quantifying emissions to water: sources, regional input patterns and reduction measures

Judy Libra and Joachim Heidemeier

Federal Environment Agency

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emission inventories – sources, pathways, loads

during the 1980s

- national developments in Germany
  - application of BAT as requirement for waste water discharges
    - sector regulations (generally binding rules)
    - requirements also for sewer discharges (incl. SME)
    - start of implementation of nutrient removal in UWWTs
- international initiatives in the marine conventions
  - common goal »50-80% reduction of inputs to the marine environment from nutrients and certain hazardous substances « from 1985-1995

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emission inventories – sources, pathways, loads

problem – how to determine input loads?

- riverine loads
  - influence of discharge pattern
  - demonstration of effect of measures difficult
- regionalised input balances – point and diffuse sources

solution – MOdelling of Nutrient Emissions in RIver Systems

- MONERIS developed as reporting tool [a]
  - currently available for nutrients, heavy metals and selected organics
  - continuous development for growing number of applications

[a] Behrendt u. a. (1999),Fuchs u. a. (2002)

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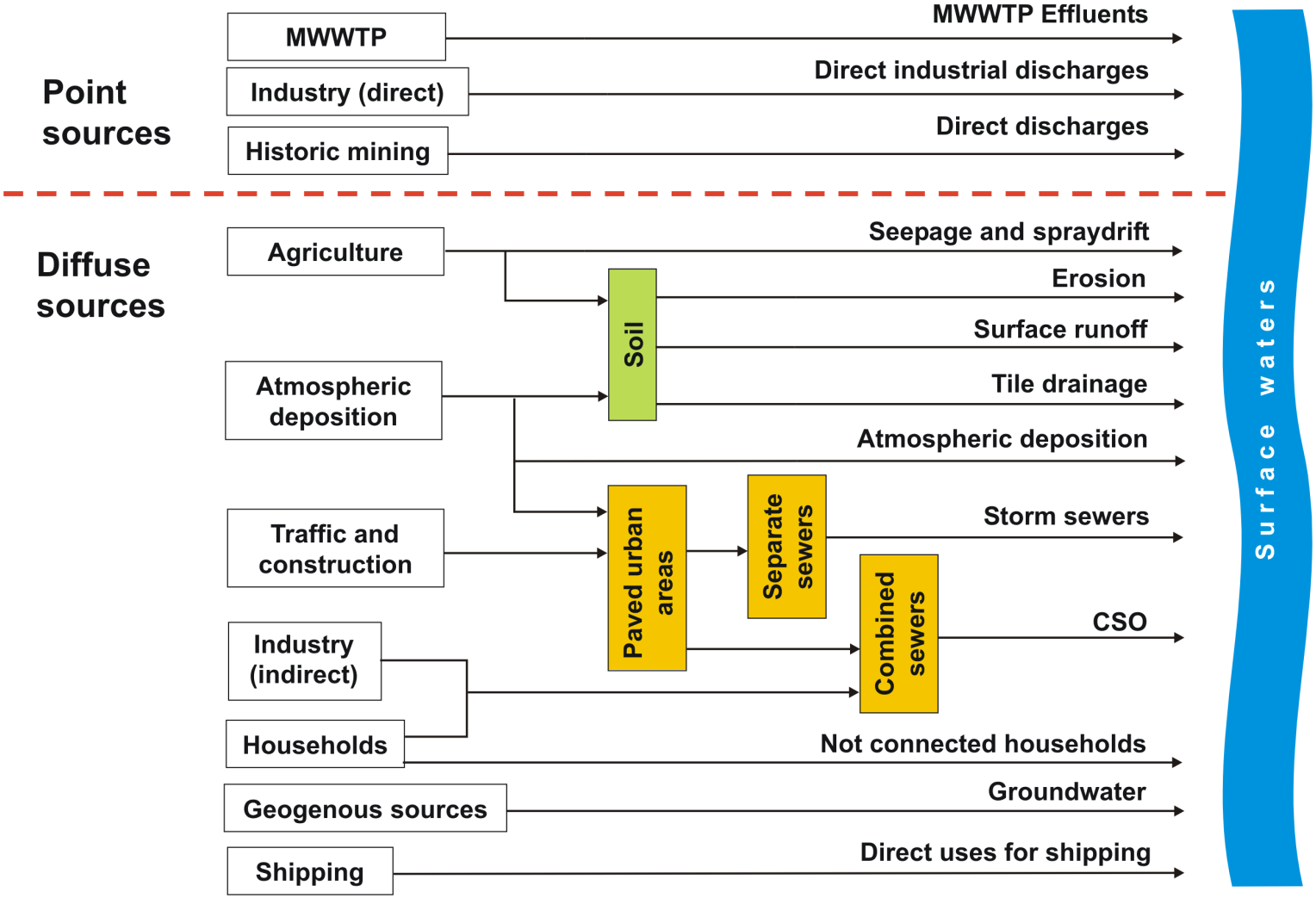
MONERIS - conceptual approach



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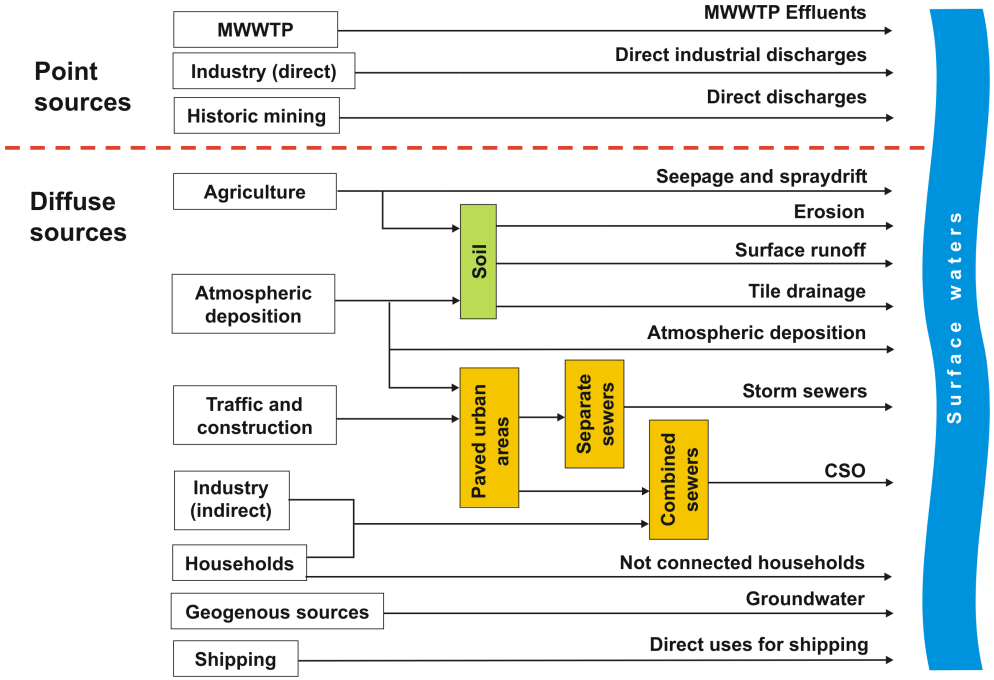
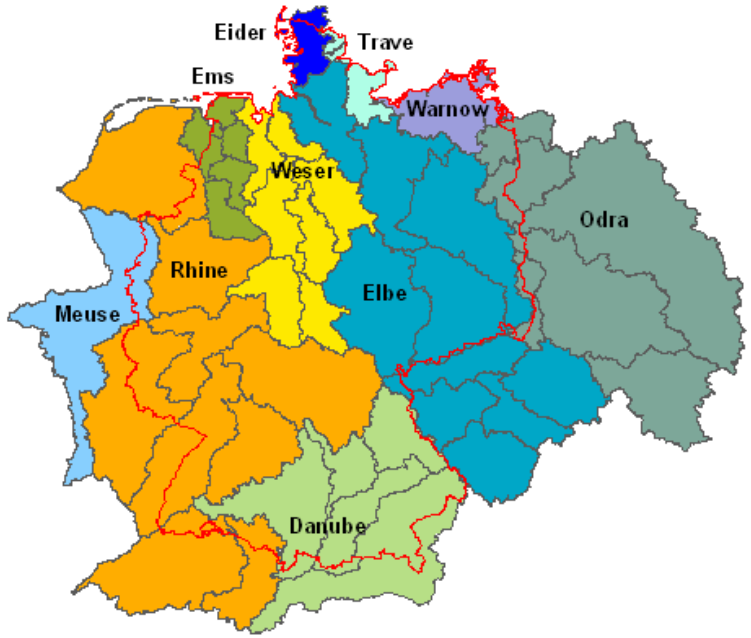


