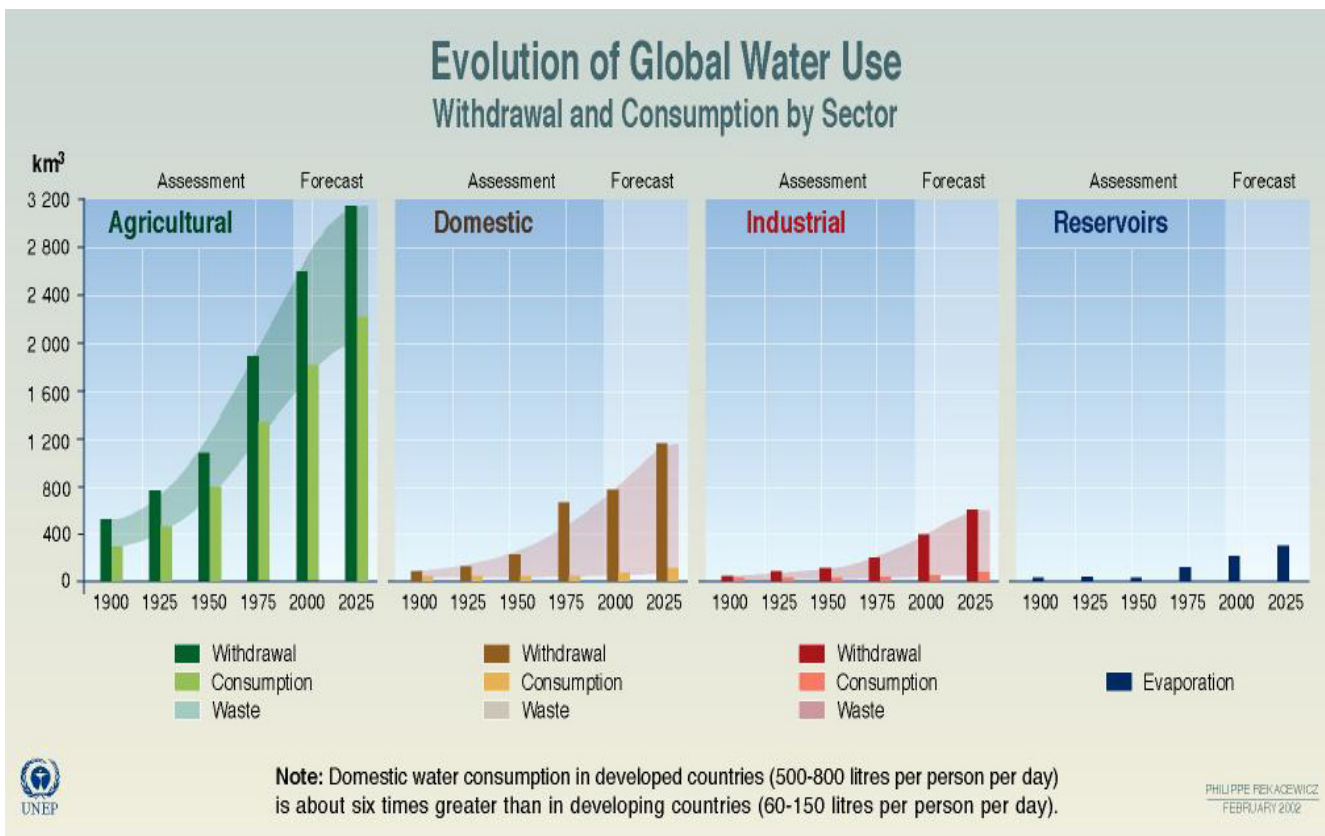


Tratto da Seth Dunn "Mutano i consumi dei combustibili fossili"
in Lester R. Brown ed al., "Vital signs 2000"; Edizioni Ambiente 2000

Crescita della produzione mondiale di materiali, 1960-95

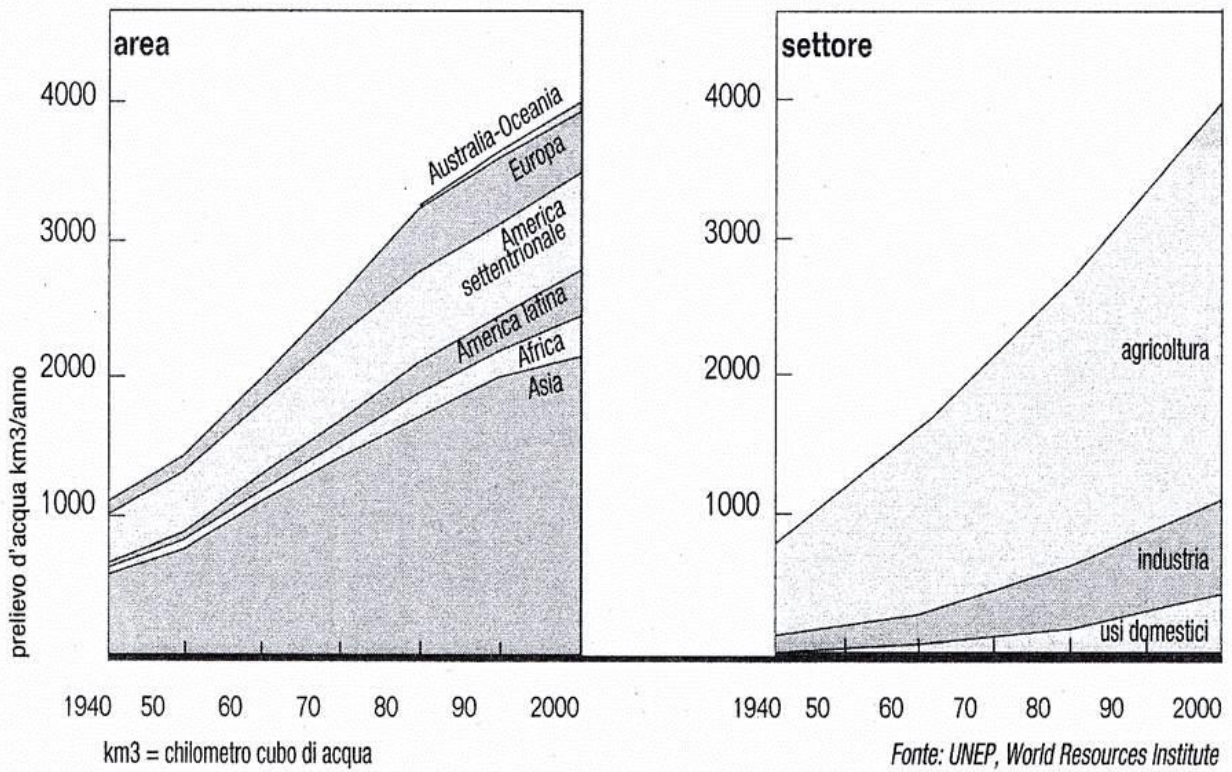
materiali ¹	produzione 1995 ¹ (milioni di tonnellate)	aumento rispetto ai primi anni Sessanta ² (fattore di aumento)
minerali ³	7.641	2,5 volte
metalli	1.196	2,1 volte
legno ³	724	2,3 volte
mat. sintetici ⁴	252	5,6 volte
totale materiali	9.813	2,4 volte

1. Solo produzione commercializzata (non indica flussi nascosti).
2. I dati sui minerali e totale materiali sono riferiti nel confronto al 1963; i dati sul legno al 1961.
3. Escluso l'uso combustibile.
4. Basati su combustibili fossili.



