

## **APPENDIX III Geochemical atlas of the soils and their parent material in the Netherlands (CD-ROM)**

Appendix III can be found on the CD-ROM attached on the back cover of this thesis. It contains the “Geochemical atlas of the soils and their parent material in the Netherlands, digital version 1.1” which forms an integral part of this thesis. Reproduction and distribution for educational and other non-commercial purposes is for free. The correct reference for this publication is:

Van der Veer, G., Vriend, S.P., Van Gaans, P.F.M, Klaver, G.Th. & Van Os, B.H.J. (2006), Appendix III: Geochemical atlas of the soils and their parent material in the Netherlands, digital version 1.1. In: Van der Veer, G. (2006). Geochemical soil survey of the Netherlands. Atlas of major and trace elements in topsoil and parent material; assessment of natural and anthropogenic enrichment factors. Netherlands Geographical Studies 347, 250 pp.

The atlas is produced by the department of Physical Geography, Faculty of Geosciences, Utrecht University in cooperation with the Netherlands Institute of Applied Geoscience TNO (NITG – TNO). Utrecht University and NITG-TNO cannot take any responsibility regarding the correctness of the data in the geochemical atlas.

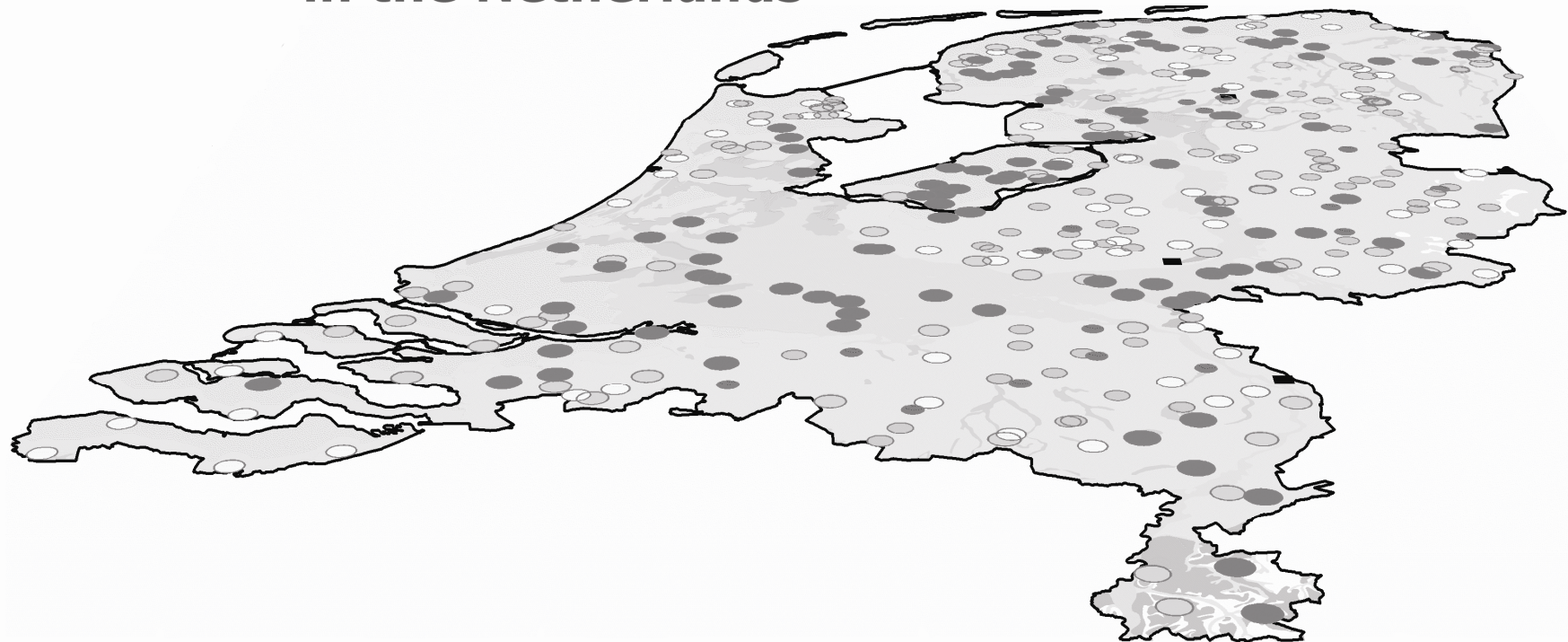
The data used in the atlas are included on the CD-ROM as well, together with the metadata (comma delimited text files). The same dataset can also be retrieved from the NITG-TNO data warehouse DINO (URL: [http://dinolks01.nitg.tno.nl/dinoLks/DINO Loket.jsp](http://dinolks01.nitg.tno.nl/dinoLks/DINO_Loket.jsp)). The coordinates of the sample locations are given in the Dutch grid (Rijksdriehoeksprojectie) and rounded off to one kilometer for privacy purposes. The use of the data is free for educational and other non-commercial purposes only.

A digital copy of the thesis can also be found on the CD-ROM. This digital version can also be found at the Utrecht University digital library IGITUR (URL: <http://www.igitur.nl/en/default.htm>).

# Geochemical

atlas of the soils and their parent material

in the Netherlands





# **Geochemical atlas of the soils and their parent material in the Netherlands**

**Grishja van der Veer, Simon Vriend, Pauline van Gaans, Gerard Klaver, Bertil van Os**

**Appendix III to the PhD-thesis  
“Geochemical soil survey of the Netherlands”  
NGS 347**

**digital version 1.1 – August 2006**



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## **Production**

Department of Physical Geography, Faculty of Geo-sciences, Utrecht University in cooperation with the Netherlands Institute of Applied Geoscience TNO (NITG – TNO)

The geochemical atlas is an integral part of the thesis “Geochemical soil survey of the Netherlands” by G. van der Veer, 2006. Reproduction and distribution for educational and other non-commercial purposes is for free. The correct reference for this publication is:

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## Contents

Information sources and explanation of tables and figures	8
Al - Aluminum	12
As - Arsenic	14
Ba - Barium	16
Be - Beryllium	18
Bi - Bismuth	20
Ca - Calcium	22
Cd - Cadmium	24
Cr - Chromium	26
Cs - Cesium	28
Cu - Copper	30
Fe - Iron	32
Ga - Gallium	34
Hf - Hafnium	36
Hg - Mercury	38
K - Potassium	40
La - Lanthanum	42
Li - Lithium	44
Mg - Magnesium	46
Mn - Manganese	48
Mo - Molybdenum	50
Na - Sodium	52
Nb - Niobium	54
Ni - Nickel	56
P - Phosphorus	58
Pb - Lead	60
Rb - Rubidium	62
S - Sulphur	64
Sb - Antimony	66
Sc - Scandium	68
Se - Selenium	70
Si - Silicon	72
Sn - Tin	74
Sr - Strontium	76



Th - Thorium	78
Ti - Titanium	80
Tl - Thallium	82
U - Uranium	84
V - Vanadium	86
Y - Yttrium	88
Zn - Zinc	90
Zr - Zircon	92
CaCO <sub>3</sub> - Carbonates	94
OM - Organic matter	96
References	99

## Information sources and explanation of tables and figures

### General information table

Information for this table is mainly taken from Reimann and Caritat (1998) and Li (2000), which have compiled data from a large number of sources. An overview of the most important sources herein is given below:

Atomic number: Lide (1996).

Atomic mass: IUAPC (1996).

Main oxidation state(s): Lide (1996), Holleman and Wiberg (1995), Streit (1994).

Electronegativity (Pauling): Periodic Table of the Elements.

Group: Periodic Table of Elements.

Affinity: Brownlow (1979), Mason and Moore (1982).

Upper continental crust: Concentration in the average upper continental crust (Wehdepohl, 1995 / Taylor and McLennan, 1995).

Shale/schist: Concentration in average shale (mainly from Turekian and Wehdepohl, 1961; see Li, 2000), and in average shale/schist (Koljonen, 1992).

Sandstone: Concentration in average sandstone (Koljonen, 1992).

Limestone: Concentration in average limestone (Koljonen, 1992).

Coal: Concentration in average coal (Bowen, 1979 / Tauber, 1988; see Li, 2000).

Volatility ratio in coal: Partition between gas and glass (solid) phase [ $\log(\text{gas/glass})$ ] during the burning of average coal at 1500 °C and one bar pressure (Li, 2000).

River water: Average concentration in world river/stream water (data mainly from Martin and Whitfield, 1981; see Li, 2000).

Ocean water: Average concentration in world ocean water (data mainly from Whitfield and Turner, 1987; see Li, 2000).

Human diet: Concentration in average daily human diet (Hamilton, 1979; see Li, 2000).

Reference man: Concentration in the reference man (Snyder et al., 1975; see Li, 2000).

Yearly production: Estimated yearly production in 1995 (Reimann and Caritat, 1998).

Host minerals: selection of minerals in which the element is present as major or minor component (+), or in traces (-). Most elements are also present as traces in clay minerals although this is often not indicated. Wehdepohl (1978), Deer et al. (1992), Holleman and Wiberg (1995).

Uses: Anthropogenic uses (various sources, see Reimann and Caritat, 1998).

Remarks: Biological impacts (various sources, see Reimann and Caritat, 1998) and soil guidelines (VROM, 1994; for a standard soil composed of 10% organic matter and 25% clay-fraction).

## Summary statistics table

Table with descriptive statistics for the lithological strata (subsoil and topsoil), leaving out any extreme values if present. Extreme values are defined as values  $> \text{mean} + 6 \cdot \text{St.Dev.}$  of the overall population (subsoil and topsoil data). See dotplots for extreme values. All concentrations are in wt% or mg/kg and based on 105 °C dry weight.

Ntot: Total number of samples (extreme values excluded). Default values (i.e. no extreme values are left out) for sand: 178, loess: 4, fluvial clay: 28, marine clay: 115, peat: 33.

Mean: Average concentration.

Median: Median concentration.

St.Dev.: Standard deviation of the concentration.

MAD: Median absolute deviation of the concentration.

Min.: Minimum concentration.

Max.: Maximum concentration (extreme values excluded).

## Scatterplot subsoil and sub- & topsoil

Scatterplot of element concentrations (in wt% or mg/kg) plotted versus the concentration of Al (wt%). For Al itself, no scatterplots are presented. The upper scatterplot shows the subsoil data classified according to the lithological stratum, whereas the lower scatterplot shows the data of the subsoil (in grey) and the topsoil (in red). The same plot ranges are used for both scatterplots (extreme values excluded). The horizontal red line represents the limit of quantitation (if present; see chapter 4).

## Bubble map subsoil and topsoil

Bubble map of the element concentrations classified into 6 equally sized classes based on the range in overall data (both subsoil and topsoil). Herein, extreme values are left out (separately indicated with crosses). The base map gives an impression of the spatial distribution of the different lithologies in the Netherlands (fig 1.), but is not the same as the lithological strata used for sampling (see chapter 3). The lithological strata are defined within a target area. Herein, various areas are left out on basis of land use (e.g. built-up areas), or profile layering, lithology (e.g. other formations; see fig. 1).

## Dotplot subsoil and topsoil

Dotplot of element concentrations in the subsoil and topsoil data (in wt% or mg/kg), both classified according to the lithological stratum (including extreme values). Note that the lithological strata only reflect the dominant lithology in this group. As such, some of the samples do have a different lithology than indicated by the stratum (see chapter 3). The vertical red line indicates the limit of quantitation (if present; see chapter 4), and the dotted vertical red line (if present) indicates the cut off level for extreme values ( $> \text{mean} + 6 \cdot \text{St.Dev.}$ ).

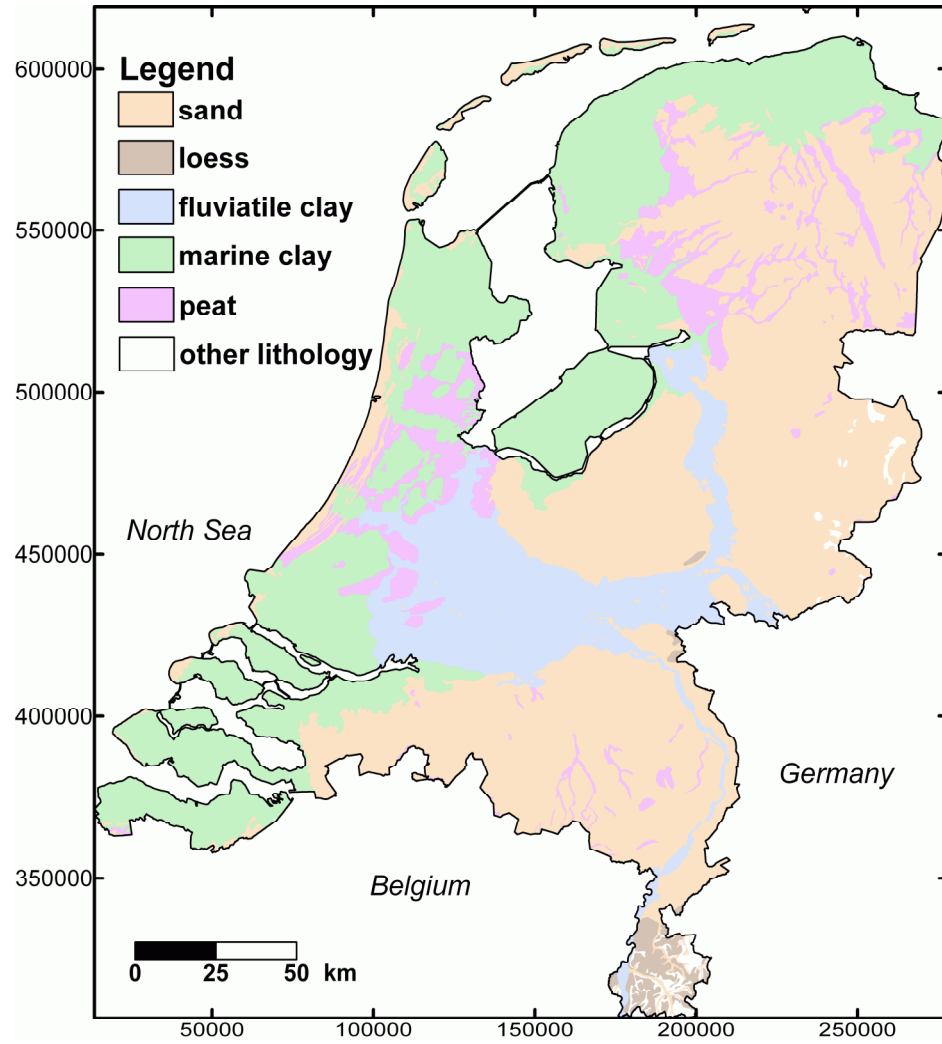


Figure 1 - Lithological map of the soils in the Netherlands (source: NITG-TNO, Dutch coordinate system, Rijksdriehoeks-projectie).



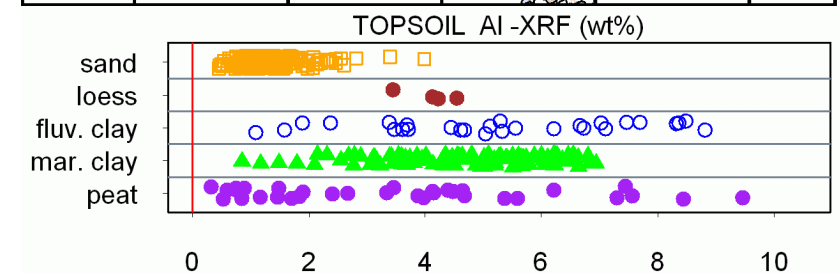
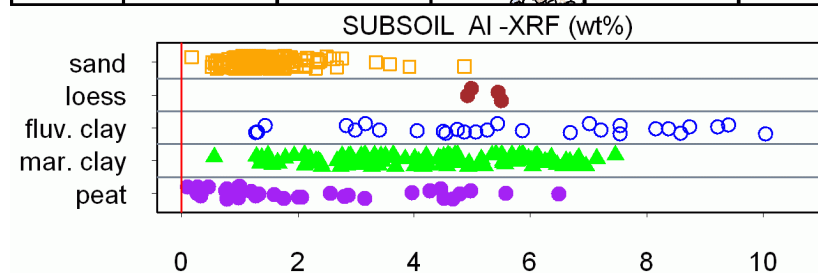
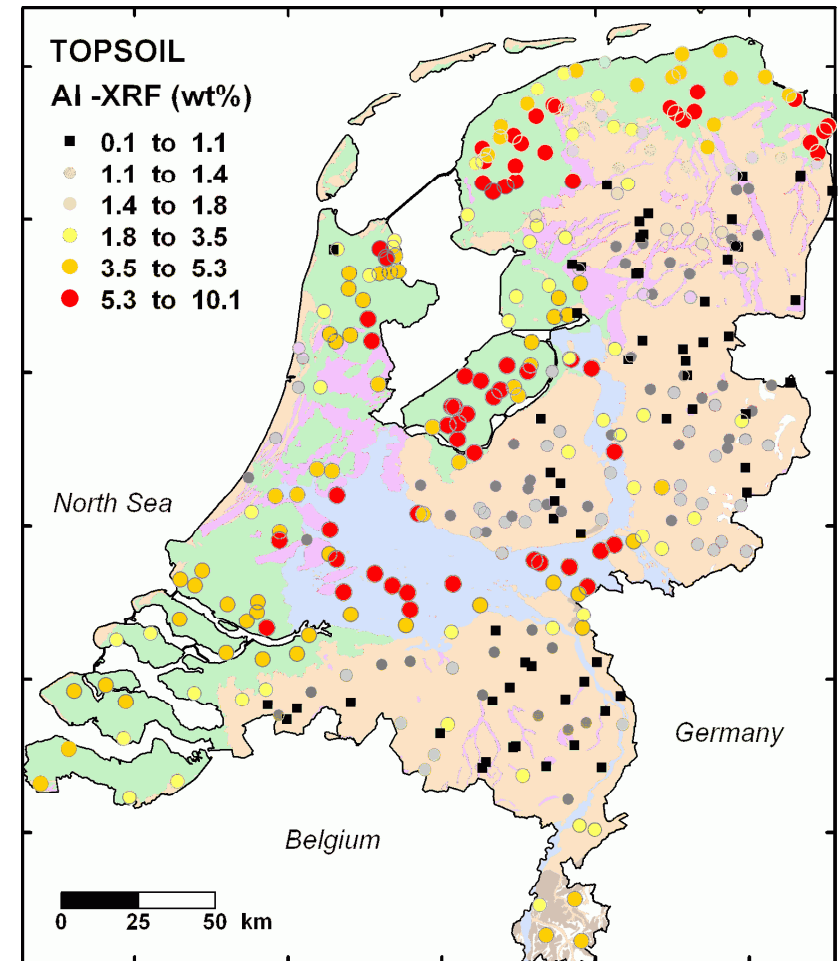
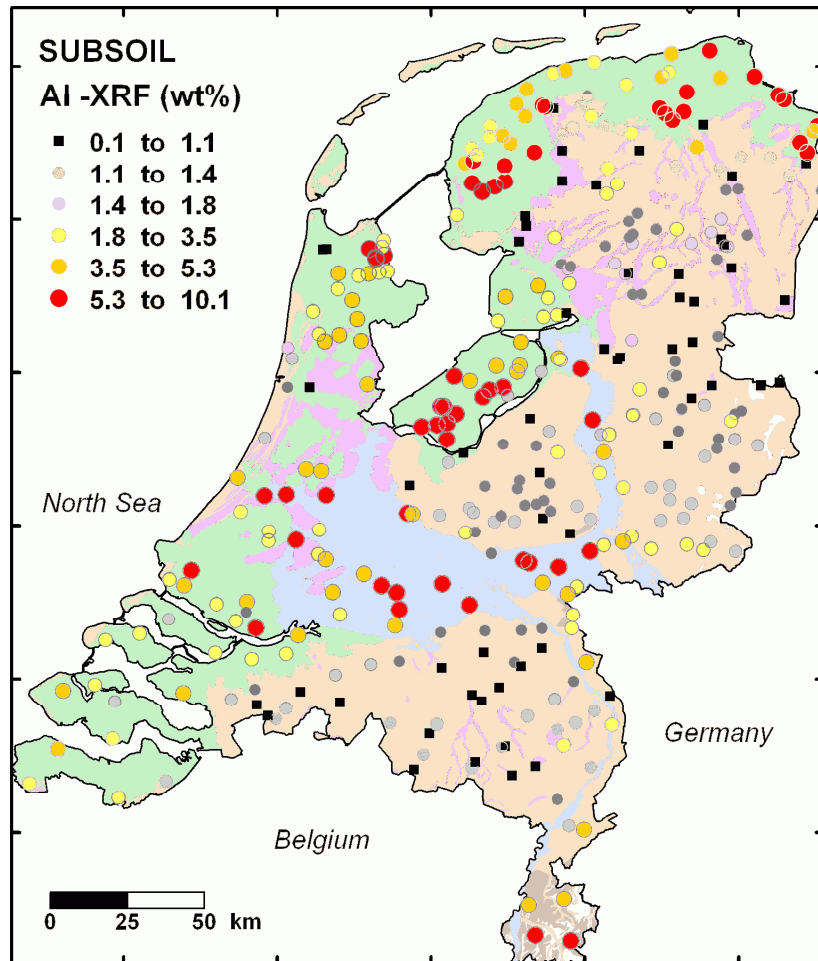
# Al - Aluminum

Atomic number: 13	Upper cont. crust: 7.7 / 8.0 wt%	River water: 50 µg/l
Atomic mass: 26.982	Shale/schist: 8.8 / 9.1 wt%	Ocean water: 0.3 µg/l
Main ox. state(s): +3	Sandstone: 3.7 wt%	Human diet: 1.7 mg/kg
Electronegativity (Pauling): 1.61	Limestone: 0.4 wt%	Reference man: 2.6 mg/kg
Group: metals	Coal: 1.0 / 2.1 wt%	Yearly production: 25.1·10 <sup>6</sup> t
Affinity: lithophile	Volatility-ratio in coal: -5.6	
Host minerals: Gibbsite (+), boehmite (+), many Al-silicates (+).		
Uses: Packaging industry (e.g. cans), abrasives, tanning, used in all sorts of constructions and consumer goods.		
Remarks: Considered essential for some organisms, but free Al ions are toxic for plants and humans.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.40	1.28	0.59	0.37	0.17	4.87
loess	4	5.22	5.22	0.31	0.38	4.92	5.51
fluviatile clay	28	5.69	5.35	2.58	3.24	1.29	10.0
marine clay	115	4.26	4.42	1.68	2.05	0.56	7.46
peat	33	2.28	1.59	1.81	1.68	0.11	6.49
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.32	1.24	0.51	0.38	0.45	3.99
loess	4	4.09	4.18	0.46	0.31	3.45	4.55
fluviatile clay	28	5.28	5.21	2.20	2.47	1.10	8.81
marine clay	115	4.66	4.82	1.36	1.57	0.85	6.94
peat	33	3.57	3.47	2.55	2.93	0.33	9.46

Concentrations are in wt% and based on 105 °C dry weight

# Al - Aluminum

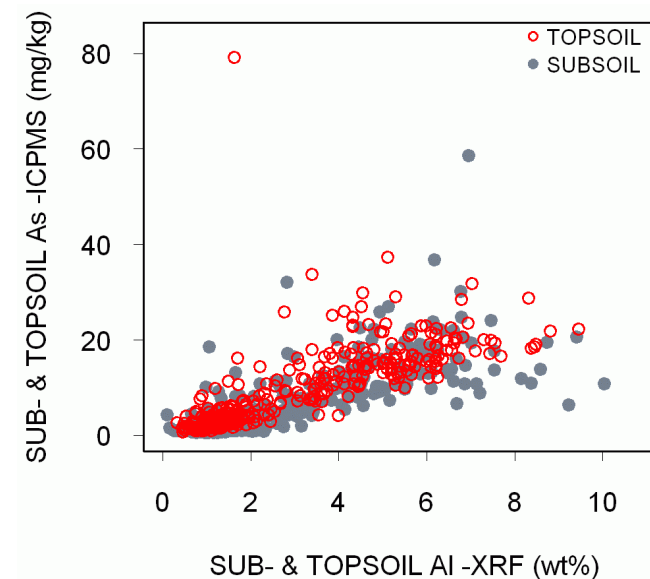
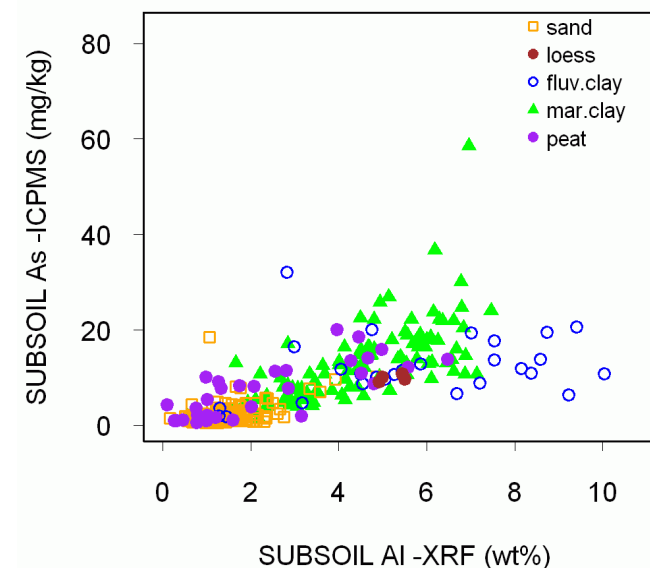


# As - Arsenic

Atomic number: 33	Upper cont. crust: 2.0 / 1.5 mg/kg	River water: 1.7 µg/l
Atomic mass: 74.921	Shale/schist: 13 / 13 mg/kg	Ocean water: 1.7 µg/l
Main ox. state(s): -3, +3 (0, +5)	Sandstone: 0.5 mg/kg	Human diet: 0.04 mg/kg
Electronegativity (Pauling): 2.18	Limestone: 1.5 mg/kg	Reference man: 0.3? mg/kg
Group: non-metals	Coal: 5 / 10 mg/kg	Yearly production: 30.5·10 <sup>3</sup> t
Affinity: chalcophile	Volatility-ratio in coal: 1.3	
Host minerals: Arsenopyrite (+), other sulphides (-), feldspars (-), magnetite (-), ilmenite (-).		
Uses: Alloys, wood preservative, ammunition, semi-conductors, batteries, paints, textile, tanning.		
Remarks: Essential for some organisms in small amounts (e.g. humans), toxic at higher concentrations. Environmental legislation for soils in the Netherlands (background: 29 mg/kg, remediate: 55 mg/kg).		

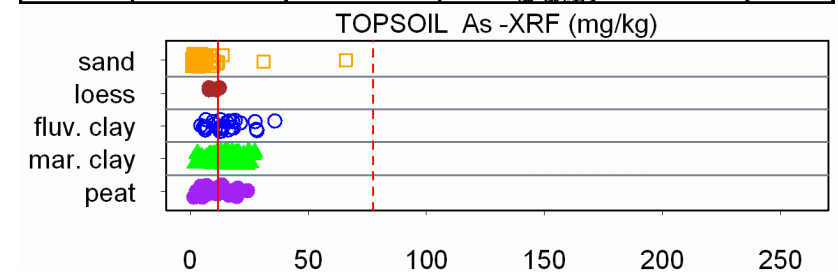
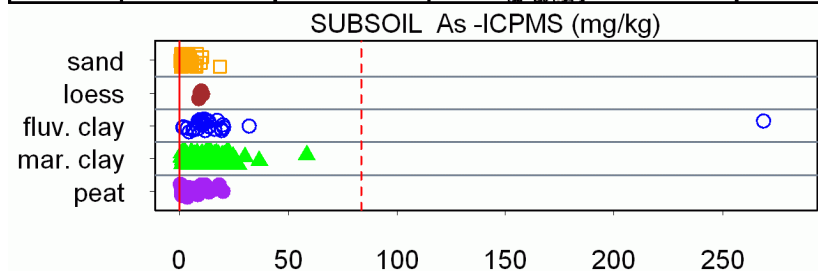
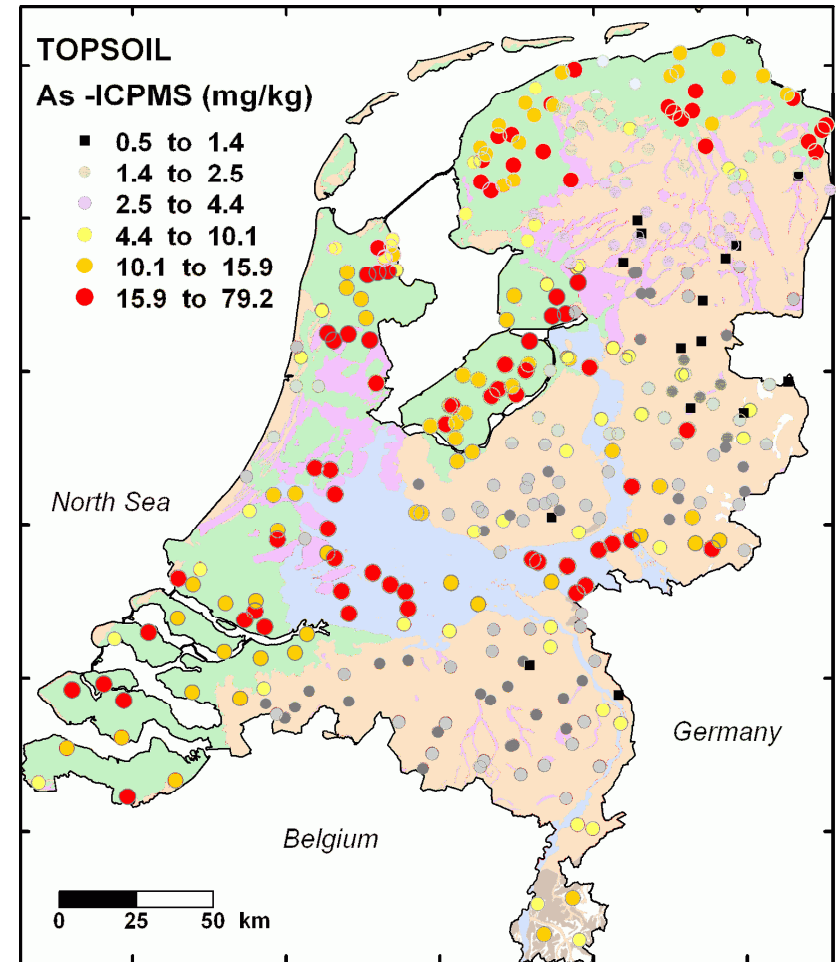
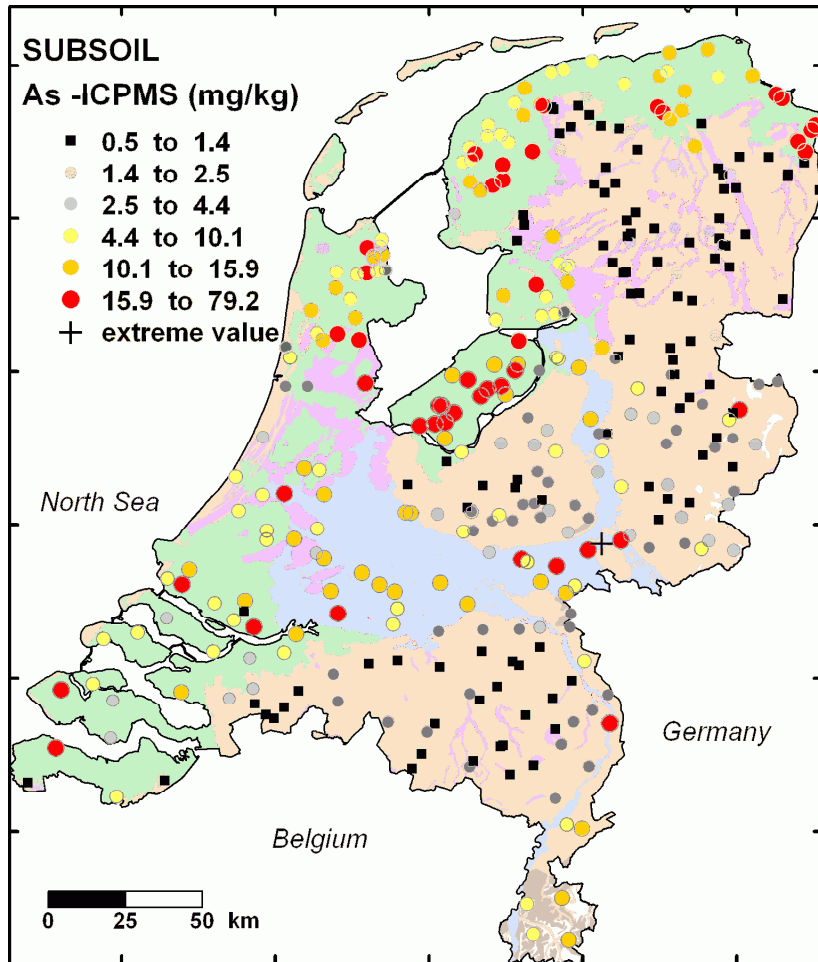
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	2.01	1.31	2.05	0.69	0.47	18.5
loess	4	9.90	9.88	0.68	0.71	9.11	10.7
fluviatile clay	27	12.1	11.0	6.62	4.16	1.80	32.1
marine clay	115	12.1	10.8	8.26	7.87	0.97	58.6
peat	33	7.07	7.65	5.73	8.35	0.58	20.0
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	3.85	2.66	6.49	1.42	0.71	79.1
loess	4	9.86	9.48	2.11	2.01	8.08	12.4
fluviatile clay	28	15.8	14.7	8.24	7.19	3.72	37.2
marine clay	115	15.1	14.8	5.56	4.63	1.92	29.8
peat	33	11.5	10.9	7.16	9.65	2.00	25.9

Concentrations are in mg/kg and based on 105 °C dry weight



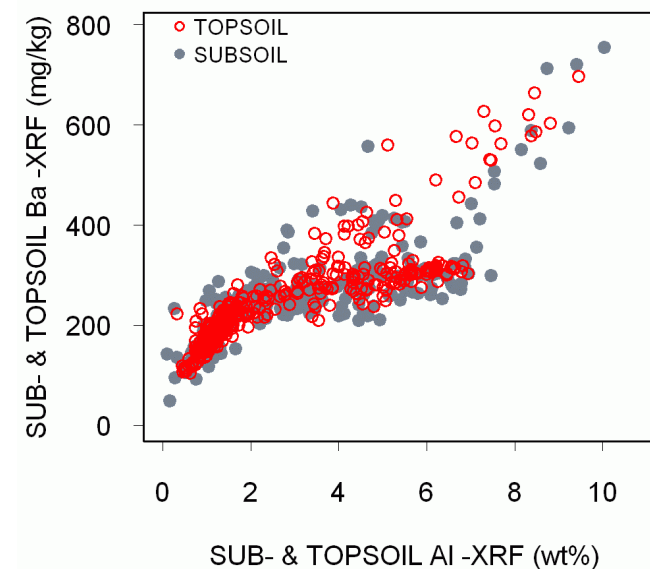
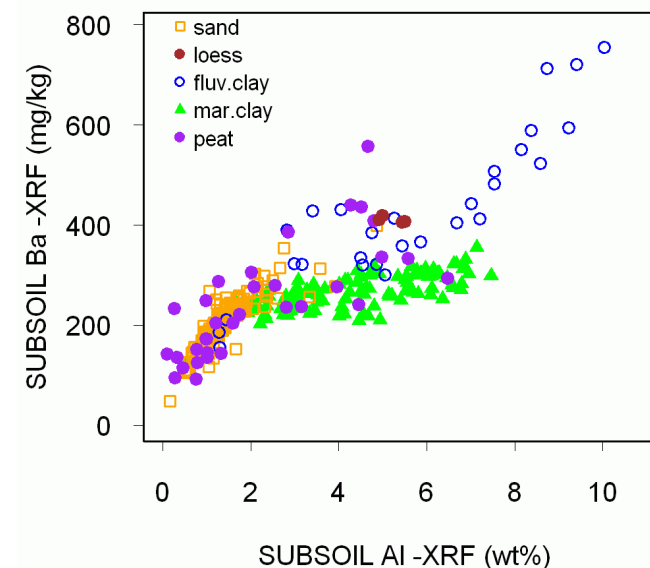


# As - Arsenic



# Ba - Barium

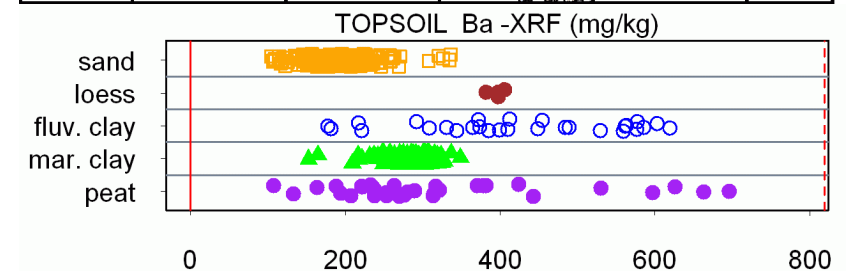
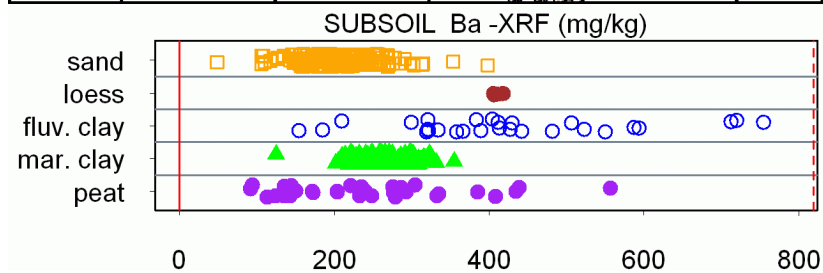
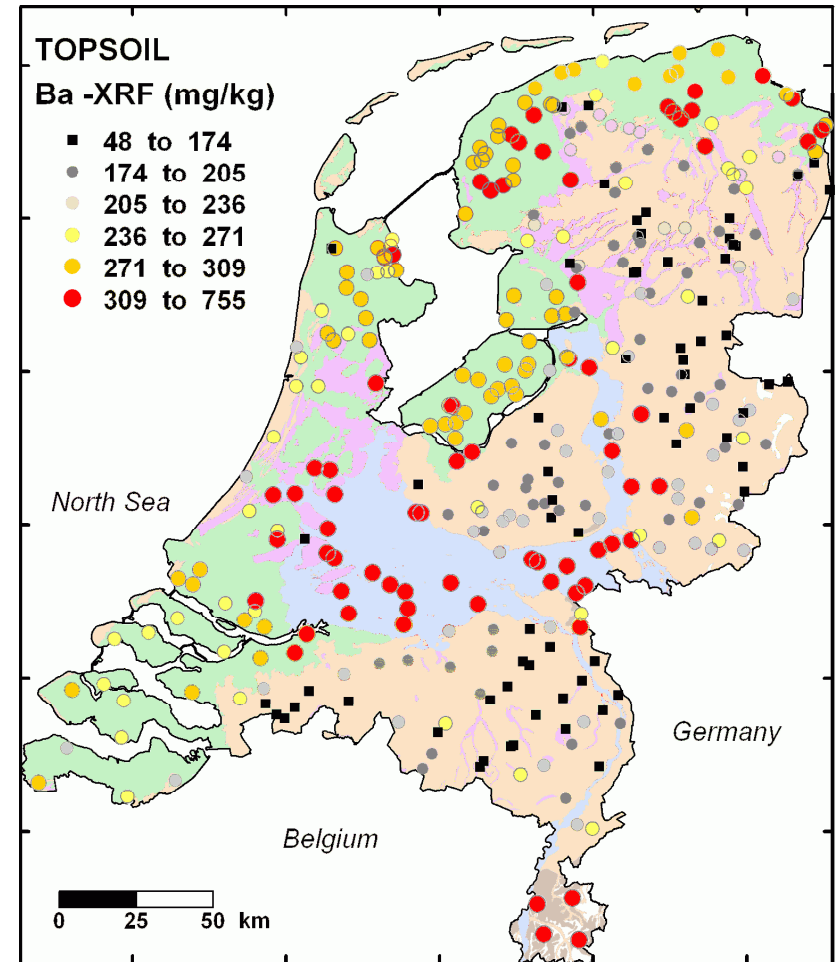
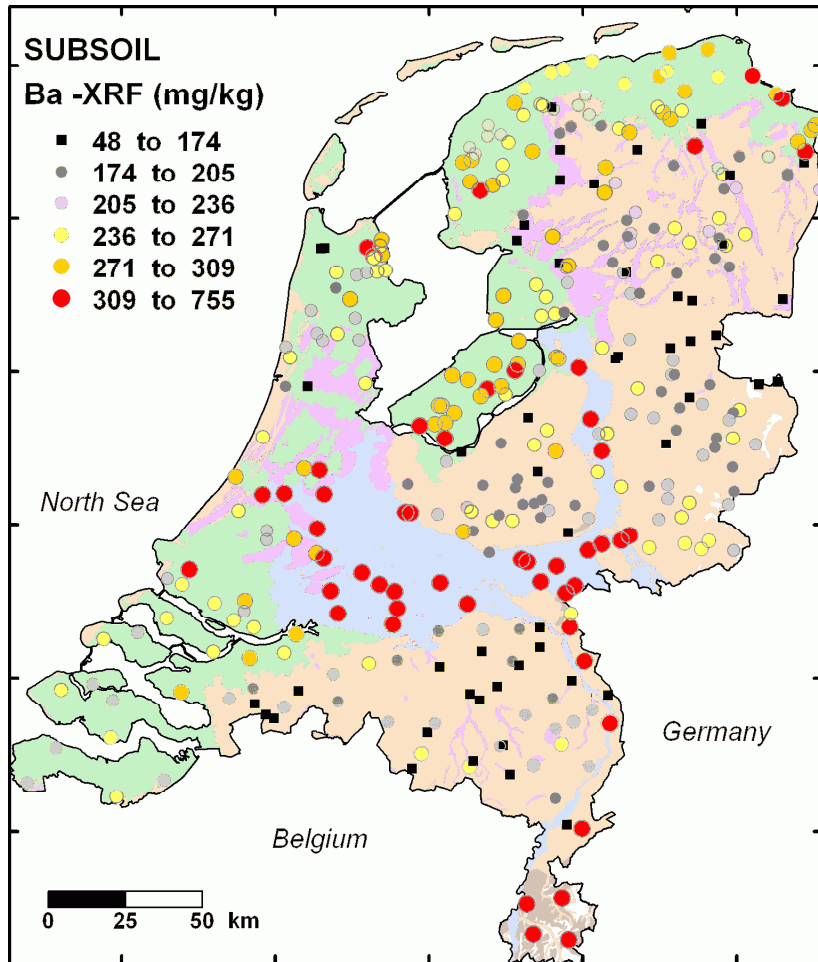
Atomic number: 56	Upper cont. crust: 668 / 550 mg/kg	River water: 60 µg/l
Atomic mass: 137.327	Shale/schist: 580 / 550 mg/kg	Ocean water: 15 µg/l
Main ox. state(s): +2	Sandstone: 300 mg/kg	Human diet: 0.44 mg/kg
Electronegativity (Pauling): 0.89	Limestone: 90 mg/kg	Reference man: 0.31 mg/kg
Group: alkaline earth metals	Coal: 200 / 250 mg/kg	Yearly production: 2.9·10 <sup>6</sup> t
Affinity: lithophile	Volatility-ratio in coal: -5.2	
Host minerals: Barite (+), witherite (+), K-feldspar (-), micas (-), apatite (-), calcite (-).		
Uses: Drilling mud, glass hardener, television tubes, paint, rubber, paper industry, ceramics, electronics, fireworks, X-ray photography (contrast liquid).		
Remarks: Considered non-essential for humans and plants. Free Ba ions are toxic for humans.		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	205	201	46.8	39.7	48.3	398
loess	4	411	409	5.69	3.70	406	418
fluviatile clay	28	426	408	152	128	155	754
marine clay	115	264	265	36.1	44.9	125	355
peat	33	244	236	112	126	92	557
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	192	190	43.3	38.7	104	336
loess	4	396	398	9.9	6.36	382	406
fluviatile clay	28	423	411	133	164	178	620
marine clay	115	286	295	32.1	23.4	153	349
peat	33	323	277	151	82	108	697

Concentrations are in mg/kg and based on 105 °C dry weight

# Ba - Barium

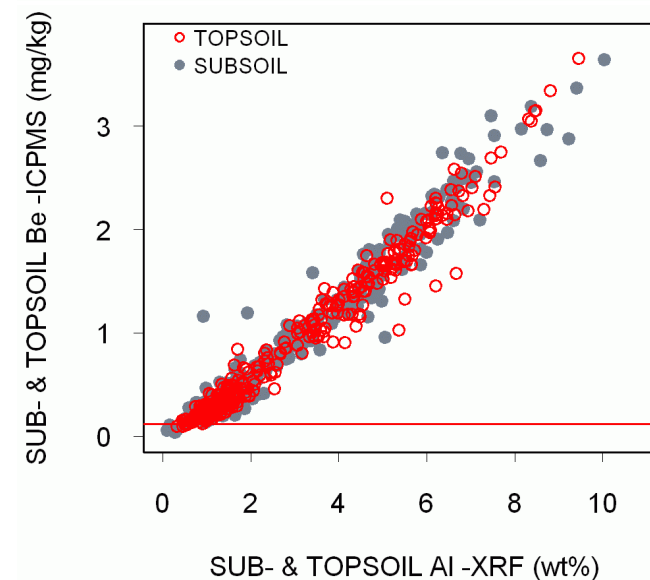
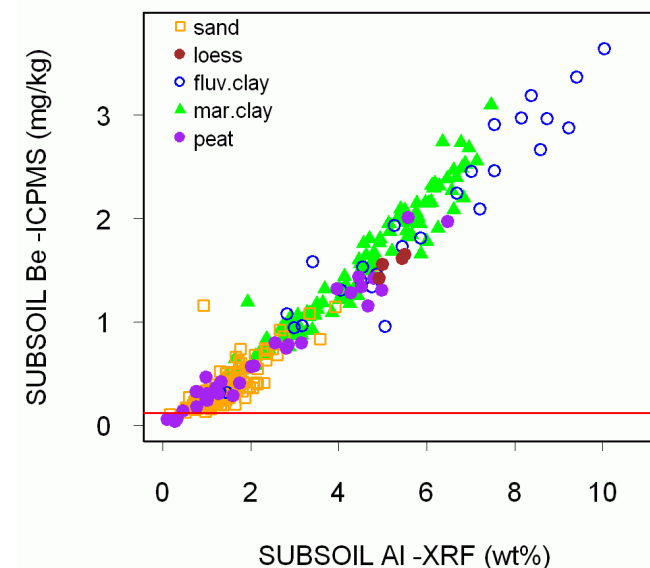


# Be - Beryllium

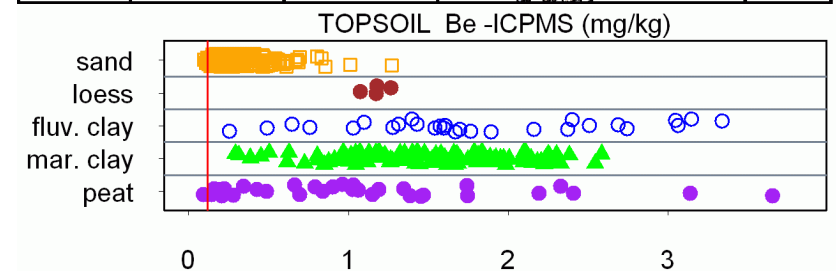
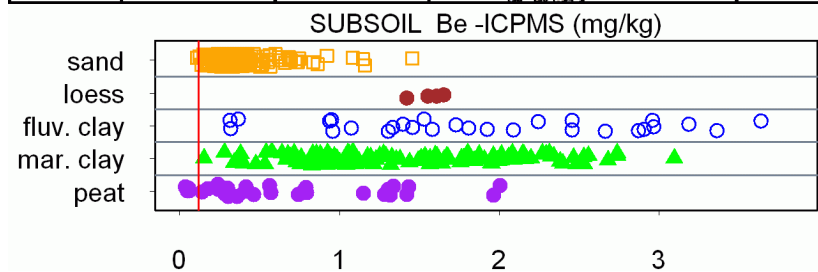
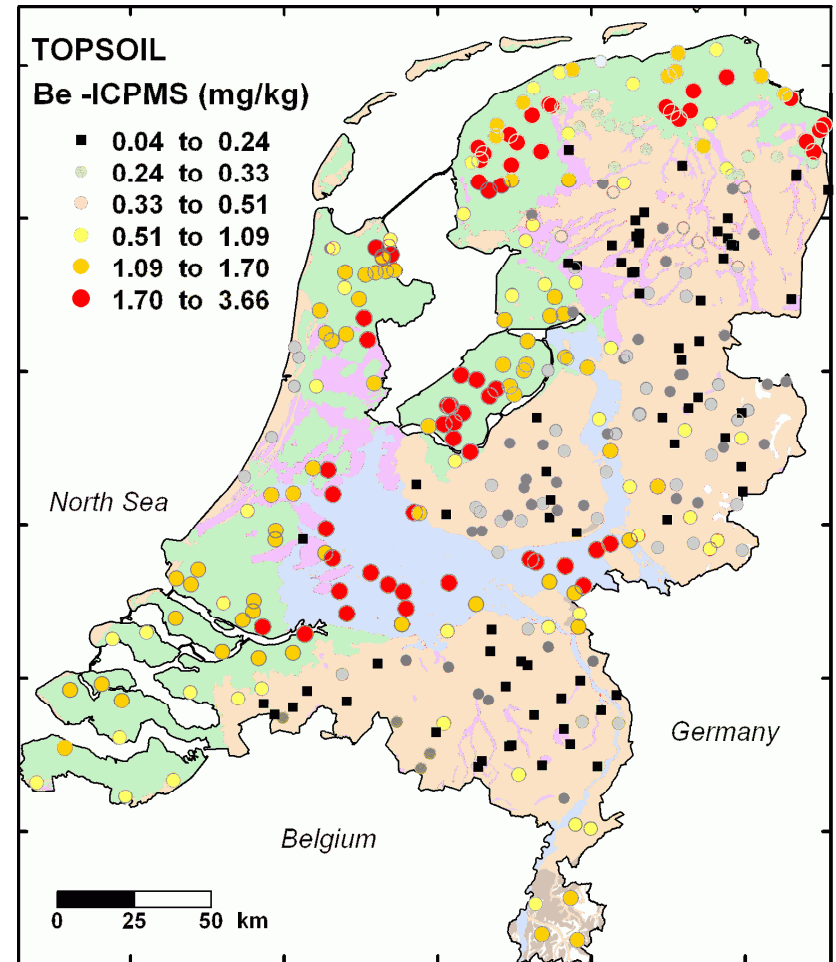
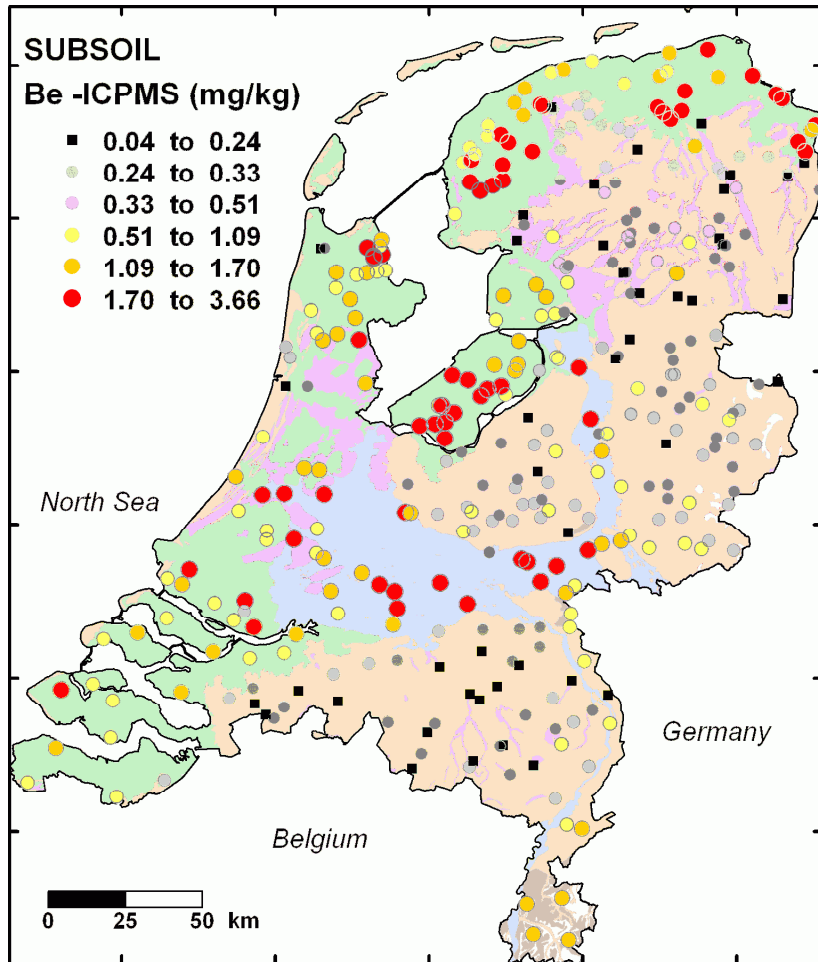
Atomic number: 4	Upper cont. crust: 3.1 / 3 mg/kg	River water: $9 \cdot 10^{-3}$ $\mu\text{g/l}$
Atomic mass: 9.012	Shale/schist: 3 / 3 mg/kg	Ocean water: $0.21 \cdot 10^{-3}$ $\mu\text{g/l}$
Main ox. state(s): +2	Sandstone: 0.7 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.57	Limestone: 0.5 mg/kg	Reference man: $0.5 \cdot 10^{-3}$ mg/kg
Group: alkaline earth metals	Coal: 1 / 1 mg/kg	Yearly production: 327 t
Affinity: lithophile	Volatility-ratio in coal: -2.2	
Host minerals: Beryl (+), plagioclases (-), micas (-), pyroxenes (-), clay minerals (-).		
Uses: Electronic circuitry, telecommunications, alloys (Cu), aircraft, missiles, satellites, nuclear industry.		
Remarks: Considered non-essential and toxic.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.36	0.31	0.20	0.11	0.11	1.45
loess	4	1.56	1.58	0.10	0.074	1.42	1.65
fluviatile clay	28	1.89	1.77	0.95	1.11	0.32	3.64
marine clay	115	1.46	1.38	0.66	0.75	0.15	3.09
peat	33	0.66	0.42	0.56	0.49	0.037	2.01
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.32	0.28	0.17	0.11	0.10	1.27
loess	4	1.17	1.18	0.079	0.070	1.07	1.27
fluviatile clay	28	1.80	1.64	0.84	0.85	0.26	3.34
marine clay	115	1.52	1.55	0.52	0.60	0.29	2.58
peat	33	1.09	0.96	0.88	0.79	0.09	3.65

Concentrations are in mg/kg and based on 105 °C dry weight

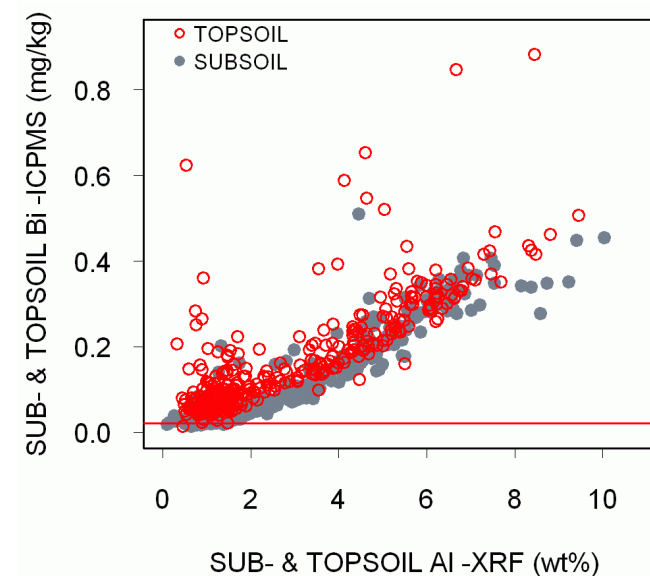
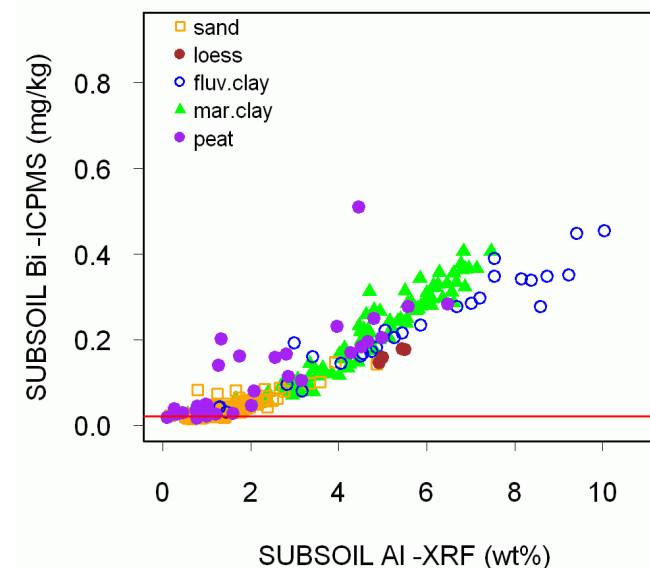


