emep

Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

Pollution abatement under the Protocol on Heavy Metals

MSC-E
МСЦ-В

Meteorological Synthesizing Centre – East, 2012

Introduction

Scientific information presented in this booklet has been prepared on the base of data generated under the Cooperative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (EMEP) and the Working Group on Effects (WGE). The objective of the given below information is to support the revision of the 1998 Protocol on Heavy Metals (Protocol). This Protocol is one of the eight protocols of the UN ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) that identifies specific measures to be taken by Parties to cut harmful effects of heavy metal emissions on the environment and human health.

Heavy metals (HMs) targeted by the Protocol:

- **Lead** is a pollutant that is toxic at very low exposure levels and has acute and chronic effects on human health. It is a multi-organ system toxicant that can cause neurological, cardiovascular, renal, gastrointestinal, hematological and reproductive effects. It also bioaccumulates and adversely impacts both terrestrial and aquatic systems.
- **Cadmium** is a non-essential and toxic element for humans mainly affecting kidneys and the skeleton. It is also a carcinogen by inhalation. Important endpoints of cadmium include kidney and bone damage and cancer. In the environment, cadmium is toxic to plants, animals and micro-organisms.
- **Mercury** is toxic in multiple forms but the main concern is associated with the organic compounds, especially methylmercury. Mercury can damage the liver, kidneys and the digestive and respiratory systems. It also causes brain and neurological damage and impair growth. It affects animals in the same way as humans and is very toxic to aquatic life.

The problem of wide concern

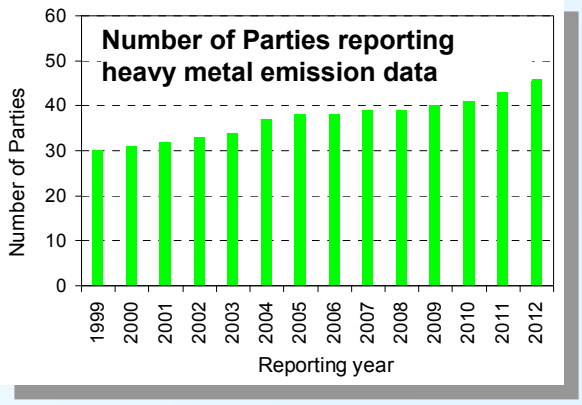
The concern regarding harmful effects of heavy metals on human health and the environment has led to the initiation of monitoring, assessment, regulation, and control activities on international and national levels.

Currently, activities of AMAP, European Commission, HELCOM, OSPAR, UNEP, WHO, Basel and Rotterdam Conventions, various national programmes etc. are focused on gradual reduction and prevention of air pollution, including long-range transboundary transport of heavy metals.

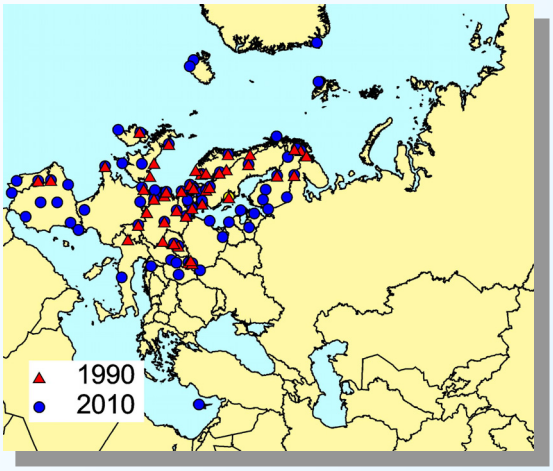
Obligations, reporting and research under the Protocol on HMs

According to the Article 7 of the Protocol *"Each Party shall report to EMEP … information on the levels of emissions of Cd, Pb, Hg, using methodologies and temporal and spatial resolution, specified by the EMEP Steering Body…"*

The total number of countries that signed or ratified the Protocol is 41 (May 2012). Since then the number of Parties that reported emission data increased from 30 to 46. Gridded emission data are reported only by 28 Parties.

