Soil Policy in the Netherlands

Recent Changes
and potential for re-use of polluted soil

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Outline

- The Netherlands: a short overview.
- Soil policy: why? A short history of soil policy in the Netherlands.
- Current issues (EU/NL) and need for policy revision.
- Soil policy 2007 - 2015
- Practical implications: re-use of polluted land (including examples from NL/EU).

Soil (policy) in the Netherlands

- Densely populated (16 million/33.000 km^2)
- Urban areas in the West, mixed rural and urban areas in the East
- (highly) Intensive agriculture (livestock)
- Trade (transport, both on land and water)
- Polluted hot-spots (old industry)
- Regional diffuse soil pollution (agriculture, industry)
- Strong interaction between soil, air and water

The Netherlands: from space (it's OK….)

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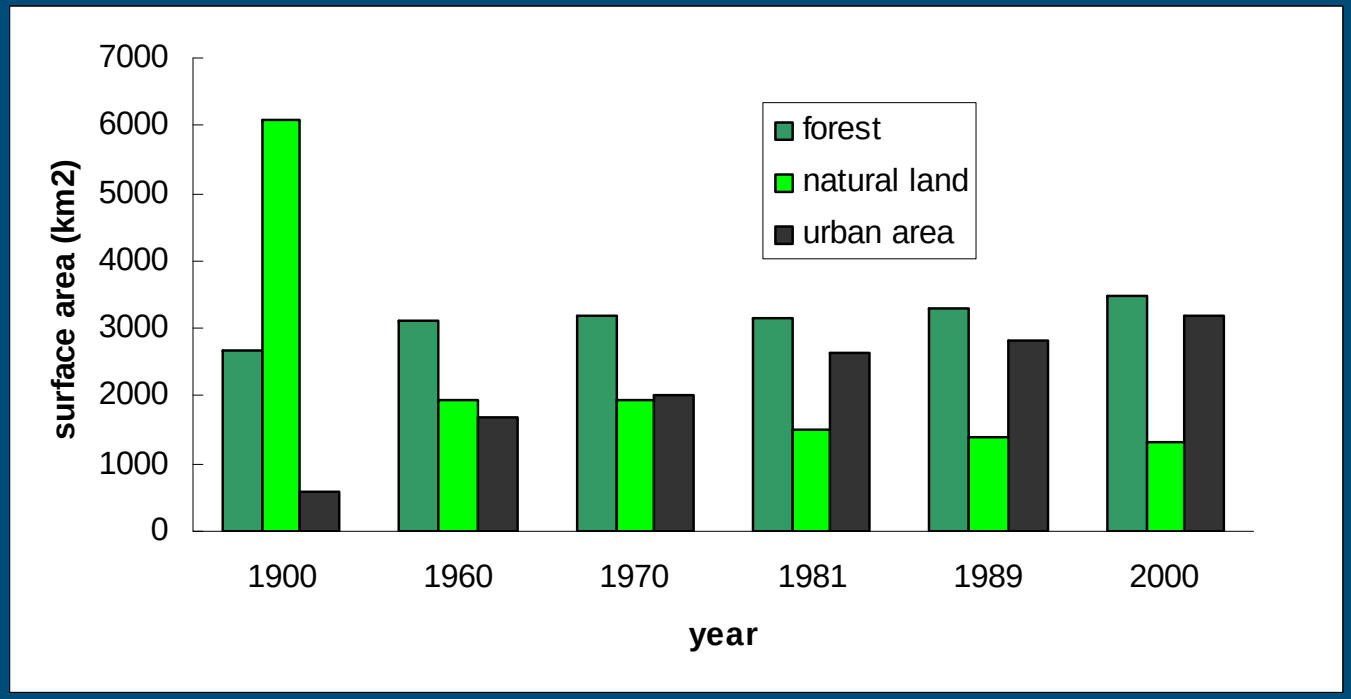
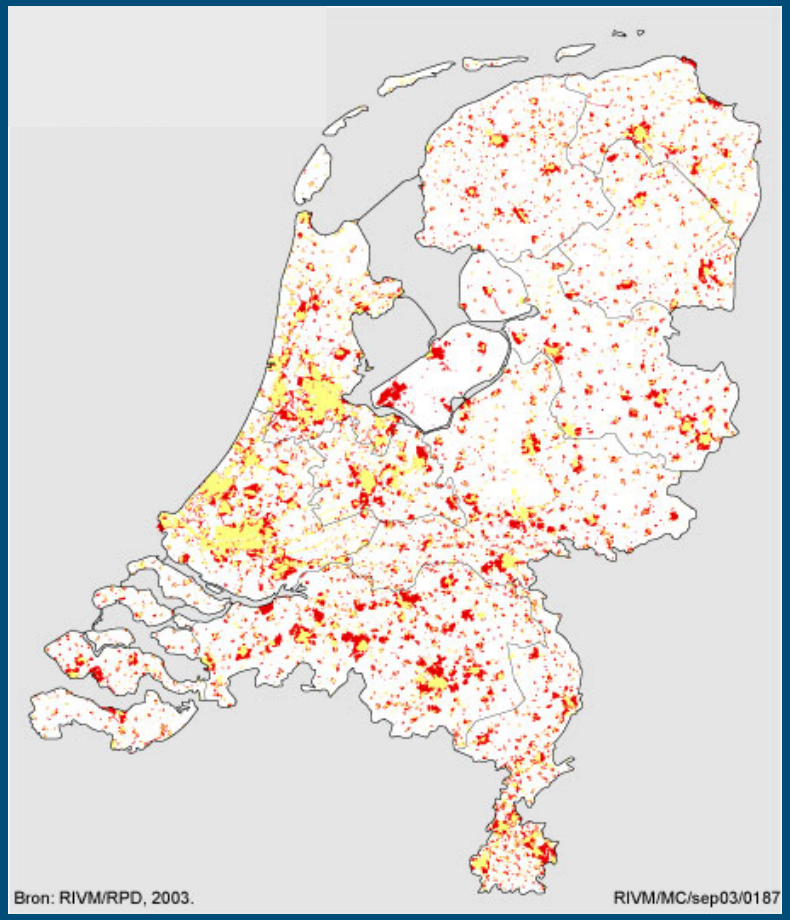
The Netherlands: urbanization and upscaling

Trends in the land use



Urbanization



Yellow: urban area 1970 (8%)

Red: urban area 2000 (12%)

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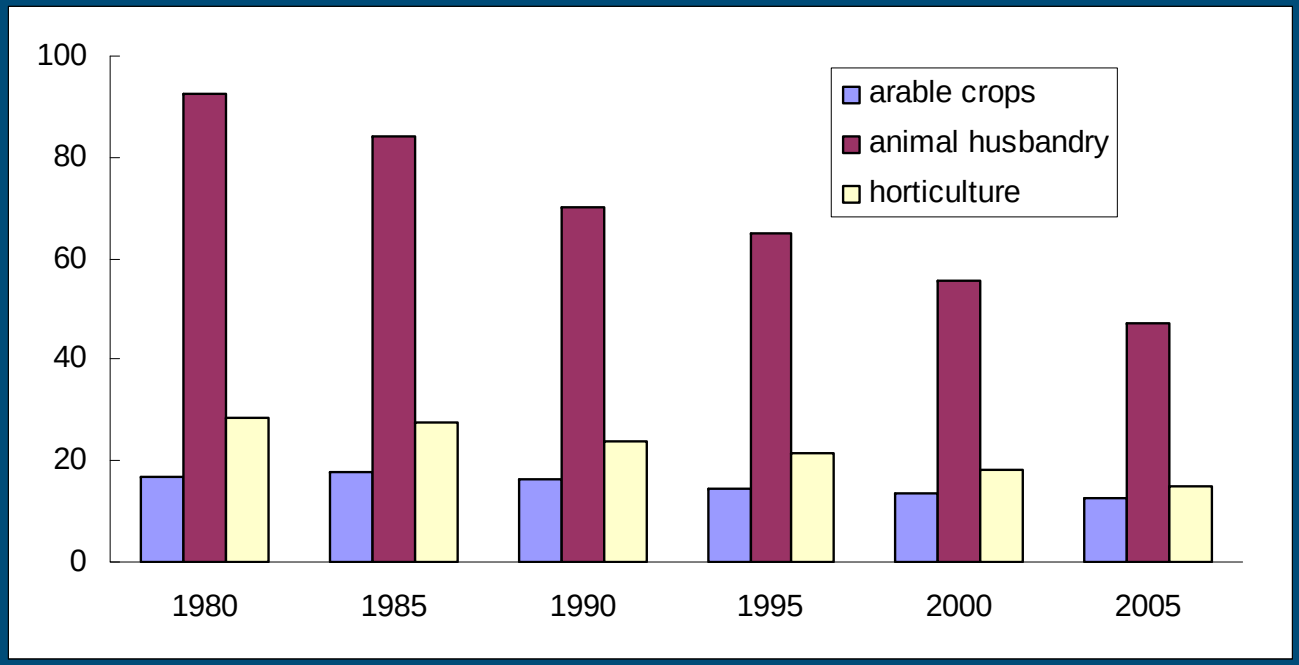
And upscaling

Decrease in # of farms from 140000 to 80000



And upscaling

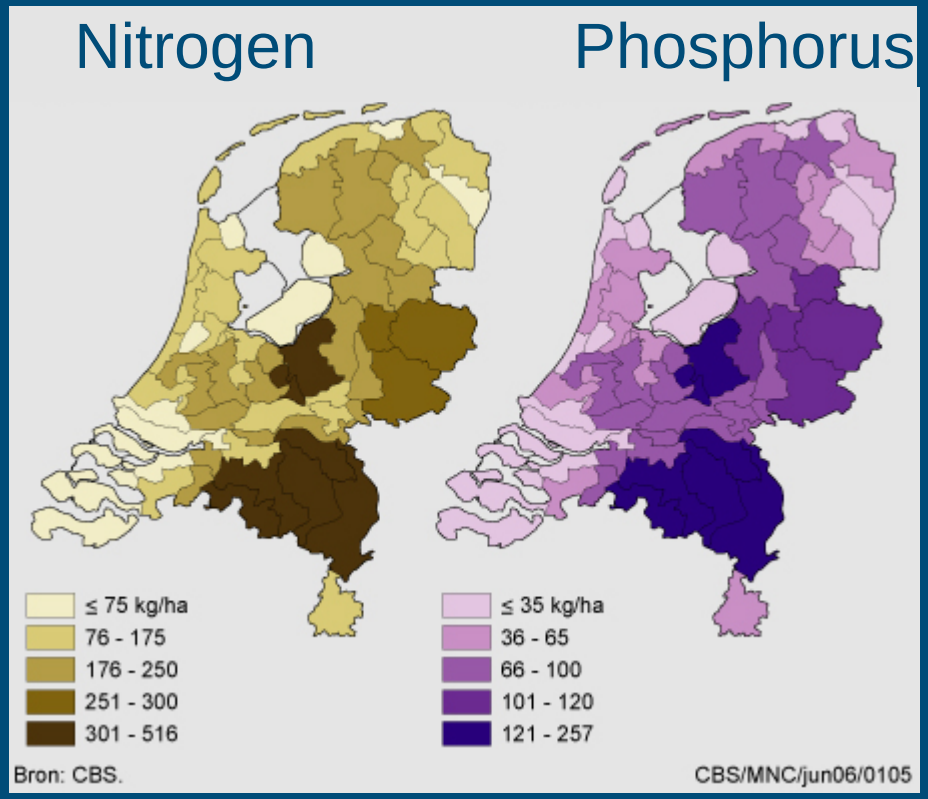
Big is beautiful….

