

39th Discussion Forum on Life Cycle Assessment, ETH Zürich

Regionalization and parameterization of LCA and LCIA of energy systems

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Parameterization concept for LCA and LCIA (Life Cycle Impact Assessment)

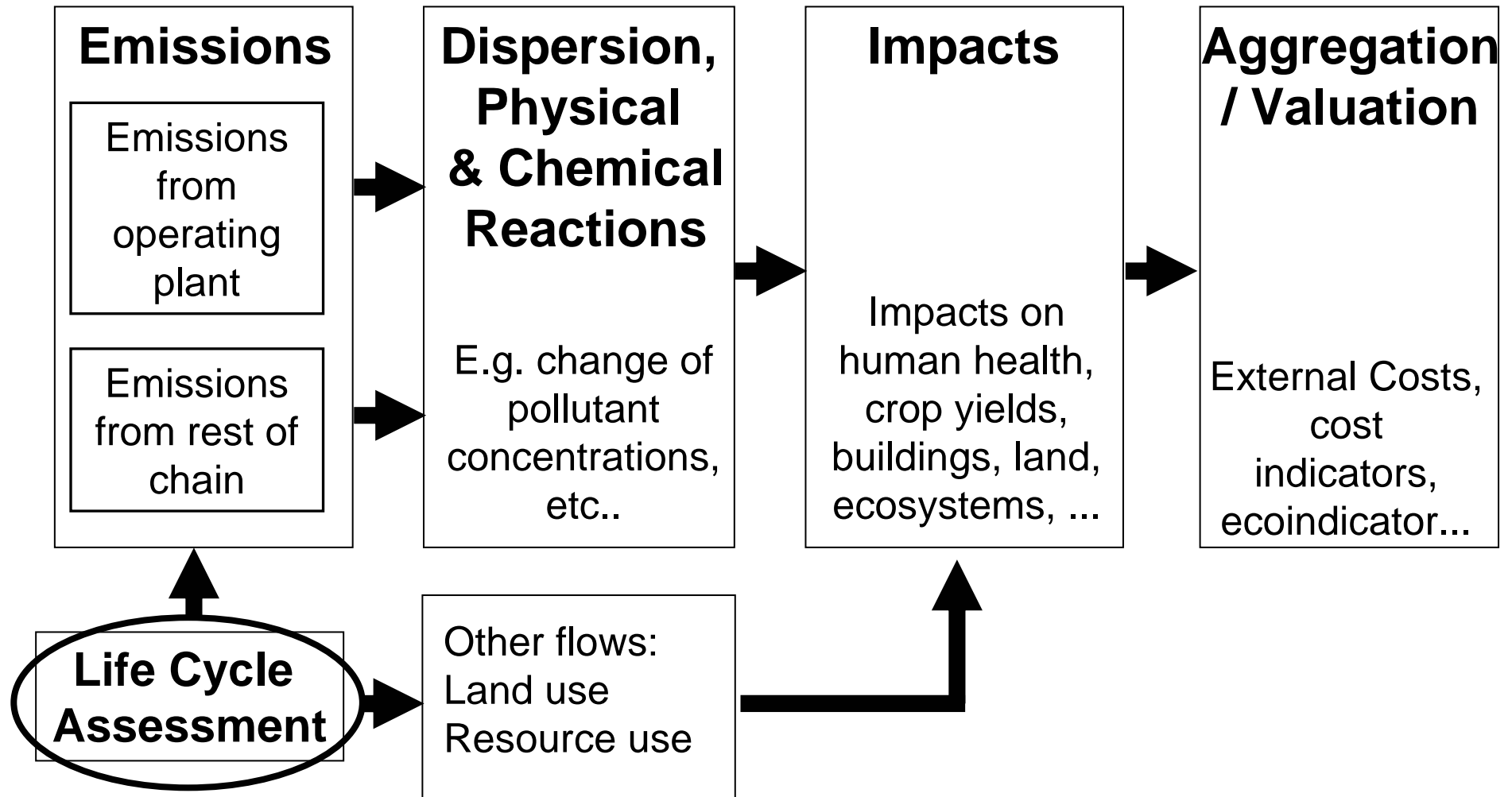
Space-dependent environmental impact modeling