# Be - Beryllium



# Bi - Bismuth

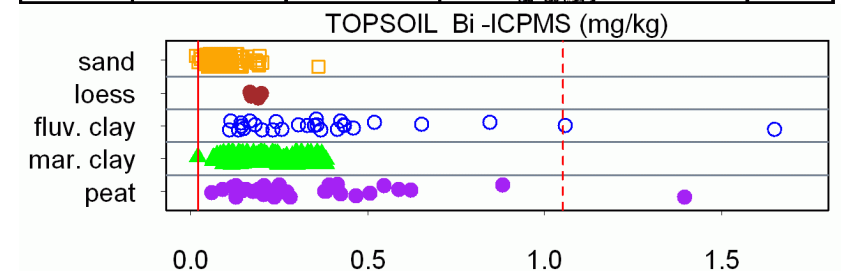
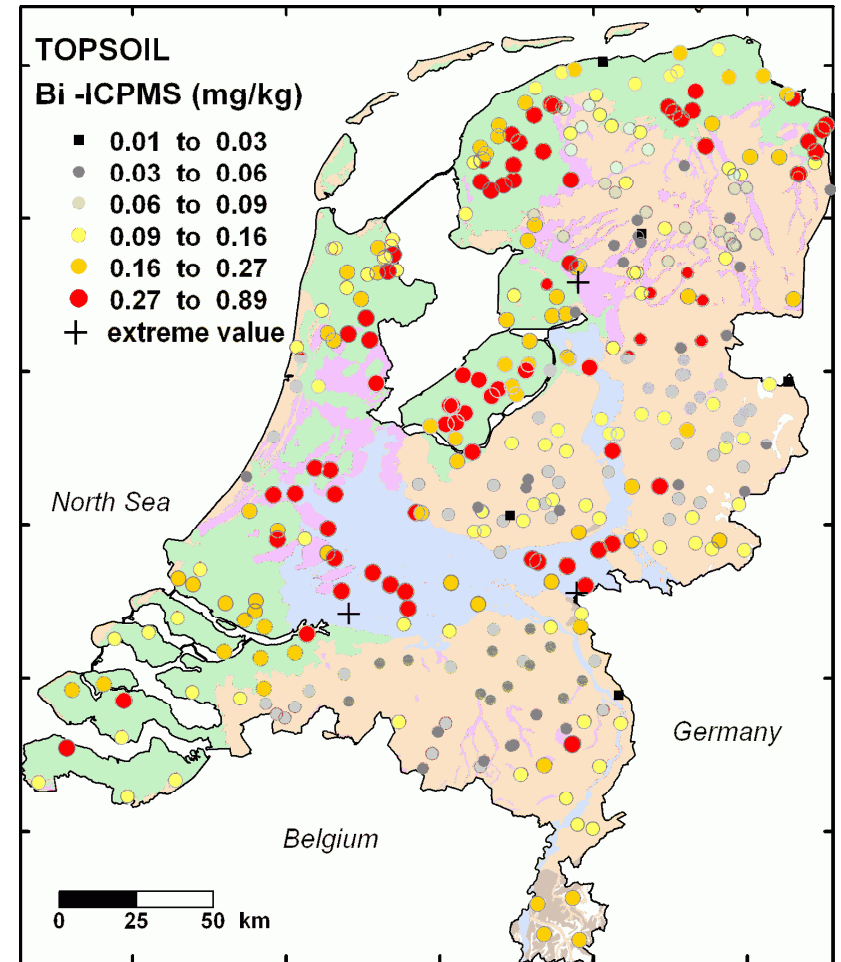
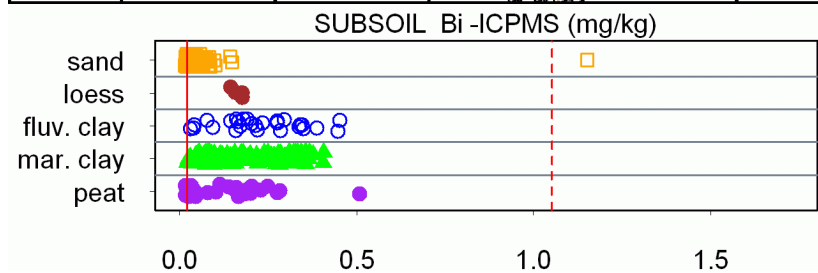
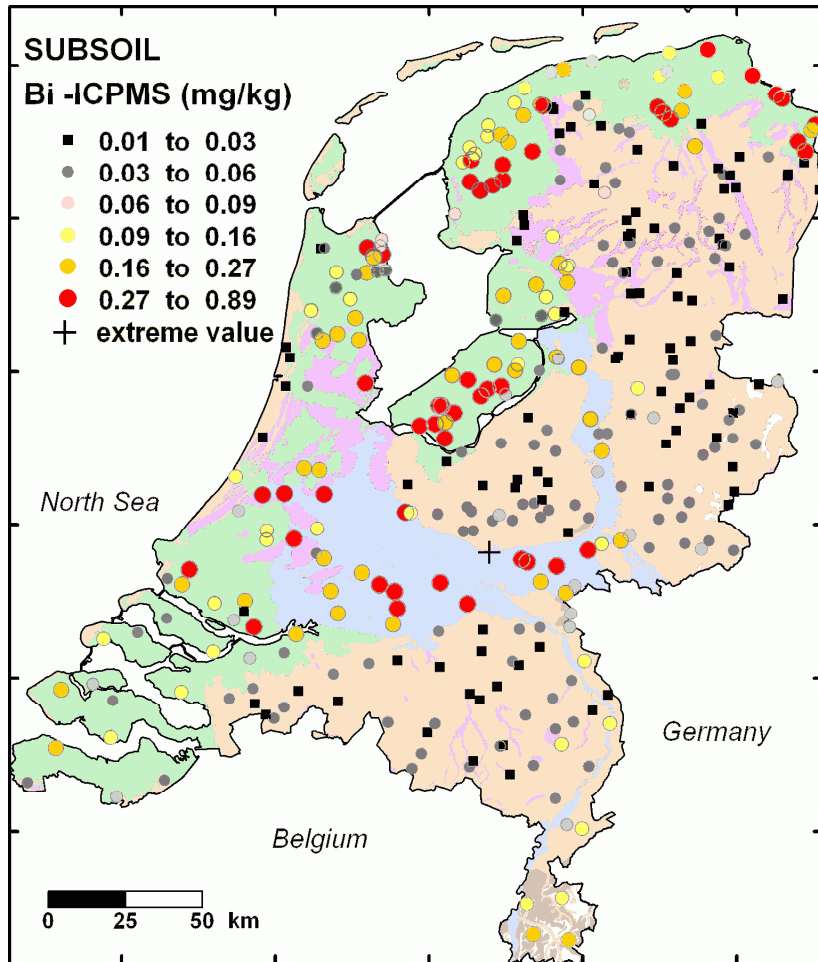
Atomic number: 83	Upper cont. crust: 0.12 / 0.13 mg/kg	River water: ?
Atomic mass: 208.980	Shale/schist: 0.43 / 0.25 mg/kg	Ocean water: $4 \cdot 10^{-6}$ µg/l
Main ox. state(s): +3 (+5)	Sandstone: 0.05 mg/kg	Human diet: ?
Electronegativity (Pauling): 2.02	Limestone: 0.1 mg/kg	Reference man: ?
Group: metals	Coal: 0.05 / -	Yearly production: 3100 t
Affinity: chalcophile	Volatility-ratio in coal: 2.3	
Host minerals: Bismuthinite (+), bismite (+), apatite (-), galena (-), sphalerite (-), chalcopyrite (-).		
Uses: Low melting point alloys, fire detection and fire extinguishing systems, catalysts, cosmetics, pharmaceuticals, batteries, magnets.		
Remarks: Considered non-essential. Little is known about its toxicity for humans.		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	177	0.037	0.031	0.020	0.012	0.014	0.148
loess	4	0.165	0.168	0.016	0.015	0.146	0.178
fluviatile clay	28	0.232	0.219	0.119	0.113	0.031	0.454
marine clay	115	0.184	0.172	0.109	0.142	0.022	0.407
peat	33	0.119	0.080	0.111	0.087	0.017	0.510
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.084	0.077	0.040	0.030	0.014	0.360
loess	4	0.183	0.182	0.016	0.017	0.168	0.201
fluviatile clay	26	0.321	0.319	0.177	0.172	0.111	0.847
marine clay	115	0.229	0.233	0.084	0.109	0.021	0.383
peat	32	0.301	0.245	0.183	0.158	0.061	0.882

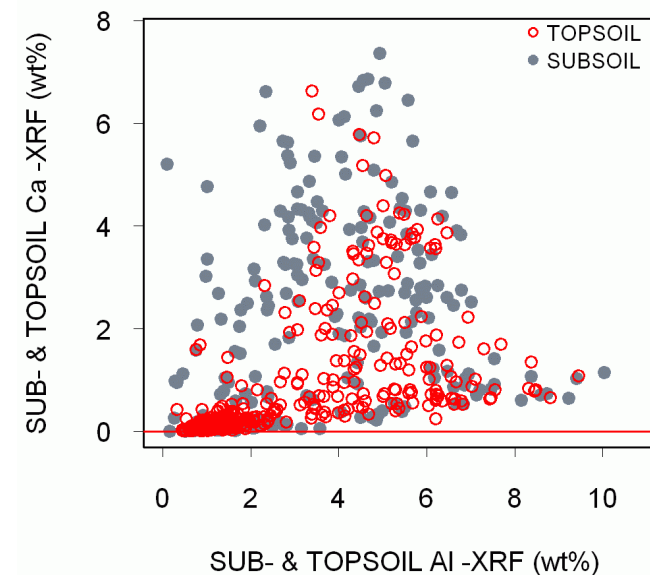
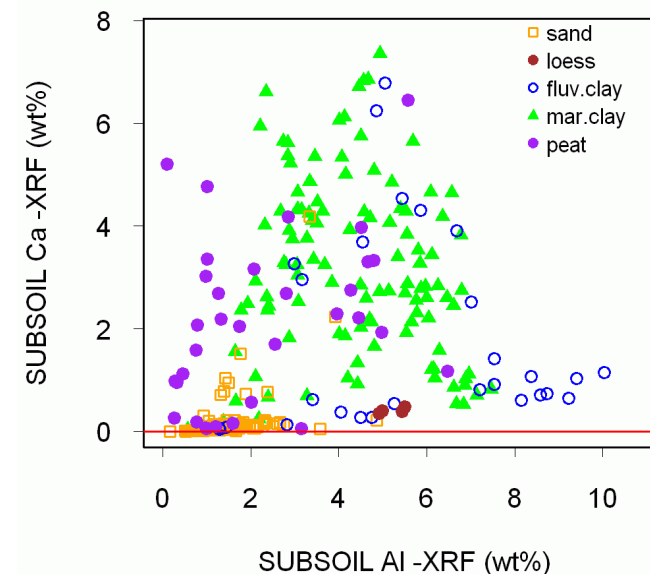
Concentrations are in mg/kg and based on 105 °C dry weight

# Bi - Bismuth



# Ca - Calcium

Atomic number: 20	Upper cont. crust: 2.8 / 3.0 wt%	River water: $13 \cdot 10^3 \mu\text{g/l}$
Atomic mass: 40.078	Shale/schist: 1.6 / 2.2 wt%	Ocean water: $450 \cdot 10^3 \mu\text{g/l}$
Main ox. state(s): +2	Sandstone: 0.90 wt%	Human diet: 990 mg/kg
Electronegativity (Pauling): 1.55	Limestone: 38 wt%	Reference man: 14000 mg/kg
Group: alkaline earth metals	Coal: 0.15 / 0.50 wt%	Yearly production: $120 \cdot 10^6 \text{ t}$
Affinity: lithophile	Volatility-ratio in coal: -7.6	
Host minerals: Calcite (+), gypsum (+), feldspars (+), amphiboles (+), pyroxenes (+), clay minerals (+).		
Uses: Lime, cement, fertilizers, metallurgy.		
Remarks: Essential for most organisms.		

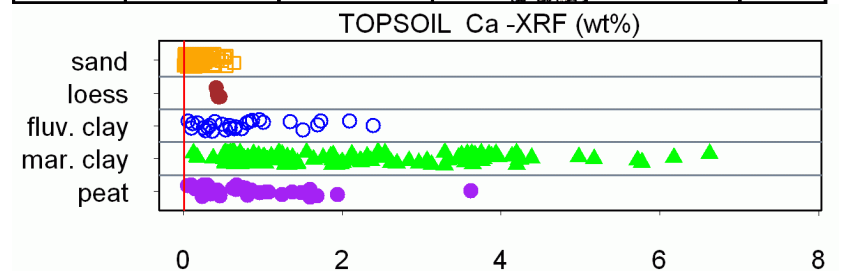
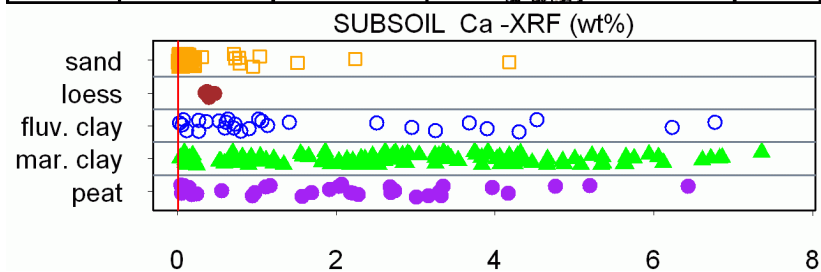
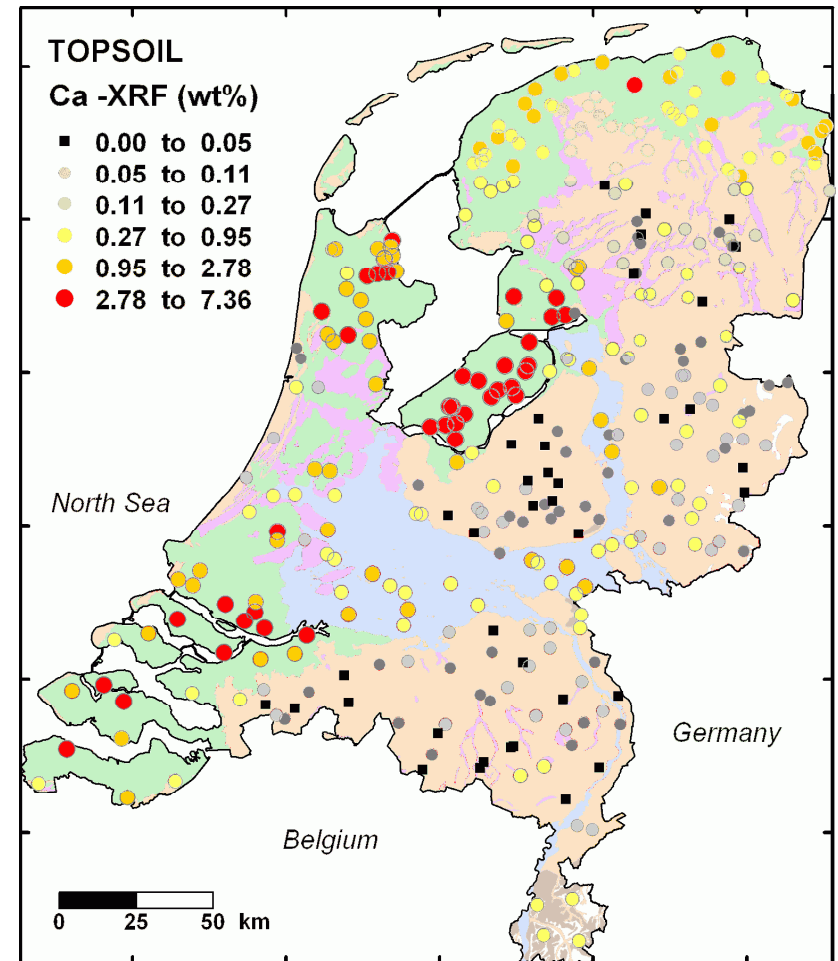
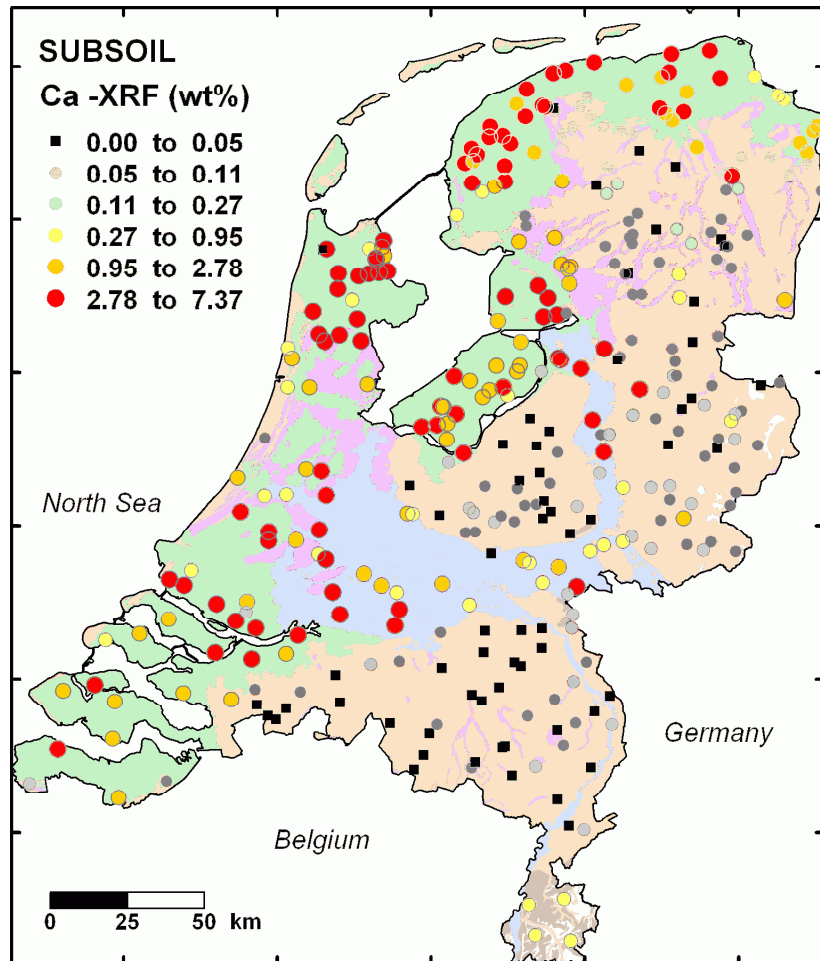


SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.14	0.062	0.39	0.042	<0.001	4.18
loess	4	0.40	0.39	0.05	0.037	0.35	0.47
fluviatile clay	28	1.77	0.85	1.93	0.87	0.033	6.77
marine clay	115	3.05	2.84	1.80	2.07	0.034	7.36
peat	33	2.13	2.07	1.64	1.66	0.043	6.44
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.15	0.12	0.12	0.11	0.005	0.64
loess	4	0.44	0.44	0.021	0.022	0.41	0.46
fluviatile clay	28	0.78	0.62	0.62	0.48	0.060	2.39
marine clay	115	2.14	1.85	1.52	1.74	0.12	6.62
peat	33	0.82	0.66	0.72	0.60	0.057	3.62

Concentrations are in wt% and based on 105 °C dry weight



# Ca - Calcium

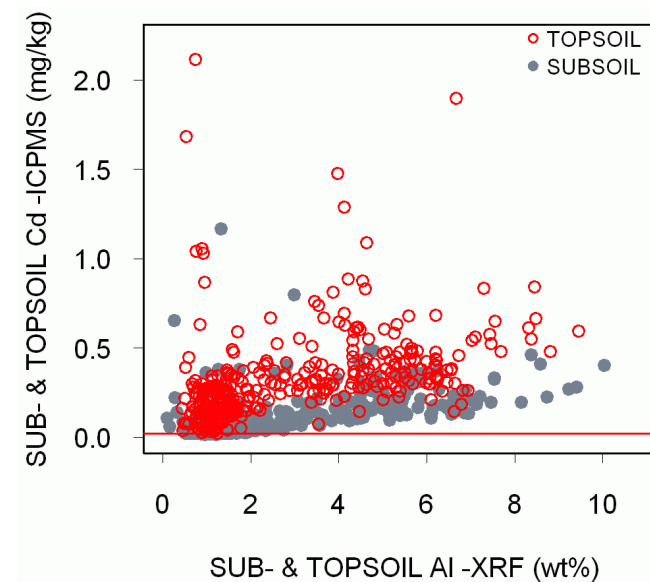
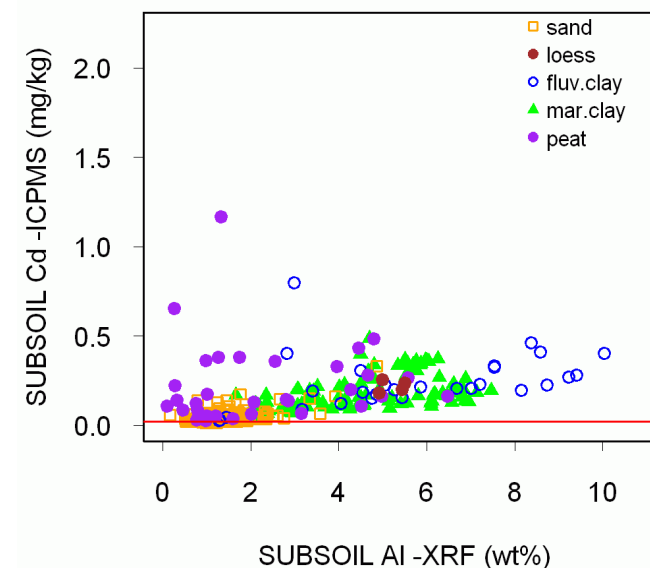


# Cd – Cadmium

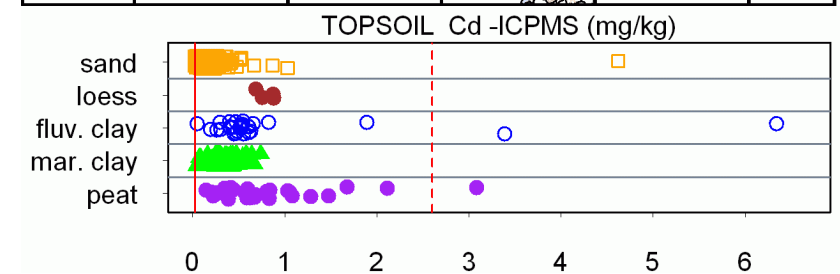
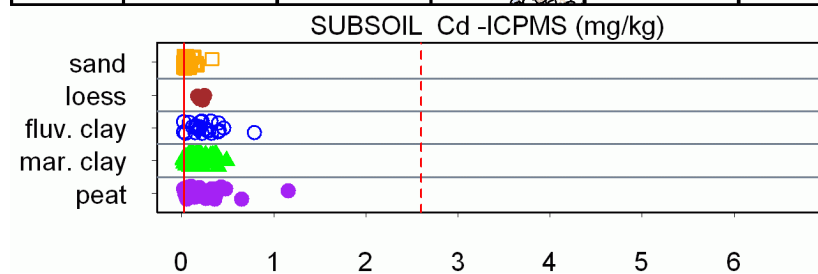
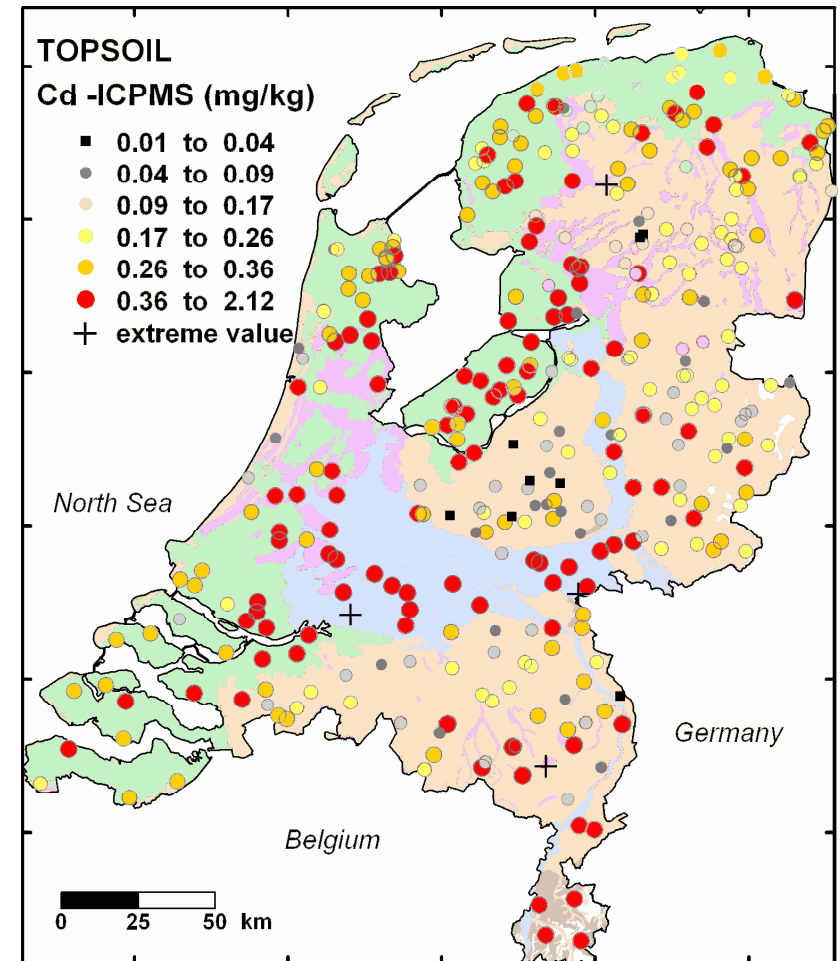
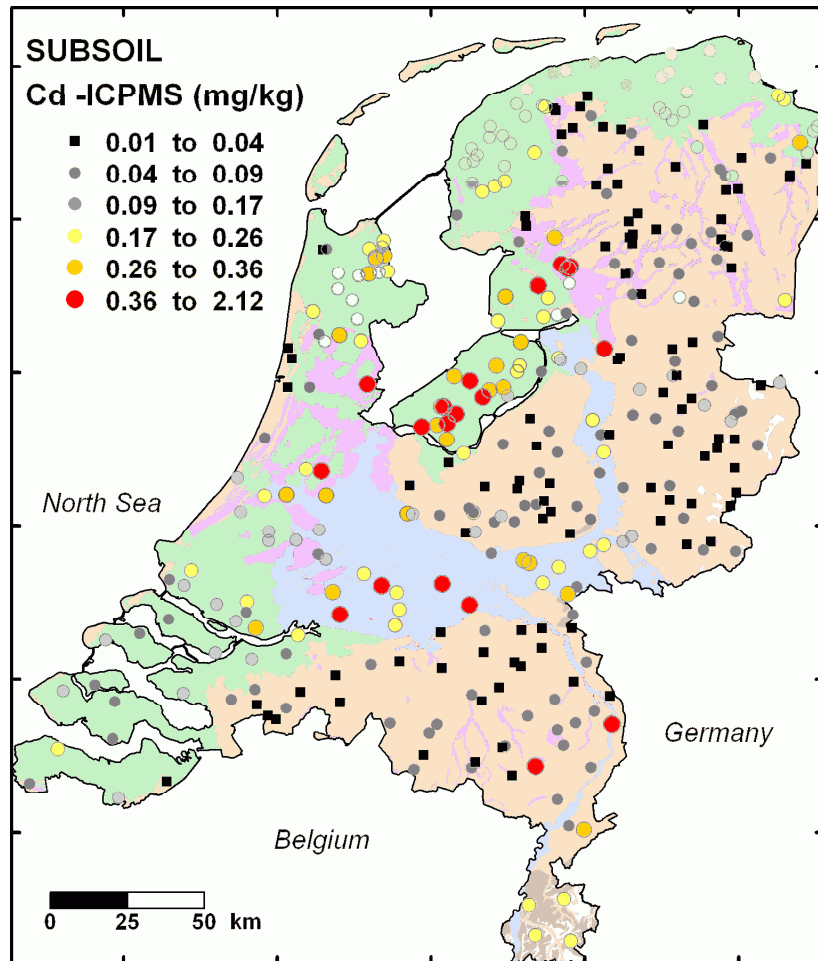
Atomic number: 48	Upper cont. crust: 0.10 / 0.01 mg/kg	River water: 0.02 µg/l
Atomic mass: 112.411	Shale/schist: 0.3 / 0.25 mg/kg	Ocean water: 0.08 µg/l
Main ox. state(s): +2	Sandstone: <0.04 mg/kg	Human diet: 0.05 mg/kg
Electronegativity (Pauling): 1.69	Limestone: 0.1 mg/kg	Reference man: 0.71 mg/kg
Group: (transition) metals	Coal: 0.2 / 1 mg/kg	Yearly production: 18.6 ·10 <sup>3</sup> t
Affinity: chalcophile	Volatility-ratio in coal: 2.3	
Host minerals: Greenockite (+), octavite (+), sphalerite (-) and other zinc ores, biotite (-), amphiboles (-).		
Uses: Electroplating, Ni-Cd batteries, pigments, stabilizers for plastic, low melting point alloys, television tubes.		
Remarks: Seems to be essential for some animals (e.g. rats) at very low concentrations. Toxic, supposedly carcinogenic. Environmental legislation for soils in the Netherlands (background: 0,8 mg/kg, remediate: 12 mg/kg).		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.047	0.038	0.035	0.019	0.014	0.33
loess	4	0.22	0.22	0.033	0.040	0.18	0.25
fluviatile clay	28	0.24	0.21	0.16	0.094	0.027	0.80
marine clay	115	0.17	0.14	0.10	0.073	0.020	0.49
peat	33	0.23	0.14	0.23	0.14	0.027	1.16
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	177	0.21	0.19	0.13	0.10	0.023	1.03
loess	4	0.80	0.82	0.093	0.093	0.69	0.89
fluviatile clay	26	0.53	0.50	0.32	0.14	0.052	1.90
marine clay	115	0.34	0.32	0.12	0.091	0.041	0.74
peat	32	0.70	0.61	0.45	0.34	0.15	2.11

Concentrations are in mg/kg and based on 105 °C dry weight

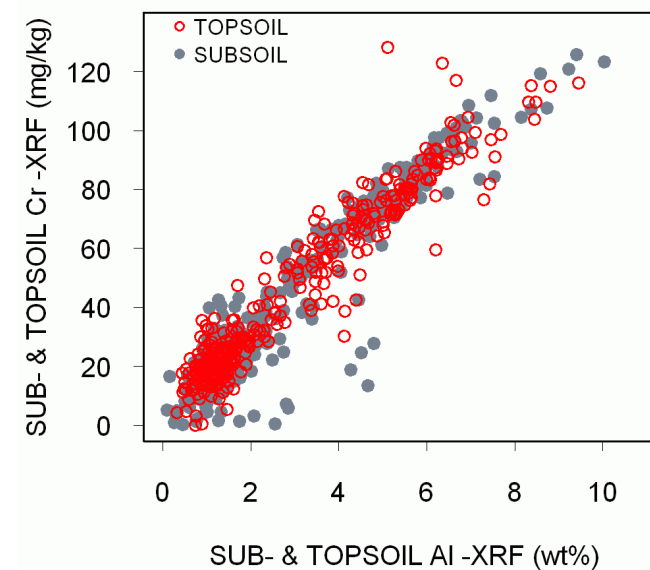
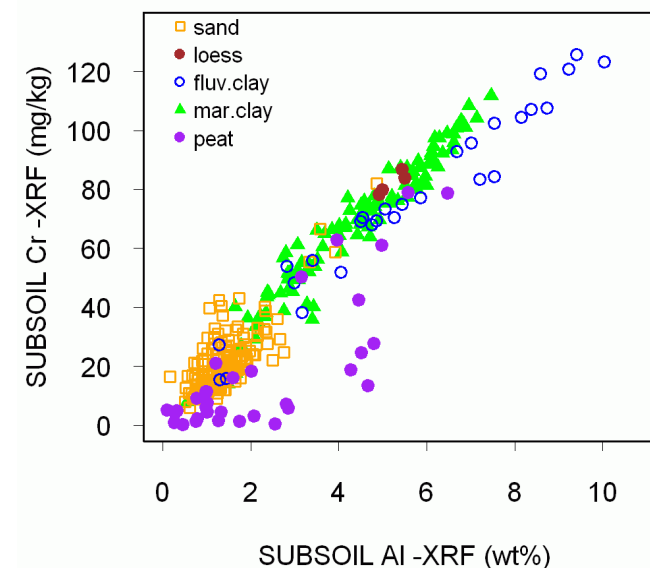


# Cd – Cadmium



# Cr - Chromium

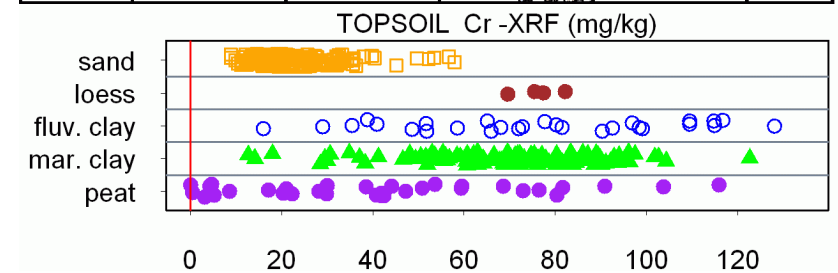
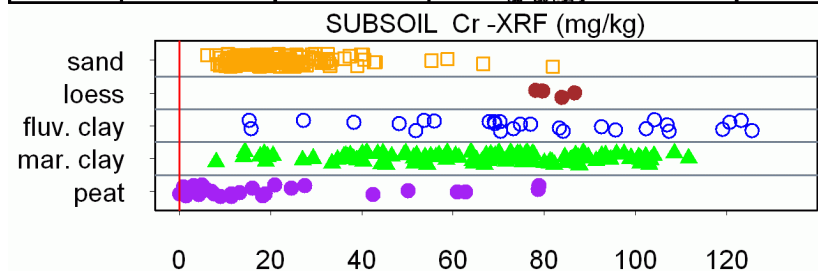
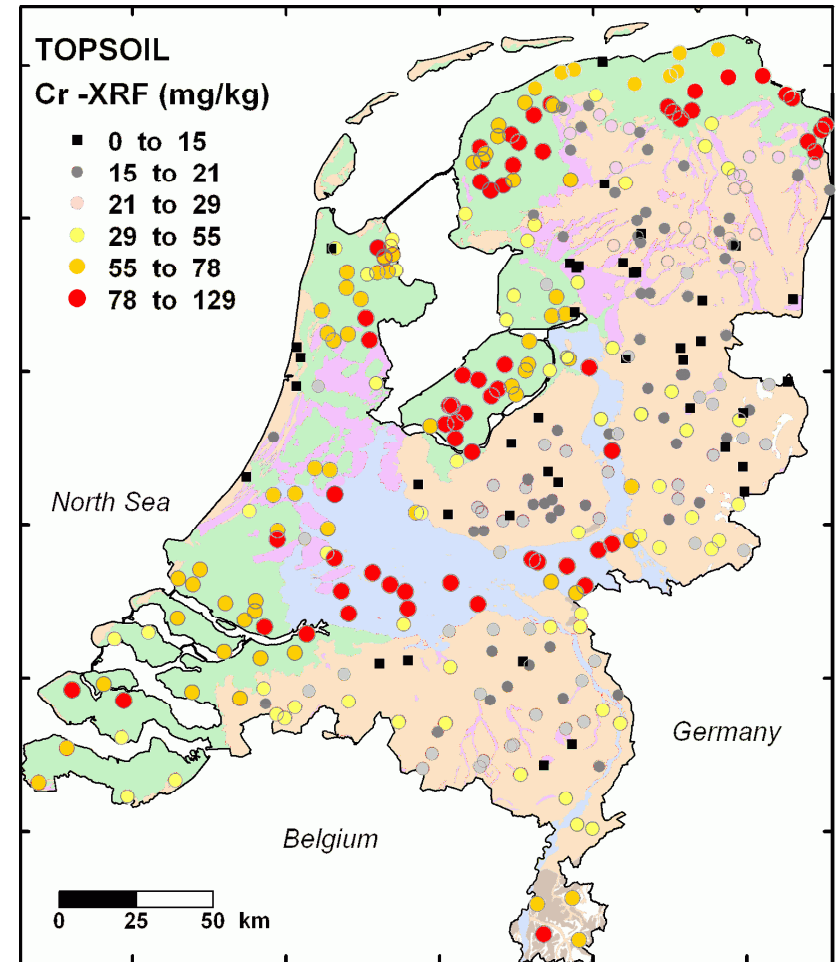
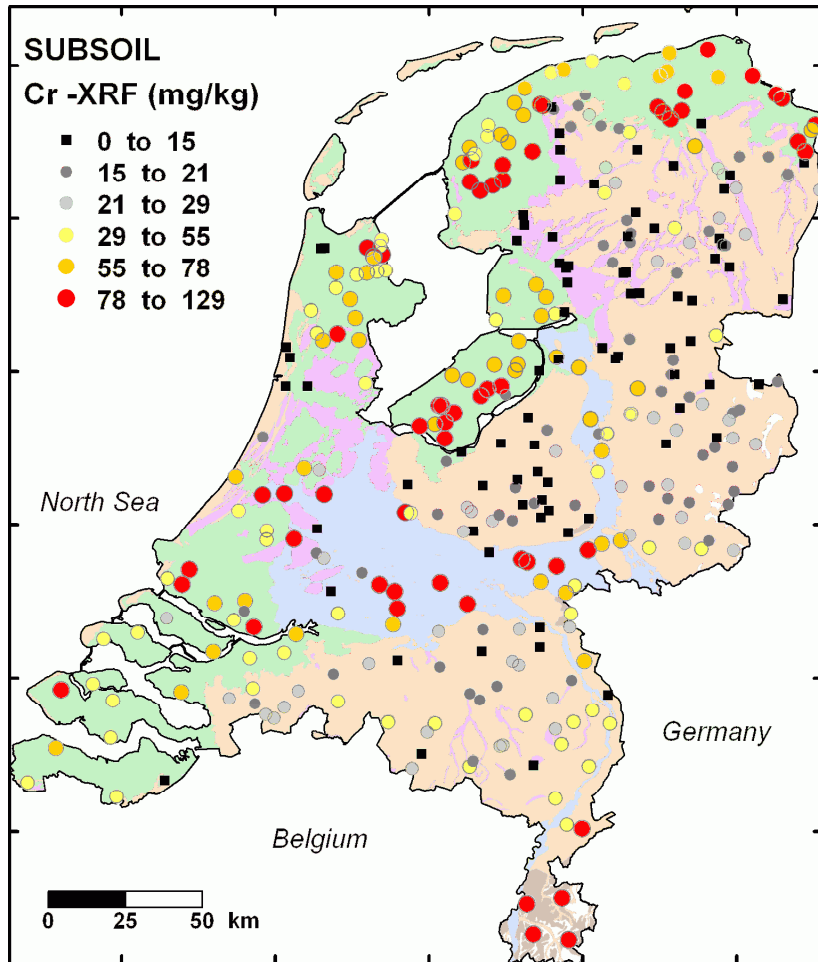
Atomic number: 24	Upper cont. crust: 35 / 35 mg/kg	River water: 1 µg/l
Atomic mass: 51.996	Shale/schist: 90 / 100 mg/kg	Ocean water: 0.25 µg/l
Main ox. state(s): +2, +3, +6 (+4, +5)	Sandstone: 35 mg/kg	Human diet: 0.23 mg/kg
Electronegativity (Pauling): 1.66	Limestone: 5 mg/kg	Reference man: 0.09 mg/kg
Group: transition metals	Coal: 10 / 20 mg/kg	Yearly production: 3.8·10 <sup>6</sup> t
Affinity: lithophile	Volatility-ratio in coal: -4.8	
Host minerals: Chromite (+), spinels (-), garnets (-), pyroxenes (-), amphiboles (-), micas (-).		
Uses: Stainless steel and many other alloys, chromium plating, pigments, catalysts, dye, tanning, wood impregnation, magnetic tapes.		
Remarks: Considered essential for some organisms. Cr <sup>3+</sup> is considered relatively harmless, whereas Cr <sup>5+</sup> and Cr <sup>6+</sup> are highly toxic. Environmental legislation for soils in the Netherlands (background: 100 mg/kg, remediate: 380 mg/kg).		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	20.8	18.3	10.2	7.07	6.01	81.9
loess	4	82.1	81.8	3.89	4.27	78.1	86.7
fluviatile clay	28	76.6	74.0	31.2	32.5	15.3	126
marine clay	115	65.7	68.1	24.3	27.5	8.01	112
peat	33	18.3	7.60	22.9	9.17	0.12	78.8
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	22.6	21.0	8.69	7.24	8.81	57.9
loess	4	76.2	76.5	5.25	4.99	69.6	82.3
fluviatile clay	28	75.9	75.3	30.0	34.9	16.1	128
marine clay	115	70.1	71.7	19.5	17.1	12.6	123
peat	33	42.6	41.9	31.2	31.8	0.062	116

Concentrations are in mg/kg and based on 105 °C dry weight

# Cr - Chromium

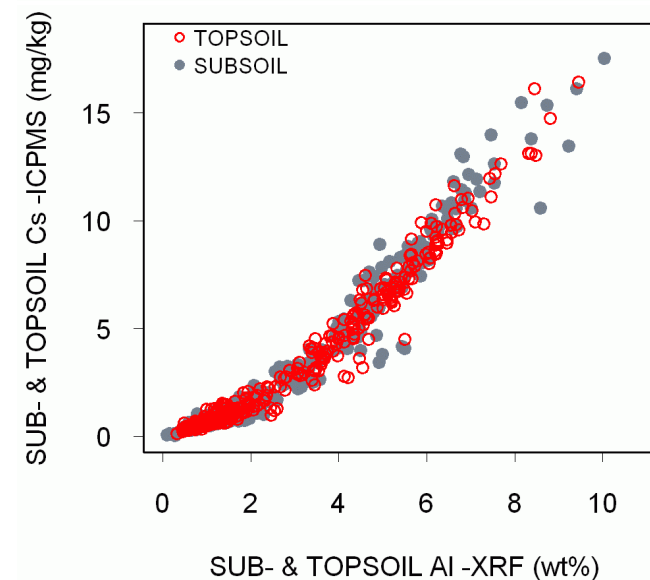
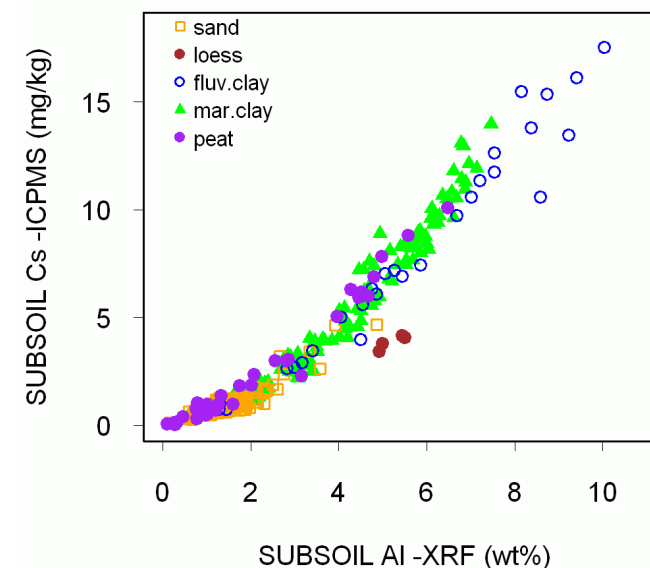


# Cs - Cesium

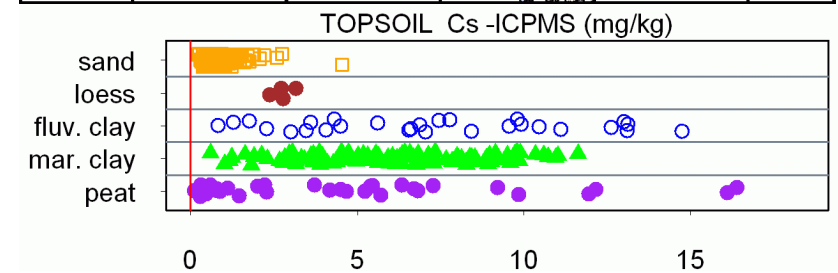
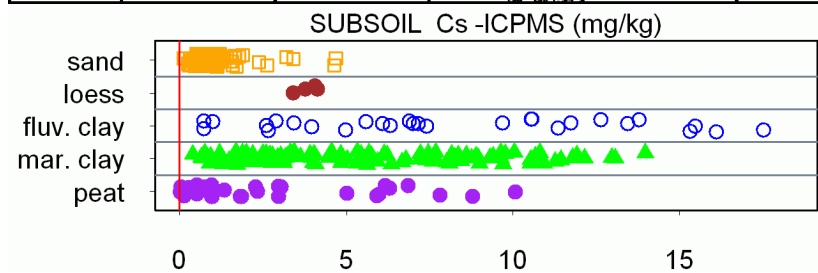
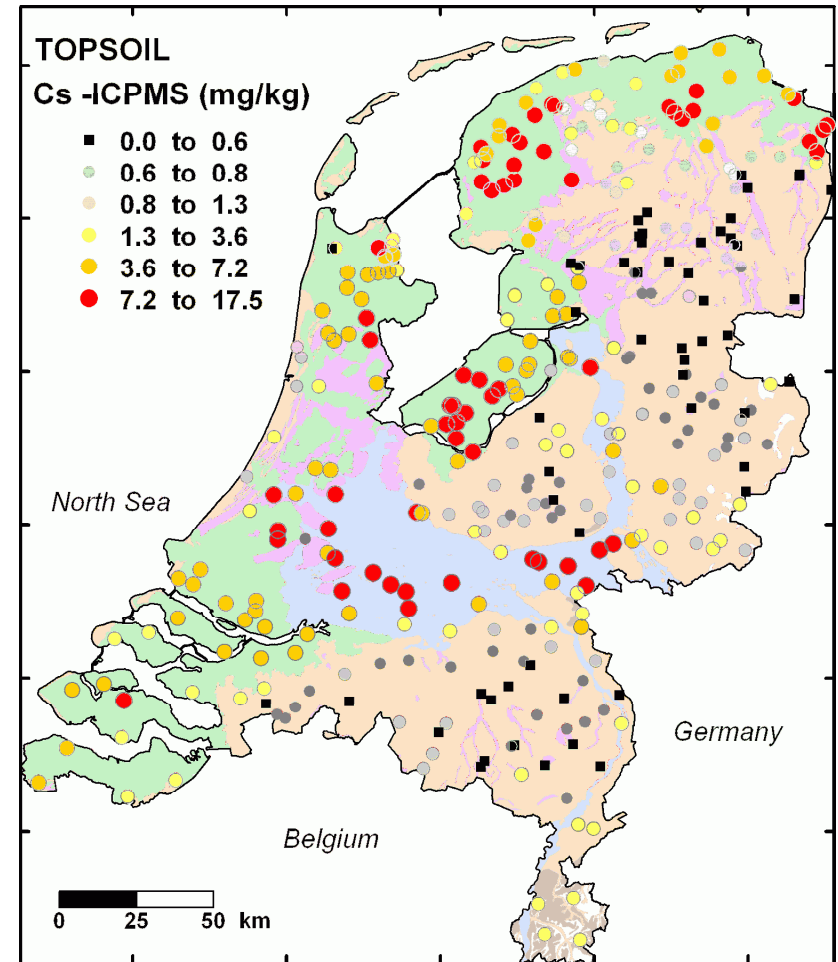
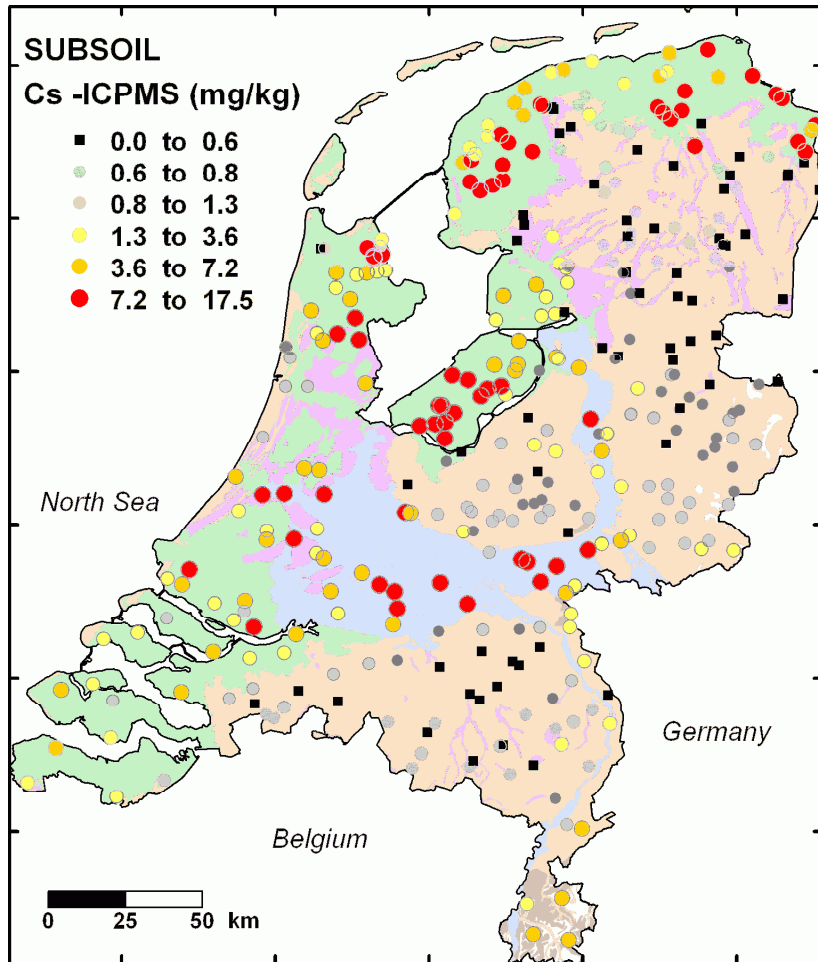
Atomic number: 55	Upper cont. crust: 5.8 3.7 mg/kg	River water: 0.035 µg/l
Atomic mass: 132.905	Shale/schist: 5 / 5 mg/kg	Ocean water: 0.31 µg/l
Main ox. state(s): +1	Sandstone: 1 mg/kg	Human diet: 0.009 mg/kg
Electronegativity (Pauling): 0.79	Limestone: 0.5 mg/kg	Reference man: 0.02 mg/kg
Group: alkali metals	Coal: 0.3 / 1 mg/kg	Yearly production: 30 t
Affinity: lithophile	Volatility-ratio in coal: -2.2	
Host minerals: Pollucite (+), micas (-), K-feldspar (-).		
Uses: Catalyst, rocket propellant, photovoltaic cells.		
Remarks: Considered non-essential for organisms.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.89	0.75	0.59	0.24	0.13	4.68
loess	4	3.85	3.92	0.33	0.27	3.42	4.14
fluviatile clay	28	8.14	7.09	5.06	6.26	0.73	17.5
marine clay	115	5.63	5.32	3.47	4.21	0.40	14.0
peat	33	2.73	1.36	2.89	1.58	0.03	10.1
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.90	0.78	0.48	0.28	0.21	4.53
loess	4	2.77	2.76	0.32	0.30	2.39	3.17
fluviatile clay	28	7.25	6.96	4.03	4.68	0.84	14.7
marine clay	115	5.96	6.05	2.61	3.20	0.60	11.6
peat	33	4.72	4.18	4.55	4.61	0.13	16.4

Concentrations are in mg/kg and based on 105 °C dry weight



# Cs - Cesium

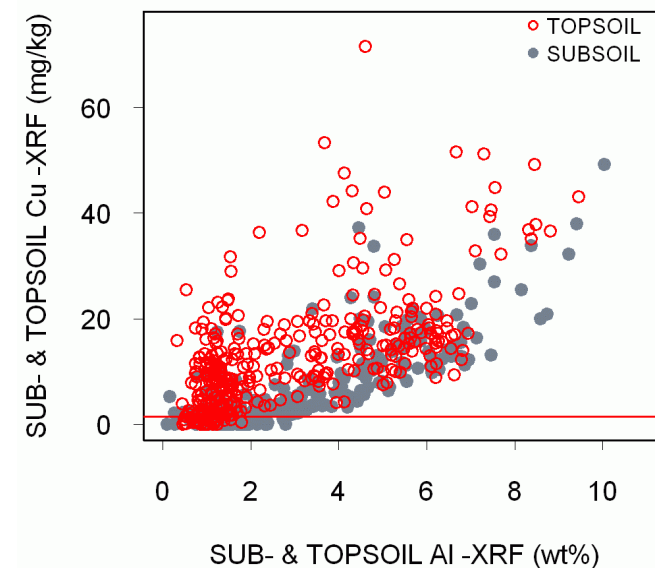
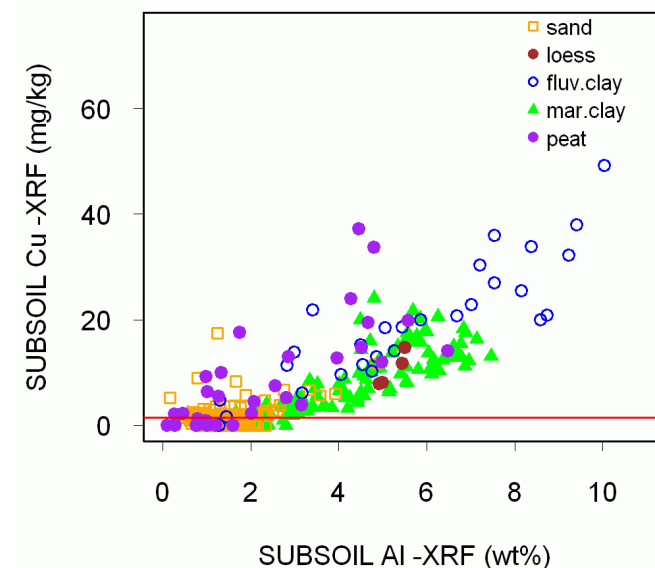


# Cu - Copper

Atomic number: 29	Upper cont. crust: 14.3 / 25 mg/kg	River water: 1.5 µg/l
Atomic mass: 63.546	Shale/schist: 45 / 45 mg/kg	Ocean water: 0.21 µg/l
Main ox. state(s): +2, 0 (+1)	Sandstone: 2 mg/kg	Human diet: 2.2 mg/kg
Electronegativity (Pauling): 1.9	Limestone: 6 mg/kg	Reference man: 1 mg/kg
Group: transition metals	Coal: 15 / 20 mg/kg	Yearly production: 10·10 <sup>6</sup> t
Affinity: chalcophile	Volatility-ratio in coal: 0.2	
Host minerals: Chalcopyrite (+), malachite/azurite (+), native copper (+), biotite (-), pyroxenes (-), amphiboles (-), magnetite (-).		
Uses: Electrical industry, water piping, pigments, alloys, algacide, bactericide, fungicide, insecticide.		
Remarks: Essential for all organisms, toxic at high doses. Environmental legislation for soils in the Netherlands (background: 36 mg/kg, remediate: 190 mg/kg).		

