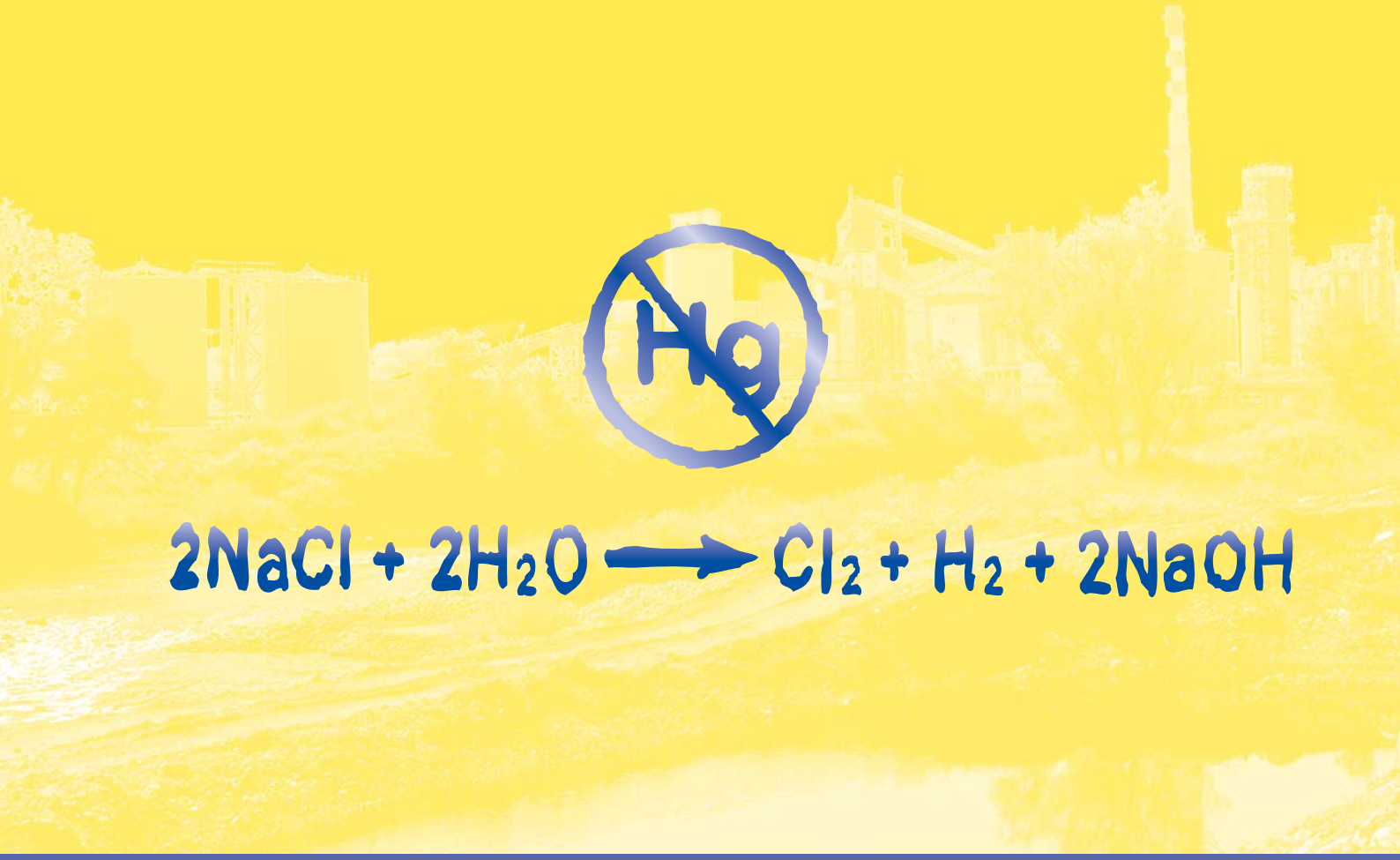
SPECIAL REPORT



Risky Business!
No need for mercury in the Chlorine Industry

zero Hg
mercury working group

OCTOBER 2006

EEB

EEB PUBLICATION NUMBER 2006/006

The Zero Mercury Working Group

The Zero Mercury Working Group, is an international coalition of more than 40 public interest non-governmental organisations from around the world formed in 2005 by the European Environmental Bureau and the Mercury Policy Project/Ban Mercury Working Group. The aim of the group is to reach 'zero' emissions, demand and supply of mercury, from all sources we can control, towards eliminating mercury in the environment, at EU level and globally."

The European Environmental Bureau (EEB)

The EEB, Europe's largest federation of environmental organisations, has over 140 environmental NGO members in 31 countries. We promote environment protection and sustainability by promoting ambitious EU laws and policies and their effective implementation and enforcement. We coordinate EU-focused activities with our national Members around Europe. We run 13 specialised Member Working Groups, produce policy papers for the EU agenda, and represent our Members in discussions with European institutions, including the Commission, Parliament, Council of Ministers and ministries in Member States. Priority areas of work include agriculture, air, biodiversity, chemicals, industrial pollution, product policy, water, waste, and sustainable development.
Many environmental NGOs in Accession and Candidate Countries and the Western Balkans regard the EEB as their main partner on European and EU issues. Our experience, relationships and position are of great value in determining these states' role in EU enlargement and environmental-related processes. Our proactive involvement has boosted our membership from New Member States and EU applicants. In 2004, the EEB, working with the Mercury Policy Project/Ban Mercury Working Group, launched the 'Zero Mercury' campaign.

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SPECIAL REPORT

RISKY BUSINESS!

NO NEED FOR MERCURY IN THE CHLORINE INDUSTRY

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OCTOBER 2006

Zero Mercury Working Group

European Environmental Bureau

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EXECUTIVE SUMMARY

Mercury is a dangerous pollutant that causes neurological and other toxic effects, especially to pregnant women and small children. Mercury is released into the environment by certain industrial facilities, such as coal-fired power plants and outdated chemical plants that use mercury to manufacture chlorine and caustic soda. Mercury air emissions settle into oceans, rivers, and lakes, where they can accumulate in fish and other organisms. Humans risk ingesting dangerous levels of mercury when they eat contaminated fish. Because mercury is a metal, it does not break down but persists in the environment indefinitely, continuously cycling in the global environment.

One of the major industrial uses of mercury worldwide is in the 'chlor-alkali' industry, which typically produces chlorine gas and caustic soda from salt or brine. Chlor-alkali manufacturers can employ any of three different technologies to manufacture these products, only one of which, the mercury-cell process, creates a mercury pollution risk. The two, mercury-free, alternative processes have long been available, are less costly, more energy-efficient, and less damaging to the environment. As a region, the EU represents by far the greatest number of plants and percentage of production capacity still using the mercury-based process.

In 1990, the Oslo Paris Commission (OSPAR) recommended that all mercury cell chlor-alkali plants be converted to mercury-free technology by 2010 (PARCOM Decision 90/3)[1]. In the light of insufficient progress towards that objective, the European Parliament[2] recently called on the European Commission to take action to implement the OSPAR Decision. Furthermore, the mercury-cell process is not considered to be a Best Available Technique (BAT) under the IPPC Directive[3], which requires installations to have a permit based on BAT by October 2007. When mercury-cell chlor-alkali plants (MCCAPs) convert to mercury-free technologies, the vast quantities of mercury in the cells need to be managed in an environmentally appropriate manner. To ensure that this mercury does not re-enter the global market, the European Commission has proposed a regulation banning exports and the safe storage of metallic mercury (from the EU), starting on 1 July 2011.

Until these plants are phased out, they will continue to emit mercury into the environment. Mercury data reported by the chlor-alkali industry itself show that up to 90 percent of the total mercury in some plants is 'unaccounted for'. There is increasing evidence that the 'unaccounted for' mercury may, in fact, represent under-reporting of emissions from MCCAPs in the EU. If EU plant emissions are, as suspected, actually several times higher than reported, the emissions from the EU plants would be roughly on a par with emissions from large EU coal-fired power plants[4], which are well recognised as a major source of EU atmospheric emissions.[5]

[1] PARCOM Decision 90/3 of 14 June 1990 of the Commission for the Protection of the Marine Environment of the North-East Atlantic (PARCOM2). Publications can be found at http://www.ospar.org.

[2] http://www.europarl.europa.eu/sides/getDoc.do;jsessionid=4F83C0DC30BD2F593CFECA28BDE00DFB.node1?language=EN&pubRef=-//EP//TEXT+TA+P6-TA-2006-0078+0+DOC+XML+V0//EN

[3] http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=31996L0061&model=guichett

[4] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East/West Sprl, October 2006, pg. 17

[5] Zero Mercury – key issues and policy recommendations for the EU strategy on mercury, EEB, HCWH, EEN, MPP, December 2005, table 2, p.41

To assess present levels of European MCCAP mercury emissions into the environment, and to identify any potential risks related to mercury exposure, the European Environmental Bureau (EEB) sponsored 'snapshot' air monitoring in three countries where these outdated chlor-alkali facilities are still active – in Spain, Italy and the Czech Republic. EEB's air quality monitoring was carried out at the sites of eleven mercury cell chlor-alkali plants in these countries. The results of this monitoring are presented in this report.

