MOdern mérnöki eszköztár Kockázat-alapú Környezetmenedzsment megAlapozásához

Nemzeti Kutatási Fejlesztési Programok
NKFP 3-020-05
I. Munkaszakasz

Áttekintés

BME II.1.2.3. Kockázatalapú határértékek és képzésük

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Holland közegészségügyi és környezet-kutatási intézet, talaj és talaj-víz kutató laboratórium

Földtani közegre és felszín alatti vízre vonatkozó kockázat szempontú határértékek Hollandiában. Határértékek és szennyezett területek remediációjának sürgőssége

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Összefoglalás

Hollandiában, a talaj- és talajvízminőség meghatározására kétlépcsős metodológiát alkalmaznak.
1. talaj- és talajvízkoncentrációk alapján kockázat meghatározása multifunkcionális szennyezőanyag-specifikus határértékekhez viszonyítva.
2. az aktuális, területspecifikus kockázat meghatározása remediáció sürgősségének eldöntésére, csak nagyon szennyezett terület esetén.

1. A holland talajvédelmi szabályzat két generikus (multifunkcionális) kockázatszempontú határértéket tartalmaz a talaj és talajvíz minőségének meghatározására: a célértéket (Target value) és a beavatkozási (Intervention value) határértéket. Ennek alapján a talaj és a felszín alatti víz három kategóriába sorolható: szennyezetlen, kevésbé szennyezett vagy erőteljesen szennyezett. A célértéket (Target value) a potenciális ökológiai kockázat, míg a beavatkozási határértéket (Intervention value) a potenciális humán és ökológiai kockázat alapján határozták meg.
2. A „nagyon szennyezett" területek elvileg remediálásra kerülnek. A remediáció sürgősségét az aktuális (terület-specifikus) humán és ökológiai kockázat alapján döntik el, figyelembe véve a szennyezőanyag transzport (migráció) aktuális kockázatát is.

1. A kockázat alapú célérték (Target value) és a beavatkozási határérték (Intervention value) meghatározása

A talaj és talajvíz minőségének meghatározására két határértéket használnak:
a célértéket és a beavatkozási határértéket. A célértéket a potenciális ökológiai kockázat, míg a beavatkozási határértéket a potenciális humán és ökológiai kockázat alapján határozták meg. A kockázat alapú célérték és beavatkozási határérték átlagából képeztek egy intermediáris/átlag nem kockázatszempontú határértéket.

1.1 A célérték (target value) meghatározása

1.1.1 A talajra vonatkozó célértéket az elhanyagolható ökológiai kockázat alapján számítják. Az elhanyagolható ökológiai kockázat a Maximális Megengedhető Ökológiai Kockázat 1%-a (MPR_{eco}). Az MPR_{eco} pedig az ökoszisztéma 5%-ára károsan ható koncentráció (HC5), ami 95%-os védettséget jelent. Tehát a megengedhető határérték az ökoszisztéma 5%-ára károsan ható koncentráció (HC5) 1 %-a. A humán expoziciót figyelmen kívül hagyták a célérték meghatározásánál. Fémek esetén a célértéket a hozzáadott kockázat elve szerint számítják. Ez azt jelenti, hogy a fent meghatározott kockázat alapú koncentrációértékhez hozzáadódik még a talaj „háttér" koncentrációja. A legtöbb fém esetén a kockázat alapú koncentráció elhanyagolható a „háttér" koncentrációhoz képest. Ezért Hollandiában „természetes" talaj környezetben az ökoszisztéma nem, vagy alig veszélyeztetett.

1.1.2 A talajvízre vonatkozó célértéket a vízi ökoszisztémára elhanyagolható ökológiai kockázat szerint számítják. Fémek esetén, a talajhoz hasonlóan, a hozzáadott kockázat elvét

alkalmazzák. Mivel a „háttér” koncentráció változik a mélységgel, két célértéket különböztetnek meg:

a) felszín közeli célérték (talajvízszint <10 m)
b) mélységi célérték (talajvízszint >10 m)

Ha nem áll rendelkezésre elegendő ökotoxikológiai adat szerves szennyezőanyagokkal szennyezett vízre, akkor a célértéket más vízminőségi szabvány vagy határérték alapján adják meg.
A talaj és talajvízre vonatkozó célértékeket az angol nyelvű anyag **A melléklete** tartalmazza.

1.2 Beavatkozási határérték

A talajra és talajvízre vonatkozó beavatkozási határértéket humán és ökotoxikológiai módszerek alapján meghatározott beavatkozási határértékből képezzük.

1.2.1 Beavatkozási határérték talajra

A humán és ökotoxikológiai értékeket magas koncentrációjú szennyezett talajra vonatkoztatott határértékek alapján számítjuk ki. A végső beavatkozási határérték tartalmazza úgy a humán, mint az ökotoxikológiai határértékeket.
A humán toxikológiai beavatkozási határérték, az a legmagasabb szennyezőanyag koncentráció a talajban (HUM-TOX SCC), amely esetén a bevitel a maximális megengedett kockázatnak felel meg (MPR_{human}), a CSOIL expoziciós modell szerint. Tehát a humán toxikológiai beavatkozási határérték (ECOTOX SCC), az koncentráció, amely a talaj ökoszisztéma (fajok és folyamatok) 50%-át veszélyezteti (HC50).

1.*2.2 Beavatkozási határérték talajvízre*

A talajvíz szennyezettség beavatkozási határértékét a talajra vonatkozó értékekből számítjuk ki, mivel Hollandiában talajvízre vonatkozó humán kockázat nem valószínű. A talajvízre vonatkozó beavatkozási határérték az a talajvizet szennyező koncentráció, amely egy talajra vonatkozó beavatkozási határértékhez tartozik. A talajvízre vonatkozó beavatkozási határérték számításánál figyelembe vesszük a szilárd fázis és pórusvíz közötti megoszlást, valamint a talajvízbe történő szennyezőanyag bemosódást. A számítás két lépésben történik:

A pórusvíz egyensúlyi koncentrációjának számítása:

- A pórusvíz egyensúlyi koncentrációja = Beavatkozási határérték talajra/ átlagos megoszlási hányados,

Talajvíz egyensúlyi koncentrációjának számítása:

- Talajvíz egyensúlyi koncentrációja = pórusvíz koncentráció/10

A talaj és talajvízre vonatkozó beavatkozási határértékeket az **A melléklet** tartalmazza.

2. A remediáció sürgősségének meghatározására alkalmazott módszerek

A remediáció sürgősségének meghatározása aktuális és nem generikus kockázati értékeken alapszik. Az aktuális kockázat jelenre és közeljövőre jellemző terület-specifikus kockázat. A remediáció sürgősségének megállapításához végzett kockázati analízis a szennyezett terület humán és ökológiai kockázata mellett, figyelembe veszi a szennyezőanyag terjedése/migrációjából eredő kockázatot is.
A remediáció sürgősségének megállapításához alkalmazott módszerek konzervatívak, ami azt jelenti, hogy a humán, ökológiai és szennyezőanyag terjedésből származó kockázatot az aktuális kockázat szempontjából határozzák meg. A számításokat egy szoftver segítségével végzik (SUS)(Urgency for Remediation Methodology).
Az aktuális humán expozició kvantitatív paramétereit a CSOIL, VOLASOIL(a területspecifikus beltéri levegőminőség számításához), és SEDSOIL (terresztriális talaj és üledékre) expoziciós modellek segítségével kapják meg. A modell bizonytalansága miatt a számításokat mérésekkel egészítik ki.

Az aktuális ökológiai kockázatot egy mátrix segítségével határozzák meg, a terület szennyezettségi foka, valamint a terület ökológiai érzékenysége függvényében.
A szennyezőanyag terjedéséből származó aktuális kockázat akkor jelentkezik, ha a telített talajban mért szennyezőanyag mennyiség meghaladja évente 100 m^3-t.
A remediáció sürgősségének meghatározásával két sürgősségi szintet különböztetnek meg:

- Sürgős beavatkozást igénylő komoly talajszennyeződés
- Nem sürgős beavatkozást igénylő komoly talajszennyeződés

A nem sürgős eseteket a vidék talaj-remediációs programjába veszik fel és a remediáció kezdetét határozatlan időre tervezik. A sürgős beavatkozást igénylő területeken a remediációt kb. 20 éven belül kell elkezdeni.