regionalisation: river catchments



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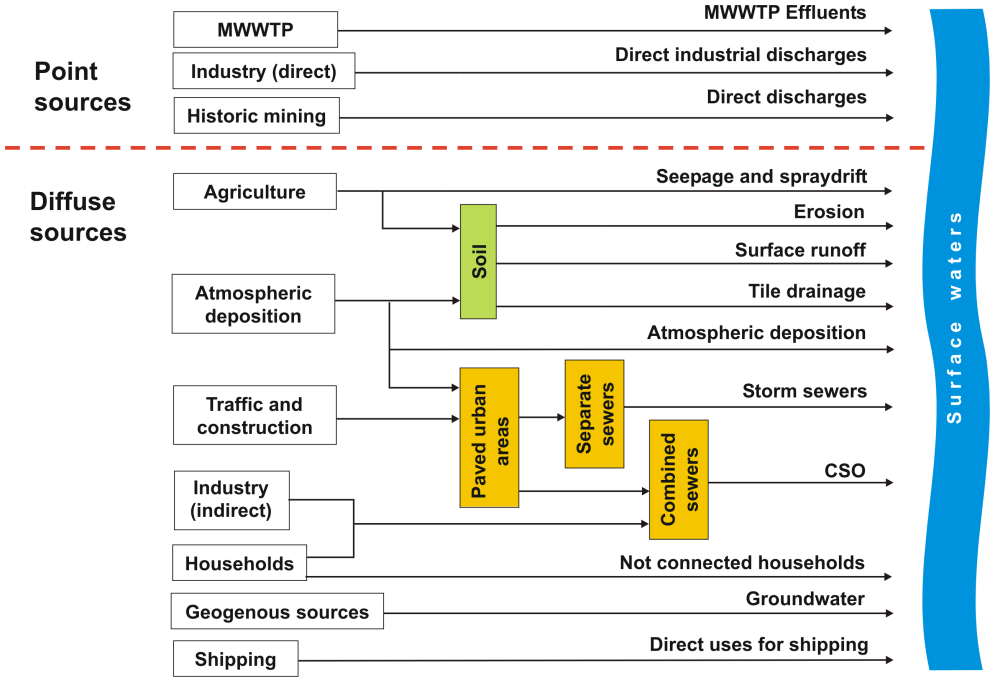
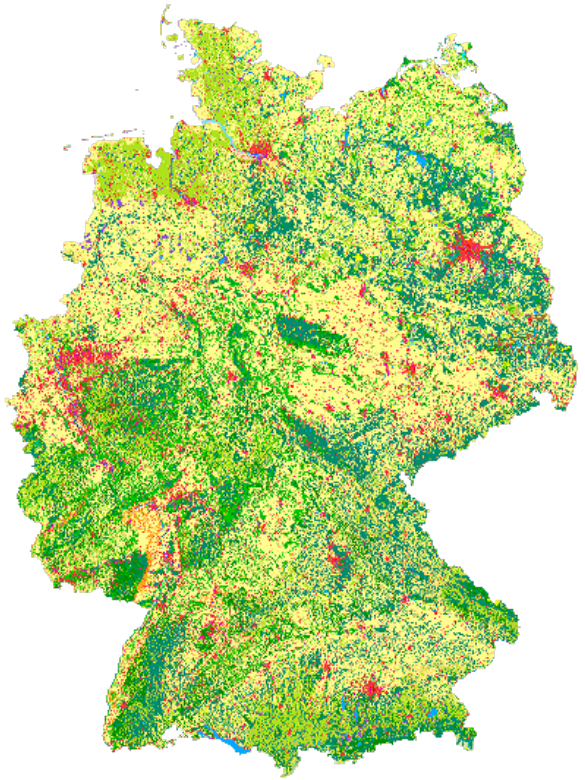


input data
corine land cover



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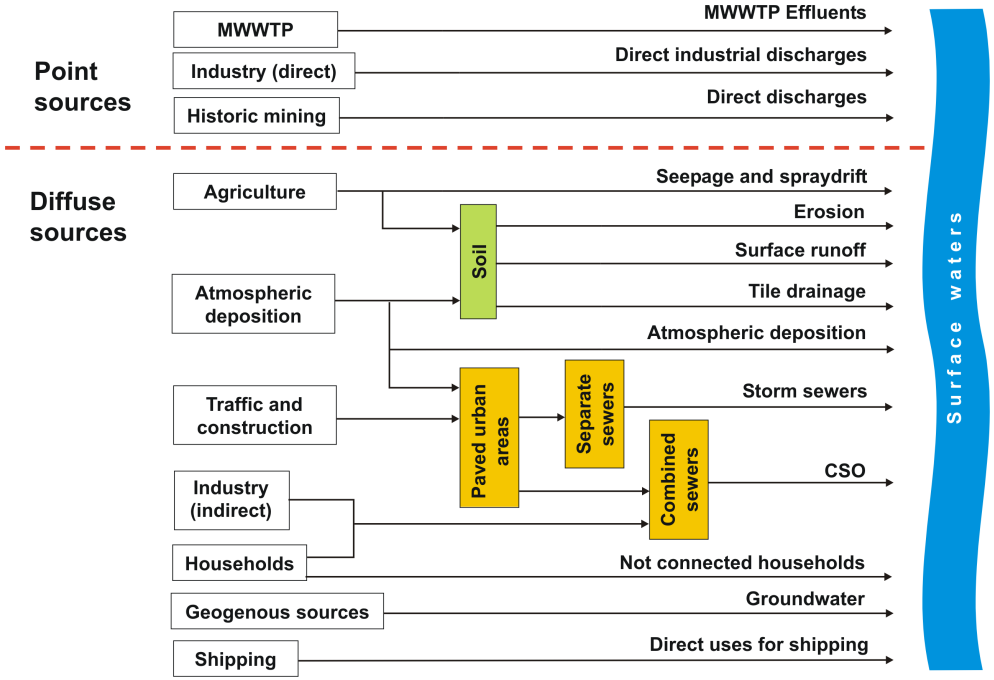
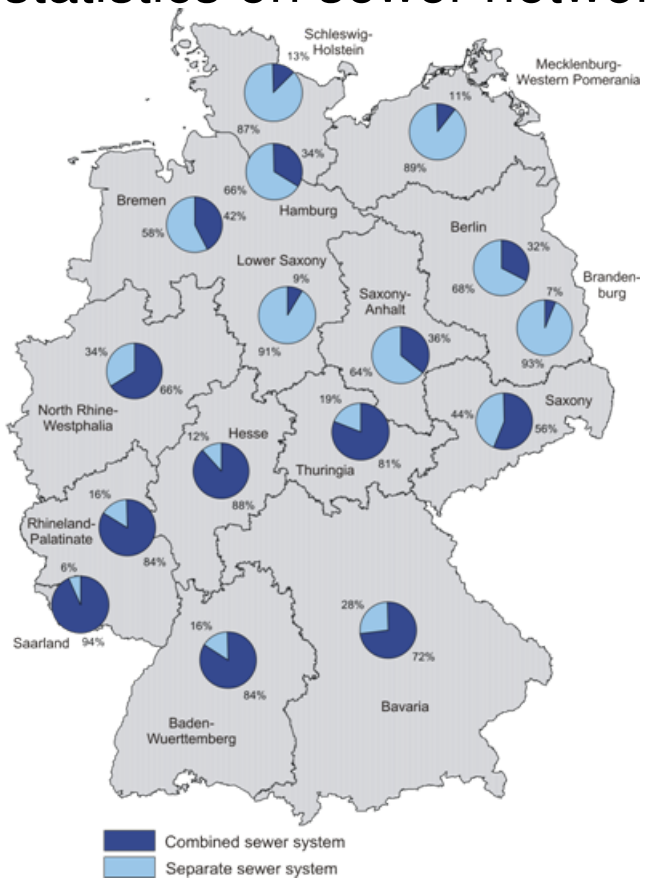


