ESPREME
EU 6th Framework Programme

Activities of ESPREME

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TFMM 8th Meeting, UBA, Dessau

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Aim:

Provision of information, that can contribute to the development of a strategy for reducing the occurrence of heavy metals in the environment in Europe.

This strategy should be

- **effective**
- **efficient**
- **Europe-wide**

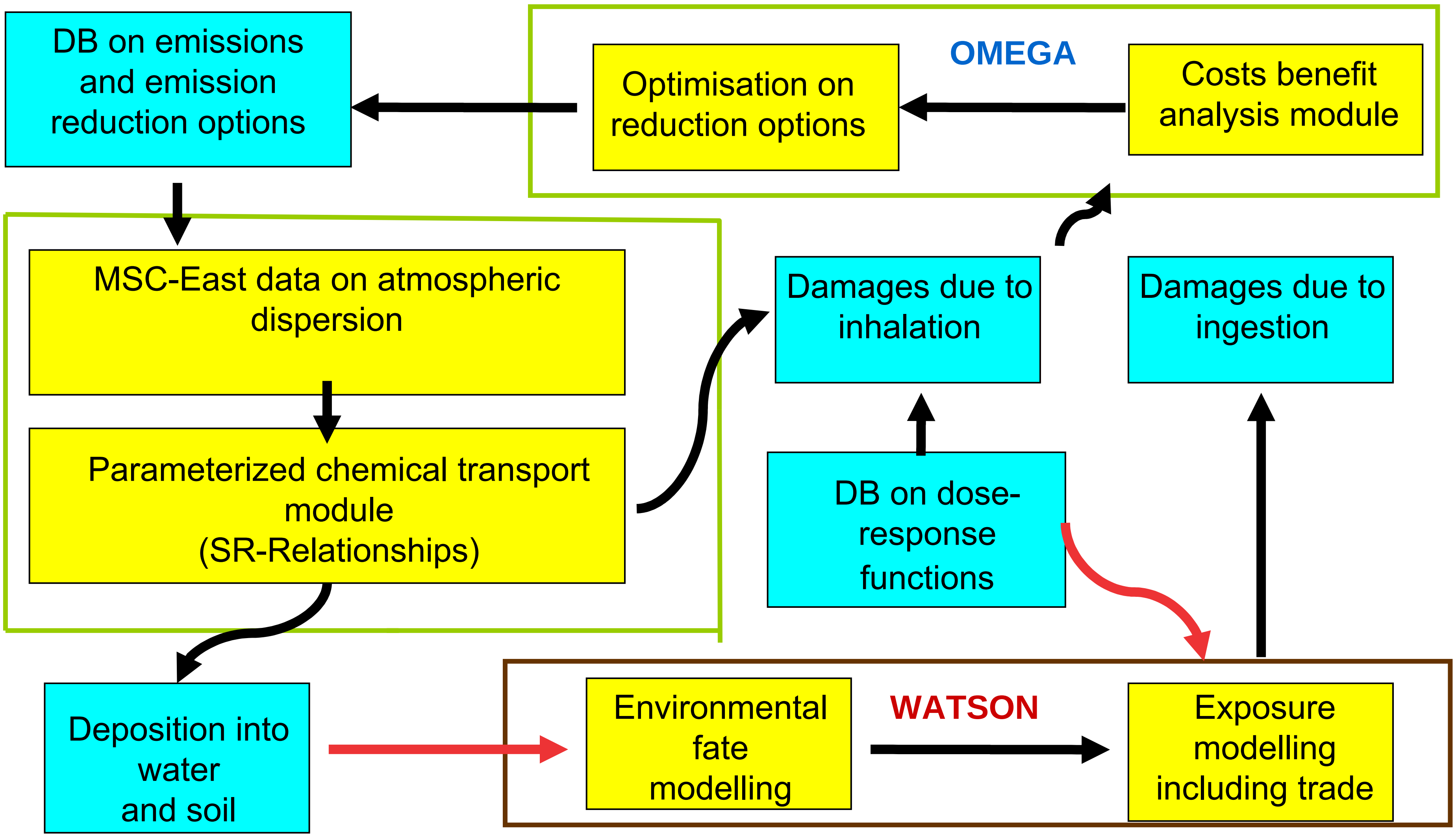
and should make use of the state-of-the-art in integrated assessment modelling.

Approach

The approach consisted of the following steps:

1. **Consolidate, improve and provide European wide emission data of heavy metals (Hg, Cd, Pb, Ni, As and Cr)**
2. **Collect systematic data on the possibilities to reduce emissions.**
3. **Improve models for the transport of HM in the atmosphere, soil and water and apply them to simulate the transport of HM in these media; modeling results were evaluated vs. measurement data.**
4. **Collect data on thresholds and information on exposure–response relationships.**
5. **Estimate the willingness-to-pay to avoid damage from HM exposure by transferring values from available contingent valuation studies.**
6. **Set up an integrated assessment model (IAM).**
7. **Carry out runs of the IAM to identify cost effectiveness strategies, i.e. bundles of measures that achieve compliance with thresholds and cost-benefit analyses to identify bundles of measures, where the difference between benefits and costs are maximised.**

