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MEDITERRANEAN ACTION PLAN

Regional Activity Centre
for Cleaner Production

Meeting of MED POL Focal Points and Government-designated
Experts to review Regional Plans as part of the implementation
of Art. 15 of the LBS Protocol

Larnaca (Cyprus), 24-25 February 2011

Diagnosis of Mercury in the Mediterranean Countries

UNEP/MAP
Athens, 2011

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Executive Summary

In the framework of the Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution and the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol), the Mediterranean Action Plan (MAP) agreed in its meeting of 2008 in Aix-en-Provence (France) to carry out an Action Plan about mercury for the biennium 2010-2011 regarding measures and timetables for the reduction of inputs of mercury into the marine environment. In this sense, MAP commissioned the CP/RAC, in collaboration with MEDPOL, to prepare a diagnosis on mercury in the Mediterranean Region.

In this context, the main objective of the report is to describe the current status of mercury in the Mediterranean region with regards to legal and institutional framework, production, trade, use, emissions, waste, prevention and control measures and the identification of future challenges.

Legal framework

Several international and regional environmental agreements address mercury from different points of view, e.g. Rotterdam Convention, Basel Convention, LRTAP Convention (Aarhus Protocol), OSPAR Convention, Barcelona Convention, and EU Mercury Strategy. However, the most important target on mercury raised to date is the global legally binding instrument launched by the Governing Council of UNEP which is currently being negotiated and it is expected to be completed by 2013.

Mediterranean countries are Parties of the Barcelona Convention. In this framework, the LBS Protocol urges Parties to phase out inputs of heavy metals and their compounds deriving from land-based sources and activities. The Strategic Action Programme (SAP MED) sets specific pollution reduction measures to reduce mercury discharges by applying BAT and BEP and adopting emission limit values (ELV) and environmental quality standards.

In addition, most northern Mediterranean countries are EU Member States. EU legal framework includes mercury legal provisions deriving from thematic policies (air, water, waste, etc.) and the EU Mercury Strategy. So far, the Strategy has resulted in restrictions on the sale of measuring devices containing mercury, a ban on exports of mercury from the EU and new rules on mercury safe storage. The Strategy is currently being reviewed and further restrictions like the ban on mercury imports and the extension of the export ban are being assessed.

As for other international agreements, the Basel Convention on transboundary movements of hazardous waste has been ratified by all Mediterranean countries, the Rotterdam Convention on international trade of certain hazardous chemicals has been ratified by half of the Mediterranean countries and the Aarhus Protocol on long-range transboundary air pollution (heavy metals) has only been ratified by five Mediterranean countries.

At national level, the most implemented mercury regulations in the Mediterranean countries are related with water discharges, air emissions and waste incineration. The development of such regulatory frameworks commonly resulted in the establishment of associated emission limit values for waste incineration and other potentially polluting activities such as chlor-alkali plants, cement production and large combustion plants. However, they are not always associated with the use of the Best Available Techniques (BAT).

Separate collection of mercury-containing wastes is fairly adopted in the Mediterranean region although products containing mercury are known to cause significant mercury emissions during their disposal if mercury is not recovered separately. Main regulated

wastes are batteries and accumulators, electrical and electronic equipment and end-of-life vehicles.

Trade on mercury has only been restricted in the EU Member States, where the exports of metallic mercury and mercury compounds with a concentration of at least 95% w/w will be banned from March 2011. Regulations on mercury storage have not been developed in the Mediterranean countries yet.

Regulations on the restriction of mercury containing products are still not extensively adopted in the Mediterranean region. However, they are being progressively implemented led by EU Mediterranean countries. Mercury restricted uses more commonly adopted are:

- Pesticides and biocides
- Preparations intended for fouling prevention, wood preservation, impregnation of fabric and treatment of industrial waters.
- Cosmetics.
- Vehicles: the use of mercury, including switches and relays, is banned, with the only exception of discharge lamps and instrument panel displays.
- Electric and electronic equipment: the use of mercury, including switches and relays, is banned with the exception of some kinds of light sources. Medical devices and monitoring and control instruments are excluded.
- Batteries and accumulators: they cannot contain more than 0.0005% w/w of mercury. Button cells can contain mercury up to 2% w/w. Batteries for medical equipment and emergency and alarm systems are exempted from the ban.
- Measuring devices (thermometers and barometers, with exceptions).

In addition, further restrictions are currently being assessed for dental amalgam, sphygmomanometers and PU elastomers in the EU framework.

Mercury production

Although mercury is no longer mined in the Mediterranean region, historically, it has been the major source of mercury from primary mining in the world. Until 2003, Spain and Algeria kept as two of the four most important world producers, providing roughly half of global mercury supply. During the Eighties and Nineties Slovenia, Italy and Turkey were also important producers. At present, China and Kyrgyzstan are the two major mercury primary producers.

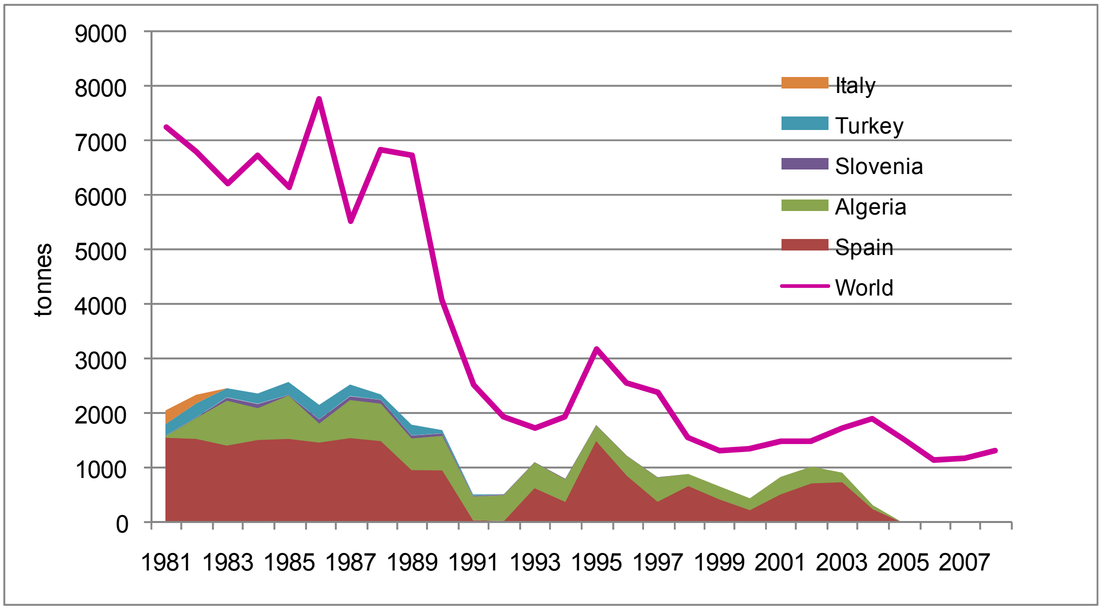

Figure 1. Mercury production in Mediterranean countries (tonnes, 1981-2007). Sources: own elaboration after Hylander & Mieli (2003); USGS-Minerals Yearbook; BRGM-Annuaire Statisque Mondial des Minerais et Metaux (2007).

Mines in Slovenia and Algeria ceased operations due to economic and technical difficulties, while others like the Almadén mine in Spain experienced pressure from growing international concern regarding mercury pollution which also led to its closure in 2004.

Mercury is also obtained from the recovery of mercury from the decommissioned chlor-alkali cells and as by-product from most non-ferrous metals mining, such as zinc, copper, lead, gold and silver. In Morocco about 1 tonne yr^{-1} of mercury is obtained as a by-product of refining silver. Moreover, mercury is recovered from natural gas cleaning in some Mediterranean countries, e.g. Algeria, Croatia, Egypt and Libya, since natural gas contains some mercury in trace quantities.

Storage of mercury and mercury containing wastes

The most important world mercury stock is placed in Almadén, Spain, the location of the closed Spanish mercury mine. The Almadén mining company, MAYASA, signed an agreement with Euro Chlor, the European chlor- alkali industry association, which allow it to buy the mercury from European plants shifting towards mercury-free processes, and sell it in the market. The total estimated amount of mercury collected until Sep. 2006 was approximately 1,500 tones. Other mercury stocks in the Mediterranean region can be found in Algeria, Egypt, Israel, Slovenia, Tunisia and, Turkey in addition to French, Italian and Spanish chlor-alkali plants.

Table 1. Mercury stocks in Mediterranean countries.

Country	Mercury in chlor-alkali facilities (tonnes)	Other stocks (tonnes)	Comments
Algeria	~1.5	1,000,000(*)	This figure refers to mercury slag ore in Azzaba mining site, which has the largest hazardous waste inventory of the country. About 600,000 m3 are stored in the plant in conditions that do not comply with environmental standards and cause infiltration of mercury in soil and groundwater contamination. The complex also stores in stacks the sludge contained in the dykes and used vases.
Egypt	0	n.a. (*)	Data are not currently available.
France	882 (-)	n.a	
Greece	48 (-)	n.a.	
Israel	4.5 (*)	n.a.	
Italy	320 (-)	n.a.	
Slovenia	0	4,000 (*)	Old mining waste deposits around the Idrija area.
Spain	888 (-)	5,000 (***)	
Syria	10	n.a.	
Tunisia	Few tonnes (*)	n.a.	The stock is in the old electrolysis unit of the chlor-alkali farm that was abandoned in 1998
Turkey	n.a.	3,920 (**)	Various mercury stocks, 85% of the mercury is located in the Aegean Region

(-) Source: EuroChlor, 2010.
(*) Source: questionnaires handed out for this diagnosis.
(++) Source: OSPAR Commission, 2009.
(**) Source: Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) to be held in Stockholm, Sweden, from June 7 to 11 2010.
(***) Lassen et al., 2008

Due to the European mercury export ban, which will enter into force in 2011, the European Commission developed a study on requirements for facilities and acceptance criteria for the safe storage of surplus mercury; however, no facilities have been authorised in the EU or in the Mediterranean region so far.

Almadén mine remains a possible candidate for permanent storage of European surplus mercury. Mercury stocks from eastern and southern Mediterranean countries might also be placed in Almadén, or similarly, in other facilities around old mercury mining sites (e.g. Turkey or Algeria).

Trade of mercury and mercury containing wastes

According to COMTRADE database, Spain has been identified as the second most important world mercury exporter (10.3% of the global mercury exports in monetary terms between 2007 and 2009), due to the activity of the Almadén mining company, MAYASA.

Other Mediterranean countries are net mercury importers. The most important net importer is France (103 tonnes in 2008). The only net exporters are Spain (221 tonnes), Italy (62 tonnes) and Turkey (20 tonnes).

As regards trade of mercury-containing wastes, according to the Basel Convention database, Germany and France are the countries receiving more mercury containing wastes from the Mediterranean region, while Italy and France are the Mediterranean countries exporting more mercury containing wastes.

Uses and substitutes

Main mercury uses identified in the Mediterranean region are chlor-alkali production, batteries, dental amalgams, measuring and control devices, light sources, electrical and electronic devices and mercury chemicals. Uses as catalyst for the production of vinyl chloride monomer and in the small-scale gold mining have been considered insignificant in the Mediterranean region.

Table 2 . Mercury use in Mediterranean countries (tonnes).

Country	Chlor-alkali production	Dental amalgams	Batteries	Measuring and control devices	Electric and electronic devices	Mercury chemicals	Other applications
Algeria	~1,5 (**)						
France	882 (*)	17,5 (++)	1 (***)	0.3 for non-fever thermometers 1.5 for barometers (++)		0.9 for for Chemical Oxygen Demand (COD) analyses (++)	
Greece	48 (*)						
Israel	4.5 (**)	1.6 (**)					2 for pesticides and biocides industry (**)
Italy	320 (*)						3.5 for producing paints (++)
Morocco		0.75 (**)	0.3 (**)	0.1 (**)			0.002 of mercury oxides, 0.001 of mercury and lead sulphates and 0.001 of copper for laboratories (+)
Slovenia		0.007 (**)	<0.001 (***)		0.002 (***)	- < 0.001 for vaccines - 0.7 for laboratory chemicals (***)	5.05 for production of mercury chloride, (**)
Spain	888 (*)						
Syria	10 (**) (***)	4.370 (**)	0.283 (**)	- 60,000 units of medical thermometers - 15,000 units of sphygmomanometers (+++)			

(*) Source: EuroChlor, 2008
(**) Source: questionnaires handed out for this diagnosis
(***)Source: UNEP, 2008
(+) Source: Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1).
(++) Lassen et al., 2008
(+++) Ad Hoc Open-ended Working Group on Mercury. Request for Information of Mercury in Products and Processes, Quantities Used, Demand, Level of Substitution, Technology Change-over, Available Substitutes.

Chlor-alkali production is currently the most significant mercury use, mainly located in France and Spain. However, the use of mercury is diminishing, due to the progressive phase out of this technology stimulated by the chlor alkali sector’s voluntary agreement.

Table 3. Capacity and amounts of metallic mercury in Mediterranean chlor alkali facilities represented by Eurochlor (tonnes, 2008). Source: EuroChlor, 2008.

Country	Company	Sites	Capacity (tCl_2/y) (-)	Total on site	Used in cells	Stored in facility
France	Arkema	Lavera	166,000	298	255	43
France	Solvay	Tavaux	240,900	584	574	10
France (++)	Arkema	St Auban (not in production anymore)	-	n.a	n.a	n.a
Greece	Hellenic Petroleum	Thessaloniki	39,899	48	48	0
Italy	Solvay	Bussi (not in production anymore)	-	225	219	6
Italy	Solvay	Rosignano (not in production anymore)	-	13	5	8
Italy	Syndial	Porto Marghera	200,441	7	3	4
Italy (*)	Syndial	Priolo	28,000			
Italy	Tessenderlo Chemie	Pieve Vergonte	41,995 (**)	75	74	1
Italy	Eredi Zarelli	Picinisco (not in production anymore)	-	0	0	0
Italy	Caffaro (+)	Torviscosa (not in production anymore)	-	0	0	0
Spain	Ercros	Flix	150,000	347	347	0
Spain	Ercros	Sabinanigo	25,000	46	46	0
Spain	Ercros	Vilaseca	135,004	198	197	1
Spain	Química del Cinca	Monzon	31,373	45	44	1
Spain	SolVin	Martorell	217,871	252	243	9
Total in Mediterranean basin				2,138	2,055	83

(-) EuroChlor, 2010
(--) own elaboration
(*) Information obtained from the questionnaire handed out for this diagnosis.
(**) Information also indicated in the answer to the questionnaire handed out for this diagnosis.
(+) In the answer to the questionnaire appears as functioning, with a production of 69,000 tonnes per year.
(++) OSPAR Commission, 2009.

Table 4. The use of mercury in Mediterranean chlor alkali plants not covered by Eurochlor.

Country	Mercury using chlor-alkali plants	Use of mercury (tonnes per year)	Comments
Algeria (*)	YES	- One installation in Baba Ali (Alger): 0.68-0.85 (data between 2001 and 2003). - One installation in Mostaghanem (west Algeria): 0.69 tonnes (data between 2003 and 2004).	The two plants are switching to mercury-free production processes.
Croatia (*)	NO		There was a chlor-alkali plant in Kaštela, near Split, which is no longer operating.
Cyprus (*)	NO		
Egypt (*)	NO		The chlor–alkali technology has been phased out.
Israel (*)	YES	- One installation in the south: 1.5. (IS1)	The plant has a stock of 3 tonnes.
Monaco (*)	NO		
Morocco (**)	NO	- One installation: 4 (Not in the Mediterranean basin)	There is also a plant using mercury for the electrolysis of sodium chloride and PVC production (with a capacity of 180 tonnes per year).

Slovenia (*)	NO		
Syria (*) (***)	YES	- One installation: 10	
Tunisia (*)	NO		There is only one chlor-alkali plant, which adopted in 1998 a mercury-free membrane process.

(*) Source: Questionnaire handed out for this diagnosis.
(**) According to the Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1), this figure range between 4.05 and 5.4 tonnes
(***) Source: UNEP, 2008

Mercury-free alternatives are available and currently used for thermometers, dental amalgams sphygmomanometers, thermostats and non-miniature batteries, switches and relays and High Intensity Discharge (HID) automobile lamps. In most cases, the price of the alternative is similar to the price of the mercury-free alternative, and in some cases it is even lower.

Mercury is still used for miniature or button cell batteries, whose production is increasing worldwide, because mercury-free alternatives are not always able to meet the demands of many miniature battery applications. Mercury containing lamps (e.g. fluorescent tubes, compact fluorescent and high-intensity discharge lamps) are still used because of their higher energy-efficiency with respect to mercury-free alternatives.

In addition, technologies for reducing the mercury non-intentional emissions from the combustion of fossil fuels, cement, iron and steel, non-ferrous metal, pulp and paper, industry and iron foundries are technically and economically feasible according to the available bibliography regarding Best Available Techniques (BAT).

In the Mediterranean region, information on the substitution of mercury is scarce, and the levels of substitution reported by countries are uneven. The main substitution processes initiated concern chlor-alkali mercury cells; mercury dental amalgams; batteries, cosmetics, measuring and control devices, pesticides and biocides, pharmaceuticals and paints. Mercury substitution in the region is in a less developed stage for light sources and electrical and electronic devices.

Emission inventories

Several regional and national inventories of mercury emissions (mainly atmospheric releases) have been identified, although figures provided by the different inventories cannot be directly compared, due to differences in the geographic coverage, the source sectors included, or the methodology and emission factors used. Many of the information provided at national level is linked to the international or regional reporting obligations, although some countries have their own national emission inventories or even in some cases specific assessments of the situation of heavy metals including mercury have been conducted.

Table 5. Review of regional inventories of mercury emissions.

Inventory	Matrix	Geographic coverage	Last year available	Sectors covered	Reported amount in Med (air) (t/yr))	Major emitting country	Major emitting sector
AMAP/UNEP Hg Programme	Air	World	2005	Mercury specific	6.8	**Turkey (27%)**	**Stationary combustion (54%)**

Inventory	Matrix	Geographic coverage	Last year available	Sectors covered	Reported amount in Med (air) (t/yr))	Major emitting country	Major emitting sector
UNEP/MAP NBB	Air, Water	Mediterranean basin	2003	Mostly industrial	6.3	**Italy (40%)**	**Cement (33%)**
EU E-PRTR	Air, Water, Soil	EU Member States	2007	Industrial	9.9	**Spain (43%)**	**Energy (33%)**
UNECE-EMEP	Air	Europe-Caucasus-Central Asia	2007	All	66.6	**Turkey (32%)**	**Energy industries (38%)**
Pirrone et al. (2001)	Air	Mediterranean countries	1995	Mercury specific	106	**France (22%)**	**Energy (29%)**

Using the available data, the total mercury atmospheric emissions in the Mediterranean region have been estimated in about **70 tonnes yr^{-1}** (~3.6% of global emissions). Five countries (Turkey, Italy, Spain, Greece and France) would account for about 80% of total emissions in the region. By regions, north Mediterranean countries (NMC) account for 56% of total emissions, followed by eastern (33%) and southern (10%) Mediterranean countries (see figure below).There is not enough information to estimate mercury emissions to water, but according to available data it can be assumed that total releases will be lower in comparison to atmospheric emissions.

Unintentional emissions resulting from the use of fossil fuels (in the energy or cement industry) appear to be the dominant source of mercury releases to the atmosphere in the Mediterranean, which is in agreement with mercury inventories in other areas. Air and water emissions from the chlor-alkali industry (intentional use of mercury) have notably been reduced over the last years. Very few information is available on mercury releases from other intentional uses of mercury, e.g. dental amalgams, breakage of measurement devices, etc.

According to available information, several countries show downward trends in their mercury atmospheric emissions. As a whole, the future trend of emissions in the Mediterranean region will mostly depend on the future use of coal and production of cement in the different countries, combined with the adoption of BATs in the energy, cement, metal and waste incineration sectors.

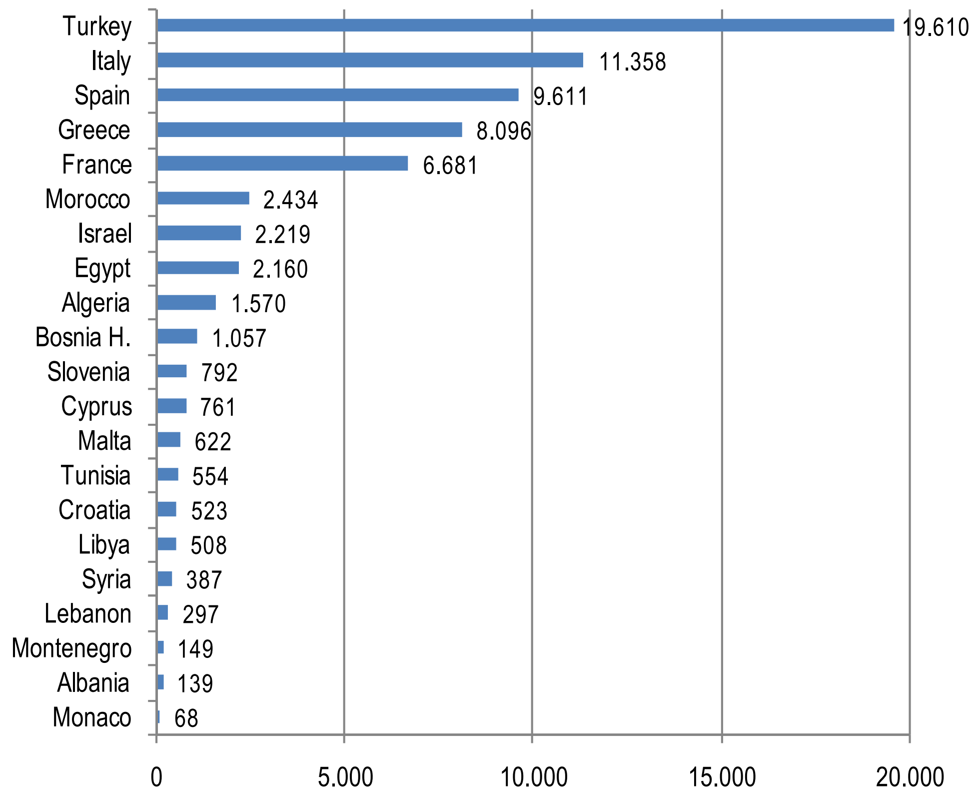

Figure 2. Estimated mercury atmospheric emissions in Mediterranean countries (kg yr^{-1}).

<u>Monitoring networks</u>

The most relevant air quality monitoring network in the Mediterranean is the UNECE/EMEP Measurement network, which includes 10 Mediterranean countries. However, data for mercury is hardly available for most of stations, although its measurement is being initiated in several countries and more data is expected to be available in the forthcoming years. A general lack of information can be observed for east and south Mediterranean countries. In northern countries mercury is also commonly monitored in freshwaters, in order to comply with EU Water Policy Framework regulations.

In the marine environment mercury has been monitored in sediments and biota for several years under the MEDPOL programme, although information is not still available for all countries. The assessment of data from the MEDPOL database is not conclusive but shows that the higher levels of mercury in sediments and biota occur in localized areas of the north western basin and Adriatic Sea. Environmental assessment criteria (EACs) for mercury and other hazardous pollutants are still pending to be developed in the Mediterranean.

Complementary information from the literature and national monitoring networks might indicate that mercury levels in the Mediterranean marine environment have decreased over the last decades, but more slowly than emissions.

Monitoring of mercury in foodstuff is conducted in most EU countries, and in other Mediterranean countries like Algeria, Tunisia or Israel. The available information from foodstuff monitoring networks (e.g. the EU Rapid Alert System for Food and Feed) shows that consumption of seafood is the major human exposure pathway to mercury. Data from literature confirm the high levels of mercury in fishes (e.g. tuna and swordfish) and cetaceans from the Mediterranean, where bioaccumulation has been frequently observed to be higher than in other marine regions.

Very few information has been obtained regarding the control of mercury in human blood or breast milk, although some countries are launching strategies to monitor it on a periodic basis (e.g. Spain).

Hot spots

Industrial sites in EU Mediterranean countries that currently concentrate most of mercury emissions can be identified using the E-PRTR inventory. In general, most of the hot spots of mercury air emissions are generated by coal-fired power plants, chlor-alkali plants and cement industries, while wastewater treatment plants and chemical industries are frequently identified as hot spots for water emissions. According to 2007 data, the major point sources of mercury air and water emissions affect the catchment areas of the rivers Ebro, Rhône and Po. Besides discharges from the Po catchment area, the north Adriatic is also affected by important point sources located around the area of Venezia and the Gulf of Trieste. Other important air emission hot spots derived from the energy and cement industry are also identified in Greece and Cyprus.

Hot spots generated by old industrial sites are mostly related with closed chlor-alkali plants (or current plants that have already adopted a mercury-free process but the surrounding environment is still polluted). Many of them have already removed their mercury stocks or remediation actions have been put in place, like in Croatia, Egypt or Tunisia. A former PVC plant in Vlora (Albania) is another of the major mercury hot spots identified in the Mediterranean, although remediation actions to confine the polluted soils are also being addressed.

The old mercury mines around the Mediterranean have also led to contamination of the surrounding areas, by the historic disposal of mining wastes containing high concentrations of mercury. The main sites are located in Spain (Almadén), Slovenia (Idrija), Italy (Monte Amiata), western Turkey and Algeria (Azzaba). The drainage of these mining areas has also increased the mercury levels in nearby coastal areas, like the Gulf of Trieste or the Gulf of Izmir in Turkey.

Recommendations

- A formal commitment not to reopen mercury old mines should be adopted by Mediterranean countries.
- A phase-out of mercury cell chlor-alkali plants must be agreed and enforced in the whole Mediterranean region.
- The Mediterranean region as a whole must assess the possible implementation of a ban on mercury exports/imports and the possible scopes of such regulations considering the existing international framework (Rotterdam Convention) and the conclusions extracted from the review of the EU Mercury Strategy regarding further restrictions on mercury imports and extended export ban to other mercury compounds, mixtures with a lower mercury content and products containing mercury, in particular thermometers, barometers and sphygmomanometers.
- Taking into account the international trends on the prohibition and restriction of mercury and the EU ban on mercury exports, the future surplus in the Mediterranean region and the potential needs for safe storage of metallic mercury should be further explored. Also, a review of the potential use as repositories of old mercury mines around the region might be conducted.
- Separate collection and mercury recovery from mercury containing wastes such as batteries, end-of-life vehicles and electrical and electronic equipment must be

regulated to reduce mercury releases from mercury containing products in the Mediterranean region.

- More comprehensive data on air and water emissions, especially in eastern and southern Mediterranean countries is needed. Also, monitoring networks of mercury in the different compartments (air, water, soil,...) need to be reinforced in order to identify priority actions and track the effect of policies and strategies. The control of mercury in foodstuff, in particular seafood, is also of major importance.
- For all products for which a mercury-alternative is available and economically competitive, the substitution process should be encouraged by legislative initiatives and economic incentives (mercury thermometers, barometers, sphygmomanometers, catalyst in PU elastomers and dental amalgams).
- The environmentally sound management of mercury-containing wastes must be ensured.
- Follow-up actions should be taken to ensure that mercury hot spots are properly remediated and the surrounding environment evolves positively. Further attention might be required to old mercury mines in Turkey or Algeria.
- As an intermediate stage, the development of an exhaustive and detailed data-base on trade of mercury-containing products of Mediterranean countries would be highly recommended for the design and the monitoring of effective policy to reduce mercury consumption.
- For certain types of potentially heavily polluting industries, for example the chlor-alkali industry, waste incineration, cement production and large combustion plants, legislation must require the use of specific, less polluting production methods and pollution prevention technologies or “Best Available Techniques" (BAT) with associated emission limit values (ELV).
- The existence of emission legislation, while a necessary step toward significant emission controls, is not sufficient to ensure compliance. A serious enforcement system must be in place as well, in which the enforcing authority not only has the power to adequately enforce the relevant legislation, but is also technically competent to understand the emission controls, measurement methods, etc.
- For those Mediterranean countries which have not yet developed a National Diagnosis on Mercury, it is strongly recommended that a comprehensive and multidisciplinary analysis is developed. As there is little information available on the use of mercury in Mediterranean countries, an additional effort should be made to collect relevant data so that to develop reduction and management policies.

1. Introduction

1.1 Mercury

Mercury is recognized as a chemical of global concern due to its long-range transport in the atmosphere, its persistence in the environment, its ability to bioaccumulate in ecosystems and its significant negative effect on human health and the environment. It is a naturally occurring element that can be released into the air and water through the weathering of rock containing mercury ore or through human activities such as industrial processes, mining, deforestation, waste incineration and the burning of fossil fuels. Mercury can also be released from a number of products that contain mercury, including dental amalgam, electrical applications (e.g., switches and fluorescent lamps), laboratory and medical instruments (e.g., clinical thermometers and barometers), batteries, seed dressings, antiseptic and antibacterial creams and skin-lightening creams.

When mercury is released to the environment, it travels with air currents and then falls back to earth, sometimes nearby the original source and sometimes very far away. Mercury can drain from soils to streams, rivers, lakes and oceans, and it can also be transported by ocean currents and migratory species. When mercury enters the aquatic environment, it is transformed by micro-organisms into a more toxic form, methylmercury. In this form, mercury enters the food chain and accumulates and bio-magnifies in aquatic organisms including fish and shellfish, and also in the birds, mammals and people who eat them.

Mercury, especially when it is in the form of methylmercury, is highly toxic to humans. Human embryos, fetuses, infants, and children are particularly vulnerable because mercury interferes with neurological development. This exposure can diminish the child's cognitive and thinking abilities, memory, attention, language acquisition, fine motor skills and visual spatial skills.

1.2 International background

The UNEP Governing Council / Global Ministerial Environment Forum (UNEP GC/GMEF) discussed the need for a global assessment of mercury at its 21st session in February 2001, in Nairobi, Kenya. As a result, the Decision 21/5 called for the initiation of a process to undertake a global assessment of mercury and its compounds, and requested the results of the assessment to be reported to the 22nd session of the Governing Council. The decision included a clause underlining the need to take preventive action to protect human health and the environment, mindful of the precautionary approach.

At its 22nd session in February 2003, the UNEP GC/GMEF considered UNEP’s Global Mercury Assessment report and in Decision 22/4 V, delegates noted sufficient evidence to warrant immediate national action to protect human health and the environment from releases of mercury and its compounds, facilitated by technical assistance and capacity building from UNEP, governments and relevant international organizations. The Executive Director was also requested to invite the submission of governments’ views on medium- and long-term actions on mercury, and to compile and synthesize these views for presentation at the Governing Council’s 23rd session, with a view to developing “a legally binding instrument, a non-legally binding instrument, or other measures or actions.”

The 23rd Session of the UNEP GC/GMEF took place from 21-25 February 2005, in Nairobi, Kenya. Delegates adopted Decision 23/9 IV, which requested the Executive Director to further develop UNEP’s mercury programme. The decision requested that governments, the private sector and international organizations take immediate actions to reduce the risks posed on a global scale by the use of mercury in products and production processes. It concluded that further long-term international action was required to reduce such risks and called for an assessment of the need for further action on mercury, including the possibility of a legally-binding instrument, partnerships and other actions at GC-24/GMEF.

The fifth session of the Intergovernmental Forum on Chemical Safety (IFCS-V) was held from 25-29 September 2006, in Budapest, Hungary. IFCS-V adopted the Budapest Statement on Mercury, Lead and Cadmium, which, inter alia: urged IFCS participants to initiate and intensify actions, as appropriate, to address the excess supply of mercury on a global scale through a variety of possible measures, such as an export prohibition, prevention of excess mercury from re-entering the global market, and a global phase-out of production of primary mercury; invited the UNEP GC to initiate and strengthen voluntary actions at the global level for mercury, lead and cadmium, including partnerships and other activities; prioritized considering further measures to address risks to human health and the environment from mercury, lead and cadmium, as well as considering a range of options including the possibility of establishing a legally-binding instrument, as well as partnerships; and called on countries to support these activities.

From 26-27 October 2006, the European Commission convened an International Mercury Conference in Brussels, Belgium. Delegates discussed actions needed at the local, national, regional and global levels to reduce health and environmental risks related to the use of mercury, with a view to providing input to GC-24/GMEF and relevant chemicals agreements. Options discussed included: development of a legally-binding international agreement on mercury; inclusion of mercury in existing legally-binding agreements; and voluntary and other measures.

At the 24th Session of the UNEP Governing Council/GMEF held from 5-9 February 2007 in Nairobi, Kenya, Delegates agreed on the need to outline priorities regarding reducing risks from releases of mercury and requested that the UNEP Executive Director prepare a report on mercury emissions and strengthen the UNEP mercury partnerships. It also established an ad hoc open-ended working group (OEWG) of government and stakeholder representatives to review and assess options for enhanced voluntary measures and new or existing international legal instruments for addressing the global challenges posed by mercury. The Working Group was mandated to provide a final report to GC-25/GMEF in 2009, which would take a decision on the matter.

The First Meeting of the Ad hoc Open-Ended Working Group (OEWG) to Review and Assess Measures to Address the Global Issue of Mercury was held from 12-16 November 2007, in Bangkok, Thailand. The OEWG discussed options for enhanced voluntary measures, and new or existing international legal instruments. Delegates agreed on seven intersessional tasks to be undertaken by the UNEP Secretariat, including analyses of: financial considerations of a free-standing convention, a new protocol to the Stockholm Convention and voluntary measures; sustainable technology transfer and support; implementation options; organization of response measures; costs and benefits of each of the strategic objectives; meeting demand for mercury if primary production is phased out; major mercury-containing products and processes with effective substitutes; and funding available through the Global Environment Facility (GEF) and the Strategic Approach to International Chemicals Management (SAICM).

The Second Meeting of the Ad hoc OEWG to Review and Assess Measures to Address the Global Issue of Mercury was held from 6-10 October 2008, in Nairobi, Kenya. The OEWG deliberated and agreed a future mercury framework including: elements to be addressed by a mercury framework; the type of framework to be used; and the capacity building, financial and technical support required to deliver on the elements. The OEWG recommended that the Governing Council (GC) consider adopting the policy framework for addressing the global challenges posed by mercury and that the elements collectively constitute a comprehensive approach that may be needed to address, and resolve, the global challenges of mercury. The recommendation included two potential implementation modalities: a new free-standing, legally-binding mercury convention; and voluntary measures.

The 25th session of the GC-25/GMEF took place from 16-20 February 2009, at the UN Office in Nairobi, Kenya. Delegates agreed to further international action on mercury consisting of the elaboration of a legally binding instrument on mercury, which could include both binding and voluntary approaches, together with interim activities. In the decision (UNEP/GC/25/CW/L.4), delegates also agreed to convene an OEWG in the second half of 2009, and an intergovernmental negotiating committee (INC) with the mandate to prepare a global legally binding instrument on mercury, commencing its work in 2010 with the goal of completing its work by GC-27 in 2013. The INC is mandated to: specify the objectives of the instrument; reduce the supply of mercury and enhance its capacity for environmentally sound storage; reduce demand in products and processes, international trade and atmospheric emissions; address mercury-containing waste; specify arrangements for capacity building; and address compliance.

The meeting of the ad hoc open-ended working group (OEWG) to prepare for the intergovernmental negotiating committee on mercury was held from 19 to 23 October 2009 in Bangkok, Thailand. During the working group meeting, a number of information sessions were held allowing opportunities to discuss certain provisions to be considered by the intergovernmental negotiating committee in developing a global legal instrument on mercury. In particular, three information sessions on issues relevant to the work of the intergovernmental negotiating committee were held, the first on mercury supply and storage, the second on artisanal and small-scale gold mining and the third on mercury in products and waste.

The first session of the intergovernmental negotiating committee to prepare a global legally binding instrument on mercury was held in Stockholm, Sweden, from June 7 to 11 2010. Negotiations are expected to be completed by 2013.

1.3 Mediterranean framework

In 1975, 16 Mediterranean countries and the European Community adopted the Mediterranean Action Plan (MAP), the first-ever Regional Seas Programme under UNEP's umbrella. The main objectives of the MAP were to assist the Mediterranean countries to assess and control marine pollution, to formulate their national environment policies, to improve the ability of governments to identify better options for alternative patterns of development, and to optimize the choices for allocation of resources.

In 1976 these Parties adopted the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) and MAP legal framework was also completed by seven Protocols addressing specific aspects of Mediterranean environmental conservation:

- Dumping Protocol (from ships and aircraft).
- Prevention and Emergency Protocol (pollution from ships and emergency situations).
- Land-based Sources and Activities Protocol (LBS Protocol).
- Specially Protected Areas and Biological Diversity Protocol.
- Offshore Protocol (pollution from exploration and exploitation).
- Hazardous Wastes Protocol.
- Protocol on Integrated Coastal Zone Management (ICZM).

The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (adopted in March 1996 and entered into force in May 2008), urges, in Article 5, Parties to eliminate pollution deriving from land-based sources and activities, in particular to phase out inputs of the substances that are toxic, persistent and liable to bioaccumulate listed in annex I. In addition, Article 15 establishes the procedure for the adoption of such Action Plans, Programmes and Measures.

The MED POL Programme (the marine pollution assessment and control component of MAP) is responsible for the follow up work related to the implementation of the LBS Protocol, the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (1980, as amended in 1996), and of the dumping and Hazardous Wastes Protocols. MED POL assists Mediterranean countries in the formulation and implementation of pollution monitoring programmes, including pollution control measures and the drafting of action plans aiming to eliminate pollution from land-based sources.

The Regional Activity Centre for Cleaner Production (CP/RAC) is one of the six Regional Activity Centres (RAC) of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme. The mission of CP/RAC is to contribute to address production and consumption patterns in an integrated manner to ensure sustainability and sound chemical management. In addition CP/RAC was endorsed in May 2009 as a Regional Centre under the Stockholm Convention on Persistent Organic Pollutants (POPs).

In this context, the MAP agreed in its meeting of 2008 in Aix-en-Provence (France) to carry out an Action Plan about mercury for the biennium 2010-2011 regarding measures and timetables for the reduction of inputs of mercury into the marine environment by the Contracting Parties of the Barcelona Convention. As a background assessment, the CP/RAC, in collaboration with MEDPOL, is in charge of the present diagnosis of mercury in the Mediterranean Region.

1.4 Object and scope

The main objective of the study is the development of a diagnostic report to describe the current status of mercury in the Mediterranean region with regards to legal and institutional framework, production, trade, use, emissions, waste, prevention and control measures and the identification of future challenges.

The countries object of the diagnosis are: France, Monaco, Italy, Croatia, Slovenia, Spain, Bosnia-Herzegovina, Montenegro, Albania, Malta, Greece, Turkey, Lebanon, Syria, Cyprus, Israel, Egypt, Libya, Tunisia, Algeria and Morocco.

2. Legislative institutional national and international framework

2.1 International legislative framework

A number of existing multilateral environmental agreements tackle issues related to mercury. The most important are the UNEP Mercury Programme; the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; and the Convention on Long-range Transboundary Air Pollution, among others.

The Governing Council of the United Nations Environment Programme established to prepare a legally binding instrument, which considered, among other issues[1]:

- The need to achieve cooperation and coordination and to avoid unnecessary duplication of proposed actions with relevant provisions contained in other international agreements and processes;
- The possible co-benefits of conventional pollutant control measures and other environmental benefits;
- Efficient organization and streamlined secretariat arrangements.

This section describes main international agreements and organizations dealing with mercury issue.

2.1.1 UNEP Mercury Programme

The main objectives of the UNEP Mercury Programme[2] are to support the negotiations on an internationally legal instrument to control mercury and develop activities on mercury through the UNEP Global Mercury Partnership.

The UNEP Global Mercury Partnership is the main mechanism for the delivery of immediate actions on mercury. The overall goal of the UNEP Global Mercury Partnership is to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global, anthropogenic mercury releases to air, water and land.

The partnership areas currently identified include:

- Mercury Management in Artisanal and Small-Scale Gold Mining.
- Mercury Control from Coal Combustion.
- Mercury Reduction in the Chlor-alkali Sector.
- Mercury Reduction in Products.
- Mercury Air Transport and Fate Research.
- Mercury Waste Management.
- Mercury Supply and Storage.

Based on needs identified by UNEP Governing Council and suggestions made by countries, a proposed business plan is also available for the following area:

- Non-Ferrous Metals Production.

[1] 25th session of the GC-25/GMEF.
[2] http://www.chem.unep.ch/mercury/

The UNEP mercury programme has been established and strengthened by a series of Governing Council decisions. During its 25th session, the Governing Council agreed to elaborate a legally binding instrument on mercury. It asked UNEP to convene an intergovernmental negotiating committee (INC) with the mandate to prepare the legally binding instrument, commencing its work in 2010. The first session of the committee was held in Stockholm, Sweden, from 7th to 11th June 2010.

To prepare for the work of the intergovernmental negotiating committee, the Governing Council established by GC decision 24/3 an Ad Hoc Open-Ended Working Group (OEWG) to review and assess measures to address the global issue of mercury and discuss the negotiating priorities, timetable and organization of the intergovernmental negotiating committee. In this context, the Ad-hoc Open Ended Working Group has developed relevant reports regarding mercury.

In its First Meeting, the Ad-Hoc-Open-Ended Working Group agreed on a programme of intersessional work to be undertaken by the secretariat in order to allow further discussions at the Working Group's second meeting. In order to do that, governments, intergovernmental organizations and non-governmental organizations were requested by the UNEP Secretariat to submit information on mercury in products and processes, quantities used, demand, level of substitution, technology change-over and available substitutes. From the Mediterranean region, only **France**, **Slovenia** and **Syria** reported such information.

According to UNEP Governing Council Decisions 23/9 and 24/3, which call for work to be facilitated on the promotion and development of inventories of mercury uses and releases, a summary report on UNEP mercury inventory activities was prepared by the Chemicals Branch of the UNEP Division of Technology, Industry and Economics in the framework of the Second Meeting of the Ad-Hoc-Open-Ended Working Group. The report included national results of a number of countries working with UNEP to develop national mercury inventories (among others, **Syria)**.

Afterwards, the Governing Council at its 25th session requested the Executive Director of UNEP the elaboration of "The paragraph29 study", which is currently at the draft outline stage, "for the purposes of informing the work of the intergovernmental negotiating committee, to conduct a study, in consultation with the countries concerned, on various types of mercury-emitting sources, as well as current and future trends of mercury emissions, with a view to analysing and assessing the cost and the effectiveness of alternative control strategies and measures".

Finally, it should be pointed out that twelve Mediterranean countries have participated in the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1): Algeria, Croatia, Egypt, France, Italy, Malta, Libya, Morocco, Slovenia, Spain, Syria and Tunisia, as well as the EU. In addition, six Mediterranean countries (**Croatia, Cyprus, Morocco, Spain, Syria** and **Turkey**) have submitted information in response to the request for further information of the INC.

2.1.2 Rotterdam Convention

The objectives of the Rotterdam Convention[3] are: 1) to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm; 2) to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

[3] www.pic.int/

The Rotterdam Convention was adopted on 10^{th} September 1998 by a Conference of Plenipotentiaries in Rotterdam, and entered into force on February 24, 2004. The Convention creates legally binding obligations for the implementation of the Prior Informed Consent (PIC) procedure.

The Convention covers pesticides and industrial chemicals, including mercury and its compounds, that have been banned or severely restricted for health or environmental reasons by Parties and which have been notified by Parties for inclusion in the PIC procedure. This procedure is a mechanism to officially receive and disseminate the decisions of the importing Parties as to whether they wish to receive future shipments of chemicals listed in Annex III of the Convention and to ensure compliance with these decisions by exporting Parties.

There are 39 chemicals listed in Annex III of the Convention and subject to the PIC procedure, including 24 pesticides, 4 severely hazardous pesticide formulations and 11 industrial chemicals. Many more chemicals are expected to be added in the future. The Conference of the Parties decides on the inclusion of new chemicals.

Once a chemical is included in Annex III, a "decision guidance document" (DGD) containing information concerning the chemical and the regulatory decisions to ban or severely restrict the chemical for health or environmental reasons, is circulated to all Parties.

The Rotterdam Convention contains provisions relating to mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds. These compounds are included in Annex III to the Convention in pesticide category. While industrial uses of mercury in products and processes are not currently listed, they may be listed in Annex III in the future if they meet the criteria for inclusion. The Convention’s trade provisions provide a possible model for a provision to be included in the global legally binding instrument on mercury related to the reduction of international trade in mercury.

The following Mediterranean countries: Bosnia&Herzegovina, Croatia, Cyprus, European Community, France, Greece, Italy, Lebanon, Libya, Slovenia, Spain and Syria have ratified the Rotterdam Convention. However, none of them have notified Final Regulatory Actions for mercury compounds (ANNEX III chemicals).

2.1.3 Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal4 is the most comprehensive global environmental agreement on hazardous and other wastes. Its aim is to protect human health and the environment against the adverse effects of the generation, management, transboundary movement and disposal of hazardous and other wastes. The Basel Convention was adopted in 1989 and entered into force on May 5, 1992.

First, the Basel Convention regulates the transboundary movements of hazardous and other waste by applying the "Prior Informed Consent" (shipments without consent are illegal). Shipments to and from non-Parties are illegal unless there is a special agreement. Each Party is required to introduce appropriate national or domestic legislation to prevent and punish illegal traffic in hazardous and other wastes. Illegal traffic is criminal.

Second, the Convention obliges its Parties to ensure that hazardous and other wastes are managed and disposed of in an environmentally sound manner (ESM). To this end, Parties are expected to minimize the quantities that are moved across borders, to treat and dispose of wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at source. Strong controls have to be applied from the

[4] www.basel.int/

moment of generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal

The Basel Secretariat has prepared a draft technical guideline on the sound management of mercury waste. The guidelines provide guidance for the environmentally sound management (ESM) of mercury waste and give comprehensive information about mercury waste, including the chemistry and toxicology of mercury, and source of mercury and mercury waste. These guidelines also present knowledge and expertise on ESM of mercury waste and provisions for mercury waste under international legal instruments. They follow the decision VIII/33 of the Conference of the Parties (COP) to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, namely the programme to support the implementation of the Strategic Plan focus area: B9 mercury waste.

All MAP countries have ratified the Basel Convention and most of them, depending on the year, have submitted periodic National Reporting.

2.1.4 OSPAR Convention

OSPAR[5] is the mechanism by which fifteen Governments of the western coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the North-East Atlantic. The fifteen Governments are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

The Convention for the Protection of the marine Environment of the North-East Atlantic (the 'OSPAR Convention') was open for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22nd September 1992. It was adopted together with a Final declaration and an Action Plan. The OSPAR Convention entered into force on 25th March 1998.

OSPAR has first developed, and is implementing, a suite of five thematic strategies to address the main threats that it has identified within its competence (the Biodiversity and Ecosystem Strategy, the Eutrophication Strategy, the Hazardous Substances Strategy, the Offshore Industry Strategy and the Radioactive Substances Strategy), together with a Strategy for the Joint Assessment and Monitoring Programme, which assesses the status of the marine environment and follows up implementation of the strategies and the resulting benefits to the marine environment. These six strategies fit together to underpin the ecosystem approach.

Work to implement the OSPAR Convention and its strategies is taken forward through the adoption of decisions, which are legally binding on the Contracting Parties, recommendations and other agreements. Decisions and recommendations set out actions to be taken by the Contracting Parties.

In the context of the Hazardous Substances Strategy, OSPAR Commission has developed the List of Chemicals for Priority Action, which was adopted in 2002. There are currently 42 substances or groups of substances on this List.

Mercury is one of the chemicals which OSPAR has identified for priority action ("priority chemical") and for which it has prepared a Background Document which covers production, uses, sources, and measures (in addition to properties and monitoring information). The Background Document has been updated through a review statement in 2009.

OSPAR holds mercury data on riverine inputs and direct discharges, concentrations in air and precipitation and concentrations in marine sediments and biota for the North-East Atlantic. On production, uses and sources, OSPAR relies on collecting information from

[5] www.ospar.org

other institutions, such as EPER, EMEP, and from industries. For example, OSPAR works with Eurochlor[6] on data relating to the chlor alkali industry (installations, production, releases to the environment). The type of information available through Eurochlor is illustrated in annual data reports for the OSPAR countries[7].

In 2008, OSPAR undertook a first assessment of progress towards its objective to cease emissions, discharges and losses of priority chemicals. The assessment tries to bring together most recent information for each chemical, including on production, uses and sources. One section deals with mercury[8].

Relevant OSPAR decisions regarding mercury are listed below:

- PARCOM Decision 90/2 on Programmes and Measures for Mercury and Cadmium Containing Batteries.
- PARCOM Decision 85.1: Programmes and Measures of 31 December 1985 on Limit Values and Quality Objectives for Mercury Discharges by Sectors other than the Chlor-alkali Industry.
- PARCOM Recommendation 85/1 on Limit Values for Mercury Emissions in Water from Existing Brine Recirculation Chlor-Alkali Plants (exit of factory site).
- PARCOM Decision 82/1 on New Chlor-Alkali Plants Using Mercury Cells.
- PARCOM Recommendation 81/1 on Other Land-Based Sources of Mercury Pollution (Thermometers, Batteries, Dental Filters).
- PARCOM Decision 80/2 on Limit Values for Mercury Emissions in Water from Existing and New Brine Recirculation Chloralkali Plants (exit of the purification plant).
- PARCOM Decision 80/1 on Environmental Quality Standard for Mercury in Organisms.
- OSPAR Recommendation 2003/4 on Controlling the Dispersal of Mercury from Crematoria. Consolidated text. Amended by OSPAR Recommendation 2006/2.
- PARCOM Recommendation 93/2 on Further Restrictions on the Discharge of Mercury from Dentistry.
- PARCOM Decision on Environmental Quality Standard for Mercury in Organisms, 1980.
- PARCOM Recommendation on Other Land-Based Sources of Mercury Pollution (Thermometers, Batteries, Dental Filters), 1981.
- PARCOM Recommendation on Limit Values for Mercury Emissions in Water from Existing Brine Recirculation Chlor-Alkali Plants (exit of factory site), 1985.
- PARCOM Recommendation 89/3 on Programmes and Measures for Reducing Mercury Discharges from Various Sources.
- Adoption of a "standstill principle" for mercury concentrations in water.
- JAMP Guidelines for the sampling and analysis of mercury in air and precipitation.
- OSPAR Reporting Format on Mercury Losses from the Chlor- Alkali Industry.
- OSPAR Recommendation 2006/1 on Reporting Formats on the Implementation and Effectiveness of OSPAR Measures Relating to the Vinyl Chloride Industry.

Only two countries, **France** and **Spain**, belong both to OSPAR and MAP geographical scope.

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[6] http://www.eurochlor.org/

[7] http://www.ospar.org/documents%5Cdbase%5Cpublications%5Cp00403_Mercury%20losses%20report%202007.pdf

[8] http://www.ospar.org/documents%5Cdbase%5Cpublications%5Cp00354_JAMP%20HA-3%20report.pdf

2.1.5 Convention on Long-range Transboundary Air Pollution (UNECE)

The aim of the Convention on Long-range Transboundary Air Pollution (LRTAP)[9] is that Parties shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution. Parties develop policies and strategies to combat the discharge of air pollutants through exchanges of information, consultation, research and monitoring.

The Convention has been extended by eight protocols that identify specific measures to be taken by Parties to cut their emissions of air pollutants.

The 1998 Aarhus Protocol on Heavy Metals targets three particularly harmful metals: cadmium, lead and mercury. According to one of the basic obligations, Parties will have to reduce their emissions for these three metals below their levels in 1990 (or an alternative year between 1985 and 1995). The Protocol aims to cut emissions from industrial sources (iron and steel industry, non-ferrous metal industry), combustion processes (power generation, road transport) and waste incineration. It lays down stringent limit values for emissions from stationary sources and suggests best available techniques (BAT) for these sources, such as special filters or scrubbers for combustion sources or mercury-free processes. It also introduces measures to lower heavy metal emissions from other products, such as mercury in batteries, and proposes the introduction of management measures for other mercury-containing products, such as electrical components (thermostats, switches), measuring devices (thermometers, manometers, barometers), fluorescent lamps, dental amalgam, pesticides and paint.

Only the following Mediterranean countries: **Croatia, Cyprus, European Community, France, Monaco** and **Slovenia** have ratified the Aarhus Protocol.

EMEP (European Monitoring and Evaluation Programme) is a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution for international co-operation to solve transboundary air pollution problems.

In particular, the EMEP programme provides scientific support to the Convention on:

a. Atmospheric monitoring and modelling;

b. Emission inventories and emission projections;

c. Integrated assessment modelling.

Initially, the EMEP programme focused on assessing the transboundary transport of acidification and eutrophication. Later, the scope of the programme has widened to address the formation of ground level ozone and, more recently, of persistent organic pollutants (POPs), heavy metals and particulate matter.

Measuring network for heavy metals covers four Mediterranean countries: **France**, **Croatia**, **Italy** and **Spain**.

2.1.6 Strategic Approach to International Chemicals Management (SAICM),

The Strategic Approach to International Chemicals Management (SAICM)[10] was adopted by the International Conference on Chemicals Management (ICCM) on 6th February 2006 in Dubai (United Arab Emirates). SAICM is a policy framework to foster the sound management of chemicals.

[9] www.unece.org/env/lrtap/
[10] www.saicm.org

SAICM was developed by a multi-stakeholder and multi-sectorial Preparatory Committee and supports the achievement of the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development of ensuring that, by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health.

SAICM consists of three basic texts:

- The **Dubai Declaration**, which expresses the commitment of ministers, heads of delegation and representatives of civil society and the private sector to the SAICM.
- The **Global Strategic Policy**, which sets out the scope of SAICM, the needs to be addressed and the objectives for risk reduction, knowledge and information, governance, capacity building and technical cooperation and illegal international traffic.
- The **Global Action Plan**, which proposes work areas and activities for implementing the Strategic Approach grouped under five main themes:
    - A. Risk reduction
    - B. Knowledge and information
    - C. Governance
    - D. Capacity-building and technical cooperation
    - E. Illegal international traffic

The SAICM Overarching Policy Strategy, in paragraphs 24 and 25, sets out that the International Conference on Chemicals Management (ICCM) will undertake periodic reviews of SAICM.

In this sense, progress in the implementation of SAICM was reviewed at the second session of the ICCM held from 11th to 15th May 2009. Agreements reached at this second session includes a set of indicators for tracking progress in implementation and the time periods for a baseline report (covering the period 2006-2008) and a first progress report (covering the period 2009-2011).

In addition, the second session of the Conference requested the secretariat to prepare a guidance to explain the indicators and to prepare a simple electronic data collection tool that can be used by stakeholders in providing information. Data reported by stakeholders (in Government, in non-governmental organizations, intergovernmental organizations and industry) will be aggregated on a regional and global basis. The secretariat will analyze the information reports and provide a concise summary identifying major trends.

On the other hand, the United Nations Institute for Training and Research (UNITAR) has undertaken a National Profile Support Programme to provide guidance, training, and technical support to assist countries in assessing their relevant legal, institutional, administrative, and technical infrastructures for the sound management of chemicals.

According to information available, the following Mediterranean countries have their National Profiles prepared: Albania, Algeria, Croatia, Cyprus, Egypt, France, Israel, Malta, Slovenia, Spain and Syria. Mercury and mercury compounds have been particularly considered by some of the National Profiles.

2.1.7 World Health Organisation (WHO)

WHO[11] is the directing and coordinating authority for health within the United Nations system? It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy

[11] www.who.int/

options, providing technical support to countries and monitoring and assessing health trends.

In 2003, experts convened by the UN Food and Agriculture Organization (FAO) and the World Health Organization (WHO) announced agreement on recommendations regarding safe intake levels for a variety of different chemicals occurring in food, including methylmercury, the most toxic form of mercury.

In the 61st meeting of the Joint Expert Committee for Food Additives and Contaminants (JECFA), the experts re-evaluated previous JECFA risk assessments for methylmercury in the light of new data and they revised the Provisional Tolerable Weekly Intake (PTWI) for methylmercury, recommending that it was reduced to 1.6 µg per kg body weight per week in order to sufficiently protect the developing foetus. This recommendation changed the prior recommendation for a dietary limit of 3.3 µg per kg body weight per week.

WHO has also identified health-care facilities as one of the main sources of mercury release into the atmosphere because of emissions from the incineration of medical waste. To understand better the problem of mercury in health-care sector, WHO prepared, in 2005, the document “Mercury in Health Care” through which short-, medium- and long-term strategic steps to work in collaboration with countries are proposed:

- Short-term: Develop mercury clean up and waste handling and storage procedures.
- Medium-term: Increase efforts to reduce the number of unnecessary use of mercury equipment.
- Long-term: Support a ban for use of mercury containing devices and effectively promote the use of mercury free alternatives.

2.1.8 Global Mercury Project (GEF/UNDP/UNIDO)

The Global Mercury Project[12] began in 2002 with a vision to address the environmental issue of mercury contamination from artisanal and small-scale gold mining. Foundational objectives of the project have been: to introduce cleaner technologies, train miners, develop regulatory capacities within national and regional governments, conduct environmental and health assessments and build capacity within participating countries to continue monitoring Hg pollution after the project finishes.

Six countries have been formally participating in the GMP: Brazil, Lao PDR, Indonesia, Sudan, Tanzania and Zimbabwe.

According to available data, activities regarding artisanal and small-scale gold mining do not exist in the Mediterranean Region.

2.1.9 United Nations Institute for Training and Research (UNITAR)

In the context of the Global Mercury Assessment (GMA) developed by the United Nations Environment Programme (UNEP) in cooperation with the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) in 2002, UNITAR assists countries in developing national strategies to reduce emissions and manage risks caused by mercury. An important aspect is the systematic collection of information concerning emissions from point (e.g. power plants) and diffuse sources (e.g. landfills, mercury containing products). Pollutant Release and Transfer Registers (PRTR) are an important tool that can assist countries in identifying and reporting emissions and transfers of mercury on a sustained basis. Knowledge of mercury emission patterns and their magnitudes can afterwards

[12] www.globalmercuryproject.org/

serve as a sound basis for targeting national reductions in mercury emissions through a national risk reduction strategy.

UNITAR's activities are in general closely related to UNITAR's long standing PRTR and Risk Management Decision Making specialized training and capacity building programmes. Activities in this area take place through a country-driven and multi-stakeholder approach in collaboration with relevant international agencies, such as UNEP.

UNITAR provides technical support for national project activities, including training activities and provision of guidance materials. UNITAR provides:

- International expertise and training to strengthen skills to develop mercury inventories.
- Training to strengthen capacities on and risk management decision-making.
- Training to strengthen capacities on PRTR development and implementation.
- Provision of guidance and training materials in support of national mercury implementation activities, such as the following: “Integrating Mercury Pollution Information into a National PRTR System: Institutional and Other Strategic Considerations”; “Developing a Risk Management Plan for a Priority Chemical”; “Linkages between Mercury Product Information and Mercury Emissions Note”; and “Mercury National Situation Analysis and Capacity Assessment Document”.
- Other country-specific activities designed to address particular point sources (e.g. a planned project to address a mercury point source in Kyrgyzstan, with the support of the Government of Switzerland).

2.1.10 Global Environmental Facility (GEF)

The Global Environment Facility (GEF)[13] unites 181 member governments — in partnership with international institutions, nongovernmental organizations, and the private sector — to address global environmental issues.

An independent financial organization, the GEF provides grants to developing countries and countries with economies in transition for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. These projects benefit the global environment, linking local, national, and global environmental challenges and promoting sustainable livelihoods.

The GEF partnership includes 10 agencies: the UN Development Programme; the UN Environment Programme; the World Bank; the UN Food and Agriculture Organization; the UN Industrial Development Organization; the African Development Bank; the Asian Development Bank; the European Bank for Reconstruction and Development; the Inter-American Development Bank; and the International Fund for Agricultural Development. The Scientific and Technical Advisory Panel provides technical and scientific advice on the GEF’s policies and projects.

Recently, the Global Environment Facility (GEF) has received a record boost from donor countries. These new resources will be channelled toward measurable results in six key environmental focal areas: climate change, biodiversity, international waters, land degradation, persistent organic pollutants, mercury and the ozone layer. Over the next four years the GEF will direct funds to:

- Lower CO2 emissions;
- Expand sustainable management of protected areas and critical landscapes;

[13] http://72.26.206.151/gef/

- Strengthen multi-state cooperation on trans-boundary water systems management;
- Reduce persistent organic pollutants in land and water; reduce mercury emissions,
- Expand and protect the Earth's forest cover.

2.1.11 Mercury Policy Project

The Mercury Policy Project (MPP) works to promote policies to eliminate mercury uses, reduce the export and trafficking of mercury, and significantly reduce mercury exposures at the local, national, and international levels. It strives to work harmoniously with other groups and individuals who have similar goals and interests.

The Mercury Policy Project and the European Environmental Bureau (EEB) started the Zero Mercury Working Group (ZMWG) in November 2004 to work on international issues. Of particular interest is the ZMWG proposal for a global Mercury Treaty.

The Zero Mercury Campaign website[14] is part of the Global Zero Mercury Campaign Project having as its ultimate objective 'Zero' emissions, demand and supply of mercury, from all sources we can control, in view of reducing to a minimum, mercury in the environment at EU level and globally.

[14] www.zeromercury.org

2.2 Regional legislative framework

2.2.1 Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)

In 1975, 16 Mediterranean countries and the European Community adopted the Mediterranean Action Plan (MAP), the first-ever Regional Seas Programme under UNEP's umbrella. The main objectives of the MAP were to assist the Mediterranean countries to assess and control marine pollution, to formulate their national environment policies, to improve the ability of governments to identify better options for alternative patterns of development, and to optimize the choices for allocation of resources.

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- Prevention and Emergency Protocol (pollution from ships and emergency situations).
- Land-based Sources and Activities Protocol (LBS Protocol).
- Specially Protected Areas and Biological Diversity Protocol.
- Offshore Protocol (pollution from exploration and exploitation).
- Hazardous Wastes Protocol.
- Protocol on Integrated Coastal Zone Management (ICZM).

The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (adopted in March 1996 and entered into force in May 2008), urges, in Article 5, Parties to eliminate pollution deriving from land-based sources and activities, in particular to phase out inputs of the substances, such as heavy metals and their compounds, that are toxic, persistent and liable to bioaccumulate listed in annex I.

The MED POL Programme (the marine pollution assessment and control component of MAP) is responsible for the follow up work related to the implementation of the LBS Protocol, the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (1980, as amended in 1996), and of the dumping and Hazardous Wastes Protocols. MED POL assists Mediterranean countries in the formulation and implementation of pollution monitoring programmes, including pollution control measures and the drafting of action plans aiming to eliminate pollution from land-based sources.

The Contracting Parties of the Barcelona Convention prepared and adopted a Strategic Action Programme (SAP MED) of regional and national activities to address land-based pollution. This Plan identifies priority target categories of polluting substances and activities to be eliminated or controlled by the Mediterranean countries through a planned timetable (up to the year 2025) for the implementation of specific pollution reduction measures and interventions.

In particular, proposed targets for heavy metals (Hg, Cd and Pb) are the following:

- By the year 2025, to phase out to the fullest possible extent discharges and emissions and losses of heavy metals (mercury, cadmium and lead).
- By the year 2005, to reduce by 50 % discharges, emissions and losses of heavy metals (mercury, cadmium and lead).
- By the year 2000, to reduce by 25 % discharges, emissions and losses of heavy metals (mercury, cadmium and lead).

Proposed activities at the Regional level are the following:

- To prepare guidelines for the application of BAT and BEP in the industrial installations which are sources of heavy metals (mercury, cadmium and lead).
- By the year 2010, to formulate and adopt, as appropriate, environmental quality criteria and standards for point source discharges and emissions of heavy metals (mercury, cadmium and lead).

Proposed activities at the National level are the following:

- To reduce discharges and emissions of heavy metals as much as possible and, in order to do so, to promote the implementation of environmental audits and apply BEP and, if possible, BAT in the industrial installations that are sources of heavy metals, giving priority to installations located in the selected hot spots.
- To prepare National Programmes on the reduction and control of pollution by Heavy Metals.
- To adopt at the national level and apply the common measures for preventing mercury pollution adopted by the Parties in 1987 (releases into the sea, max. conc. 0.050 mg/l).
- To adopt and apply for the industries of the alkaline chloride electrolysis sector, as well as the previous standard, the maximum value of 0.5 grams of mercury in the water per tonne of chlorine production capacity installed (brine recirculation), 5 grams of mercury in the water per tonne (lost brine technology) and, if possible, 2 g of mercury from total releases into water, air and products).
- To adopt at the national level and apply the anti-pollution common measures for cadmium and cadmium compounds adopted by the Parties in 1989 (releases into the sea, max. conc. 0.2 mg/l).

