Rijksinstituut voor Volksgezondheid en Milieu
Ministerie van Volksgezondheid, Welzijn en Sport

Lead in Soil - Dutch Toxicological and Risk Assessment Approach

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Content

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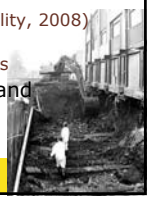
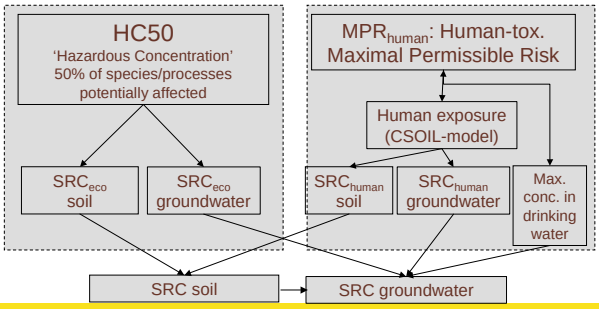
1. Soil Policy (Dutch Soil Protection act)

- Soil remediation
  - Intervention Values Soil (Decree on soil quality, 2008)
  - Remediation Criteria (Ministerial Circular, 2009)
  - Remediation objectives (= Maximal values)
- Soil management
  - Rules for re-use of soil (Decree on soil quality, 2008)
    - Generic Maximal Values
    - Local Maximal Values by local authorities
- Covenant on soil development policy and strategy for urgent sites (2009)

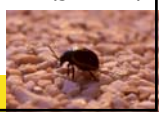


2. Intervention Values: derivation

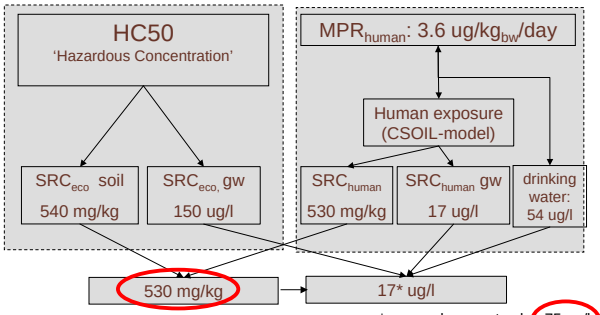


2. Intervention Value: background

- Maximal Permissible Risk (MPR) for children:
  - Above MPR: a potential health risk (25 ug/kgbw/week)
  - Based on toxicological and epidemiological studies
- Human exposure 'residential with garden':
  - Soil ingestion: 100 mg/day
  - Relative bioavailability of lead in soil = 0.74
    - P80 for relative bioavailability of lead in tested soils
  - Crop consumption from own garden: 10%
  - Bioconcentration factor (BCF) based on field data (geomean)
- Ecotoxicological effect on species/processes (HC50)

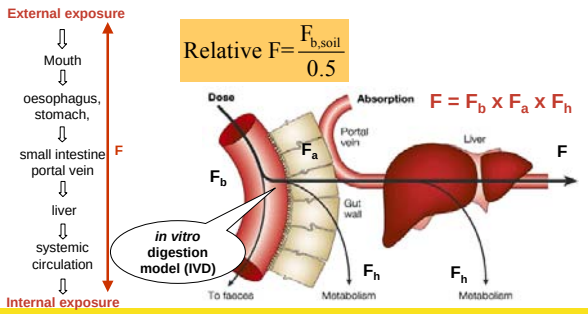


2. Intervention Value: lead



*proposal, current value 75 ug/l

3. Relative oral bioavailability?



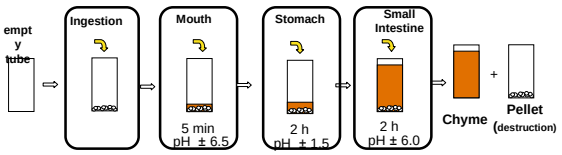
3. Bioavailability in made soils: set up

- Goal: derivation generic factor for the bioavailability of lead in Dutch made soils, correlated with lead and soil characteristics
- 45 sites (15 cities on 5 soil types)
- Bioaccessibility:
  - IVD model (90 soils)
  - Tiny-TIM model (16 soils)
- Soil characteristics (OM, clay, pH, CaCO3)
- Lead characteristics (e.g. particle size, speciation)

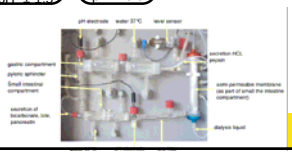
3. Bioavailability in made soils: methods

- In vitro digestion model (IVD):

Bioaccessibility ($F_{b,soil}$) = (Lead in chyme) / (Total lead in soil)



- TNO Intestinal Model (Tiny-TIM)

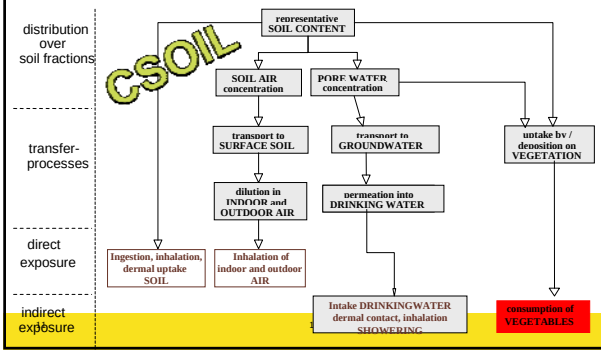


3. Bioavailability in made soils: results

	relative oral bioavailability factor		
	IVD (I)	IVD (II)	Tiny-TIM
Number of soils	90	16	16
Lowest value Highest value	0.11 1.77	0.40 1.03	0.04 0.21
Percentile 50 Percentile 90	0.67 1.02	0.64 0.81	0.12 0.17

