Final Storage Landfills:
Key Element of Sustainable Waste Management

Vertederos de almacenamiento finales – elemento clave de todo sistema de gestion sostenible de los residuos

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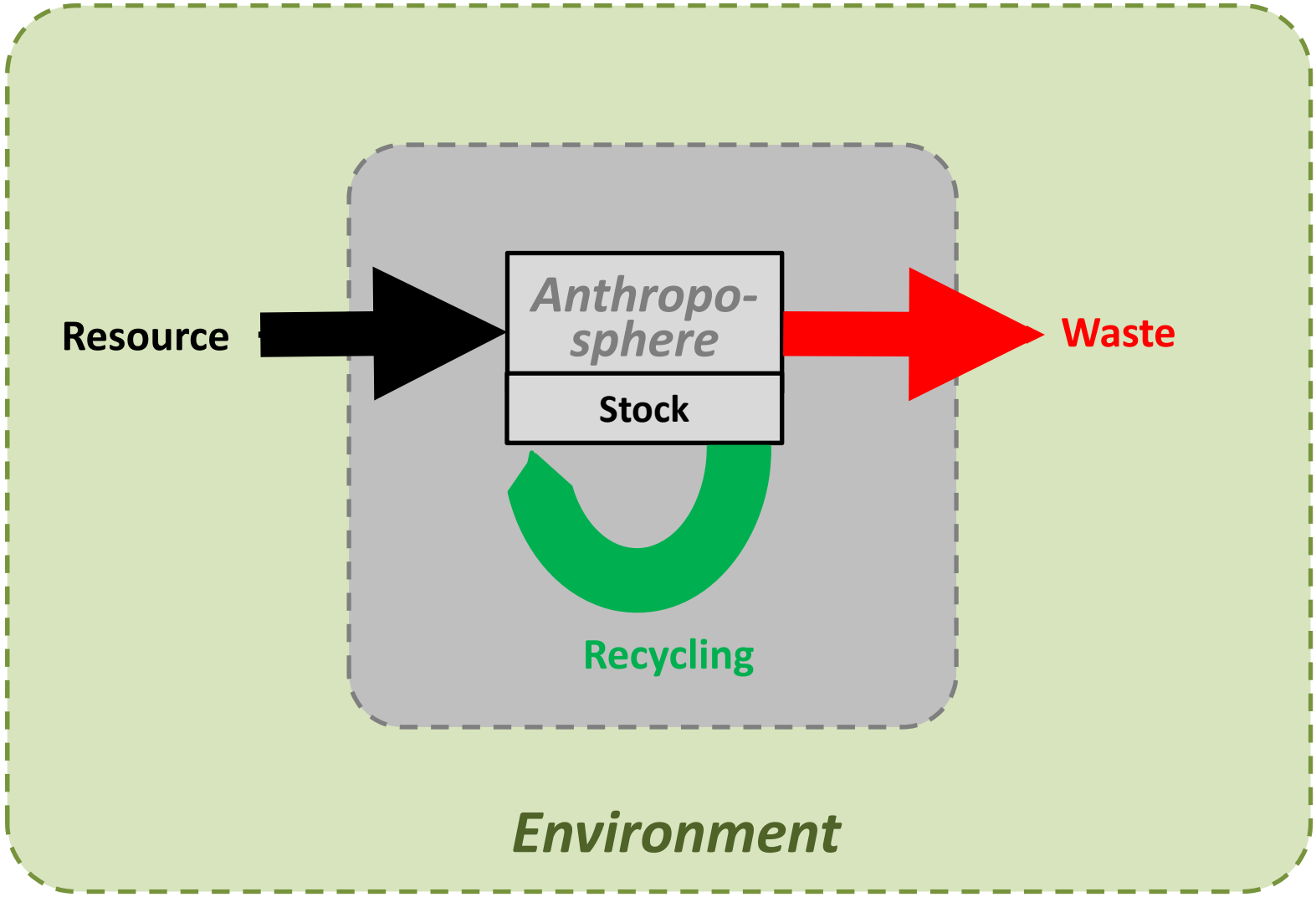
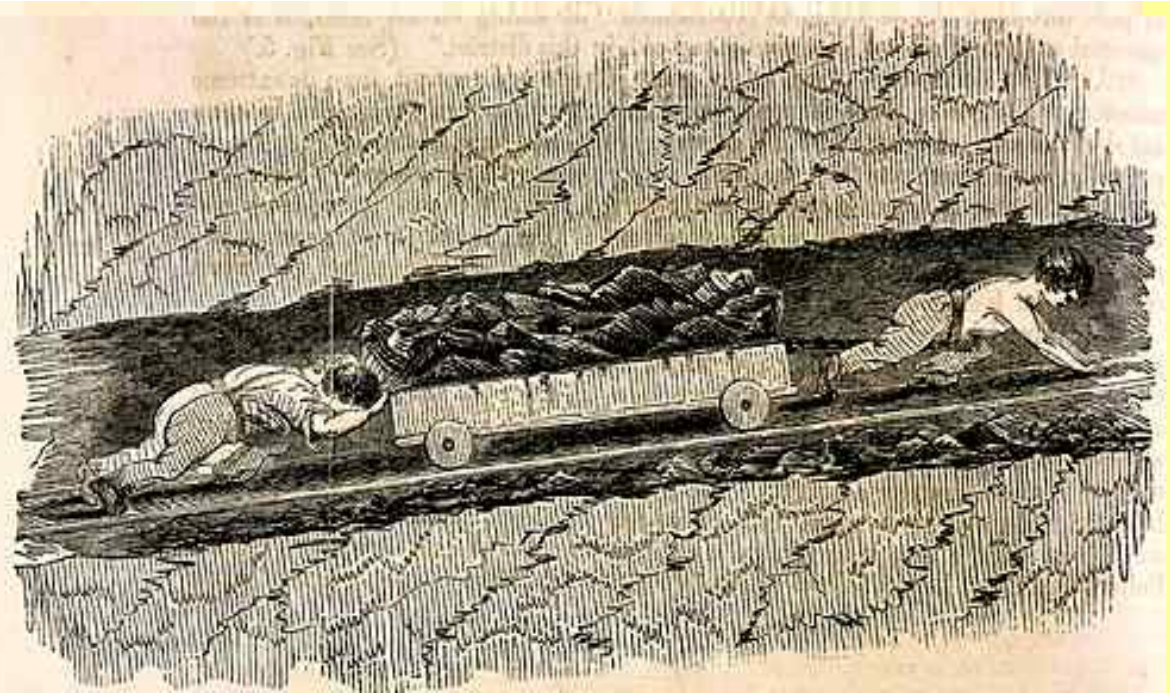
Resources, cycles and flows to sinks