Examples for space-dependent impacts

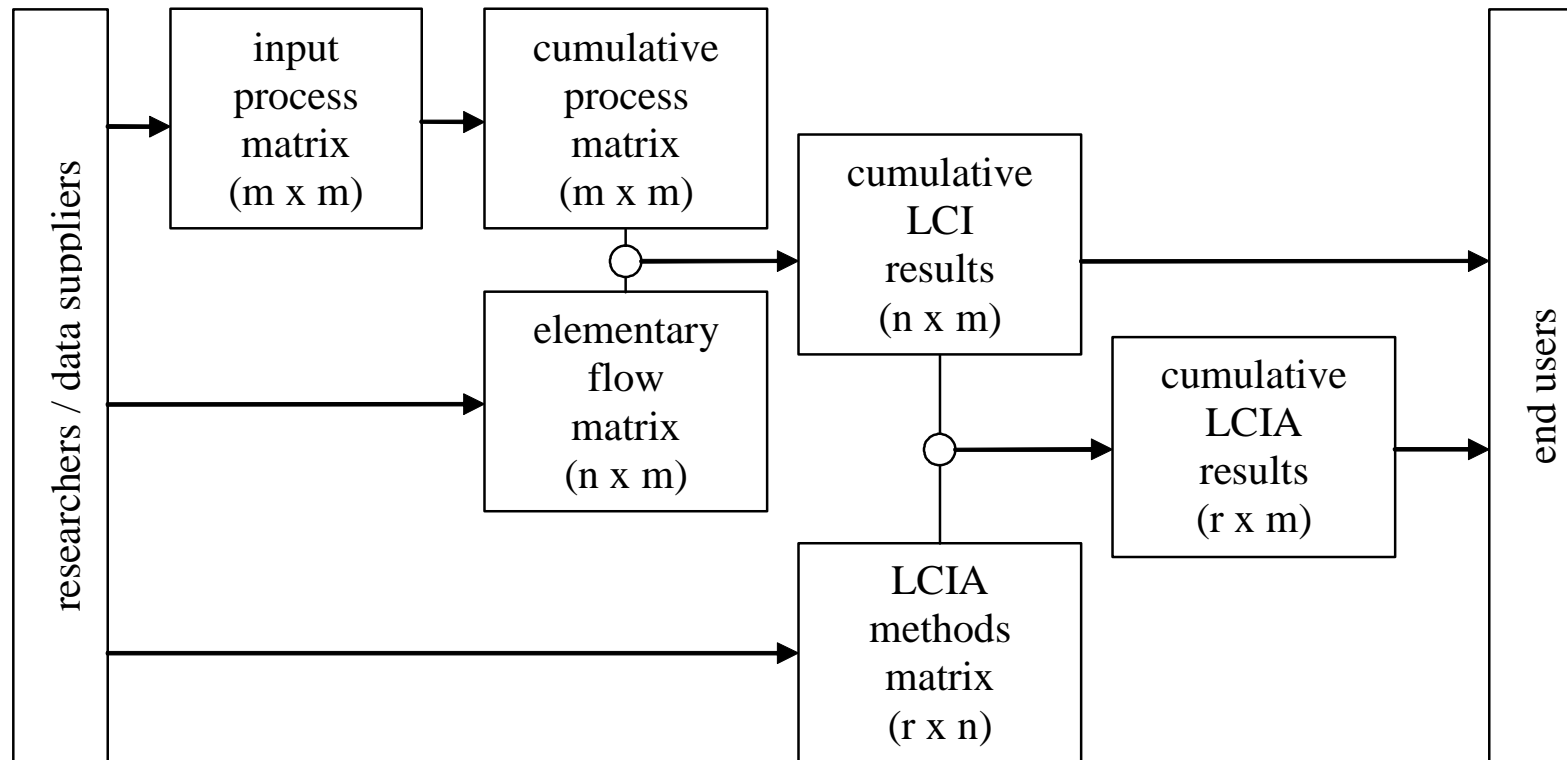
Examples for site-specific impact assessment including LCA (aggregation: external costs)

Conclusions

Space-dependent impact pathway approach including LCA



Current structure of ecoinvent database for LCA

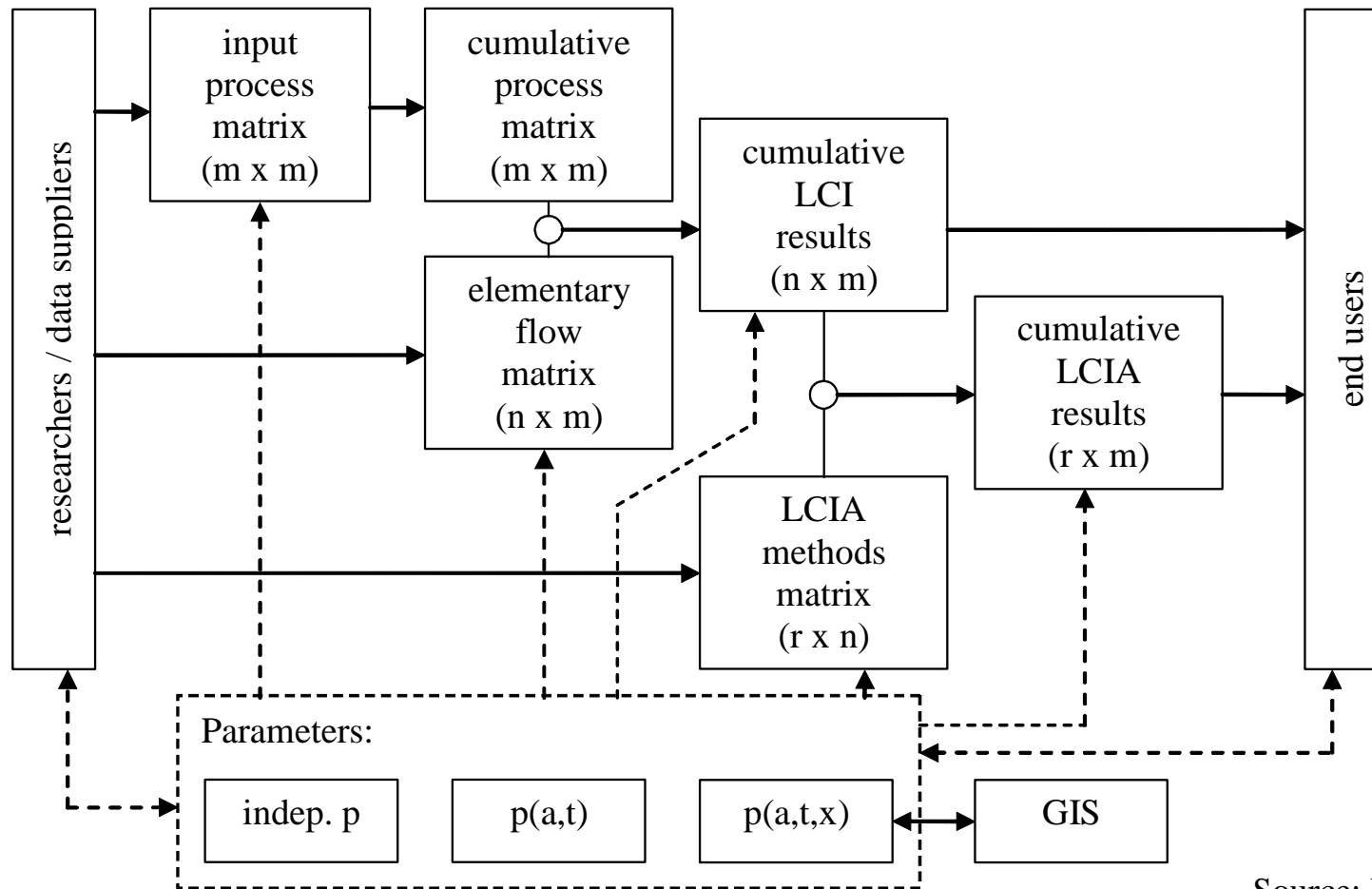


Source: Heck et al. 2009

$m \approx 4000$, $n \approx 1000$, $r \approx 200$ (as of year 2009)