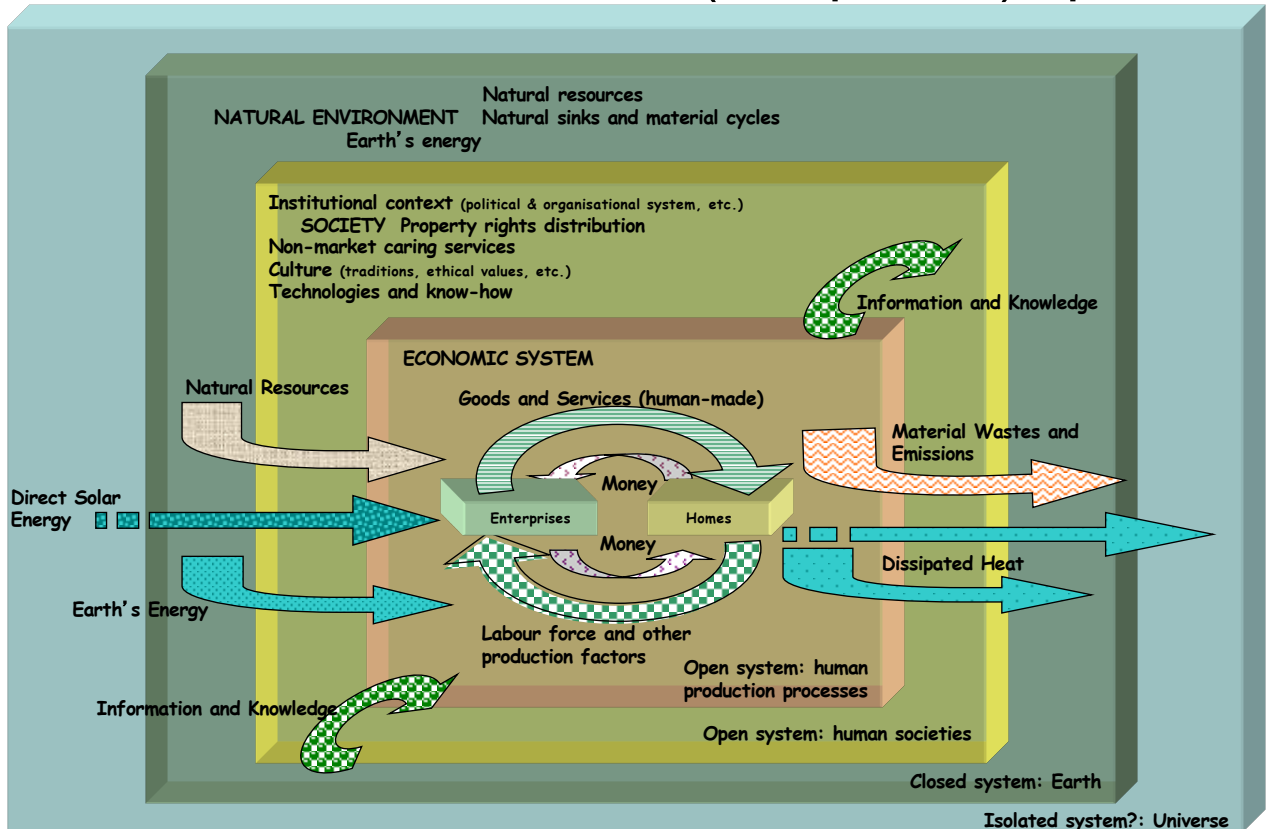
Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.

**Uso dell'acqua a livello mondiale
nelle diverse aree
e nei diversi settori, 1940-2000**



Material Flow Accounting and Analysis

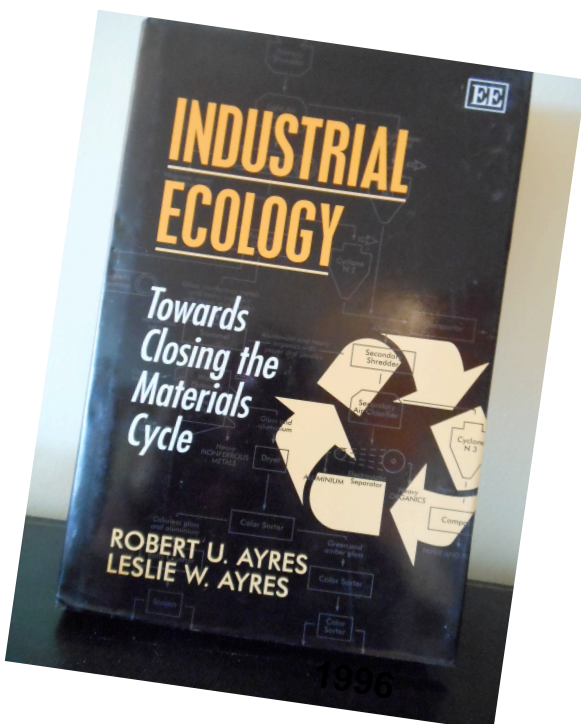
L' economia: un sistema (complesso) aperto



JMAlier: The environmentalism of the poor

1969

idea of material accounting
AYRES, Robert U.
KNEESE, Allen V.
Production, consumption, and externalities. *The American Economic Review*, 1969, 59.3: 282-297.



In the emerging discipline of industrial ecology, researchers view modern economies, metaphorically, as living organisms.

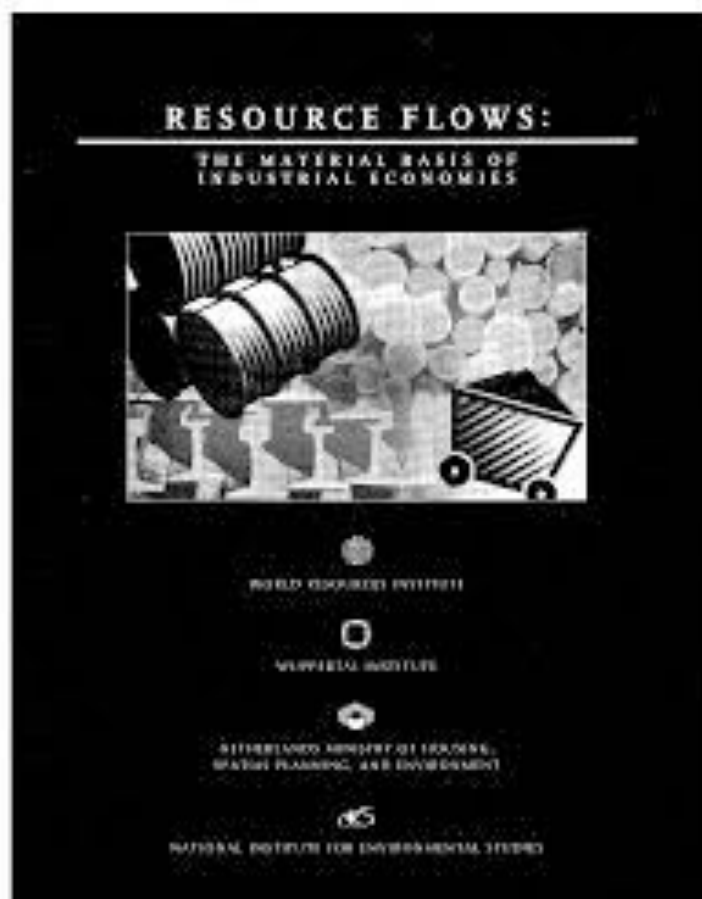
Industrial economies “ingest” raw materials, which are “metabolized” to produce goods and services, and they “excrete” wastes in the form of discarded materials and pollution.