Country	Monitoring Location	Maximum Mercury Concentration Measured Outside the Plant (ng/m3)	Exceeds EPA health benchmark for air?
Italy	Porto Maghera	1493	yes
	Pieve Vergonte	Around 750	yes
	Torviscosa	1208	yes
	Rosignano	1211	yes
	Bussi	7696	yes
	Priolo	Around 50-60	no
Spain	Torrelavega	510	yes
	Huelva	1924	yes
	Monzón	19650	yes
Czech Republic	Spolana	989[6]	yes
	Spolchemie	412	yes

The results show that mercury-cell chlor-alkali facilities remain significant sources of airborne mercury exposure to local citizens and the environment. Maximum concentrations at all but one plant exceeded both the US EPA health benchmark for mercury in air (300 ng/m^3) and the US ATSDR minimum risk level (200 ng/m^3), and eight of the eleven plants exceeded the EPA health benchmark by at least a factor of two. The highest concentrations detected outside of the plant premises were found at the Monzón plant in Spain, where concentrations exceeded the US EPA health benchmark by 65 times. At the few plants where mercury measurements were taken inside the perimeter, these measurements also showed high levels of mercury in the air, some exceeding national occupational limits. Notably, mercury levels were still high at one plant that had already been decommissioned, underlining the need for remediation of these facilities after decommissioning.

There is evidence that emissions from the chlor-alkali plants are higher than reported and because measured atmospheric concentrations of mercury at the perimeter of many chlor-alkali plants were higher than expected (far exceeding normal background conditions, typically around 2 ng/m^3), chlor-alkali plant emissions are most likely underestimated by inhabitants and regulators alike. These results suggest that chlor-alkali plants continue to add significant quantities of mercury to the environment, posing risks not only to the local environment, humans and wildlife, but also contributing to the total amount of mercury circulating in the global environment.

In addition to what is evidently a major contribution by MCCAPs to the global mercury pool, monitoring results show that MCCAPs remain a considerable source of mercury in the EU environment. The benefits of converting EU MCCAPs to membrane

[6] A concentration of 1441 ng/m3 was observed near the railroad tracks near the facility, but it is not certain if this concentration is related to the plant.

technology are substantial. The operating benefits such as reduced energy consumption, reduced carbon emissions, decreased occupational exposure and elimination of hazardous wastes containing mercury, are pronounced. But if we also consider the public health benefits of eliminating these mercury emissions, the total benefits far outweigh the costs of decommissioning and conversion. Political pressure has also been increasing for the past two decades in favour of eliminating the use of mercury from this process.

Based on these conclusions, EEB and cooperating NGOs strongly recommend that the following actions be taken:-

- The mercury-cell chlor-alkali process for all EU plants should be phased out as soon as possible, and by 2010 at the latest;
- Any surplus supplies of mercury resulting from decommissioning MCCAPs should be safely stored;
- Mercury contamination resulting from the operation and waste disposal practices of plants should be remediated, through clean up, capping, or other methods of appropriate management;
- Competent local authorities should refuse operating permits to plants with obsolete non-BAT technology, under the IPPC Directive;
- Comprehensive guidelines should be developed for decommissioning mercury-cell plants and safe storage of all mercury;
- Mercury emissions from mercury-cell plants should be continuously and comprehensively monitored and independently verified, and companies should account for any mass balance discrepancies;
- The exposure and health of workers and residents working and living near plants should be more carefully studied and monitored.

Acknowledgments

EEB and its partner organisations would like to give special thanks to Centro de Estudios de Almadén - Universidad de Castilla La Mancha, Spain and to Lumex Analytics of Germany, for providing equipment and training for this mercury monitoring exercise. EEB is also grateful for financial assistance provided by the Sigrid Rausing Trust, in the UK. Finally, the EEB appreciates the assistance of Peter Maxson in summarising and interpreting industry reports of mercury emissions and releases.

INTRODUCTION

Background on mercury

Mercury is a dangerous pollutant that causes neurological and other toxic effects. Mercury is released into the environment by certain industrial facilities, such as coal-fired power plants and outdated chemical plants that use mercury to manufacture chlorine and caustic soda.

Mercury air emissions settle into oceans, rivers, and lakes, where they are converted by bacteria into another chemical form called methylmercury. Methylmercury accumulates in fish and other organisms. Mercury then works its way up the food chain as large fish consume contaminated smaller fish. Humans risk ingesting dangerous levels of mercury when they eat contaminated fish. The Commission's Directorate General for Health & Consumer Protection has recommended that women who are breastfeeding or who are or might become pregnant, should limit their consumption of large predatory fish, such as swordfish, shark, marlin, pike and tuna.[7] People working or living near major industrial sources of mercury also run the risk of inhaling unsafe levels of mercury in the air. Since mercury is a metal, it does not break down but persists in the environment indefinitely, circulating in the global environment through air, water, soil, sediment and in biological organisms. Mercury, especially mercury emitted into the air, can travel long distances from the point of emission, making mercury pollution a global concern.

Health risks of mercury exposure

Once in the human body, mercury acts as a neurotoxin, interfering with the brain and nervous system. Exposure to mercury can be particularly hazardous for pregnant women and small children. During development and the first several years of life, high levels of mercury exposure can cause mental retardation, cerebral palsy, deafness, and blindness. Even in low doses, mercury may affect a child's development—delaying the start of walking and talking, shortening attention span, having an impact on fine motor skills, and causing learning disabilities.

The European Commission's Extended Impact Assessment in support of its mercury strategy estimated that EU residents in coastal areas of Mediterranean countries, and around one-five percent of the population in northern and central Europe, are exposed to mercury at levels around (or above) the reference dose, that is, the dose above which there may be health-risks from mercury[8]. Mediterranean fishing villages and Arctic populations are at particularly high risk, because of their high consumption of contaminated fish and/or marine mammals.

The mercury-cell chlor-alkali process

[7] http://www.efsa.europa.eu/en/science/contam/contam_opinions/259.html

[8] European Commission. SEC(2005)101 Communication from the Commission to the Council and the European Parliament on Community Strategy Concerning Mercury *EXTENDED IMPACT ASSESSMENT* {COM(2005)20 final}28.1.2005, p. 12

One of the major industrial uses of mercury worldwide is in the 'chlor-alkali' industry, which typically produces chlorine gas and caustic soda (and sometimes caustic potash) from salt or brine. These products are important intermediate chemicals in many industrial processes, as are the production of paper, soap, and detergent and the manufacture of polyvinyl chloride (PVC) and other plastics. Chlor-alkali manufacturers can employ any of three different technologies to make these products, only one of which, the mercury-cell process, creates a mercury pollution risk. The two BAT mercury-free processes are the membrane and the non-asbestos diaphragm technology. The membrane is the most commonly used mercury-free option. It has been available since the eighties and compared to the mercury-cell process it is less costly, more energy-efficient and less damaging to the environment.

Many mercury cell chlor-alkali plants (MCCAPs) in the EU (and elsewhere) have converted to mercury-free alternatives. However, just under 50 of these plants remained in operation in the EU at the beginning of 2005, containing some 11,000 tonnes of mercury in electrolytic cells, responsible for nearly six million tonnes of chlorine production annually. These plants consume 175-200 tonnes of mercury every year, amounting to 40-50 percent of the total EU consumption of mercury.[9] By comparison, elsewhere in the world, the proportion of chlorine produced with the mercury cell process is much lower than in the EU. For example, the US has only eight remaining MCCA plants, two of which are committed to stop using mercury.[10] In India there is a voluntary agreement between government and industry, initiated by the (Indian) Central Pollution Control Board according to which the phase-out of Indian MCCAPs will occur by 2012.[11] As a region, the EU represents, by far, the greatest number of plants and the highest percentage of production capacity still using the mercury-based process.

Important policy decisions on the chlor-alkali industry and mercury

Several policy decisions have been, or are about to be, taken concerning the chlor-alkali industry:-

- Considering the danger posed by mercury to waters in Western Europe,[12] and because alternative mercury-free processes exist, in 1990 the Oslo Paris Commission (OSPAR) recommended that all mercury cell chlor-alkali plants be converted to mercury-free technology by 2010 (PARCOM Decision 90/3).[13] This date was chosen to give substantial lead time (20 years) for plants to plan the phase out.[14] In 1999, Euro Chlor, the chlor-alkali industry trade association in Europe, asked OSPAR/PARCOM to postpone the phase–out date until 2025, but OSPAR rejected this and maintained the 2010 deadline.[15]

[9] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East/West Sprl, October 2006, Executive Summary. About half of the 175-200 tonnes of mercury consumption ends up in various mercury wastes. Most of the wastes are sent for disposal, but some are retorted to recover the mercury.
[10] Oceana (2006). *Poison Plants II: 19th Century Chlorine Factories Still Pose Mercury Contamination Risk.* January 2006. http://www.oceana.org/fileadmin/oceana/uploads/mercury/poisonplants2FINAL.pdf PPG announced in August 2005 that it will convert it Louisiana plant to membrane cell technology by 2007; in April 2006, Occidental announced that it will close its Muscle Shoals, Alabama, mercury-cell chlor-alkali plant, and consolidate it with operations in Louisiana, by 2008.
[11] *Central Pollution Control Board,* Annexure 1, Section 8, point 12, http://www.cpcb.nic.in/Charter/status.htm
[12] Comprising all European river basins emptying into the North Atlantic, i.e., much of Western Europe.
[13] PARCOM Decision 90/3 of 14 June 1990 of the Commission for the Protection of the Marine Environment of the North-East Atlantic (PARCOM2). Publications can be found at http://www.ospar.org.
[14] As agreed, PARCOM Decision 90/3 "recommends that existing mercury cell chlor-alkali plants should be phased out as soon as practicable. The objective is that they should be phased out completely by 2010."
[15] As described by Status Report: Mercury-cell chlor-alkali plants in Europe, Concord East/West Sprl, October 2006, pg 2-3.

