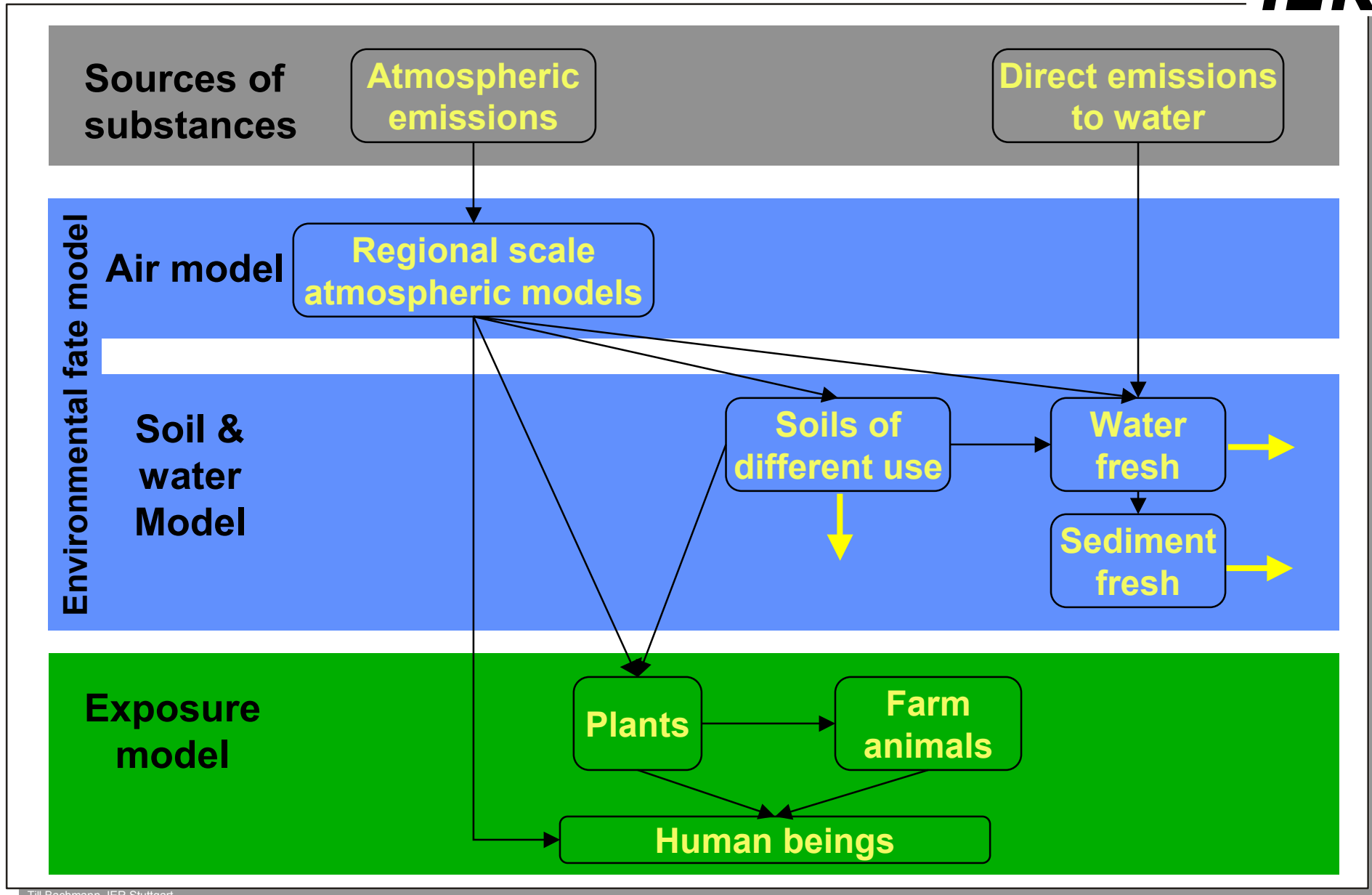


Extensions of methodology II: Treatment of toxic substances in water and soil

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and their application”
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Spatial characteristics

- Environmental media distinguished taking differences in **permeability, soil erosion** and human (in)direct **exposure** into account
- These are:

Top soils of:

- Pastures
- Arable land
- Non-vegetated areas
(e.g. rocks, open cast mining)
- Semi-natural ecosystems

Other compartments:

- Freshwater bodies
- Sediment
- Built-up areas
- Glaciers

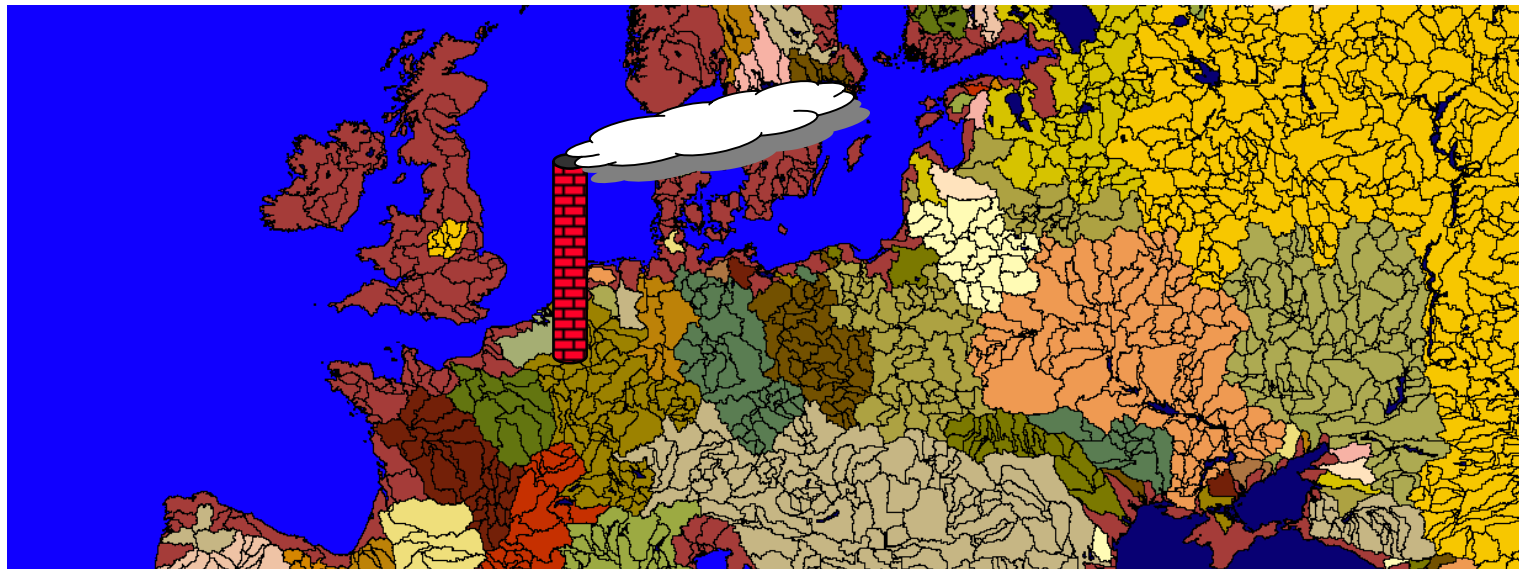
⇒ about 11500 different compartments in 3400 base regions

Temporal characteristics

- Climatological annual average data for hydrology
- Temporal resolution:
 - **Steady-state**
 - **Quasi dynamic**: temporal concentration development in different media and food
 - **„Time to steady-state“**: assessing when a certain percentage of the steady state solution will be reached

Scenario

- Case study: 1000 kg Pb/a emitted in Flanders



- Reference: European emissions in 1990 (UBA/TNO/EMEP 1998)
- Exposure via inhalation and ingestion

Intake fractions for pulse emission of cadmium and lead in 1990

Exposure horizon	Intake fraction	Share of intake fraction due to exposure via ...						
		milk	beef	wheat	barley	rye	potato	air
Cadmium								
1 a	0.0006%	0.015%	0.013%	22.9%	0.31%	3.4%	2.0%	71.3%
10 a	0.0022%	0.040%	0.036%	63.8%	0.86%	9.4%	5.7%	20.1%
100 a	0.0157%	0.047%	0.042%	77.4%	1.04%	11.7%	7.0%	2.79%
steady-state	0.0796%	0.045%	0.039%	79.3%	1.04%	11.8%	7.2%	0.55%
Lead								
1 a	0.0006%	0.08%	0.00%	3.0%	0.04%	0.2%	0.2%	96.4%
10 a	0.0008%	0.58%	0.04%	22.9%	0.31%	1.8%	1.7%	72.8%
100 a	0.0026%	1.64%	0.10%	66.0%	0.90%	5.1%	4.7%	21.6%
steady-state	0.0467%	1.91%	0.12%	85.0%	1.11%	5.6%	5.1%	1.22%

} 20%

} 6%

Maximum concentrations at steady-state and after 1000 years

	Maximum concentration		Compliance check	
	at steady-state	after 1000 a	Standard	Exceedances at steady-state [fraction of area affected]
Any soil [mg/kg DW]				
Cd	1.57-1.67	0.42-0.52	0.3 ^a	0.6-1.6%
Pb	2738-2755	21-38	38 ^a	3.9-12.7%
Arable land [mg/kg DW]				
Cd	1.13-1.23	0.33-0.43	1 ^b	0.02-0.02%
Pb	92-109	20.5-37.5	50 ^b	1.8-5.4%
Surface water [mg/l]				
Cd	0.002	0.001	0.001 ^c	0.01%
Pb	0.048	0.018	0.05 ^c	0%

^a source: [de Vries; Bakker 1998]

^b source: Directive 86/278/EEC

^c source: Directive 75/440/EEC

Damage cost per kg of pollutant

€/kg	UWM	EcoSense-WATSON	Recommended
Arsenic	80		80
<i>of which inhalation</i>	46.4	111	
Cadmium	19	59	39
Chromium	14 ^a - 23 ^b	44 ^a - 71 ^b	29 ^a - 34 ^b
Lead	1633	n/a	1600
Nickel	2.6	5.0	3.8
Formaldehyde	0.12 ^c		0.12

^a coal-fired power plants

^b oil-fired power plants

^c Inhalation only, CRF of ExternE [2000]

Conclusions

- The methodology for the assessment of external costs has been successfully extended to multi-media exposure assessment
- The developed methodology offers possibilities for a detailed temporal and spatial analysis of environmental impacts
- However, the use of exposure-response functions has not yet been possible for ingestion or is connected with large uncertainties
- Currently, the applicability of the DALY approach is explored