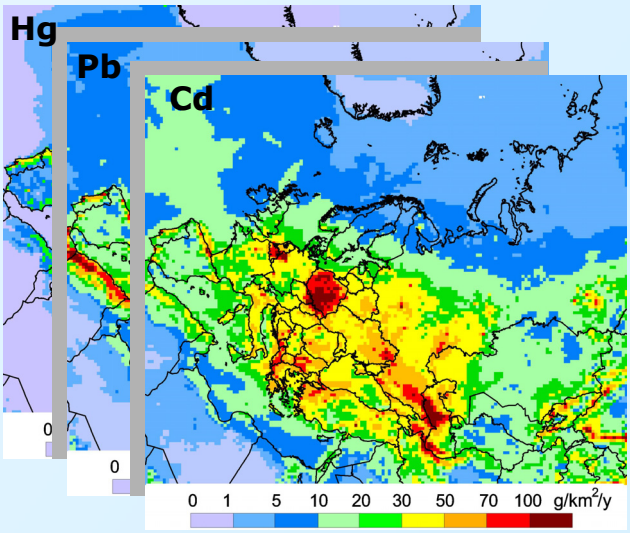


EMEP monitoring network for heavy metals



"Parties shall encourage research, development, monitoring …" (Article 6). The number of monitoring sites increased from 44 in 1990 to 66 in 2010. The monitoring network covers a large part of the EMEP countries. However, significant territories in Eastern and Southern Europe remain uncovered.

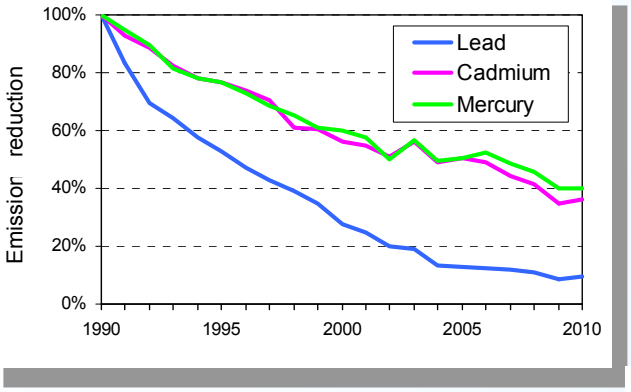
HM deposition in 2010



"EMEP shall provide to the Executive Body calculations on transboundary fluxes and deposition of HMs…" (Article 8). Model assessment of heavy metal pollution levels is performed annually for the EMEP domain.

Changes of heavy metal pollution over the period 1990-2010

HM emission reduction

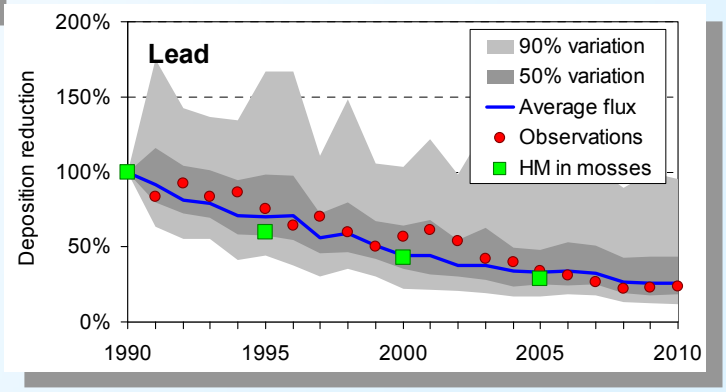


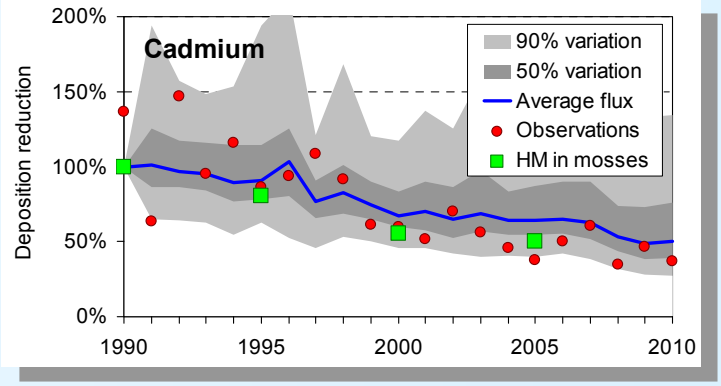
Anthropogenic emissions were significantly reduced in the EMEP countries over last 20 years: by 60% for cadmium and mercury and by 90% for lead