Number of farms relative to size

	0-5 ha	5-10 ha	10-50 ha	50-100 ha	> 100 ha
1980	47	26	68	3	0
1985	44	23	64	4	0
1990	41	21	57	5	1
1995	38	18	50	6	1
2000	30	15	44	7	1
2005	24	12	36	9	2

But has its consequences

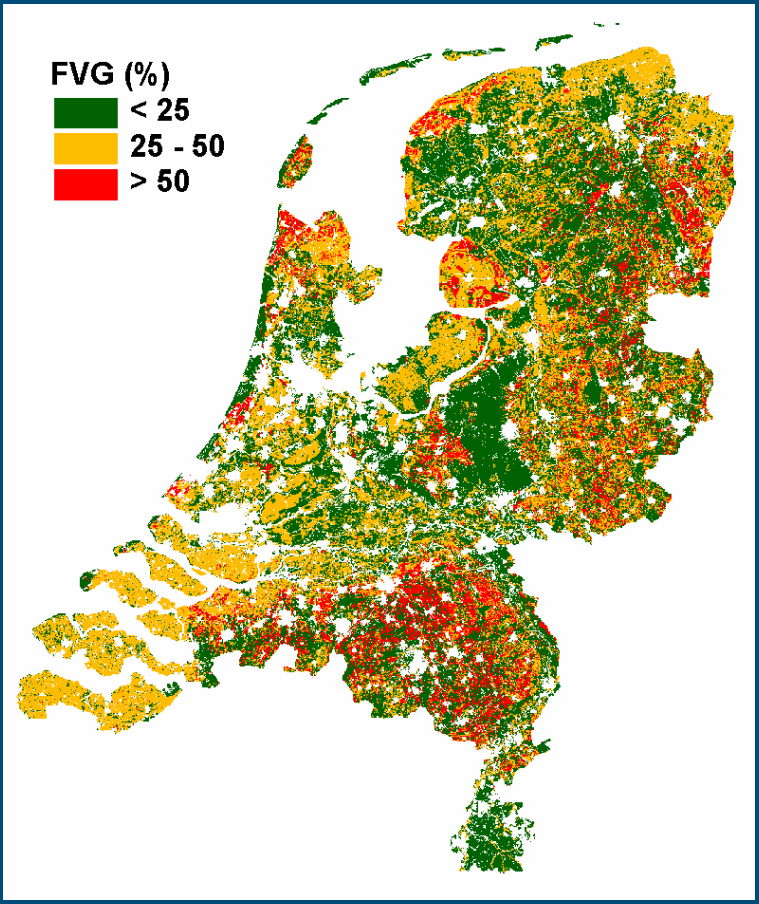
The Netherlands: N & P production at a regional level



Linked to animal husbandry

(eastern sandy district)

The Netherlands: diffuse pollution - Phosphate



1. High degree of P-saturation in sandy soil
2. High leaching losses to ground- and surface waters

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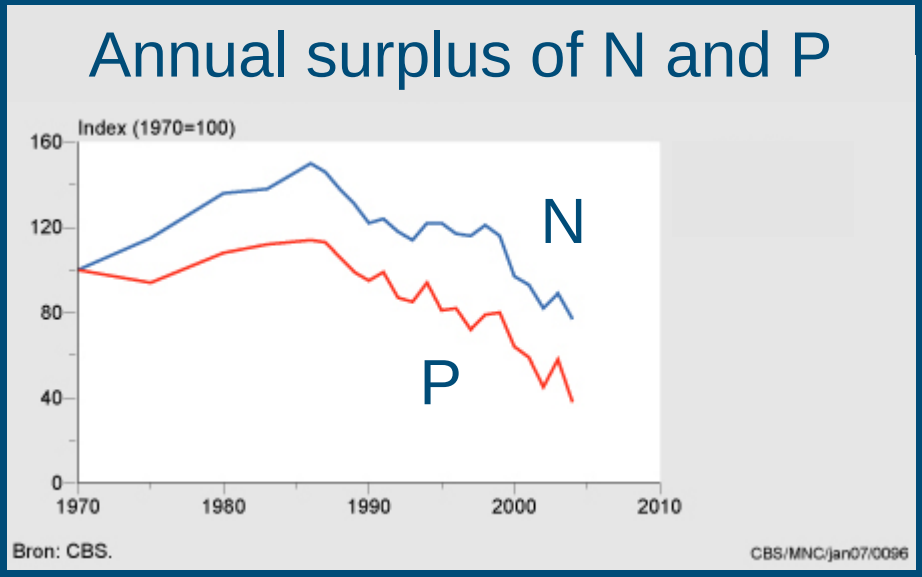
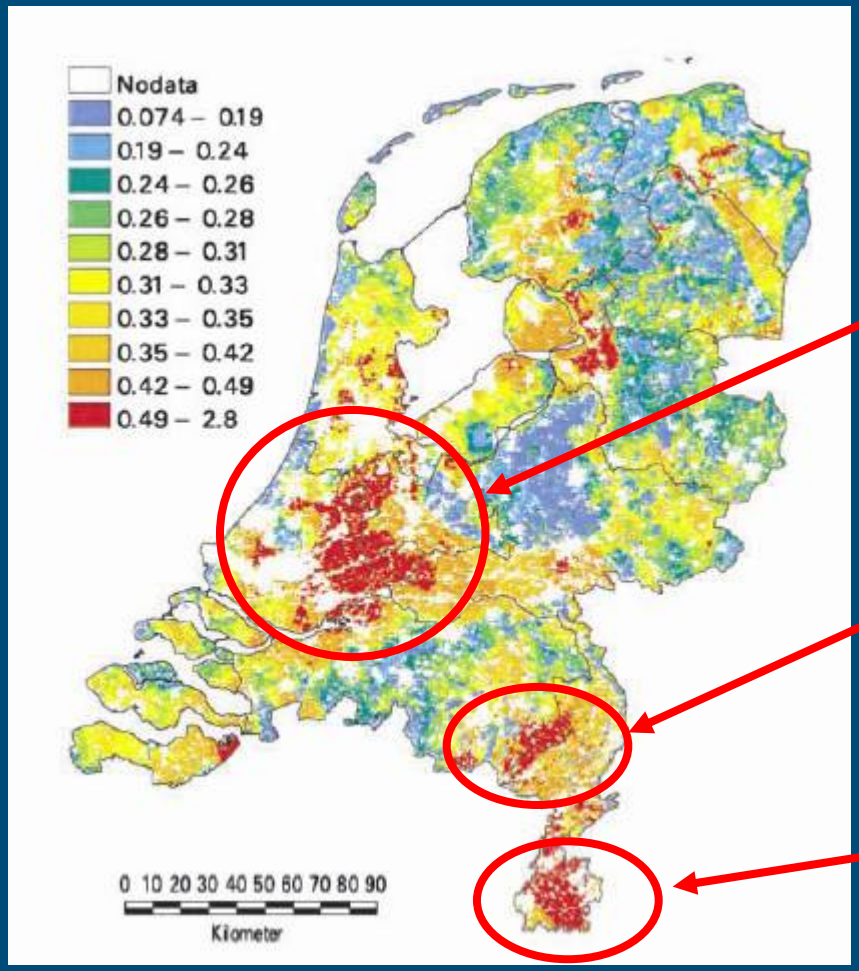
The Netherlands: trends



1. Decrease # of animals
2. Decrease allowed N and P loads to soil (EU)
3. Decrease allowed P-content in additives
4. MINAS (minerals accounting system)
5. Yearly fluctuation (high yields in 2004)

The Netherlands: diffuse pollution - Metals

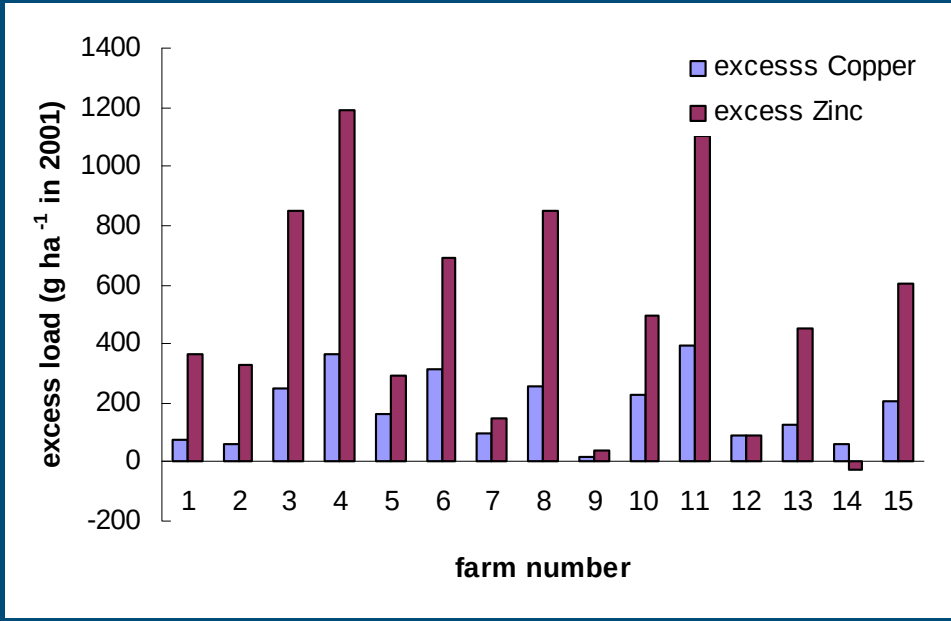


Peat areas (“Toemaak”)

Kempen (industrial)

Limburg (geogenous/industrial

Diffuse pollution - Agriculture

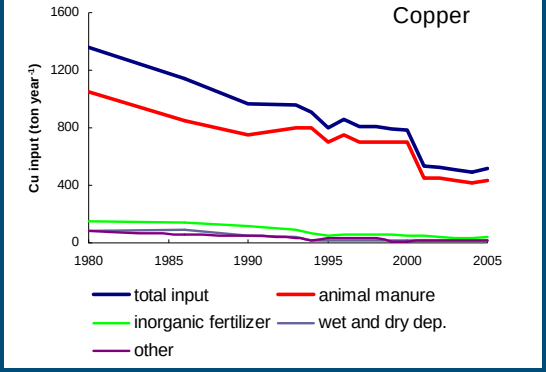


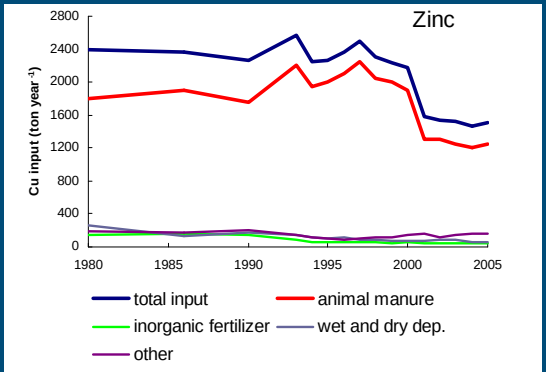
Excess load highly variable:

Cu [17 ~ 574 g ha^{-1}]

Zn [-29 ~ 1187 g ha^{-1}]

Diffuse pollution – Agriculture (trends)





1. Reduction of # of animals (20%)
2. Reduction in allowed levels in feed
3. Stricter policy regarding manure application (N, P)

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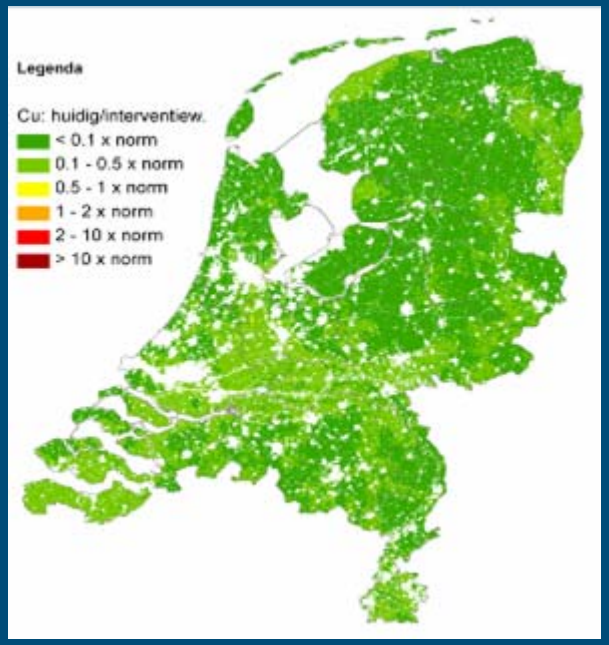
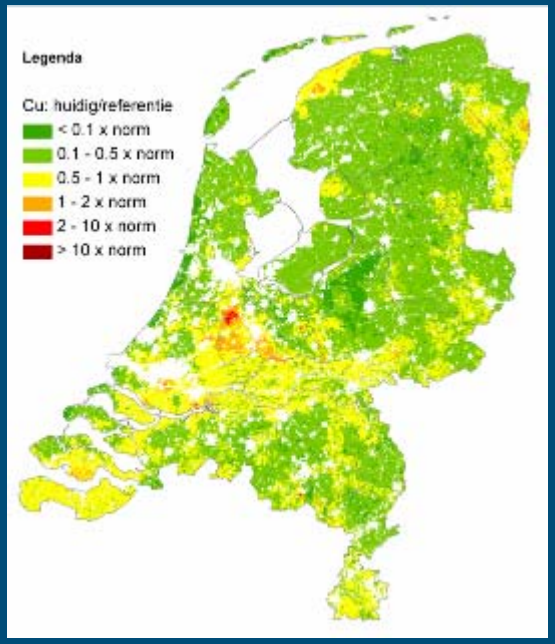
Present quality of soil