To prepare environmental voluntary agreements to which authorities, producers and users are committed on the basis of a reduction plan.

2.2.2 EU Mercury Strategy

The European Union launched the EU Mercury Strategy (EC, 2005b) in 2005, which is a comprehensive plan intended to protect human health and the environment from all releases of mercury both in the EU and globally.

The EU Mercury Strategy proposes 20 actions to reduce emissions, supply and demand, address surpluses and reservoirs, protect against exposure, improve understanding, and support international action.

Its implementation has resulted in restrictions on the sale of measuring devices containing mercury, a ban on exports of mercury from the EU that will come into force in 2011 and new rules on safe storage.

The European Commission must examine together with the Member States and the relevant stakeholders by 2010 if there is a need to also ban mercury imports into the EU and if the export ban shall be extended to other mercury compounds, mixtures with a lower mercury content and products containing mercury, in particular thermometers, barometers and sphygmomanometers.

a) Mercury in measuring devices.

Its implementation resulted in restrictions on the sale of measuring devices containing mercury, a ban on exports of mercury from the EU that will come into force in 2011 and new rules on safe storage.

The EU strategy contains a commitment to restrict the marketing for consumer use and health care of non-electrical or electronic measuring and control equipment containing mercury, as this fall outside the scope of Directive 2002/95/EC which restricts the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive).

To this end, Directive 2007/51/EC[15] prohibited the placing on the market of mercury in all clinical thermometers and other, new, measuring devices containing mercury (e.g. barometers and thermometers) to the general public. There was a derogation for barometers until 3 October 2009, to allow industry time to adjust, with an outright derogation for all mercury-containing instruments over 50 years old on the 3 October 2007. Specialist medical, scientific and industrial applications are also excluded, but subject to review by 3 October 2009.

In October 2009, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published their Opinion on: Mercury Sphygmomanometers in Healthcare and the Feasibility of Alternatives. Their opinion is that mercury sphygmomanometers are not needed for normal healthcare practice, nor special cases (hypertension, pre-ecclampsia etc) or for calibration purposes. They may only be needed for validation of sphygmomanometers in specialised centres and long term epidemiological studies.

At present, in consideration of the obligation to review the mercury restrictions in Entry 18a of Annex XVII of REACH[16], the European Chemicals Agency (ECHA) is evaluating the information and will prepare, if appropriate, an Annex XV Dossier to propose the subsequent restrictions.

The Annex XVII of REACH incorporates dangerous substances such as mercury compounds and mercury restricted in the framework of Directive 76/769/EEC and Directive 2007/51/EC respectively. With respect to the review of the availability of reliable safer alternatives that are technically and economically feasible for mercury containing sphygmomanometers and other measuring devices in healthcare and in other professional and industrial uses by 3 October 2009 (Directive 2007/51/EC), the Entry 18a establishes that “the Commission shall, if appropriate, present a legislative proposal to extend the restrictions in paragraph 1 to sphygmomanometers and other measuring devices in healthcare and in other professional and industrial uses, so that mercury in measuring devices is phased out whenever technically and economically feasible”.

b) The export of mercury from the European Union

In September 2008, Regulation (EC) No 1102/2008[17] was adopted, banning all exports of mercury from the European Union with effect from March 2011.

The new legislation also calls for mercury that is no longer used in the chlor-alkali industry or that is produced in other major industrial operations, to be safely stored. Although the new legislation makes safe storage an obligation, Euro Chlor, the business association representing chlor-alkali producers in the EU and the European Free Trade Association regions, has agreed to go beyond the requirements of the legislation. Surplus mercury will be removed from decommissioned chlorine plants, transported to its final destination in approved sealed steel containers and preferably stored in deep underground salt mines. These mines provide safe final disposal of mercury as there is no humidity or possibility of

[15] Directive 2007/51/EC of the European Parliament and of the Council of 25 September 2007 amending Council Directive 76/769/EEC relating to restrictions on the marketing of certain measuring devices containing mercury.

[16] Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and Regulation (EC) No 552/2009 of 22 June 2009 amending Annex XVII.

[17] Regulation (EC) No 1102/2008 of the European Parliament and of the Council of 22 October 2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury.

corrosion. This voluntary commitment from industry has been formally acknowledged by a Commission Recommendation[18].

With regards to the adoption of Regulation (EC) No 1102/200, it should be pointed out that the European Parliament legislative resolution of 20 June 2007 on the proposal for a regulation of the European Parliament and of the Council on the banning of exports and the safe storage of metallic mercury (COM(2006)0636 – C6-0363/2006 – 2006/0206(COD)[19] approved in its Article 10 that Member States should draw up a **register of buyers, sellers and traders of mercury, cinnabar ore and mercury compounds**, and collect relevant information. However, the Regulation was finally adopted in 2008 (Regulation (EC) No 1102/200) without this article.

c) Safe storage

The Commission has recently developed the study on "Requirements for facilities and acceptance criteria for the disposal of metallic mercury" prepared for DG ENV by BiPRO GmbH (April 2010). Main conclusions consist of possible options for a safe storage of surplus mercury, acceptance criteria and additional facility related requirements, recommended options on pre-treatment technologies and recommended timeframe for a temporary storage.

d) Review of continued mercury use in products and applications

In its continued implementation of the EU mercury strategy, the Commission commissioned the study “Options for reducing mercury use in products and applications and the fate of mercury already circulating in society” (Lassen *et al*., 2008).

The main conclusions of the report were that there is a sound basis for concluding that dental amalgam and thermometers should be seriously considered for further restrictions, while measures to reduce the mercury input due to sphygmomanometers, barometers and PU elastomers may be put forward as soon as possible without major impacts on manufacturers and users.

With respect to dental amalgams, obligatory installation of high efficiency filters in dental clinics is a very cost-effective measure for reducing mercury releases to the waste water systems and may be put forward as soon as possible.

e) Review of the Community Strategy Concerning Mercury

The EU Mercury Strategy was being reviewed by the time of the finalisation of the present diagnosis; a draft report prepared by Bio Intelligence Services on the Review of the Community Strategy concerning Mercury has been distributed by June 2010 (EC (DG ENV), 2010).

The report identifies, out of the 20 actions of the Strategy, seven actions whose implementation is considered to be incomplete and other possible additional actions. The seven key topics of the actions which have not been achieved are:

- Assessing the effects of IPPC Directive and LCP Directive on mercury emissions (application of emission levels associated with the use of BAT).
- Reviewing the treatment of dental amalgam waste and taking appropriate steps.

[18] Commission Recommendation of 22 December 2008 on the safe storage of metallic mercury no longer used in the chlor-alkali industry (notified under document number C(2008) 8422).

[19] http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P6-TA-2007-0267#def_2_12

- Expert opinions on dental amalgam.
- Input to international activities, technology transfer.
- Support to UNECE CLRTAP Heavy Metals Protocol.
- Support to UNEP Mercury Programme
- Support to global efforts to reduce use of mercury in gold mining.

Other possible additional actions proposed by the report are related with: reduce supply; reduce demand for mercury in products and processes; reduce international trade of mercury; reduce or eliminate mercury emissions; achieve environmentally sound management of mercury-containing wastes; remediate existing contaminated sites; protecting against exposure; support and promote international action; information exchange and public awareness and monitoring.

2.2.3 EU legislation on mercury

Mercury is regulated by a number of legal provisions aimed at environmental and public health protection. Table 6 describes briefly main references affecting both directly and/or indirectly mercury, putting special emphasis on specific mercury limitations deriving from them.

Table 6. EU legal provisions affecting mercury.

Air Quality	Hg limitations
Directive 96/62/EC on ambient air quality assessment and management.	Commonly referred to as the Air Quality Framework Directive. It describes the basic principles as to how air quality should be assessed and managed in the Member States. Annex I lists the pollutants for which air quality standards and objectives will be developed and specified in legislation. It includes mercury.
Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air	This is the Fourth Daughter Directive and completes the list of pollutants initially described in the Framework Directive. Target values for all pollutants except mercury are defined for the listed substances, though for PAHs, the target is defined in terms of concentration of benzo(a)pyrene which is used as a marker substance for PAHs generally. Only monitoring requirements are specified for mercury.
Directive 2008/50/EC on ambient air quality and cleaner air for Europe.	This new Directive does not consider mercury specifically, however, it includes the following key elements: ▪ The merging of most of existing legislation into a single directive (except for the fourth daughter directive 2004/107/EC) with no change to existing air quality objectives. ▪ New air quality objectives for PM2.5 (fine particles) including the limit value and exposure related objectives – exposure concentration obligation and exposure reduction target. ▪ The possibility to discount natural sources of pollution when assessing compliance against limit values. ▪ The possibility for time extensions of three years (PM10) or up to five years (NO2, benzene) for complying with limit values, based on conditions and the assessment by the European Commission.

Emissions of Air Pollutants	Hg limitations
Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants.	The overall aim is to reduce emissions of acidifying pollutants, particles, and ozone precursors. It sets emission limit values for SO_2, NOx and dust. Mercury is not particularly considered, however, it is known that benefits from reducing dust emissions by dust abatement equipment provide benefits on reducing particle–bound heavy metal emissions.
Regulation (EC) No 166/2006 on the European Pollutant Release and Transfer Register (E-PRTR).	The E-PRTR contains data reported annually by some 24,000 industrial facilities covering 65 economic activities across Europe. For each facility, information is provided concerning the amounts of pollutant releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water from a list of 91 key pollutants including heavy metals, pesticides, greenhouse gases and dioxins for the year 2007 onwards.
Directive 2008/1/EC on Integrated Pollution Prevention and Control (IPPC).	Industrial and agricultural activities with a high pollution potential, covered by Annex I of the IPPC Directive, are required to obtain an environmental permit from the competent authority of the Member State concerned. Among other requirements, permits are to include emission limit values for polluting substances which are to be based on the "Best Available Techniques" (BAT) for the sector, but taking account of the technical characteristics of the installation concerned, its geographical location and the local environmental conditions.
Directive 2000/76/EC on incineration of waste.	The aim of the Directive is to prevent or to reduce as far as possible negative effects on the environment caused by the incineration and co-incineration of waste. This is to be achieved through the application of operational conditions, technical requirements, and emission limit values for incineration and co-incineration plants within the EU. The WI Directive sets emission limit values and monitoring requirements for pollutants to air such as dust, nitrogen oxides (NOx), sulphur dioxide (SO_2), hydrogen chloride (HCl), hydrogen fluoride (HF), heavy metals and dioxins and furans. **Emission limit value for discharges of waste water from the cleaning of exhaust gases for mercury and its compounds, expressed as mercury (Hg) is 0.03 mg/l.** **Air emission limit value for mercury and its compounds, expressed as mercury (Hg) is 0.05 mg/m^3.**

Water	Hg limitations
Directive 98/83/EC on quality of water intended for human consumption.	Drinking Water Directive sets quality standards for drinking water quality at the tap (microbiological, chemical and organoleptic parameters) and the general obligation that drinking water must be wholesome and clean. **For mercury, the quality standard is 1.0 µg/l.** It also obliges Member States to regular monitoring of drinking water quality and to provide to consumers adequate and up-to-date information on their drinking water quality.
Directive 2006/7/EC concerning the management of bathing water	This Directive lays down provisions for the monitoring and

quality and repealing Directive 76/160/EEC.	classification of bathing water quality; the management of bathing water quality; and the provision of information to the public on bathing water quality. Mercury is not particularly considered.
Directive 91/271/EEC on Urban Waste Water Treatment.	Council Directive 91/271/EEC concerning urban waste water treatment was adopted on 21 May 1991 to protect the water environment from the adverse effects of discharges of urban waste water and from certain industrial discharges. Mercury is not particularly considered.
Directive 2008/1/EC on Integrated Pollution Prevention and Control (IPPC).	Industrial and agricultural activities with a high pollution potential, covered by Annex I of the IPPC Directive, are required to obtain an environmental permit from the competent authority of the Member State concerned. Among other requirements, permits are to include emission limit values for polluting substances which are to be based on the “Best Available Techniques” (BAT) for the sector, but taking account of the technical characteristics of the installation concerned, its geographical location and the local environmental conditions.
Marine Strategy Framework Directive (2008/56/EC).	The aim of Marine Strategy Framework Directive (adopted in June 2008) is to protect more effectively the marine environment across Europe. It aims to achieve good environmental status of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. It establishes European Marine Regions on the basis of geographical and environmental criteria. Each Member State - cooperating with other Member States and non-EU countries within a marine region - are required to develop strategies for their marine waters. The goal of the Marine Strategy Framework Directive is in line with the objectives of the 2000 Water Framework Directive.
Water framework Directive (2000/60/EC)	The Water Framework Directive establishes a legal framework to protect and restore clean water across Europe and ensure its long-term, sustainable use. It requires surface freshwater and ground water bodies - such as lakes, streams, rivers, estuaries, and coastal waters - to be ecologically sound by 2015.
Directive 2008/105/EC on environmental quality standards in the field of water policy.	The new Priority substances Directive sets environmental quality standards for the priority substances and certain other pollutants is the result of the requirements set in Article 16(8) of the Water Framework Directive. In addition, the Annex II to this new directive replaces Annex X of the Water Framework Directive referring to the list of priority substances, which includes mercury and its compounds as a priority hazardous substance. Annex I sets **Environmental Quality Standards (EQS) as Annual Average (AA) and Maximum Allowable Concentration (MAC) concentrations (µg/l) in surface waters.** **Mercury values are, respectively, 0.05 and 0.07.**

Waste management	Hg limitations
Directive 2008/98/EC on waste (Waste Framework Directive).	This Directive establishes a legal framework for the treatment of waste * within the Community. It aims at protecting the environment and human health through the prevention of the harmful effects of waste generation and waste management. In order to better protect the environment, the Member States should take measures for the treatment of their waste in line with the following hierarchy which is listed in order of priority: prevention, preparing for reuse; recycling, other recovery-notably energy recovery; disposal.
Council Directive 91/689/EEC of 12 December 1991 on hazardous waste.	This Directive lays down rules on hazardous waste. The list of hazardous wastes covered by the Directive has been drawn up on the basis of the categories, constituents and properties set out in the Annexes to the Directive. In particular, **mercury and mercury compounds** are listed in Annex II as constituents of the wastes which render them hazardous when they have the corresponding properties.
Directive 2006/66/EC on batteries and accumulators and waste batteries.	The Directive **prohibits batteries and accumulators**, whether or not incorporated in appliances, containing more than **0.0005% by weight of mercury** (except for button cells, which must have a mercury content of less than 2% by weight); portable batteries and accumulators, including those incorporated in appliances, with a cadmium content by weight of more than 0.002% (except for portable batteries and accumulators for use in emergency and alarm systems, medical equipment or cordless power tools). Arrangements must be made to enable end-users to discard spent batteries and accumulators at collection points in their vicinity and have them taken back at no charge by the producers. Collection rates of at least 25% and 45% have to be reached by 26 September 2012 and 26 September 2016 respectively. The recycling of battery and accumulator content to produce similar products or for other purposes has to reach the following levels by 26 September 2011: ▪ At least 65% by average weight of lead-acid batteries and accumulators, including the recycling of the lead content to the highest degree that is technically feasible; ▪ 75% by average weight of nickel-cadmium batteries and accumulators, including the recycling of the lead content to the highest degree that is technically feasible; ▪ At least 50% by average weight of other battery and accumulator waste.
Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).	The aim of the Directive is to minimise the disposal of waste electrical and electronic equipment (WEEE) as unsorted municipal waste and to set up separate collection systems for WEEE. The objective of these schemes is to increase the recycling and/or re-use of such products. It also sets targets on the rates of recovery according to categories of electrical and electronic equipment.
Directive 2000/53/EC on end-of life vehicles (ELV).	It is meant to minimize the impact of the end of life of vehicles on environment by restricting the use of certain heavy metals in new vehicles from 1 July 2003. The objective is to ensure that 85% of an end

	of life vehicle by weight will be recycled by the year 2006, increasing to 95% by the year 2015 with additional de-pollution tasks being progressively introduced. In particular it **prohibits the use of lead, mercury, cadmium and hexavalent chromium-**, it introduces a "certificate of destruction" for scrapped vehicles; it requires producers to mark certain vehicle components to aid recycling; it requires producers to make available dismantling information in respect of new vehicles; and it requires that ELVs can only be scrapped ('treated') by authorised treatment facilities, which must meet tightened environmental standards.
Council Directive 99/31/EC on the landfill of waste.	The Directive is intended to prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health. It defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land. Landfills are divided into three classes: landfills for hazardous waste; landfills for non-hazardous waste; landfills for inert waste. A standard waste acceptance procedure is laid down so as to avoid any risks and the list of wastes that may not be accepted in a landfill.
Council Decision 2003/33/EC of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC.	This Decision establishes the criteria and procedures for the acceptance of waste at landfills in accordance with the principles set out in Directive 1999/31/EC and in particular Annex II thereto. **Limit concentration of Hg in waste leachate for the inert waste landfill is 0.01 mg/kg of dry matter.** **Limit concentration of Hg in waste leachate for the non-hazardous waste landfill is 0.2 mg/kg of dry matter.** **Limit concentration of Hg in waste leachate for the hazardous waste landfill is 2 mg/kg of dry matter.**
Directive 2000/76/EC on incineration of waste.	The aim of the Directive is to prevent or to reduce as far as possible negative effects on the environment caused by the incineration and co-incineration of waste. This is to be achieved through the application of operational conditions, technical requirements, and emission limit values for incineration and co-incineration plants within the EU. The WI Directive sets emission limit values and monitoring requirements for pollutants to air such as dust, nitrogen oxides (NOx), sulphur dioxide (SO_2), hydrogen chloride (HCl), hydrogen fluoride (HF), heavy metals and dioxins and furans. **Emission limit value for discharges of waste water from the cleaning of exhaust gases for mercury and its compounds, expressed as mercury (Hg) is 0.03 mg/l.** **Air emission limit value for mercury and its compounds, expressed as mercury (Hg) is 0.05 mg/m^3.**
Commission Recommendation the safe storage of metallic mercury no longer used in the chlor-alkali industry.	Euro Chlor, the business association representing chlor-alkali producers in the EU and the European Free Trade Association regions, has agreed to go beyond the requirements of the legislation. Surplus mercury will be removed from decommissioned chlorine plants, transported to its final destination in approved sealed steel containers and preferably

	stored in deep underground salt mines.

Soil protection	Hg limitations
Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.	This Directive aims to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and humans, while encouraging its correct use. Member States must prohibit the application of sewage sludge to soil where the concentration of one or more metals in the soil exceeds the limit values laid down in a first annex. For mercury, the soil limit value is **1 to 1.5 mg/kg** of dry matter for soils with a pH higher than 6 and lower than 7.

Food and health safety	Hg limitations
Regulation EC 1881/2006 setting maximum levels for certain contaminants (Hg) in foodstuffs.	The foodstuffs listed in the Annex shall not be placed on the market whether they contain a contaminant listed in the Annex, i.e. **mercury**, at a level exceeding the maximum level set out in the Annex.
Commission Directive 2001/22/EC of 8 March 2001 laying down the sampling methods and the methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs.	It lays down the sampling methods and the methods of analysis for the official control of the levels of **mercury** in foodstuffs.

Restrictions on products containing mercury	Hg limitations
Directive 89/677/EEC of 21 December 1989 amending for the eighth time Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the member states relating to restrictions on the marketing and use of certain dangerous substances and preparations.	Mercury compounds may not be used as substances and constituents of preparations intended for use: (a) to prevent the fouling by micro-organisms, plants or animals of: - the hulls of boats, - cages, floats, nets and any other appliances or equipment used for fish or shellfish farming, - any totally or partly submerged appliances or equipment; (b) in the preservation of wood; (c) in the impregnation of heavy-duty industrial textiles and yarn intended for their manufacture; (d) in the treatment of industrial waters, irrespective of their use.
Directive 98/8/EC of 16 February 1998 concerning the placing of biocidal products on the market.	According to this Directive, after 13 May 2010 at latest, no biocidal products with mercury compounds would be allowed in any Member State.

Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC.	The Regulation lays down approval criteria for active substances. As such, an active substance shall only be approved if it is not classified as category 1A or 1B mutagenic, carcinogenic or toxic for reproduction, and is not considered to have endocrine disrupting properties. Furthermore, an active substance which is considered to be a persistent organic pollutant, or as persistent, bioaccumulative and toxic, or even as a very persistent and very bioaccumulative substance, shall not be approved. Pesticides containing mercury were already prohibited by the Plant Protection Products Directive 79/117/ECC which will be repealed by this Regulation from 14 June 2011.
Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.	From 1 July 2006, new electrical and electronic equipment put on the market can not contain lead, **mercury**, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE), except for applications listed in the Annex.
Directive 94/62/EC of 20 December 1994 on packaging and packaging waste.	Concentration levels of heavy metals present in packaging 1. Member States shall ensure that the sum of concentration levels of lead, cadmium, mercury and hexavalent chromium present in packaging or packaging components shall not exceed 100 ppm by weight after 30th June 2001. The concentration levels shall not apply to packaging entirely made of lead crystal glass as defined in Directive 69/493/EEC.
Council Directive 76/768/EEC of 27 July 1976 on the approximation of the laws of the Member States relating to cosmetic products (Cosmetics Directive).	The Directive sets out a list of substances which cannot be included in the composition of cosmetic products (Annex II) and a list of substances which cosmetic products may contain only under the restrictions and conditions laid down (Annex III). Mercury and its compounds are included in Annex II.
Directive 2009/48/EC of 18 June 2009 on the safety of toys	This Directive came into force on 20 July 2009, and will become a legal document in all Member States once it has been implemented into national legislation (by 20 January 2011). The following migration limits, from toys or components of toys, shall not be exceeded for mercury: mg/kg in dry, brittle, powder-like or pliable toy material: 7,5 mg/kg in liquid or sticky toy material: 1,9 mg/kg in scraped-off toy material: 94
Directive 2007/51/EC on restrictions on the marketing of certain measuring devices containing mercury.	It prohibits the placing on the **market of mercury** in all clinical thermometers and other, new, measuring devices containing mercury (e.g. barometers and thermometers) to the general public. There is a derogation for barometers until 3 October 2009, to allow industry time to adjust, with an outright derogation for all mercury-containing instruments over 50 years old on the 3 October 2007. Specialist medical, scientific and industrial applications are also excluded, but subject to review by 3 October 2009.
Regulation EC 1102/2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury.	**The export of metallic mercury, cinnabar ore, mercury (I) chloride, mercury (II) oxide and mixtures of metallic mercury** with other substances, including alloys of mercury, with a mercury concentration of **at least 95 % weight by weight from the Community shall be prohibited from 15 March 2011.** From 15 March 2011, the following shall be considered as waste and be disposed of in accordance with Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on waste: (a) metallic mercury that is no longer used in the chlor-alkali industry;

	(b) metallic mercury gained from the cleaning of natural gas; (c) metallic mercury gained from non-ferrous mining and smelting operations; and (d) metallic mercury extracted from cinnabar ore in the Community as from 15 March 2011.
Council Decision 2006/730/EC of 25 September 2006 on the conclusion, on behalf of the European Community, of the Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous chemicals and pesticides in international trade. Regulation (EC) n° 689/2008 of the European Parliament and of the Council of 17 June 2008 concerning the export and import of dangerous chemicals.	The purpose of the Regulation is to implement the provisions of the Rotterdam Convention within the European Community. It will ensure that the measures laid down in the Convention are adopted; at the same time, some of the provisions contained in the Regulation will go beyond what is required in the Convention. Mercury compounds, including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds are included in the List of chemicals subject to export notification procedure (Annex I), their use limitations are classified into sr — severe restriction or b — ban. Cosmetic soaps containing mercury are particularly subjected to export ban according to Annex V.

2.2.4 National legislation on mercury exceeding EU legislation

Recently, Norway (1st January 2008), Sweden (1st January 2009) and Denmark have introduced a general ban on use of mercury in products. In Norway the ban includes use of new amalgams. There are exemptions for special patient groups until end of 2010. However, in Sweden derogation may be granted until 31st December 2011 in exceptional cases and only in hospitals and for adults (OSPAR Commission, 2009b).

The world's most progressive legislation on mercury in products entered into force 1st January 2008 in Norway with a general prohibition on production, import, export, sale and use of mercury and mercury compounds. The regulation provides for a few general exemptions until 31st December 2010.

Of the EU Member States, Denmark and the Netherlands have a general prohibition on import, export and sale of mercury and mercury-containing products, but a wide range of products containing mercury are exempted.

Sweden has a prohibition on production, sale and export of thermometers and other measuring equipment, level switches, pressure switches, thermostats, relays, circuit breakers and electrical contacts, but also permits a few exemptions. Sweden intends to enact a general ban in the relatively near future.

2.3 National legislative framework

Mercury, as an extended and persistent pollutant, is commonly approached by different areas of action and different competent public bodies. Mercury regulatory measures have been analysed for Mediterranean countries in order to obtain both an overview of the regional level of implementation of mercury provisions for the different areas of concern and a detailed analysis by country.

According to the answers to questionnaire handed out for the present diagnosis, most Mediterranean countries developed some kind of legal framework regarding mercury. A general overview of the level of adoption of mercury policies by Mediterranean countries is shown in Figure 3. The most addressed mercury impacts are the ones arising from discharges to water, emissions to air and waste incineration. However, the development of such regulatory frameworks do not necessarily implies the establishment of specific mercury quality standards or emission limit values in all countries (see section 7). Control of mercury in foodstuff and water and soil quality criteria are also key areas in which most Mediterranean countries have implemented regulatory measures.

Regulations on storage have not been developed in the Mediterranean countries yet. Only few countries reported to have established legislation arising from the 4th and 5th ordinary meetings of the contracting parties of Barcelona Convention regarding, respectively, maximum concentration of mercury in seafood and quality criteria for bathing waters (UNEP/IG.56/5) and maximum concentration of mercury for discharges into the Mediterranean Sea (UNEP/IG.74/5).

Table 7 shows a summary of the national mercury regulations. It should be noted that only legal framework on air quality, emissions and water quality for bathing which contain specific provisions on mercury has been considered (at least two countries, i.e. Monaco and Tunisia, have reported not to have such specific provisions).

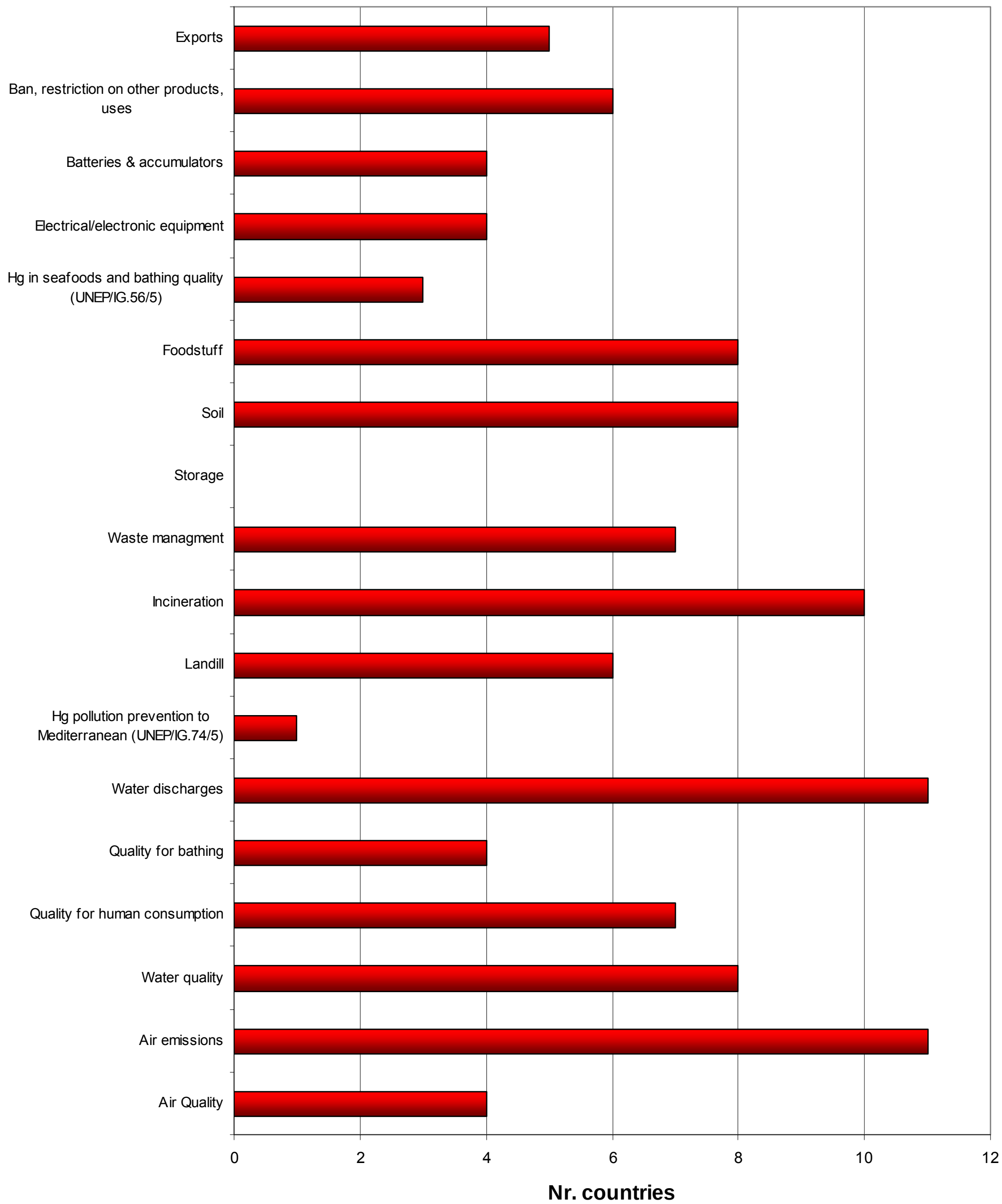


Figure 3. Level of implementation of mercury national legislation in the Mediterranean region.

Table 7. Summary of the status of mercury regulations in Mediterranean countries.

Country	AIR			WATER						WASTE			SOIL		H&S		MARKETING & TRADE			
	Quality Air	Air emissions	Sectorial legislation	Quality standards	Quality for human consumption	Quality for bathing	Discharges	Sectorial legislation	Hg pollution prevention to Mediterranean	Landfill	Incineration	Waste managment	Storage	Soil	Foodstuff	Hg in seafoods and bathing quality (UNEP/IG.56/5)	Electrical/electronic equipment	Batteries & accumulators	Ban, restriction on other products, uses	Exports
Albania																				
Algeria	✗	✓	✗	✓		✓	✓			✓	✓	EEE		✗	✗		✗	✗	Coatings, paints, plastic materials, inks, clays	✗
Bosnia Herzegovina																				
Croatia	✓	✓	Chloralkali, cement, co-incineration	✓	✓	✗	✓	✗	✗	✓	✓	Batteries and accumulators		✓(sewage sludge in agriculture)	✓	✓	✗	✓	Fouling prevention; Wood preservatives; Impregnation of fabric and yarns; Treatment of industrial waters; Thermometers; Measuring devices.	UD
Cyprus	✓	✓	HW incineration, large combustion plants		✗	UD	✓		✗	✗	✓	Only general waste management		✗	✓	✗	✗	✓	REACH	✓
Egypt		✓	Hospital incinerators				✓				✓ (hospital incinerators)	Hazardous waste			✓				Pesticides	

Country	AIR			WATER						WASTE			SOIL		H&S		MARKETING & TRADE			
	Quality Air	Air emissions	Sectorial legislation	Quality standards	Quality for human consumption	Quality for bathing	Discharges	Sectorial legislation	Hg pollution prevention to Mediterranean	Landfill	Incineration	Waste managment	Storage	Soil	Foodstuff	Hg in seafoods and bathing quality (UNEP/IG.56/5)	Electrical/electronic equipment	Batteries & accumulators	Ban, restriction on other products, uses	Exports
France																				
Greece	✓	✓	Incineration	✓	✓	✓				✓	✓	EEE, batteries (UD)					✓	UD		✓
Israel	UD	✓	✗	✓	✓	✗	✓	✗	✓		✓			✓	✓	✓				
Italy			Incineration	✓	✓		✓	✗			✓(also waste energy recovery)	EEE, ELV, batteries, packagin g, medical waste		✓	✓	✓	✓	✓		✓
Lebanon																				
Libya																				
Malta																				
Monaco		✓				✓									✓					
Montenegro																				
Morocco	UD	✓			✓	✓	✓								✓				Mercury oxide; mercury chloride; Mercury iodide; Syrup of mercury bi iodide or Gibert, mercury sulphate, mercury sulfide and preparation	

Country	AIR			WATER						WASTE			SOIL		H&S		MARKETING & TRADE			
	Quality Air	Air emissions	Sectorial legislation	Quality standards	Quality for human consumption	Quality for bathing	Discharges	Sectorial legislation	Hg pollution prevention to Mediterranean	Landfill	Incineration	Waste managment	Storage	Soil	Foodstuff	Hg in seafoods and bathing quality (UNEP/IG.56/5)	Electrical/electronic equipment	Batteries & accumulators	Ban, restriction on other products, uses	Exports
																			s, mercury thiocyanate	
Slovenia		✓	Incineration							✓	✓			✓	✓					✓
Spain	✓	✓	Incineration	✓	✓		✓	Chlor-alkali, vinyl chloride, other mercury users		✓	✓	EEE, ELV, batteries		✓	✓		✓	✓	Fouling prevention; Wood preservatives; Impregnation of fabric and yarns; Treatment of industrial waters; Thermometers; Measuring devices.	✓
Syria		✓					✓	Chlor-alkali						✓						
Tunisia	✓	UD	UD	✓	✓	✓	✓				✓	Batteries		✓	✓					
Turkey	UD	✓		✓		✓	✓			✓	✓	EEE, ELV		✓ (sewage sludge in agricult			✓			

Country	AIR			WATER						WASTE			SOIL		H&S		MARKETING & TRADE			
	Quality Air	Air emissions	Sectorial legislation	Quality standards	Quality for human consumption	Quality for bathing	Discharges	Sectorial legislation	Hg pollution prevention to Mediterranean	Landill	Incineration	Waste managment	Storage	Soil	Foodstuff	Hg in seafoods and bathing quality (UNEP/IG.56/5)	Electrical/electronic equipment	Batteries & accumulators	Ban, restriction on other products, uses	Exports
														ure)						

UD: under development

3. Main action lines taken for the management of mercury and the implementation of the UNEP mercury programme

3.1 Work areas within the UNEP Mercury Programme

So far, the UNEP Mercury Programme, in coordination with Governments, intergovernmental organizations, stakeholders and the Global Mercury Partnership, has developed international actions on mercury in the following areas:

- Enhancing capacity for mercury storage;
- Reducing the supply of mercury from primary mercury mining;
- Conducting awareness-raising and pilot projects in key countries to reduce mercury use in artisanal and small-scale gold mining;
- Reducing mercury use in products and processes and raising awareness of mercury-free alternatives;
- Providing information on best available techniques, best environmental practices and the conversion of mercury-based processes to non-mercury based processes;
- Enhancing development of national inventories on mercury;
- Raising public awareness and supporting risk communication;
- Providing information on the sound management of mercury.

In particular, the UNEP Global Mercury Partnership has attempted to minimize and, where feasible, ultimately eliminate global, anthropogenic mercury releases to air, water and land in the following fields:

- Mercury management in artisanal and small-scale gold mining.
- Mercury control from coal combustion.
- Mercury reduction in the chlor-alkali sector.
- Mercury reduction in products.
- Mercury air transport and fate research.
- Mercury waste management.
- Mercury supply and storage.
- Non-ferrous metals production.

Furthermore, the future global legally binding instrument agreed by the **Governing Council** in its **Decision 25/5** will include the following provisions in order to develop a comprehensive and suitable approach to mercury:

(a) To specify the objectives of the instrument;
(b) To reduce the supply of mercury and enhance the capacity for its environmentally sound storage;
(c) To reduce the demand for mercury in products and processes;
(d) To reduce international trade in mercury;
(e) To reduce atmospheric emissions of mercury;
(f)To address mercury-containing waste and remediation of contaminated sites;
(g) To increase knowledge through awareness-raising and scientific information exchange;
(h) To specify arrangements for capacity-building and technical and financial assistance;
(i) To address compliance;

In the framework of the present diagnosis, Mediterranean countries have been asked about the status of the implementation of the UNEP Mercury Programme through the existence of national mercury assessments, plans and/or strategies. In addition, detailed measures addressed to the prevention and control of mercury impacts have also been requested, in particular regarding the following topics:

- Air emission inventories.
- Water emission inventories.
- Solid Waste inventories.
- Stockpiles inventories.
- Contaminated soil inventories.
- Hot Spots inventories.
- Air quality control.
- Water quality control.
- Mercury use and production control.
- Mercury emissions control.
- Food stuff and biota contaminants control.
- Mercury substitution initiatives.
- Control of mercury levels in human blood.
- Control of mercury levels in breast milk.
- Mercury import/export inventories.
- Participation in regional monitoring networks.

The section 3.2 describes the obtained results.

3.2 State of the implementation of the UNEP Mercury Programme in the Mediterranean countries

According to information collected through the questionnaires, Mediterranean countries have translated international action into national scope unevenly. The state of the implementation of the UNEP Mercury programme is resumed in

Table 8.

Table 8. Status of the implementation of the UNEP Mercury Programme in Mediterranean countries.

Country	Implementation of the UNEP mercury programme		
	National Assessment	National Mercury Plan/Strategy	Measures on mercury management
Albania			
Algeria	YES	YES	YES
Bosnia Herzegovina			
Croatia	YES	YES	YES
Cyprus	NO	NO	YES
Egypt	NO	NO	NO
France			
Greece	n.a.	n.a.	YES
Israel	n.a.	n.a.	YES
Italy	n.a.	n.a.	YES
Lebanon			
Libya			
Malta			
Monaco	NO	NO	YES
Montenegro			
Morocco	YES	YES	YES
Slovenia	YES	NO	YES
Spain	YES	YES	YES
Syria	UD	UD	YES
Tunisia	UD	UD	YES
Turkey	NO	NO	YES

Source: questionnaires

Out of the eleven Mediterranean countries that provided information on this issue, four stated to have developed both a National Assessment on Mercury and a National Mercury Plan or Strategy (Algeria, Croatia, Morocco and Spain); two countries (Syria and Tunisia) reported to be developing both; one country, Slovenia, reported to have only developed a National Assessment; whereas and, finally, four countries (Cyprus, Egypt, Monaco and Turkey) reported to have developed neither a mercury diagnosis nor a mercury plan or strategy.

As for the implementation of concrete measures for the management of mercury, most Mediterranean countries that answered this question reported to have implemented some measures. Furthermore, the information provided by the countries has been completed and contrasted with the following bibliography:

- Submissions from Governments[20] for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) to be held in Stockholm, Sweden, from June 7 to 11 2010.
- Regional emission inventories and environmental quality networks like UNEP Hg Programme, UNEP/MAP NBB, UNECE-EMEP, EU-PRTR and MEDPOL Programme. These main regional emission inventories, their geographical

20 http://www.unep.org/hazardoussubstances/Mercury/Negotiations/INC1/Submissions/tabid/4325/language/en-US/Default.aspx

coverage and a summary of results are described in detail in section 8.1. Hot spots and areas of influence are usually identified from these inventories and networks. They are described more in detail in section 9.

- OSPAR Commission (2009a) and Eurochlor (2010) data reporting on chloralkali industry.
- National diagnoses and strategies, when available (RAC/CP, 2007, 2010a, 2010b for Spain).

Table 9 summarizes the measures and instruments on mercury management identified for each country, which are developed in the following sections.

Table 9. Status of the implementation of measures on mercury management in Mediterranean countries.

Country	Air emission inventories	Water emission inventories	Solid Waste inventories	Mercury stocks	Contaminated soil inventories	Hot Spots	Air quality control	Water/sediment/biota quality control	Mercury use and production control	Mercury emissions control	Food stuff contaminants control	Mercury substitution initiatives	Control of mercury levels in human blood/breast milk
Albania	✓	✓				✓		✓					
Algeria	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Bosnia Herzegovina	✓	✓					✓						
Croatia	✓	✓	✓			✓	✓	✓	✓	✓			✓
Cyprus	✓	✓	✓			✓	✓	✓	✓	✓			
Egypt	✓	✓				✓		✓					
France	✓	✓		✓		✓	✓	✓	✓	✓			
Greece	✓	✓	✓			✓	✓	✓	✓	✓			
Israel	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		
Italy	✓	✓				✓	✓	✓	✓	✓			
Lebanon	✓	✓						✓			✓		
Libya	✓	✓											
Malta	✓	✓					✓	✓					
Monaco	✓	✓						✓			✓		
Montenegro	✓	✓					✓	✓					
Morocco	✓	✓	✓			✓		✓			✓		
Slovenia	✓	✓				✓		✓					✓
Spain	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Syria	✓	✓	✓						✓				
Tunisia	✓	✓	✓	✓	✓	✓	✓	✓	✓	UD	✓	✓	✓
Turkey	✓	✓				✓	✓	✓	✓	✓		✓	

4. Production, import, export, trade and use

4.1 Production of mercury in the Mediterranean countries

The most important mercury source is mining, followed by the recovery of mercury from the decommissioned chlor-alkali cells and by-products from mineral ores and natural gas cleaning, as well as stocks and inventories (Table 10).

Table 10. Global mercury supply (2005). Source: UNEP, 2008.

Key sources	Mercury supply (metric tonnes)
Mercury mining	1,150-1,500
Mercury from chlor-alkali cells (after decommissioning)	700-900
By-product mercury from other ores, including natural gas cleaning	410-580
Stocks and inventories	300-400
Total	2,560-3,380

Table 11 shows the components of the global mercury supply between 1995 and 2005.

Table 11. Global mercury supply (2005). Source: Maxson, 2006.

Year	Mining & by-product mercury	Recycled mercury, including chlor-alkali wastes	Mercury recovered from decommissioned mercury cell chlor-alkali plants	Mercury from stocks	Total
1995	3,338	459	575	300	4,672
1996	2,782	501	475	0	3,758
1997	2,529	539	500	1,000	4,568
1998	2,496	510	460	0	3,466
1999	2,200	575	600	0	3,375
2000	1,900	610	800	0	3,310
2001	2,300	620	650	0	3,570
2002	2,650	630	230	0	3,510
2003	2,650	640	290	0	3,580
2004	1,965	560	489	0	3,014
2005	1,996	650	644	400	3,690

Figure 4 shows the components of global mercury supply between 1981 and 2005. It can be observed that mercury obtained from mining and by-products was notably lower in the Nineties than in the Eighties. On the contrary, mercury recovered by chlor-alkali industries increased, as a result of the shift to mercury-free technologies. In addition, mercury form stocks and recycled mercury also increased.

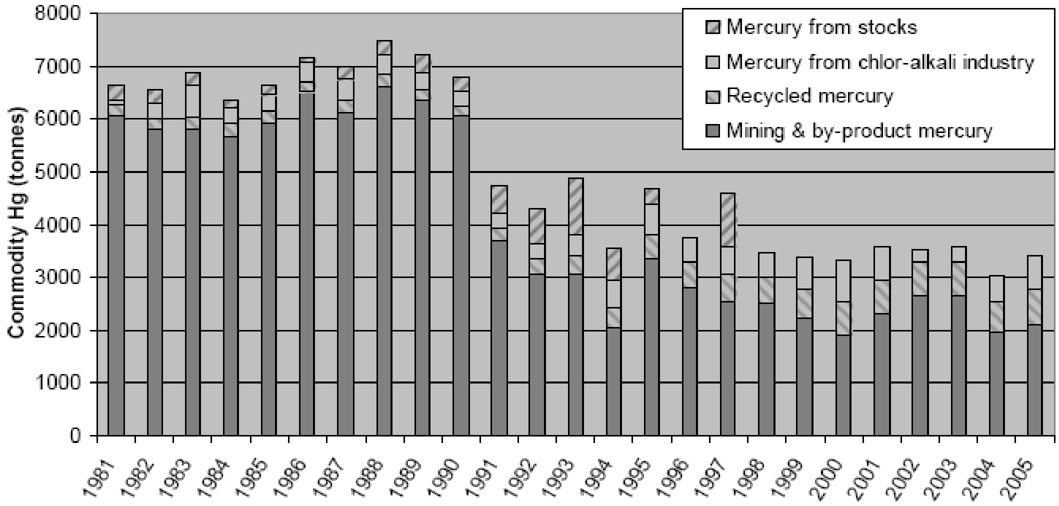


Figure 4. Global mercury supply (1981-2005). Source: UNEP, 2006.

The next sections will explore the main global mercury sources, i.e. primary production; recycling from industries and products; stocks and inventories.

4.1.1 Primary production

Table 12 shows that until 2003 most world mercury mine production took place in four countries, i.e. Spain, Algeria, China and Kyrgyzstan, two of which belong to the Mediterranean region. However, the two Mediterranean countries ceased their production between 2003 and 2004, causing an increase in prices and a later reduction in demand (UNEP, 2008).

Table 12. Most important mercury mine production, 2000-2005 Source: UNEP (2008).

Mercury mining (tonnes)	2000	2001	2002	2003	2004	2005
Spain	236	523	727	745	0	0
Algeria	216	320	307	234	90	0
China	203	193	495	612	700-1,140	800-1,094
Kyrgyzstan	590	574	542	397	488	304

In addition to the production shown in Table 12, UNEP (2008) estimates an additional 50-100 tonnes of mercury mined in other countries. In any case, nowadays Kyrgyzstan is the only significant mercury exporter, since China's mercury is mostly for internal use (UNEP, 2008; Maxson, 2006). However, Kyrgyzstan confirmed during the first session of the intergovernmental negotiating committee to prepare a global legally binding instrument on mercury (INC 1), in June 2010, the commitment on the closure of its primary mercury mine.

Figure 5 shows mercury production in Mediterranean countries. As mentioned above, Spain and Algeria were by far the most important producers (and the only ones after 1991). However, according to the questionnaires handed out for this report, Algeria produced 600 tonnes of mercury on average per year, before ceasing production in 2004, which is a much higher figure than the data shown in Table 12. Turkey was the third most important Mediterranean producer, but ceased its production in 1991. Italy produced a small amount of mercury at the beginning of the Eighties, and Slovenia gave an even smaller contribution during the Eighties.

According to UNEP/UNITAR (2009), mines in Slovenia and Algeria ceased operations due to economic and technical difficulties, while others like the Almadén mine in Spain experienced pressure from growing international concern regarding mercury pollution which also led to its closure in 2004. However, there is no formal commitment not to reopen old mines by these countries.

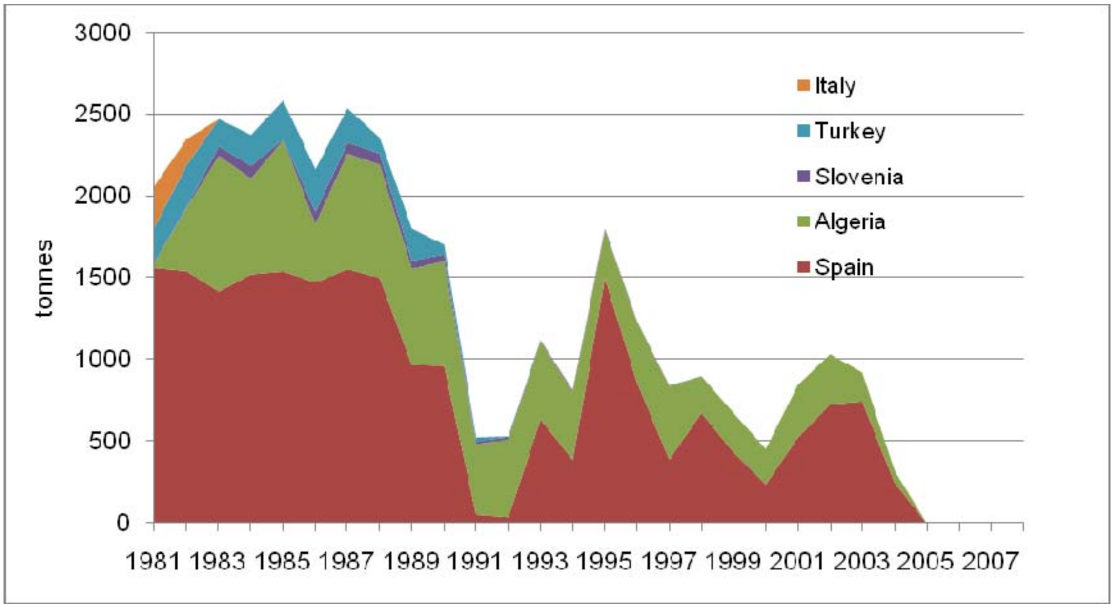


Figure 5. Mercury production in Mediterranean countries (tonnes, 1981-2007). Sources: own elaboration after Hylander & Mieli (2003); USGS-Minerals Yearbook; BRGM-Annuaire Statisque Mondial des Minerais et Metaux (2007).

Figure 6 shows a comparison between global mercury production and the Mediterranean countries' production. Mediterranean countries (i.e. mainly Spain and Algeria) provided from the beginning of the Nineties until 2003 roughly half of global mercury supply (53% in 2003).

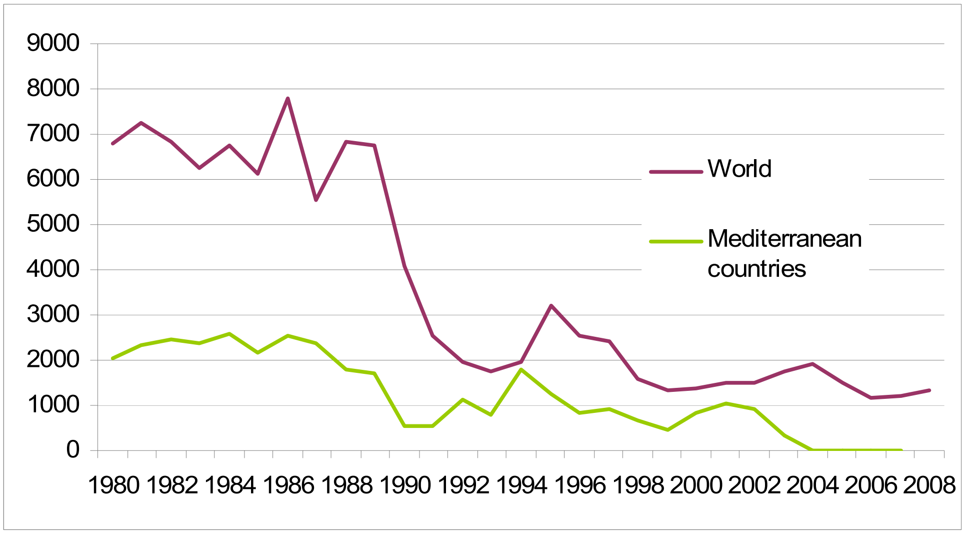


Figure 6. Mercury production of Mediterranean countries and comparison with global mercury production. Sources: own elaboration after Hylander & Mieli (2003); USGS-Minerals Yearbook; BRGM-Annuaire Statisque Mondial des Minerais et Metaux, 2007 (tonnes).

4.1.2 Secondary production

Mercury can also be obtained from the mining and processing of other metal ores, such as zinc, copper, silver or gold which can contain trace amounts of mercury and from the mercury recovery from industries using mercury in the production process such as chlorine industry and vinyl chloride monomer production.

As Table 10 shows, the most important source of mercury, after mining, is the chlorine industry, which is shifting towards mercury-free processes. Mercury that is removed from the cells when a mercury cell chlor-alkali facility is closed or converted to a mercury-free process can be collected and reused. However, recycling of mercury wastes is still rather limited, due to its high costs.

In 2005, in the EU-25 there were almost 6 million tonnes of mercury cell chlorine capacity (Maxson, 2006). However, different countries announced the closing or conversion of around one million tonnes of chlorine capacity (UNEP, 2008). In addition, most of the remaining European mercury cell chlor-alkali facilities are expected to phase out the mercury cells (Maxson, 2006). In fact, European chlor-alkali facilities agreed on a voluntary mercury phase-out by 2020, partly because of the fact that most chlor-alkali facilities will have become uneconomic or reached the end of their lifetime by 2020 (UNEP, 2006, Lassen *et al.*, 2008). In extra-European countries there are around 4 million tonnes of mercury cell chlorine capacity, which will be slowly decommissioned when mercury cell chlor-alkali facilities close and are replaced by mercury free processes (Maxson, 2006). More information on chlor- alkali industries can be found in section 4.2.1.

Mercury can also be recovered from vinyl chloride monomer production. However, since VCM facilities using mercury are mostly in Russia and China (the latter representing 80-90% of the total) VCM is not a relevant category for Mediterranean countries (Maxson, 2006, AMAP/UNEP, 2008).

In addition, mercury can be obtained as by-product from most non-ferrous metals mining, such as zinc, copper, lead, gold and silver (Table 13). Mercury is generally emitted to the atmosphere during the smelting process, but it may be recovered and sold (UNEP, 2008). Maxson (2006) calculates that 1,000-1,500 tonnes of mercury are released globally every year from non ferrous ores refining processes, out of which about 345 tonnes are recovered (2005 data).

Table 13. By-product mercury recovered world-wide in 2005 (tonnes). Source: Maxson (2006).

	EU-25	Global
Zinc refining	48	90
Gold refining	0	225
Copper, lead, silver refining	5	30
Other by-product:		
Russian Federation incl. Ukraine	0	80
Tajikistan Sb-Hg mine	0	40
Other	0	30
Natural gas cleaning	26	36
Total	**79**	**531**

As regards zinc, Spain is the most important European zinc producer (525,000 tonnes in 2004), France the fourth (260,000), and Italy the eighth. However, in most cases mercury recovery is not economically profitable, and therefore not many operators separate mercury from zinc in order to sell it (Maxson, 2006). In this sense, a decreasing trend in the production of mercury from zinc metallurgy in Spain during the 1990s is reported by RAC/CP, 2010a, as it can be observed in Table 14.

Table 14. Production of mercury as by-product from zinc metallurgy in Spain (in tonnes).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Zinc metallurgy	66.8	52.1	36.3	24.8	6.6	2.6	0.1	nd	nd	nd	nd

Other Mediterranean countries reported small amounts of mercury secondary production, i.e. Morocco reported to have a hydrometallurgical processing facility which allows a total recuperation of mercury as a by-product of silver refining (1 tonne per year)[21] and Slovenia reported in the questionnaire a mercury secondary production of approximately 0.3 t/year (2008).

In addition, mercury can be recovered from natural gas cleaning, since natural gas contains some mercury in trace quantities. In some areas, such as in Algeria and Croatia, mercury concentration in natural gas is relatively high (Maxson, 2006). Croatia indicated in the questionnaires handed out for the present diagnosis that mercury is produced as a natural gas by-product in Molve. There are no data on the amount of mercury recovered through natural gas cleaning, but Maxson (2006) reports that the PURASPEC equipment for gas cleaning is operative (among Mediterranean countries) in Egypt and Libya.

According to Lassen *et al.* (2008), 350-410 tonnes of mercury could be potentially recovered in the EU 27 from non-ferrous ores and natural gas cleaning, of which 65-90 are already being recovered.

[21] UNEP Global Mercury Partnership. Reports on supply, trade and demand according to Decision 23/9 (2006)

4.1.3 Recycled mercury from products

Mercury can also be recovered from products, such as control and measuring instruments (thermometers, barometers, hospital equipments), dental fillings, fluorescent lamps, batteries, electrical and electronic equipment (Maxson, 2006; UNEP, 2008). The recovery ratio depends on the country's regulation and it is expected to increase as environmental legislation becomes stricter.

The mercury supply through recycling is very variable from one year to the next, because it is able to rapidly respond to changing demand, thanks to the diversity of the sources (UNEP, 2008).

It is estimated that the EU-25 recovers 20-30% of the mercury contained in wastes. Table 15 shows the share of mercury consumption which is recovered in Europe.

Table 15. EU-25 and global product/process mercury recycling (2005). Source: Maxson (2006).

	Hg in EU-25 waste stream (t)	EU-25 Hg recycled or recovered (%)	EU-25 Hg recycled or recovered (t)	Hg in global waste stream (t)	Global Hg recycled or recovered (%)	Global Hg recycled or recovered (t)
SS gold mining	not applicable	not applicable	not applicable	not applicable	not applicable	not applicable
Chlor-alkali	not applicable	not applicable	32	not applicable	not applicable	84
Batteries	40	25%	10	500	15%	75
Dental	72	25%	18	200	15%	30
Measuring & control	42	25%	11	160	15%	24
Lighting	46	25%	11	150	15%	23
Electrical & electronic	42	25%	11	150	15%	23
VCM	Unknown	unknown	unknown	700	43%	301
Other, laboratory, pharmaceutical, etc.	36	25%	9	50	15%	8
Total for these categories	278		101	1910		566

4.2 Use of mercury at the Mediterranean countries

Table 16 shows the most important global mercury uses, and two different reduction scenarios: 1) highest future consumption, reflecting trends, legislation and initiatives already in place; 2) a more ambitious scenario, developed by the UNEP Global Mercury Partnership within the Reduction of mercury in product partnership area, reflecting lower mercury consumption in products containing mercury.
The most important mercury user at the global level is the artisanal and small-scale gold mining sector. However, this application will not be discussed in this report, because gold mining is not carried out in Mediterranean countries. The second most important application is as catalyst in the production of vinyl chloride monomer (VCM). However, this mercury use is mostly carried out in China and Russia, and it is not reported in Mediterranean countries (UNEP, 2008), so that it will be not discussed in this report[22]. The other important users, in order of importance, are chlor-alkali plants, batteries, dental amalgams, measuring and control devices, lamps and electrical and electronic devices.

Table 16. Global mercury consumption (2005). Source: UNEP(2008).

Application	Consumption range 2005 (tonnes)	Conservative "status quo" projections to 2015	More progressive UNEP Product Partnership targets for 2015
Artisanal mining	650 - 1000	no significant change	not applicable*
VCM/PVC	715 - 825	increase to 1250, followed by gradual decrease	not applicable*
Chlor-alkali	450 - 550	reduction of 30%	not applicable*
Batteries	260 - 450	reduction of 50%	reduction of 75%
Dental amalgam	300 - 400	reduction of 10%	reduction of 15%
Measuring & control devices	300 - 350	reduction of 45%	reduction of 60%
Lamps	120 - 150	reduction of 10%	reduction of 20%
Electrical & electronic devices	170 - 210	reduction of 40%	reduction of 55%
Other applications	200 - 420	reduction of 15%	reduction of 25%
Total consumption	3,165 - 4,365		
Recycled & recovered mercury	(650 - 830)	increase from 20% of consumption to about 28%	not applicable*
Net consumption	2,500 - 3,500		

* not covered within the products partnership

Table 17 shows the evolution of mercury uses in Europe between 2001 and 2007. The most important mercury use in 2007 was in chlor-alkali plants (41% of the total use), followed by dental amalgams (24%) and chemicals (10%).

Table 17. Evolution of mercury consumption in products and industrial processes in the EU 2001, 2005 and 2007. Source: Lassen *et al.* (2008).

[22] Algeria answer to the questionnaire handed out for this report indicated that the Skikda plastic material farm switched to a mercury-free production process. Israel answered that the main PVC manufacturer in Haifa bay (EIL) was shut down.

Application area	Mercury consumption t/year			% (2007)
	2001 (1)	2005 (2)	2007	
Chlor-alkali production	n.a	190	160-190	41
Light sources	5.9	35	11-15	3
Batteries	9	20	7-25	4
Dental amalgams	90	90	90-110	24
Measuring equipment	33	35	7-17	3
Switches, relays, etc.	9	35	0.3-0.8	0.1
Chemicals			28-60	10
Miscellaneous uses	55 (3)	35 (3)	15-114	15
Total	202+n.a.	440	320-530	100

(1) EU15+ Czech Republic, Poland and Slovenia
(2) EU 25
(3) Miscellaneous uses" includes consumption with chemicals

It can also be observed that the use of mercury decreased between 2005 and 2007, due to the gradual substitution of mercury in regulated products and processes, such as paints, batteries, pesticide, chlor-alkali and an increasing environmental regulation. In addition, mercury product manufacturing is gradually shifting from higher income to lower income countries (UNEP, 2008).

4.2.1 Chlor –alkali facilities

At a mercury cell chlor-alkali facility, elemental mercury is used as a fluid electrode in an electrolytic processes used for production of chlorine and sodium hydroxide (NaOH) or potassium hydroxide (KOH) from salt brine (the electrolysis splits the salt, NaCl).

As shown above (section 4.2), the chlor-alkali industry is the third most important global application for mercury use, and the first one at the European level. According to Eurochlor, which represents the majority of chlor-alkali producers in the EU-27, mercury processes accounted for 34% of the installed capacity of European chlor-alkali installation at the beginning of 2009. However, the use of mercury is diminishing, due to the progressive phase out this technology stimulated by the chlor alkali sector's voluntary agreement. Between 2008 and 2009 six European units shut down or reduced their activity, including three in Italy (Caffaro, Eredi Zarelli and Solvay). Table 18 shows the total amount of mercury in European chlor-alkali facilities represented by Eurochlor.

Table 18. Capacity and amounts of metallic mercury in Mediterranean chlor-alkali facilities represented by Eurochlor (tonnes, 2008). Source: EuroChlor, 2008.

Country	Company	Sites	Capacity (tCl_2/y) (-)	Total on site	Used in cells	Stored in facility	Belonging to Med. basin (approx. distance to Med. Sea, in km) (--)
France	Arkema	Jarrie	170,070	241	237	4	NO
France	Arkema	Lavera (FR1)	166,000	298	255	43	YES (2)
France	PPChemicals	Thann	72,000	175	151	24	NO
France	Solvay	Tavaux (FR2)	240,900	584	574	10	YES (500)
France	SPCH	Harbonnières	22,500	24	24	0	NO
France	Tessenderlo Chemie	Loos	18,040	44	42	2	NO
France (++)	Arkema	St Auban (not in production anymore) (FR3)	-	n.a	n.a	n.a	YES (150)

Country	Company	Sites	Capacity (tCl_2/y) (-)	Total on site	Used in cells	Stored in facility	Belonging to Med. basin (approx. distance to Med. Sea, in km) (--)
Greece	Hellenic Petroleum	Thessaloniki (GR1)	39,899	48	48	0	YES (2)
Italy	Solvay	Bussi (not in production anymore) (IT1)	-	225	219	6	YES (50)
Italy	Solvay	Rosignano (not in production anymore) (IT2)	-	13	5	8	YES (2)
Italy	Syndial	Porto Marghera (IT3)	200,441	7	3	4	YES (0)
Italy (*)	Syndial	Priolo (IT4)	28,000				YES (1)
Italy	Tessenderlo Chemie	Pieve Vergonte (IT5)	41,995 (**)	75	74	1	YES (200)
Italy	Eredi Zarelli	Picinisco (not in production anymore) (IT6)	-	0	0	0	YES (70)
Italy	Caffaro (+)	Torviscosa (not in production anymore) (IT7)	-	0	0	0	YES (25)
Spain	ELNOSA	Lourizan	33,552	70	69	1	NO
Spain	Ercros	Flix (SP1)	150,000	347	347	0	YES (50)
Spain	Ercros	Sabinanigo (SP2)	25,000	46	46	0	YES (270)
Spain	Ercros	Vilaseca (SP3)	135,004	198	197	1	YES (5)
Spain	Ercros	Huelva/Palos	100,929	148	148	0	NO
Spain	Química del Cinca	Monzon (SP4)	31,373	45	44	1	YES (160)
Spain	Solvay	Torrelavega	62,747	124	122	2	NO
Spain	SolVin	Martorell (SP5)	217,871	252	243	9	YES (30)
Spain (++)	Ercris	Hernani (partly converted to membrane technology)	n.a.	n.a.	n.a.	n.a.	NO
Total in Mediterranean basin				2,138	2,055	83	YES

(-) EuroChlor, 2010
(--) own elaboration
(*) Information obtained from the questionnaire handed out for this diagnosis.
(**) Information also indicated in the answer to the questionnaire handed out for this diagnosis.
(+) In the answer to the questionnaire appears as functioning, with a production of 69,000 tonnes per year.
(++) OSPAR Commission, 2009a.