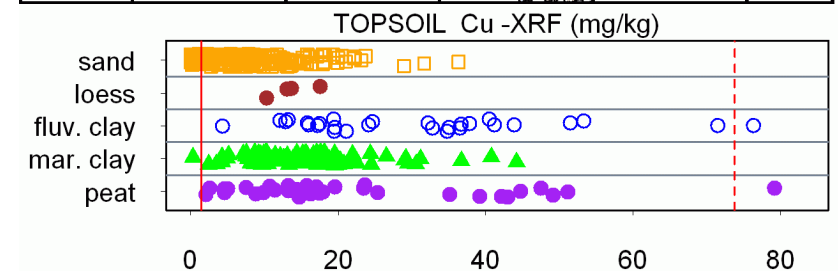
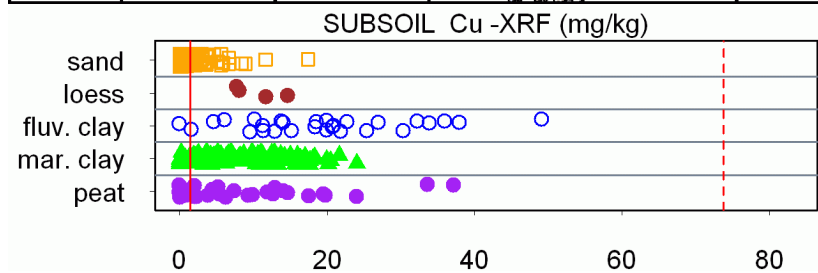
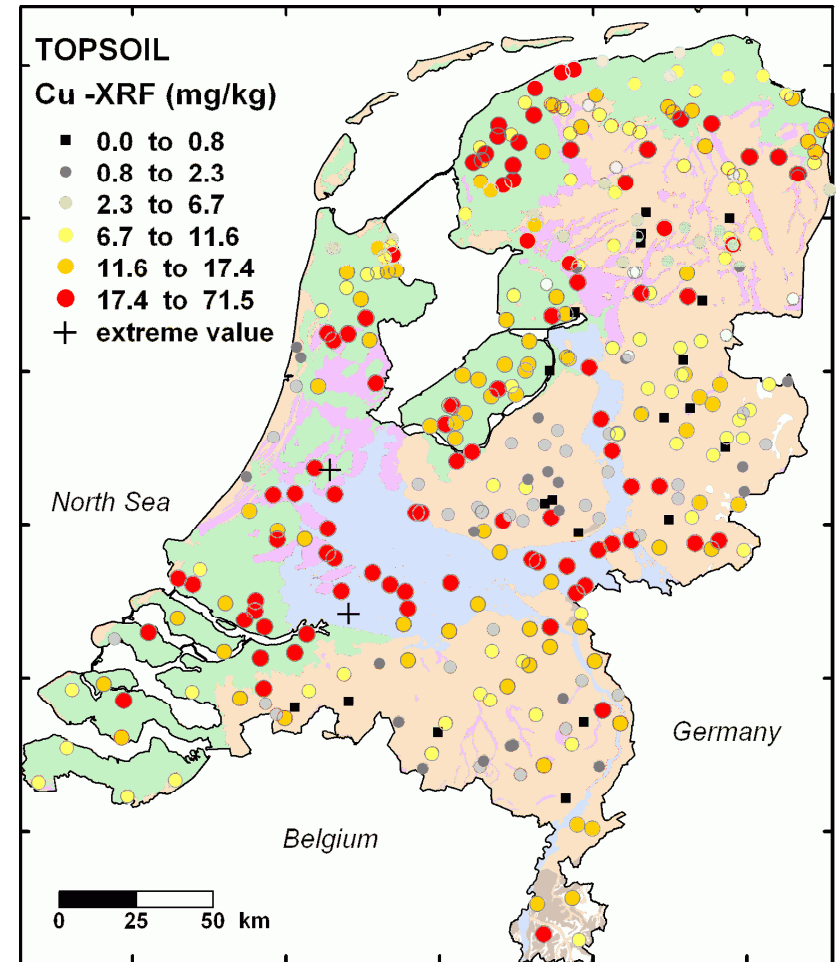
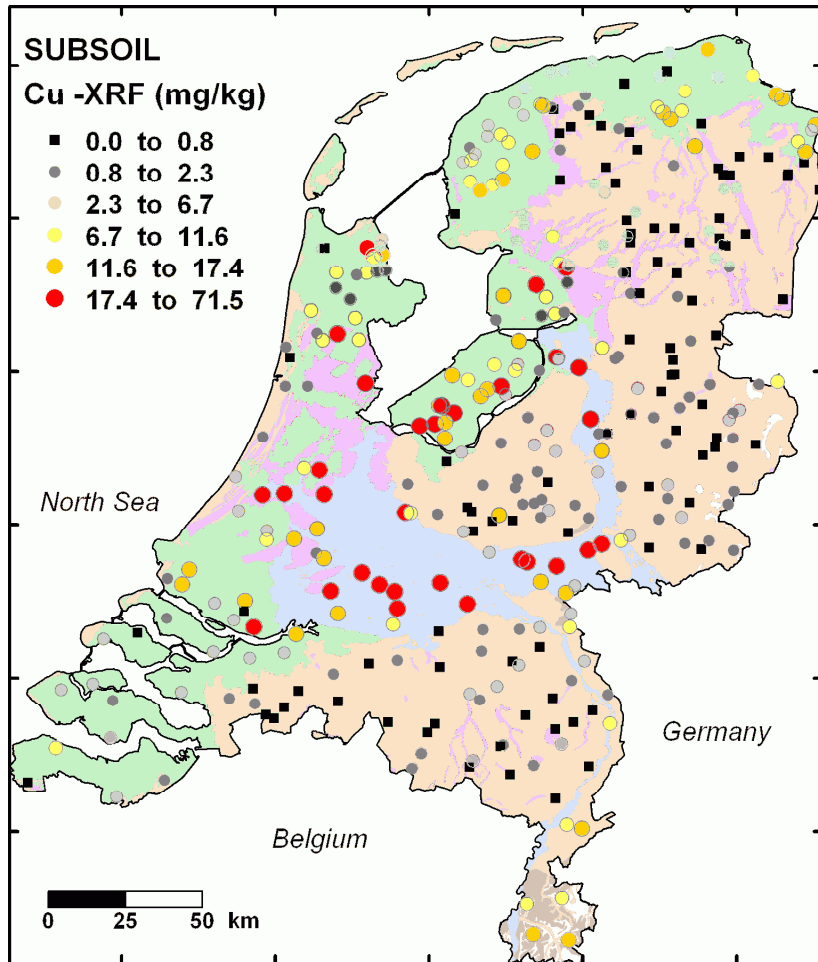
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.40	0.83	2.12	1.21	<0.001	17.4
loess	4	10.6	9.91	3.26	2.90	7.79	14.7
fluvatile clay	28	19.5	19.3	11.6	11.5	0.004	49.1
marine clay	115	8.16	7.01	5.92	6.58	0.009	24.1
peat	33	8.52	5.23	9.76	7.73	0.012	37.1
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	7.74	6.83	6.64	6.78	0.001	36.3
loess	4	13.7	13.4	3.02	2.51	10.3	17.7
fluvatile clay	27	29.1	24.7	15.3	15.4	4.39	71.5
marine clay	115	15.4	15.2	7.37	6.41	0.35	44.2
peat	32	20.9	16.1	15.0	11.1	2.17	51.2

Concentrations are in mg/kg and based on 105 °C dry weight





# Cu - Copper

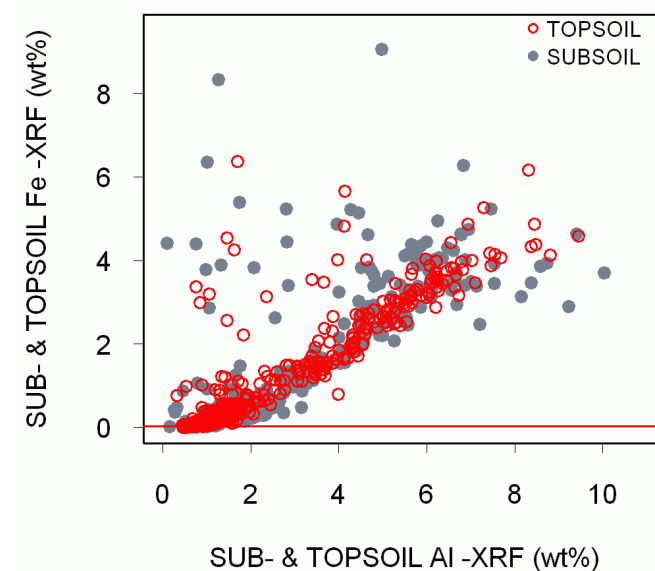
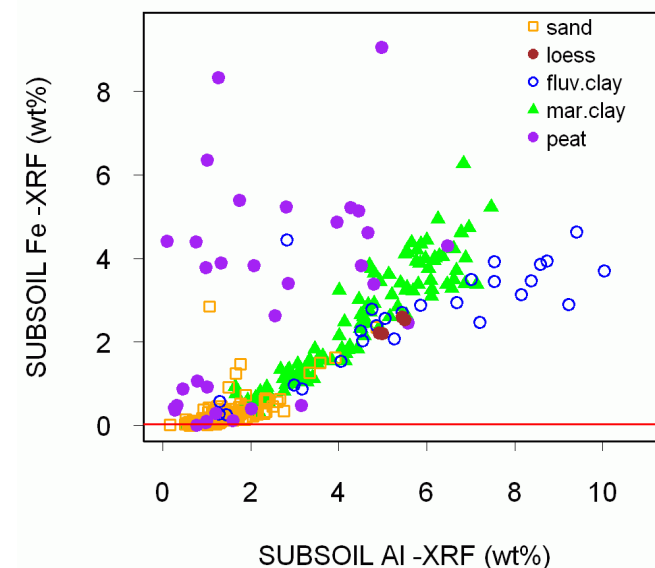


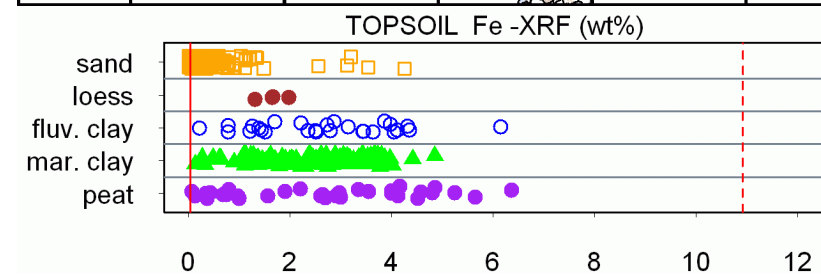
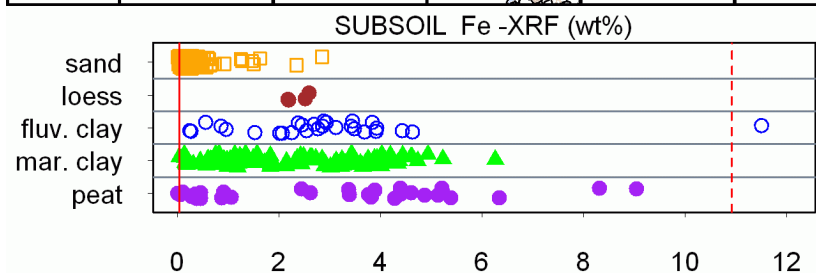
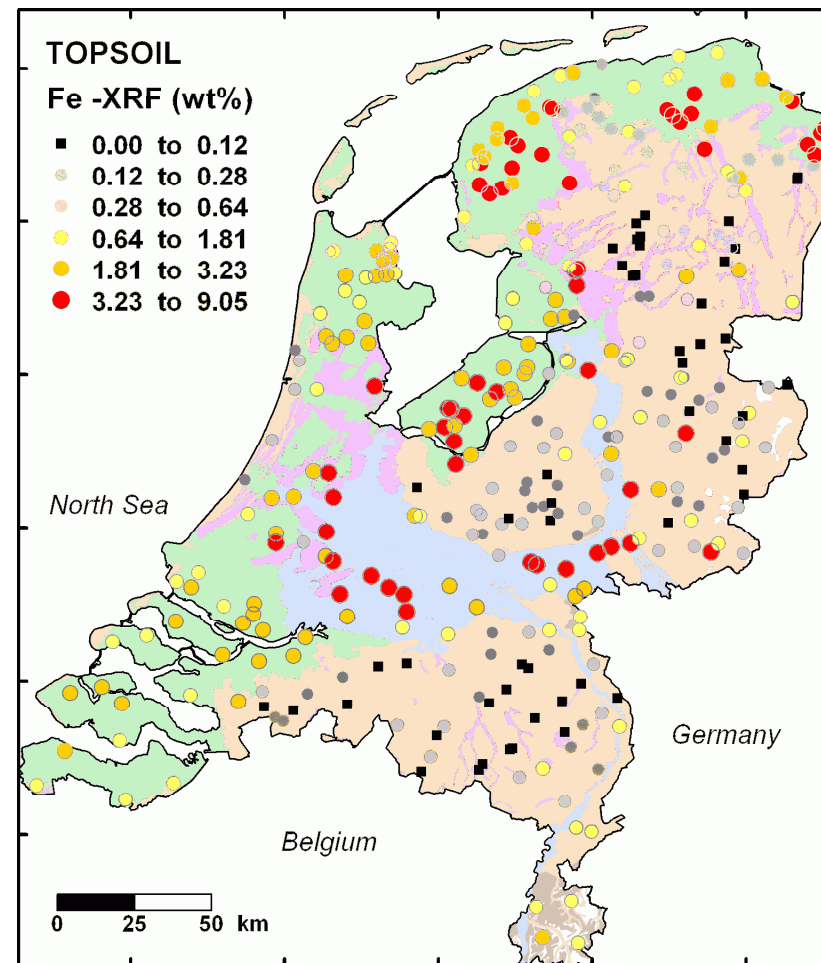
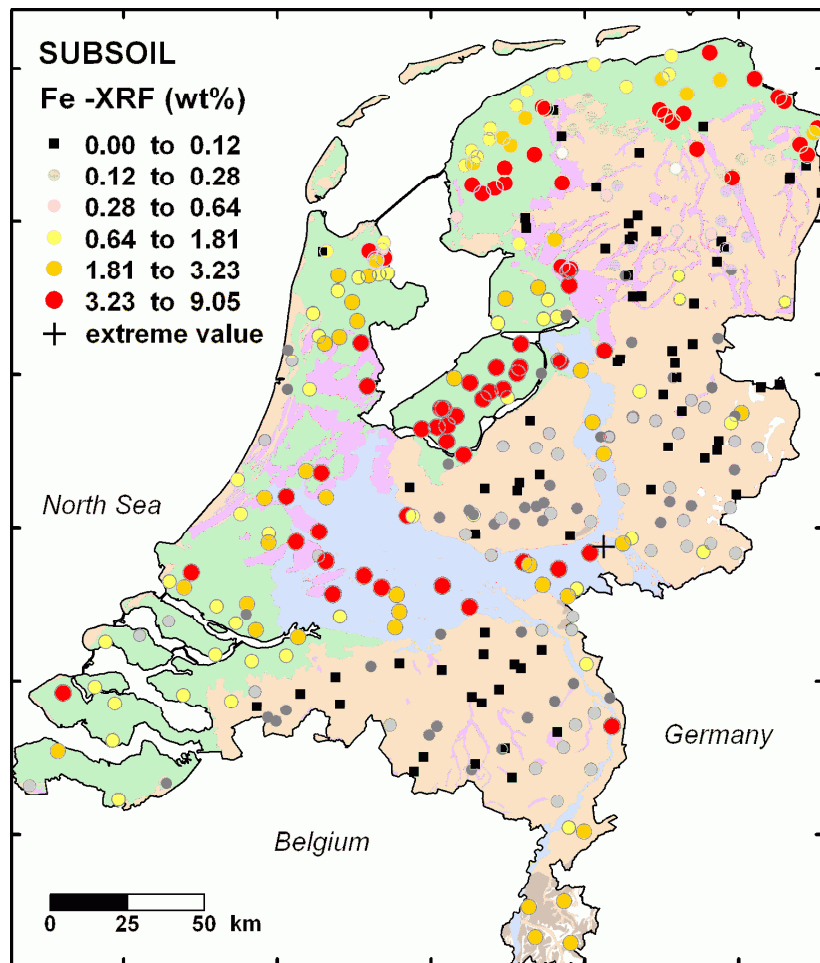
# Fe - Iron

Atomic number: 26	Upper cont. crust: 3.1 / 3.5 wt%	River water: 40 µg/l
Atomic mass: 55.845	Shale/schist: 4.7 / 5.5 wt%	Ocean water: 0.25 µg/l
Main ox. state(s): +2,+3 (+4, +6)	Sandstone: 1.0 wt%	Human diet: 17 mg/kg
Electronegativity (Pauling): 1.83	Limestone: 0.5 wt%	Reference man: 60 mg/kg
Group: transition metals	Coal: 0.8 / 1.0 wt%	Yearly production: 570·10 <sup>6</sup> t
Affinity: chalcophile, siderophile	Volatility-ratio in coal: -5.5	
Host minerals: Goethite/limonite (+), magnetite (+), hematite (+), pyrite (+), siderite (+), olivine (+), pyroxenes (+), amphiboles (+), biotite (+), chlorite (+), clay minerals (+) and other common Al-silicates.		
Uses: Steel (building and construction), pigments, many different consumer goods, sewage treatment.		
Remarks: Essential for all organisms. Toxic for humans at higher levels. Iron deficiency widespread.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.26	0.16	0.35	0.13	0.002	2.85
loess	4	2.38	2.36	0.21	0.25	2.19	2.59
fluviatile clay	27	2.60	2.77	1.23	1.06	0.25	4.63
marine clay	115	2.32	2.15	1.43	1.75	0.035	6.26
peat	33	3.03	3.39	2.49	2.96	0.003	9.05
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.40	0.24	0.59	0.22	<0.001	4.25
loess	4	1.65	1.66	0.27	0.24	1.32	1.98
fluviatile clay	28	2.69	2.63	1.37	1.70	0.22	6.16
marine clay	115	2.42	2.47	1.01	1.21	0.13	4.85
peat	33	2.73	2.70	1.79	2.51	0.075	6.37

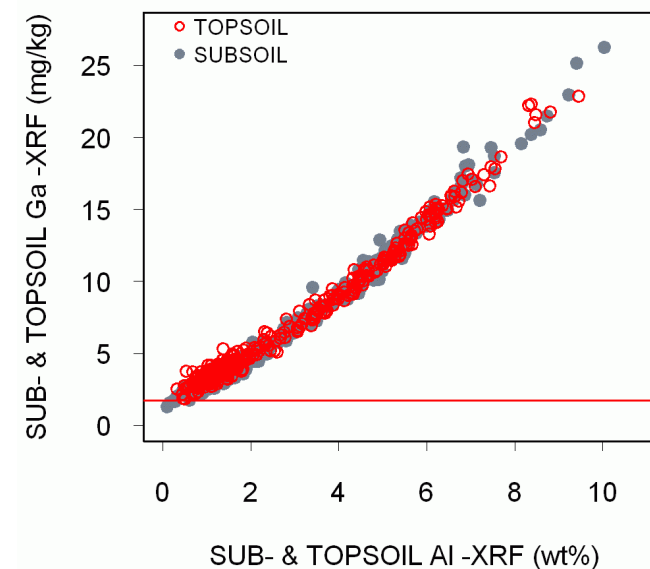
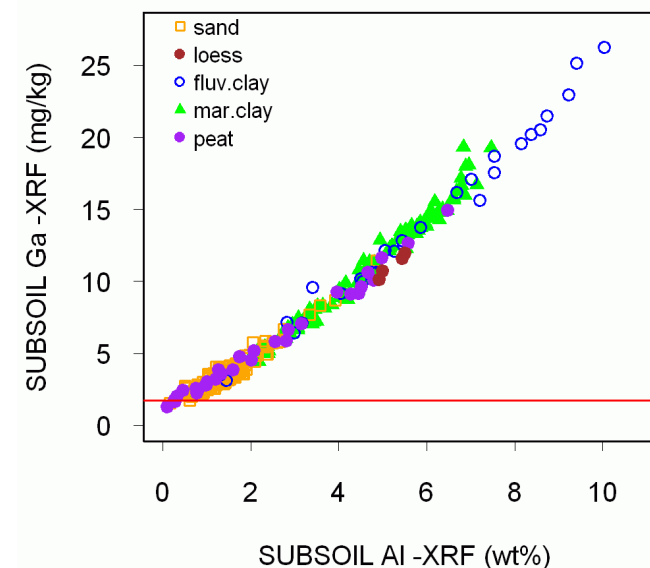
Concentrations are in wt% and based on 105 °C dry weight





# Ga - Gallium

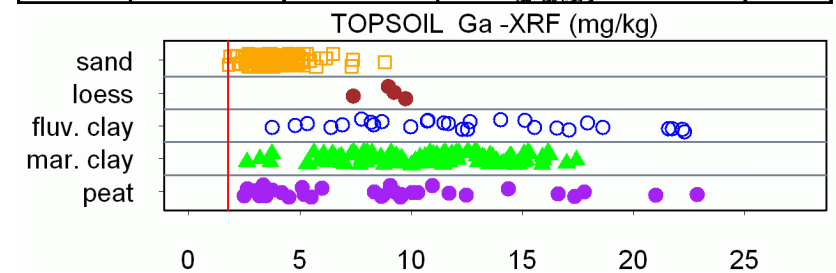
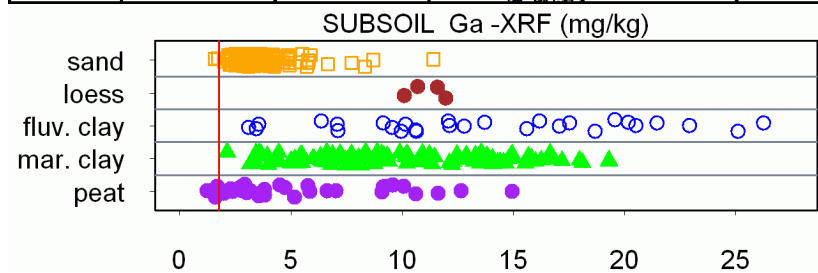
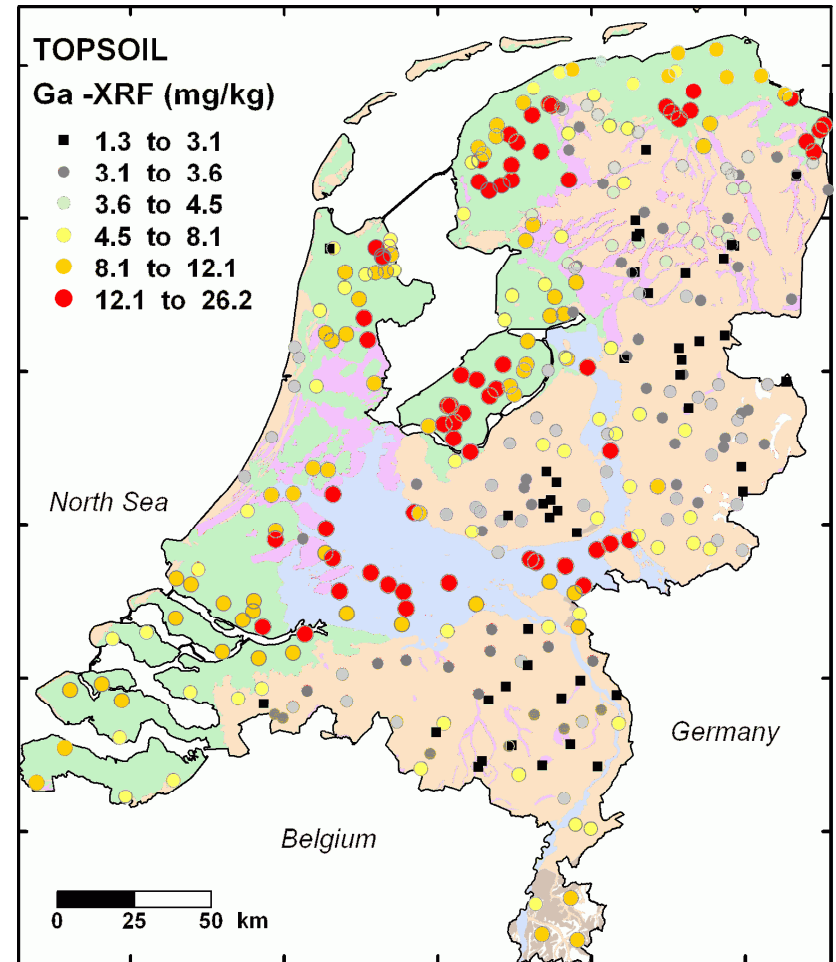
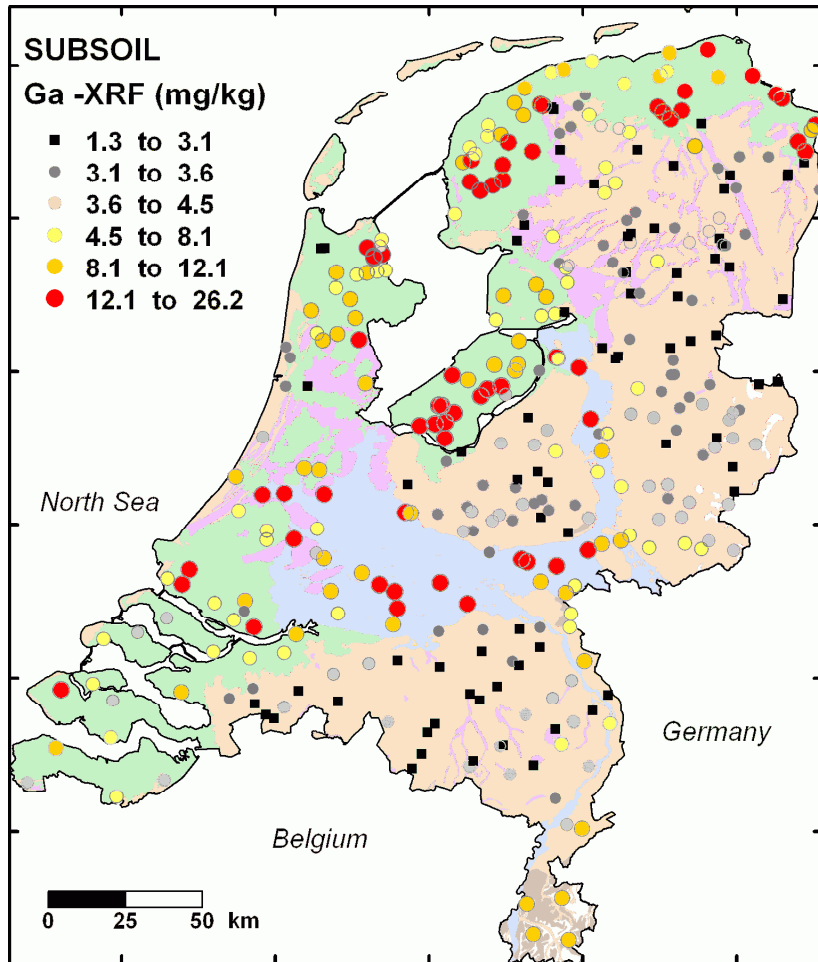
Atomic number: 31	Upper cont. crust: 14 / 17 mg/kg	River water: 0.09 µg/l
Atomic mass: 69.723	Shale/schist: 19 / 20 mg/kg	Ocean water: 0.0017 µg/l
Main ox. state(s): +3 (+1, +2)	Sandstone: 8 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.81	Limestone: 1 mg/kg	Reference man: ?
Group: metals	Coal: 5 / 5 mg/kg	Yearly production: 20 t
Affinity: chalcophile	Volatility-ratio in coal: -1.1	
Host minerals: Feldspars (-), amphiboles (-), micas (-), clay minerals (-), magnetite (-).		
Uses: Electronics (semi-conductor), low melting point alloys, chemotherapy.		
Remarks: Non-essential, toxicity considered low.		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	3.53	3.27	1.20	0.65	1.57	11.4
loess	4	11.1	11.2	0.84	0.92	10.1	12.0
fluviatile clay	28	13.7	12.5	6.57	7.70	3.12	26.2
marine clay	115	10.0	9.89	4.21	5.27	2.14	19.3
peat	33	5.51	3.85	3.69	2.72	1.26	14.9
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	3.76	3.62	0.96	0.77	1.81	8.80
loess	4	8.86	9.13	1.01	0.56	7.43	9.75
fluviatile clay	28	12.7	12.0	5.51	5.91	3.78	22.3
marine clay	115	10.8	10.8	3.33	4.00	2.63	17.4
peat	33	8.75	8.67	5.55	6.14	2.50	22.9

Concentrations are in mg/kg and based on 105 °C dry weight

# Ga - Gallium

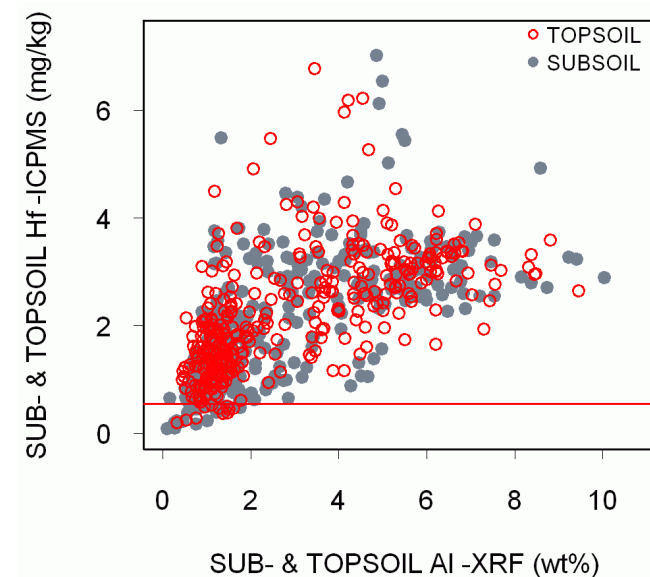
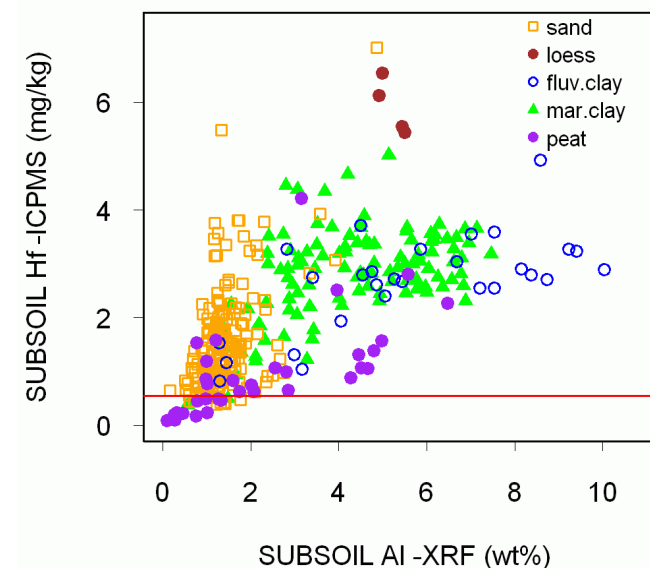


# Hf - Hafnium

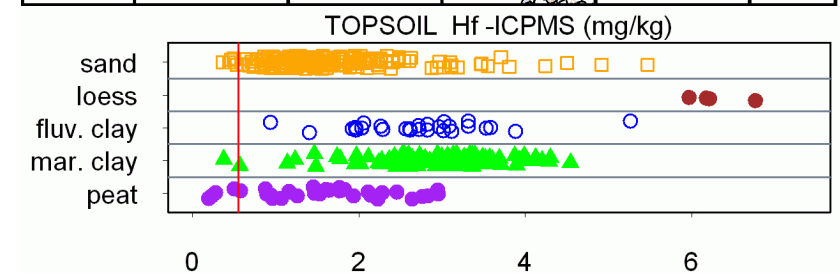
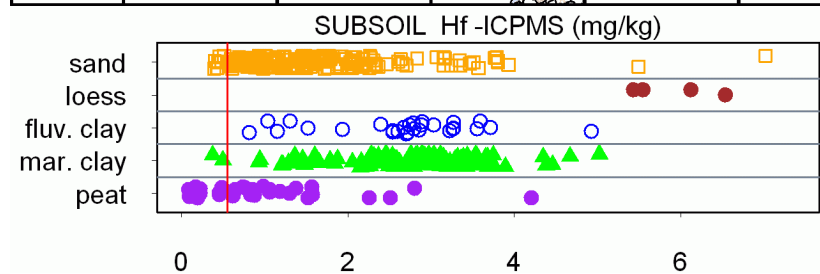
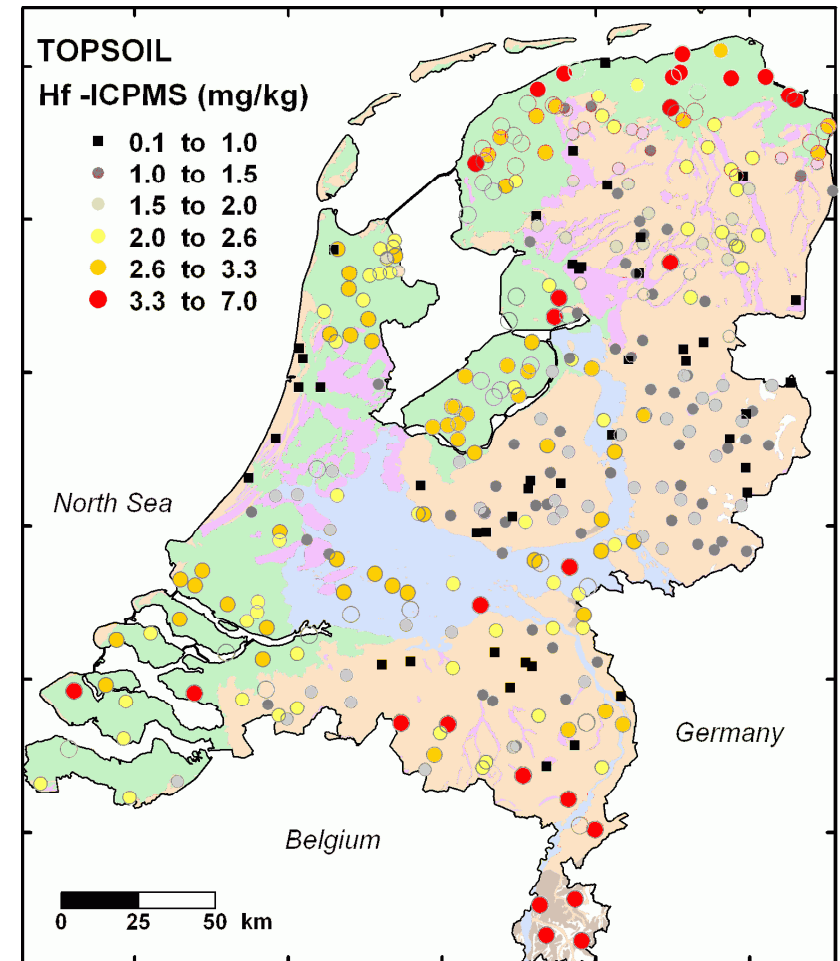
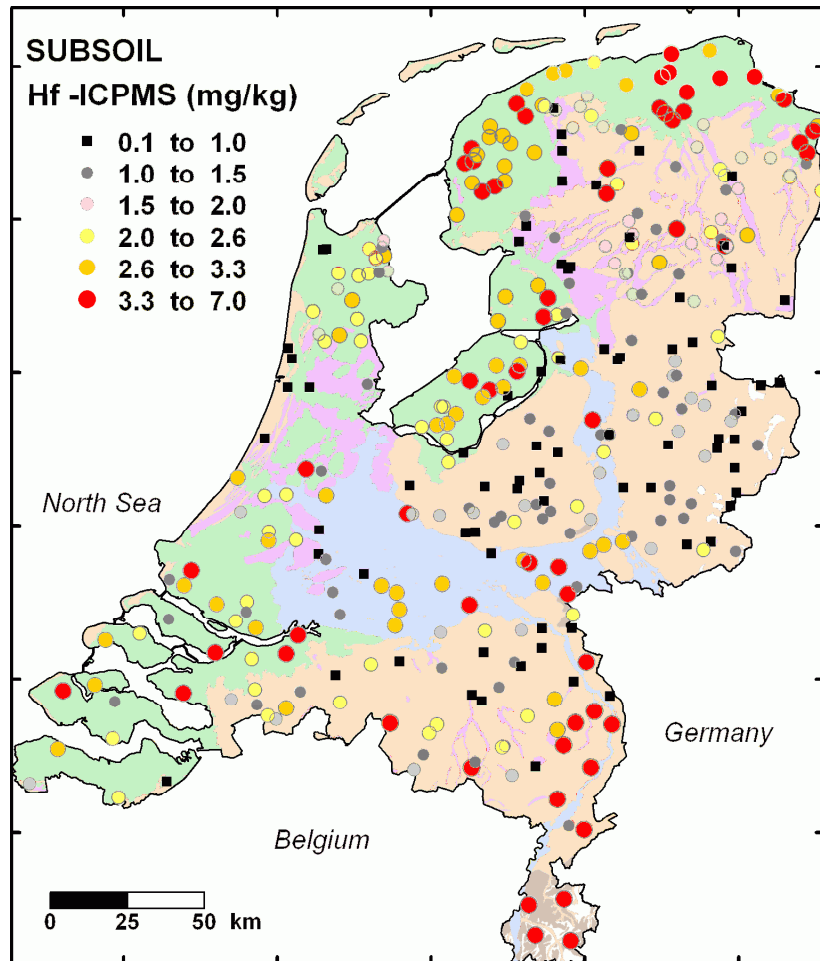
Atomic number: 72	Upper cont. crust: 5.8 / 5.8 mg/kg	River water: 0.01 µg/l
Atomic mass: 178.42	Shale/schist: 5 / 4 mg/kg	Ocean water: 0.0034 µg/l
Main ox. state(s): +4	Sandstone: 6 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.3	Limestone: 0.4 mg/kg	Reference man: ?
Group: transition metals	Coal: 0.9 / 1 mg/kg	Yearly production: ?
Affinity: lithophile	Volatility-ratio in coal: low	
Host minerals: Zircon (+), baddeleyite (+), pyroxenes (-), garnets (-), biotite (-).		
Uses: Alloys, nuclear industry (reactor control rods), photography.		
Remarks: Considered non-essential, little is known about its toxicity.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.57	1.38	0.96	0.72	0.39	7.01
loess	4	5.91	5.83	0.52	0.51	5.43	6.54
fluviatile clay	28	2.67	2.76	0.90	0.61	0.82	4.92
marine clay	115	2.79	2.91	0.84	0.71	0.37	5.02
peat	33	1.02	0.83	0.88	0.56	0.088	4.21
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.66	1.50	0.83	0.60	0.36	5.47
loess	4	6.28	6.19	0.34	0.18	5.97	6.77
fluviatile clay	28	2.71	2.72	0.84	0.78	0.94	5.26
marine clay	115	2.96	3.03	0.72	0.59	0.38	4.54
peat	33	1.62	1.60	0.83	0.95	0.20	2.95

Concentrations are in mg/kg and based on 105 °C dry weight



# Hf - Hafnium

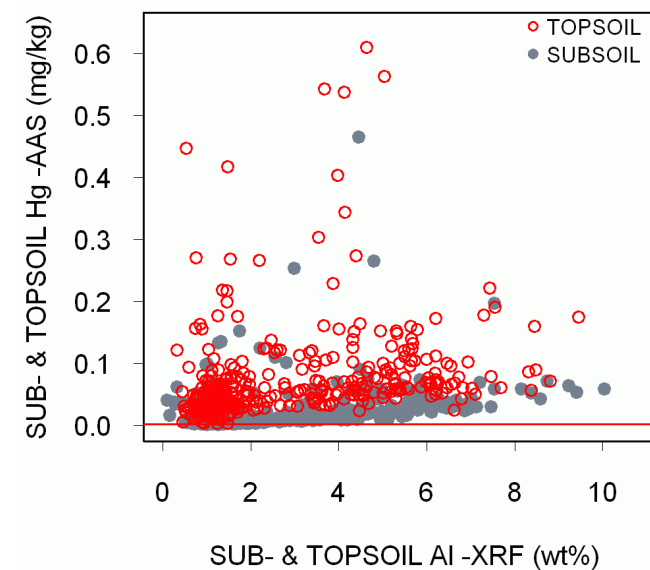
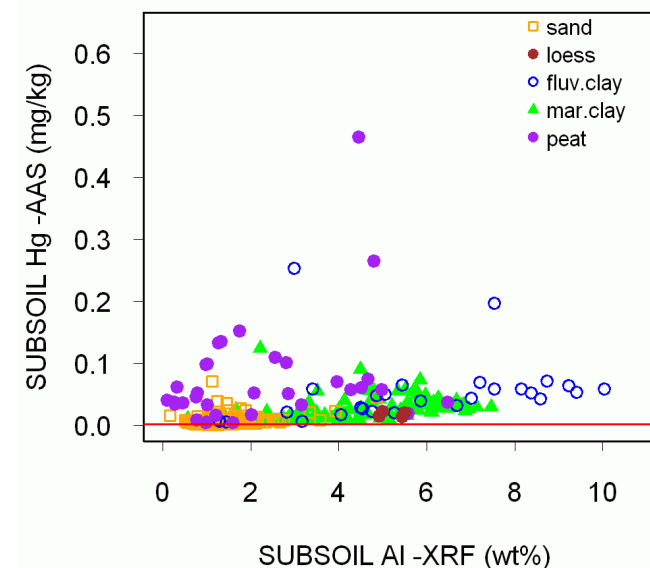


# Hg - Mercury

Atomic number: 80	Upper cont. crust: 0.056 / 5.8 mg/kg	River water: 0.05 µg/l
Atomic mass: 200.59	Shale/schist: 0.18 / 0.18 mg/kg	Ocean water: 42·10 <sup>-3</sup> µg/l
Main ox. state(s): +2, 0 (+1, +3)	Sandstone: 0.01 mg/kg	Human diet: ?
Electronegativity (Pauling): 2	Limestone: 0.02 mg/kg	Reference man: ?
Group: (transition) metals	Coal: 3? / 0.1 mg/kg	Yearly production: 2900 t
Affinity: chalcophile	Volatility-ratio in coal: 8.9	
Host minerals: Cinnabar (+), native Hg (+), amphiboles (-), sphene (-), sphalerite (-) and other sulphides (-).		
Uses: Caustic soda and chlorine production, gold ore processing, batteries, dentistry, wood impregnation, thermometers, detonators, Hg-vapor lamps.		
Remarks: Considered non-essential and very toxic. Environmental legislation Environmental legislation for soils in the Netherlands (background: 0.3 mg/kg, remediate: 10 mg/kg).		

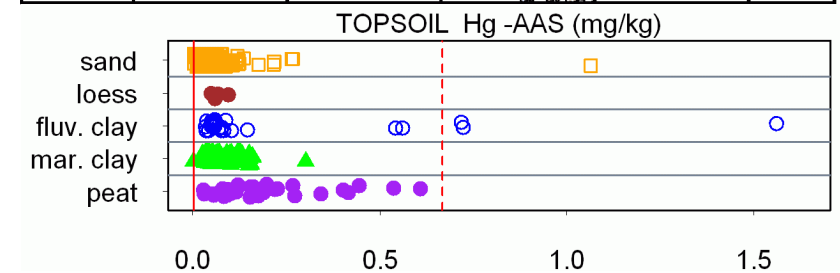
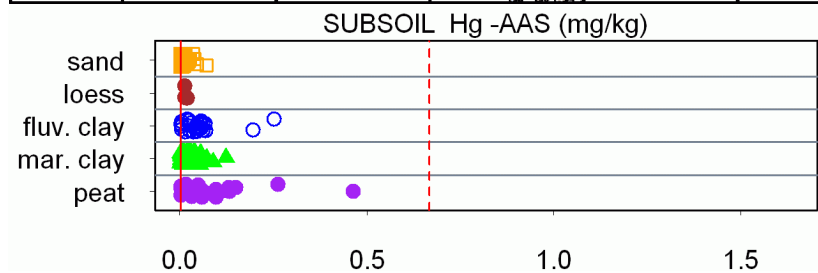
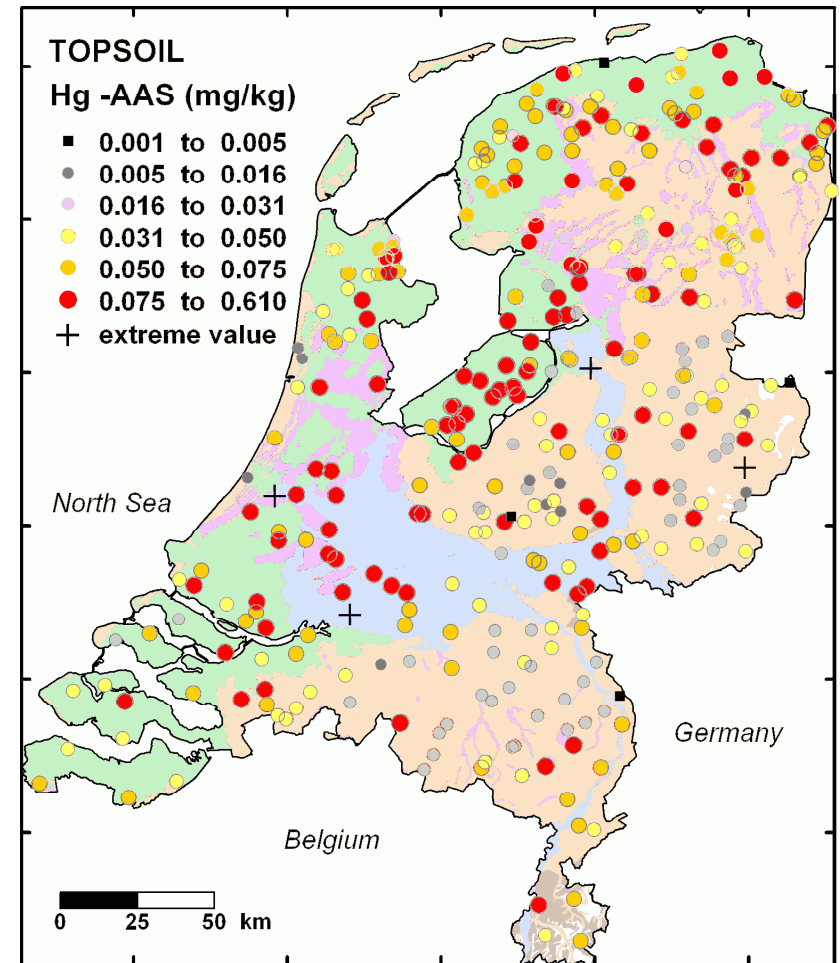
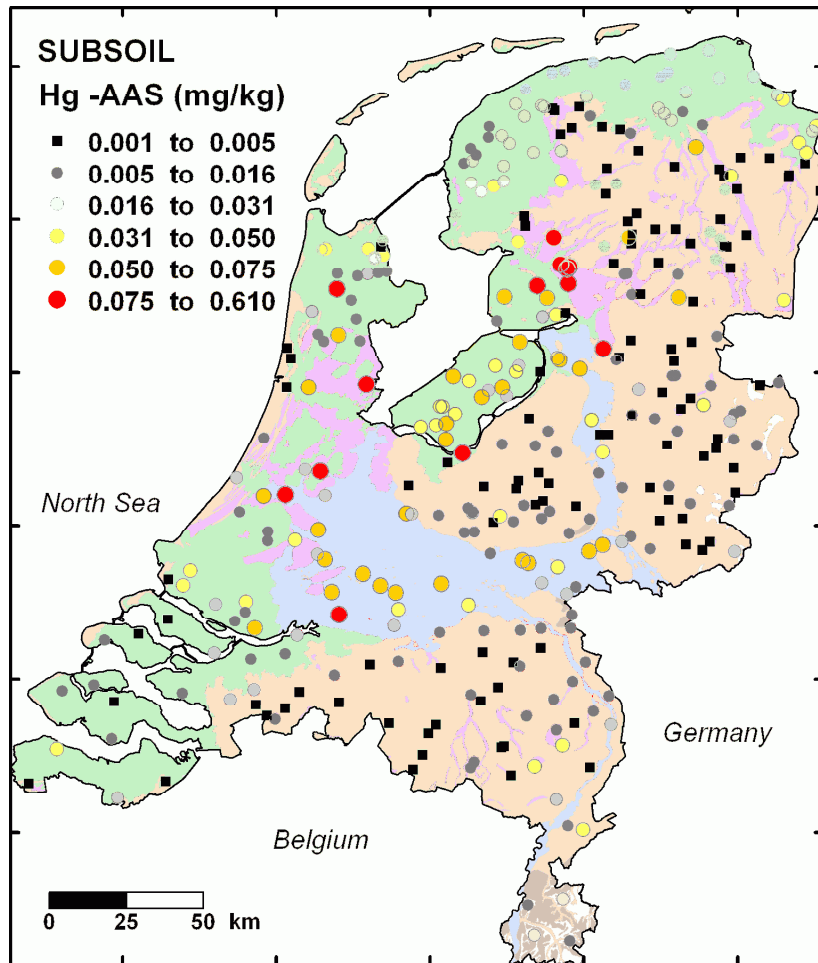
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.007	0.005	0.008	0.002	0.001	0.071
loess	4	0.018	0.018	0.004	0.005	0.014	0.022
fluviatile clay	28	0.052	0.046	0.053	0.028	0.005	0.253
marine clay	115	0.024	0.021	0.019	0.016	0.002	0.124
peat	33	0.075	0.052	0.088	0.033	0.004	0.465
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	177	0.048	0.036	0.041	0.021	0.003	0.268
loess	4	0.069	0.065	0.020	0.015	0.050	0.096
fluviatile clay	25	0.104	0.060	0.137	0.024	0.035	0.562
marine clay	115	0.075	0.066	0.040	0.028	0.003	0.302
peat	33	0.201	0.164	0.142	0.096	0.030	0.609

Concentrations are in mg/kg and based on 105 °C dry weight





# Hg - Mercury

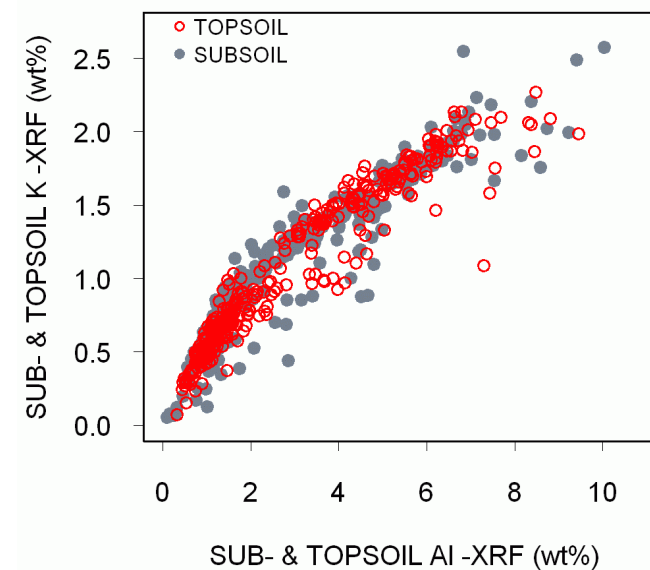
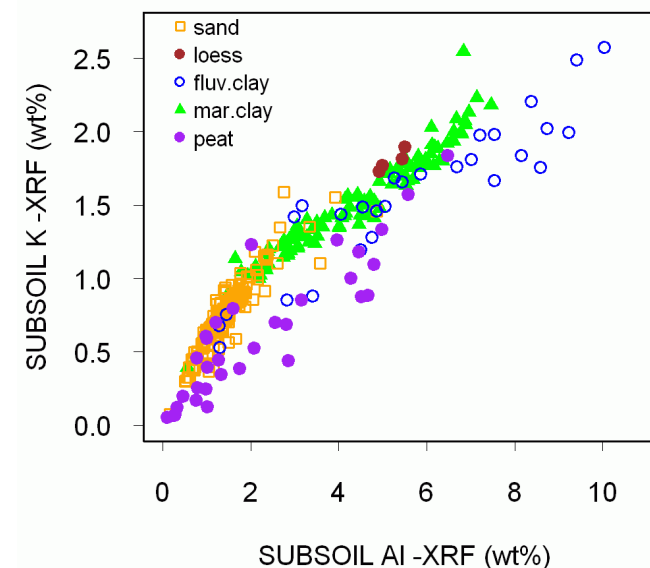


# K - Potassium

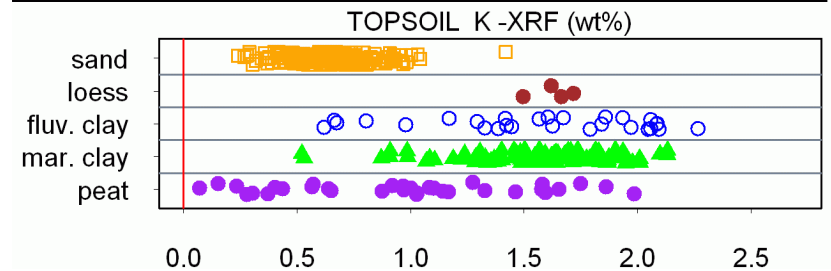
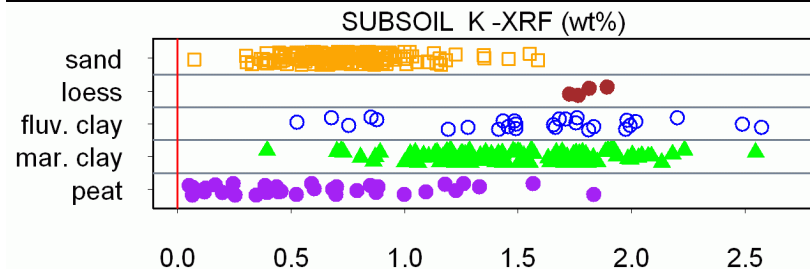
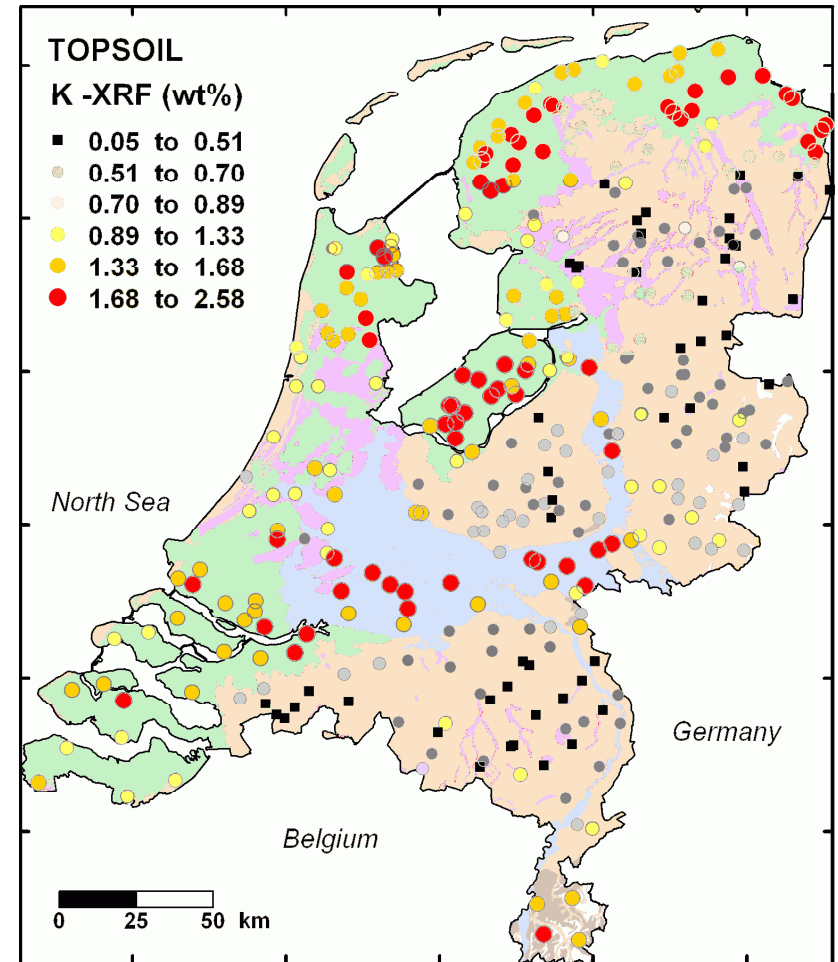
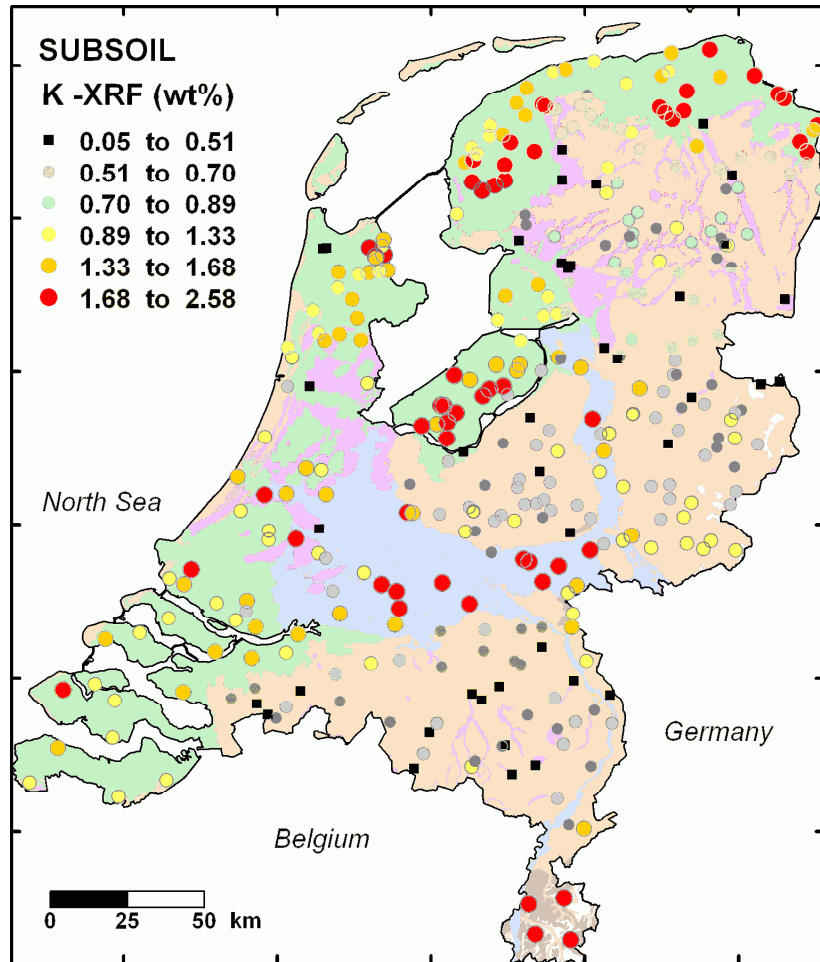
Atomic number: 19	Upper cont. crust: 2.9 / 2.8 wt%	River water: 1500 µg/l
Atomic mass: 39.098	Shale/schist: 2.7 / 2.7 wt%	Ocean water: 390·10 <sup>3</sup> µg/l
Main ox. state(s): +1	Sandstone: 1.1 wt%	Human diet: 2000 mg/kg
Electronegativity (Pauling): 0.82	Limestone: 0.3 wt%	Reference man: 2000 mg/kg
Group: alkali metals	Coal: 0.3 / 0.35 wt%	Yearly production: 20.4·10 <sup>6</sup> t
Affinity: lithophile	Volatility-ratio in coal: -2.4	
Host minerals: K-feldspar (+), micas (+), illite (+), other Al-silicates (+).		
Uses: Fertilizers, alloys, chemical industry, fireworks.		
Remarks: Considered essential for all organisms. Toxic to plants and animals at high levels.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.74	0.71	0.23	0.19	0.07	1.59
loess	4	1.80	1.79	0.07	0.06	1.73	1.89
fluviatile clay	28	1.57	1.66	0.51	0.41	0.53	2.57
marine clay	115	1.48	1.43	0.37	0.39	0.39	2.55
peat	33	0.65	0.59	0.46	0.50	0.05	1.84
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.64	0.65	0.18	0.16	0.24	1.42
loess	4	1.63	1.64	0.09	0.07	1.50	1.72
fluviatile clay	28	1.56	1.62	0.49	0.50	0.62	2.27
marine clay	115	1.57	1.62	0.30	0.29	0.52	2.13
peat	33	0.97	1.00	0.53	0.64	0.07	1.99

Concentrations are in wt% and based on 105 °C dry weight



# K - Potassium

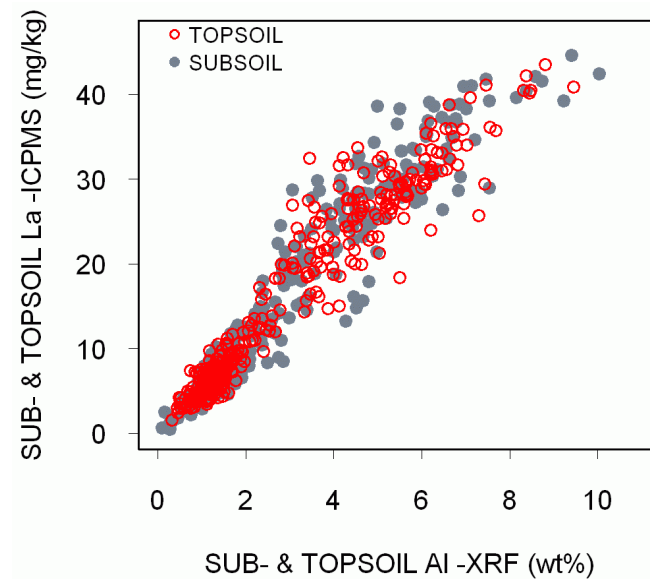
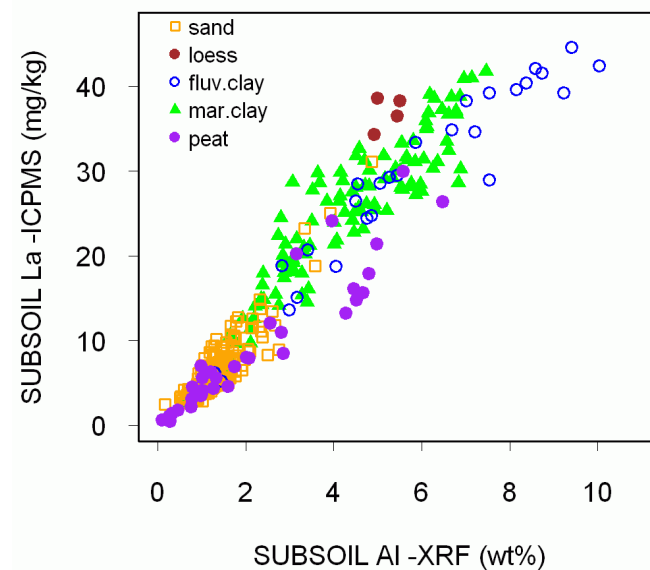