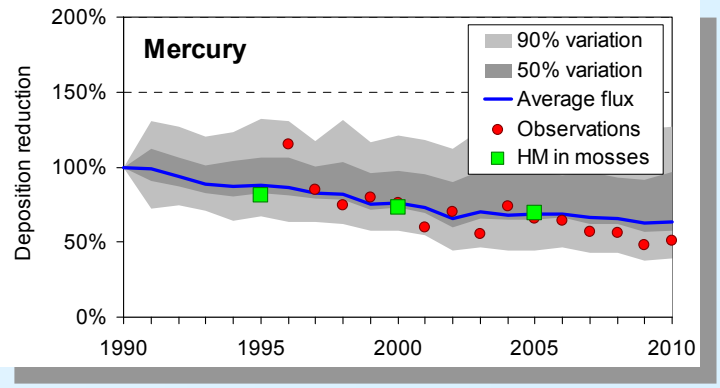
Changes in HM deposition

The trend of heavy metal deposition between 1990 and 2010 varies over EMEP countries. Both modelling results and observations show that deposition fluxes decreased on average by 75% for lead, 50% for cadmium, and 30% for mercury.

Estimates of deposition changes agree well both with the EMEP observations and measurements of heavy metals in mosses performed by the ICP Vegetation.





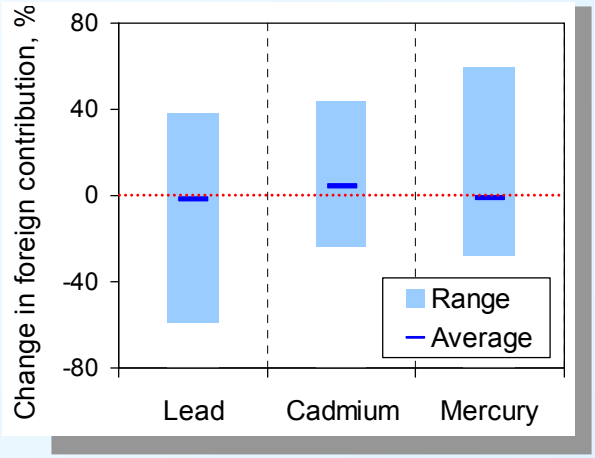


Transboundary pollution

In spite of considerable reduction of heavy metal deposition transboundary transport continues to play an important role in pollution of the EMEP countries.

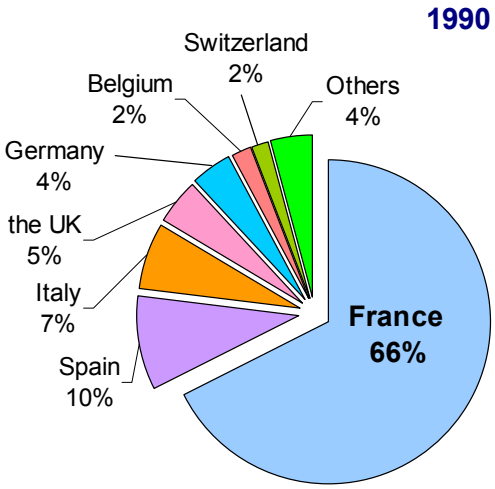
The change in the emission pattern since 1990 led to redistribution of transboundary fluxes. The share of the transboundary contribution to anthropogenic deposition of heavy metals has changed noticeably but continues to be significant in most countries.

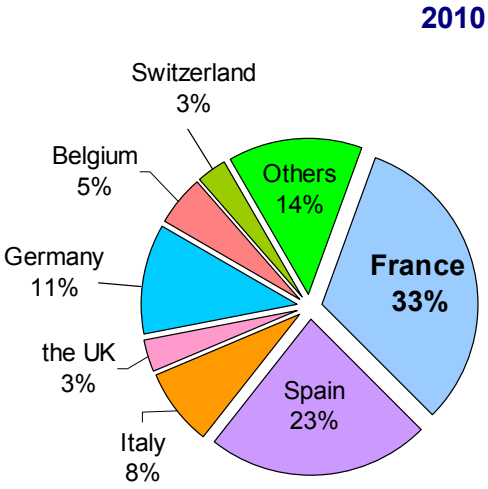
Change in contribution of foreign sources to deposition of heavy metals in the EMEP countries (1990-2010)



In some EMEP countries contribution of transboundary fluxes changed significantly between 1990 and 2010.