Dataflow of modelling framework

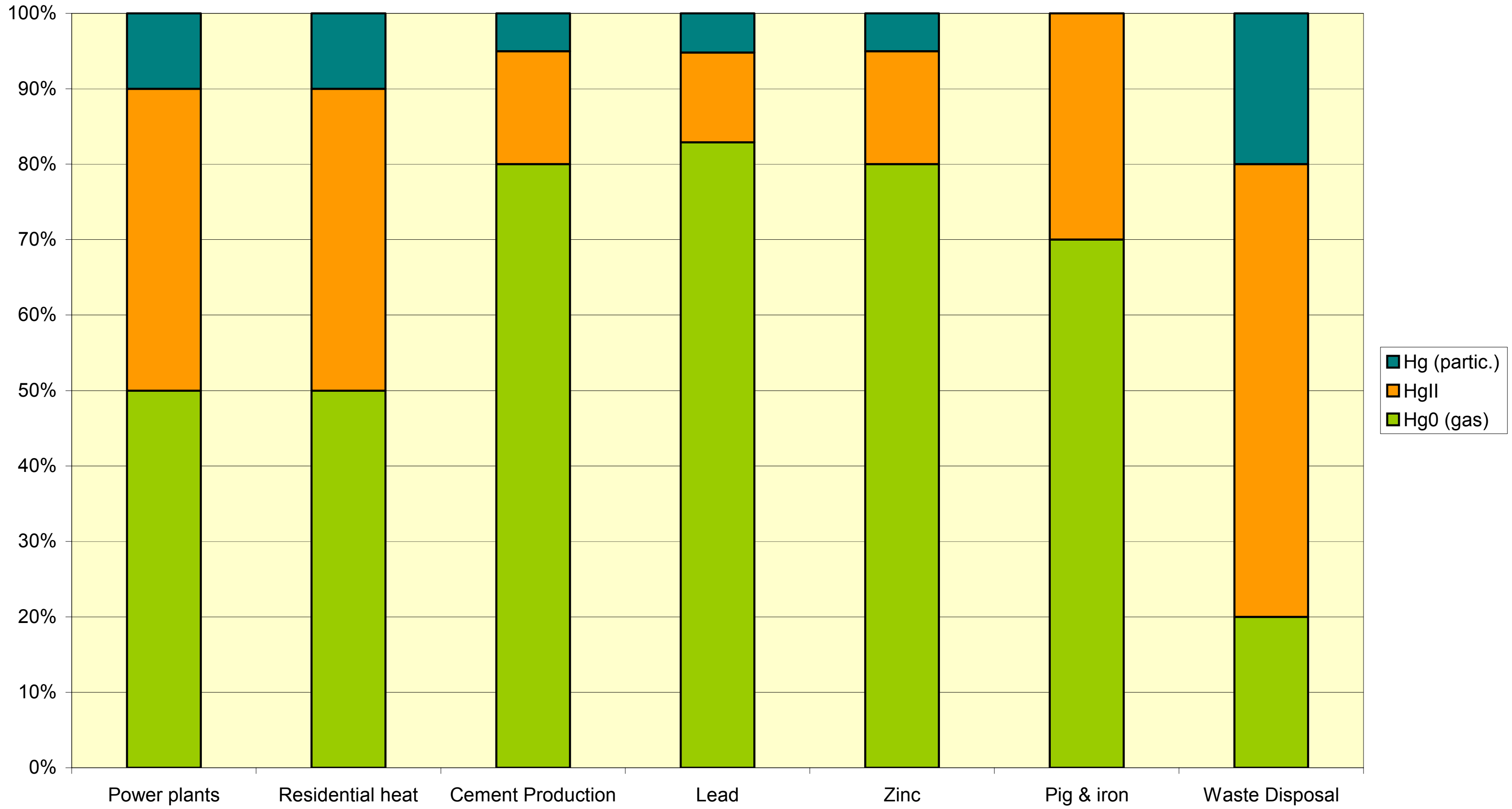


Total Hg Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion		Oil Combustion	Cement Production	Non-ferrous Metals		Iron & Steel Production	Caustic Soda	Waste Disposal	Other Sources	**Total**	Information Source 2000
	Power Plants	Residential heat			Lead	Zinc						
Albania	0.07									0.10	0.17	JP/EP
Austria	0.10	0.57	0.10	0.13			0.10	0.03	0.07		1.10	EMEP 1/2002
Belarus	0.02	0.32	0.01	0.01							0.36	National
Belgium	1.06			0.13	0.06	0.25	0.06	0.44	0.06		2.06	EMEP 1/2002 (1), JP/EP
Bosnia-Herzegovina	0.22										0.22	JP/EP
Bulgaria	1.64	1.64	0.06	0.06	0.06	0.06	0.06	0.49		0.12	4.19	EMEP 1/2002
Croatia										0.31	0.31	EMEP 1/2002 (1)
Cyprus										0.10	0.10	JP/EP
Czech Republic	1.71	1.71	0.02	0.05			0.07	0.28			3.84	EMEP 1/2002, JP/EP
Denmark	0.60	0.17		0.17					0.85	0.26	2.05	EMEP 1/2002
Estonia	0.40	0.10		0.02			0.03				0.55	National
Finland	0.05	0.21		0.05		0.16	0.05	0.03		0.05	0.60	EMEP 1/2002, JP/EP
France	2.06	0.14		3.44	0.69	1.79	1.37	0.70	2.61	2.20	15.00	EMEP 1/2002
Germany	5.24	4.05	1.19	5.49		2.00	1.24	1.19	3.00		23.40	JP/EP
Greece	0.73	0.63		1.56	0.10		0.20	0.03	0.20		3.45	JP/EP
Hungary	1.00	1.11	0.10	0.30			0.10	0.20	1.04	0.36	4.21	National
Iceland											0.00	
Ireland	0.20			0.12	0.11						0.43	JP/EP
Italy	0.46	2.54		3.27	0.10	0.70	0.56	0.65	1.00	0.50	9.78	JP/EP
Latvia	0.08			0.07							0.15	National