Elementary flows = emissions, land use, resource use

Proposed structure of parameterized LCA system

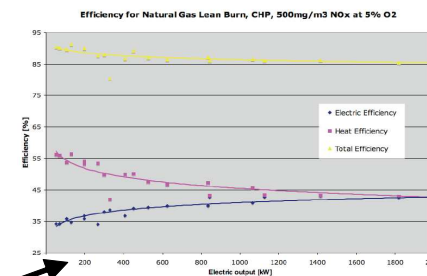
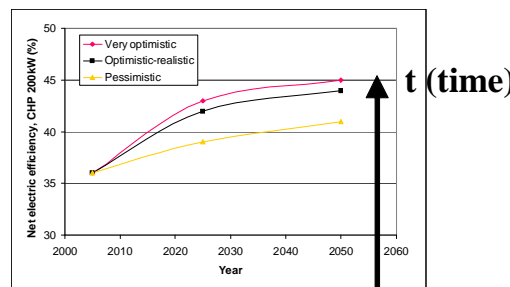


t = time, x = space, a = technology/other. GIS = Geographical Information System

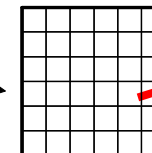
Source: Heck et al. 2009

Regionalization/space-dependency embedded in general parameterization concept

„Three dimensions“ of parameterization:



x (space)



focus
 in this
 presentation

Parameterization concept, see:

T. Heck, C. Bauer, and R. Dones (2009). *Development of parameterisation methods to derive transferable life cycle inventories - Technical guideline on parameterisation of life cycle inventory data*. Report RS1a D4.1, NEEDS (New Energy Externalities Developments for Sustainability). European Commission. (www.needs-project.org/2009).

EcoSense model (Europe) for impact + EC assessment

developed at
 IER Stuttgart, EU
 project ExternE

Air quality model

+ ISC local
 10km x 10km
 + SROM
 regional
 ozone model

Emission data
 needed for:
 WTM air quality
 modelling domain

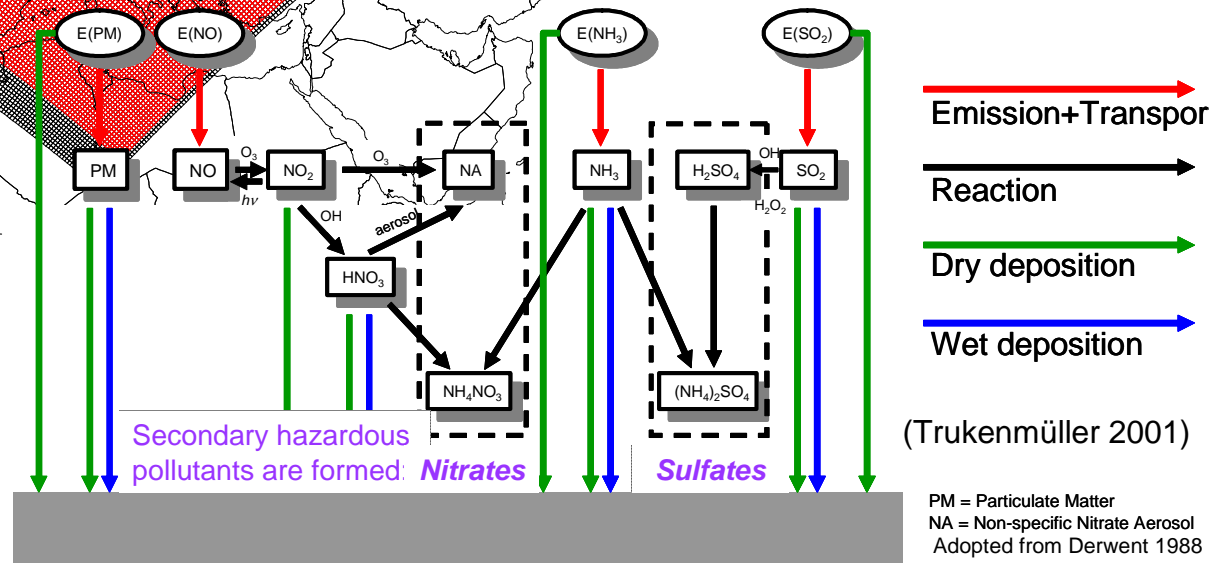
Impact assessment
 modelling domain

Grid about 50km x 50km

Emissions: PM (Particulate Matter),
 SO₂, NO_x, NH₃, CO, organic
 compounds, heavy metals