- In addition, Euro Chlor's member companies have voluntarily committed themselves to phase out the mercury-cell process at all EU plants by 2020, with the exception for the co-production of chlorine with certain speciality chemicals where no mercury-free alternative technologies exist. [16]

- The chlor-alkali industry is covered by the Integrated Pollution Prevention and Control Directive (IPPC)[17], which requires installations to seek permits based on best available techniques (BAT). The benchmarks or criteria that comprise BAT are described in BAT Reference (BREF) documents. According to the chlor-alkali BREF document[18], the mercury-cell process is not considered to be BAT for the chlor-alkali sector.[19] The Directive states that existing installations, i.e. installations in operation before October 1999, should operate in accordance with the requirements of the Directive by October 2007. However, when determining the permit requirements, based on BAT, for a specific installation, the competent authority takes into account the technical characteristics of the installation concerned, its location and local environmental conditions. So it is the local competent authority which decides on the specific permit requirements. Local authorities in EU countries must take into account the IPPC BREF when permitting MCCAPs to continue operating after 2007.

- The European Parliament's resolution on the Community Strategy on Mercury[20] (March 2006), called on the European Commission to take action to implement OSPAR Decision 90/3, which recommends phasing out mercury-cell chlor-alkali plants as soon as practicable, with the goal of completely phasing them out by 2010.

- When MCCAPs convert to mercury-free technologies, the vast quantities of mercury in their cells will need to be managed in an environmentally appropriate manner. To prevent this surplus mercury from flooding the world mercury commodity market, and given that the mercury use in the EU is decreasing, the European Commission has proposed a regulation banning exports of metallic mercury (from the EU), starting on 1 July 2011. The proposal includes parallel provisions of safe storage of the excess mercury which will mainly be coming from decommissioned mercury-cell chlor-alkali plants. To that end Euro Chlor has been asked by the European Commission and has agreed to develop a Voluntary Agreement for the storage of surplus chlor-alkali mercury, acknowledging that storage will be needed.[21]

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[16] in "Euro Chlor's contribution to the European Commission's consultation document on the development of an EU Mercury Strategy," Euro Chlor, 11 May 2004. http://ec.europa.eu/environment/chemicals/mercury/pdf/eurochlor.pdf

[17] Integrated Pollution Prevention and Control Directive (Council Directive 96/61/EC). http://ec.europa.eu/environment/ippc/index.htm

[18] *IPPC Reference Document on Best Available Techniques in the Chlor-Alkali Manufacturing Industry*, European IPPC Bureau, Institute for Prospective Technological Studies, European Commission Joint Research Centre, Seville, December 2001, http://eippcb.jrc.es/pages/FActivities.htm

[19] IPPC, BREF for the chlor-alkali industry, December 2001, p.109 - http://eippcb.jrc.es/pages/FActivities.htm
The selected process technology has a major impact on the energy use and emissions from the manufacture of chlor-alkali.
Best available techniques for the production of chlor-alkali is considered to be membrane technology. Non-asbestos diaphragm technology can also be considered as BAT. The total energy use associated with BAT for producing chlorine gas and 50% caustic soda is less than 3000 kWh (AC) per tonne of chlorine when chlorine liquefaction is excluded and less than 3200 kWh (AC) per tonne of chlorine when chlorine liquefaction and evaporation are included. The BREF (p.37) mentions that MCCAP energy requirement is around 3600 kwh/tonne chlorine gas produced, whereas membrane energy requirement is around 3000 kwh/tonne chlorine. Therefore, in addition to the need to shift to mercury-free technology in terms of emissions, in order to meet its energy requirements under IPPC, industry would need to convert to the membrane technology.

[20] http://www.europarl.europa.eu/sides/getDoc.do;jsessionid=4F83C0DC30BD2F593CFECA28BDE00DFB.node1?language=EN&pubRef=-//EP//TEXT+TA+P6-TA-2006-0078+0+DOC+XML+V0//EN

[21] Report from the EEB Conference, "EU mercury surplus management and mercury-use restrictions in measuring and control equipment", October 2006

In the light of the discussion above, it is evident that political pressure to phase out the use of mercury in the chlor-alkali industry has been growing for the past two decades.

EEB MONITORS MERCURY EMISSIONS FROM MERCURY-CELL CHLOR-ALKALI PLANTS

To assess present levels of European MCCAP mercury releases into the environment, and to identify any potential risks related to mercury exposures, the European Environmental Bureau (EEB) sponsored 'snapshot' air monitoring in three countries where mercury-cell chlor-alkali facilities are still active, Spain, Italy and the Czech Republic. These countries were chosen because of the large number of plants still using the mercury-cell process as well as previous indications of excessive mercury emissions. The monitoring was carried out by Ecologistas en Acción in Spain, by Legambiente in Italy, and by Arnika in the Czech Republic. The monitoring was part of a broader effort by EEB and cooperating organisations to:-

- create momentum in each country towards obtaining a national commitment for the early conversion of existing mercury-cell chlor-alkali plants, while ensuring that decommissioned mercury from these plants will be safely stored and not re-enter the market; and to
- raise awareness on mercury issues in general.

Background on mercury emissions from selected plants

Mercury is not 'used up' in the chlor-alkali manufacturing process. It is used only to conduct an electric current. Replenishment is only necessary when mercury leaks into the plant or the surrounding environment or when it leaves the plant in the form of waste or residue. Ideally, facilities would report all loss of mercury in the products, air, water, soil and waste that leaves the plant. In practice, however, facilities routinely report buying and adding much more replenishment mercury to the process than they report as releases. A recent report in the USA examined discrepancies between purchasing data and emissions reports, and quantities known to be in products (ie mass balance calculations that track mercury within the sector). The report found that between 2000 and 2004, the US chlor-alkali industry could not account for more than 130 tons of mercury in addition to the 29 tons it admitted releasing into the environment.[22]

In the EU, MCCAPs report their mercury consumption and losses to Euro Chlor, which in turn makes these data public. The difference between the overall consumption of mercury and the admitted losses is the 'difference to balance', which represents mercury consumption that is unaccounted for. Data for the Czech, Italian and Spanish plants included in the EEB study show that, apart from mercury disposed of in waste, up to 90 percent of total mercury releases from these plants are unaccounted for:-

[22] Natural Resources Defense Council (2006). *Lost and Found: Missing mercury from chemical plants pollutes air and water.* April. Available at http://www.nrdc.org/health/effects/chlor/contents.asp

Table1: Reported Mercury Releases at Selected EU MCCA Plants, 2005[23]

Country	Plant	Reported losses to products air and water (tonnes)	Reported mercury disposed in waste (tonnes)	Unaccounted for mercury losses (tonnes)	Total mercury releases (tonnes)	Unaccounted for mercury losses as a percentage of total mercury releases
Italy	Porto Maghera	0.134	0.303	4.486	4.923	91%
	Pieve Vergonte	0.019	0.059	-0.171	-0.093*	n/a
	Torviscosa	0.089	1.6	0.1	1.788	5%
	Rosignano	0.062	9.728	0.030	9.820	<1%
	Bussi	0.082	0.532	4.445	5.05	88%
	Priolo	0.279	11.887	1.863	14.019	13%
Spain	Torrelavega	0.047	1.880	0.303	2.230	13%
	Huelva	0.109	0.217	0.721	1.047	69%
	Monzón	0.038	1.297	-0.194	1.141	n/a
Czech Republic	Spolana	0.141	0	0.164	0.305	54%
	Spolchemie	0.036	0.337	0.049	0.422	12%

*According to the reporting methodology used by Euro Chlor member companies, any (previously "unaccounted for") mercury recovered from drains, equipment, etc., may be included in the total mercury inventory of the plant for that year, effectively reducing the apparent mercury consumption for the year. In the case where the amount of mercury recovered results in an effective inventory increase for the year, the "difference-to-balance" or "unaccounted for" mercury loss for the year may appear as a negative number. This may also occasionally lead to the anomalous situation in which a plant's total apparent mercury releases for the year appear as a negative number. The details of such circumstances that result in extraordinary inventory changes are not publicly reported by Euro Chlor.