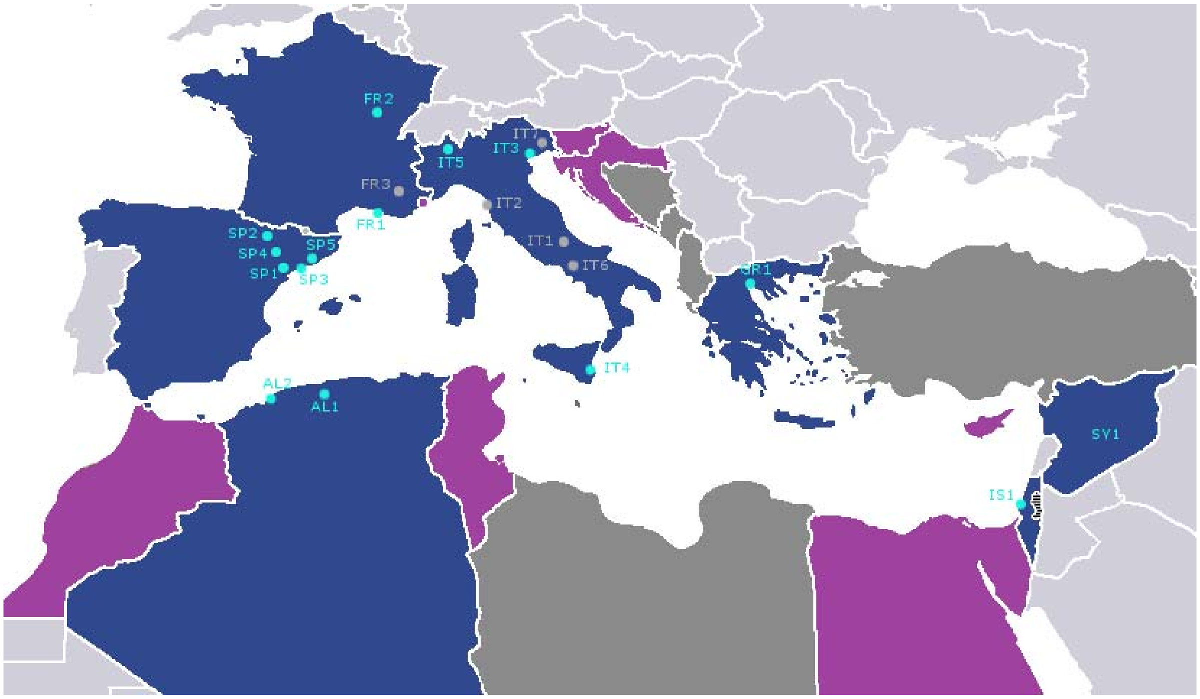
To estimate the amount of mercury used and mercury containing wastes and obsolete products stored by chlor-alkali plants in developing countries and economies in transition is even more difficult than for Europe, because of a considerable lack of data (UNEP, 2002). Table 19 includes the available information on mercury chlor-alkali plants which complements Eurochlor data for the Mediterranean countries.

Table 19. The use of mercury in Mediterranean chlor alkali plants not covered by Eurochlor.

Country	Mercury using chlor-alkali plants	Use of mercury (tonnes per year)	Comments
Algeria (*)	YES	- One installation in Baba Ali (Alger): 0.68-0.85 (data between 2001 and 2003). (AL1) - One installation in Mostaghanem (west Algeria): 0.69 tonnes (data between 2003 and 2004). (AL2)	The two plants are switching to mercury-free production processes.
Croatia (*)	NO		There was a chlor-alkali plant in Kaštela, near Split, which is no longer operating.
Cyprus (*)	NO		
Egypt (*)	NO		The chlor–alkali technology has been phased out.
Israel (*)	YES	- One installation in the south: 1.5. (IS1)	The plant has a stock of 3 tonnes.
Monaco (*)	NO		
Morocco (**)	NO	- One installation: 4 (not in Mediterranean basin)	There is also a plant using mercury for the electrolysis of sodium chloride and PVC production (with a capacity of 180 tonnes per year).
Slovenia	NO		
Syria (*) (***)	YES	- One installation: 10 (SY1)	
Tunisia (*)	NO		There is only one chlor-alkali plant, which adopted in 1998 a mercury-free membrane process.

(*) Source: Questionnaire handed out for this diagnosis.
(**) According to the Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1), this figure range between 4.05 and 5.4 tonnes
(***) Source: UNEP, 2008b

Figure 7 shows the overall status of mercury chlor-alkali plants within the Mediterranean region.



Dental amalgam is the most commonly used dental filling material. It is a mixture of mercury and a metal alloy. The normal composition is 45-55% mercury; approximately 30% silver and other metals such as copper, tin and zinc.

Dental amalgams represent a significant part of the annual mercury consumption, even though this application is declining in industrialized countries. In lower income regions, the use of mercury for dental amalgams may increase in the next years because of changing diets and better access to dental care (Lassen *et al.*, 2008).

The annual EU market for mercury amalgams is about 80-110 tonnes (out of which 70% is used as premeasured capsules of mercury and 30% as liquid mercury), including 17.5 tonnes in France (Lassen *et al.*, 2008).

In addition, it has been estimated that 100 tonnes of mercury is presently accumulated as dental amalgams in French population, and that 1,300 tonnes is accumulated in the EU-15 population (Lassen *et al.*, 2008).

Other available data concerning dental amalgams in Mediterranean countries obtained through the questionnaire handed out for this diagnosis are the following:

- Israel indicated mercury imports of 5.056 tonnes in 2008 and 1.601 tonnes in 2009 for dental amalgams.
- In Morocco mercury consumption for dental amalgams is estimated at 750 kg/year.
- Syria reported 4,370 kg/year of mercury for dental uses.
- In Slovenia, mercury consumption for dental amalgams has decreased from 0,772 t/y in 2004 to 0,007 t/y in 2006.

As regards treatment of waste generated by dental amalgams in Mediterranean countries, few data are available. According to Lassen *et al.* (2008), in Slovenia 0.84 tonnes of wastes containing mercury were recovered and 0.03 incinerated in 2006, while in France 7.5-10 tonnes were recycled in 2004.

4.2.3 Measuring and control devices

Mercury is still used in measuring and control devices[23], such as thermometers, barometers, sphygmomanometers, even though policy initiatives are being taken to stimulate a substitution of these devices with mercury-free alternatives (UNEP, 2008). In this framework, the European Directive 2007/51/EC banned the use of mercury in thermometers and barometers for sale to the general public (see section 2.2.2).

Main measuring and control devices containing mercury are the following:

1. Thermometers are devices that are used to measure temperature. There are many types of thermometers that may contain mercury, including refrigerator, dishwasher, oven, candy, and meat thermometers; thermometers used to measure indoor and outdoor temperature; laboratory thermometers; fever thermometers; basal thermometers used to measure the basal metabolic temperature; thermometers used in industrial applications.
2. Sphygmomanometers: mercury sphygmomanometers are devices used to measure blood pressure.
3. Manometers: manometers measure the difference in gas pressures between the measured environment and a reference. They are mostly mercury-containing U-shaped glass or plastic tubes, where the difference in the levels of mercury in each side of the tube indicates the pressure of the measured gas.
4. Barometers: barometers are instruments used to measure atmospheric pressure.
5. Strain gauges: they measure blood flow and blood pressure in body parts using a technique called strain gauge plethysmography. It consists of a fine rubber tube filled with mercury which is placed around the body part in which the blood pressure or blood flow is measured. They are used for diagnosing arteriosclerosis.
6. Hygrometers (or psychrometers): they are used to measure relative humidity. They consist of two (often mercury) thermometers mounted together, one of which has a cloth wick over its bulb and is called a wet-bulb thermometer.
7. Tensiometers: they are used to determine the level of soil moisture tension. It is a ceramic sensor and a manometer for reading. The latter generally consists of a mercury column similar to that of a mercury manometer.
8. Mercury-containing reference electrodes: they are used for a variety of measurements as they provide a stable potential whatever the measurement conditions.
9. Hanging drop mercury electrodes are used in polarography and voltammetry. The electrodes are formed by mercury dropping regularly from a capillary tube.
10. Gyrocompasses are mercury-containing compasses that find the north using a fast-spinning wheel and friction forces in order to exploit the rotation of the Earth.
11. Gas flow meters used for calibration of other gas flow meters for small flows, may contain mercury in a frictionless sealing. They are used by institutions calibrating

[23] The most important equipment that may use mercury are the following: thermometers (mercury-in glass thermometers; mechanical mercury thermometers with a dial for remote control); manometers; barometers; blood pressure measuring devices (sphygmomanometers; strain gauges); hygrometers; hydrometers; tensiometers; gyrocompasses; mercury-containing reference electrodes; hanging drop mercury electrodes; gas flow meters; coulter counters; permeters.

equipment. In any case, the mercury consumption for this application is estimated to be insignificant.

12. Hydrometers are devices that measure the density or specific gravity of a liquid in a variety of applications. The old ones may contain mercury.
13. Coulter counters are used for automated counting and measuring the size of microscopic particles in the hospital sector. Mercury can be contained in a pressure gauge, on-off switch, timing count gauge, vacuum gauge and possibly other gauges.
14. Blood lead analysers are equipments for measuring lead in blood that may apply a mercury electrode.

According to Lassen *et al.* (2008), the total EU 27 mercury consumption for measuring devices in 2007 was between 7 and 17 tonnes. The main applications were sphygmomanometers (3-6 tonnes per year), barometers for households (2-5 tonnes per year) and medical thermometers (1-3 per year). The latter two are now banned, so that they will not be produced anymore in the future. The same authors estimate that the total accumulated amount of mercury in Europe is between 40 and 100 tonnes.

It is quite difficult to find data on non European Mediterranean countries. However, the following data are available:

- According to the answer to the questionnaire, the use of mercury for thermometers in Morocco is 150 kg/year. However, according to INC-1 submissions, 24 kg/year of mercury contained in the thermometers is reported to be sold in the market in Morocco [24].
- In Syria, 60,000 units of medical thermometers and 15,000 units of sphygmomanometers are reported to be consumed annually[25].
- In France in 2007 0.3 tonnes mercury was used for non-fever thermometers and 1.5 for barometers (Lassen *et al.*, 2008).

4.2.4 Electrical and electronic devices

Mercury is also contained in a great variety of electrical switches, relays, thermostats and arc rectifiers, which are used in electrical and electronic equipment and vehicles.

The use of mercury in electrical and electronic devices has been strongly limited in the European Mediterranean countries by the Directive 2000/53/EC on end-of life vehicles (ELV Directive) and the Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive). The former prohibited the use of mercury in cars, including switches and relays, and with the only exception of discharge lamps and instrument panel displays. The latter prohibits the use of mercury in electrical and electronic equipment, including switches and relays, and with the exception of some kinds of light sources. However, the categories of equipment that are within the scope of the Directive 2002/96/EC on waste electrical and electronic equipment (the WEEE Directive), i.e. “Medical devices” and “monitoring and control

[24] Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) to be held in Stockholm, Sweden, from June 7 to 11 2010

[25] Ad Hoc Open-ended Working Group on Mercury. Request for InformationA of Mercury in Products and Processes, Quantities Used, Demand, Level of Substitution, Technology Change-over, Available Substitutes.

instruments", are outside the scope of the RoHS Directive[26]. They represent approximately 1% of the quantity of electrical and electronic equipment sold in the EU. Large-scale stationary industrial tools are outside the scope of both the RoHS and the WEEE directives, but monitoring and control instruments used in industrial installations are included in the category "monitoring and control instruments".

Main types of electric and electronic devices containing mercury are the following:

1. Tilt switches: mercury tilt switches are small tubes with electrical contacts at one end of the tube. As the tube tilts, the mercury collects at the lower end, providing a conductive path to complete the circuit. When the switch is tilted back, the circuit is broken.
2. Thermoregulators are types of thermostats that consist of a sealed glass unit with a regulating mechanism at the top, a calibrated section in degrees containing a spindle screw, a pointer mounted on a rider, and a glass stem which contains twin capillary bores which connect to a sensitive mercury filled bulb. Attached to the rider is a contact wire that extends into the capillary bore. A reservoir for storage of surplus mercury is also provided by extending a glass partition up into the adjustment section.
3. Wetted reed relays: a relay is an electrically controlled device that opens or closes electrical contacts to effect the operation of other devices in the same or another electrical circuit and the reeds are thin flat ferromagnetic blades that serve as a contact, spring, and magnetic armature. A mercury wetted reed relay consists of a glass encapsulated reed with its base immersed in a pool of mercury and the other end capable of moving between two sets of contacts. The mercury flows up the reed by capillary action and wets the contact surface of the reed and the stationary contacts. Wetted mercury reed relays are typically used in test, calibration, and measurement equipment applications where stable contact resistance over the life of the product is necessary. The main uses are maintenance of older equipment; ATE markets: automatic test equipment, cable testers, high voltage testers, in-circuit testers; industrial instrumentation and control equipment, power plants; transportation systems: railway circuits; medical equipment.
4. Displacement relays and contactors: the displacement relay uses a metallic plunger device to displace mercury. The plunger is lighter than mercury so it floats on the mercury. The plunger provides the same functionality in a mercury displacement relay as an armature in a mechanical relay. When the coil power is off, the mercury level is below the electrode tip and no current path exists between the insulated centre electrode and the mercury pool. When coil power is applied, the plunger is drawn down into the mercury pool by the pull of the magnetic field and the plunger centres itself within the current path. They have been used in high-current, high-voltage applications such as industrial process controllers, power supply switching, resistance heating, tungsten lighting, welding, high current/voltage lighting, flood lights, copiers, battery chargers, energy management systems, and industrial ovens.
5. Pressury switches: they use pistons, diaphragms, or bellows acting as the pressure sensor to actuate the mercury switch. They are used for heating, ventilation, and air conditioning, medical uses, appliances and other uses.

According to Goodman and Robertson (2006), mercury may still be in circulation for equipment banned by RoHS directive (in particular, mercury pressure switches and displacement relays and applications in vehicles); the use of mercury in switches was estimated at 0.2 kg in 2006. In addition, Lassen *et al.* (2008) estimated the total mercury

[26] Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

consumption for switches, relays and other electrical components at 0.3 – 0.8 tonnes and UNEP (2008b) estimated a mercury demand for electrical and electronic devices in Slovenia at 0.002 tonnes per year.

Data about use of mercury for electrical and electronic devices in the non-European Mediterranean countries are scarce.

4.2.4.1 Mercury use in vehicles

The Directive 2000/53/EC on end-of life vehicles (ELV Directive), as well as the prohibition of the use of mercury in cars with the exception of discharge lamps and instrument panel displays, it also stipulates that all components identified as containing mercury as far as feasible shall be removed by the end of the life of the vehicle in order to recover mercury and avoid releases during the ELV's disposal processes, in particular, emissions from scrap processing facilities.

Mercury has been extensively used in vehicles for tilt light switches and G-force sensors in ABS systems, air bag sensors and auto seat belt mechanisms.

The G-force sensor systems typically contained three one-gram mercury switch capsules embedded in a solid plastic component. The sensors may be present in older cars in use, but no data have been available on the total accumulated quantities in the EU. In the USA, the National Vehicle Switch Recovery Program (NVMSRP)[27] began in 2001, through which, about 9 tonnes of mercury in switches were recovered from vehicles retired in 2003. The entire vehicle fleet was roughly estimated to contain in total 123 tonnes mercury (Clean Car Campaign, 2004 in Lassen *et al.*, 2008).

In the EU, as the most recent application in vehicles was G-force sensors in airbags in a few brand models until 1996, mercury contacts would only be present in older vehicles. Therefore, it is estimated that the total mercury content of the EU vehicle fleet in contacts is probably less than 1 tonne (Lassen *et al.*, 2008).

Mercury is also used for high-intensity discharge (HID) automotive headlamps for use on some high-end luxury or performance automobiles, which provide improved nighttime visibility, smaller size, longer life, and better efficiency over halogen headlamps. However, mercury-free halogen lamps are currently used for the majority of automobiles and xenon headlamps without mercury can achieve the same high-intensity effect of mercury lamps. In addition, two recently mercury-free headlamp technologies have been developed: HID headlamps that use zinc iodide as a substitute for mercury, and LED headlamps.

No information on mercury uses in vehicles has been identified for the non EU Mediterranean countries.

4.2.5 Mercury light sources

Mercury light sources produce light by making an electrical current passing through mercury vapour. Mercury containing lamps are still used because of their higher energy-efficiency with respect to mercury-free alternatives.

This efficient method of producing light is used in a variety of lamps, including:

1. Fluorescent lamps: include, among others, straight tubes of varying lengths, compact fluorescent lamps (CFLs) used to replace incandescent light bulbs, halo-shaped indoor lamps, and small fluorescent (dimmable cold cathode) lamps found

[27] http://www.ecocenter.org/cleancar/introduction.php

in backlit LCDs in TVs and laptop computers and other devices, appliances, navigational systems, etc.

2. High-intensity discharge (HID) lamps: mercury vapour, metal halide, (most) high-pressure sodium, low-pressure mercury discharge, etc.
3. Cold cathode: ultraviolet and (some) “neon” light sources.

The mercury-containing lamps are used in a wide variety of applications including: residential, commercial and industrial lighting; outdoor lighting and street lamps; automobile headlamps; and backlighting for liquid crystal displays (LCDs).

The total mercury consumption in the EU-27 for lamps in 2006 was estimated at about 8-11 tonnes (Lassen *et al.*, 2008).

Mercury lamps are also incorporated in electric and electronic devices, such as laptops or TV displays. Even though these lamps are small, they often contain nearly the same quantity of mercury as larger compact fluorescent lamps do. For devices such as laptops or TV displays, there may be six or more lamps in one display. Lassen *et al.* (2008) estimates that consumption in Europe for this kind of devices is in the range of 3.5-4.5 tonnes per year, mostly imported into the EU with the electronics.

Lassen *et al.* (2008) also report information on the use of mercury lamps in Europe, obtained through questionnaires. The data regarding Mediterranean countries are reported here:

- Cyprus reported that 7 tonnes of wastes containing mercury were recycled in Belgium in 2006;
- France reported that 47 million lamps (corresponding to 2-3 tonnes of mercury) were processed in 2004 by sorting glass, metals, mercury and powders. According to UNEP (2008b), France uses between 0.4 and 0.65 tonnes of mercury per year for light sources;
- Slovenia reported that 152 tonnes mercury were recovered in 2006 (even though the authors assume this is the weight of the recycled lamps).

4.2.6 Batteries

The use of mercury in various types of batteries has been extensive and it has been among the largest product uses of mercury, mainly in primary (that is non-rechargeable) batteries. Mercury is used in high concentrations (about 30-32% w/w) in mercury oxide batteries (sometimes called zinc-mercury batteries), which have probably mainly been sold as button shape cells, but also in larger cylindrical and other shapes (UNEP, 2010).

The use of mercury in batteries is decreasing because many countries have implemented policies against it. The EU Directive 2006/66/EC bans batteries and accumulators that contain more than 0.0005% of mercury in terms of their weight. Button cells can contain mercury up to 2% by weight. Batteries for “medical equipment” and “emergency and alarm systems” are exempted from the ban.

According to Lassen *et al.* (2008), around 4-5 tonnes of mercury are contained in button cell batteries marketed every year in the EU27+2, plus 600 kg in other primary batteries. Considering batteries imported from outside Europe and those not respecting the 0.0005% limit, the total amount could be around 5-7 tonnes. Another kind of batteries are the larger mercuric oxide primary batteries (also known as mercury batteries), whose mercury content is very high. Lassen *et al.* (2008) estimates a total consumption of mercury for batteries between 2 and 17 tonnes per year and a total accumulation in society of some 90-110 tonnes. UNEP, 2008b estimates the demand of mercury for batteries in France at 1 tonne per year and in Slovenia at less than 0.001 tonnes per year. Syria and Morocco also reported, respectively, a mercury consumption of 283 kg/year and 0.3 tonnes by the production of batteries[28].

Part of the mercury contained in the batteries is recycled. The members of the association European Battery Recycling Association (EBRA), which represents most European recycling companies, collected almost 31 thousand tonnes of batteries, out of which 9 thousand in France, 688 in Spain and 193 in Greece[29]. According to Schutz, (2007), cited by Lassen *et al.* (2008), only 15% of the volume of batteries sold in Europe is recycled. In 2006, 70 tonnes of button cells were recycled by EBRA, out of which 22 tonnes in France and 6 in Spain.

4.2.7 Vinyl chloride monomer production

The acetylene process used to manufacture vinyl chloride monomer (VCM) uses mercuric chloride on carbon pellets as a catalyst. Although its use has increased in China (AMAP/UNEP, 2008), this technology has not widely been used in Europe, and apparently there is no plant in operation in the EU (EC, 2002), nor in the Mediterranean region.

4.2.8 Small-scale gold mining

Artisanal and small-scale gold mining (ASGM) remains the largest global user of mercury. It reportedly continues to increase with the upward trend in the price of gold and is the largest source of environmental release from intentional use of mercury (AMAP/UNEP, 2008). This type of mining relies on rudimentary methods and technologies and is typically performed by miners with little or no economic capital who operate in the informal economic sector, often illegally and with little organization. However, in the Mediterranean region this activity has not been reported to be in place.

4.2.9 Mercury chemicals

Mercury has been also used in several particular applications such as biocides and pesticides (paper industry, paints), laboratory chemicals (reagents, catalysts, etc.), pharmaceuticals (preservatives in vaccines, eye drops, some herbal medicines and other products), cosmetics and related products (skin lightening creams, soaps, and as preservatives in some eye cosmetics). However, some specific uses are already restricted or prohibited in the EU and some Mediterranean countries, e.g.:

- The prevention of fouling by micro-organisms, plants or animals, the preservation of wood; the impregnation of heavy-duty industrial textiles and the treatment of industrial waters are banned in the EU (Directive 89/677/EEC) and also in other countries such as Algeria and Croatia.
- Pesticides containing mercury are also prohibited in some Mediterranean countries such as Egypt and EU Members (Plant Protection Products Directive 79/117/ECC and Regulation (EC) No 1107/2009).

[28] Information obtained through the questionnaire handed out for this diagnosis.
[29] It should be noted that not all batteries collected are recycled: a part of the total amount of collected batteries is landfilled or otherwise disposed.

- The marketing of mercury-containing soaps in the EU is regulated by Directive 76/768 (with amendments) while the export of the soaps is prohibited by Regulation (EC) n° 689/2008 concerning the export and import of dangerous chemicals.
- Furthermore, after 13 May 2010 at latest, no biocidal products with mercury compounds are allowed in any Member State according to Directive 98/8/EC.

According to Lassen *et al.,* (2008), despite regulations, main applications of mercury chemicals identified in the EU are as follows:

1. Use as a chemical intermediate or catalyst: e.g. mercury (II) chloride is commonly used as an intermediate for the production of other mercury compounds like thimerosal and phenylmercuric chloride.
2. Used as catalyst in the production of polyurethanes: mercury organic compounds remain a very important catalyst in the production of polyurethane elastomers that are cast (poured or injected into a mould) into sometimes complex shapes, or sprayed onto a surface as insulation, corrosion protection, etc.
3. Uses in laboratories and the pharmaceutical industry: mercury II sulphate is used in COD analysis and Kjeldahl method for detection of nitrogen in organic compounds; Nessler's reagent for determination of Pseudomonas aeruginosa contains potassium tetraiodomercurate; mercury (II) chloride is used in the determination of the enzyme ALAD and PKU test.
4. Preservative in vaccines and eye/nasal products: thimerosal (or thiomersal, 2-mercapto-benzoic acid).
5. Preservatives and fungicides in water-based paint: mercury compounds were used to extend shelf-life by controlling bacterial fermentation in the can (in-can preservatives) and to retard fungus attacks upon painted surfaces under damp conditions (fungicides).
6. Disinfectants of medical equipment and process equipment and for veterinary uses (mercurochrome, thimerosal, mercury iodide, mercury oxycyanide, and mercury-II-chloride).
7. Pigments for artwork and restoration (vermillion or cinnabar -mercuric sulphide, HgS-).
8. Other possible applications not evidenced: skin lightening soaps, mining, fireworks, mercury fulminate detonator, pesticides, tanning and preparation of felt.

The estimated mercury consumed in such applications in the EU is shown in

Table 20.

Table 20. Mercury consumption with chemicals in EU in 2007.

Application	Estimated Hg content of compounds consumed in EU Tonnes Hg/year	Comments
Chemical intermediate or catalyst (except PU)	10 -20	
PU catalyst	20 -35	Indicates the amount of mercury in PU in products used within the EU. The use for production of PU elastomers in the EU is estimated to be lower
Laboratories & pharmaceutical industry	3 -10	not including use of Hg compounds as a chemical intermediate
Preservatives in vaccines and eyes/nasal products	0.1 -0.5	
Preservatives in paints	4 -10	
Disinfectant	1 -2	
Pigments	<1	
Other applications	<1	

Despite the difficulties to estimate the amount of mercury consumption in these categories in the Mediterranean region, the following data are available for Mediterranean countries:

- Israel indicated, in its answer to the questionnaire handed out in the context of the present diagnosis, 2,001 tonnes of mercury imports in 2008 and the same amount for 2009 for pesticides and biocides industry.
- Slovenia declared in the questionnaire that 5.05 tonnes of mercury were used for the production of mercury chloride preparations in the country in 2006. UNEP (2008b) estimates the demand for mercury for vaccines in Slovenia at less than 0.001 tonnes per year, and that for chemicals for laboratory use at 0.7 tonnes per year.
- Syria reported a demand of 325 kg/year of mercury for pharmaceuticals uses (e.g. disinfectants, vaccine preservatives)[30].
- Morocco reported that many reagents containing mercury are used in its laboratories, which are all imported. In 2008, 2 kg of mercury oxides, 135.50 kg of mercury and lead sulphates and 13 kg of copper mercury nitrate were imported for Morocco laboratories[31].
- In Italy, approximately 3.5 tonnes mercury were used for the production of paints (Lassen *et al.*, 2008).
- COD analysis represented in France the major laboratory chemical use and it is reported that about 900 kg. of mercury were annually used for this analysis method only (Lassen *et al.,* 2008).

[30] Ad Hoc Open-ended Working Group on Mercury. Request for InformationA of Mercury in Products and Processes, Quantities Used, Demand, Level of Substitution, Technology Change-over, Available Substitutes.
[31] Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) to be held in Stockholm, Sweden, from June 7 to 11 2010.

4.2.10 Other applications

Mercury is also used for a number of other miscellaneous applications. Mercury is known to be used in the following new products marketed in the EU (Lassen et al., 2008):

1. Mercury metal for porosimetry and pycnometry are measurement methods for characterization of pore structure of materials that take advantage of the property that mercury at atmospheric pressure will not enter pores smaller than 15 microns in diameter
2. Calibration of mercury monitors: environmental mercury monitors are used to monitor very low concentrations of mercury in ambient air.
3. Mercury triple point cells for thermometer calibration.
4. Mercury-cadmium-telluride (MCT) in infrared light detectors: MTC is a ternary alloy semiconductor that is used as the detector material in high-performance infrared detectors.
5. Conductors in seam welding machines: the transfer of electrical current from a shaft to a rotating part takes place using mercury.
6. Mercury slip rings: a mercury slip ring is a unipolar rotary mercury ring with a hole inside.
7. Mercury in plasma display panels: the mercury is used to retard the cathode sputter onto the anode electrodes.
8. Fire gilding: mercury may be applied when antique work is to be repaired or an exact replica made.
9. Mercury pendulums: many old clocks were fitted with mercury compensated pendulums. Mercury is used in very limited amounts for repair of old clocks.
10. Elbow shock absorber wristband: it is a support that incorporates encapsulated mercury to absorb vibrations.
11. Folklore medicine;
12. Ethnic/cultural/ritualistic uses and.

Mercury is used for maintaining of products already in circulation in society and the applications may add significantly to the pool of mercury in accumulated in society.

13. Lighthouses: lens floating in mercury which minimises friction.
14. Mercury in large bearings of rotating mechanical part in, for example, older wastewater treatment plants.

For the following applications, although there is no evidence of their marketing in the EU, it cannot be ruled out that they may be present both in the EU (Lassen et al., 2008) and the Mediterranean region:

15. Esophageal dilators and gastrointestinal tubes with Hg;
16. Recoil suppressor for rifles and shotguns;
17. Vacuum pumps with mercury;

18. Tire balancers;

According to Lassen et al., 2008, there are two applications in which mercury is used worldwide, and it is expected that mercury will be used for this application in the future in the EU and the Mediterranean region:

19. Liquid mirror telescopes;
20. Target in spallation neutron sources;

Lassen *et al.* (2008) estimate a use between 15 and 114 tonnes per year for miscellaneous applications. From these, the main mercury uses are in laboratories for porosimetry and pycnometry and for hanging drop electrodes. The estimated mercury consumptions in 2008 in the EU were 10-100 tonnes and 0.1-0.5 tonnes, respectively. However, later information included in UNEP (2010) indicated that the actual consumption for porosimetry and pycnometry is most likely in the lower end, and 20 tonnes will be used as best estimate.

No data are available for mercury consumption in such miscellaneous applications for non-European Mediterranean countries.

4.2.11 Summary of the use of mercury in Mediterranean countries

Table 21 shows the accessible data on mercury use in the Mediterranean countries. It can be noted that available data are notably limited, meaning that an additional effort is necessary to build up a coherent and exhaustive data-base on mercury use in Mediterranean countries.

Table 21 . Mercury use in Mediterranean countries (tonnes).

Country	Chlor-alkali production	Dental amalgams	Batteries	Measuring and control devices	Electric and electronic devices	Mercury chemicals	Other applications
Algeria	~1.5 (**)						
France	882 (*)	17.5 (++)	1 (***)	0.3 for non-fever thermometers 1.5 for barometers (++)		0.9 for for Chemical Oxygen Demand (COD) analyses (++)	
Greece	48 (*)						
Israel	4.5 (**)	1.6 (**)					2 for pesticides and biocides industry (**)
Italy	320 (*)						3.5 for producing paints (++)
Morocco		0.75 (**)	0.3 (**)	0.1 (**)			0.002 of mercury oxides, 0.001 of mercury and lead sulphates and 0.001 of copper for laboratories (+)
Slovenia		0.007 (**)	<0.001 (***)		0.002 (***)	< 0.001 for vaccines - 0.7 for laboratory chemicals (***)	5.05 for production of mercury chloride, (**)
Spain	888 (*)						
Syria	10 (**) (***)	4.370 (**)	0.283 (**)	60,000 units of medical thermometers 15,000 units of sphygmomanometers (+++)			0.3 for pharmaceutical uses (+++)

(*) Source: EuroChlor, 2008
(**) Source: questionnaires handed out for this diagnosis
(***)Source: UNEP, 2008b
(+) Source: Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1).
(++) Lassen et al., 2008
(+++) Ad Hoc Open-ended Working Group on Mercury. Request for InformationA of Mercury in Products and Processes, Quantities Used, Demand, Level of Substitution, Technology Change-over, Available Substitutes.

4.3 Storage of mercury and mercury containing wastes

4.3.1 Stocks and inventories in the Mediterranean region

As regards stocks and inventories, the most important commercially available mercury inventory of a single organisation is in Almadén, Spain (UNEP, 2008). Even though in this area mining was ceased in 2003 and processing in 2004, the company[32] still sells mercury accumulated from previous mining, purchased from Kyrgyzstan, or obtained from decommissioned chlor-alkali facilities (UNEP, 2008). In fact, Euro Chlor, the European chlor- alkali industry association, signed an agreement with Almadén mining company, which establishes that the latter will buy the mercury from European plants shifting towards mercury-free processes, and sell it in the market (Basel Convention, 2010)[33]. The annual amounts of mercury collected by MAYASA due to the agreement with Eurochlor are shown in Figure 8**.** The total estimated amount of mercury collected until Sep. 2006 was approximately 1,500 tones.

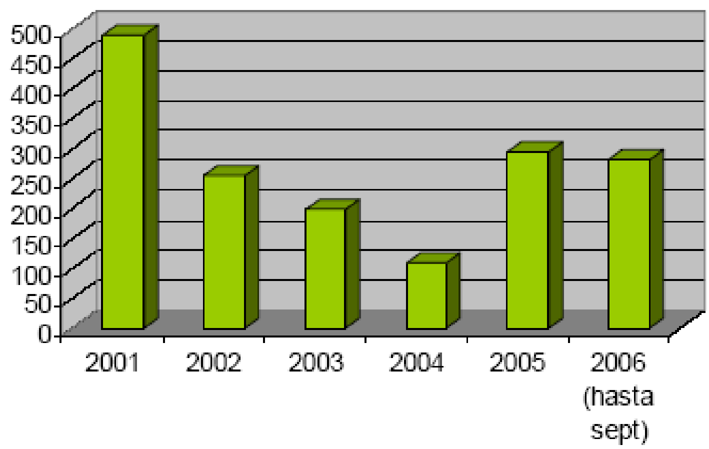


Figure 8. Mercury collected by MAYASA from Eurochlor agreement (RAC/CP, 2007).

These data agree with Maxson (2006), which estimated that in Almadén there were 1,000-2,000 tonnes of mercury stocked in 2005. Furthermore, Lassen *et al.* (2008) reported that in Almadén there was in 2007 a stock of cinnabar ore above-ground containing about 1,500-2,000 tonnes of mercury, plus some 3,000 tonnes or more in mercury storage tanks with previously refined mercury and mercury sent from decommissioned chlor-alkali facilities.

Apart from Almadén, there are probably other stocks, even thought the overall quantity is difficult to quantify (Maxson, 2006). UNEP (2008) notes that this difficulty is probably due to increased speculation of brokers, which is stimulated by the volatility of mercury prices. Information can be found about the reserves of metallic mercury in Turkey (3,920 tonnes in 2010, the 85% of which is located in the Aegean Region)[34] and old mining waste

[32] http://www.mayasa.es.
[33] The future ban on European exports begining in 2011 (Regulation EC 1102/2008) will cease this trade.
[34] Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) to be held in Stockholm, Sweden, from June 7 to 11 2010.

deposits (4,000 tonnes) around the Idrija area in Slovenia. According to Lassen *et al.* (2008) there may be approximately 150-250 tonnes of mercury in the inventory of other metals traders, dealers and recyclers, plus 160-200 tonnes on shelves of laboratories, clinics and schools, and 85-115 tonnes in dental clinics.

The largest quantified stock of mercury, a part from mining sites, is located in chlor- alkali facilities. According to data provided by Eurochlor, 2,138 tonnes of metallic mercury are stored in European Mediterranean chlor-alkali facilities, out of which 2,055 are used in cells and 83 are stored in the facilities (see section 4.2.1).

The available information on mercury stocks in Mediterranean countries is summarized in Table 22.

Table 22 . Mercury stocks in Mediterranean countries.

Country	Mercury in chlor-alkali facilities (tonnes)	Other stocks (tonnes)	Comments
Algeria	1.37-1.54	1,000,000(*)	This figure refers to mercury slag ore in Azzaba mining site, which has the largest hazardous waste inventory of the country. About 600,000 m3 are stored in the plant in conditions that do not comply with environmental standards and cause infiltration of mercury in soil and groundwater contamination. The complex also stores in stacks the sludge contained in the dykes and used vases.
Egypt	0	n.a. (*)	Data are not currently available.
France	882 (-)	n.a.	
Greece	48	n.a.	
Israel	4.5 (*)	n.a.	
Italy	320 (-)	n.a.	
Slovenia	0	4,000 (*)	Old mining waste deposits around the Idrija area.
Spain	888 (-)	5,000 (***)	
Syria	10	n.a.	
Tunisia	Few tonnes (*)	n.a.	The stock is in the old electrolysis unit of the chlor-alkali farm that was abandoned in 1998
Turkey	n.a.	3,920 (**)	Various mercury stocks, 85% of the mercury is located in the Aegean Region

(-) Source: EuroChlor, 2010.
(*) Source: questionnaires handed out for this diagnosis.
(++) Source: OSPAR Commission, 2009a.
(**) Source: Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) to be held in Stockholm, Sweden, from June 7 to 11 2010.
(***) Lassen *et al*., 2008

4.3.2 Safe storage in the Mediterranean region

As the reduction in global mercury use will increase the amount of mercury to be stored, mercury safe storage is considered, at international level, a major challenge in the short, medium and long terms.

In the framework of the EU Mercury Strategy (see section 2.2.2), the safe storage of surplus mercury with the aim to prevent it from re-entering the market is regulated by Regulation EC (N°) 1102/2008. In addition, the European Commission has recently developed a report on the requirements for facilities and acceptance criteria for the disposal of metallic mercury (Dg Environment by BiPRO GmbH, 2010).

The study includes the possible options for a safe storage of surplus mercury both for permanent and temporary storage. However, based on an economic and environmental assessment the following options are recommended:

1. Pre-treatment (Sulphur stabilisation) of metallic mercury and subsequent permanent storage in salt mines (highest level of environmental protection, acceptable costs).
2. Pre-treatment (Sulphur stabilisation) of metallic mercury and subsequent permanent storage in a hard rock underground formation (high level of environmental protection, acceptable costs).
3. Permanent Storage of metallic mercury in salt mines (high level of environmental protection, most cost effective option).

The report states that due to the fact that no permanent solution is available at present by March 2011, when the export ban will enter into force, temporary storage solutions are required to bridge the gap until final solutions are available.

In the Mediterranean framework, Almadén mine remains a possible candidate for permanent storage of European surplus mercury. The European Parliament resolution on the Community strategy concerning mercury (2005/2050(INI)) of 14th March 2006 considers the possibility of using Almadén for the safe storage of the existing metallic mercury stocks or metallic mercury sub-produced by industry all over Europe, thus making use of the infrastructures, local manpower and technological expertise existing there.

4.4 Import, export and trade of mercury in the Mediterranean countries

Mercury prices are very volatile (Figure 9). During the Nineties, the prices reached the lowest levels of the century (adjusting for inflation), ranging between 3,550 $/tonne in 1991 and 4,500 $/tonne in 2000 (U.S. Geological Survey data-base). Taking inflation into account, in that decade the price was less than 5% of its peak price in the Sixties (UNEP, 2006). The sharp reduction in the mercury price in this period was due both to a high world supply and to a reduction in demand, the latter caused by an increasing regulatory pressure (UNEP, 2006).

However, mercury price increased notably afterwards, reaching 10,200 $/tonne in 2004, 16,100 $/tonne in 2005 and 19,400 $/tonne in 2006. The main reason for such increase was the closure of the two most important world suppliers: the Spanish and Algerian mercury mines.

Due to the increased price, the global yearly mercury supply also increased in the last few years, passing from 1,150 tonnes in 2006 to 1,200 in 2007 and 1,320 in 2008. This small increase in global mercury supply caused a slight reduction of the price, which amounted to 15,400 $/tonne in 2007 and 17,400 $/tonne in 2008.

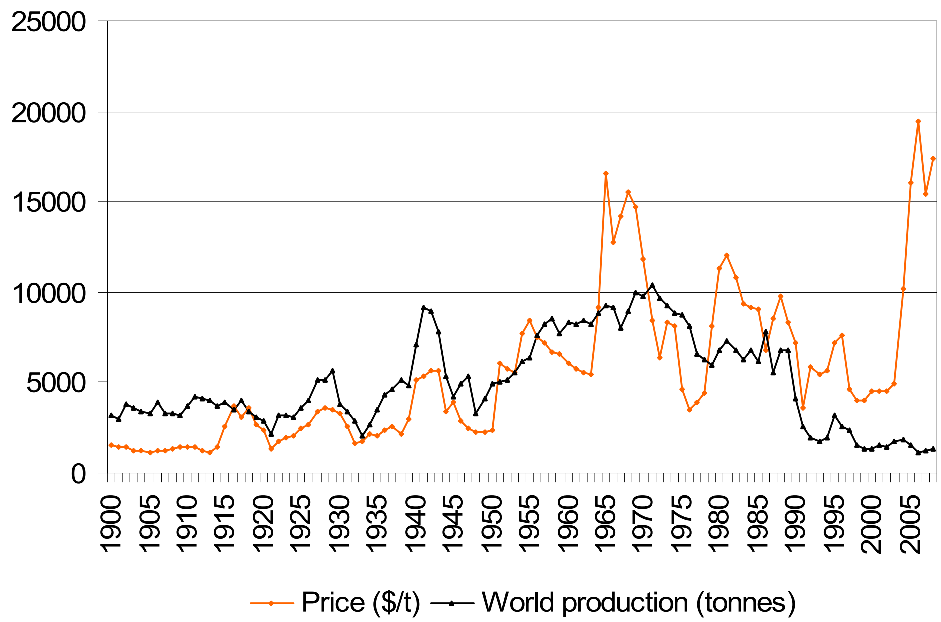


Figure 9. Mercury world production and price. Source: own elaboration after U.S. Geological Survey data-base.

According to Maxson (2006), the market for commodity mercury is composed of a small number of virgin mercury producers, a larger number of secondary mercury producers and a small group of mercury traders and brokers, mainly located in the main mining sites, in the Netherlands, the UK, Germany, the USA, India and Hong Kong.

4.4.1 Import, export and trade of mercury, mercury compounds and goods containing mercury in the Mediterranean countries

As regards trade flows among countries, the most important source of data on trade is the Comtrade data-base, which is run by the United Nations Statistics Division[35]. It includes three systems of classification: the Harmonized System (HS), the Standard International Trade Classification (SITC) and the Broad Economic Categories (BEC).

The only two categories[36] that are explicitly related to mercury and included in the Comtrade data-base of recent years are "mercury"[37] and "Compounds, inorganic/organic, of mercury, excluding amalgams"[38].

Spain was the second most important mercury exporter (10.3% of the global mercury exports in monetary terms between 2007 and 2009), after the Netherlands (17.8%). Spain was also the second most important importer (20.2% of the global market). The importance of Spain in global mercury trade, despite the fact that Spanish mercury mining completely ceased in 2003, is due to the activity of the Almadén mining company, MAYASA. As mentioned in Section 4.3, MAYASA still sells the mercury accumulated from previous mining, purchased from abroad or obtained from decommissioned chlor-alkali facilities (thanks to a contract with Euro Chlor, the European Chlor-alkali industry association).

Table 23 shows the available data about mercury trade in Mediterranean countries in Comtrade data-base.

[35] http://comtrade.un.org.
[36] Another relevant category is "*organo-mercury compounds*", which will not be included in this report because the last available year is 1997.
[37] Code 280540 in HS classification and 52227 in SITC 3 and 4 classification (not included in BEC classification).
[38] Code 285200 in HS classification and 52496 in SITC 3 and 4 classification (not included in BEC classification).

Table 23. Mercury trade in Mediterranean countries (2008).

Country	Imports			Exports			Net imports (kg)
	Total imports (kg)	Main partners (kg)	Average price ($/kg) (*)	Total exports (kg)	Main partners	Average price ($/kg) (*)	
Spain	417,865	• Poland (251,528); • Italy (82,683); • UK (24,179); • Germany (21,166); • Finland (13,110)	14.3	639,207	• Portugal (84,710); • Singapore (80,040); • UK (66,103); • France (55,005); • Peru (47,316); • Iran (47,316); • Italy (45,808)	7.8	-221,342
France	106,295	• Switzerland (75,900); • Germany (18,400)	3.7	3,224	• United Arab Emirates (1,700); • New Zealand (586)	25.3	103,071
Italy	21,754	• Spain (13,898); • China (6,000); • USA (900)	20.7	84,247	• Spain (54,928); • Brazil (15,000); • UK (6,384); • Belgium (6,185)	10.1	-62,493
Israel	7,124 (**)	Germany	25.7	n.a.	n.a.	10.1	14,113
Egypt	7,535 (***)	• Netherlands (4,020); • Spain (3,515)	14.2	n.a.	n.a.	n.a.	7,535
Turkey	3,069	• Netherlands (2,501); • India (522)	30.6	22,885	India (22,805)	8.5	-19,816
Greece	2,628	Cyprus (2,500)	3.5	n.a.	n.a.	n.a.	2,628
Lebanon	1,395	Spain (1,380)	2.9	25	Sudan (25)	n.a.	1,370
Algeria	326	Germany (300)	20.0	n.a.	n.a.	n.a.	326
Slovenia (****)	57	Germany (48)	81.7	3	Serbia (n.d.)	10.1	54
Malta	25	Netherlands (24)	1,526.9	n.a.	n.a.	n.a.	25
Tunisia	21 (*****)	Italy (14)	128.6	n.a.	n.a.	n.a.	21
Croatia	12	• Netherlands (7); • Czech Republic (4)	155.3	1	Bosnia Herzegovina (1)	118.0	11
Bosnia Herzegovina	12	Croatia (8)	54.2	n.a.	n.a.	n.a.	12
Cyprus	1	Germany (1)	62.0	n.a.	n.a.	n.a.	1

Source: our calculations on the base of the data of Comtrade data-base (SITC Rev.4 and HS2007 classifications)

(*) Unitary prices were calculated by dividing global import and export flows in monetary terms by the corresponding flows measured in kg.

(**) Source: questionnaire handed out for this report

(***) This figure does not corresponds with the answer to the questionnaire handed out for this report, where it was indicated a yearly mercury import of approximately 1000 kg.

(****) Since Slovenia's exports are available only in monetary term in the Comtrade data-base, the physical quantity in kg was obtained by dividing the trade flows in monetary terms by the median of the price of the other Mediterranean countries imports (25.7 $/kg) and exports (10.1 $/kg). Using the median was considered more appropriate than using the average, because of the extreme values of the reported prices of some countries (e.g. Malta's import price).

(*****) Tunisia indicated in the answer to the questionnaire handed out for this report that it imported 1 kg mercury in 2009, and added that mercury imports are strictly controlled and that an almost complete ban was imposed, except for research purposes.

i

Most Mediterranean countries are net mercury importers. The most important net importer is France (103 tonnes in 2008). The only net exporters are Spain (221 tonnes), Italy (62 tonnes) and Turkey (20 tonnes). It should be noted that after 2011 the EU Mediterranean countries will not be allowed to export mercury anymore, because of the EU export ban mentioned in Section 2.22.

The most important mercury importers, among Mediterranean countries, are Spain (418 tonnes) and France (106 tonnes), followed by Italy (21 tonnes). The most important exporters after Spain (639 tonnes) are Italy (84 tonnes) and Turkey (23 tonnes).

As regards the category “compounds, inorganic or organic, of mercury, excluding amalgams”, between 2007 and 2009 France was the most important world importer (24% of global imports), followed by the UK (9%), Belgium (9%) and Spain (6%). As regards exports, the most important countries are the UK (24% of the world market), the USA (19%) and Japan (14%).

Table 24 shows the available data about trade of mercury compounds in Mediterranean countries in the Comtrade data-base.

Table 24. Trade of compounds, inorganic or organic, of mercury, excluding amalgams, in Mediterranean countries (2008).

Country	Imports			Exports			Net imports (kg)
	Total imports (kg)	Main partners (kg)	Average price ($/kg) (*)	Total exports (kg)	Main partners	Average price ($/kg) (*)	
Spain	6,257,837	• UK(3,689,171); • Germany (2,474,188)	7.8	76,879	• UK (20.000); • France (16,753); • Pakistan (10,250)	14.0	6,180,958
France	4,668,356	• Germany (2,077,800); • Belgium (1,142,300)	4.2	n.a.	n.a.	n.a.	4,668,356
Italy	706,926	• Spain (450,354); • France (119,148); • Germany (60,351); • Belgium (38,474)	2.6	17,873	• Spain (6,402); • Greece (3,561); • Egypt (2,255); • Lebanon (1,000)	10.1	689,053
Greece	139,257	Bulgaria (133,410)	1.9	n.a.	n.a.	n.a.	139,257
Slovenia	36,794	• Germany (30,852); • France (4,943)	12.4	263	• Serbia (152); • Croatia (108)	11.6	36,531
Algeria	17,151	• Germany (10,095; • China (6,101)	3.0	n.a.	n.a.	n.a.	17,151
Malta	5,173	Italy (5,163)	2.1	n.a.	n.a.	n.a.	5,173
Israel (**)	*2,984*	Germany, USA	12.4	*198*	India	10.1	2,786
Turkey	1,076	• India (550); • Germany (266); • Spain (255)	123.5	2,293	Cyprus (1,790)	2.7	-1,217
Bosnia	789	Slovenia (784)	2.4	n.a.	n.a.	n.a.	789
Tunisia	218	France (188)	42.1	n.a.	n.a.	n.a.	218
Cyprus	51	• Germany (37); • UK (14)	31.1	n.a.	n.a.	n.a.	51
Lebanon	16	Germany (13)	111.3	n.a.	n.a.	n.a.	16
Egypt	7	USA (7)	366.9	n.a.	n.a.	n.a.	7
Albania	6	Belgium (6)	42.7	n.a.	n.a.	n.a.	6
Croatia	4	Germany (4)	219.3	23	Slovenia (23)	9.9	-19

Source: our calculations on the base of the data of Comtrade data-base (SITC Rev.4 and HS 2007 classifications)

(*) Unitary prices were calculated by dividing global import and export flows in monetary terms by the corresponding flows measured in kg.

(**) Since Israel's imports and exports are available only in monetary term in the Comtrade data-base, the physical quantity in kg was obtained by dividing the trade flows in monetary terms by the median of the price of the other Mediterranean countries imports (12.4 $/kg) and exports (10.1 $/kg). Using the median was considered more appropriate than using the average, because of the extreme values of the reported prices of some countries (e.g. Croatia's import price).

Most Mediterranean countries are net importers of mercury compounds. The most important net importer is Spain (6,181 tonnes of net imports in 2008), followed by France (4,668 tonnes) and Italy (689 tonnes).

The most important importers are Spain (6,258 tonnes), France (4,668 tonnes) and Italy (707 tonnes). Only some countries (Spain, Italy, Slovenia, Israel, Turkey and Croatia) export mercury compounds. The most important exporters are Spain (77 tonnes), Italy (18 tonnes) and Turkey (2 tonnes), and the only net exporters are Turkey and Croatia.

To analyse the trade of mercury compounds will be crucial after the EU mercury export ban comes into force in 2011. According to Maxson (2006), trading in mercury compounds could become a way to circumvent the ban. In fact, mercury can be easily converted into mercury compounds, exported, and then reconverted to elemental mercury outside EU, where it could develop a black market for non-controlled activities such as artisanal and small-scale gold mining. However, in 2010 the Commission will possibly extend the export ban to other mercury compounds, mixtures with lower mercury content, as well as the mercury containing products (see Section 2.2.2). In addition, in 2010 the European Commission will also consider the possibility of also banning mercury imports into the EU.

It should be observed that Comtrade data are not entirely reliable. In fact, in many cases data about exports from a country to another do not correspond to data on imports to the latter from the former. For example, Italian exports to Spain in 2008 are reported to be 54,928 kg, but Spanish mercury imports from Italy appear to be 82,683 kg. In any case, UNEP (2006) suggests, in case of discrepancies, to use the highest value, because it is highly unlikely that a country reports a transaction that has not taken place.

In addition, the average price of mercury and mercury compounds for some countries seems to be too unrealistically high, e.g. mercury import price for Malta.

It is also important to observe that Comtrade data do not indicate whether the source of a mercury trade flow is the first origin of the material or whether the country is the final destination (Maxson, 2006). Also, there is no indication of mercury end use.

Data on mercury are also available for European countries in the Comext data-base[39]. Comext is prepared by Eurostat, the statistical division of the European Union[40], and includes more categories of mercury containing goods than Comtrade. It uses the HS, SITC, BEC classification systems, such as the Comtrade data-base, and also the Combined Nomenclature (CN) classification system[41], which is more detailed.

Table 25 show the net imports of mercury containing goods in Mediterranean countries[42].

Table 25 Net imports of goods containing mercury in the European Mediterranean countries (100 kg), 2009

[39] The total amount of import and export of each country was calculated by summing the EU-27 intra and extra trade.
[40] http://epp.eurostat.ec.europa.eu/newxtweb.
[41] The CN classification corresponds to the HS system, plus a further breakdown at 8-digit level, the SITC, the BEC, the Classification of Products by Activity (CPA) and the Standard Goods Classification for Transport Statistics/Revised (NST/R). We use this classification system because it is more complete and include the HC and the SITC ones.
[42] The total amount of import and export of each country was calculated by summing the EU-27 intra and extra trade.

	Cyprus	France	Greece	Italy	Malta	Slovenia	Spain
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB[43] VALUE PER FLASK OF <= € 224	-	-	-	1	-	-	-273
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	2	2,213	6	-696	-	-	1,185
MERCURY OXIDES	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	10	34,973	989	14,205	-	181	6,616
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	-	2,816	182	106	1	-	758
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	1	-	-	-	-	-16
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	2	19	-	843	-	-18	112
MERCURY VAPOUR LAMPS	1	996	454	281	-	-34	1,276

Source: our elaboration after Comext data base (CN8 classification)

It can be observed that Spain in 2009 was a net exporter of mercury in flasks (27 tonnes) whereas Italy was a net importer (0.1 tonnes). No data are available for the other European Mediterranean countries.

As regards mercury (excluding mercury in flasks), in 2009 the most important net importer among European Mediterranean countries was France (221 tonnes) followed by Spain (118). On the contrary, Italy was the only net exporter (70 tonnes).

Data on mercury oxides are not available for 2009. Data on mercury compounds for 2009 are available for all Mediterranean countries (except Malta) which were all net importers. The largest net importers were France (3,497 tonnes), Italy (1,420) and Spain (661).

All Mediterranean countries were net importers of mercury oxide cells and batteries in the form of cylindrical cells. France, Spain, Greece and Italy were the major net importers (respectively 282, 76, 18 and 11 tonnes). There are no data available for Cyprus and Slovenia.

Only France and Spain declared trade in mercury oxide cells and batteries in the form of button cells in 2009, Spain was net exporter (2 tonnes) and France net importer (0.1 tonnes).

[43] FOB means Free On Board and indicates that the supplier pays the shipping costs from the manufacture to the destination.

As regards mercuric oxide cells and batteries (excl. spent, and in the form of cylindrical or button cells), the only net exporter was Slovenia (2 tonnes). On the contrary, Italy, Spain, France and Cyprus were net importers (respectively, 84, 11, 2 and 0.2 tonnes).

Finally, the largest net importers of mercury lamps were Spain (128 tonnes), followed by France (100), Greece (45) and Italy (28), whereas Slovenia was the only net exporter (3 tonnes).

Table 26, Table 27, Table 28, Table 29, Table 30, Table 31 and Table 32 show the data on trade of mercury containing goods in Mediterranean countries that are available in COMEXT data-base for the years 2006, 2007, 2008 and 2009.

Table 26. Trade of goods containing mercury in the European Mediterranean countries (100 kg), Cyprus

	2006			2007			2008			2009		
	Exports	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	-	-	-	-	-	-	-	-	-	-	-	-
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	-	-	-	-	1	1	-	1	1	-	2	2
MERCURY OXIDES	-	4	4	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	-	48	48	-	8	8	-	10	10
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	-	-	-	-	2	2	-	-	-	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	-	-	-	-	-	-	1	1	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	-	24	24	-	34	34	-	-	-	-	2	2
MERCURY VAPOUR LAMPS	-	10	10	-	1	1	-	1	1	-	1	1

Source: our elaboration after Comext data base (CN8 classification)

Table 27. Trade of goods containing mercury in the European Mediterranean countries (100 kg), France

	2006			2007			2008			2009		
	Exports	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	2	-	-2	-	-	-	-	-	-	-	-	-
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	270	1,382	1,112	39	2,359	2,320	17	1,023	1,006	6	2,219	2,213
MERCURY OXIDES	-	8	8	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	-	65,424	65,424	-	46,663	46,663	-	34,973	34,973
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	1	231	230	7	894	887	11	2,302	-2,291	8	2,824	2,816
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	-	-	-	3	3	-	2	2	-	1	1
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	15	537	522	1	216	215	2	1	-1	6	25	19
MERCURY VAPOUR LAMPS	42	108	66	22	163	141	3	1,423	1,420	81	1,077	996

Source: our elaboration after Comext data base (CN8 classification)

Table 28. Trade of goods containing mercury in the European Mediterranean countries (100 kg), Greece

	2006			2007			2008			2009		
	Exports	Imports	Net imports	Exports	Imports	Net imports	Exports	Imports	Net imports	Exports	Imports	Net imports
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	-	1	1	-	1	1	-	-	-	-	-	-
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	-	7	7	-	-	-	-	25	25	-	6	6
MERCURY OXIDES	-	-	-	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	5,553	31,561	26,008	-	1,381	1,381	-	989	989
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	27	307	280	-	121	121	-	387	387	-	182	182
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	-	-	-	1	1	-	2	2	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	-	157	157	1	1	0	-	-	-	-	-	-
MERCURY VAPOUR LAMPS	-	321	321	-	958	958	-	397	397	-	454	454

Source: our elaboration after Comext data base (CN8 classification).

Table 29. Trade of goods containing mercury in the European Mediterranean countries (100 kg), Italy.

	2006			2007			2008			2009		
	Exports	Imports	Net imports	Exports	Imports	Net imports	Exports	Imports	Net imports	Exports	Imports	Net imports
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	132	159	27	56	67	11	64	20	-44	2	3	1
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	14	340	326	1,207	63	-1,144	779	195	-584	890	194	-696
MERCURY OXIDES	-	15	15	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	3,870	8,597	4,727	174	8,497	8,323	58	14,263	14,205
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	121	1	-120	292	112	-180	130	53	-77	146	252	106
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	7	3	-4	-	-	-	-	1	1	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	3	1,054	1,051	13	804	791	3	695	692	10	853	843
MERCURY VAPOUR LAMPS	84	85	1	52	161	109	94	602	508	22	303	281

Source: our elaboration after Comext data base (CN8 classification)

Table 30. Trade of goods containing mercury in the European Mediterranean countries (100 kg), Malta.

	2006			2007			2008			2009		
	Exports	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	-	-	-	-	-	-	-	-	-	-	-	-
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	-	-	-	-	-	-	-	-	-	-	-	-
MERCURY OXIDES	-	-	-	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	-	23	23	-	51	51	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	-	-	-	-	5	5	-	-	-	-	1	1
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	-	-	-	-	-	-	-	-	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	-	1	1	-	8	8	-	-	-	-	-	-
MERCURY VAPOUR LAMPS	-	6	6	-	5	5	-	9	9	-	-	-

Source: our elaboration after Comext data base (CN8 classification)

Table 31. Trade of goods containing mercury in the European Mediterranean countries (100 kg), Slovenia.

	2006			2007			2008			2009		
	Exports	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	-	-	-	-	-	-	-	-	-	-	-	-
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	-	-	-	-	-	-	-	-	-	-	-	-
MERCURY OXIDES	-	-	-	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	249	1,571	1,322	3	371	368	-	181	181
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	-	-	-	-	-	-	-	-	-	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	-	-	-	-	-	-	-	-	-	-	-
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	-	-	-	1	-	-1	-	-	-	18	-	-18
MERCURY VAPOUR LAMPS	18	71	53	28	70	42	19	59	40	58	35	-34

Source: our elaboration after Comext data base (CN8 classification).

Table 32. Trade of goods containing mercury in the European Mediterranean countries (100 kg), Spain.

	2006			2007			2008			2009		
	Exports	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**	**Exports**	**Imports**	**Net imports**
MERCURY IN FLASKS OF A NET CONTENT OF 34.5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <= € 224	934	1,757	823	1,320	3,310	1,990	326	2,746	2,420	273	-	-273
MERCURY (EXCL. IN FLASKS OF A NET CONTENT OF 34,5 KG "STANDARD WEIGHT", OF A FOB VALUE PER FLASK OF <=€ 224)	3,778	5,507	1,729	6,481	4,861	-1,620	6,077	1,435	-4,642	3,492	4,677	1,185
MERCURY OXIDES	-	1	1	-	-	-	-	-	-	-	-	-
COMPOUNDS, INORGANIC OR ORGANIC, OF MERCURY (EXCL. AMALGAMS)	-	-	-	325	105,721	105,396	766	62,567	61,801	1,532	8,148	6,616
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF CYLINDRICAL CELLS (EXCL. SPENT)	-	-	-	-	276	276	18	590	572	20	778	758
MERCURIC OXIDE CELLS AND BATTERIES, IN THE FORM OF BUTTON CELLS (EXCL. SPENT)	-	-	-	-	1	1	20	-	-20	19	3	-16
MERCURIC OXIDE CELLS AND BATTERIES (EXCL. SPENT, AND IN THE FORM OF CYLINDRICAL OR BUTTON CELLS)	1	67	66	8	-	-8	-	18	18		112	112
MERCURY VAPOUR LAMPS	1	18	17	5	18	13	57	1,181	1,124	41	1,317	1,276

Source: our elaboration after Comext data base (CN8 classification)

It can be observed that the available data are too few to allow making a comparative analysis among countries for most categories. However, some observations can be made. First of all, France and Spain are the countries that declare the highest volumes of mercury imports (respectively 222 and 468 tonnes in 2009). Spanish exports are the highest among Mediterranean countries (349 tonnes). The third most important country is Italy, which in 2009 imported 19 tonnes and exported 89.

As regards the category "Mercury in flasks of a net content of 34.5 kg "standard weight", of a FOB value per flask of < € 224", Italy and Spain are the only countries to declare imports and exports for all years between 2006 and 2009. Spanish exports are two orders of magnitude higher than Italy's and one order of magnitude higher than Spanish imports (the figure on Spanish trade is not available for 2009).

Most Mediterranean countries declare the trade in the category "compounds, inorganic or organic, of mercury (excl. amalgams)". The most important importers are again France (3,497 tonnes in 2009), Italy (1.420 tonnes) and Spain (815 tonnes), which are all net importers. The main exporters in 2009 were Spain (153 tonnes) and Italy (6 tonnes).

As regards mercuric oxide cells and batteries in the form of cylindrical cells, imports are much higher than exports in France, Greece and Spain. The declared imports are 282, 76 and 18 tonnes, respectively. The country with a higher quantity of exports is Italy (15 tonnes), whereas the other countries declare low or no exports.

There are few data on mercuric oxide cells and batteries in the form of button cells; the most relevant data is that Spain exported 2 tonnes in 2009. As regards other mercuric oxide cells and batteries, the countries that declare a highest level of trade are Italy (with 85 imported tonnes and 1 exported tonne in 2009) and Spain, (11 tonnes of imports and no exports).

Finally, mercury vapour lamps are mostly imported by Spain (132 tonnes in 2009) and France (108 tonnes). Exports are notably lower. The highest exports are declared by France (8 tonnes) and Slovenia (6 tonnes).

Neither the Comtrade nor the Comext data-bases include data on the most important mercury end uses, e.g. dental amalgams, chemical products, fertilizers, equipments. It is also important to note that the data of the two data-bases do not match (although the order of magnitude corresponds).

In addition, the following data were obtained from the questionnaires handed out for this report:

- Croatia indicated the following figures for mercury imports: Mercury (II) Acetate 0,1 kg; Mercury (II) Chloride 12,4 kg;
- Israel dental amalgam industry imported 5,056 tonnes in 2008 and 1,601 in 2009;
- Israel's pesticides and biocides industry imported 2,001 tonnes in 2008 and the same amount in 2009;
- Monaco does not import pure mercury.

In summary, data availability on trade of mercury and mercury containing products are still insufficient and a coordinated effort by the statistical institutions of Mediterranean countries is needed to fill the existing gaps. Reliable statistics are crucial to design effective policies to decrease mercury consumption and reduce the associated pollution.

4.4.2 Import and export of mercury containing wastes in the Mediterranean countries

Table 33 shows data on mercury- containing wastes that are imported to or exported by a Mediterranean country, according to the data collected under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. It can be observed that available data are mainly associated with the Y29 category (Wastes having as constituents: Mercury; mercury compounds). The only Mediterranean countries for which export/import data are available are Croatia, France, Greece, Italy, Slovenia, Spain and Turkey. Germany and France are the countries receiving more mercury containing wastes from the Mediterranean region while Italy and France are the Mediterranean country exporting more mercury containing wastes.

