Scientific aspects underlying the regulatory framework in the area of fertilisers – state of play and future reforms

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Proposed Cd limits are

*Fertilising product with > 5 % P_2O_5

At date of publication: 60 mg Cd/kg P_2O_5
Three years later: 40 mg Cd/kg P_2O_5
Twelve years later: 20 mg Cd/kg P_2O_5

*Fertilising product with < 5 % P_2O_5
3 mg Cd/kg P_2O_5

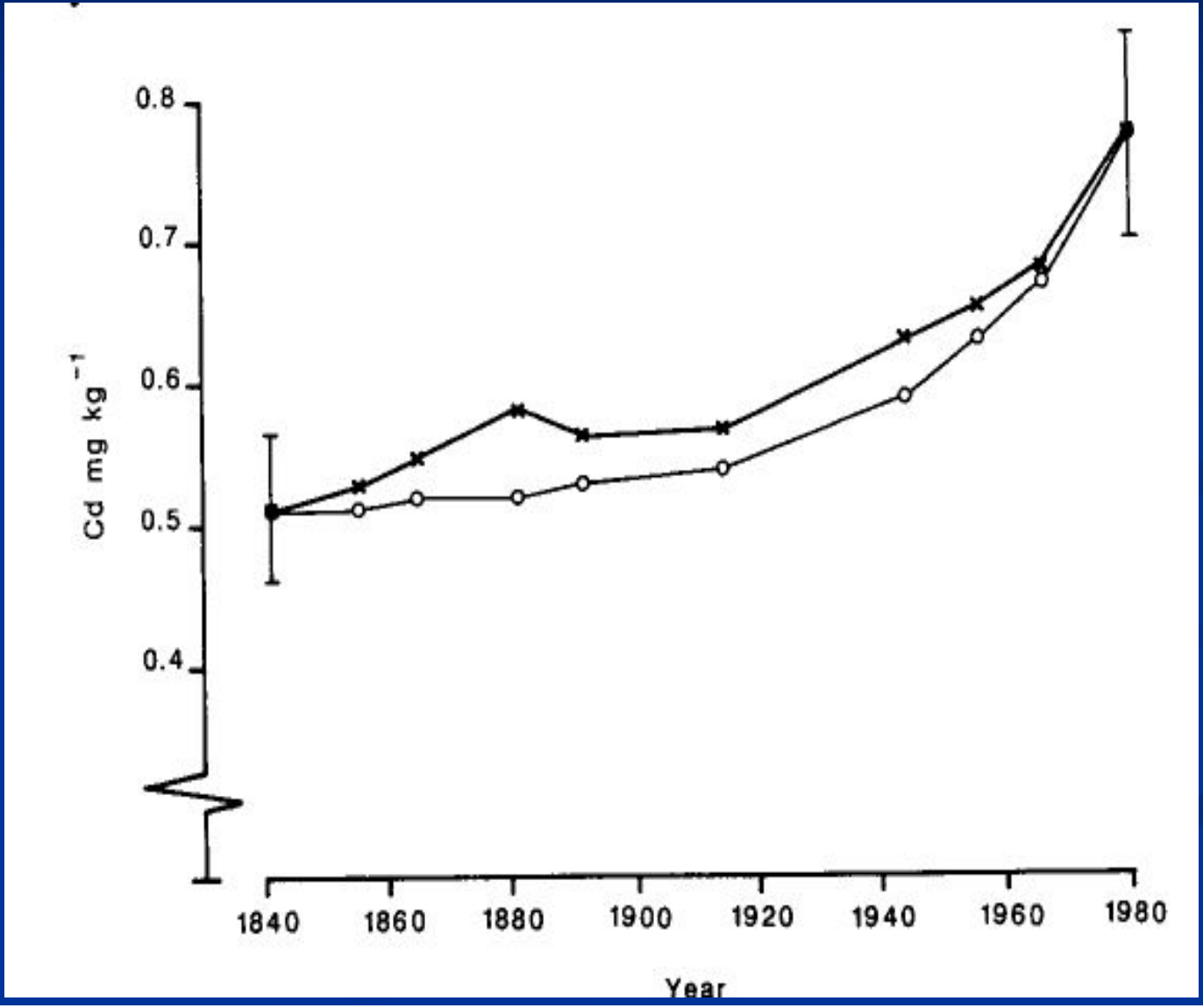
European agricultural soils	0.3	mg Cd/kg
Phosphate rock (McLaughlin et al. 1996)		
Kola (Russia)	< 1	mg Cd/kg P_2O_5
Morocco	47-100	mg Cd/kg P_2O_5
Tunis	38	mg Cd/kg P_2O_5
Phosphate fertilisers EU-28+1 market (2014)		
10^{th} percentile	< 1	mg Cd/kg P_2O_5
50^{th} percentile	24	mg Cd/kg P_2O_5
90^{th} percentile	57	mg Cd/kg P_2O_5