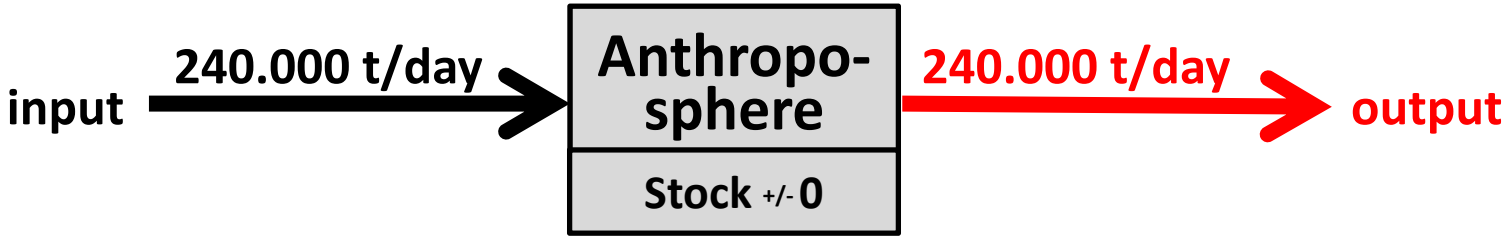


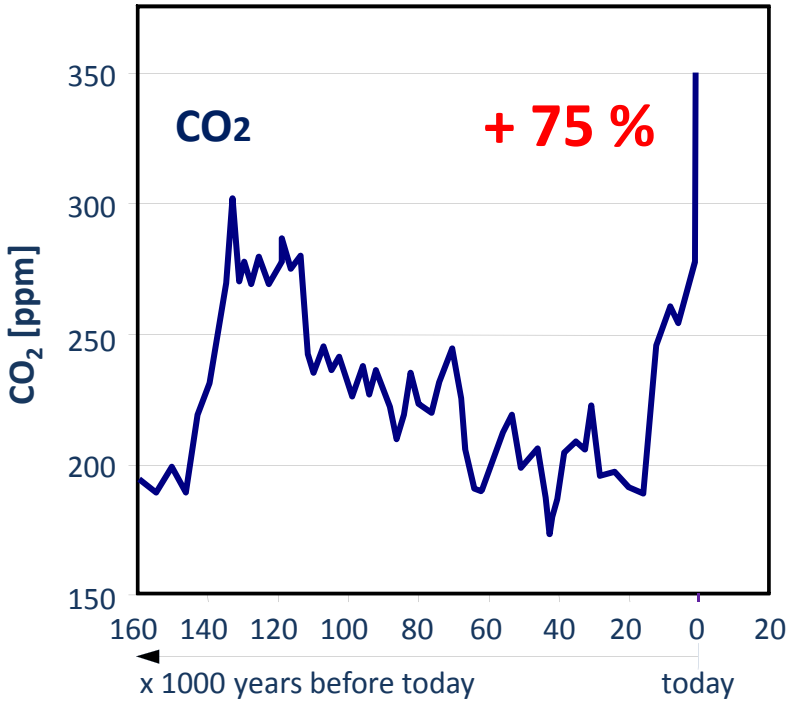
Coal mining then …

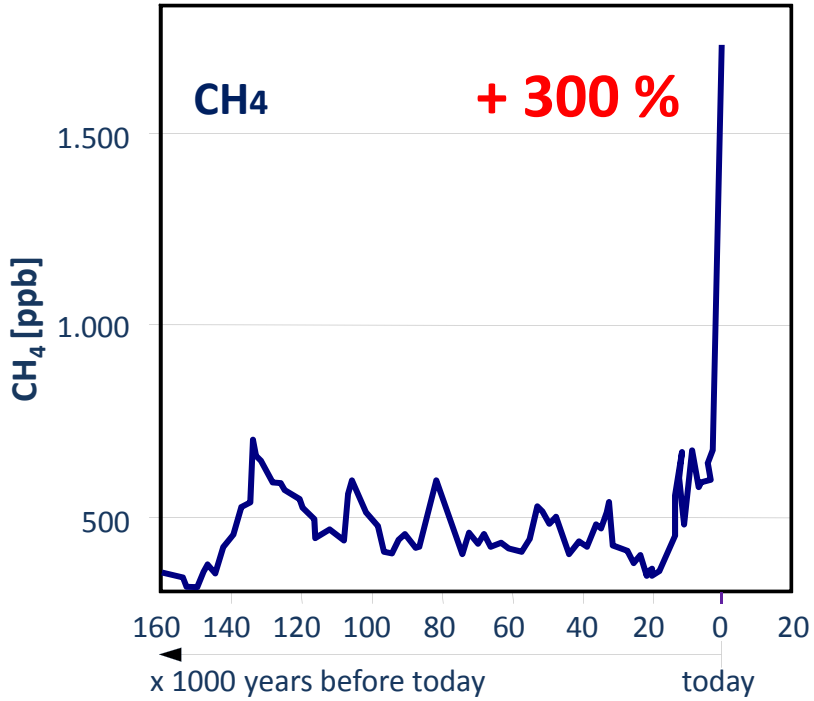


Unlimited progress of technology

“Input equals output”



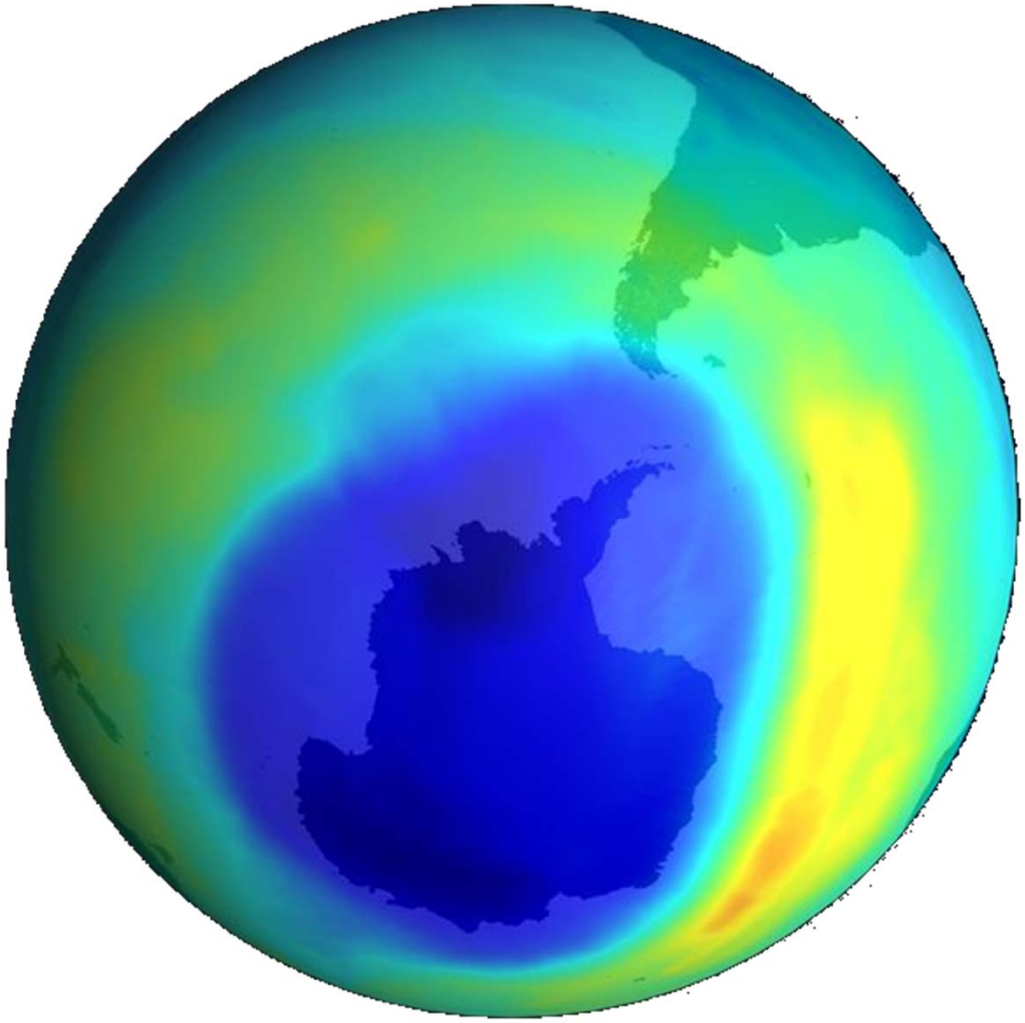




Consequences of resource extraction at the "back end"