WRI 2000, p 1

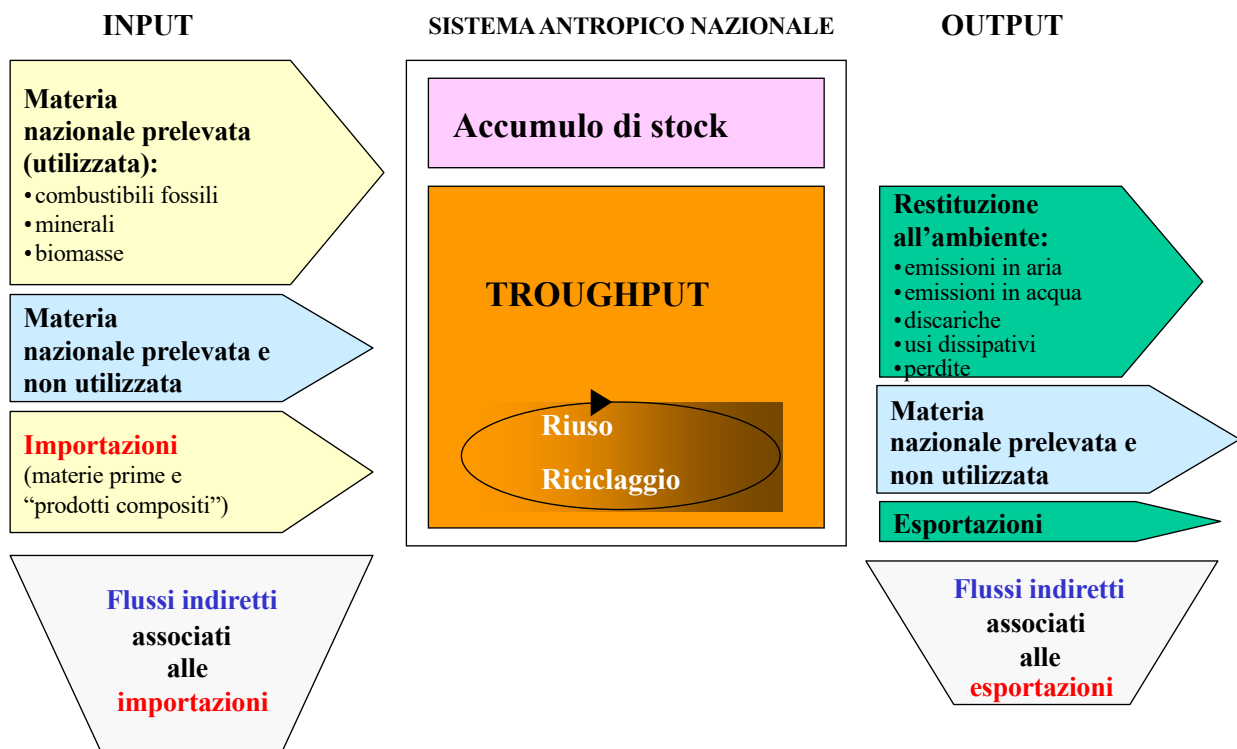
RESOURCE FLOWS:
THE MATERIAL BASIS
OF INDUSTRIAL
ECONOMIES

ADRIANSEE et AL.

1997 World Resource
Institute



Bilanciamento di input e output



Aldo Femia

Istat, Direzione Centrale della Contabilità Nazionale

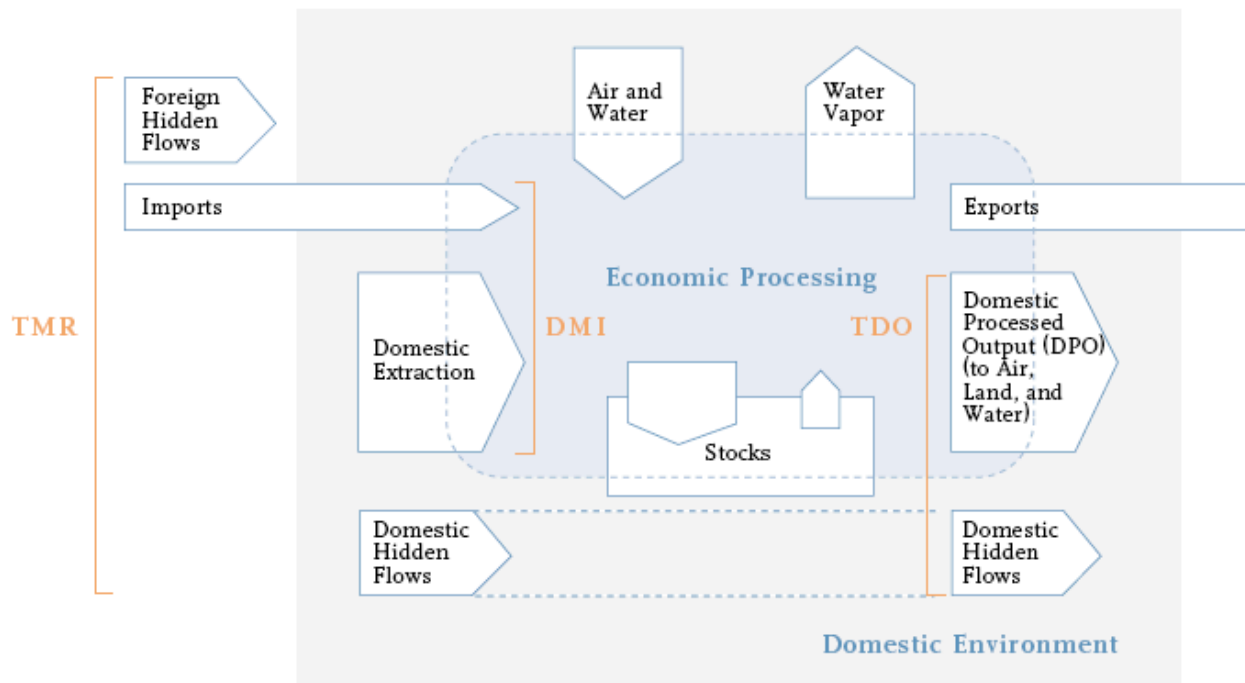
Bilancio materiale dell'economia italiana anno 1997

Importazioni	289	Esportazioni	111
di cui:			
Materie prime e semilav.	276	Accumulo di stock	467
Prodotti finiti	13	di cui:	
Estrazione interna		Infrastrutture di trasporto ed edifici	290
di materiali utilizzati	616	Macchinari	13
di cui:		Altri beni durevoli	8
Combustibili fossili	20	Variazione delle scorte	157
Minerali	409	Animali vivi	-1
Biomasse	187	Emissioni	480
Input ausiliari	677	di cui:	
di cui:		Anidride carbonica	457
Aria per combustione, respirazione, decomposizione	574	Altre emissioni atmosferiche	12
Acqua per abbeveramento	103	Emissioni in acqua	11
Discrepanza statistica	7	Rifiuti depositi in discarica	56
		Utilizzi dissipativi di prodotti e perdite dissipative	144
		Altri output gassosi	331
		di cui:	
		Vapore acqueo da combustione	250
		Anidride carbonica e vapore acqueo da respirazione	81

Aldo Femia

Istat, Direzione Centrale della Contabilità Nazionale

FIGURE 1 | THE MATERIAL CYCLE



TMR (Total Material Requirement)=DMI+Domestic Hidden Flows+Foreign Hidden Flows

DMI (Direct Material Input)=Domestic Extraction+Imports

NAS (Net Additions to Stock)=DMI-DPO-Exports

TDO (Total Domestic Output)=DPO+Domestic Hidden Flows

DPO (Domestic Processed Output)=DMI-Net Additions to Stock

SOME USEFUL DEFINITIONS

Direct Material Input (DMI):

Flow of natural resource commodities that enter the industrial economy for further processing.