A táblázatokban a kockázatfelmérésen, ill. hatáson alapuló határértékek láthatóak.

Appendix A. Maximal Permissible Risk for intake (MPR_{human}), Target Value for Soil and Groundwater (10% Organic Matter, 25% Clay Ecotoxicological and Human Toxicological intervention value, Intervention Value for Soil and Groundwater (10% Organic Matte 25% Clay)

Contaminant	MPR_{human} [$\mu g \cdot kg^{-1} \cdot d^{-1}$]	Target Value soil [$mg \cdot kg^{-1}$]	Target Value groundwater [$\mu g \cdot l^{-1}$]		Ecotoxicol. interv. value [$mg \cdot kg^{-1}$]	Human toxicological interv. value [$mg \cdot kg^{-1}$]	Intervention Value soil [$mg \cdot kg^{-1}$]	Intervention Value groundwater [$\mu g \cdot l^{-1}$]
I. Metals and trace elements			<10m	>10m				
Antimony	0.66	3.0	---	0.15	2900	557	15	20
Arsenic	2.1	29	10	7.2	40	668	58	60
Barium	20	160	50	200	625	4260	625	625
Beryllium	0.5	1.1	--	0.05	29	233	(30)*	(15)*
Cadmium	1.0	0.8	0.4	0.06	12	34.9	12	6
Chromium*	5.0	100	1.0	2.4	230	2263	380	30
Cobalt	1.4	9.0	20	0.6	240	452	240	100
Copper	140	36	15	1.3	190	15703	190	75
Mercury	0.01	0.3	0.05	0.01	10	197	10	0.3
Lead	3.6	85	15	3.7	290	502	530	75
Molybdenum	10	3.0	5.0	0.7	480	911	200	300
Nickel	50	35	15	2.1	210	6582	210	75
Selenium	5.0	0.7	---	0.07	5.0	948	(100)*	(160)*
Silver	5.0	—	—	—	15	282	(15)*	(40)*
Tellurium	2.0	—	–	--		388	(600)*	(70)*
Thallium	0.2	1.0		2.0	14	118	(15)*	(7.0)*
Tin	2000	---	—	2.2	910	224030	(900)*	(50)*
Vanadium	2.0	42	—	1.2	250	1030	(250)*	(70)*
Zinc	1200	140	65	2.4	720	565920	720	800
II. Inorganic contaminants								
Cyanides (free)	50	1.0		5.0	—	6.8	20	1500
Cyanides (complex, pH < 5)	13	5.0		10	—	4.36	650	1500
Cyanides (complex, pH ≥ 5)	13	5.0		10	--	4.36	50	1500
Thiocyanates (sum)	11	1.0			—	3.69	20	1500

Appendix A. (*Continued*)

Contaminant	MPR_{human} [$\mu g \cdot kg^{-1} \cdot d^{-1}$]	**Target Value soil** [$mg \cdot kg^{-1}$]	**Target Value groundwater** [$\mu g \cdot l^{-1}$]	Ecotoxicol. interv. value [$mg \cdot kg^{-1}$]	Human toxicological interv. value [$mg \cdot kg^{-1}$]	**Intervention Value soil** [$mg \cdot kg^{-1}$]	**Intervention Value groundwater** [$\mu g \cdot l^{-1}$]
III. Aromatic contaminants							
Benzene	4.3	**0.01**	**0.2**	25	1.09	**1**	**30**
Ethyl benzene	136	**0.03**	**4.0**	—	244	**50**	**150**
Phenol	60	**0.05**	**0.2**	40	74.1	**40**	**2000**
Cresoles (sum)	50	**0.05**	**0.2**	50	117	**5**	**200**
Toluene	430	**0.01**	**7.0**	130	339	**130**	**1000**
Xylene	10	**0.1**	**0.2**	—	25.6	**25**	**70**
Catechol	40	**0.05**	**0.2**	—	22.9	**20**	**1250**
Resorcinol	20	**0.05**	**0.2**	—	10.4	**10**	**600**
Hydrochinon	25	**0.05**	**0.2**	—	10.8	**10**	**800**
Dodecylbenzene	5.0	—	—	—	1010	**(1000)**[a]	**(0.02)**[a]
Aromatic solvents	170	—	—	211	1450	**(200)**[a]	**(150)**[a]
Monochloroanilines	0.9	**0.005**	—	46	17.8	**50**	**30**
Dichloroanilines	—	**0.005**	—	43	—	**(50)**[a]	**(100)**[a]
Trichloroanilines	—	—	—	7.8	—	**(7.8)**[a]	**(10)**[a]
Tetrachloroanilines	—	—	—	27	—	**(30)**[a]	**(10)**[a]
Pentachloroanilines	—	—	—	5.9	—	**(10)**[a]	**(1.0)**[a]
4-chloro-2-methylphenol	20	—	—	15	39.3	**(15)**[a]	**(350)**[a]
4-chloro-3-methylphenol	300	—	—	15	589	**(15)**[a]	**(350)**[a]
IV. Polycyclic aromatic hydrocarbons							
Naphthaline	50	—	**0.01**	—	603	—	**70**
Anthracene	50	—	**0.0007**	—	29000	—	**5.0**
Phenantrene	20	—	**0.003**	—	661	—	**5.0**
Fluoranthene	20	—	**0.003**	—	1070	—	**1.0**
Benzo(a)anthracene	20	—	**0.0001**	—	11200	—	**0.5**
Chrysene	2.0	—	**0.003**	—	420	—	**0.2**
Benzo(a)pyrene	2.0	—	**0.0005**	—	1110	—	**0.05**
Benzo(*ghi*)perylene	20	—	**0.0003**	—	12000	—	**0.05**
Benzo(k)fluoranthene	20	—	**0.0004**	—	11600	—	**0.05**
Indeno(1,2,3-cd)pyrene	20	—	**0.0004**	—	11800	—	**0.05**
Total PAHs (10)	—	**1**	—	40	—	**40**	—
V. Chlorinated hydrocarbons							
1,1-dichloroethane	80	**0.02**	**7.0**	42	15.1	**15**	**900**
1,2-dichloroethane	14	**0.02**	**7.0**	60	3.86	**4.0**	**400**
1,1-dichloroethene	3.0	**0.1**	**0.01**	130	0.216	**0.22**[a]	**5.8**[a]
1,2-dichloroethene (cis)	6.0	—	—	238	0.51	—	—
1,2-dichloroethene (trans)	17	—	—	238	0.81	—	—
1,2-dichloroethene (sum)		**0.2**	**0.01**	238	—	**1.0**	**20**
Dichloromethane	60	**0.4**	**0.01**	60	18.9	**10**	**1000**
Tetrachloromethane	4.0	**0.4**	**0.01**	60	0.92	**1.0**	**10**
Tetrachloroethene	16	**0.002**	**0.01**	60	3.89	**4.0**	**40**
Trichloromethane	30	**0.02**	**6.0**	60	8.86	**10**	**400**
1,1,1-trichloroethane	80	**0.07**	**0.01**	88	14.6	**15**	**300**
1,1,2-trichloroethane	4.0	**0.4**	**0.01**	400	8.38	**10**[a]	**130**[a]
Trichloroethene	540	**0.1**	**24**	60	303	**60**	**500**
Vinylchloride	3.5	**0.01**	**0.01**	60	0.077	**0.1**	**5.0**
Dichloropropanes	60	**0.002**	**0.8**	125	1.81[a]	**2.0**[a]	**80**[a]
Chlorobenzenes:							
Monochlorobenzene	300	—	**7.0**	—	520	—	**180**
Dichlorobenzenes (sum)	190	—	**3.0**	—	1154	—	**50**
Trichlorobenzenes (sum)	0.5	—	**0.01**	—	9.04	—	**10**
Tetrachlorobenzenes (sum)	0.5	—	**0.01**	—	18	—	**2.5**