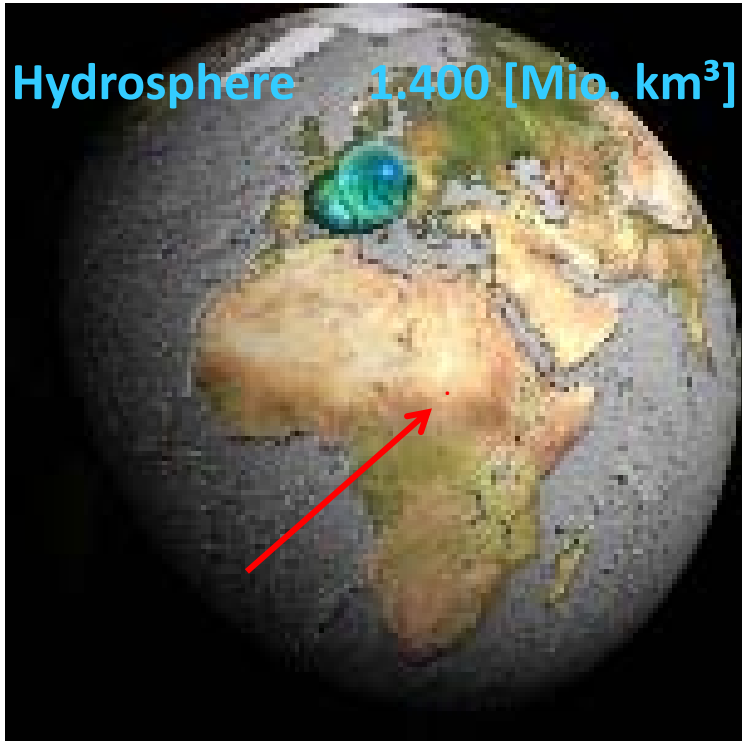
Muir and Riggs Glaciers

CO_2 not the only example: CFCs et al.



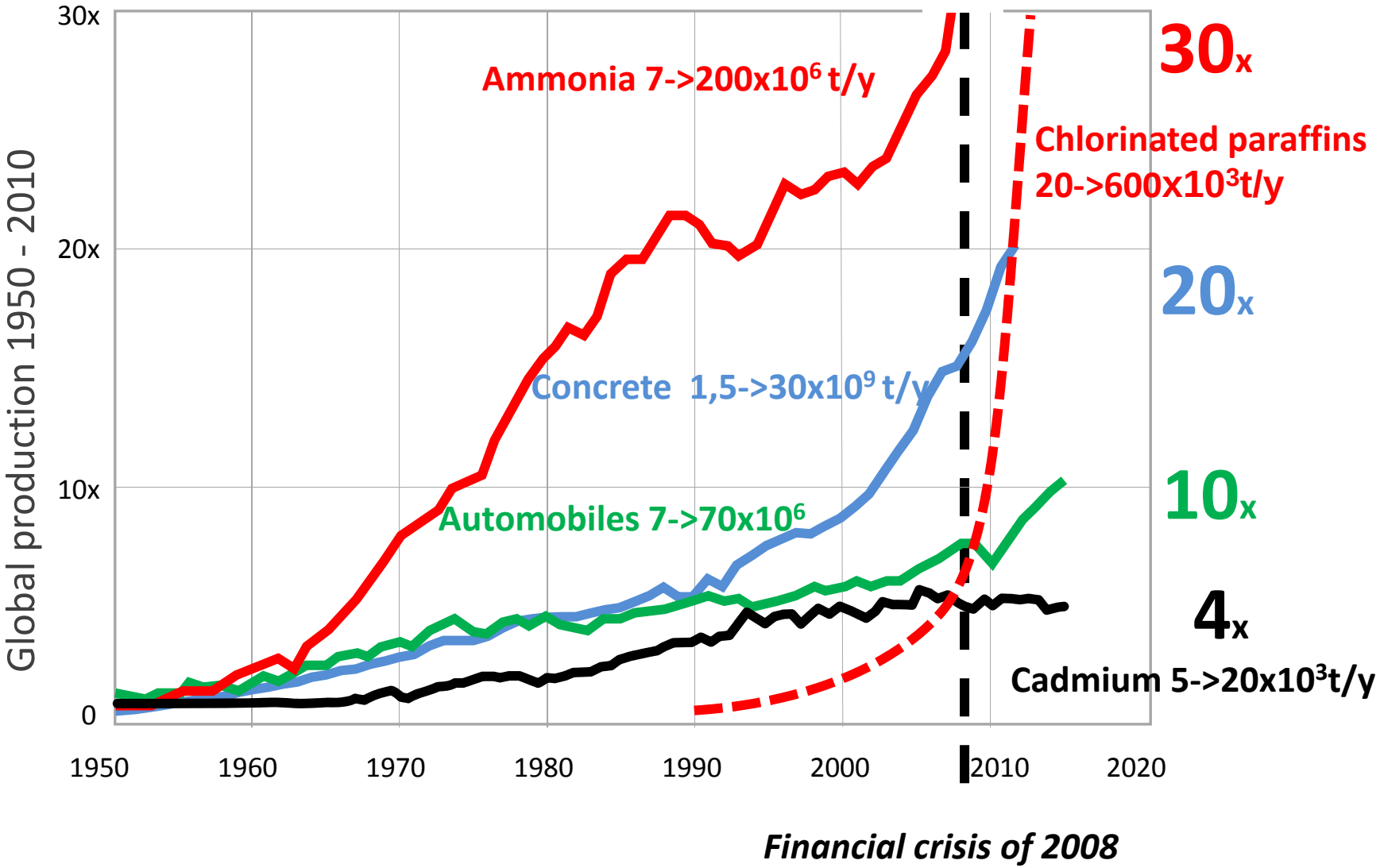
http://earthobservatory.nasa.gov/images/imagerecords/0/926/ozone_oct_sep_avg2000.jpg