Included in this category are

grains used by a food processor, petroleum sent to a refinery, metals used by a manufacturer, and logs taken to a mill

Total Material Requirement (TMR):

This is the sum of the total material input and the **hidden or indirect material flows**, including deliberate landscape alterations.

It is the total material requirement for a national economy, including all, domestic and imported natural resources.

The TMR gives the best overall estimate for the potential environmental impact associated with natural resource extraction and use.

SOME USEFUL DEFINITIONS

Hidden material flow: This is the portion of the total material requirement that never enters the economy.

It is the natural resource use that occurs when providing those commodities that do enter the economy.

The hidden material flow comprises two components, **ancillary flows** and **excavated or disturbed flows**.

1. Ancillary material flow (auxiliary)

This is the material that must be removed from the natural environment, along with the desired material to obtain the desired material.

Some examples are the portion of an ore that is processed and discarded to concentrate the ore and the plant and forest biomass that is removed from the land along with the logs and grain,

SOME USEFUL DEFINITIONS

2. Excavated and/or disturbed material flow.

This is material moved or disturbed to obtain a natural resource, or to create and maintain infrastructure.

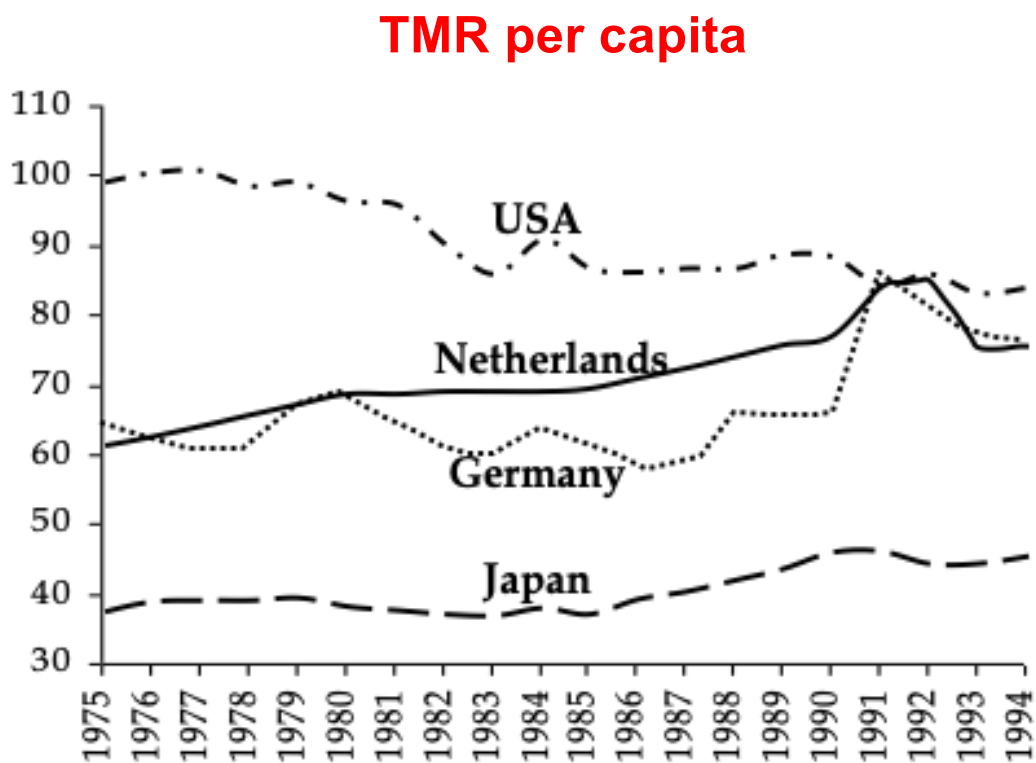
Included in this category is the overburden that must be removed to permit access to an ore body, the soil erosion from agriculture, and the material moved in the construction of infrastructure (e.g. highway or a building,) or in the dredging of harbors and canals

For simplicity, both ancillary and excavated or disturbed material have been combined into the single category of hidden material, even though they can have markedly different environmental impacts.

SOME USEFUL DEFINITIONS

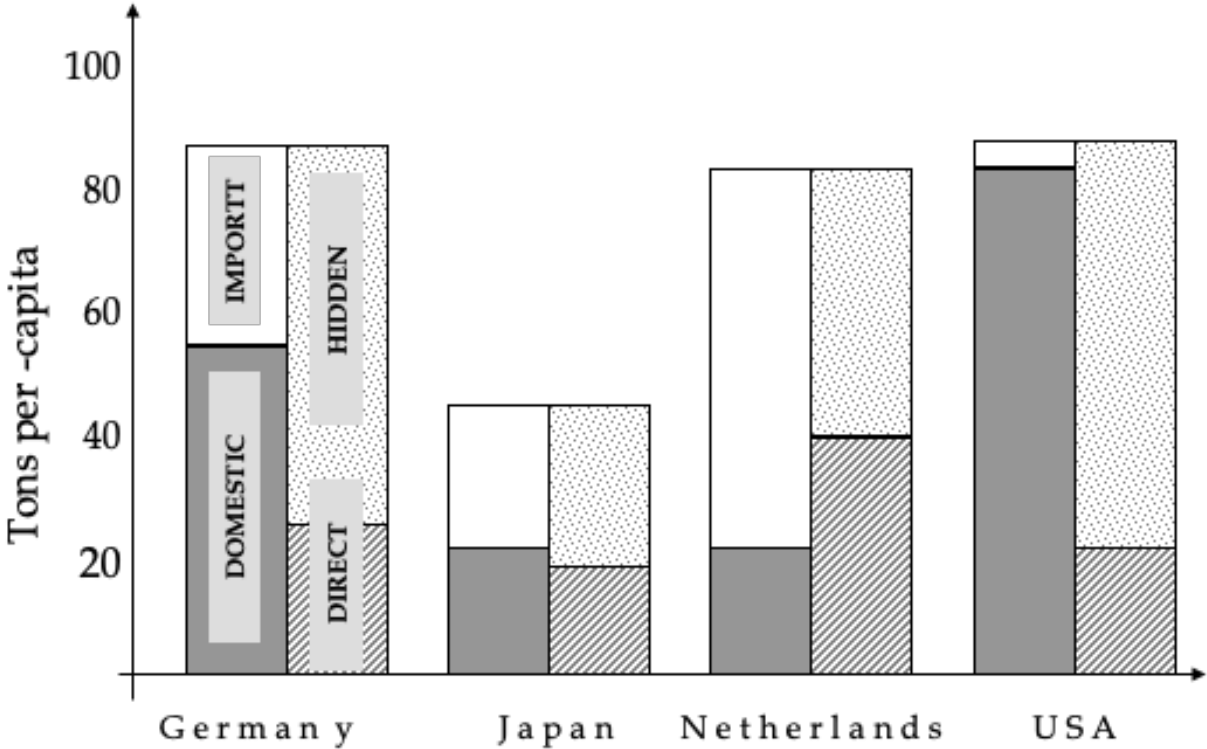
Hidden flows have been calculated for six categories of material flows:

- fossil fuels,
- metals and industrial minerals,
- construction materials,
- renewable natural resources,
- infrastructure creation and maintenance, and
- soil erosion.