Appendix A. (Continued)

Contaminant	$MPR_{1,m}$ [$\mu g \cdot kg^{-1} \cdot d^{-1}$]	Target Value soil [mg·kg^{-1}]	Target Value groundwater [$\mu g \cdot l^{-1}$]	Ecotoxicol. interv. value [mg·kg^{-1}]	Human toxicological interv. value [mg·kg^{-1}]	Intervention Value soil [mg·kg^{-1}]	Intervention Value groundwater [$\mu g \cdot l^{-1}$]
Pentachlorobenzene	0.5	--	0.003	-	22.2	—	1.0
Hexachlorobenzene	0.5	—	0.00009	—	26.8	—	0.5
Total chlorobenzenes	—	0.01	—	10		30	
Chlorophenols:							
Monochlorophenols (sum)	3.0	--	0.3	10	14.9	—	100
Dichlorophenols (sum)	3.0	—	0.2	10	16.5	—	30
Trichlorophenols (sum)	2.0	—	0.03	10	59.3		10
Tetrachlorophenols (sum)	3.0	—	0.01	10	28.2	--	10
Pentachlorophenol	30	--	0.04	5.0	29.6	—	3.0
Total chlorophenols	—	0.01	—	10	-	10	--
Chlorophthalonil	0.5	—	—	—	0.12	10	6.0
Polychlorobiphenyls:							
Trichlorobiphenyl	0.29	--	—	—	5.52	—	—
Hexachlorobiphenyl	0.29	--	--	--	8.72	—	—
Total polychlorobiphenyls	--	0.02	0.01	1.0	--	1.0	0.01
Dioxins	0.20001	—	—	0.0026	0.001	(0.001)[a]	(0.000001)[a]
VI. Pesticides							
Organochlorine pesticides:							
DDT	20		--	--	11300	—	—
DDE	20	—	—	—	7840	—	—
Total DDT/TDD/DDE	—	0.01	0.001 ng.l^{-1}	7.0		4.0	0.01
Aldrin	0.1	--	0.009 ng.l^{-1}	0.35	13.8	--	--
Dieldrin	0.1	—	0.1 ng.l^{-1}	4.0	5.45	—	—
Endrin	0.1	—	0.04 ng.l^{-1}	0.06	1.36	--	--
Total drins	—	0.005	—	4.0		4.0	0.1
α-HCH	1	—	—	2.0	2.1	—	—
β-HCH	0.02	--	—	—	0.42	—	—
γ-HCH	1	—	—	2.0	27.1	--	--
Total HCHs	--	0.01	0.05	2.0	--	2.0	1.0
Other pesticides:							
Carbaryl	10	0.03 μg.kg^{-1}	2.0 ng.l^{-1}	5.0	461	5.0	50
Carbofuran	10	0.02 μg.kg^{-1}	9.0 ng.l^{-1}	1.5	435	2.0	100
Maneb	50	2.0 μg.kg^{-1}	0.05 ng.l^{-1}	35	29820	35	0.1
Atrazin	5	0.2 μg.kg^{-1}	29 ng.l^{-1}	6.0	21	6.0	150
Azinphosmethyl	5	0.009 μg.kg^{-1}	0.1 ng.l^{-1}	1.5	29.9	(2)[a]	(2)[a]
Chlordane	0.5	0.03 μg.kg^{-1}	0.02 ng.l^{-1}	5.4	5.76	4.0	0.2
Heptachlor	0.1	0.7 μg.kg^{-1}	0.005 ng.l^{-1}	2.0	1.51	4.0	0.3
Heptachloro epoxide	0.1	0.0002 μg.kg^{-1}	0.005 ng.l^{-1}	—	0.98	4.0	3.0
Endosulfan	6	0.01 μg.kg^{-1}	0.2 ng.l^{-1}	7.1	2470	4.0	5.0
Tributyltinoxide	0.3	--		0.48	21.5	--	—
Triphenyltin compounds	0.5	—	--	5.1	110	—	—
Total organotin compounds (sum)	-	1.0 μg.kg^{-1}	0.05 ng.l^{-1}	2.5	--	2.5	0.7
MCPA	1.5	0.05 μg.kg^{-1}	0.02	95	3.59	4.0	50
VII. Other pollutants							
Mineral oil	—	50	50	-	- -	5000	600
Cyclohexanone	4000	0.5	0.5	--	270[a]	45	15000
Butyl benzylphthalate	25	--			776	--	--
Di(2-ethylhexyl)phthalate	25			--	4028	—	—
Total phthalates	25	0.1	0.5	60	—	60	5.0
Pyridine	1	0.1	0.5	150	1.86	0.5	50
Styrene	77	0.3	6.0		2–9	100	300
Tetrahydrofuran	10	0.1	0.5		0.43	2.0	300
Tetrachloroethylene	186	0.1	0.5	4.1	94.0	90	5000
Ethylene-glycol	405	—	—	90	269	(100)[a]	(5500)[a]

Holland és nemzetközi irodalmi hivatkozások a következő témakörökben:

- **Határérték meghatározása földtani közegre és talajvízre**
- **Humán expozició**
- **Szennyezőanyag hatása és humán toxikológia**
- **Szennyezőanyag kockázata**
- **Ökotoxikológiai módszerek a kockázatfelmérésben**
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RIVM reports related to soil quality standards (Target Values, Intervention Values, Soil-use Specific Remediation Objectives) and actual risks (priority of remediation, building permits, active soil management) due to soil contamination.

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[*1] Please note that about half of the reports are in Dutch (with English summary).

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GENERAL

Van de Meent, D, T. Aldenberg, J.H. Canton, C.A.M. van Gestel, and W. Sloof (1990)
Desire for levels. Background study for the policy document "Setting environmental quality standards for water and soil". In English: Rivm report 6701010012. RIVM, Bilthoven, The Netherlands.
Description of the methodology used to derive risk concentrations for metals, PAHs, chlorophenols and pesticides.

Peijnenburg, W.J.G.M., M.A.G.T. van der Hoop, D. van der Meent, and J. Struijs (1996?).
Een conceptuele basis voor het omgaan met risicogrenzen en achtergrondgehalten bij het afleiden van milieukwaliteitsdoelstellingen (*in Dutch/English*). Rivm report no. 719101018. RIVM, Bilthoven, The Netherlands. 20 pages.
Two methods are evaluated to derive environmental quality objectives, incorporating background concentrations and availability: the so-called methods of effect-addition and effect limitation.

Jager, T., M.G.J. Rikken and P. van der Poel (1997).
Uncertainty analysis of EUSES: Improving risk management by probabilistic risk assessment. RIVM report 679102039. RIVM, Bilthoven, The Netherlands. 80 pages.
This report advocates a transition from a deterministic approach to a probabilistic approach and demonstrates how this could improve risk assessment.

Lijzen JPA ; Otte PF ; Kovar K ; Swartjes FA ; Bloemen H ; Hoogendoorn E ; Krystek P ;
Ritsema R ; Rompelberg C ; Verschoor A. (2003).
Progress report on the Evaluation of the Dutch method to determine urgency of soil remediation; analysis of restraints and exploration of possible solutions (*In Dutch*). RIVM report 711701028. RIVM, Bilthoven, The Netherlands. 87 pages.

DERIVATION OF SOIL AND GROUNDWATER QUALITY STANDARDS

Berg, R. van den, and J.M. Roels (1991).
Beoordeling van risico's voor mens en milieu bij blootstelling aan bodemverontreiniging. Integratie van deelaspecten (*in Dutch*). Rivm report no. 725201007; In English: Rivm report no. 725201013; in German: Rivm report no. 725201012. RIVM, Bilthoven, The Netherlands. Circa 100 pages
For the 1st series of compounds: integration of ecotoxicological criteria with the results of CSOIL calculations based on the human-toxicological criteria, yielding proposals for soil Intervention Values; note that several of the then proposed values have been modified at a later stage.