# La - Lanthanum

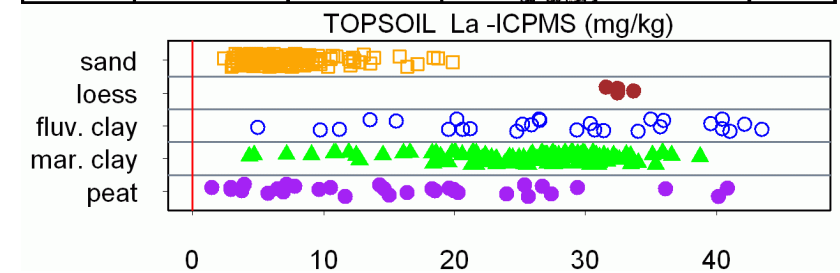
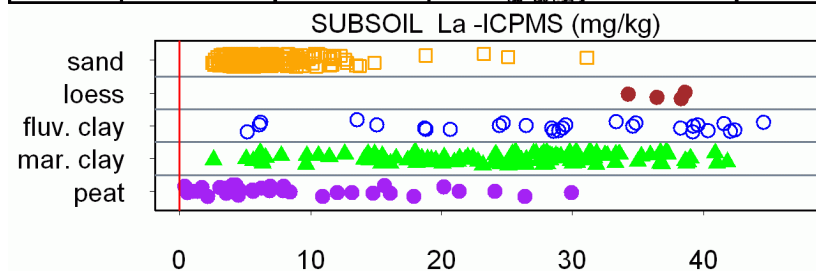
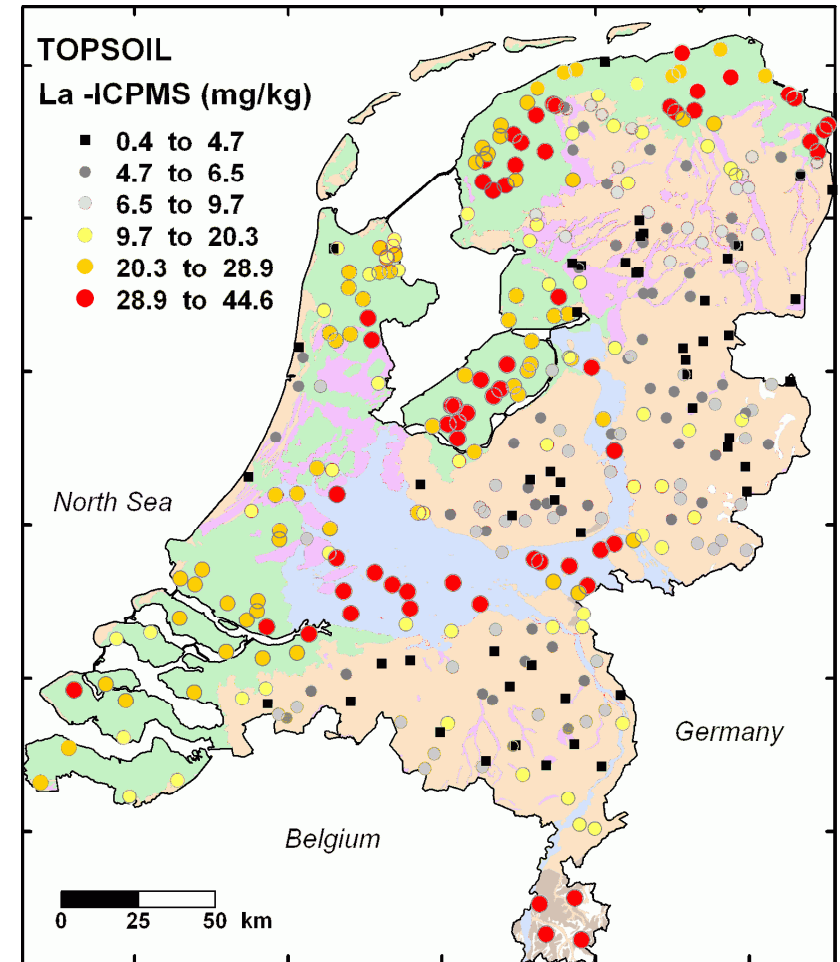
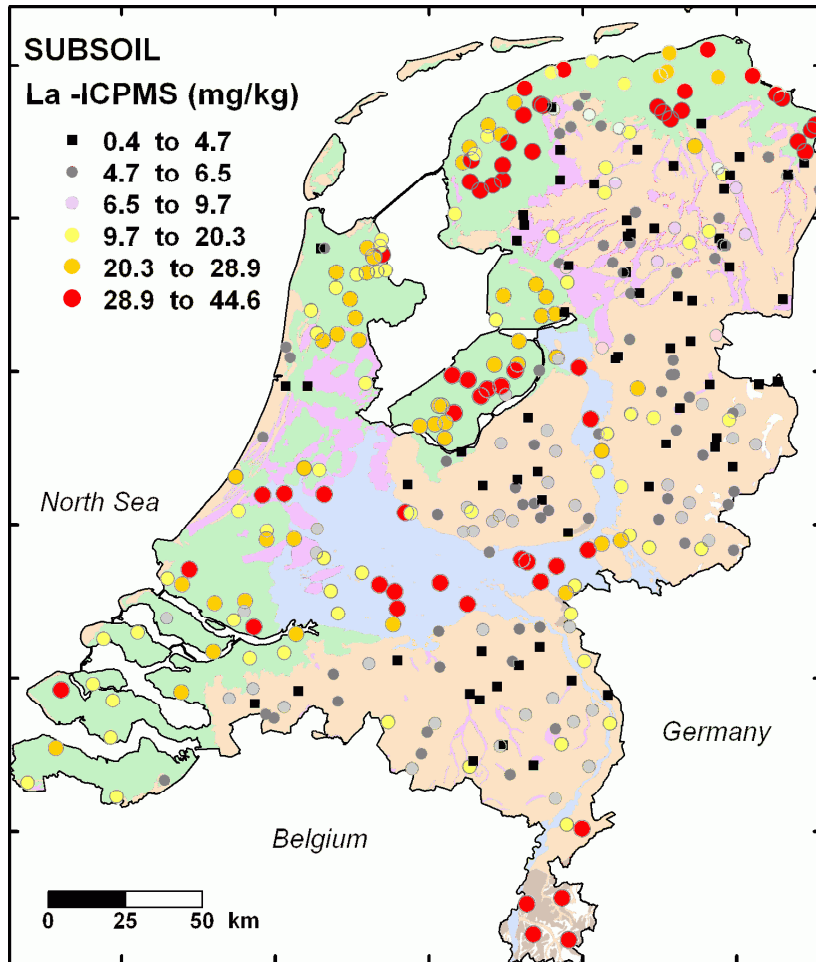
Atomic number: 57	Upper cont. crust: 32 / 30 mg/kg	River water: 0.05 µg/l
Atomic mass: 138.905	Shale/schist: 43 / 40 mg/kg	Ocean water: 0.006 µg/l
Main ox. state(s): +3	Sandstone: 20 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.1	Limestone: 6 mg/kg	Reference man: ?
Group: lanthanides	Coal: 5 / 10 mg/kg	Yearly production: 54·10 <sup>3</sup> t (REE-minerals)
Affinity: lithophile	Volatility-ratio in coal: -9.6	
Host minerals: Monazite (+), zircon (-), biotite (-), apatite (-), pyroxenes (-), feldspars (-).		
Uses: Superconductors, catalysts, glass additives, glass polishing, fiber optics, ceramics, batteries.		
Remarks: Considered non-essential, little is known about its toxicity.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	6.80	5.83	3.76	2.37	2.49	31.1
loess	4	36.9	37.4	2.00	1.59	34.3	38.6
fluviatile clay	28	28.4	29.1	11.7	15.0	5.20	44.6
marine clay	115	24.5	26.1	9.13	8.76	2.59	41.8
peat	33	9.50	6.88	8.03	6.97	0.43	29.95
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	6.89	6.15	3.09	2.34	2.42	19.9
loess	4	32.6	32.5	0.86	0.66	31.6	33.7
fluviatile clay	28	27.7	28.0	10.6	11.5	5.02	43.5
marine clay	115	25.6	27.1	6.73	5.74	4.33	38.7
peat	33	16.3	15.0	11.0	12.6	1.51	40.8

Concentrations are in mg/kg and based on 105 °C dry weight



# La - Lanthanum

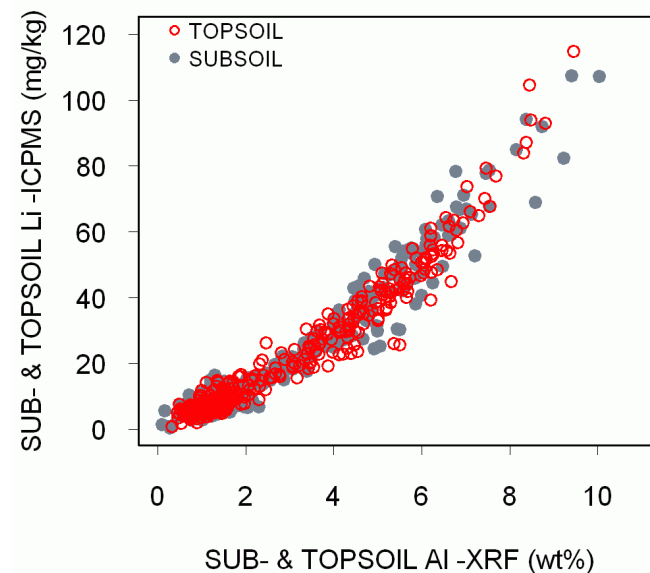
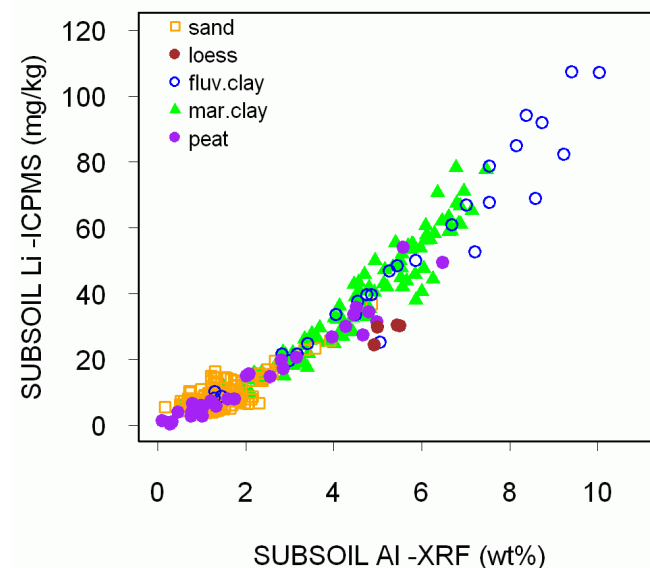


# Li - Lithium

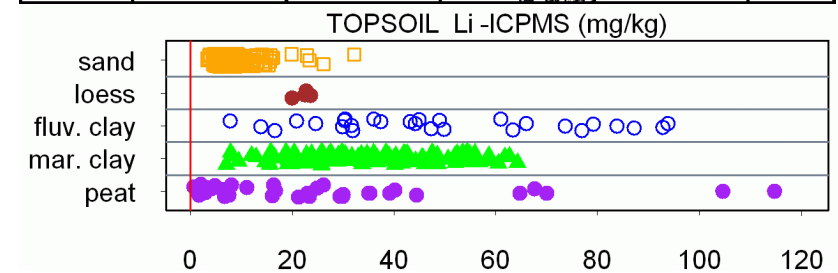
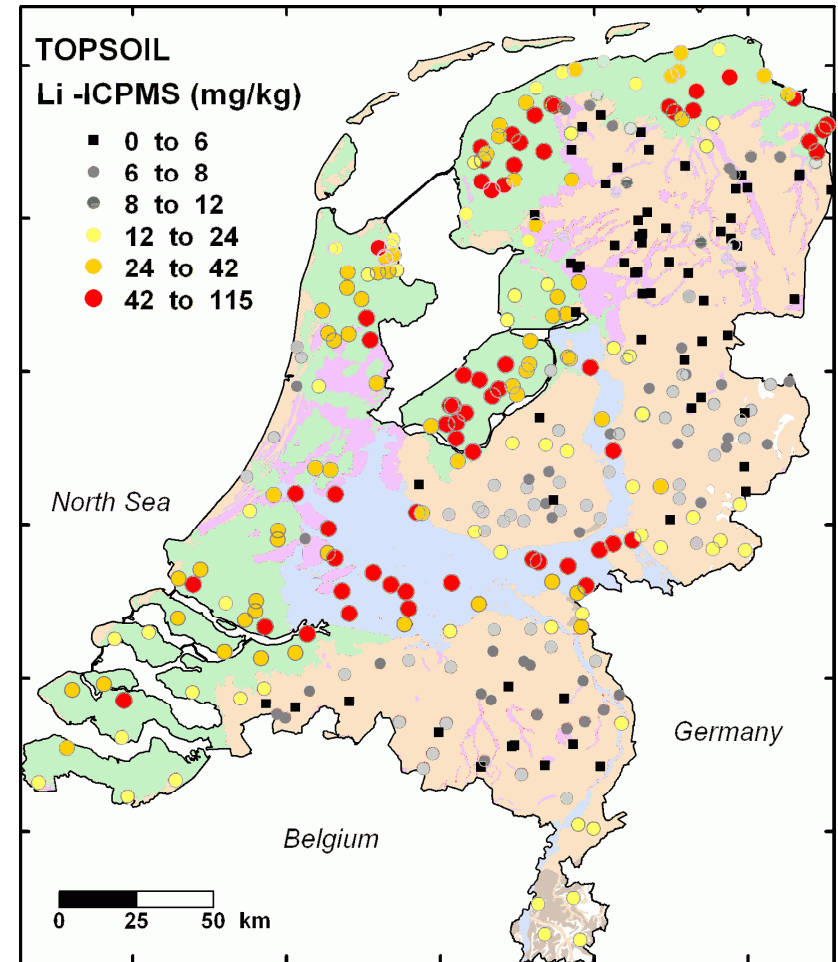
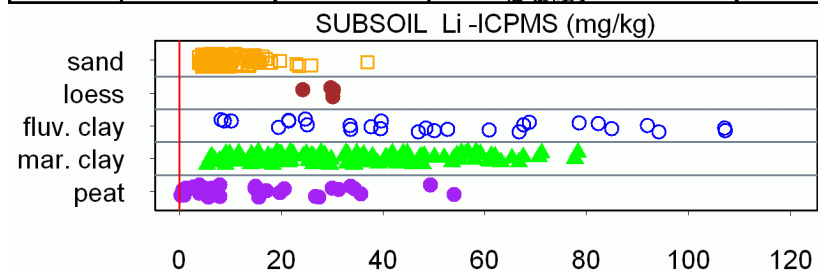
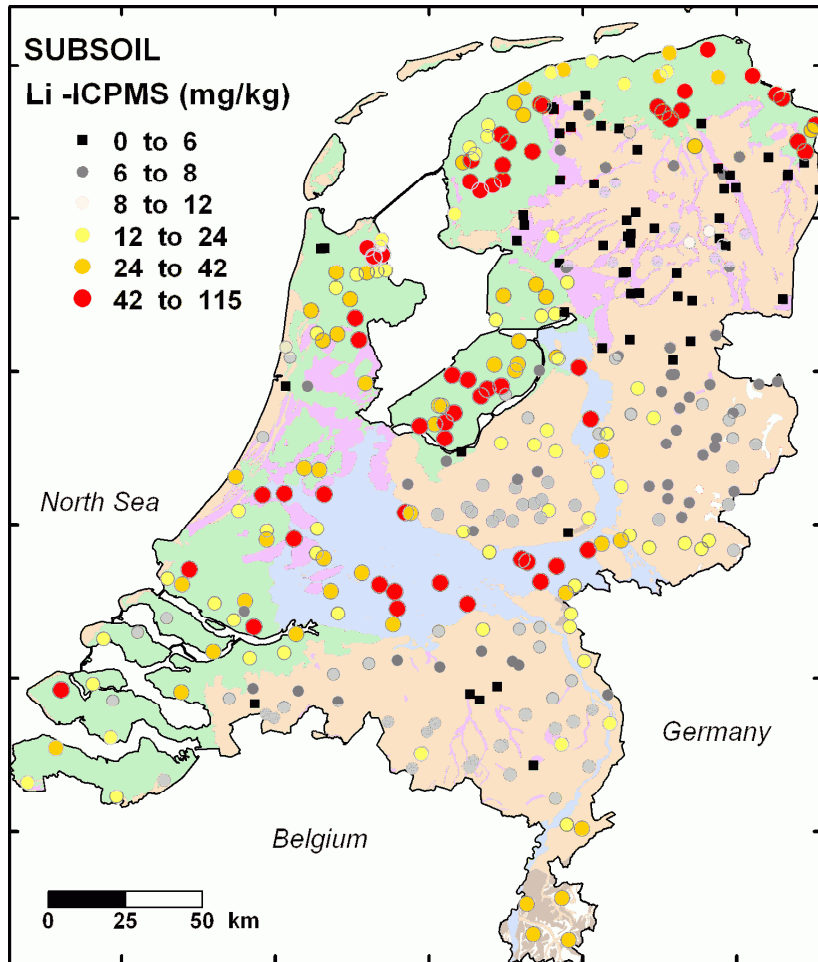
Atomic number: 3	Upper cont. crust: 22 / 20 mg/kg	River water: 12 µg/l
Atomic mass: 6.941	Shale/schist: 66 / 60 mg/kg	Ocean water: 180 µg/l
Main ox. state(s): +1	Sandstone: 10 mg/kg	Human diet: 0.08 mg/kg
Electronegativity (Pauling): 0.98	Limestone: 5 mg/kg	Reference man: ?
Group: alkali metals	Coal: 10 / 30 mg/kg	Yearly production: 9550 t (REE-minerals)
Affinity: lithophile	Volatility-ratio in coal: 1.3	
Host minerals: Spodumene (+), lepidolite (+) and other micas (biotite, -), amphiboles (-).		
Uses: Glass, ceramics, Al-production (flux), specific alloys (with Pb and Al), batteries, electrodes, lubricants, greases, cooling agent in nuclear reactors, pharmaceuticals.		
Remarks: Considered essential, toxicity considered low.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	8.72	7.71	4.22	1.96	3.81	36.8
loess	4	28.7	30.0	2.90	0.43	24.3	30.3
fluviatile clay	28	51.2	47.7	29.9	33.7	8.23	107
marine clay	115	34.8	32.9	18.7	21.8	5.40	78.3
peat	33	15.4	7.99	14.6	10.4	0.33	54.0
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	8.49	7.46	4.02	2.35	3.25	32.1
loess	4	22.2	22.6	1.57	0.84	20.0	23.7
fluviatile clay	28	48.9	44.6	25.1	26.2	7.81	93.9
marine clay	115	35.8	36.2	14.0	16.2	6.98	64.2
peat	33	28.3	23.0	28.4	24.0	0.71	115

Concentrations are in mg/kg and based on 105 °C dry weight



# Li - Lithium

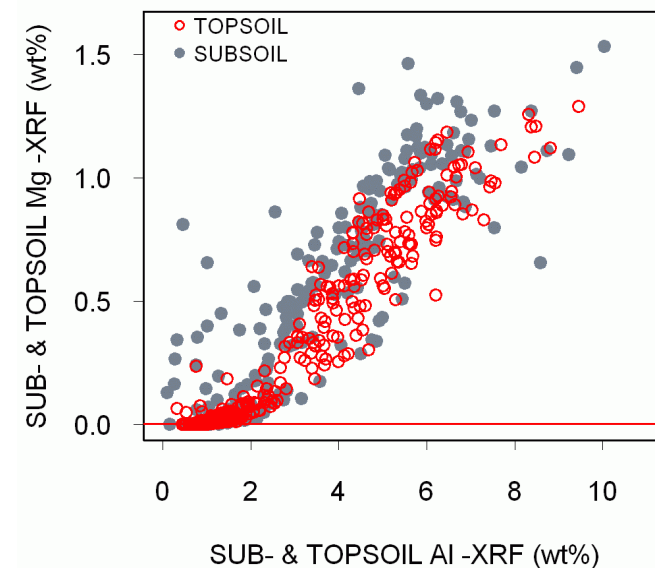
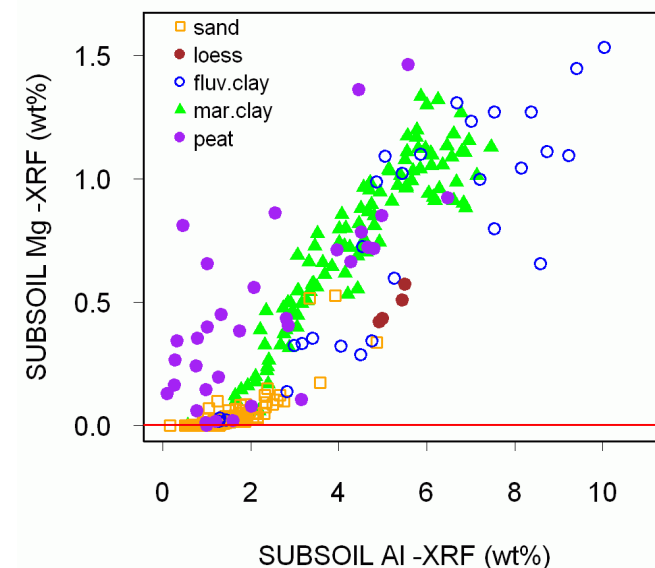


# Mg - Magnesium

Atomic number: 12	Upper cont. crust: 1.4 / 1.3 wt%	River water: $3.1 \cdot 10^3$ µg/l
Atomic mass: 24.305	Shale/schist: 1.5 / 1.6 wt%	Ocean water: $1.3 \cdot 10^6$ µg/l
Main ox. state(s): +2	Sandstone: 0.7 wt%	Human diet: 180 mg/kg
Electronegativity (Pauling): 1.31	Limestone: 0.4 wt%	Reference man: 270 mg/kg
Group: alkaline earth metals	Coal: 0.2 / 0.3 wt%	Yearly production: $311 \cdot 10^3$ t
Affinity: lithophile	Volatility-ratio in coal: -4.6	
Host minerals: Brucite (+), magnesite (+), dolomite (+), many Al-silicates (+) such as olivine, pyroxenes, amphiboles, biotite, chlorite, various clay minerals, garnets, spinels.		
Uses: Many alloys (e.g. with Al), fertilizers, fire resistant materials, reduction agent, anti-corrosion agent, special cements.		
Remarks: Considered essential for all organisms. Mg deficiency is much more widespread than Mg toxicity problems.		

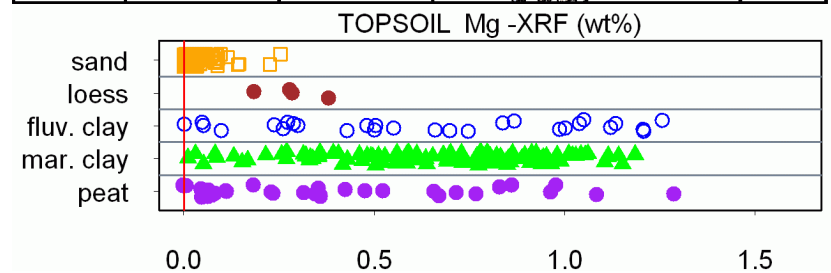
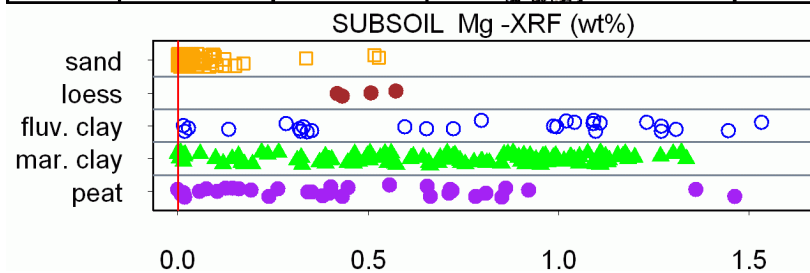
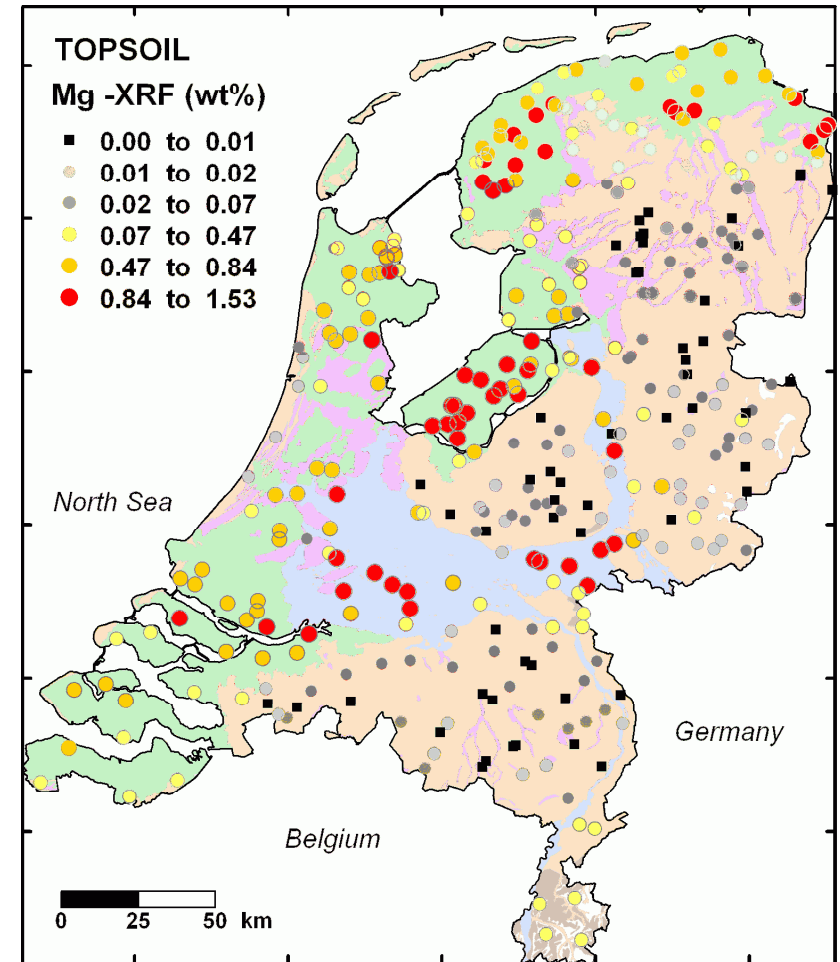
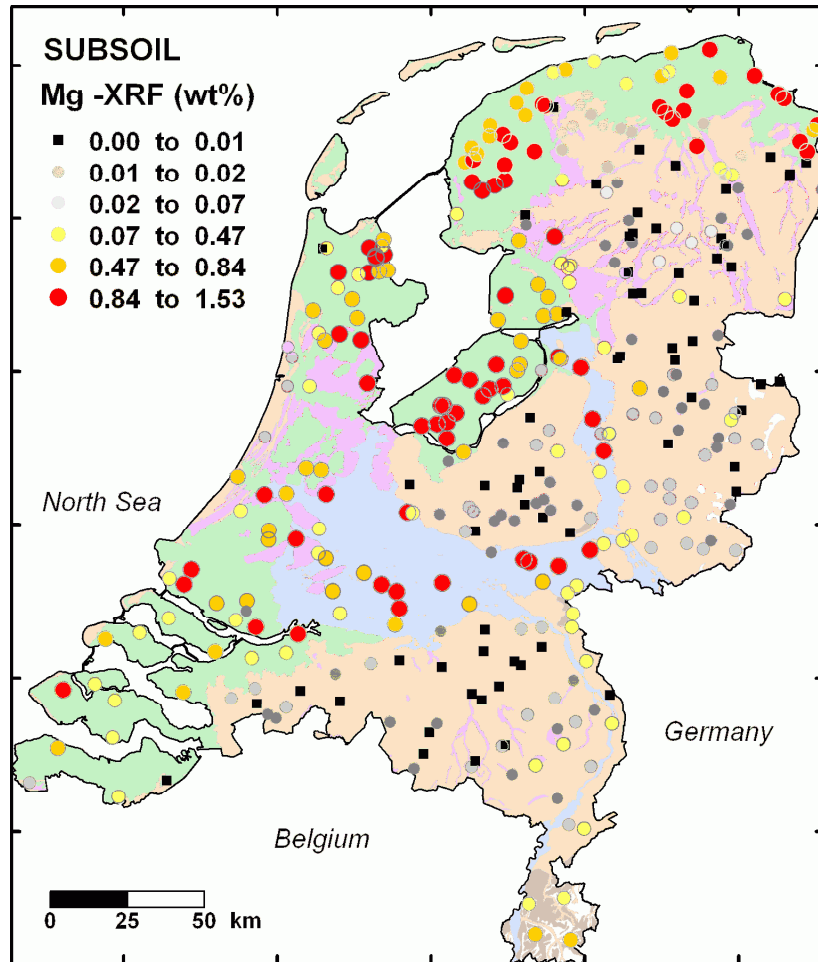
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.029	0.013	0.064	0.015	<0.001	0.53
loess	4	0.48	0.47	0.071	0.066	0.42	0.57
fluviatile clay	28	0.77	0.89	0.47	0.56	0.015	1.53
marine clay	115	0.71	0.74	0.36	0.39	<0.001	1.33
peat	33	0.46	0.40	0.38	0.43	0.001	1.46
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.024	0.013	0.035	0.016	<0.001	0.25
loess	4	0.28	0.28	0.08	0.075	0.19	0.38
fluviatile clay	28	0.64	0.61	0.40	0.53	0.002	1.26
marine clay	115	0.67	0.73	0.28	0.27	0.011	1.18
peat	33	0.40	0.35	0.36	0.42	<0.001	1.29

Concentrations are in wt% and based on 105 °C dry weight





# Mg - Magnesium

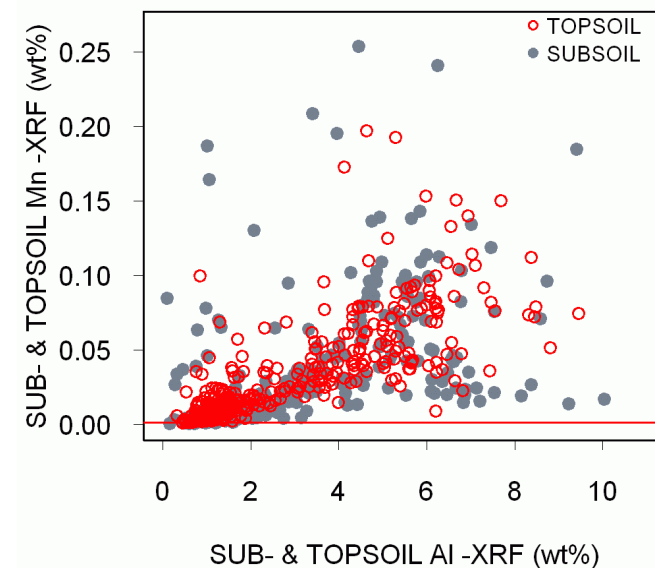
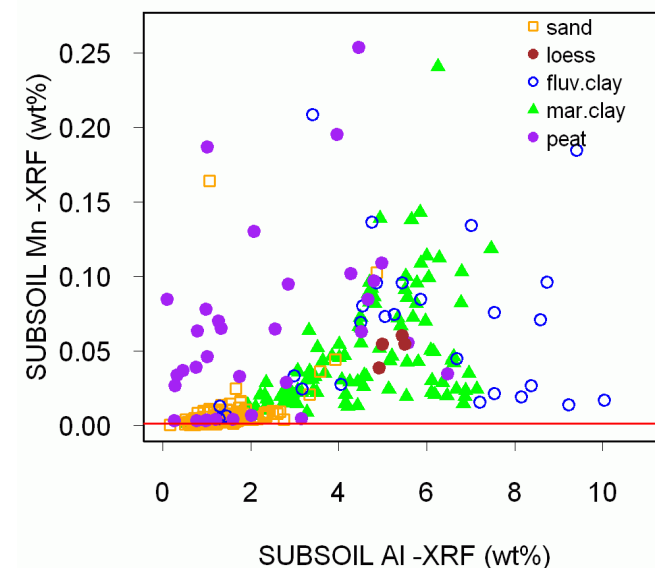


# Mn - Manganese

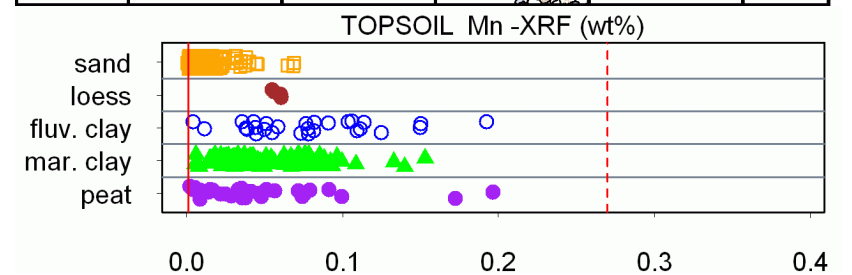
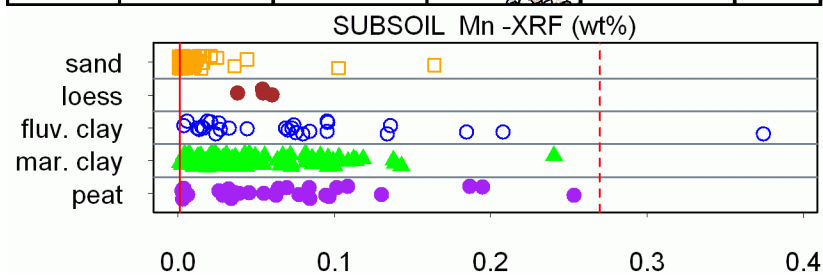
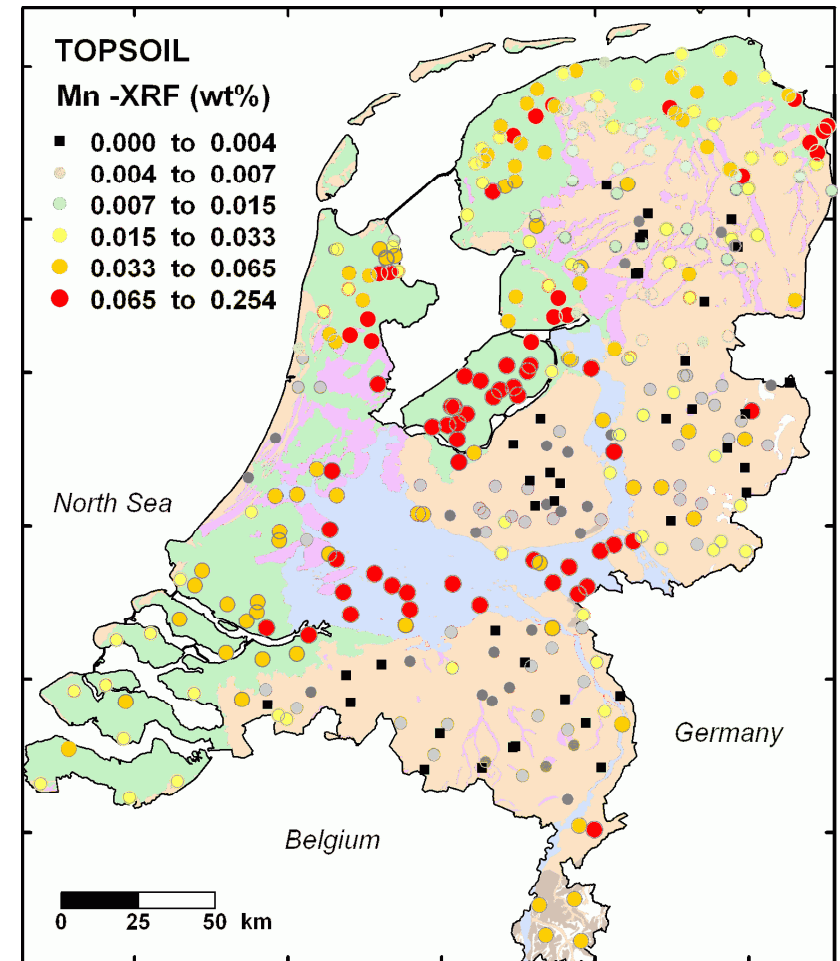
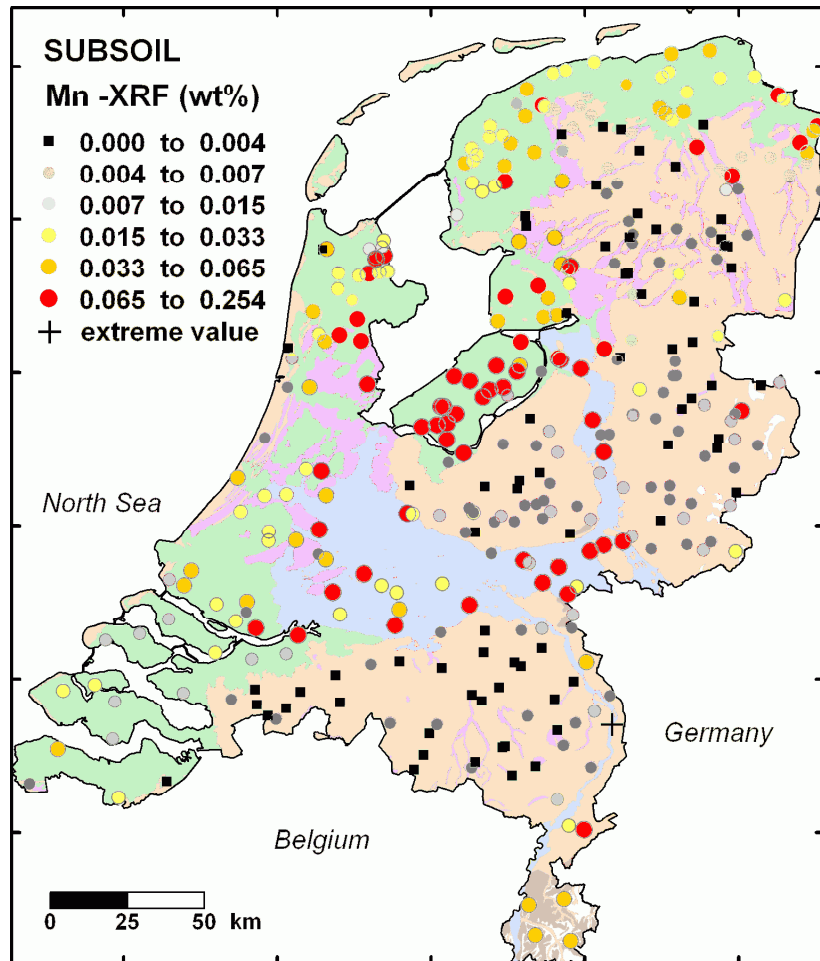
Atomic number: 25	Upper cont. crust: 0.053 / 0.06 wt%	River water: 8.2 µg/l
Atomic mass: 54.938	Shale/schist: 0.085 / 0.085 wt%	Ocean water: 0.072 µg/l
Main ox. state(s): +2, +4 (+1, +3, +5, +6, +7)	Sandstone: 0.01 wt%	Human diet: 2 mg/kg
Electronegativity (Pauling): 1.15	Limestone: 0.07 wt%	Reference man: 0.17 mg/kg
Group: transition metals	Coal: 0.005 / 0.004 wt%	Yearly production: 8.2·10 <sup>6</sup> t
Affinity: lithophile	Volatility-ratio in coal: -5.3	
Host minerals: Pyrolusite (+), hausmannite (+), rhodochrosite (+), garnets (-), olivine (-), pyroxenes (-), amphiboles (-), micas (-), calcite (-), dolomite (-).		
Uses: Steel, alloys (e.g. with Al, Mg, Cu), batteries, catalysts, fertilizers, pigment, wood preservative, fungicide, antiknock agent in gasoline (as replacement for Pb).		
Remarks: Considered essential for all organisms. Mn deficiency is much more widespread than Mn toxicity problems.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.007	0.004	0.015	0.002	<0.001	0.164
loess	4	0.052	0.054	0.009	0.004	0.038	0.060
fluviatile clay	27	0.064	0.069	0.054	0.063	0.004	0.208
marine clay	115	0.044	0.031	0.038	0.024	0.001	0.241
peat	33	0.064	0.055	0.060	0.043	0.003	0.253
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.012	0.010	0.011	0.008	0.001	0.069
loess	4	0.058	0.058	0.003	0.003	0.055	0.061
fluviatile clay	28	0.079	0.077	0.044	0.048	0.004	0.193
marine clay	115	0.051	0.042	0.028	0.026	0.006	0.153
peat	33	0.047	0.036	0.044	0.031	0.002	0.197

Concentrations are in wt% and based on 105 °C dry weight

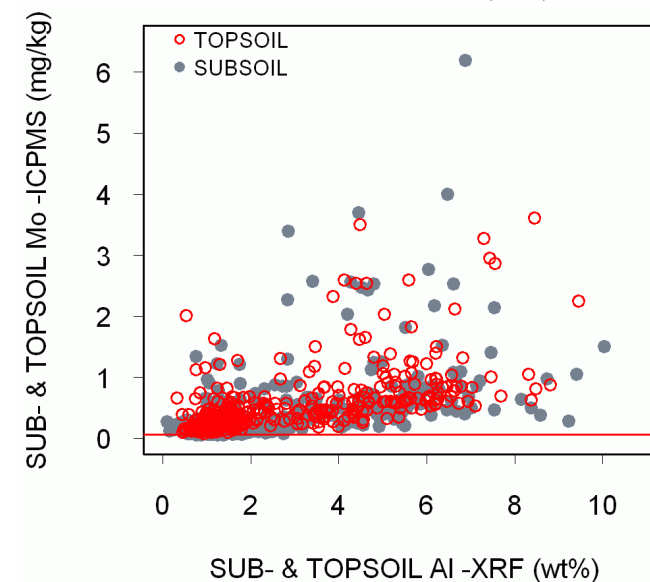
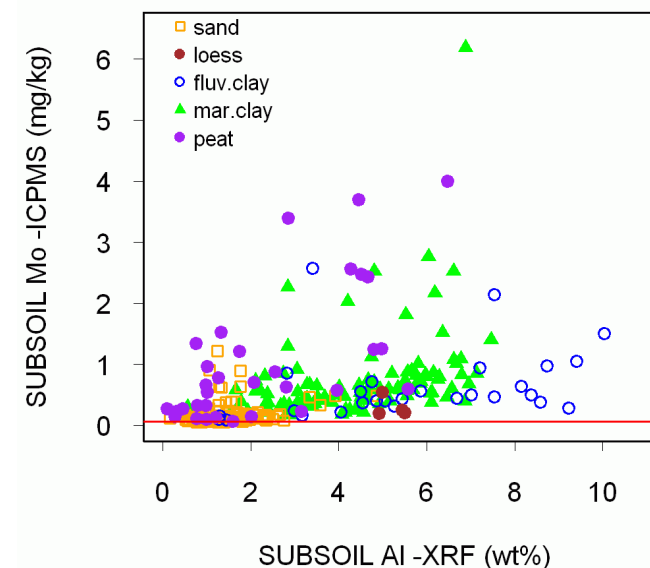


# Mn - Manganese



# Mo - Molybdenum

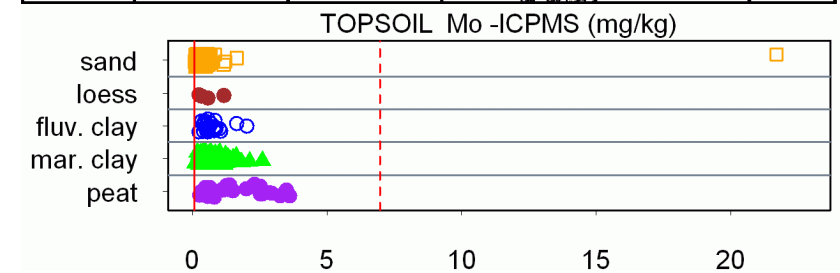
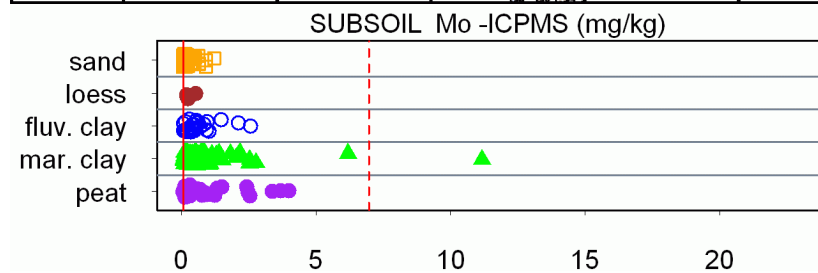
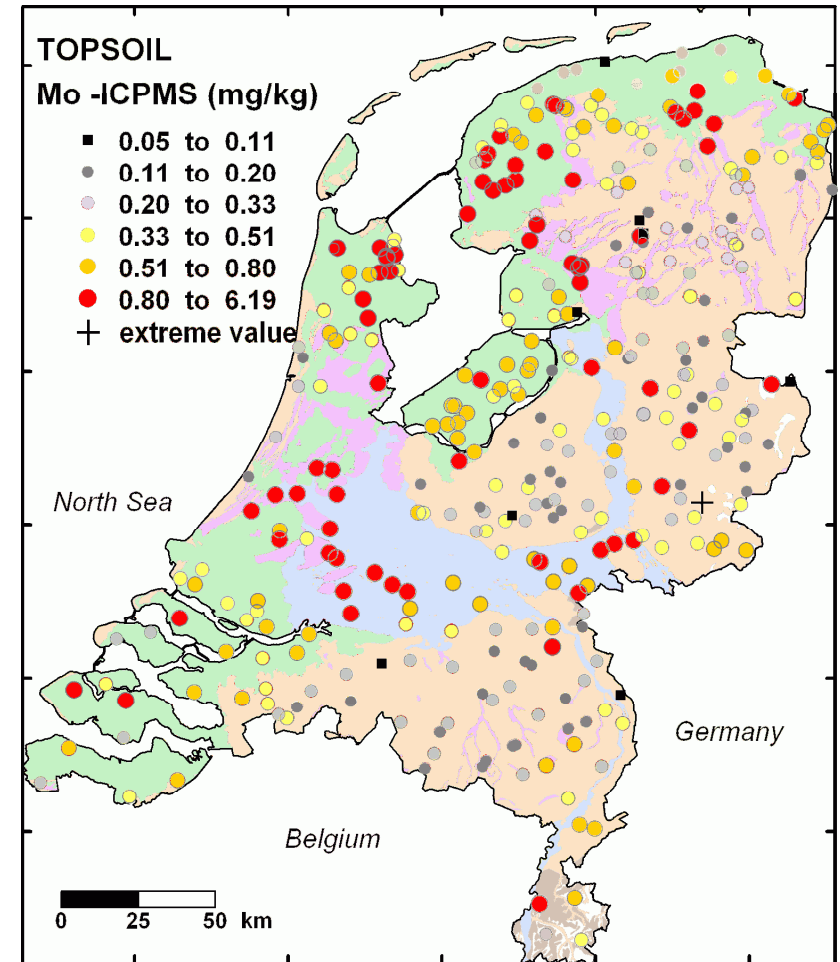
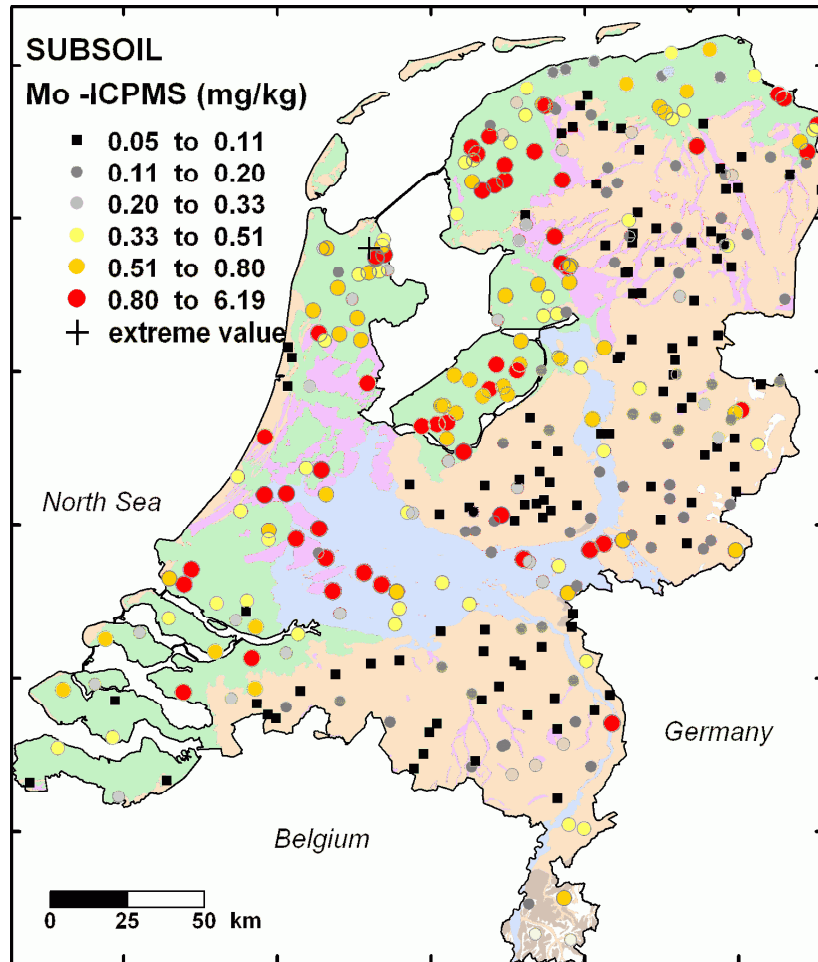
Atomic number: 42	Upper cont. crust: 1.4 / 1.5 mg/kg	River water: 0.5 µg/l
Atomic mass: 95.94	Shale/schist: 2.6 / 2 mg/kg	Ocean water: 10 µg/l
Main ox. state(s): +2, +6 (+3, +4, +5)	Sandstone: 0.3 mg/kg	Human diet: 0.09 mg/kg
Electronegativity (Pauling): 2.16	Limestone: 0.3 mg/kg	Reference man: ?
Group: transition metals	Coal: 3 / 3 mg/kg	Yearly production: 119·10 <sup>3</sup> t
Affinity: chalcophile, siderophile	Volatility-ratio in coal: -0.2	
Host minerals: Molybdenite (+), scheelite (-), wolframite (-), does not substitute into silicates.		
Uses: Alloys, catalysts, anti-corrosion agent, flame retardant, lubricant, pigments, fertilizers.		
Remarks: Considered essential for organisms in small amounts, toxic at higher concentrations.		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.15	0.11	0.15	0.038	0.051	1.22
loess	4	0.29	0.22	0.16	0.033	0.20	0.54
fluviatile clay	28	0.64	0.45	0.58	0.30	0.089	2.57
marine clay	114	0.69	0.54	0.73	0.31	0.080	6.19
peat	33	1.03	0.62	1.10	0.72	0.058	4.00
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	177	0.30	0.26	0.20	0.12	0.077	1.63
loess	4	0.59	0.46	0.42	0.24	0.25	1.18
fluviatile clay	28	0.72	0.60	0.38	0.26	0.26	2.03
marine clay	115	0.69	0.60	0.40	0.27	0.093	2.59
peat	33	1.45	1.12	1.03	0.97	0.29	3.61

Concentrations are in mg/kg and based on 105 °C dry weight

# Mo - Molybdenum

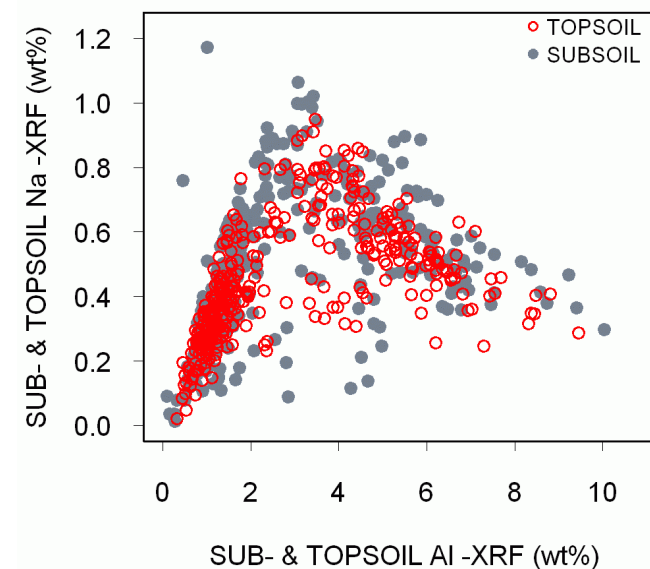
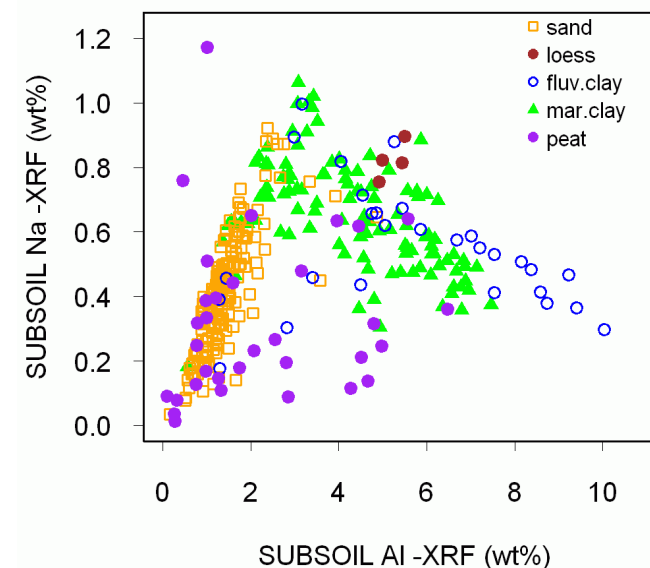


# Na - Sodium

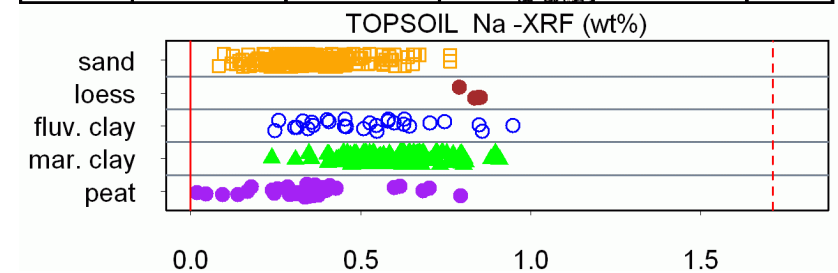
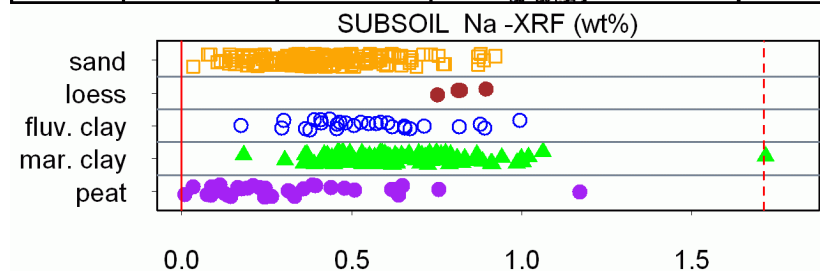
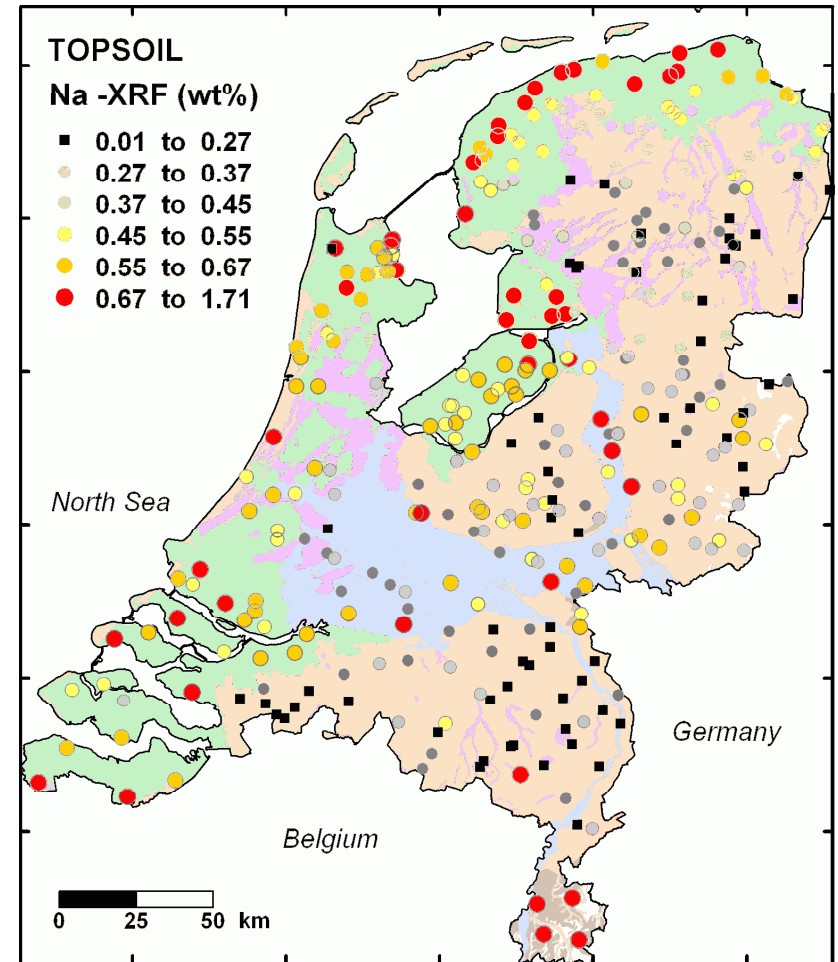
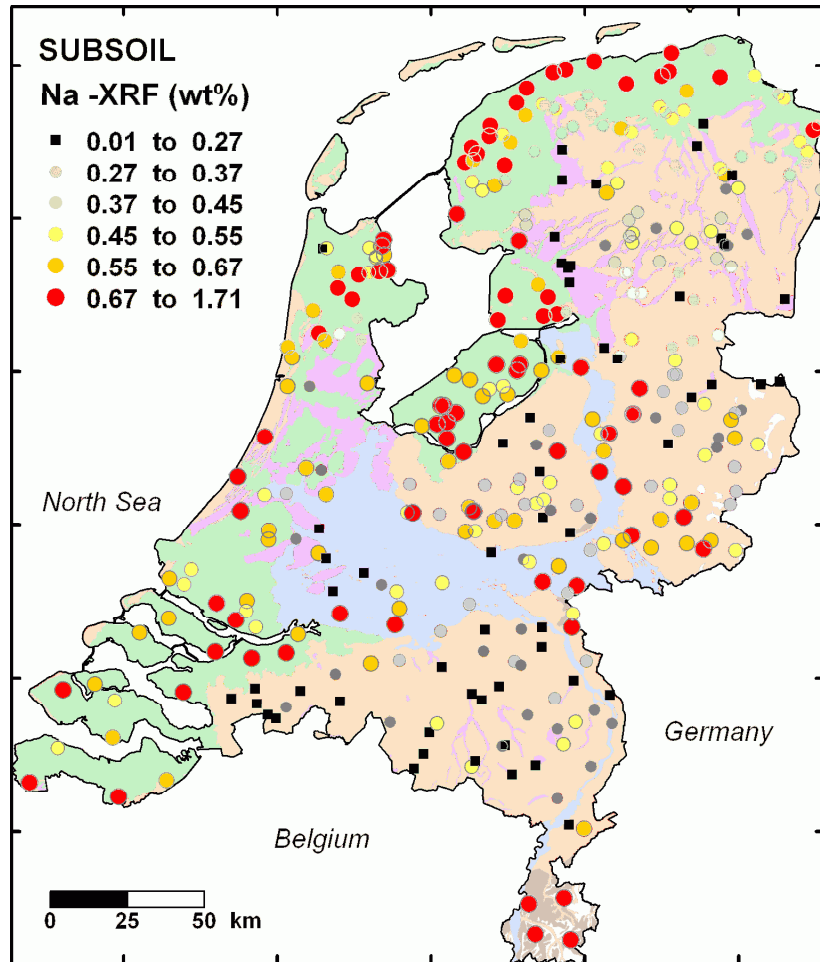
Atomic number: 11	Upper cont. crust: 2.6 / 2.9 wt%	River water: $5.3 \cdot 10^3$ µg/l
Atomic mass: 22.990	Shale/schist: 0.59 / 1.3 wt%	Ocean water: $11 \cdot 10^6$ µg/l
Main ox. state(s): +1	Sandstone: 1.7 wt%	Human diet: $3.4 \cdot 10^3$ mg/kg
Electronegativity (Pauling): 0.93	Limestone: 0.6 wt%	Reference man: $1.4 \cdot 10^3$ mg/kg
Group: alkali metals	Coal: 0.04 / 0.09 wt%	Yearly production: $53 \cdot 10^6$ t
Affinity: lithophile	Volatility-ratio in coal: -0.8	
Host minerals: Albite (+), micas (+), clay minerals (+), plagioclases (+), amphiboles (+), halite (+).		
Uses: Detergents, fertilizers, chemical industry, antiknock agent in gasoline (as replacement for Pb), food additive.		
Remarks: Considered essential for most organisms. Toxic to plants and animals at high levels.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.41	0.40	0.17	0.14	0.034	0.92
loess	4	0.82	0.82	0.06	0.05	0.75	0.89
fluviatile clay	28	0.55	0.52	0.19	0.17	0.17	1.00
marine clay	114	0.64	0.63	0.17	0.18	0.18	1.06
peat	33	0.32	0.25	0.25	0.20	0.011	1.17
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.36	0.34	0.13	0.12	0.083	0.76
loess	4	0.83	0.84	0.03	0.01	0.79	0.85
fluviatile clay	28	0.52	0.52	0.19	0.18	0.25	0.95
marine clay	115	0.59	0.58	0.13	0.12	0.24	0.91
peat	33	0.35	0.35	0.18	0.09	0.020	0.79

Concentrations are in wt% and based on 105 °C dry weight



# Na - Sodium

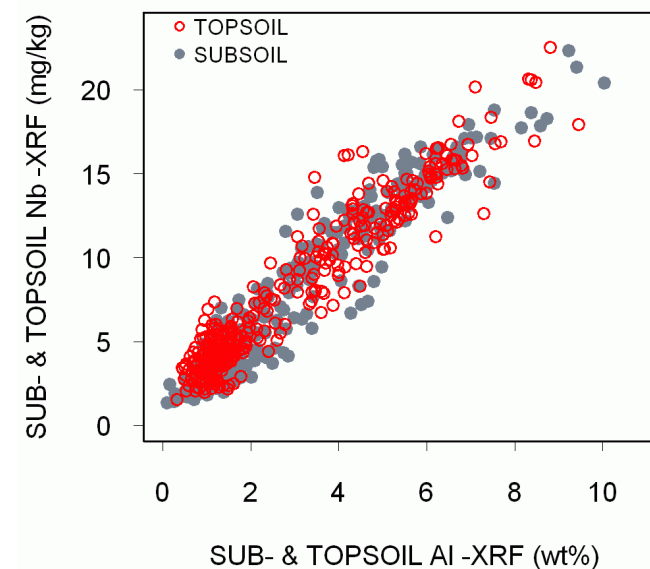
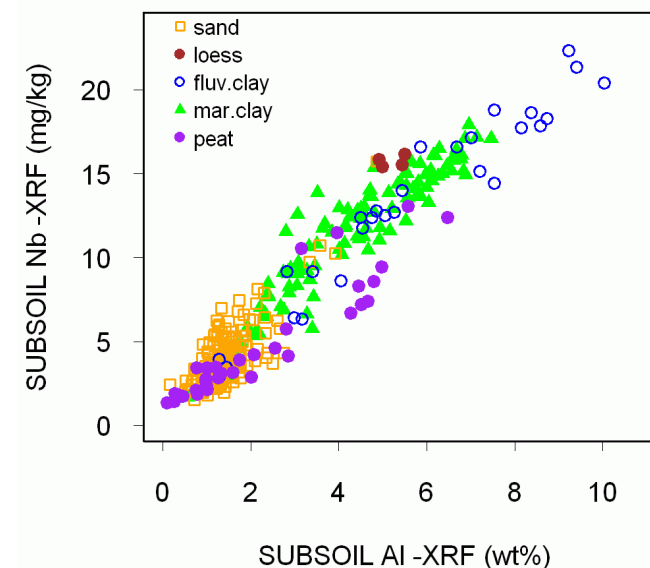


# Nb - Niobium

Atomic number: 41	Upper cont. crust: 26 /25 mg/kg	River water: ?
Atomic mass: 92.906	Shale/schist: 11 / 17 mg/kg	Ocean water: 0.01 µg/l
Main ox. state(s): +5 (+2, +3, +4?)	Sandstone: 10 mg/kg	Human diet: 0.014 mg/kg
Electronegativity (Pauling): 1.6	Limestone: 0.1 mg/kg	Reference man: ?
Group: transition metals	Coal: 10 / 2 mg/kg	Yearly production: 18·10 <sup>3</sup> t (Nb-Ta)
Affinity: lithophile	Volatility-ratio in coal: -5.3	
Host minerals: pyrochlore (+), columbite-tantalite (+), rutile (-), ilmenite (-), sphene (-), biotite (-), zircon (-)		
Uses: Alloys (e.g. stainless steel), welding, nuclear industry.		
Remarks: Considered non-essential for humans and plants. Little is known about its toxicity.		

