Mercury emissions from India and South East Asia

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Abstract

Mercury is an element of growing global concern. The United Nations Environment Programme plans to finalise a new global legally binding instrument on mercury by 2013, to coordinate actions to reduce emissions of mercury.

It has been well established that Asia represents not only the region contributing to greatest current mercury emissions but also the region with the fastest growth rate. Despite this, emissions from human activities in most countries in this region are not well characterised.

This report summarises the limited data available on mercury emissions from India, Cambodia, Indonesia, Malaysia, the Philippines, Thailand and Vietnam. These countries were specifically selected as they are areas of potentially significant growth in energy use in the near future. Information is given on the major sources of mercury in these countries, concentrating mostly on coal combustion and the non-ferrous metal industry. Although it is beyond the scope of this report to make new estimates for emissions, information is provided on current fossil fuel use and industrial activity as well as projections for these sectors to 2020 to give an indication of the general scale of these sources and the potential for increased emissions in the future.

Some countries have established regulations or action plans on emissions and these are summarised where possible. Recommendations are then made for potential actions which could be taken in each country to encourage action and achieve economic reduction in mercury emissions.

Acronyms and abbreviations

ACI	activated carbon injection
AMAP	Arctic Monitoring and Assessment Programme
BFBC	bubbling fluidised bed combustion
CBFC	circulating fluidised bed combustion
EMB	Environment Management Bureau, Philippines
ESP	electrostatic precipitators
Exec	extended emissions control, AMAP scenario where emissions control technologies currently used in Europe and the USA are used elsewhere
FBC	fluidised bed combustion
FGD	flue gas desulphurisation
GW	gigawatt
IGCC	integrated gasification combined cycle
iPOG	interactive (computer programme) Process Optimisation Guidance, UNEP
ktoe	kilotonnes oil equivalent
LBIM	Legally Binding Instrument on Mercury
LHV	lower heating value
MATS	Mercury and Air Toxics Standard, USA
Mtce	million tonnes of coal equivalent
Mtoe	million tonnes of oil equivalent
MFTR	maximum feasible technology reduction, AMAP scenario where all available solutions/measures are implemented
MW	megawatt
NTPC	National Thermal Power Ltd, India
OECD	Organisation for Economic Co-operation and Development
POG	Process Optimisation Guidance document, UNEP
SQ	status quo, AMAP scenario where current patterns, practices and uses continue. Economic activity increases but emissions control practices remain unchanged
UNEP	United Nations Environment Programme

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1 Introduction

Mercury emissions have surged and fluctuated through human history. During the 19th century the activities associated with the American gold and silver rush released up to 1500 t/y of mercury into the global atmosphere. This declined during the wars and depression of the early 20th century to under 1000 t/y. However, the recent decades have seen a resurgence in emissions due to further gold mining along with other sources such as coal combustion, metal processing and cement production. The current rate of emission to the atmosphere is around 1000 t/y (Streets and others, 2012).

In the build-up to the completion of the 2013 United Nations Environment Programme (UNEP) Global Legally Binding Instrument on Mercury (LBIM) there is growing interest in the amount of mercury arising from different sectors and from different global regions. For the UNEP Instrument to be most effective, control strategies should be targeted towards those regions and sectors which could achieve the most significant mercury reduction. To this end, there has been growing interest in establishing emission inventories. Much of this work has been carried out under the auspices of UNEP, using their Mercury Inventory Toolkit (UNEP, 2011a). This is a relatively simple interactive Excel spreadsheet based on default emission factors which allows national activity data to be used to produce a standardised emission inventory for mercury for individual countries. More accurate, country-specific, emission factors can be used if these are available. Information on the UNEP inventory toolkit is available here:
http://www.unep.org/hazardoussubstances/Mercury/MercuryPublications/GuidanceTrainingMaterialToolkits/MercuryToolkit/tabid/4566/language/en-US/Default.aspx

This report includes the most recent inventories produced by UNEP and AMAP (the Arctic Monitoring and Assessment Programme). However, supplementary data have been included where possible. Although these inventories include all uses of mercury, including gold production, batteries and so on, this report concentrates on emissions from coal combustion and from non-ferrous metal industries.