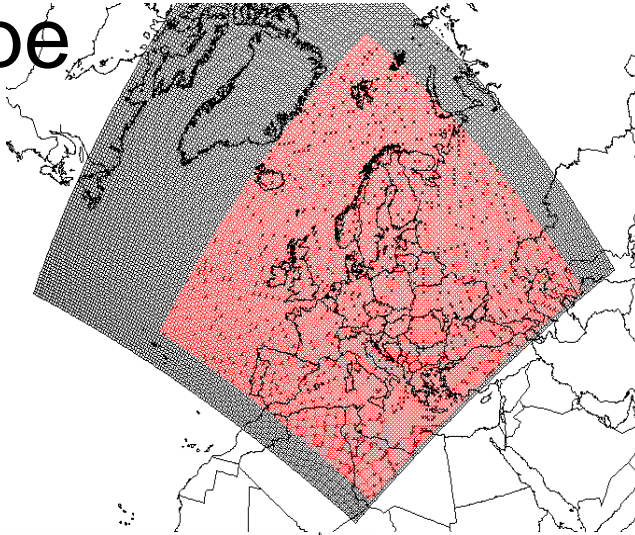
EC = External Costs

WTM Windrose
 Trajectory Model

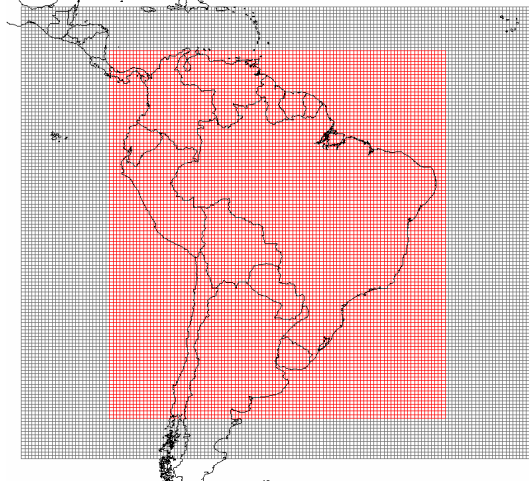
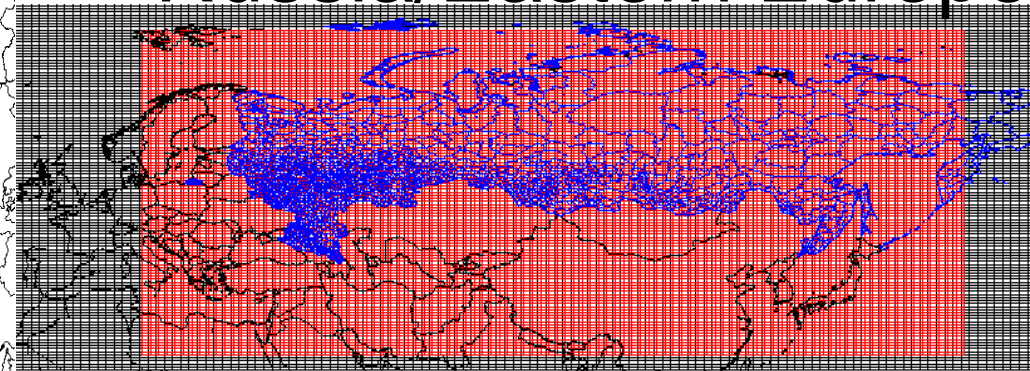


EcoSense Model, Multi-Source Versions (derived from ExternE)