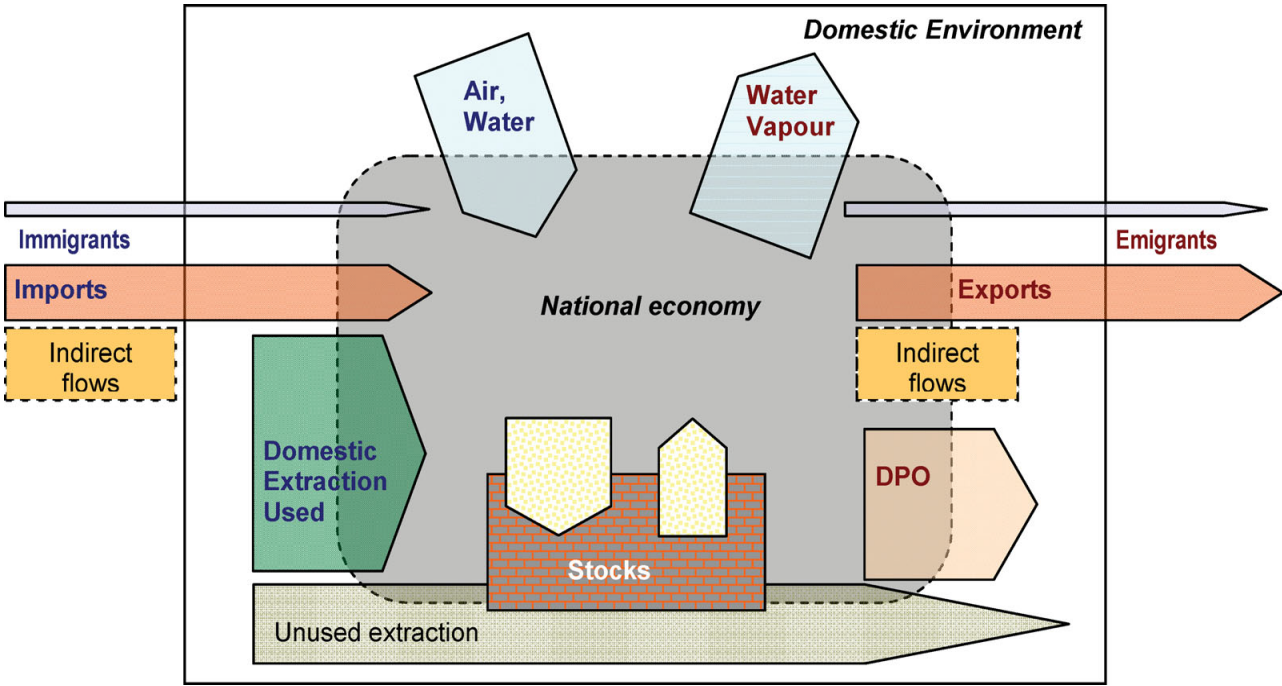


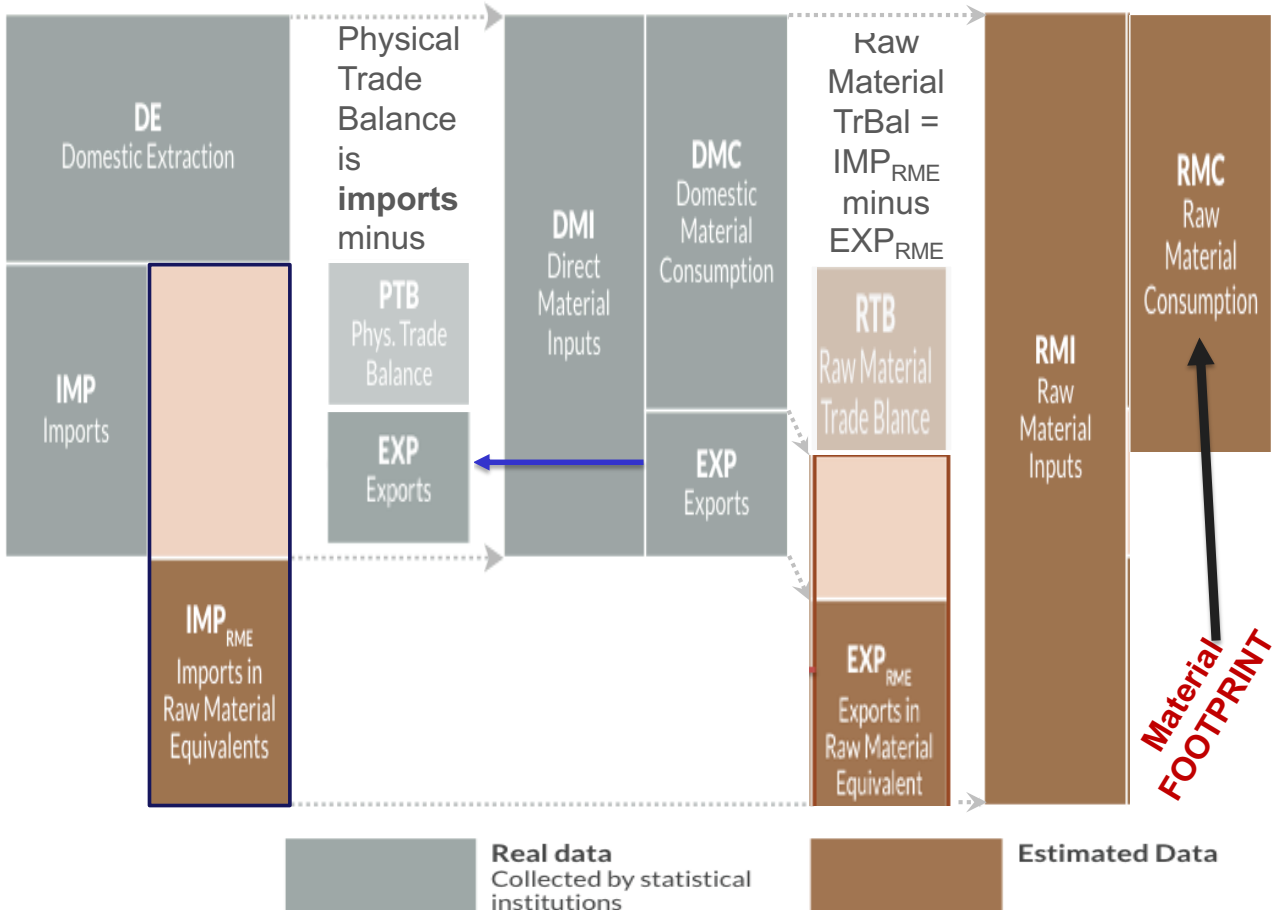
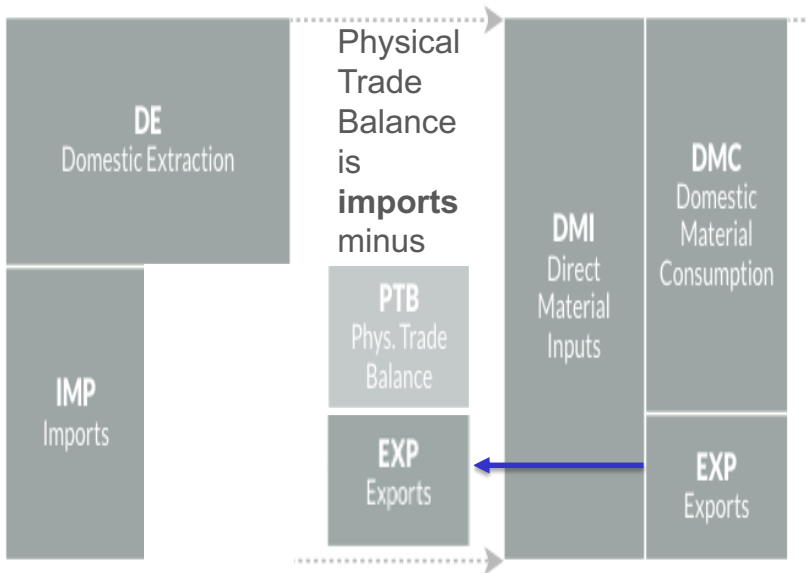
Adriansee et. al 1997