„Planet earth“ as a limited sink



nach A. Nieman ergänzt durch G. Döberl

Fast growing global material flows

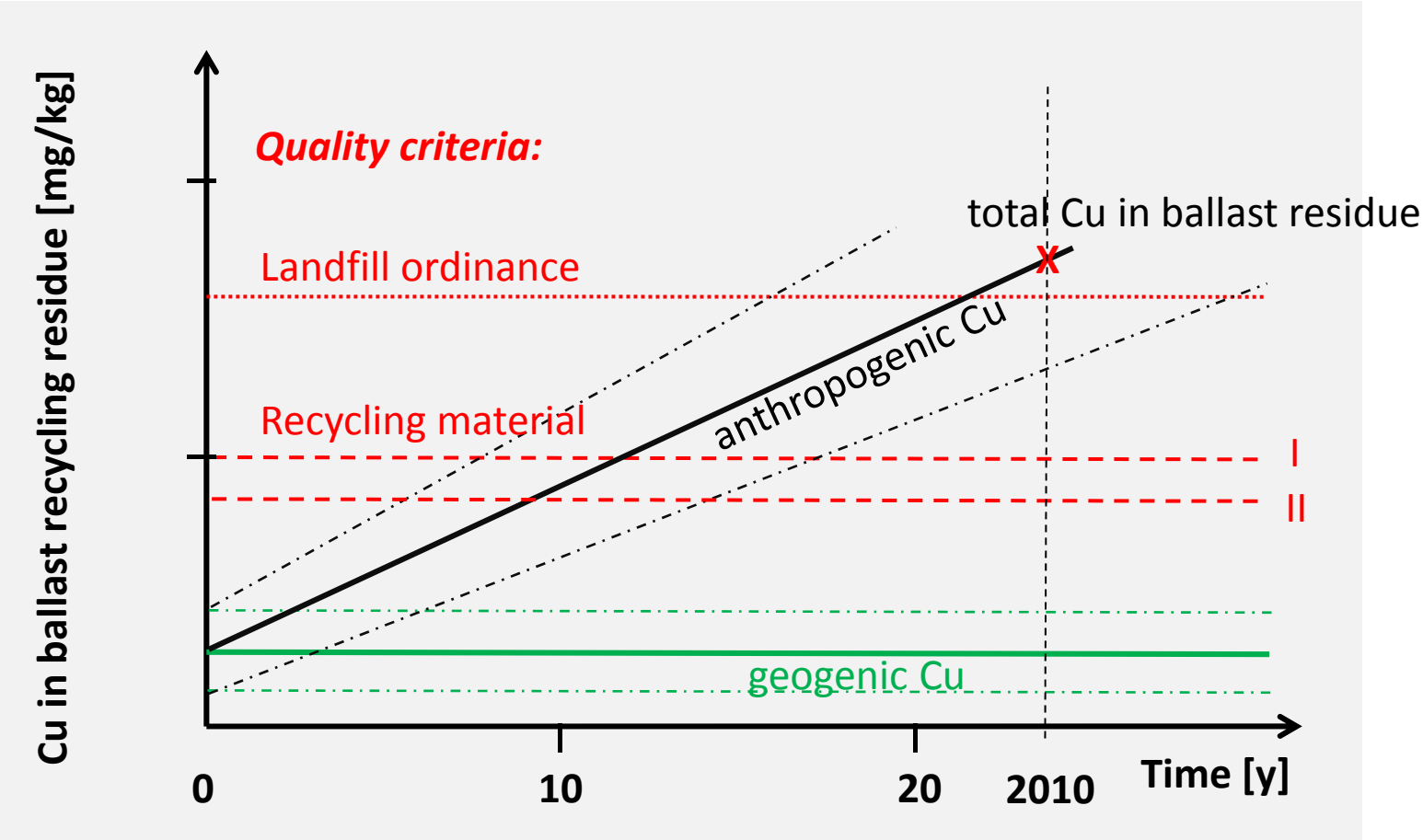


Substance flows to sinks are invisible (Cu)