Lithuania										0.25	0.25	EMEP 1/2002
Luxemburg	0.14						0.13				0.27	EMEP 1/2002
Monaco	0.04	0.04									0.08	National
Netherlands	0.05	0.05		0.15			0.15	0.03	0.10		0.53	EMEP 1/2002 (1), JP/EP
Norway		0.24		0.24			0.24		0.24		0.96	EMEP 1/2002, JP/EP
Poland	10.20	12.84		0.10		0.10	0.90	0.10	0.57	0.79	25.60	National
Portugal	0.17			0.88				0.03			1.08	JP/EP
Republic of Moldova	0.06	0.07								0.05	0.18	EMEP 1/2002 (1), INTAS
Romania	2.10	2.70		0.05			0.05		0.10		5.00	National
Russian Federation	15.50	11.00		3.70	5.90		1.90	28.00	0.10		66.10	INTAS/ JP,EP
Slovakia	1.09	1.09		0.27			0.27	0.11		1.62	4.45	EMEP 1/2002
Slovenia	0.29									0.29	0.58	EMEP 1/2002
Spain	5.39	4.35		5.60	0.42	2.49	1.04	0.61		3.10	23.00	EMEP 1/2002
Sweden	0.06	0.06					0.06	0.04	0.25	0.07	0.54	EMEP 1/2002 (1)
Switzerland	0.10	0.10		0.20			0.80	0.10	1.30	0.03	2.63	National
TFYR of Macedonia				0.04						0.01	0.05	National
Turkey				2.69			1.17			0.20	4.06	JP/EP
Ukraine	5.70	1.71		0.85			1.69	6.26	0.08		16.29	INTAS
United Kingdom	3.42	0.62		0.26	0.09	0.09	0.13	0.68		3.25	8.54	EMEP 1/2002
Yugoslavia	3.52	0.66	0.21	0.28	0.10	0.20	0.12	0.40		1.60	7.09	JP/EP
EUROPE	**63.47**	**48.72**	**1.69**	**30.18**	**7.63**	**7.84**	**12.49**	**40.40**	**11.57**	**15.26**	**239.25**	

(1) 1999 year

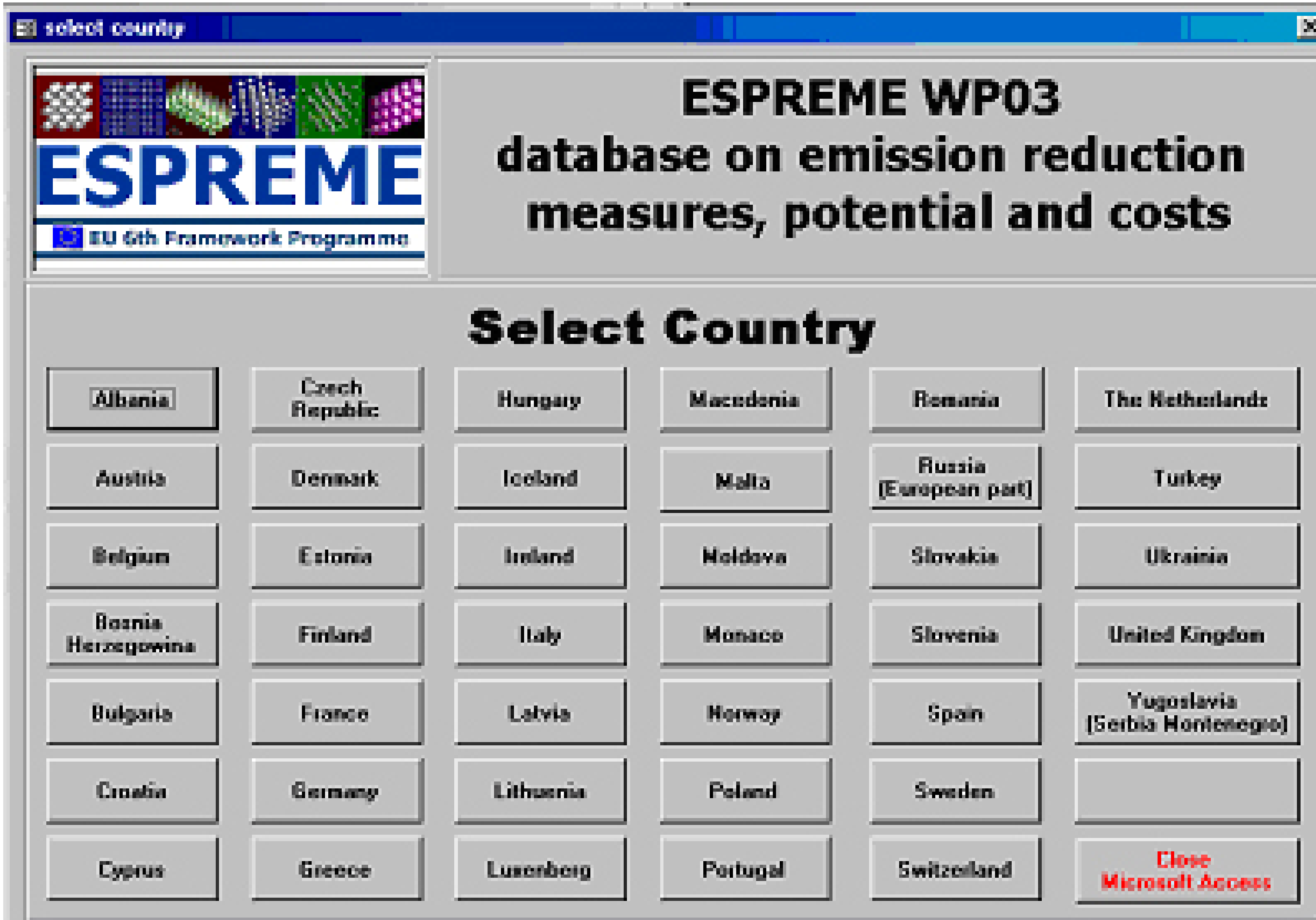
Emission profiles for different chemical forms of mercury and various source categories