TMR COMPOSITION in 1991



Adriansee et. al 1997





DomesticMaterialConsumption:=DomesticExtraction+IMP-EXP

$$DMC=DE+IMP-EXP$$

$$DMC+EXP=DE+IMP$$

$$DE+IMP:=DMI$$

DomExtr+Imports=:DirectMatInput

The Raw Material Input (RMI) equals the sum of Domestic Extraction (DE) plus Imports in Raw Material Equivalents (IMP-RME).

RMI represents total final use of products in a country expressed in Raw Material Equivalents. It illustrates the amount of materials required along all supply chains as input to the production system in order to meet a country's consumption, investment, and export demand, both from domestic and foreign origins.

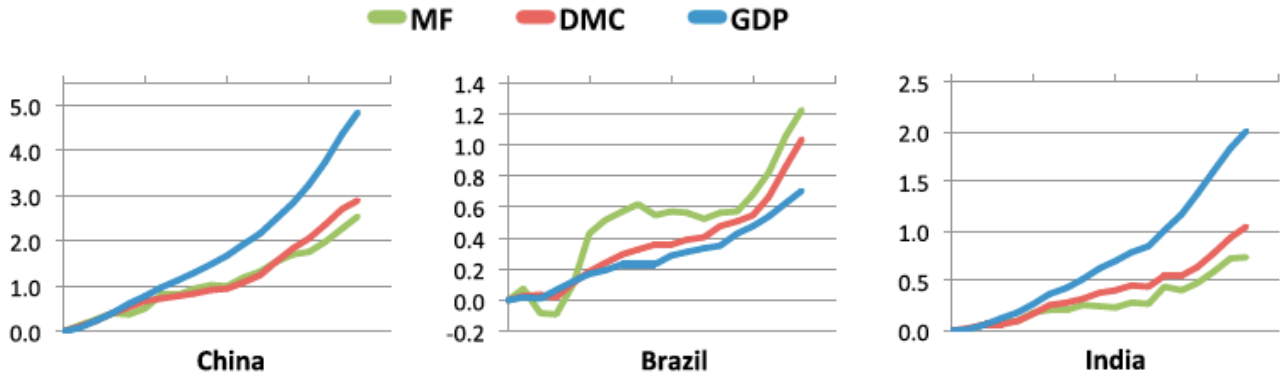
Raw Material Consumption (RMC) illustrates the domestic final use of products in terms of Raw Material Equivalents. RMC thus captures the amount of domestic and foreign extraction of materials needed along all supply chains to produce the final products consumed in a country.

RMC equals the sum of Domestic Extraction (DE) plus Imports in Raw Material Equivalents (IMP-RME) minus exports in Raw Material Equivalents (EXP-RME), i.e. trade balance in RME.

The Raw Material Trade Balance (RTB) measures the physical trade surplus or physical trade deficit of a country, including domestic and foreign extraction of materials needed along all supply chains to produce the imports and exports. RTB equals imports in Raw Material Equivalents (IMP-RME) minus exports in Raw Material Equivalents (EXP-RME).

Wiedmann, T. O., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J., & Kanemoto, K. (2015). The material footprint of nations. *Proceedings of the national academy of sciences*, 112(20), 6271-6276.

Fig. 3. Relative changes in total resource use (MF and DMC) and GDP-PPP-2005 between 1990 and 2008 [values are plotted as $\Delta X = (X_t - X_{t0})/X_{t0}$; $t_0 = 1990$].



Wiedmann, T. O., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J., & Kanemoto, K. (2015). The material footprint of nations. *Proceedings of the national academy of sciences*, 112(20), 6271-6276.

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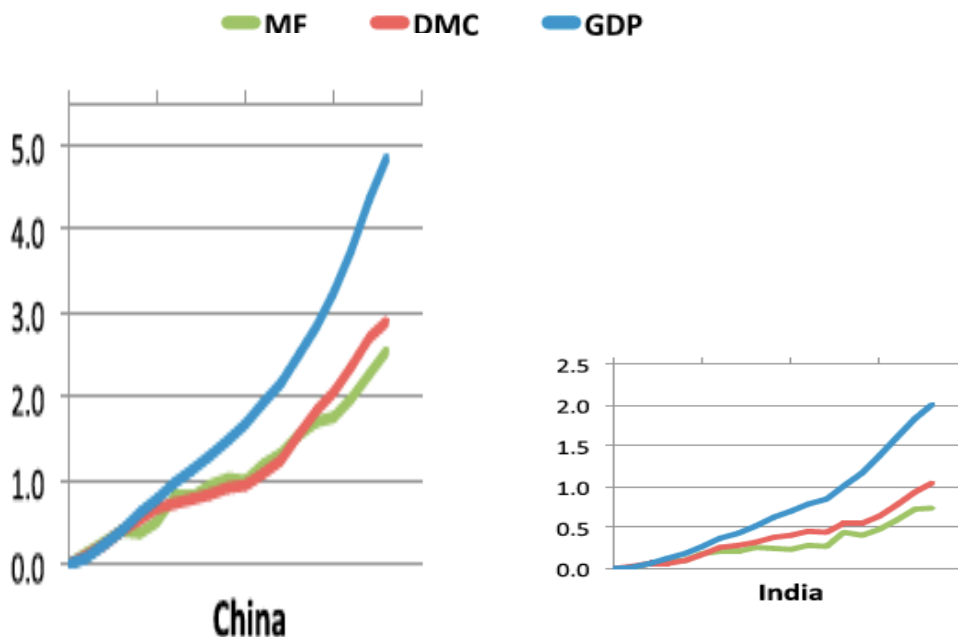