- P50 of IVD 0.67 and of Tiny-TIM 0.12
- Reasons: pH in stomach, separation method
- Validation needed
- No relation with soil characteristics
- Qualitative correlation between *Rel* F and lead speciation (IVD only)

4. Crop consumption & plant uptake



4. Crop consumption & plant uptake: parameters

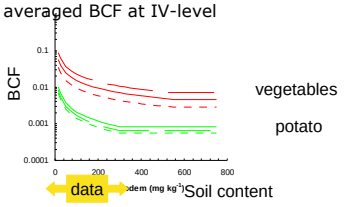
- Crop consumption rate (adult/child) [g/day]
- Fraction contaminated crop [%]
- Food basket (how much of each type of crop) [g/day]
- Calculation crop concentrations [mg/kg$_{dw}$]:

$$Concentration\ Pb_{crop} = BCF\ Pb_{crop} * Concentration\ Pb_{soil}$$

- Currently based on geomean
- **log[BCFcrop] = a + b*log[Pbsoil]** + c*log[OM] + d*log[Clay] + e*pH

4. Crop consumption & plant uptake; results

- New field data for different crops (n= 2500)
- Consumption averaged BCF at IV-level



Crop	Current (geomean)	New (Geomean)	New BCF-relation
Potato	0.0017	0.0025	0.0007
vegetables	0.044	0.009	0.0043

5. Approaches for risk assessment

- **A. Exposure model and Rfd (MPR)**
- *CSOIL exposure model*

- **B. lead-blood model and critical lead-blood concentration**
- *IEUBK (=Integrated Exposure Uptake Bio kinetic) Model*

5. Comparison lead-blood model and MPR approach [1]

- *Differences in assumptions*

Subjects	IEUBK-model	CSOIL+Rfd
Critical blood-lead concentration	Often critical blood-lead concentration = 100 ug/l	Rfd at which blood-lead concentration <50ug/l
Age categories	Seven	One
Background exposure	Included	No background exposure
Generic relative bioavailability	0.6	0.74
Absorption process	Can be saturated	Cannot be saturated

5. Comparison lead-blood model and MPR approach; result

- *Lead-blood concentration of children IEUBK-model compared with CSOIL/MPR*

Modification in IEUBK-model (other assumptions standard)	Lead-blood concentration of children
Soil concentration is equal/lower than 530 mg/kg	geomean: 61 µg/l* Max: 77 µg/l (1-2 year)
Soil concentration 390 mg/kg	geomean: 50 µg/l*
Soil concentration 1080 mg/kg	geomean: 100 µg/l*

* For different age categories.

- *Conclusion: no large differences; in CSOIL no background exposure*

6. Soil policy: Remediation Criteria (2009)*

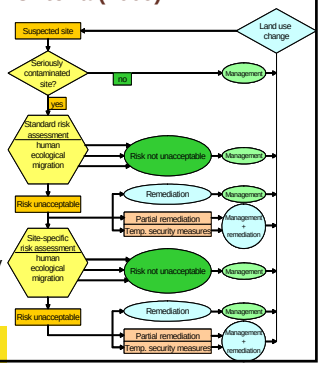
Tier 1: Intervention Value

Tier 2 Assessment:

- Land use specific
- Risk assessment for children
- Bio accessibility: Rel F= 0.74
- Geomean BCF

Tier 3 Assessment:

- Measurements in crops
- Measurement of bio accessibility
- For 'made soil': Rel F= 0.4



 *Webapplication www.sanscrit.nl

6. Soil policy: Remediation criteria critical concentrations*

Land use	OLD: exposure of children	OLD: life-long average	NEW (april 2009), risks for children: Tier 2: Generic	Tier 3: made ground: IVD-model	Tier 3: made ground: Tiny TIM-model	Tier 3: made ground: used
Rel. bioavailability	1	1	0.74	0.67	0.12	0.4
* Residential with garden (standard scenario)	301	1440	534 (700)	574	1382	805
* Places where children play	-	2370	729	805	4457	1350
* Residential with veg. garden	-	204	140 (500)	143	167	154
* infrastructure and industry		14500	3600	4000	21900	6700

 *Webapplication www.risicotoolboxbodem.nl

6. Soil policy: Soil management

Always to be applied	Class Residential	Class Industry	Not to be applied

Background values

Maximal Values Class Residential

Maximal Values Class Industry

- *Maximal Values*

Land use →	Nature area	**Residential with garden**	**Industrial, other green areas**
	mg/kg	mg/kg	mg/kg
Human risks	1800	270	1800
Agricultural risks	n.a.	n.a.	n.a.
Ecological risks generic	50	214	540
Ecological risks secondary poisoning	50	n.a.	515
Maximal Value (lowest)	**50**	**210**	**530**

7. Concluding remarks and outlook

- Much information about lead, but…
- Also still uncertainties: mainly on bioavailability (site specific)
- New evaluation of lead toxicity by EFSA and JECFA
- Urgent human sites remediated in the Netherlands <2015!
- Validation study with juvenile pigs planned for 2011
- Implementation results plant uptake data and validation study (2011?)

Thank you for your attention!

Questions?