input data
statistics on sewer network



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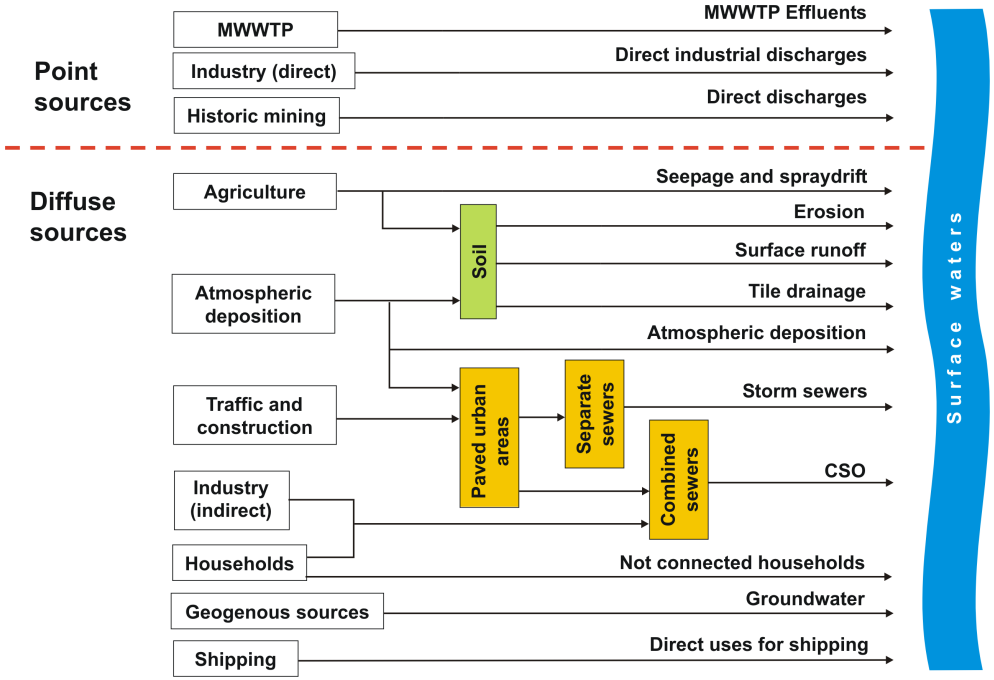
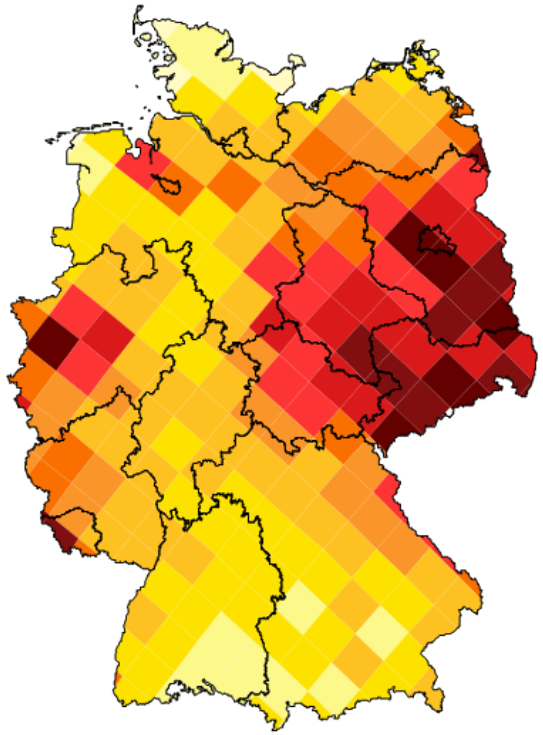


input data:
deposition data



MONERIS - conceptual approach

- empirical catchment based model
  - semi-static model for nutrients and heavy metals
  - suited for catchments $\geqslant 100\,km^2$: in DE ~ 3000 catchments
- approach
  - annual loads per catchment via various »pathways« including diffuse and point sources
  - short term hydrological effects averaged out thru 3-5 year aggregation
- results
  - riverine outflows using retention along river net
  - aggregation of pathways for origin (e.g. agriculture)
  - good agreement with measured load
- ongoing extension als scenario tool

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MONERIS - conceptual approach

but:

- no explicit information and quantification of sources (e.g. use pattern of substances)

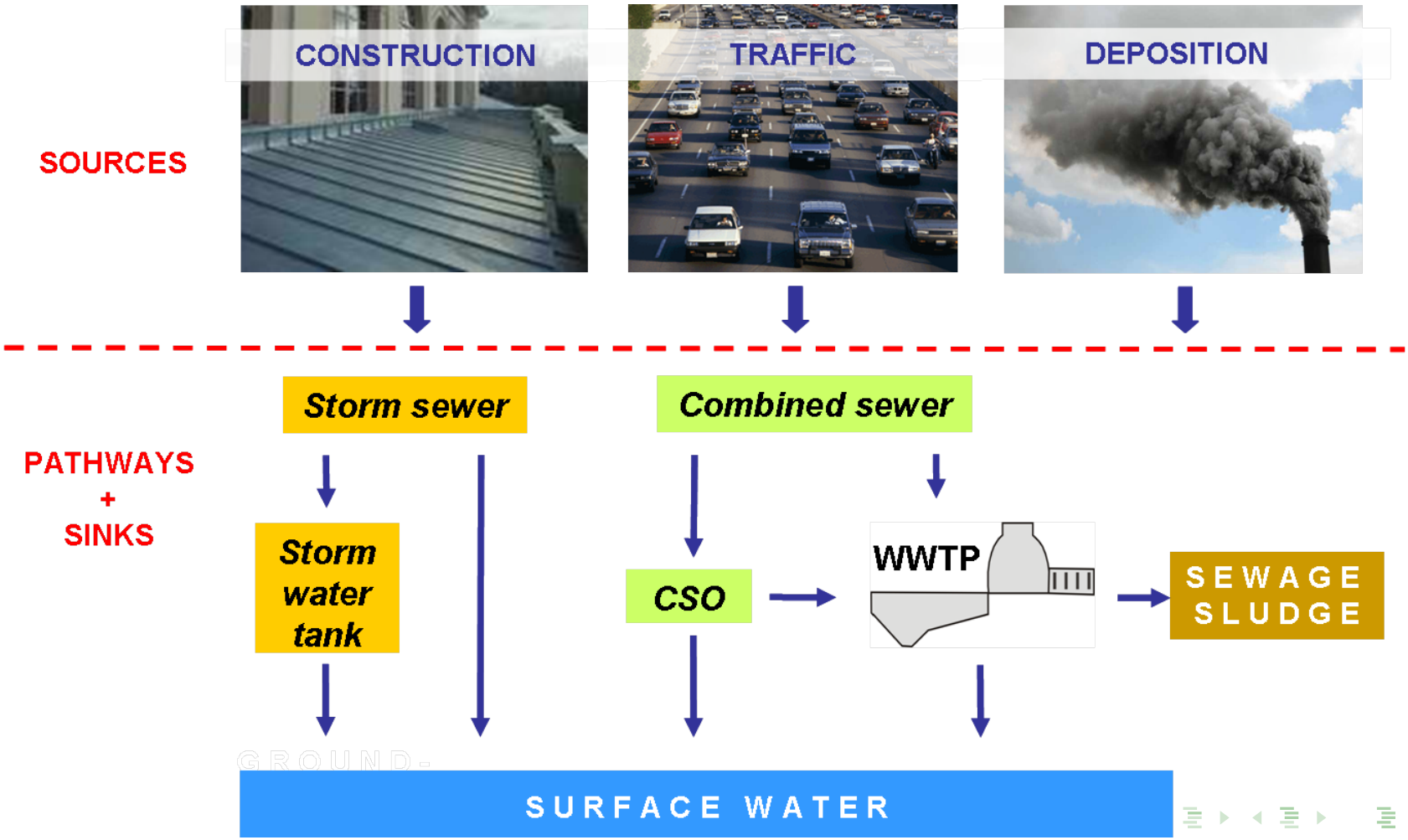
so:

- complementary approach necessary – material flow balance[a]