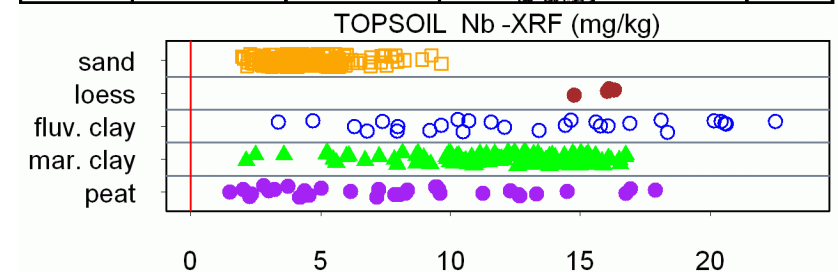
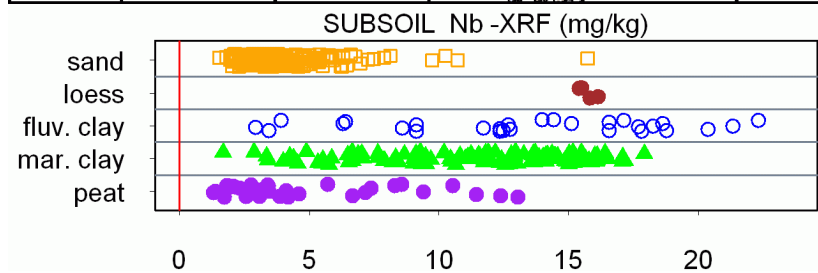
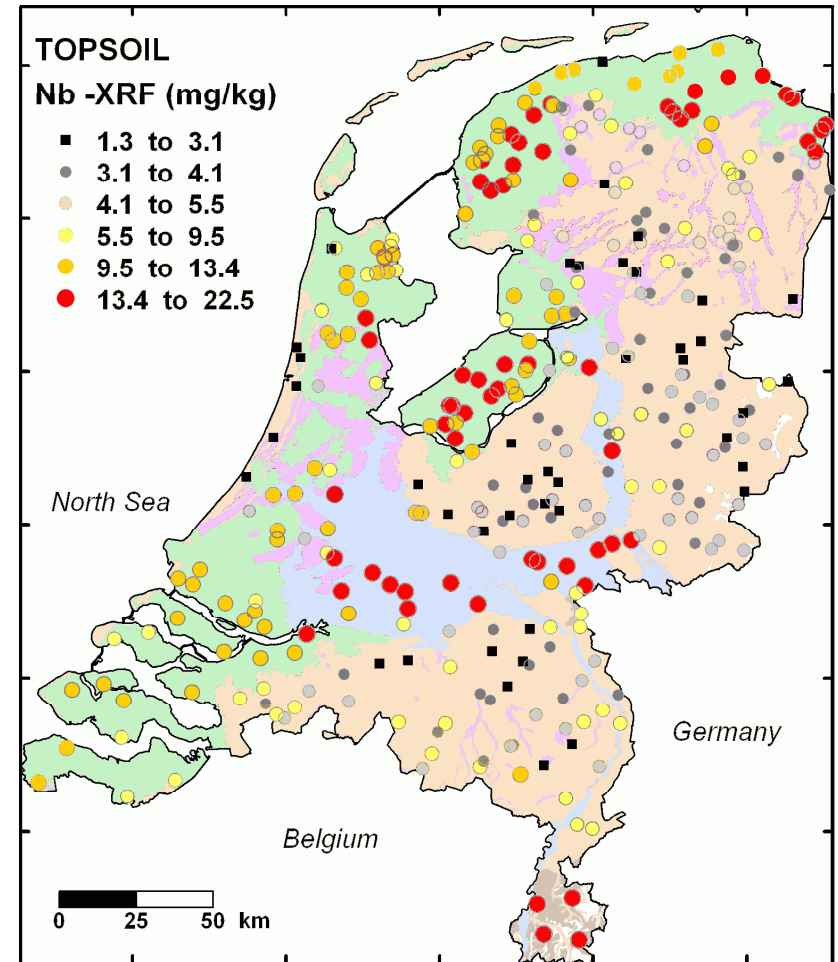
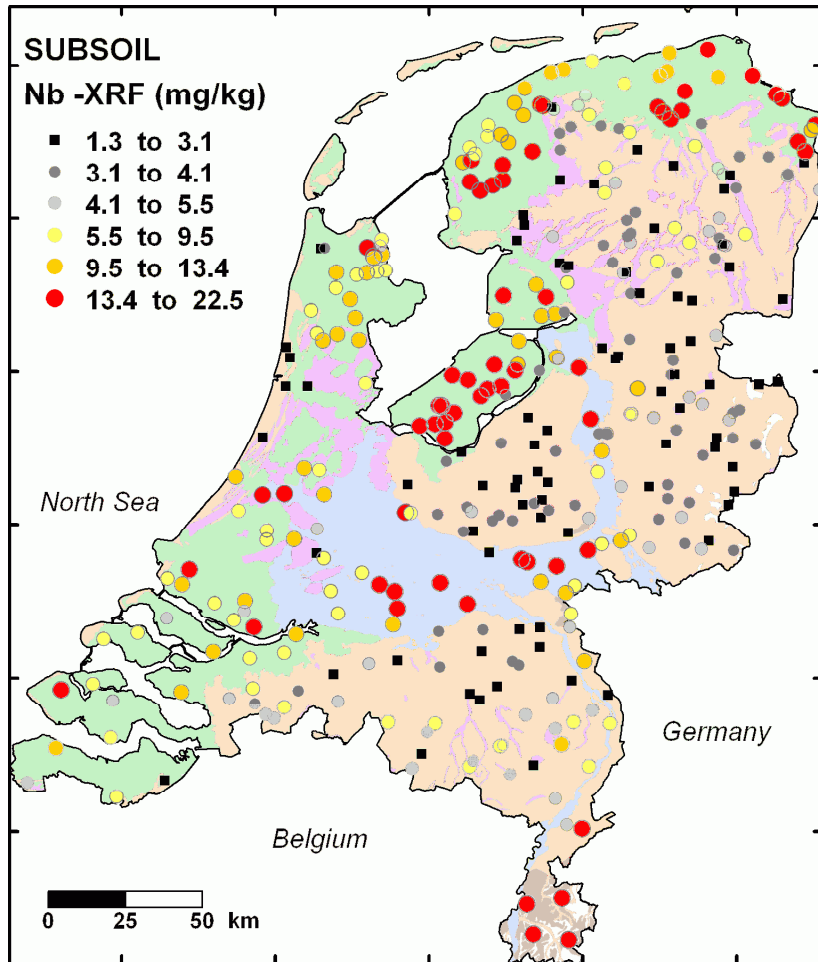
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	3.99	3.58	1.77	1.18	1.54	15.7
loess	4	15.7	15.7	0.33	0.32	15.4	16.1
fluviatile clay	28	13.3	13.4	5.48	6.36	2.94	22.3
marine clay	115	11.2	11.8	3.87	4.10	1.68	17.9
peat	33	4.90	3.42	3.43	2.30	1.32	13.1
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	4.39	4.20	1.45	1.27	1.98	9.65
loess	4	15.8	16.09	0.70	0.18	14.8	16.3
fluviatile clay	28	13.1	12.75	5.39	6.61	3.38	22.5
marine clay	115	11.9	12.47	3.10	2.83	2.14	16.7
peat	33	7.97	7.87	4.70	5.45	1.52	17.9

Concentrations are in mg/kg and based on 105 °C dry weight





# Nb - Niobium

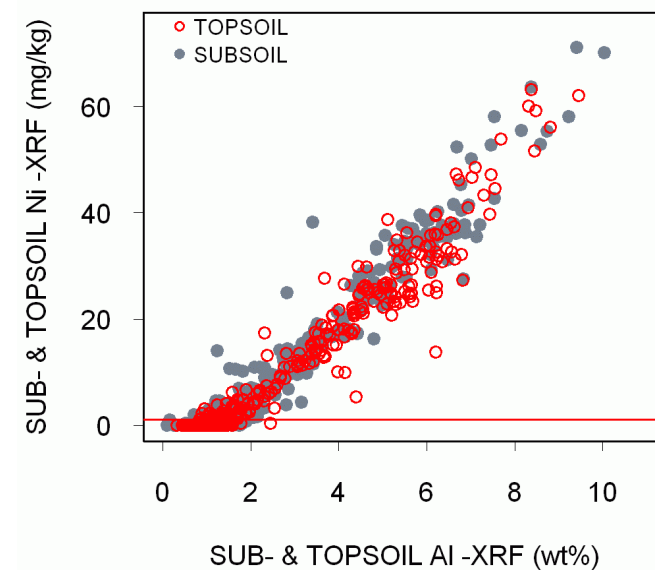
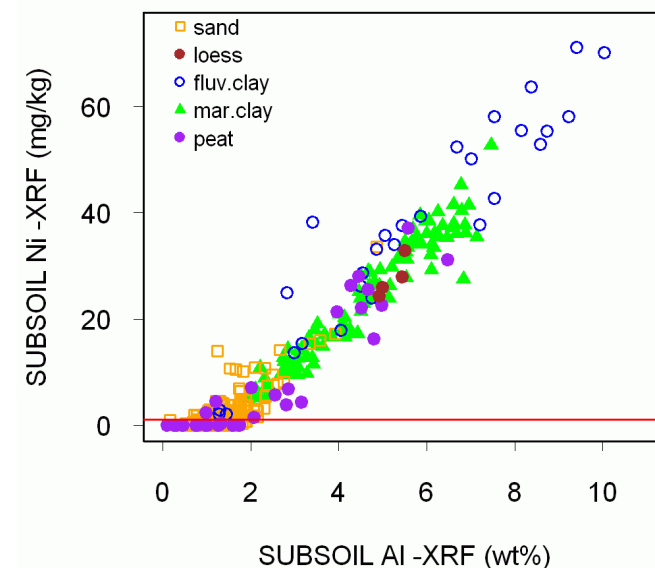


# Ni - Nickel

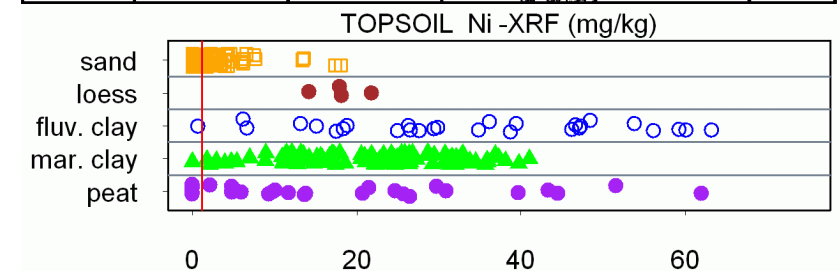
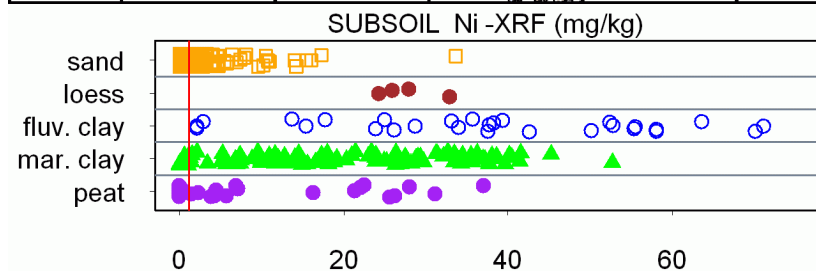
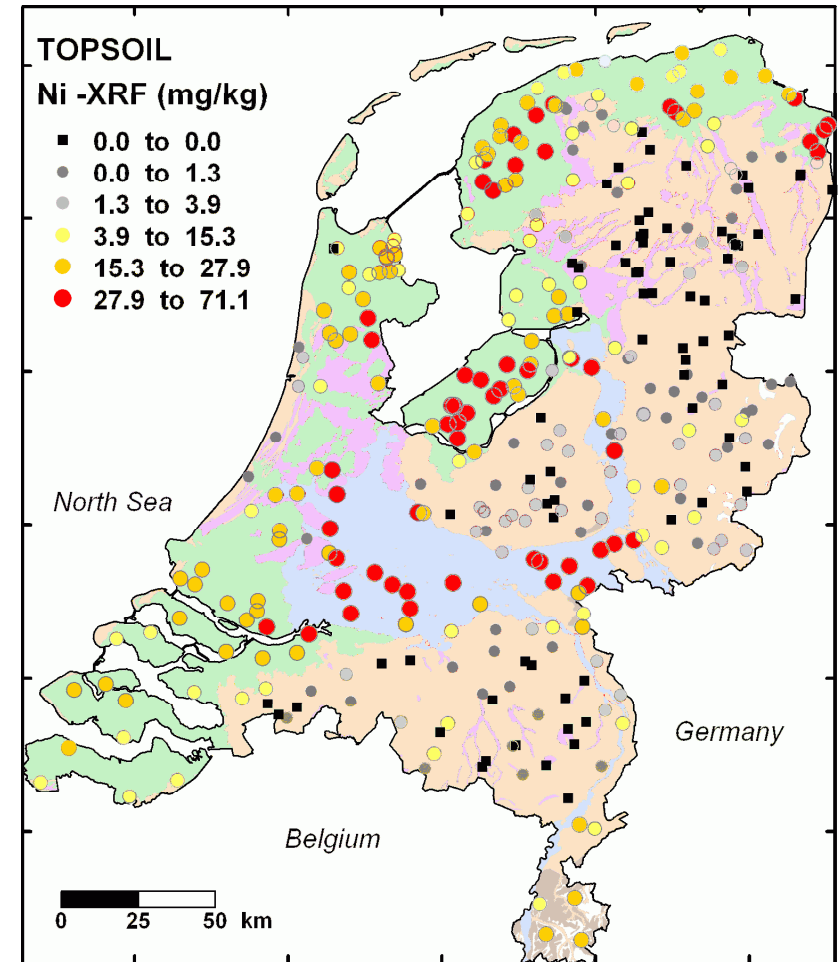
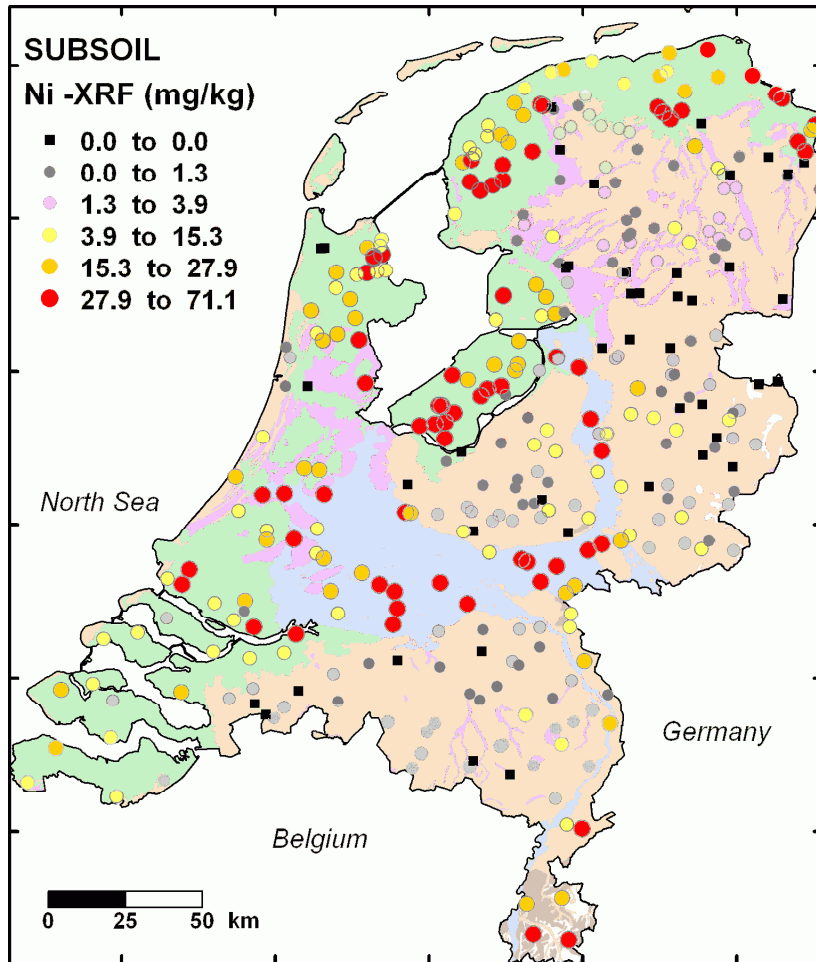
Atomic number: 28	Upper cont. crust: 19 / 20 mg/kg	River water: 0.5 µg/l
Atomic mass: 58.693	Shale/schist: 50 / 70 mg/kg	Ocean water: 0.53 µg/l
Main ox. state(s): +2 (-1, 0, +1, +3, +4)	Sandstone: 2.0 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.91	Limestone: 5.0 mg/kg	Reference man: 0.14 mg/kg
Group: transition metals	Coal: 10 / 20 mg/kg	Yearly production: 1.0·10 <sup>6</sup> t
Affinity: chalcophile, siderophile	Volatility-ratio in coal: -2.4	
Host minerals: Pentlandite and other Ni-sulphides (+), olivine (-), pyroxenes (-), amphiboles (-), micas (-), garnets (-), pyrite (-).		
Uses: Many different alloys (>3000), electroplating, batteries, pigments, catalysts (e.g. in margarine production), magnetic tapes.		
Remarks: Essential for some organisms. Ni <sup>2+</sup> compounds are relatively non-toxic, whereas other Ni-compounds are extremely toxic and/or carcinogenic. Environmental legislation for soils in the Netherlands (background: 35 mg/kg, remediate: 210 mg/kg).		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	2.40	1.28	3.99	1.69	<0.001	33.6
loess	4	27.8	26.9	3.75	2.71	24.3	32.9
fluvatile clay	28	37.3	37.6	19.9	22.1	2.12	71.1
marine clay	115	21.5	20.3	12.6	15.9	<0.001	52.7
peat	33	8.08	1.44	11.5	2.14	<0.001	37.1
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.47	0.48	2.68	0.71	<0.001	18.0
loess	4	18.0	18.0	3.11	2.91	14.2	21.8
fluvatile clay	28	33.5	32.4	17.6	21.5	0.68	63.2
marine clay	115	22.3	23.3	9.18	11.0	0.005	41.0
peat	33	15.5	9.86	17.3	14.6	<0.001	62.0

Concentrations are in mg/kg and based on 105 °C dry weight



# Ni - Nickel

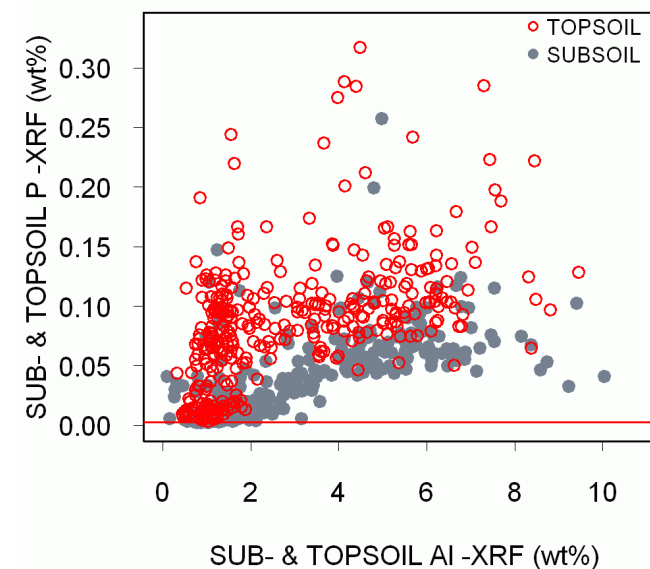
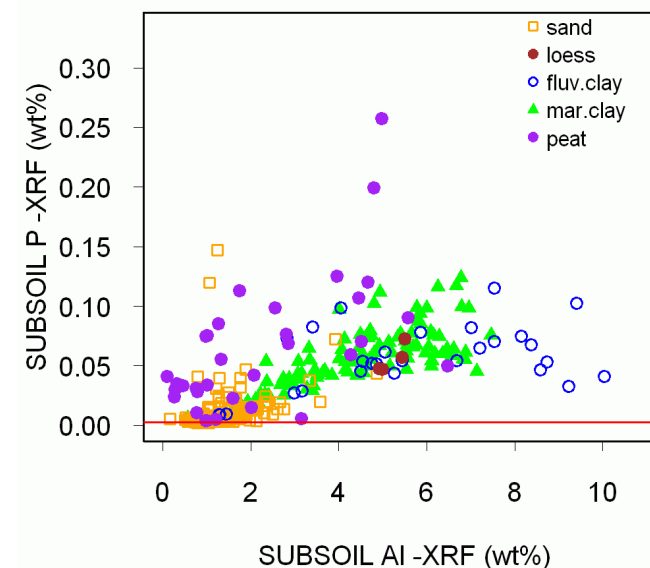


# P - Phosphorus

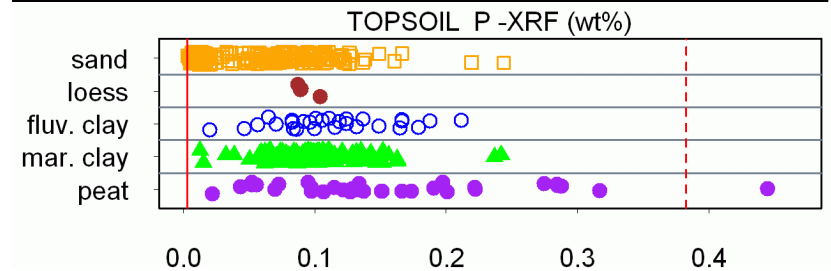
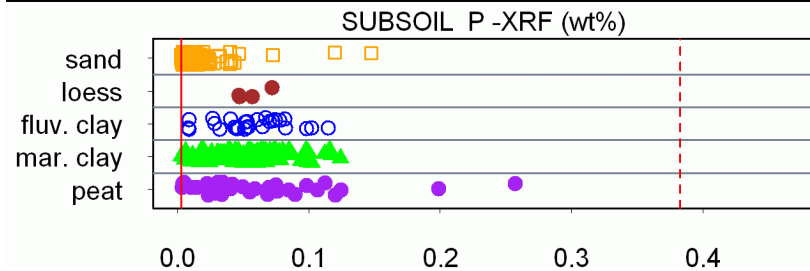
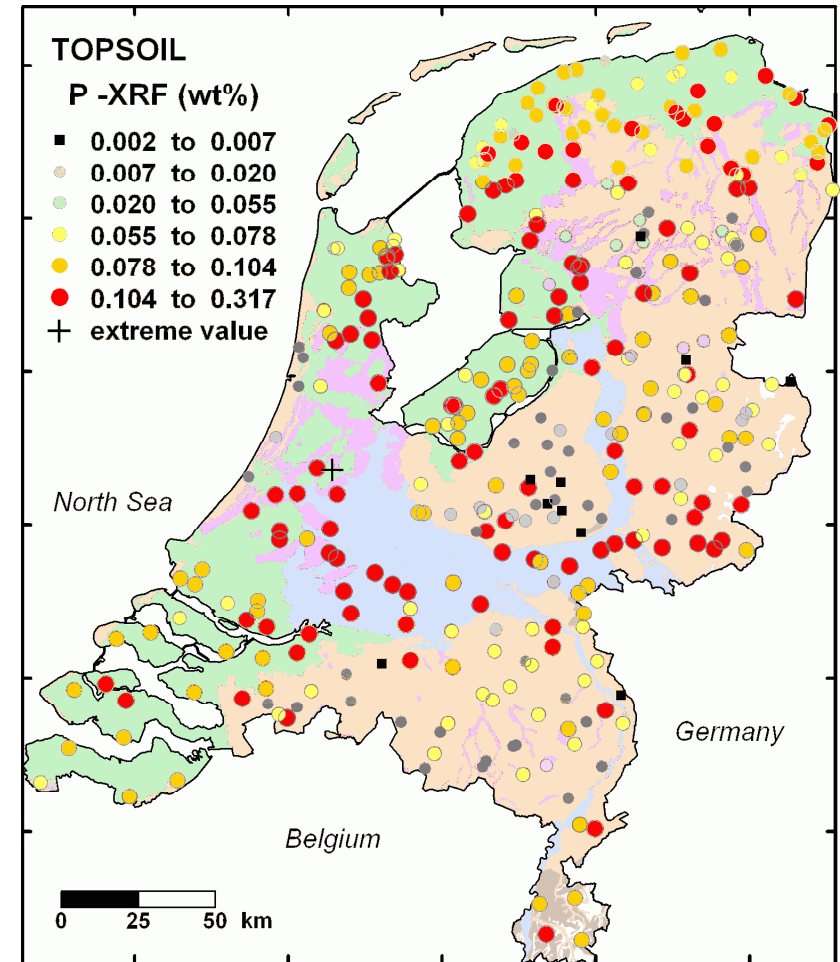
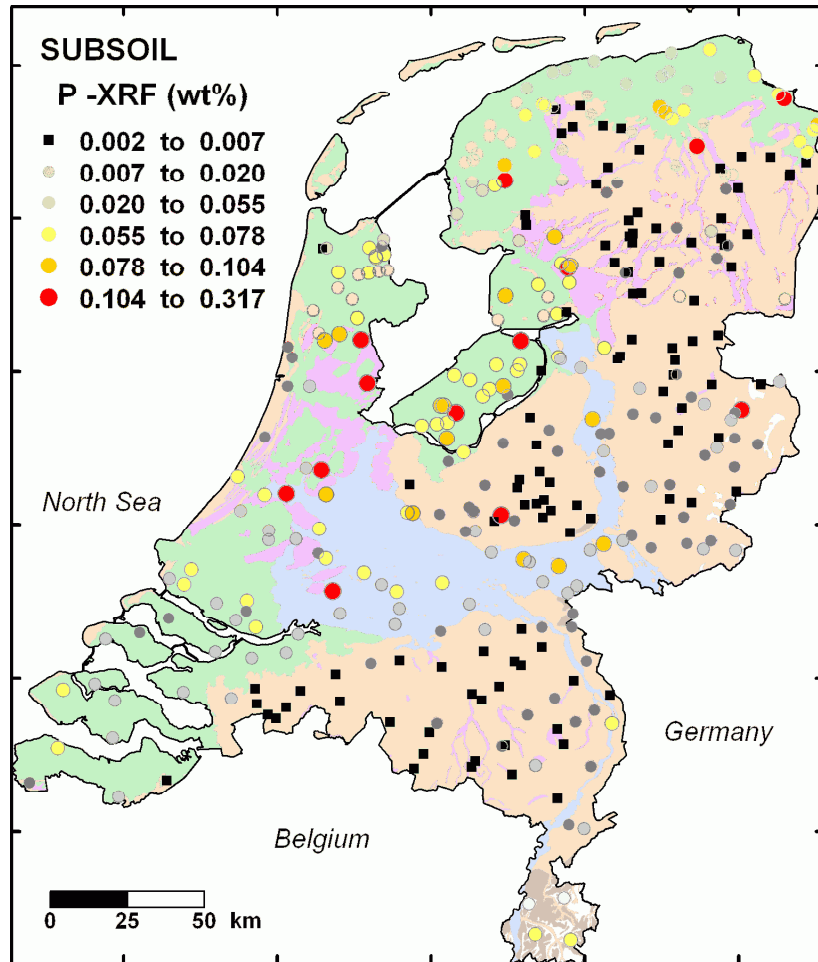
Atomic number: 15	Upper cont. crust: 0.067 / 0.07 wt%	River water: 25 µg/l
Atomic mass: 30.973	Shale/schist: 0.07 / 0.08 wt%	Ocean water: 65 µg/l
Main ox. state(s): +5 (-3, +3, +4)	Sandstone: 0.003 wt%	Human diet: 1.4·10 <sup>3</sup> mg/kg
Electronegativity (Pauling): 2.19	Limestone: 0.035 wt%	Reference man: 11·10 <sup>3</sup> mg/kg
Group: non-metals	Coal: 0.013 / 0.015 wt%	Yearly production: 18.2·10 <sup>6</sup> t
Affinity: biophile, lithophile, siderophile	Volatility-ratio in coal: -2.1	
Host minerals: Apatite (+) and other phosphates (+), olivine (-), pyroxenes (-), amphiboles (-), micas (-), garnets (-), feldspars (-).		
Uses: Fertilizers, detergents, chemical industry, semiconductors, explosives and warfare chemicals, fireworks, pesticides.		
Remarks: Essential for all organisms. Toxic at high doses.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.011	0.006	0.016	0.003	0.002	0.147
loess	4	0.056	0.052	0.012	0.007	0.047	0.072
fluviatile clay	28	0.056	0.054	0.027	0.026	0.009	0.115
marine clay	115	0.053	0.053	0.026	0.025	0.003	0.124
peat	33	0.063	0.050	0.056	0.039	0.004	0.257
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.062	0.065	0.044	0.052	0.003	0.244
loess	4	0.093	0.090	0.008	0.002	0.087	0.104
fluviatile clay	28	0.114	0.108	0.045	0.038	0.020	0.212
marine clay	115	0.100	0.098	0.033	0.025	0.013	0.242
peat	32	0.150	0.134	0.080	0.088	0.022	0.317

Concentrations are in wt% and based on 105 °C dry weight



# P - Phosphorus

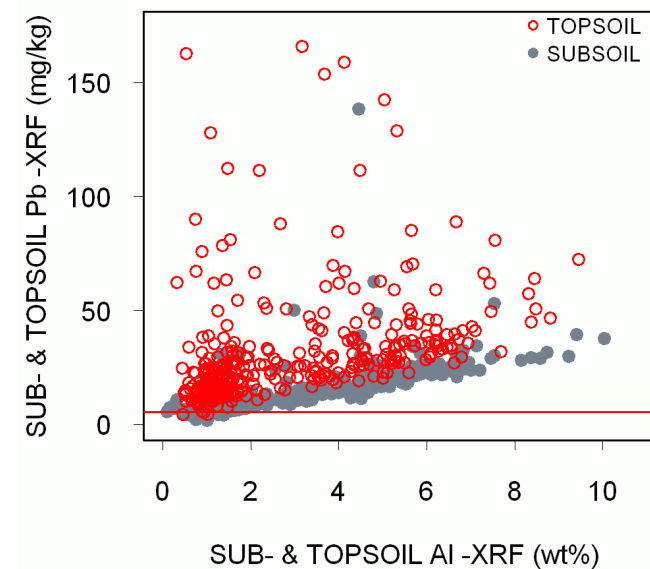
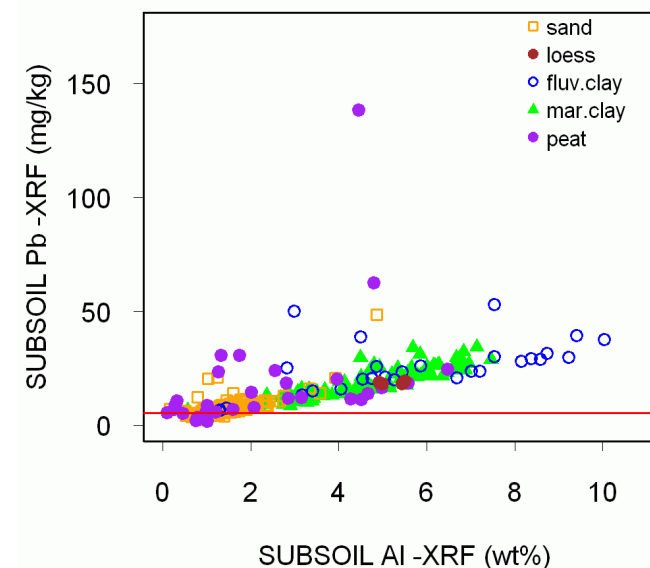


# Pb - Lead

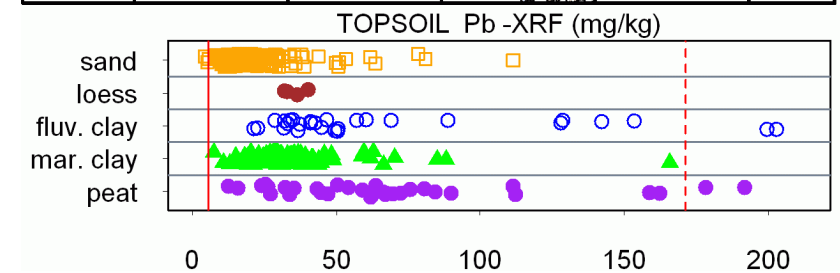
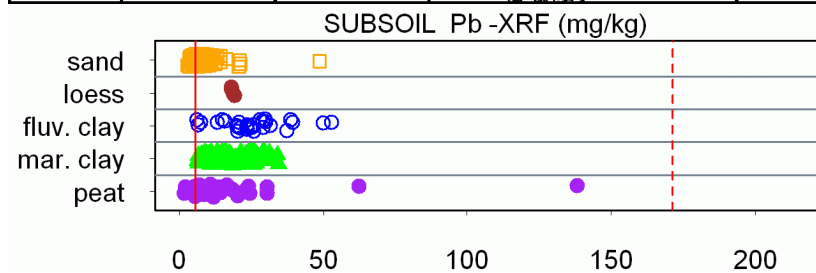
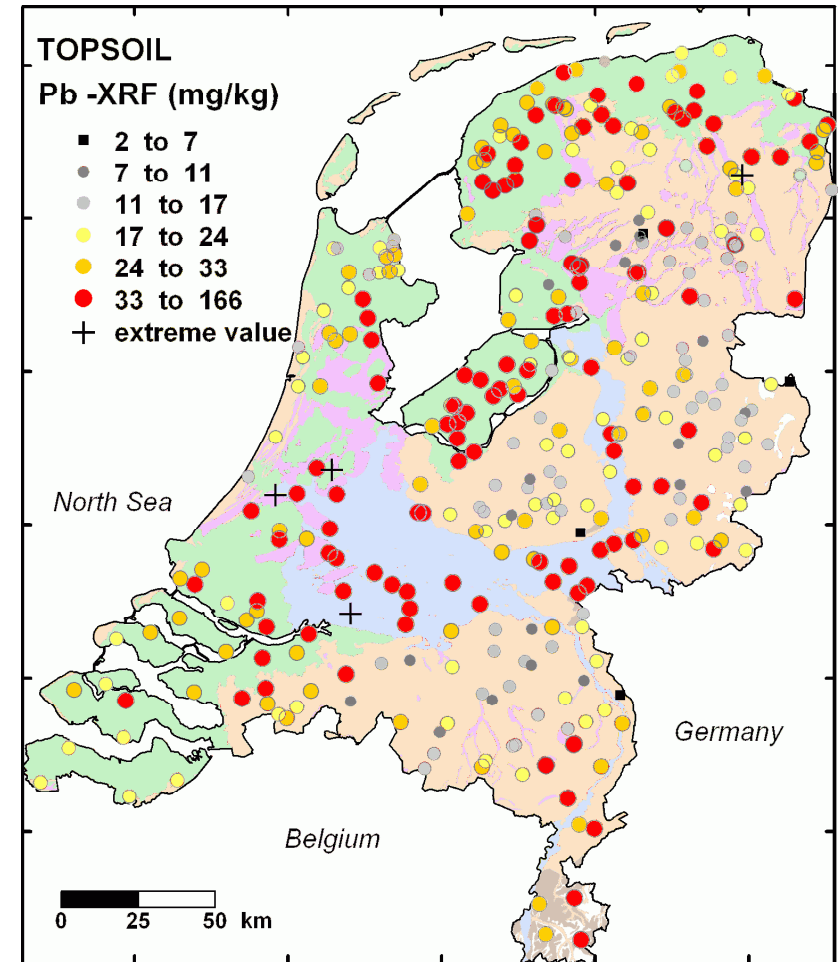
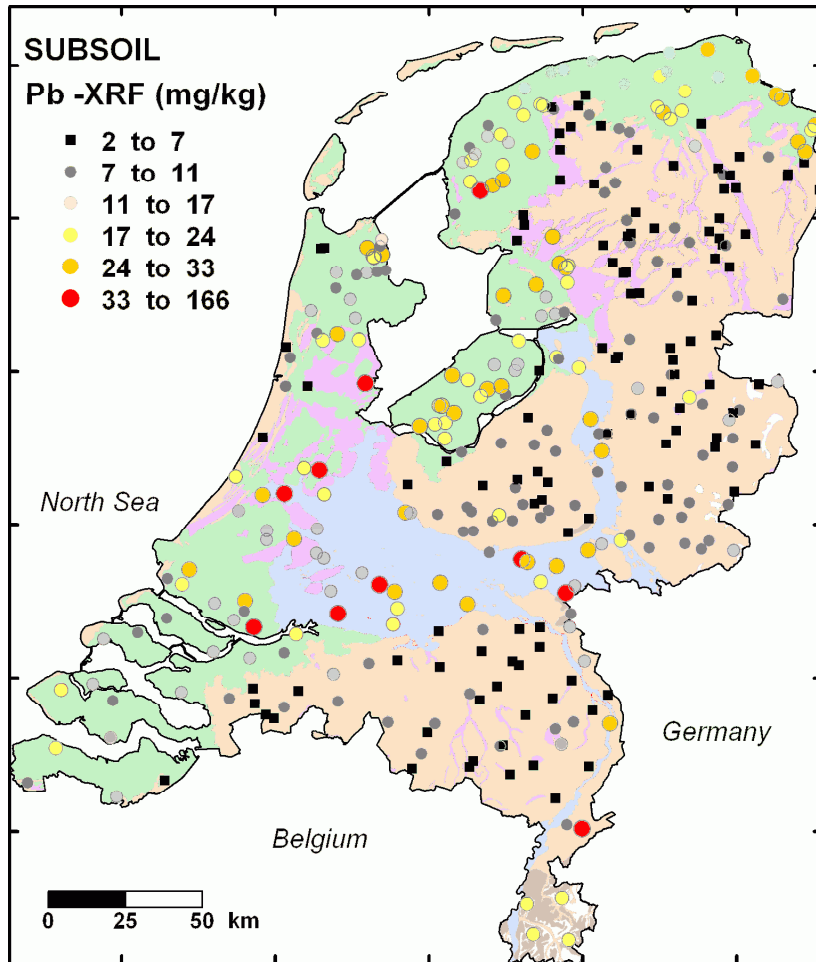
Atomic number: 82	Upper cont. crust: 17 / 20 mg/kg	River water: 0.1 µg/l
Atomic mass: 207.2	Shale/schist: 20 / 22 mg/kg	Ocean water: 0.003 µg/l
Main ox. state(s): +2 (+4)	Sandstone: 10 mg/kg	Human diet: 0.23 mg/kg
Electronegativity (Pauling): 2.33	Limestone: 5.0 mg/kg	Reference man: 1.7 mg/kg
Group: metals	Coal: 10 / 20 mg/kg	Yearly production: 2.6·10 <sup>6</sup> t
Affinity: chalcophile	Volatility-ratio in coal: 0.7	
Host minerals: Galena (+), cerrucite (+), K-feldspar (-), plagioclase (-), micas (-), magnetite (-), zircon (-).		
Uses: Batteries, pigments, stabilizer in plastics, ammunition, special alloys, cable sheeting, sheets, piping, solder, antiknock agent in gasoline.		
Remarks: Considered non-essential and toxic. Environmental legislation for soils in the Netherlands (background: 85 mg/kg, remediate: 530 mg/kg).		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	7.45	6.78	4.18	1.85	2.68	48.6
loess	4	18.6	18.5	0.56	0.54	18.1	19.3
fluviatile clay	28	25.4	24.5	11.4	7.52	6.21	52.9
marine clay	115	17.4	16.4	7.05	8.47	6.16	34.3
peat	33	17.4	11.3	24.7	8.66	1.61	138
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	20.7	17.4	13.5	7.49	4.20	111
loess	4	35.5	34.8	3.71	3.31	32.1	40.2
fluviatile clay	26	58.0	43.8	37.9	16.5	21.4	154
marine clay	115	33.4	29.5	18.3	10.1	7.4	166
peat	31	62.5	61.9	36.4	27.6	12.5	162

Concentrations are in mg/kg and based on 105 °C dry weight

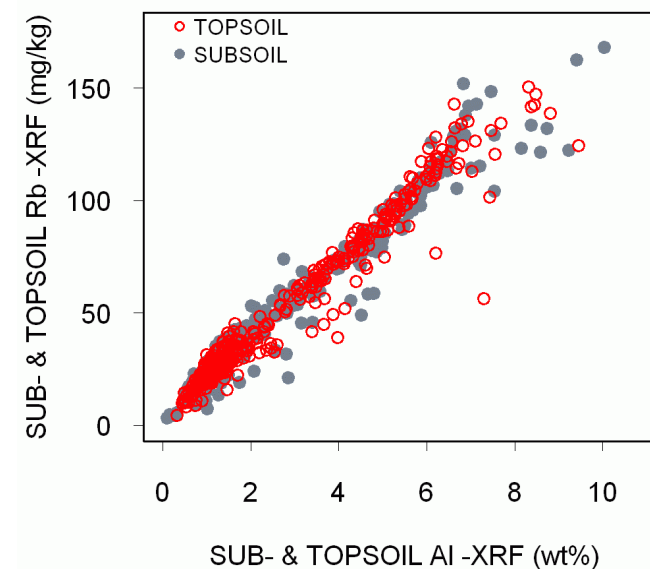
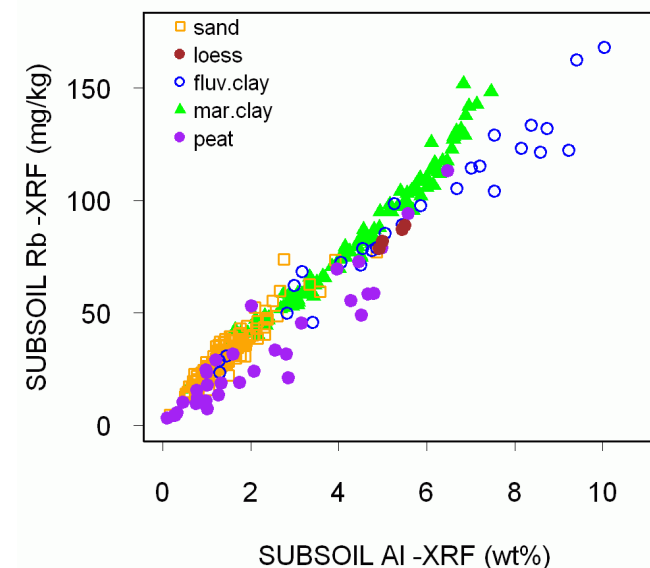


# Pb - Lead



# Rb - Rubidium

Atomic number: 37	Upper cont. crust: 110 / 112 mg/kg	River water: 1.5 µg/l
Atomic mass: 85.467	Shale/schist: 140 / 140 mg/kg	Ocean water: 120 µg/l
Main ox. state(s): +1 (+2, +3, +4)	Sandstone: 40 mg/kg	Human diet: 3.2 mg/kg
Electronegativity (Pauling): 0.82	Limestone: 4.0 mg/kg	Reference man: 9.7 mg/kg
Group: alkali metals	Coal: 20 / 15 mg/kg	Yearly production: 3 t
Affinity: lithophile	Volatility-ratio in coal: 3.9	
Host minerals: K-feldspar (-), K-bearing micas (-), K-salts (-).		
Uses: Electronics, semi-conductors, glass.		
Remarks: Considered non-essential and non-toxic.		

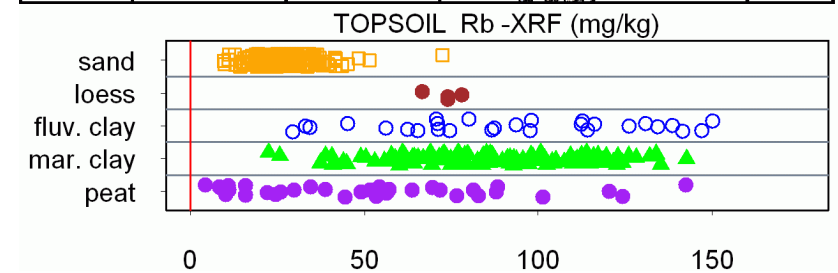
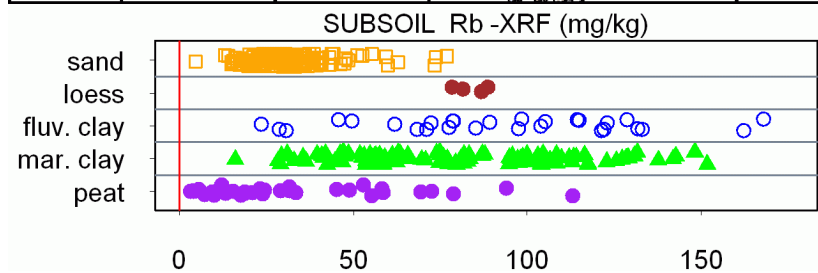
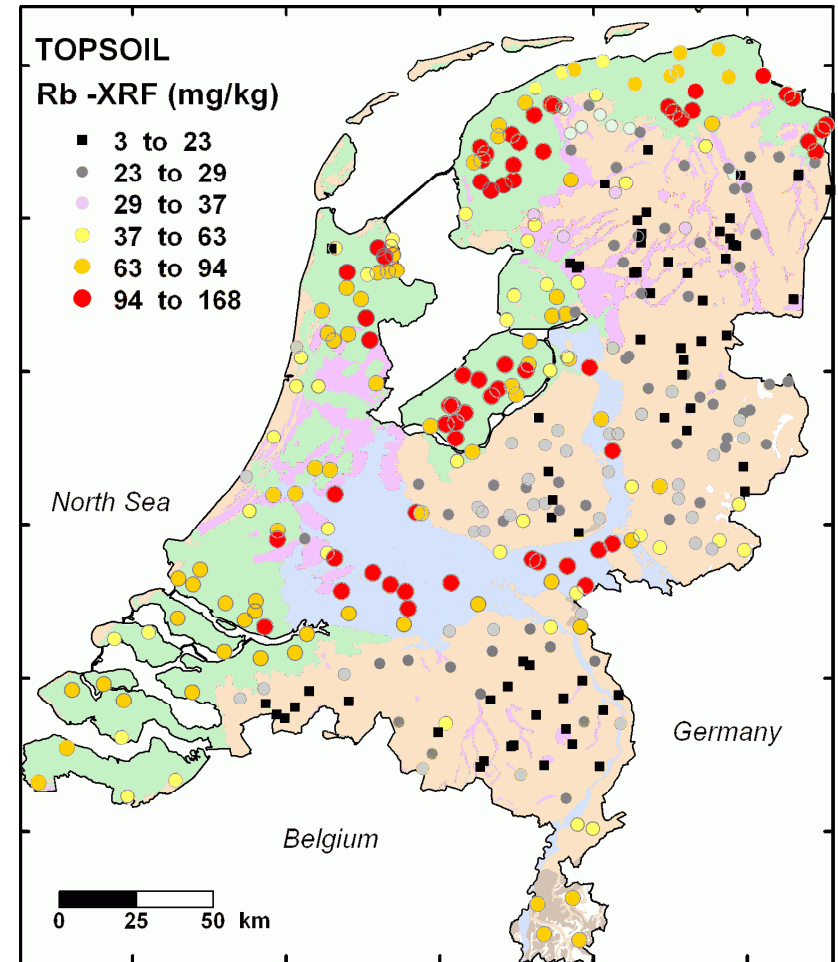
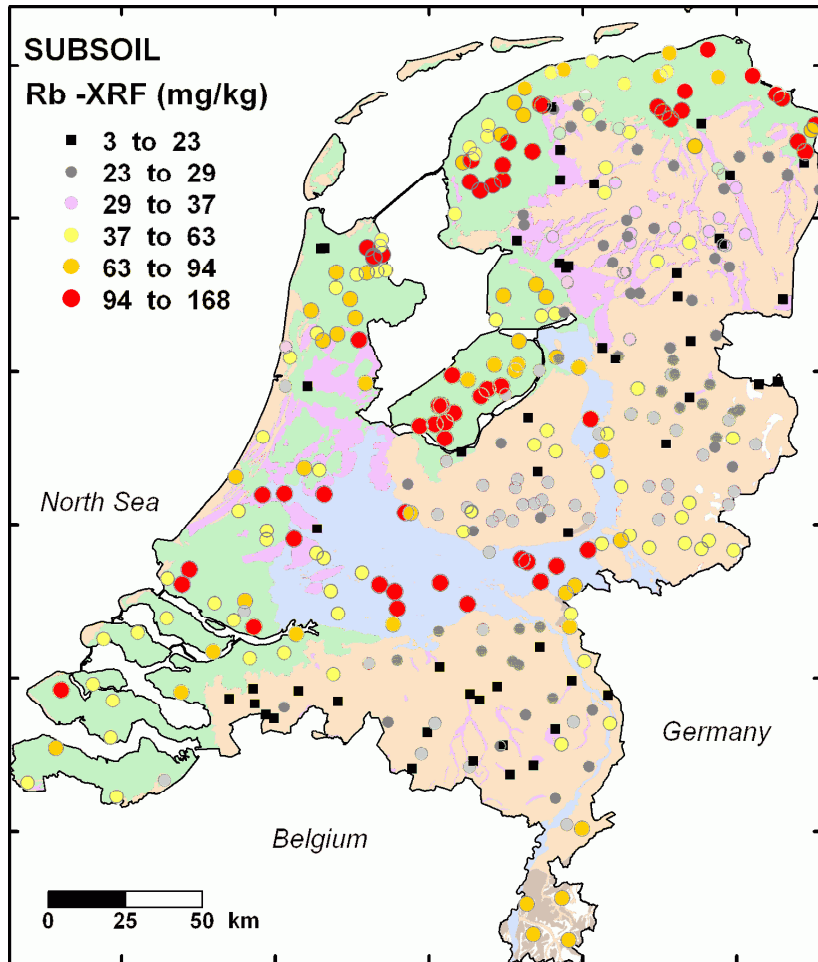


SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	30.7	28.9	10.6	7.10	4.63	76.9
loess	4	83.9	84.3	4.78	5.27	78.4	88.7
fluviatile clay	28	92.4	93.4	37.9	39.3	23.5	168
marine clay	115	79.7	77.3	31.0	35.0	16.1	152
peat	33	33.9	23.9	28.2	21.3	3.2	113
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	26.9	26.1	8.36	7.70	9.61	72.6
loess	4	73.3	74.1	4.74	2.93	66.7	78.1
fluviatile clay	28	92.3	90.6	36.1	37.7	29.6	150
marine clay	115	86.8	86.6	25.5	29.2	22.5	143
peat	33	52.7	51.7	36.9	43.9	4.40	143

Concentrations are in mg/kg and based on 105 °C dry weight



# Rb - Rubidium

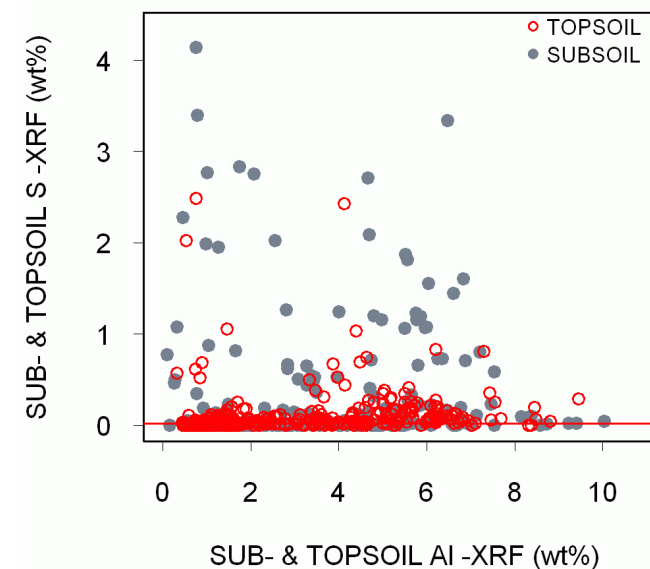
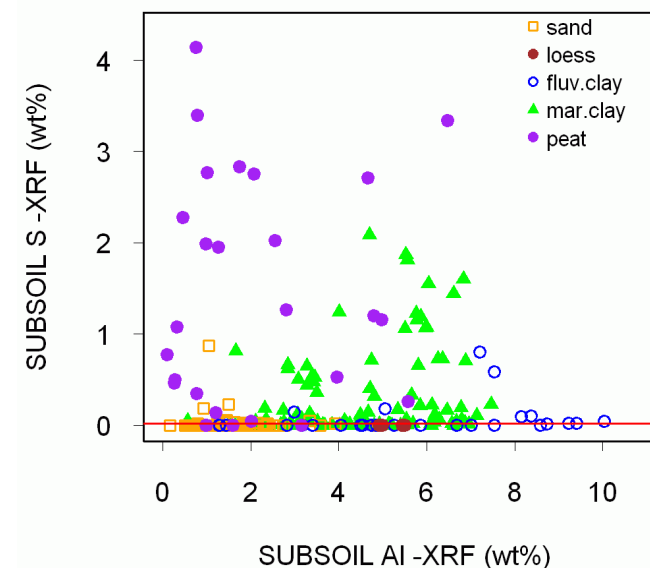