Table 33. Import and export of mercury wastes in 2006 (as reported by Parties as at 18/06/09). Source: Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Data sources, http://www.basel.int/natreporting/datasrces/index.html

Country of export	Waste streams	Characteristics	Amount exported (tonnes)	Country of Transit	Country of destination
Andorra	fluorescents lights and batteries (watch battery and others without Hg)		35.510		Spain
Greece	Fluorescent tubes and other mercury-containing waste	-	14.000	Netherlands	Belgium
Italy	Wastes having as constituents: Mercury; mercury compounds	-	3,287.000	Austria	Germany
Slovenia	Mercury; mercury compounds	-	27.306	Austria	Germany
Spain	Wastes having as constituents: Mercury; mercury compounds	Ecotoxics	17.000	Netherlands, France	Germany
Turkey	Wastes having as constituents: Mercury; mercury compounds		15.150	Spain, France, Belgium	Germany
Luxemburg	Wastes having as constituents: Mercury; mercury compounds		112.000		France
Netherlands	Wastes having as constituents: Mercury; mercury compounds		941.170		France
Netherlands	Wastes having as constituents: Mercury; mercury compounds		67.723		Italy

Country of import	Waste stream	Characteristics	Amount imported (tonnes)	Country of transit	Country of origin
Austria	Mercury bearing wastes	Fluorescent tubes	4.000	Slovenia	Croatia
Belgium	Wastes having as constituents: Mercury; mercury compounds		114.000		France
Belgium	Wastes having as constituents: Mercury; mercury compounds		18.000		Greece
Germany	Wastes having as constituents: Mercury; mercury compounds		469.087		France
Germany	Wastes having as constituents: Mercury; mercury compounds		8.540	France	Spain

Country of export	Waste streams	Characteristics	Amount exported (tonnes)	Country of Transit	Country of destination
Germany	Wastes having as constituents: Mercury; mercury compounds		521.980	Austria, Switzerland	Italy
Germany	Wastes having as constituents: Mercury; mercury compounds		27.306	Austria	Slovenia
Germany	Wastes having as constituents: Mercury; mercury compounds		0.350	Spain, France	Turkey
Netherlands	Wastes having as constituents: Mercury; mercury compounds		0.700		France
Spain	Wastes having as constituents: Mercury; mercury compounds		31.000		Andorra

5. Emissions of mercury from products and processes

This section includes a description of the main sources of mercury emissions, considering intentional and non intentional sources. The main sources of mercury emissions are classified in four types:

(a) Use of materials containing mercury as impurity -non intentional source.
(b) Manufacturing industries - intentional use of mercury.
(c) Use of products containing mercury - intentional use.
(d) Waste treatment from intentional and non intentional use.

Available data of mercury emissions from the sources described along this section for each Mediterranean country are analysed in section 8.1.

5.1 Use of materials containing mercury as impurity - non intentional source

Of the primary anthropogenic sources of mercury, the major sources are those where mercury is emitted mainly as an unintentional 'by-product'. With the exception of mercury mining itself, the mercury emissions arise from mercury that is present as an 'impurity' in the fuel or raw material used. The main 'by-product' emissions are from sectors that involve combustion of coal or oil, production of pig iron and steel, production of non-ferrous metals and cement production (AMAP/UNEP, 2008).

5.1.1 Power and heat production by carbon fossil fuels

Concentrations of mercury in coals and fuel oils vary substantially depending on the type of the fuel and its origin, as well as the affinity of the element for pure coal and mineral matter (EC, 2002a). Mercury is naturally present in coal as a trace contaminant and is released during combustion, entering the atmosphere via the flue gases.

Concentrations of mercury in coal vary between geographical regions and are usually in the range 0.1 to 0.3 ppm but higher levels, up to 1.5 ppm, can be also found (EC, 2002a; UNEP/DTIE, 2010). Lignites are somewhat less contaminated than bituminous and subbituminous coals, but it should be noted that concentrations of mercury within the same mining field can vary by one order of magnitude or more (EC, 2002a).

Although these are not high concentrations of mercury, the amount of coal that is burned and the fact that emissions from coal-burning plants (industrial or residential power plants) go mainly to the atmosphere mean that coal burning is the largest anthropogenic source of unintentional mercury emissions to the atmosphere (AMAP/UNEP, 2008).

Combustion of other fossil fuels for energy or heat production, contribute to mercury emissions but to a significantly smaller extent than coal. There is only limited information on the content of mercury in oil. In general, mercury concentrations in crude oils range from 0.01 to as much as 30.0 ppm (Pacyna, 1987; in EC 2002a). Major revision of current data on the mercury content in crude oil indicates a concentrations range from 0.01 to 0.5 ppm (AMAP/UNEP, 2008). It is expected that mercury concentrations in residual oil are higher than those in distillate oils, which are produced at an earlier stage in an oil refinery. Heavier refinery fractions, including residual oil, contain higher quantities of ash containing mercury (EC, 2002a).

Natural gas may contain small amounts of mercury but the element should be removed from the raw gas during the recovery of liquid constituents, as well as during the removal of hydrogen sulphide. Therefore, it is believed that mercury emissions during the natural gas combustion are insignificant (EC, 2002a).

5.1.2 Cement production

Another major source of ‘by-product’ releases of mercury is associated with cement production. Regardless of the types of processes and kiln type (e.g. wet- and dry-kiln processes), mercury is introduced into the kiln with raw materials (limestone etc), where the mercury content varies from region to region, and with the various fuels that are used to generate the heat required for the clinker manufacturing process, mainly pulverized coal (black coal and lignite) and petcoke, heavy fuel oil and natural gas, but also other, less expensive fuels, such as shredded municipal garbage, chipped rubber, petroleum coke, and waste solvents are widely used and may contribute to mercury emission from cement production (AMAP/UNEP, 2008, UNEP/DTIE, 2010).

The main output of mercury in the clinker manufacturing process is expected to occur in the kiln where mercury leaves the kiln with the dust and exhaust gas. As a volatile heavy metal, mercury cannot be effectively controlled by removing the dust from kiln exhaust gases. In fact, part of the volatile heavy metals always remains volatile, i.e. they are not absorbed onto the surface of the dust particles. The drying process is expected to produce low mercury emissions to air since the drying temperature is usually well below the boiling point of mercury. This however might not be the case for every dryer since some are operated at high temperatures leading to mercury being volatilized to a higher extent (UNEP/DTIE, 2010).

Mercury that is not emitted to air or captured in emission control equipment can remain in the cement product. According to the UNEP toolkit (2010) the content is expected to be between 0.01 –0.1 g mercury per ton of cement produced. (Figure 10).

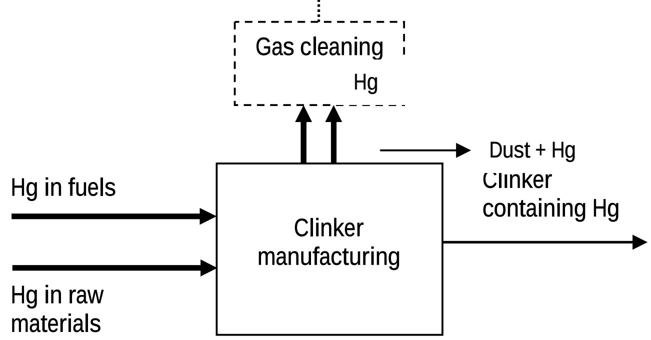


Figure 10. Mercury flows in the clinker manufacturing process (own elaboration based on UNEP/DTIE, 2010).

5.1.3 Miner and metal industry

Mining and industrial processing of ores, in particular in primary production of iron and steel and non-ferrous metal production (especially copper, lead and zinc smelting), release mercury as a result of both fuel combustion and mercury present as impurities in ores, and through accelerating the exposure of rock to natural weathering processes. Metal production sources of mercury also include mining and production of mercury itself (a relatively minor source) and production of gold, where mercury is both present in ores and used in some industrial processes to extract fold from lode deposits (AMAP/UNEP, 2008).

The non-ferrous metals are produced from mined ores which are treated in several process steps to extract the final product. Mercury emissions from non-ferrous metal production depend mainly on the content of mercury in the non-ferrous metal ores used and the type of industrial technology, as well as the control technology employed in the production of non-ferrous metals. Mercury occurs as an impurity in many sulphide ores because it can substitute the elements zinc, copper, cadmium, bismuth, lead, and arsenic. In some metal ores it also occurs as elemental mercury or as an alloy with other metals (amalgams). In some of these deposits mercury contents were high enough to allow an aimed production of mercury as a by-product. Mercury is commonly found associated with gold deposits although the amount of mercury in gold ore can vary widely, from less than 0.1 mg/kg to over 100 mg/kg (UNEP/DTIE, 2010).

The industrial technology employed will, to a large extent, determine the fate of the mercury contained in the ore. If high temperature processes (i.e. roasting and sintering) are used in the initial treatment of the ore, the mercury will be released to air whereas if electrolytic processes are employed, the mercury will remain in the liquid phase.

In the high temperature process, during the roasting and sintering processes, most of the mercury in the concentrate is expected to be evaporated from the oxidation. The evaporated mercury follows the gas stream which can be cleaned by particle filters (cyclones) and dry and wet electrostatic precipitators (ESPs), or scrubbers, resulting in either dry solid wastes or sludges containing mercury (UNEP toolkit, 2010). Remaining mercury from roasting or sintering is expected to follow the residue to recycling or deposition.

The leaching process as a part of the electrolytic process, results in a mercury containing liquid leach product and a solid residue. Parts of remaining mercury may follow precipitates to further processing from the purification process. No data has been identified on mercury emissions from the electrolysis step (UNEP Toolkit, 2010).

The smelting process can include secondary materials which in principle could represent a source of mercury. Mercury in a smelter feed will be volatized and enter the gas stream. Mercury emissions from fuels used in heating processes are regarded to be less significant (UNEP/DTIE, 2010).

5.1.4 Pulp and paper production

In the pulp and paper industry, wood pulp is produced from raw wood via chemical or mechanical means or a combination of both. The source of mercury input is trace levels of mercury in the wood raw material, in fuels used for energy production, and - most likely - in the chemicals applied in the processes (NaOH, chloride, and possibly other) (UNEP, 2010).

Atmospheric emissions from combustion processes, involving fossil fuels, bark and other wood wastes, and carbon containing process liquids (for chemicals recycling and energy production), disposal of solid wastes and aqueous releases from the processes are among the output pathways of mercury from pulp- and paper manufacture (UNEP, 2010).

If the mercury is not purged from the process in the wastewater or as dregs, it can accumulate in the chemical recovery area and subsequently be emitted from the chemical recovery combustion sources. The amount of mercury emitted may depend on how tightly closed the pulping process is (such as the degree to which process waters are recycled and reused) (UNEP, 2010).

5.2 Manufacturing industries- intentional use of mercury

5.2.1 Mercury mining

Mercury mining is known to have caused extensive mercury releases to terrestrial, atmospheric and aquatic environments, with both local and regional pollution as a consequence. In the Mediterranean region, an important mercury mining area, there are several examples of polluted sites which will be described in the hot spots section of this report.

Mercury ores that are mined generally contain about 1% mercury, although the strata mined in Spain typically contain up to 12-14% mercury (UNEP, 2002; in UNEP, 2005). Mercury balances have been made for one of the large mercury extraction facilities in the world in Idrija, Slovenia, which was closed down in 1995. For the total period of 1961-1995, 9,777 metric tons of mercury were extracted from 4.2 million metric tons of ore. For the same period, an estimated amount of 243 metric tons of mercury was lost to the environment, of which, 168 metric tons were deposited in landfills as smelting residue, 60 tons were emitted to the atmosphere with flue gas, and 15 tons were released to the Idrijca river with condensation water (Kotnik et al., 2004). In Almaden (Spain), the world largest mercury mine, Ferrara et al. (1998) estimated a total mercury flux into the atmosphere in the rage from 600 to 1200 g h-1 (up to 10 t per year).

Mercury extracted from mining is still of similar magnitude as all current anthropogenic Hg emissions to the atmosphere, mined Hg may account for more than one third of these emissions (Hylander and Meili, 2003). Also before use, mercury is emitted from Hg mines locally during the mining and refining processes and from mining waste. Global direct emissions to the atmosphere amount to 10–30 t per year currently (up to 10 at Almadén alone), and probably exceed 10 000 t historically. Termination of Hg mining reduces associated local emissions to the atmosphere and biosphere (Hylander and Meili, 2003).

5.2.2 Secondary production of mercury

Mercury can also be extracted from the mining and processing of other metal ores, such as zinc, copper, silver or gold which can contain trace amounts of mercury. In the process of extracting metals from the ore, processes are used which release this mercury from the rock material. This mercury may evaporate and follow the gaseous streams in the extraction processes (in most cases) or follow wet (liquid) process streams, depending on the extraction technology used. Unless the mercury is captured by process steps dedicated to this purpose, major parts of it may likely be released to the atmosphere, land and aquatic environments. Retained mercury may be sold in the form of "calomel" (Hg_2Cl_2), normally sold for off site extraction of metal mercury or on-site processed metal mercury, or it may be stored or deposited as solid or sludgy residues. Marketing of recovered by-product mercury from extraction of non-ferrous metals accounts for a substantial part of the current global mercury supply (UNEP, 2010).

Ore for extraction of gold (often in the form of sulphide ore) can contain trace amounts of mercury which may in some cases be elevated compared to other natural raw materials. Mercury content in gold ore has in some cases been high enough to motivate the recovery of the mercury from solid residues from gold extraction for commercial purposes. Such recovery and marketing of by-product mercury from extraction of gold accounts for some of the current global mercury market supply. This recovery may also partly be motivated by the desire to reduce releases of the same mercury from the gold production and also because this mercury may serve as a substitute for dedicated primary mercury mining (COWI, 2002, in UNEP, 2010).

Some examples of mines where mercury has been extracted as by-product can be found in Finland (Outokumpu Mining Oyj), which dominated production in central and northern Europe with 40–90 t of Hg per year during 1994–2000, in some USA gold mines (15 t per year), and in Peru, where the Yanacocha Gold Mine produced 48 t of Hg in 2000 and has reported reserves for two more decades of operation (Hylander and Meili, 2003).

5.2.3 Gold and silver small scale miner

Use of mercury to extract gold in artisanal and small-scale gold mining operations is an intentional use also giving rise to large emissions both to air and to water. Because of inefficient mining practices, mercury amalgamation in ASGM results in the consumption and release of an estimated 650 to 1000 tonnes of mercury per annum (AMAP/UNEP, 2008). Water emissions are in this case larger than the air emissions and may result in significant environmental impacts on the local scale (UNEP/DTIE, 2010)

However, in the Mediterranean region this activity has not been reported to be in place.

5.2.4 Chlor-alkali industry

At a mercury cell chlor-alkali facility, mercury is released to the environment with air emissions, water releases, in solid wastes and to a minor degree in products (such as NaOH) (UNEP, 2005). Major points of mercury release in the mercury cell process of chlor-alkali production include: by-product hydrogen stream, end box ventilation air, and cell room ventilation air (AMAP/UNEP, 2008). Most mercury releases occur as fugitive emissions from the cell room and other locations, which can be reduced with preventive measures and good management practices.

The use of mercury cell process to produce caustic soda in the chlor-alkali industry has decreased significantly over the past 15 years worldwide. Many operators have phased out this technology and converted to the more energy-efficient and mercury-free membrane process, others have plans to do so, and still others have not announced any such plans. In many cases, governments have worked with industry representatives and/or provided financial incentives to facilitate the phase-out of mercury technology (AMAP/UNEP, 2008). For instance, in Europe the industry decided to achieve an emission target of 1g Hg/t chlorine capacity on a national basis by end 2007, with no plant being above 1.5 above 1.5 g Hg/t chlorine capacity (Eurochlor, 2009). In 2008, the overall European emissions amounted to 0.92 g Hg/tonne chlorine capacity, as shown on Figure 11 . In the OSPAR catchment area, total mercury losses through product, wastewater and air from the chlor-alkali industry have decreased from about 56 tonnes in 1982 to less than 5 tonnes in 2007 (i.e., a reduction of about 93%) (OSPAR, 2009).

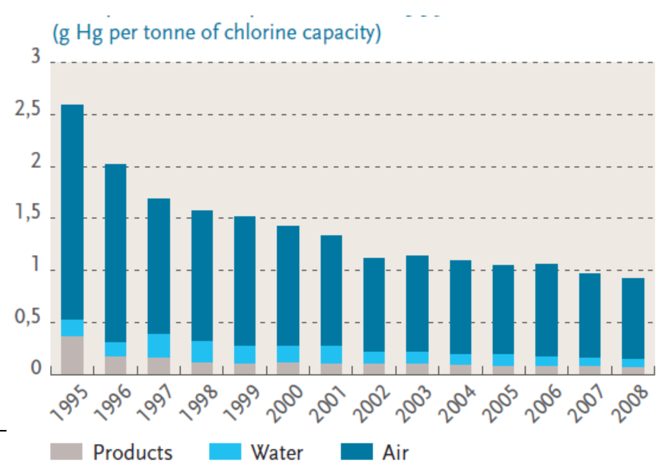


Figure 11. Mercury emissions from the chlor-alkali industry in Europe. Source: Eurochlor, 2009.

Within the Eurochlor countries, currently there are still 10 plants relevant for mercury emissions in the Mediterranean basin (Spain, France, Italy and Greece). Their emission data are shown in

Table 35. During the year 2009 three plants operating with mercury stopped or converted in these countries, and in the past years around 2 plants per year did convert or close for the Mediterranean basin.

Table 34. Mercury emissions from the European chlor-alkali sites located in the Mediterranean basin (2008). Source: Eurochlor, 2009

Country	Company	Site	Capacity (t Cl2/y)	Via products (g/t)	In waste water (g/t)	In atmosphere (g/t)	In waste disposed of (g/t)
FRANCE	Arkema	Lavera	166 000	0.05	0.12	0.70	0.00
FRANCE	Solvay	Tavaux	240 900	0.05	0.00	1.08	5.26
GREECE	Hellenic Petroleum	Thessaloniki	39 899	0.03	0.04	0.09	4.94
ITALY	Syndial	Porto Marghera	200 441	0.03	0.01	0.40	6.00
ITALY	Tessenderlo	Pieve Vergonte	41 995	0.07	0.00	0.68	11.28
SPAIN	Ercros	Flix	150 000	0.07	0.03	0.59	20.98
SPAIN	Ercros	Sabinanigo	25 000	0.09	0.01	0.71	0.00
SPAIN	Ercros	Vilaseca	135 004	0.07	0.05	0.60	4.83
SPAIN	Quimica del Cinca	Monzon	31 373	0.14	0.02	0.62	19.99
SPAIN	Solvin	Martorell	217 871	0.02	0.01	0.38	4.16

5.2.5 Vinyl chloride monomer production

Mercury outputs in VCM production depend on annual consumption of catalyst with mercury, and mercury concentration in such catalyst. Main releases are due to catalyst treatment or disposal (UNEP, 2010). However, this is a technology that has not widely been used in Europe, and apparently there is no plant in operation in the EU (EC, 2002), nor in the Mediterranean region.

5.3 Use of products containing mercury-intentional use

5.3.1 Dental amalgams

Dental amalgam is a mixture of mercury and a metal alloy. In 1991, the World Health Organization confirmed that mercury contained in dental amalgam is the greatest source of mercury vapour in non-industrialized settings, exposing the concerned population to mercury levels significantly exceeding those set for food and for air (WHO, 2005).

Emissions resulting from use of dental amalgam can occur during production, handling and disposal of dental amalgam and also during cremation of human remains (see 5.4.5). UNEP inventories include only emissions from cremations, although emissions during production, handling and routine disposal of dental amalgams may be significantly larger than the cremation emissions in some countries (AMAP/UNEP, 2008). The complex pathways of dental mercury may include amalgam waste (generated by drilling out a previous filling) going to the wastewater system; the excess material carved from a new amalgam filling; the removal of teeth containing amalgam; unused amalgam going to solid waste; mercury emissions directly to the air; the traps, filters and other devices in dental clinics designed to remove mercury from the wastewater; and various waste disposal alternatives (Lassen *et al*., 2008).

5.3.2 Measuring and control equipment

There is a wide selection of <u>mercury-containing measuring and control devices</u>, including thermometers, barometers, manometers, still manufactured in various parts of the world, although most international suppliers now offer mercury-free alternatives. (AMAP/UNEP, 2008).

Mercury thermometers have traditionally been the most common and widely used application and may contain between about 0.6 and several 100 grams/unit, depending on the use (medical, industrial, etc.). Releases of mercury may take place at different stages (UNEP, 2010):

1. From <u>production</u> of mercury thermometers (to air, water and soil) depending on how closed manufacturing systems are, and on the handling and workplace procedures in the individual production units (The most significant potential sources of emissions are mercury purification and transfer, mercury filling, and the heating out (burning-off) process);
2. By breakage or loss of thermometers (to air, water, soil) during <u>use</u>; and
3. During <u>disposal</u> of the thermometers after their use (directly to soil or landfill and subsequently to water and air), closely depending on types and efficiency of employed waste collection and handling procedures.

The rest of measuring devices are supposed to have similar sources of mercury losses.

5.3.3 Electrical and electronic devices

Mercury has traditionally been used in a great variety of electrical switches, relays, arc rectifiers and thermostats. These components have been used in a variety of electrical and electronic equipment and vehicles.

Similar to other products containing mercury, releases may occur (UNEP, 2010):

1. From production of mercury switches and relays (to air, water and soil);
2. By breakage or loss of switches (to air, water, soil) during use; and
3. During disposal of the products containing the switches (or the switches themselves) after their use (directly to soil or landfill and subsequently to water and air).

5.3.4 Mercury light sources

Mercury-containing lamps remain the standard for energy-efficient lamps, where ongoing industry efforts to reduce the amount of mercury in each lamp are countered, to some extent, by the ever-increasing number of energy-efficient lamps purchased and installed around the world (AMAP/UNEP, 2008).

Mercury releases can take place during production, use and disposal. Mercury emissions from fluorescent lamp manufacturing may occur during mercury handling operations and during lamp production. Handling operations that may result in mercury vapour emissions include mercury purification, mercury transfer, and parts repair. During lamp production, mercury may be emitted from the mercury injection operation and from broken lamps, spills, and waste material (UNEP, 2010).

The releases of mercury by disposal of the lamps depend of the disposal method. In many countries systems for collection of used mercury lamps for recycling exist. The collected lamps may be processed for recycling of the mercury-containing phosphorous powder for production of new lamps or the collected lamps may be processed for recovery of the mercury contained in powder. In some countries the collected powder may be disposed of on landfills without recovery of the mercury. During recycling, mercury may be released from the cutting/crushing of lamps or from the recovery of mercury from the powder. Lamps disposed of to landfills will to a large extent break by the disposal and the mercury vapour will be released immediately to the atmosphere. The major part of the mercury in the lamps is bound to the phosphorous powder and will only slowly be released. By incineration of lamps the majority of the mercury will evaporate and be captured by the pollution abatement controls or emitted to the atmosphere (UNEP, 2010).

5.3.5 Batteries

The use of mercury in batteries, while still considerable, continues to decline as many nations have implemented policies to deal with the problems related to diffuse mercury releases related to batteries (AMAP/UNEP, 2008).

Batteries still contribute significantly to contamination because of three reasons: 1) the large volumes sold; 2) the older batteries in the waste stream contain much higher quantities of mercury than the new ones; 3) mercuric oxide batteries, which are banned in Europe, may continue to be traded through the EU (Lassen *et al.*, 2008).

Mercury is released during production or disposal. In battery manufacture, the workplace procedures, particularly for mercury oxide batteries, and product reject rates, may be an important factor determining the extent of releases. The actual mercury concentrations in batteries and the collection and disposal practices of each country will determine releases during disposal. Even in countries with separate battery collection, major parts of the consumed batteries are disposed of with general household waste. For batteries in wastes lead to protected landfills, parts of the mercury will be released only slowly as the encapsulation is degraded, by gradual evaporation to the atmosphere, with slow leaching to waste water (or the ground water, if no membrane is used under the landfill). For batteries in wastes that end up in waste incineration, some of the mercury will be released to the atmosphere when incinerated, while other parts will remain in the solid incineration residues, and if applied, in flue gas cleaning residues, and subsequently deposited in landfills or other deposits (UNEP, 2010).

5.3.6 Other mercury containing products

Mercury is also contained in several products such as biocides and pesticides (paper industry, paints), laboratory chemicals (reagents, catalysts, etc.), pharmaceuticals (vaccines, eye drops, some herbal medicines and other products), cosmetics and related products (skin lightening creams, soaps, and as preservatives in some eye cosmetics).

1. Pesticides and biocides. mercury compounds have been used in biocides in paper industry, in paints, and on seed grain and other agricultural applications. These uses have been discontinued or banned in many countries. The most important factors deciding the releases are the mercury concentration in the used products, and the way these products are applied. While the majority of the product in use will end up on land, some will likely end up in water through disposal of unused amounts, washing of the equipment used, leaching to ground water and runoff with surface water. Unused product, including stocks of obsolete pesticides, may be lost diffusely or disposed of with normal waste or through special disposal programs (UNEP, 2010).
2. Paints (as preservatives/fungicides). Phenyl mercuric acetate (PMA) and similar mercury compounds were formerly widely added as biocide to water based paints and may still be used in some countries. When mercury-containing paints were applied, the painted surfaces released elemental mercury to the air, and only a minor part of the paint was discharged with waste water by cleaning of the equipment and a part remaining in the cans was disposed of with solid waste (UNEP, 2010).
3. Pharmaceuticals for human and veterinary uses (as preservatives). Mercury has been used in various pharmaceuticals such as vaccines, eye drops, some herbal medicines and other products, functioning mainly as preservatives, but its use has decreased significantly in recent years. Mercury in pharmaceuticals is released through the body to waste water or land, and unused products may be disposed of as general or hazardous waste depending on prevalent waste management practices. (UNEP, 2010).
4. Cosmetics and related products (as preservatives). Mercury has been used in skin lightening creams, soaps, and as preservatives in some eye cosmetics. These products are rare or non-existent in some countries. The production and use has decreased significantly in the West over the past decades, but in other countries production and use continue. The main pathway is assumed to be releases to water when the cosmetics are removed by washing. A small part left in the tubes and containers may be disposed of with general waste (UNEP, 2010).
5. Laboratory chemicals. Mercury is used in laboratories in reagents, preservatives, and catalysts. Some of this mercury is released to air, primarily through lab vents. However, most of the mercury may be released in wastewater or disposed of as hazardous waste or municipal waste (UNEP, 2005).
6. Laboratory equipment. Mercury is used in measurement methods like porosimetry and pycnometry. Most of the mercury losses are expected to follow mercury

saturated sample wastes from the analyses; waste which is mainly expected to be recycled or disposed of at hazardous waste landfills. (Lassen *et al*., 2008).

7. Polyurethane with mercury catalysts: like any catalyst used in PU elastomer systems, the mercury catalyst is incorporated into the polymer structure and remains in the final product. Over time – and accelerated by exposure to harsh environments, UV, abrasion, etc. – the polymer structure breaks down and mercury is released. Releases from the manufacturing of polyurethane systems and final polyuretheane parts may be significant, but no data has been available for estimating the releases (Lassen *et al*, 2008). According to UNEP (2010) it may be roughly assumed that on average 5% of the mercury in the polyurethane is released to waste water and 10% to the air over the entire service life of the products.

5.4 Waste treatment from intentional and non intentional use

5.4.1 Waste incineration (municipal, sanitary and hazardous waste)

The main influences on the total emission of mercury to air from waste incineration is the mercury content in the waste, the waste burning capacity of the incinerator, the type of incinerator (mass burn excess air or modular starved air), the way in which it is operated (e.g. whether it includes heat recovery) and the degree of abatement fitted to the plant. Pre-treatment of the waste such as separating and removing mercury-containing material before the waste is introduced into the incinerator is the most important primary measure to reduce mercury emissions to air (UNEP/DTIE, 2010).

Mercury can be present in household waste in highly variable concentrations in different countries, mainly depending on the occurrence of mercury in household products and the existence of systems for collection of mercury or if the products are disposed on in the regular waste stream. Common product groups which may contain mercury are batteries, thermometers and fluorescent light sources (UNEP/DTIE, 2010).

There are three key classes of MSW incineration technology which depend on the quantity and form of the waste burned. These are mass burn units, modular combustors and fluidised bed combustors (EMEP/EEA, 2009; in UNEP/DTIE, 2010). Hazardous waste, which may have high mercury content, is usually burned either in special technology incinerators or in rotary kiln type furnaces. Special technology incinerators include very low technology drum type, grate type, or muffle type furnaces. Also, other technologies (such as supercritical water oxidation, and electric arc vitrification) which treat hazardous waste, can be included in this group (although they are not necessarily classified as “incineration”). Hazardous waste is in some countries incinerated at cement plants and light weight aggregate kilns. In some countries medical waste is incinerated in hazardous waste incinerators or in municipal waste incinerators suited for the purpose (UNEP, 2010).

5.4.2 Waste landfills

Mercury content in the general waste stream originates from three main groups: 1) intentionally used mercury in spent products and process waste; 2) natural mercury impurities in bulk materials (plastics, tin cans, etc.) and minerals, and; 3) mercury as an anthropogenic trace pollutant in bulk materials (UNEP, 2010).

Throughout the history of any deposit/landfill, relatively small amounts of mercury are released annually from the deposit with outputs of water (leaching water and surface run-off), and with air to the atmosphere, because part of the mercury is slowly evaporating from the waste. The fate of the mercury released with water depends greatly on the presence and efficacy of protective lining under the deposit and associated waste water management. If the water is not collected and sent to waste water cleaning, the mercury (and other substances) may contaminate soil and groundwater under and around the deposit. If the water is sent to waste water cleaning, the mercury will mainly follow the sludge fraction and go to land use or other fate, while the rest will follow the water discharge from the waste water treatment (UNEP, 2010).

The largest "release" of mercury, in terms of mercury quantities associated with deposition of waste, is of course the actual accumulation of waste - and thereby mercury - on the site, possibly giving rise to long term environmental impacts through excavation, urbanisation and other impacts (UNEP, 2010).

5.4.3 Wastewater treatment plants

Mercury content in waste water mainly originates from the two source groups: 1) intentionally used mercury in products and processes (such as from dental amalgams, spillage from thermometers and other devices, and industrial discharges); and 2) atmospheric mercury washed out by precipitation that goes to waste water systems (originating from both anthropogenic and natural sources). As such, waste water treatment is an intermediate mercury release source where mercury inputs from original mercury contamination is distributed on the output pathways water (with treated water), land (through the application of sludge as fertiliser) and air (through sludge incineration and sludge application). In addition some sludge is disposed of in landfills (UNEP, 2010).

In activated sludge treatment systems, or other systems with a high retention of particulate material, notable parts (up to 50%) of the mercury in the waste water will follow the sludge. In some countries the spreading of waste water sludge on farmland as fertiliser is preferred, and threshold limits on allowable mercury concentrations may be applied. Other sludge fractions (particularly those with concentrations of pollutants exceeding the thresholds) are deposited on landfills or incinerated (UNEP, 2010).

5.4.4 Waste recycling

In Europe, most waste fractions of mercury-containing products are considered hazardous waste regardless of the mercury content, whereas several of the mercury containing waste entries are considered hazardous waste only if dangerous substances are present above a certain threshold concentration. Specific regulations pertinent to the collection of mercury-containing products apply to mercury-containing lamps (WEEE Directive), batteries (Battery Directive), switches and lamps in vehicles (ELV Directive), and switches, relays and other mercury-containing components in electrical and electronic equipment (WEEE Directive). For each of the waste fractions there is a specific entry in the European Waste Catalogue, and in principle it should be possible to obtain an overview of the waste management situation across the EU for these waste categories (Lassen *et al*, 2008).

Major sources of recycled mercury include chlor-alkali plants, dental amalgams, scrap mercury from instrument and electrical manufacturers (lamps and switches), wastes and sludges from research laboratories and electrolytic refining plants, and mercury batteries (UNEP, 2010). In Europe, most of the recycled mercury comes from the chlor-alkali production and dental amalgams, as shown in

Table 35.

Table 35. Mercury in waste from intentional uses of mercury in Europe (Lassen *et al*, 2008).

Products category	Quantities ending up in waste Tonnes Hg/year	Quantities recycled Tonnes Hg/year	Contribution to total amount recycled, %	Recycling efficiency within category and totally, %
Chlor-alkali production	119	35	34	29
Light sources	14	1.6	2	11
Batteries	30	4	4	13
Dental amalgams	95	30	29	32
Measuring equipment	21	4.5	4	21
Switches, relays, etc.	14	7	7	50
Chemicals	41	6.5	6	16
Miscellaneous uses	70	13	13	19
Total (rounded)	**404**	**102**	**100**	**25**

The lowest mercury recycling efficiencies are found for light sources, batteries and chemicals. All are characterised by a waste stream with a relatively low mercury concentration (Lassen *et al*, 2008).

Regarding batteries, Directive 2006/66/EC sets collection rates of at least 25% and 45% by 26 September 2012 and 26 September 2016 respectively and at least 50% by average weight for the recycling of mercury containing batteries by 26 September 2011. The members of the association European Battery Recycling Association (EBRA), which represents most European recycling companies, collected almost 31 thousand tonnes of batteries for recycling, out of which 9 thousand in France, 688 in Spain and 193 in Greece. In addition, in Spain 6 tonnes of button cells were recycled in 2006. (Lassen *et al.*, 2008).

During sorting and separation activities, collection of metallic mercury will typically include breaking of switches, thermometers and other types of small glass containers used in measuring, monitoring and electrical equipment. The operation naturally allows some emission of mercury to air. Mercury contained in fluorescent tubes and mercury lamps are removed by cutting the glass container and emptying it by vacuum (EC, 2002b).

Shredding plants are used for fragmenting inhomogeneous metal waste (typically cars, refrigerators and miscellaneous other items from households and companies) into small normally homogenous parts that can be separated by mechanical means such as ballistic separation, magnetic separation and occasionally also fluid separation. Shredding can cause emissions to air depending on the efficiency of the scrubber or other kind of air cleaning equipment. Fluids still present in the waste (e.g. mercury) will be released to the interior of the plant and either evaporate or leak to the ground or be collected as sludge (EC, 2002b).

Regarding recycling and recovery operations, there are different methods for treating mercury. Some mercury waste merely needs to be filtered and cleaned, with no thermal treatment at all, such as the mercury removed from chlor-alkali cells or produced at industrial mining sites. Other types of waste are treated by thermal processes to make the mercury evaporate for succeeding condensation, by hydrometallurgical (wet) extraction processes; some of which involve electrolytic extraction (Lassen *et al.*, 2008).

In general, recovery of mercury is normally done by distillation in a closed system. This process is applied to most mercury waste inclusive metallic mercury, batteries as well as residues from e.g. laboratories. The volatile nature of mercury means that the greatest concern of the distillation process as well as other collection and recovery processes generally will be paid to the risk of air emission (EC, 2002b).

Concerning fluorescent lamps, there are two main methods for removing mercury (Lassen *et al.*, 2008). One method is to cut the end(s) off the glass tube of the lamp and remove the mercury and phosphor powder. The second method is to shred the lamp and then mechanically separate out the powder. Mercury releases need to be controlled also from the recycling of liquid crystal displays (LCDs), where mercury vapours are generated due to broken lamps in used LCDs[44]

Batteries with a significant mercury and/or silver content (i.e., silver oxide or mercuric oxide) are generally treated with a thermal process. Batteries with a very low or zero mercury content (e.g. zinc air, zinc carbon, alkaline manganese) may alternatively be treated with a hydrometallurgical (wet chemical) process (Lassen *et al.*, 2008).

During recycling of ferrous metals (iron and steel), mercury may be present as contaminant in iron and steel scrap, as a result of presence of natural mercury impurities in the original materials, as well as presence of mercury contamination originating from anthropogenic use of mercury (e.g. mercury switches in cars going to iron/steel recycling) (EC, 2002b; UNEP, 2010). Mercury can be released to air as a result of this recycling process.

5.4.5 Cremation and cemeteries

Cremation is a common practice in many societies to incinerate human corpses. Mercury is released during such cremation. Most of the mercury released is due to the presence of dental amalgam fillings that contain mercury. However, smaller amounts of mercury present in body tissues, such as in blood and hair are also released during cremation. The amount of mercury each corpse varies considerably and largely depends on the number of dental amalgam fillings (UNEP, 2010).

Since cremations involve high temperatures and since most crematories have limited emission controls that would reduce mercury releases, the vast majority of the mercury in a corpse that is cremated is expected to be released to the air through the stack. In some crematoria, however, that applies efficient emission controls, a significant part of the mercury may end up in fly ash and other residues (UNEP, 2010).

When estimating the emissions related with crematoria, it must be considered that cremations are not a common practices in countries with a predominantly Muslim population, or in some Orthodox Christian countries (e.g. Greece) (AMAP/UNEP, 2008). In the OSPAR region, where mercury from crematoria represents a significant source of emissions, several countries report that emissions are expected to increase due to the increasing number of mercury amalgam fillings per corpse, and the increase in cremation practices. For instance, Sweden reports that emissions of mercury from crematoria are now the most important point source (OSPAR, 2003).

In cemeteries, mercury in the human body, primarily from dental amalgam fillings, can be considered that will be released to the soil.

[44] "Recyclers tackle mercury vapour from used LCDs" in ENDS Europe, Thursday 28 January 2010.

6. Technologies and practices to prevent and control mercury emissions

6.1 Intentional emissions

This section explores the main alternatives available in the market to the most common mercury uses identified in the Mediterranean region. The information was mainly obtained from UNEP, 2006; Lassen *et al.*, 2008, UNEP, 2008 and the related BREF[45] documents.

6.1.1 Secondary production

Production from the mercury content of other non-ferrous processes such as copper, lead and zinc is classified into intentional emissions because it continues to be a source of mercury. Secondary mercury production from the treatment of dental amalgam, batteries and lamps is now generally performed as a demercurising service to produce mercury free feedstock for metal recovery or disposal and it is described in section 6.3.1 as a waste management process.

Mercury ores and concentrates are initially processed by crushing, and sometimes screening. The crushed ore is then heated in either retorts, at small operations, or furnaces, at large operations, to the temperatures at which mercuric sulphide sublimates. The resulting mercury vapour is condensed in a cooling system and collected as mercury metal. Soot from the condensers and settling tanks should be removed, treated with lime and returned to the retort or furnace.

For efficient recovery of mercury the following techniques can be used:

- Measures to reduce dust generation during mining and stockpiling, including minimizing the size of stockpiles;
- Indirect heating of the furnace;
- Keeping the ore as dry as possible;
- Bringing the gas temperature entering the condenser to only 10 to 20°C above the dew point;
- Keeping the outlet temperature as low as possible;
- Passing reaction gases through a post-condensation scrubber and/or a selenium filter.

Dust formation can be kept down by indirect heating, separate processing of fine grain classes of ore, and control of ore water content. Dust should be removed from the hot reaction gas before it enters the mercury condensation unit with cyclones and/or electrostatic precipitators.

[45] Reference documents on Best Available Techniques of the European IPPC Bureau. http://eippcb.jrc.es/reference/

Table 36 shows the most important control measures for the non-ferrous metal industry.

Table 36. Control measures and dust reduction efficiency for the primary non-ferrous metal industry. Source: The 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution

Emission source	Control measure	Dust reduction efficiency (%)
	Primary non-ferrous metal industry	
Fugitive emissions Suction hoods, enclosure, etc.	Suction hoods, enclosure, etc. off-gas cleaning by FF	>99
Roasting/sintering	Updraught sintering: ESP + scrubbers (prior to double contact sulphuric acid plant) + FF for tail gases	
Conventional smelting (blast furnace reduction)	Shaft furnace: closed top/efficient evacuation of tap holes + FF, covered launders, double bell furnace top	
Imperial smelting	High-efficiency scrubbing	>95
	Ventury scrubbers	
	Double bell furnace top	
Pressure leaching	Application depends on leaching characteristics of concentrates	>99
Direct smelting reduction processes	Flash smelting, e.g. kivcet, Outokumpu and Mitsubishi process	
	Bath smelting, e.g. top blown rotary converter, Ausmelt, Isasmelt, QSL and Noranda processes	
	Secondary non-ferrous metal industry	
Lead production	Short rotary furnace: suction hoods for tap holes + FF; tube condenser, oxy-fuel burner	99.9
Zinc production	Imperial smelting	>95

In addition, BREF of Non-Ferrous Metal Industry (EC, 2009b) also considers as BAT (Best Available Techniques) the following techniques and measures for both air and water emissions.

1. BAT is to prevent emissions of mercury to air by using a combination of the techniques listed in Table 37.

Table 37. BAT for the abatement techniques for components in the off gas.

Process Stage	Abatement option	Component in the off gas
Handling secondary material	Enclosed handling, scrubbing of ventilation gases.	Dust, Hg vapour Handling free Hg and dried material

Product handling	Enclosed filling station, scrubbing of ventilation gases.	Hg vapour. Depends on gas collection from furnace and launders

The related BAT-AEL (Associated Emission Level) for mercury by using techniques such as Boliden-Norzink process, Bolchem process, Outotec process, sodium thyocyanate process, activated carbon filter, among others, is 0.02 mg/Nm^3[46].

2. The emissions to water are based on a bleed from the scrubber and cooling systems. In particular, BAT is to precipitate mercury as mercury sulphide by neutralising the waste water, treat it with sodium sulphide and passing the water through a carbon filter before discharge. The emission level to water of <50 Pg/l as mercury is the BAT-AEL. For waste water emissions, the BAT-AELs are based on qualified random samples or 24 hour flow proportional composite samples.

6.1.2 Chlor-alkali production

Mercury-based chlor alkali production has two alternative mercury-free technologies: the membrane process and the diaphragm process. In the latter, a diaphragm is used to separate the chlorine at the anode and the hydrogen and caustic soda produced at the cathode. A disadvantage of the diaphragm cell process is that the diaphragm is usually made of the toxic material asbestos; however, operation is possible with non-asbestos diaphragms.

The membrane cell process is considered the Best Available Technique (BAT). The membrane is typically fluoropolymer based and it separates the anode and cathode. The brine solution flows through the anode compartment and produces chlorine gas. The sodium ions pass through the membrane to the cathode compartment and form a caustic soda solution. Advantages of the membrane cell process include the production of a very pure caustic soda solution, and less energy requirements than the other two processes. A disadvantage is that the brine feedstock must be of high purity, and often requires costly purification steps prior to electrolysis.

The average cost of converting from the mercury-cell process to membrane is estimated at US$ 400-600 per metric ton of chlorine production capacity. Membrane processes allow a significant savings in the operating costs, including a 20-30% reduction in electricity requirement.

In addition, it is important to minimize mercury emissions during the remaining life of mercury cell plants, before they are substituted with mercury-free technologies. Measures to minimise mercury losses to air, water and with products include (EC, 2001):

- Use of equipment and materials and, when possible, a lay-out of the plant (for example, dedicated areas for certain activities) that minimise losses of mercury due to evaporation and/or spillage.
- Collection and treatment of mercury-containing gas streams from all possible sources, including hydrogen gas.
- Minimising the amount of waste water and treatment of all mercury-containing waste water streams.

[46] Collected emissions only. BAT-AELs are given as daily averages based on steady state operation and continuous monitoring during the operating period.

- Reduction of mercury levels in caustic soda.
- Good housekeeping practices and motivation of personnel to work in such a way;
- Good maintenance routines, including planning of periodical maintenance and repair works;

The best performing mercury cell plants are achieving total mercury losses to air, water and with products in the range of 0.2-0.5 g mercury per tonne of chlorine capacity as a yearly average.

Furthermore, it should be observed that the majority of mercury losses are in the various wastes from the process. They can be reduced by minimising current and future mercury emissions from handling, storage, treatment and disposal of mercury-contaminated wastes through the following measures (EC, 2001):

- Implementation of a waste management plan drawn up after consultation with the appropriate authorities.
- Minimising the amount of mercury-containing wastes.
- Recycling the mercury contained in wastes when possible.
- Treatment of mercury-contaminated wastes to reduce the mercury content in the wastes.
- Stabilisation of residual mercury-contaminated wastes before final disposal.

In addition, it is important that decommissioning is carried out in a way that prevents environmental impact during and after the shutdown process as well as safeguarding human health.

6.1.3 Dental amalgams

Use of mercury for dental amalgams is declining in most industrialized countries, partly because of the measures carried out by many governments. Mercury dental amalgams can be substituted with mercury-free alternatives:

- <u>Composites</u>. They are made of a mixture of acrylic resin and powdered glass or silica filler. They require more time to be placed and are more expensive. One of their advantages is the colour, which is very similar to the tooth colour. Another advantage is the fact that they can be chemically bonded to the tooth cavity, and for this reason they require less healthy tooth material to be removed when preparing the cavity. Composites are the most used alternatives to mercury amalgams.
- <u>Glass ionomers</u>. They are composed of a mixture of acrylic acids with fine glass powders that are used to fill cavities. They are less resistant to fracture than composites. For this reason, they are primarily used on small, non-load bearing fillings, such as those on the root surfaces of teeth. Also they are more likely to wear than amalgams or composites. Their advantages over amalgams are the same as those of composites (tooth-like colour and stronger tooth structure). In addition, glass ionomer fillings also contain fluoride, which is slowly released over time to help prevent additional decay of the tooth. Such as in the case of composites, the disadvantages include higher cost and a longer time required for placement.
- <u>Resin ionometers and resin-modified glass ionomers (RMGI)</u>. They are a mixture of acrylic acids and acrylic resin with glass filler. They are tooth-coloured and can release fluoride over time to help prevent further tooth decay. Like glass ionomers, resin ionomers bond to the tooth cavity and require a smaller amount of the healthy tooth material to be removed when preparing the cavity. Resin ionomers outperform

glass ionomers in certain mechanical properties including strength and coefficient of thermal expansion. Resin ionomers are less resistant to fracture than composites, and tend to wear when used on chewing surfaces. For these reasons, the use of resin ionomers is typically limited to small, non-load bearing fillings or short term fillings in primary teeth. The cost of resin ionomer fillings is similar to composite filling but more than amalgam fillings.

- Gold, Ceramic and Porcelain. They are typically used for indirect restorations and therefore are not considered to be alternatives to amalgams, which are primarily used for direct restorations. They require two or more dentist visits and typically involve the placement of a temporary filling.
- Polycarboxylate Cement. It is used for temporary fillings and as a cementing medium for cast alloy and porcelain restorations. It only partially represents an alternative to mercury amalgams because it is temporary.
- Zinc Oxides. They are used for a variety of dental purposes including temporary fillings. They are often used in combination with eugenol, a liquid derived from the oil of cloves, and acts to relieve pain and is slightly antiseptic. They only partially represent an alternative to mercury amalgams because they are temporary.

It is important to observe that the difference in price of mercury-free alternatives to mercury dental amalgams is not really relevant, because the cost of the amalgam materials is typically not higher than 5% of the total cost of amalgam filling.

Dental amalgams are generally the main source of mercury to municipal wastewater. If not collected through amalgam separators, most mercury content of the amalgam waste goes down the drain. Most dental clinics have a basic chairside filter in the wastewater system to capture the larger amalgam particles, and some have secondary vacuum filters upstream of the vacuum pump. In addition, modern amalgam filters are available to be placed in the dental clinic wastewater systems, which can collect over 90% of the amalgam in the clinic wastewater. The collected mercury should be considered as hazardous waste and consigned to a waste management facility with a licence to handle hazardous wastes. The equipment for dentists to reduce mercury emissions are straightforward to install and operate and not expensive. For example, the cost to preventing mercury releases down the drain is between $US37 and 100.

6.1.4 Measuring and control devices

A variety of measuring and control devices contain mercury, including, among others, thermometers, sphygmomanometers, barometers, manometers and pressure gauges.

1. Thermometers

Medical thermometers are banned in Europe since October 2008, and their use is decreasing also in extra-European countries[47]. They can be substituted with a variety of alternatives, including electrical and electronic thermometers, single-use “disposables”, and glass thermometers containing a GA/In/Sn “alloy”.

Non-medical thermometers can also be substituted using other liquids as the measuring medium, i.e. gas, electrical and electronic sensors. The chosen alternative depends on the temperature range, the objectives of the application and the need for precision.

[47] In the questionnaire handed out by UNEP (2008), France declared no demand of mercury for thermometers. In fact, mercury is banned in France since 1998.

Mercury thermometers are still preferable for a small number of precision applications for technical reasons: calibration of other thermometer types, international standards. Mercury-free thermometers are not necessarily more expensive than mercury thermometers; on the contrary in many cases their prices are comparable. For this reason, mercury thermometers are nearly phased out, at least in the industrialized countries. Where alternatives are not cheaper, they are better than mercury thermometers in terms of longevity and faster performances.

The most common categories of alternatives to mercury-containing thermometers are:

- Mercury-free liquid-in-glass thermometer. It is the most common substitute for mercury thermometers at temperatures up to 250º. It uses alcohol, kerosene and dried citrus-extract-based solvents as liquids and has a comparable price.
- Dial thermometers for manual reading. It consists of a liquid or air-filled metal cylinder with a dial for manual reading, or bimetal dial thermometer that uses a bimetal coil. The coil consists of two dissimilar metal bonded together that have different coefficients of thermal expansion and, when the temperature changes, cause a rotation of the coil. Dial thermometers can measure temperatures between -70º and 600º and cost about 50 €, i.e. approximately 2-4 times the price of a similar mercury thermometer.
- Electronic thermometers, with a digital display and/or automatic data logging. The most used types are based on thermocouples thermistors or resistance probes. They are replacing mercury thermometers for most industrial applications and represent an increasing share of the thermometer market, due to the advantages of automatic reading.
- Infrared thermometers, which is a non-contact temperature measurement device. They can measure temperatures in applications where conventional sensors cannot be employed.
- One use of mercury thermometers without alternative is in flash-point determination, which is used in the oil industry and by companies providing analytical services.

2. Sphygmomanometers

Mercury sphygmomanometers can be replaced by:

- Equipment for blood pressure measurements based on the auscultatory technique, such as the aneroid manometer and the electronic pressure transducer, which have the same limitations as mercury sphygmomanometers.
- Equipment for blood pressure measurements based on the oscillometric technique, which operate under a completely different principle and are thus not considered as true "alternatives" to Hg sphygmomanometers.

Although several aneroid and automated alternative blood pressure devices have been validated against the mercury sphygmomanometer and they might also be suitable as a reference for clinical validation of newly developed devices in the future, mercury sphygmomanometers are still needed as reference for clinical validation studies of aneroid and automated blood pressure measurement devices (SCENIHR, 2009).

3. Manometers

In order to replace mercury manometers, different kinds of pressure-measuring instruments can be used. The most common are the following:

- Bourdon tube manometers, a circular-shaped tube with an oval cross section. They are presently sold for applications where U-tube manometers with mercury were previously used.
- Electronic manometers (or digital manometers), which measure the pressure using pressure transducer (e.g. piezoelectric pressure transducers or capacitance pressure transducers). They cost approximately 3-4 times more than mercury manometers, but they have the additional advantage of the possibility of automatic and remote control.
- Pressure gauges with diaphragm elements.

4. Barometers

Mercury-containing barometers are being increasingly replaced by mercury-free alternatives, including

- Electronic barometers (e.g. aneroid displacement transducers, digital piezo-resistive barometers or cylindrical resonator barometers) and electronic resistance or capacitance barometers. The most common ones for professional used are the electronic barometers for automatic data logging, whereas the aneroid (i.e. liquid free) barometers are mostly used in households.
- Aneroid mechanical barometers, which consists of an evacuated metal diaphragm linked mechanically to an indicating needle. They are more compact than mercury barometers and are as accurate.
- Mercury-free liquid barometers, such as the U-shaped glass tube filled with a red silicone fluid and gas that is produced by the Belgian manufacturer Dingens Barometer. They cost one-third to one-half less than a comparable mercury barometer.

5. Strain gauges

Mercury-containing strain gauges can be replaced by strain gauges with Indium-Gallium or photo cell or laser-Doppler techniques. There is at present no alternative to mercury-containing plethysmographs in research where absolute blood flow in arms and legs is examined. That is because of the huge body of reference material that has been built up during decades of use. However, when, in few years, mercury-free plethysmographic equipment will be validated for all clinical and research areas where strain gauges are used, mercury-free techniques will be able to replace mercury-containing devices.

6. Other measuring and control devices
    - Hygrometers (or psychrometers): alternatives to mercury hygrometers are spirit-filled hygrometers and electronic hygrometers, which cost approximately the same. Electronic hygrometers are widely available.
    - Tensiometers: the manometer of the mercury tensiometer can be replaced by mercury-free electronic tensiometers and tensiometers with mechanical bourdon manometers for all applications.
    - Mercury-containing reference electrodes: for pH measurements and as a reference electrode, mercury-containing electrodes have mostly been replaced by electrodes based on silver/silver chloride, but they can be detrimentally affected by sulphides and can be unsuitable as a reference electrode for chemical analysis of chloride or

silver concentrations. The problem with sulphide can be overcome by the use of a suitable barrier, and commercial silver/silver chloride electrodes for use in sulphide environments are available.

- Hanging drop mercury electrodes: the polarographic method is an alternative used to analyze trace elements in water, environmental samples or ultrapure chemicals. The advantage of the mercury equipment is primarily that it is cheap compared to the equipment for more advanced measuring methods.
- Gyrocompasses: mercury- free gyrocompasses are available and are currently used in any kind of vessel. They use a mercury- free liquid consisting of tensides and other harmless organic compounds. However, mercury cannot be replaced in mercury- containing gyrocompasses: rather the whole gyroscope has to be replaced.

Table 38 summarizes the main mercury applications for measuring and control devices, the marketed alternatives, the difference in price and the degree of substitution in Europe.

Table 38. Overview of marketed alternatives to mercury-containing measuring equipment. Source: Lassen *et al.*, 2008.

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury measuring devices	Substitution level	Remarks
Fever thermometers	Liquid-in-glass thermometer	=	2-4	Banned by Directive 2007/51/EC
	Electronic thermometers	=		
Mercury-in-glass thermometers for machines, engines, boilers, etc.	Liquid-in-glass thermometer (up to 250°C) (at 1 degree)	=	3-4	Some applications in industry where mercury is difficult to substitute
	Dial thermometers (up to 650°C)	+		
	Electronic thermometers (at 0.1 degree)	++		
Mercury-in-glass thermometers for ambient air temperature measurements incl. min/max measurements	Liquid-in-glass thermometer -	=	4	
	Electronic thermometers	+/++		
Mercury dial thermometers for use in the industry and on ships	Dial thermometers with rods/capillaries with other liquid or gases	+	4	

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury measuring devices	Substitution level	Remarks
	Electronic thermometers	++		
Mercury-in-glass glass thermometers for laboratory use	Liquid-in-glass thermometer (at 1 degree)-	=	3	Electronic thermometers ~ same price as certified Hg thermometers Some applications in laboratories where mercury is difficult to substitute
	Liquid-in-glass thermometer with proprietary liquid (at 0.1 degree) -limited temperature range	=/+		
	Electronic thermometers (at 0.1 degree resolution at a wide temperature range)	+/++		
Mercury pyrometers for high temperature measurements -	Infrared temperature sensors	N	n.a.	
	Pyrometers with nitro gen containing stem	N		
Manometers for pressure measurement in the heating and ventilation sector	Bourdon tube manometers	-/=	4	
	Electronic manometers	+		
Barometers for households	Aneroid barometers	=	2-4	Banned by Directive 2007/51/EC
	Mercury-free liquid barometers	=		
Barometers for weather stations, ships, offshore installations, etc.	Electronic resistance or capacitance barometers	N	3-4	
High-accuracy barometers, e.g. for calibration	Electronic barometer with vibrating cylinder air pressure transducers	N	3-4	
Manual blood pressure measurements	Aneroid sphygmomanometer	-/=	3-4	
	Shock resistant aneroid sphygmomanometer	=		
	Manual electronic sphygmomanometer	=		
Blood pressure measurements reference manometer for general medical practitioners	Manual electronic sphygmomanometer	+	3-4	

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury measuring devices	Substitution level	Remarks
Blood pressure measurements in the home	Semiautomatic electronic devices	=	4	
Automatic blood pressure measurements in hospitals	Automatic blood pressure measuring devices for monitoring of blood pressure and other vital signs	++	4	
Strain gauges	Indium-gallium strain gauges	N	3-4	For research there is still a need for more independent validations of the alternatives against the mercury gauges
	Photo cell or laser-Doppler techniques	N		
Hygrometers	Hydrometers with mercury-free thermometer Electronic hygrometers	=	3-4	
Hydrometers	Hydrometers with mercury-free thermometer	N	3-4	
Tensiometers	Electronic tensiometers	-/=	4	
	Tensiometers with mechanical bourdon manometer	+		
Hanging drop electrodes	A number of other analysis methods	++	2-3	The alternatives applies totally different methods and are not readily comparable
Mercury reference electrodes	Alternatives are not available for some specific applications	N	2-3	
Gyrocompasses	Gyrocompasses applying an organic liquid for electrical contact	=	2-3	
Coulter counters		N	n.a.	

Key assigned to the overall current user/consumer price levels for mercury-free alternatives as compared to mercury technology:
– Lower price level (the alternative is cheaper)
= About the same price level
+ Higher price level
++ Significant higher price levels (more than 5 times higher)

N Not enough data to assign an indicator

Key to assigned substitution level indices:
0 No substitution indicated in assessed data sources; development often underway
1 Alternatives are in commercial maturation, or are present on the market but with marginal market shares
2 Alternatives are commercially matured and have significant market shares, but do not dominate the market
3 Alternatives dominate the market, but new production with mercury also have significant market shares
4 Mercury use is fully, or almost fully, substituted
N Not enough data found to assign an indicator
? Indicator very uncertain due to limited data

In most Mediterranean European countries mercury-containing equipment is collected together with other types of hazardous waste and separated out for recycling. No separate collection system exists for mercury-containing measuring equipment.

6.1.5 Electrical and electronic devices

There are no technical obstacles to replacing electrical components, relays and other contacts with mercury-free equivalents. In most cases, the price of the alternative is similar to the price of the mercury-free alternative, and in some cases it is even lower. However, mercury is still used for some application, as detailed below.

1. Tilt switches

Even though the most important uses of mercury tilt switches have been phased out by the RoHS and the ELV Directives, mercury tilt switches are still used in some medical devices and laboratory equipment; motion/vibration sensors; float switches and level switches; certain clocks; lifeboats; thermostats. Many mercury- alternatives are currently marketed, which are generally cost competitive:

- Rolling metallic balls, which are used to create the electrical connection by moving with the movement of the tilt switch housing or being moved by actuator magnets.
- Electrolytic tilt sensors, which contain multiple electrodes and are filled with an electrically conductive fluid. As the sensor tilts, the surface of the fluid remains level due to gravity. The conductivity between the electrodes is proportional to the length of electrode immersed in the fluid.
- Potentiometers, which consist of a curved conductive track with a connection terminal at each end and a moveable wiper connected to a third terminal. As the shaft of the potentiometer is rotated, the length of the electrical path and resistance changes proportionally.
- Mechanical tilt switches, which may be a snap-switch or micro-switch that may be actuated in a variety of methods, such as with a metallic rolling ball.
- Solid-state tilt switches, which are often referred to as an inclinometer or accelerometer depending upon the application.
- Capacitive tilt switches, which use a capacitive based sensor that produces output directly proportional to the relative tilt.

2. Thermoregulators

Mercury- containing thermoregulators can be replaced by digital electronic thermostats and thermoregulators, which are available for domestic and industrial type workloads and temperature control.

3. Wetted reed relays

There are several alternatives to mercury wetted reed relays available which include field effect transistors (FETs), electromechanical switches, coaxial switches and standard radio frequency microelectromechanical systems (RF MEMS).

4. Displacement relays and contactors

Mercury relays and contactors can be replaced by a large number of alternatives, such as, for example, the E-SAFE mercury-free relays system from Watlow.

5. Pressury switches

They can be replaced by two alternatives, which are both cost competitive. However, they may not be suitable for all retrofits.

- Mechanical pressure switch. It uses a piston, diaphragm, bellows as the pressure sensor. The sensor can either 1) directly activate a switch, or 2) use a push-rod, lever, or compression spring to activate a snap-acting micro-switch.
- Solid-state pressure switches. They contain one or more strain gauge pressure sensors, a transmitter, and one or more switches – all in a compact package. In addition to opening or closing the pressure switch circuit, they can provide a proportional analogue or digital output.

Table 39 shows the currently available alternatives to mercury-containing switches and other electrical components, together with the difference in price and the degree of substitution in Europe.

Table 39. Marketed alternatives to mercury-containing switches and other electrical components. Source: Lassen *et al*., 2008.

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury electrical components	Substitution level	Remarks
Tilt switch for general applications	Many mercury-free alternative technologies currently in use for tilt switch products and application	=	3-4	
Motion sensors for personal alarms and tracking wildlife	Electronic devices. Alternatives may not available for some applications	N	0-4	For some applications replacement may have taken place, but for some specific applications alternatives may not to be available

Application area / product type	Marketed alternatives	Price of al-ternatives compared to mercury electrical components	Substitution level	Remarks
Float switch	Alternatives include magnetic dry switch, optical float switch, conductivity float switch, conductivity float switch, thermistor switch, capacitance level float switch	=	3-4	
Pressure switch	Couple of mercury-free alternative technologies	=		
Thermostats and thermoregulators	Couple of mercury-free alternative technologies both digital and electromechanical thermo-stats	=	3-4	
Mercury displacement relay	Alternatives to mercury relays include dry magnetic reed relays and other electro-mechanical relays, such as general purpose, specific purpose, heavy duty, and printed circuit board mounted relays.	=	3-4	Alternatives have been de-signed specifically for use in most applications, including demanding process control applications, al-though retrofits may pose problems for some equipment (primarily due to equipment design)
Mercury wetted reed relay	Alternatives include field effect transistors (FETs), electromechanical switches, co-axial switches and standard radio frequency micro electromechanical system	=/+	3-4	Has been replaced for all other applications than WEEE group 8 and 9 applications. There are a small number of applications where only mercury-based switches meets all of the essential technical requirements
Flame sensor	Using an electronic ignition system in gas appliances eliminates the need for a standing pilot light, and is generally a viable alternative. Most manufacturers also make a mercury-free electronic ignition flame detection unit.	=	4	Alternatives are readily available and have largely replaced mer-cury flame sensors already.

Key assigned to the overall current user/consumer price levels for mercury-free alternatives as compared to mercury technology:
– Lower price level (the alternative is cheaper)
= About the same price level
+ Higher price level
++ Significant higher price levels (more than 5 times higher)
N Not enough data to assign an indicator

Key to assigned substitution level indices:
0 No substitution indicated in assessed data sources; development often underway
1 Alternatives are in commercial maturation, or are present on the market but with marginal market shares
2 Alternatives are commercially matured and have significant market shares, but do not dominate the market
3 Alternatives dominate the market, but new products with mercury also have significant market shares
4 Mercury use is fully, or almost fully, substituted
N Not enough data found to assign an indicator
? Indicator very uncertain due to limited data

6.1.6 Mercury light sources

Mercury containing lamps (e.g. fluorescent tubes, compact fluorescent, high-intensity discharge lamps) are still used because of their higher energy-efficiency with respect to mercury-free alternatives. In fact, they typically consume 3-5 times less energy than incandescent lamps, and moreover their useful life time is typically 5-10 times higher. Therefore, cheap and energy-efficient alternatives to mercury lamps are not broadly available.

However, technological progress has allowed the mercury content of lamps to be reduced to almost a tenth of the amounts used earlier in standard fluorescent lamps. Lamps with a low amount of mercury are more expensive than the traditional ones. Incandescent and other alternative lamps are generally cheaper than energy efficient lamps, but their energy/operating costs are higher. The most used alternatives to mecury-containing lamps are the following.