Berg, R. van den, Bockting, G.J.M., Crommentuyn, G.H. & Janssen, P.J.C.M. (1994)
Proposals for intervention values for soil clean-up: Second series of compounds. In English: Rivm report no. 715810004. RIVM, Bilthoven, The Netherlands. 163 pages.
Physicochemical properties, results of CSOIL calculations, derivation of the serious-soil-contamination-concentrations (scc) using the ecotoxicological and human-toxicological criteria; integration of values yielding proposals for Intervention Values; this second series consists of 12 compounds.

Kreule, P., Berg, R. van den, Waitz, M.F.W. & Swartjes, F.A. (1995)
Calculation of human-toxicological serious soil contamination concentrations and proposals for intervention values for clean-up of soil and groundwater: Third series of compounds. In English: Rivm report no. 715810010 (available from November 1995). RIVM, Bilthoven, The Netherlands. 85 pages.

Physicochemical properties, results of CSOIL calculations, derivation of the serious-soil-contamination-concentrations (scc) using the ecotoxicological and human-toxicological criteria; integration of values yielding proposal for Intervention Values; this 3rd series consists of 15 compounds.

Berg, R. van den (1997).

Verantwoording van gegevens en procedures voor de 1e tranche interventiewaarden: van RIVM-rapporten naar de Notitie Interventiewaarden bodemsanering (*in Dutch*). RIVM-rapport 715810012. RIVM, Bilthoven, The Netherlands. 117 pages.

The report describes the adjustments and changes that were made in models, parameters and data, during the period from release of the first series of proposals for Intervention Values (1991) up to implementation into the Dutch Act on Soil Protection (1994).

Swartjes, F.A. (1997).

Stofselectie voor afleiden "voorstellen voor interventiewaarden" (*in Dutch*). Rivm report 71581016. RIVM, Bilthoven, The Netherlands. 97 pages.

Criteria for selecting compounds for deriving Intervention Values; Inventory and selection of compounds for (eventual) deriving Intervention Values.

Kreule, P., F.A. Swartjes (1998).

Proposals for Intervention Values for soil and groundwater, including the calculation of human-toxicological serious soil contamination concentrations: Fourth series of compounds. In English: Rivm report no. 711701005. RIVM, Bilthoven, The Netherlands. 89 pages.

Physicochemical properties, results of CSOIL calculations, derivation of the serious-soil-contamination-concentrations (scc) using the ecotoxicological and human-toxicological criteria; integration of values yielding proposal for Intervention Values; this fourth series consists of 15 compounds.

Lijzen, J.P.A., A.J. Baars, G.H. Crommentuijn, P.F. Otte, E. van de Plassche, M.G.J. Rikken, C.J.M. Rompelberg, A.J.A.M. Sips en F.A. Swartjes (1999).

Revision Intervention Value of lead (*in Dutch*). RIVM report 711701013. RIVM, Bilthoven, The Netherlands. 65 pages.

The following elements were evaluated and adjusted: human exposure model input parameters, Maximum Permissible Risk for exposure, ecological risk limits, availability in the human body, soil type correction for bioavailability, partition coefficient.

Franken, R.O.G., A.J. Baars, G.H. Crommentuijn, P. Otte. 1999.

A proposal for revised Intervention Values for petroleum hydrocarbons on base of fractions of petroleum hydrocarbons. In English: RIVM report 711701015. RIVM, Bilthoven, The Netherlands. 58 pp

The present Dutch Intervention Values of TPH are not based on risk assessment. For this reason revised values have been proposed, for 5 fractions of aliphatics and 5 fractions of aromatics. The data are based on human risk assessment only, which were taken from the work which was performed by the Total Petroleum Hydrocarbon Criteria Working Group

Lijzen, J.P.A., F.A. Swartjes, P.F. Otte, J. Willems. 1999.

Soil-use specific Remediation Objectives. Procedure and results (*in Dutch*). RIVM report 711701016. RIVM, Bilthoven, The Netherlands. 41 pp

In 1997 the Dutch government decided to change the remediation approach of "multifunctionality" in case of immobile contamination cases. Soil-use specific Remediation Objectives have been proposed for four classes of soil use.

Revision Intervention Value for lead (*in Dutch*). RIVM report 711701013, RIVM, Bilthoven, The Netherlands. 41 pages.
Revision of the Intervention value for Lead, including correction for oral bioavailability in the human body.

Otte, P., M. van Elswijk, M. Bleijenberg, F. Swartjes, K. van der Guchte. 2000.
Calculation of human risk limits for sediments (*in Dutch*). RIZA-werkdocument 2000.084x. RIZA/ RIVM, Mai 2000.
Revision of the SEDISOIL model, which calculates human exposure to sediments, and calculation of human toxicological based risk limits.

Lijzen, J.P.A., A.J. Baars, P.F. Otte, M.G.J. Rikken, F.A. Swartjes, E.M.J. Verbruggen, A.P. Van Wezel. 2001.
Technical evaluation of the Intervention Values for Soil/sediment and groundwater. RIVM report 711701023, February 2001. RIVM, Bilthoven, The Netherlands. 147 pages.
Overall report of the project Evaluation of Intervention Values, resulting in revised proposals (see also the underlying reports 711701- 22/ 23/ 25).

Lijzen, J.P.A., A.J. Baars, P.F. Otte, E.M.J. Verbruggen, A.P. van Wezel (2002)
Background information with the revised risk limits for soil, sediment and groundwater in the framework of the "Evaluation Intervention Values soil remediation" (*in Dutch*). RIVM report 711701028. RIVM, Bilthoven, The Netherlands.

Lijzen, J.P.A., M. Mesman, T. Aldenberg, C.D. Mulder, P.F. Otte, R. Posthumus, E. Roex, F.A. Swartjes, C.W. Versluijs, P.L.A. van Vlaardingen, A.P. van Wezel, H.J. van Wijnen. 2002.
Evaluation of the foundation of the Soil-use Specific Remediation Objectives (in Dutch). RIVM report 711701029. RIVM, Bilthoven, The Netherlands.

Wezel, Van A., W. de Vries, M. Beek (ed.) (2003).
Land-use specific Remediation Objectives for Agriculture, Nature reserves and Sediments (*in Dutch*). RIVM report 711701031. RIVM, Bilthoven, The Netherlands.

Swartjes, F.A., A.J. Baars, R.H.L.J. Fleuren, P.F. Otte (2004.
Risk limits for MTBE (Methyl *tertiary*- Butyl Ether) in soil, sediment, groundwater, surface water, drinking water en for drinking water preparation. RIVM report 711701039/2004, Dec. 2004, RIVM, Bilthoven, The Netherlands.

HUMAN EXPOSURE

Linders, J.B.H.J. (1990)
Risicobeoordeling bij de mens bij blootstelling aan stoffen. Uitgangspunten en veronderstellingen (*in Dutch*). Rivm report no. 725201003. RIVM, Bilthoven, The Netherlands.
Description of calculation formulae to be used for estimation of human exposure via several routes in case of soil contamination; the formulas in this report were used in the compilation of the CSOIL-model as reported in the Rivm report by van den Berg (1995).

De Nijs, A.C.M., T.G. Vermeire (1990).
Soil-plant mammal transfer factors. in English: Rivm report no. 670203001. RIVM, Bilthoven, The Netherlands. 31 pages.
The factors controlling accumulation in fruits, vegetables, grains, meat, and dairy products are derived.

Van den Berg, R. van den (1991/1994/1995)
Blootstelling van de mens aan bodemverontreiniging. Een kwalitatieve en kwantitatieve analyse leidend tot voorstellen voor humaantoxicologische C-toetsingswaarden (beperkt herziene versie). **Modified version of the original report Van den Berg, 1991/ Van**

den Berg 1994. *In Dutch*: Rivm report no. 725201006; *in English*: Rivm report no. 725201011. RIVM, Bilthoven, The Netherlands. Circa 100 pages.
Description of the formulas that constitutes the CSOIL model, the model used to estimate human exposure in case of soil contamination; based on the human-toxicological criteria (MPR-values) for the 1st series of compounds, CSOIL is used to derive human-toxicological Intervention Values; table 2 to this report gives 'new' modified human-toxicological Intervention Values.