# S - Sulphur

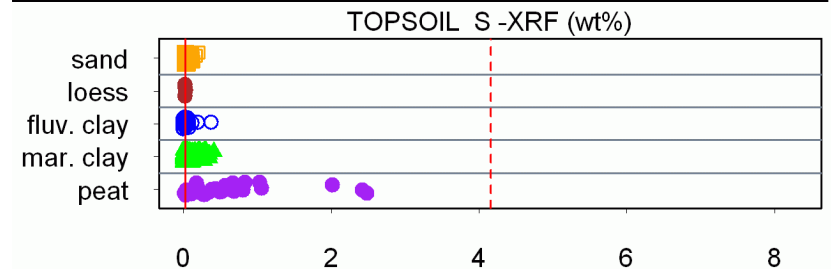
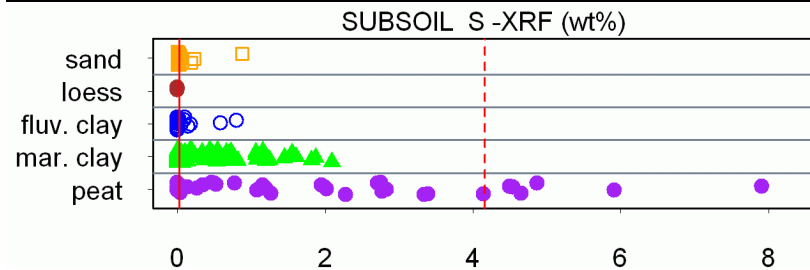
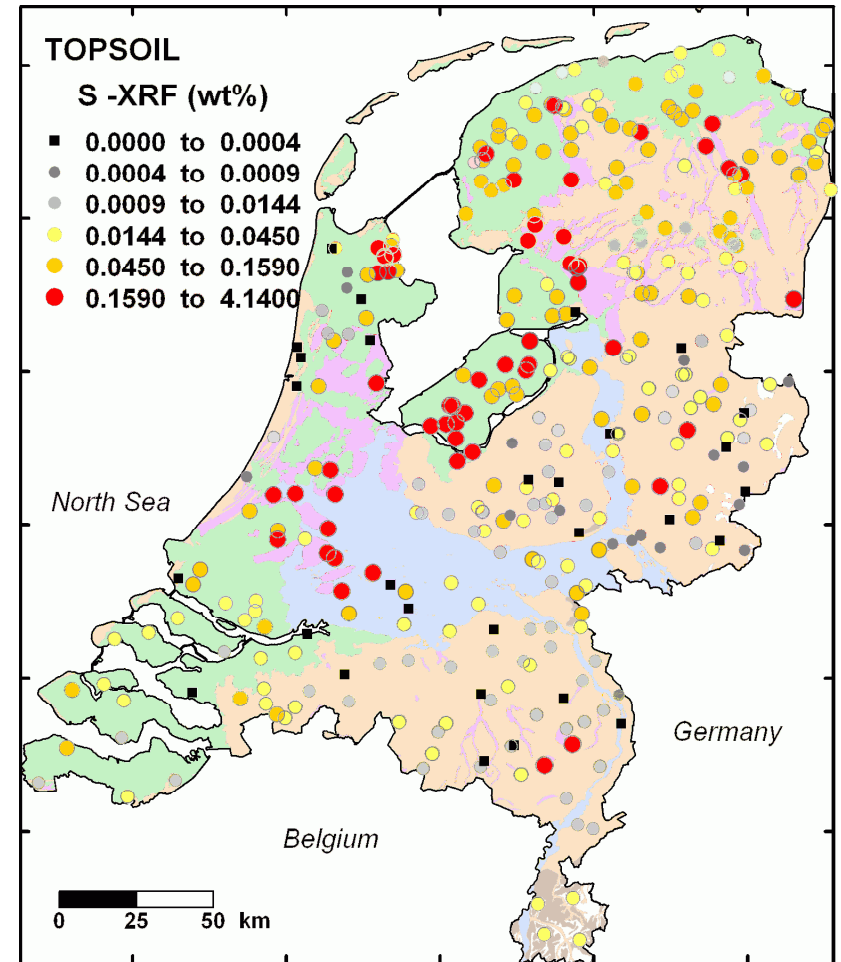
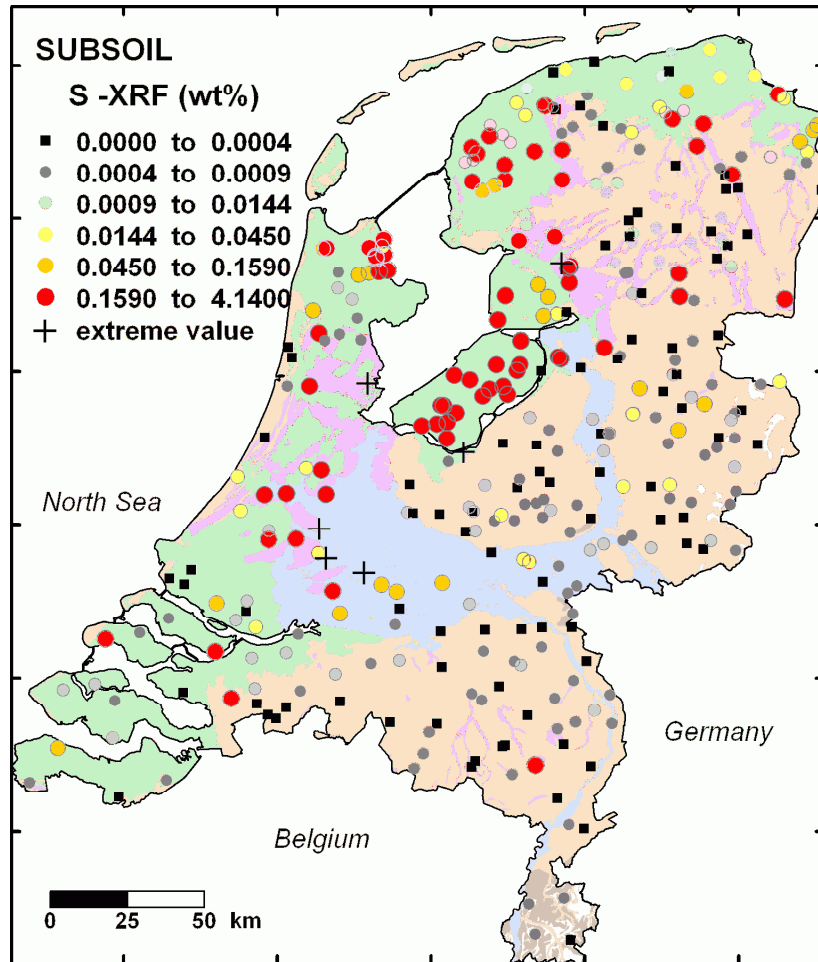
Atomic number: 16	Upper cont. crust: 0.095 / 0.03 wt%	River water: $3.7 \cdot 10^3$ µg/l
Atomic mass: 32.066	Shale/schist: 0.24 / 0.11 wt%	Ocean water: $900 \cdot 10^3$ µg/l
Main ox. state(s): -2, 0, +4, +6 (+2)	Sandstone: 0.02 wt%	Human diet: 680 mg/kg
Electronegativity (Pauling): 2.58	Limestone: 0.05 wt%	Reference man: $2 \cdot 10^3$ mg/kg
Group: non-metals	Coal: 1.5 / 2.0 wt%	Yearly production: $56 \cdot 10^6$ t
Affinity: biophile, chalcophile	Volatility-ratio in coal: 8.1	
Host minerals: Pyrite (+) and other sulphides, sulphates (+), biotite (-), hornblende (-).		
Uses: Chemical industry, rubber production, fertilizers, pharmaceuticals, fireworks.		
Remarks: Essential for all organisms. Pure S not toxic, but other compounds are (H <sub>2</sub> S, SO <sub>2</sub> ).		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.010	0.001	0.069	<0.001	<0.001	0.870
loess	4	<0.001	0.001	<0.001	<0.001	<0.001	0.001
fluviatile clay	28	0.072	0.001	0.184	0.001	<0.001	0.804
marine clay	115	0.278	0.036	0.469	0.053	<0.001	2.09
peat	27	1.40	1.15	1.26	1.51	<0.001	4.14
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.027	0.015	0.034	0.021	<0.001	0.201
loess	4	0.024	0.022	0.006	0.002	0.020	0.032
fluviatile clay	28	0.050	0.026	0.077	0.038	<0.001	0.380
marine clay	115	0.092	0.060	0.091	0.069	<0.001	0.408
peat	33	0.592	0.436	0.623	0.376	0.016	2.48

Concentrations are in wt% and based on 105 °C dry weight



# S - Sulphur

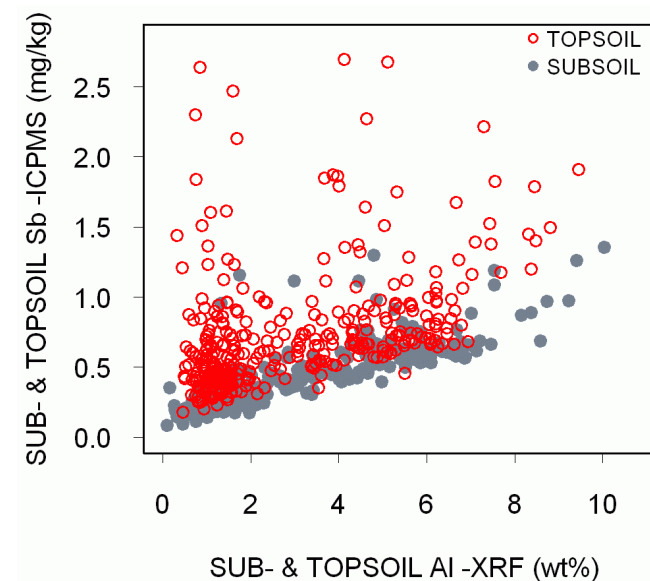
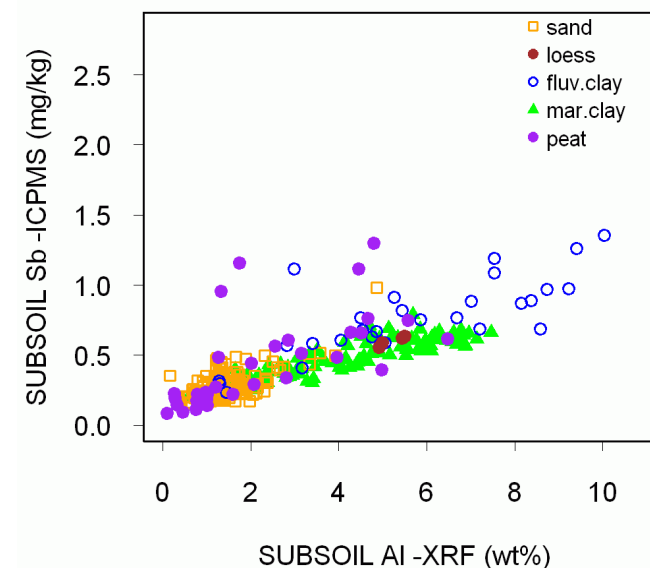


# Sb - Antimony

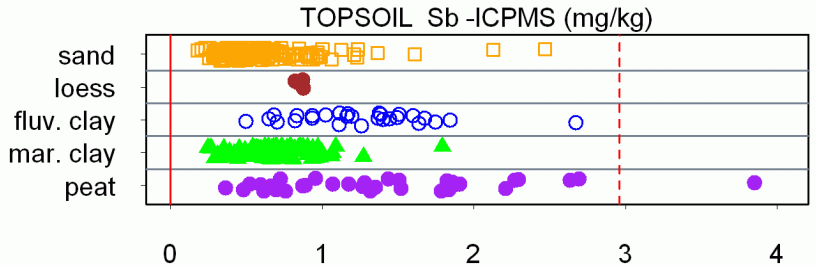
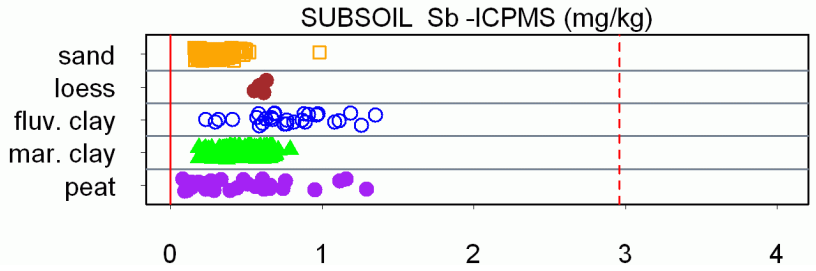
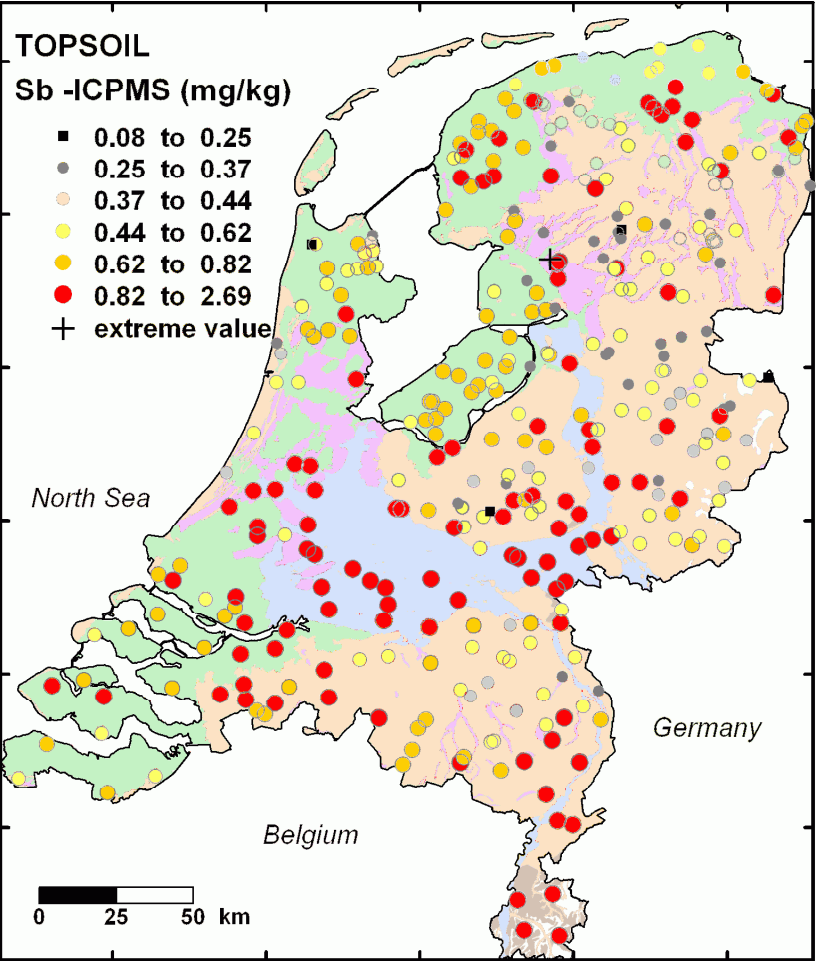
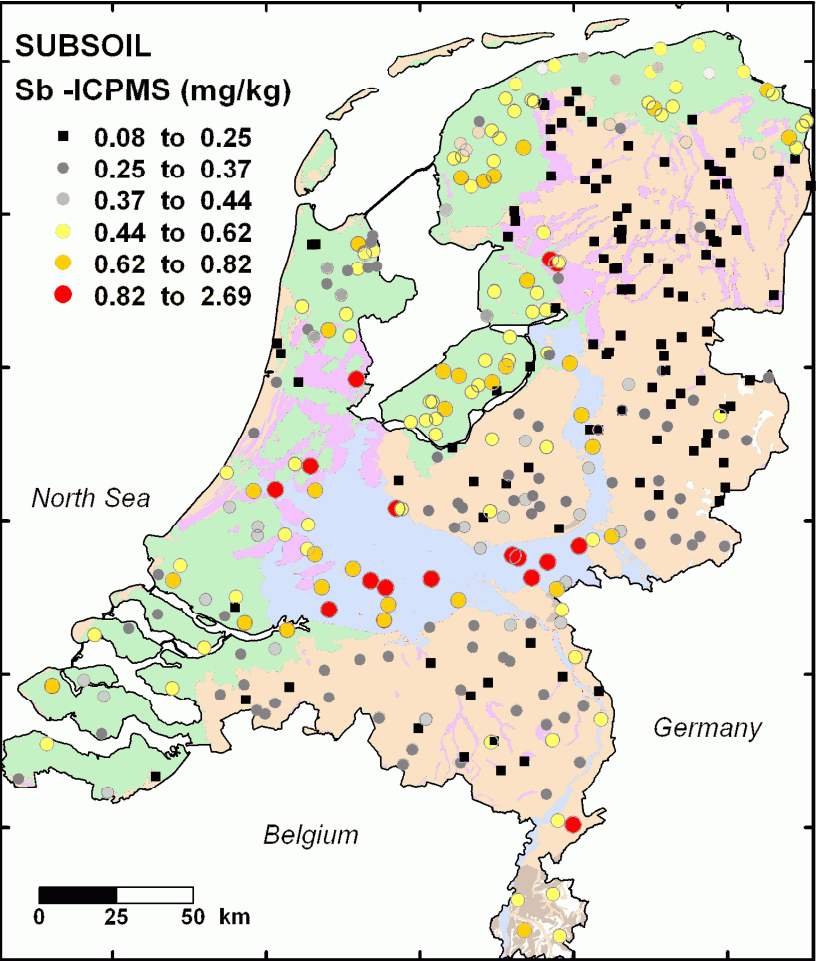
Atomic number: 51	Upper cont. crust: 0.31 / 0.2 mg/kg	River water: 0.07 µg/l
Atomic mass: 121.780	Shale/schist: 1.5 / 1.0 mg/kg	Ocean water: 0.15 µg/l
Main ox. state(s): +3 (-3, +4, +5)	Sandstone: 0.05 mg/kg	Human diet: 0.025 mg/kg
Electronegativity (Pauling): 2.05	Limestone: 0.15 mg/kg	Reference man: 0.03 mg/kg
Group: metals	Coal: 1.0 / 2.0 mg/kg	Yearly production: 119·10 <sup>3</sup> t
Affinity: chalcophile	Volatility-ratio in coal: 6.9	
Host minerals: Stibnite (+) and other Sb-sulphides (+), ilmenite (-), rutile (-), olivine (-), sulphides (-).		
Uses: Alloys, batteries, paint, semi-conductors, ammunition, flame retardant, rubber manufacturing, glass production, pharmaceutical industry, bactericide.		
Remarks: Considered non-essential, toxic.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.27	0.25	0.10	0.075	0.16	0.98
loess	4	0.60	0.60	0.034	0.032	0.56	0.63
fluviatile clay	28	0.77	0.76	0.28	0.24	0.23	1.35
marine clay	115	0.48	0.49	0.14	0.17	0.19	0.79
peat	33	0.45	0.34	0.33	0.26	0.082	1.30
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.57	0.47	0.30	0.17	0.18	2.47
loess	4	0.85	0.86	0.026	0.027	0.82	0.88
fluviatile clay	28	1.26	1.23	0.45	0.42	0.50	2.67
marine clay	115	0.70	0.69	0.21	0.15	0.25	1.79
peat	32	1.35	1.30	0.66	0.81	0.37	2.69

Concentrations are in mg/kg and based on 105 °C dry weight



# Sb - Antimony

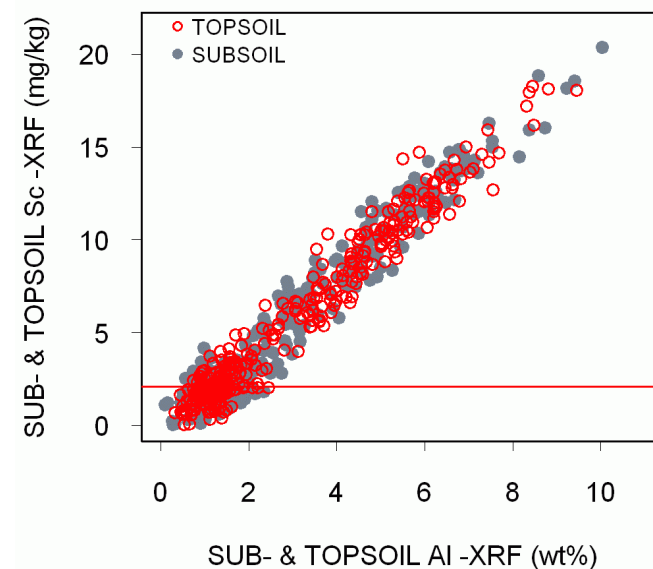
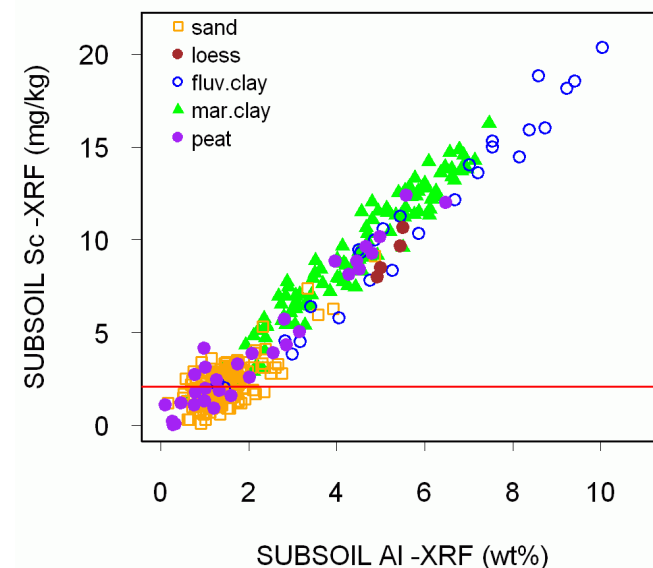


# Sc - Scandium

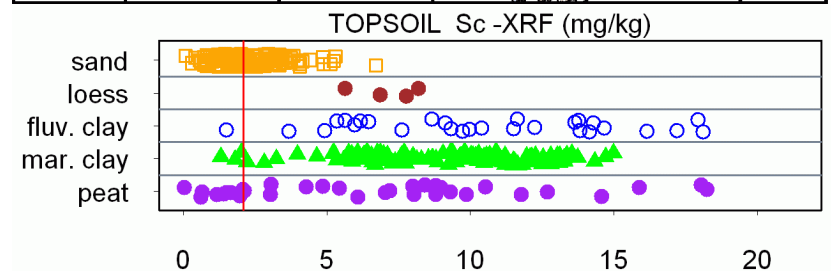
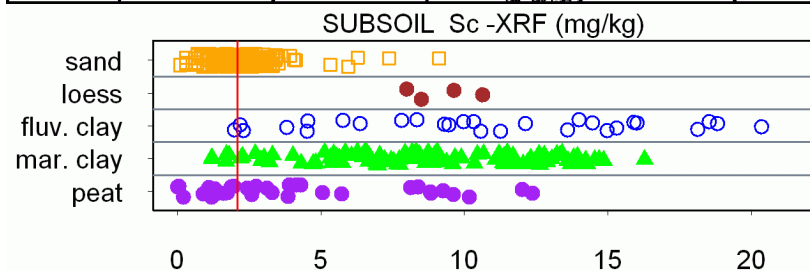
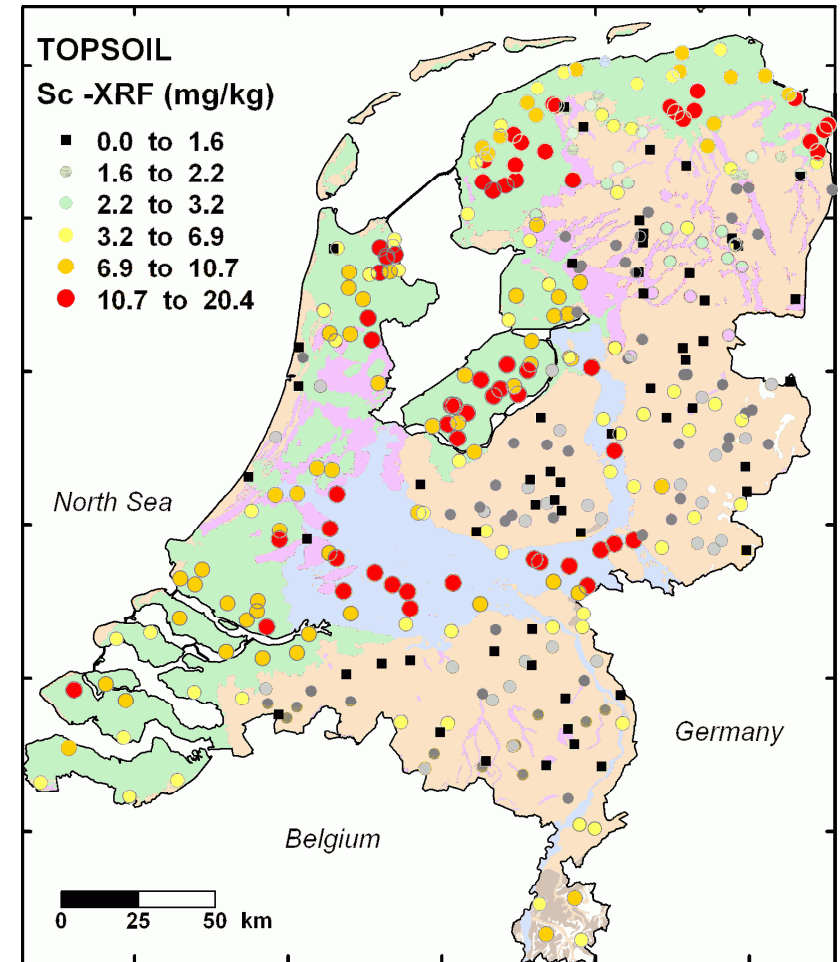
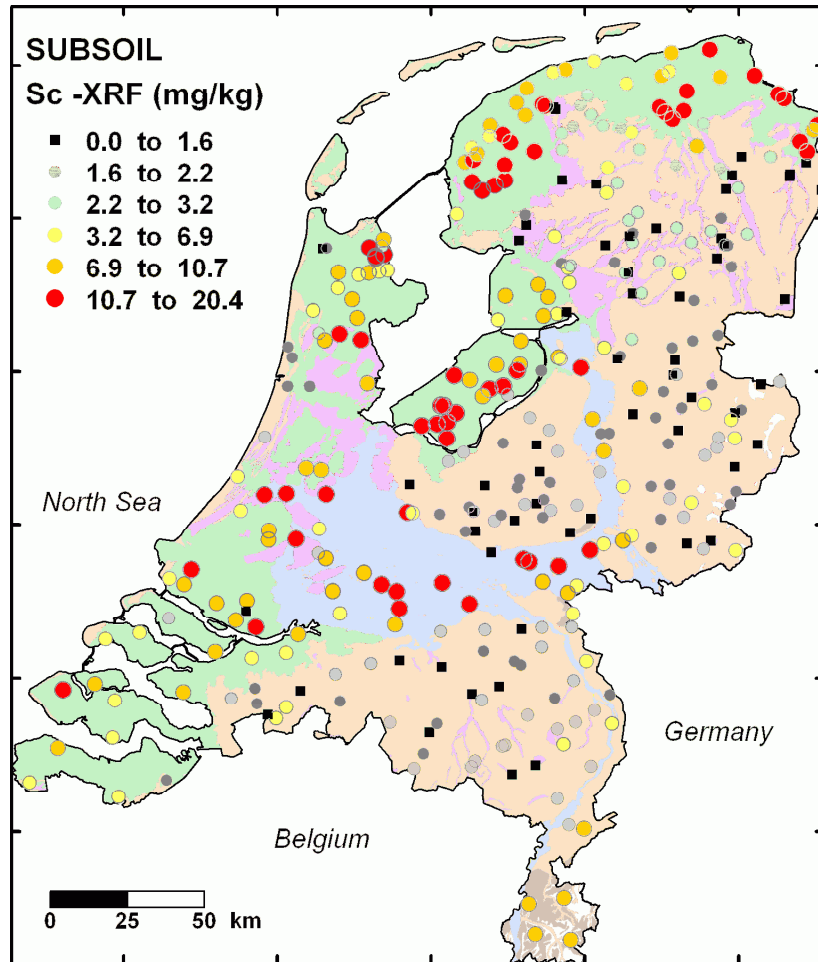
Atomic number: 21	Upper cont. crust: 7 / 11 mg/kg	River water: 0.004 µg/l
Atomic mass: 44.956	Shale/schist: 13 / 15 mg/kg	Ocean water: 86·10 <sup>-3</sup> µg/l
Main ox. state(s): +3	Sandstone: 3 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.36	Limestone: 1 mg/kg	Reference man: ?
Group: transition metals	Coal: 5 / 5 mg/kg	Yearly production: ?
Affinity: lithophile	Volatility-ratio in coal: -10	
Host minerals: Thorveitite (+), pyroxenes (-), amphiboles (-), biotite (-), garnets (-), xenotime (-), zircon (-), monazite (-).		
Uses: Cathode-ray tubes, lasers, fluorescent materials.		
Remarks: Considered non-essential, little is know about the toxicity of Sc.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	2.18	2.01	1.15	0.89	0.10	9.12
loess	4	9.19	9.07	1.18	1.22	8.00	10.6
fluviatile clay	28	10.8	10.5	5.48	6.83	2.00	20.4
marine clay	115	8.84	8.74	3.72	4.38	1.20	16.3
peat	33	4.34	3.13	3.69	2.87	0.020	12.4
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	2.15	1.97	1.05	0.90	0.072	6.70
loess	4	7.12	7.32	1.13	0.98	5.64	8.19
fluviatile clay	28	10.5	10.2	4.52	5.71	1.51	18.1
marine clay	115	9.28	10.0	3.05	3.32	1.30	15.0
peat	33	6.86	7.04	5.16	5.93	0.047	18.3

Concentrations are in mg/kg and based on 105 °C dry weight



# Sc - Scandium

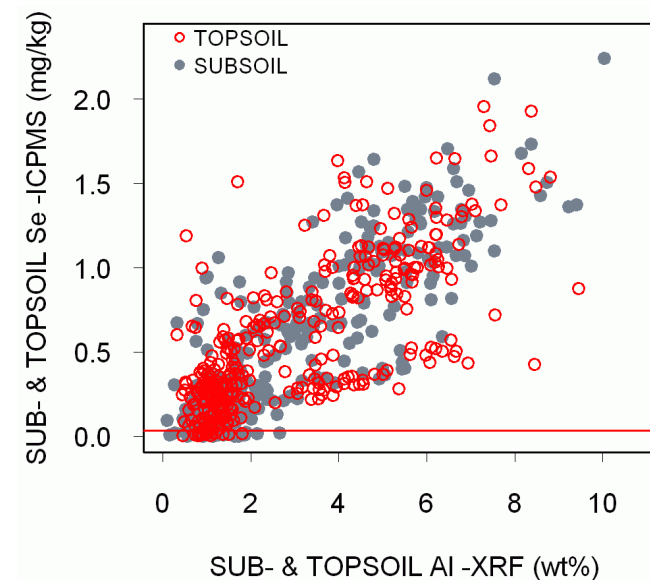
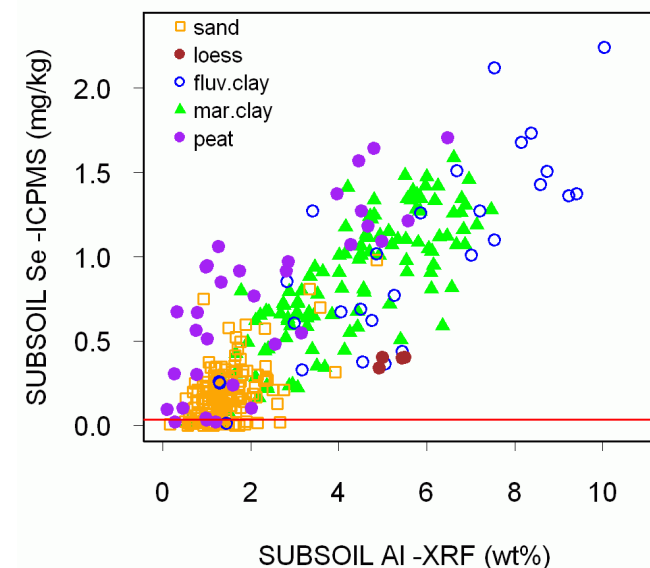


# Se - Selenium

Atomic number: 34	Upper cont. crust: 0.083 / ? mg/kg	River water: 0.06 µg/l
Atomic mass: 78.96	Shale/schist: 0.6 / 0.3 mg/kg	Ocean water: 0.15 µg/l
Main ox. state(s): -2, +4 (0, +6)	Sandstone: 0.01 mg/kg	Human diet: 0.15 mg/kg
Electronegativity (Pauling): 2.55	Limestone: 0.025 mg/kg	Reference man: 0.11 mg/kg
Group: non- metals	Coal: 3 / 3 mg/kg	Yearly production: 2300 t
Affinity: chalcophile	Volatility-ratio in coal: 6.4	
Host minerals: Native Se and selenides (+), sulphides (-).		
Uses: Glass manufacturing, galvanizing, semi-conductors, pigments, vulcanizing agent, agriculture.		
Remarks: Considered essential for many organisms in small amounts, toxic at higher concentrations (narrow range of optimal concentrations).		

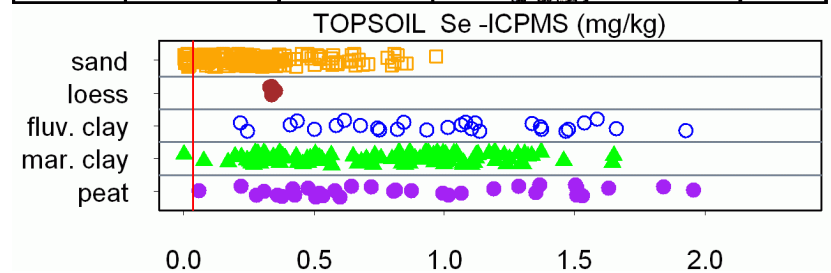
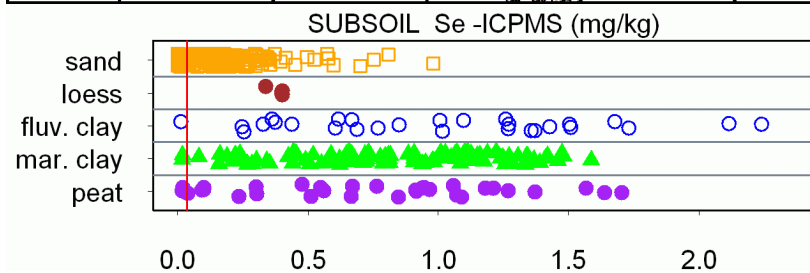
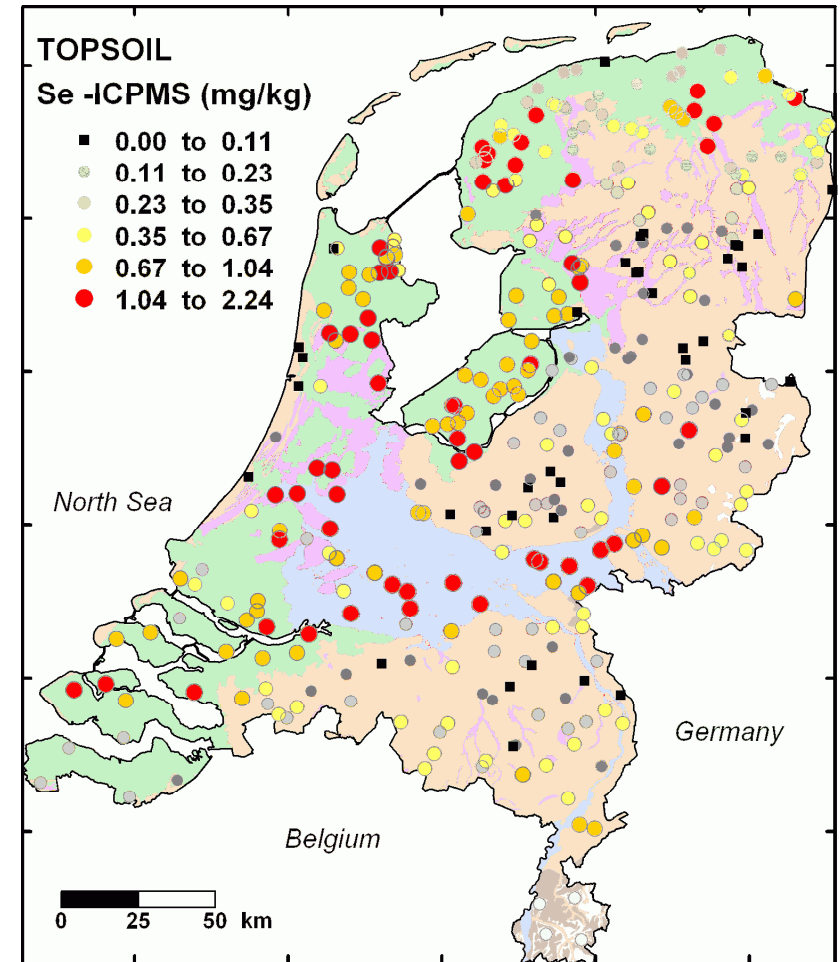
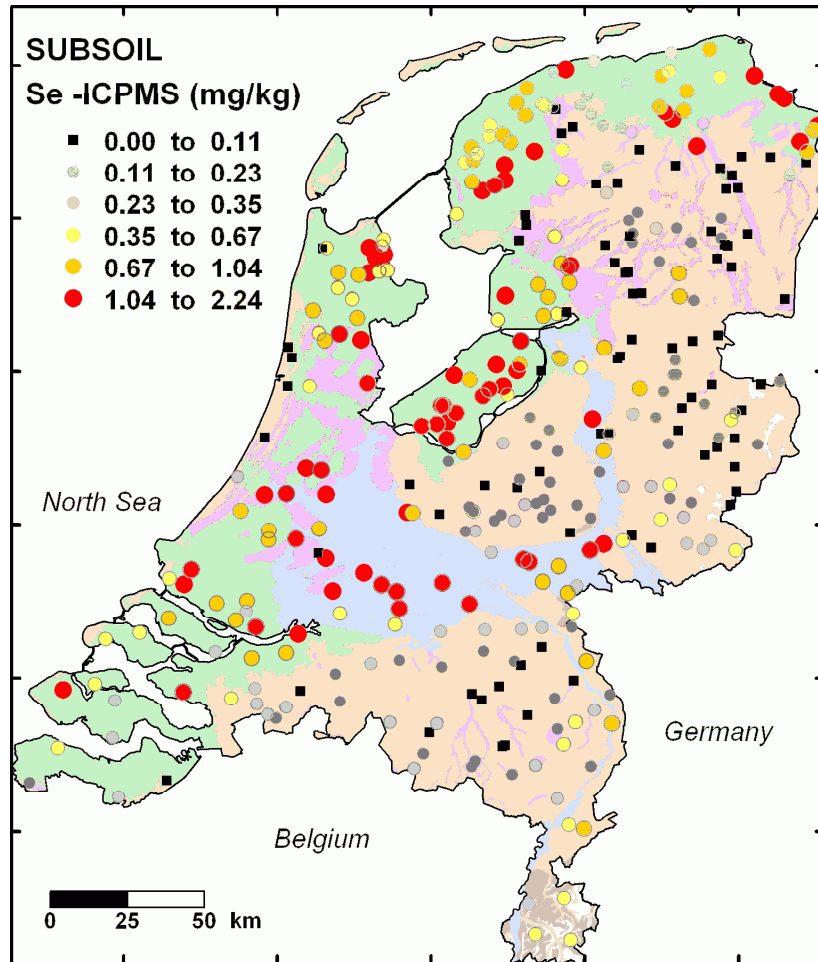
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.17	0.15	0.16	0.15	<0.001	0.98
loess	4	0.39	0.40	0.032	0.003	0.34	0.40
fluviatile clay	28	1.00	1.01	0.58	0.61	0.013	2.24
marine clay	115	0.84	0.82	0.39	0.44	0.018	1.59
peat	33	0.73	0.77	0.50	0.61	0.019	1.70
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.28	0.26	0.21	0.17	0.003	0.97
loess	4	0.34	0.34	0.009	0.005	0.33	0.35
fluviatile clay	28	1.00	1.04	0.45	0.52	0.22	1.93
marine clay	115	0.79	0.86	0.37	0.39	0.002	1.65
peat	33	0.89	0.81	0.52	0.57	0.061	1.96

Concentrations are in mg/kg and based on 105 °C dry weight





# Se - Selenium



# Si - Silicon

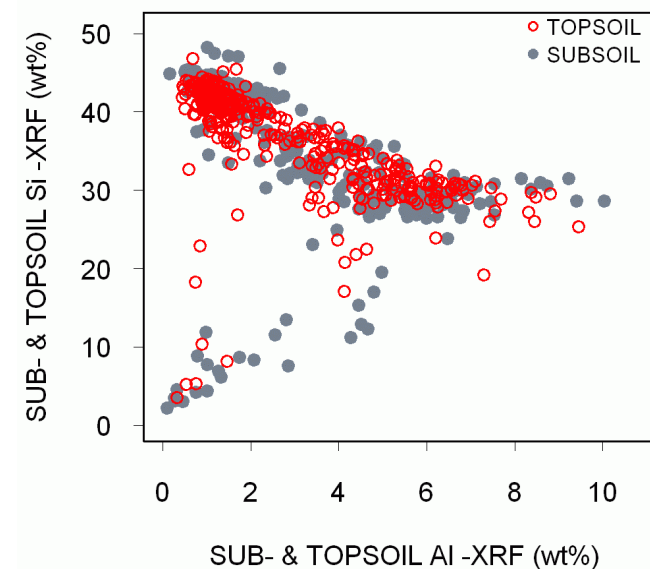
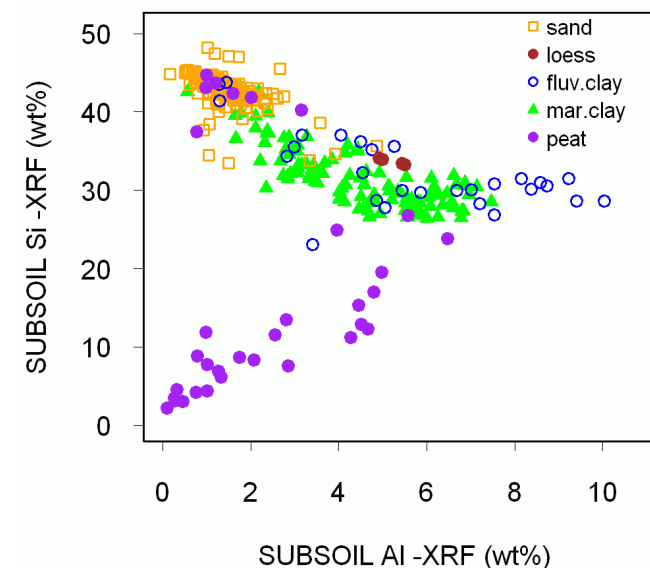
Atomic number: 14	Upper cont. crust: 30.4 / 30.8 wt%	River water: $5 \cdot 10^3$ $\mu\text{g/l}$
Atomic mass: 28.085	Shale/schist: 27.5 / 28.8 wt%	Ocean water: $2.5 \cdot 10^3$ $\mu\text{g/l}$
Main ox. state(s): +4	Sandstone: 40.3 wt%	Human diet: ?
Electronegativity (Pauling): 1.9	Limestone: 3.1 wt%	Reference man: 260 mg/kg
Group: non-metals	Coal: 3.0 / 3.4 wt%	Yearly production: $3.1 \cdot 10^6$ t
Affinity: lithophile	Volatility-ratio in coal: -6.7	
Host minerals: Quartz (+) and other silicate minerals (+), biogenic silica (+).		
Uses: Semi-conductors, glass, ceramics, cement.		
Remarks: Essential for many organisms.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	42.9	43.3	2.06	1.21	33.5	48.2
loess	4	33.6	33.6	0.39	0.46	33.2	34.0
fluviatile clay	28	32.4	30.9	4.94	3.62	23.0	43.7
marine clay	115	32.3	31.4	4.57	4.36	26.4	44.0
peat	33	17.3	11.9	14.4	11.1	2.20	44.7

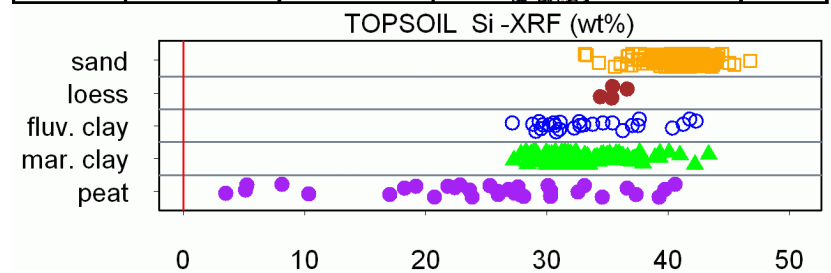
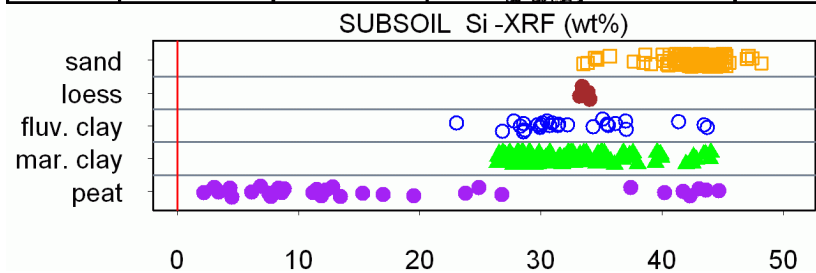
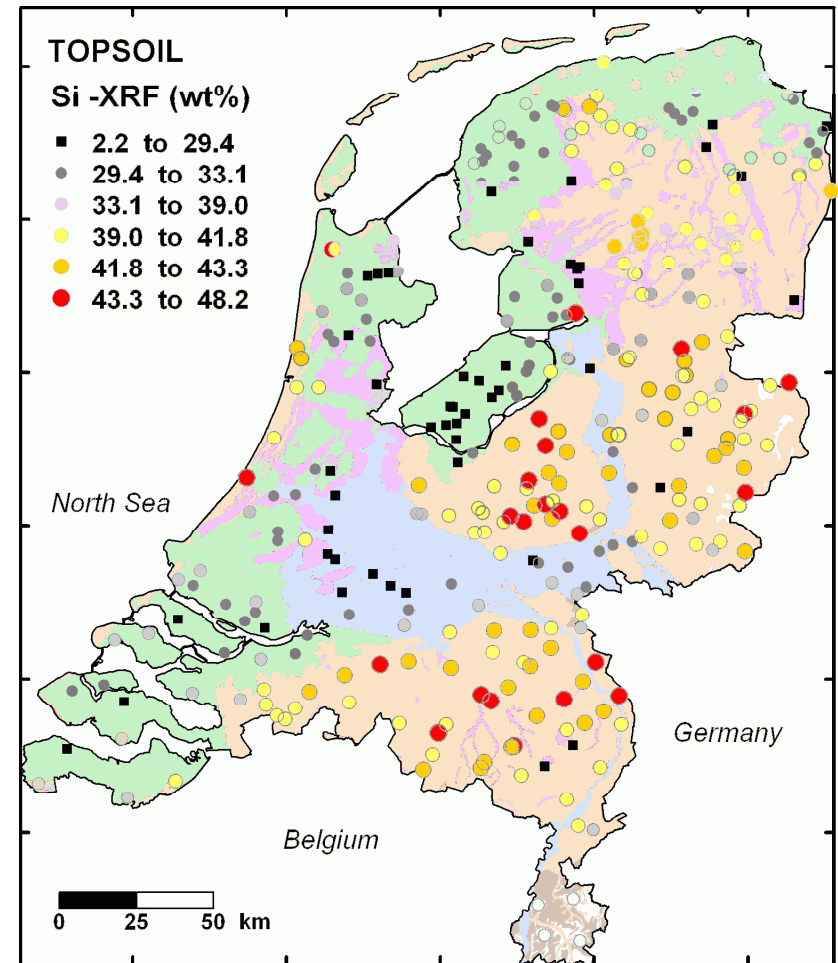
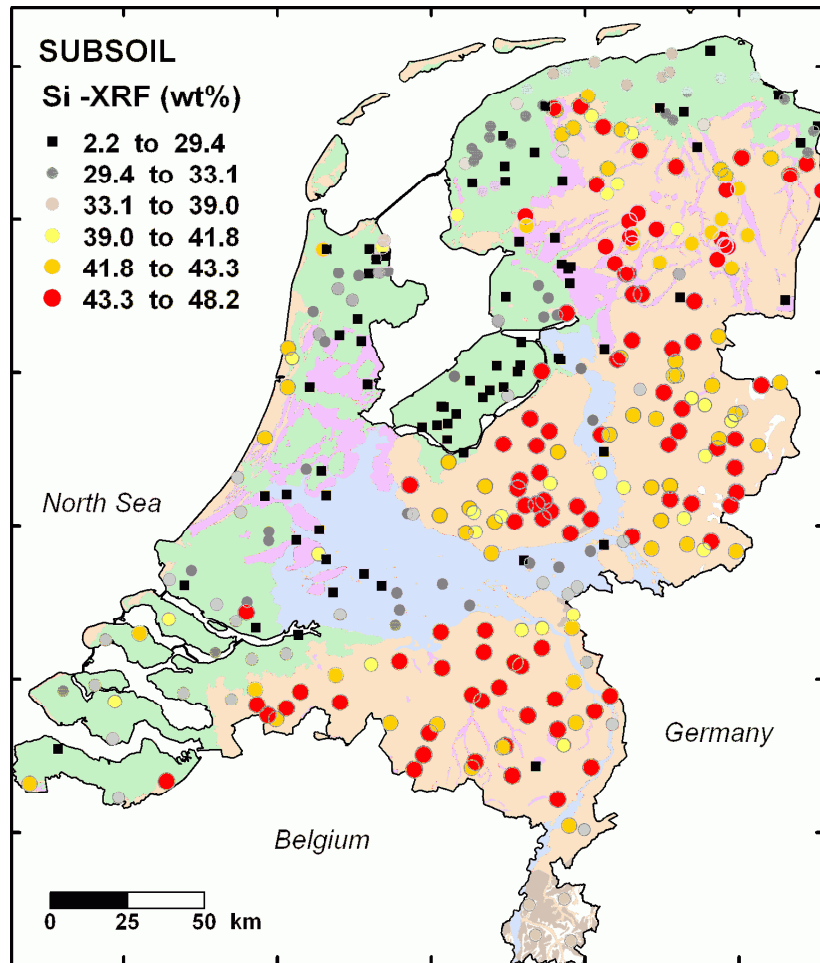
  

TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	41.1	41.4	2.16	1.70	33.1	46.8
loess	4	35.5	35.4	0.92	0.77	34.4	36.7
fluviatile clay	28	33.6	32.7	4.26	4.28	27.2	42.3
marine clay	115	32.5	31.3	3.39	3.09	27.2	43.3
peat	33	24.9	26.0	10.0	7.81	3.52	40.6

Concentrations are in wt% and based on 105 °C dry weight



# Si - Silicon

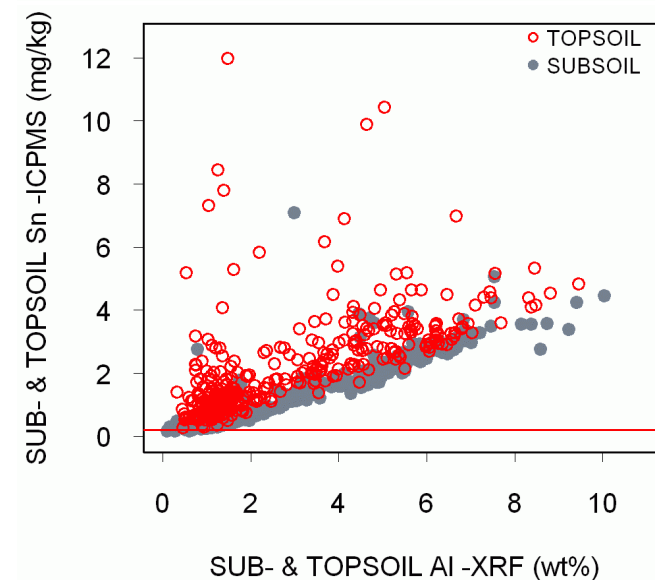
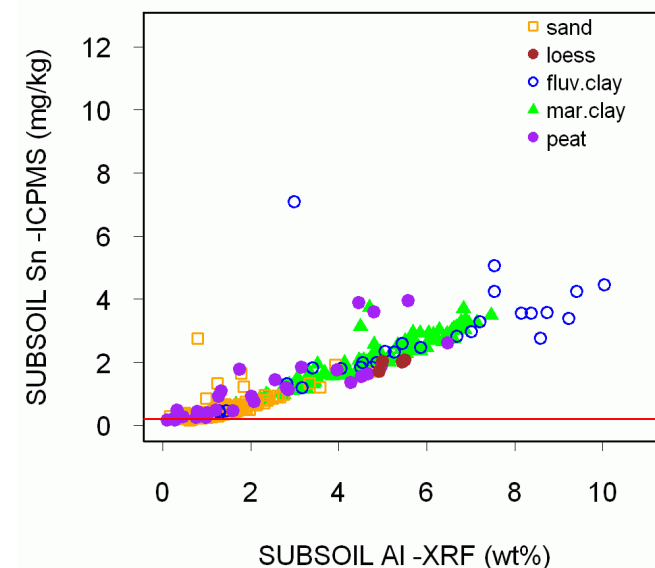


# Sn - Tin

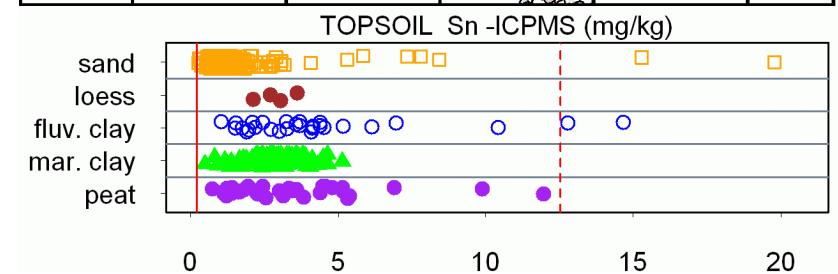
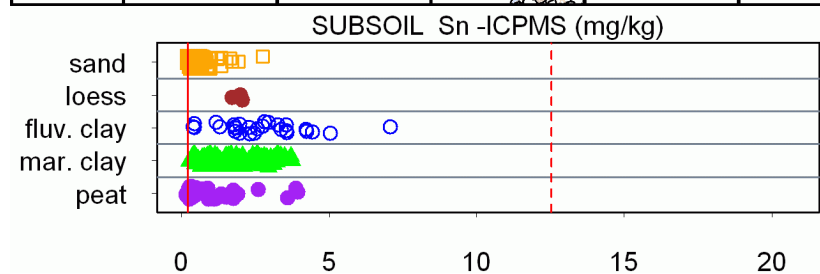
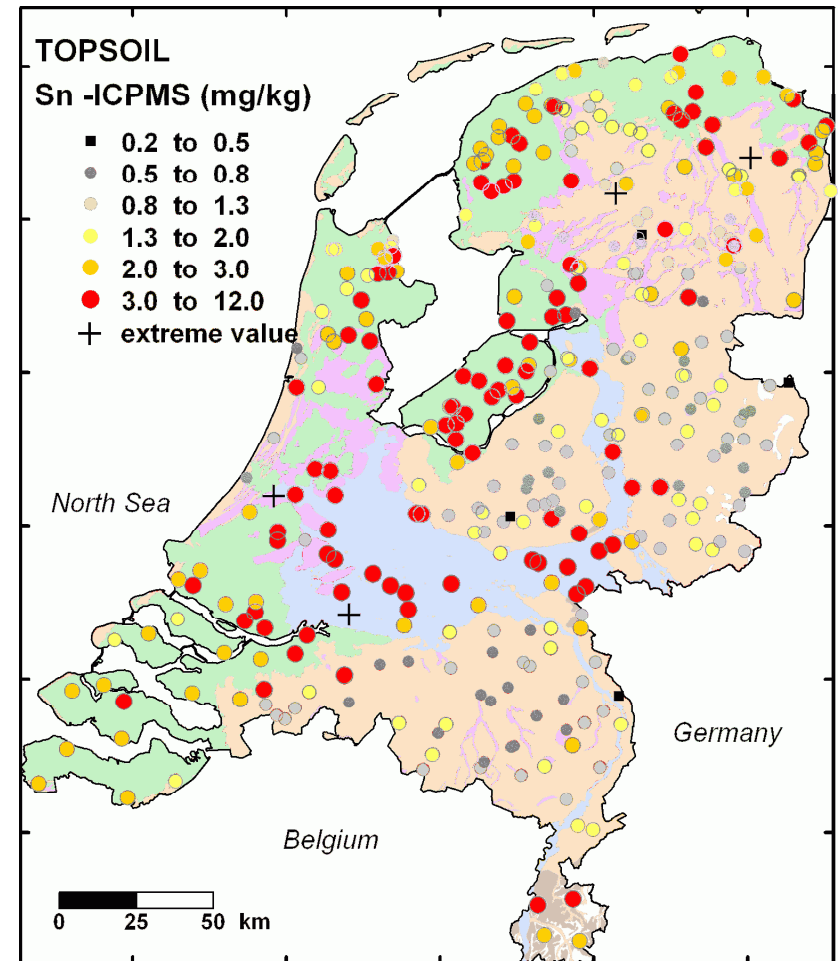
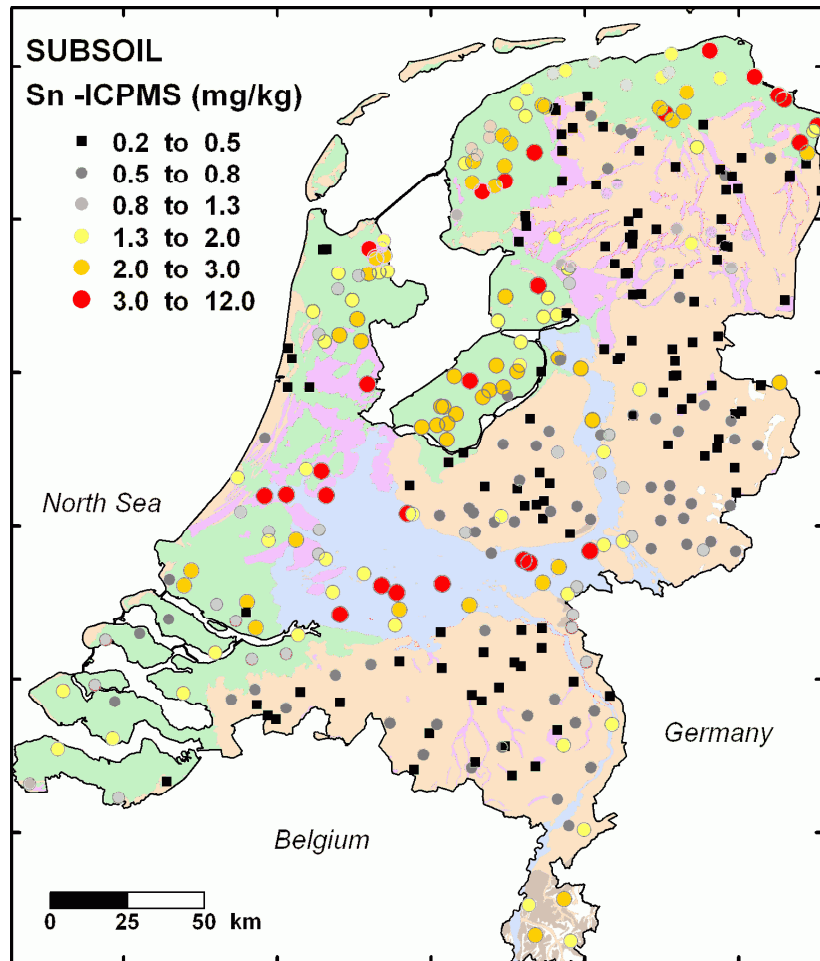
Atomic number: 50	Upper cont. crust: 2.5 / 5.5 mg/kg	River water: ?
Atomic mass: 118.710	Shale/schist: 3 / 5 mg/kg	Ocean water: $60 \cdot 10^{-3}$ $\mu\text{g/l}$
Main ox. state(s): +4 (+2)	Sandstone: 0.6 mg/kg	Human diet: 0.14 mg/kg
Electronegativity (Pauling): 1.96	Limestone: 0.3 mg/kg	Reference man: 0.24 mg/kg
Group: metals	Coal: 2 / 8 mg/kg	Yearly production: $189 \cdot 10^3$ t
Affinity: siderophile	Volatility-ratio in coal: -0.65	
Host minerals: Cassiterite (+), biotite (-), muscovite (-), amphiboles (-), sphene (-), rutile (-), magnetite (-).		
Uses: Sn-plated steel, alloys, pesticide, stabilizer in PVC, paint (especially for ships), solder.		
Remarks: Possibly essential for some organisms (e.g. humans). Many Sn compounds are toxic for lower organisms.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.50	0.43	0.31	0.15	0.17	2.75
loess	4	1.96	2.02	0.16	0.044	1.72	2.06
fluviatile clay	28	2.70	2.53	1.49	1.19	0.40	7.08
marine clay	115	1.88	1.94	0.88	1.09	0.25	3.75
peat	33	1.15	0.91	1.07	0.94	0.17	3.95
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	176	1.35	1.06	1.16	0.49	0.27	8.44
loess	4	2.88	2.89	0.63	0.67	2.13	3.62
fluviatile clay	26	3.63	3.43	2.01	1.55	1.06	10.4
marine clay	115	2.83	2.88	0.85	0.82	0.49	5.14
peat	33	3.54	3.02	2.46	2.06	0.74	12.0