1. Incandescent lamps. Light is produced by an incandescent bulb when an electric current passes through a thin tungsten filament, heating it until it incandesces. Incandescent lamps are viewed as being old technology and are significantly less efficient than fluorescent lamps and LEDs. Approximately 90 percent of the energy used is given off as heat. In addition, it should be noted that even though incandescent lamps do not contain mercury, their life-cycle mercury emissions often exceed those of equivalent mercury-containing compact fluorescent lamps (CFL). In fact, coal- and oil-fired power plants release mercury emissions when generating electricity and incandescent lamps consume more electricity than CFLs. In 2007 General Electric announced that it was developing high efficiency incandescent lamps, which would be two to four times as efficient as current incandescent bulbs and present the same light quality and instant-on convenience as current incandescent lamps.
2. Mercury-free light emitting diodes (LEDs) are commercially available to substitute mercury-containing traditional lamps. They can be used, among others, in digital clocks, mobile phones, traffic lights, auto rear/brake lights, emergency exit signs, scanners, printers and liquid crystal display (LCD) panels. However, the emitted light spectra are still not close enough to the appreciated warm and wide spectrum emitted by traditional incandescent lamps. Available options to overcome this hurdle are close to commercialization, for example by applying specialized diffuser materials, which mix and spread the light, in combination with optimized mixes of coloured LEDS. Moreover LEDs using 230 and 110 volts directly, i.e. without any need for AC/DC transformers have been developed recently.
3. LED Downlight Lamps. They are a replacement for CFL reflector lamps used in recessed light fixtures. These products are intended for new construction or

remodelling where new recessed light fixtures will be installed. They are compatible with standard recessed housing fixtures. Advantages of the LED downlights include: long life (50,000 hours), warm light colour similar to incandescent lamps, low heat generation, and they are dimmable. LED downlights are energy-efficient, and in some cases, they consume less energy than equivalent CFL lamps. They are expensive, because they are a relatively new technology and therefore prices are high and availability is limited. In addition, a light failure may require the replacement of the entire unit, which is much more costly than replacing a CFL lamp.

4. Mercury-free HID headlamps. They can substitute the high-intensity discharge automobile headlamps, which are used in some luxury and performance cars, because of their distinctive blue-white light (which ensure a better night-time visibility with respect of halogen headlamps).
5. Halogen head lamps. They are significantly less expensive than HID headlamps, but they are less energy-efficient and have a shorter life. Halogen lamps do not produce the glare that is common with HID lamps but provide a worse night- time visibility.
6. LED headlamps. They represent an emerging technology, which allow high efficiency and a longer life-spam than HID or halogen.
7. LED backlight units. They can substitute cold-cathode fluorescent lamps (CCFLs), which are currently used in televisions and computers. They are commonly used for small and cheap LCD displays, and are now increasingly being incorporated into the larger LCD displays used for computers and televisions. They have a long life-span (approximately 50,000 hours). In addition, they allow adjusting light intensity and a higher contrast ratio. The price gap between LED backlight-based and CCFL backlight-based televisions and laptop computers has narrowed recently. The difference between LED backlight technology and CCFLs is approximately $100-200 for several models of both televisions and laptop computers.

Table 40 summarizes the most important marketed alternatives to mercury lamps.

Table 40. Marketed alternatives to mercury-containing light sources. Source: Lassen *et al*., 2008.

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury lamps	Substitution level	Remarks
Compact lamps, standard sock-ets	LED lamps, standard sockets	=	1	Available in consumer retail shops and inter-net shops in 2007 and 2008; price references: E.g. (Trenden 2008); (Dioder.dk 2008).
Backlights in PC laptop screens	LED backlights	+	1	(Sony 2008)
Backlights in LCD TV screens	LED backlights	+	1	(Sony 2008)
Backlights in computer game consol screens	LED backlights	=	2	Sony Playstation Port-able (Infoworld 2006). Price of backlight is not deemed a determining factor for product choice.
Automobile headlights	LED headlights	=/+?	1	Price of headlight is not deemed a determining factor for product choice.

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= About the same price level
+ Higher price level
++ Significantly higher price levels (more than 5 times higher)
N Not enough data to assign an indicator

Key to assigned substitution level indices:
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4 Mercury use is fully, or almost fully, substituted
N Not enough data found to assign an indicator
? Indicator very uncertain due to limited data

6.1.7 Batteries

Batteries currently sold in the market can be divided in two categories: 1) miniature batteries and 2) non-miniature batteries. The former contain a small amount of mercury (except for mercuric oxide miniature batteries) and have limited non-mercury alternatives available for substitution. On the contrary, the latter contain significant amounts of mercury and can be easily replaced by various non-mercury alternatives.

6.1.7.1 Miniature batteries

Miniature batteries are typically coin or button-shaped batteries and are used for supplying electrical power for toys, hearing aids, watches, calculators, and other portable devices.

The most important technologies used for miniature batteries are: 1) silver oxide; 2) zinc air; 3) alkaline; 4) lithium. The mercury content in most silver oxide, zinc air, and alkaline miniature batteries is approximately 0.1-2% of the battery weight. On the contrary, lithium miniature batteries contain no mercury and can be considered a potential alternative to mercury containing miniature batteries. Lithium miniature batteries have a much higher nominal voltage and a different physical shape (typically flatter and wider - coin shaped) than the other three miniature battery technologies, and therefore cannot easily be substituted in existing products. They are commonly used in products such as electronic games, watches, calculators, car lock systems, electronic organizers, and garage door openers.

Mercury-free alternatives for a vast variety of miniature batteries have been available for many years. However, mercury-free miniature batteries are approximately 24-30% more expensive than mercury-containing batteries.

Examples of alternatives are mercury-free zinc-air batteries and other button-cell alternatives (which however still contain less than 10 mg of mercury), which replace mercury oxide and mercury -zinc (medical) “button cell” batteries. Mercury-free versions of silver oxide, alkaline manganese dioxide (“alkaline”) and zinc air miniature batteries are also beginning to be marketed. The companies Sony and New Leader market silver oxide batteries, which are mainly used in watches, digital fever thermometers and game products. The former produces over 40 models of silver oxide batteries and planned already in 2005 to cease producing mercury- containing batteries.

6.1.7.2 Non-miniature batteries

As regards non-miniature mercury-containing batteries, there are four categories: 1) Paste-type zinc-manganese cylinder batteries; 2) Paperboard type zinc-manganese cylinder batteries; 3) Alkaline zinc-manganese cylinder batteries and 4) mercuric oxide batteries. The most important alternative is the alkaline manganese cylinder battery, which is readily available in the many sizes and power needed for the various cylinder battery applications.

6.1.8 Mercury chemicals

Mercury is used in laboratories as reagents, preservatives and catalysts in a great variety of applications. Most of these uses can be substituted with mercury-free alternatives.

Even though some standard uses of mercury may be difficult to substitute, the use of mercury in schools and universities can be restricted to few uses, e.g. references and standard reagents. In addition, various manufacturers provide mercury removal equipment for laboratories. Mercury-free substitutes in laboratories are nearly always competitive, and in addition allow additional savings in employee safety training and precautions, reduced cleanup costs and reduced equipment and disposal costs. However, mercury substitution in laboratories may be difficult because some of the present standards were developed around the use of certain mercury compounds, and they are sometimes considered necessary in order to reliably reproduce certain analyses. In addition, technicians tend to favour the procedures they know well and have long used.

The use of mercury in pesticides and biocides has been ceased or banned in many countries, and have been substituted with mercury-free alternatives, whose cost is in general comparable. The same holds for paints.

Mercury is also used in different categories of pharmaceuticals (e.g. vaccines, eye drops, herbal medicines, disinfectants) mainly as a preservative, but in some cases also as the active ingredient. One of the most important application is thimerosal or thiomersal (ethil thiosalicylate), which is used in vaccines marketed in multiple-dose units. The mercury amounts for this application are very small compared with other uses (e.g. dental fillings, thermometers, batteries), but it is cause for concern because it is directly injected in human blood. However, WHO recommends the use of thimerosal-containing vaccines, because it considers that thimerosal's benefits outweigh the associated risks. For this reason, the use of mercury for pharmaceuticals is decreasing. As regard costs, single-dose vaccines without preservatives are typically 50% more expensive than multi-dose vaccines.

In addition, mercury is used in skin-lightening creams, soaps and as a preservative in eye cosmetics. The use of mercury-containing cosmetics has significantly decreased in the Western countries due to legal restrictions, but it is widespread in many African and Asian countries. The most used alternative to mercury for skin lightening cosmetics are hydroquinone and corticosteroids.

Table 41 shows the most important mercury compounds and their marketed alternatives.

Table 41. Overview of alternatives to mercury-containing chemicals marketed in the EU. Source: Lassen *et al.*, 2008.

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury chemicals	Substitution level	Remarks
Mercury catalysts for PU elastomer production	Tin and amine catalysts are alternatives to Hg catalysts for some PU elastomer applications, titanium and zirconium compounds have been introduced for others, while bismuth, zinc, platinum, palladium, hafnium, etc., com-pounds are marketed for still others	=	3	The substitution level may be different for different PU elastomer applications
Mercury II sulphate for COD analysis	COD without the addition of mercuric sulphate; TOC analysis; Biochemical oxygen demand (BOD) analyses	N	2-3	
Chemical reactants for other reagents e.g. Nessler's reagent, Hayem Diluting Fluid and others	Not investigated	N	2-3	
Thimerosal in vaccines	Not investigated	N	2-4	Replaced by other preservatives in many vaccines
Thimerosal for preservation of eye make up products	Not investigated	N	3-4	
Mercury compounds used as disinfectants	A number of organic compounds	N	3-4	

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury chemicals	Substitution level	Remarks
Biocides in paint	A large number of organic compounds	=	3-4	
Pigment (vermilion, HgS)	Organic and inorganic pigments	=	4	Used for restoration work, where specific colour is

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+ Higher price level
++ Significantly higher price levels (more than 5 times higher)
N Not enough data to assign an indicator

Key to assigned substitution level indices:
0 No substitution indicated in assessed data sources; development often underway
1 Alternatives are in commercial maturation, or are present on the market but with marginal market shares
2 Alternatives are commercially matured and have significant market shares, but do not dominate the market
3 Alternatives dominate the market, but new production with mercury also have significant market shares
4 Mercury use is fully, or almost fully, substituted
N Not enough data found to assign an indicator

6.1.9 Other applications

Table 42 shows relevant alternatives for other current mercury-containing products identified within the EU by Lassen *et al*., 2008.

Table 42. Overview of alternatives to mercury-containing miscellaneous products marketed in the EU. Source: Lassen *et al*., 2008.

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury usage	Substitution level	Remarks
Mercury porosimetry	For some poresizes no alternatives seem to be available	- / no alternatives	2	For materials which can be measured by alternative methods, the alternatives are less costly
Mercury pycnometers	Gas displacement techniques	N	N	
Mercury-cadmium-telluride (MCT) in infrared light detectors	For certain wavelength ranges alternatives are not available	no alternatives	0	
Calibration of mercury monitors	no alternatives	no alternatives	0	

Application area / product type	Marketed alternatives	Price of alternatives compared to mercury usage	Substitution level	Remarks
Plasma display panels	Most plasma display panels apply mercury-free technology	=	4	
Fire gilding	Electroplating	-	4 general 0-2 specific restoration work	Electroplating may not give exactly the same appearance -relevant by restoration work
Conductors in seam welding machines	Mercury-free conductors	N	3-4 (new equipment)	Mercury-free conductors may not be available for replacement in existing machines Differences between machines for straight and curved welding
Mercury slip rings	Gold plated brass slip rings and gold alloy brushes	N	N	
Pigments for art and restoration work	A number of organic and inorganic pigments	N	4 general 0 specific restoration work	Mercury compounds in general phased out for art work For restoration of some specific colours substitutes may not be available

Key assigned to the overall current user/consumer price levels for mercury-free alternatives as compared to mercury technology:
– Lower price level (the alternative is cheaper)
= About the same price level
+ Higher price level
++ Significantly higher price levels (more than 5 times higher)
N Not enough data to assign an indicator

Key to assigned substitution level indices:
0 No substitution indicated in assessed data sources; development often underway
1 Alternatives are in commercial maturation, or are present on the market but with marginal market shares
2 Alternatives are commercially matured and have significant market shares, but do not dominate the market
3 Alternatives dominate the market, but new production with mercury also have significant market shares
4 Mercury use is fully, or almost fully, substituted
N Not enough data found to assign an indicator

6.2 Non intentional emissions

According to the 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution, the following categories of mitigation measures can be undertaken to reduce mercury non-intentional emissions:

- Application of low-emission process technologies, in particular in new installations;
- Off-gas cleaning (secondary reduction measures) with filters, scrubbers, absorbers, etc.;
- Change or preparation of raw materials, fuels and/or other feed materials (e.g. use of raw materials with low heavy metal content);
- Best management practices, such as good housekeeping, preventive maintenance programmes, or primary measures such as the enclosure of dust-creating units;
- Appropriate environmental management techniques for the use and disposal of certain products containing mercury.

The most relevant sectors for heavy metal emissions according to the 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution are combustion of fossil fuels in utility and industrial boilers, primary and secondary iron and steel industry, iron foundaries, primary and secondary non-ferrous metal industry, cement industry and the waste incineration.

This section presents the available technologies to reduce or eliminate mercury emissions in these sectors. The main sources for this information are the1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution; UNEP, 2008 and the European Commission Reference Document on Best Available Techniques (BREFs).

6.2.1 Combustion of fossil fuels in utility and industrial boilers

The combustion of coal in boilers is one of the most important sources of mercury emissions (the mercury content in coals is several order of magnitude higher than in oil or natural gas). In general, mercury emissions from combustion of fossil fuels constituted about 45% of the global anthropogenic emissions of mercury in 2005 (UNEP, 2009).

In order to reduce mercury emission from coal combustion, four categories of measures can be used (UNEP, 2009): 1) Improvement of energy efficiency (as well as conversion from coal to oil and natural gas combustion processes); 2) Coal treatment; 3) Co-benefit removal; 4) Dedicated mercury removal technologies.

Improvement of plant efficiency can be obtained by a number of measures, such as the improvement of the boiler operation, operating and maintenance practices, such as for example, steam line maintenance or water treatment, can improve plant efficiency and reduce deterioration.

Coal treatment includes the following techniques:

- Conventional coal washing aim at minimize the ash and sulfur content of coal. However, it also decreases the mercury content of coal.
- Coal beneficiation includes coal washing and additional treatment designed to decrease the mercury content of coal.
- Coal blending and coal additives specifically aim at minimizing mercury emissions by promoting chemical transformations of mercury in the power plant's combustion and post-combustion equipment that facilitate mercury removal. They can be used in addition to coal washing (e.g., blending of two streams of washed coal) or as stand-alone approaches (e.g., halide addition into the boiler).

As regards the third category, technologies for reducing particulate, SO_2 and NO_x emissions can often also reduce mercury emissions. There are two main types of particulate control systems for coal-fired plants: electrostatic precipitators (ESP) and fabric filters (baghouses). According to Sloss (2008), on average, cold-site ESP systems capture around 30% of the mercury in the coal. Baghouses can be more effective for mercury control than ESP, especially with bituminous coals, as the filter cake on the baghouse acts as a fixed-bed reactor for unburnt carbon to enhance mercury capture. In addition, flue gas desulphurisation (FGD) is also useful to reduce mercury emissions.

The most important dedicated mercury removal technology is the use of sorbent injection. The sorbent most often used and most thoroughly tested is powdered activated carbon (PAC)

Table 43 reports the available control measures for reducing mercury emissions in the combustion of fossil fuels in utility and industrial boilers.

Table 43. Control measures and reduction efficiency for fossil fuel combustion emissions. Source: The 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution

Emission source	Control measure	Reduction efficiency
Combustion of fuel oil	Switch fuel oil to gas	70-80
Combustion of coal	Electrostatic precipitators (ESP)	10-40
	Wet fuel gas desulphurization (FGD) (*)	10-90
	Fabric filters	10-60

(*) This technology is primarily used for SO_2 reduction. Reduction in heavy metal emissions is a side benefit.

The EC BREF gives the same indications and also identifies as BAT for the reduction of mercury emissions in coal combustion the use of high performance ESP (reduction rate >99.5 %) or fabric filters (reduction rate >99.95 %). High efficiency ESPs show good removal of mercury (bituminous coal) at temperatures of less than 130 ºC. In addition, some combinations of flue-gas cleaning systems can remove oxidised and particle bound mercury to some extent. For FFs or ESPs operated in combination with FGD techniques, such as wet limestone scrubbers, spray dryer scrubbers or dry sorbent injection, an average removal rate of 75 % (50 % in ESP and 50 % in FGD) or 90 % in the additional presence of SCR can be obtained. The reduction rate when firing sub-bituminous coal or lignite is considerably lower and ranges from 30 – 70 %. The lower levels of mercury capture in plants firing sub-bituminous coal and lignite are attributed to the low fly ash carbon content and the higher relative amounts of gaseous mercury in the flue-gas from the combustion of these fuels.

Finally BREF considers mercury periodic monitoring as a BAT, and recommends a frequency of every year up to every third year, depending on the coal used. It should be observed that total mercury emissions should be monitored and not only mercury in the particle matter (EC, 2006).

6.2.2 Cement industry

Particulates are emitted at all stages of the cement production process, consisting of material handling, raw material preparation (crushers, dryers), clinker production and cement preparation. Heavy metals, including mercury, are brought into the cement kiln with the raw materials, fossil and waste fuels.

Unlike heavy metals with no or low volatility (i.e. As, Be, Co, Cr, Cu, Mn, Sb, Se, Te, V, Zn) and semi-volatile heavy metals (i.e. Ti, Pb and Cd), mercury emissions, being a volatile heavy metal, cannot be effectively controlled by removing the dust from kiln exhaust gases. In fact, part of the volatile heavy metals always remains volatile, i.e. they are not absorbed onto the surface of the dust particles. In the cement industry, mercury is mostly emitted in vapour form, implying that the lower the temperature of the exhaust gas in the filter, the more mercury absorbed in the dust particles can be eliminated by the exhaust gases. There are basically three ways of reducing heavy metal emissions in the cement industry (CP/RAC, 2008):

- Reducing the amount of mercuric metals fed into the system.
- Modifying the existing process (at-source primary prevention measures or reduction measures).
- Adding a gas cleaning unit for the output gases (secondary reduction measures, end-of-pipe treatment).

Reducing the amount of mercury and installing efficient dust removal systems are the most common ones. There are also a number of secondary measures, such as adsorption with active carbon, which is a highly expensive measure and it is only viable through the financing of public bodies.

The most important control measure according to the 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution for the cement sector is shown in Table 44.

Table 44. Control measures and reduction efficiency for the cement industry. Source: The 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution

Emission source	Control measure	Reduction efficiency (%)
Direct emissions from rotary kilns	Carbon adsorption	Hg>95

6.2.3 Primary iron and steel industry

Emission of mercury in primary iron and steel industry occur in association with particulates. The content of the heavy metals of concern in the emitted dust depends on the composition of the raw materials and the types of alloying metals added in steel-making. In order to avoid mercury emissions, fabric filters should be used, which allow reducing the dust content to less than 20 mg/m3. If this is not possible for the peculiar characteristics of the production processes, electrostatic precipitators and/or high efficiency scrubbers can be used.

Table 45 shows the most important control measure for the primary iron and steel industry.

Table 45. Control measures and dust reduction efficiency for the primary iron and steel industry. Source: The 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution

Emission source	Control measure	Dust reduction efficiency (%)
Sinter plants	Emission optimized sintering	ca. 50
	Scrubbers and electrostatic precipitators (ESP)	> 90
	Fabric filters (FF)	> 99
Pellet plants	ESP + lime reactor+ fabric filters	> 99
	Scrubbers	>95
Blast furnaces, blast furnace gas cleaning	FF/ESP	>99
	Wet scrubbers	>99
	Wet ESP	>99
BOF	Primary dedusting: wet separator/ESP/FF	>99
	Secondary dedusting: dry ESP/FF	>97
Fugitive emissions	Closed conveyor belts, enclosure, wetting stored feedstock, cleaning of reads	80-99

6.2.4 Secondary iron and steel industry

In the secondary iron and steel industry, it is very important to capture all emissions efficiently by installing doghouses or movable hoods or by total building evacuation. Afterwards, the captured emission must be cleaned. Dedusting in fabric filters, which reduces the dust content to less than 20 mg /m3, is considered a BAT for dust-emitting processes in the secondary iron and steel industry. When BAT is used also for minimizing fugitive emissions, dust emissions do not exceed 0.1-1.35kg/Mg steel, including fugitive emission directly related to the process.

Two different types of furnace are used for the melting of scrap: open-hearth furnaces and electric arc furnaces (EAF). The latter are about to be phased out, and their mercury emissions can be significantly reduced with electrostatic precipitators (ESP) or fabric filters (see Table 46).

Table 46. Control measures and dust reduction efficiency for the secondary iron and steel industry. Source: The 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution

Emission source	Control measures	Dust reduction efficiency (%)
Open-hearth furnaces and electric arc furnaces (EAF)	ESP FF	> 99-99.5

As well as dust reduction techniques, it is also considered as BAT by the BREF (EC, 2009) to select appropriate scrap qualities and other raw material such as wastes and by-products and to undertake an appropriate inspection during reception to avoid substances e.g. PCDD/F, PCB and heavy metals, and in particular, mercury, in order to achieve low emission levels for relevant pollutants.

6.2.5 Iron foundries

Such as for secondary iron and steel industry, capturing all emissions efficiently is very important for iron foundries, by installing doghouses or movable hoods or by total building evacuation. After capturing them, the emissions must be cleaned.

In iron foundries, direct particulate and gaseous heavy metal emissions are mostly associated with melting, and, to a smaller extent, with pouring.

Table 47 shows the most important emission reduction measures, which can reduce dust concentration to 20mg/m^3 or less.

Table 47. Control measures and dust reduction efficiency for iron foundaries. Source: The 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution

Emission source	Control measure	Dust reduction efficiency (%)
EAF	ESP	>99
	FF	>99.5
Induction furnace	FF/dry absorption+FF	>99
Cold blast cupula	Below-the-door take-off: FF	>98
	Above-the-door take-off: FF+pre-dusting	>97
	FF+chemisorption	>99
Hot blast cupola	FF+pre-dusting	>99
	Disintegrator/venture scrubber	>97

In general, the minimisation of dust emissions, as presented above and in the BREF (EC, 2005) also minimises possible metal emissions. However, this is not true for metals with high volatility such as mercury, which may cause gaseous emissions which are not related to dust. In view of the implementation of a European policy on mercury emissions, there is a need for research on the emissions of mercury from melting processes in general and more specifically from (non-ferrous) foundries in particular (EC, 2005).

6.2.6 Pulp and paper

Measures to reduce SO_2 emissions and other gaseous pollutants also contribute to the reduction of Hg emissions although heavy metal emissions normally do not occur in significant concentrations in the pulp and paper sector (EC, 2010).

Dry and semi-dry processes are mainly used to separate minor pollutant loads. They mostly serve as waste gas cleaning plants for a variety of pollutants such as SO2, HCl, HF, TOC, heavy metals, PCDDs/PCDFs. The facilities mainly consist of a dry reactor or spray absorber followed by an efficient particulate control device such as an ESP or fabric filter and some accessory facilities to manipulate adsorbants and separate dust.

Active carbon can be added to the system and will remove mercury and organic compounds such as dioxins and furans. Active carbon may be required for co-incineration boilers.

6.3 Waste management

6.3.1 Mercury containing waste treatment

According to BREF document on waste treatment industries (EC, 2006b), the following measures related with the reduction of mercury emissions are considered as BATs:

- To identify waste waters that may contain hazardous compounds (e.g. metals, such as mercury, cadmium, lead, copper, nickel, chromium, arsenic and zinc).
- To segregate the previously identified waste water streams on-site
- To treat specifically waste water on-site or off-site.

In addition, some specific techniques regarding the treatment of waste containing mercury are the following:

a) Pretreat the waste containing mercury as follows:

- Shredding/crushing of batteries and button cells.
- Sorting/breaking/separating of thermometers and contactors.
- Centrifuging the sludge containing mercury in order to remove most of the metallic mercury. The residual sludge has a low content of mercury and is treated in the vacuum distillation process.
- Shredding/sieving the gas discharge lamps, removing the iron and separating it in fractions. The fluorescent powder containing mercury is treated in the vacuum distillation.
- End-cut/air-push treatment of the gas discharge lamps through heating and cooling the ends break. Afterwards, the fluorescent powder containing mercury is blown out (airpush).

A selection unit can be added to this pretreatment technique. This detects the powders in order to selectively blow them out. Re-use of the powders is possible

b) Carry out the following sequence of treatments:

- Separate and concentrate the mercury by evaporation and condensation
- Treat the off gases with dust filters and activated carbon filters
- Return the dust and the contaminated carbon from the gas treatment into the process

c) Treat the distillate (water and organic fractions) by:

- Incineration in a waste incinerator
- Conducting the gases from the distillation through an after-burner (at approximately 850 ºC) and a condenser. The off-gases are cleaned by flue-gas treatment (e.g. scrubber, dust filter and activated carbon filter). The separated dust and the contaminated carbon are returned to the distillation vessel. This alternative raises the recovery rate.
- Purifying the water fraction (after separation) and returning the deposit to the distillation vessel. This alternative raises the recovery rate.

In a thermal soil remediation plant, with a throughput of 2 t/h of soil containing mercury and with mercury raw gas concentrations of up to 20 mg/Nm3, a maximum removal rate of 99.9 % has been reported. It has also been reported that the mercury content of the soil (1

- 300 mg/kg) decreased to less than 5 mg/kg following thermal treatment. Another treatment reported a resulting percentage of the mercury emitted to the air as being 0.0015 %. The emissions range from 0.04 to 0.2 mg/Nm3.

In the vacuum distillation of the sludge containing mercury (1 – 4 % mercury), 99.6 % of the mercury is recovered. About 0.1 % of the mercury is left in the residue and about 0.15 % comes along with the distillate, which is to be incinerated. The latter percentage ends up in the off-gases. By means of the activated carbon filter, 99.9 % of this mercury is separated. The maximum concentration of mercury in the residue is 50 mg/kg DM.

Vacuum distillation is applicable to sludge containing mercury from the oil and gas production industry, batteries, catalysts, activated carbon filters, thermometers, waste from the dental sector, fluorescent tubes, blasting grit and soil. Different waste streams are separately treated in the vacuum distillation. The capacities of the example installations range from 300 to 600 t/yr of waste containing mercury.

6.3.2 Waste incineration

Mercury emissions are associated from the incineration of municipal, medical and hazardous waste. The only relevant primary techniques for preventing emissions of mercury to air are those which prevent or control, if possible, the inclusion of mercury in the waste (EC, 2006a):

- Efficient separate collection of waste that may contain heavy metals e.g. cells, batteries, dental amalgams, etc.
- Notification of waste producers of the need to segregate mercury.
- Identification and/or restriction of receipt of potential mercury contaminated wastes:
    - By sampling and analysis of wastes where this is possible.
    - By targeted sampling/testing campaigns.
- Where such wastes are known to be received - controlled addition to avoid overload of abatement system capacity.

As for secondary techniques, the selection of a process for mercury abatement depends upon the load fed in and upon the chlorine content of the burning material. At higher chlorine contents, mercury in the crude flue gas will be increasingly in the ionic form which can be deposited in wet scrubbers. This is a particular consideration at sewage sludge incineration plants where raw gas chlorine levels may be quite low. If, however, the chlorine content in the (dry) sewage sludge is 0.3 % by mass or higher, only 10 % of the mercury in the clean gas is elemental; and the elimination of only the ionic mercury may achieve a total Hg emission level of 0.03 mg/Nm³.

Metallic mercury can be removed from the flue-gas stream by:

- Transformation into ionic mercury by adding oxidants and then deposited in the scrubber -the effluent can then be fed to waste water treatment plants with heavy metal deposition, where the mercury can be converted to a more stable form (e.g. HgS), thus more suitable for final disposal or
- Direct deposition on sulphur doped activated carbon, hearth furnace coke, or zeolites.

The use of an overall flue-gas treatment (FGT) system, when combined with the installation as a whole, generally provides for the operational emission levels of dust and mercury listed in Table 48 for releases to air associated with the use of BAT.

Table 48. Operational emission level ranges associated with the use of BAT for releases to air (in mg/Nm3 or as stated).

Substance(s)	Non-continuous samples	½ hour average	24 hour average	Comments
Total dust		1 – 20	1 – 5	In general the use of fabric filters gives the lower levels within these emission ranges. Effective maintenance of dust control systems is very important. Energy use can increase as lower emission averages are sought. Controlling dust levels generally reduces metal emissions too.
Mercury and its compounds (as Hg)	<0.05	0.001 – 0.03	0.001 – 0.02	Adsorption using carbon based reagents is generally required to achieve these emission levels with many wastes -as metallic Hg is more difficult to control than ionic Hg. The precise abatement performance and technique required will depend on the levels and distribution of Hg in the waste. Some waste streams have very highly variable Hg concentrations – waste pretreatment may be required in such cases to prevent peak overloading of FGC system capacity. Continuous monitoring of Hg is not required by Directive 2000/76/EC but has been carried out in some MSs

In addition, the 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution sets that the best available technology for dedusting in municipal, medical and hazardous waste incineration is the use of fabric filters in combination with dry or wet methods for controlling volatiles. Electrostatic precipitators in combination with wet systems can also be designed to reach low dust emissions, but they offer fewer opportunities than fabric filters especially with pre-coating for adsorption of volatile pollutants.

Table 49 shows the most important available control measure for mercury emissions due to municipal, medical and hazardous waste incineration.

Table 49. Emission sources and control measures for municipal, medical and hazardous waste incineration. Source: 1998 Protocol on Heavy Metals, Convention on Long-range Transboundary Air Pollution.

Emission source	Control measure	Reduction efficiency (%)
Stack gases	High-efficiency scrubbers	Hg:ca.50
	Carbon injection + FF	Hg>85
	Carbon bed filtration	Hg>99

6.4 Level of implementation in the Mediterranean region

Table 50 shows the available information on the level of implementation of technologies to prevent mercury emissions and the level of substitution of mercury-containing products in Mediterranean countries, obtained from UNEP (2008b) and the answers to the questionnaires handed out for this report.

Table 50. Available information on substitution of mercury-containing products in Mediterranean countries

Country	Product	Level of substitution	Source
Algeria	Chlor-alkali production	Substitutes available in market but minimally used	Questionnaire
Algeria	Vinyl chloride monomer (VCM) production	Substitutes available in market but minimally used	Questionnaire
Algeria	Pesticide and biocides	Substitutes available in market and commonly used.	Questionnaire
Egypt	Batteries	Substitutes available in market and commonly used	Questionnaire
Egypt	Chlor-alkali production	Gas stream cooling, mist eliminators, scrubbers, adsorption on activated carbon and membrane process are available in market and commonly used	Questionnaire
Egypt	Coal combustion	Mercury-reducing measures (i.e. shifting to low-mercury coal; pre-combustion coal wash; post-combustion equipment for the flue gas emission reduction.) available in market and commonly used	Questionnaire
Egypt	Cosmetics	Substitutes available in market and commonly used	Questionnaire
Egypt	Dental amalgams	Substitutes available in market but minimally used	Questionnaire
Egypt	Electrical and electronic components (except batteries and light sources).	Substitutes available in market but minimally used	Questionnaire
Egypt	Light sources.	Substitutes available in market but minimally used	Questionnaire
Egypt	Measuring and control devices (except thermometers).	Substitutes available in market but minimally used	Questionnaire
Egypt	Paints	Substitutes available in market and commonly used	Questionnaire
Egypt	Pesticides and biocides.	Substitutes available in market and commonly used	Questionnaire
Egypt	Pharmaceuticals	Substitutes available in market and commonly used	Questionnaire
Egypt	Primary extraction and processing of mercury	Condensers to remove mercury are available in market but minimally used	Questionnaire
Egypt	Production of other minerals and materials with mercury impurities (cement production, pulp and paper production)	Dust removal systems and use of alternative fuels are available in market but minimally used	Questionnaire
Egypt	Production of recycled mercury	Activated-charcoal filtered exhaust systems and scrubbers are available in market but minimally used	Questionnaire
Egypt	Thermometers	Substitutes available in market but minimally used	Questionnaire
Egypt	Vinyl chloride monomer (VCM) production	Adsorption on activated carbon are available in market but minimally used	Questionnaire
Egypt	Waste incineration	Wet scrubbers (sludge incinerators) and flue gas cleaning are available in market but minimally used	Questionnaire
Egypt	Waste treatment, disposal, deposition/ landfilling	Separating mercury containing items from the waste stream, special designed landfills for hazardous wastes and collection centres for small quantities of hazardous wastes are available in market but minimally used	Questionnaire
France	Batteries	EU ban on mercury-containing batteries, with exemptions	UNEP, 2008b
France	Chlor-alkali production	50% of chlorine is produced with mercury-free techniques	
France	Dental amalgams	Substitutes available and minimally used	UNEP, 2008b
France	Light sources	No available substitutes for mercury lamps (this	UNEP, 2008b

Country	Product	Level of substitution	Source
		indication does not presumably take into account incandescent and halogen lamps as substitutes)	
France	Thermometers	Mercury-free thermometers are currently used	UNEP, 2008b
Slovenia	Coal combustion	Measures available but minimally used	Questionnaire
Slovenia	Primary extraction and processing of mercury	Measures available but minimally used	Questionnaire
Slovenia	Production of other minerals and materials with mercury impurities (cement production, pulp and paper production)	Measures available in the market and commonly used	Questionnaire
Slovenia	Chlor-alkali production	Substitutes available in market and commonly used.	Questionnaire
Slovenia	Dental amalgams	Substitutes for mercury amalgams are currently available in the market and commonly used	Questionnaire
Slovenia	Thermometers	Mercury-containing thermometers are currently available in the market and commonly used	Questionnaire
Slovenia	Measuring and control devices (except thermometers).	Substitutes available but minimally used	Questionnaire
Slovenia	Electrical and electronic components (except batteries and light sources).	Substitutes available but minimally used	Questionnaire
Slovenia	Light sources	Substitutes available in market and commonly used.	Questionnaire
Slovenia	Batteries	Substitutes available and commonly used for mercury-containing batteries	Questionnaire
Slovenia	Pesticides and biocides	Substitutes available in market and commonly used	Questionnaire
Slovenia	Paints	Substitutes available in market and commonly used	Questionnaire
Slovenia	Pharmaceuticals	Substitutes available in market and commonly used	Questionnaire
Slovenia	Cosmetics	Substitutes available in market and commonly used	Questionnaire
Slovenia	Waste incineration	Measures available but minimally used	Questionnaire
Slovenia	Waste treatment, disposal, deposition/ landfilling	Measures available but minimally used	Questionnaire
Syria	Thermometers	mercury thermometers are replaced by alcohol and digital electronic thermometers	UNEP, 2008b
Tunisia	Chlor-alkali production	The only chlor-alkali plant in Tunisia adopted in 1998 a mercury-free membrane process.	Questionnaire
Turkey	Pesticides and biocides	Mercury is not used in pesticides and biocides.	Questionnaire
Turkey	Thermometers	Mercury usage in thermometer is forbidden since 2007-	Questionnaire

7. Emission limit values and quality objectives

7.1 International framework

7.1.1 The 1998 Aarhus Protocol on Heavy Metals

As already mentioned in section 2.1.5, the Aarhus Protocol aims at cutting emissions of three particularly harmful metals: cadmium, lead and mercury from industrial sources (iron and steel industry, non-ferrous metal industry), combustion processes (power generation, road transport) and waste incineration targets. For this purpose, it lays down stringent limit values for emissions from stationary sources and suggests best available techniques (BAT) for these sources.

In particular, each Party shall apply the limit values specified in annex V of the Protocol to each existing stationary source within a major stationary source category specified in annex II, by the implementation of the Best Available Techniques (BAT) described in annex III, insofar as this are technically and economically feasible.

Table 51 shows limit values for each stationary source. As can be observed, two types of limit value are established for heavy metal emission control:

- Values for specific heavy metals or groups of heavy metals.
- Values for emissions of particulate matter in general.

Specific emission limit values for mercury are only defined for chlor-alkali installations with respect to their production capacity and for air emissions from hazardous and municipal waste incinerators.

Most limit values are defined for particulate matter, which cannot replace specific limit values for cadmium, lead and mercury, because the quantity of metals associated with particulate emissions differs from one process to another. However, compliance with these limits contributes significantly to reducing heavy metal emissions in general

Table 51. Specific limit values for selected major stationary sources set in annex V of Aarhus Protocol on Heavy Metals.

Combustion of fossil fuels (annex II, category 1): ▪ Limit values refer to 6% O_2 in flue gas for solid fuels and to 3% O_2 for liquid fuels. ▪ Limit value for particulate emissions for solid and liquid fuels: **50 mg/m³.**
Sinter plants (annex II, category 2): ▪ Limit value for particulate emissions: **50 mg/m³.**
Pellet plants (annex II, category 2): ▪ Limit value for particulate emissions: (a) Grinding, drying: 25 mg/m³; and (b) Pelletizing: 25 mg/m³; or ▪ Limit value for total particulate emissions: **40 g/Mg of pellets produced.**

Blast furnaces (annex II, category 3):

- Limit value for particulate emissions: **50 mg/m3.**

Electric arc furnaces (annex II, category 3):

- Limit value for particulate emissions: **20 mg/m3.**

Production of copper and zinc, including Imperial Smelting furnaces (annex II, categories 5 and 6):

- Limit value for particulate emissions: **20 mg/m^3.**

Production of lead (annex II, categories 5 and 6):

- Limit value for particulate emissions: **10 mg/m^3.**

Cement industry (annex II, category 7):

- Limit value for particulate emissions: **50 mg/m^3.**

Glass industry (annex II, category 8):

- Limit values refer to different O_2 concentrations in flue gas depending on furnace type: tank furnaces: 8%; pot furnaces and day tanks: 13%.
- Limit value for lead emissions: **5 mg/m^3.**

Chlor-alkali industry (annex II, category 9):

- Limit values refer to the total quantity of mercury released by a plant into the air, regardless of the emission source and expressed as an annual mean value.
- Limit values for existing chlor-alkali plants shall be evaluated by the Parties meeting within the Executive Body no later than two years after the date of entry into force of the present Protocol.
- Limit value for new chlor-alkali plants: **0.01 g Hg/Mg Cl_2 production capacity.**

Municipal, medical and hazardous waste incineration (annex II, categories 10 and 11):

- Limit values refer to 11% O_2 concentration in flue gas.
- Limit value for particulate emissions:

  (a) **10 mg/m^3** for **hazardous and medical waste incineration;**

  (b) **25 mg/m^3** for **municipal waste incineration.**
- Limit value for mercury emissions:

  (a) **0.05 mg/m^3** for hazardous waste incineration;

  (b) **0.08 mg/m^3** for municipal waste incineration;

  (c) Limit values for mercury-containing emissions from medical waste incineration shall be evaluated by the Parties meeting within the Executive Body no later than two years after the date of entry into force of the present Protocol.

7.1.2 World Health Organisation (WHO)

As already mentioned in section 2.1.7, WHO has recommended a **Provisional Tolerable Weekly Intake (PTWI) for methylmercury of 1.6 µg per kg body weight per week** in order to sufficiently protect the developing foetus. This recommendation changed the prior recommendation for a dietary limit of 3.3 µg per kg body weight per week.

In addition, a **drinking-water guideline** value for health-related organics (applies to all forms of mercury) has been established in **1.0 µg/L.**

7.1.3 OSPAR Convention

There are several recommendations both on limits values and quality objectives under OSPAR to reduce mercury emissions, discharges and losses from specific sectors, being those related to the chlor-alkali industry and to sectors other than the chlor-alkali industry the most relevant.

7.1.3.1 Limit values

Regarding the chlor-alkali industry, PARCOM Recommendation on Limit Values for Mercury Emissions in Water from Existing Brine Recirculation Chlor-Alkali Plants (exit of factory site) sets, from 1 July 1986, a limit value of **0.5 g of mercury per tonne of chlorine production** capacity as a monthly mean and **2 g of mercury per tonne as a daily mean.**

As for other sectors, PARCOM Decision 85/1 on Programmes and measures of 31 December 1985 on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry establishes the limit values indicated in Table 52 to be complied as from July 1989.

Table 52. Limit values for mercury discharges by sectors other than the chlor-alkali electrolysis industry.

Industrial sector	Limit value	
1. Chemical industries using mercury catalysts: a. in the production of vinyl chloride	0.05 0.1	mg/l effluent g/t vinyl chloride production capacity
b. in other processes	0.05 5	mg/l effluent g/kg mercury processed
2. Manufacture of mercury catalysts used in the production of vinyl chloride	0.05 0.7	mg/l effluent g/kg mercury processed
3. Manufacture of organic and non-organic mercury compounds (expect for products referred to in paragraph 2)	0.05 0.05	mg/l effluent g/kg mercury processed

Industrial sector	Limit value	
4. Manufacture of primary batteries containing mercury	0.05 0.03	mg/l effluent g/kg mercury processed
5. Non-ferrous metal industry a. Mercury recovery plants	0.05	mg/l effluent
b. Extraction and refining of non-ferrous metals	0.05	mg/l effluent
6. Plants for the treatment of toxic wastes containing mercury	0.05	mg/l effluent

7.1.3.2 Quality objectives

Ecological Quality Objectives (EcoQOs) have been developed as tools to help the OSPAR and the North Sea Conference process to apply the ecosystem approach to the management of human activities that may affect the marine environment. Where these EcoQOs are met, the marine ecosystem is considered to be in a healthy condition. Where EcoQOs are not met, the responsible authorities should take steps to protect the marine environment from any relevant adverse effect caused by human activities.

The EcoQOs cover different aspects of the ecosystem, including plankton, benthic organisms, fish, sea birds and marine mammals, and also habitats. Most objectives can be linked to specific human activities. EcoQOs can take the form of targets (values where there is a commitment to attain them), limits (values where there is a commitment to avoid breaching them) or indicators (values which highlight a change in the ecosystem and can trigger research to explain what is happening).

In particular, the EcoQO system proposes the following quality objectives on mercury in seabird eggs for Common Tern and Oystercatcher (OSPAR Commission, 2007) based on concentrations in feathers in non-industrial sites:

- 0.1 mg/kg (Oystercatcher)
- 0.2 mg/kg (Common Tern)

In addition, PARCOM Decision 85/1 sets the following quality objectives regarding mercury discharges by sectors other than the chlor-alkali electrolysis industry:

- The concentration of mercury in a representative sample of fish flesh chosen as an indicator must not exceed 0.3 mg/kg wet fish.
- The concentration of mercury in solution in estuary waters up to the freshwater limit affected by discharges must not exceed 0.5 μg/l as the arithmetic mean of the results obtained over a year.

- The concentration of mercury in solution in the following waters[48] must not exceed 0,3 μg/l as the arithmetic mean of the results obtained over a year:
    a. territorial waters
    b. waters, other than estuary waters, on the landward side of the base line from which the breadth of the territorial sea is measured and extending in the case of watercourses up to the freshwater limit.

7.1.4 European Union

7.1.4.1 Emission limit values

As described in section 2.2.3, Directive 2008/1/EC on Integrated Pollution Prevention and Control (IPPC) establishes that industrial and agricultural activities with a high pollution potential are required to obtain a permit issued by the competent authority. The decision to issue a permit must contain a number of specific requirements, including, among others, emission limit values for polluting substances such as mercury and mercury compounds. These emission limit values (or equivalent parameters or technical measures) have to take account of the "Best Available Techniques" (BAT) for the sector, the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. For this reason, general emission limit values for industrial and agricultural activities are not established by European legal framework.

However, there are some exceptions such as waste incineration, regulated by Directive 2000/76/EC which sets general European Union emission limit values for pollutants to air. In particular, the air emission limit value for mercury and its compounds, expressed as mercury (Hg) is **0.05 mg/m^3** and the emission limit value for discharges of waste water from the cleaning of exhaust gases for mercury and its compounds, expressed as mercury (Hg) is **0.03 mg/l.**

Also in the field of waste management, Directive 86/278/EEC which regulates the use of sewage sludge in agriculture sets the soil limit value for mercury in **1 to 1.5 mg/kg** of dry matter for soils with a pH higher than 6 and lower than 7.

As for waste landfill, Council Decision 2003/33/EC establishes the limit concentration of Hg in waste leachate for the **inert waste landfill (0.01 mg/kg of dry matter);** for the **non-hazardous waste landfill (0.2 mg/kg of dry matter)** and for **hazardous waste landfill (2 mg/kg of dry matter).**

7.1.4.2 Quality objectives

The European Union has approved environmental quality standards in the field of water policy (Directive 2008/105/EC). **Environmental Quality Standards** (EQS)[49] as Annual Average (AA) in surface waters for mercury is **0.05** µg/l and **Maximum Allowable Concentration** (MAC) is **0.07** µg/l.

As for **drinking water** (Directive 98/83/EC) mercury quality standard is **1.0 µg/l.**

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[48] A quality objective for the high seas is not fixed on the understanding that the quality objective for territorial waters and other waters will protect the high seas from pollution.

[49] 'Environmental quality standard' means the concentration of a particular pollutant or group of pollutants in water, sediment or biota which should not be exceeded in order to protect human health and the environment (Article 2, Directive 2000/60/EC).

7.1.5 Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)

In the framework of the obligations derived from Convention for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources and Activities (entered into force in 2008), the LBS Protocol lays down (Article 5) that the Contracting Parties shall eliminate pollution of the Protocol Area from Land-Based Sources. The substances that should be avoided are those listed in Annex I ("Black list of substances") to the Protocol. In order to do that, they shall elaborate and implement the necessary programmes and measures, which shall include, in particular, common emission standards and standards of use.

Up to October 1995, the Contracting Parties to the Barcelona Convention and Protocols adopted the two common measures for the control of mercury pollution (UNEP/MAP, 1995). First, measures to prevent mercury pollution to the Mediterranean Sea agreed in the 5th meeting of Barcelona Convention (UNEP/IG.74/5) establish a maximum concentration (to be calculated as a monthly average) of **50 ug mercury per litre** (expressed as total mercury) for all effluent discharges before dilution into the Mediterranean sea. Second, in the 4th meeting of Barcelona Convention (UNEP/IG.56/5) and on the basis of the assessment of the quality of Mediterranean seafood with regard to its mercury content prepared by FAO/UNEP, the Contracting Parties took note of the interim criterion proposed by the joint FAO/WHO Committee of Experts on food additives. According to this criterion, the **Provisional Tolerable Weekly Intake of 0.3 mg of mercury** for a person of 70 Kg bodyweight, of which not more than 0.2 mg should be methylmercury, should not be exceeded;

Furthermore, the Strategic Action Programme (SAP MED), as seen in section 2.2.1, proposes targets and activities, both at regional and national level, for heavy metals (Hg, Cd and Pb) by the year 2025. Among the activities at national level, the adoption of the following emission limit values is proposed:

- To adopt at the national level and apply the common measures for preventing mercury pollution adopted by the Parties in 1987 (**releases into the sea**, max. conc. **0.050 mg/l**).
- To adopt and apply for the industries of the alkaline chloride electrolysis sector, as well as the previous standard, the maximum value of **0.5 grams of mercury in the water per tonne of chlorine production capacity installed** (brine recirculation), 5 grams of mercury in the water per tonne (lost brine technology) and, if possible, 2 g of mercury from total releases into water, air and products).

7.2 National framework

Mercury emission limit values and quality objectives have been analysed for this report for Mediterranean countries, with two objectives: 1) analysing their consistency with international mercury standards; 2) obtaining a regional overview on the implementation of mercury standards. According to the answers to the questionnaire handed out for the present diagnosis, most Mediterranean countries have legislation prescribing quality objectives and maximum allowable releases of mercury from industrial and other facilities to air, water and soil. Also, legislation has been implemented preventing or limiting the release of mercury from processes to the wastewater system. In particular, releases to the water recipient and the use of the sludge as fertiliser on agricultural land were regulated.

As described in section 7.1.4.1, in EU Member States and other Mediterranean countries, most emission limit values for industrial and agricultural activities are regulated by competent local authorities. The limits are established according to the technical characteristics of the installation concerned, its geographical location and the local environmental conditions, as well as the “Best Available Techniques” (BAT) for the sector.

A summary of the main international and national mercury standards within the Mediterranean region is shown in Table 53. It can be observed that mercury standards are heterogeneous within the Mediterranean countries. The most common regulated issues are waste incineration, soil, discharges to water, emissions to air and water quality objectives. However, some national standards are found to mostly match with the corresponding international standards, i.e.:

- EU mercury standards on waste incineration, which are adopted by Croatia, Israel and Turkey, as well as by EU Mediterranean countries.
- Water quality criteria for human consumption recommended by the WHO, which are adopted by Croatia, Greece, Israel, Italy, Spain and Tunisia.

The emission limits in other fields vary among the Mediterranean countries and depend on the following factors:

- Air emission limit values differ between industrial sectors and technologies, e.g. chlor-alkali plants.
- Emission limit values for wastewater discharges depend on the receiving environment and subsequent treatment.
- Air, water and soil quality standards depend on the geographical location, local conditions and potential uses.

As seen in section 2.3, only few countries reported to have regulated mercury standards arising from the 4th and 5th ordinary meetings of the contracting parties of Barcelona Convention regarding, respectively, maximum concentration of mercury in seafood and quality criteria for bathing waters (UNEP/IG.56/5) and maximum concentration of mercury for discharges into the Mediterranean Sea (UNEP/IG.74/5).

Table 53. Mercury emission limits values and quality objectives at international level and Mediterranean national level.

Country	Quality Standards	Emissions Limit Values	Quality Standards	Quality for human consumption	Quality for bathing	Discharges	Other	Hg pollution prevention to Mediterranean (UNEP/IG.74/5)	Landfill	Incineration	Soil	Workplace	Foodstuff	Hg in seafood and bathing quality (UNEP/IG.56/5)
LRTAP Convention - Aarhus Protocol						Chloralkali (new plants): 1.0 g Hg/t Cl_2 (annual mean)				0.05 mg/m3 (HW), 0.08 mg/m3 (MW)				
WHO	1 µg/m³ (annual mean for inorganic mercury vapour)			1 µg/l									1.6 µg per kg body weight per week	
OSPAR Convention			0.5 µg/l estuary waters, 0.3 µg/l other waters			0.05 mg/l Chloralkali: 0.5 g Hg/t Cl_2 (monthly mean) vinyl chloride production: 0.1 g/t, other mercury processes: 0.03-5.0 mg/kg mercury							0.3 mg/kg wet fish	
European Union			Annual Average (AA) in surface waters: 0.05 µg/l - Maximum Allowable Concentration (MAC): 0.07 µg/l.	1 µg/l					Inert: 0.01 mg/kg Non-hazardous: 0.2 mg/kg Hazardous: 2 mg/kg	Waste gas: 0.05 mg/m3 Waste water exhaust gases: 0.03 mg/l	1 mg/kg dry matter soil pH <7 - 1.5 mg / kg dry matter soil pH> 7.			

Country	Quality Standards	Emissions Limit Values	Quality Standards	Quality for human consumption	Quality for bathing	Discharges	Other	Hg pollution prevention to Mediterranean (UNEP/IG.74/5)	Landfill	Incineration	Soil	Workplace	Foodstuff	Hg in seafood and bathing quality (UNEP/IG.56/5)
Barcelona Convention		Chlor-alkali: Total releases (water, air, products): 2 g / t				Chlor-alkali: Brine recirculation : 0.5 g / t Cl_2 Lost brine: 5 g / t Total releases (water, air, products): 2 g / t Cl_2		50 µg/l discharges into sea						Tolerable Weekly Intake of 0.3 mg of mercury for 70 Kg bodyweight
Albania														
Algeria	NO	0.25 mg/Nm3				0.01 mg/l								
Bosnia Herzegovin a														
Croatia	1 µg m^{-3}	0.05-1.0 mg/m3, Chloralkali: 0.01 (news) -1.5 g Hg/t chlorine, Cement: 0.05 mg/m3	0.05 µg/l (annual average) 0.07 µg/l (maximum)	1 µg/l	NO	0.001 mg/l		NO	Inert: 0.01 mg/kg Non-hazardous: 0.2 mg/kg Hazardous: 2 mg/kg	Waste gas: 0.05 mg/m^3 Waste water exhaust gases: 0.03 mg/l	Soil: 0.2 mg/kg soil dry matter (5.0<pH<5.5) - 0.5 mg/kg soil dry matter (5,5<pH<6,5) - 1mg/kg soil dry matter (pH>6,5). Sewage sludge in agriculture: 5 mg/kg		0.3 - 1 ppm	

Country	Quality Standards	Emissions Limit Values	Quality Standards	Quality for human consumption	Quality for bathing	Discharges	Other	Hg pollution prevention to Mediterranean (UNEP/IG.74/5)	Landfill	Incineration	Soil	Workplace	Foodstuff	Hg in seafood and bathing quality (UNEP/IG.56/5)
Cyprus	NO	10-50 mg/m3 (particuled)	0.05 µg/l (annual average) 0.07 µg/l (maximum)	NO	UD	NO		NO	NO	Waste gas: 0.05 mg/m[3] Waste water exhaust gases: 0.03 mg/l				
Egypt		3 mg/m3 from exhaust - Hospital incinerators : 0.1 mg/m3				0.005 mg/l				Hospital incinerators 0.1 mg/m3		Average 8 hrs: Alkyl Compounds 0.01mg/m3 Aryl compounds 0.1mg/m3 Elemental & Inorganic forms 0.025 mg/m3		
France														
Greece				1 µg/l					Inert: 0.01 mg/kg Non-hazardous: 0.2 mg/kg Hazardous: 2 mg/kg	Waste gas: 0.05 mg/m[3] Waste water exhaust gases: 0.03 mg/l				

Country	Quality Standards	Emissions Limit Values	Quality Standards	Quality for human consumption	Quality for bathing	Discharges	Other	Hg pollution prevention to Mediterranean (UNEP/IG.74/5)	Landfill	Incineration	Soil	Workplace	Foodstuff	Hg in seafood and bathing quality (UNEP/IG.56/5)
Israel	In SPM: 1.8 $\mu g/m^3$ hourly - 0.3 µ/m3 yearly	After 2008: 0.05 mg/m3, 0.25 g/h Before 2008: 0.1 mg/m3, 0.5 g/h	0.002 mg/l unrestricted irrigation - 0.005 mg/l discharge to rivers - 0.0004 mg/l marine water	0.001 mg/l	NO	0.05 mg/l discharge - 0.005 mg/l discharge to public sewer systems		marine discharge: 0.005 mg/l (grab sample max)		Waste gas: 0.05 mg/m^3	Residential: 5mg/kg - Industrial: 8 mg/kg - Agriculture: 10 mg/kg - GW protection: 3-20 mg/kg		(mg/kg) Milk 0.01- Dairy products 0.1 - Oil 0.02 - Fruits and vegetables 0.03/0.15 - Seaweeds fresh/dry 0.5/2.5 - Cocoa 0.2 - Cereals 0.03 - Meat 0.2 - Eggs 0.03 - Sugar 0.1 - Salt 0.1 - Baby food 0.004-0.015 - Food additives 0.1 - Beverages (inc. alcoholic) 0.01 - Bottled water 0.001 - Tea raw/readymade 0.05/0.005	0.5 - 1.0 mg/kg Fish 1ppm (UD)
Italy		Chlor-alkali: 0.05 - 5.0 g Hg/t chlorine Other sectors: 0.03-5.0 g Hg /t	Inland waters: 0.03 µg/l - Other surface waters: 0.01 µg/l - MAC 0.6 µg/l	1 µg/l		0,005 mg/l - 0.5-5 g/t Chloralkali - 0.03-5 g/t Others	Sediment 0.3 µg/l - Biota 20 µg/l			Waste gas: 0.05 mg/m^3 Waste water exhaust gases: 0.03 mg/l	Residential: 1mg/kg - Commercial and Industrial: 5 mg/kg			Fishery products 0.5 - 1 mg/kg
Lebanon														
Libya														
Malta														

Country	Quality Standards	Emissions Limit Values	Quality Standards	Quality for human consumption	Quality for bathing	Discharges	Other	Hg pollution prevention to Mediterranean (UNEP/IG.74/5)	Landfill	Incineration	Soil	Workplace	Foodstuff	Hg in seafood and bathing quality (UNEP/IG.56/5)
Monaco	NO	NO	NO	NO	NO	NO							NO	
Montenegro														
Morocco	UD	UD	UD			0,05-0,1 mg/l								
Slovenia									Hazardous waste landfills: 3 mg/kg d. m. Inert waste landfills: 10 mg/kg d.m. Eluate at all landfills: Soil: limit value (mg/kg d. s.l): 0.8 warning value (mg/kg d. s.): 2 critical value (mg/kg d. s.): 10	Waste gas: 0.05 mg/m3 Waste water exhaust gases: 0.03 mg/l	Soil: limit value (mg/kg dry soil): 0.8 warning value (mg/kg dry soil): 2 critical value (mg/kg dry soil): 10			
Spain			Chlor-alkali: surface water quality objective: 1µg / l	1 µg/l		0,05 - 0,1 mg/l - Chlor-alkali: discharges <50 µg/l (monthly average), recycled brine: monthly average <0.5 g / t other evacuations <1 g / t. - Vinyl chloride production: 0.1 g / t		from land to sea: 0,05 mg/l.	Inert: 0.01 mg/kg Non-hazardous: 0.2 mg/kg Hazardous: 2 mg/kg	Waste gas: 0.05 mg/m^3 Waste water exhaust gases: 0.03 mg/l	Soil: 1 mg/kg dry matter soil pH <7 - 1.5 mg / kg dry matter soil pH> 7. Sewage sludge: 16 mg/kg dry matter soil pH <7 - 25 mg/kg dry matter soil pH> 7			

Country	Quality Standards	Emissions Limit Values	Quality Standards	Quality for human consumption	Quality for bathing	Discharges	Other	Hg pollution prevention to Mediterranean (UNEP/IG.74/5)	Landfill	Incineration	Soil	Workplace	Foodstuff	Hg in seafood and bathing quality (UNEP/IG.56/5)
Syria														
Tunisia		UD	imperative value: 0,001 mg/l - guidance value: 0,0005 mg/l	0,001 mg/l.	NO	0.001 mg / l for the maritime and hydraulic public domain - 0.01 mg / l for public drainage.					Soil: Inorganic mercury: 36 mg/ kg dry matter - Organic mercury : 4 mg/ kg dry matter		0.5. 10^{-6} g	
Turkey	UD	20 mg/Nm3 (present) 0.2 mg/Nm3 (from 01.01.2012) 0.05 mg/Nm3 (For solid fuels other than coal and wood)	0.05 µg/l (annual average) 0.07 µg/l (maximum)		0.004 mg/L				For inert waste-≤ 0.001; For Non-hazardous waste 0.001– 0.02; For hazardous waste- < 0.02– 0.2	Waste gas: 0.05 mg/m^3 Waste water exhaust gases: 0.03 mg/l	Sewage sludge in agriculture: 5 mg/kg			

8. Networks and tools for monitoring and control of mercury

8.1 Emission inventories

8.1.1 UNEP Mercury Programme & the "Paragraph 29 Study"

At its 25th session, the Governing Council agreed to elaborate a legally binding instrument on mercury. It asked UNEP to convene an intergovernmental negotiating committee (INC) with the mandate to prepare the legally binding instrument, commencing its work in 2010. The first session of the committee will be held in Stockholm, Sweden, from 7 to 11 June 2010.

To inform the INC the Governing Council at its 25th session requested the Executive Director of UNEP to develop a study on various mercury emitting sources ("The paragraph29 study"), including future trends and a cost-benefit analysis of alternative control strategies and measures.

To perform this study, information is currently being collected from a number of countries, making use of targeted questionnaires. The draft outline of the study was presented at the Ad hoc open-ended working group meeting in Bangkok (19-23 October 2009), and the "Zero Draft Report" has been recently issued (UNEP/DTIE, 2010).

This report provides a summary of available knowledge on mercury emissions to air; short description of the sectors selected for this study; where mercury enters the processes and where/how it is released to air; control options and the associated costs. It is based on reports on global mercury emissions in 2005 and qualitative assessment of costs and efficiencies of control options, prepared for UNEP (AMAP/UNEP, 2008)[50], as well as recent information available from the open literature on emissions, control options and costs. This Zero Draft report also contains an overview of future scenarios for mercury emissions and initial assumptions to be used in the preparation of scenario calculations during Phase 2 of the study. The main results of this report are presented below, to provide an overview of the estimated share of mercury sources at global level, that might be used later on to identify Mediterranean specificities when compared with regional and national inventories.

8.1.1.1 Sources of global atmospheric emissions

The estimated global anthropogenic emissions of mercury to air in 2005 from the various sectors are presented in Table 54 and Figure 12, and totally accounts for 1921 tonnes. Stationary combustion of coal is the largest single source category of anthropogenic mercury emission to air, represented in Figure 12 by coal combustion in power plants (26%) and by residential and other combustion (20%). Artisanal and small-scale gold production accounts for 17% of global emissions (323 tonnes), followed by cement production (10%), non-ferrous metal production (7% -mostly in China-), and large-scale gold production (6%). Large scale waste incineration represented 2% of global emissions, while the total emissions of mercury from the waste sector (i.e. including small scale burning, emissions from waste land-fills) represent an additional 4 % of the global total.

[50] The global inventory of anthropogenic emissions to air for 2005, described in UNEP/AMAP (2008) and summarized in UNEP (2008) was the most comprehensive such inventory presented to date. A revision was undertaken in 2010, which for 2005 resulted in only small changes in the global total emissions of mercury to air.

Table 54. Estimated global anthropogenic emissions of mercury to air in 2005 from various sectors (adapted from UNEP/DTIE, 2010).

Sector	Emissions	
	Tonnes	Percentage
Coal combustion in power plants and industrial boilers	498	26%
Residential heating/other combustion	382	20%
Artisanal and small-scale gold production	323	17%
Cement production	189	10%
Non-ferrous metals	132	7%
Large scale gold production	111	6%
Other waste	74	4%
Pig iron and steel, secondary steel	61	3.2%
Chlor alkali industry	47	2.4%
Waste incineration	42	2.2%
Dental amalgam (cremation)*	27	1.4%
Other	26	1.4%
Mercury production	9	0.5%
TOTAL	1,921	100%

* Does not include other releases from production, handling and disposal of dental amalgam

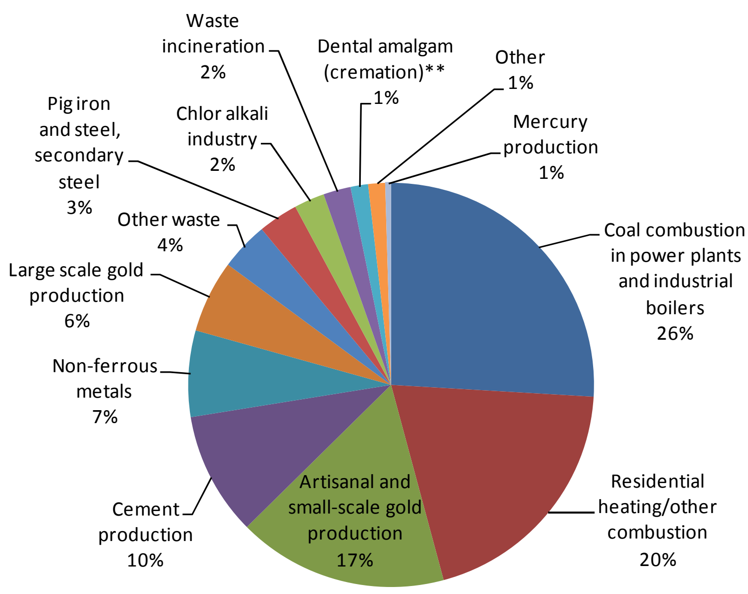


Figure 12. Proportion of global anthropogenic emissions of mercury to air in 2005 from various sectors (adapted from UNEP/DTIE, 2010).

UNEP has prioritized five sectors (coal combustion in power plants and industrial boilers, non-ferrous metals, large scale gold production, cement production and waste incineration), due to their respective relative contribution to global emissions of mercury to air (51% in total), and as being sectors largely consisting of point sources with high temperature combustion or processes where installation and use of similar technical emission control equipment is feasible.

8.1.1.2 Trends in global atmospheric emissions

According to the revised estimates, by-product emissions have increased somewhat from 1990 to 2005, while the intentional use emissions have decreased over the same period of time (Figure 13). Overall, when adding by-product and intentional use sources the level of mercury emissions to air on the global scale has been relatively stable from 1990-2005 and with small variations.