Emissions of As, Cd, Cr, Ni and Pb in Europe in the year 2000

Source Category	As		Cd		Cr		Ni		Pb	
	tons	%	tons	%	tons	%	tons	%	tons	%
1. Combustion										
- stationary sources	**391**	**51**	**367**	**63**	**1 394**	**51**	**3 795**	**79**	**1 623**	**12**
- mobile sources									**6 772**	**52**
2. Industrial processes	**279**	**37**	**162**	**27**	**947**	**35**	**542**	**11**	**4 398**	**33**
3. Other sources	**93**	**12**	**61**	**10**	**370**	**14**	**460**	**10**	**364**	**3**
TOTAL	**763**	**100**	**590**	**100**	**2 711**	**100**	**4 797**	**100**	**13 157**	**100**

Database on emission reduction measures, potential and costs



Database on emission reduction measures, potential and costs (2)

ESPREME WP03 - database on emission reduction measures, potential and costs

Country: Ireland

ID: 1

Short List Proposition (SLP):

Main group of control methods	Primary measures (process oriented measures)	Code of main group	MP
Main category method	Technical oriented measures	Code of main category method	MPt
Control method within a main category method	HM content minimization	Code of control method within a main category	MPtc
Option within a control method	fuel cleaning/washing	Code of option within a control method	MPtc02
Status of the control method	A	Final code of the method	MPtc02A
Process	Hard coal combustion for power/heat generation	Code of measure-process	MPtc02A-1H/2H
Option of process	Hard coal combustion in large and medium-sized combustion plants	Final code of the method-process	MPtc02A-1H

Status codes: A - medium; B - state-of-the-art; C - optimized; D - retrofitted; E - emerging

The method-process investment costs	0	(Euro/MWh)	The method implement degree [%] in base year	0	%
The method-process operating costs	0,03	(Euro/MWh)	The method implement degree [%] in 2010	0	%