Where information has been made available, this report summarises the assumptions made in the preparation of the inventories reported. But in many instances, the default values provided by UNEP (2011a) are used. This leads to estimates with relatively high levels of uncertainty and, in many cases, the values reported err towards estimating the maximum emissions from source categories such as coal combustion. For example, the default input emission factor range in the UNEP Toolkit is 0.05–0.5 g Hg/t coal for coal combustion, representing the minimum and maximum values respectively. The range used in the AMAP (2008) report for UNEP was 0.1–0.3 g/t for coal combustion in power plants and 0.3 g/t for coal combustion in residential and commercial boilers. By comparison, the data in the recent US EPA information collection project in advance of the new emission standard – MATS (mercury and air toxics standard) suggested values from well below 0.1 g/t up to 0.38 g/t, a wider range than that used by AMAP and UNEP. However, for the basis of making estimates of emissions where data are sparse, the use of average values (excluding outliers and extreme values) makes sense. Of course, countries using the UNEP toolkit are encouraged to prepare their own emission factors based on typical national coal use where possible. This should take into account factors such as the average mercury content of coal combusted, whether the coal is washed and how effective the method is for mercury removal, and the control technologies in place on the fleet of operational coal-fired plants. In some countries, however, this level of information is not available and the UNEP toolkit allows a 'best guess' estimate to be made.

As part of the UNEP work towards establishing national emissions inventories, AMAP (2008) has prepared an inventory of emissions for 2005. The emission factors are shown in Table 1. Using these values, estimates were made for global regions for the year 2005. Total emissions from the Asian region (excluding Russia) amounted to 65% of the global total emissions from human activities. The

Table 1 Emission factors used in the AMAP mercury emission inventory (AMAP, 2008)

Source	Emission factor
Coal combustion	
Power plants	0.1–0.3 g/t
Residential and commercial boilers	0.3 g/t
Oil combustion	0.001 g/t
Non-ferrous metal production	
Copper	5.0 g/t Cu produced
Lead	3.0 g/t Pb produced
Zinc	7.0 g/t Zn produced
Cement production	0.1 g/t cement
Pig iron and steel production	0.04 g/t of steel
Waste incineration	
Municipal waste	1.0 g/t waste
Sewage sludge wastes	5.0 g/t waste
Mercury production (primary)	0.2 g/t ore mined
Gold production (large-scale)	0.025–0.027 g/t gold mined
Caustic soda production	2.5 g/t

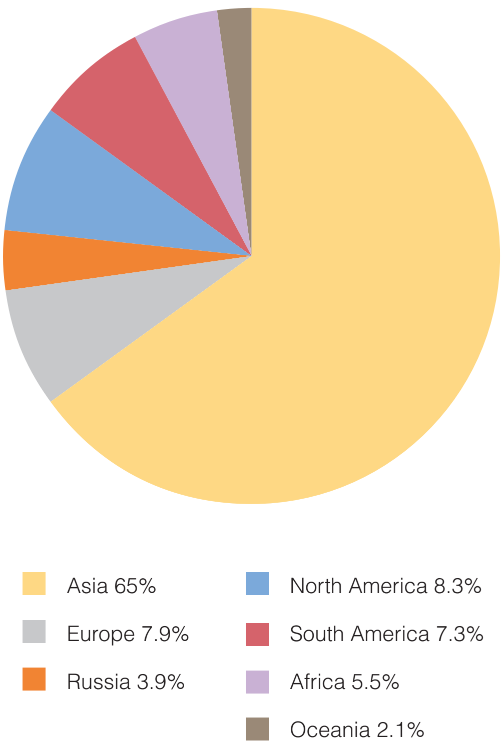

Figure 1 Total global emissions of mercury from human activities for 2005 by region (AMAP, 2011)

country contributions are shown in Figure 1 (AMAP, 2011). Figure 2 then shows the comparatively rapid increase in emissions from Asia from 1990 to 2005. Unfortunately there are no figures demonstrating how the different countries within Asia contribute to this total. However, the majority of emissions are from China, which is not surprising given the size and population of the country and the recent rapid growth in investment in energy production.

For Asia, the largest source of mercury emissions to the atmosphere was stationary combustion at 622 t/y, around 64% of the total emissions from this region. The next largest sources were cement production (138 t/y, 14%) non-ferrous metal production (90 t/y, 9%) and gold production (59 t/y, 6%)(AMAP, 2008).

Uncertainties in the emission calculations were estimated at ±25% for stationary fuel combustion and ±30% for cement, iron and steel, and non-ferrous metal production. The uncertainty was at least five times higher for