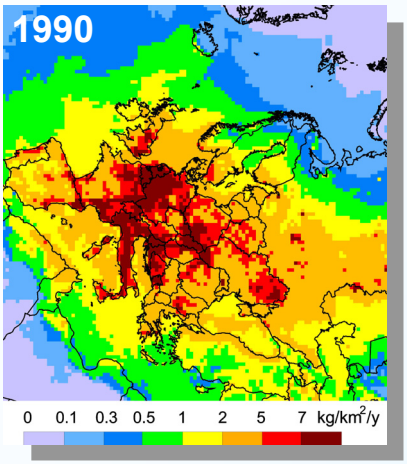
<u>Example:</u> Contribution of foreign countries to lead deposition in France

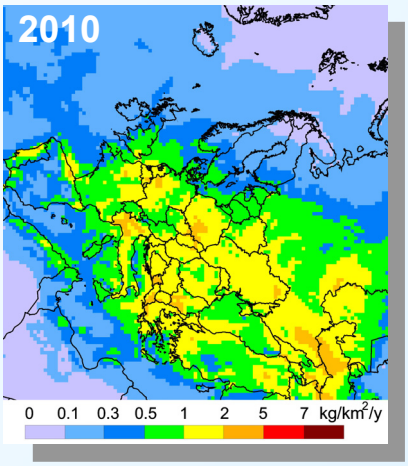




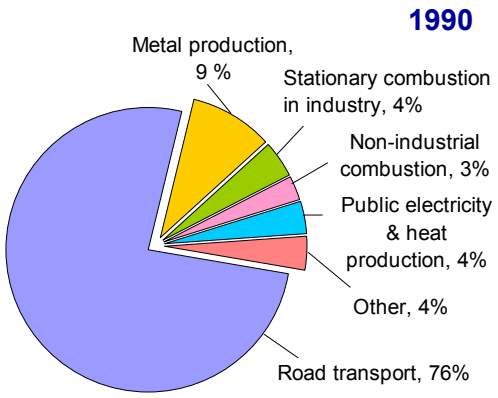
Has the problem of lead been solved?

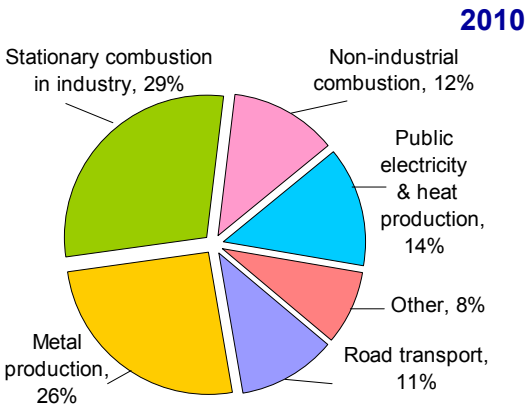
Lead deposition dramatically decreased in the EMEP countries mostly due to the phase out of leaded gasoline from use in road transport. However, reduction of lead emissions from other sectors was less significant.