[23] Data are from 2005, as provided by Euro Chlor, except for Priolo, where data are from 2000 since recent data were not reported. Mercury cell operations at the Priolo plant are now closed.

These data are consistent with the proportion of mercury emissions unaccounted for among all EU MCCA plants, where overall about 40 percent of mercury losses were unaccounted for in 2005:-

Table 2: EU-25 mercury releases from chlor-alkali plants, based on Euro Chlor reports (tonnes)[24]

	2004	2005
Reported emissions to products, air and water	6	6
Reported mercury disposed of in waste	86	86
Reported unaccounted for "difference-to-balance" mercury losses	78	53
Total mercury releases (may not be exact due to rounding)	**171**	**146**

There is increasing evidence to suggest that "unaccounted for" mercury may, in fact, reflect under-reporting of emissions from MCCAPs. For example, in the EU, mercury emissions are typically reported to be about 1 gramme Hg per tonne of chlorine production capacity. By comparison, in the US, reported emissions several times higher, despite very similar processes and plant management. Based on specific on-site and peer-reviewed research studies, the analysis prepared by Concord East/West Sprl has concluded that there is no alternative but to question the accuracy of the mercury emissions and releases reported by MCCAP operators to Euro Chlor. A recent US study that monitored mercury in the air outside of MCCAPs also found that more mercury is lost to the local environment around these facilities than is normally assumed.[25] Although that report was focused on US plants, the mercury cell process design of European MCCAPs is similar to those in the US[26] If EU plant emissions are actually several times higher than reported, the emissions from these plants would be roughly on par with emissions from large coal-fired power plants[27], which are recognised as a major source of EU atmospheric emissions.[28]

EEB Monitoring

EEB's air quality monitoring was carried out at the sites of eleven mercury cell chlor-alkali plants in three countries. All monitoring teams used a mobile mercury analyser (Lumex RA 915+) to measure mercury in ambient air. This hand-held, sensitive detector has a minimum detection limit for mercury of 2 nanogrammes per metre^3 of air (ng/m^3) and a maximum limit of 200,000 ng/m^3 (one nanogramme equals one billionth of a gramme). The US EPA has successfully used this device in its own sampling studies. Operators from the different organisations, trained by the Lumex supplier, performed all measurements, except in Spain, where experts from the Centro de Estudios de Almadén - Universidad de Castilla La Mancha helped with the monitoring.

The monitoring was conducted in June, 2006. Typically, monitoring was carried out by walking around, driving or stopping on public roads beside plants. In some places, the monitoring team was invited inside plants to monitor areas near existing or historical

[24] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East./West Sprl., October 2006, pg 7.
[25] Natural Resources Defense Council (2006). *Lost and Found: Missing mercury from chemical plants pollutes air and water.* April. Available at http://www.nrdc.org/health/effects/chlor/contents.asp
[26] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East./West Sprl, October 2006, pg.10-11.
[27] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East./West Sprl, October 2006, pg. 17
[28] Zero Mercury – key issues and policy recommendations for the EU strategy on mercury, table 2, p.41

mercury-cell processes. For each facility, the teams also measured background mercury concentrations some distance away from the plant. The measurements reflect ten-second averages, automatically logged into the computer. In some cases, maximum, instantaneous (one-second) values were recorded by hand directly from the monitoring device's continuous display.

The concentration of mercury in the air measured outside the plant can be compared to two health-based benchmarks for public exposure: the US EPA's reference concentration for chronic mercury exposure (300 ng/m^3) and the Agency for Toxic Substances and Disease Registry (ATSDR) safe level for chronic exposure, or Minimal Risk Level (MRL) (200 ng/m^3). Measurements inside the plant are more appropriately compared to occupational limits. The (US) National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for mercury vapour of 50,000 ng/m^3 (time weighted average, TWA), while the American Conference of Governmental Industrial Hygienists (ACGIH) has assigned mercury vapour a threshold limit value (TLV) of 25,000 ng/m^3 (TWA). At EU level, no target value or quality standard for mercury in the air has been established, and no EU-wide occupational exposure limit value for mercury has yet been developed.[29]

It is important to bear in mind that even if mercury concentrations in the air do not exceed health-based benchmarks, the emitted mercury nevertheless becomes part of the mercury burden circulating in the global environment, and some of that enters the food chain, posing risks to those who eat contaminated fish.

Summary of Monitoring Results

The EEB monitoring exercise shows that mercury-cell chlor-alkali facilities continue to be a significant source of airborne mercury pollution. Maximum concentrations outside all plants except the Priolo site (no longer operating), in Italy, exceeded both the EPA health benchmark of 300 ng/m^3 and the ATSDR threshold of 200 ng/m^3. Eight of the eleven plants exceeded the EPA public exposure benchmark by at least a factor of two. The highest concentrations detected outside of the plant premises were found at the Monzón plant in Spain, and the Bussi plant in Italy. At these two places, the highest concentrations exceeded the US EPA health benchmark by 65 times and 25 times respectively, and exceeded the ATSDR MRL by factors of 98 and 38, respectively. For reference, the background mercury concentration is usually considered to be around 2ng/m^3.

In three of the plants, air measurements were made inside of the plants. In Porto Maghera, the measurements were made inside an active cell room. The concentration exceeded 34,000 ng/m^3, which is above the recommended ACGIH limit, and the national standard for Italy. In Priolo, the highest concentrations noted were nearly 17,000 ng/m^3. Notably, these measurements were made around inactive cells, where most of the mercury had already been removed and shipped to Almadén for storage. The Priolo measurements are a stark reminder that even after decommissioning, plants may remain a significant source of mercury contamination that must be addressed.

Therefore, since measured atmospheric concentrations of mercury adjacent to many chlor-alkali plants were higher than expected, far exceeding normal background conditions (typically around 2 ng/m^3), it appears that chlor-alkali plant emissions are also much higher than the local inhabitants, and indeed also the regulators, believe them to be. This observation is completely consistent with the independent research

[29] European Commission, Communication from the Commission to the Council and the European Parliament - Community Strategy Concerning Mercury, COM(2005) 20 final, p.9.

findings cited previously.[30] It is clear that mercury-cell chlor-alkali plants continue to deposit significant quantities of mercury into the environment, posing risks not only to the local environment, people and wildlife, but also contributing to the total amount of mercury circulating in the global environment.

Table 3: Summary of Highest Detected Levels at Each Plant Monitored in the EEB Study

Country	Monitoring Location	Maximum Mercury Concentration Measured Outside the Plant (ng/m3)	Exceeds EPA health benchmark for air?	Maximum Mercury Concentration Measured Inside the Plant (ng/m3)[31]
Italy	Porto Maghera	1493	yes	n/a
	Pieve Vergonte	Around 750	yes	34,720.70
	Torviscosa	1208	yes	n/a
	Rosignano	1211	yes	n/a
	Bussi	7696	yes	n/a
	Priolo	Around 50-60	no	16,885.40
Spain	Torrelavega	510	yes	n/a
	Huelva	1924	yes	n/a
	Monzón	19650	yes	n/a
Czech Republic	Spolana	989[32]	yes	n/a
	Spolchemie	412	yes	9,631

Annexes A, B and C provide more details of the monitoring efforts in each country, including maps of locations sampled and levels found.

OTHER STUDIES

Other published studies have also examined the concentrations of mercury in the environment (water, soil, fish) and in human beings (workers and local residents), as well as health outcomes, in regions around European MCCAPs. Some details of these studies for Spain, the Czech Republic and Italy are briefly noted in Annexes A, B and C respectively. Since mercury is a global pollutant, the specific mercury contamination noted in local environments cannot necessarily be directly attributed to emissions from the plants. However, these studies indicate that mercury contamination is a concern for local communities, and for people who work in these plants.

CONCLUSIONS AND RECOMMENDATIONS

All of the information discussed above leads to the conclusion that MCCAPs remain a major source of mercury in the EU's environment. Every year, tonnes of mercury are reported to be emitted from MCCAPs. If these reports are in fact underestimates, as suggested, air emissions from these sources may be similar in magnitude to emissions

[30] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East./West Sprl, October 2006, pg. 17

[31] None of the concentrations measured inside the plants exceeded the Czech occupational limit for mercury in air, 50,000 ng/m3; only the Pieve Vergonte measurement exceeded the AGCIH recommended standard of 25,000 ng/m3 which to our information is also being used in Italy as a standard.

[32] A concentration of 1441 ng/m3 was observed near the railroad tracks near the facility. However, it is not known if this mercury concentration is related to the facility.

from large EU coal-burning plants. Given the hazards of mercury, the availability and viability of mercury-free technology and the economic and health benefits of conversion to mercury-free technologies, many members of the EU community have pressed for the conversion of MCCAPs since 1990, and this direction has been confirmed in recent European Parliamentary resolutions and the IPPC BREF. EEB's monitoring exercise around EU plants further confirms that MCCAPs are a source of fugitive emissions of mercury, and underlines the urgent need to convert these facilities.