Europe

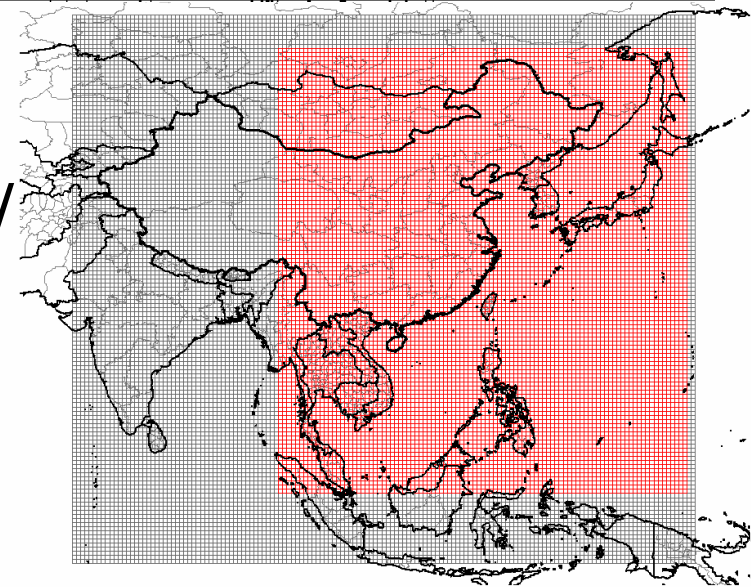


Russia/Eastern Europe



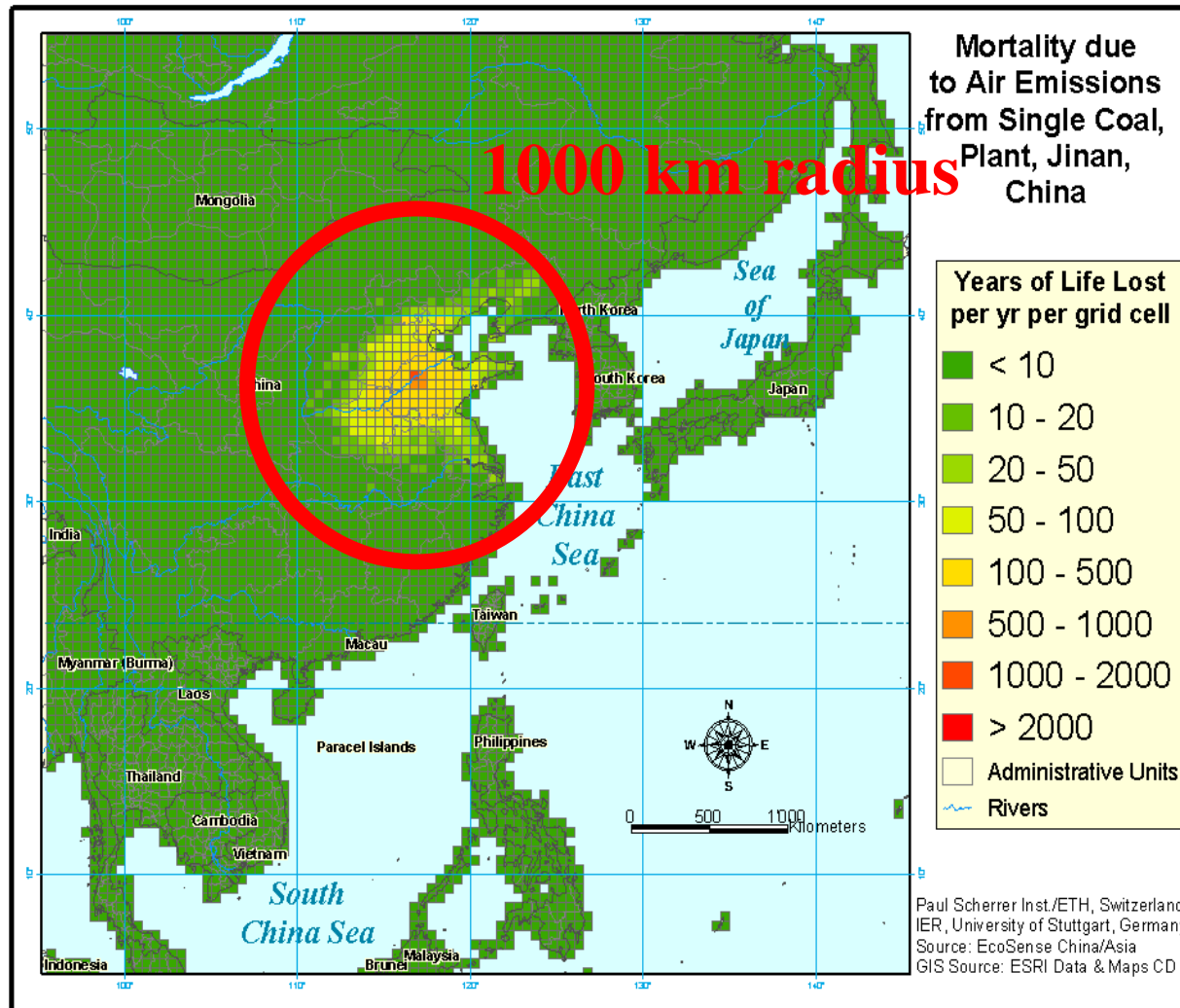
Brazil/
South
America

China/
Asia
(IER+PSI)



EcoSense multi-source versions developed at IER Stuttgart (Heck et al.)

Mortality due to Air Pollution – Jinan (China) Coal Power Plant



Single-source calculation

Coupling to LCA:
 Rest of chain
 has to be added
 (minor contribution
 in this case)

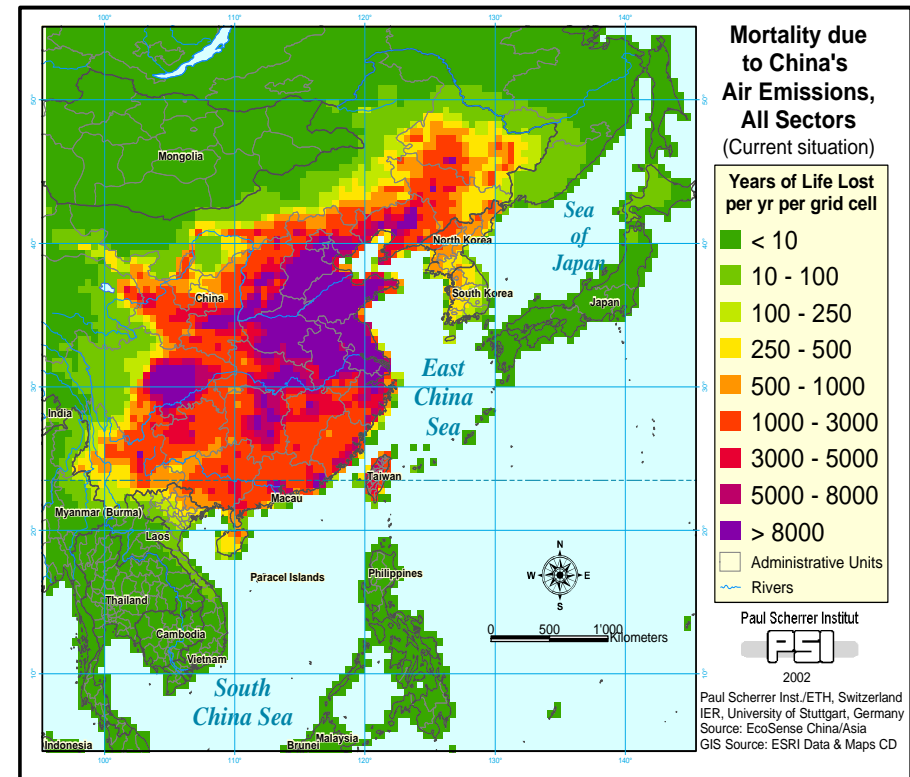
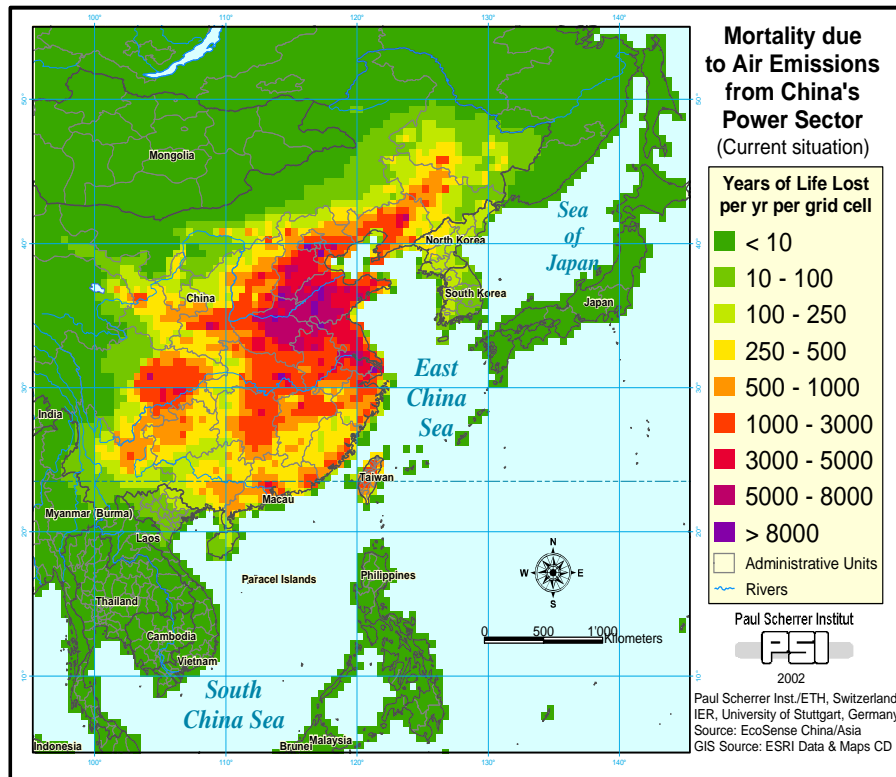
Source:
 Heck 2007