Vineyard and railway

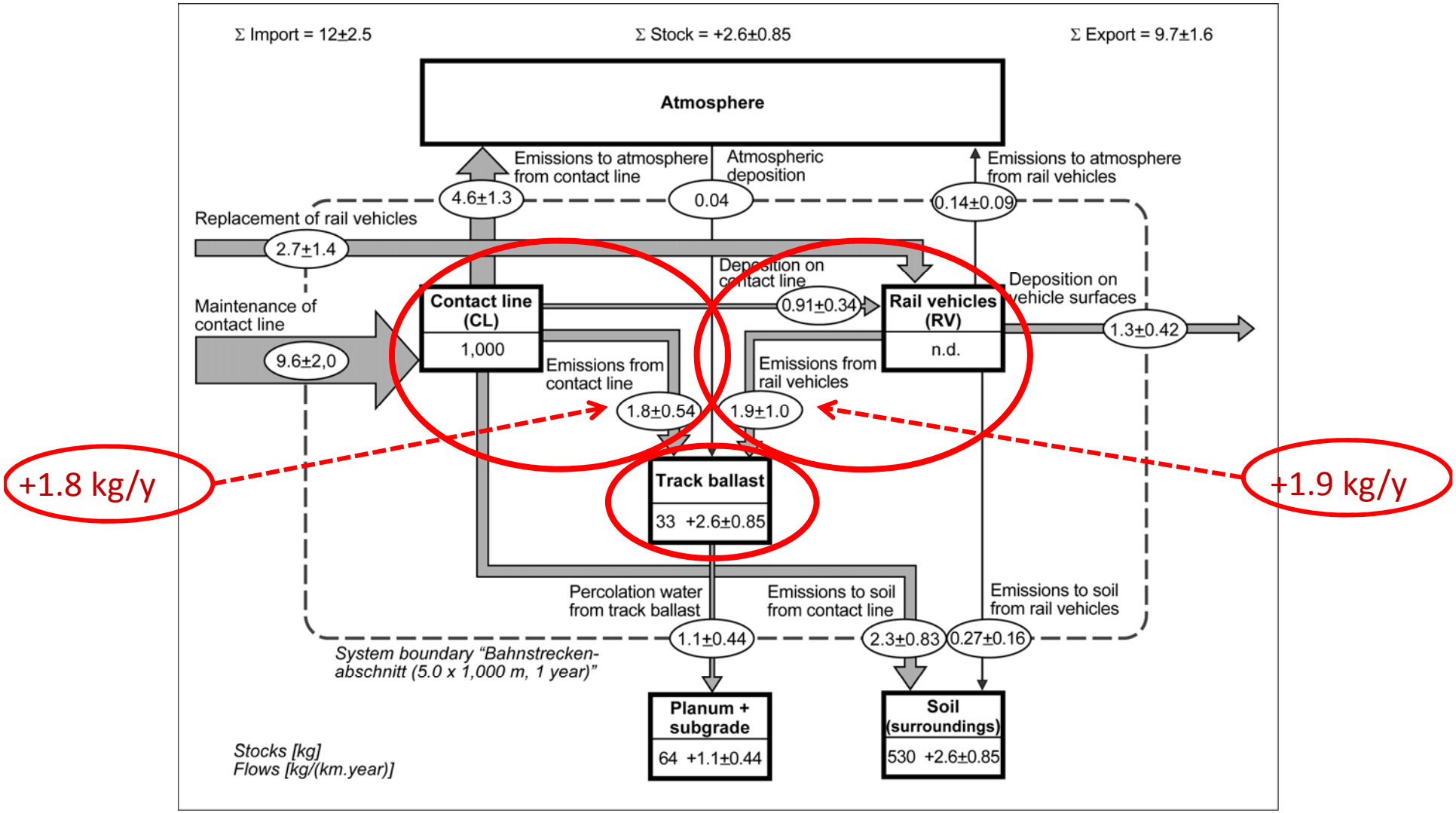
copper

Ballast as a “sink” for Cu from railroads



Investigating into Cu metabolism

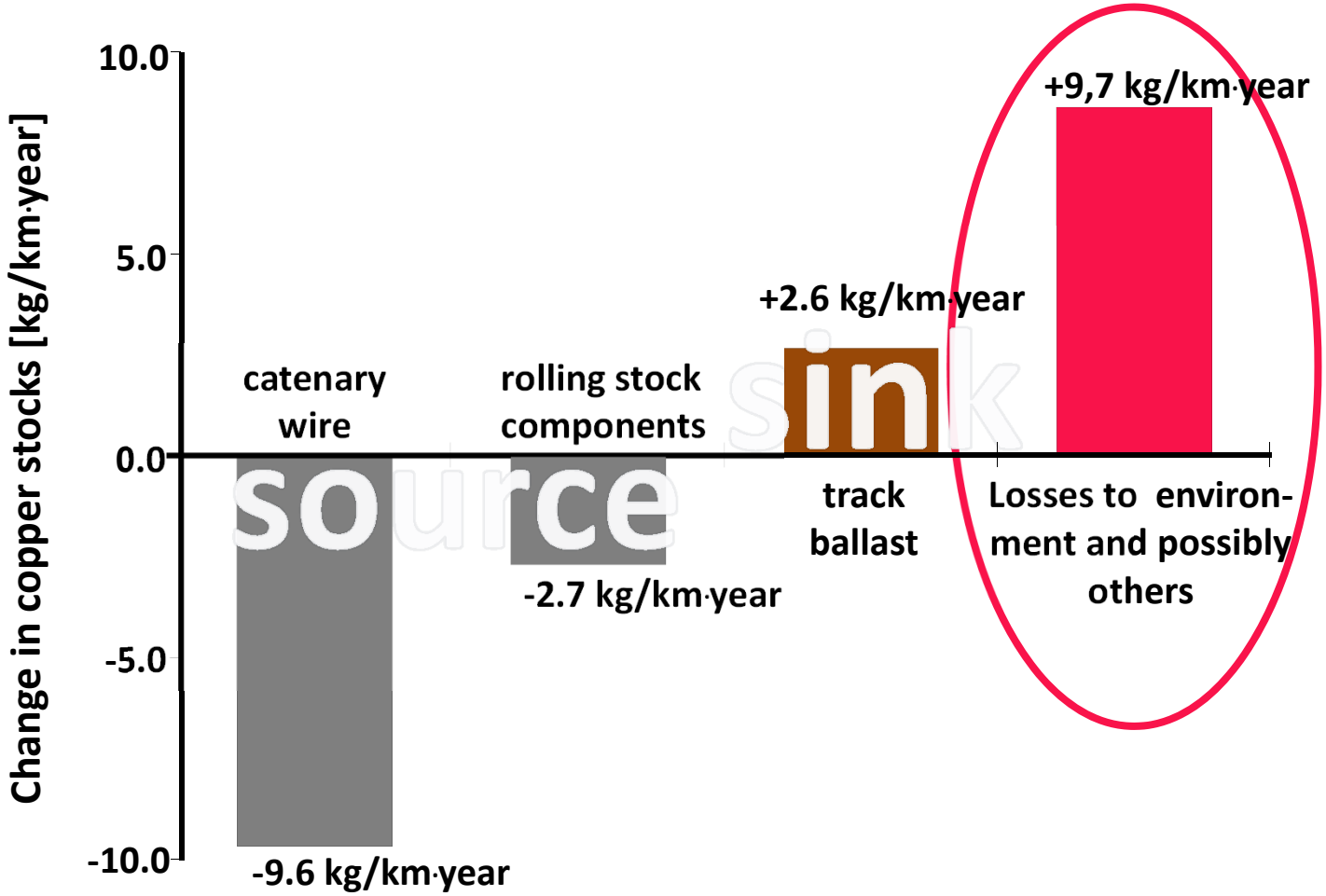
MFA for railway derived Cu



From sources to sinks – the full picture

~ 20 % of Cu flow to recycling and landfilling

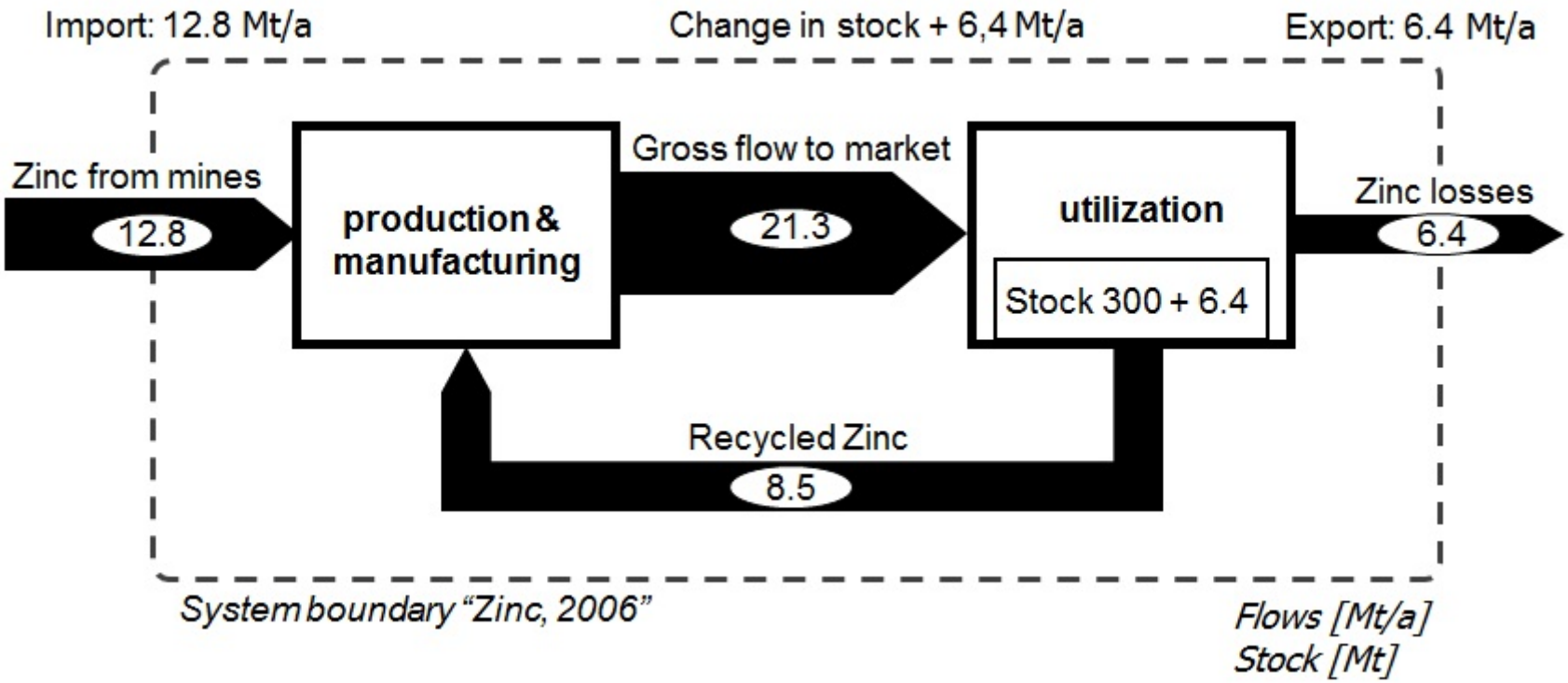
~ 80 % of Cu flow uncontrolled into the environment