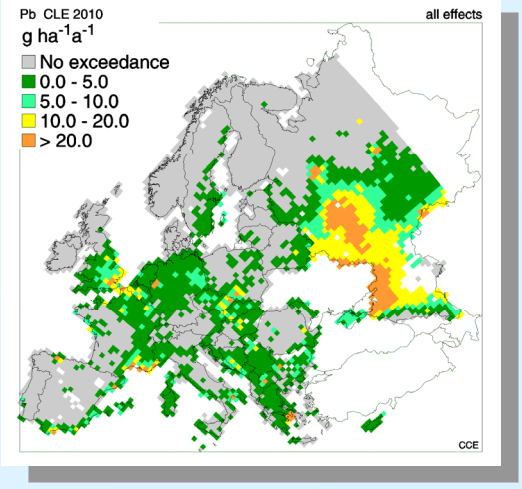


Key source categories contributing to Pb deposition



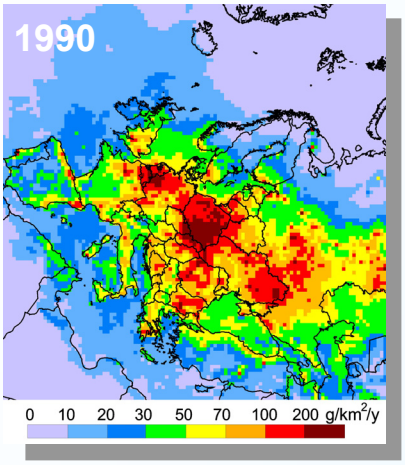


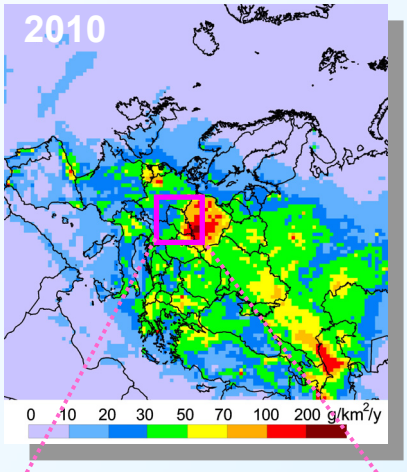
Exceedance of critical loads of lead in 2010



Human health and the environment continue to be at risk in many EMEP countries despite important reductions of lead deposition.

Cadmium: pollution 'hot spots'

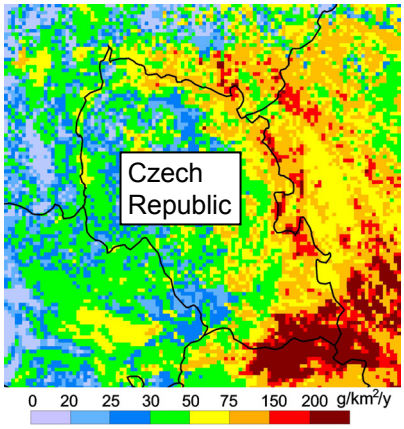




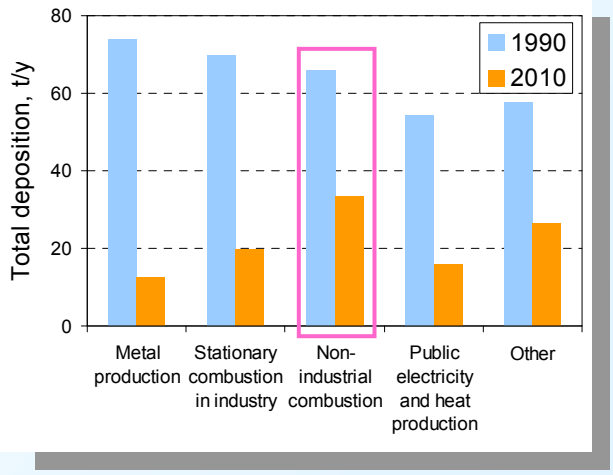
Cadmium deposition noticeably decreased in the EMEP countries. However, high deposition levels still remain in a number of 'hot spots' close to industrial regions, which require more detailed analysis on national and local scales.

Relative importance of emission sectors has changed since 1990. Emissions from non-industrial combustion in few countries become to play the prevailing role in cadmium pollution. Are these data complete?

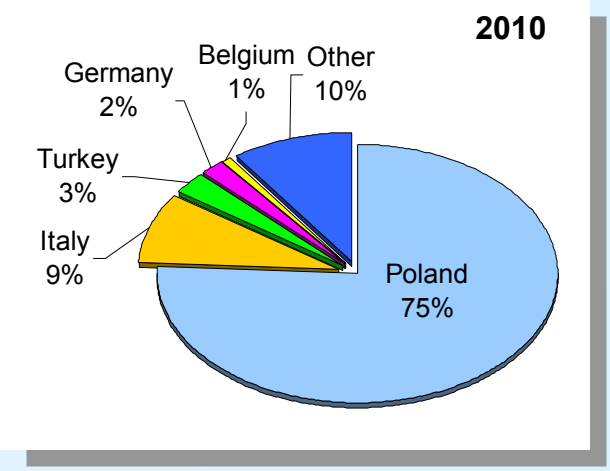
Cadmium deposition in Central Europe (5x5 km)