Concentrations are in mg/kg and based on 105 °C dry weight



# Sn - Tin

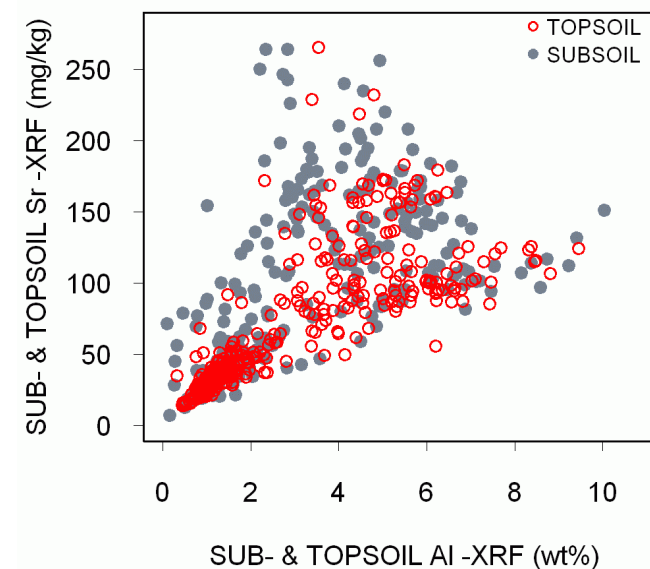
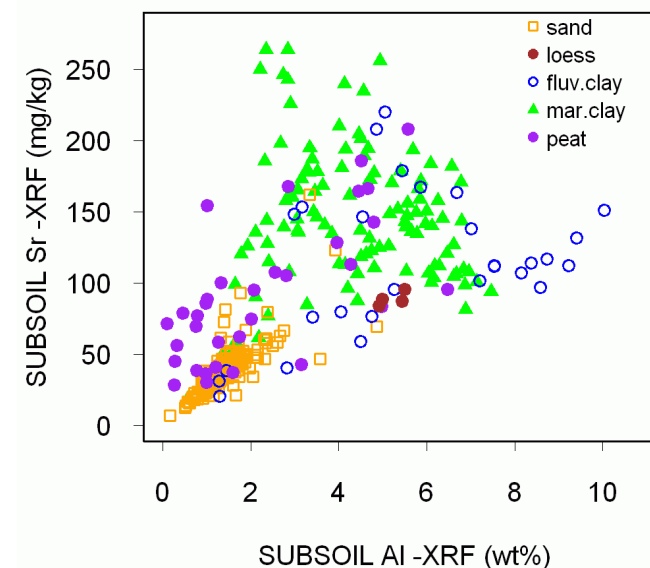


# Sr - Strontium

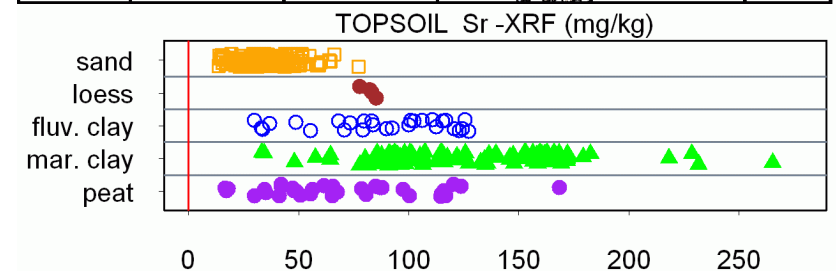
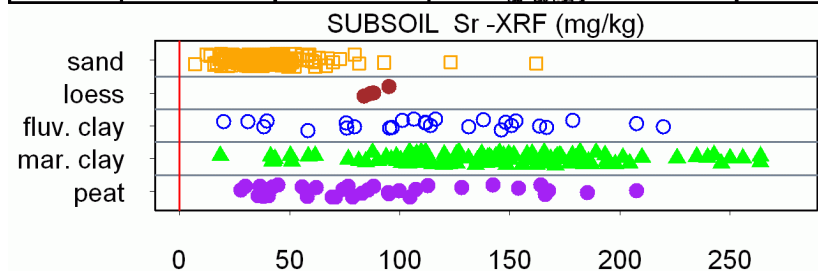
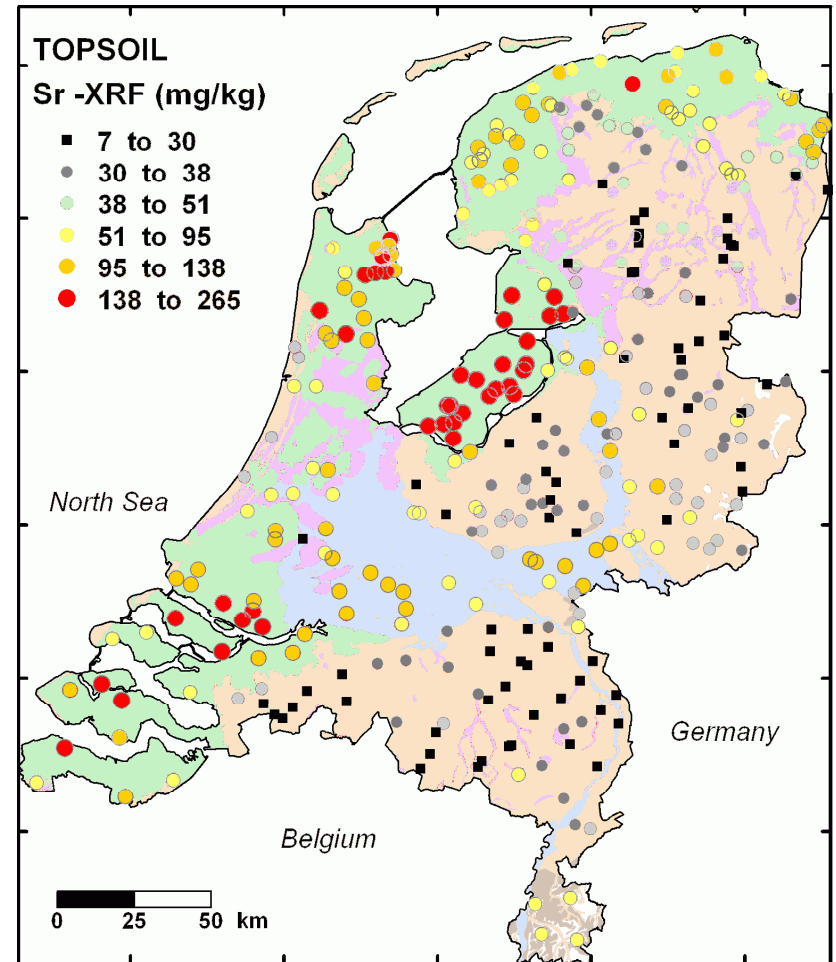
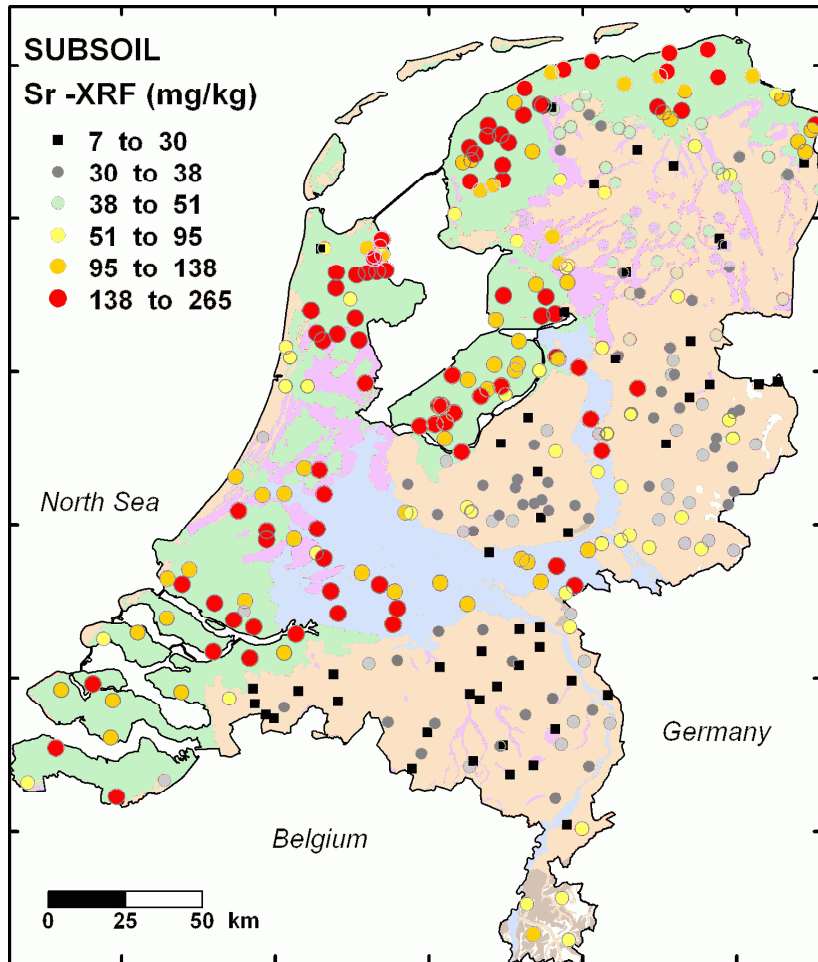
Atomic number: 38	Upper cont. crust: 316 / 350 mg/kg	River water: 60 µg/l
Atomic mass: 87.62	Shale/schist: 170 / 250 mg/kg	Ocean water: 7.8·10 <sup>3</sup> µg/l
Main ox. state(s): +2	Sandstone: 100 mg/kg	Human diet: 0.62 mg/kg
Electronegativity (Pauling): 0.95	Limestone: 500 mg/kg	Reference man: 4.6 mg/kg
Group: alkaline earth metals	Coal: 150 / 150 mg/kg	Yearly production: 170·10 <sup>3</sup> t
Affinity: lithophile	Volatility-ratio in coal: -6.1	
Host minerals: Strontianite (+), celestine (+), feldspars (-), micas (-), gypsum (-), calcite (-), dolomite (-).		
Uses: Alloys, color television tubes, fireworks, zinc refining.		
Remarks: Considered non-essential for most organisms.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	38.6	35.6	17.4	10.1	7.04	162
loess	4	88.5	87.5	4.78	3.25	83.9	95.2
fluviatile clay	28	113.9	111.9	51.0	53.1	20.3	220
marine clay	115	143.0	141.6	50.2	46.9	18.5	264
peat	33	91.9	83.1	49.0	44.3	28.0	208
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	34.8	33.7	11.2	10.1	13.6	77.0
loess	4	82.2	82.9	3.20	2.23	77.8	85.3
fluviatile clay	28	87.4	91.3	30.9	33.0	30.0	127
marine clay	115	121	108	40.2	31.7	33.3	265
peat	33	70.9	65.4	36.8	34.5	16.6	169

Concentrations are in mg/kg and based on 105 °C dry weight



# Sr - Strontium

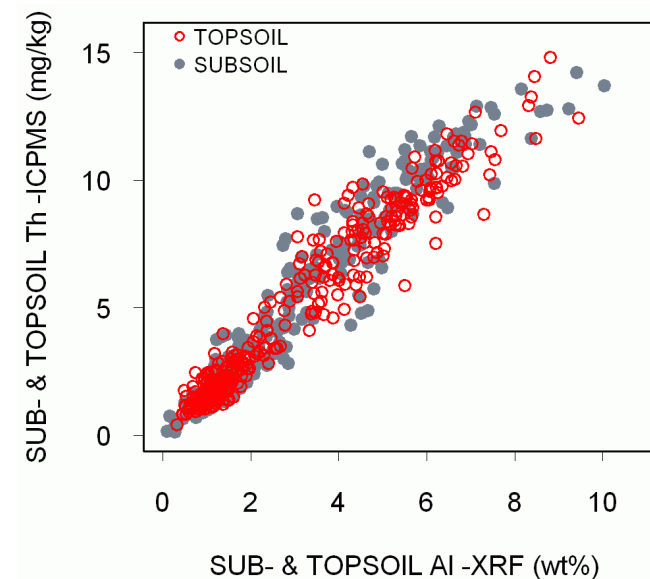
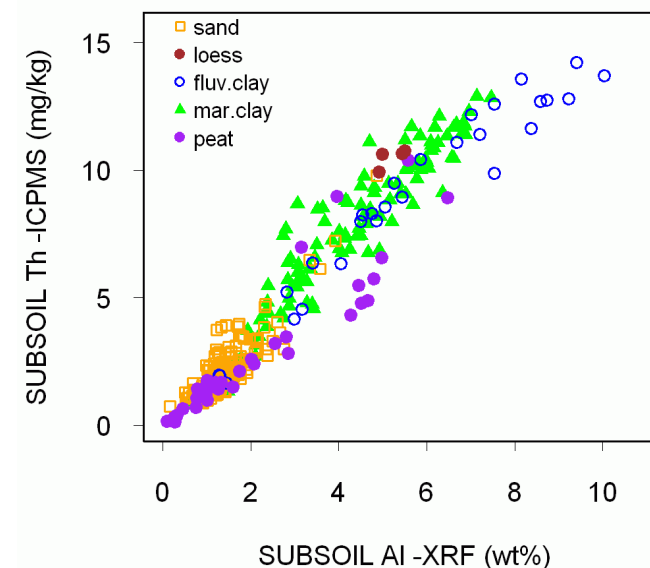


# Th - Thorium

Atomic number: 90	Upper cont. crust: 10 / 11 mg/kg	River water: 0.04 µg/l
Atomic mass: 232.038	Shale/schist: 12? / 12 mg/kg	Ocean water: 0.05·10 <sup>-3</sup> µg/l
Main ox. state(s): +4 (+2?, +3?)	Sandstone: 5 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.3	Limestone: 2 mg/kg	Reference man: 0.005 mg/kg
Group: Actinides	Coal: 2 / 2 mg/kg	Yearly production: 700 t
Affinity: lithophile	Volatility-ratio in coal: -8.9	
Host minerals: Thorite (+), monazite (+), zircon (-), sphene (-), epidote (-), xenotime (-).		
Uses: Nuclear industry, coating of optical lenses, Mg-Ni alloys.		
Remarks: Considered non-essential. Chemotoxic and radiotoxic.		

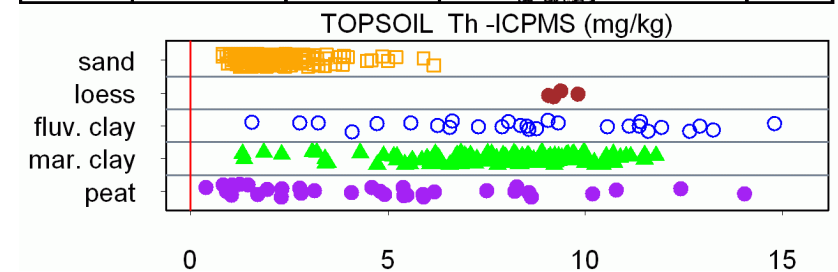
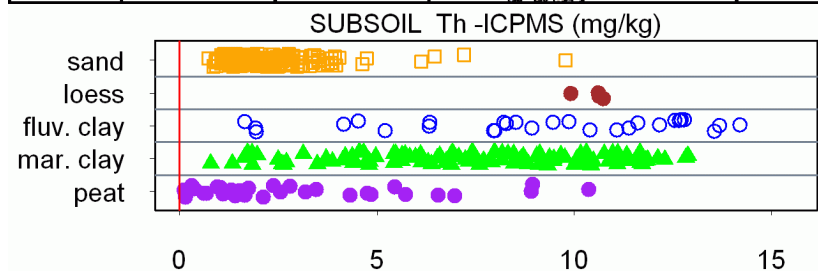
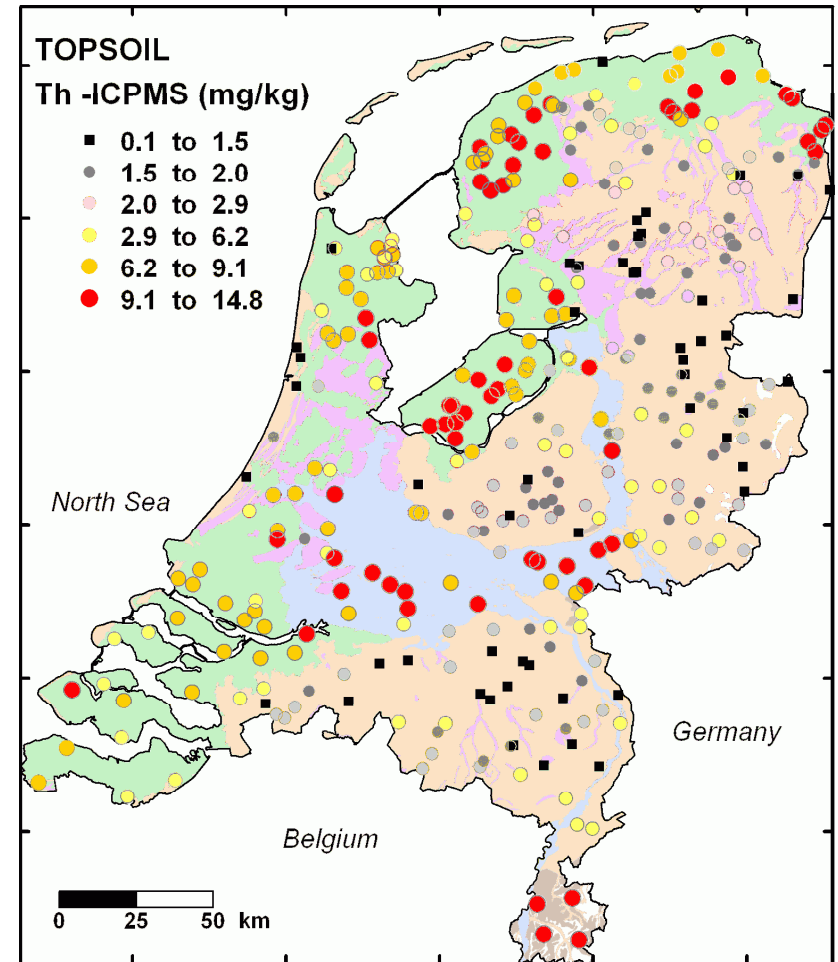
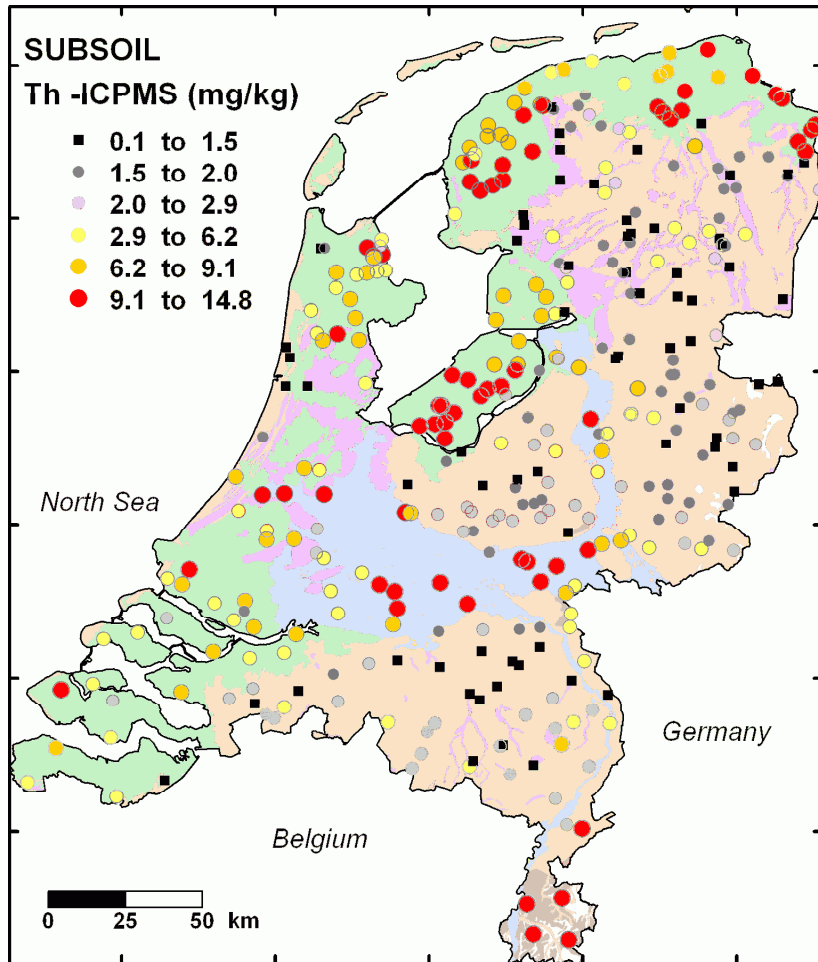
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	2.15	1.90	1.15	0.78	0.74	9.78
loess	4	10.5	10.6	0.38	0.094	9.92	10.8
fluviatile clay	28	8.94	9.20	3.77	4.32	1.66	14.2
marine clay	115	7.62	7.91	3.04	3.38	0.79	12.9
peat	33	3.07	1.76	2.78	1.68	0.13	10.4
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	2.10	1.92	0.91	0.70	0.81	6.17
loess	4	9.38	9.30	0.32	0.22	9.09	9.83
fluviatile clay	28	8.54	8.56	3.41	3.98	1.56	14.8
marine clay	115	7.80	8.20	2.26	2.09	1.31	11.8
peat	33	5.01	4.81	3.61	4.25	0.40	14.0

Concentrations are in mg/kg and based on 105 °C dry weight





# Th - Thorium

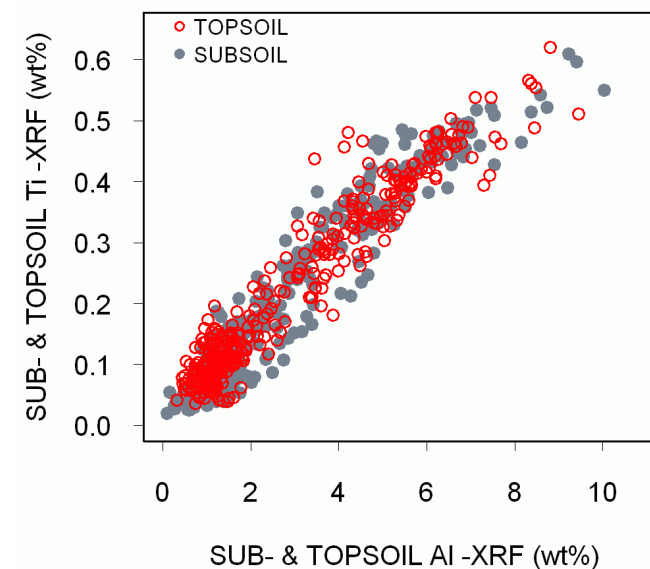
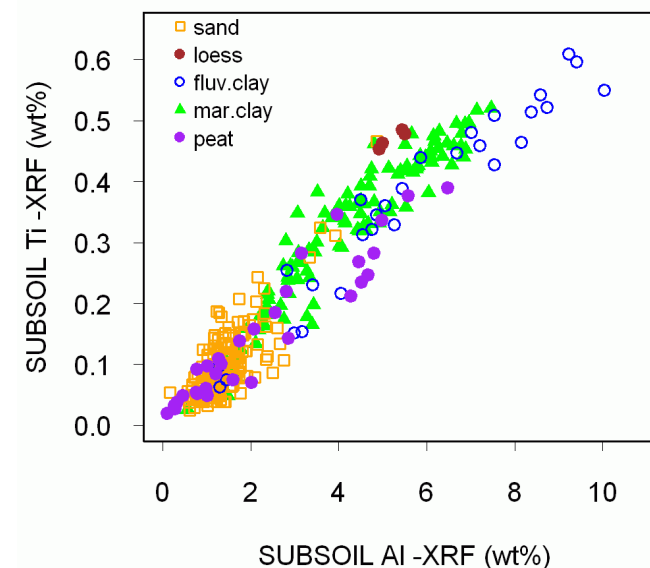


# Ti - Titanium

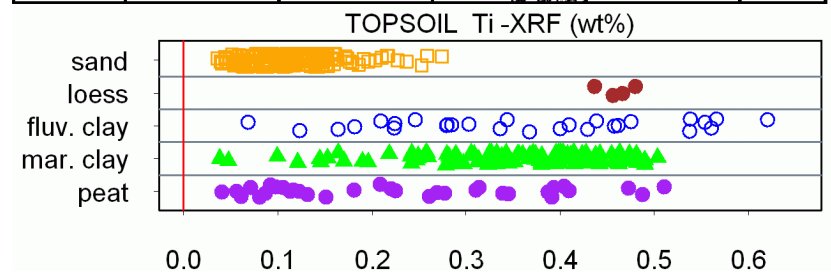
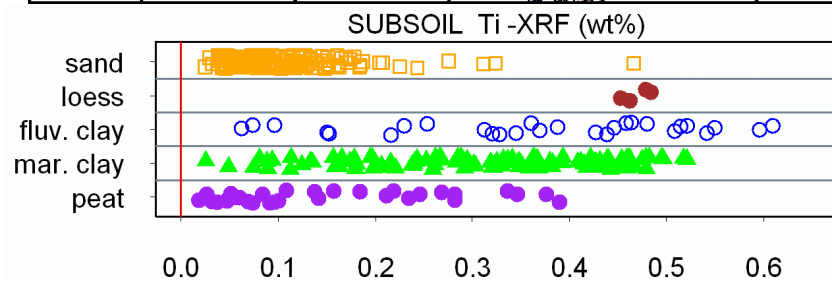
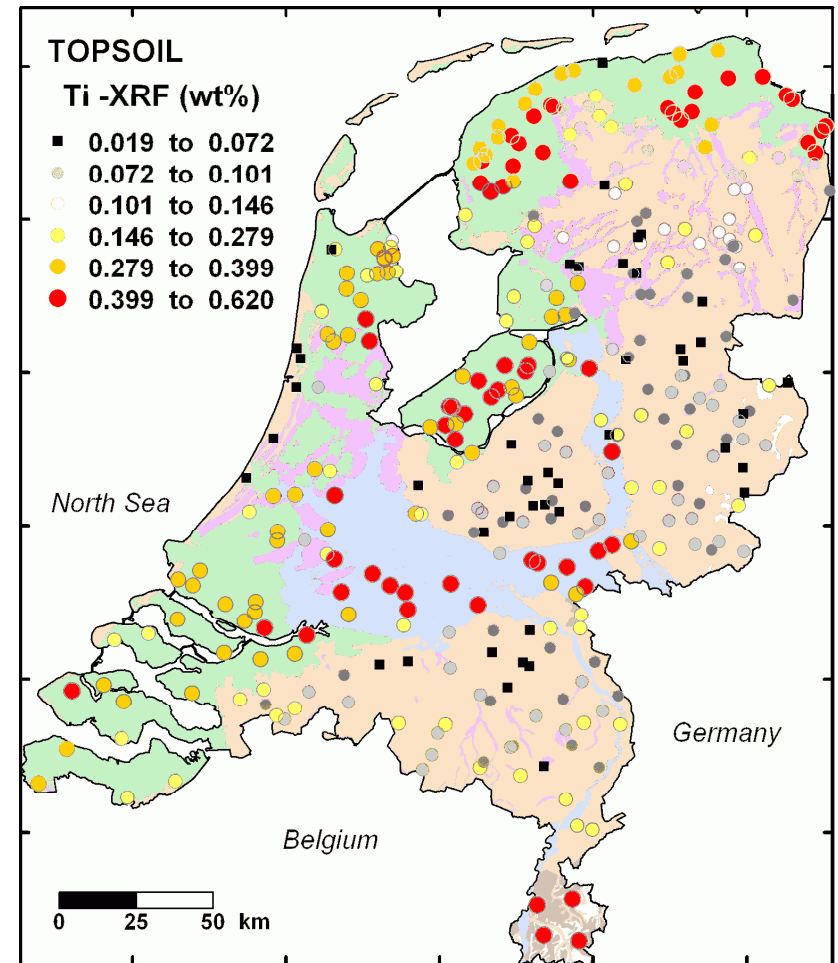
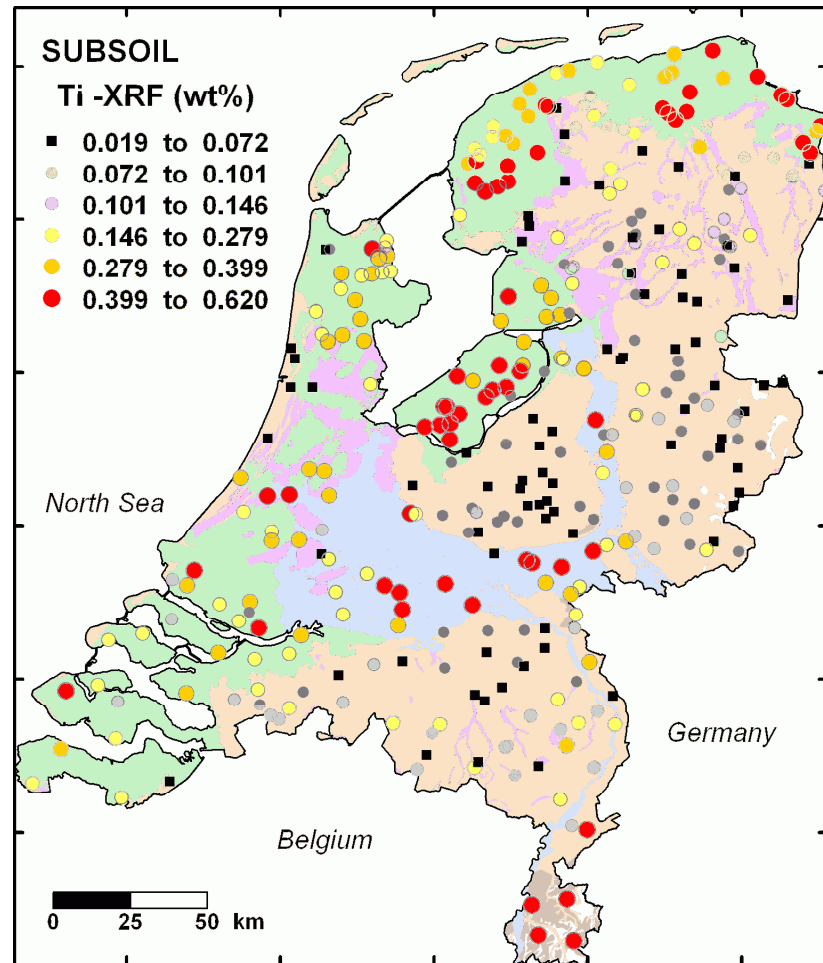
Atomic number: 22	Upper cont. crust: 0.31 / 0.30 wt%	River water: 10 µg/l
Atomic mass: 47.867	Shale/schist: 0.46 / 0.60 wt%	Ocean water: 0.01 µg/l
Main ox. state(s): +4 (+2, +3)	Sandstone: 0.15 wt%	Human diet: 0.6 mg/kg
Electronegativity (Pauling): 1.54	Limestone: 0.04 wt%	Reference man: ?
Group: transition metals	Coal: 0.10 wt%	Yearly production: 2.4·10 <sup>6</sup> t
Affinity: lithophile	Volatility-ratio in coal: -7.2	
Host minerals: Ilmenite (+), rutile (+), sphene (+), pyroxenes (-), amphiboles (-), micas (-), garnets (-).		
Uses: Pigments, alloys, catalyst in PE production, toothpaste, food additive.		
Remarks: Considered non-essential and generally non-toxic for organisms.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.098	0.086	0.057	0.042	0.025	0.466
loess	4	0.469	0.470	0.014	0.016	0.453	0.484
fluviatile clay	28	0.365	0.379	0.160	0.189	0.063	0.609
marine clay	115	0.324	0.348	0.123	0.136	0.026	0.521
peat	33	0.149	0.101	0.113	0.084	0.019	0.390
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.110	0.104	0.044	0.041	0.036	0.275
loess	4	0.460	0.461	0.018	0.018	0.437	0.480
fluviatile clay	28	0.360	0.356	0.150	0.170	0.069	0.620
marine clay	115	0.348	0.356	0.098	0.089	0.039	0.503
peat	33	0.235	0.220	0.143	0.182	0.041	0.511

Concentrations are in wt% and based on 105 °C dry weight



# Ti - Titanium

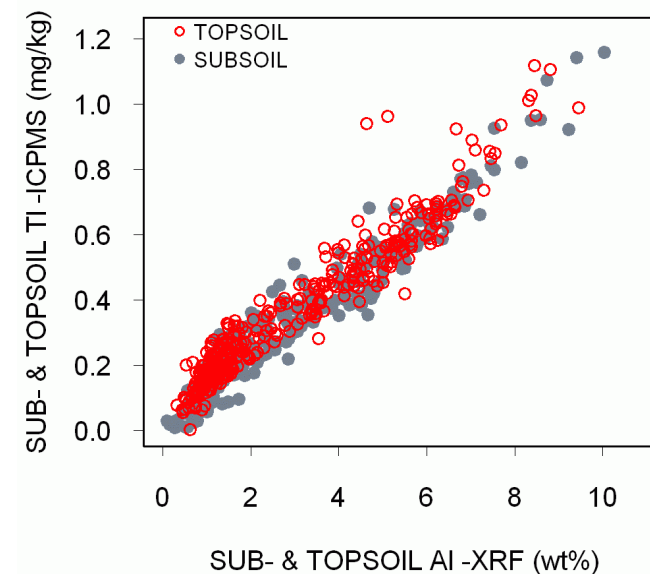
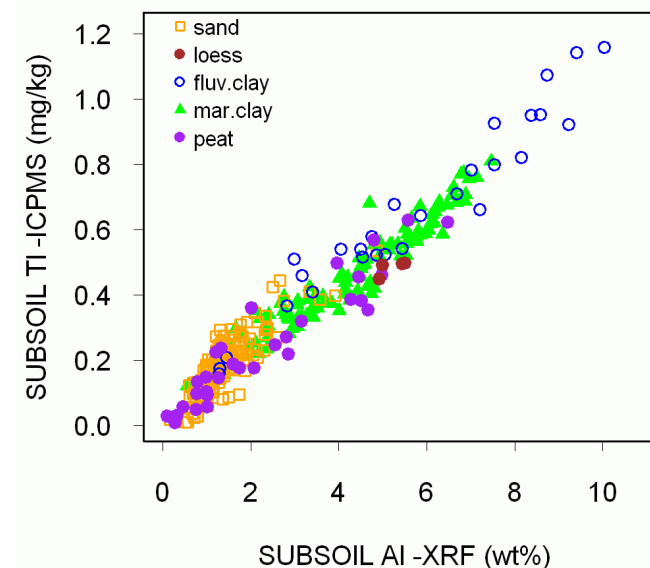


# Tl - Thallium

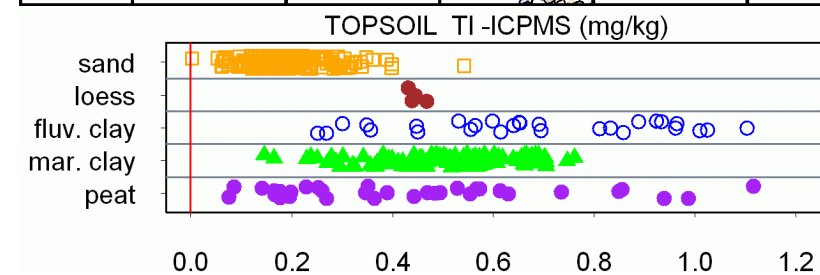
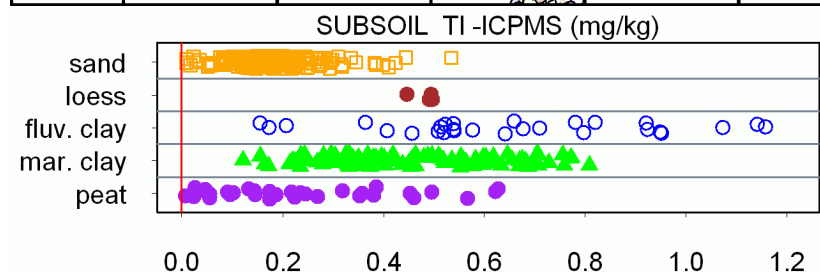
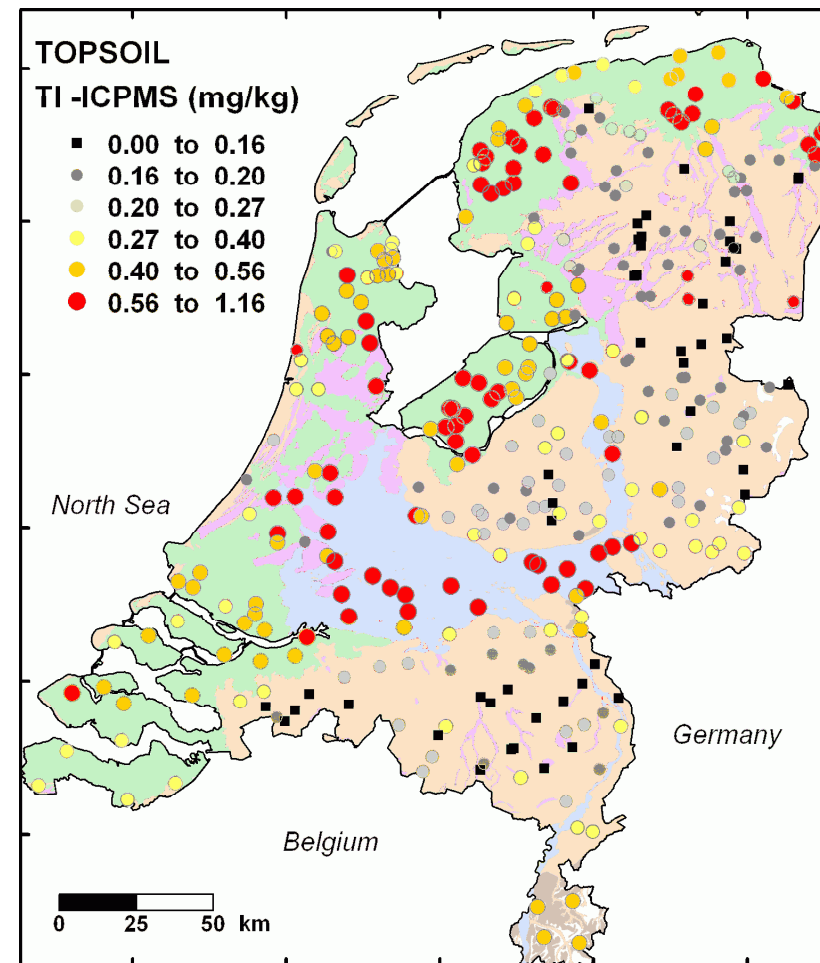
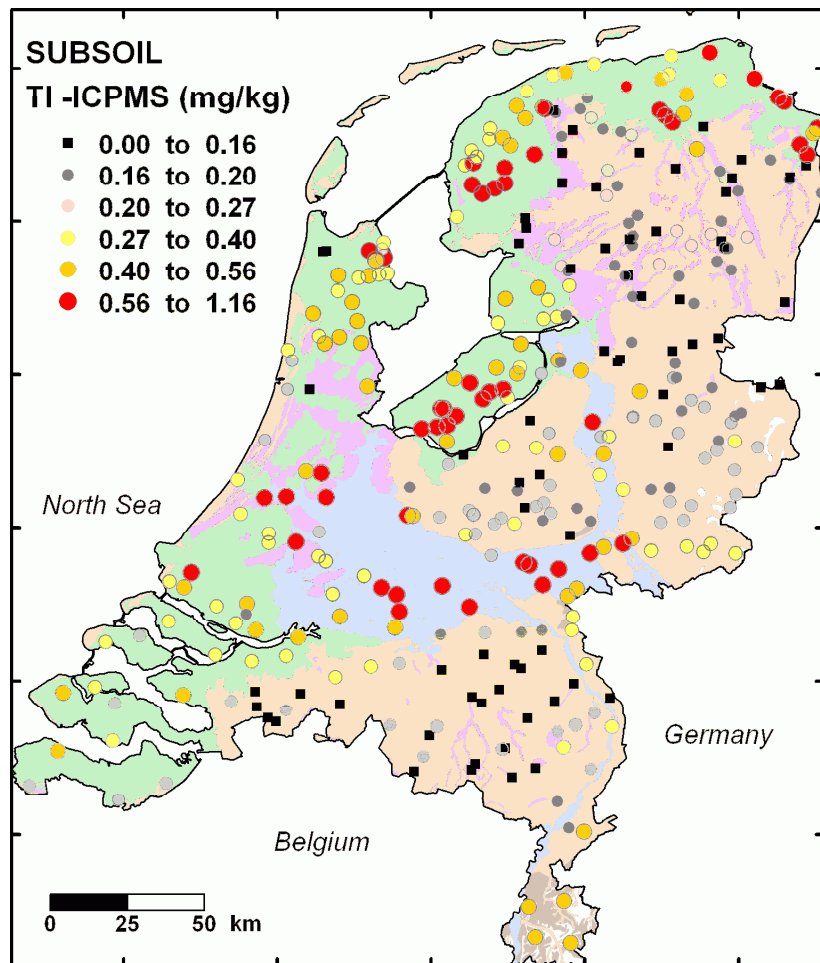
Atomic number: 81	Upper cont. crust: 0.75 / 0.75 mg/kg	River water: 0.04 µg/l
Atomic mass: 204.383	Shale/schist: 0.7? / 1 mg/kg	Ocean water: 0.014 µg/l
Main ox. state(s): +1 (+3)	Sandstone: 0.4 mg/kg	Human diet: ?
Electronegativity (Pauling): 2.04	Limestone: 0.05 mg/kg	Reference man: ?
Group: metals	Coal: 0.2 / 3 mg/kg	Yearly production: 30 t (in 1984)
Affinity: chalcophile	Volatility-ratio in coal: 3.5	
Host minerals: K-bearing silicates (-), sulphides (-).		
Uses: Alloys, low temperature thermometers, electronics, glass, rhodenticide.		
Remarks: Considered non-essential and highly toxic.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.19	0.18	0.081	0.063	0.009	0.53
loess	4	0.48	0.49	0.024	0.005	0.45	0.50
fluviatile clay	28	0.65	0.61	0.27	0.27	0.16	1.16
marine clay	115	0.46	0.44	0.16	0.18	0.12	0.81
peat	33	0.24	0.19	0.18	0.20	0.009	0.63
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.20	0.19	0.075	0.063	0.002	0.54
loess	4	0.45	0.44	0.016	0.010	0.43	0.47
fluviatile clay	28	0.68	0.65	0.25	0.30	0.25	1.10
marine clay	115	0.50	0.51	0.13	0.12	0.15	0.76
peat	33	0.45	0.39	0.28	0.28	0.076	1.12

Concentrations are in mg/kg and based on 105 °C dry weight

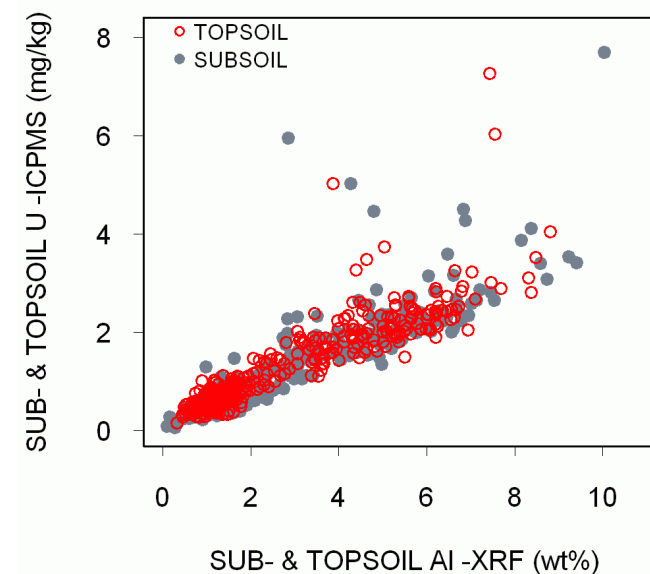
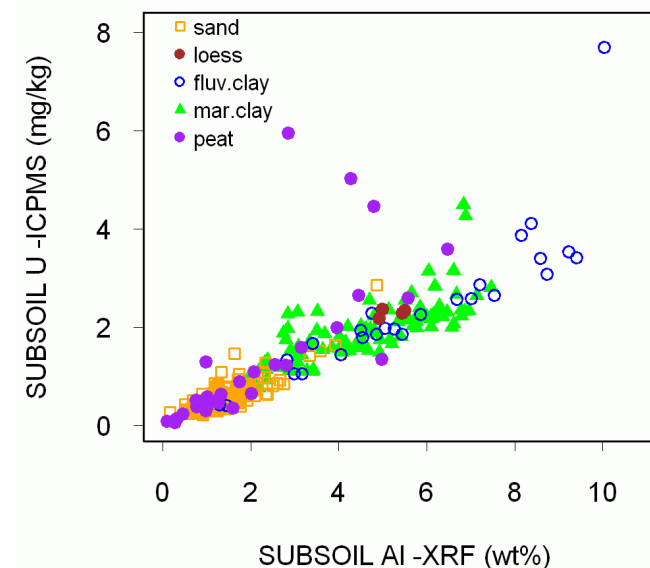


# TI - Thallium



# U - Uranium

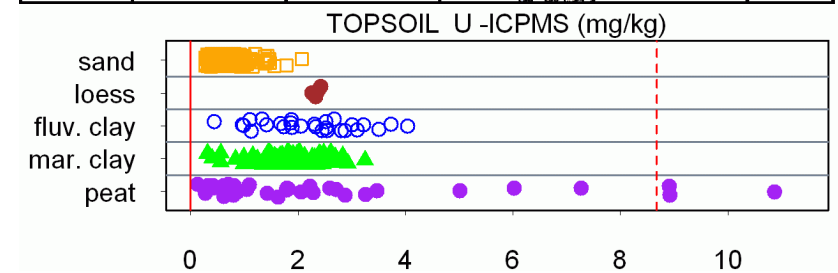
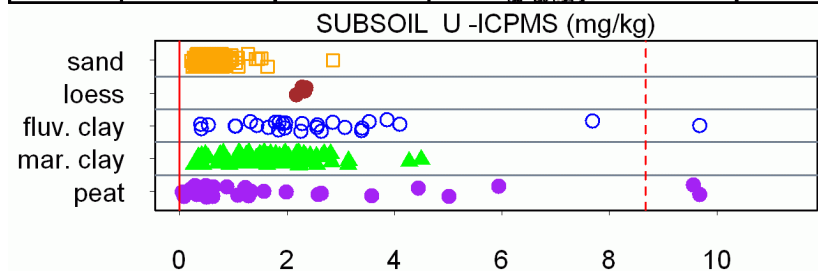
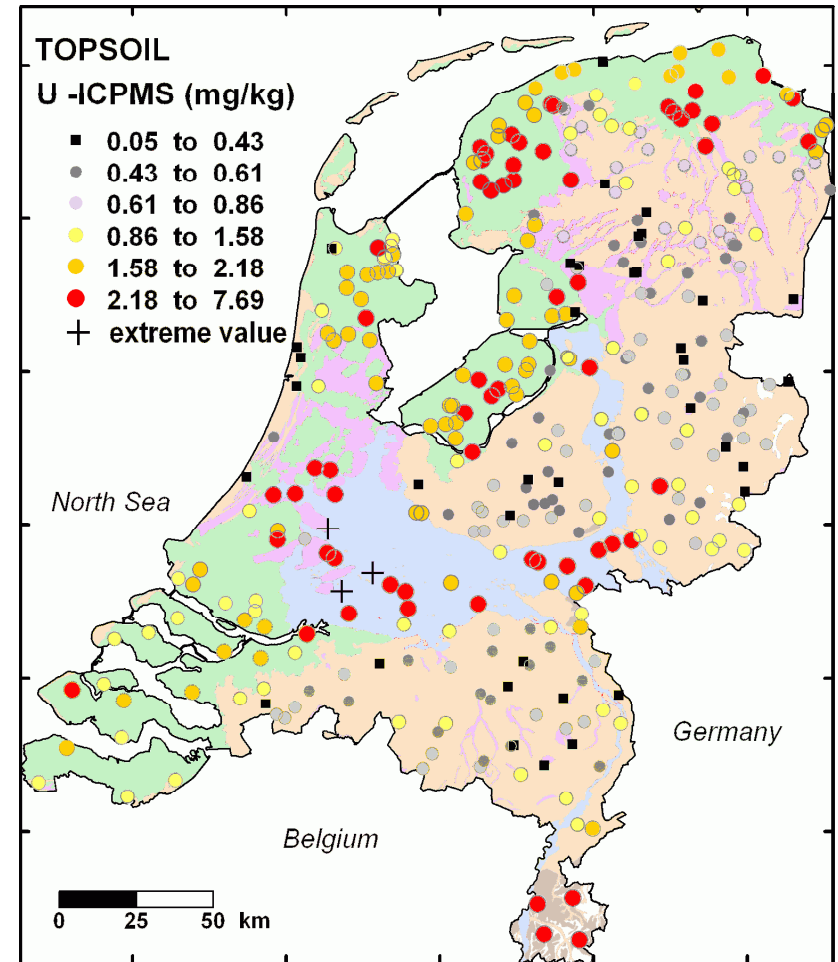
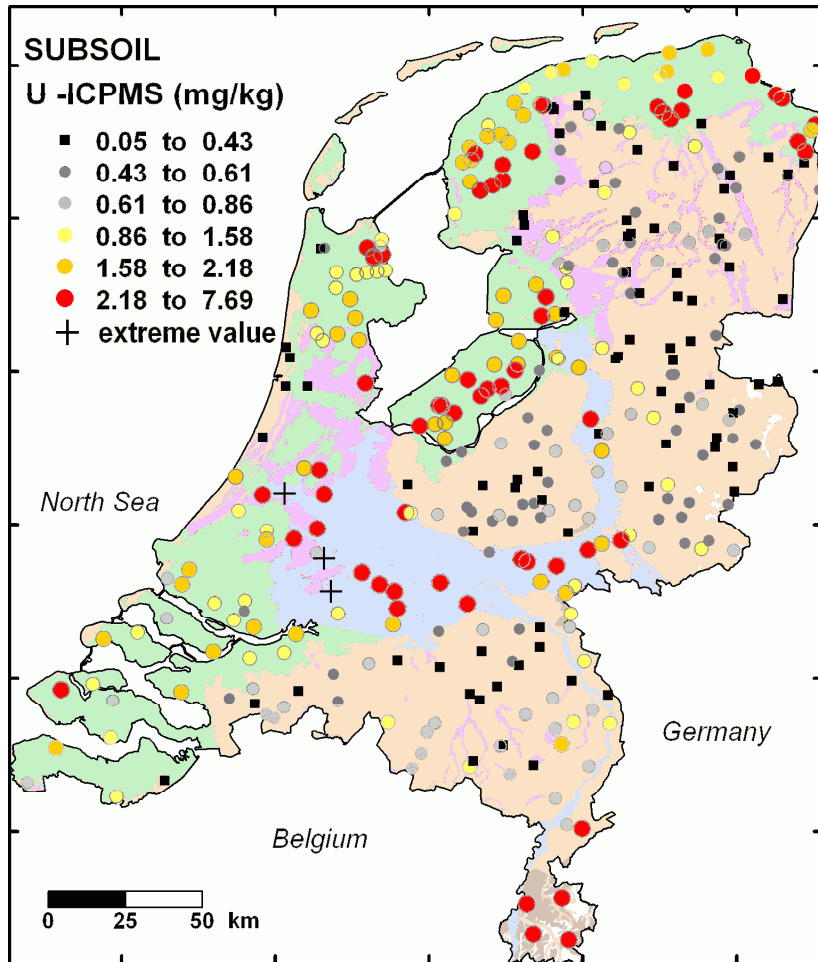
Atomic number: 92	Upper cont. crust: 2.5 / 2.8 mg/kg	River water: 0.24 µg/l
Atomic mass: 238.209	Shale/schist: 2.7 / 3.2 mg/kg	Ocean water: 3.2 µg/l
Main ox. state(s): +6 (+2, +3, +4, +5)	Sandstone: 1.3 mg/kg	Human diet: $0.7 \cdot 10^{-3}$ mg/kg
Electronegativity (Pauling): 1.38	Limestone: 1 mg/kg	Reference man: $13 \cdot 10^{-3}$ mg/kg
Group: actinides	Coal: 1 / 2 mg/kg	Yearly production: $32.7 \cdot 10^3$ t
Affinity: lithophile	Volatility-ratio in coal: -11	
Host minerals: Uraninite (+), zircon (-), apatite (-), allanite (-), monazite (-), Nb-Ta minerals (-).		
Uses: Nuclear industry, nuclear bombs, specific glass, ship ballast, counterweight of plane, missiles.		
Remarks: Considered non-essential. Chemotoxic and radiotoxic, carcinogenic.		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.56	0.48	0.30	0.21	0.22	2.85
loess	4	2.29	2.31	0.08	0.06	2.18	2.36
fluviatile clay	27	2.35	1.97	1.47	1.00	0.40	7.69
marine clay	115	1.77	1.77	0.71	0.67	0.27	4.50
peat	31	1.32	0.63	1.53	0.74	0.051	5.94
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.69	0.64	0.29	0.24	0.27	2.07
loess	4	2.35	2.35	0.071	0.073	2.26	2.43
fluviatile clay	28	2.22	2.32	0.90	0.89	0.45	4.04
marine clay	115	1.91	1.96	0.53	0.48	0.32	3.25
peat	30	1.89	1.53	1.73	1.34	0.14	7.27

Concentrations are in mg/kg and based on 105 °C dry weight

# U - Uranium

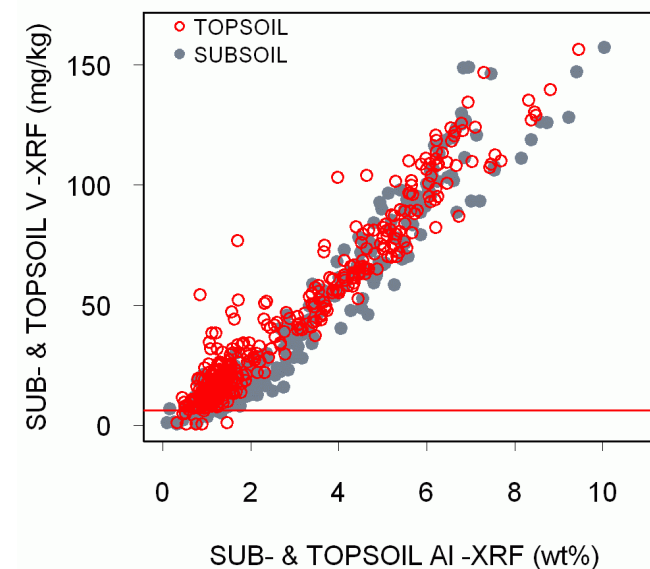
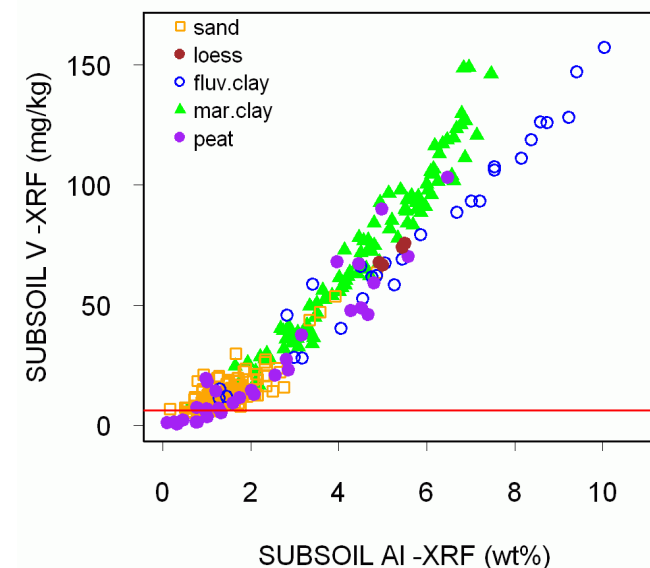


# V - Vanadium

Atomic number: 23	Upper cont. crust: 53 / 60 mg/kg	River water: 0.76 µg/l
Atomic mass: 50.941	Shale/schist: 130? / 130 mg/kg	Ocean water: 2.2 µg/l
Main ox. state(s): +5 (+2, +3, +4)	Sandstone: 20 mg/kg	Human diet: ?
Electronegativity (Pauling): 1.63	Limestone: 15 mg/kg	Reference man: ?
Group: transition metals	Coal: 20 / 40 mg/kg	Yearly production: 32·10 <sup>3</sup> t
Affinity: lithophile	Volatility-ratio in coal: -2.5	
Host minerals: Vanadates (+), magnetite (+ and -), pyroxenes (-), amphiboles (-), micas (-), sphene (-), rutile (-).		
Uses: Steel production, Ti alloys, catalysts (e.g. production of sulpheric acid), polymerization catalyst for propylene and ethylene.		
Remarks: Considered essential for some organisms. Toxicity depends on redox state.		