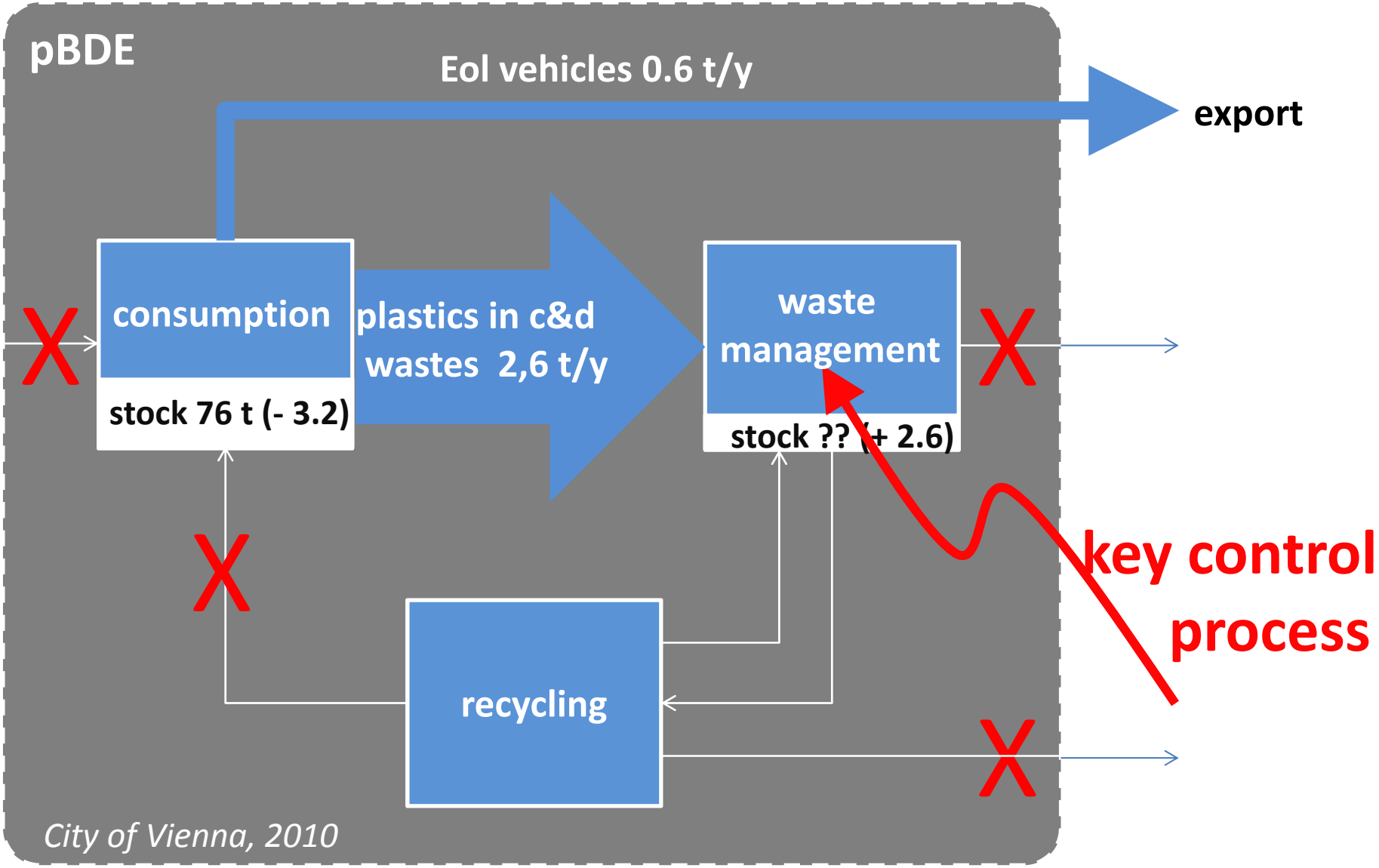
Just a railway issue? Cf. urban surfaces…

where is the zinc?