[a] Böhm u. a. (2002),Hillenbrand u. a. (2005),Hillenbrand u. a. (2007)

material flow balance

example copper: production, utilization and emissions



material flow balance

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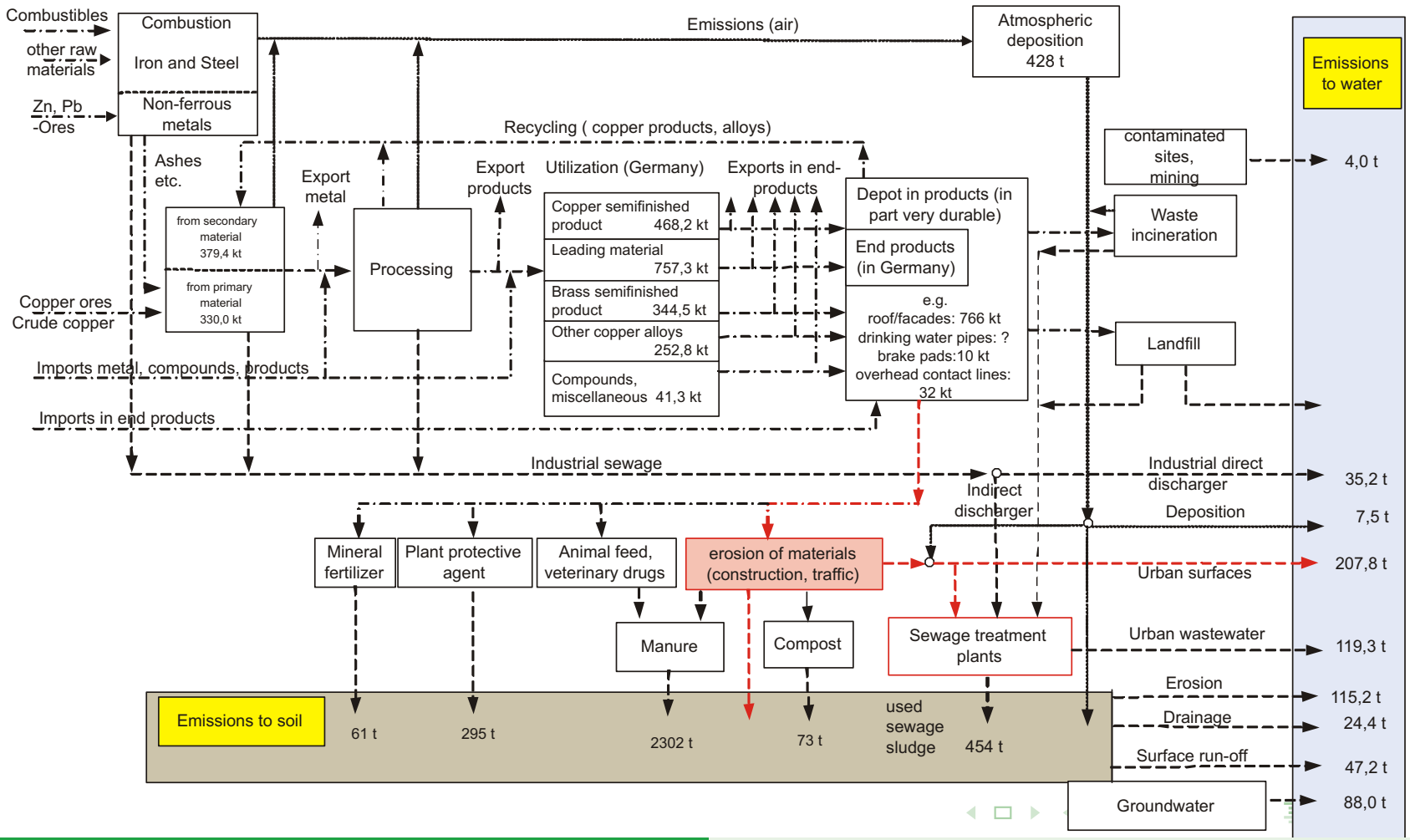
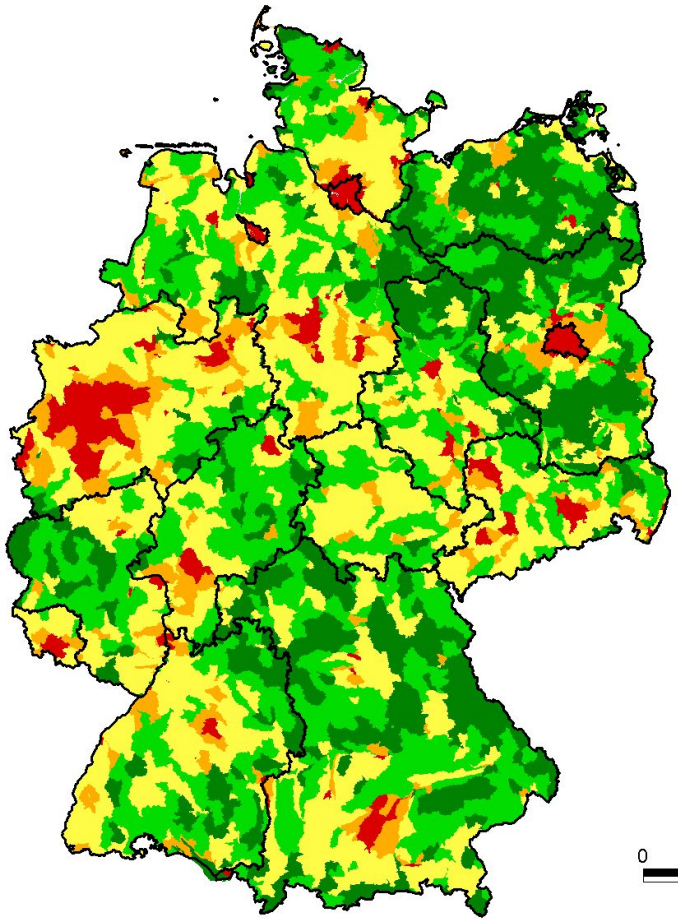


results: regionalised emissions

heavy metal emissions



Specific emissions of Zinc
into surface waters
via urban systems
for the period of 2003-2005

Zinc [g/(ha a)]

- 0 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- > 100

0 100 200 300 Km

N

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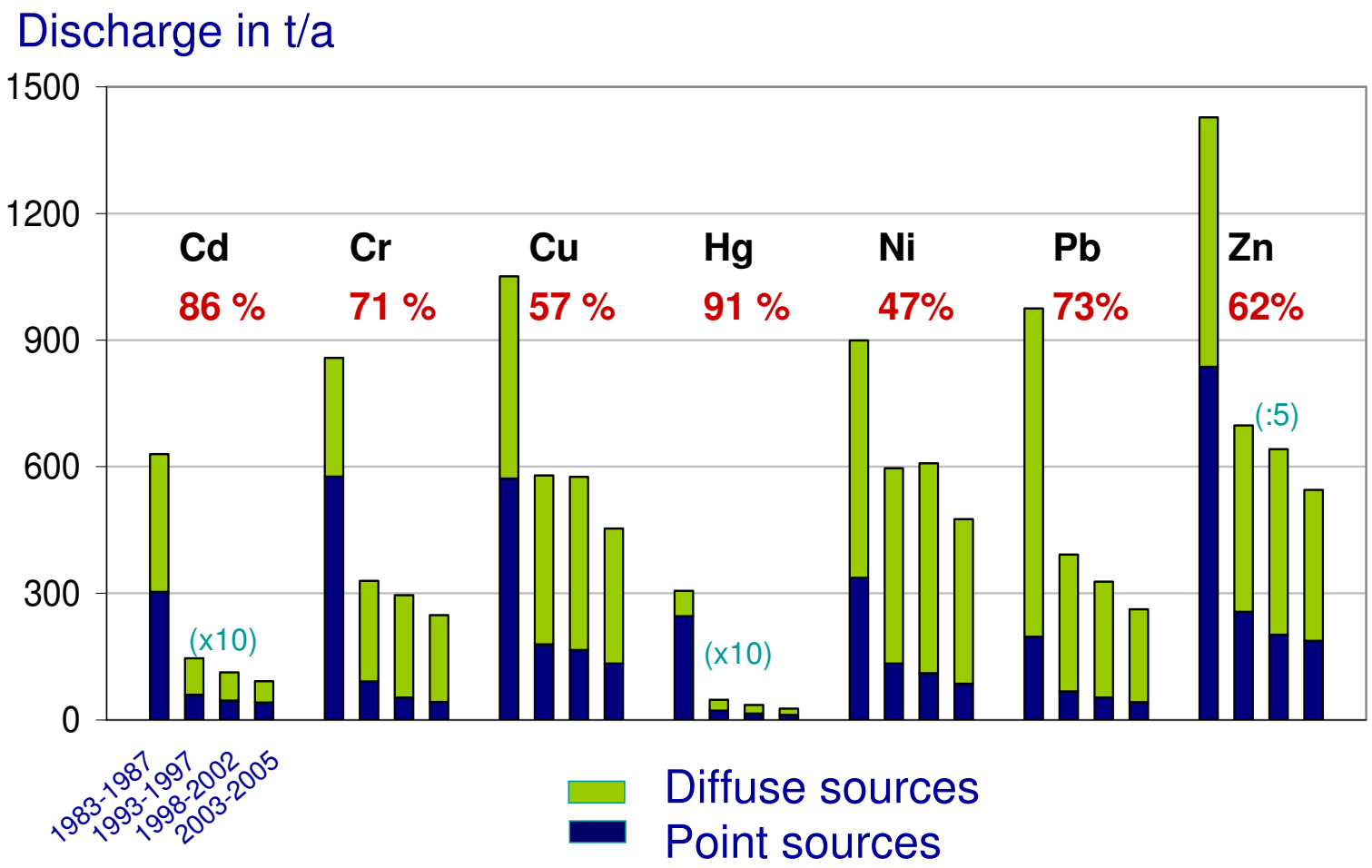
changes over time