References (costs): ESPREME,2004

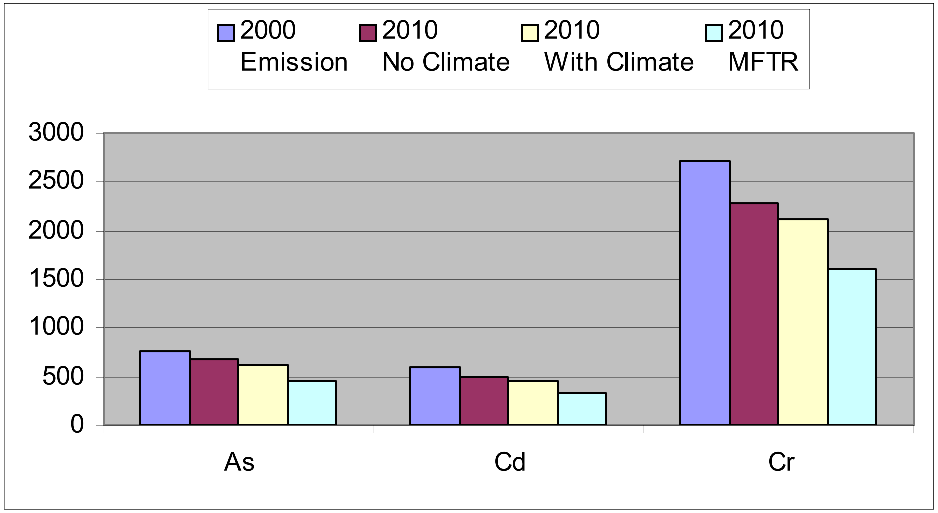
Base year: 2000

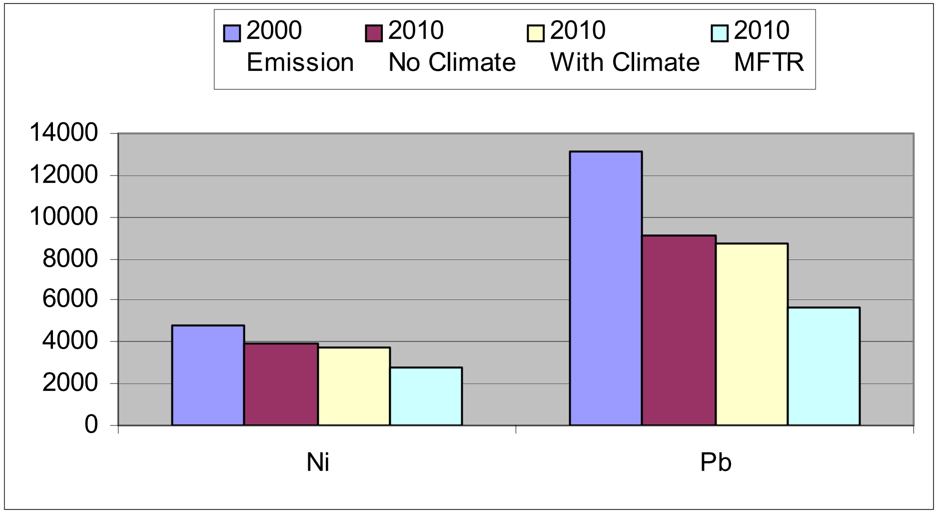
% of Hg emission reduction	25	%	Hg emission factors - UNABATED	0,00035	[kg Hg/SAI]
% of Cd emission reduction	40	%	Cd emission factors - UNABATED	0,00016	[kg Cd/SAI]
% of Cr emission reduction	40	%	Cr emission factors - UNABATED	0,0036	[kg Cr/SAI]
% of Ni emission reduction	40	%	Ni emission factors - UNABATED	0,00707	[kg Ni/SAI]
% of As emission reduction	40	%	As emission factors - UNABATED	0,00507	[kg As/SAI]
% of Pb emission reduction	60	%	Pb emission factors - UNABATED	0,016	[kg Pb/SAI]

References (% reduction): Pavlish,1999

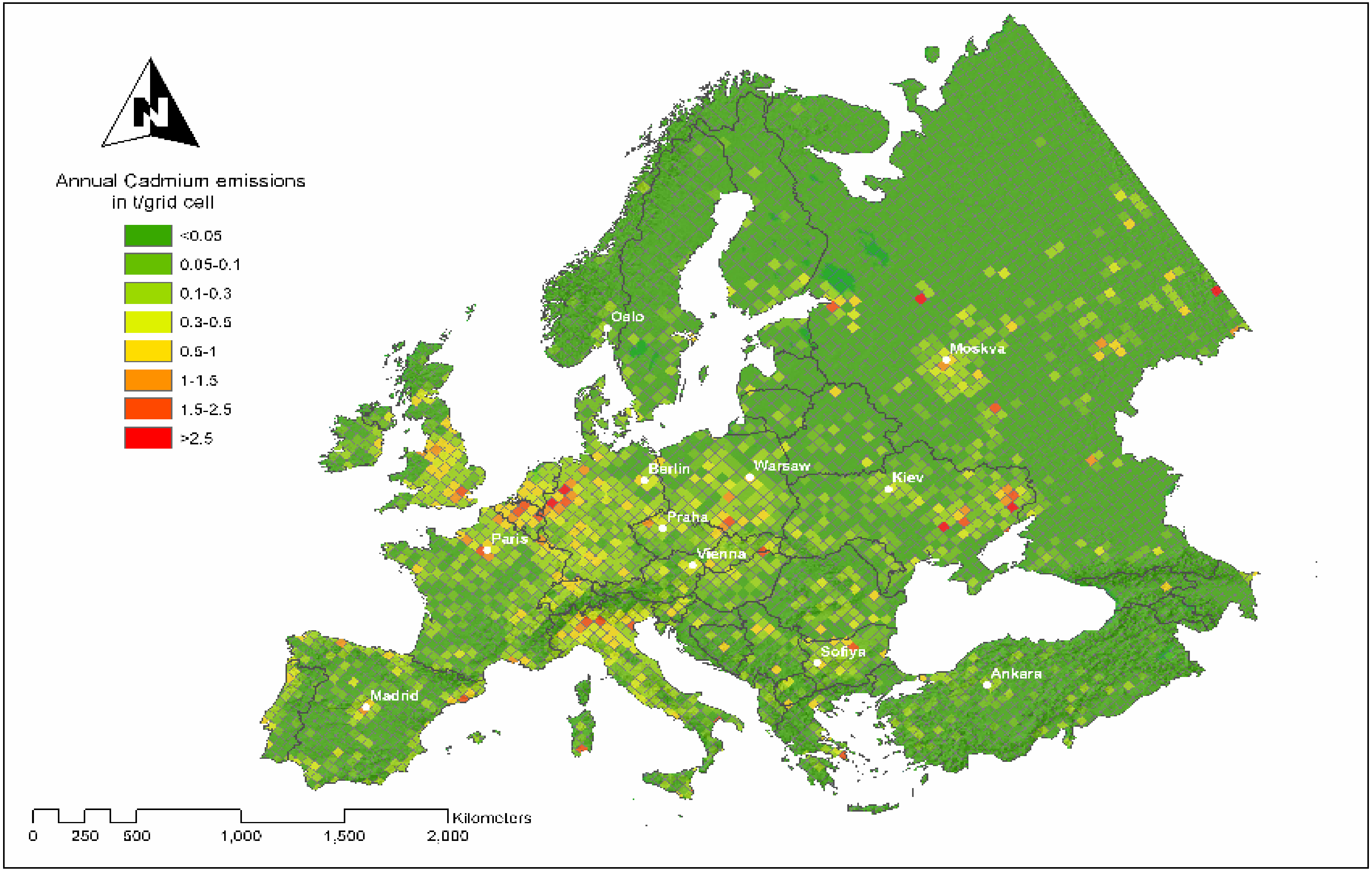
Specific activity indicator SAI: MWhe

The 2010 emission scenarios for As, Cd, Cr, Ni and Pb in Europe (in tonnes)