Bockting, G., and R. van den Berg (1992).
De accumulatie van sporenelementen in groenten geteeld op verontreinigde bodems. Een literatuurstudie (*in Dutch*). Rivm report 725201009. RIVM, Bilthoven, The Netherlands. 87 pages.
Literature-research on the accumulation of metals in plants, grown on contaminated sites; the basis for human exposure due to plant uptake.

Heijna-Merkus, E., and M. Hof (1994).
Harmonisation of model parameters. In English: Rivm report no. 679102022. RIVM, Bilthoven, The Netherlands. 20 pages.
The report describes the differences in input parameters used in different exposure models used in the Netherlands for compound independent characteristics.

Bockting, G.J.M., F.A. Swartjes, L.G.M. Koolenbrander, and R. van Berg (1994).
Beoordelingssystematiek bodemkwaliteit ten behoeve van bouwvergunnings-aanvragen. Deel I. Bodemgebruikspecifieke beoordelingsmethodiek voor de humane blootstelling (*in Dutch*). Rivm report no. 715810001. RIVM, Bilthoven, The Netherlands. 123 pages.
Methodology for estimating actual (i.e. location specific) human exposure using formulas from the CSOIL model and measurements in contact media; several standard soil use categories are defined using standard assumptions as to human exposure; this method is part of a system for the evaluation of soil quality in dealing with requests for official building permits to be granted by local authorities.

Polder, M.D., E.M. Hulzebos, and D.T. Jager (1994).
Validation of models on uptake of organic chemicals by plant roots. In English: Rivm report 679102024. RIVM, Bilthoven, The Netherlands. 45 pages.
In this report the application of soil-plant transfer factors was investigated. It is concluded that the root concentration factor is an appropriate instrument for the estimation of residues in roots, whereas the application of the stem factor is insufficient.

Hulzebos, E.M. (1994).
The uptake of air-borne substances in plants. In English: Rivm report 679102023. RIVM, Bilthoven, The Netherlands. 24 pages.
In this report several models, time-dependant and time-independent models, are discussed which describe the deposition of aerosols and gases and the subsequent uptake into plants.

Rikken, M.J.G. (1995).
De accumulatie van zeldzame aardmetalen in planten. Een literatuurstudie (*in Dutch*). Rivm report 601014013. RIVM, Bilthoven, The Netherlands. 51 pages.
The report summarises literature data on the transfer of rare earth metals in plants.

Jager, D.T. (1995).
Feasibility of validating the Uniform System for the Evaluation of Substances (USES). In English: Rivm report 679102026. RIVM, Bilthoven, The Netherlands. 56 pages.
The report describes a procedure that can be followed to show the user of the USES (Uniform System for Evaluation of Substances)-model the degree of accuracy of model calculations. For this purpose separate (sub)modules of USES should be validated.

Jager, D.T. (1995).

Uncertainty analysis of the Uniform System for the Evaluation of Substances (USES). Example calculations. In English: Rivm report 679102032. RIVM, Bilthoven, The Netherlands. 47 pages.
Example calculations are presented, based on Monte Carlo simulations, showing the contribution of some major parameters to the calculation results of some USES (Uniform System for Evaluation of Substances)-(sub)modules.

Jager, D.T., and W. Slob (1995).
Uncertainty analysis of the Uniform System for the Evaluation of Substances (USES). In English: Rivm report 679102027. RIVM, Bilthoven, The Netherlands. 65 pages.
A uncertainty analysis on the USES (Uniform System for Evaluation of Substances)-(sub)modules has been performed using the multiplicative models (analytical method) and the non-multiplicative (sub)modules (Monte Carlo techniques) .

Hooft, W.F. van (1995).
Risico's voor de volksgezondheid als gevolg van blootstelling van runderen aan sporenelementen bij beweiding (*in Dutch*). Rivm report 693810001. RIVM, Bilthoven, The Netherlands. 123 pages.
A model was developed to calculate concentrations of trace elements in tissues and milk for human consumption, to be able to quantify the risks to public health of exposition of grazing cattle to trace elements.

Janus, J.A., M.G.J. Rikken, M. Rutgers, H. Booij, E.M. Paardekoper (1995).
Overdracht van zeldzame aardmetalen in de keten kunstmest, bodem, plant, vee en mens (*in Dutch*). Rivm report 601014014. RIVM, Bilthoven, The Netherlands. 31 pages.
The report summarises literature data on the transfer of rare earth metals in the chain artificial fertilisers, soil, crops, livestock and man.

Waitz, M.F.W., J.I. Freijer, P. Kreule, F.A. Swartjes (1996).
The VOLASOIL risk assessment model based on CSOIL for soils contaminated with volatile compounds. In English: Rivm report 715810014. RIVM, Bilthoven, The Netherlands. 189 pages.
Description and evaluation of VOLASOIL, a model to calculate the site-specific indoor air quality, where variable groundwater table depth, convective flow of contaminated air originating from the soil and variability of building construction features have been incorporated.

Sips, A.J.A.M., and J.C.H. van Eijkeren (1996).
Oral bioavailability of heavy metals and organic compounds from soil; too complicated to adsorb? An inventory of factors affecting bioavailability of environmental contaminants from soil. In English: Rivm report no. 711701002. RIVM, Bilthoven, The Netherlands. 36 pages.
The report gives an overview of the data available on bioavailability of the heavy metals Pb, As, Cd, and organic toxicants as PCDD's/PCDF's and PCB's from soil. It is concluded that the soil matrix can reduce the bioavailability of environmental contaminants up to 10.

Polder, M.D., E.M. Hulzebos, and D.T. Jager (1996).
Bioconcentration of gaseous organic chemicals in plant leaves: comparison of experimental data with model predictions. In English: Rivm report 679102034. RIVM, Bilthoven, The Netherlands. 33 pages.
Evaluation of the models of Riederer (1990) and Trapp and Matthies (1995).

Bockting, G.J.M., J.G.M. Koolenbrander, F.A. Swartjes (1996).
Model ter berekening van de humane blootstelling ten gevolge van verontreinigde waterbodems (in Dutch). Rivm report 715810011. RIVM, Bilthoven, The Netherlands. 50 pages.

Description of the SEDISOIL model, which model enables quantification of human exposure due to contaminated sediments.

Sinke, J., H.J.G.M. Derks, K. Groen, and A.J.A.M. Sips (1996).
Bioavailability in the dog of benzo(a)pyrene from contaminated soil. In English: Rivm report 711701001. RIVM, Bilthoven, The Netherlands. 21 pages.
To come to a realistic risk assessment for benzo(a)pyrene the absolute oral bioavailability of the contaminant, based on influence of the soil matrix, is assessed. To this purpose dogs received B(a)p orally or intravenously in a four-way cross-over study design.

Vissenberg, H.A., and F.A. Swartjes (1996).
Evaluatie van de met CSOIL berekende blootstelling, middels een op Monte Carlo technieken gebaseerde gevoeligheids- en onzekerheidsanalyse. Hoofdrapport en bijlagen (*in Dutch*). Rivm report 715810018. RIVM, Bilthoven, The Netherlands. 130 + 90 pages.
The spread in the potential human exposure was quantified for five major contaminants. Furthermore, the contribution of the input-parameters for the spread in actual and potential human exposure was investigated.

Vermeire, T.G., M.P. van Veen, M.P.M. Janssen, R.C.G.M. Smetsers (1997).
De schatting van de blootstelling van de mens aan stoffen en straling (*in Dutch*). Rivm report 601132002. RIVM, Bilthoven, The Netherlands. 102 pages.
This report gives a review of models related to the assessment of human exposure to contaminants and radiation, developed at the RIVM. In the report purpose, concepts and default parameters of the models has been described.

Versluijs, C.W., R. Koops, P. Kreule, and M.F.W. Waitz (1998).
The accumulation of soil contaminants in crops, location-specific calculation based on the CSOIL module. Part I: Evaluation and suggestions for model development. In English: Rivm report 711701008. RIVM, Bilthoven, The Netherlands. 66 pages.