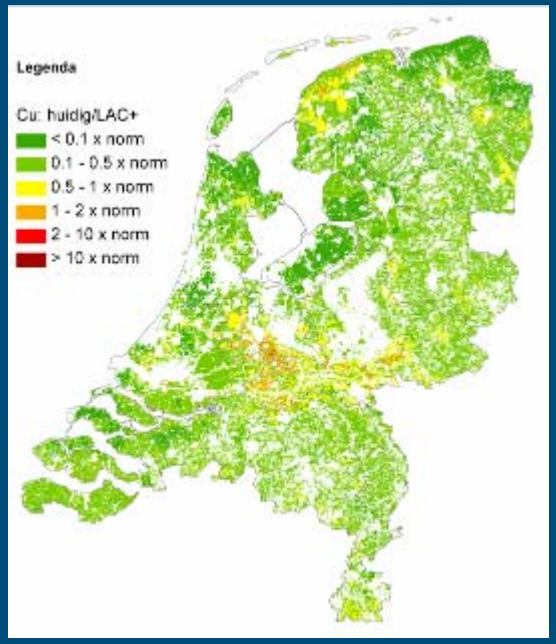
Intervention value



Background Value 2000



Agricultural Advisory Levels



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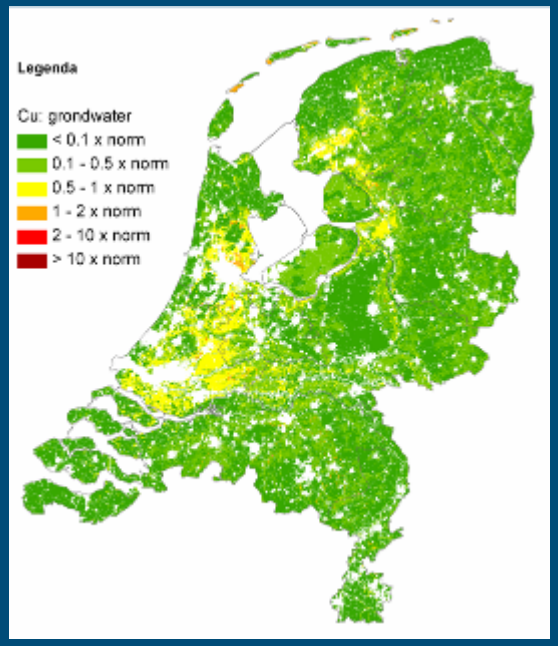
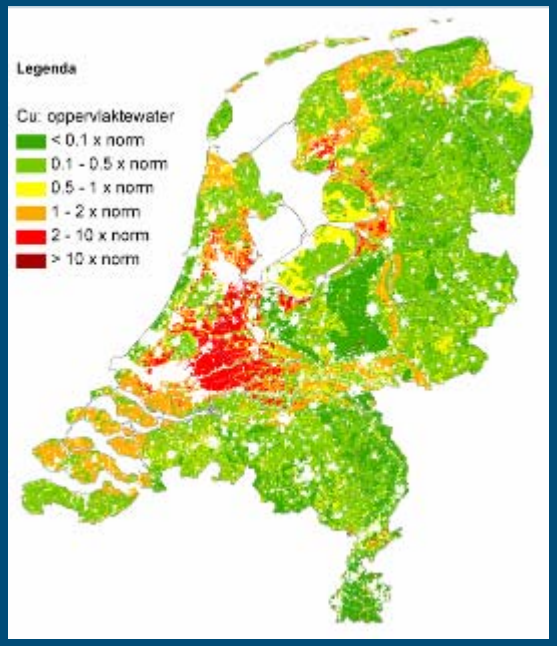
Present quality of ground- and surface waters

(shallow) groundwater

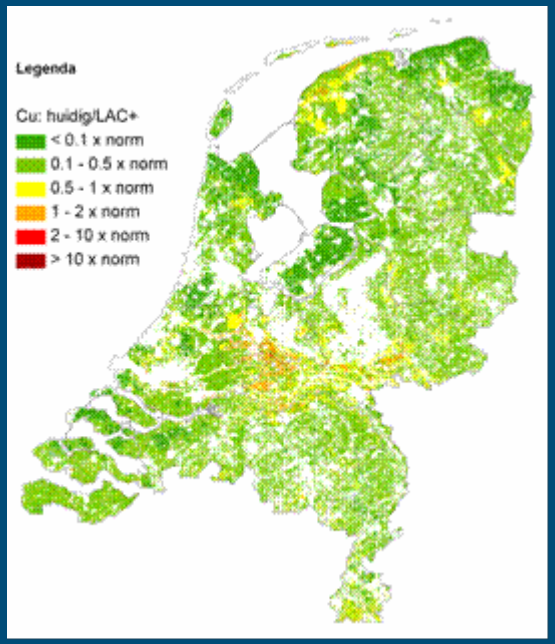


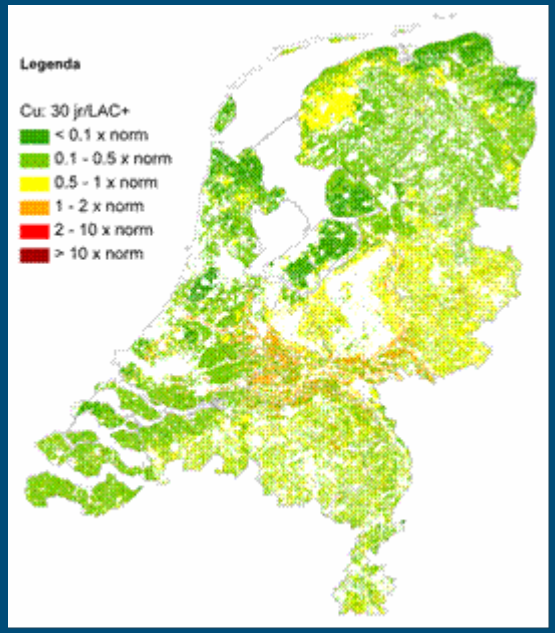
Surface water

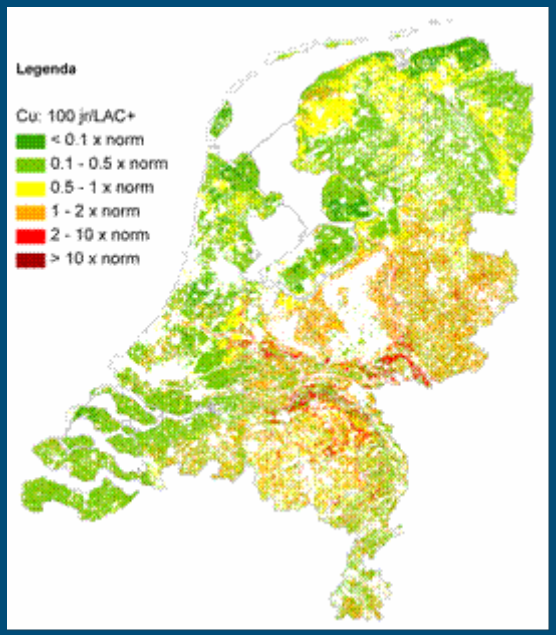


But what about the future?

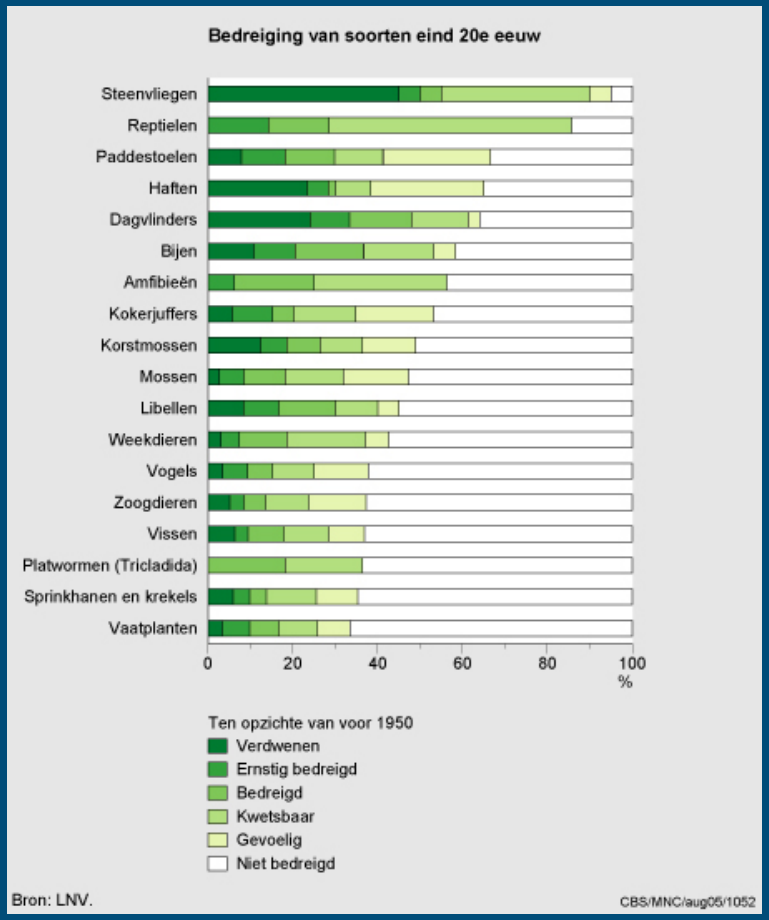
2007 → 2037 → 2107







Diffuse pollution and land use: impact on ecosystem



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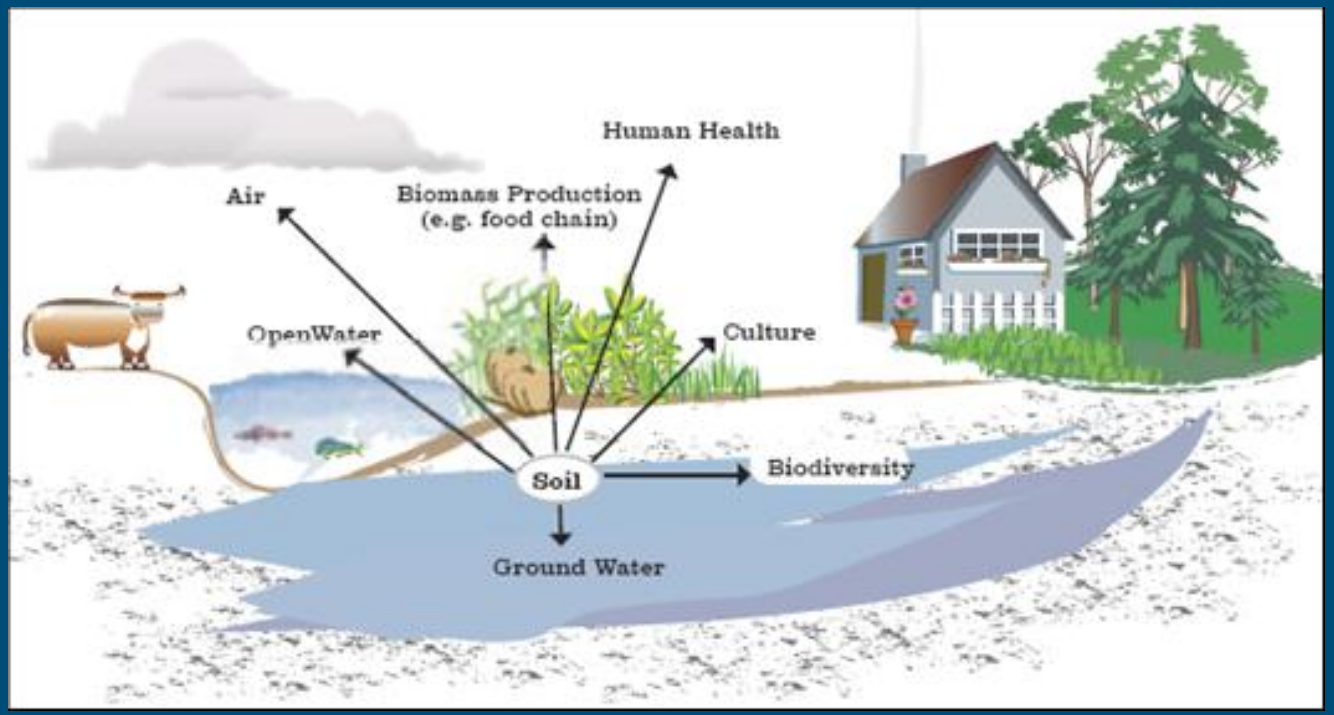
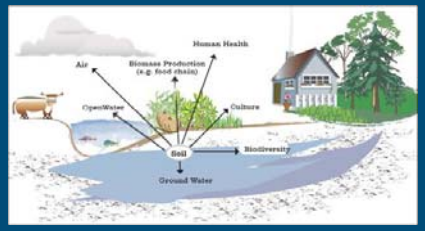
Soil and the Environment: time for action

- Increased pressure on land across EU/NL
- Soil as a sustainable resource
- Interaction between soil, ecosystem and water has become more evident
- Need to integrate soil, air and water policy