Benefits of conversion

The benefits of conversion to membrane technology can be substantial. Based on a range of other research works, Concord East/West[33] conservatively estimated the benefits (within the EU) of eliminating mercury emissions to be in the range of €25-30 per gramme of atmospheric mercury emissions eliminated. Considering only the reported mercury emitted to air from EU MCCAPs of five-six tonnes (five-six million grammes), eliminating these mercury emissions would confer annual health benefits of at least €150m, and would significantly exceed this amount if actual emissions, as expected, are higher than those reported.

Membrane technology has other cost advantages besides the elimination of mercury use and emissions. For example, membrane technology requires substantially less energy, and plants will realise benefits in electricity savings, as well as reduced carbon emissions from the generation of electricity. Plants will also benefit from avoiding costs associated with the removal of mercury during the production process, and will no longer have to handle, treat and dispose of mercury-containing waste, and will avoid environmental and occupational monitoring for mercury exposure. In combination with the public health benefits of converting to mercury-free technology, these operating benefits far outweigh the costs of decommissioning and conversion.[34]

[33] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East/West Sprl, October 2006, pg. 27
[34] Status Report: Mercury-cell chlor-alkali plants in Europe, Concorde East/West Sprl, October 2006, pg. 27

Recommendations

Based on these conclusions, EEB and the cooperating NGOs strongly recommend that the following actions be taken:-

- **The mercury-cell chlor-alkali process for all EU plants should be phased out as soon as possible, and by 2010 at the latest.**

This recommendation is consistent with OSPAR Decision 90/3 and the European Parliament's resolution of March 2006. As far as possible, accelerated phase-out should be part of an EU initiative or commitments at Member State level.

- **Any surplus supplies of mercury resulting from decommissioning MCCAPs should be safely stored**

The storage of decommissioned mercury from the chlor-alkali industry should begin as soon as possible, in continuously-monitored secure sites, located where immediate intervention can occur if necessary. Storage should begin even before the effective date of the EU mercury export ban, and excess mercury should not re-enter the global market. Allowing such a large quantity of mercury to flood the global market would depress the price of mercury and would encourage its use elsewhere in the world, particularly in artisanal and small scale gold mining (ASM), where releases are uncontrolled and contaminate people and the environment. ASM is the world's largest source of mercury emissions from the intentional use of mercury.

- **Mercury contamination resulting from the operation and historical waste disposal practices of the plants should be remediated, through clean up, capping or other methods of appropriate management**

All MCCAPs should perform a site assessment to characterise the extent of current levels of contamination, so that the plant management and regulatory authorities can evaluate and plan for site remediation when the plants ultimately decommission.

- **Competent local authorities should refuse operating permits to plants with obsolete non- BAT technology, under the IPPC Directive**

When issuing operating permits to plants, national and regional authorities are obliged to require Best Available Techniques (BAT) under the IPPC Directive. Since the use of mercury to produce chlorine and caustic soda is not considered BAT, authorities should deny operating permits to plants using this obsolete technology, and only under exceptional circumstances should permit them to continue operations. Such plants should have a well-defined conversion schedule, with final conversion no later than the 2010 deadline. Thorough justifications for any exceptions should be provided and fully open to public scrutiny.

In the light of the Directive's inherent flexibility, a strict and homogenous approach to MCCAP permit requirements is far from assured. Therefore, soon after October 2007, the European Commission should carry out a comparative assessment of the operating

requirements imposed by the permits given to EU mercury-cell chlor-alkali plants to continue their operations after October 2007, under the IPPC Directive.[35]

Discrepancies in the implementation of the Directive in Member States under similar local environmental conditions should then lead to further, stricter measures to be taken across the EU.[36]

- **Comprehensive guidelines should be developed for decommissioning mercury-cell plants and safe storage of all mercury.**

No standard criteria are defined for the time being, specifying how mercury-cell plants should be decommissioned. Although Euro Chlor offered to carry out such a task[37], and has produced a general set of guidelines, clear environmental conditions must be defined and made known to the competent authorities and plants. The strict application of these conditions must be ensured in all relevant plants across Europe. The chlor-alkali BREF should be reviewed as soon as possible to include a benchmark for decommissioning mercury-cell technology

- **Until then, mercury emissions from mercury-cell plants should be continuously and comprehensively monitored and independently verified, and companies should account for any mass balance discrepancies**

Current methods for calculating mercury emissions from MCCAPs are insufficient to account for the mercury in these plants. Companies should work with the authorities to identify appropriate monitoring locations and timeframes. The monitoring conducted in this report allowed only a 'snapshot' of conditions. Monitoring should be conducted over the long-term, under different meteorological and operating conditions, including 'upset' conditions, to get a true picture of emissions patterns. To ensure reliability and transparency of the results, monitoring should be independently conducted and/or verified

- **Companies should be required to account for any mass balance discrepancies**

The Euro Chlor data show that plants often cannot accurately account for mercury in their own facilities. To manage this dangerous chemical properly, companies should be required to account for the fate of all mercury in their plants and report all emissions, whether in products, waste, air and water, to the authorities and the public. The interim and final destination of any mercury-bearing waste (including any mercury-containing waste classified as 'product' leaving the plant) should also be meticulously reported to the responsible authorities and to the public

[35] The Commission has recently launched several external projects including one on the assessment of the implementation by the Member States of the IPPC directive, but the chlor-alkali sector is not one of the sectors chosen for the project.
Draft Final Report
http://forum.europa.eu.int/Public/irc/env/ippc_rev/library?l=/implementation_entec/draft_final_report/draft_reportpdf/_EN_1.0_&a=d
Selection Criteria for Detailed Assessment of Permits under Tasks 3 & 4,
http://forum.europa.eu.int/Public/irc/env/ippc_rev/library?l=/implementation_entec/selection_criteria/_EN_1.0_&a=d

[36] For example the European Commission should make use of Article 18 of the IPPC Directive to ensure that the EU meets its OSPAR commitments. On the basis of this article the Commission could propose emission limit values (ELV) for the industries covered by the directive, e.g. in the case of chlor-alkali industry, an ELV of zero gr Hg/ tonnes of chlorine capacity, since this value represents the BAT (membrane technology) emission level.

[37] Report from the EEB Conference "EU mercury surplus management and mercury-use restrictions in measuring and control equipment", October 2006, p.12

- **The mercury exposure and health of workers and residents working and living near the plants should be more carefully studied and monitored, and measures should be taken accordingly**

This should take place regularly, to track changes in the health and exposure status of these populations over time, and to determine if they are adversely affected by plant operations. This is particularly critical near the facilities in Spain and Italy, where very high concentrations of mercury were detected in air outside the plant

ANNEX A – SPAIN

Spanish report prepared by Ecologistas en Accion, Madrid, Spain - Inmisiones de mercurio de la industria clorocáustica
http://www.ecologistasenaccion.org/article.php3?id_article=5397

Air monitoring was performed by Ecologistas en Acción in collaboration with the Centro de Estudios de Almadén - Universidad de Castilla La Mancha during June 2006. Mercury was monitored in air around 3 (out of total 9) Hg-cell chlor-alkali plants: Torrelavega (Cantabria) of Solvay, Palos (Huelva) of Aragonesas, and Monzón (Huesca) of Química del Cinca.