Rothamsted classic experiments

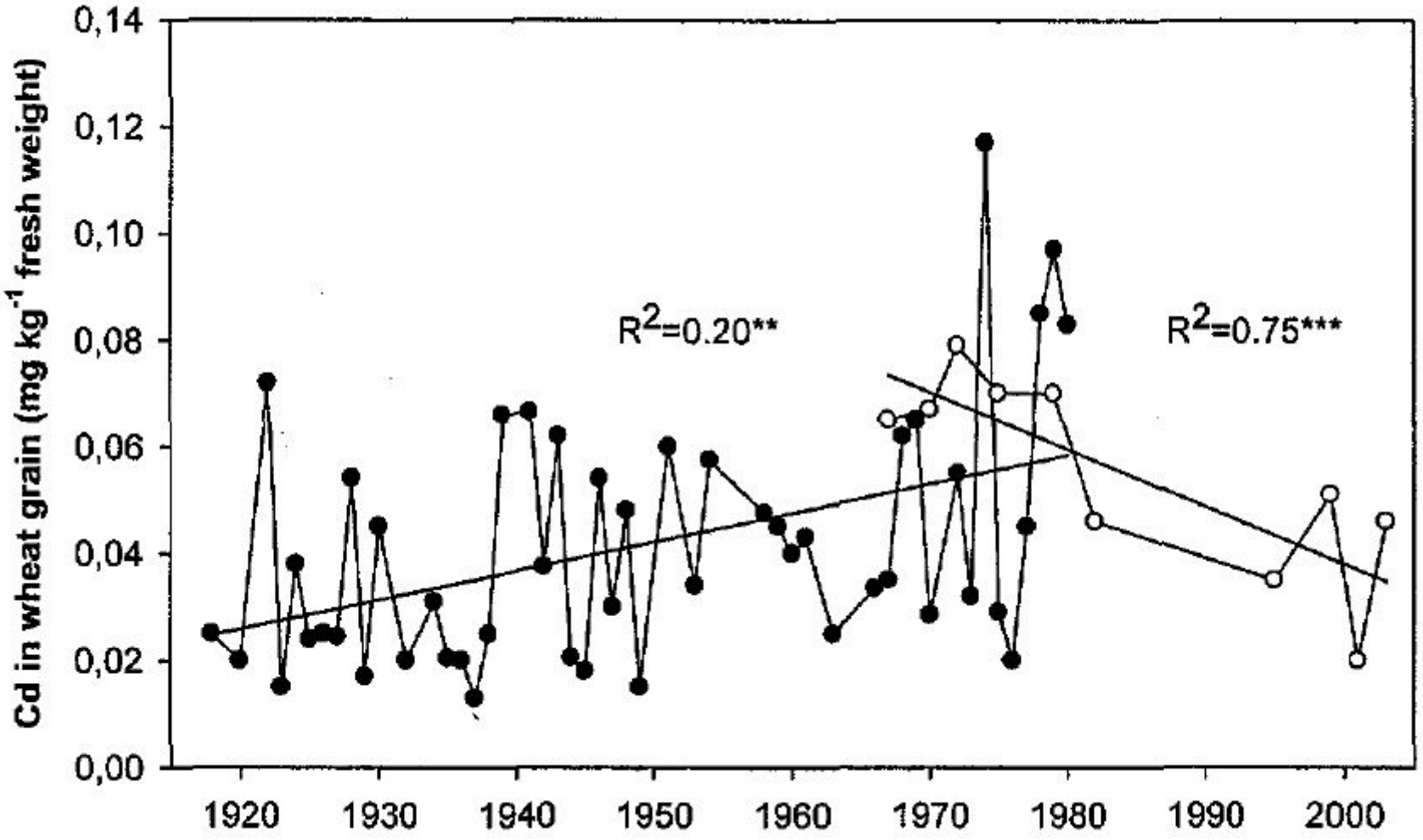
1843

2012

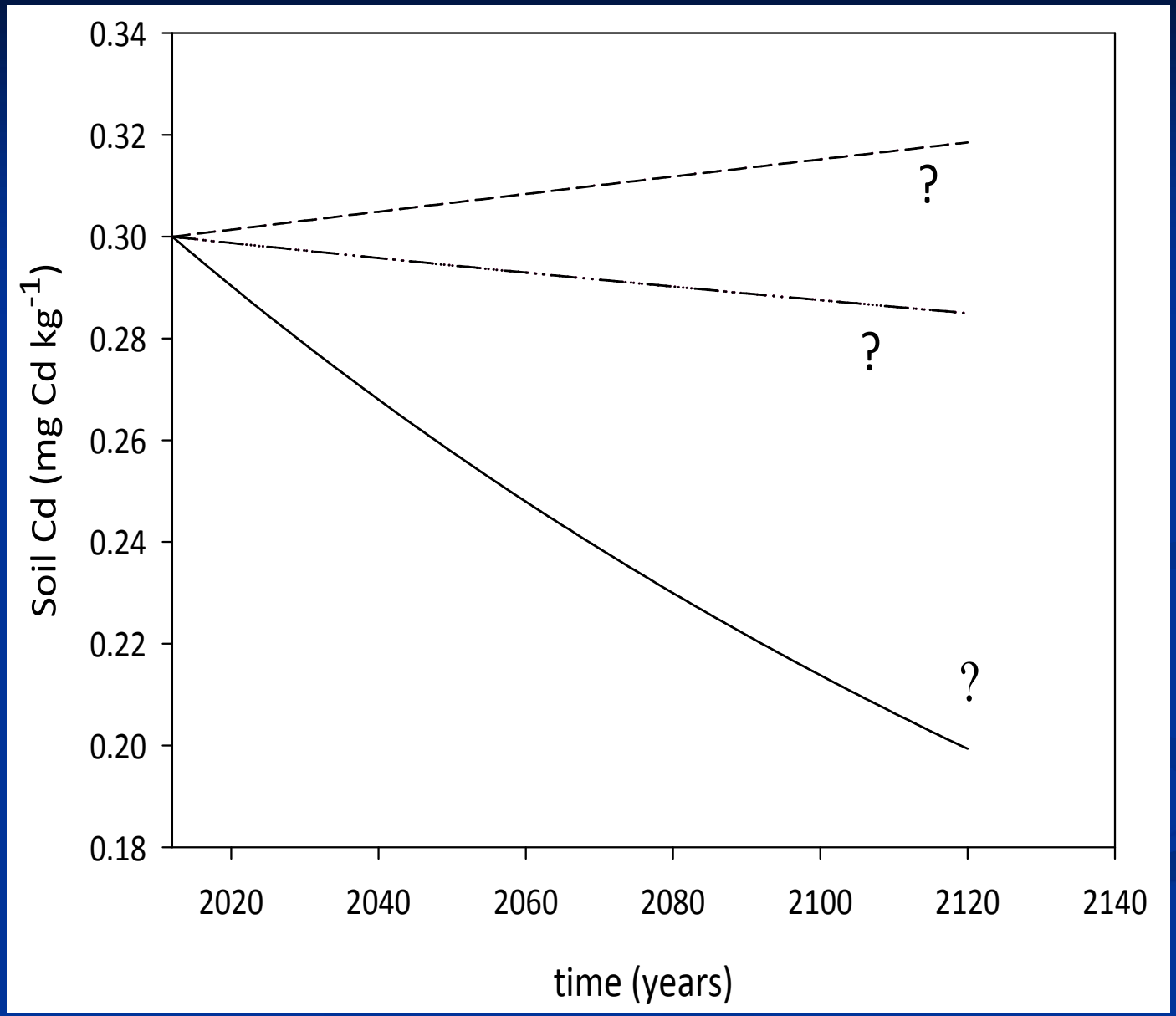
Archived soil samples illustrate rising soil Cd concentrations.
Sources: soil Cd in Broadbalk, Rothamsted (1846 -1980)
Jones et al., 1987