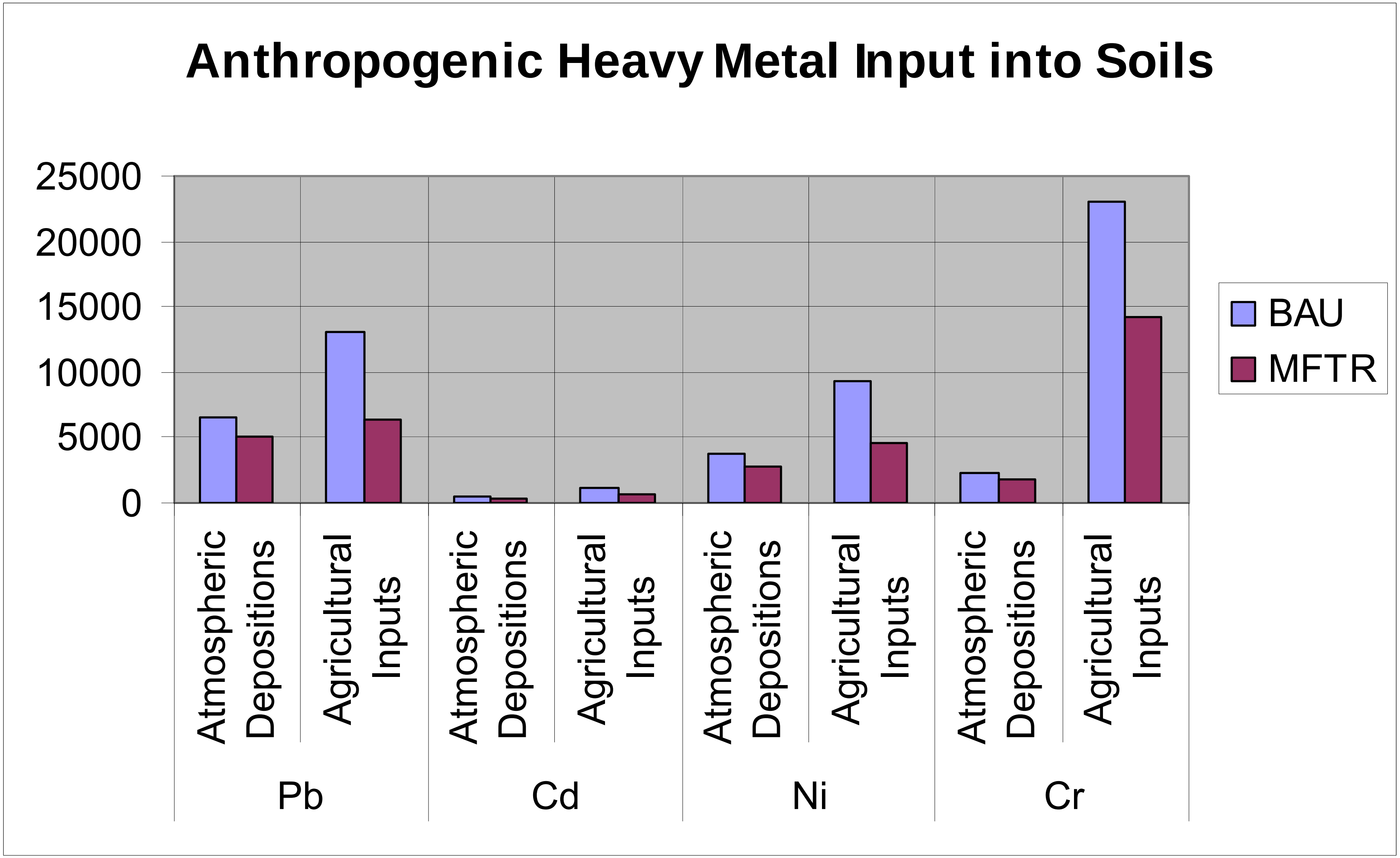




Cd Emissions – Spatial Distribution

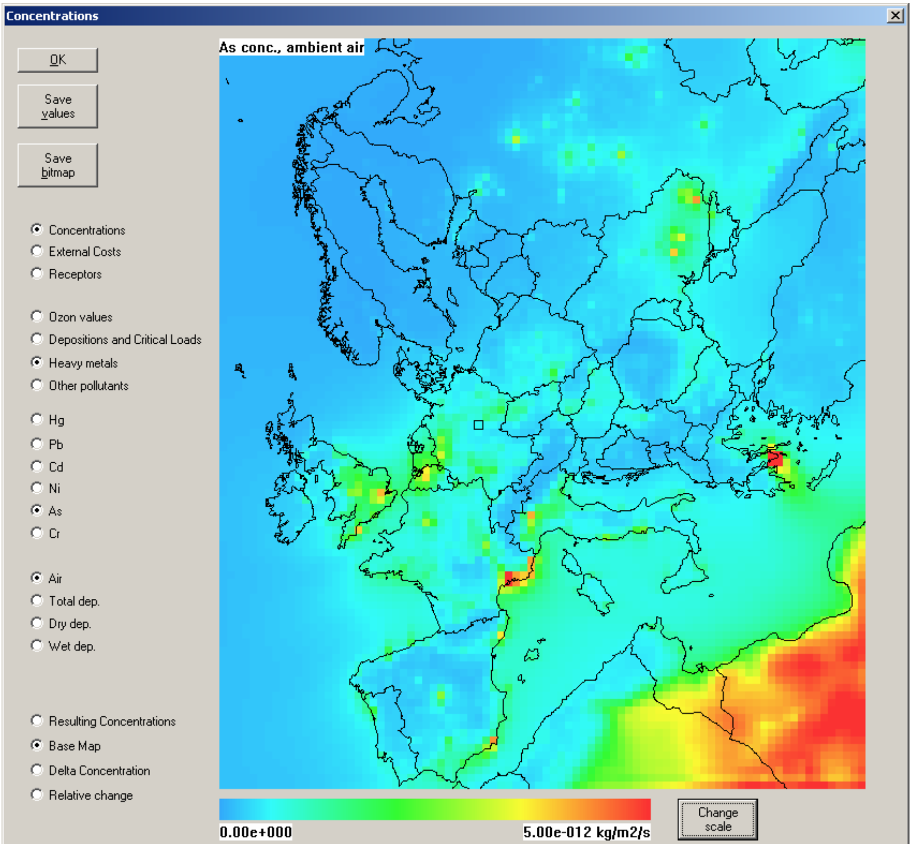


Comparison of agricultural and atmospheric input into soils



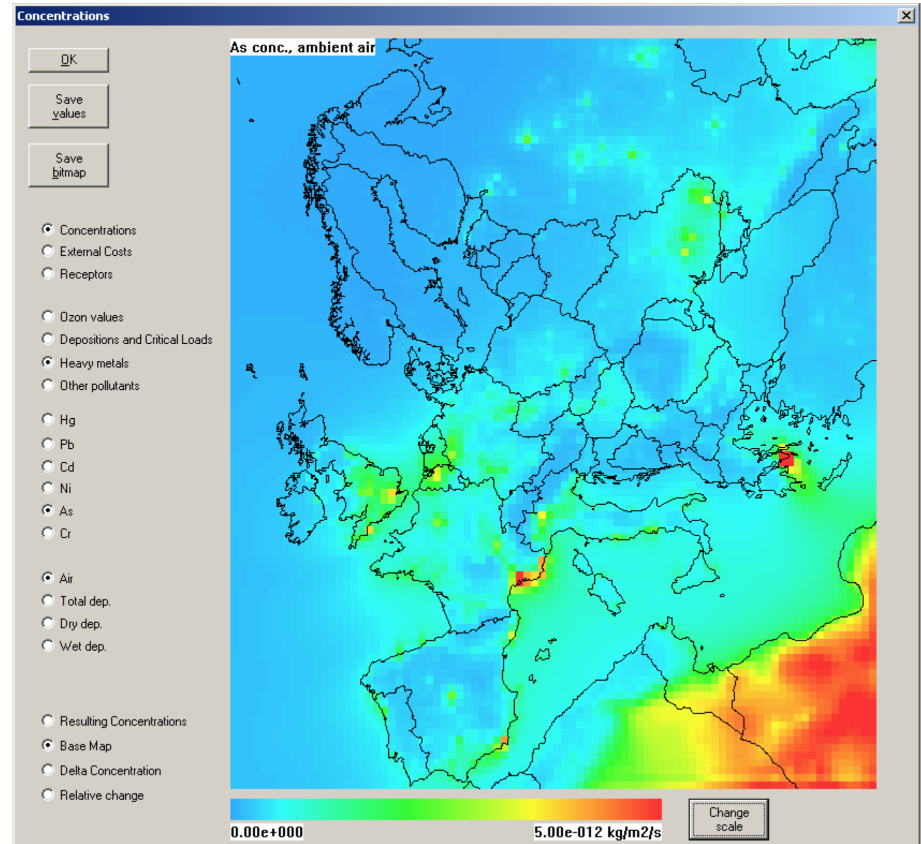
Average annual As concentration

BAU

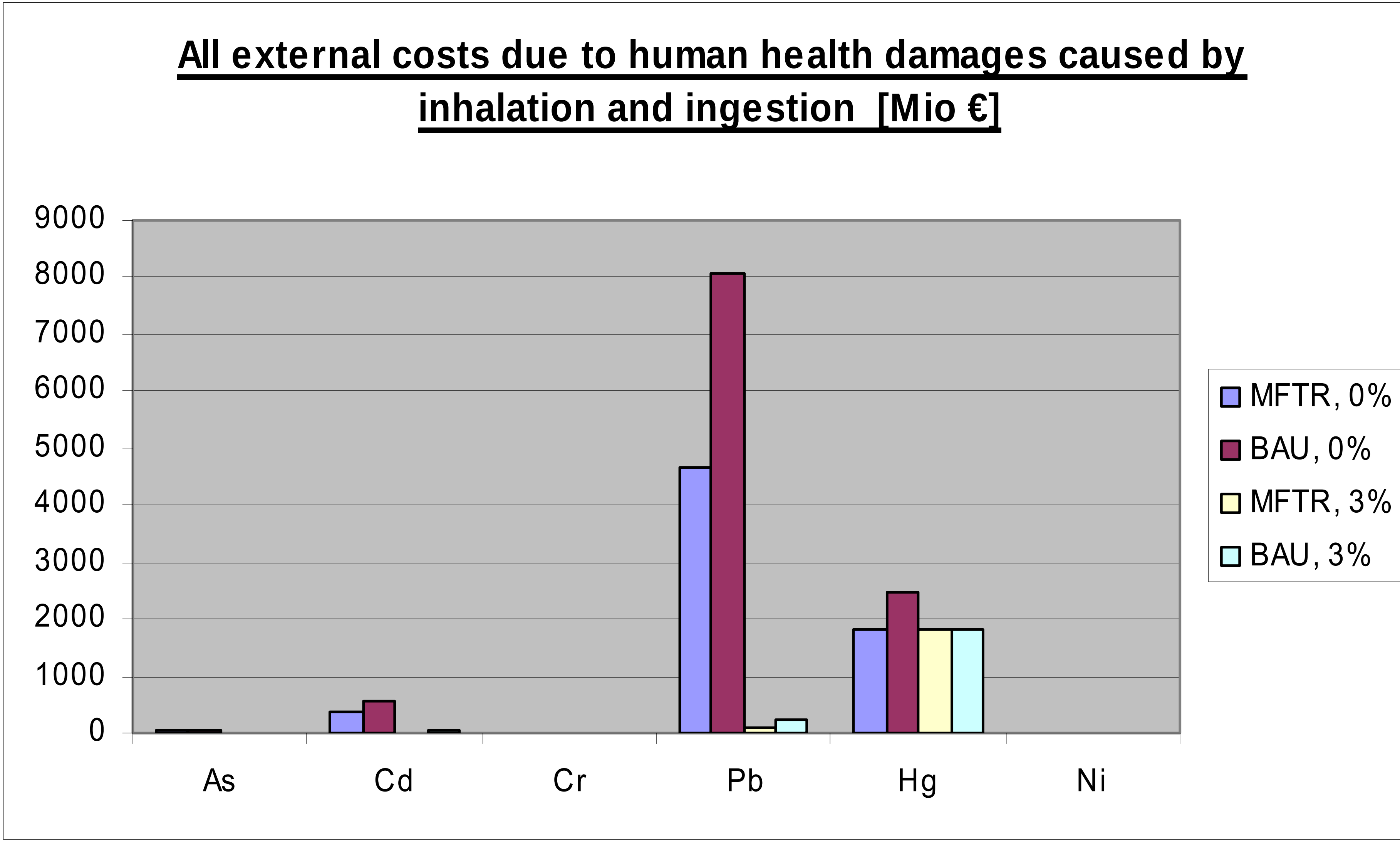


Cell (100,60): 0,627 ng/m3

MFTR



Cell (100,60): 0,576 ng/m3


All external costs due to human health damages caused by inhalation and ingestion [Mio €]
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
As
Cd
Cr
Pb
Hg
Ni
MFTR, 0%
BAU, 0%
MFTR, 3%
BAU, 3%

Conclusions (1)

- **Further progress has been made in assessing sources and emissions of HMs to the atmosphere at a country and regional (European) level**
- **At least 3 European wide emission inventories have been presented by groups of emission experts for the reference year 2000: ESPREME (for HMs), TNO (HMs and POPs), and MSC-E (HMs and POPs)**
- **Emission estimates prepared by expert groups are higher than the estimates provided by countries (so-called official estimates)**