Mortality impacts due to Air Pollution from China

Multi-source calculations

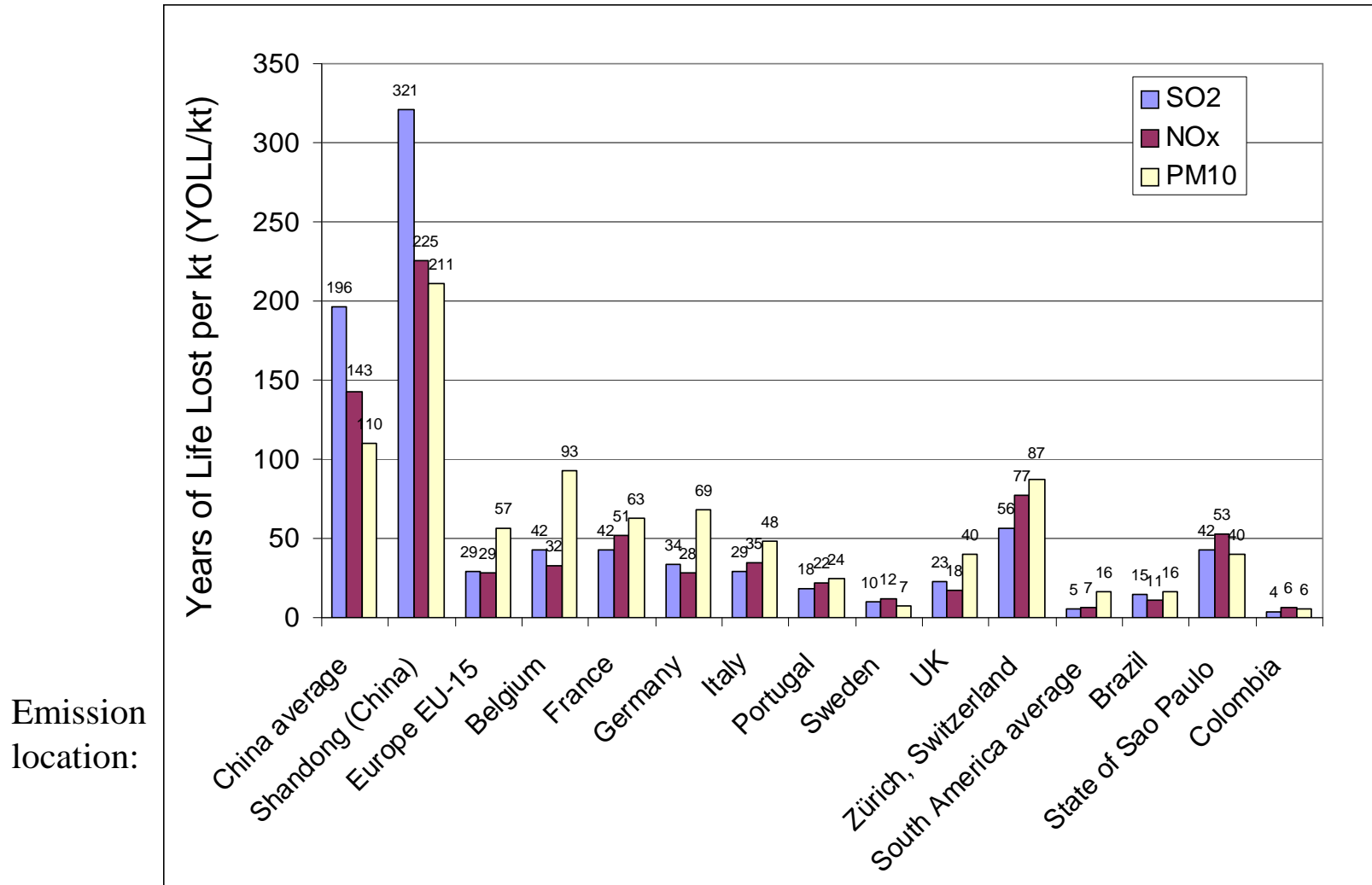
Emissions from Power Sector

Emissions from all Sectors



Source: Heck et al. 2003, published in Hirschberg et al. 2003

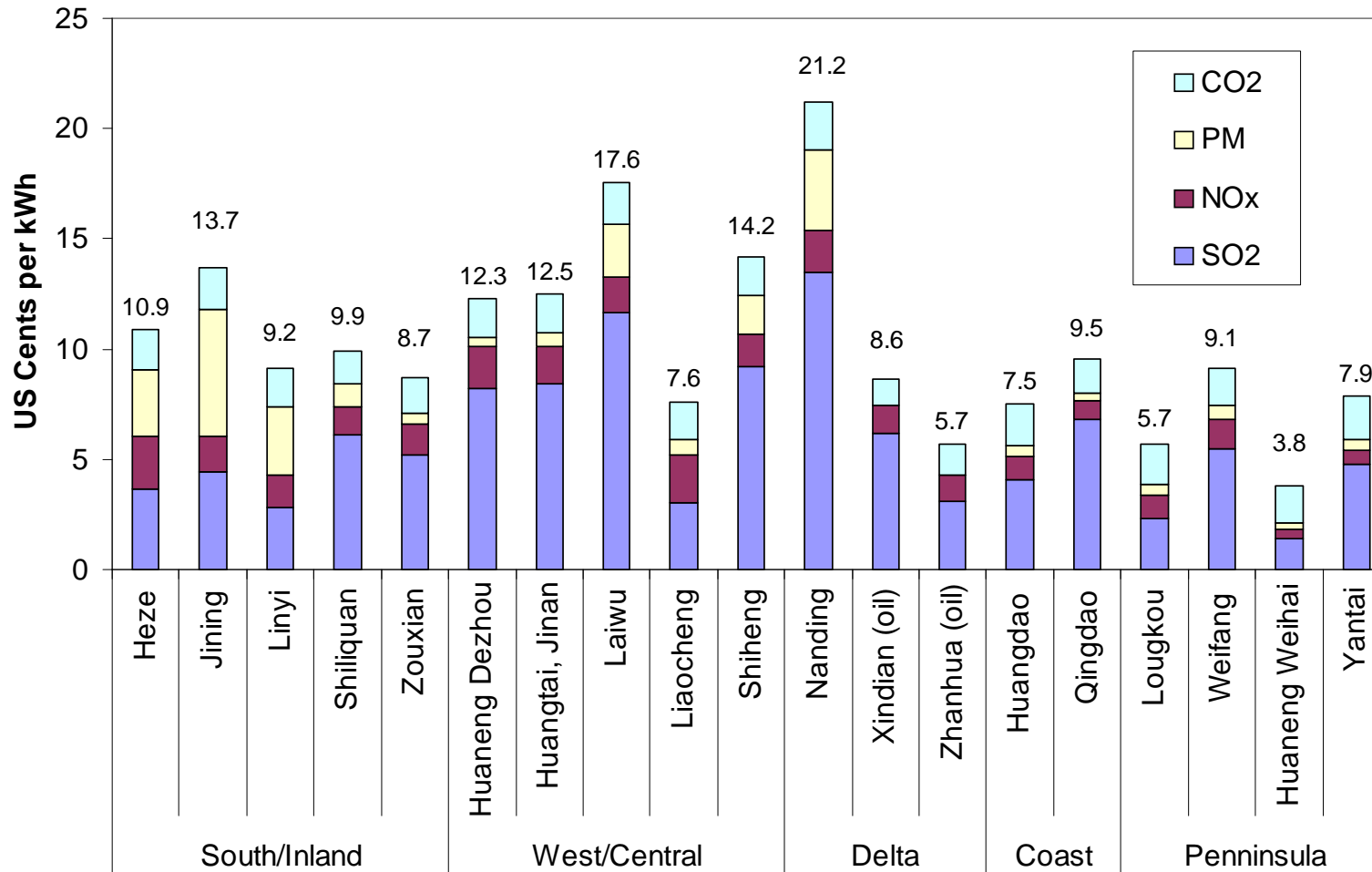
Mortality per Unit Air Emissions for Different Locations of the World