Trends of wheat grain Cd in Sweden: from accumulation to depletion



Kirchmann et al. 2009


0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
Soil Cd (mg Cd kg-1)
?
?
?
2020
2040
2060
2080
2100
2120
2140
time (years)

Trends in soil Cd based on mass balances

Scientific papers

Tjell and Christensen, 1992 (DK)
Moolenaer and Lexmond, 1998 (NL)
Six and Smolders, 2014 (EU-27+1)

Use of soil Cd mass balance to estimate impact of fertiliser Cd limits in Europe

Proposal from the CSTEE, 2002 (EU-15)
Six and Smolders, 2013 report to Fertilizers Europe (EU-28)

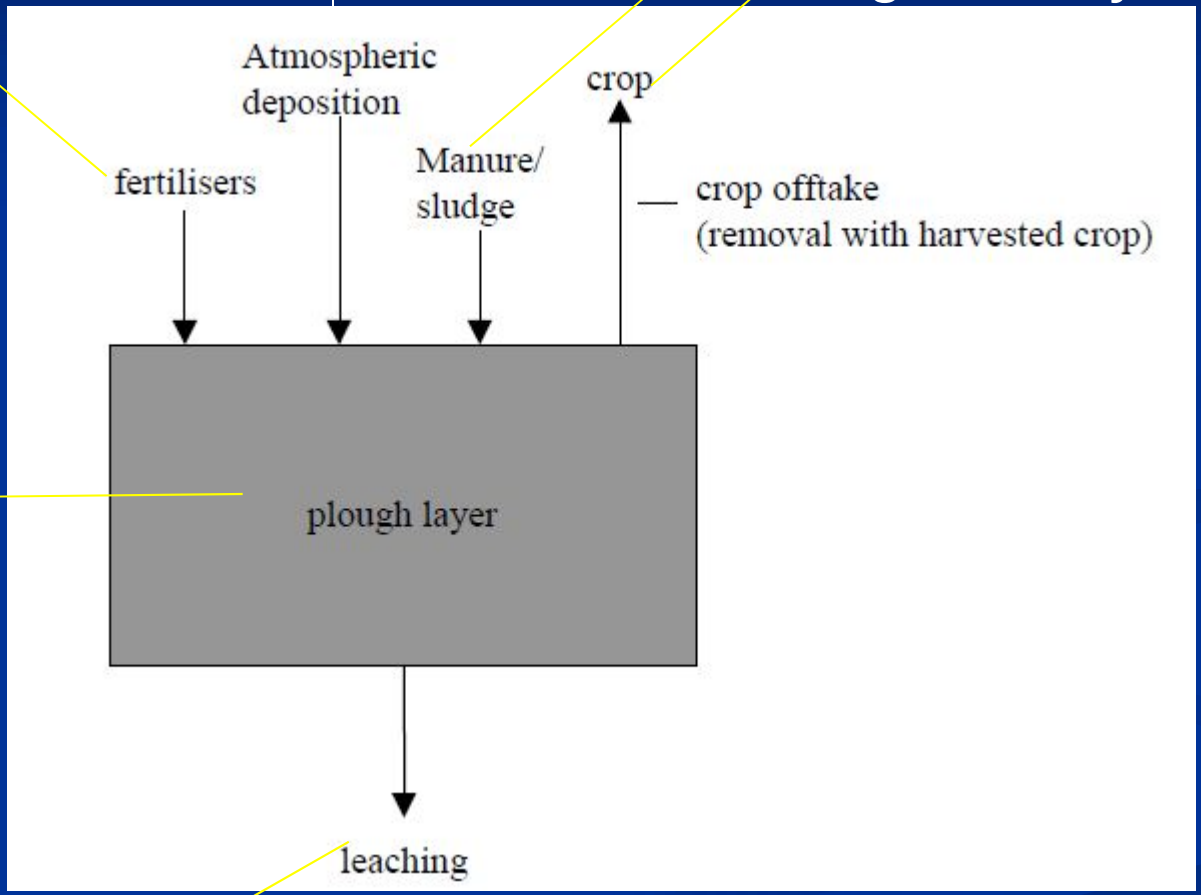
Average Cd mass balance in EU 27+1 (Six and Smolders, 2014)