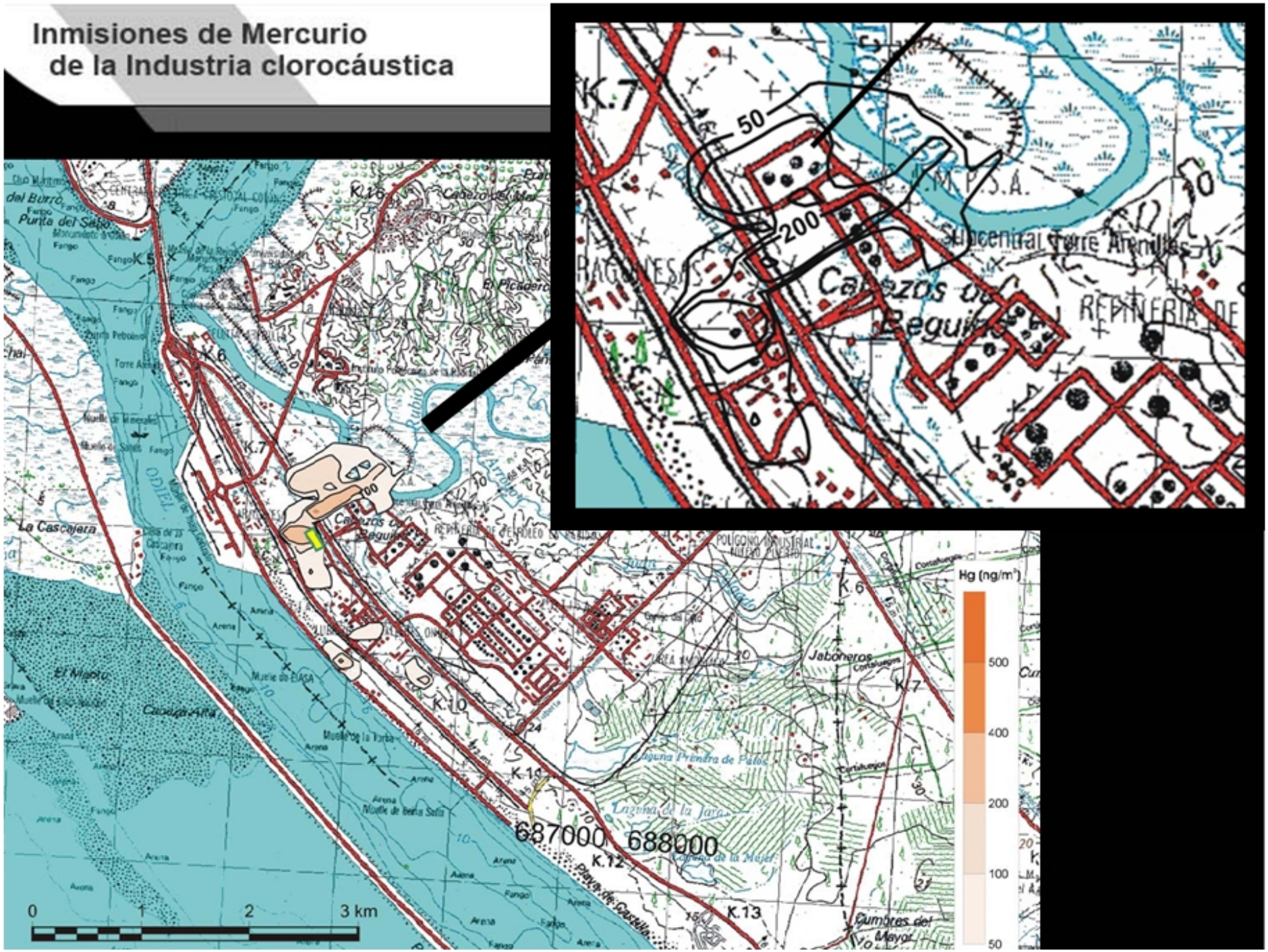
Monitoring Results

The monitoring results showed dramatically high concentrations at one of the facilities, Monzon, where the highest level exceeded 60 times the US EPA benchmark for mercury. In this case, the highest concentrations were observed near the wastewater treatment areas, suggesting that mercury is volatilizing from the wastes or treatment processes. These measurements, which reached 19,650 ng/m3, were taken on the banks of the Cinca River, near inhabited housing, a sports complex, a school and a zone of planned urban development.

At Huelva, the maximum concentration was 6 times the US EPA value; in this case, the cell room was believed to be the major source of the mercury. At Torrelavega, the maximum exceeded the EPA value by nearly two times, and the cell rooms and waste storage areas are assumed to be the source of mercury. Notably, the **average** (not only maximum) mercury concentration at Monzon also exceeded the EPA benchmark.

Hg concentrations [ng/m3] measured in air at the three plants studied

	Huelva	**Torrelavega**	**Monzon**
N	5538	4401	3901
Max	1924.14	510.34	19650.5
Min	14.71	5.96	0.01
Std dev	248.03	47.04	1347.56
Average	95.99	40.95	362.32


Inmisiones de Mercurio
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K.7
50
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500
400
200
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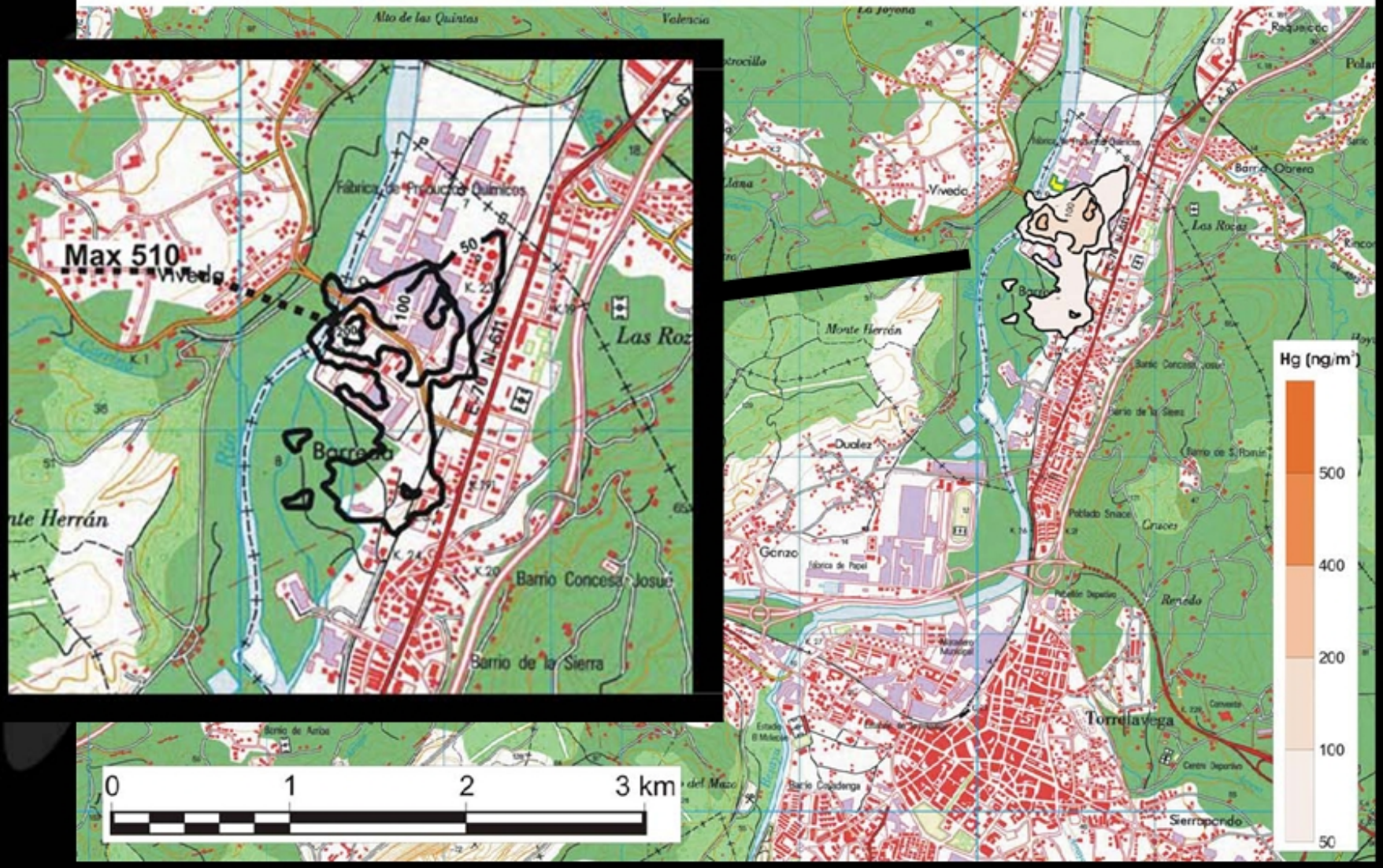
Inmisiones de Mercurio de la Industria clorocáustica