Key source categories contributing to Cd deposition



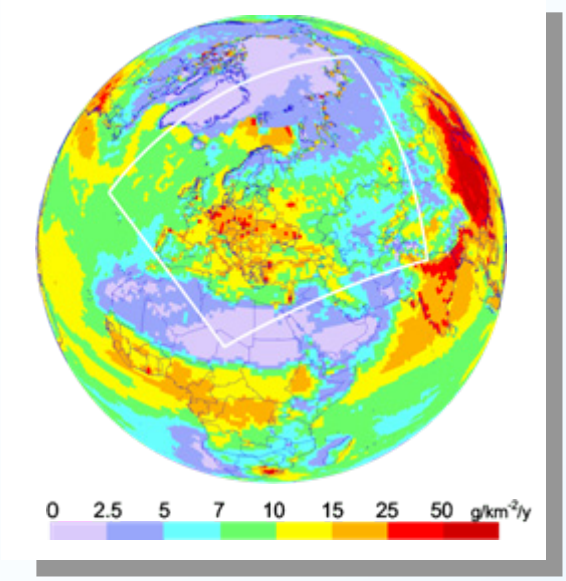
Total cadmium deposition to the EMEP countries



Cadmium emissions from non-industrial combustion

Mercury is a global pollutant

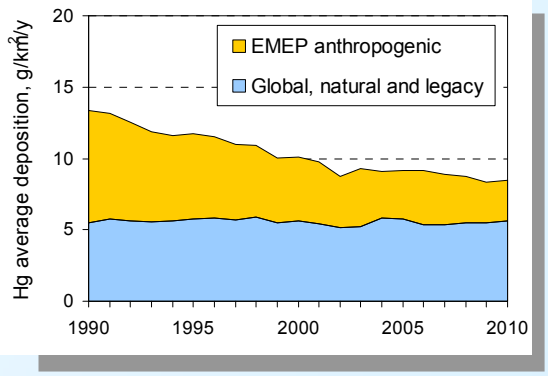
Mercury deposition in 2010



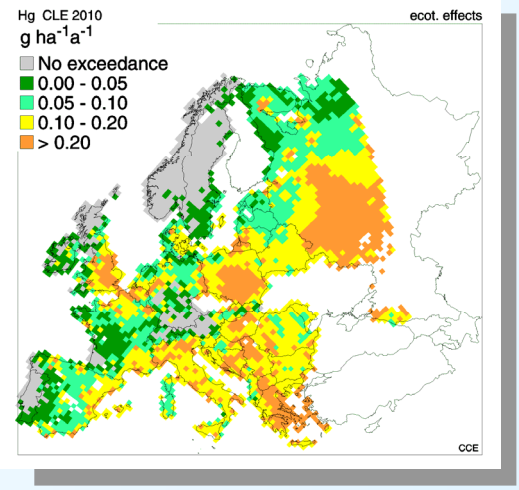
Mercury is dispersed globally in the atmosphere. Its deposition in the EMEP countries decreased slightly (30%) since 1990 due to large contribution of emissions from other continents.

Nowadays, intercontinental transport contributes more than 65% to total mercury deposition in the EMEP countries. Therefore, both regional and global efforts are needed to reduce mercury pollution.

Mercury deposition changes in the EMEP countries



Exceedance of critical loads of mercury in 2010



Mercury levels in many EMEP countries still pose a significant risk to human health and the environment. It accumulates in the food chain, for example in predatory fish in lakes and seas and reaches humans.