Otte, P., M. van Elswijk, M. Bleijenberg, F. Swartjes, K. van der Guchte. 2000.
Berekening van humane risicogrenzen voor waterbodems (*in Dutch*). RIZA-werkdocument 2000.084x. RIZA/ RIVM, mei 2000.
This report is describes an update of the 1996 SEDISOIL model, which model calculates human exposure to contaminated sediments. Furthermore sediment-specific quality standards have been derived, on the basis of human exposure scenarios for waterside recreation and fish consumption.

Otte, P.F., J.P.A. Lijzen, J.G. Otte, F.A. Swartjes, C.W. Versluijs. 2001.
Evaluation and revision of the CSOIL parameter set. RIVM report 711701021, March 2001. RIVM, Bilthoven, The Netherlands.
One of the reports of the project Evaluation Intervention Values, focusing on the evaluation and revision of the CSOIL parameter set, resulting in proposals for revised Intervention Values.

Rikken, M.G.J., J.P.A. Lijzen and A.A. Cornelese. 2001.
Evaluation of model concepts on human exposure. Proposals for updating the most relevant exposure routes of CSOIL. RIVM report 711701022, RIVM, Bilthoven, The Netherlands. 125 pages.
One of the reports of the project Evaluation Intervention Values, focusing on the evaluation and revision of the CSOIL exposure model, resulting in proposals for revised Intervention Values.

Versluijs, C.W., P.F. Otte. 2001.
Accumulation of metals in crops (*in Dutch*). RIVM report 711701024, RIVM, Bilthoven, The Netherlands. 138 pages.
Derivation of equations to calculate the amounts of metals in vegetables.

Swartjes, F.A. 2002.
Variation in calculated human exposure: Comparison of calculations with seven European human exposure models. RIVM report 711701030, March 2001. RIVM, Bilthoven, The Netherlands. 122 pages.
Oomen AG ; Lijzen JPA. 2004.
Relevancy of human exposure via house dust to the contaminants lead and asbestos RIVM report 711701037, RIVM, Bilthoven, The Netherlands. 58 pages.

EFFECT ASSESSMENT, HUMAN TOX

Vermeire, T.G., Apeldoorn, M.E. van, Fouw, J.C. de & Janssen, P.J.C.M. (1991)
Voorstel voor de humaantoxicologische onderbouwing van C-(toetsings)waarden (*in Dutch*): Rivm report no. 725201005. RIVM, Bilthoven, The Netherlands. 170 pages.
Human-toxicological criteria (MPR-values) for 1st series of compounds, this 1st series consists of 55 compounds or groups of compounds; includes description of the method used to derive the MPR-values.
Vermeire, T.G. (1993)
Voorstel voor de humaantoxicologische onderbouwing van C-(toetsings)waarden. Betreft addendum op rapport 725201005. RIVM, Bilthoven, The Netherlands (*in Dutch*). Rivm report no. 715801001.
Reevaluation of the Maximum Permissible Intake values for 9 (groups of) compounds from the set dealt with in the Vermeire et al.-report from 1991.
Janssen, P.J.C.M., M.E. van Apeldoorn, van Koten-Vermeulen, and W.C. Mennes (1995).
Human-toxicological criteria for serious soil contamination: Compounds evaluated in 1993 & 1994. In English: Rivm report 715810009. RIVM, Bilthoven, The Netherlands. 96 pages.
This report gives the derivation of the Maximal Permissible Risk levels for human intake for 26 compounds, which were used in the second and third series of the Intervention Values.
Janssen, P.J.C.M., and Speijers, G.J.A. (1997)
Guidance document on the Derivation of Maximum Permissible Risk levels for human intake of soil contaminants. In English: Rivm report 711701006. RIVM, Bilthoven, The Netherlands. 49 pages.
Step by step procedure to derive the Maximum Permissible Risk levels
Pieters, M.N., and W.H. Könemann (1997)
Mengseltoxiciteit: een algemeen overzicht en evaluatie van de veiligheidsfactor van 100 toegepast in het stoffenbeleid (*in Dutch*). Rivm report 620110004. RIVM, Bilthoven, The Netherlands. 57 pages.
The report gives i) an overview of the Dutch standard setting procedures in general; ii) an overview of common concepts in toxicology of mixtures and strategies which can be followed in their risk evaluation; iii) the plausibility of combined effects of compounds at low doses; iv) an evaluation of the safety factor of 100 used for the combined action of chemicals (difference between maximum tolerable risk and negligible risk).
Slob, W., and M.N. Pieters (1997).
A probabilistic approach for deriving acceptable human intake limits and human health risks from toxicological studies: general framework. In English: Rivm report 620110005. RIVM, Bilthoven, The Netherlands. 34 pages.
In this report a general framework is discussed that quantifies both the uncertainties in the estimated no-effect level in the animal and the uncertainties in the several extrapolation steps.

Janssen, P.J.C.M., M.E. van Apeldoorn, J.G.M. van Engelen, P.C.J.I. Schielen, and M.F.A. Wouters (1998).

Maximal Permissible Risk Levels for Human Intake of Soil Contaminants: Fourth series of compounds: In English: Rivm report 711701004. RIVM, Bilthoven, The Netherlands. 118 pages.

This report gives the derivation of the Maximal Permissible Risk levels for human intake for 13 compounds, which were used in the fourth series of the Intervention Values.

Baars, A.J., Theelen, R.M.C., P.J.C.M. Janssen, J.M. Hesse, M.E. van Apeldoorn, C.M. Meijerink, L. Verdam, M.J. Zeilmaker. 2001.

Re-evaluation of the human-toxicological maximum permissible risk levels. RIVM report 711701025, March 2001. RIVM, Bilthoven, The Netherlands. 297 pages.

Evaluation

One of the reports of the project Evaluation Intervention Values, focusing on the re-evaluation of the human-toxicological maximum permissible risk levels for exposure, resulting in proposals for revised Intervention Values.

CONTAMINANT BEHAVIOUR IN RELATION TO RISKS

Lagas, P., H. Snelting, R. van den Berg (1990).

Verspreiding van stoffen bij bodemverontreiniging (*in Dutch*). Rivm report no. 725201002. RIVM, Bilthoven, The Netherlands. 27 pages.

Four instruments for predicting the risks due to contaminant migration are presented: i) mobility (retardation); ii) velocity and direction of groundwater flow; iii) contaminant concentration; and iv) potential volume of polluted soil or groundwater.

Bockting, G.J.M., E.J. van der Plassche, J. Struijs, J.H. Canton (1993).

Soil-water partition coefficients for some trace metals. In English: Rivm report no. 679101003. RIVM, Bilthoven, The Netherlands. 51 pages.

Partition coefficients in soils and sediments have been derived for Ba, Be, Co, Mo, Se, Ti, Sb, Sn, and V, based on literature search.

Bockting, G.J.M., E.J. van der Plassche, J. Struijs, J.H. Canton (1993).

Soil-water partition coefficients for organic compounds (*in Dutch*). Rivm report no. 679101013. RIVM, Bilthoven, The Netherlands. 143 pages.

Organic carbon normalised partition coefficients in soils and sediments have been derived for, among others, halogenated biphenyls and benzyltoluenes, chlorinated anilines and nitrobenzenes, various pesticides, phthalate esters and organotin compounds, based on literature search.

Swartjes, F.A., L.G.M. Koolenbrander, and G.J.M. Bockting, G.J.M. (1994)

Beoordelingssystematiek bodemkwaliteit ten behoeve van bouwvergunnings-aanvragen. Deel II. Methodiek ter bepaling van het verspreidingsrisico (*in Dutch*): Rivm report no. 715810002. RIVM, Bilthoven, The Netherlands. 68 pages.

Method for classification of calculated fluxes into 3 classes of increasing risk of contaminant dispersal; this classification provides a pragmatic assessment of the risk of dispersal; this method is part of a system for the evaluation of soil quality in dealing with requests for official building permits to be granted by local authorities.

Elzinga, E.J., B. van den Berg, J.J.M. van Grinsven, and F.A. Swartjes (1997).