Soil and the Environment: the EU view



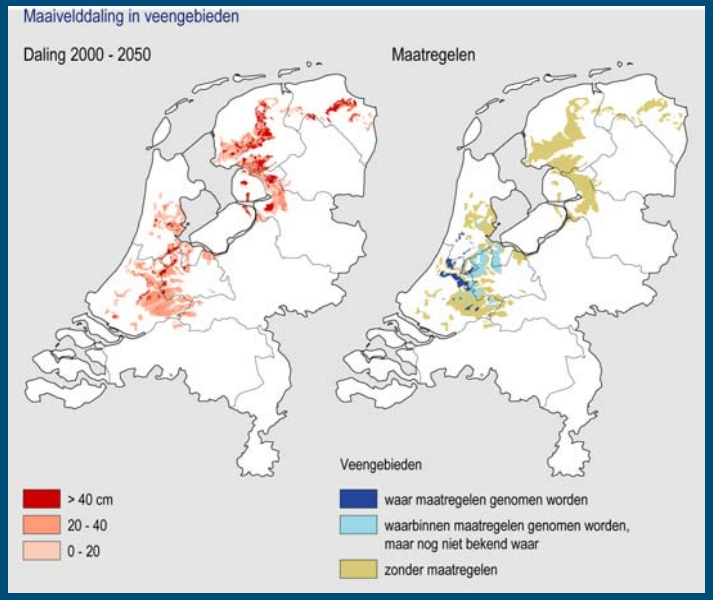
Soil Policy: key issues related to contaminants



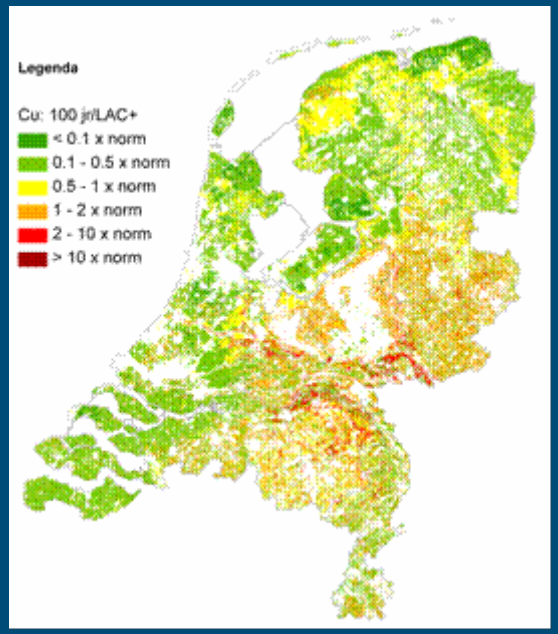
- Key issues
  - Sustainable land use (aspect of time)
  - Stand-still (no further accumulation) and reduced emission of “prioritary dangerous substances (oa Cd)
  - Important cross links with Water Framework Directive

The Netherlands: most important issues

Dynamics of organic matter in soils (peat areas)



Diffuse pollution



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Dutch Soil Policy: the essentials

- Soil policy based on:
  - Protection of human health
  - Protection of ecosystem
  - Protection of agricultural production
- Directed towards cleanup operations ánd
- Soil management including application of dredgings and emission from constructions (Decree on Soil Quality)

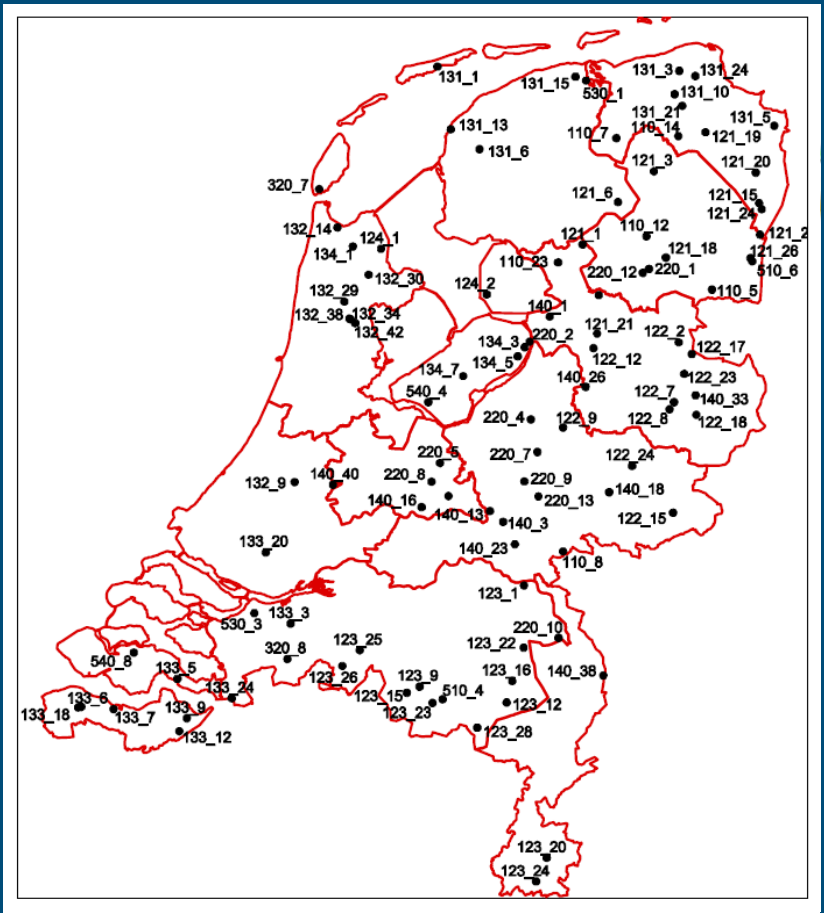
Dutch Soil Policy: the essentials

- Different (un)acceptable levels:
  - Background values in soil: current levels of contaminants in non-polluted soils
  - Reference values: acceptable levels depending on the use of the soil, 7 defined functions
  - Intervention values: action level above which further testing is required

Dutch Soil Policy: Background values

- Equal to average quality of soil in areas without obvious influence from industry
- Based on measurements in topsoil and subsoil at 100 statistically selected locations in the Netherlands (soil type/land use combinations)
- In total database for 252 difference substances
- 95 percentile of AW2000 level is equal to “no-risk” levels (practical definition)
- Correction for clay and organic matter

Dutch Soil Policy: Background values



Stratum		Codering stratum	Oppervlak (ha)	Aantal gelote locaties
Landbouw				
Veengronden	veen	110	164.387	6
Fries-Drents keileemplateau	zand	121	331.823	12
Oostelijk en Centraal dekzandgebied	zand	122	288.404	10
Zuidelijk dekzand en lössgebied	zand	123	328.907	12
Zandgronden kustgebied	zand	124	48.780	2
Noordelijke zeekleigebied	zeeklei	131	261.049	9
Hollands zeekleigebied	zeeklei	132	184.595	7
Zuid-Westelijk zeekleigebied	zeeklei	133	239.946	9
Zeeklei in IJsselmeerpolders	zeeklei	134	102.119	4
Rivierkleigronden	rivierklei	140	265.108	10
Bos en Natuur				
Bos op zandgronden	zand	220	282.099	10
Overige natuur op zandgronden	zand	320	84.504	3
Veengronden	veen	510	36.048	2
Zeekleigronden	zeeklei	530	29.420	2
Rivierkleigronden	rivierklei	540	13.458	2

To 100 sampling sites

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Dutch Soil Policy: Background values

Contaminant	Level (mg kg^{-1})
As	20
Cd	0.6
Cr	55
Cu	40
Hg	0.15
Pb	50
Ni	30
Zn	140
PAH (10)	1
DDT/DDE/DDD	0.3
Drins	0.01

Note: these levels are valid for a soil containing 25% clay and 10% organic matter

Dutch Soil Policy: the essentials

- AW2000 serve as first testing level of soil quality:
  - If level in soil < AW2000: free use and shipping of soil
  - If level in soil > AW2000: restrictions in use
  - Further use of soil depends on function
  - But: no relation with risk of substance in soil! (pragmatic approach)

Dutch Soil Policy: Reference Values

- Serve as basis for soil clean-up
- Function specific:
  - Living with gardens
  - Playground for children
  - Private gardens
  - Agriculture
  - Nature
  - “green” area with high contact level (sport)
  - Other including industry, building
- Levels are related to risk (calculations)

Dutch Soil Policy: Reference Values

- Human toxicological criteria (ingestion of soil, exposure to dust, inhalation, oral availability)

substance	MTR µg/kg/d	background µg/kg/d	MTR-WAB µg/kg/d
As	1.0	0.3	0.7
Ba	20	9	11
Cd	0.50	0.22	0.28
Cr	5	1	4
Co	1.4	0.3	1.1
Cu	140	30	110
Hg (met.)	2.0	0.1	1.9

Dutch Soil Policy: Reference Values

- Human toxicological criteria (ingestion of soil, exposure to dust, inhalation, oral availability)
- Consumption of home grown vegetables (0 – 100% depending on use)
- Protection of agriculture (crop quality)
- Ecological criteria
- Quality of ground- and surface water (leaching)

Dutch Soil Policy: Reference Values

	housing/ garden	playground children	private garden	agriculture	nature	parks	other
Sb	15	22	4	**4**	4	22	**22**
As	27	27	27	**20**	20	27	**76**
Ba	550	550	550	**190**	190	550	**920**
Be	1.9	1.9	1.9	**1.5**	1.5	1.9	**30**
Cd	3.7	3.7	1.2	**0.6**	0.6	1.2	**4.3**
Cr	62	62	62	**55**	55	62	**180**
Co	35	35	35	**15**	15	35	**190**
Cu	54	54	54	**40**	40	54	**190**
Hg	8.4	8.4	8.4	**0.15**	0.15	0.83	**4.8**
Pb	210	210	70	**50**	50	210	**530**
Mo	88	88	54	**1.5**	1.5	88	**190**

Note: values for “standard soil” (10% org mat, 25% clay)

Dutch Soil Policy: Reference Values

- Boundary conditions:

  Reference values cannot be lower than Background value

  (Ref < 95% AW2000 data)

  Reference values can not exceed Intervention values

Dutch Soil Policy: Intervention Values

- Action level: if soil metal content > Intervention value, more testing is needed
- Same criteria as for Reference level but now related to serious effect
- Tierd approach: from generic assessment to location specific research if needed

Dutch Soil Policy: Intervention Values

Contaminant	level (mg kg^{-1})
As	55
Cd	12
Cr	380
Cu	190
Hg	10
Pb	530
Ni	210
Zn	720
PAH (10)	40
DDT/DDE/DDD	4
Drins	4

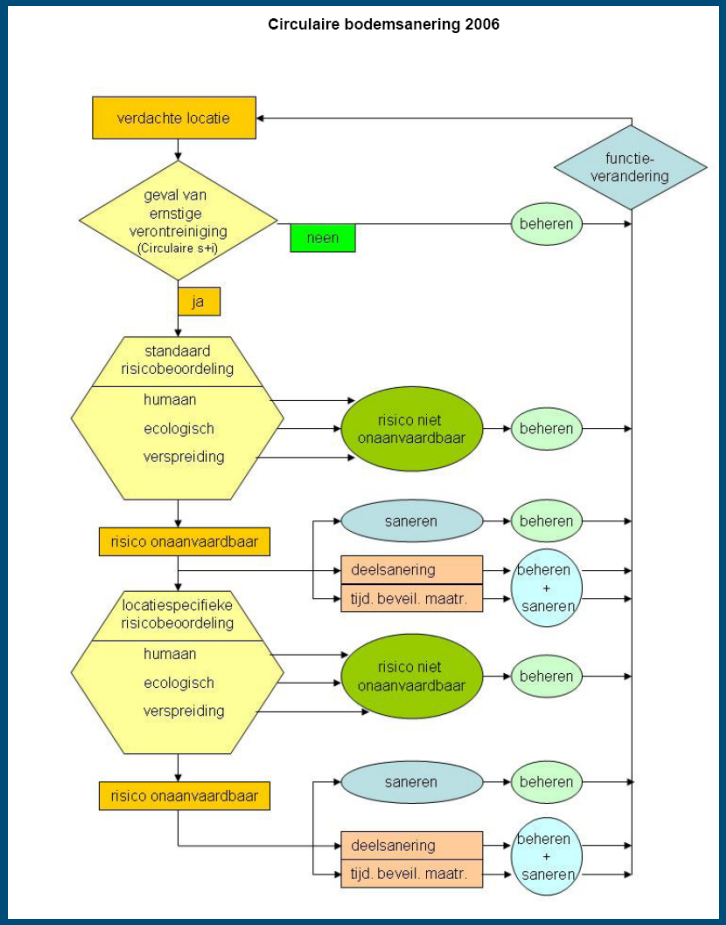
Dutch Soil Policy: correction for soil type

Soil type correction:

Me-soil = A + B*clay + C*Organic matter

				As	Ba	Cd	Co	Cr	Cu
			A	15	30	0.4	2	50	15
			B	0.4	5	0.007	0.28	2	0.6
	OM	clay	C	0.4	0	0.021	0	0	0.6
standard	10	25		55	625	12	240	380	190
sand	3	3		33	181	7	76	213	98
clay	5	25		51	625	10	240	380	174
peat	30	15		63	423	17	165	304	222
loess	3	10		38	323	8	128	266	120

Dutch Soil Policy: tierd approach



From generic level (Intervention value)

To risk assessment (SUS: model calculation of risk)

To location specific tests (field/laboratory)

Dutch Soil policy: tools and harmonization

- Tools for calculation of risk levels:

  "Risk Assessment Toolbox"
  (www.risicotoolboxbodem.nl)

- European activities on harmonization of risk assessment methods:

  HERACLES

  HUMAN AND ECOLOGICAL RISK ASSESSMENT FOR CONTAMINATED LAND IN EUROPEAN MEMBER STATES:Towards the development of common references

HERACLES

- Development of conceptual framework:
  - Negligible risk level – background level
  - Intermediate risk level – further testing
  - unacceptable risk level – intervention level
- Screening versus site-specific testing

HERACLES: still some way to go

Table 4.6. Screening values for potentially unacceptable risk (residential soil-use) for metals and metalloids (mg/kg d.w.).