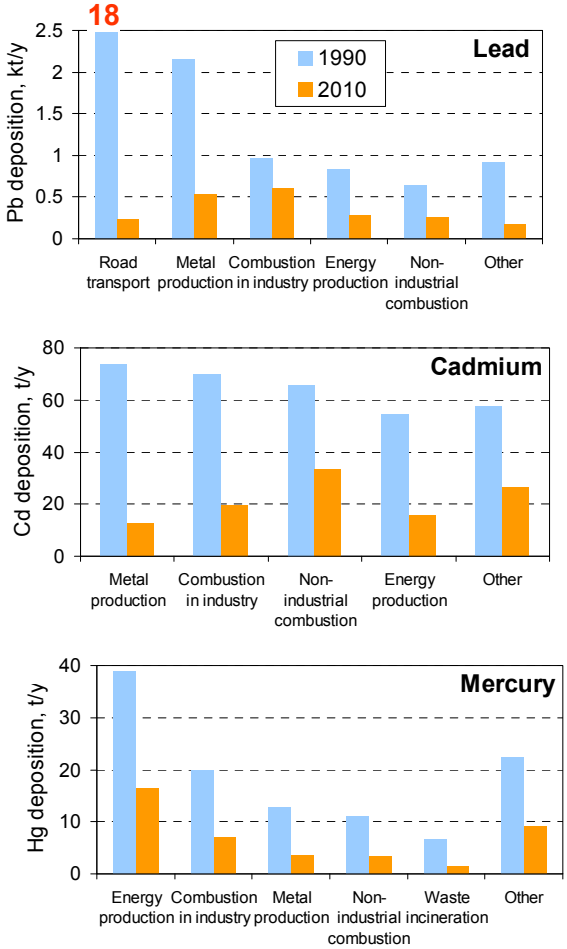
Changes in key source categories

Reduction of heavy metal pollution levels was accompanied by changes in the key source categories of both emissions and deposition. Prevailing contribution of road transport for lead and metal production for cadmium in 1990 was replaced by industrial and non-industrial combustion in 2010. Changes in sectoral composition of mercury emissions were less significant.

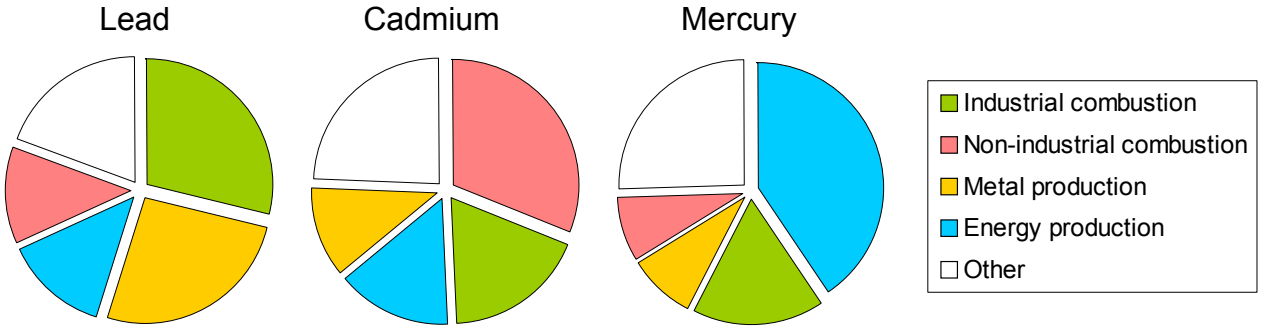
Nowadays, the prevailing sectors in deposition of all three metals include industrial combustion (1A2)[1], non-industrial combustion (1A4), metal production (2C) and energy production (1A1a).

[1] See EMEP/EEA Air Pollutant Emission Inventory Guidebook (2009) for the reference