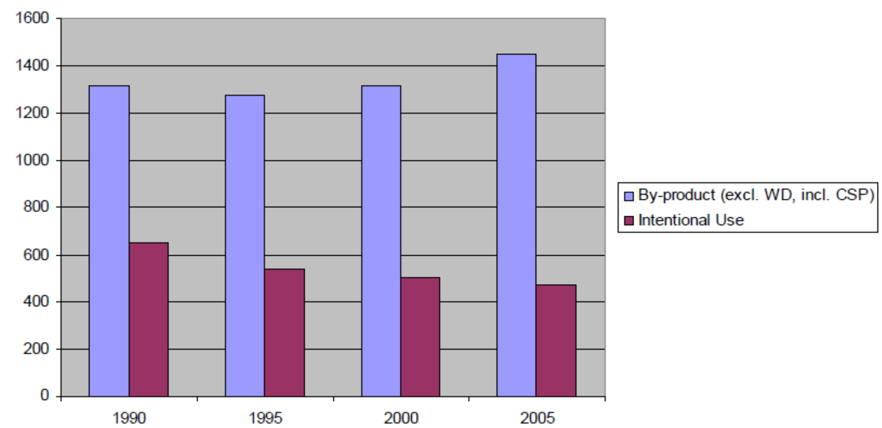


Figure 13. Total global anthropogenic mercury emissions to air (tonnes) from 'by-product' and 'intentional-use' emission sectors in 1990, 1995, 2000 and 2005 (WD=Waste Disposal, CSP=Caustic Soda Production) (UNEP/DTIE, 2010).

8.1.1.3 Emissions by geographic region

Even though the level of global emissions of mercury to air has been relatively stable since 1990, there has been a considerable regional shift in where the emissions originate. Regional trends in (combined) emissions from 'by-product' and 'intentional-use' sectors for 1990, 1995, 2000 and 2005 are summarized in Figure 14. The figure shows that anthropogenic mercury emissions to air have increased substantially in Asia and to a much lesser extent in Africa and South America, while emissions in Europe, Europe-Asia (Russia) and North America have decreased from 1990 to 2005.

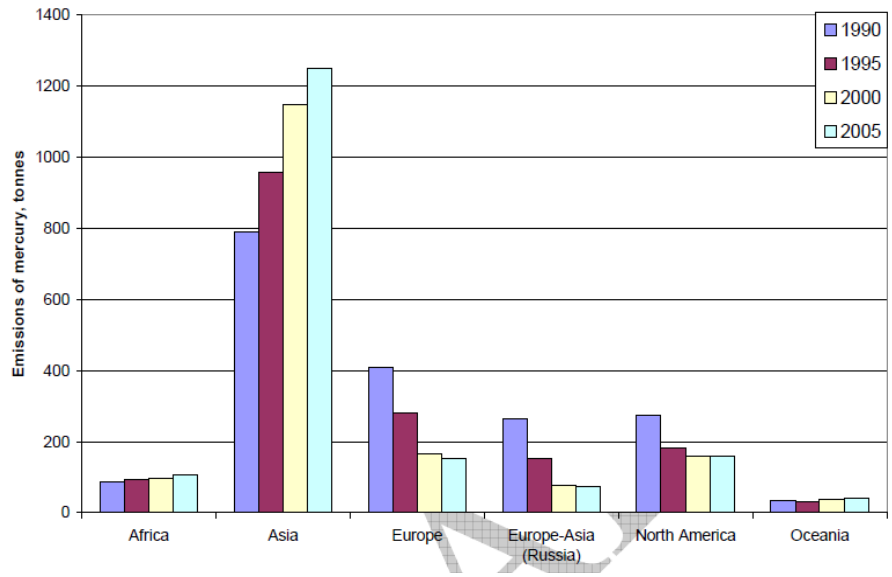


Figure 14. Revised estimates of anthropogenic mercury emissions to air tonnes) in 1990, 1995, 2000 and 2005 from different continents/regions (UNEP/DTIE, 2010).

In 2005 the Asian countries contributed about 67 percent to the global mercury emissions to air from anthropogenic sources, followed by North America and Europe. From the compiled inventory data, it is possible to rank individual countries by their emissions. China, with its more than 2000 coal-fired power plants, is the largest single emitter of mercury to air worldwide, by a large margin. Together, three countries, China, India, and the United States are responsible for 57 percent of the total estimated global emissions of mercury to air in 2005 (1097 out of 1921 tonnes).

8.1.1.4 Specific emissions in the Mediterranean countries

The inventory on which the previous data is based on, i.e. the 2005 global inventory of atmospheric mercury emissions (AMAP/UNEP, 2008), included a country breakdown of estimated emissions. Specific data for Mediterranean countries have been collected from this inventory, which is shown in Table 55. As it can be observed, Turkey was estimated to be the major emitting country in the Mediterranean, with about 18 tonnes (27%), followed by Italy (13t; 19%), Spain (10t; 15%) and France (9t; 13%). These four countries account for almost 75% of total emissions in the Mediterranean region. Egypt would be the first emitting country in the southern region. The total emissions in the Mediterranean region were estimated in about **68 tonnes**, i.e., 3.5% of global mercury air emissions in 2005 (1921 t).

Table 55. Estimated global anthropogenic emissions (in Kg) of mercury to air in 2005 from various sectors, in Mediterranean countries. Source of data: AMAP/UNEP, 2008.

Country	Stationary combustion	Metal production	Cement production	Large-scale gold production	Mercury production (primary sources)	Incineration of MSW	Caustic soda production	Other sources	Total
Turkey	13,149.7	1,287.9	3,424				250		18,111.6
Italy	5,324.9	2,481.9	3,092.7			675.3	1,304.9		12,879.7
Spain	4,898.4	898.6	3,508.8			163.4	613.6	99.1	10,181.9
France	4,795.7	617.1	547.6			1,195.9	818	790.8	8,765.1
Egypt	700.1	190.4	2,880				125		3,895.5
Greece	1,587.1	65.9	1,036.2			7.3	78.5	417.2	3,192.2
Israel	2,771.6	12	408						3,191.6
Morocco	1,156.6	0.2	880	60.4	2				2,099.2
Algeria	306.08	216	1,024	24.2					1,570.3
Malta	586.8	0				30.9		0.3	618.0
Tunisia	15.6	2.4	536						554.0
Libya	167.6	52	288						507.6
Syria	124.5	2.8	376						503.3
Croatia	291.9	0	118.8			7.2		3.1	421.0
Slovenia	300	96.2	17.6						413.8
Lebanon	40	0	264						304.0
Bosnia-H.	101.7	40.7	47.6					40.7	230.7
Cyprus	14		144						158.0
Albania	12	1	39.8					27.3	80.1
Monaco	80								80.0
Totals	36,424.3	5,965.1	18,633.1	84.6	2	2,080	3,190	1,378.5	67,757.6

The sectoral share of emissions according to UNEP estimates is shown in Figure 15. As expected, stationary combustion is the major source of mercury emissions (54%), which is in agreement with global estimates (46%, see Figure 12). Cement production seems to be a major source of mercury emissions in the Mediterranean region, comparing to global estimates (27% *vs*. 10%). Other important sources are metal production (non-ferrous and ferrous metals) and the chlor-alkali industry. Contrary to other regions, gold production is not an important source in the Mediterranean.

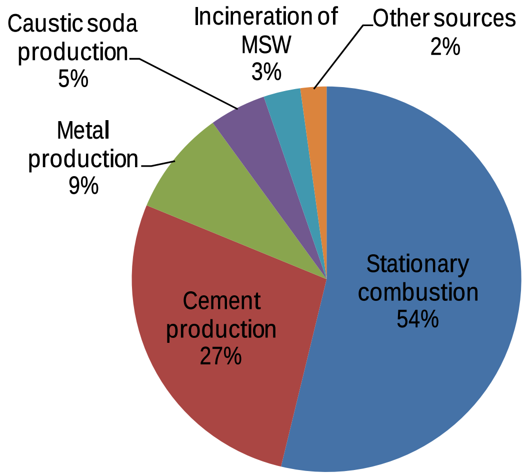


Figure 15. Proportion of global anthropogenic emissions of mercury to air in 2005 from various sectors, in Mediterranean countries. Source of data: AMAP/UNEP, 2008.

8.1.2 The UNEP/MAP Mediterranean National Baseline Budget (NBB)

8.1.2.1 Introduction

The National Baseline Budget (UNEP/MAP, 2002) includes emission data to air and water for SAP priority pollutants in all MAP countries. The first baseline year was 2003, and the database compiled by MEDPOL can be organized by substance, sector, subsector, country and administrative region (see Figure 16). Therefore, this database has a major potentiality to be used as a baseline on current national and regional loads of pollutants, and to analyse the specific sources of pollutants by sector and administrative regions. Currently a new baseline for year 2008 is being updated and refined, which will enable a comparison with 2003 data. For comparative purposes with other inventories, it must be noted that the NBB mostly include point source emissions from industrial facilities, within the Mediterranean administrative regions of each country. This is especially relevant for those countries with significant non-Mediterranean coastal regions or catchment areas, such as France, Spain or Turkey.

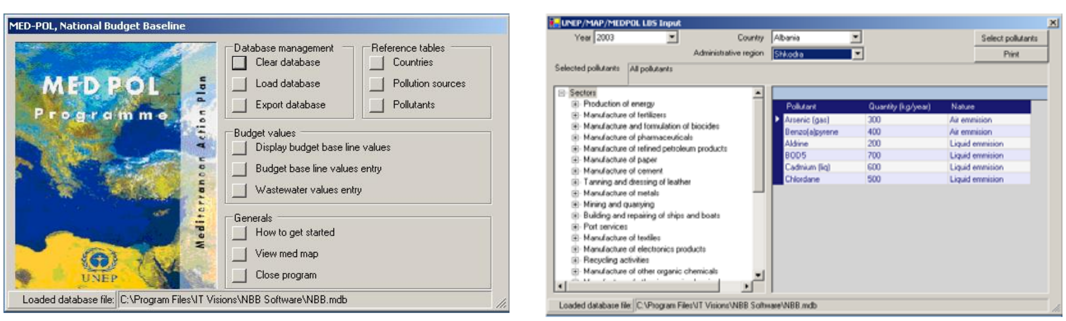


Figure 16. Some views of the National Baseline Budget database.

8.1.2.2 Available data

The NBB database compiled by MEDPOL in 2003 contains about 7600 records, each record indicating the emission of a substance for a given activity sector and subsector, in an administrative region and country. The analysis of the number of records by region, sector, and substance, can provide an idea of the availability of data in the NBB database.

The 2003 NBB database contains 165 records for mercury emissions, 96 records for air emissions, and 69 records of emissions to water. The majority of data have been reported by northern Mediterranean countries (73% of records, particularly from Italy and Spain), while southern and eastern countries accounts for 19% and 8% of records, respectively (see Figure 17). Differences in the number of records can be related with the size and level of industrial development in each country, the regional and sectoral scope of the inventory, the availability of data, and the level of detail that each country operates its inventories.

Regarding activity sectors, the NBB database contains more information of mercury emissions for the production of energy sector (29%) and manufacture of cement (16%). About 20% of records have not been allocated to an activity sector. The total number of records is shown in Figure 18. It can be considered that the sectors with more reported records are those that a) are usually present in all economies (e.g. energy production); or b) production data and emission factors are well established/available (e.g. energy or cement production).

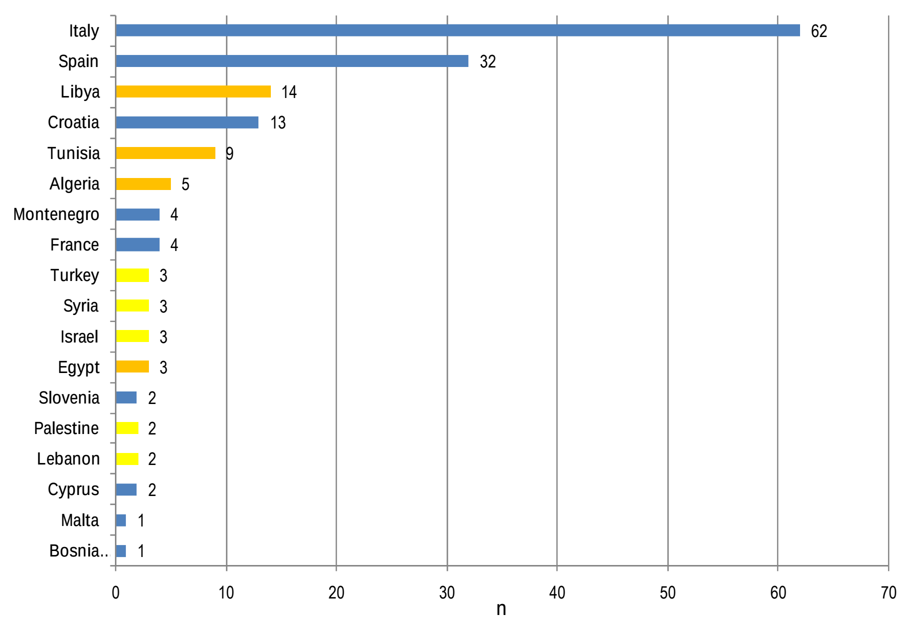


Figure 17. Number of mercury records (n) in the NBB database, per country and subregion.

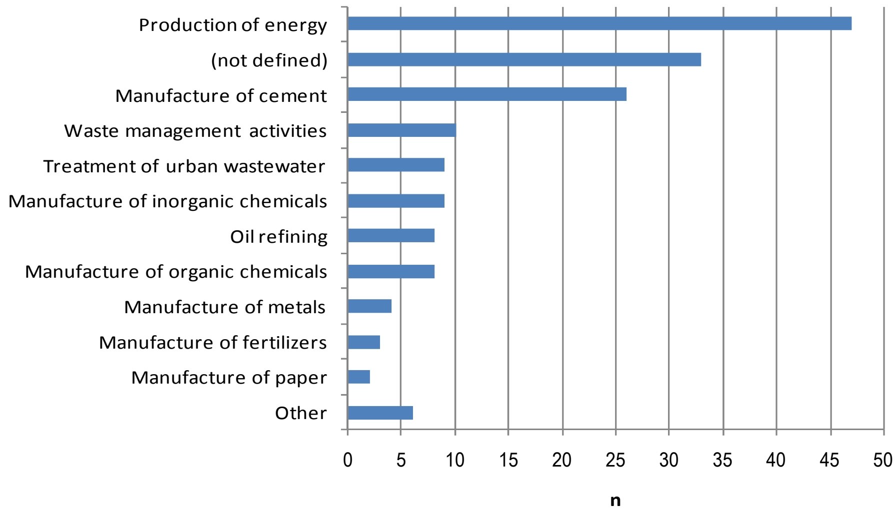


Figure 18. Number of mercury records (n) in the 2003 NBB database, per sector.

8.1.2.3 Emissions by country and activity sector

In this section some information on total mercury air and water emissions and its sources, according to the 2003 NBB database, is presented. As it can be observed in Table 56 and Figure 19, mercury air emissions accounts for about 6 tonnes, and are mostly originated by the cement, energy, and metal industry, which is in agreement with other inventories, which also highlighted the relative importance of the cement industry in the Mediterranean comparing to other regions. Regarding mercury releases to water, anomalous figures have been reported by Algeria and Tunisia as a result of their fertilizer industry (249t and 772t, respectively). If these specific sources (which would account for 99% of water releases) are not taken into account, the main activity sectors emitting mercury to water would be the chemical industry, wastewater treatment, and the metal industry (see Figure 19).

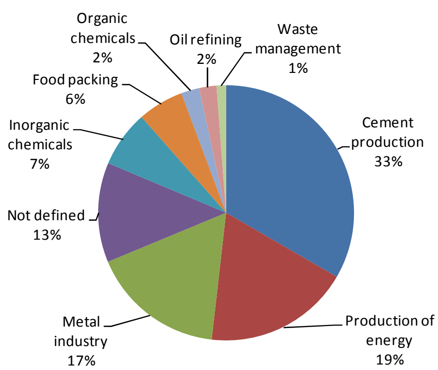
The extremely high mercury releases reported from the fertilizer industry might be a mistake but in any case it deserves further attention. Indeed, the manufacture of phosphorus fertilizers can be a source of mercury pollution, as phosphate ores contains small but very variable amounts of mercury, in quantities exceeding its average content in the earth's crust (Jackson et al., 1986; UNEP/UNIDO, 1998; Mirlean et al., 2008). Mercury pollution in soils and in the marine environment as a consequence of the phosphate fertilizer industry have been reported in different locations around manufacturing sites such as in Brazil or Australia (Jackson et al., 1986; Mirlean et al., 2008). *No information have been identified in the literature about mercury related problems derived from the phosphorus fertilizer industry in Tunisia or Algeria, and this issue has neither been raised by National Focal Points, or detected by the MEDPOL environmental quality database, therefore it cannot be ensured that mercury releases reported in the NBB database are actually taking place at the reported values.*

Table 56. Total loads of mercury (kg/yr) to air and water, reported by Mediterranean countries in the NBB2003, by country and sector.

Country	Sector	Hg (gas)	Hg (liq)	Total
Algeria	Food packing	364.11		364.11
	Manufacture of cement	54.12		54.12

Country	Sector	Hg (gas)	Hg (liq)	Total
	Manufacture of fertilizers		248,600.00	248,600.00
Algeria Total		418.23	248,600.00	249,018.23
Bosnia Herzegovina	Manufacture of cement	0.00		0.00
Bosnia Herzegovina Total		0.00		0.00
Croatia	Manufacture of cement	26.74		26.74
	Production of energy	120.53		120.53
	Treatment of urban wastewater		118.18	118.18
Croatia Total		147.27	118.18	265.45
Cyprus	Manufacture of cement	18.00		18.00
	Production of energy	12.20		12.20
Cyprus Total		30.20		30.20
Egypt	Manufacture of cement	407.51		407.51
	Production of energy	17.09		17.09
Egypt Total		424.60		424.60
France	Manufacture of other organic chemicals	21.00	5.50	26.50
	Waste incineration and management of its residues		2.80	2.80
	Waste management activities		2.80	2.80
France Total		21.00	11.10	32.10
Israel	Manufacture of cement	253.00		253.00
	Production of energy	291.40		291.40
Israel Total		544.40		544.40
Italy	Manufacture of cement	103.00		103.00
	Manufacture of metals	1,060.00	240.90	1,300.90
	Manufacture of other inorganic chemicals	446.60	109.40	556.00
	Manufacture of other organic chemicals	122.00	12.40	134.40
	Manufacture of paper		30.05	30.05
	Manufacture of pharmaceuticals		3.50	3.50
	Manufacture of refined petroleum products	137.10	9.60	146.70
	Production of energy	577.10	102.00	679.10
	Treatment of sewage sludge		96.40	96.40
	Waste management activities	75.10	51.80	126.90
Italy Total		2,520.90	656.05	3,176.95
Lebanon	Manufacture of cement	268.00		268.00
	Production of energy	22.80		22.80
Lebanon Total		290.80		290.80
Libya	Manufacture of cement	36.00		36.00
	Manufacture of other organic chemicals		1,000.00	1,000.00
	Production of energy	68.32		68.32
Libya Total		104.32	1,000.00	1,104.32
Malta	Treatment of urban wastewater		199.80	199.80
Malta Total			199.80	199.80
Montenegro	Building and repairing of ships and boats		0.77	0.77
	Manufacture of refined petroleum products		0.01	0.01

Country	Sector	Hg (gas)	Hg (liq)	Total
Montenegro Total			0.77	0.77
Palestine	Treatment of urban wastewater		0.38	0.38
	(not defined)		0.01	0.01
Palestine Total			0.39	0.39
Slovenia	Management of urban solid waste		0.00	0.00
	Manufacture of cement	82.70		82.70
Slovenia Total		82.70	0.00	82.70
Spain	(not defined)	789.24	90.46	879.70
Spain Total		789.24	90.46	879.70
Syria	Manufacture of cement	187.00		187.00
	Production of energy	17.60		17.60
Syria Total		204.60		204.60
Tunisia	Manufacture of cement	484.00		484.00
	Manufacture of fertilizers		772,200.00	772,200.00
	Production of energy	25.48		25.48
Tunisia Total		509.48	772,200.00	772,709.48
Turkey	Manufacture of cement	166.07		166.07
Turkey Total		166.07		166.07
TOTAL		6,253.81	1,022,876.75	1,029,130.56



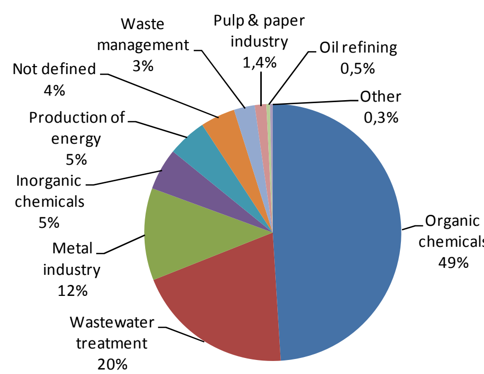


Figure 19. Total loads (main sectors, in %) of mercury to air (left) and water (right), reported by Mediterranean countries in the NBB 2003. Mercury releases to water from the manufacture of fertilizers have been removed.

By country, air emissions of mercury are dominated by Italy, with 2.5 tonnes (40%), followed by Spain (8t; 13%), Israel (0.54t, 9%) and Tunisia (0.5t; 8%).

Table 57. Total loads of mercury (kg/yr) to air and water, reported by Mediterranean countries in the NBB2003.

Country	Hg (gas)	Hg (liq)
Albania		
Algeria	418.23	248,600.00
Bosnia H.	0.00	
Croatia	147.27	118.18
Cyprus	30.20	
Egypt	424.60	
France	21.00	11.10
Greece		
Israel	544.40	
Italy	2,520.90	656.05
Lebanon	290.80	
Libya	104.32	1,000.00
Malta		199.80
Montenegro		0.77
Morocco		
Palestine		0.39
Slovenia	82.70	0.00
Spain	789.24	90.46
Syria	204.60	
Tunisia	509.48	772,200.00
Turkey	166.07	
Total	6,253.81	1,022,876.75

8.1.3 The European Pollutant Release and Transfer Register (E-PRTR)

The European Pollutant Release and Transfer Register (E-PRTR) is the new Europe-wide register that provides easily accessible key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein and Norway. It replaces and improves upon the previous European Pollutant Emission Register (EPER). This register implements for the European Union the UNECE (United Nations Economic Commission for Europe) PRTR Protocol to the Aarhus Convention on Access to Information.

The obligations under the E-PRTR Regulation extend beyond the scope of EPER mainly in terms of more facilities included, more substances to report, additional coverage of releases to land, off-site transfers of waste and releases from diffuse sources, public participation and annual instead of triennial reporting.

The new register contains data reported annually by some 24,000 industrial facilities covering 65 economic activities across Europe. For each facility, information is provided concerning the amounts of pollutant releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water from a list of 91 key pollutants including mercury, for the year 2007 onwards. In this context, wastes (e.g. mercury containing wastes) which are sent to final disposal (e.g. landfill) are not included by E-PRTR, moreover, only amounts of mercury releases to air and water exceeding the threshold value of 10 kg/year to air and 1 kg/year to water are covered, which means that mercury releases out of the scope of the E-PRTR could possibly exceed 20% of the total releases.

The first reporting year under the E-PRTR has been 2007, for which the data were reported in June 2009. These data are now published in the Register. From 2010 on, Member States will need to report data to the E-PRTR by the end of March and the Register website will be updated accordingly.

The previous EPER data (since 2001) has been published on a website (http://eper.ec.europa.eu/) which is hosted by the European Environment Agency (EEA). For the time being EPER will stay online until the full integration of its dataset into E-PRTR which is currently being undertaken.

The mercury emissions reported by EU Mediterranean countries to E-PRTR are shown in Table 58. As it can be observed, the industrial facilities in these countries emitted in 2007 a total of **9.9** tonnes to air and **5.8** tonnes to water. Air releases were dominated by Spain (43%), France (29%) and Greece (16%), while emissions to water were more concentrated in Italy (72%), followed by Spain (17%) and France (10%) (see Figure 20).

Table 58. Releases of Hg and compounds (as Hg) reported by Mediterranean countries to the E-PRTR Register. Data in Kg (2007).

Country	Air	Water	Soil	Total
Cyprus	166.50			166.50
France	2,861.30	561.34	104.63	3,527.27
Greece	1,549.90	68.80		1,618.70
Italy	1,022.00	4,179.42	1.10	5,202.52
Slovenia	38.10	5.31		43.41
Spain	4,251.40	1,009.66		5,261.06
Total general	9,889.20	5,824.53	105.73	15,819.46

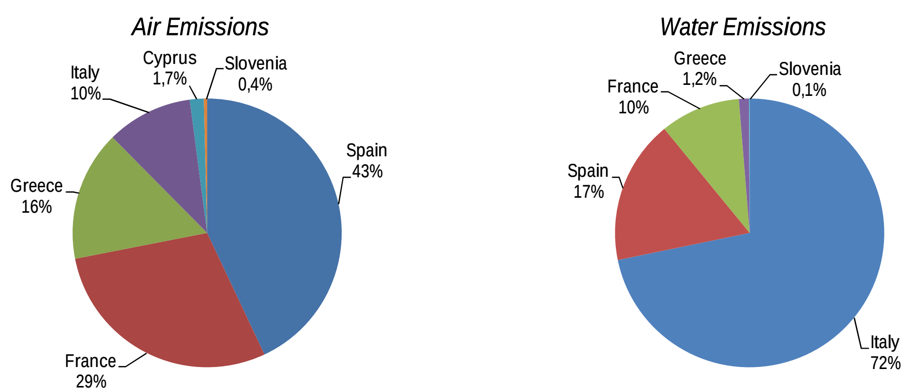


Figure 20. Country distribution of Hg releases to air and water (2007). Source: E-PRTR.

By sectors (see Table 59 and Figure 21), air mercury emissions are dominated by the energy sector (34%), chemical industry (24%), mineral industry (18%) and metal industry

(12%). These results in Mediterranean countries slightly differ from the overall picture for all European countries, where energy production facilities are responsible of about 50% of total mercury releases, while releases from the cement industry are more important in the Mediterranean. On the other side, energy production is the main activity sector emitting mercury to water (69%), followed by wastewater management (25%) and the chemical industry (4%). Soil releases have only been reported by France, mainly from urban wastewater plants (probably in WWTP sludge). A more detailed breakdown of mercury releases by sector and subsector is provided in Table 60.

Table 59. Releases of Hg, by sectors, in Mediterranean countries reporting to the E-PRTR Register. Data in Kg (2007).

Sector	Air	Water	Soil	Total
Chemical industry	2354.9	228.31		2583.21
Energy production	3318.3	4044.89	3.8	7366.99
Metal industry	1161.9	46.78		1208.68
Mineral industry	1755.7	3.16		1758.86
Oil & gas	781	17.6		798.6
Other activities		3.04	23.3	26.34
Pulp & paper	38	48.37	7.37	93.74
Waste and wastewater management	479.4	1432.38	71.26	1983.04
Total	9889.2	5824.53	105.73	15819.46

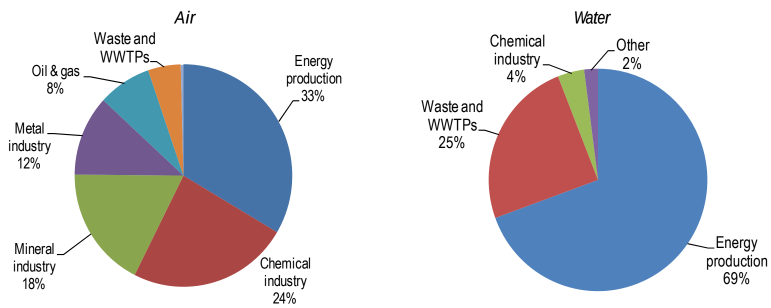


Figure 21. Sector distribution of Hg releases to air and water (kg; 2007). Source: E-PRTR.

Table 60. Releases of Hg, by sectors and subsectors, in Mediterranean countries reporting to the E-PRTR Register. Data in Kg (2007).

Sector / subsector	Air	Water	Soil	Total
Chemical industry	2354.9	228.31		2583.21
Production of basic inorganic chemicals	1673.8	194.81		1868.61
Production of basic organic chemicals	681.1	28.8		709.9
Production of basic pharmaceutical products		1.1		1.1
Production of basic plant health products and of biocides		3.6		3.6
Energy production	3318.3	4044.89	3.8	7366.99
Thermal power stations and other combustion installations	3318.3	4044.89	3.8	7366.99
Metal industry	1161.9	46.78		1208.68
Ferrous metal foundries	91.8			91.8
Metal ore (including sulphide ore) roasting or sintering	82.6			82.6
Processing of ferrous metals	65	7.3		72.3

Production of non-ferrous crude metals	124.2	26.14		150.34
Production of pig iron or steel including continuous casting	798.3	11.54		809.84
Surface treatment of metals and plastics		1.8		1.8
Mineral industry	1755.7	3.16		1758.86
Manufacture of ceramic products	67.6			67.6
Manufacture of glass, including glass fibre	78			78
Production of cement clinker or lime	1610.1			1610.1
Underground mining and related operations		3.16		3.16
Oil & gas	781	17.6		798.6
Gasification and liquefaction		1.6		1.6
Mineral oil and gas refineries	781	16		797
Other activities		3.04	23.3	26.34
Building of, painting or removal of paint from ships		1.85		1.85
Food and drink production			14.6	14.6
Pretreatment or dyeing of fibres or textiles		1.19		1.19
Slaughterhouses			8.7	8.7
Pulp & paper	38	48.37	7.37	93.74
Production of paper and board and other primary wood products	38	40.67		78.67
Production of pulp from timber or similar fibrous materials		7.7	7.37	15.07
Waste and wastewater management	479.4	1432.38	71.26	1983.04
Disposal of non-hazardous waste		814.55		814.55
Disposal or recovery of hazardous waste	178.7	24.44	1.48	204.62
Incineration of non-hazardous waste	300.7	27.82		328.52
Industrial waste-water treatment plants		11.6		11.6
Urban waste-water treatment plants		553.97	69.78	623.75
Total general	9889.2	5824.53	105.73	15819.46

8.1.4 UNECE-EMEP

Major international activity to assess source-receptor relationships for mercury in the environment has been carried out within the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution Transmission (LRTAP). The aim of this activity is to assess major sources of mercury emissions in Europe, the environmental impact of these emissions, and eventually the emission reductions.

Within the LRTAP Convention, data is basically collected and assessed under the EMEP Programme (Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe). The EMEP programme relies on three main elements: (1) collection of emission data, (2) measurements of air and precipitation quality and (3) modelling of atmospheric transport and deposition of air pollutions. Through the combination of these three elements, EMEP fulfils its required assessment and regularly reports on emissions, concentrations and depositions of air pollutants, the quantity and significance of transboundary fluxes and related exceedances to critical loads and threshold levels.

Currently the EMEP Centre on Emission Inventories and Projections (CEIP) has the task to collect emissions and projections of acidifying air pollutants, heavy metals, particulate matter and photochemical oxidants. The CEIP hosts officially submitted data by the Parties to the Convention on LRTAP to the EMEP programme via the UNECE secretariat.

However, as these data can be inconsistent and/or incomplete, the CEIP also provides expert corrected and/or gap-filled data, which can be used for modelling and intercomparison purposes. Both official and corrected data on mercury emissions reported by Mediterranean Parties to the LRTAP Convention are provided in this section.

8.1.4.1 Emissions by country

According to EMEP corrected and gap-filled data, in 2007 the north Mediterranean countries (plus Turkey) emitted around **67** tonnes of mercury to air (see Table 61 and Figure 22). The major emitters were Turkey (32%), Greece (19.6%), Italy (16%), Spain (13.6%) and France (10.1%).

Table 61. Total mercury air emissions in North Mediterranean countries in 2007. Source of data: UNECE/EMEP emission database (WebDab).

Country	Hg emissions (tonnes)
Turkey	21.11
Greece	13.00
Italy	10.71
Spain	9.04
France	6.68
Bosnia H.	1.88
Cyprus	1.36
Slovenia	1.17
Malta	0.63
Croatia	0.62
Albania	0.20
Montenegro	0.15
Monaco	0.06
Total	66.61

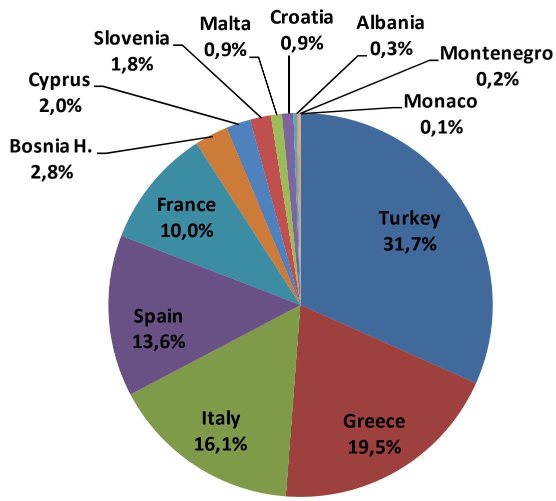


Figure 22. Total mercury air emissions in North Mediterranean countries in 2007. Source of data: UNECE/EMEP emission database (WebDab).

8.1.4.2 Temporal trends

In Europe, according to officially reported data to UNECE LRTAP Convention, mercury emissions have steadily decrease since 1990, with an accumulated reduction of about 50% until 2007 (see Figure 23). However, this temporal trend can vary between countries. For instance, as it can be observed in Figure 24, some European Mediterranean countries have decreased atmospheric mercury emissions, like Italy, Spain, and specially France, while others have increased their releases (e.g. Turkey, Slovenia or Cyprus). Figure 25 shows yearly EMEP estimations for each country, and it can be observed how Turkey has notably increased its emissions during the last years. It is also interesting to note the sharp decrease of mercury emissions in France, who shifted from the top position to be placed below Spain or Greece. Italy has also decreased its total emissions during the period 1990-2007, but some increasing trends can be observed during the last years.

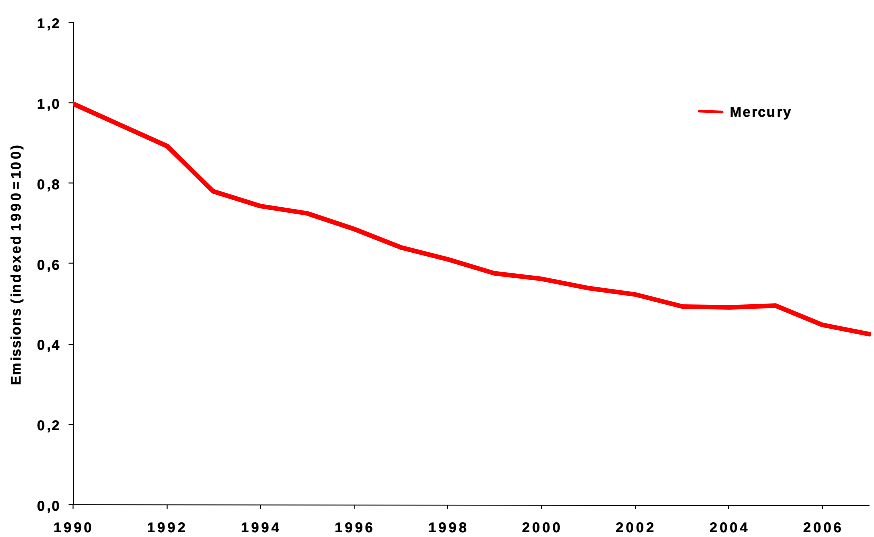


Figure 23. Hg air emission trends (1990-2007) in EEA member countries - indexed 1990 = 100. Source: EEA aggregated and gap-filled air emission dataset, based on 2009 officially reported emissions to UNECE LRTAP Convention. Data for Iceland, Liechtenstein and Turkey not available.

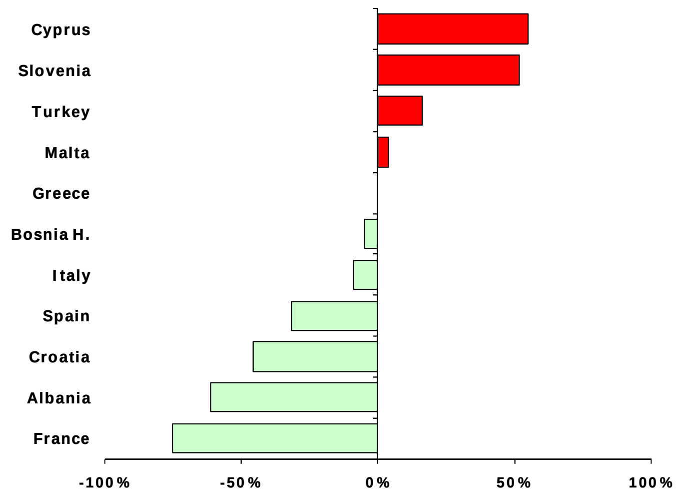


Figure 24. Change (%) in mercury air emissions 1990-2007 in EMEP North Mediterranean countries). Source of data: UNECE/EMEP emission database (WebDab).

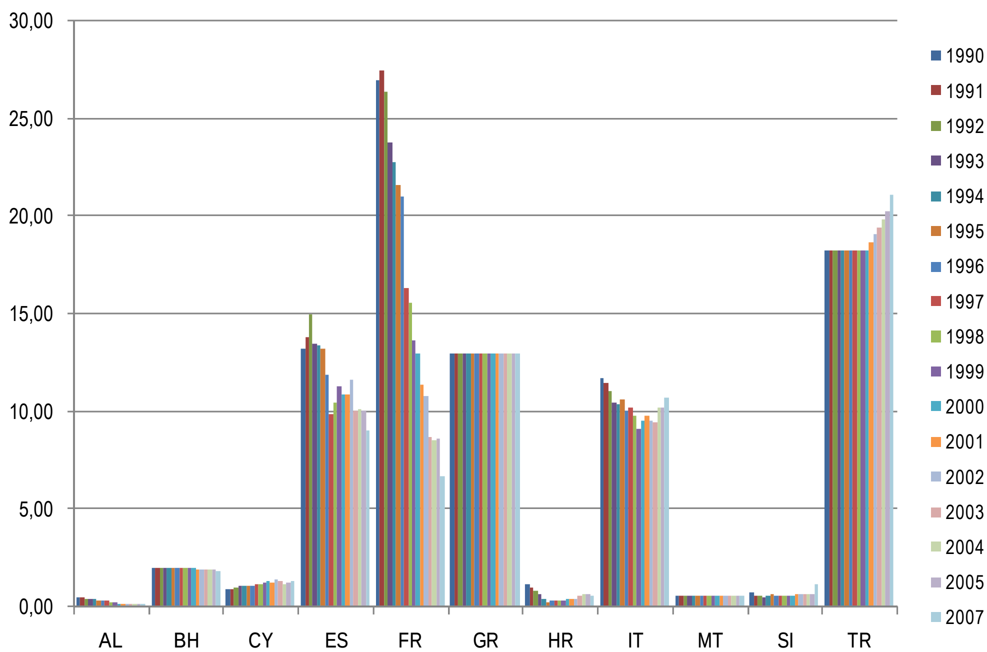


Figure 25. Total mercury emissions (tonnes) in North Mediterranean countries (1990-2007). Source of data: UNECE/EMEP emission database (WebDab).

8.1.4.3 Emissions by activity sector

Emission data from EMEP can be consulted by activity sector using two different nomenclatures:

- SNAP - Selected Nomenclature for sources of Air Pollution: this is the nomenclature developed as part of the CORINAIR project for distinguishing emission source sectors, sub-sectors and activities.
- NFR - Nomenclature For Reporting: this is a classification system developed by the UN/ECE TFEIP for the Reporting Guidelines

Mercury emission data that have been collected from the EMEP database will be shown below using the SNAP nomenclature, as this the classification used in corrected and gap-filled data. The main group categories are the following:

Group 1: Combustion in energy and transformation industries

Group 2: Non-industrial combustion plants

Group 3: Combustion in manufacturing industry

Group 4: Production processes

Group 5: Extraction & distribution of fossil fuels and geothermal energy

Group 6: Solvent and other product use

Group 7: Road transport

Group 8: Other mobile sources and machinery

Group 9: Waste treatment and disposal

Group 10: Agriculture

Group 11: Other sources and sinks

A breakdown of mercury emission data by activity sectors is only available for some countries. As shown in Table 62 and Figure 26, mercury is mostly released by energy industries (38%), followed by a similar contribution of combustion sources in industry (24%) and industrial production processes (24%). Non-industrial combustion plants (i.e. commercial or residential) account for 11% of mercury emissions. Finally, waste management represents about 3% of total emissions within this group of countries. Other sources are hardly reported, but comparatively are expected to be of minor importance for mercury emissions, such as road transport.

Table 62. Mercury emissions by activity sector in some Mediterranean countries (tonnes, 2007). Source of data: UNECE/EMEP emission database (WebDab).

SNAP Sector		Cyprus	Spain	France	Croatia	Italy	Malta	Slovenia	Total
S1	Energy industries	1173.1	4579.9	3522.1	184.1	1062.3	610.7	469.9	11602.2
S2	Other (energy)		80.5	204.8	130.5	2653.5		131.2	3200.5
S3	Industry (energy)	190.1	1660.5	1812.9	283.2	3300.7		49.7	7297.0
S4	Industry (processes)		2559.9	609.0	23.6	3523.4		399.6	7115.6
S5	Extraction fossil fuels				0.7				0.7
S6	Solvent use								0.0
S7	Road transport							118.2	118.2

S8	Other mobile sources		44.7	0.7				0.7	46.1
S9	Waste management		113.7	531.7	2.0	171.5	15.4		834.3
S10	Agriculture								0
Total		1363.2	9039.3	6681.1	624.1	10711.4	626.1	1169.4	30214.6

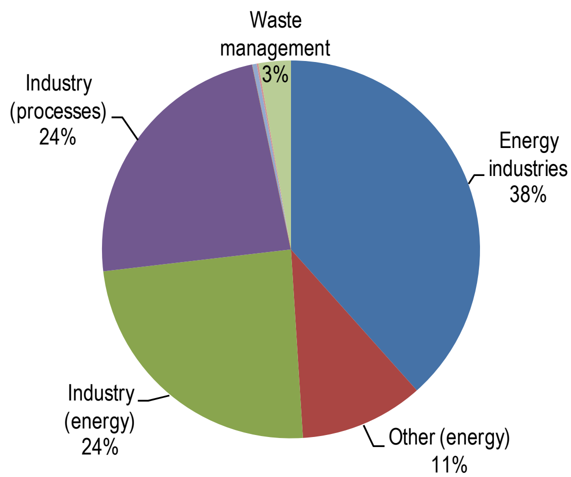


Figure 26. Mercury emissions in EMEP Mediterranean countries, by activity sector (2007). Source of data: UNECE/EMEP emission database (WebDab).

8.1.4.4 Geographic distribution of anthropogenic and natural emissions

According to EMEP models, mercury anthropogenic emissions are concentrated in central and eastern Europe (Figure 27), while natural emissions are more predominant in southern Europe and Mediterranean region (Figure 28).

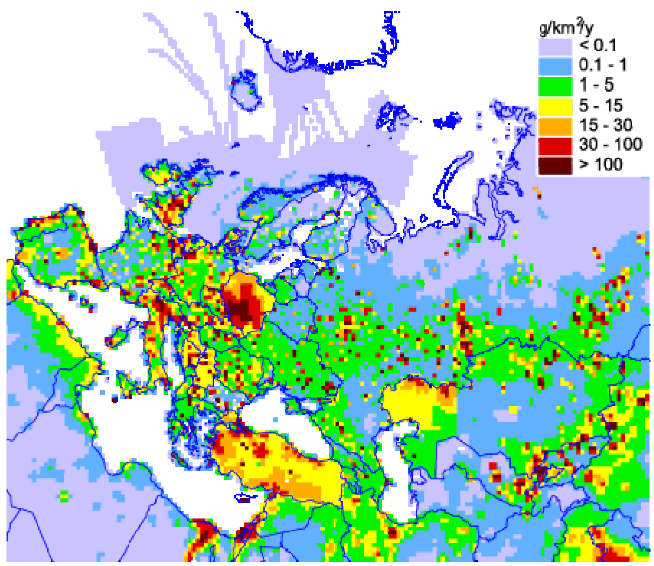


Figure 27. Spatial distribution of mercury anthropogenic emissions in 2007, g/km2/y. Source: EMEP.

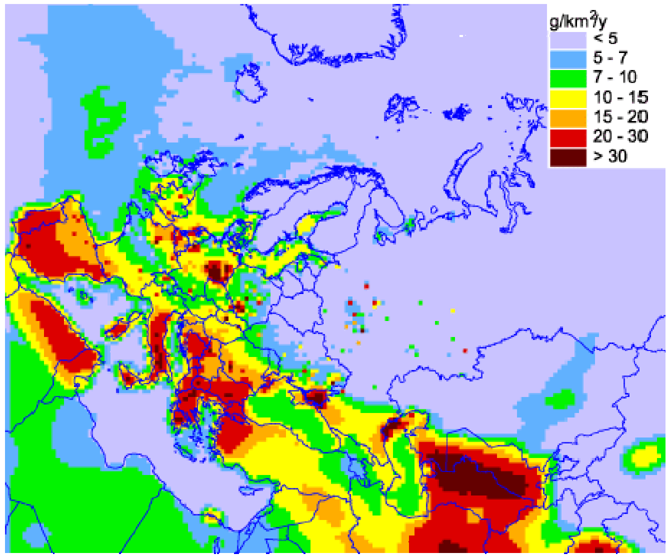


Figure 28. Spatial distribution of natural mercury emissions in the EMEP region in 2007, g/km2/y. Source: EMEP.

8.1.5 Regional inventories in literature

The most comprehensive study that has been identified in the scientific literature was conducted by **Pirrone et al. (2001)**, who estimated past, current and projected mercury emissions to the atmosphere from major anthropogenic and natural sources in the Mediterranean region. Natural sources considered in this inventory included volatilisation of mercury from surface water and emissions from volcanoes, using data from previous studies (Ferrara et al., 2000a; Ferrara et al., 2000b). Due to the lack of reliable stack measurements in the region, industrial emissions where estimated using available emission factors from the literature, which are summarized in Table 63.

Table 63. Emissions factors used by Pirrone et al (2001) to estimate industrial mercury emissions in the Mediterranean region.

Source category	Developed countries	Developing countries*
Coal-fired power plants	0.05 g-Hg t^{-1}	0.12 g-Hg t^{-1}
Oil-burning power plants	0.05 g-Hg t^{-1}	0.065 g-Hg t^{-1}
Incineration of MSW	0.8 g-Hg t^{-1}	1 g-Hg t^{-1}
Cement production	0.09 g-Hg t^{-1}	0.5 g-Hg t^{-1}

* Includes North-Africa and the Middle East (except Israel)

Anthropogenic total atmospheric emissions where estimated in about **106 t yr^{-1}** (1995 estimates). The contribution from fossil fuels combustion (29.9 t yr^{-1}), cement production (28.8 t yr^{-1}), and incineration of solid wastes (27.6 t yr^{-1}), accounted altogether for about 82% of total regional emissions (see Table 64 and Figure 29). By countries, France was the major emitting country (22.8 t yr^{-1}), followed by Turkey (16.2 t yr^{-1}), Italy (11.4 t yr^{-1}), and Spain (9.8 t yr^{-1}).

Regarding trends, according to this study, total emissions increased from 80 t yr^{-1} in 1983 to 106 t yr^{-1} in 1995, and are expected to increase up to 191 t yr^{-1} by 2025. The increase in mercury emissions in France, Italy or Spain is primarily due to a projected increase in emissions from incineration of MSW. However, recent reports from EMEP and French national inventories (see section 8.1.4 and 8.1.6.5), clearly indicate that mercury emissions in these countries have decreased, particularly due to pollution abatement techniques in MSW incinerators.

Table 64. Total anthropogenic emissions (t yr-1) of Hg to the atmosphere in the Mediterranean basin (1995 estimates) by country and emission source category. Source: Pirrone et al. (2001).

Country	Coal	Oil	MSW	Cement	Smelters	Iron–Steel	Misc.	Total
Albania		<0.1	0.2		<0.1		<0.1	0.26
Algeria		0.3	1.5				0.2	2.0
Bulgaria	1.7	0.2	0.5	2.6	0.5	0.7	0.6	6.8
Cyprus		0.1	<0.1	0.7			0.1	0.9
France	1.9	2.3	11.6	2.2	1.4	1.3	2.1	22.8
Israel		0.1	0.2	0.4			0.1	0.8
Greece	0.8	0.1	0.1	1.3		<0.1	<0.2	2.5
Italy	1.3	1.8	1.7	4.2	0.1	1.3	1.0	11.4
Jordan		0.1	0.2	1.0			0.1	1.4
Lebanon		0.7	0.2	0.5			0.1	1.5
Libya		0.3	0.3	1.3	0.8		0.3	2.3
Morocco	0.3	0.3	1.5	3.7	0.6		0.6	6.7
Spain	3.0	1.0	0.9	2.6	0.1	0.6	0.8	9.0
Syria		0.4	0.7	2.1			0.3	3.5
Tunisia		0.2	0.5	1.9			0.3	2.9
Turkey	7.2	1.0	3.3	3.0	0.2		1.5	16.2
Egypt		0.9	3.1	0.9	0.6		0.6	6.1
Yugoslavia	3.6	0.3	1.3	0.4	0.5	0.9	0.7	7.7
Total	19.8	10.1	27.8	28.8	4.8	4.8	9.6	105.7
% of the total	18.8	9.5	26.3	27.3	4.6	4.6	9.1	

*Blank spaces in this table indicates that the emission rate is unknown.

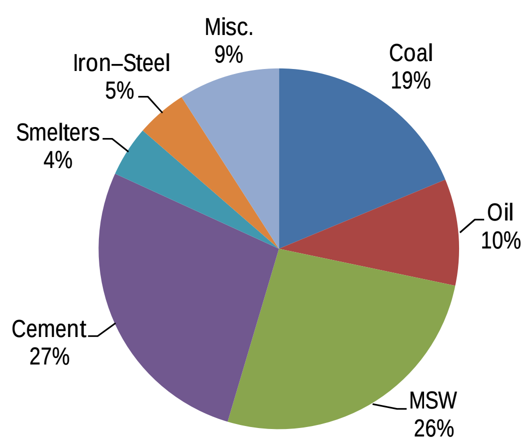


Figure 29. Contribution of source categories to total anthropogenic emissions (t yr-1) of Hg to the atmosphere in the Mediterranean basin (1995 estimates). Source of data: Pirrone et al. (2001).

The annual emission from natural sources was estimated in 110 t yr^{-1}, that is, 51% of total emissions, although this figure only includes the volatilisation of elemental mercury from surface waters (the major source) and emissions from volcanoes. Recently, mercury emissions released as a consequence of forest fires in Mediterranean countries were estimated in 4.3 t yr^{-1} (Cinnirela et al., 2008).

Therefore, natural and anthropogenic sources in the Mediterranean region release annually about 215 t of mercury, which represents a significant contribution to the total mercury budget released in Europe and to the global atmosphere.

8.1.6 National emission inventories

8.1.6.1 Albania

No information has been obtained from the NFP and any national inventory of emissions has been identified. However, some data for Albania can be obtained from the AMAP/UNEP (2008) inventory and EMEP.

8.1.6.2 Algeria

Emission inventories of mercury have not been identified in Algeria. However, the NFP reported some data on wastewater releases from the chlor-alkali industry. According to this information, the chlorine production site in Baba Ali (Alger) generates about 180 tonnes per year of wastewater containing mercury (with an average concentration of 0.349 mg Hg/l). Wastewaters from another chlorine production facility in Mostaganem (west Algeria) contain 0.4 mg Hg/l. However, both complexes are in a reconversion process to substitute the mercury cells by membrane technology.

On the other side, the National Inventory of Hazardous Wastes (CNDS) also identifies the mercury wastes generated by the already closed mercury production site in Azzaba, and the wastes generated by the Baba Ali chlor-alkali site.

8.1.6.3 Croatia

According to the NFP, the following inventories are available in Croatia:

Air emission inventory: In accordance with CLRTAP Executive Body's Decision 2002/10 on emission data reporting under the Convention and the Protocols in force Croatia is obliged to report on air emissions in line with Emission Reporting Guidelines (2003) and methodology described in EMEP/CORINAIR Emission Inventory Guidebook 2007. According to the Inventory Report to the LRTAP convention for 2007, mercury emission into the air occurs mainly due to the fossil fuel combustion, in particular combustion in manufacturing industry (45.4 % of the national total). In 2007, total emissions of mercury were 624.4 kg, which was 6.2% lower than in 2005 and 54.1% lower than in 1990. High levels of emission in the period from 1990 to 1992 are due to the emissions from sector 05, particularly from the natural gas extraction in INA-Naftaplin, GTP Molve III plant. In 1993 the process units for removal of mercury from natural gas were put into operation. With this measure for mercury emission reduction, the inlet average mercury concentration of 516 μg/m3 decreases at the outlet to 0.12 μg/m3 of average mercury concentration.

At facility level, mercury compounds expressed as Hg are prescribed to be measured in waste gases, the technological process of chlorine production, for the production of alkali chlorides using electrolysis employing the amalgamation process, in the waste gas from incineration plants (including the gaseous and the vapour forms of the relevant heavy metal emissions and their compounds).

Water emission inventory: Ordinance on the Environmental pollution register (Official Gazette no. 35/08) prescribes the required content and manner of keeping the register of environmental pollution, taxpayers provide information in the registry, the manner, methodology and timing of collection and delivery of data on the discharge, transfer and disposal of pollutants into the environment and waste, data on pollutants, the company, facility, organizational unit within the polluters, the deadline and method of informing the public, the manner of verification and quality assurance data retention period of data and perform professional tasks of keeping the registry. Environmental pollution register is maintained by the Agency for environmental protection (AZO).

Solid waste inventories: Ordinance on the Environmental pollution register (OG No. 35/08) prescribes that AZO maintains the Register with data on waste, waste producers and waste management. Register contains data on waste according to European Waste List.

The available data on mercury releases to air and water, provided by the Croatian NFP are shown in Table 65.

Table 65. Mercury emissions to air and water in Croatia. Source: NFP.

Source activity	Mercury in air (t/year)	Mercury in waste water (t/year)
Coal combustion in power plants (>50 MW_{th})	NO	0,00002
Coal combustion in residential use (<50 MW_{th})	NO	
Metal industry	0,0114	
Chlor-alkali industry		
Cement production	NA	
Paper industry	IE	
Production of basic organic chemicals	-	
Waste incineration	0,00198	
Waste landfill	-	
Mineral oil and gas refineries	0,00014	0,0000001
Phosphorous fertilizers	-	
Spreading of sewage sludge on agricultural land	-	
Cremation	-	
Other activities with mercury emission	IE	0,0003
TOTAL mercury emissions	0,6244[1]	0,0003[2]

note[1] - last inventory Report for 2007

note[2] – the numbers are referring to the amount of the mercury in the wastewater which is flown into the sea. The calculations are based on the amount of wastewater and the results of analysis from 2008.

8.1.6.4 Cyprus

Cyprus reports Hg air emission data to the Executive Body of the Long-Range Transboundary Air Pollution (LRTAP) Convention. The data presented for the time period 2006-2008 is shown in Table 66. As it can be observed, mercury air emissions in Cyprus have been about 0.18 tonnes yr^{-1}, with no significant change during the last years. Emissions are dominated by combustion in the manufacturing industry (e.g. cement), with 92% of total emissions.

Similarly, under the directive 2006/12/EK, the Hg waste is reported under hazardous waste.

Table 66. Mercury emissions to air in Cyprus, as reported to EMEP. Source: NFP.

NFR Code	2006	2007	2008
	t/year	t/year	t/year
1 A 1 a Public electricity and heat production	0,01299	0,01330	0,01391

1 A 2 b Combustion in industries: Non-ferrous metals	0,00003	0,00002	0,00002
1 A 2 c Combustion in industries: Chemicals	0,00001	0,00001	0,00001
1 A 2 d Combustion in industries: Pulp, Paper and Print	0,00001	0,00000	0,00000
1 A 2 e Combustion in industries: Food processing	0,00011	0,00008	0,00008
1 A 2 f i Combustion in industries: (Cement/ Lime/Brick &Tiles Industries)	0,16971	0,16676	0,16798
1 A 4 b i Residential: Stationary plants	0,00013	0,00013	0,00011
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	0,00008	0,00008	0,00007
4 F Field burning of agricultural wastes	0,00006	0,00004	0,00002
National total	0,183	0,180	0,182

8.1.6.5 France

National data on mercury **atmospheric emissions** can be obtained from the Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique (CITEPA)[51], who provides an annual inventory of emissions in mainland France, using national and international (SNAP codes) source categories. The figures provided by CITEPA are the same as those reported to EMEP, and already shown in section 9.1.4. However, more detailed information is provided to explain results in the national report (CITEPA, 2009).

In 2007, total mercury atmospheric emissions in France accounted for 6.7 tonnes, which means a decrease of 75% since year 1990 (see Figure 30). This reduction can be explained by the improvement of performance in waste incineration, the limitation or prohibition to use mercury in batteries and thermomethers, the improvement of waste collection systems, and the optimization of processes in the chlor-alkali industry (CITEPA, 2009).

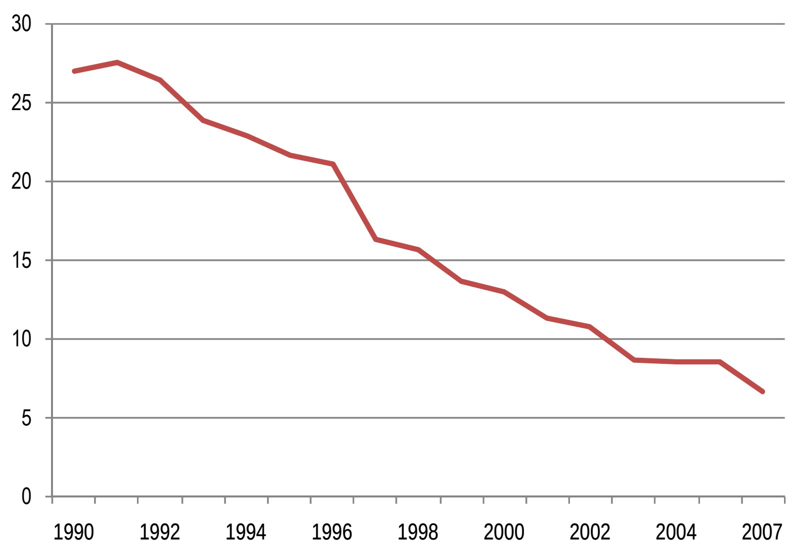


Figure 30. Mercury atmospheric emissions in France (tonnes). Source of data: CITEPA/EMEP.

[51] CITEPA: www.citepa.org

Mercury is mainly released by the energy transformation sector and the manufacturing industry. Within energy transformation (52% of emissions in 2007), mercury emissions are mostly produced in power generation (77%), particularly by the consumption of solid fossil fuels. During 1990-2007 this consumption has decreased in 22%. Within manufacturing industry, the following sub-sectors are the major sources:

- Chemical industry (33%), particularly chlor-alkali (20% of manufacturing industry);
- Mineral industries (25%), with cement production accounting for 6% of the manufacturing industry;
- Waste treatment (17%), basically incineration.

Per capita releases has decreased from 0.48 g/inhab in 1990, to 0.11 g/inhab in 2007 (77% reduction), while releases per unit of PIB decreased from 26.1 µg/€ to 3.5 µg/€ (87% reduction).

Emission data can also be obtained detailed by regions and departments for the year 2000 (CITEPA, 2005). The Mediterranean regions with higher mercury emissions are Provence Alpes Côte d'Azur and Rhône-Alpes (Figure 31). Major emissions took place in the region Nord-Pas-de-Calais, however, these have drastically been reduced after closure of METALEUROP site in Noyelles Godault, which was an important producer of zinc and lead (CITEPA, 2009).

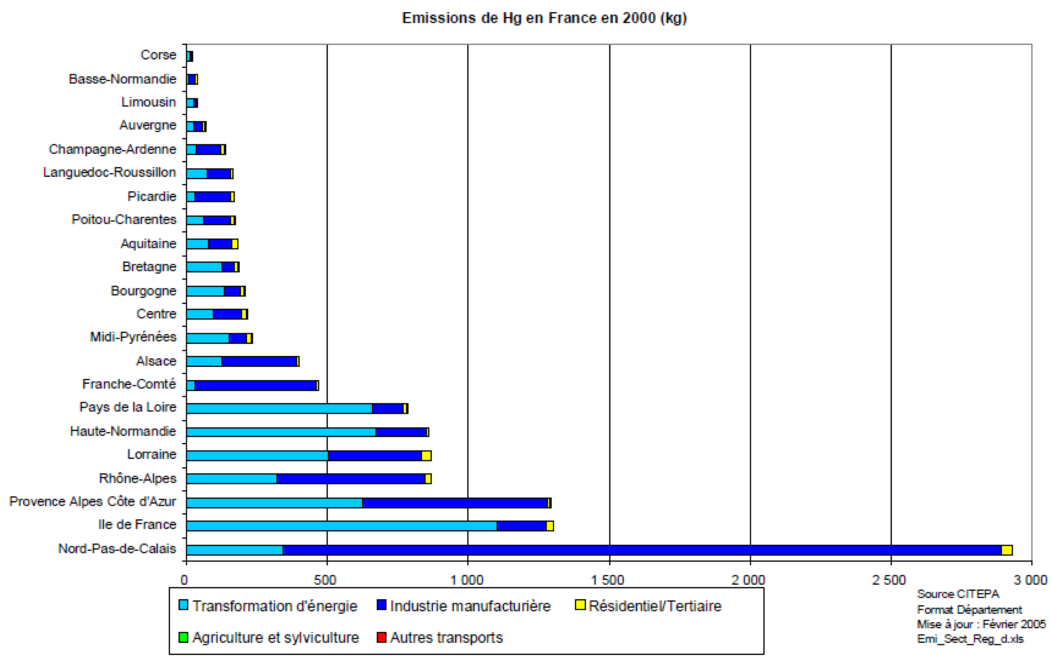


Figure 31. Mercury atmospheric emissions in France, by regions. Source: CITEPA, 2005.

France also reports air mercury emissions from major industrial sites to the E-PRTR inventory. According to 2007 data, these industrial sites reported a total of 2.86 tonnes mercury, mostly from the chemical and metal industry. The total emissions estimated by

AMAP/UNEP (2008) were 8.7 tonnes (2005 data). In addition, France provides specific emissions from the chlor-alkali industry according to provisions of the OSPAR Convention.

France reports to E-PRTR water emissions of mercury from industrial sites. The French PRTR country-specific website[52] is provided by the Ministry of Ecology, Energy, Sustainable Development and the Sea. France also provides to the OSPAR Convention specific mercury water emissions from the chlor-alkali industry.

The Ministry of Ecology, Energy, Sustainable Development and the Sea hosts statistic information on hazardous waste generation in France[53] as well as about polluted soils in France[54], and a database of polluted sites in France is available on-line (BASOL[55]).

8.1.6.6 Greece

Air and water mercury emission inventories have not been identified or reported by the NFP, although Greece reports mercury emissions to the E-PRTR register, mainly from thermal power stations and cement industries. A solid waste inventory is available, were companies that are permitted to manage hazardous waste are registered, and data concerning the hazardous waste managed by each company are kept. Up to date data regarding mercury waste export (and more specifically mercury vapour lamps and mercury lamps waste exported to EU member states for recycling) have been submitted and included.

8.1.6.7 Israel

The following information was provided by the NFP:

Air emission inventories: data of stack emissions is kept, checks done by the industrial plants and the ministry (Emission values kg/h & concentrations mg/m3). There is information on mercury for 72 plants out of 500.

Water emissions inventories: The WWTP in Israel monitor mercury in effluent and sludge emissions. The Ministry of Environmental Protection (MoEP) control the emissions in major WWTP.

Contaminated soils inventories: The MoEP manages a national information system of contaminated soils.

The report submitted by Israel to MEDPOL for the NBB 2008 includes mercury atmospheric and liquid emissions, within the Mediterranean watershed. Therefore, this inventory does not cover all the national territory. Moreover, within these regions, the specific share of atmospheric emissions that may affect the Mediterranean Sea are calculated taken into account the sea/land wind directions annual distribution.

The total mercury atmospheric emissions in 2008 were 1,246 kg, of which 601.5 kg were estimated to be directed to the Mediterranean Sea (Table 67). About 50% of these emissions were released by cement plants, followed by coal combustion for energy production (42%). Mercury releases to the Mediterranean watershed were estimated in 75 kg.