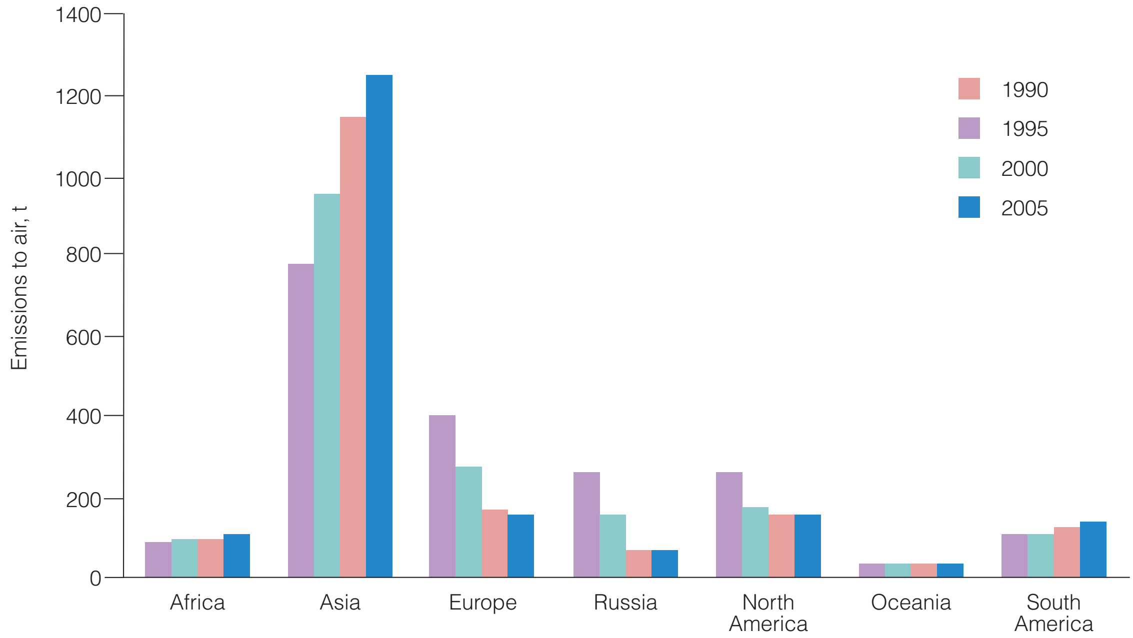

Figure 2 Increase in regional mercury emissions 1990 to 2005 (AMAP, 2011)

emissions from waste incineration and completely unknown for mercury and gold production. The uncertainty for total emission estimates for the Asia region were estimated at ±40%.

In a now somewhat dated report, Pacyna and Pacyna (2001) estimated global emissions of trace metals from human activities and put the total emissions of mercury at 1475 t/y for 1995. Of this, 860 t/y (58%) was estimated to arise from Asia. China was reported to contribute to 495 t/y (34%) of the total, and India to 117 t/y (8%).

In 2003, Pacyna and others (2003) updated their estimate to a global emission from human activities for 1995 to 1912.8 t/y of which 1074.3 (56%) was from Asia. Of this Asian total, 860.4 t/y (80%) was from stationary combustion, 87.4 t/y (8%) was from non-ferrous metal production, 81.8 t/y (7%) was from cement production and the remaining 4% from pig iron and steel production, and waste disposal.

Jaffe and others (2005) have produced an interesting report based on the measurement of mercury in remote locations and the traceability of these back to source regions. Results suggest that emissions of mercury from the Asia region may be significantly greater (more than double) the values estimated by Pacyna and others (2003). It was suggested that this could be due to a number of reasons including underestimation of emissions from this region, re-emissions of previously deposited Hg, natural emissions or errors in the understanding of the chemistry of atmospheric Hg.

From this brief review of the most quoted estimates of global mercury emissions it is clear that there is a significant amount of uncertainty in actual values for emissions from different regions and sectors. Despite this, there is fairly unanimous agreement that Asia is the largest regional source of emissions and, within this, stationary combustion is the largest single source sector (somewhere between 64% and 80%) with cement production (7–14%) and non-ferrous metal combustion (8–9%) contributing significantly less. Emissions from gold production remains the sector which poses the greatest challenge with respect to the estimation of actual emissions since much of the activity in this sector is small-scale or illegal. Emissions from gold production are beyond the scope of this report.

Chapter 2 of this report looks at published estimates for mercury emissions in India concentrating on emissions from coal combustion and the non-ferrous metal industries. Information on potential growth in these sectors is included along with a short discussion of the potential growth in emissions to 2020. Chapter 3 then presents similar work on mercury emissions from different sectors in Cambodia, Indonesia, Malaysia, the Philippines, Thailand and Vietnam now and to 2020. Countries such as China and Japan were not included as these countries have well established national emission inventories and already have action plans working towards mercury reduction from the energy sector. Where possible, Chapters 2 and 3 discuss any potential regulations, action plans or changes in national priorities which could affect mercury emissions from the selected countries in the future. Potential pathways to reducing emissions are discussed, concentrating as much as possible on the technologies and techniques which would be most appropriate for mercury reduction in each country.