- **The EMEP modellers are recommended to use the research based emission inventories for HMs e.g. ESPREME in their estimates of concentrations, deposition, and critical load until more complete and accurate official data from various countries are available.**
- **National emission experts are recommended to analyze the research based emission inventories and contribute to closing eventual gaps between the official and research based data.**

Conclusions (2)

- It was developed a tool to carry out integrate assessment for heavy metals and it is available, however high uncertainties at all steps.
- Hg, Pb and Cd cause higher impacts than As, Cr VI and Ni.
- External costs per kg range from several € (Ni, CrVI), ca 100 € (As), several hundred € (Pb, Cd) to several 1000 € (Hg) (with zero discounting).
- Generally damage due to ingestion is higher than damage due to inhalation; however it occurs farer in the future, thus issue of sustainability versus current welfare.
- Agricultural activities cause the highest (long term) human health damage for Cr, Ni, Pb, Cd and possess the highest reduction potential.
- Combustion of fuels is still the main source of ESPREME heavy metals, except for Pb (gasoline combustion)
- More extensive introduction of renewable energy sources may result in reducing the coal combustion and then heavy metal emissions

Conclusions (3)

- Cement production, iron & steel manufacturing, and non-ferrous metal production, are important sources of heavy metal emissions.
- Waste disposal is underestimated as a source of heavy metal releases to the atmosphere.
- More focus should be done on accurate assessment of Hg emissions from contaminated sites (re-emission) and selected natural sources (geologically bound Hg in rocks).
- For coal combustion and industrial processes, an improvement of implementation and of efficiency of dust filters may be efficient – also PM 10 strategy.
- Mercury: further implementation of FGD.
- For household heating, switch from coal and oil to natural gas or renewables or to central heating (CHP) – also climate strategy.
- For lead should be explore possibilities to further reduce lead in “lead-free” gasoline and use biofuels.
- The contribution of annual emissions to critical load exceedance is low. However critical loads will be frequently exceeded in the far future, if emissions continue for very long time spans.

Thank you for your attention

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