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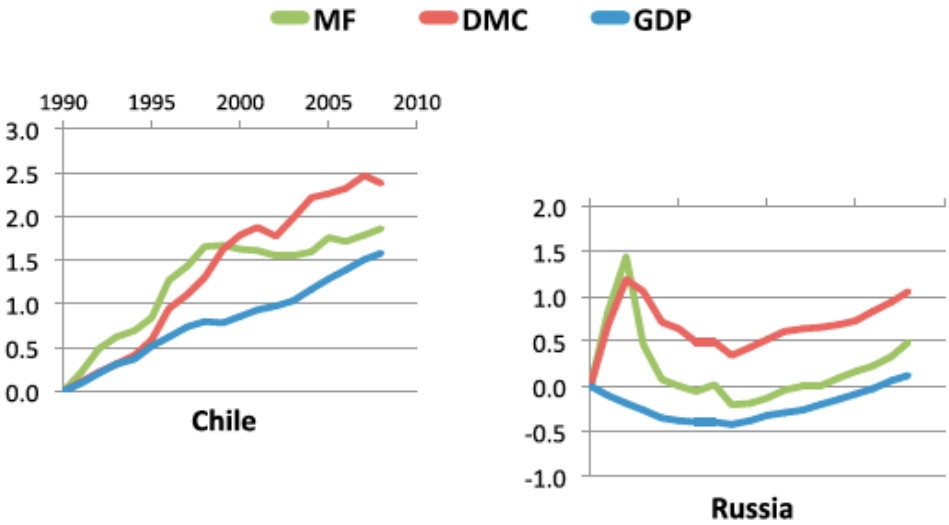