Freundlich Isothermen voor Cadmium, Koper en Zink als functie van de bodemeigenschappen, op basis van een literatuuronderzoek (*in Dutch*). Rivm report no. 711501001. RIVM, Bilthoven, The Netherlands. 136 + 50 pages.

For cadmium, copper and zinc a soil specific Freundlich adsorption isotherm has been derived, based on literature research. To improve the possibilities for application several combinations of soil characteristics has been implemented in the regression

equations. Besides, the influence of correction for metal free ion activity and precipitation on the Freundlich equations has been investigated.

Koops, R., J.J.M. van Grinsven, T. Crommentuijn, M.A.G.T. van der Hoop, F.A. Swartjes, P.R.G. Kramer, W.J.G.M. Peijnenburg (1998).

Evaluatie van door het RIVM gehanteerde partitiecoefficienten voor metalen (*in Dutch*). Rivm report no. 711401005. RIVM, Bilthoven, The Netherlands. 84 pages.

The report gives a critical review of the 15 sets of partition coefficients used at the RIVM in recent years. It is recommended that only 1 or 2 sets are suited, concentrating on Dutch field data, and taking into account at least the effects of pH, CEC and concentration level. For sediments there is a serious lack of good partition data.

RISK ASSESSMENT ECOTOX

Denneman, C.A.J., and C.A.M. van Gestel (1990)

Bodemverontreiniging en bodemecosystemen: voorstel voor C-(toetsings)waarden op basis van ecotoxicologische risico's (in Dutch). Rivm report no. 725201001. RIVM, Bilthoven, The Netherlands. 64 pages. + 133 pages.

Ecotoxicological criteria for 1st series of compounds; only data for soil organisms taken into consideration; the separate data for the individual compounds are presented in the appendix to this report.

Denneman, C.A.J., and C.A.M. van Gestel (1991)

Afleiding van C-waarden voor bodemecosystemen op basis van aquatisch ecotoxicologische gegevens (*in Dutch*). Rivm report no. 725201008. RIVM, Bilthoven, The Netherlands. 29 pages.

For the 1st series of compounds aquatic ecotoxicological data and QSARs were now also taken into consideration for derivation of C-values for water; from the latter values soil C-values were calculated and compared to the soil C-values previously derived leading to changes for several compounds.

Plassche, E.J. van der, and J.H.M. de Bruijn (1992).

Towards integrated environmental quality objectives for surface water, groundwater, sediment and soil for nine trace metals. In English: Rivm report no. 679101005. RIVM, Bilthoven, The Netherlands. 33 pages.

The ecotoxicological Maximum Permissible Concentrations (MPCs) and Negligible Concentrations (Ncs) are derived for surface water, groundwater, sediment and soil for nine exotic trace metals. The derivation includes secondary poisoning, derivation of partition coefficients, and selection of background levels in the different compartments.

Van der Plassche, E.J., and G.J.M. Bockting (1993).

Towards integrated environmental quality objectives for several volatile compounds. In English: Rivm report no. 679101011. RIVM, Bilthoven, The Netherlands. 78 pages.

The ecotoxicological Maximum Permissible Concentrations (MPCs) and Negligible Concentrations (Ncs) are derived for water, sediment and soil. In a second step the limit and target values are harmonised, because a limit value in a specific compartment may not lead to exceeding of a limit value in other compartments.

Crommentuijn, G.H., E.J. van der Plassche, and J.H. Canton, J.H. (1994).

Guidance document on the derivation of ecotoxicological criteria for serious soil contamination in view of the intervention value for soil clean-up. In English: Rivm report no. 950011003. RIVM, Bilthoven, The Netherlands.

Description of the methodology used to derive ecotoxicological criteria in a stepwise protocol: data needs, formulas for normalisation & standardisation, data selection & method for calculation of the several HC50-values.

Jongbloed, R.H., J. Pijnenburg, B.J.W.G. Mensink, Th.P. Traas, and R. Luttik (1994).

A model for environmental risk assessment and standard setting based on biomagnification. Top predators in terrestrial ecosystems. In English: Rivm report no. 719101012. RIVM, Bilthoven, The Netherlands. 99 pages.
In this study Maximal Permissible Concentrations have been derived for soil contaminants based on the risk of secondary poisoning for top predators. Secondary poisoning is based on the risks for birds and mammals through consumption of worms that are exposed to contaminated soil.

Jongbloed, R.H., J. Pijnenburg, B.J.W.G. Mensink, Th.P. Traas, and R. Luttik (1994).
A model for environmental risk assessment and standard setting based on biomagnification. Top predators in terrestrial ecosystems. In English: Annex to Rivm report no. 719101012. RIVM, Bilthoven, The Netherlands. 188 pages.
Annex to Rivm report no. 719101012

Van der Plassche, E.J. (1994).
Towards integrated environmental quality objectives for several compounds with a potential for secondary poisonings. In English: Rivm report no. 679101012. RIVM, Bilthoven, The Netherlands. 120 pages.
The ecotoxicological Maximum Permissible Concentration (MPCs) is derived for 25 compounds with a potential for secondary poisoning. Two foodchains are taken into account: an aquatic route and a terrestrial route.

E.J. van der Plassche, J.H. Canton, Y.A. Eijs, J.W. Evers, P.J.C.M. Janssen, J.E.M. van Koten-Vermeulen, M.D. Polder, R. Posthumus, and J.M. de Stoppelaar (1994).
Towards integrated environmental quality objectives for several compounds with a potential for secondary poisonings. In English: Annex to Rivm report no. 679101012. RIVM, Bilthoven, The Netherlands. 130 pages.
Annex to Rivm report no. 679101012.

De Zwart, D (1994).
Verslag Discussiebijeenkomst "Kwantificering van actuele risico's voor ecosystemen bij bodemverontreiniging" (De Bilt, 27/10/1993) (*in Dutch*) Rivm report 719102026. RIVM, Bilthoven, The Netherlands. 42 pages.
Philosophical discussion on the possibilities how to deal with site specific risk assessment of ecosystems.

Crommentuijn, G.H., R. Posthumus, and D.F. Kalf (1995).
Ecotoxicological criteria for serious soil contamination in view of the intervention value for soil clean-up, second and third series of substances. In English: Rivm report no. 715810008. RIVM, Bilthoven, The Netherlands. 141 pages.
This report gives the derivation of the ecotoxicological serious soil contamination concentration (ECOTOX SCC), which is part of the derivation of the Intervention Values, for the compounds used in the second and fourth series of the Intervention Values.

Posthuma. L. (1995).
An inventory on delayed effects of toxicants in biological systems. In English: Rivm report 711311002. RIVM, Bilthoven, The Netherlands. 28 pages.
An uncertainty in ecological risk-assessment is the occurrence of delayed effects caused by exhaustion of biological homoeostatic mechanisms, due to a mobilisation of chemicals stored in soils and sediments in response to slow alterations in the environment.

Notenboom, J., H.J.P. Eijsackers, and F.A. Swartjes (1995).
Beoordelingssystematiek ten behoeve van bouwvergunningsaanvragen. Deel III. Methodiek ter bepaling van het actuele risico voor het ecosysteem (*in Dutch*). Rivm report no. 715810003. RIVM, Bilthoven, The Netherlands. 33 pages.

Method, which provide a pragmatic assessment for determination of risks for ecosystems used during the evaluation of soil quality in dealing with requests for official building permits to be granted by local authorities.

Weltje L., L. Posthuma, F.C. Mogo, E.M. Dirven-van Breemen, R.P.M. van Veen (1995).
Toxische effecten van combinaties van cadmium, zink en koper op terrestrische oligochaeten in relatie tot bodem-chemische interacties (*in Dutch*). Rivm report 719102043. RIVM, Bilthoven, The Netherlands. 92 pages.
The joint toxicity of heavy metal combinations to soil organisms was studied. Effects of mixtures were evaluated by applying the toxic unit concept and the isobolograhpic method. The influence of soil chemical behaviour of the metals was also studied.