0.15 g Cd/ha/y

0.35 g Cd/ha/y

0.2 g Cd/ha/y

0.8 g Cd/ha/y



900 g Cd/ha

0.8+0.35+0.15-0.2-2.6= -1.5 g Cd/ha/y

2.6 g Cd/ha/y

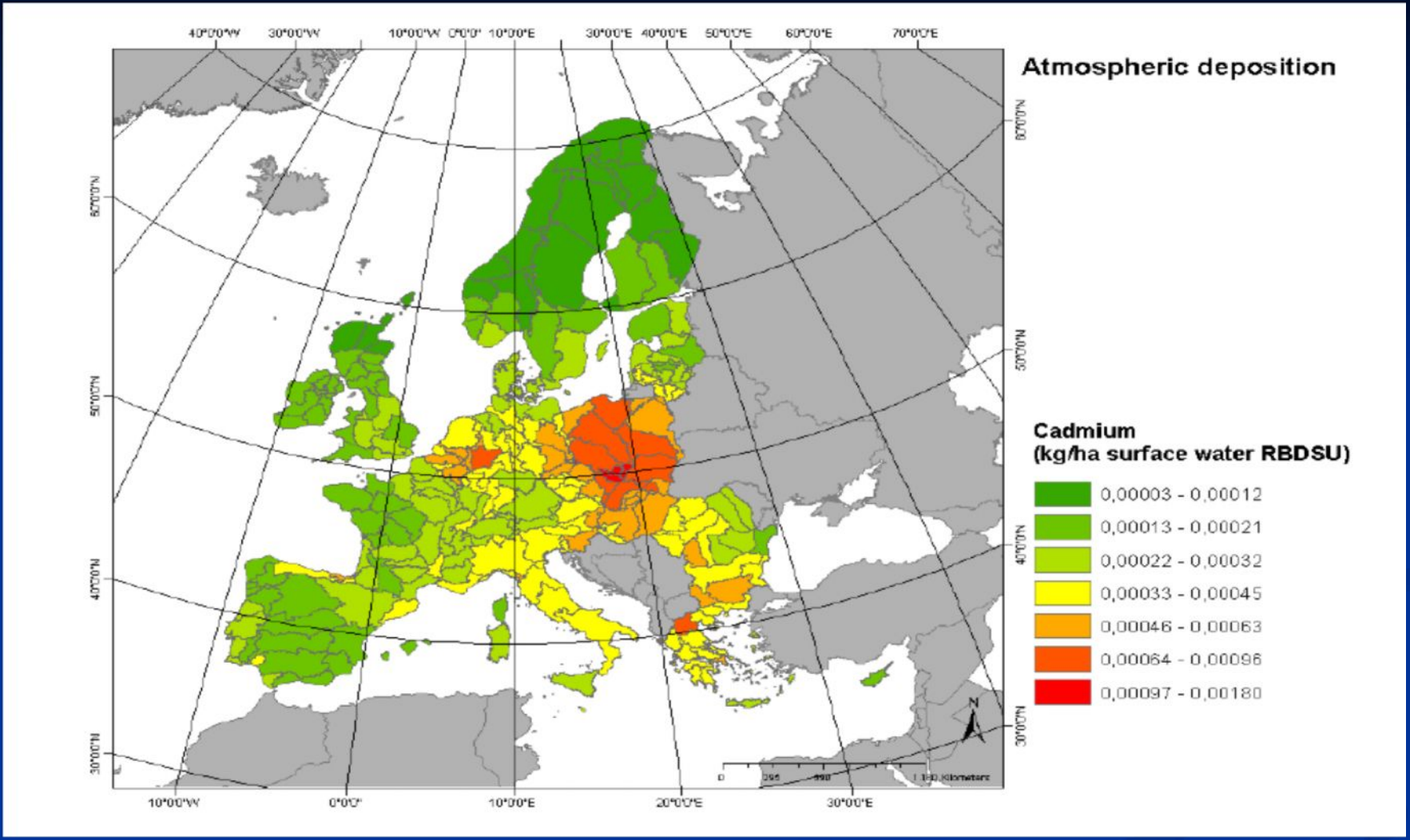
Annual input of Cd has decreased in recent 15 years, suggesting no more net soil Cd accumulation in the average scenarios

An overview of inputs and outputs (g Cd ha^{-1} yr^{-1}) considered in different European Cd mass balance studies or input inventories.