Legend: Austria (AUT); Belgium Flanders (BE(F)); Belgium Bruxelles (BE(B)), Belgium Walloon (BE(W)); Czech Republic (CZE); Finland (FIN); Italy (ITA); Lithuania (LTU); Netherlands (NLD); Poland (POL); Slovakia (SVK); United Kingdom (UK); Denmark (DNK)

	AUT	BE(F)*	BE(B)	BE(W)	CZE	FIN	ITA	LTU	NLD	POL	SVK	UK	DNK
As	50	110	110	300	70	50	20	10	55	22.5	50	20	20
Ba					1000			600	625	285	2000		
Be					20		2	10	20		20		
Cd	**10**	**6**	**6**	**30**	**20**	**10**	**2**	**3**	**12**	**5.5**	**20**	**2**	**5**
Co					300	100	20	30	240	45	300		
Cr	250		300	520	500	200	150	100	380	170	800	130	1000
Cu	600	400	400	290	600	150	120	100	190	100	500		1000
Hg	10	15	15	56	10	2	1	1.5	10	4	10	8	3
Pb	500	700	700	700	300	200	100	100	530	150	600	450	400
Mo					100			5	200	25	200		
Ni	140	470	470	300	250	100	120	75	210	75	500		30
Sb	5				40	10	10	10	15				
Se							3	5	100		20	35	
Sn					300		1	10	900	40	300		
Te									600				
Tl	10						1		15				
V					450	150	90	150	250		500		
Zn		1000	1000	710	2500	250	150	300	720	325	3000		1000

**For new contaminants only*

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Dutch soil policy on soil protection: 1980

Discovery of polluted material (toluene/xylene) underneath houses in Lekkerkerk

(thanks to a broken water pipe!)

…but there were little or no risks for public health

Soil Pollution and Spatial Planning

- Some examples on the re-use of (formerly) polluted or treated soil/areas
- Source: ministry of VROM (Housing, Spatial Planning and the Environment)

Krimpenerwaard

Problem:

presence of ditches filled with all kinds of waste

Effect:

risks for cattle and ecosystem

Treatment:

1. Mapping of worst sites;
2. Covering with clean soil
3. Monitoring of soil/ecosystem

Recreational area on waste dump

Problem:

presence of waste dump

Effect:

smell, not attractive

Treatment:

1. Landscaping
2. Covering with clean soil
3. Monitoring of drainage water

In situ clean-up of existing housing area

Problem:

presence of chlorinated solvents (10 ha)

Effect:

dangerous, potential large impact on housing if classically treated (decrease groundwater)

Treatment:

1. biological in situ remediation
2. Monitoring of groundwater quality

Remediation of former power plant/waste incinerator

Problem:

presence of industry near residential area

Effect:

human health effects (air quality, soil pollution)

Treatment:

1. Excavation of soil, replacing by clean soil
2. Install playgrounds/sporting fields

Transformation of Gasworks to urban park

Problem:

presence of gasworks (Utrecht)

Effect:

brown field within city limits, polluted soil

Treatment:

1. Excavation of soil, replacing by clean soil, isolation of polluted soil (reactive barriers)
2. Creation of ponds and green

From polluted harbor area to yachting club

Problem:

presence of deserted and polluted harbor area (Middelburg)

Effect:

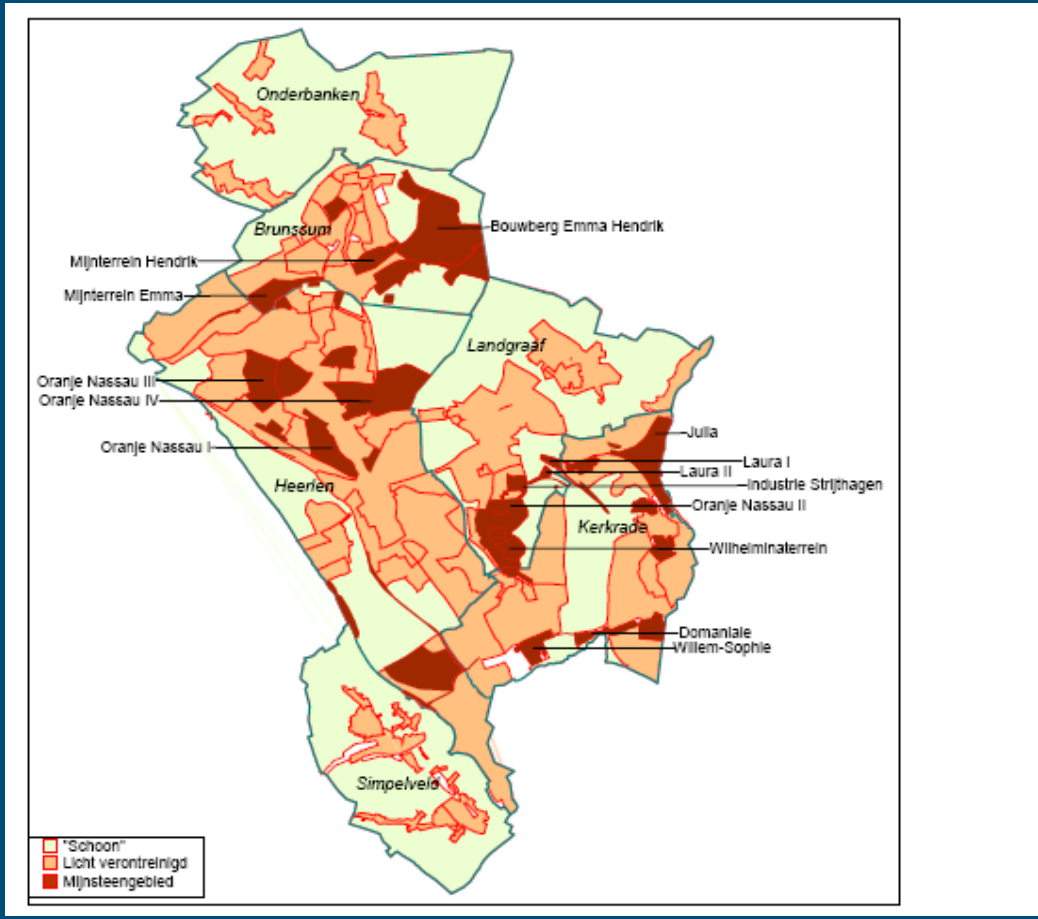
brown field within city limits, polluted soil, impact on water quality

Treatment:

1. Excavation of polluted soil, replacing by clean soil
2. Creation of yachting area

- CASE 1: Redevelopment of former mining area

Redevelopment of former mining area



Mining: 1900 – 1975

13 coal mines in the area

Redevelopment of former mining area

Redevelopment of former mining area

Redevelopment of former mining area

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Redevelopment of former mining area

Public concern about human health:
presence of mine waste in private gardens

Redevelopment of former mining area

Public concern about human health: safety of home-grown food?

Redevelopment of former mining area

And the role of the media……

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Redevelopment of former mining area

- Major issues:

1. How to redevelop the area?
2. What are risks of mining waste?

Risk Assessment of PAH's in soil

Problem:

aste may lead to
nsumption of home

erogeneous

ased by science!

(Show us that it is safe!)

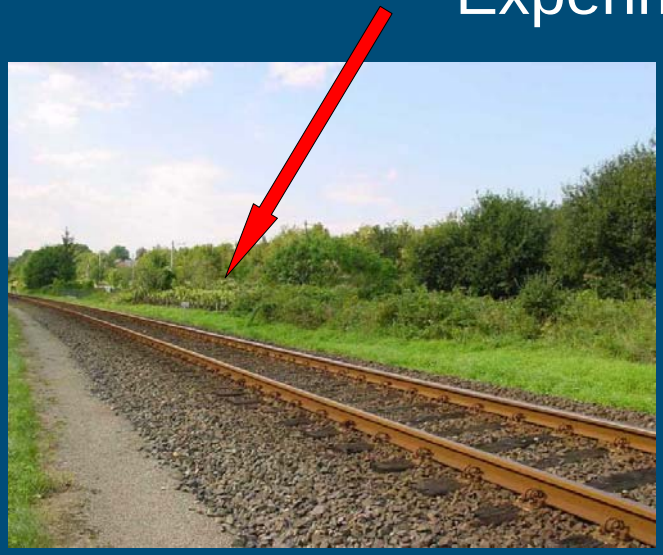
Risk Assessment of PAH's in soil

Experiments:

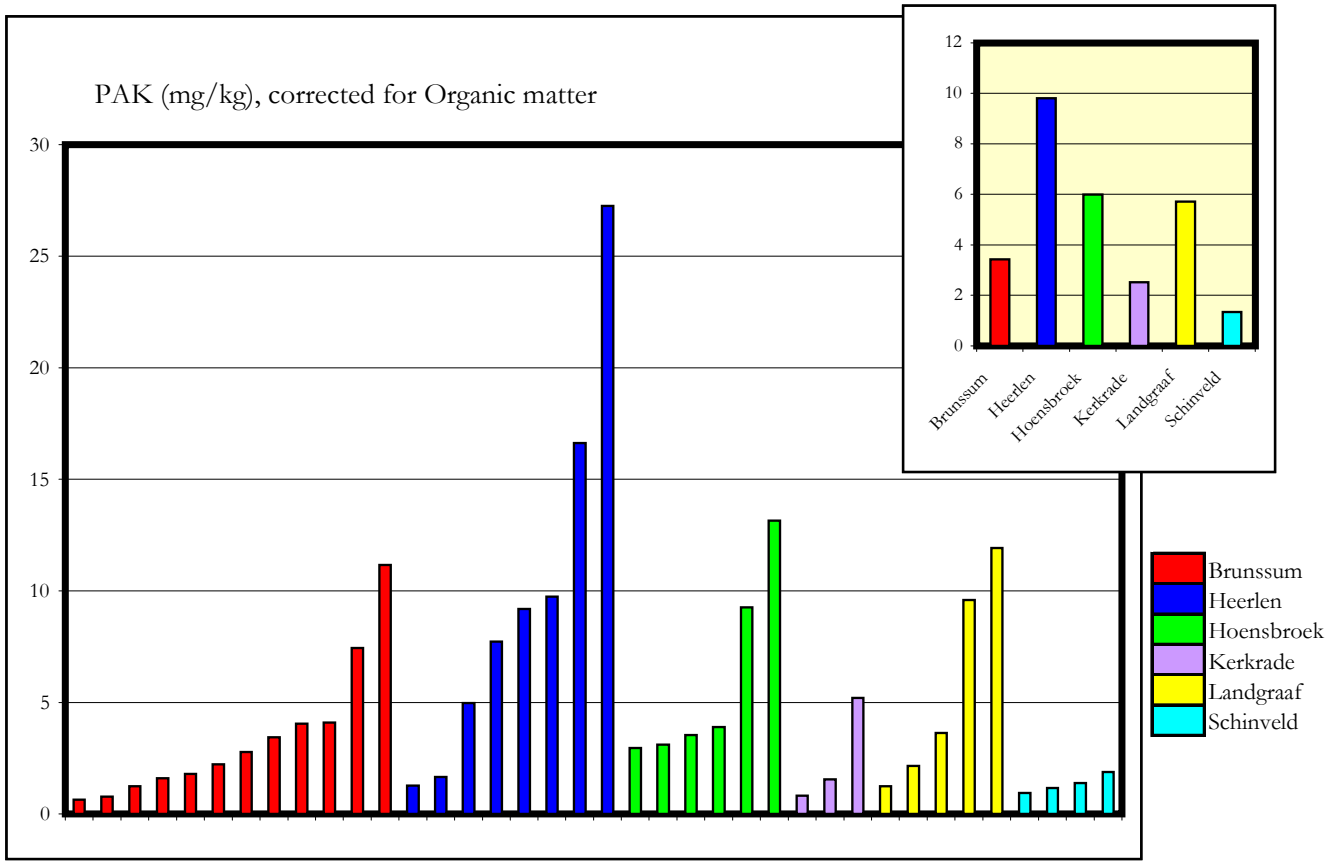
- Measurement of PAH in existing gardens (soil/crop) with different degree of pollution
- Setting up new gardens on extremely polluted soil (not used as private garden
- Measurement of PAH uptake in pot experiment (well controlled)