Posthuma, L, L. Weltje, F.A. Antón-Sánchez (1996).
Joint toxic effect of cadmium and pyrene on reproduction and growth of the earthworm *Eisenia andrei.* In English: Rivm report 607506001. RIVM, Bilthoven, The Netherlands. 38 pages.
Emperical data concerning toxic effects of PAH, cadmium and mixtures.

Janssen, R.P.T., L. Posthuma, R. Baerselman, H.A. den Hollander, R.P.M. van Veen, W.J.G.M. Peijnenburg (1996).
Equilibrium partitioning of heavy metals in Dutch soils: Prediction of metal accumulation in earthworms. In English: Rivm report no. 719101028. RIVM, Bilthoven, The Netherlands. 38 pages.
To evaluate the adequacy of the equilibrium partitioning concept in predicting metal bio-accumulation, earth worms (Eisenia andrei) was exposed in twenty Dutch field soils with moderate metal concentration. Multivariate statistical analyses suggested that the BCFs for As, Cd, Cu, and Zn are governed by the same soil characteristics that determine the equilibrium partition coefficients.

Alkemade, J.R.M., A.J. Schouten, P. Kersten, M.L.P. van Esbroek (1996).
Vergelijking van effectniveaus voor bodemorganismen met het Maximaal toelaatbaar risico. Een veldstudie naar de invloed van zware metalen in een gradiënt te Budel (*in Dutch*). Rivm report 607505001. RIVM, Bilthoven, The Netherlands. 35 pages.
The main objective is to verify ecotoxicological standards for soil by evaluation the representativeness of laboratory experiments for the toxic effects in the field situation, field- (mesocosm)experiments and research in a contaminated area.

Janssen, R.P.T., F.A. Swartjes, M.A.G.T van de Hoop, W.J.G.M. Peijnenburg (1996).
Evaluatie van het evenwichtspartitieconcept voor zware metalen in bodems en sedimenten (*in Dutch*). Rivm report 719101027. RIVM, Bilthoven, The Netherlands. 42 pages.
This report describes the applicability of partition coefficients of Cd, Cr, Ni, Pb, and Zn for the derivation of integrated environmental targets for soil and sediments.

Posthuma, L., J. Notenboom (1996).
Toxic effects of heavy metals in three worms species exposed in artificially contaminated soil substrates and contaminated soils. In English: Rivm report 719102048. RIVM, Bilthoven, The Netherlands. 79 pages.
Ecotoxicological effects in natural and artificial soils due to zinc and mixtures of metals were compared for three worm species. The predictability of effects in field soil from laboratory toxicity data improved when differences in metal extractability and joined effects of metals were taken into account.

Ter Meulen-Schmidt, G.R.B., W. de Vries, J. Bril, W. Ma (1996).
Programmeringsstudie Veranderend landgebruik Gedrag van geaccumuleerde stoffen in verband met veranderingen in landgebruik en herstelbaarheid van ecosystemen (*in Dutch*). Rivm report 711401001. RIVM, Bilthoven, The Netherlands. 122 pages.

The aim of this programming study is to determine the available knowledge and the short-, medium-, and long-term research, needed to develop a risk assessment system for the effects of mobilisation of nutrients and contaminants due to changes in land-use from agriculture to natural areas.

Jager, D.T., and T, Hamers (1997).
Estimation methods for bioaccumulation in risk assessment of organic chemicals. In English: Rivm report 679102013. RIVM, Bilthoven, The Netherlands. 83 pages.
In this study the methodology for estimating bioaccumulation of organic chemicals in three types of organisms (fish, earthworms and plants) is evaluated. A simple mechanistic model for estimating BCF is proposed, which performs well against measured data.

Lijzen, J.P.A., G.R.B. ter Meulen, and W. de Vries (1997).
Opzet voor een Leidraad Bodembeoordeling bij natuurontwikkeling (in Dutch). Rivm report 711501003. RIVM, Bilthoven, The Netherlands. 123 pages.
The report describes a framework of a Guideline for the evaluation of soil contamination, which can be used for limiting, constructing, managing or purchasing agricultural land on behalf of nature reserves (in the framework of the Netherlands' National Ecological Network).

Posthumus, R., T. Crommentuijn, and E.J. van de Plassche (1998).
Ecotoxicological Serious Soil Contamination Concentrations: Fourth series of compounds. In English: Rivm report no. 717701003. RIVM, Bilthoven, The Netherlands. 112 pages.
This report gives the derivation of the ecotoxicological serious soil contamination concentration (ECOTOX SCC), which is part of the derivation of the Intervention Values, for 15 compounds, which were used, in the fourth series of the Intervention Values.

Posthuma, L, C.A.M. van Gestel, C.E. Smit, D.J. Bakker, and J.W. Vonk (Eds.) (1998).
Validation of toxicity data and risk limits for soils: final report. In English: Rivm report no. 607505004. RIVM, Bilthoven, The Netherlands. 230 pages.
Validation of toxicity data and risk limits for soils: final report. The project was set up to evaluate the ecotoxicological relevance of i) laboratory data and ii) ecotoxicological risk limits, and to identify uncertain factors. Therefor toxic effects on zinc and other metals were studied on selected species and on microbial degradation. Differences in bioavailability were found to be of prime importance in laboratory-to-field extrapolation.

De Zwart, D. de, M. Rutgers, and J. Notenboom (1999)
Bepaling van het locatiespecifieke ecologische risico van bodemverontreiniging: een opzet voor een beoordelingssystematiek (*in Dutch*). RIVM report 711701011. RIVM, Bilthoven, The Netherlands. 48 pages.
This report describes a framework for site-specific ecological risk assessment taking into account landuse, soil and contamination characteristics and the ecology at the site. The framework (a DSS) consists of three tiers: i) definition of desired landuse; ii) summing up site-specific ecological aspects related to this landuse; iii) setting up an instrumentarium according to the Triad approach.

Pothuma, L., A.C. de Groot, D.T. Jager, W.J.G.M. Peinenburg, R. Baerselman, R. Ritsema, E.G. van der Velde, A. de Jong, R.O.G. Franken. 1999 (*in Dutch*). RIVM report 733007006. RIVM, Bilthoven, The Netherlands. 64 pages.
Beoordeling van de ecotoxicologische risico's van de verspreiding van baggerspecie op land.
A pilot study has been executed to quantify the biological availability of heavy metals and PAHs resulting from deposition of dredged sediments on land soil. Because

biological availability is strongly influenced by soil type, environmental effects of deposited dredgings depend on both total contaminant concentration and soil characteristics.

Van Dijk, S. van, P.R.G. Kramer, R.O.G. Franken, L. Postuma. 1999.
Vergelijking van voorspelde metaalgehalten in landbodems met (eco)toxicologische risiconiveaus (*in Dutch*. RIVM report 733007005. RIVM, Bilthoven, The Netherlands. 46 pages.
In this report predicted heavy metal sediment concentrations are used to calculate the probability to exceed different (eco)toxicological standards.

Notenboom, J., A. Verschoor, A. van der Linden, E. van der Plassche, C. Reuther.
Pesticides in groundwater: occurrence and ecological impacts. In English: RIVM report 601506002. RIVM, Bilthoven, The Netherlands. 77 pages.
In this report the ecotoxicological risk concept as a fundament for setting environmental quality objectives is applied to pesticides in groundwater. To this purpose, several approaches for setting ecotoxicological critical groundwater are elaborated in an explorative sense and compared with EU-standards .

Breure, A.M., M. Rutgers. 1999.
Vaststellen van veldeffecten van en indicator voor pollution-induced tolerance (PICT) (*in Dutch*). RIVM report 607601006. RIVM, Bilthoven, The Netherlands. 32 pages.
The phenomenon of Pollution Induced Community Tolerance (PICT) is explained in this report. Besides it is indicated how the PICT concept can be used to develop an indicator for field-effects of environmental stressors.

Verbruggen, E.M.J., R. Postumus and A.P. van Wezel. 2001.
Ecotoxicological Serious risk Concentrations for soil, sediment and (ground)water; updated proposals for first series of compounds. RIVM report 711701020. April 2001. RIVM, Bilthoven, The Netherlands. 263 pp + 122 pp (Annex).