ecologistasenaccion

TORRELAVEGA



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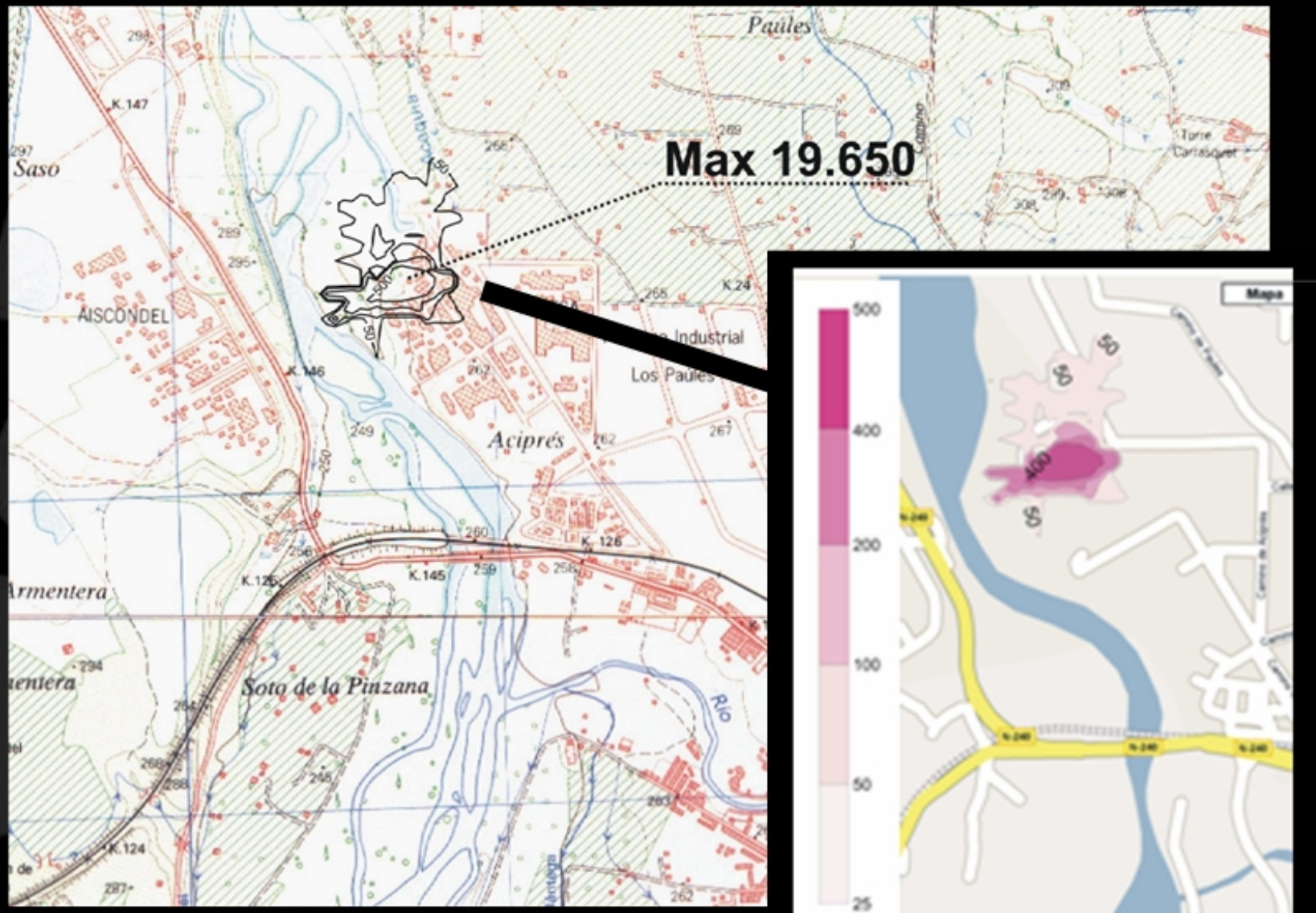


Measurements of hair in workers were taken in July of 2006. The measurements show high concentrations above recommended EPA limits for all of the workers tested:

Mercury in hair from Aragonesas workers (Palos)
July 4, 2006

Sample	**Hg (mg/kg)**	**Distance from cells (m)**
m1	16.1	0
m2	4.1	0
m3	6.8	
m4	11.1	0
m5	4.5	10
m6	5.2	300
m7	5.6	
m8	4.4	
m9	4.5	500
EPA limit:	1.0	

ANNEX B – CZECH REPUBLIC

Czech Republic report prepared by Arnika, Prague, Czech Republic. The report called “Mercury measurements in the surroundings and in the premises of the chlor-alkali plants in the Czech Republic” is available at the Arnika´s website: http://english.arnika.org/mercury/documents.shtml

Air monitoring was performed by Arnika, with a LUMEX RA 915+ kindly offered by Lumex Analytics GmbH, Germany. Mercury was monitored in air around the two Czech mercury-cell chloralkali plants in June 2006.

Spolek pro chemickou a hutni vyrobu, a.s. Usti nad Labem (Spolchemie) is located in the Ústí Region of the Czech Republic, close to the centre of the city of Ústí nad Labem. This city is located in the valley near an estuary of the river Bílina, which flows into the Elbe.

Picture 1: View on Spolchemie

Monitoring Results:

At Spolchemie, measurements were taken inside the plant around the production units of the electrolysis operation. Mercury concentrations on the Spolchemie premises ranged from 11 ng/m3 to 9,631 ng/m3 (the mean value for the period of 20 minutes was 970 ng/m3). Additional monitoring was conducted at two locations within the plant with the highest mercury concentrations: the first in front of the NaOH storage tank, where the mercury concentrations were in the range from 127 ng/m3 to 5,333 ng/m3 (the mean value for the period of 5 minutes was 1,493 ng/m3); and the second in the surroundings of the waste water demercurisation unit (in the area of the waste water transportation bridges), where the mercury concentrations ranged from 912 ng/m3 to 7,816 ng/m3 (the mean value for the period of 5 minutes was 3,145 ng/m3). These values do not exceed occupational limits for mercury as established by the Czech republic (50,000 ng/m3), but show that mercury is escaping into the air from the operations of the plant (see Figure 1).

Outside of the plant, mercury was monitored around the entire perimeter of the plant. The highest mercury concentrations outside of the plant were measured in Solvayova street, above the electrolysis operation. The maximum concentration detected there was 412 ng/m3, which is above the US EPA health benchmark and twice the ATSDR MRL. Increased concentrations were also measured at the corner of Okružní and Solvayova streets., where the Caustic Lyes Operation is located. In the Caustic Lyes Operation, the alkaline hydroxides which contain mercury are treated. The maximum concentrations noted here was 141 ng/m3. (See Figure 2).

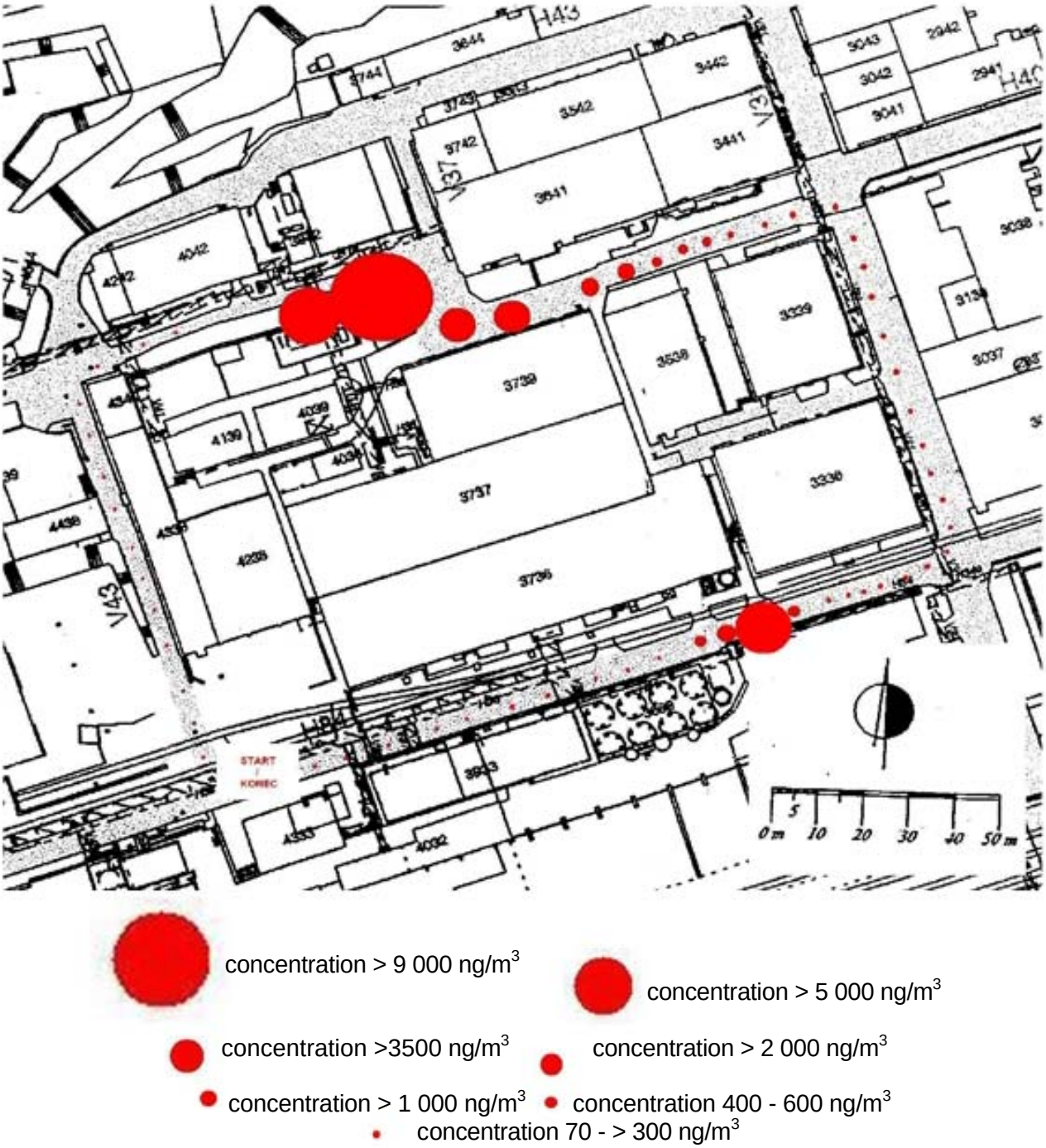


Figure 1: Found mercury concentrations in the surroundings of buildings of the Electrolysis technology in Spolchemie (Source: Spolchemie, application for an integrated permit for a set of equipment for production of alkaline lyes, chlorine, and hydrochloric acid, 2006)