heavy metal emissions



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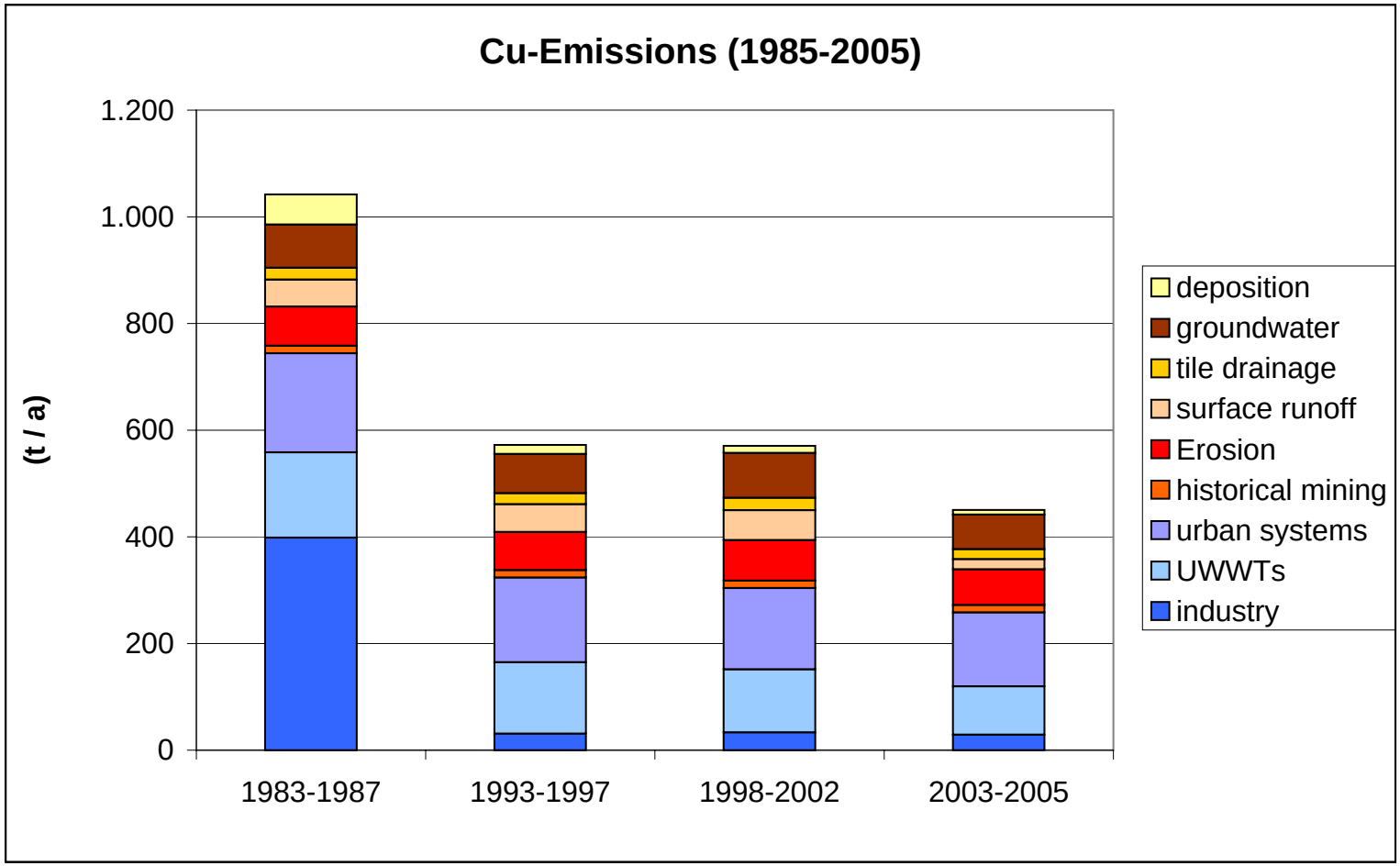

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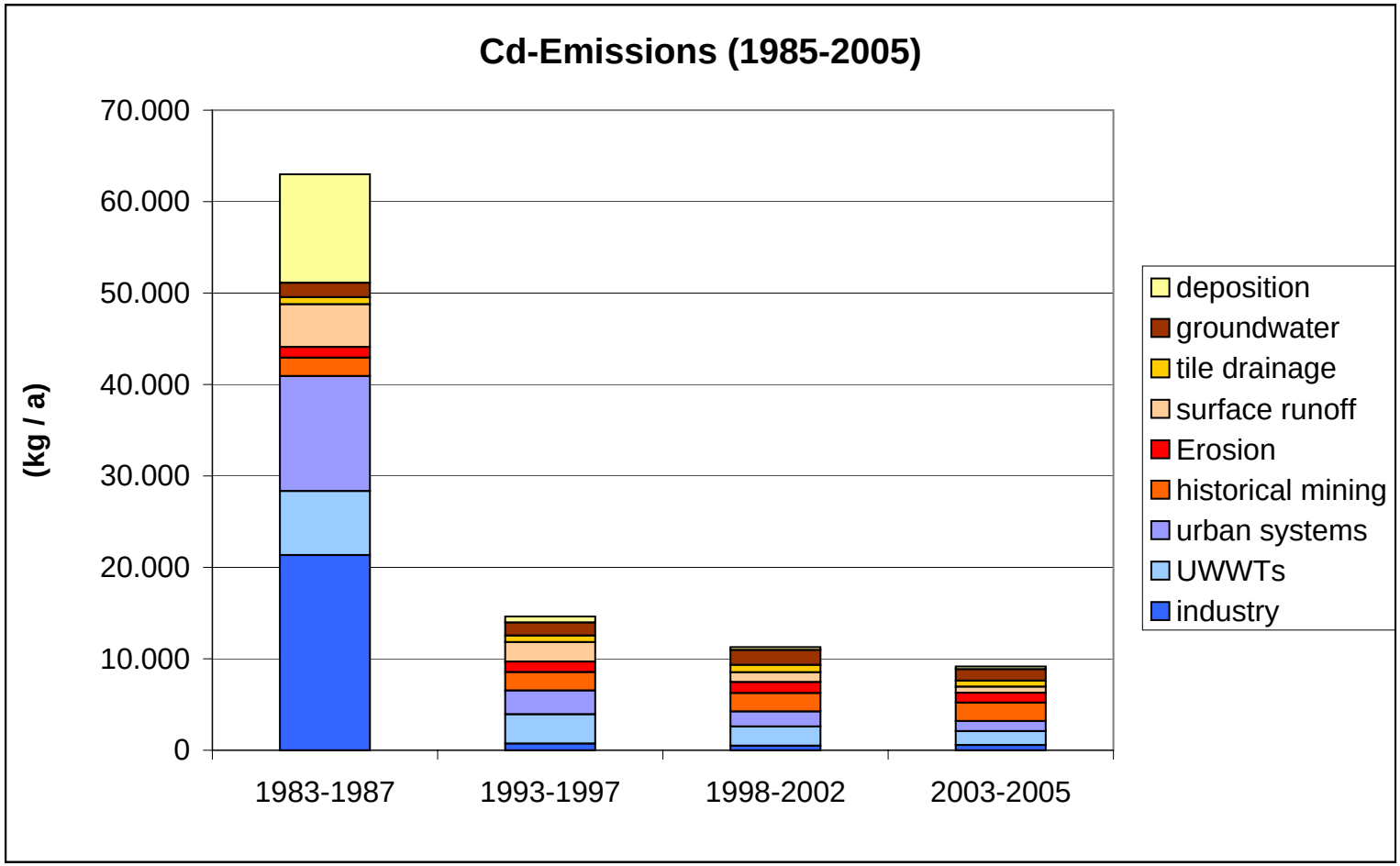