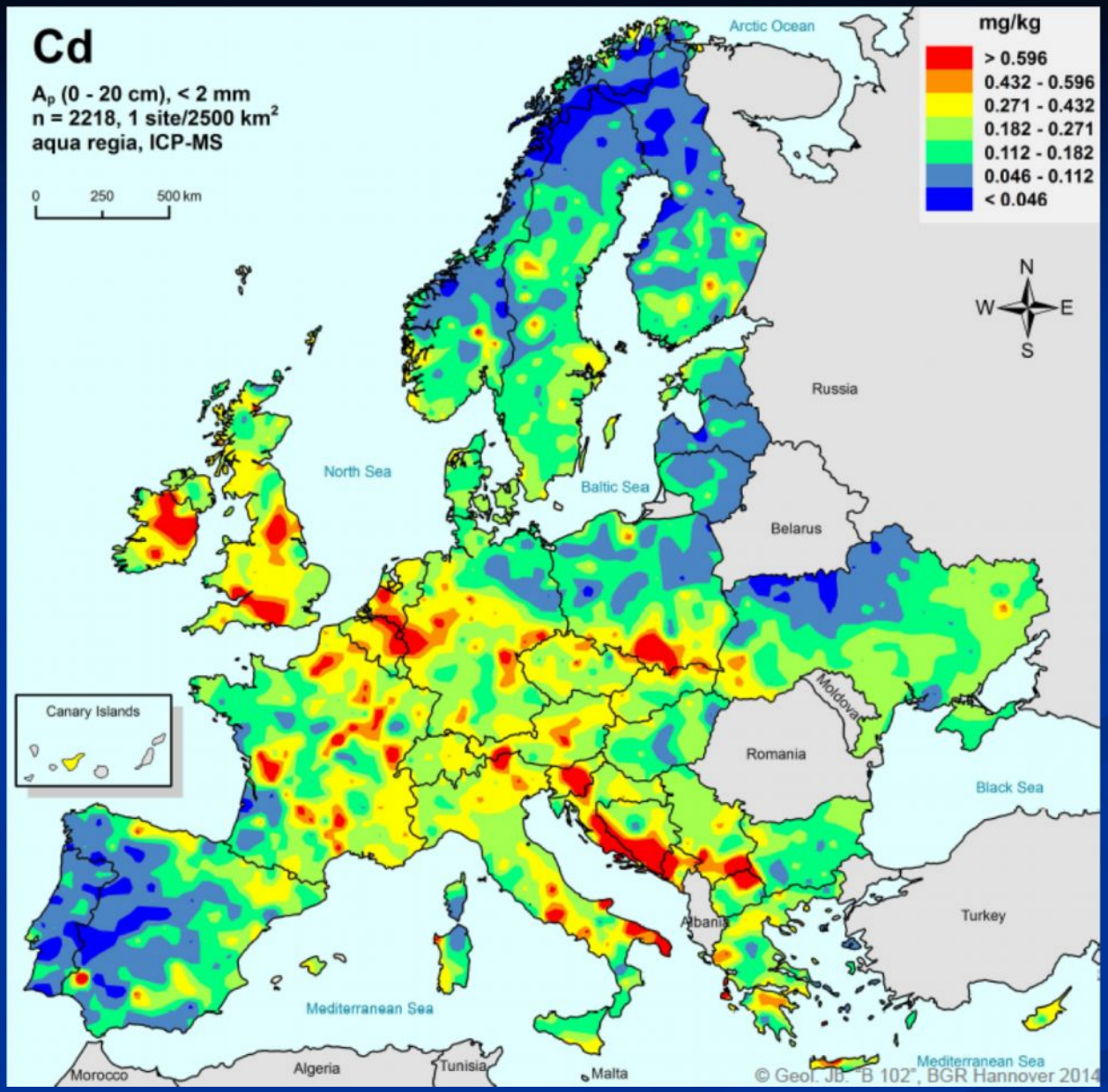
Reference	Hutton and Symon (1986)	Alloway and Steinnes (1999)	Moolenaar and Lexmond (1998)	Nicholson et al. (2003)	CSTEE (2002)	Sternbeck et al. (2011)	Belon et al. (2012)	Update (2010 as reference)
Country of relevance	UK	Europe	The Netherlands	UK	EU15	Sweden	France	EU27 + 1
Inputs								
Atm. Dep.	3.00	3.00	1.30	1.90	3.00	0.31–0.39	0.25	0.35
P fertilizers	4.40	2.50	1.50–2.50	1.60	0.46–4.14[a]	0.10–0.60[a]	0.98	0.79
Manure and compost	nd.	nd.	0.05	1.4 to 6[b]	nd.	nd.	0.44	0.01
Sewage sludge	0.9	nd.	nd.	0.14	nd.	0.06–0.55[c]	0.08	0.05
Lime	nd.	nd.	nd.	0.14	nd.	0.04	0.04	0.09
Total input	>8.3	>5.5	>2.85–3.85	5.18–9.78	>3.46–7.14	>0.51–1.58	1.79	1.29