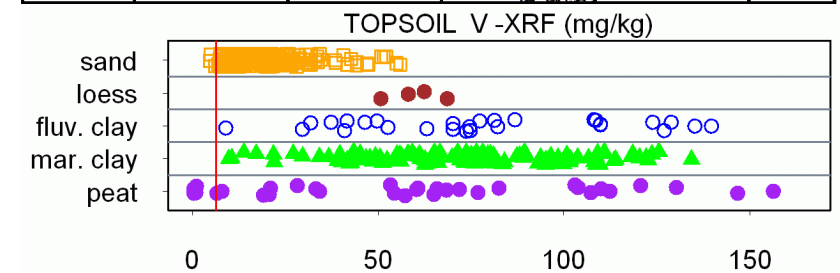
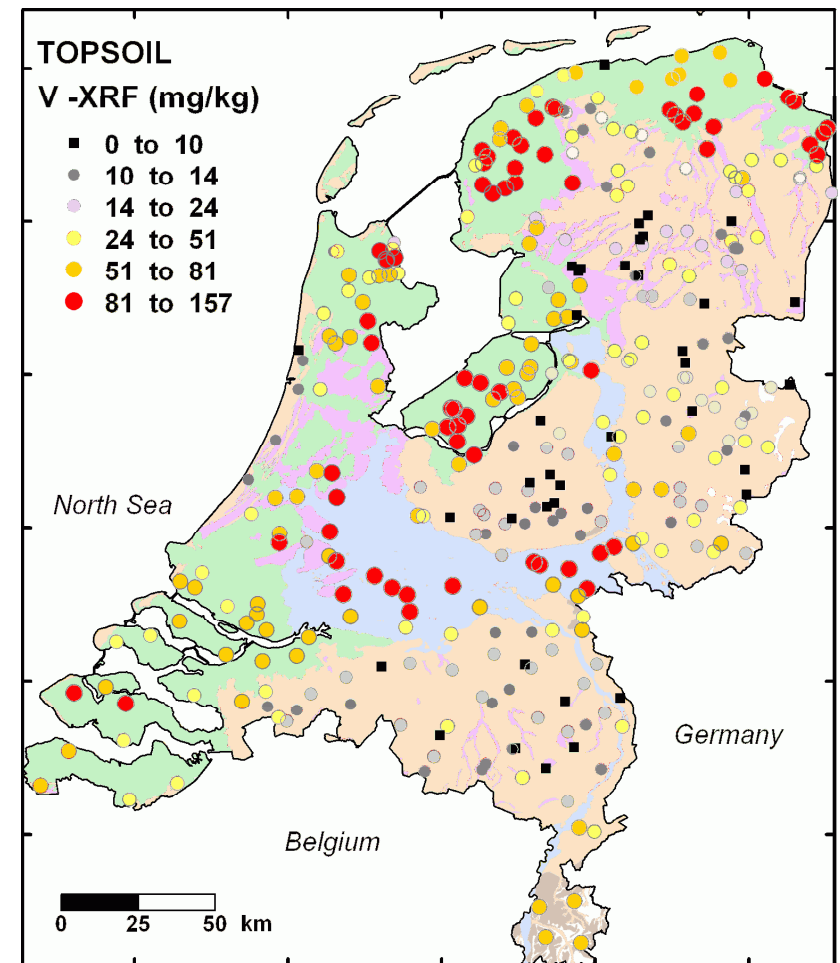
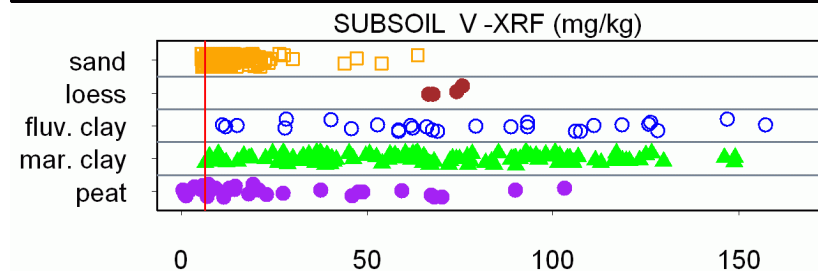
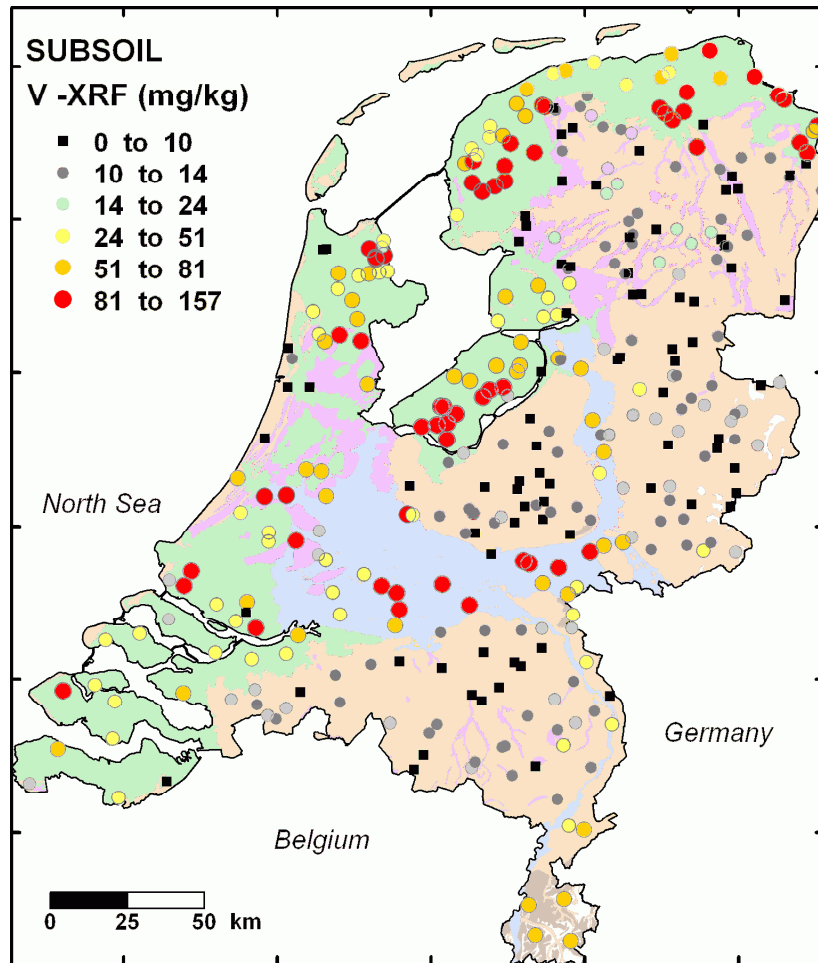
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	12.9	11.4	7.54	4.00	5.41	63.5
loess	4	71.1	71.0	4.51	5.56	66.6	75.7
fluviatile clay	28	77.1	68.3	41.1	48.8	11.1	157
marine clay	115	65.8	63.5	35.5	40.8	6.41	149
peat	33	25.9	14.3	28.5	19.3	0.51	103
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	19.4	17.2	10.6	8.92	4.63	55.8
loess	4	60.0	60.3	7.48	7.75	50.9	68.6
fluviatile clay	28	78.1	74.8	35.8	49.3	9.09	140
marine clay	115	73.1	73.4	28.3	32.1	9.81	134
peat	33	60.1	60.3	46.1	60.9	0.48	156

Concentrations are in mg/kg and based on 105 °C dry weight



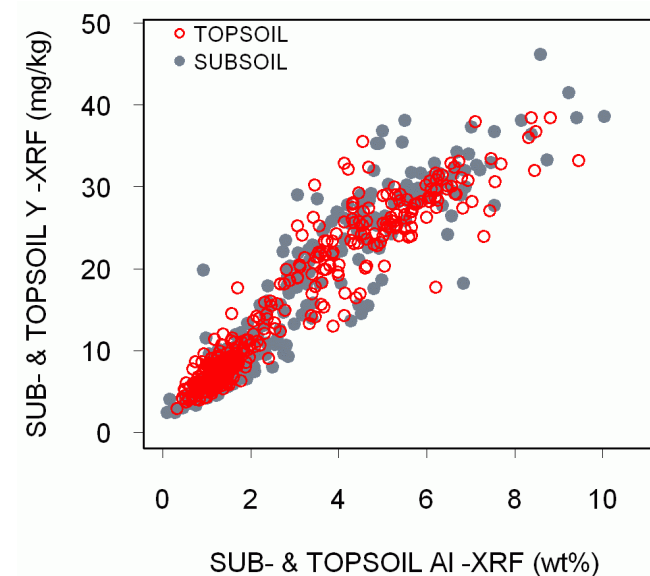
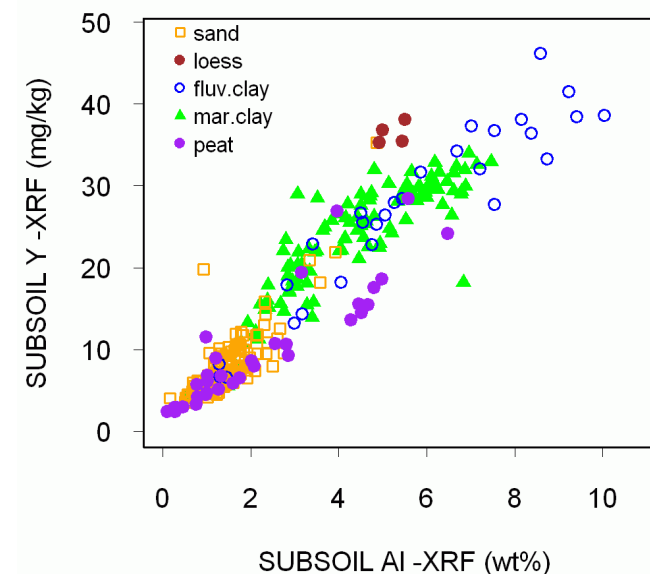


# V - Vanadium



# Y - Yttrium

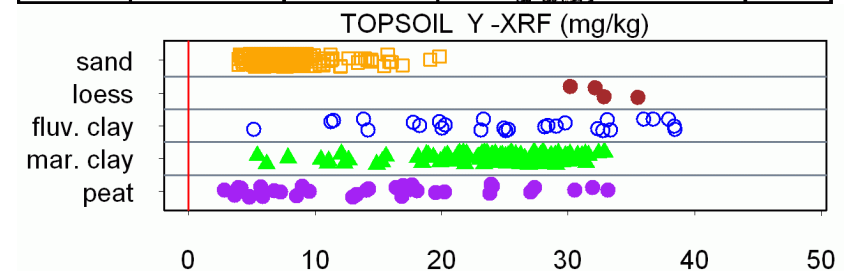
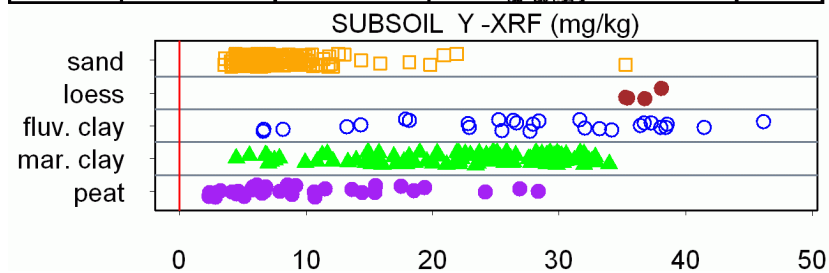
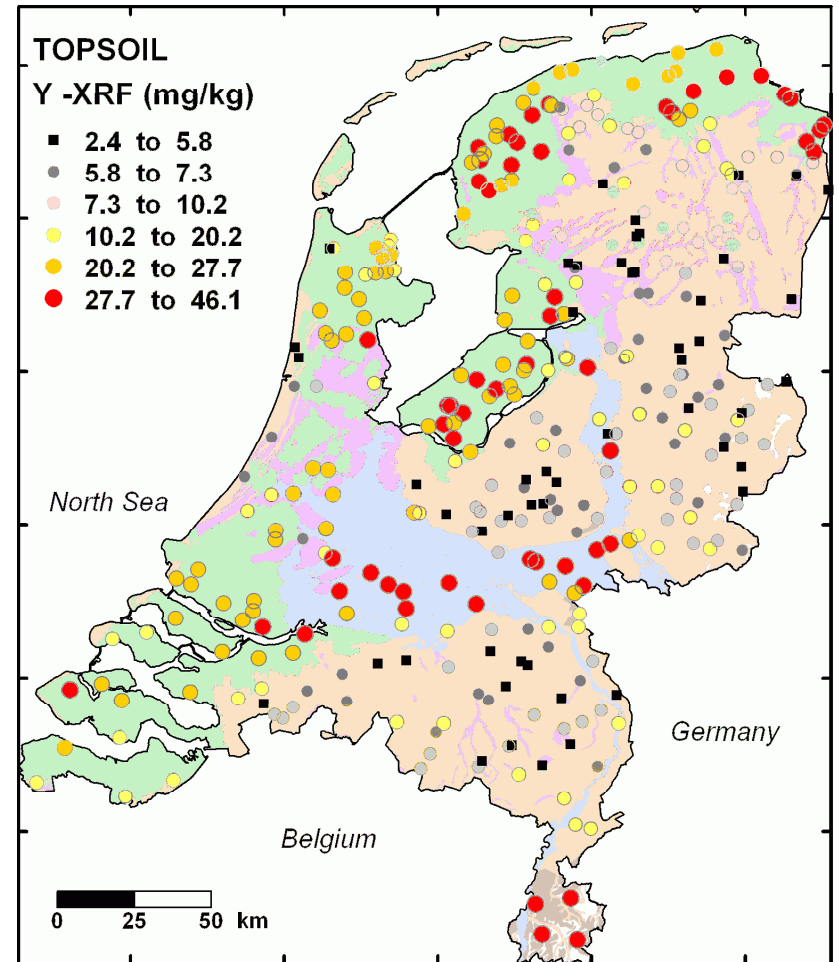
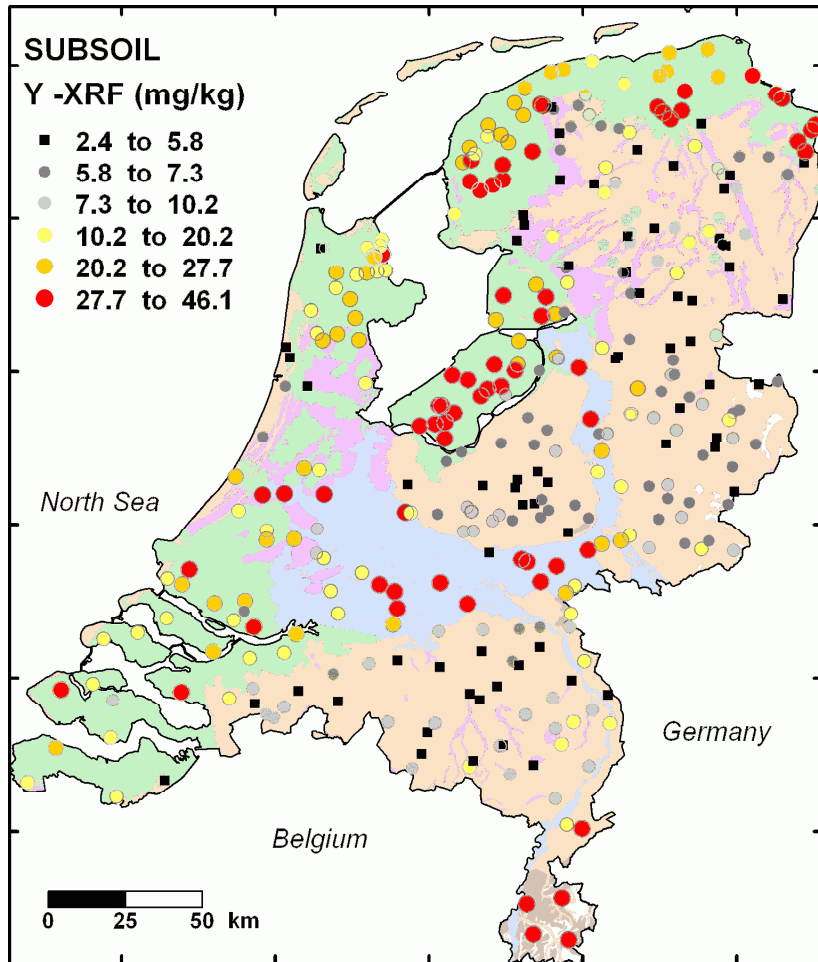
Atomic number: 39	Upper cont. crust: 21 / 22 mg/kg	River water: ?
Atomic mass: 88.905	Shale/schist: 26 / 30 mg/kg	Ocean water: 0.013 µg/l
Main ox. state(s): +3	Sandstone: 15 mg/kg	Human diet: 0.012 mg/kg
Electronegativity (Pauling): 1.22	Limestone: 4 mg/kg	Reference man: ?
Group: transition metals	Coal: 7 / 3 mg/kg	Yearly production: 1150 t
Affinity: lithophile	Volatility-ratio in coal: ?	
Host minerals: Monazite (+), xenotime (+), biotite (-), pyroxenes (-), feldspars (-), apatite (-).		
Uses: Ceramic industry, alloys (e.g. Cu-Ni steel), high temperature superconductors, lasers, catalyst in ethylene polymerization, glass, fluorescent materials.		
Remarks: Non-essential. Toxicity considered low.		



SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	7.52	6.67	3.61	2.14	3.52	35.3
loess	4	36.4	36.1	1.31	1.13	35.3	38.1
fluviatile clay	28	27.2	27.8	10.8	13.0	6.62	46.1
marine clay	115	23.0	24.8	7.39	7.03	4.48	33.9
peat	33	10.1	7.97	7.20	5.60	2.37	28.4
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	7.85	7.32	2.86	2.15	3.92	19.8
loess	4	32.7	32.5	2.19	1.96	30.2	35.5
fluviatile clay	28	25.3	25.2	9.19	10.81	5.15	38.4
marine clay	115	24.3	25.4	5.65	4.27	5.44	32.9
peat	33	15.1	14.3	9.04	11.1	2.85	33.2

Concentrations are in mg/kg and based on 105 °C dry weight

# Y - Yttrium

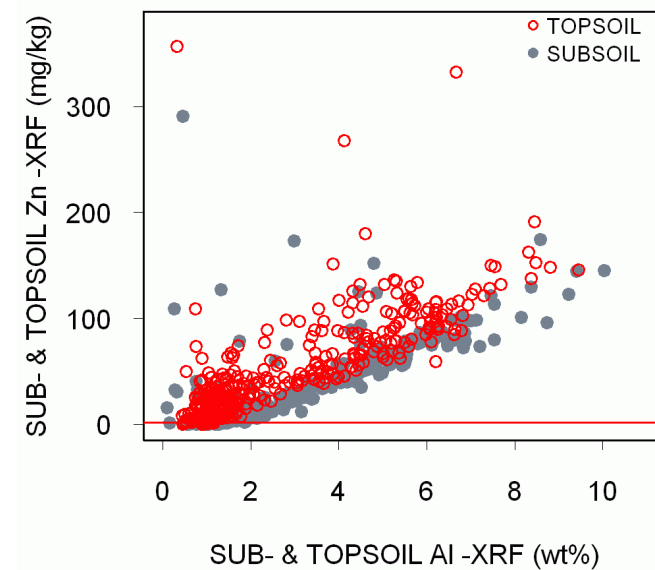
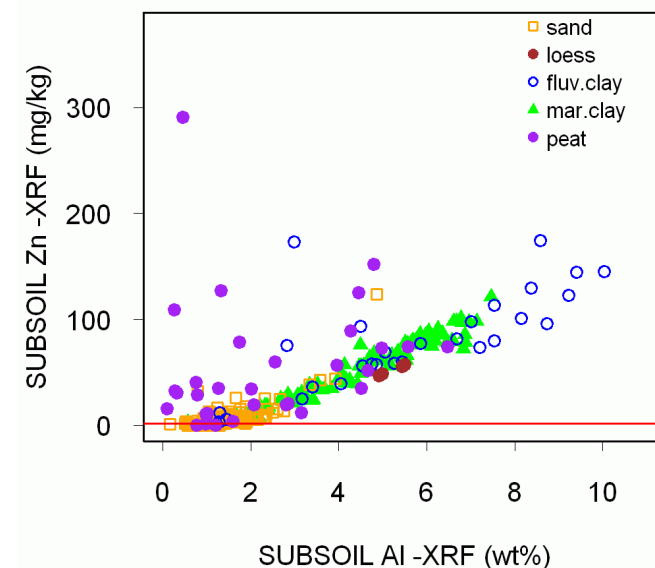


# Zn - Zinc

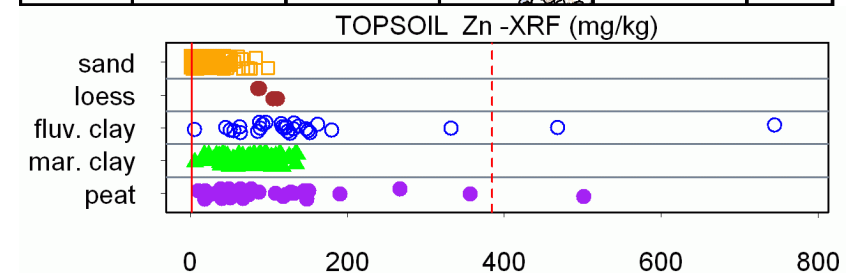
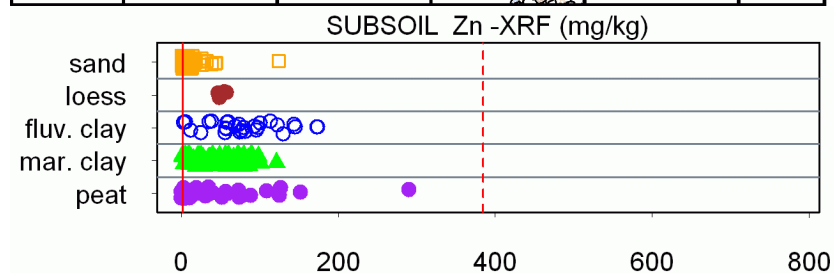
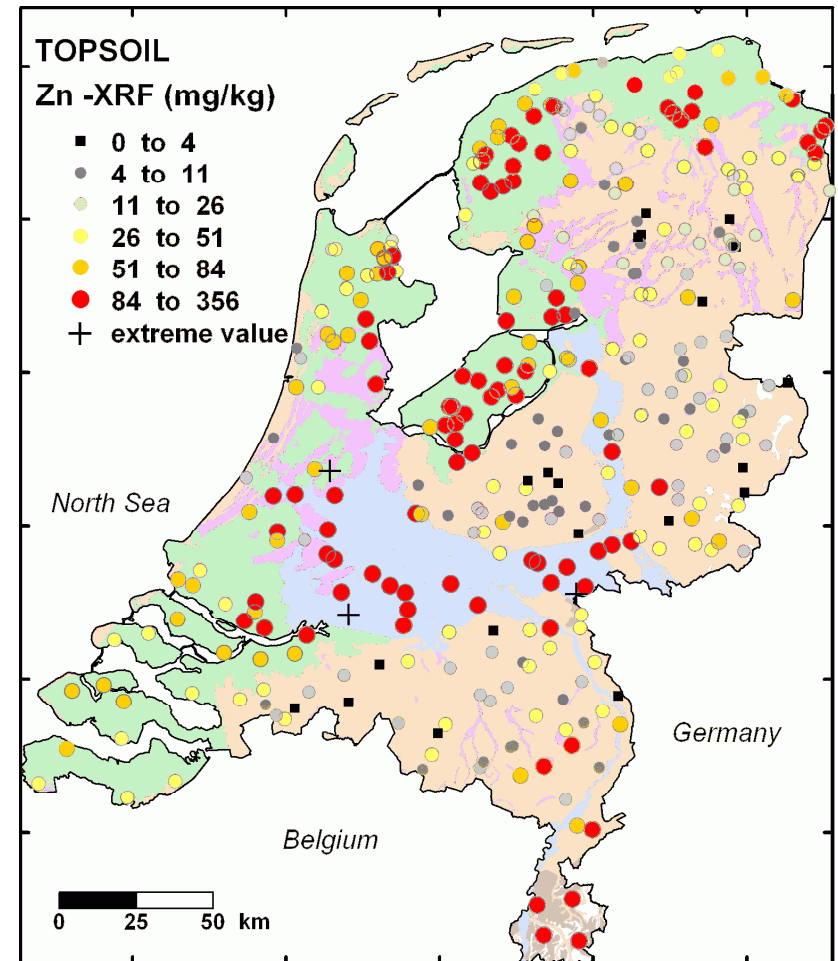
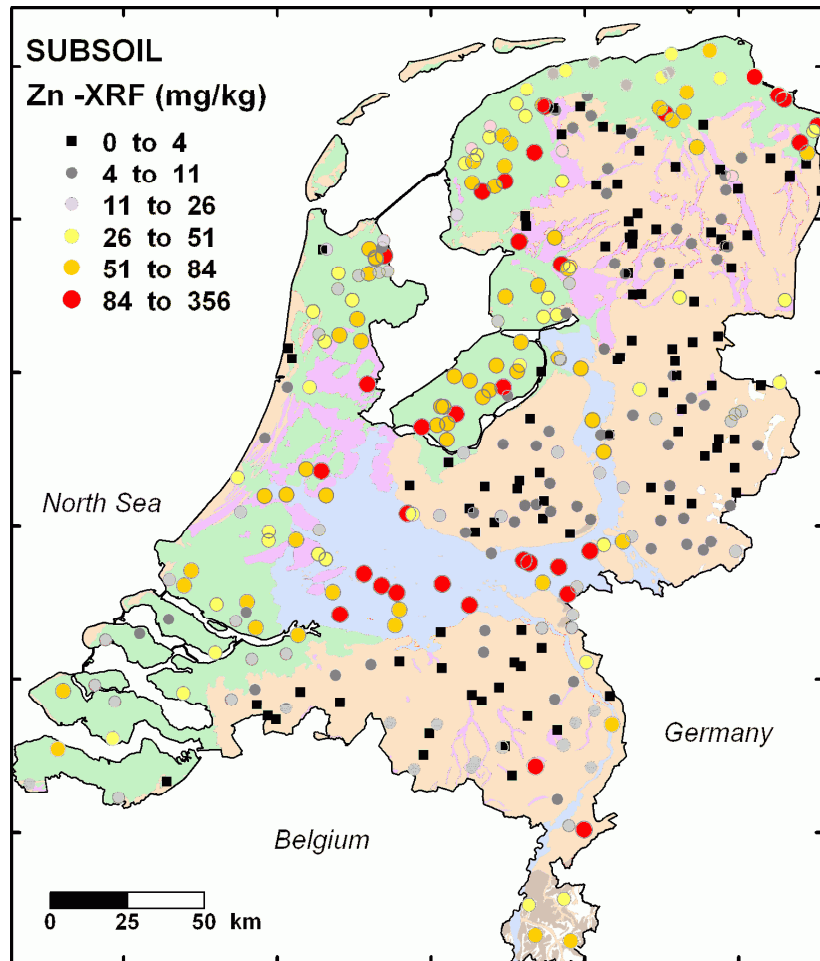
Atomic number: 30	Upper cont. crust: 52 / 71 mg/kg	River water: 0.7 µg/l
Atomic mass: 65.39	Shale/schist: 95 / 100 mg/kg	Ocean water: 0.32 µg/l
Main ox. state(s): +2	Sandstone: 20 mg/kg	Human diet: 10 mg/kg
Electronegativity (Pauling): 1.65	Limestone: 40 mg/kg	Reference man: 33 mg/kg
Group: (transition) metals	Coal: 50 / 50 mg/kg	Yearly production: 6.8·10 <sup>6</sup> t
Affinity: chalcophile	Volatility-ratio in coal: -0.01	
Host minerals: Sphalerite/wurtzite (+), zincite (+), pyroxenes (-), amphiboles (-), micas (-), garnets (-), magnetite (-).		
Uses: Galvanizing, alloys, rubber production, pigments and paint, glass, plastics, lubricants, batteries, pesticides, pharmaceuticals, buildings (e.g. gutters and drains).		
Remarks: Essential for all organisms. Toxicity considered low, deficiency more important. Environmental legislation for soils in the Netherlands (background: 140 mg/kg, sanitation: 720 mg/kg).		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	6.30	3.88	11.2	3.40	0.038	124
loess	4	51.8	51.8	5.19	6.53	46.6	57.1
fluviatile clay	28	80.4	75.9	46.2	34.5	3.26	174
marine clay	115	49.3	48.2	29.2	36.6	0.58	121
peat	33	52.1	33.9	58.8	34.7	0.052	290
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	21.4	19.0	17.1	16.0	0.024	98.2
loess	4	97.9	97.1	12.4	14.4	86.2	111
fluviatile clay	26	115	119	60.5	45.3	5.01	332
marine clay	115	75.8	77.4	29.5	35.4	5.81	136
peat	32	91.4	67.1	74.3	49.7	10.1	356

Concentrations are in mg/kg and based on 105 °C dry weight



# Zn - Zinc

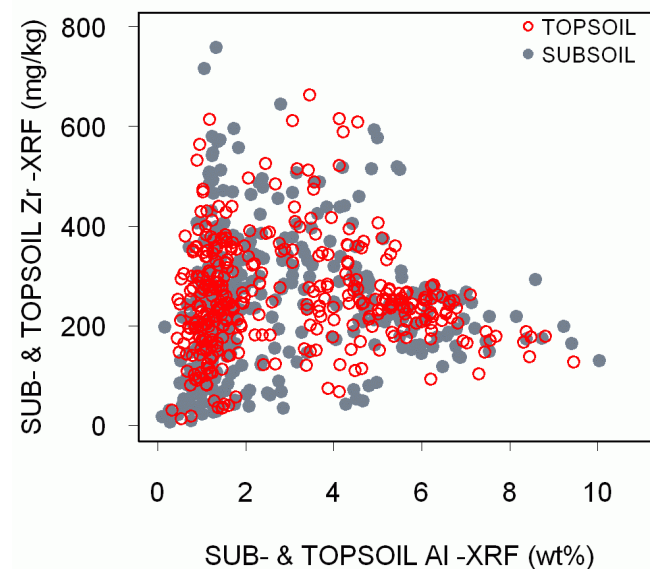
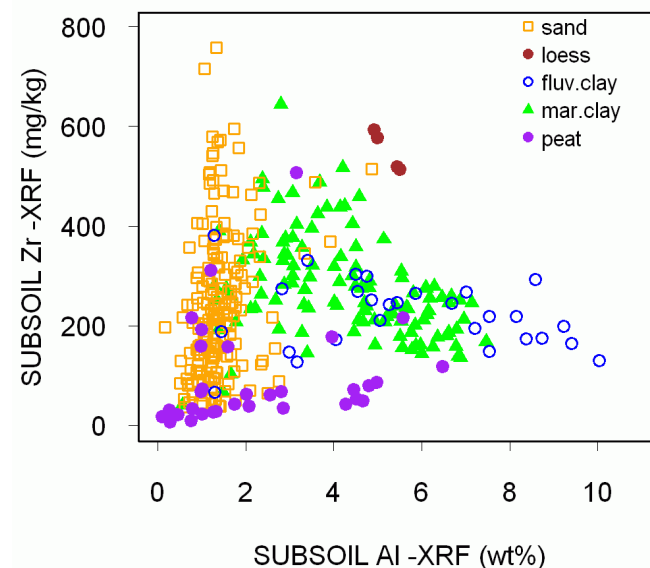


# Zr - Zircon

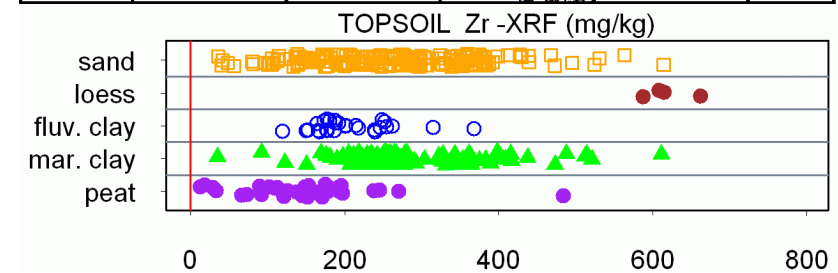
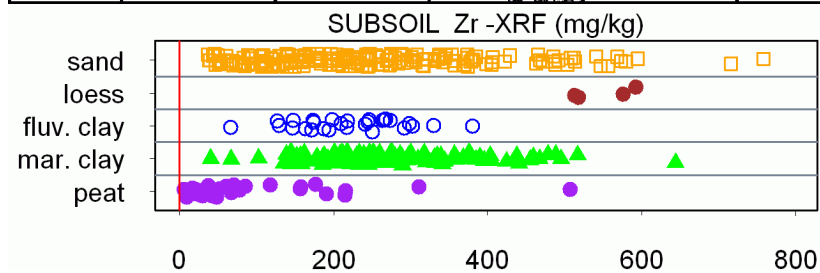
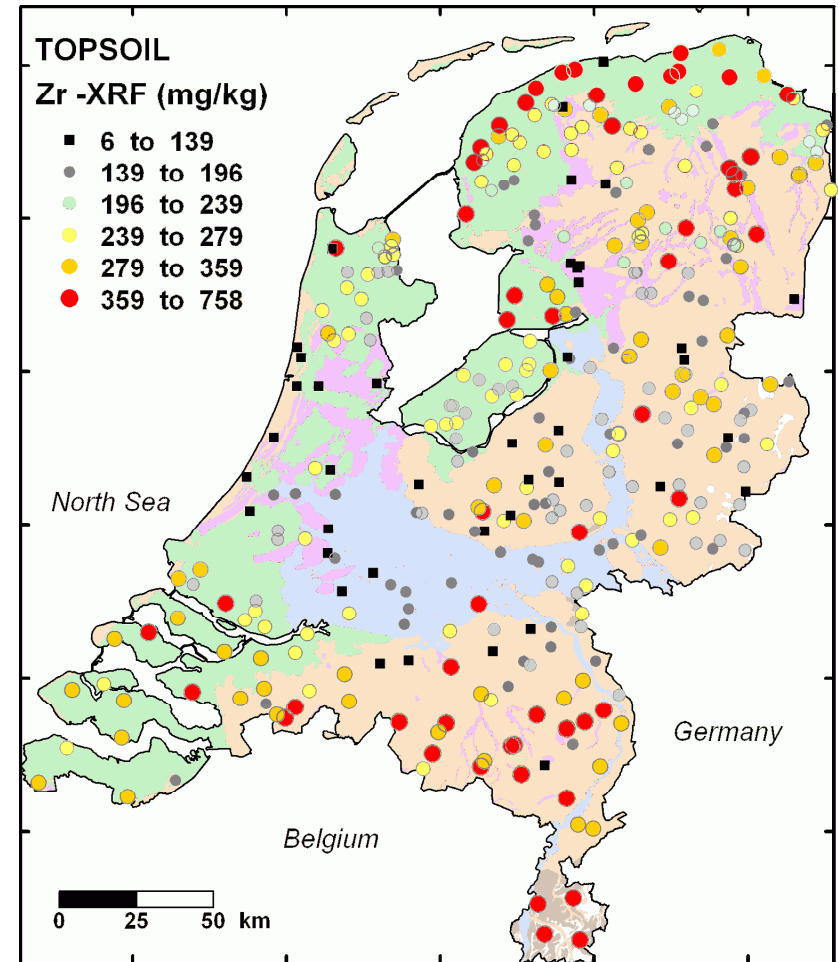
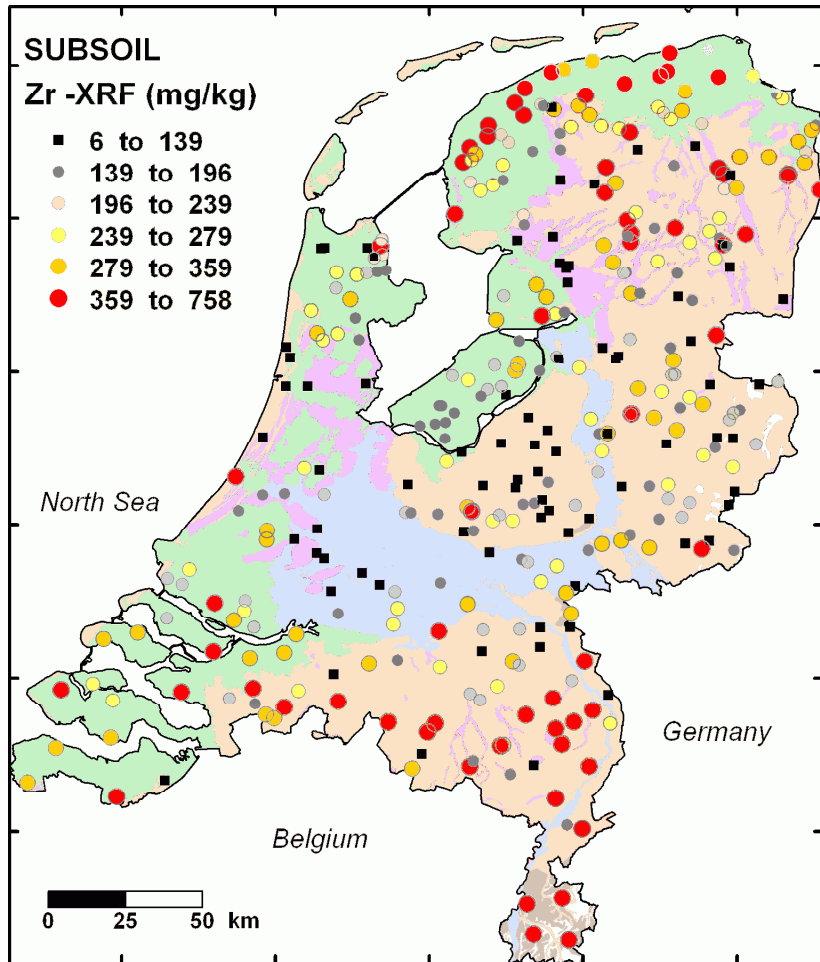
Atomic number: 40	Upper cont. crust: 240 / 190 mg/kg	River water: 1? µg/l
Atomic mass: 91.224	Shale/schist: 160 / 160 mg/kg	Ocean water: 0.017 µg/l
Main ox. state(s): +4 (+2, +3)	Sandstone: 250 mg/kg	Human diet: 0.04 mg/kg
Electronegativity (Pauling): 1.33	Limestone: 20 mg/kg	Reference man: ?
Group: transition metals	Coal: 50 / 20 mg/kg	Yearly production: 950·10 <sup>3</sup> t Zr sand
Affinity: lithophile	Volatility-ratio in coal: -11	
Host minerals: Zircon (+), baddeleyite (+), pyroxenes (-), amphiboles (-), micas (-), garnets (-), ilmenite (-), rutile (-).		
Uses: Glass and ceramic industry, abrasives, nuclear industry, textile impregnation, alloys.		
Remarks: Considered non-essential. Toxicity considered low.		

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	245	219	147	144	36.5	758
loess	4	550	547	40.5	46.6	513	593
fluviatile clay	28	221	218	69.7	70.4	66.5	381
marine clay	115	276	259	101	90.7	40.6	644
peat	33	93.5	60.7	104	49.1	6.06	507
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	257	248	107	111	35.7	614
loess	4	618	612	31.3	20.2	588	662
fluviatile clay	28	208	191	52.8	37.5	120	368
marine clay	115	283	260	88.6	54.6	35.2	611
peat	33	148	147	87.6	66.0	13.1	484

Concentrations are in mg/kg and based on 105 °C dry weight



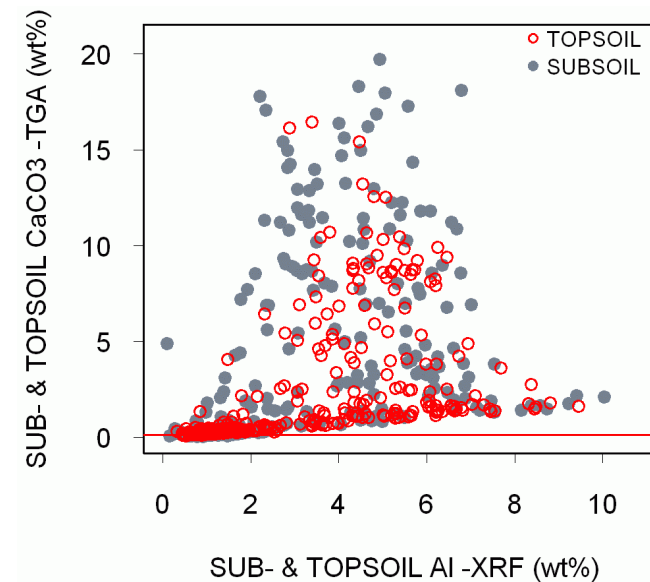
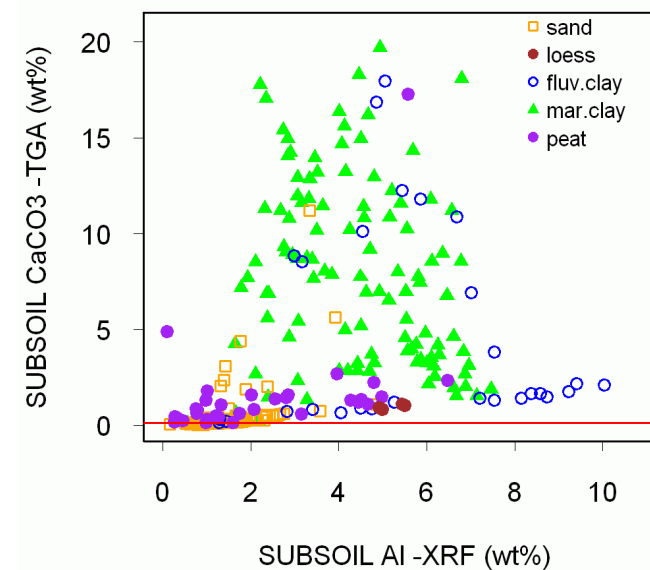
# Zr - Zircon



# CaCO<sub>3</sub> - Carbonates

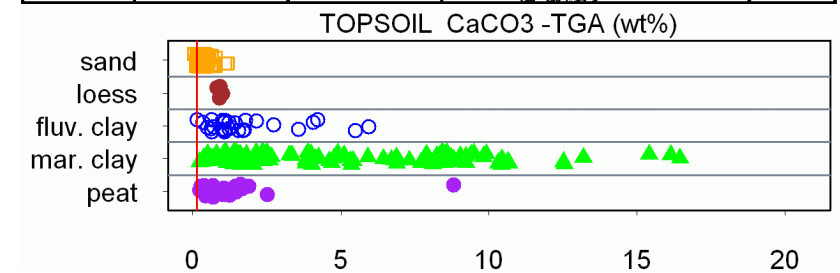
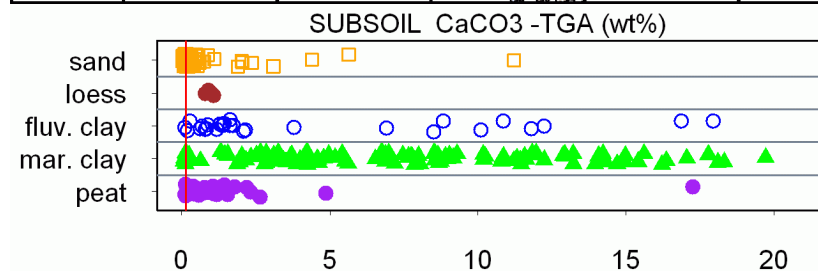
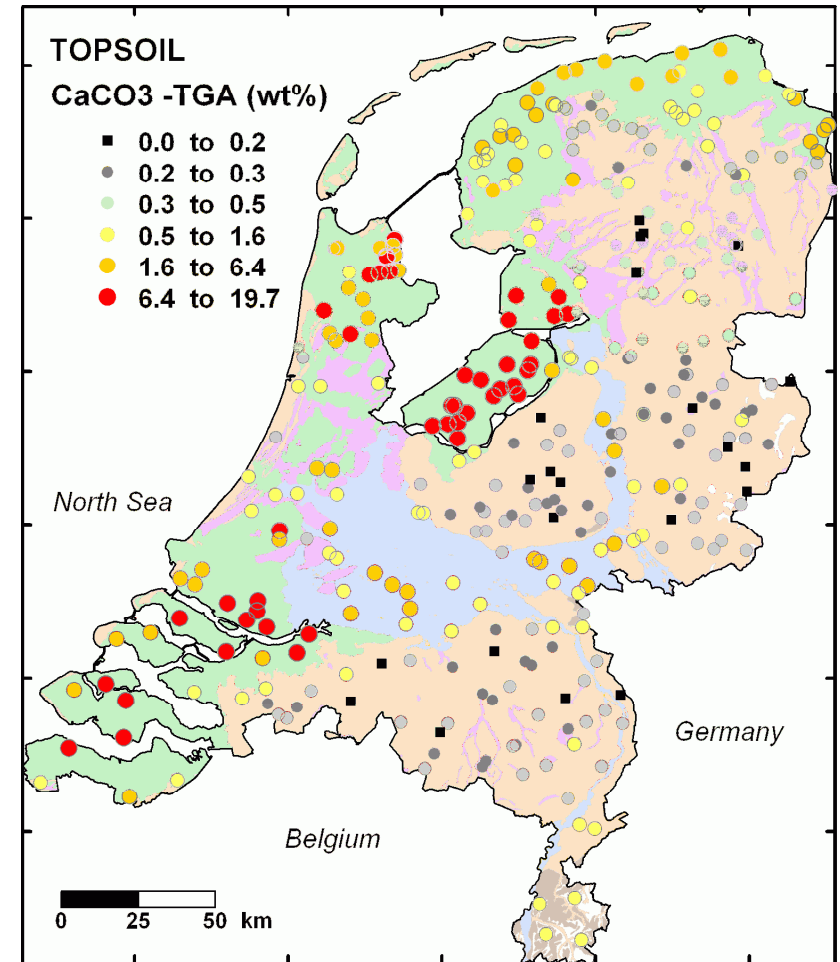
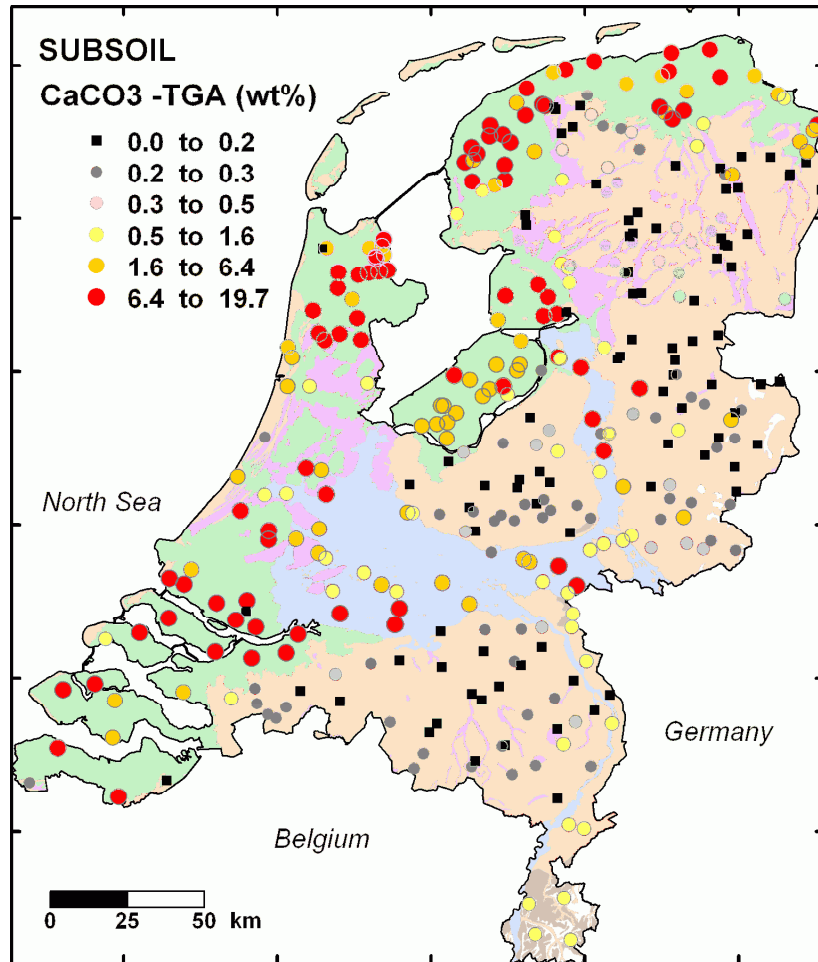
SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	0.38	0.18	1.03	0.07	0.02	11.2
loess	4	0.96	0.97	0.12	0.13	0.82	1.08
fluviatile clay	28	4.59	1.65	5.34	1.45	0.12	17.9
marine clay	115	7.54	7.19	4.99	5.97	0.08	19.7
peat	33	1.60	1.08	2.97	0.74	0.12	17.3
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	0.31	0.28	0.15	0.11	0.05	1.19	0.31
loess	0.93	0.93	0.080	0.072	0.84	1.03	0.93
fluviatile clay	1.80	1.24	1.52	0.79	0.17	5.96	1.80
marine clay	5.07	4.04	3.89	4.03	0.23	16.4	5.07
peat	1.20	0.85	1.49	0.72	0.25	8.82	1.20

Concentrations are in wt% and based on 105 °C dry weight





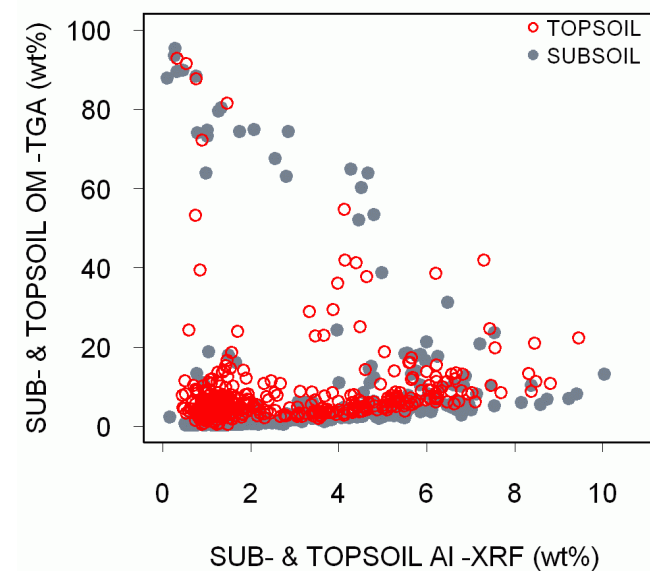
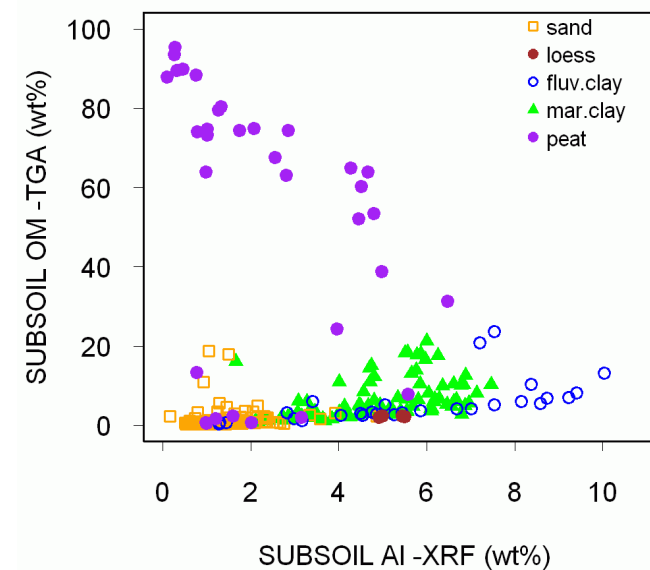
# CaCO<sub>3</sub> - Carbonates



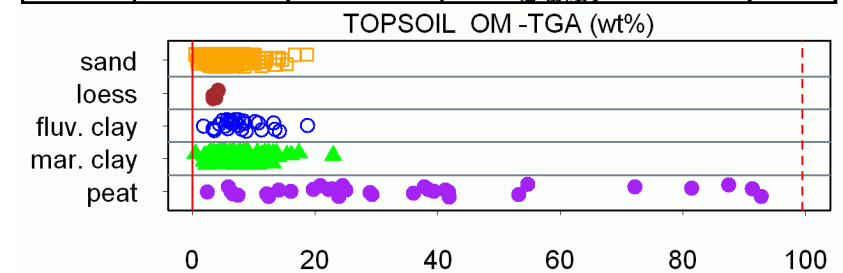
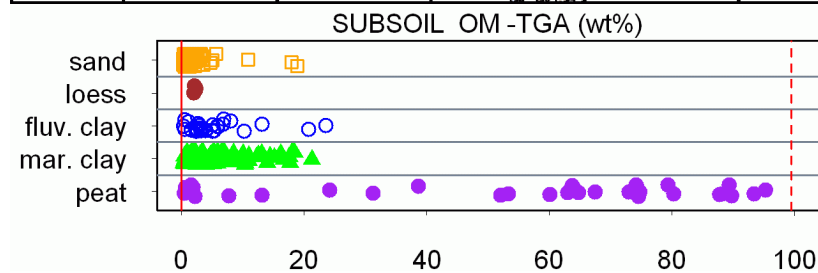
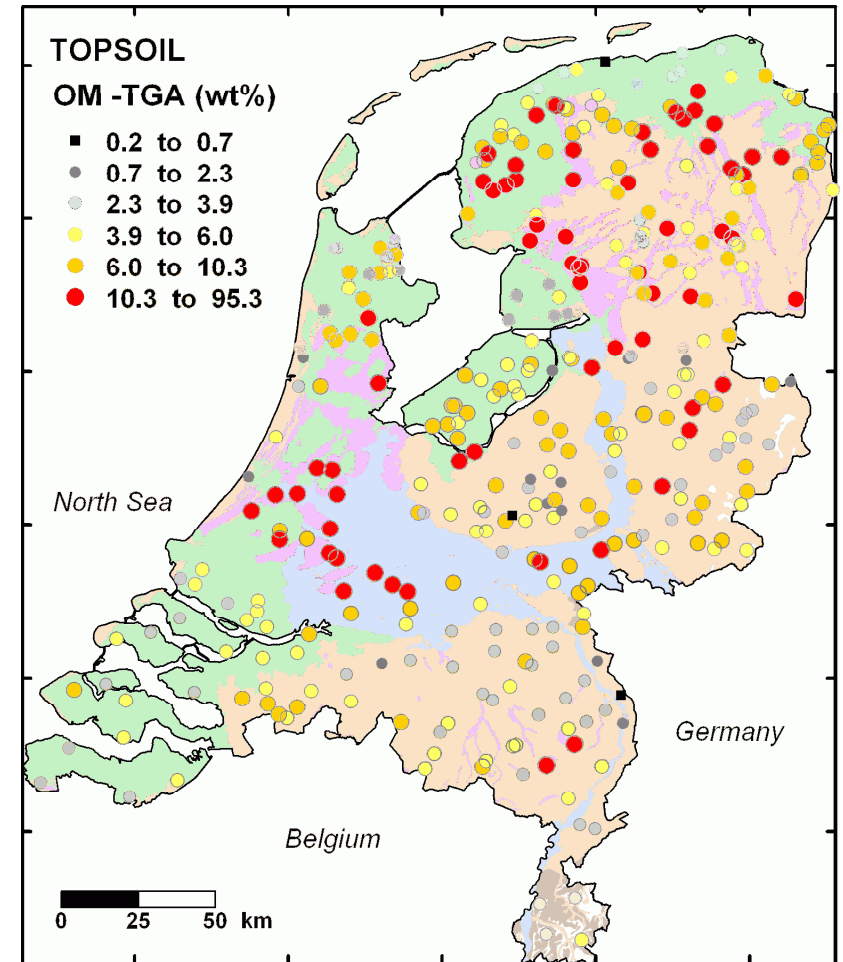
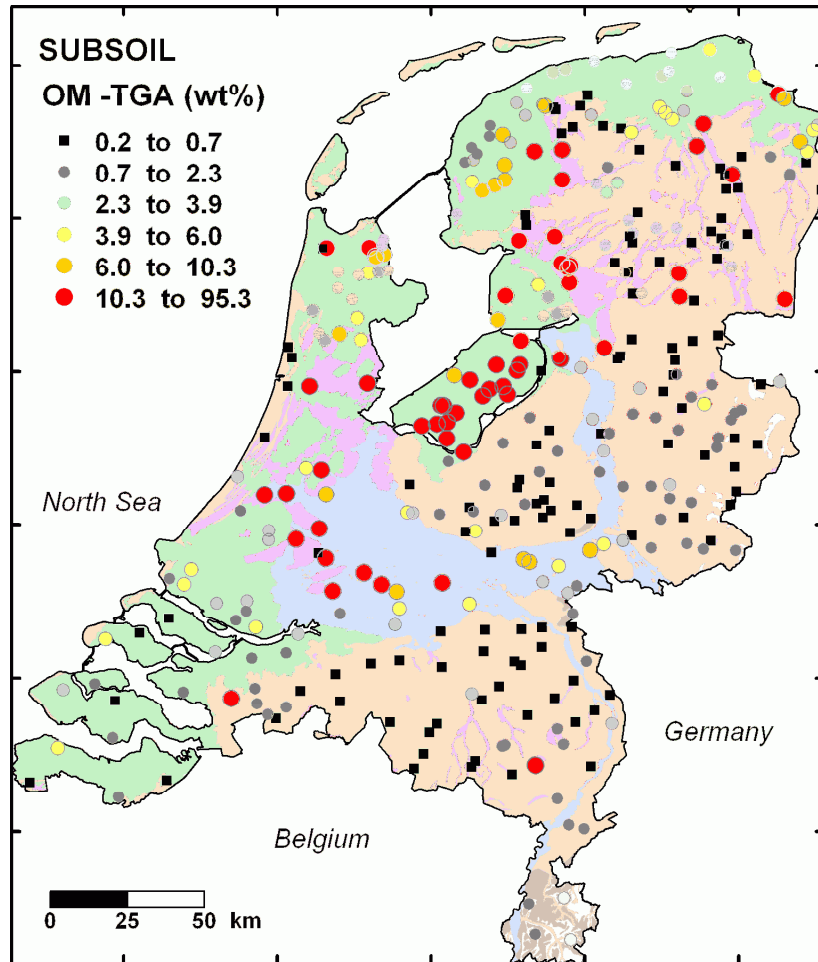
# OM – Organic matter

SUBSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	1.17	0.67	2.15	0.32	0.24	18.8
loess	4	2.20	2.23	0.15	0.12	2.01	2.32
fluviatile clay	28	5.58	3.84	5.54	2.70	0.36	23.6
marine clay	115	5.23	3.58	4.92	3.13	0.37	21.3
peat	33	53.3	63.9	32.9	35.5	0.49	95.3
TOPSOIL	Ntot	Mean	Median	St.Dev.	MAD	Min.	Max.
sand	178	5.62	4.72	3.19	2.44	0.44	18.6
loess	4	3.70	3.61	0.39	0.32	3.36	4.21
fluviatile clay	28	7.84	7.07	3.79	2.54	1.80	18.8
marine clay	115	6.40	5.44	3.71	2.90	0.44	22.9
peat	33	34.4	25.0	25.7	20.0	2.42	92.8

Concentrations are in wt% and based on 105 °C dry weight



# OM – Organic matter





## References

- Brownlow, A.H., 1979. Geochemistry. Prentice Hall Inc., Englewood Cliffs, USA, 498 pp.
- Deer, W.A., Howie, R.A., Zussman, J., 1992. An Introduction to the Rock-forming Minerals, 2nd edition. Longman Scientific and Technical, London, UK, 696 pp.
- Holleman, A.F., Wiberg, E., 1995. Holleman und Wiberg Lehrbuch der Anorganischen Chemie. 101. Auflage, Walter de Gruyter and Co., Berlin, Germany, 2036 pp.
- IUAPC, 1996. Atomic weights of the elements 1995. International Union of Pure and Applied Chemistry (IUAPC). Pure and Applied Chemistry 68, pp. 2339 - 2359.
- James, A.M., Lord, M.P., 1992. Macmillan's Chemical and Physical Data. Macmillan, London, UK, 565 pp.
- Koljonen, T. (ed.), 1992. Geochemical Atlas of Finland, part 2: Till. Geological Survey of Finland, Espoo, Finland, 218 pp.
- Li, Y.-H. (2000), A Compendium of Geochemistry. Princeton University Press, 440 pp.
- Lide, D.R. (editor-in-chief), 1996. CRC Handbook of Chemistry and Physics. 77<sup>th</sup> Edition, 1996 – 1997. CRC press, Boca Raton, USA.
- Mason, B.H., Moore, C.B., 1982. Principles of Geochemistry. Fourth edition, Wiley, New York, USA, 344 pp.
- Periodic Table of Elements SE v3.54. 1991 – 1997 SMI corporation.
- Reimann C., De Caritat, P., 1998. Chemical Elements in the Environment - Factsheets for the geochemist and environmental scientist. Springer Verlag, Berlin-Heidelberg-New York, 397 pp.
- Streit, B., 1994. Lexion der Oecotoxicologie. Zweite Auflage. VCH Verlagsgesellschaft, Weinheim, Germany, 901 pp.
- Tauber, C., 1988. Spurenelemente in Flugaschen. Verlag TUV Rheinland GmbH, Köln, Germany, 469 pp.
- VROM, 1994. Circulaire streef- en interventiewaarden. Rapport nr. DBO0749013, Ministerie van VROM, Den Haag, the Netherlands, 52 pp.
- Wehdepohl, K.H. (executive editor), 1978. Handbook of Geochemistry. Springer-Verlag Berlin. 5 volumes.
- Wehdepohl, K.H., 1995. The composition of the continental crust. Geochim. et Cosmochimica Acta 59, No. 7, pp 1217 - 1232.