Risk Assessment of PAH's in soil

Experimental "garden" next to railroad



Risk Assessment of PAH's in soil



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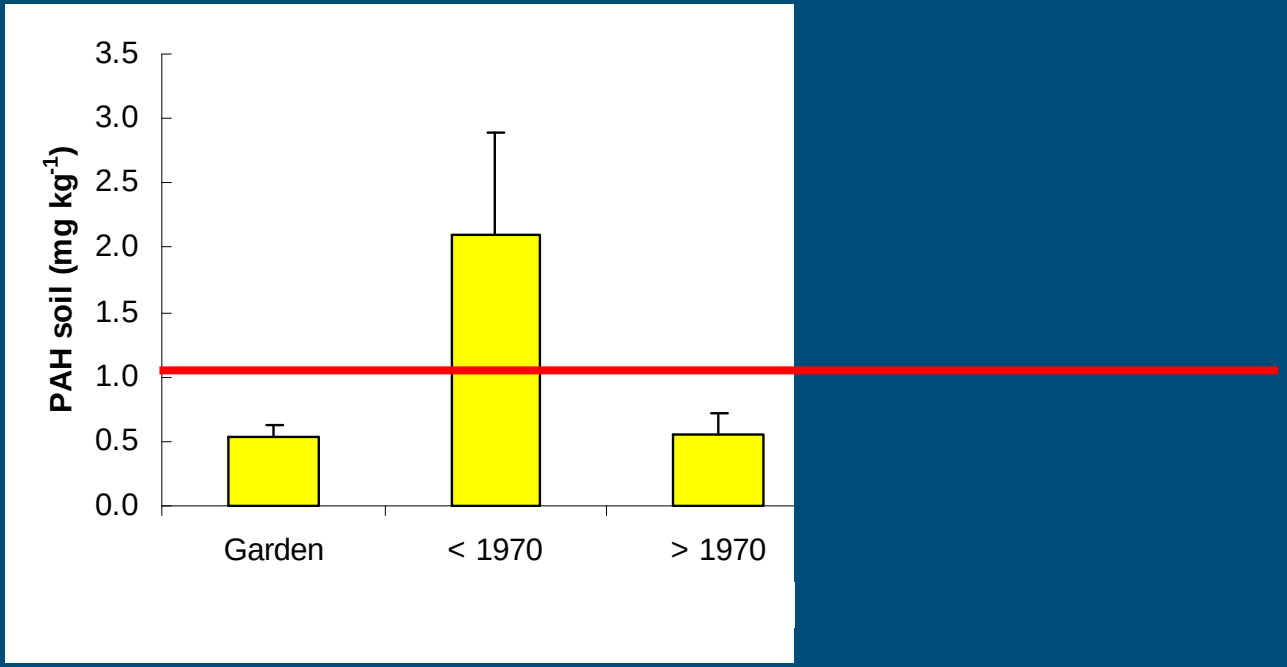
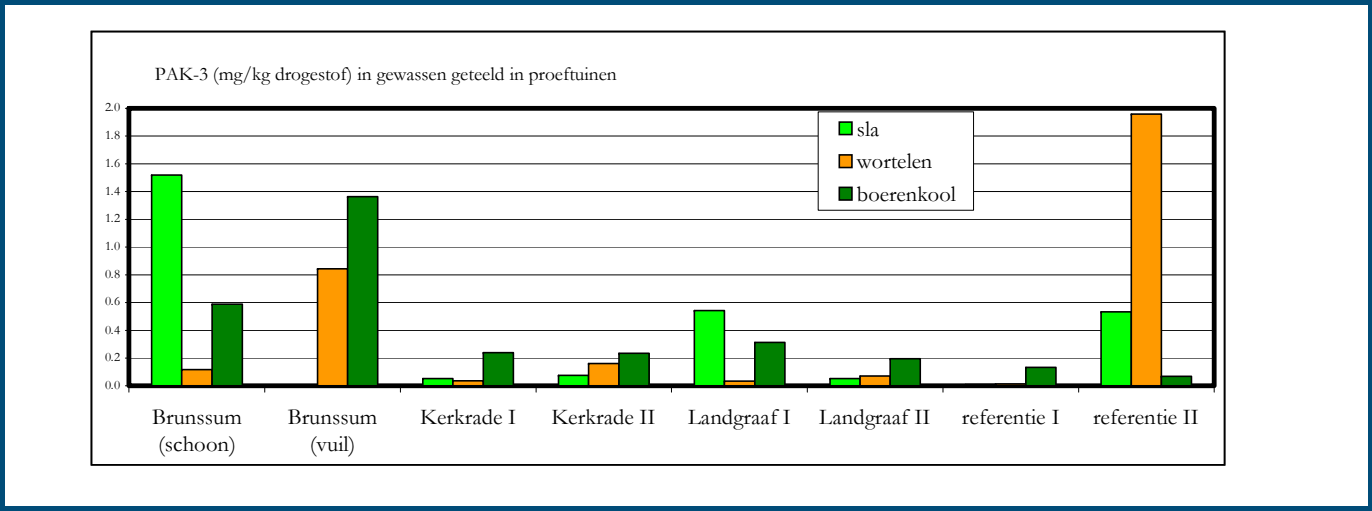
Risk Assessment of PAH's in soil



Risk Assessment of PAH's in soil

- Results:
  - Soil pollution not very serious
  - Uptake by crops not related to PAH level in soil

Risk Assessment of PAH's in soil



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Risk Assessment of PAH's in soil

- Results:
  - Soil pollution not very serious
  - Uptake by crops not related to PAH level in soil
  - Effect of "dust" is very large (and washing also)
  - No further measures are needed
  - Public concern was taken away by "real" data from their own environment (risk perception!)

Redevelopment of former mining area

- Spatial Planning of the area:
  - Consider risks in relation to use;
    Heavily polluted areas – extensive use (light industry)
    Moderately polluted areas – redesign, covering
    Non polluted areas – parks, redesign (fishing ponds)
  - Activities for local/regional population

Redevelopment of former mining area

And now

More conventional recreation opportunities

Green oasis in a highly urbanised area:

- Zoo
- Flower theme park
- Horse racing track
- Skiing arena
- Fish ponds
- Hiking/biking trails
- Museum for industrial heritage

Redevelopment of former mining area

View from the top of the re-designed waste dump

(race track, multi-event arena (pop concerts)

Redevelopment of former mining area

Indoor ski slope

(with FIS license!)

Redevelopment of former mining area

Redevelopment of former mining area

Flower & Garden

Theme-park

“Gaia-Park”

Redevelopment of former mining area

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- Case 2 Kempen Area

The Kempen area: its famous inhabitants

Vincent van Gogh was born 150 years ago. He lived some years in The Kempen area.

Before……

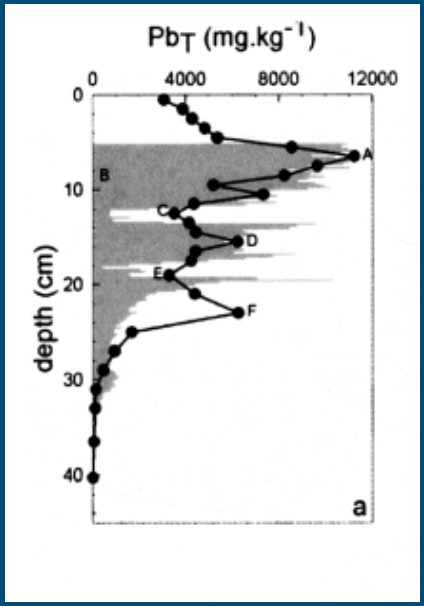
Zn and Cd smelter near Budel

Cd (mg / kg soil)

- 350 km^2 > 1,0
- 2,5 km^2 > 2,5

Kempen area

- The problem: emission of Cd, Pb and Zn from ore treatment plants in B and NL:



Development of Pb levels in sediments of natural peat bogs

Kempen area

- The effects:

1. Approx. 450 km^2 affected (soil cadmium levels > 1 ppm where 0.1 to 0.3 is normal)
2. Increased levels of cadmium in arable products
3. Elevated cadmium and zinc levels in ground- and surface waters as well as sediments (> 50 ppm)
4. Increased occurrence of lung cancer (Nawrot et al., 2006) due to dust inhalation and exposure

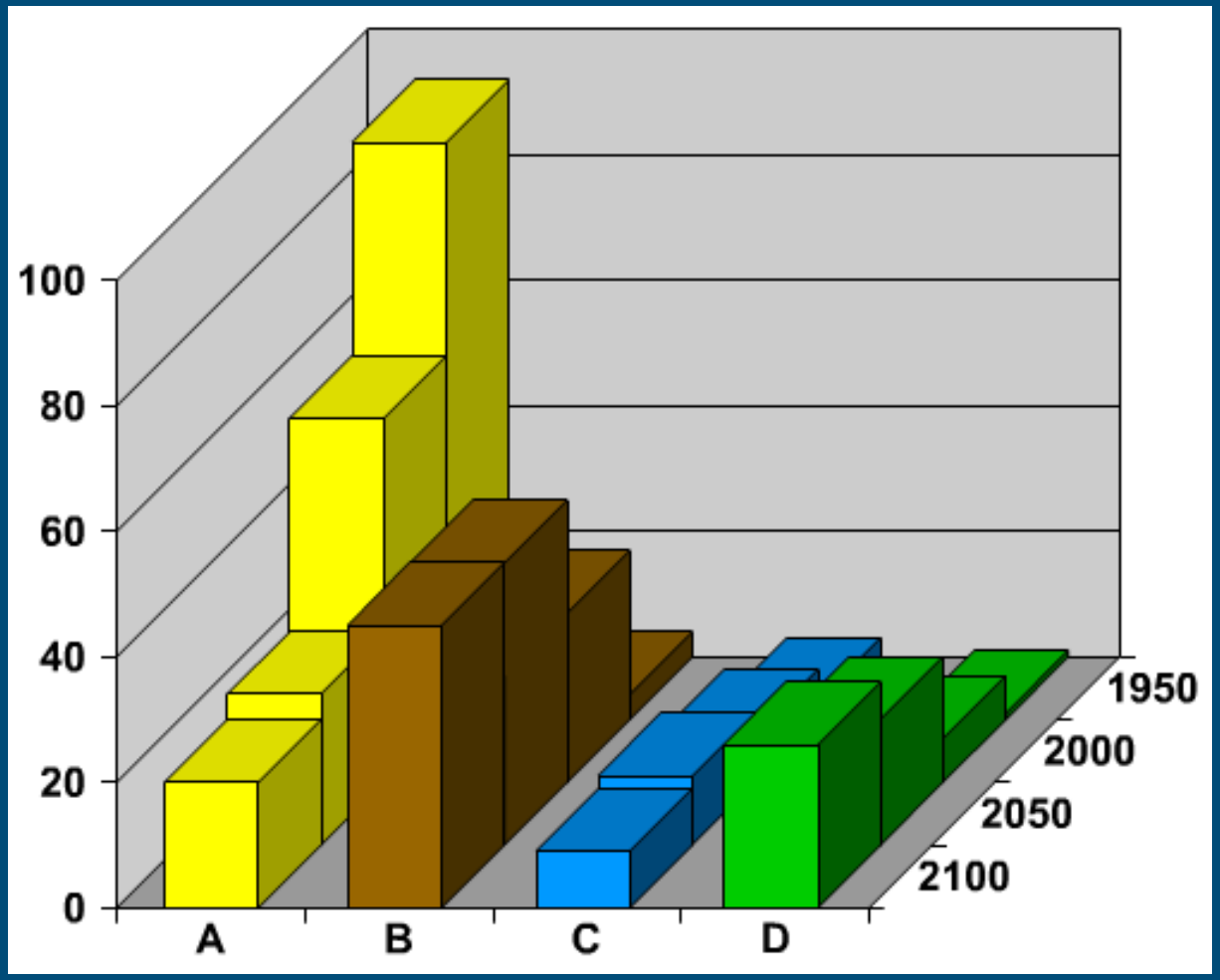
Kempen: an integrated regional approach

- Divide problem into pieces that can be managed:
  - Zink ash distribution
  - Peoples gardens (food crops)
  - Polluted sediments along rivers (Dommel)
  - Groundwater
  - Agriculture
  - Nature

Kempen: an integrated regional approach

- Establish degree of risk
- Find out what is happening (process knowledge)
- Determine need to clean or treat or manage
- Design specific action plans for different fields
- Communicate with local stakeholders (farmers) and civilians (owners of gardens)
- Make action plan (and stick to it!)