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[52] http://www.pollutionsindustrielles.ecologie.gouv.fr/IREP/)
[53] http://www.stats.environnement.developpement-durable.gouv.fr/
[54] http://stats.environnement.developpement-durable.gouv.fr/donnees-essentielles/activites-humaines/industrie/la-pollution-des-sols.html
[55] http://basol.ecologie.gouv.fr/

Table 67. Mercury atmospheric emissions in Israel Mediterranean regions, 2008. Source: NFP.

Source	Total emissions (kg/yr)	Emissions toward the Med sea kg/yr)
Coal combustion for energy production	525	270.38
Fuel oil combustion for energy production	59.37	27.4
Cement plants	660	303
Residential Fuel Combustion in Urban Centres	2	0.76
TOTAL	1246.37	601.54

8.1.6.8 Italy

The Italian air emission inventory follows the CORINAIR methodology and provides data to the LRTAP Convention. Detailed data is provided at national level by the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), through the National Network of Environmental Information (SINAnet[56]). Emission data can also be obtained by region and province.

The mercury release to air and water in 2008 are shown in Table 68.

Table 68. Mercury emissions to air and water in Italy in 2008. Source: NFP.

Source activity	Mercury in air (t/year)	Mercury in emissions to water (t/year)
Coal combustion in power plants (>50 MW_{th})	0.828	0,000
Coal combustion in residential use (<50 MW_{th})	0.872	0,000
Metal industry	3.148	0,015
Chlor-alkali industry	0.222	0,184
Cement production	1.276	0,000
Paper industry	-	0,022
Production of basic organic chemicals	-	0,018
Waste incineration	0.154	0,007
Waste landfill	-	0,000
Mineral oil and gas refineries	0.160	0,014
Phosphorous fertilizers	-	0,000
Spreading of sewage sludge on agricultural land	-	0,000
Cremation	-	0,000
Other activities with mercury emission	5.285	0,375
TOTAL mercury emissions	10.482	0,635

8.1.6.9 Lebanon

According to the INC-1 Submission report by Lebanon, the estimated releases of mercury from health care waste (thermometers and sphygmomanometers) is approximately 31 Kg Hg per year, according to information derived from the project entitled “Demonstrating and Promoting Best Techniques and Practices for Reducing Health-Care Waste to Avoid Environmental Releases of Dioxins and Mercury”, prepared in 2007.

56 http://www.sinanet.apat.it/it/sinanet/sstoriche

8.1.6.10 Malta

No information has been obtained from the NFP and any national inventory of emissions has been identified. However, some data for Malta can be obtained from the AMAP/UNEP (2008) inventory and EMEP.

8.1.6.11 Monaco

According to the NFP, there is no stock of mercury in the Principality of Monaco. Moreover, no industry produces nor uses mercury in its processes.

8.1.6.12 Montenegro

No information has been obtained from the NFP and any national inventory of emissions has been identified. However, some data for Montenegro can be obtained from the UNECE/EMEP and the NBB database.

8.1.6.13 Morocco

According to the NFP, the Environmental Department of Morocco is developing a national assessment of exposure to pollution of mercury, lead and cadmium. This study includes an inventory of uses of Pb, Cd, and Hg at national level, as well as the identification of the major potential or actual sources of intentional and unintentional release of these metals to water, air and soil (Table 69). According to this assessment, mercury atmospheric emissions in Morocco account for about 2.8 tonnes yr^{-1}, mainly produced by the cement industry and thermal power plants. Water releases were estimated in 0.28 tonnes yr^{-1}, as a result of dental amalgams and a chlor-alkali plant. Mercury releases to soil/waste were also estimated in 0.65 tonnes yr^{-1}, mainly from the disposal of Hg containing batteries and thermometers.

Table 69. Mercury emissions in Morocco. Source: NFP.

Source activities		Estimated releases of Hg (kg/yr)		
		Water	Air	Soil
Manufacturing industry	Lead primary smelting		134	
	Steel secondary smelting		47	
	Chlor-alkali	96	53	136
	Cement production		1596	
	Subtotal industry	*96*	*1830*	*136*
Energy sector	Thermal plant Mohammedia (carbon)		133	
	Thermal plant Mohammedia (fuel)		420	
	Thermal plant de Jerarda (carbon)		125	
	Thermal plant Kenitra (fuel)		400	
	Thermal plant JLEC (carbon)		680	
	Subtotal energy	*0*	*938*	*0*
Consumption products	Batteries			300

	Thermometers			150
	Dental amalgams	187		63
	Subtotal products	*187*	*0*	*513*
TOTAL		283	2768	649

8.1.6.14 Slovenia

The available atmospheric mercury emission inventories in Slovenia are linked to reporting obligations to EMEP (LRTAP Convention), the E-PRTR register, and the NBB (Barcelona Convention). Some data is also available from the AMAP/UNEP (2008) mercury inventory. Slovenia reports to E-PRTR water emissions of mercury from industrial sites. The NFP has reported mercury air emissions of 1.26 tonnes yr^{-1} (2008), mainly from waste incineration and coal-fired power plants, and 0.12 tonnes yr^{-1} of mercury released to water, mainly from mercury primary and secondary production.

Annual data on solid waste generation in Slovenia can be obtained on-line from the Statistical Office of the Republic of Slovenia.

The Centre for Soil and Environmental Science (Biotechnical Faculty, University of Ljubljana) hosts the Soil Information System of Slovenia. The SIS includes the Soil Pollution Monitoring layer, with point data on concentrations of several organic and inorganic pollutants, including mercury.

8.1.6.15 Spain

The available atmospheric mercury emission inventories in Spain are linked to reporting obligations to EMEP (LRTAP Convention), the E-PRTR register, and the NBB (Barcelona Convention). Spain also provides specific emissions from the chlor-alkali industry according to provisions of the OSPAR Convention. Water releases of mercury are included in the E-PRTR register and the chlor-alkali emissions inventory provided to OSPAR.

Data on hazardous waste generation are collected by the Ministry of the Environment, Rural and Marine affairs (MARM) as well as by the different Autonomous Communities. Mercury wastes from the chlor-alkali industry are available from the reporting to OSPAR (OSPAR, 2009).

According to the 2nd National Plan for Polluted Soils Remediation, a National Inventory on Polluted Soils will be prepared. This inventory will integrate information from the Autonomous Communities, some of which have already conducted their own inventories.

8.1.6.16 Syria

According to the NFP, Syria signed a Memorandum of Understanding with the UNEP Chemicals in 4 October 2007, hereby Syria will execute a national inventory of mercury uses and releases. The national inventory project focused on the potential sources of mercury uses and its releases out of the various service and industrial activities of the public, private and common sectors including intentional and unintentional uses of mercury and its compounds. The emission calculations were based on the minimum and maximum default values of the UNEP inventory toolkit, although the minimum values were considered as more appropriate for the situation in Syria. In this sense, mercury atmospheric emissions are in the range 271-2271 kg/yr, produced by oil refining, waste incineration and the chlor-alkali industry, while wastewater emissions are estimated in 65 kg/yr from landfills, as indicated below:

Mercury focus	Mercury in air (kg/year)	Mercury in waste water (kg/year)	Mercury in solid waste (kg/year)	Mercury in soil (kg/year)
Coal combustion in power plants (>50 MW_{th})				
Coal combustion in residential use (<50 MW_{th})				
Metal industry				
Chlor-alkali industry	1.3 - 21		98 - 1568	
Cement production				
Paper industry				
Production of basic organic chemicals				
Waste incineration	250			
Waste landfill		65	20	26
Mineral oil and gas refineries	20 - 2000			
Phosphorous fertilizers				
Spreading of sewage sludge on agricultural land				
Cremation				
Other activities with mercury emission				
TOTAL mercury emissions	271.3-2271	65	118-1588	26

8.1.6.17 Tunisia

The following information was provided by the NFP:

Air emission inventories: Tunisia reports the emissions from major industrial sites to the MEDPOL National Baseline Budget (NBB). This includes air and water mercury emissions.

Water emission inventories: A study has been conducted to update the potential sources of pollution of water resources (hot spots), as well as the development of a national network for the monitoring of water pollution.

Solid waste inventories: there is a national waste management plan which includes potential hazardous wastes (heavy metals, POPs,...).

Contaminated soil inventories: there is a study on management and remediation of polluted sites in Tunisia (2001).

8.1.6.18 Turkey

According to the NFP, there is no inventory of mercury emissions in Turkey. However, Turkey provides information to the NBB inventory, and the EMEP includes Turkey on their estimations of atmospheric mercury releases.

8.1.7 Synthesis of information and estimated emissions

8.1.7.1 Regional inventories

A review of main characteristics of the different regional inventories described above is summarized in Table 70. As it can be observed, all the inventories include data on air emissions, while only two of them include releases to water (E-PRTR and the NBB), and just one inventory considers releases to soil (E-PRTR). There are some inventories that cover all Mediterranean countries, but these are punctual assessments, while inventories conducted on an annual basis only covers EU member states (E-PRTR) or north Mediterranean countries (UNECE/EMEP).

Comparability of results is not only affected by the geographic coverage, but also by the activity sectors included in the inventory. While the UNECE/EMEP inventory includes all potential sources of atmospheric emissions, other inventories are focused on industrial point source releases (e.g. E-PRTR or NBB), or on source sectors specifically targeted to estimate mercury emissions (e.g. AMAP/UNEP Hg Programme).

In any case, unintentional emissions resulting from the use of fossil fuels (in the energy or cement industry) appear to be the dominant source of mercury releases to the atmosphere in the Mediteranean, which is in agreement with mercury inventories in other areas.

On the other side, when included, Turkey seems to be the major emitting country in the region, followed by some EU member states like Italy, Spain or France. According to the NBB, Italy is the major emitting country, but this result might be influenced by the fact that data has not been homogeneously reported by all countries, and that within this inventory, in principle, only the coastal administrative regions or the Mediterranean catchment area is taken into account (which might affect countries like Turkey, which has a significant part of its territory out of the Mediterranean basin).

Total estimated mercury releases to air are in the range 6.3 – 106 tonnes per year. However, as indicated above, figures provided by the different inventories cannot be directly compared, due to differences in the last reported year, the geographic coverage, the source sectors included, or the methodology and emission factors used.

Table 70. Review of regional inventories of mercury emissions.

Inventory	Matrix	Geographic coverage	Mediterranean countries included	Periodicity	Last year reported	Sectors covered	Reported amount in Med (air) (t/yr))	Major emitting country	Major emitting sector
AMAP/UNEP Hg Progamme	Air	World	All	Punctual	2005	Mercury specific	6.8	Turkey (27%)	Stationary combustion (54%)
UNEP/MAP NBB	Air, Water	Mediterranean basin	All	Variable (2003;2008)	2003	Mostly industrial	6.3	Italy (40%)	Cement (33%)
EU E-PRTR	Air, Water, Soil	EU Member States	CY, FR, GR, IT, SI, ES	Annual	2007	Industrial	9.9	Spain (43%)	Energy (33%)
UNECE-EMEP	Air	Europe-Caucasus-Central Asia	ES, FR, MC, IT, MT, SI, HR, BA, ME, AL, GR, CY, TR	Annual	2007	All	66.6	Turkey (32%)	Energy industries (38%)
Pirrone et al. (2001)	Air	Mediterranean countries	All	Punctual	1995	Mercury specific	106	France (22%)	Energy (29%)

8.1.7.2 National information

Many of the information provided at national level by NFP is linked to the international or regional reporting obligations that countries have with UNECE, E-PRTR or NBB. Some countries provide data to these regional frameworks from their own national inventories (e.g. France or Italy), and others have conducted specific assessments of the situation of heavy metals including mercury, like Morocco or Syria. No information from national sources has been obtained or identified for some small countries, but data is available for the more populated and industrialized countries, and by combining national with regional information, some figures can be obtained for all Mediterranean countries (see below). In general, there is more information on atmospheric emissions, comparing to water releases or mercury waste inventories.

8.1.7.3 Estimated emissions

Data on atmospheric mercury emissions available from regional or national inventories described above are summarized in Table 71. These data has been used to estimate the 'best value' for each country, taking into account (i) most recent data; (ii) inventories covering a wider range of source categories (e.g. EMEP); and (iii) data provided or identified at national level. In this sense, most of the estimated values results from the mean value of the AMAP and EMEP figures.

The obtained values (shown on Table 71 and Figure 32) indicate that the total estimated mercury atmospheric emissions in the Mediterranean region are **69.6 tonnes yr^{-1}** (about **3.6%** of global emissions, 1921 tonnes yr^{-1}). Turkey would account for 28% of regional emissions, followed by Italy (16%), and Spain (14%). Along with Greece and France, these countries would account for about 80% of total atmospheric emissions in the Mediterranean. By regions, north Mediterranean countries (NMC) account for 56% of total emissions, followed by eastern (33%) and south (10%) Mediterranean countries (see Figure 33).

There is not enough information to estimate mercury emissions to water, but according to available data it can be assumed that total releases will be lower in comparison to atmospheric emissions.

Table 71. Mercury emissions (kg yr^{-1}) to air according to the available regional and national inventories in the Mediterranean countries, and best value estimated emission.

Inventory	AMAP/UNEP	NBB	PRTR	EMEP	Pirrone (2001)	National	Best Value
Country	2005	2003	2007	2007	1995	2007-2008	2003-2008
Albania	80.10			197.70	260.00		138.90
Algeria	1,570.28	418.23			2,000.00		1,570.28
Bosnia H.	230.70	0.00		1,883.51			1,057.11
Croatia	421.00	147.27		624.13			522.57
Cyprus	158.00	30.20	166.50	1,363.19	900.00	180.00	760.60
Egypt	3,895.50	424.60			6,100.00		2,160.05
France	8,765.10	21.00	2,861.30	6,681.14	22,800.00	6,700.00	6,681.14

Greece	3,192.20		1,549.90	12,999.93	2,500.00		8,096.07
Israel	3,191.60	544.40			800.00	1,246.37	2,218.99
Italy	12,879.70	2,520.90	1,022.00	10,711.41	11,400.00	10,482.00	11,357.70
Lebanon	304.00	290.80			1,500.00		297.40
Libya	507.60	104.32			2,300.00		507.60
Malta	618.00			626.10			622.05
Monaco	80.00			56.00			68.00
Montenegro				149.00			149.00
Morocco	2,099.20				6,700.00	2,768.00	2,433.60
Slovenia	413.80	82.70	38.10	1,169.36		1,263.00	791.58
Spain	10,181.90	789.24	4,251.40	9,039.26	9,000.00		9,610.58
Syria	503.30	204.60			3,500.00	271-2271	387.15
Tunisia	554.00	509.48			2,900.00		554.00
Turkey	18,111.60	166.07		21,109.10	16,200.00		19,610.35
Total	67,757.58	6,253.81	9,889.20	66,609.83	88,860.00		69,594.70

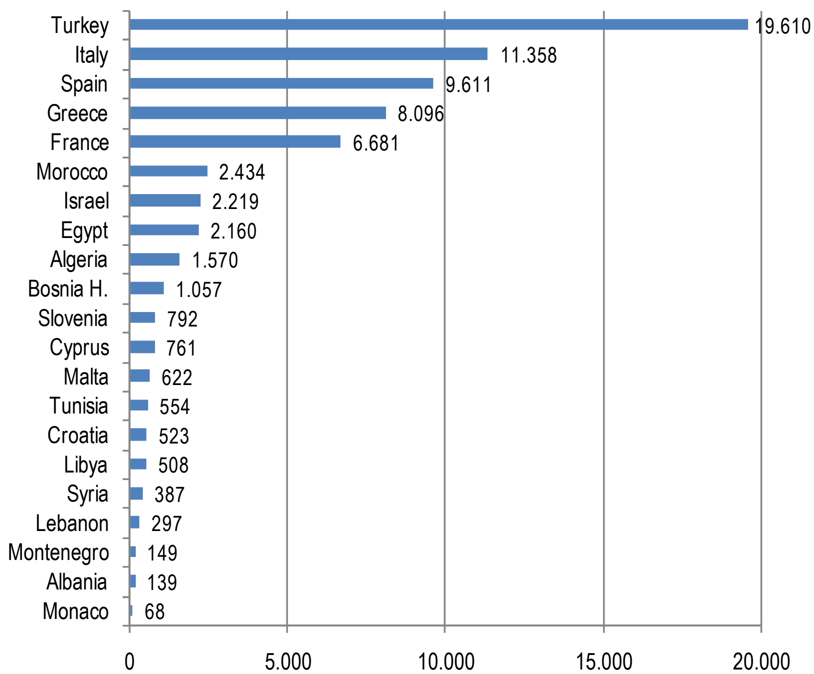

Figure 32. Estimated mercury atmospheric emissions in Mediterranean countries (kg yr^{-1}).

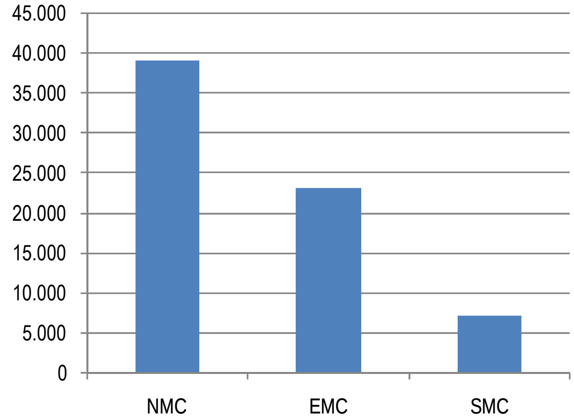

Figure 33. Estimated mercury atmospheric emissions in Mediterranean sub-regions (kg yr^{-1}).

8.2 Quality monitoring networks

8.2.1 Air

8.2.1.1 UNECE/EMEP Measurement Network

As it has been presented above (see section 8.1.4), besides collection of emission data, the EMEP programme includes measurements of air and precipitation quality as well as modelling of atmospheric transport and deposition of air pollutions. The EMEP measurements are coordinated by the Chemical Coordinating Centre (EMEP-CCC), which has been hosted by the Norwegian Institute for Air Research (NILU) since the beginning of the programme in 1979.

According to the EMEP-CCC website[57], there are 35 monitoring stations in 10 Mediterranean countries (Spain: 9; France:12; Italy: 2; Malta:1; Slovenia: 4; Croatia:2; Bosnia H.: 1; Montenegro:1; Greece:2; and Turkey:1). However, not all these stations are monitoring mercury data, but they might have the potentiality to include this parameter. The stations that measured heavy metals and mercury in 2007 are shown in Figure 34. The sites are divided in those measuring both concentrations in air and in precipitation, and those measuring only one of them. There were 22 sites measuring at least one form of mercury, which is an increase of 6 sites from the previous year. However, it can be observed that the spatial reduction in east and southern Europe is still unsatisfactory, especially for mercury, though the situation could improve as a result of the new EMEP monitoring strategy (UNECE/EMEP, 2009), and the EUs daughter directive on heavy metals and PAH (EMEP, 2009a). The available mercury measurements for 2007 are shown in Figure 35.

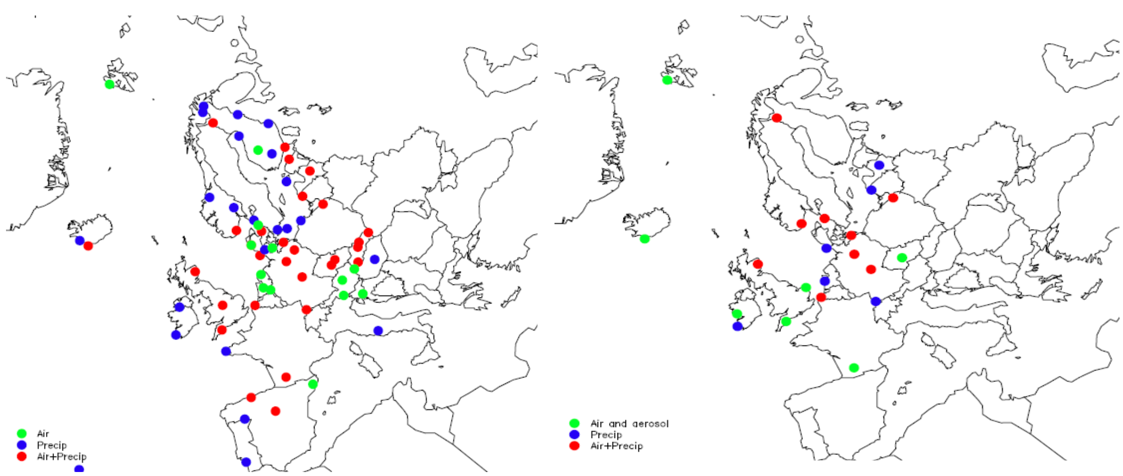

Figure 34. EMEP Measurement network of heavy metals (+Cyprus outside the map area), 2007 (*left*) and measurement network of mercury, 2007 (*right*). (EMEP, 2009a).

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[57] http://tarantula.nilu.no/projects/ccc/network/index.html

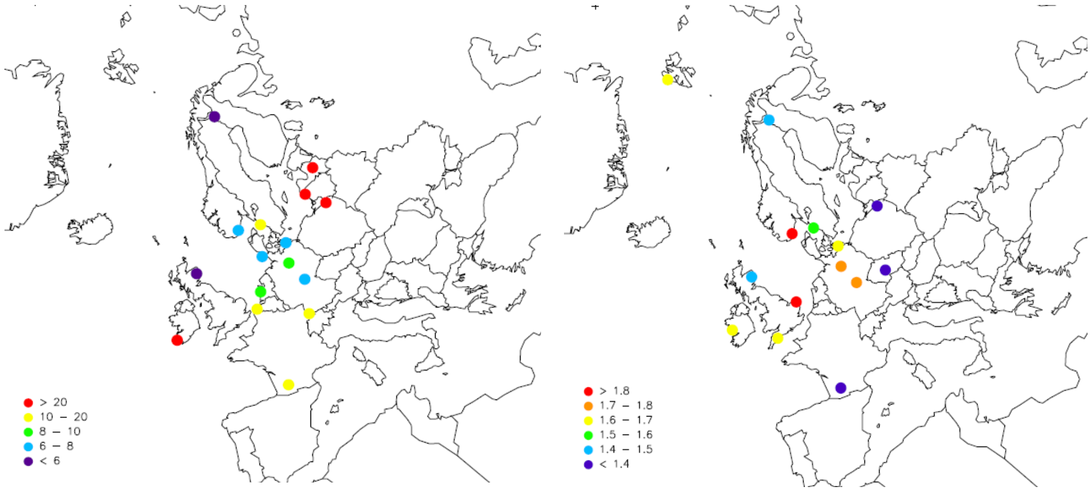

Figure 35. Mercury in precipitation (ng/l) (*left*) and in air (ng/m^3) (*right*), in 2007 (EMEP, 2009a).

The EMEP also releases annual reports on transboundary pollution of heavy metals, where measured and modelled/calculated data is presented. According to its last report (EMEP, 2009b), in Europe and Central Asia the calculated concentrations of mercury in air varied from 1.4 to 1.7 ng/m^3 over most part of the territory (Figure 36). In the central part of Europe in the regions known for significant emissions the concentrations exceeded 1.7 ng/m^3. Concentrations in precipitation in Europe ranged from 5 to 12 ng/L (in Central Asia, 12-18 ng/L) (Figure 37). Higher concentrations in precipitation in Central Asia compared to Europe can be explained by lower precipitation amounts in this region. The same reason explains the elevated concentrations in the northern part of Africa (EMEP, 2009b).

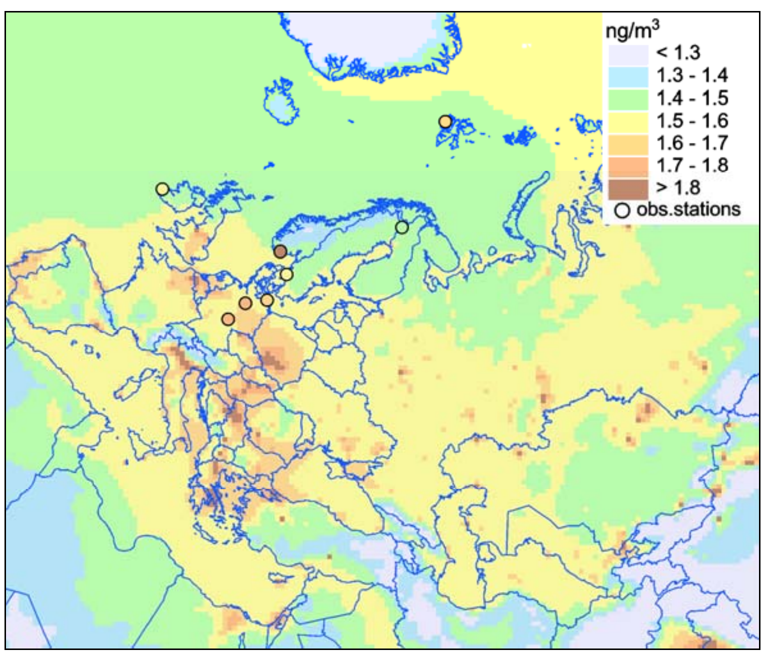

Figure 36. Calculated and measured surface concentrations of mercury in air over Europe and Central Asia in 2007, ng/m^3 (EMEP, 2009b).

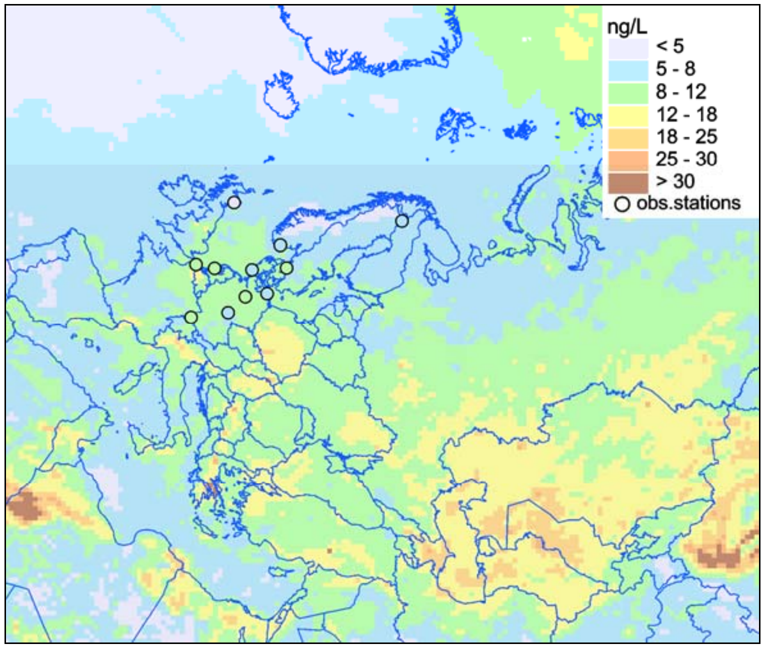

Figure 37. Calculated and measured concentrations of mercury in precipitation over Europe and Central Asia in 2007, ng/L (EMEP, 2009b).

Mercury total deposition varied from 7 to 20 g/km^2/y over most of Europe and Central Asia (Figure 38). Countries with the highest deposition relate to the regions with high emission of mercury, e.g. Poland, Belgium, north of Italy, and the Balkan region. Total deposition fluxes in these regions exceeded 50 g/km^2/y. The lowest (less than 5 g/km^2/y) deposition levels were found over the Arctic region and over the deserted areas of Africa and Central Asia.

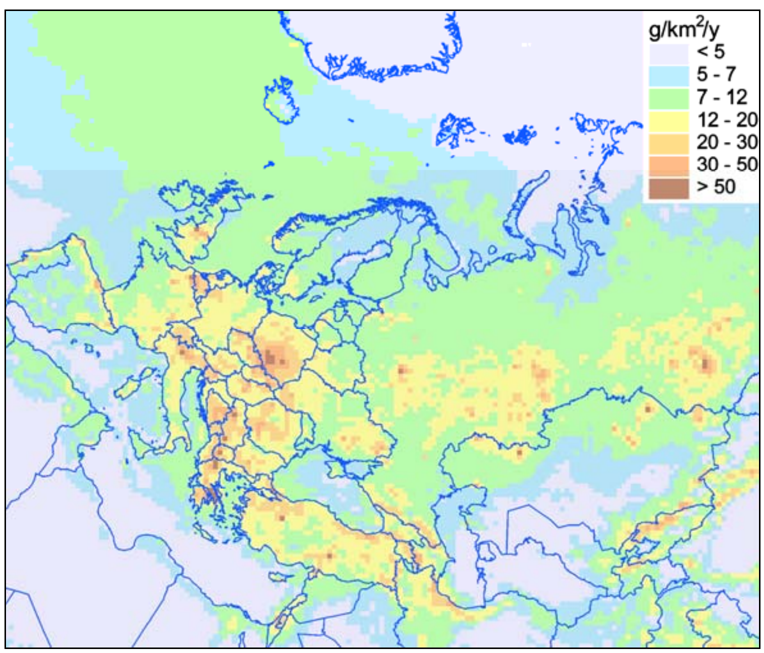

Figure 38. Total annual deposition of mercury in Europe and Central Asia in 2007, g/km^2/y (EMEP, 2009b).

Country-averaged deposition of mercury in the European and the Central Asian countries in 2007 varied from 4 g/km^2/y in Turkmenistan to 27 g/km^2/y in Belgium (Figure 39). Some Balkan and eastern Mediterranean countries show deposition rates above average European rates, particularly Bosnia H., Greece, Montenegro and Slovenia. In 35 countries (of 50) the deposition from non-EMEP sources exceeded 50%, which indicates that sources located outside the EMEP region significantly affect mercury pollution levels in Europe (EMEP, 2009b).

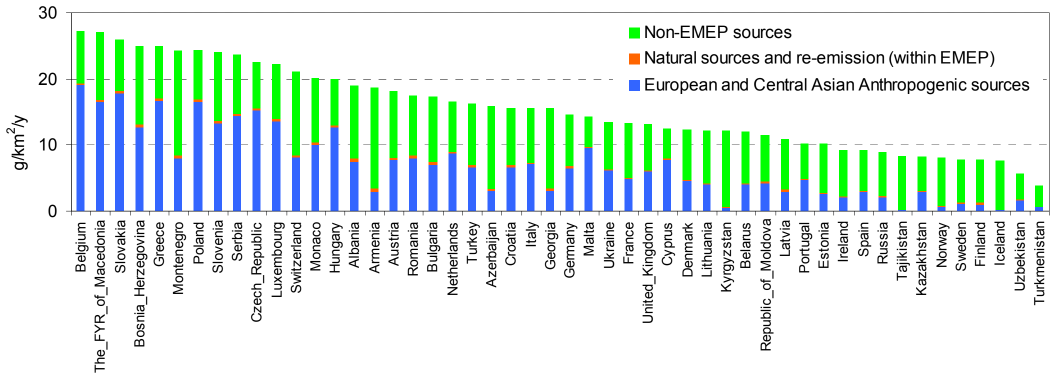

Figure 39. Country-averaged deposition fluxes of mercury from the European and Central Asian anthropogenic, natural/historical and non-EMEP sources in 2007 (EMEP, 2009b).

Contribution of the transboundary transport to anthropogenic deposition of mercury in Europe varied essentially from country to country (Figure 40). Except in some Balkan countries, Mediterranean countries are less affected by transboundary transport (e.g. Malta, Turkey, Greece, Spain or Cyprus). On the other side, comparing to other regional seas, the Mediterranean show lower deposition rates of mercury (Figure 41).

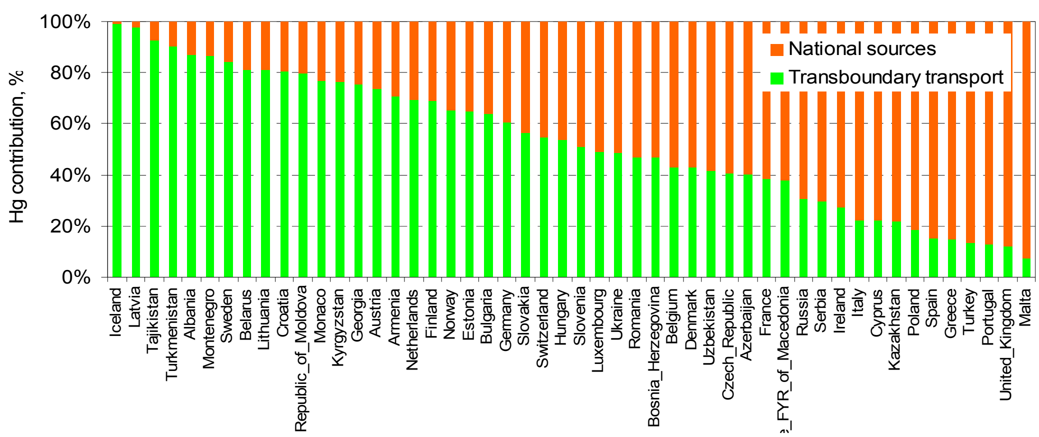

Figure 40. Relative contribution of the transboundary transport and national sources to anthropogenic mercury deposition in the European and Central Asian countries in 2007 (EMEP, 2009b).

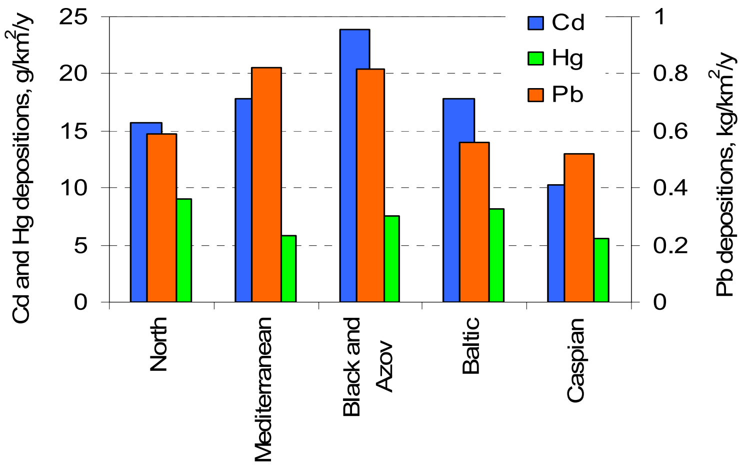

Figure 41. Averaged deposition fluxes of lead, cadmium and mercury to regional seas in 2006 (EMEP, 2009b).

The EMEP data and assessments presented above suggest that actual mercury inputs to Mediterranean territories and marine environment have a strong transboundary component, therefore effective actions to reduce mercury pollution need to be coordinated at supra-national and even supra-regional level.

8.2.1.2 EEA - AirBase

AirBase is the air quality information system maintained by the European Environment Agency (EEA) through the European topic centre on Air and Climate Change. It contains air quality data delivered annually under 97/101/EC Council Decision establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States (EoI Decision).

The EoI Decision distinguishes between information which must be transmitted in particular relating to the Directive on Air Quality (96/62/EC) and information that must be submitted where it is available. The four annexes in the EoI Decision (list of pollutants, statistical parameters and units of measurement; information concerning networks, stations and measurement techniques; data validation procedure and quality assurance; criteria for the aggregation of data and the calculation of statistical parameters) were amended by Commission Decision 2001/752/EC and its corrigendum.

The EEA requests all its member and collaborating countries to provide the information foreseen by the EoI Decision because air pollution is a pan European issue and the EEA produces assessments of air quality, which cover the whole geographical area of Europe.

The public air quality database, including information on mercury concentrations in air, is available at http://www.eea.europa.eu/themes/air/airbase. However, very few stations include data on mercury air concentrations.

8.2.1.3 National information

a) Algeria

According to the NFP, the University of Annaba conducted a study about the mercury atmospheric pollution and its potential effects on human health in the region of Annaba and Azzaba.

b) Croatia

According to the NFP, in Croatia there is a programme on air quality measurement in the national air quality monitoring network (OG 43/02). Mercury is monitored in measuring stations for air pollution in settlements and industrial zone. Once the state air network is established, Hg will be also monitored in measuring stations for background pollution, regional and long-range transboundary transport, and for monitoring performed within the scope of international commitments of the state, and in measuring stations in areas of natural and cultural interest, in the PM10 and PM2,5 fractions.

c) Cyprus

Atmospheric air Hg concentrations are measured/calculated from PM10 filter samples collected daily from the Air Quality Monitoring Traffic Station of Nicosia (hospital) in ng/m^3. For 2007 the annual average was 0.32 ng/m^3 and for 2008 it was 0.30 ng/m3. Background atmospheric air Hg concentrations are also measured/calculated from the Air Quality Monitoring EMEP station from PM10 filter samples collected daily. For 2007 the annual average was 0.29 ng/m3 and for 2008 it was 0.34 ng/m3. The raw data for these measurements is found in the EEA AirBase[58].

d) Egypt

According to the NFP, there are no national monitoring networks for mercury.

e) France

At national level, the ADEME (*Agence de l'environnement et de la maîtrise de l'énergie*) coordinates the national network for air quality monitoring (AASQA)[59], which includes the monitoring of mercury levels.

A review of available monitoring networks, databases and sources of information on air quality data in France is provided by Déléry & Mandin (2009). This report provides also a synthesis of collected data on mercury levels in different environments as shown in Table 72.

Table 72. Air mercury levels in different environments in France.

Environment	Average concentration (ng/m^3)
Urban	<0.1 – 4.1
Rural	0.8 – 6

[58] http://air-climate.eionet.europa.eu/databases/airbase/index_html
[59] http://preprod.medd.nexint.net/Reseaux-de-surveillance,11109.html; http://www.atmo-france.org/fr/

Industrial	<0.04 -14.7

f) Israel

According to the NFP, mercury air quality control in Israel is performed by the industrial plants and the environmental authorities (Emission values -kg/h- and concentrations -mg/m3-), and information on mercury is available for 72 plants out of 500.

g) Malta

The Malta Environment and Planning Authority (MEPA) is the competent Authority responsible for the monitoring of air pollution in ambient outdoor air and for coordinating policy measures. Data from 4 air monitoring stations, including mercury levels, can be obtained on-line from MEPA's website (http://www.mepa.org.mt/airquality).

h) Slovenia

Since 2009, the Environmental Agency of the Republic of Slovenia (EARS) provides data on the average concentration of mercury in ambient air (http://www.arso.gov.si/en/air/data/), in the monitoring station of monitoring site Iskrba pri Kocevski Reki. In 2009, the average annual concentration was 1.5 ng/m^3, while maximum values (7.5 ng/m^3) where reached in the month of September.

Monitoring of mercury levels have also been carried out around the Idrija mine.

i) Spain

The EMEP/VAG/CAMP monitoring network, created in 1983 and reunified in 2006, deals with Spain's commitments on air pollution monitoring against different programmes (RAC/CP, 2010b):

- EMEP – European Monitoring and Evaluation Programme (UNECE/CLRTAP Convention)
- GAW – Global Atmosphere Watch (UN World Meteorological Organization)
- CAMP – Comprehensive Atmospheric Monitoring Programme (OSPAR Convention)

This network has 13 stations and in 2007 the sampling of total gaseous mercury and mercury in PM_{10} was initiated.

There are also other air pollution monitoring networks, managed by Autonomous Communities or municipalities (>50,000 inhab.), that report data to the Ministry of Environment, Rural and Marine affairs; although only a few of them have initiated the monitoring of mercury levels (RAC/CP, 2010b).

Some punctual campaigns have also been conducted by the Ministry of the Environment. In 2005 and 2007 mercury levels were measured in the Niembro station, obtaining mean values of 1.8 ng m^{-3} and 0.005 ng m^{-3} for gas and particulate phase, respectively (2005 data).

j) Tunisia

According to the NFP, a decree related with atmospheric emissions foresees the control of air mercury emissions in Tunisia. Modelling of air quality is going to be used to assess the amount of mercury in air.

k) Turkey

According to the NFP, in Turkey there is no inventory of mercury emissions to air but there are national emission and air quality limit values to which industrial facilities draw programs and take measures to comply with. Furthermore, policy tools are being applied, such as the national legislation on industrial air pollution control, being amended to incorporate further limitation of mercury.

8.2.2 Water

8.2.2.1 The EU Water Information System for Europe (WISE)

The Water Information System for Europe (WISE) compiles a number of data and information collected at EU level by various institutions and bodies. The WISE viewer is a central location where geographically-mapped information on water-related issues can be found for the whole of Europe. This includes data on water quality and information on implementation of EU water legislation. All data displayed in the Water Information System for Europe are reported by Member States or other countries reporting to the European Commission (EC) or the European Environment Agency (EEA). The data are reported in the context of the official reporting on the basis of EU legislation, in particular the Water Framework Directive (2000/60/EC), the Urban Waste Water Directive (91/271/EEC) or the Bathing Water Directive (76/160/EEC) or the data are submitted on a voluntary basis in the context of the EIONET agreements of the EEA.

8.2.2.2 National information

The following information has been obtained from national sources:

a) Algeria

According to the NFP, in Algeria there is a monitoring network for coastal waters quality. The National Observatory for Environment and Sustainable Development (ONEDD) has conducted analysis of concentrations of methyl mercury in a polluted river (Oued El-Harrach) close to the bay of Alger.

b) Croatia

Water quality control: According to the Law on Waters (Official Gazette no. 153/09), Art. 44, Croatian Waters (Hrvatske vode) are responsible for monitoring water. The content of mercury in the land surface water (water and sediment) and groundwater is measured as a part of this monitoring. Total amount of mercury was investigated until 2008, and amount of dissolved mercury is under investigation from 2009. Croatian Waters (Hrvatske vode) are, through the Croatian Environment Agency (AZO), submitting the results of monitoring to the Water Information System for Europe (WISE)

c) France

In France a monitoring control network of the different water bodies has been established within the framework of the European Water Framework Directive .

Eau France (www.eaufrance.fr) is the national portal of the Water Information System (SIE), which is managed by the Service Nationale des Données et Référentiels sur l'Eau (SANDRE). Quality data of surface waters can be accessed through water agencies, which for the Mediterranean are:

- Rhône Méditerrranée: www.rhone-mediterranee.eaufrance.fr
- Corse : www.corse.eaufrance.fr

A specific inventory was carried out in 2005 by the water agencies to assess the occurrence of priority pollutants in the different water environments, including sediments (http://rsde.ineris.fr).

d) Greece

According to the NFP, the General Chemical Laboratory of Greece monitored surface water quality for the period 2006-2008. Hg levels were monitored, together with a number of other parameters, at approximately 200 monitoring points, 4 times/year. These monitoring points correspond to lakes and rivers located at the different regions of Greece. There were very few exceedances observed during this period: more specifically, exceedances were observed at 6 monitoring points in 2007 and at one monitoring point in 2008.

e) Israel

The Ministry of Health carries out regular monitoring and control of Drinking water wells.

f) Italy

In Italy monitoring programmes have been implemented in compliance with the Water Framework Directive 2000/60/EC (legislative decree 152/06 Annex 1.)

g) Malta

Malta has to comply with the EU Water Policy Framework Regulations concerning monitoring of water quality. For the case of mercury in marine sediments in Malta, Lampedusa and Linosa, levels were found to be relatively low, except for some outlier maxima reported in the immediate vicinity of the main outfall in Malta (UNEP/MAP, 2010).

h) Monaco

A quality control of the Drinking Water Production is in place based on French framework for frequency and parameters including Hg.

i) Morocco

According to the NFP, the following activities on water quality monitoring, including mercury, have been conducted in Morocco:

- Monitoring of water pollution in the bay of Nador
- Monitoring of the Oum Er Rbia river basin
- Assessment of the R'Dom river waters state of pollution, previous to the construction of a wastewater treatment plant for Sidi Kacem wastewaters.

j) Slovenia

The Environmental Agency of the Republic of Slovenia is responsible of the programmes for monitoring the quality of waters (rivers, lakes, groundwater and sea) and keep databases with the related information.

In Slovenia, the chemical status of rivers has been evaluated in accordance with the Regulation on the chemical status of surface waters since 2002 (EARS, 2008). In 2002, mercury was determined above sediment quality standards in 7 out of more than 90 river monitoring stations. In 2003 only 3 stations appeared to be above standards, and after 2004 all stations meet quality criteria for mercury. Mercury is also monitored in groundwater.

To comply with the Directive on the quality required for shellfish waters, three monitoring sites have been chosen in the shellfish growing areas (Piran Bay, Strunjan Bay and Debeli rtič. Along with other paramters, mercury is monitored with the frequency of twice to 12 times a year.

k) Spain

- Surface waters: As a result of the different european and national regulations, the Water Quality Integrated Netword (ICA) was created in Spain (RAC/CP, 2010b). The COCA network (General Water Quality Control), which includes mercury monitoring, reports data to ICA. Besides this, the ICA network also integrates the Hazardous Substances Moniroting Network, which includes the moniroting of mercury in water, river sediments and biota (fishes). According to data provided by the different Catchment authorities (*Confederaciones Hidrográficas*), some stations reports mercury concentrations in sediments above international reference standards (RAC/CP, 2010b). In the Ebro catchment area, high values of mercury in fishes have also been observed in some stations.

- Groundwater: The competent authorities of some autonomous communities manage monitoring networks in groundwater, including heavy metals (RAC/CP, 2010b). Some catchment authorities are also monitoring heavy metals in groundwater.

l) Tunisia

According to the NFP, a national monitoring network for the control of inland and coastal waters is operating in Tunisia. A new decree is being prepared dealing with water resources quality (including surface waters and groundwater).

8.2.3 Marine environment

The occurrence of pollutants in the Mediterranean marine environment has been monitored since some decades in the Mediterranean by regional programmes

(MEDPOL), national programmes (e.g. RNO in France, or SIDIMAR in Italy), or by specific research works. The MAP Technical report series are also a source of information, as well as regional assessments for specific substances (like for Persistent and Toxic Substances (UNEP/GEF, 2002)). Relevant information can also be obtained from the scientific literature and outcomes of specific projects (e.g. MITYLOS[60]).

8.2.3.1 The MEDPOL programme

When the Mediterranean Pollution Monitoring and Research Programme (MEDPOL) started in 1975 its main aim was the establishment of a network of Institutions undertaking marine pollution work and the collection of information regarding the level of pollution in the Mediterranean Sea. The monitoring activities covered heavy metals in marine biota (mainly mercury and cadmium), halogenated hydrocarbons in marine biota (mainly PCBs and DDTs), and petroleum hydrocarbons in seawater. The development and maintenance of these national monitoring programmes was the aim of the second phase, adopted in 1981, whereas later (1996) the emphasis shifted from pollution assessment to pollution control.

The MEDPOL monitoring and assessment program finished its Phase III in 2005, and the Phase IV programme is now operative until 2013. MED POL Phase III and IV monitoring programmes are designed to cover basically two different types of marine sites; hot spots and coastal/reference areas. Samples are collected from different environmental media. The mandatory monitoring matrices for MEDPOL programme are biota and sediment for hazardous substances. Total mercury and cadmium are the only ones which are mandatory, however, most of the national programmes contain more than those as recommended.

A major outcome of the Phase III programme was the setting up of the MEDPOL database. The content and data of this database has been recently assessed and is described below, with a focus on available information on mercury (UNEP/MAP, 2009).

a) Available data on mercury

The MEDPOL database includes data on samples or observations from a total of 685 stations, located in coastal areas of 13 different countries, during the period 1999-2008. Specific information for mercury is mostly available for biota and sediments, with 3188 and 809 observations, respectively. Some data is available for rivers and seawater, but these have been reported by just one or two countries. Data on mercury concentrations in sediments is available for 158 stations, while there are about 250 stations including data for biota. The distribution of measurements by matrix and reporting country is shown in Table 73. Biota samples are mainly divided in two classes: bivalves (217 stations; 2263 observations) and fishes (33 stations; 904 observations). The most representative species that are used are the mussel *Mytilus galloprovincialis* and the benthic fish *Mullus barbatus*, with some exceptions in eastern Mediterranean countries (e.g. Israel).

[60] MYTILOS Project: http://mytilos.tvt.fr/Projet/(language)/eng-GB

Table 73. Number of observations of total mercury (HgT), by matrix and country, in the MEDPOL database (1999-2008) (UNEP/MAP, 2009).

Country	Biota	Sediments	Total
Albania	41		41
Croatia	140	14	154
Cyprus	52		52
Egypt	9	10	19
France	465		465
Greece	81		81
Israel	1089	112	1201
Italy	472	496	968
Morocco	50		50
Slovenia	44		44
Spain	211		211
Tunisia	103	4	107
Turkey	410	114	524
Total	**3167**	**750**	**3917**

b) Mercury concentrations in sediments

Mean and median concentrations of Total Hg in sediments, by country, are shown in Table 74. Stations from Croatia appear to show the higher mean values, followed by Italy. A summary of mean levels of total Hg in all stations is shown in Figure 42. As it can be seen, the Western Mediterranean and the southern coast are underrepresented.

Table 74. Mean and median concentrations of Total Hg in sediments (µg g^{-1} dw), by country.

Country	Mean	Median
CRO	23.36	0.67
EGY	0.24	0.25
ISR	0.25	0.10
ITA	0.71	0.11
TUN	0.26	0.23
TUR	0.22	0.16

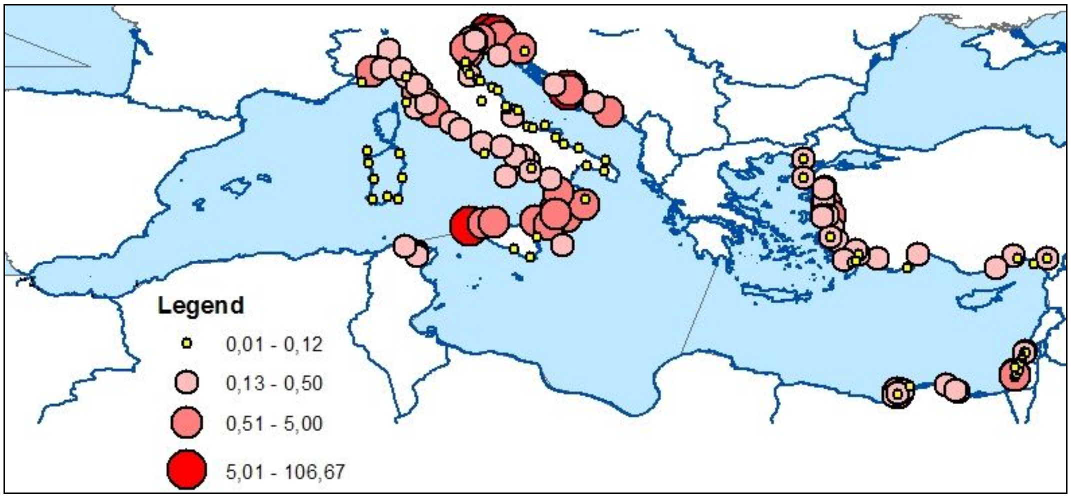

Figure 42. Mean concentrations of Total Hg in sediments (µg g^{-1} dw) (UNEP/MAP, 2009).

c) Mercury concentrations in biota

Average concentrations of mercury in mussels and fish are shown in Table 75. In general, the concentrations exhibit a large span of values for all countries (Figure 43) but the average values are of the same order of magnitude, with the exception of the total Hg concentrations in Spanish bivalves, with the higher levels.

The geographical distribution of stations and values for *Mytilus Galloprovincialis* (MG) and *Mullus Barbatus* (MB) are shown in Figure 44 and Figure 45, respectively. While MG covers a large area of the basin, fish samples do the Aegean-Levantine basin.

Table 75. Mean concentrations of Total Hg in *Mytilus Galloprovincialis* (MG) and *Mullus Barbatus* (µg g^{-1} dw), by country.

Country	MG	MB
ALB	0.35	.
CRO	0.57	.
CYP	.	0.34
FRA	0.14	.
GRE	1.13	0.66
ISR	0.28*	0.33
ITA	0.30	.
MOR	0.18	.
SLO	0.12	.
SPA	7.59	.
TUN	0.22	.
TUR	0.05	0.13

*Values corresponding to *Mactra coralline*

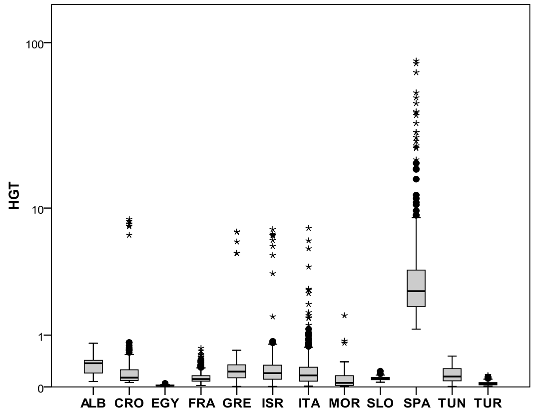

Figure 43. Concentrations of Total Hg in bivalves (µg g^{-1} dw) by country (UNEP/MAP, 2009).

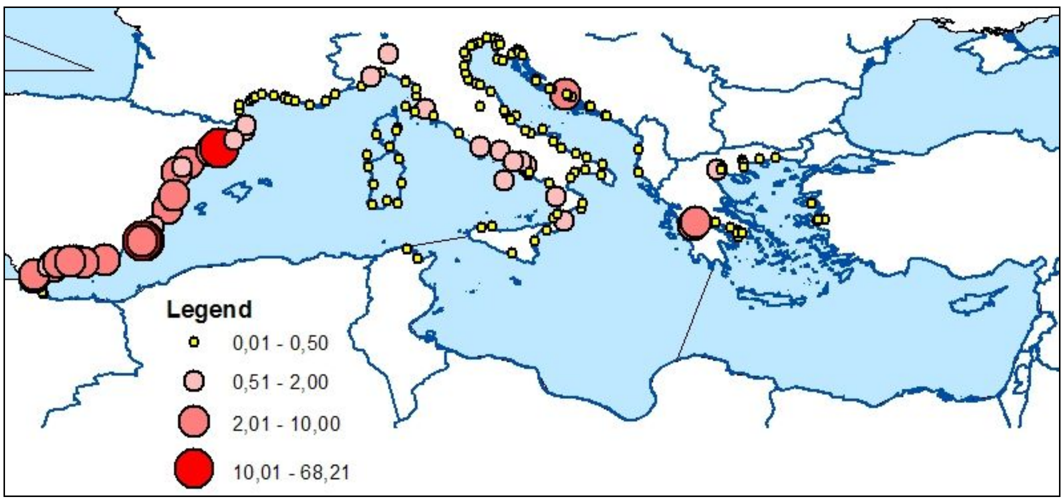

Figure 44. Map of mean concentrations of Total Hg in *Mytilus galloprovincialis* (µg g^{-1} dw). (UNEP/MAP, 2009).

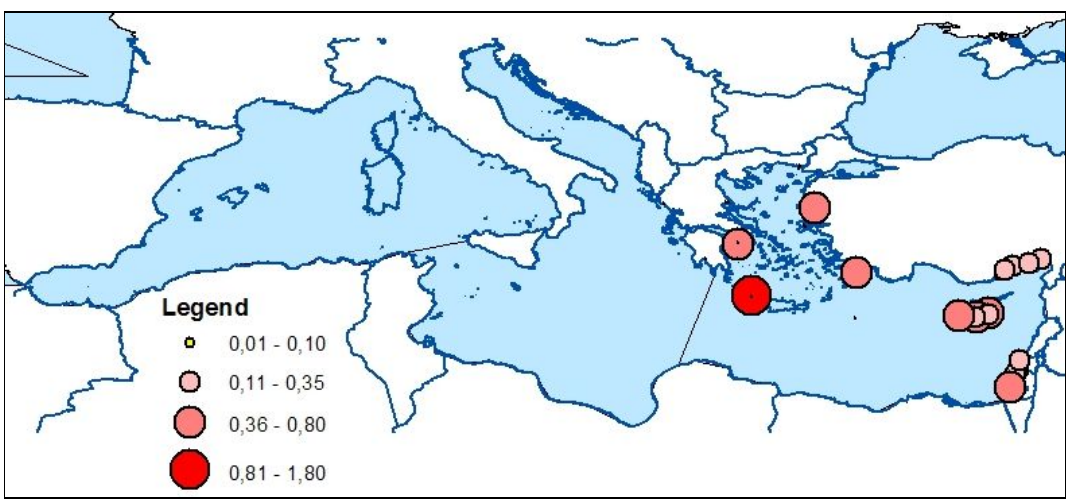

Figure 45. Map of mean concentrations of Total Hg in *Mullus Barbatus* (µg g^{-1} dw) (UNEP/MAP, 2009).

d) Mercury distribution in different regions

By eco-regions, the western Mediterranean area presents the highest levels of mercury, both in sediments and biota (Table 76).

Table 76. Median and concentration ranges of Total Hg in sediments and in Mytilus Galloprovinciallis.

Region	HgT in sediments ($\mu g\ g^{-1}$ dw)	HgT in *Mytilus galloprovinciallis* ($\mu g\ g^{-1}$ dw)
Adriatic	0.10 (0.01-166.9)	0.15 (0.01-8.45)
Aegean - Levantine	0.16 (0.00-5.18)	0.06 (0.01-0.63)
Central	0.05 (0.01-6.00)	0.18 (0.01-7.00)
Western	0.16 (0.02-12.6)	0.16 (0.01-259)

8.2.3.2 The MYTILOS/MYTIMED projects

The main objective of Mytilos and Mytimed projects is to assess the level of chemical contamination for the Western and Eastern Mediterranean coastal waters, using a standard protocol developed since 1996 by IFREMER using man-made cages containing mussels (Mytilus galloprovincialis) (Andral et al., 2007).

Mytilos project (2004 to 2006) was developed for the whole Western Mediterranean basin (with 120 mussel cage stations), including the coasts of Spain, France, West Italy, Morocco, Algeria and north of Tunisia. Mytimed project (2006 to 2008) concerns Eastern Mediterranean coastal waters (about 120 stations), and the geographical areas are Aegean sea (Greece and Turkey), Coasts of South Turkey, Syria, Lebanon and Cyprus, East of Tunisia, South-east of Italy and Western coast of Greece (linked to Mytilos project).

Mercury is one of the trace metals considered within these projects. Explotation of results shall be available through an internet site (http://mytilos.tvt.fr/Projet/(language)/eng-GB).

8.2.3.3 National information

a) France

The French National Monitoring Network (RNO)[61] was created in 1974 and is managed by IFREMER. Pollutants in sediments and biota are monitored since 1979, and since 2003 it also measures biological effects (imposex). The parameters include 9 metals (including mercury), organochlorinated compounds, αHCH, PCBs and PAHs. Biota is

[61] http://www.ifremer.fr/envlit/surveillance/rno.htm

monitored annually, while sediments are sampled in a 10 years period, although with the adoption of the WFD the frequency will be every 6 years since 2007.

The RNO dataset provides the longest temporal trend available for the Mediterranean region. Data on mercury concentrations for samples of *Mytilus galloprovincialis* collected in 21 stations along the period 1979-2006 are available, showing a general slow decline of concentrations during this time span (Figure 46).

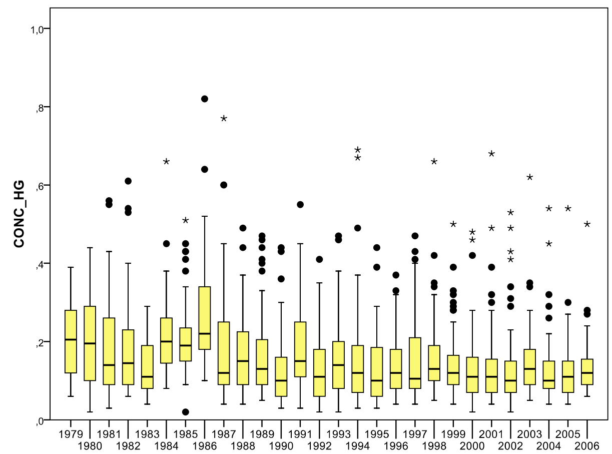

Figure 46. Temporal trend in concentrations of mercury in *Mytilus Galloprovincialis* (µg g^{-1} dw), along the French Mediterranean coasts. Source of data: RNO.

b) Italy

In Italy an initial coastal monitoring programme was undertaken in the Adriatic between 1990-1993, which was followed by a national programme (except Sicily) in 1996-2000, and since 2001 it operates at national level (SIDIMAR[62]). Data on hazardous substances is available for sediments and biota, and parameters are similar to RNO, including some additional substances like TBTs.

During the period 2001-2005, a total of 545 observations of mercury levels in mussels can be obtained from the SIDIMAR database. The mean value is 0.29 µg g^{-1} dw (0.003-7.4 µg g^{-1} dw).

c) Spain

The Spanish Oceanographic Institute (IEO) operates the marine monitoring network that collects quality data on sediments and biota for the MEDPOL programme, which includes the analysis of mercury in 27 stations along the mediterranean coastal area. Besides this, some Autonomous Communities operate monitoring networks in coastal waters, such as the region of Murcia (35 stations) or Andalucía (mercury in water and sediments). In the Mediterranean area of Andalucía the higher levels of mercury in coastal waters and sediments have been observed in the area of Algeciras Bay (RAC/CP, 2010b).

The National Ports Autority (Puertos del Estado) also collects data in differents ports of Spain (e.g. Barcelona, Valencia, Cartagena, Maó-Balearic Islands), where high levels of mercury have been detected in sediments (RAC/CP, 2010b).

62 http://www.sidimar.tutelamare.it/

According to NFP responses, other countries like Monaco or Tunisia have their national monitoring programmes of the quality of the marine environment, and they use these data to report to the MEDPOL program,

8.2.3.4 Information from the scientific literature

The occurrence of mercury in the marine environment has been widely studied and many research works can be identified in the scientific literature. In the Mediterranean, several articles have highlighted since the 1970s the high levels of mercury in the marine environment, particularly in fish, although frenquently these studies concern only the north western basin. These comparatively higher levels of the Mediterranean have been sometimes attributed to the higher natural background levels of mercury in the region. Although this is beyond the scope of this work, some examples of these studies and their findings are indicated below.

In sediments, elevated levels of mercury are more often found in the immediate vicinity of industrialized or heavily urbanized coasts (UNEP/MAP, 2010). For example, Buccolieri et al. (2006) found mercury levels in the Gulf of Taranto range from 40 to 410 ng g-1 dw in sediments near the coast and 70 ng g-1 dw in sediments offshore, in the centre of the gulf. An extensive study in the Strait of Sicily revealed that mercury levels ranged from 50 to 70 ng g-1 dw, with samples registering higher contents with maxima up to 202 ng g-1 dw (Di Leonardo et al., 2006). Similarly, sediments of the Strait of Otranto reached 78 ng g-1 dw. Mercury levels in marine offshore sediments as recorded in the Ionian Sea were generally found to be comparable to those from other Mediterranean areas (around 50 ng g-1 dw) (UNEP/MAP, 2010).

Concerning biota, mussels have commonly been used in monitoring programmes and research studies since they accumulate pollutants in their tissues at elevated levels in relation to pollutant biological availability in the marine environment. For example, Kljakovic-Gaspic et al. (2007) monitored the mercury content in the Blue Mussel (Mytilus galloprovincialis) in the Mali Ston Bay, located on the eastern Adriatic coast, from 1998 to 2005. The mean content of mercury in edible tissues was found to be 0.15 µg g-1 dw, and the analysis of temporal trends during the 7 years of monitoring showed that metal concentrations had not changed over time. Higher levels of mercury have been measured in mussels sampled closed to urban or industrial hot spots, such as Portman Bay, Spain (Benedicto et al., 2008), the Venice Lagoon (Zatta et al., 1992), or in the Izmir Bay, Turkey (Kucuksezgin et al., 2006). In these places high levels of mercury were also measured in fishes.

In the marine environment mercury bioaccumulates and biomagnifies at all trophic levels, leading to an additional pressure to top predator populations and posing a risk to human health by the consumption of seafood (Storelli, 2008). In the Mediterranean, concentrations of mercury in top predators and cetaceans, have been reported to be higher than in other marine regions, particularly in dolphins (Monaci et al., 1998; Capelli et al., 2007). Monaci et al. (1998) found mercury levels as high as 5,441 µg g-1 dw in livers of stripped dolphins from the Ligurian and Tyrrhenian Seas. Most recent studies by Capelli et al. (2007) also found high levels of mercury in cetaceans, specially in dolphins, although levels were lower than those observed by Monacci about a decade before. In the same species, the low range concentrations corresponded to the younger individuals, indicating the strong effect of age on Hg accumulation.

8.2.4 Food stuff and human levels

8.2.4.1 The Rapid Alert System for Food and Feed (RASFF)

In Europe the DG Health operates the Rapid Alert System for Food and Feed (RASFF), which was put in place to provide food and feed control authorities with an effective tool to exchange information about measures taken responding to serious risks detected in relation to food or feed. This exchange of information helps Member States to act more rapidly and in a coordinated manner in response to a health threat caused by food or feed.