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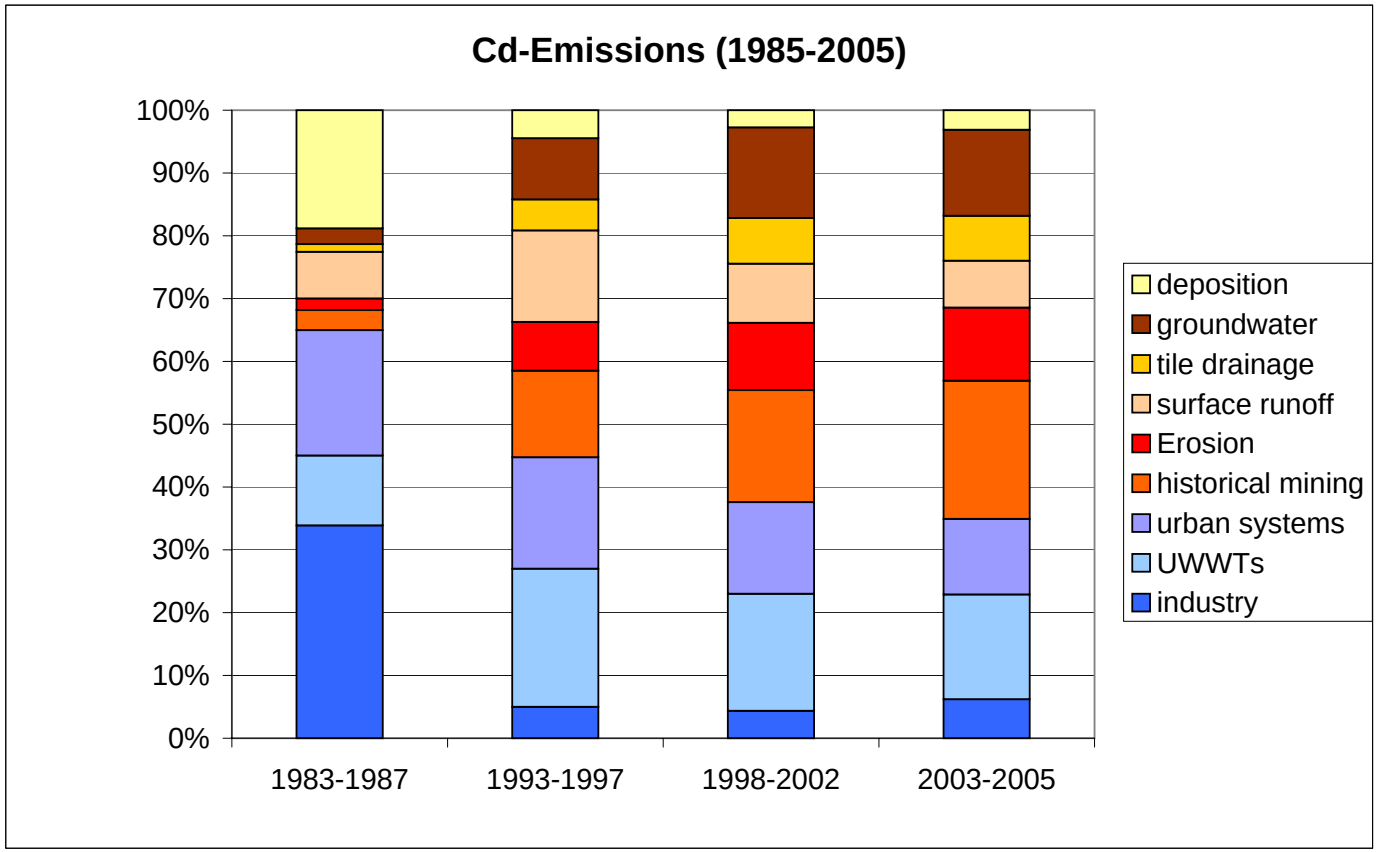

key findings

- clear reduction of point sources
  - industrial direct discharges
  - municipal discharges
- less reduction from diffuse sources
- urban areas important source
  - no correlation to industrial discharges in sewers (BAT for SME since 1980s)
  - possible diffuse sources drinking water supply, construction material, traffic
- erosion processes

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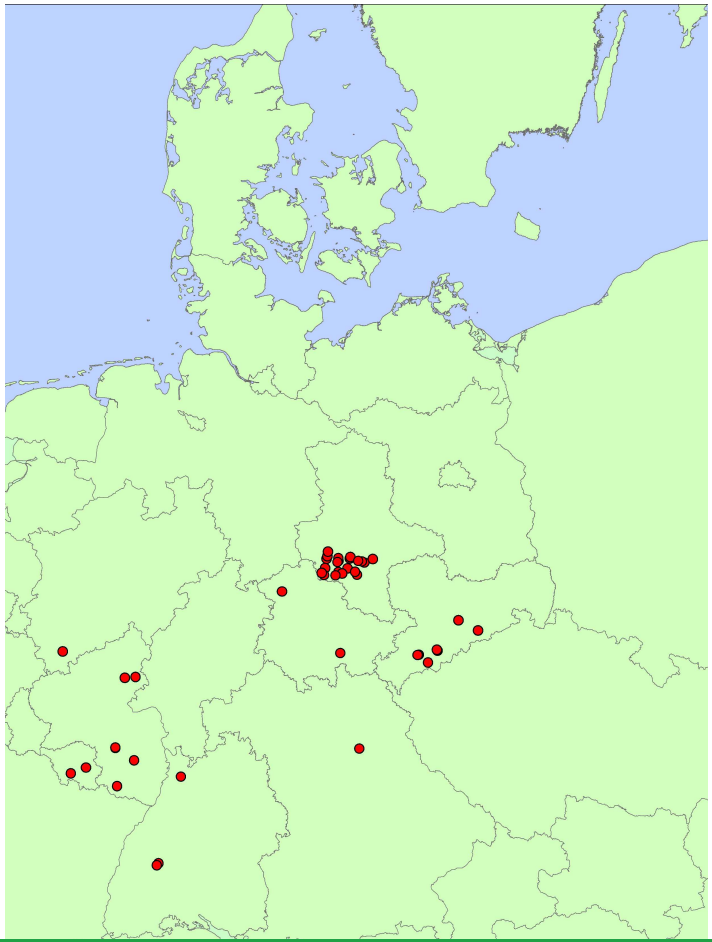
historical mining activities

relevance and regional distribution



- relevant source for DE
- ~ 20 % Cd, 14 % Zn load for Germany
- regional problem
- ongoing data collection
- long term treatment required