Identification of sources and pathways



A: Topsoil

B: subsoil (adsorbed)

C: sub-soil in waterphase

D: Flux towards sediments

Presence of zinc ashes

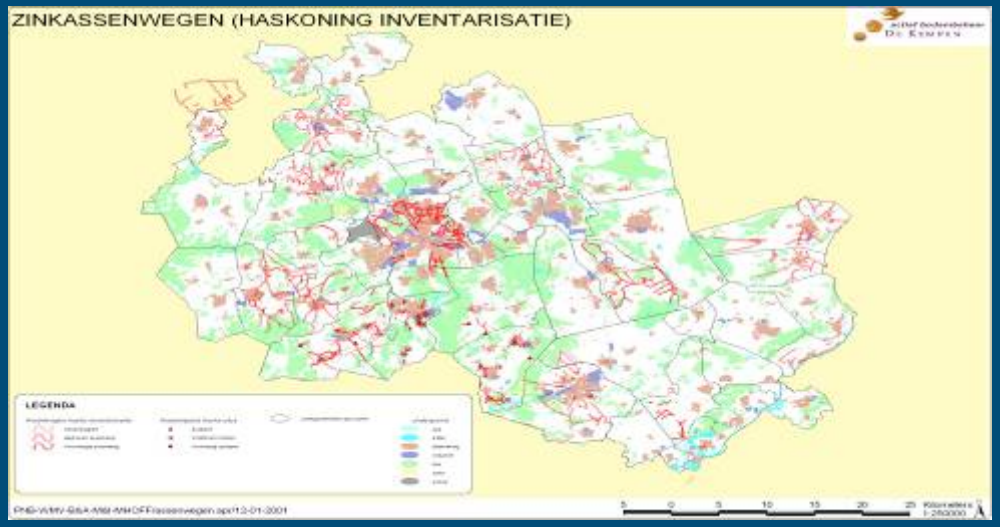
Presence of highly polluted ashes throughout the region.

Used for roads and pavement of yards near houses

Cd: > 50 ppm

Zn: > 5000 ppm

Presence of zinc ashes



Decision:

1. Very high risk
2. Complete removal
3. 60% paid by national government, 0% - 40% by community, depending on use
4. People have own responsibility (step approach)

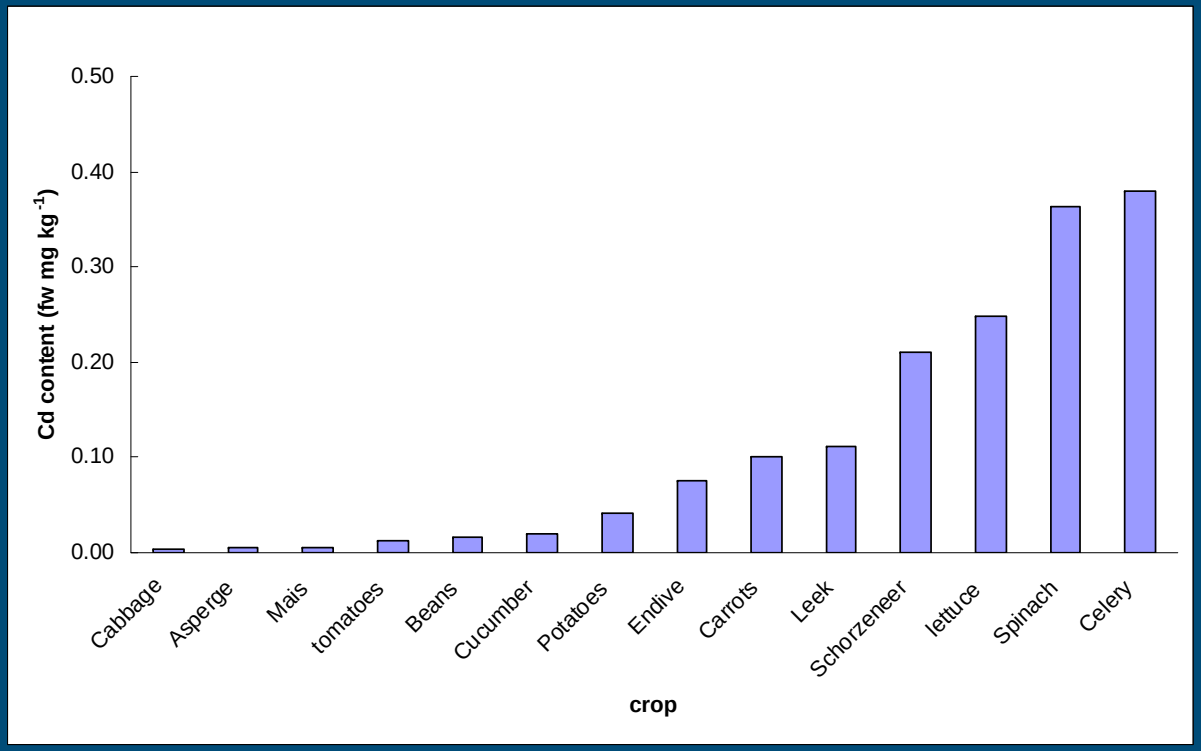
Clean up of ashes from private gardens

1. Gain information
2. Apply for soil test & testing
3. Analysis of results by local/regional government
4. Decision of need for clean-up
   - Flower garden = 100% compensation
   - Food production = 60% compensation
5. Signing of agreement
6. Preparation and execution of clean-up

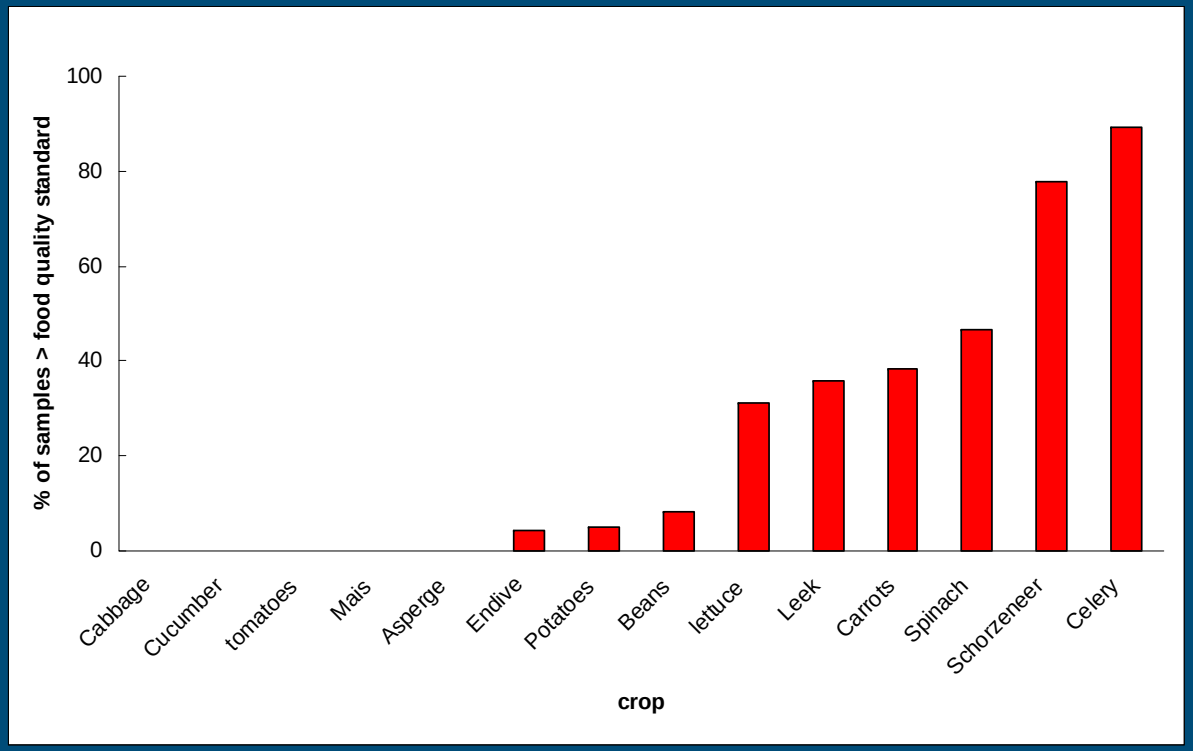
Risks for agriculture

- Problem
  - Crops do not meet EU food safety regulations
- Approach:
  - Determine levels in soil and crop
  - Measure other soil properties (pH, organic matter)
  - Establish relationship between soil and crop cadmium levels
  - Derive measures to reduce uptake by crops

Cadmium levels in field grown crops (1)



Cadmium levels in field grown crops (2)



Cadmium in crops

- Reason for high cadmium levels in crops:
  - low pH (4 – 5.5)
  - Low organic matter content (< 5%)
  - Low clay content (< 4%)
- Solution: increase pH of the soil!
  - No removal of cadmium -> soil management
- Make “look-up tables” for farmers

Look-up tables for animal fodder

MAIS

bodemgehalten:	pH: 4.00	pH: 4.50	pH: 5.00	pH: 5.50	pH: 6.00	pH: 6.50
[Cd]: 0.40 mg/kg	0.30	0.21	0.15	0.11	0.08	0.06
[Cd]: 0.80 mg/kg	0.52	0.37	0.26	0.19	0.14	0.10
[Cd]: 1.20 mg/kg	0.71	0.51	0.36	0.26	0.19	0.13
[Cd]: 1.60 mg/kg	0.89	0.63	0.45	0.32	0.23	0.17
[Cd]: 2.00 mg/kg	1.05	0.75	0.54	0.39	0.28	0.20
[Cd]: 2.40 mg/kg	1.22	0.87	0.62	0.45	0.32	0.23
[Cd]: 2.80 mg/kg	1.37	0.98	0.70	0.50	0.36	0.26
[Cd]: 3.20 mg/kg	1.52	1.09	0.78	0.56	0.40	0.29
[Cd]: 3.60 mg/kg	1.67	1.19	0.85	0.61	0.44	0.31
[Cd]: 4.00 mg/kg	1.81	1.30	0.93	0.66	0.47	0.34
[Cd]: 4.40 mg/kg	1.95	1.40	1.00	0.71	0.51	0.37
[Cd]: 4.80 mg/kg	2.09	1.49	1.07	0.76	0.55	0.39

GRASS

bodemgehalten:	pH: 4.00	pH: 4.50	pH: 5.00	pH: 5.50	pH: 6.00	pH: 6.50
[Cd]: 0.40 mg/kg	0.36	0.23	0.15	0.10	0.06	0.04
[Cd]: 0.80 mg/kg	0.85	0.54	0.35	0.23	0.15	0.09
[Cd]: 1.20 mg/kg	1.39	0.89	0.57	0.37	0.24	0.15
[Cd]: 1.60 mg/kg	1.97	1.27	0.82	0.52	0.34	0.22
[Cd]: 2.00 mg/kg	2.58	1.66	1.07	0.69	0.44	0.29
[Cd]: 2.40 mg/kg	3.23	2.08	1.34	0.86	0.55	0.36
[Cd]: 2.80 mg/kg	3.90	2.51	1.61	1.04	0.67	0.43
[Cd]: 3.20 mg/kg	4.59	2.95	1.90	1.22	0.79	0.51
[Cd]: 3.60 mg/kg	5.30	3.41	2.19	1.41	0.91	0.58
[Cd]: 4.00 mg/kg	6.02	3.88	2.49	1.61	1.03	0.67
[Cd]: 4.40 mg/kg	6.76	4.35	2.80	1.80	1.16	0.75
[Cd]: 4.80 mg/kg	7.52	4.84	3.12	2.01	1.29	0.83

MAIZE

bodemgehalten:	pH: 4.00	pH: 4.50	pH: 5.00	pH: 5.50	pH: 6.00	pH: 6.50
[Zn]: 50 mg/kg	357	219	134	82	50	31
[Zn]: 100 mg/kg	584	358	220	135	83	51
[Zn]: 150 mg/kg	779	477	293	180	110	68
[Zn]: 200 mg/kg	955	586	359	220	135	83
[Zn]: 250 mg/kg	1119	686	421	258	158	97
[Zn]: 300 mg/kg	1273	781	479	294	180	110
[Zn]: 350 mg/kg	1421	871	534	328	201	123
[Zn]: 400 mg/kg	1562	958	587	360	221	135
[Zn]: 450 mg/kg	1698	1041	639	392	240	147
[Zn]: 500 mg/kg	1830	1122	688	422	259	159
[Zn]: 550 mg/kg	1958	1201	736	452	277	170
[Zn]: 600 mg/kg	2082	1277	783	480	295	181

GRASS

bodemgehalten:	pH: 4.00	pH: 4.50	pH: 5.00	pH: 5.50	pH: 6.00	pH: 6.50
[Zn]: 50 mg/kg	269	174	112	72	47	30
[Zn]: 100 mg/kg	438	283	182	117	76	49
[Zn]: 150 mg/kg	583	376	242	156	101	65
[Zn]: 200 mg/kg	714	460	297	191	123	80
[Zn]: 250 mg/kg	835	539	347	224	144	93
[Zn]: 300 mg/kg	950	612	395	255	164	106
[Zn]: 350 mg/kg	1058	682	440	284	183	118
[Zn]: 400 mg/kg	1163	750	483	312	201	130
[Zn]: 450 mg/kg	1263	814	525	339	218	141
[Zn]: 500 mg/kg	1360	877	566	365	235	152
[Zn]: 550 mg/kg	1455	938	605	390	251	162
[Zn]: 600 mg/kg	1547	997	643	415	267	172