Sources: EcoSense calculations, Krewitt et al., Heck et al., Hirschberg et al.

Aggregated: External costs per kWh electricity in Shandong (China)

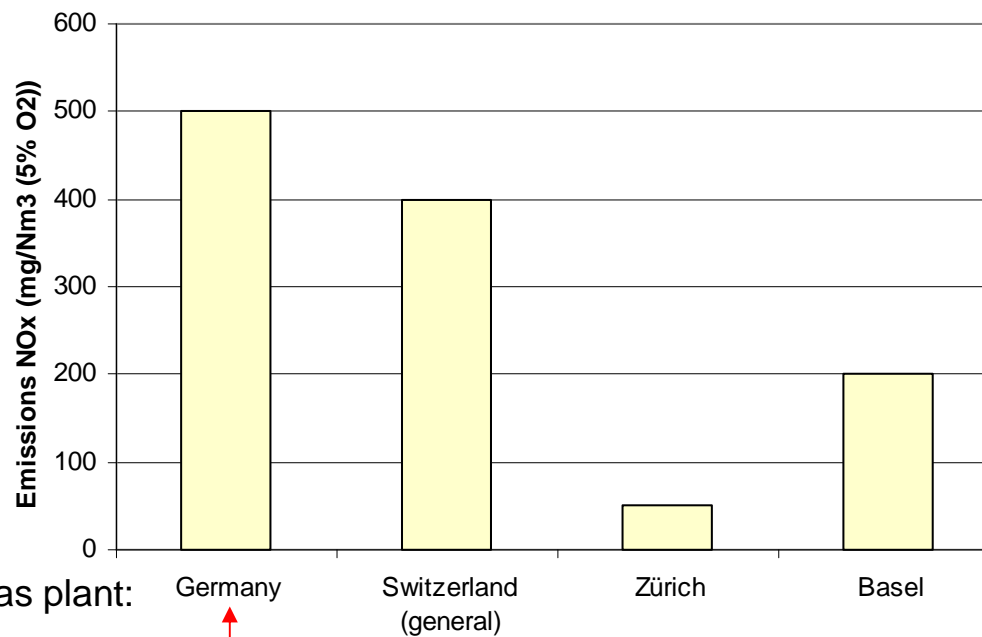
including LCA



Source: Hirschberg et al. 2003

Example: Site-specific emission limits for biogas plant

Assumption: The same biogas combined heat and power (CHP) plant type considered at different locations adjusted to NO_x emission limits.