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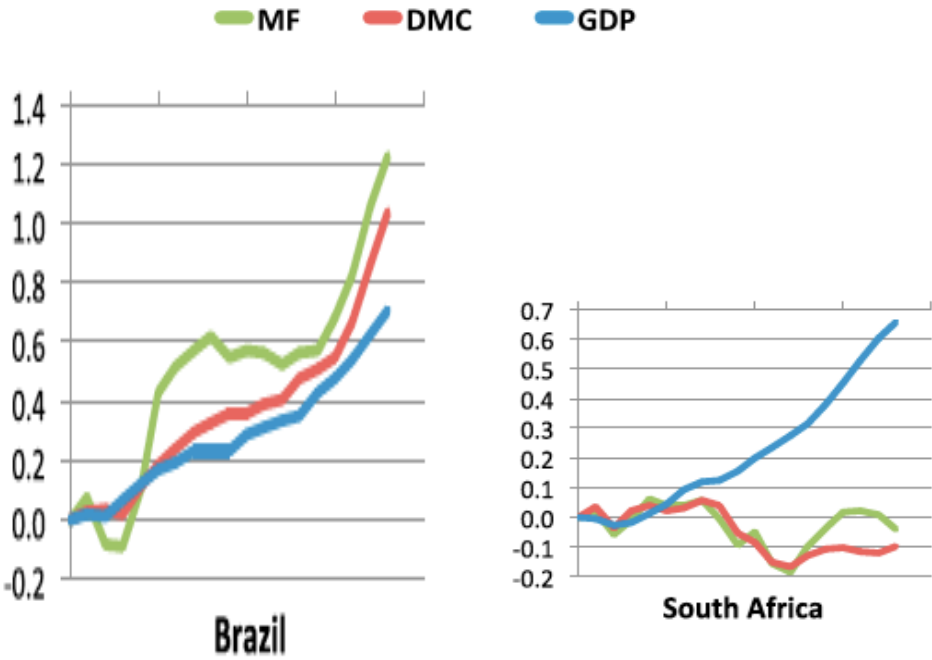
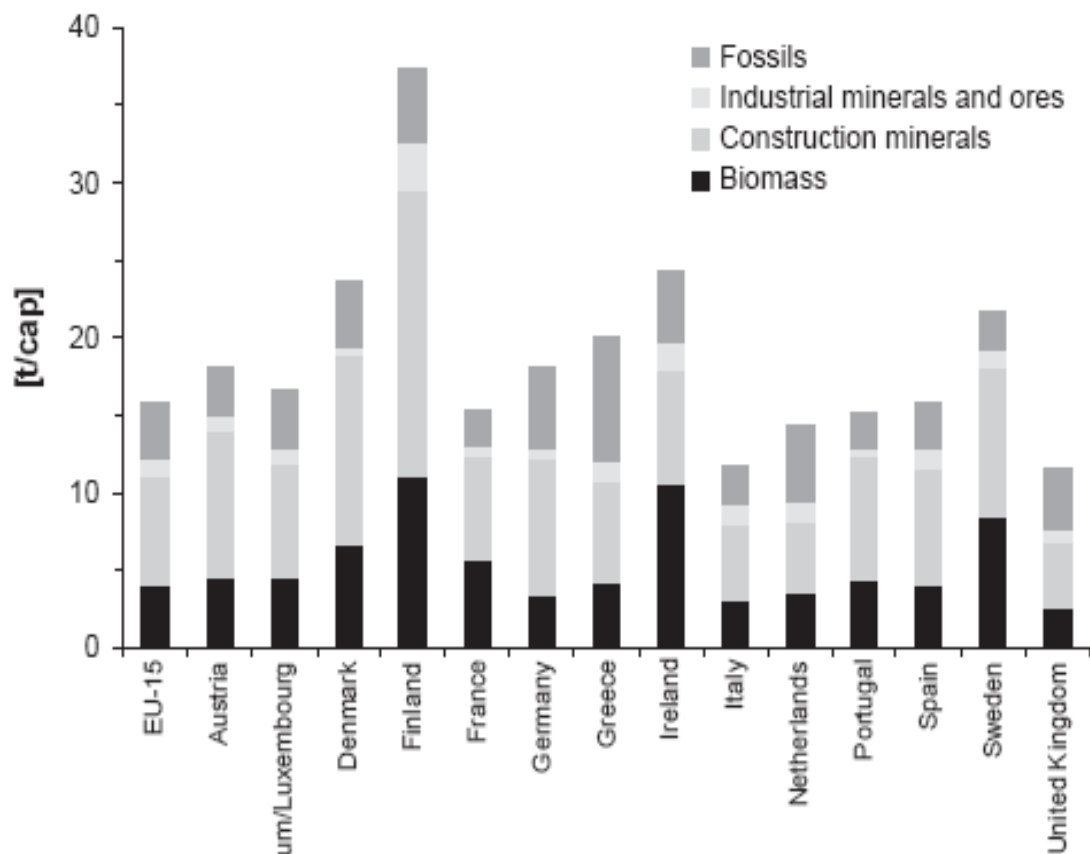
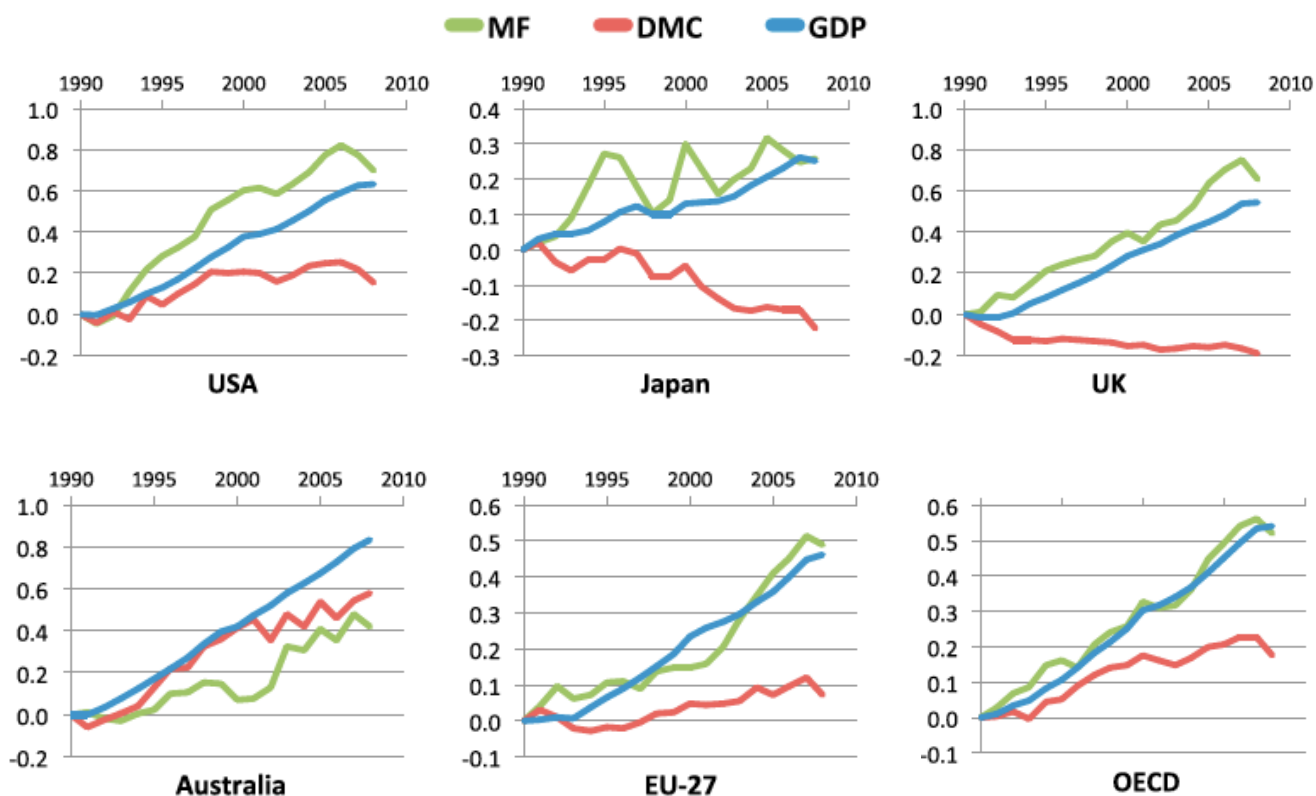
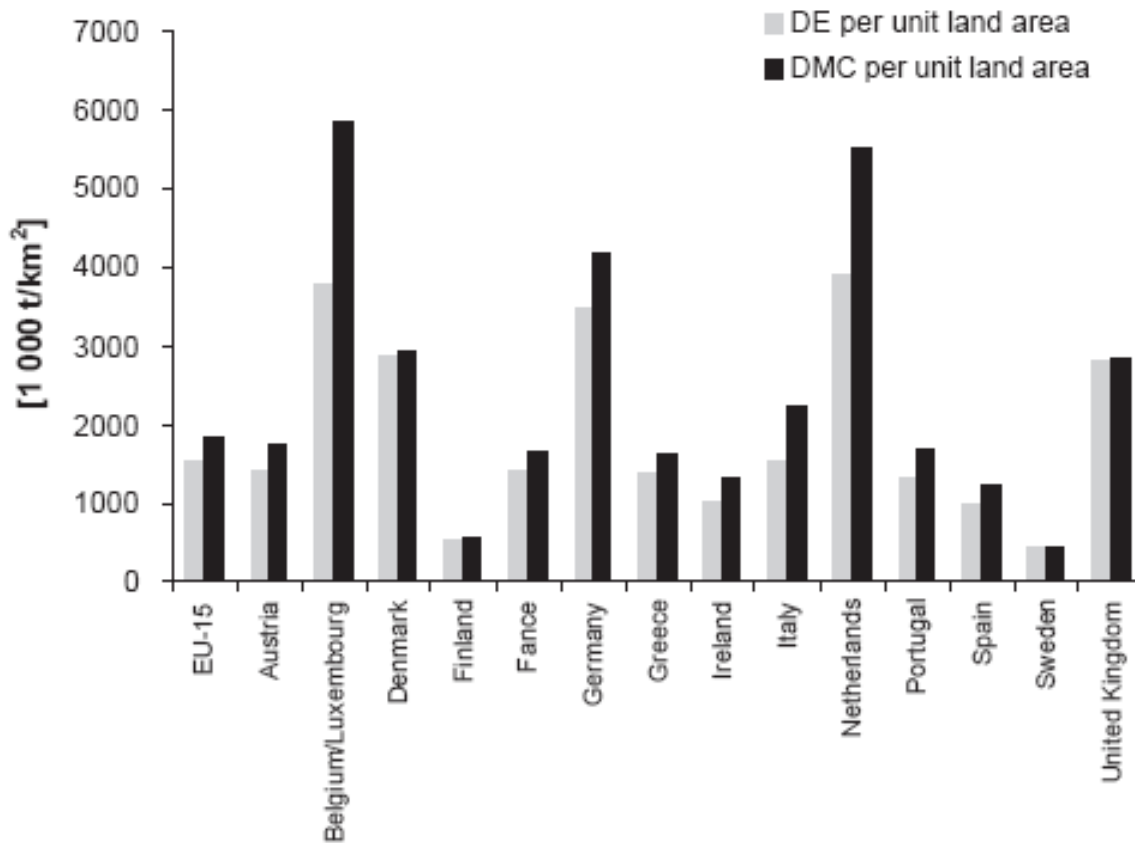


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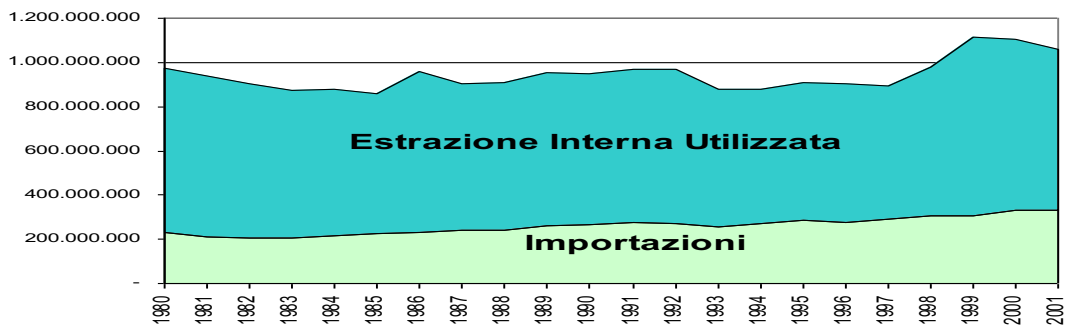


Composition of DMC per capita (2000)



DMC e DE per unità di territorio

Input Materiale Diretto (DMI) Italia 1980-2001, tonnellate



Fabbisogno Materiale Totale (TMR), Italia 1980-2001, tonnellate