Management of natural areas: flooded river plains

Management of natural areas: flooded river plains

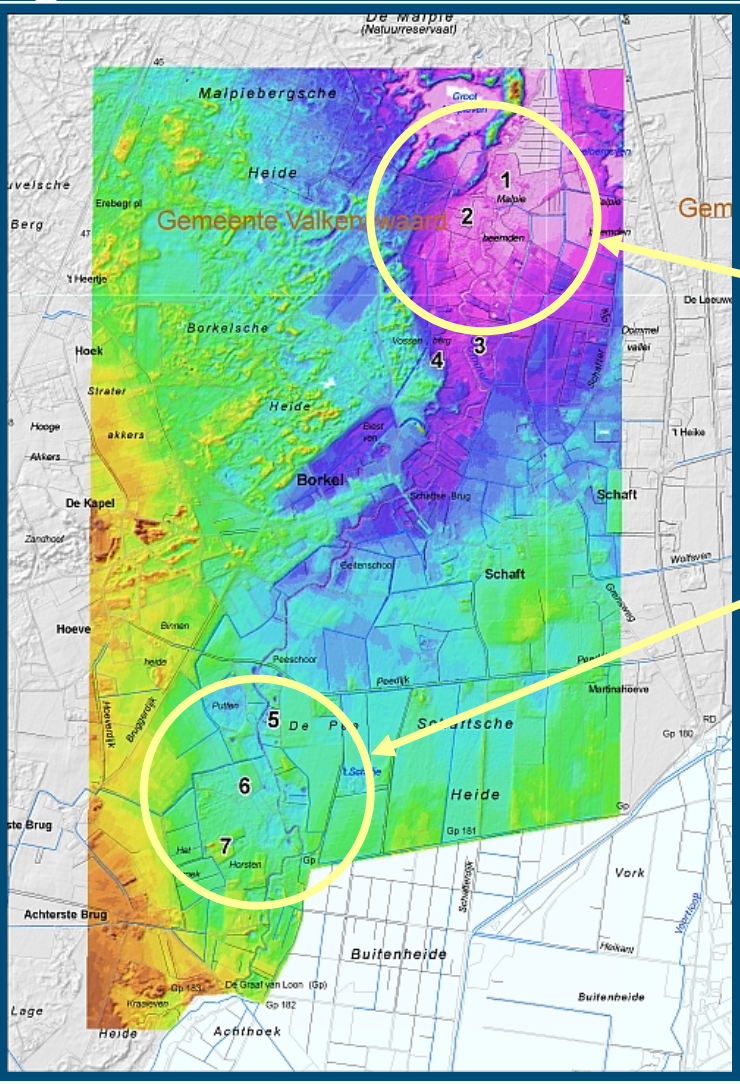
Problem: high levels of cadmium, zinc and lead in flooded river soils “Malpiebeemden” (n=26): natural area!

	pH	OM	Cd	Pb	Zn
Min	4.3	3.6	**5.0**	31	115
Median	5.2	10.5	**22.0**	157	395
Max	6.4	29.3	**123**	472	1992

Management of natural areas: flooded river plains

- Problem
  - Heterogeneous soil pollution
  - High content of cadmium in grass (> EU fodder regulation)
  - Intake of cows too high, accumulation of Cd in kidney
- Approach
  - Measure levels in grass in relation to deposition level (low, medium, high)
  - Calculate Cd levels in kidney
  - Allow cows in higher areas only
  - Remove kidney from foodchain

Management of natural areas: flooded river plains



Low lying areas (frequently flooded)

Higher situated areas (less frequently flooded)

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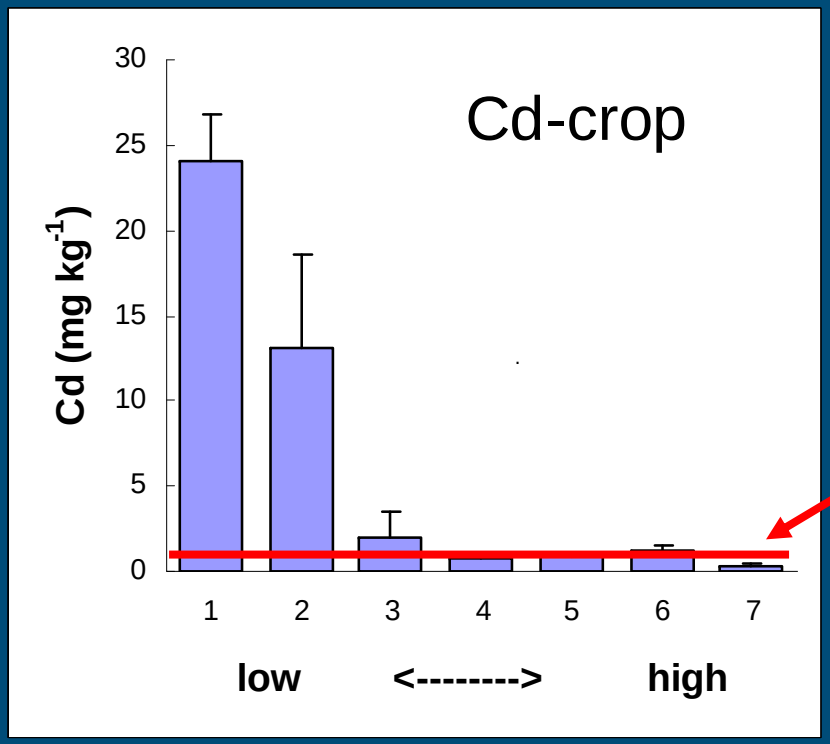
Management of natural areas: flooded river plains



EU fodder regulation

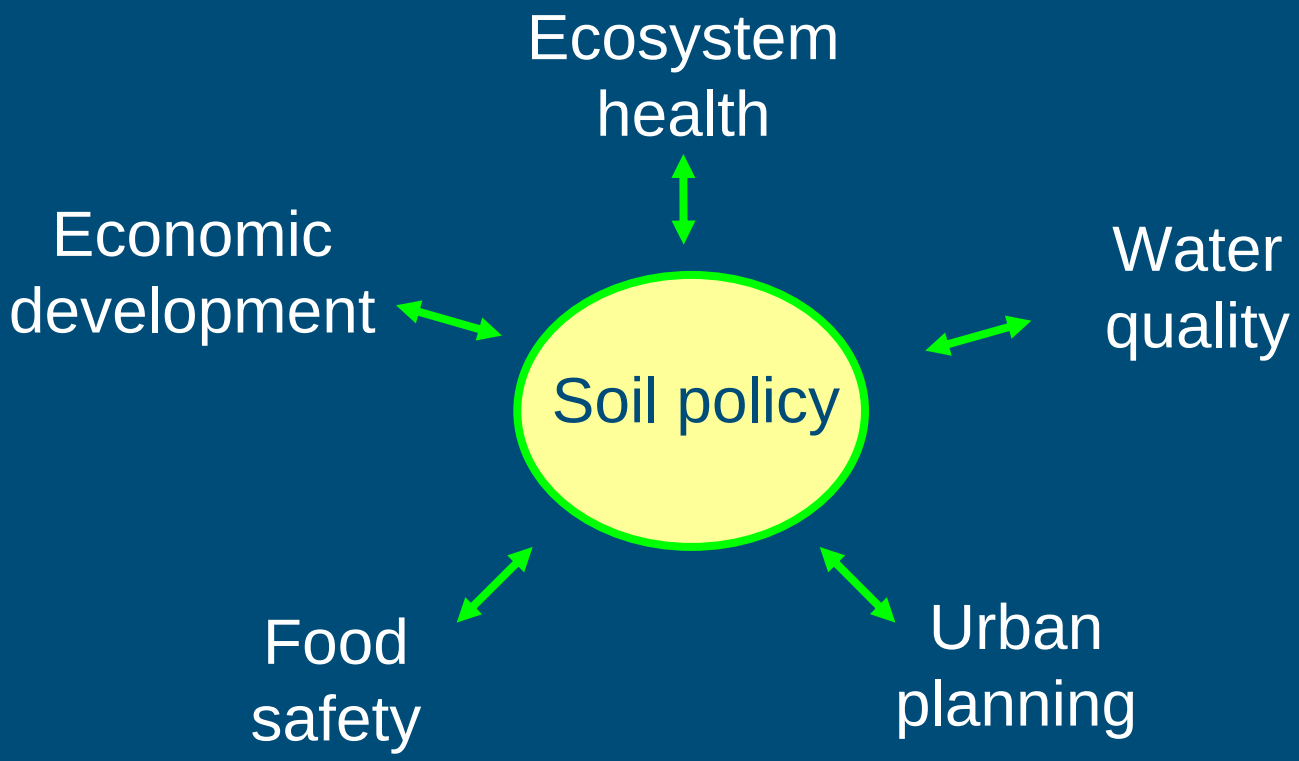
Are cows at risk?

- Cadmium-kidney:
  - soil + grass + additives = total intake
  - total intake * Biotransfer coefficient = Cd-kidney
- Cd-kidney 0.5 – 3.0 mg kg^{-1} in higher plots (4 – 7)
- Cd-kidney 2.3 – 57 mg kg^{-1} in low plots (1, 2, 3)
- EU food quality standard = 1.0 mg kg^{-1}
- toxic level for cows > 100 mg kg^{-1}

Management of natural areas: flooded river plains

- Decision of policy makers:
  - Cows and cow products not suitable for human consumption
  - Cows are allowed to graze in polluted areas (maintain grassland)
  - Careful monitoring for increased signs of toxicity (animal health)

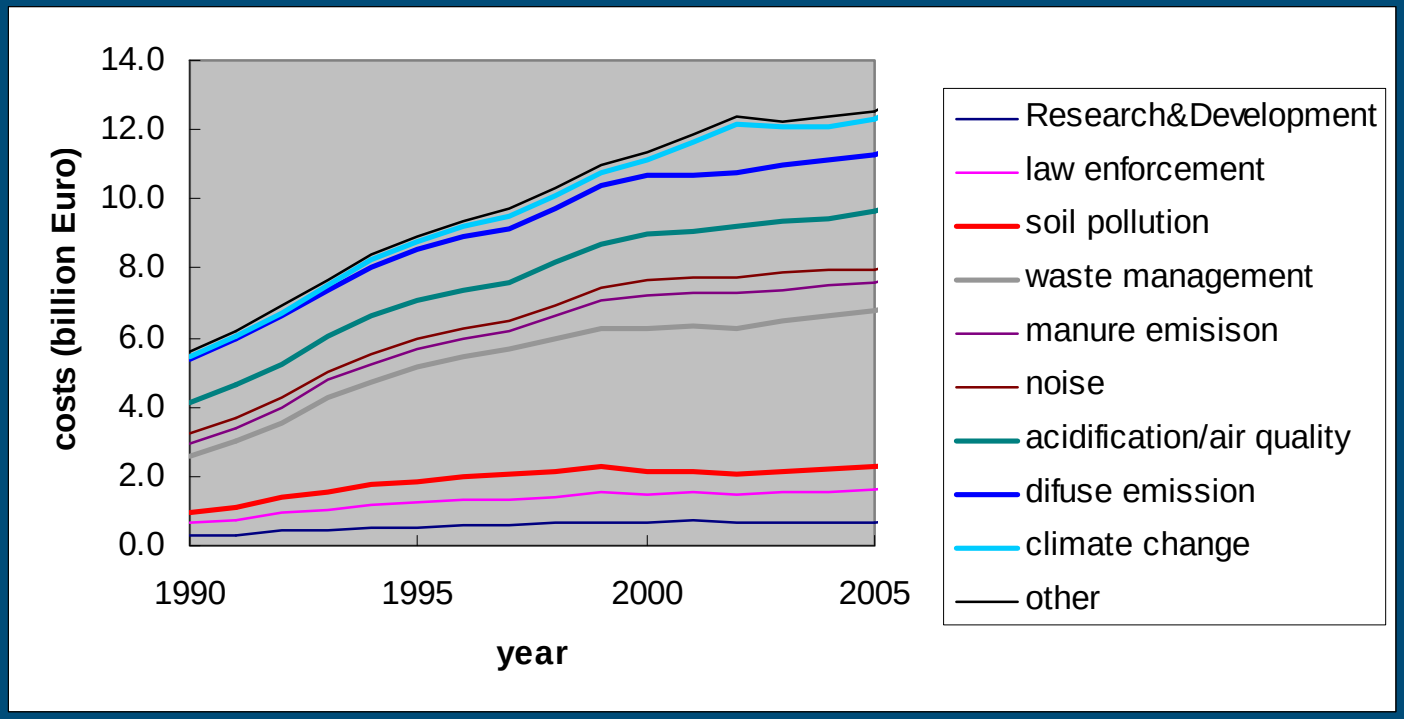
In conclusion…..



Soil policy: the essence

- Soil policy:
  - Keep clean what is clean — *prevent* risk
  - Clean up what really needs to be cleaned — *remove* risk
  - Manage the rest (re-use of polluted soil) — *minimize* risk

But its not for free……



Soil policy

But worth the effort!

Thank you!