Global Zinc flows to sinks

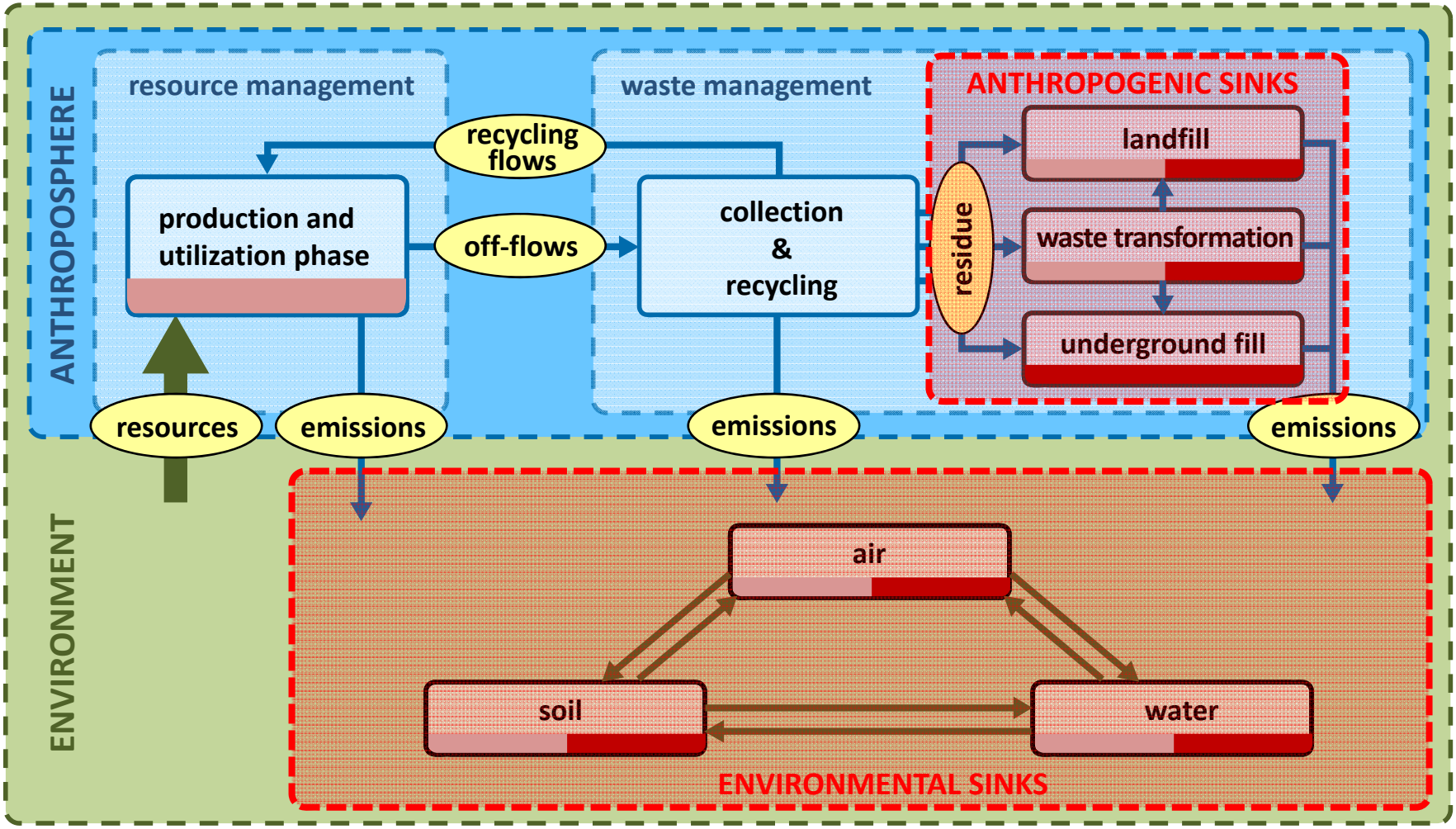


From inorganic to organic substances



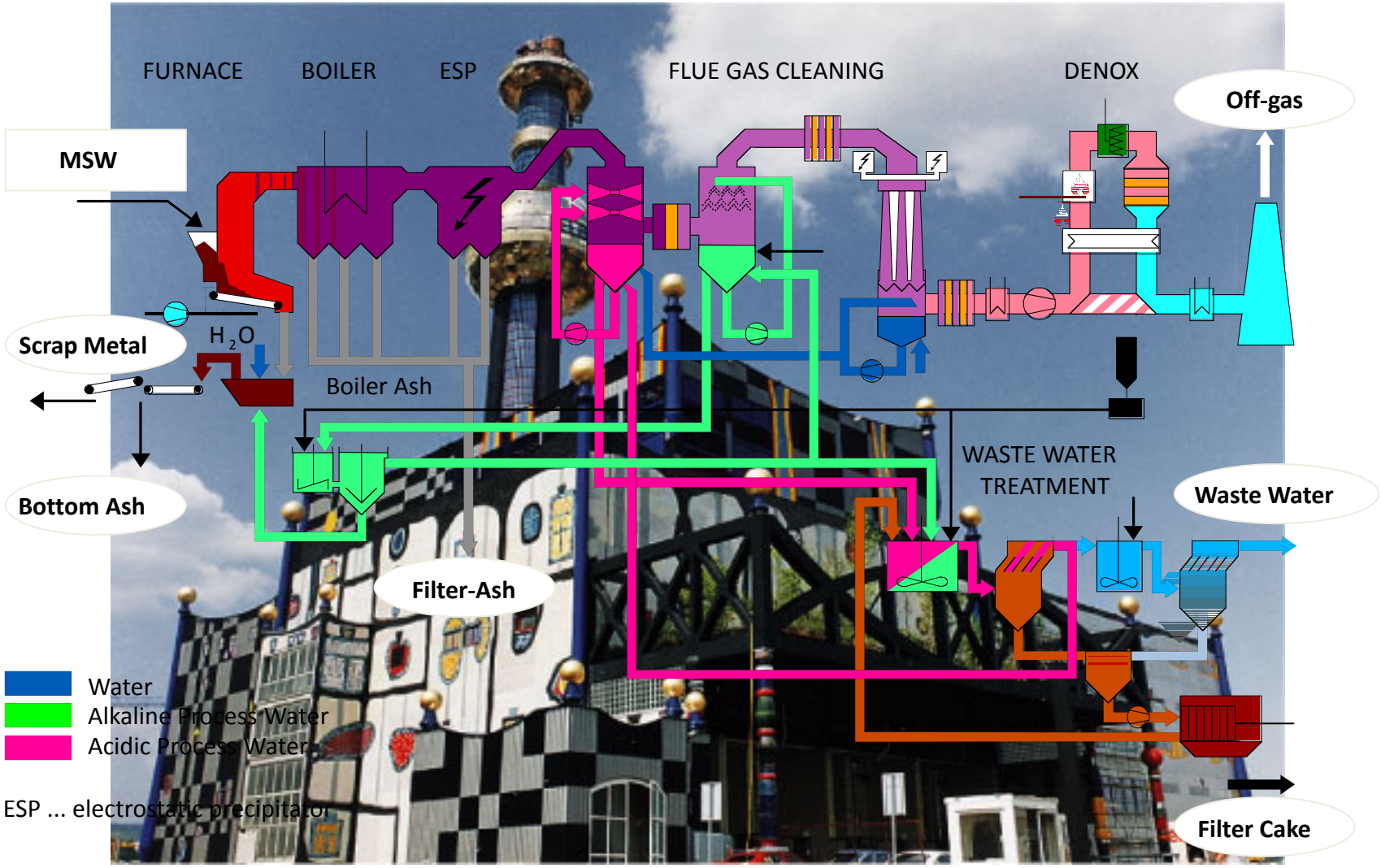
Vyzinkarova et al, 2013

The need for sinks and final sinks



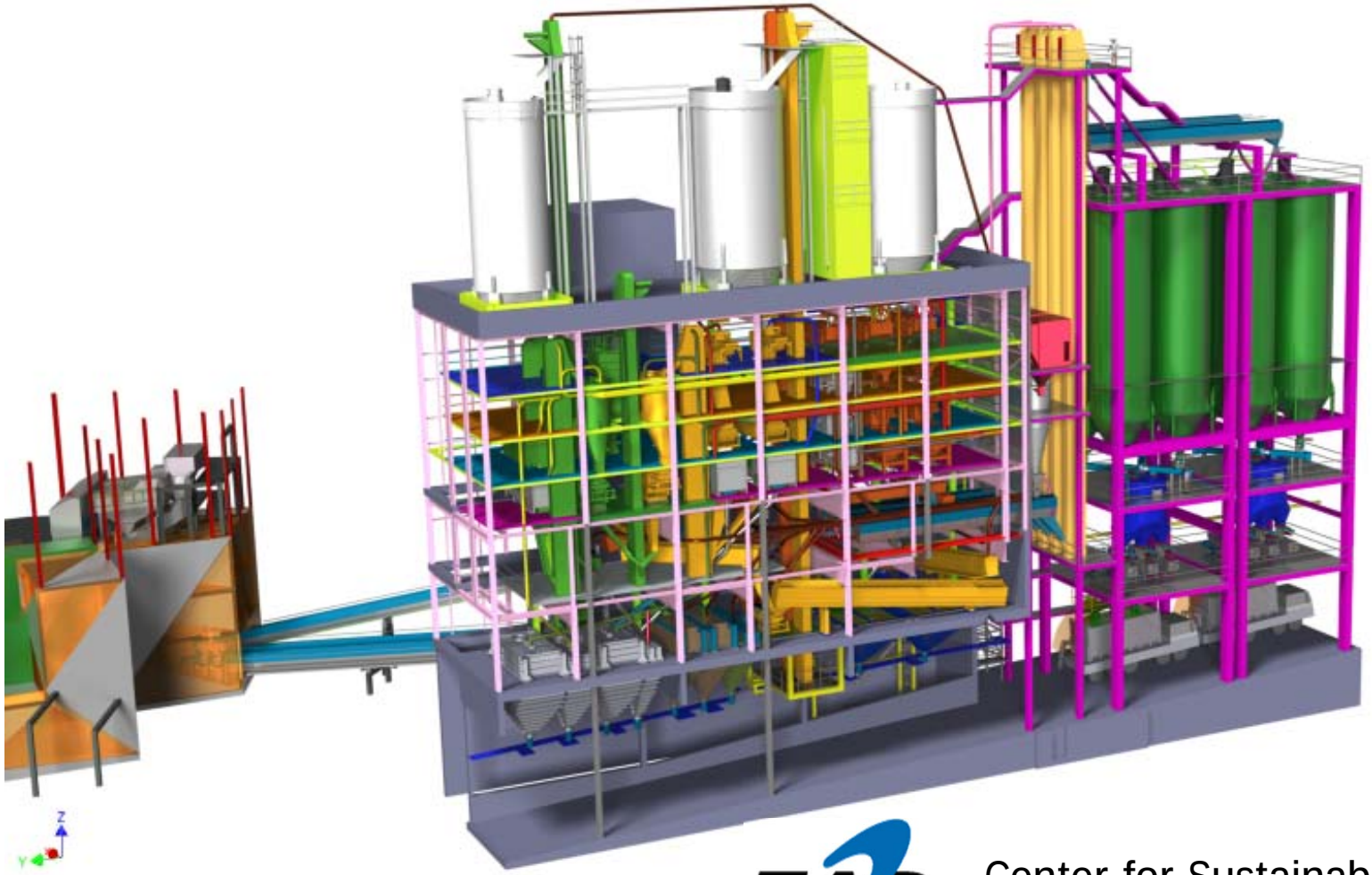
Intermediate sink final sink

Incineration: perfect sink for organics



Source: SGP-VA

Resource recovery from WTE-bottom ash



Center for Sustainable Waste Recovery and Resource Use

Recovery of NF-metals from separated ash

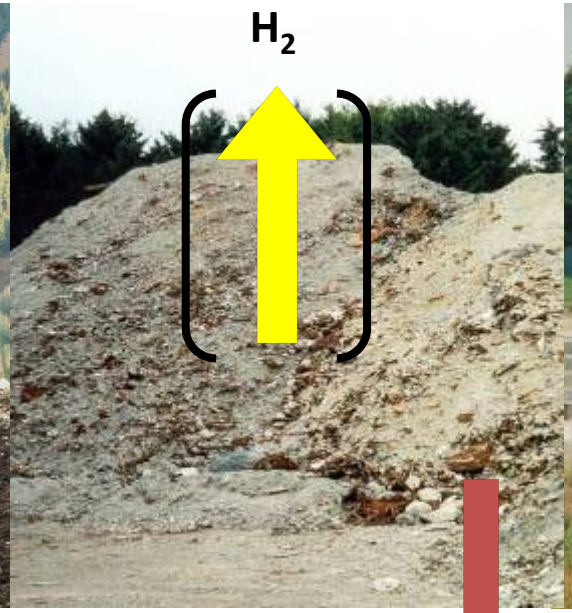
Metal	Concentration [g/100g]
Aluminum	70
Copper	15
Silver	0.06
Gold	0.003
Palladium	0.001

	Recovery-Efficiency
1st generation	62 %
2nd generation	95 %
3rd generation	>98 %

Source: ZAR Center for Sustainable Waste Recovery and Resource Use

The landfill: a “Final Sink” for wastes?