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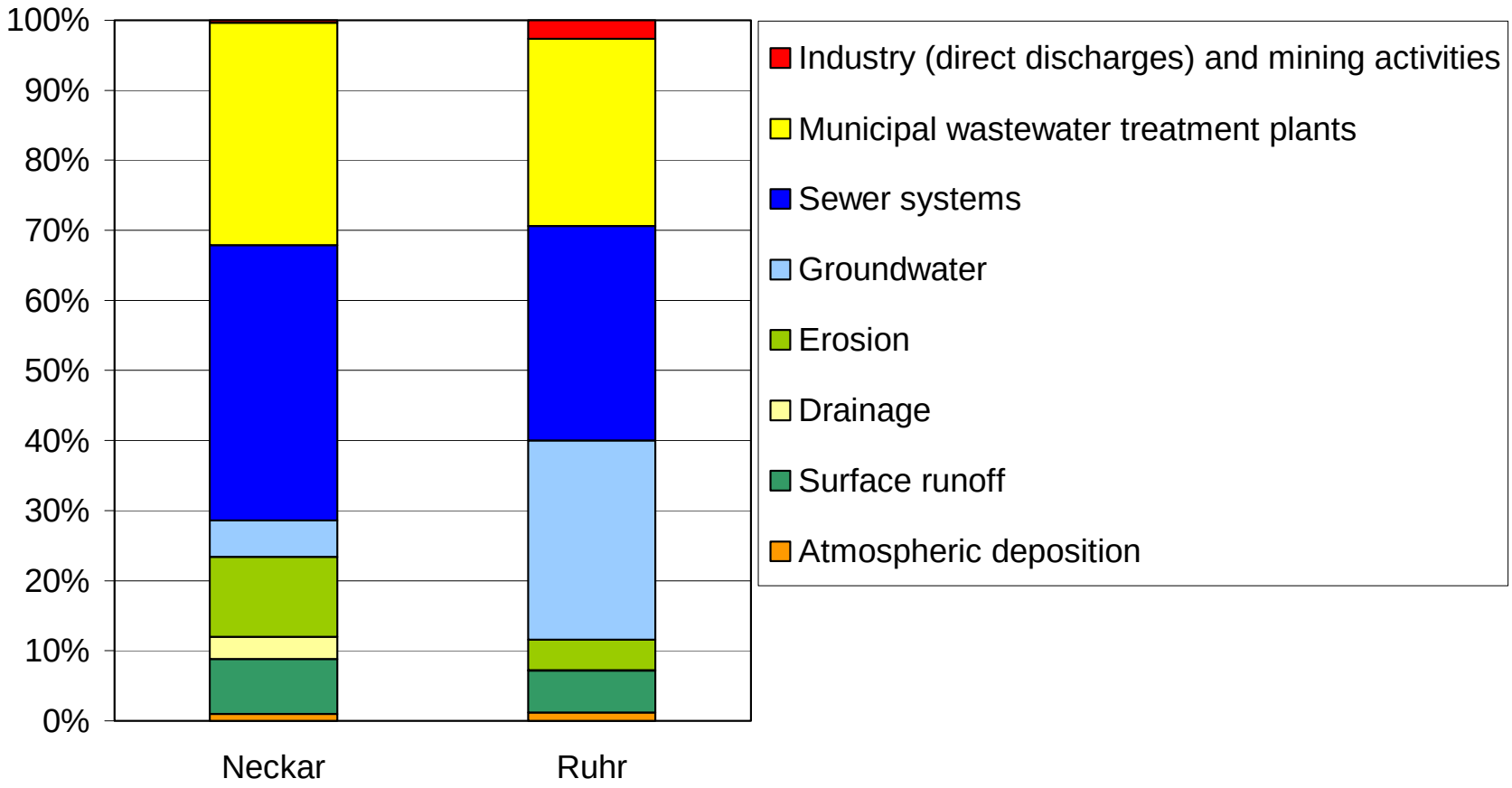
regional relevance

Zn emissions from two middle sized catchments in Germany



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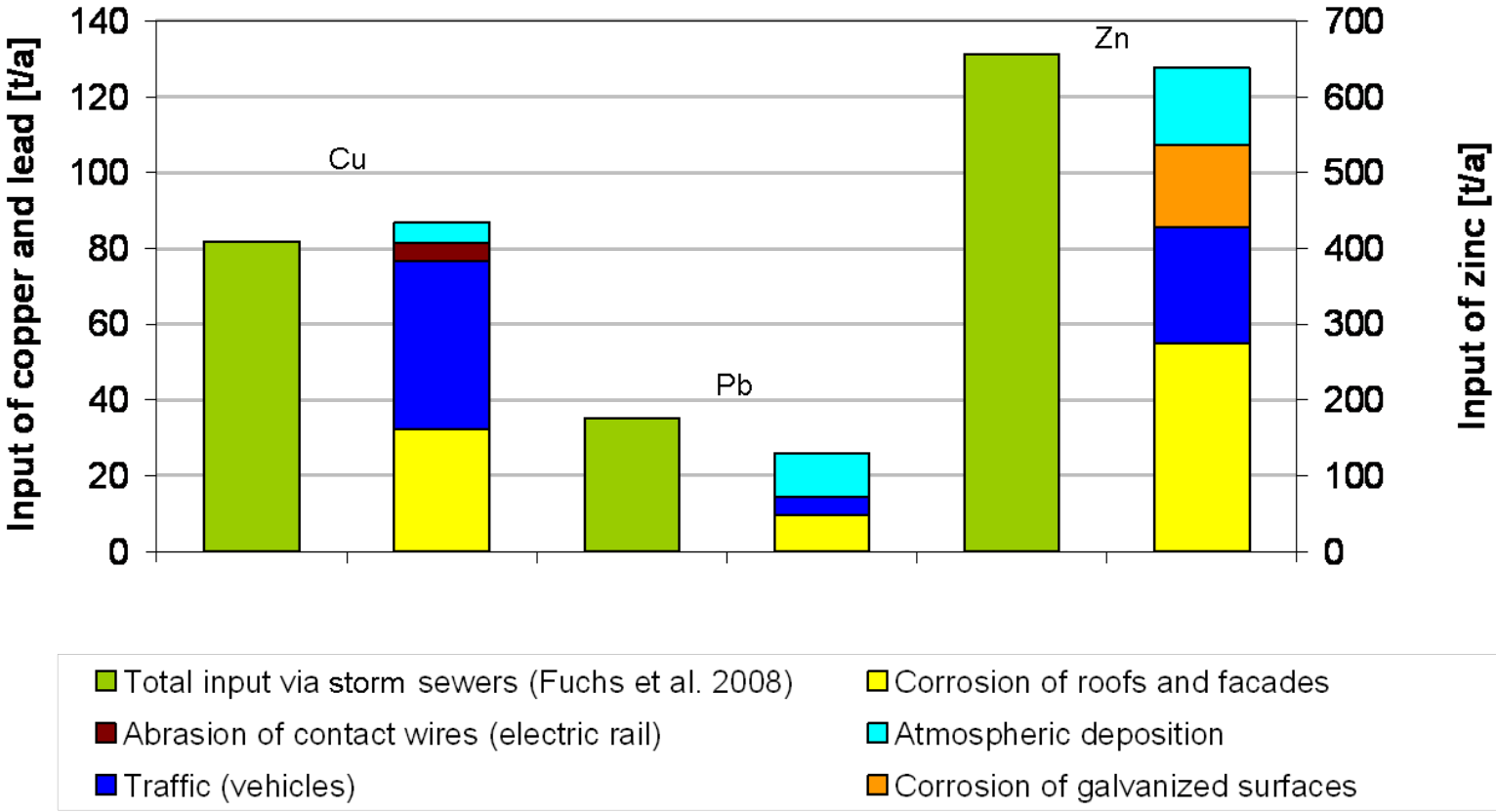
comparison of MONERIS and material flow balance