	UK	EU	NL	UK	EU15	SE	FR	EU27+1
	1986	1989	1998	2003	2002	2011	2012	2010
Input g Cd/ha/y	>8.3	>5.5	2.8-3.5	5.2-9.8	3.5-7.1	0.5-1.6	1.8	1.3

Six and Smolders, 2014, Sci. Tot. Environ.

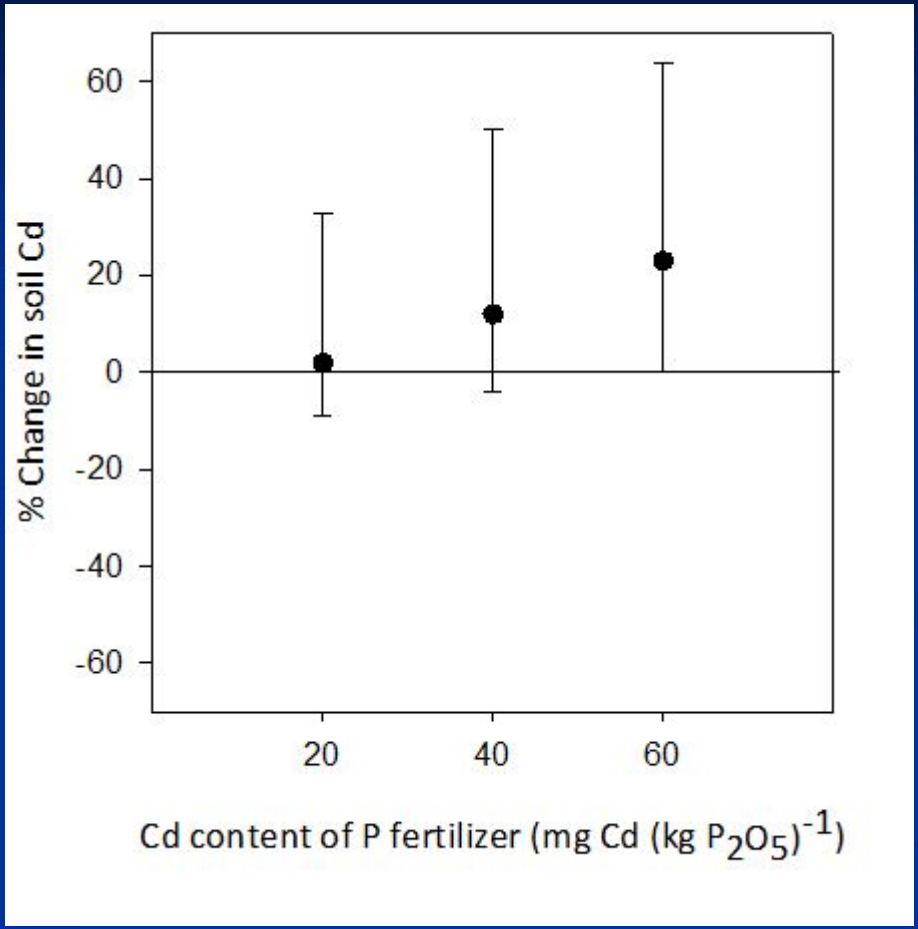


The wet Cd deposition in 2009 (right). Source : EMEP= European Monitoring and Evaluation Programme, a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution (CLRTAP)