Organic waste (MBT) landfill | **Bottom ash landfill** | **Filter ash landfill**



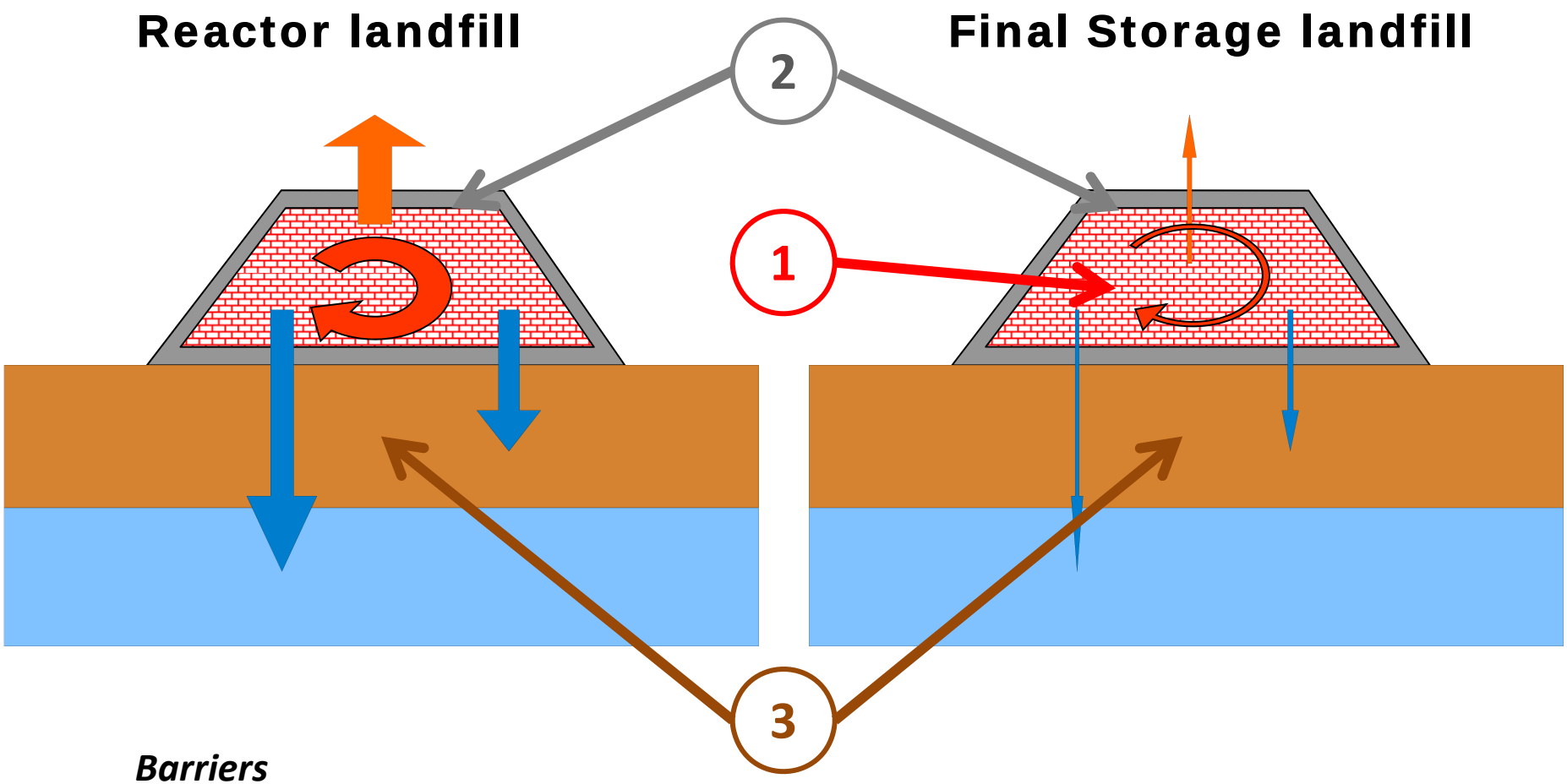
TOC NH_4 Cl etc.

SO_4 Cl etc.

emissions of leachate, gas, TOC and N

large ←→ **small**

“Reactor” versus “Final Storage” landfill



Barriers

1st: Treated (mineralized) waste -> ***After care free!!!***

2nd: Top and bottom landfill liners to keep out water and for control

3rd: Geogenic barrier (“natural attenuation”)

Conclusions

1. Sinks as ultimate resource?
2. Zero waste is not feasible!
3. New role and priorities for waste management:
   -> *„clean“ cycles and „safe final sinks“*
4. “Design for sinks” as a new objective of WM
5. WM must signal sink constraints!
6. WM must supply sinks: incineration and landfills
7. New knowledge base for planning:
   -> *“Metabolism of the anthroposphere”*!

Recycling is not …

the end

….is the final sink