The system differentiates between 'market' notifications and 'border rejections'. Market notifications are about products found on the Community territory for which a health risk was reported. Products that are subject of a border rejection never entered the Community and were sent back to the country of origin, destroyed or give another destination.

According to the last annual report of the DG Health Rapid Alert System for Food and Feed (EC, 2009), heavy metals on fish and shellfish are of particular concern, as they are frequently and increasingly detected above health-based legal standards. As shown in Figure 47, mercury accounts for the majority of notifications in fish (particularly swordfish and sharks), while cadmium is more prevalent in crustaceans and cephalopods.

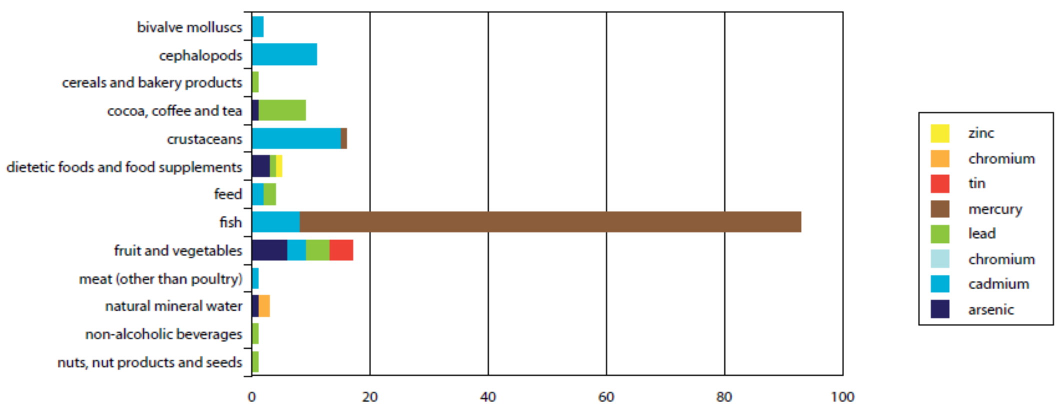

Figure 47. Number of notifications of heavy metals under the Rapid Alert System for Food and Feed (RAFFS) in 2008 (EC, 2009).

8.2.4.2 National information

a) <u>Albania</u>

No information about the control of mercury levels in human blood in Albania has been identified, but the mercury content in hair, for exposed, for exposed dental workers and unexposed groups of people living in Albania was studied by Babi et al (2000). The authors found a mean value of mercury content in hair of 0.705 µg/g (lower than the value referred from the WHO) and, as expected, a significant positive correlation of Hg content with the number of dental amalgam fillings, time under exposure and frequency of fish consumption in the diet was found.

b) Algeria

The National Centre of Toxicology undertakes analyses on fishes and crustaceans, making use of European health-based standards as a reference (1 ppm and 0.5 ppm for fishes and crustaceans, respectively). This centre also is responsible for analysis of mercury in blood of exposed workers (the standard is 2µg/100ml).

c) Croatia

In Croatia the control of mercury levels in human blood is carried out by the Institute for Medicinal Researches and Occupational Health.

d) France

The French Agency for Food, Environmental and Occupational Health Safety (ANSES) performs studies and surveillance of mercury in food, especially concerning the occurrence of methyl mercury in seafood.

In coastal areas, the French National Monitoring Network (RNO) , created in 1974 and managed by IFREMER, monitors mercury in sediments and biota since 1979. Biota is monitored annually, while sediments are sampled in a 10 years period, although with the adoption of the WFD the frequency will be every 6 years since 2007.

A review of available monitoring networks, databases and sources of information on levels of certain pollutants (including mercury) in food products in France is provided by Déléry & Mandin (2009). This report, in its Annex F, provides also a synthesis of collected data on total mercury levels in different products, whose mean values are summarized in Table 77. As observed, the higher values can be found in seafood.

Table 77. Mercury levels in different food products in France.

Product	Mean concentrations (µg/kg ww)
Seafood	17 – 266
Animal-based products	3 – 11.3
Milk-based products	3 – 6.75
Fruits and vegetables	0.01 – 80

e) Israel

The Ministry of Health carries out regular monitoring and control of local and imported foodstuff.

f) Monaco

In Monaco a yearly quality control of marine molluscs is carried to study the accumulation of pollutants, including mercury. The accumulation of trace metals in ray-Grass is also monitored at undetermined frequency.

g) Slovenia

Erzen et al (2002) studied the dietary intake of mercury from the consumption of plant and animal-based food in Slovenia. 1583 samples from 17 groups of plant and 11 groups of animal origin foods were taken in total, in nine Slovene regions. The authors determined that the mercury content in foods disposable in Slovenia is low, therefore, the quantity of mercury consumed with analysed foods is 12.3% of PTWI (Provisional Tolerable Weekly Intake) for mercury.

No information has been identified on the monitoring of mercury levels in human blood in Slovenia. Klemenc et al., (1992) determined mercury levels in blood and urine samples of professionally exposed and control groups in 63 dental surgeries in Slovenia. The mean value for mercury in blood was 3.0 ng Hg/g (range: 0.9-7.7), which can be considered as the normal range for the general population. Urinary mercury levels were also low, only 3 of 44 values exceeded 15 ng Hg/g.

No information has been identified on the monitoring of mercury levels in breast milk in Slovenia. Kosta et al (1982) measured mercury contents of samples of human milk, mainly colostrum and transitional, in the Ljubljana area. A mean value for mercury was 11.8 µg/kg dw, with a range of 1.2 – 37.4 µg/kg dw.

h) Spain

The Spanish Agency of Food Safety and Nutrition (AESAN) operates the Rapid Coordinated Information Exchange System (SCIRI), which includes the control of the occurrence (above certain reference values) of chemical substances in food products. According to its last annual report (AESAN, 2009), an important share of total notifications have been originated by the occurrence of heavy metals, particularly mercury in seafood (swordfish, tuna and shark). This information is used to report to the European Rapid Alert System for Food and Feed (RASFF).

In surface waters, as indicated before, the Hazardous Substances Monitoring Network collects data on levels of mercury in fishes.

In some Autonomous Communities a monitoring of bioaccumulation of heavy metals in mosses is performed.

In the scientific literature several studies can be identified that have addressed the dietary exposure to mercury in different areas of Spain (e.g. Sahuquillo et al., 2007). Although the relation between seafood consumption and the intake of mercury is widely demonstrated, unacceptable exposure levels have not been observed (RAC/CP, 2007).

The Health Institute Carlos III, under an agreement with the Ministry of the Environment, is developing an strategy for monitoring of pollutants in humans. This institute will conduct a survey in the Spanish population of levels of certain priority pollutants, including methyl mercury (RAC/CP, 2010b).

In Spain, several studies can be identified in the scientific literature, that relates occupational exposure (e.g. dentists, workers from chlor-alkali plants) and proximity to hot spots (e.g. Flix, Aznalcóllar) to increased levels of mercury in human samples (blood, hair, urine) (RAC/CP, 2007).

i) Tunisia

The monitoring of pollution by heavy metals in coastal biota is performed within the framework of MEDPOL. The Ministry of Agriculture, Hydraulic Resources and Fishereis also performs other controls on the quality of seafood.

According to the NFP, In Tunisia the levels of mercury in blood is controled in workers from certain activity sectors.

9. Focuses of main emissions (hot spots and areas of influence)

In this section mercury hot spots in the Mediterranean region are identified. To do this identification, both emission and environmental quality data have been taken into account. Different sources of information, at regional and national level, have been used, which are described below.

9.1 Emission hot spots

Emission hot spots can be systematically identified through the E-PRTR inventory of emissions, which includes mercury emissions to air, water and soil from major industrial facilities (see section 8.1.3). However, the scope of this database covers only EU Member States; therefore additional sources of information will be needed to identify hot spots in non-EU Mediterranean countries.

Major point source emissions can be identified with the E-PRTR database at facility or city level. This second option has been preferred in this study, in order to identify any potential clustering of mercury emitting facilities in a very small territory. From the environmental point of view, this additive effect of mercury emissions is of major relevance for the receiving environment. In any case, the identification of major emitting facilities was also performed, leading to similar results in the identification of hot spots (i.e. cities frequently results in a hot spot due to the releases of a single major facility).

The top 20 locations or cities with major mercury emissions to air and water are shown in Table 78 and Table 79, respectively. The main source sectors responsible of these emissions are also indicated.

The top 20 air emission locations or hot spots account for about 5 tonnes of mercury, i.e. 51% of total reported emissions in E-PRTR Mediterranean countries (9.9 tonnes yr^{-1}). The major reported hot spot is located in Agios Dimitrios, Greece (with 0.52 tonnes yr^{-1} emitted from a coal-fired power plant), followed by Lierio (Spain; chemical industry), and Cubillos del Sil (Spain; thermal power plant). In general, most of the hot spots of mercury air emissions are generated by the energy, chemical and cement industry.

Table 78. Top 20 mercury air emission locations from industrial facilities in EU Mediterranean countries. Source of data: E-PRTR inventory, 2007.

Location/City	Country	Hg air emissions (Kg)	Sector(s)
Agios Dimitrios	Greece	516.00	Energy
Lieiro	Spain	483.00	Chemical industry
Cubillos del Sil	Spain	403.00	Energy
Puertollano	Spain	364.90	Oil refining, Energy
Pontes de Garcia Rodriguez	Spain	353.00	Energy
Barcelona	Spain	283.00	Chemical Industry, cement production
Meson do Vento	Spain	274.00	Energy
Thann	France	252.00	Chemical industry

Location/City	Country	Hg air emissions (Kg)	Sector(s)
Kamari	Greece	241.00	Cement production
Tineo	Spain	241.00	Energy
Tavaux	France	226.00	Chemical industry
Brindisi	Italy	212.00	Energy
Taranto	Italy	174.00	Metal industry
Martigues	France	159.00	Chemical industry
Fos-sur-mer	France	157.60	Metal industry
Aviles	Spain	150.00	Metal industry
Andorra	Spain	150.00	Energy
Portaria	Greece	149.00	Cement production
Venezia	Italy	140.50	Chemical industry, energy
Mundolsheim	France	132.00	Oil refining

Water emissions top 20 hot spots account for about 5.3 tonnes yr^{-1} (Table 79), that is, 92% of total reported mercury releases. A major hot spot is located in Trieste, Italy, with 3.7 tonnes reported by a thermal power station. Other important hot spots are located in Sestao (wastewater treatment plant in north Spain) and Metz (a thermal power plant in north France). In general, wastewater treatment plants and chemical industries (chlor-alkali plants) are frequently identified as hot spots for water emissions. Metal industries that frequently appeared as mercury hot spots in previous EPER and PRTR inventories seem to have decreased its atmospheric and water releases.

In order to further identify priority hot spots, additional criteria can be used, like the following:

- The location is placed within top 10 air OR water mercury reported emissions;
- The location is placed within the Mediterranean catchment (or coastal) area;
- The location appears in both air and water lists; and/or
- The location is close to other hot spots, leading to a subregional cluster.

Table 79. Top 20 mercury water emission locations from industrial facilities in EU Mediterranean countries. Source of data: E-PRTR inventory, 2007.

Location/City	Country	Water emissions (Kg)	Sector(s)
Trieste	Italy	3710.00	Energy
Sestao	Spain	765.00	Wastewater treatment plant
Metz	France	308.00	Energy
Granada	Spain	60.13	Wastewater treatment plant
Sindos	Greece	59.00	Wastewater treatment plant
Pavia	Italy	56.90	Wastewater treatment plant
Torrelavega	Spain	56.00	Chemical industry

Crispijana	Spain	46.20	Wastewater treatment plant
Saint-Fons	France	37.00	Wastewater treatment plant
Scarlino	Italy	34.40	Chemical industry
Lyon	France	27.80	Wastewater treatment plant
Bologna	Italy	23.00	Wastewater treatment plant
Jarrie	France	23.00	Chemical industry
Verona	Italy	22.70	Wastewater treatment plant
Modena	Italy	22.60	Waste incineration
Chioggia	Italy	20.60	Wastewater treatment plant
Martigues	France	20.00	Chemical industry
Thann	France	17.80	Chemical industry
Duino-Aurisina	Italy	16.20	Pulp and paper industry
Colombes	France	14.80	Wastewater treatment plant

Taking into account the above criteria, and enlarging the list to the top 20 facilities located in the Mediterranean area, the following priority emission hot spots can be preliminarily identified:

- The cluster around Golfe de Fos / Étang de Berre (Lavera, Fos-sur-Mer, Martigues, Berre-l'Etang) ; chlor-alkali plant, oil refining, metal industry.
- Agios Dimitrios – Ellispontos (Greece); Thermal power plant
- Trieste (Italy); Thermal power plant
- Barcelona (Spain); Chlor-alkali plant and cement industries
- Kamari (Greece); cement production plant
- Tavaux (France); chlor-alkali plant
- Brindisi (Italy); thermal power plant
- Taranto (Italy); iron & steel industry
- Lyon & Saint-Fons (France): wastewater treatment plants
- Granada (Spain): wastewater treatment plant

According to the information available from the E-PRTR, it can be observed that the major point sources of mercury air and water emissions affect the catchment areas of the rivers Ebro, Rhône and Po. Besides discharges from the Po catchment area, the north Adriatic is also affected by important point sources located around the area of Venezia and the Gulf of Trieste. Finally, it can also be noticed that several plants identified as hot spots are operated by a few group of corporations from the energy, cement, chemical and metal sectors, therefore any further improvements adopted by these companies to prevent mercury emissions might have a notable effect in total releases in the Mediterranean region.

The information provided by the UNEP/MAP report on the identification of priority pollution hot spots in the Mediterranean (UNEP/MAP, 1999) can be used to identify other potential mercury hot spots in countries not covered by the E-PRTR inventory. The report provides some few data of mercury discharges in some hot spots, which is shown in Table 80. As it can be observed, major emissions (1.3 tonnes yr^{-1}) were reported by the hot spot located in El-Mex Bay, Egypt. However, a footnote within this report indicates that these discharges were produced by a chlor-alkali plant, using mercury cells, which had already been dismantled and buried in a secured landfill.

Table 80. Reported mercury discharges within the UNEP/MAP hot spot lists (UNEP/MAP, 1999).

Country	Hot spot	Hg (kg/yr)
Croatia	Zadar + ind.zone	10.1
Cyprus	Larnaca (petrol refinery)	0.07
Egypt	El-Mex Bay	1,278
Israel	Gush Dan	60
Israel	Haifa Bay (Industrial)	7.3
Morocco	Tetouan	0.38

In the list of hot spots by country, a couple of references to mercury pollution can also be identified:

- Hot spot in Vlora (Albania), with mercury pollution in soils due to an old PVC factory.
- Hot spot in Panzano Bay (Gulf of Trieste, Italy), due to mercury discharges of a chlor-alkali plant.

9.2 Mercury mining related hot spots

9.2.1 Almadén, Spain

The Almadén mercury district can be regarded as the largest geochemical anomaly of mercury on Earth (Higueras et al., 2006). The mercury mines in Almadén (Spain) were active over 2000 years and have alone contributed one third to the total reported world production (i.e., 305,000t out of 923,000t totally mined over time) (Hylander and Meili, 2003). The mining activity was ceased in 2003.

A comprehensive survey of different environmental compartments (stream sediments, soil, and water Hg chemistry; plants and water crustaceans Hg intake) around this area was carried out by Higueras et al. (2006). The mercury distribution in soils of the district revealed the existence of high, and extremely high mercury values (up to 8889 mu g g(-1)), whereas concentrations in stream sediments and waters reached exceptional values of up to 16,000 mu g g(-1) and 11,200 ng l(-1) respectively. On the other hand, very high concentrations of methylmercury (MeHg) were detected in calcines (up to 3100 ng g(-1)), sediments (0.32-82 ng g(-1)), and waters (0.040-30 ng l(-1)). Concentrations of up to 9060 ng g(-1) (muscle tissue) were observed in a river crustacean, while local plants yielded values of up to 298 mu g g(-1) Hg. High levels of mercury concentrations in different in waters, sediments and bivalves were also measured by Berzas Nevado et al. (2003).

Strong anomalies have also been detected in air concentrations, reaching values in the order of 14,000 ng Hg m(-3) around the Almadén metallurgical roaster (Higueras et al., 2006). High mercury concentrations (100–5,000 ng m-3) had also been previously measured in the early 90s over the village of Almadén by Ferrara et al. (1998), who estimated a total mercury flux into the atmosphere in the rage from 600 to 1200 g h-1 (up to 10 t per year).

9.2.2 Valle del Azogue, Spain

The Valle del Azogue mining area is located in SE Spain (Almeria Province). The mercury mine was active approximately between 1873 and 1890, producing about 1,000 t of Hg from two smelter sites located near the mining works (Navarro et al., 2005). Mercury ores were processed in retorts, and the resulting calcines were stockpiled near the furnace. An enrichment of mercury levels in vegetation close to the mining site was found by Viladevall et al. (1999). High mercury contents have also been measured in soils, calcines and mine wastes, with mean values of 357.3, 66-470 and 530-1,000 mg kg(-1), respectively (Navarro et al., 2005).

9.2.3 Asturias Hg mines (Spain)

In Asturias, North of Spain, some abandoned mercury mines are also located. Mining activity is known to date back to Roman period, although it is in the 19th and 20th centuries when this activity became a prosperous industry in the region, becoming an important mercury world producer from the 1950s to the 1970s. Although mines were progressively been abandoned since the 70s, several studies have confirmed that a great parat of the liberated Hg remains in the surrounding environment (Loredo et al., 2003; Loredo et al., 2006). Around La Brañalamosa old mine, high concentrations have been found in mining wastes (mean values of 1045 µg/g Hg) and in soils affected by the old mine workings (400 times higher than the local background levels) (Loredo et al., 2003). In another site, La Soterraña, Loredo et al. (2006) also found Hg concentrations in soils up to 502 µg/g (near the metallurgical plant), i.e. 500 times higher than local background levels. The effects of mining were also found to be intense both in waters and stream sediments, as well as in the local atmosphere, whose Hg content was10 times higher than the background level in the area.

9.2.4 Idrija mine (Slovenia) and the Gulf of Trieste

About 107,000 tonnes of mercury have been produced in the mining area of Idrija (Slovenia) over the last 500 years, until its closure in 1995 (Hylander and Meili, 2003). According to the Slovenian NFP, the Idrija mining area (about $10km^2$) contains about 4000 tonnes of mercury contained in the old residue deposits, and 100 additional tonnes are contained in the residues of the old smelters around Idrija. The mining activity has severely enhanced the mobilisation of Hg, and tailings and contaminated soils are continuously eroded and serve as a continuous source for the river, the flood plains and the Gulf of Trieste (Horvat et al., 1999). The impact of the Idrija mercury mine area on the surrounding environment and the Gulf of Trieste has been widely studied.

With the progressive reduction of mining activity, mercury in air over the Idrija region has notably decreased over time, from more than 20,000 ng m(-3) in the early 1970s to values below 100 ng m(-3) in the 1980s, and finally reaching a level of 10 ng m(-3) in 2004 (Kotnik et al., 2005). In soils, mercury concentrations varied between 8.4 and 415 mg kg(-1) and were up to 40-fold higher than the maximum permissible set by Slovenian legislation (Kocman et al., 2004). The mercury emission flux (MEF) from contaminated soils of the Idrija Hg-mine region have recently been estimated from less than 2 to 530 ng m(-2) h(-1), with the highest emissions from contaminated alluvial soils and soils near the mining district in the town of Idrija (Kocman and Horvat, 2010).

The Gulf of Trieste in one of the most mercury-contaminated areas in the Mediterranean Sea, due to the high mercury inputs from the Isonzo River, whose tributary, the Idrijca River, drains the mercury mining area of Idrija (Covelli et al., 1999). According to the Slovenian NFP, the Idrija and Soča river sediments contain about 30.000 tonnes of mercury that have been discharged by the mining activity over a period of 500 years. Total mercury concentrations in sediments have been observed in the reange 0.064-30.38 mug g(-1) (average 5.04 mug g(-1)) (Covelli et al., 2001). The Hg enrichment of sediments in the central sector of the Gulf of Trieste reached a maximum up to 25-fold above the proposed natural regional background of 0.17 mug g(-1) (Covelli et al., 2001). Data obtained from different environmental compartments (estuarine and marine waters, sediments, and organisms) during the period 1995-1997, showed that even 10 years after closure of the Hg mine, Hg concentrations in river sediments and water are still very high and did not show the expected decrease of Hg in the Gulf of Trieste (Horvat et al., 1999). The major source of inorganic mercury has been observed to be still the River Soca (Isonzo) while the major source of methylmercury is the bottom sediment of the Gulf. (Horvat et al., 1999; Fanganelli et al., 2003).

9.2.5 Monte Amiata, Italy

In Italy mercury was extracted from the Abbadia San Salvatore mine (Monte Amiata, region of Toscana), since the end of the XIX century until 1982, when the smelter was closed. During the XX century it was one of the largest sources of mercury in the world

(Hylander and Mieli, 2003). In this area, atmospheric mercury emissions have been reported from the geothermal power plants, the abandoned mine structures and the spoil banks of roasted cinnabar ore (Ferrara et al., 1998; Bacci et al., 2000). The area affected by mercury sources was found to display an average air mercury concentration of 20 ng m(-3) during the summer and 10 ng m(-3) in winter (Ferrara et al., 1998). High levels of mercury were also detected in agricultural products collected from this area (Barghigiani and Ristori, 1994).

9.2.6 Mercury mines in western Turkey and the Izmir Bay

As in other locations of the Mediterranean, mercury has been mined in Turkey since ancient times. More than 50 known mercury deposits and occurrences are in the west half of Turkey. These mines were gradually abandoned until early 1990s due to the low prices, low demand, and environmental concerns of mercury (Gemici and Oyman 2003). Actually, the acid drainage and the mine wastes, which are potentially hazardous for surface and ground waters and soils, create potential environmental problems around these mines (Gemici, 2004). Several assessments of the environmental effects of mercury abandoned mines in this area have been carried out in the old mines of Alaşehir, Karaburun, Kalecik, Odemis, Halikoy, or Turknu (Gemici and Oyman, 2003; Gemici, Ü, 2004; Gemici and Tarcan, 2007; Gemici, Ü, 2008; Gemici et al., 2010). The location of some of these abandoned mines is shown in Figure 48.

The drainage of these polluted areas to the Izmir Bay has increased mercury levels in sediments and biota of this coastal area. For instance, mercury concentrations in fish from the Izmir Bay have been found to exceed maximum permissible mercury limits accepted by the WHO (Kontas, 2006).

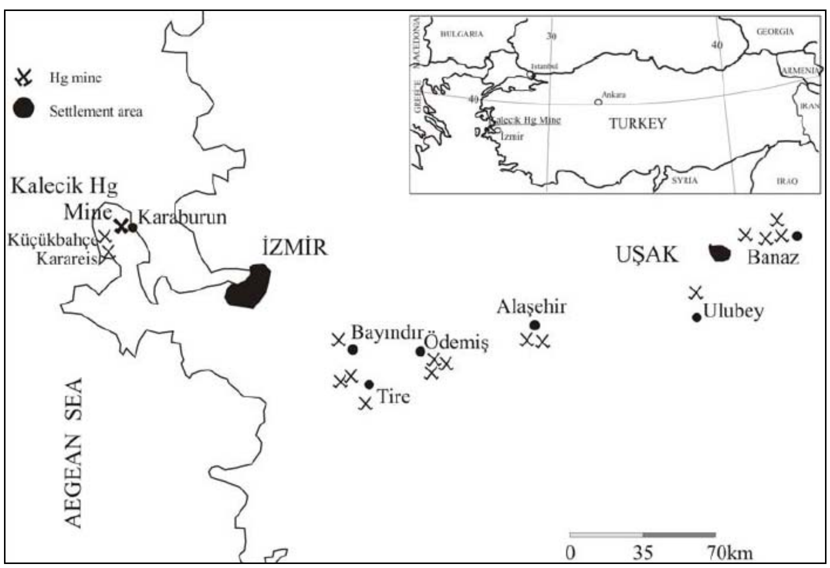

Figure 48. Distribution of some abandoned Hg mines in western Turkey (Gemici & Oyman, 2003).

9.2.7 Azzaba, Algeria

Algeria produced 200-500 tonnes per year during the 90s, but stopped its production in 2005. Cinnabar was extracted from the mines of Azzaba (Skikda Province), and it was processed at the Complex Mercuriel d'Ismail (operated by ENOF). Limited information has been identified regarding the activity and characteristics of this site, but significant mercury pollution has been reported in the surrounding soils, air and water (Benderradji, M., 1999). According to the NFP, the affected area covers 25ha, with 600,000m^3 of wastes containing mercury, which are disposed of at open air, leading to potential contamination of groundwater.

9.3 Hot spots based on environmental quality data

9.3.1 Hot spots according to the MEDPOL database

The assessment the state of the environment and pollution trends that was conducted by MEDPOL using the information included in the database of levels of hazardous pollutants in the Mediterranean (UNEP/MAP, 2009), allowed the identification of the stations with the higher levels of mercury observed in sediments and biota (shown before in Figure 42 and Figure 44). Although the information does not cover the entire Mediterranean basin, higher levels of mercury in sediments are located in some stations from Italy and Croatia, while higher levels of mercury in biota are found in Spanish coasts.

However, this identification of hot spots is only indicative, as for the Mediterranean region there is still a need to establish environmental assessment criteria (EAC) for sediments and biota.

9.3.2 Hot spots according to other sources of information

9.3.2.1 Questionnaires to National Focal Points

Very few information has been obtained from NFP on mercury hot spots. Most of the available responses relate to old chlor-alkali plants that have already phase-out the mercury cells, like Croatia, Tunisia, or Egypt. More detailed information on actual and old chlor-alkali plants have been provided in section 4.2.1. Remediation plans have also been addressed for these old facilities (e.g. in Tunisia). Algeria provided data about the old mercury mines of Azzaba (information provided above), and Turkey also reported two coastal areas with high levels of mercury in the environment: the Candarli Gulf, and the Izmir Gulf.

9.3.2.2 Literature

The EEA report on priority issues of in the Mediterranean region (EEA, 2006), based on UNEP/MAP information, identifies the following locations affected by mercury pollution:

- Vlora district (Albania): mercury contamination is reported inland of the former chlor-alkali plant, in an area of 20 ha around the factory at a soil depth of 1.5 m (more information on this hot spot provided below);
- Bay of Algiers (Algeria): heavy metals, including mercury, are reported in sediments as a result of urban and industrial wastewaters;
- Skikda (Algeria): heavy metal pollution is reported as a result of urban and industrial wastewater, originated from a range of industries including mercury production.
- Mostaganem (Algeria): mercury pollution is reported due to urban and industrial wastewater;

- Lake Maryut (Egypt): a significant accumulation of heavy metals in sediments and biota, including mercury, is reported as a consequence of industrial wastewaters.
- Haifa area (Israel): Cadmium, mercury, lead and zinc are accumulated in the sediments of the harbour;
- Sfax coastal zone (Tunisia): industrial wastewater (12 000 tonnes of fluoride, 5 700 tonnes of phosphorus, 2.4 tonnes of cadmium and one tonne of mercury) and phosphogypsum wastes dumped on the seafront (19 million m3 in two dumping sites);
- Buyuk Menderes River (Turkey): untreated industrial wastewater leads to mercury and other heavy metal pollution.

The Vlora old PVC plant: The former PVC plant, situated 3 km west of Vlora city (Albania), was part of the larger industrial complex that produced chlorine, alkali, vinyl chloride monomer, PVC, hydrochloric acid, soda and a variety of other related chemicals. This complex was closed in 1992, and its buildings have been completely destroyed since that time. The contamination of soil and water with mercury was due to technological looses and non controlled waste discharges. The quantity of mercury discharged in the environment only during the period 1977-1983 was estimated about 65 tons (Beqiraj et al., 2008). High levels of mercury have been measured in the surrounding soils (5,000-60,000mg/kg), in groundwater and coastal sediments of Vlora Bay (up to 2.33 mg/kg) (UNEP/MAP, 2010). On July 2002, a mission of UNEP/MAP (GEF Project GF/ME/6030-00-08) had identified this area as a “hot spot” and recommended a rehabilitation study to be carried out. Also, in the framework of the project Environmental Clean-up of the PVC plant in Vlora (December 2007 - January 2008), a geochemical investigation was carried out in order to study the current concentrations of the mercury in soil, water, sludge, leaching, air and to estimate the volumes of contaminated soils to be placed within a Confined Disposal Facility (CDF) (Beqiraj et al., 2008). In total, about 50,000m^3 have been estimated that will need to be confined. Some remediation works have been performed in this site by Geotest[63].

[63] http://www.geotest.cz/engl/aalban.htm

10. Analysis of strengths and weaknesses

In 2005, the European Commission set up with a Communication about its Mercury Strategy (EC, 2005b), which was complemented by an Extended Impact Assessment (EC, 2005c) that identified the impacts of the different policy options to reduce mercury pollution. Table 81 shows the objectives and the proposed actions of the EU Mercury Strategy.

Table 81. Objectives and proposed actions of the EU mercury strategy.

Objectives	Actions
Reducing mercury emissions	Action 1. The Commission will assess the effects of applying IPPC on mercury emissions[64], and consider if further action like Community emission limit values is needed, as data under the IPPC and EPER6 reporting requirements are submitted, and in a broader strategy review by the end of 2010. This will include review of the cobenefit effect of controls to be implemented by 1 January 2008 under Directive 2001/80/EC to reduce sulphur dioxide emissions from large combustion plants.
	Action 2. The Commission will encourage Member States and industry to provide more information on mercury releases and prevention and control techniques, so conclusions can be drawn in BREFs helping to reduce emissions further. The second edition of the chlor-alkali BREF will include information to address the risk of releases in decommissioning mercury cells.
	Action 3. The Commission will undertake a study in 2005 of options to abate mercury emissions from small scale coal combustion, to be considered alongside the broader CAFE assessment.
	Action 4. The Commission will review in 2005 Member States' implementation of Community requirements on the treatment of dental amalgam waste, and will take appropriate steps thereafter to ensure correct application.
Reducing the entry into circulation of mercury in society by cutting supply and demand	Action 5. As a pro-active contribution to a proposed globally organised effort to phase out primary production of mercury and to stop surpluses re-entering the market as described in section 10, the Commission intends to propose an amendment to Regulation (EC) No. 304/2003 to phase out the export of mercury from the Community by 2011.
	Action 6. In the short term the Commission will ask the Medical Devices Expert Group to consider the use of mercury in dental amalgam, and will seek an opinion from the Scientific Committee on Health and Environmental Risks, with a view to considering whether additional regulatory measures are appropriate.
	Action 7. The Commission intends to propose in 2005 an amendment to Directive 76/769/EEC13 to restrict the marketing for consumer use and healthcare of nonelectrical or electronic measuring and control equipment containing mercury.
	Action 8. The Commission will further study in the short term the few remaining products and applications in the EU that use small amounts of mercury. In the medium to longer term, any remaining uses may be subject to authorisation and consideration of substitution under the proposed REACH Regulation14, once adopted.
Resolving the long-term fate of mercury surpluses and societal reservoirs (in products still in use or in storage).	Action 9. The Commission will take action to pursue the storage of mercury from the chlor-alkali industry, according to a timetable consistent with the intended phase out of mercury exports by 2011. In the first instance the Commission will explore the scope for an agreement with the industry.
	Action 10. The Commission will undertake further study in the short to medium term of the fate of mercury in products already circulating in society.
Protecting against mercury exposure	Action 11. In the short term, EFSA will investigate further specific dietary intakes of different types of fish and seafood among vulnerable subpopulations (e.g. pregnant women, children).
	Action 12. The Commission will provide additional information concerning mercury in food as new data become available. National authorities will be encouraged to give advice in the light of local specificities.
Improving	Action 13. Priorities for mercury research will be addressed in the 7th RTD Framework

[64] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control, OJ L 257, 10.10.96

understanding of the mercury problem and its solutions.	Programme and other appropriate funding mechanisms.
Supporting and promoting international action on mercury.	Action 14. The Community, Member States and other stakeholders should pursue input to international fora and activities, and bilateral engagement and projects with third countries, including technology transfer, to address the mercury problem.
	Action 15. The Commission will consider establishing a specific funding scheme for research and pilot projects to reduce mercury emissions from coal combustion in countries with a high dependency on solid fuels, e.g. China, India, Russia, etc., similar to the CARNOT programme that promotes the clean and efficient use of solid fuels
	Action 16. The Community should promote an initiative to make mercury subject to the PIC procedure of the Rotterdam Convention.
	Action 17. The Community and Member States should continue to support work under the Heavy Metals Protocol to the UNECE Convention on Long Range Transboundary Air Pollution.
	Action 18. The Community, Member States and other stakeholders should also support the UNEP Global Mercury Programme, e.g. through review of materials and provision of technical knowledge and human and financial resources.
	Action 19. The Community and Member States should support global efforts contributing to reduced use of mercury in the gold mining sector, e.g. the UNDP/GEF/UNIDO Global Mercury Project. They will also consider possibilities to support individual developing countries through the various instruments related to development cooperation assistance, taking national strategies for development into account.
	Action 20. To reduce mercury supply internationally, the Community should advocate a global phase-out of primary production and encourage other countries to stop surpluses re-entering the market, under an initiative similar to that of the Montreal Protocol on substances that deplete the ozone layer. To support this objective, the envisaged amendment of Regulation (EC) No. 304/2003 would phase out the export of mercury from the Community by 2011.

As a result of the objectives set by the Strategy and the Extended Impact Assessment, restrictions on the sale of certain measuring devices (thermometers and barometers) containing mercury, a ban on exports of metallic mercury and mercury compounds and mixtures (>95% w/w) from the EU (coming into force in 2011) and new rules on safe storage have been implemented. Currently, the EU Mercury Strategy is being reviewed ((EC (DG ENV), 2010) and actions not completed and further actions are being assessed (see section 2.2.2).

An analysis of strengths and weaknesses of Strategy actions in the Mediterranean context is shown in Table 82. It is based on the results of the Extended Impact Assessment, the level of compliance of the Strategy objectives at present and the adaptation of these actions in the Mediterranean context.

As regards possible options to reduce mercury emissions from coal combustion in large plants (more than 50 MW_{th}), it should be highlighted that while the Extended Impact Assessment indicated that it is not necessary to implement new measures, because coal combustion in large combustion plants is already covered by Community legislation, the recent report reviewing the Strategy identifies mercury emissions from coal combustion plants and industrial emissions as a topic of action not completed by the implementation of the Strategy and proposes additional measures to address the gap. Main additional measures consist of the adoption and effective implementation of emissions limit values associated with Best Available Techniques (BAT) regarding large combustion plants and industrial emissions and reconsider the option of defining Emission Limit Values for medium sized and large coal combustion plants.

Finally, the Extended Impact Assessment also indicates that it is not appropriate to implement policies to reduce mercury emissions from cremation, either through a traditional regulatory tool or a standardisation initiative. In fact, mercury emissions from cremation are already covered by an OSPAR Recommendation, and by legislation in some of the remaining Member States who are not parties to the OSPAR Convention. Moreover, available data on mercury emissions from cremation are limited

In addition, other possible actions on mercury-waste treatment which were not covered by the EU Mercury Strategy but have also been identified during its review are analysed in Table 83.

Table 82. Impacts of the actions of EU mercury strategy in the Mediterranean context. Source: own elaboration after EC, (2005b), EC (2005c) and EC (DG ENV), 2010.

Issue	Options	Description	Strengths	Weaknesses	Actions
Mercury supply and trade (including the fate of surplus mercury from the chlor-alkali industry)	• *Addition of mercury to the list of substances covered by the Prior Informed Consent (PIC) procedure of the Rotterdam Convention.*	• Mercury compounds are currently included in Annex III to the Convention only in pesticide category. Industrial uses of mercury in products and processes are not currently listed. • International mercury trade is made more transparent but would not introduce any restriction. • This option operates at an international level, affecting all 78 countries that are parties to the Rotterdam Convention	• Countries may make more informed decision on whether or not to permit mercury imports. • Reduction in mercury use and emissions of a moderate order of magnitude. • This option may imply a slight reduction of mercury exports, particularly to developing countries where certain prevalent mercury uses (e.g. in artisanal gold mining) are illegal. • The export of metallic mercury, mercury compounds and mixtures of metallic mercury with other substances, with a Hg concentration of at least 95 % w/w from the Community shall be prohibited from 15 March 2011.	• Some Mediterranean countries have not yet ratified the Rotterdam Convention and none of ratifying countries has notified Final Regulatory Actions for mercury compounds (ANNEX III chemicals). • Other uses of mercury apart from pesticide are currently not covered by PIC procedure. • It would not involve an actual legal restriction on mercury production, supply and export.	Action 16
	• *Stopping primary mercury production.*	Mercury is no longer mined in the Mediterranean region.	N.a.	N.a.	Action 20
	• *Stopping mercury export from the Mediterranean region..*	• As a consequence, surplus mercury from the chlor-alkali industry has to be stored or disposed of. • EU mercury exports will stop from 15 March 2011.	• Primary production in the Mediterranean region does not start again. • Reduction in the global mercury supply. • Avoid mercury emissions occurring during the life-cycle products (mainly caused by improper waste disposal). • Following of the EU good example regarding the implementation of policies to reduce mercury emissions. • Increase in revenue and jobs for companies exporting mercury-free products.	• Possible increase in the mercury supply, due to the price increase. • Risk that more mercury goes to waste disposal. • Loss of revenue and jobs for companies exporting mercury containing products. • Storage costs (see below).	Action 5
	• *Temporary storage of mercury from the chlor-alkali industry (instead of returning it to the market).*	• Mercury from the chlor-alkali industry is temporary stored, like in the USA and EU.	• Less mercury in the market. • The environmental impact from storing is very low. • Social benefits associated with the reduction of mercury emissions from artisanal gold mining. • Cheaper than permanent storage.	• Risk that the storage facilities might be neglected or damaged in the future. • Costs. • Possible negative social effects for the region chosen for mercury storage.	Action 9

Issue	Options	Description	Strengths	Weaknesses	Actions
	• *Permanent disposal of mercury from the chlor-alkali industry.*	• Mercury would be placed out of human reach.	• This option eliminates the possibility of the mercury escaping into the environment as a result of neglect or accidents in the facility. • Long-run solution. • A report on the requirements for facilities and acceptance criteria for the disposal of metallic mercury developed by EC recommends: • 1. Pre-treatment (Sulphur stabilisation) of metallic mercury and subsequent permanent storage in salt mines (highest level of environmental protection, acceptable costs). • 2. Pre-treatment (Sulphur stabilisation) of metallic mercury and subsequent permanent storage in a hard rock underground formation (high level of environmental protection, acceptable costs). • 3. Permanent Storage of metallic mercury in salt mines (high level of environmental protection, most cost effective option).	• The environmental impact depends on the chosen disposal option. • Possible risk due to natural processes in the long run. • If in the future the mercury need increases, as a result of a new technology, the permanent storage option may imply the need to new mining activities. • Costs for permanent disposal. • Possible impact on the competitiveness of the EU chlor-alkali industry if it is obliged to bear the storage costs.	• Action 9
Measuring and control equipment	• *Marketing and use restriction*	• The measuring and control devices are not allowed to be marketed in EU by means of an amendment to the "Limitations Directive"[65] • Some exemptions are allowed, for example for mercury sphygmomanometers.	• Mercury in healthcare waste streams is less. The consequence is a reduction of mercury emissions from landfill and incineration and of mercury spills in dwellings.	• The handling of mercury-containing measuring and control equipment already in households is not included in this action, even though it is much ore important from a quantitative perspective than the sales of new instruments. • For some specialist industrial and scientific measuring devices adequate substitutes are not available or are much more expensive, so that the legislation include various exemptions.	Action 7

[65] Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations, OJ L 262 , 27.9.76.

Issue	Options	Description	Strengths	Weaknesses	Actions
Coal combustion and Industrial activities	• *Analyse possible options for further reduction of mercury emission from coal combustion and industrial activities.*	• Adoption and effective implementation of emissions limit values associated with Best Available Techniques (BAT) regarding large combustion plants and industrial emissions. • Consider defining ELV for mercury emissions from medium sized and large coal combustion plants. • Possible options for reducing mercury emissions in small combustion plants and residential coal burning are studied. • Regulate the future phase-out of mercury cell chlor-alkali plants.	• Reduction in mercury emission from coal combustion and industrial activities.	• Costs for coal combustion plants and industries.	Action 3

Table 83. Impacts of other possible actions in the Mediterranean context. Source: own elaboration after EC (DG ENV), 2010.

Issue	Options	Description	Strengths	Weaknesses	Actions
Waste treatment	• *Reviewing the treatment of dental amalgams waste*	• Make installation of high efficiency amalgam separators and/or filters obligatory in dental clinics, possibly complemented by obligatory inspection, maintenance, documentation by certified service suppliers.	• Reduction in mercury emissions to waste water systems. • Possible revenues and jobs for inspection and maintenance service suppliers.	• Costs for dental clinics.	
	• *Achieve environmentally sound management of mercury-containing wastes*	• Increase the awareness and technical insight of mercury's presence in waste (generally, and for specific products) and the need for its safe collection and treatment, through effective communication at all levels • Encourage national activities (state or private driven) to actively collect and safely recycle or dispose of obsolete mercury containing products from households, institutes, schools, clinics and other places. • Define a limit values for the mercury content in waste.	• Reduction in mercury releases from waste recycling activites and landfills. • Reduction of mecury emissions to waste water systems. • Possible revenues and jobs for separate collection and treatment of mercury containing wastes exceeding limit values.	• Cost for safely storage and recycling of the mercury containing wastes exceeding the limit values.	-

11. Conclusions and recommendations

Sources of information

1. Available information on mercury is substantial and extensive. Several international organisms have devoted resources to tackle the mercury problem. UNEP, EMEP, Basel Convention, OSPAR Commission, European Commission - DG Environment, Eurochlor and MAP/MEDPOL have been the main general sources of information on mercury considered for the preparation of the present diagnosis.
2. At national level, available information has been mainly extracted from:
    - o Questionnaires sent to RAC/CP and MEDPOL National Focal Points.
    - o Submissions from Governments for the first session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on Mercury (INC1) and for other studies.
    - o Regional emission inventories and environmental quality networks like UNEP Hg Programme, UNEP/MAP NBB, UNECE-EMEP, EU-PRTR, and MEDPOL Programme.
    - o National diagnoses, strategies and inventories, when available.
    - o Scientific literature.

General

3. Mercury is an element of global concern due to its long-range transport in the atmosphere, its persistence in the environment, its ability to bioaccumulate in ecosystems and its significant negative effect on human health and the environment.
4. Mercury can be released to the environment through a variety of human activities and mercury containing products. Due to its chemical properties, mercury has been used in a wide range of products and industrial processes and, as a natural occurring element; mercury is also unintentionally released by other industrial processes, mostly involving combustion.
5. In this context, it is widely agreed that global and local measures are required to protect human health and the global environment from the release of mercury and its compounds by minimizing and, where feasible, ultimately eliminating global, anthropogenic mercury releases to air, water and land.

Legal framework

6. Since the publication of the Global Mercury Assessment by the UNEP in 2002, international initiatives, like the UNEP Mercury Programme, have been developed with the aim of establishing an international legally-binding instrument on mercury. In February 2009, the Governing Council of UNEP finally agreed on the need to develop a global legally binding instrument on mercury and convened an International Negotiating Committee (INC) responsible for preparing it. Negotiations are currently taking place and are expected to be completed by 2013.
7. Several international and regional environmental agreements address mercury from different points of view, e.g.:
    - o Rotterdam Convention, it regulates international trade of certain hazardous chemicals.
    - o Basel Convention, it regulates transboundary movements of hazardous wastes and their environmental sound management and disposal.

- LRTAP Convention (Aarhus Protocol), it regulates long-range transboundary air pollution, in particular heavy metals.
- OSPAR Convention, it aims to protect the marine environment of the North-East Atlantic.
- Barcelona Convention, it aims to protect the Mediterranean Sea against pollution from land-based sources.
- EU Mercury Strategy, it is comprehensive plan addressing mercury pollution both in the EU and globally.

8. While Basel Convention has been ratified by all Mediterranean countries, Rotterdam Convention has been ratified by the half of the Mediterranean countries and Aarhus Protocol on heavy metals has only been ratified by five Mediterranean countries.

9. The Barcelona Convention and the EU Mercury Strategy are the agreements which mostly affect the Mediterranean region:

    - Regarding the Barcelona Convention, the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol), urges Parties to phase out inputs of heavy metals and their compounds deriving from land-based sources and activities. The Strategic Action Programme (SAP MED) sets specific pollution reduction measures to reduce mercury discharges by applying BAT and BEP and adopt emission limit values (ELV) and environmental quality standards. The MEDPOL Programme is responsible for the follow-up of the implementation of LBS Protocol.
    - Besides mercury legal provisions deriving from thematic policies (air, water, waste, etc.), the EU Mercury Strategy has resulted in restrictions on the sale of measuring devices containing mercury, a ban on exports of mercury from the UE and new rules on mercury safe storage. The Strategy is currently being reviewed and further restrictions like the ban on mercury imports and the extension of the export ban are being assessed.

10. Most Mediterranean countries reported to have developed some legal provisions regarding mercury. The most implemented mercury regulations are related with water discharges, air emissions and waste incineration. The development of such regulatory frameworks commonly implies the establishment of associated emission limit values.

11. Regulation on air emissions and water discharges mostly affect chlor-alkali plants, cement production, large combustion plants and waste incineration.

12. Separate collection of mercury-containing wastes is fairly adopted in the Mediterranean region. Main regulated wastes are batteries and accumulators, electrical and electronic equipment and end-of-life vehicles.

13. Most Mediterranean countries also reported to have implemented measures on the control of mercury in foodstuff and water and soil quality criteria.

14. Few Mediterranean countries reported to have established specific legislation arising from the 4th and 5th ordinary meetings of the contracting parties of Barcelona Convention regarding, respectively, maximum concentration of mercury in seafood and quality criteria for bathing waters (UNEP/IG.56/5) and maximum concentration of mercury for discharges into the Mediterranean Sea (UNEP/IG.74/5).

15. Trade on mercury has only been restricted in the EU, where the exports of metallic mercury and mercury compounds with a concentration of at least 95% w/w will be banned from March 2011. As for other Mediterranean countries, only Croatia reported to be developing such restrictions.

16. Regulations on mercury storage have not been developed in the Mediterranean countries yet.
17. Regulations on the restriction of mercury containing products are still not extensively adopted in the Mediterranean region. However, they are being progressively implemented led by EU Mediterranean countries. Mercury restricted uses are the following:
    - Pesticides.
    - Preparations intended for fouling prevention, wood preservation, impregnation of fabric and treatment of industrial waters.
    - Cosmetics.
    - Vehicles: the use of mercury in cars, including switches and relays is banned, with the only exception of discharge lamps and instrument panel displays.
    - Electric and electronic equipment:: the use of mercury in electrical and electronic equipment, including switches and relays is banned with the exception of some kinds of light sources. Medical devices and monitoring and control instruments are excluded.
    - Batteries and accumulators: they cannot contain more than 0.0005% of mercury in terms of their weight. Button cells can contain mercury up to 2% by weight. Batteries for “medical equipment” and “emergency and alarm systems” are exempted from the ban.
    - Measuring devices (thermometers and barometers with exceptions).
    - Biocides.
    - Packaging materials
    - Toys.

<u>Measures on the implementation of the UNEP Mercury Programme</u>

18. Few Mediterranean countries (Algeria, Croatia, Morocco and Spain) reported to have developed a National Assessment on Mercury and/or a National Mercury Plan or Strategy.
19. However, most Mediterranean countries stated to have implemented some concrete measures for the management of mercury e.g. inventory initiatives, monitoring networks and control of mercury use, production and emissions.
20. On the other hand, measures less implemented by Mediterranean countries are the control of mercury levels in human blood and breast milk, the implementation of mercury substitution initiatives and the development of mercury contaminated soil inventories.

<u>Mercury production</u>

21. The most important source of mercury is mining, followed by the recovery of mercury from the decommissioned chlor-alkali cells and by-products from mineral ores and natural gas cleaning.
22. Global mercury mining is steadily decreasing. However, the reduction of global mining is being partly compensated with increased mercury recycling, especially from chlor-alkali facilities. At present, China and Kyrgyzstan are the two major primary producers of mercury.
23. Although mercury is no longer mined in the Mediterranean region, historically, it has been the major source of mercury from primary mining in the world. Until 2003, Spain

and Algeria kept as two of the four most important world producers, providing roughly half of global mercury supply. The Spanish mines of Almadén contributed alone to one third of the world's mine mercury. During the Eighties and Nineties Slovenia, Italy and Turkey were also important producers.

24. Mines in Slovenia and Algeria ceased operations due to economic and technical difficulties, while others like the Almadén mine in Spain experienced pressure from growing international concern regarding mercury pollution which also led to its closure in 2004. However, there is no formal commitment not to reopen old mines by these countries.

25. Mercury can be obtained as by-product from most non-ferrous metals mining, such as zinc, copper, lead, gold and silver. In Morocco about 1 tonne yr^{-1} of mercury is obtained as a by-product of refining silver. Moreover, mercury can be recovered from natural gas cleaning, since natural gas contains some mercury in trace quantities (Algeria, Croatia, Egypt and Libya).

Storage of mercury and mercury containing wastes

26. The most important world mercury stock is in Almadén, Spain, the location of the closed Spanish mercury mine. Almadén mining company, MAYASA, signed an agreement with Euro Chlor, the European chlor- alkali industry association, which allow it to buy the mercury from European plants shifting towards mercury-free processes, and sell it in the market. The total estimated amount of mercury collected until Sep. 2006 was approximately 1,500 tones.

27. Other mercury stocks in the Mediterranean region are: approximately 1 million tonnes of mercury slag ore in Azzaba mining site, Algeria and a stock of 3,920 tonnes in Turkey. In Slovenia, about 4,000 tonnes of mercury are contained in the old mining waste deposits around the Idrija area. Also, mercury stocks can be found in French, Italian and Spanish chlor-alkali plants and other small mercury stocks were reported by Israel, Tunisia and Egypt.

28. Due to the European mercury export ban, which will enter into force in 2011, temporary and permanent storage solutions are required. Although the European Commission developed a study on requirements for facilities and acceptance criteria for the safe storage of surplus mercury, no facilities have been authorised in the EU or in the Mediterranean region so far.

29. Almadén mine remains a possible candidate for permanent storage of European surplus mercury. The European Parliament resolution on the Community strategy concerning mercury (2005/2050(INI)) of 14th March 2006 considers the possibility of using Almadén for the safe storage of the existing metallic mercury stocks or metallic mercury sub-produced by industry all over Europe. Mercury stocks from eastern and southern Mediterranean countries might also be placed in Almadén, or similarly, in other facilities around old mercury mining sites (e.g. Turkey or Algeria).

Trade on mercury and mercury containing wastes

30. Spain remains the second most important world mercury exporter (10.3% of the global mercury exports in monetary terms between 2007 and 2009), due to the activity of the Almadén mining company, MAYASA.

31. Most Mediterranean countries are net mercury importers. The most important net importer is France (103 tonnes in 2008). The only net exporters are Spain (221 tonnes), Italy (62 tonnes) and Turkey (20 tonnes).

32. Available data on trade of mercury-containing products of Mediterranean countries are scarce.

33. As regards trade of mercury-containing wastes, Germany and France are the countries receiving more mercury containing wastes from the Mediterranean region while Italy and France are the Mediterranean countries exporting more mercury containing wastes.

Uses and substitutes

34. There is little information available on the use of mercury in Mediterranean countries; however, main uses are known to be chlor-alkali production, batteries, dental amalgams, measuring and control devices, lamps, electrical and electronic devices and mercury chemicals.

35. Uses as catalyst for the production of vinyl chloride monomer and in the small-scale gold mining have been considered insignificant in the Mediterranean region.

36. The use of mercury has decreased in the last few years due to the gradual substitution of mercury in regulated products and processes.

37. The most important mercury users regarding chlor-alkali production are, among Mediterranean countries, France and Spain. However, the chlor-alkali industry is converting to mercury-free processes. In particular, the European chlor-alkali industry announced a voluntary phase out from mercury-cell plants by 2020.

38. Although the use of mercury in dental amalgams in European Mediterranean countries is steadily decreasing, it is still common in extra-European countries, such as Syria, Slovenia, Morocco and Israel.

39. Mercury was also extensively used in vehicles for different applications; however, they have been substituted. In the EU, the most recent application in vehicles was G-force sensors in airbags in a few brand models until 1996. No information on mercury uses or substitution in vehicles has been identified for the non EU Mediterranean countries; however, it is likely that such old cars are still running in several Mediterranean countries.

40. Mercury is also used in laboratories as reagents, preservatives and catalysts in a great variety of applications. Most of these uses can be substituted with mercury-free alternatives, e.g.: catalyst for PU elastomer production, Mercury II sulphate for COD analysis, preservative in vaccines and other pharmaceuticals and biocide in paints.

41. Mercury is still used for miniature, or button cell batteries, whose production is increasing worldwide, because mercury-free alternatives are not always able to meet the demands of many miniature battery applications. Mercury containing lamps (e.g. fluorescent tubes, compact fluorescent, high-intensity discharge lamps) are still used because of their higher energy-efficiency with respect to mercury-free alternatives. LEDs are currently available to substitute mercury-containing linear and compact fluorescent lamps, but they are suitable only for limited types of applications due to their lower light output and higher cost.

42. Mercury-free alternatives are available and currently used for thermometers, dental amalgams sphygmomanometers, thermostats and non-miniature batteries, switches and relays and High Intensity Discharge (HID) automobile lamps. In most cases, the price of the alternative is similar to the price of the mercury-free alternative, and in some cases it is even lower.

43. In addition, technologies for reducing the mercury non-intentional emissions from the combustion of fossil fuels, cement, iron and steel, non-ferrous metal, pulp and paper, industry and iron foundries are technically and economically feasible according to the available bibliography regarding Best Available Techniques (BAT).

44. Information on the substitution of mercury in the Mediterranean region is scarce, and the levels of substitution reported by countries are uneven. The main substitution processes initiated are regarding chlor-alkali mercury cells; mercury dental

amalgams; batteries, cosmetics, measuring and control devices, pesticides and biocides, pharmaceuticals and paints.

45. Mercury substitution in the Mediterranean region is in a less developed stage for light sources and electrical and electronic devices.

Mercury emission sources

46. Mercury emissions may arise from its intentional use in a wide range of products such as: dental amalgams, batteries, measuring and control devices, mercury light sources, electrical and electronic devices, mercury chemicals. The use of products containing mercury cause mercury emissions in different stages:
    - o From production (to air, water and soil) depending on how closed manufacturing systems are, and on the handling and workplace procedures in the individual production units;
    - o By breakage or loss of the products (to air, water, soil) during use; and
    - o During disposal of the products after their use (directly to soil or landfill and subsequently to water and air), closely depending on types and efficiency of employed waste collection and handling procedures
47. Mercury emissions are also released to air water and land from industrial processes, mainly chlor-alkali plants.
48. 'By-product' or unintentional mercury emissions are mainly emitted to air. Sectors that involve combustion of coal or oil, production of pig iron and steel, production of non-ferrous metals, cement production and waste treatment are the most relevant.

Emission limit values and quality objectives

49. International organisms setting mercury standards have served as reference for Mediterranean countries in the adoption of mercury emission limit values and environmental quality standards:
    - o EU legal framework has been the main reference for the adoption of mercury restrictions in the Mediterranean countries regarding incineration.
    - o WHO criteria regarding water for human consumption has also extensively been adopted by Mediterranean countries.
50. On the other hand, some emission limit values have been differently adopted by Mediterranean countries depending on the following factors:
    - o Air emission limit values differ between industrial sectors and technologies, e.g. chlor-alkali plants.
    - o Emission limit values for wastewater discharges depend on the receiving environment and subsequent treatment.
    - o Air, water and soil quality standards depend on the geographical location, local conditions and potential uses.

Emission inventories

55. Several regional and national inventories of mercury emissions (mainly atmospheric releases) have been identified, although figures provided by the different inventories

cannot be directly compared, due to differences in the geographic coverage, the source sectors included, or the methodology and emission factors used.

56. Using the available data, the total mercury atmospheric emissions in the Mediterranean region have been estimated in about 70 tonnes yr^{-1} (about 3.6% of global emissions). Five countries (Turkey, Italy, Spain, Greece and France) would account for about 80% of total emissions in the region.

57. Unintentional emissions resulting from the use of fossil fuels (in the energy or cement industry) appear to be the dominant source of mercury releases to the atmosphere in the Mediterranean, which is in agreement with mercury inventories in other areas. Air and water emissions from the chlor-alkali industry (intentional use of mercury) have notably been reduced over the last years. Very few information is available on mercury releases from other intentional uses of mercury, e.g. dental amalgams, breakage of measurement devices, etc.

58. According to available information, several countries show downward trends in their mercury atmospheric emissions. As a whole, the future trend of emissions in the Mediterranean region will mostly depend on the future use of coal and production of cement in the different countries, combined with the adoption of BATs in the energy, cement, metal and waste incineration sectors.

Monitoring networks

59. The most relevant air quality monitoring network in the Mediterranean is the UNECE/EMEP Measurement network, which includes 10 Mediterranean countries. However, data for mercury is hardly available for most of stations, although its measurement is being initiated in several countries and more data is expected to be available in the forthcoming years. Some non-EMEP Mediterranean countries also foresee the monitoring of mercury, like Israel or Tunisia, but a general lack of information can be observed for east and south Mediterranean countries. In northern countries mercury is also commonly monitored in freshwaters, in order to comply with EU Water Policy Framework regulations.

60. In the marine environment mercury has been monitored in sediments and biota for several years under the MEDPOL programme, although information is not still available for all countries. The assessment of data from the MEDPOL database is not conclusive but shows that the higher levels of mercury in sediments and biota occur in localized areas of the north western basin and Adriatic Sea. Environmental assessment criteria (EACs) for mercury and other hazardous pollutants are still pending to be developed in the Mediterranean.

61. Complementary information from the literature and national monitoring networks might indicate that mercury levels in the Mediterranean marine environment have decreased over the last decades, but more slowly than emissions.

62. Monitoring of mercury in foodstuff is conducted in most EU countries, and in other Mediterranean countries like Algeria, Tunisia or Israel. The available information from foodstuff monitoring networks (e.g. the EU Rapid Alert System for Food and Feed) shows that consumption of seafood is the major human exposure pathway to mercury. Data from literature confirm the high levels of mercury in fishes (e.g. tuna and swordfish) and cetaceans from the Mediterranean, where bioaccumulation has been frequently observed to be higher than in other marine regions.

63. Very few information has been obtained regarding the control of mercury in human blood or milk, although some countries are launching strategies to monitor it on a periodic basis (e.g. Spain).

Hot spots

64. Industrial sites in EU Mediterranean countries that currently concentrate most of mercury emissions can be identified using the E-PRTR register. Highest air emissions (0.51 t/yr) are reported by a thermal power plant in Ellispontos (north Greece). In general, most of the hot spots of mercury air emissions are generated by coal-fired power plants, chlor-alkali plants and cement industries.

65. Regarding water releases, a major hot spot is located in Trieste, Italy, with 3.7 tonnes reported by a thermal power station. Wastewater treatment plants and chlor-alkali facilities are frequently identified as mercury water emissions hot spots.

66. Hot spots generated by old industrial sites are mostly related with closed chlor-alkali plants (or current plants that have already adopted a mercury-free process). Many of them have already removed their mercury stocks or remediation actions have been put in place, like in Croatia, Egypt or Tunisia. A former PVC plant in Vlora (Albania) is another of the major mercury hot spots identified in the Mediterranean, although remediation actions to confine the polluted soils are also in place.

67. The old mercury mines around the Mediterranean have also led to contamination of the surrounding areas, by the historic disposal of mining wastes containing high concentrations of mercury. These sites are located in Spain (Almadén, Valle del Azogue, Asturias), Slovenia (Idrija), Italy (Monte Amiata), western Turkey and Algeria (Azzaba). The drainage of these mining areas has also increased the mercury levels in nearby coastal areas, like the Gulf of Trieste or the Gulf of Izmir in Turkey.

Recommendations

- Due to mercury properties and its significant negative effect on human health and the environment, both global and local measures are required to protect human health and environment. The future global legally binding instrument on mercury must be the framework for Mediterranean countries to tackle mercury from an integrated point of view.
- All Mediterranean countries must ratify Rotterdam Convention and Aarhus Protocol on Heavy Metals.
- For those Mediterranean countries which have not yet developed a National Diagnosis on Mercury, it is strongly recommended that a comprehensive and multidisciplinary analysis is developed. As there is little information available on the use of mercury in Mediterranean countries, an additional effort should be made to collect relevant data so that to develop reduction and management policies.
- As most Mediterranean countries have already developed some legal provisions regarding mercury, it is of great importance that all of these provisions are assessed with regards to their enforcement and effectiveness, e.g. the emission limits values.
- The existence of emission legislation, while a necessary step toward significant emission controls, is not sufficient to ensure compliance. A serious enforcement system must be in place as well, in which the enforcing authority not only has the power to adequately enforce the relevant legislation, but is also technically competent to understand the emission controls, measurement methods, etc.
- For certain types of potentially heavily polluting industries, for example the chlor-alkali industry, waste incineration, cement production and large combustion plants, legislation must require the use of specific, less polluting production methods and pollution prevention technologies or “Best Available Techniques" (BAT) with associated emission limit values (ELV).
- In addition to the completion of the national diagnosis and the development of the related legal frameworks, greatest efforts are needed in technical assistance and capacity

building, especially in Mediterranean developing countries, to ensure that proposed measures are implemented and periodically monitored, updated and reviewed.

- A formal commitment not to reopen mercury old mines should be adopted by Mediterranean countries.
- A phase-out of mercury cell chlor-alkali plants must be agreed and enforced in the region.
- Separate collection and mercury recovery from mercury containing wastes such as batteries, end-of-life vehicles and electrical and electronic equipment must be regulated to reduce mercury releases from mercury containing products in the Mediterranean region.
- The environmentally sound management of mercury-containing wastes must be ensured.
- Due to its cost-effectiveness, the installation of high efficiency filters in dental clinics must be implemented for reducing mercury releases to the waste water systems from dental amalgams.
- For all products for which a mercury-alternative is available and economically competitive, the substitution process should be encouraged by legislative initiatives and economic incentives (mercury thermometers, barometers, sphygmomanometers, catalyst in PU elastomers and dental amalgams).
- The Mediterranean region as a whole must assess the possible implementation of a ban on mercury exports/imports and the possible scopes of such regulations considering the existing international framework (Rotterdam Convention) and the conclusions extracted from the review of the EU Mercury Strategy regarding further restrictions on mercury imports and extended export ban to other mercury compounds, mixtures with a lower mercury content and products containing mercury, in particular thermometers, barometers and sphygmomanometers.
- As an intermediate stage, the development of an exhaustive and detailed data-base on trade of mercury-containing products of Mediterranean countries would be highly recommended for the design and the monitoring of effective policy to reduce mercury consumption.
- Taking into account the international trends on the prohibition and restriction of mercury and the EU ban on mercury exports, the future surplus in the Mediterranean region and the potential needs for safe storage of metallic mercury should be further explored. Also, a review of the potential use of old mercury mines around the region might be conducted.
- More research and technological development is needed to substitute button cell batteries, whose production is increasing worldwide, because mercury-free alternatives are not always able to meet the demands of many miniature battery applications.
- More technological development is needed to allow LEDs to substitute mercury lamps in more applications. In addition, economically competitive and widely usable mercury-free alternatives to HID lamps and LED backlight for computers and televisions still need to be developed.
- More comprehensive data on air and water emissions, especially in eastern and southern Mediterranean countries is needed. Also, monitoring networks of mercury in the different compartments (air, water, soil,...) need to be reinforced in order to identify priority actions and track the effect of policies and strategies. The control of mercury in foodstuff, in particular seafood, is also of major importance.
- Follow-up actions should be taken to ensure that mercury hot spots are properly remediated and the surrounding environment evolves positively. Further attention might be required to old mercury mines in Turkey or Algeria.
- Measures on information exchange and public awareness on mercury issue must be promoted across the region.

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