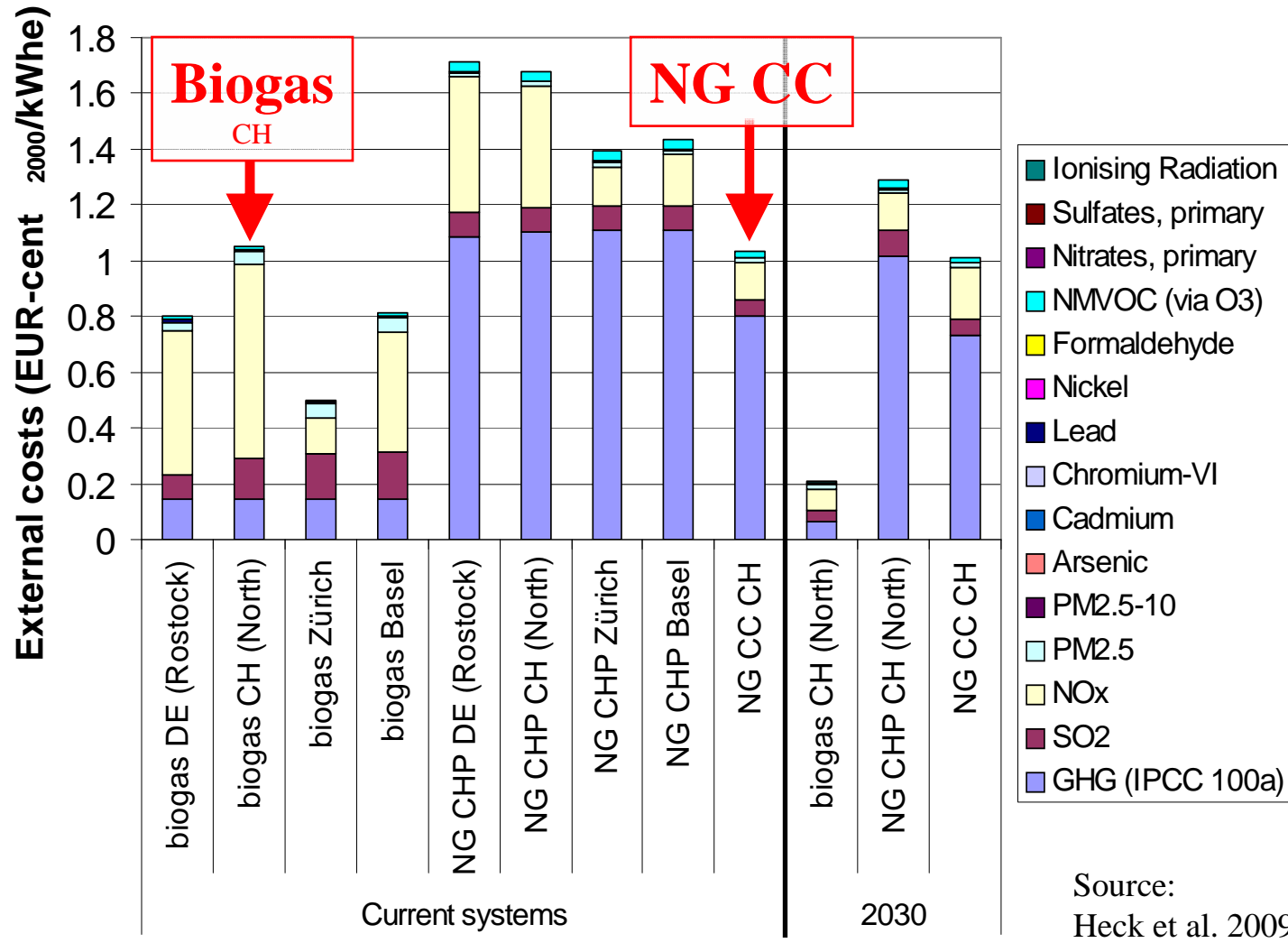
Sources:
 TA-Luft Germany 2002,
 LRVA Switzerland 2005,
 Brättig 2003,
 Tehlar 2007.

Location of biogas plant:

Conclusion from LCIA with constant (global) impact factors would be that the first biogas plant is associated with highest impacts.

But look at site-specific calculations (next sheet) ...

Example: Site-specific EC+LCA: biogas/natural gas



With
 19Euro/ton CO2
 Combined Heat
 and Power (CHP):
 exergy allocation
 NG=Natural Gas
 CC=Combined Cycle

Conclusions

Environmental impacts due to emissions depend in many cases strongly on the location of the emission sources.

Regional or local impacts have to be considered in general (global impact factors can lead to wrong conclusions).

Appropriate spatial resolution has to be considered (non-trivial) -> software solutions should be kept flexible.

Coupling of life cycle assessment and environmental impact assessment is essential for a comprehensive assessment of systems.

Parameterization is a practical approach to combine regional (or site-specific) Life Cycle Inventory (LCI) data and regional (or site-specific, resp.) impact assessment.

Space-dependent parameters should be viewed together with other parameter dependencies (time- or technology-dependencies), e.g. in order to include future scenarios (see e.g. NEEDS project for energy systems, scenarios until year 2050).