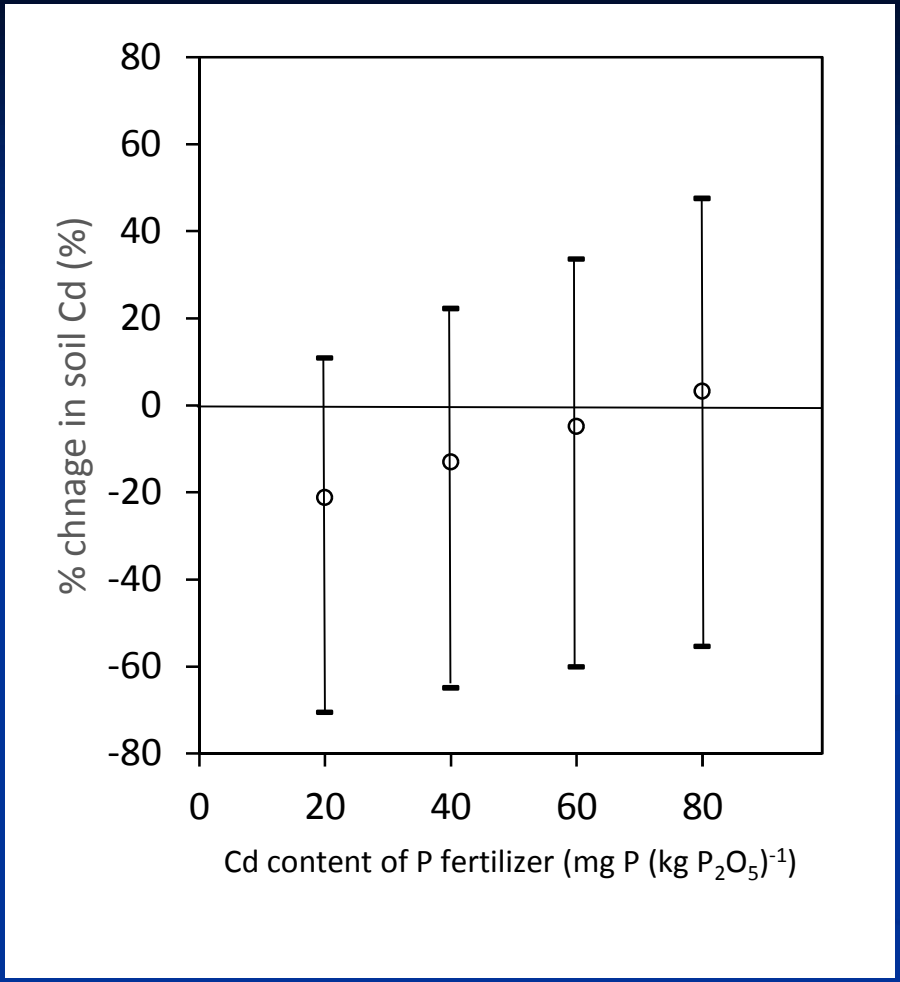
Total soil Cd concentrations in arable soils (source: GEMAS 2014)

Analysis in 2002 for Europe



Predicted change in soil Cd in European agricultural soil after 100 years application of inorganic P fertilizers at different Cd levels. Means (●) and 10th - 90th percentile of different simulations (source: CSTEE, 2002, Member state assessments of the risk to health and environment from cadmium in fertilizers. products)

Analysis of 2016



The predicted change in soil Cd after 100 years of emissions using different Cd concentrations in phosphate fertilizers based on the model described in Smolders and Six, 2014 and updated for 2016 with spatial variability accounted for using the GEMAS EU soil database (2014). Means are circles, the ranges are the 10-90th percentiles of different soils in Europe

	Nziguheba and Smolders 2008	Smolders and Salaets, unpublished
n	196	397 (samples with >5%P_2O_5)
samples collected in	2005	2014
mean Cd (mg/kg P_2O_5)	36	27
weighted mean Cd (mg/kg P_2O_5)*	no data	32
% samples exceeding **60 mg Cd/kg P_2O_5** **40 mg Cd/kg P_2O_5** **20 mg Cd/kg P_2O_5** **3 mg Cd/kg fertilizer for samples <5%P_2O_5 (n=17)**	 21% 47% 80%	 8% 31% 56% one in 17 samples (6%)

*weighted mean=country mean concentration multiplied with the corresponding fraction of total P use in that country relative to total tonnage used in EU.

Conclusions

- Proposal of Cd limits is based on stand-still principle
- Current proposal is based on analysis of 2002
- Largest scientific uncertainty is the loss of Cd by leaching
- Analysis of 2013 shows that Cd input has decreased in last 15 years suggesting that the 2002 analysis is conservative