Cu, Pb and Zn emissions in DE



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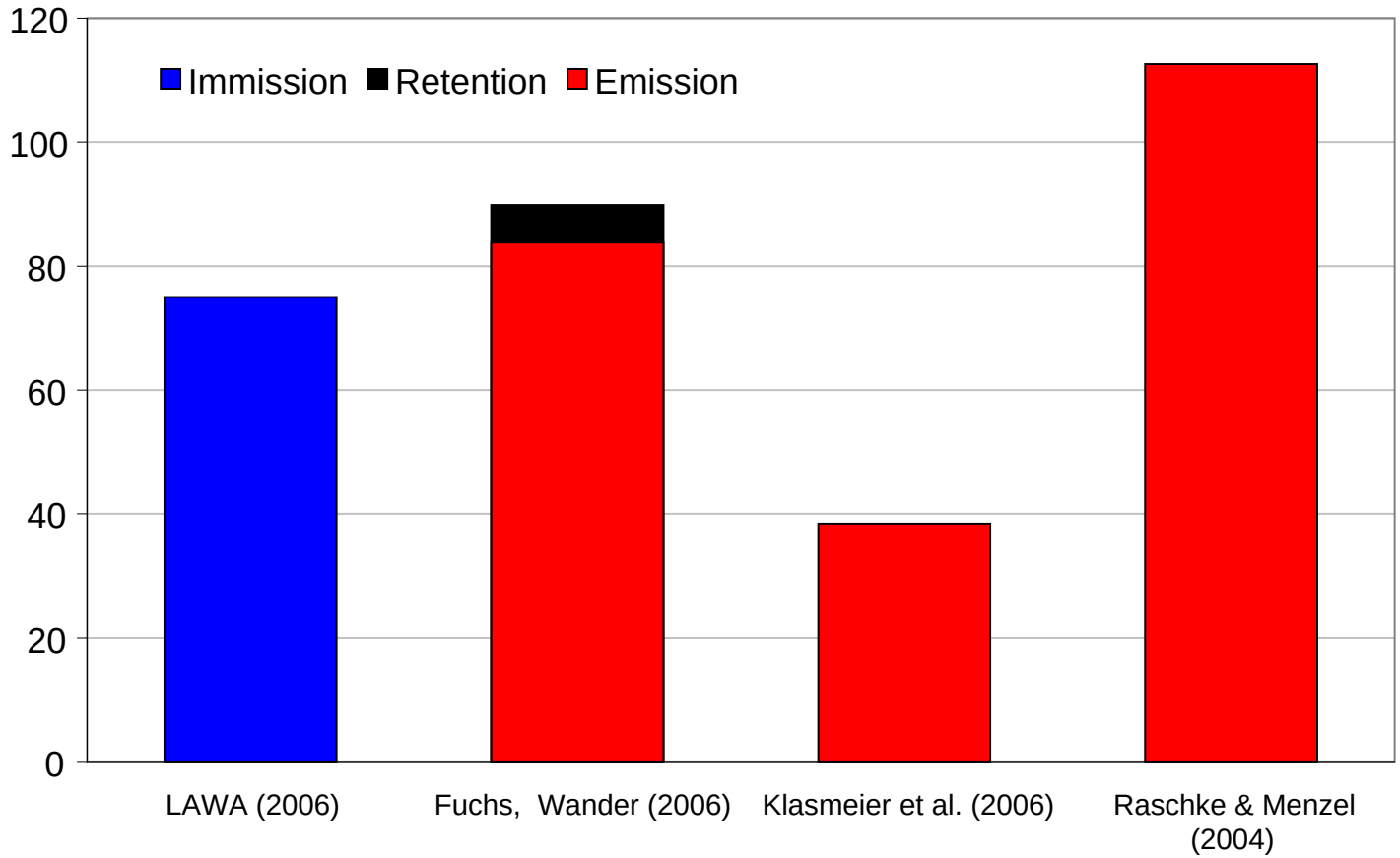
comparison of different quantification approaches

Zn emissions into the Ruhr catchment



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reduction measures

- tool box approach
  - develop variety of tools
  - adapt to region and substance
- tailor made strategies necessary
  - input pattern
  - regional patterns
  - use patterns
  - cost effectiveness
- overall legal considerations
  - product measures best at European level
  - interface problems in European legislation

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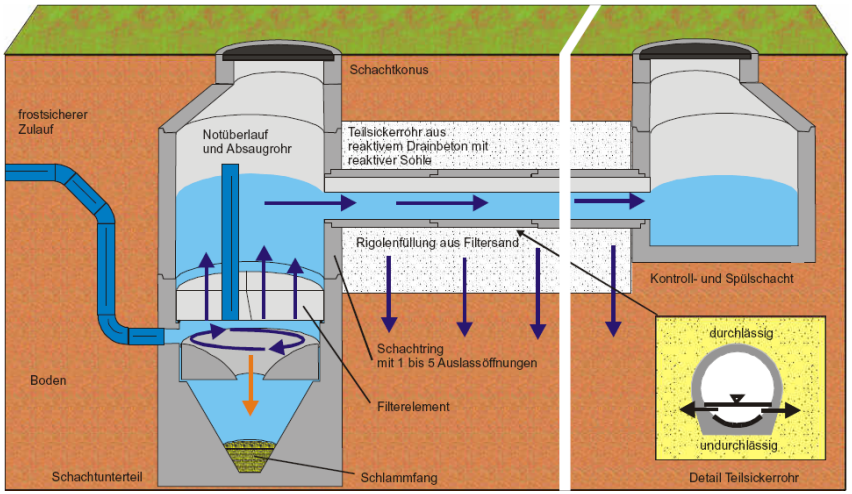
non substance-specific measures

improved stormwater handling

- decentralized pretreatment of stormwater at source
- surface desealing and infiltration of surface run-off
- improved treatment of stormwater from combined and separate sewer systems



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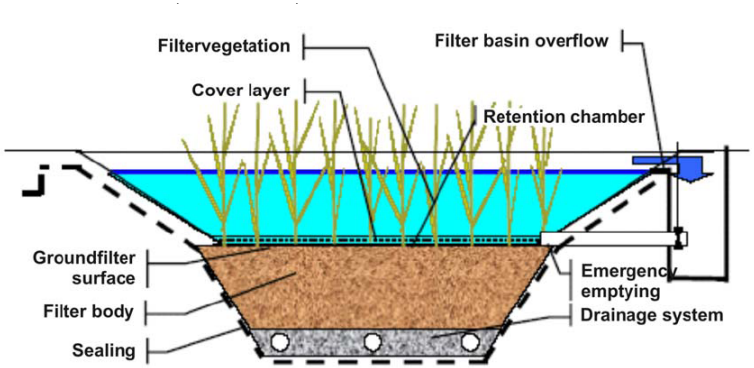


substance specific measures

- substitution, product bans (e.g.)
  - Cu, Pb containing brake pads
  - products (batteries)
  - Pb use as construction material
  - lead shot, angling equipment ...
- additional treatment as requirement
- additional coating of zinc galvanized materials
- central softening of drinking water ....

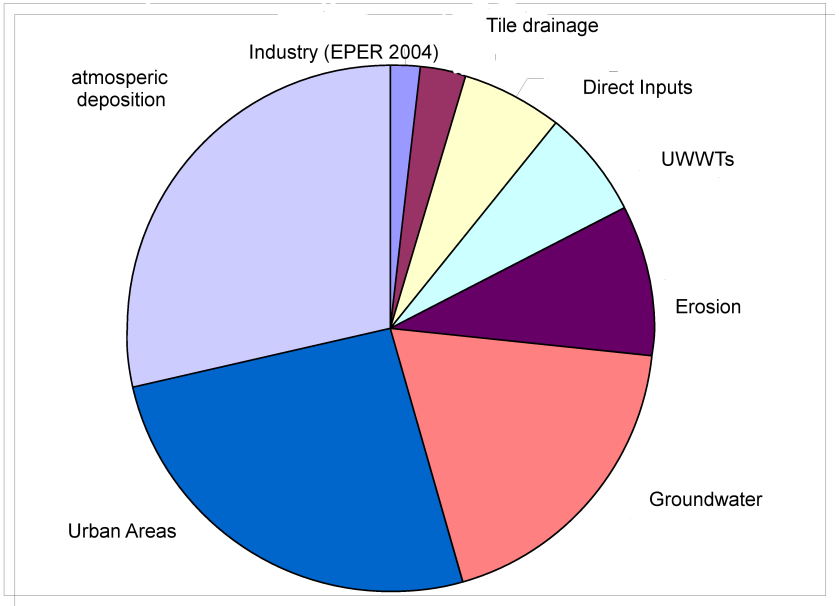
conclusions

- input pattern with high variability in several dimensions
- models necessary *but* careful interpretation of results
- urban areas important source
- tool box approach for reduction measures required

ongoing development for priority substances

current emission inventory for PAH

- data availability problems
- analytical problems
- high uncertainty for groundwater (low concentration, high volume)
- high importance deposition
- first estimates of regionalisation and pathway separation



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scenario analysis

model development for scenarios

goal: estimate effects of planned measures

ongoing work

- different time scales for noticeable effects
  - short term - point sources
  - long term - nutrient inputs from groundwater
- finer spatial differentiation of processes
- more process detail
- quantification of effectiveness
  - technical
  - economic
  - cumulative

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further reading

available from `www.umweltbundesamt.de`

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