Source categories of heavy metal deposition



Prevailing sectors of lead, cadmium and mercury deposition in 2010

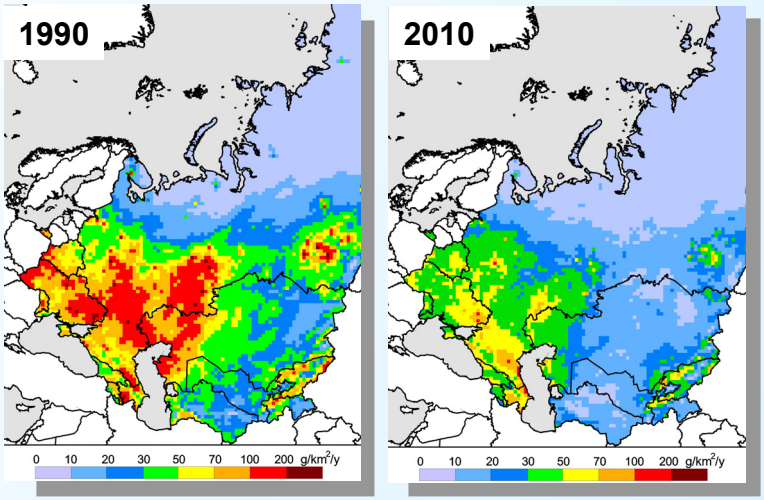


EECCA countries

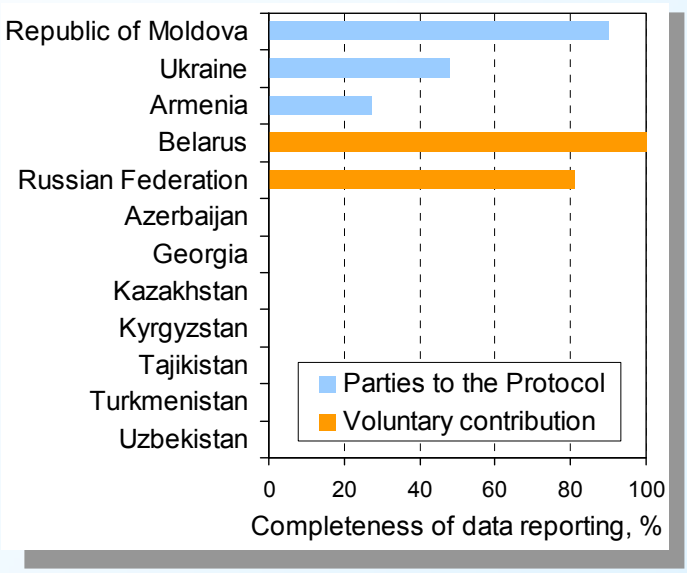
Pollution reduction in the Eastern Europe, Caucasus and Central Asia (EECCA) countries currently is of high priority within the LRTAP Convention (*Action Plan for EECCA*)

Reduction of heavy metal deposition in the EECCA countries are somewhat lower than in the other EMEP countries. The largest decrease takes place in the western part of the region close to major emission sources. However, the analysis is limited by the lack of national emissions and monitoring data.

Cadmium deposition in the EECCA countries



Completeness of emission reporting



National data on anthropogenic emissions are the primary information for assessment of pollution levels. Only 5 of 12 EECCA countries report data on heavy metal emissions. Of them 2 countries report information on spatial distribution of emissions.

No monitoring data on heavy metal concentration in air and precipitation are reported by the EECCA countries so far. It largely restricts evaluation of the model estimates of pollution levels in this part of the EMEP domain.

Future perspectives of heavy metal pollution

Although, heavy metal pollution levels have been reduced considerably in the EMEP countries, they are still high enough to pose a significant risk to human health and the environment at present and in future

- In spite of the deposition reduction transboundary transport continues to play an important role in heavy metal pollution of the EMEP countries
- Deposition of lead has decreased drastically due to the phase-out of leaded gasoline but it is still noticeable to cause adverse effects on human and the environment
- Cadmium remains to be an unresolved problem in many 'hot spots' located close to industrial regions
- Mercury as a global pollutant requires abatement efforts both on regional and global scales
- Heavy metal pollution in the EECCA countries is not characterized adequately due to the lack of observations and national information on emissions
- Four key source categories – *stationary combustion in industry*, *non-industrial combustion*, *metal production* and *public electricity and heat production* – make up the largest contribution to current pollution with all three metals and require priority mitigation efforts in future

This booklet has been prepared by Meteorological Synthesizing Centre – East (MSC-E) with contributions from Centre on Emission Inventories and Projections (CEIP), Chemical Co-ordinating Centre (CCC) and Coordination Center for Effects (CCE).

More detailed information is available in the joint Centres report:

"**Long-term changes of Heavy Metal Transboundary Pollution of the Environment (1990-2010)**" EMEP Status Report 2/2012 and at the websites:

CEIP (http://www.ceip.at/), CCC (http://www.nilu.no/projects/ccc/index.html), CCE (http://www.rivm.nl/en/Topics/Topics/C/Coordination_Centre_for_Effects_CCE), MSC-E (www.msceast.org), Convention on LRTAP (http://www.unece.org/env/lrtap/), EMEP (http://www.emep.int/), ICP Vegetation (http://icpvegetation.ceh.ac.uk/), UNEP (http://www.unep.org/), WHO (www.who.int), AMAP (www.amap.no), WGE (http://www.unece.org/env/lrtap/WorkingGroups/wge/welcome.html).