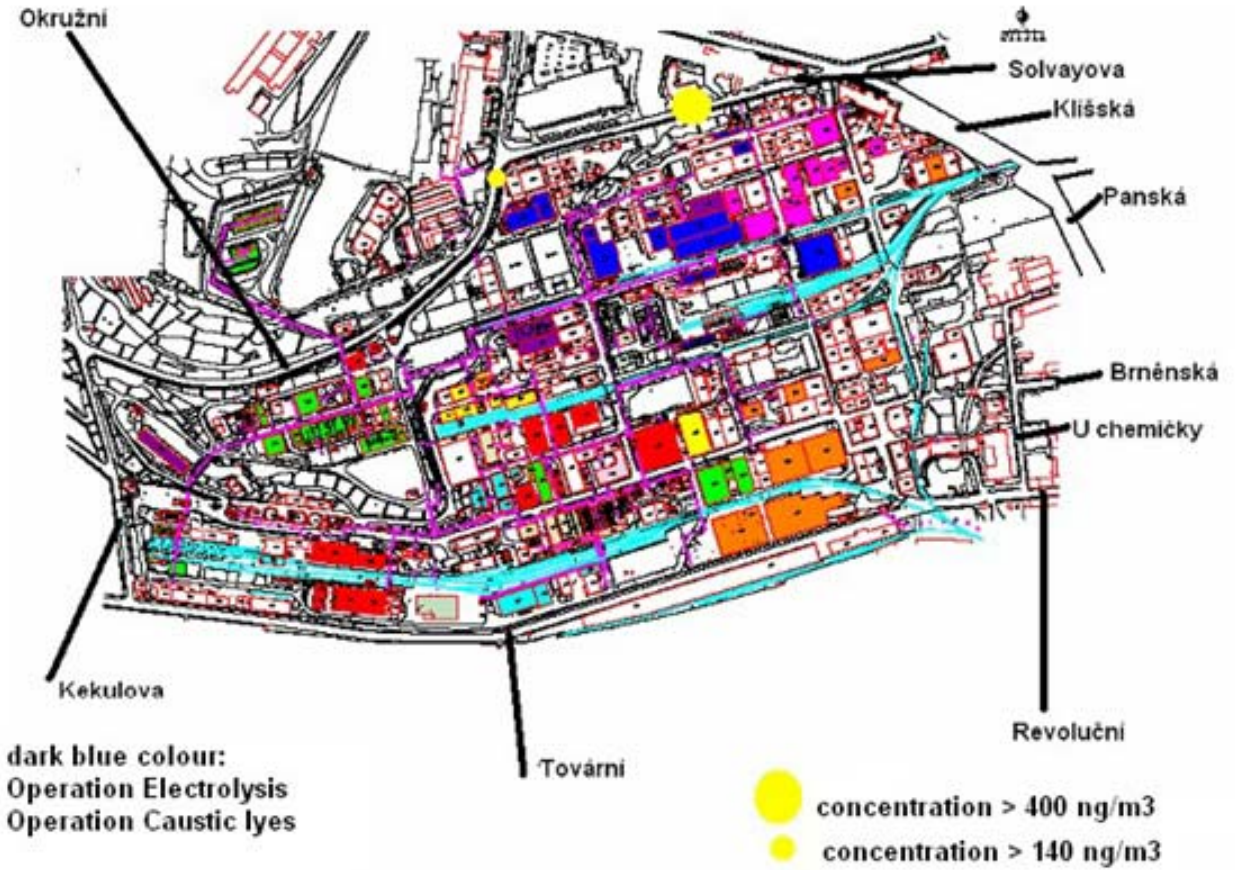


Figure 2: Places where the highest mercury concentrations in the air were found in the vicinity of the Spolchemie premises (yellow points)

Spolana is located in the Stredocesky Region of the in the Czech Republic, and is located near to the Elbe. The plant is located north of the capital city of Prague close to Neratovice city.

Picture 2: The Chlorine Release from Spolana during the flood in 2002 (author: Vaclav Vasku)

At the Spolana plant, the monitoring team carried out measurements outside of the factory only. The team was not permitted to take measurements inside the Spolana factory. (Note that measurements taken inside the factory in 2003 are available in the main report, available at the web address noted above.) While measurements were carried out around most of the perimeter of the factory, access was limited by presence of private homes and lands near the factory boundaries, and measurements were taken at a relatively far distance from the factory in most locations. The highest mercury measurements were detected on public lands located directly across the river from the factory.

The highest concentration close to the Neratovice city centre were measured at the railway crossing point, where the maximum concentration detected was over 1400 ng/m3 (see Figure 3). The source of this mercury is not known. High mercury concentrations were also found in two main locations on the river bank: the first location opposite the building B1290(chlorine lime production building). Close to this place, the old amalgam electrolysis was carried out in the past. At this time, this old amalgam electrolysis site is considered to be an old ecological burden. The soil and buildings in this area are contaminated by more than 250 tonnes of mercury. Here, the maximum concentration was 989 ng/m3. The second spot, near the cooling tower, is probably due to the current amalgam electrolysis. The maximum concentration detected here was 155 ng/m3. This operation is located farther inside Spolana´s property than the old amalgam electrolysis buildings, and thus is farther from the river bank where the measurements were taken (see Figure 4).

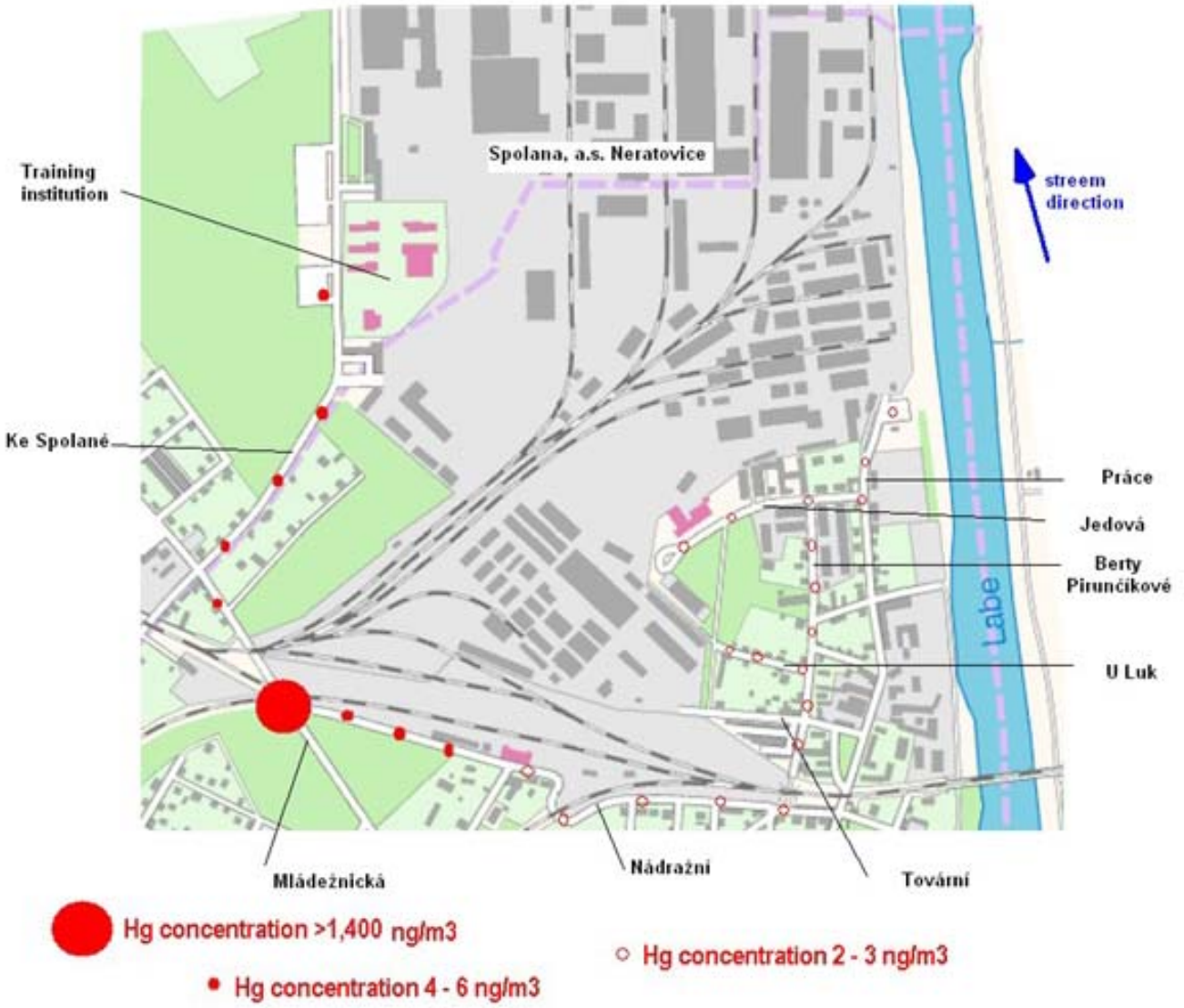


Figure 3: The highest concentration close to the Neratovice city centre

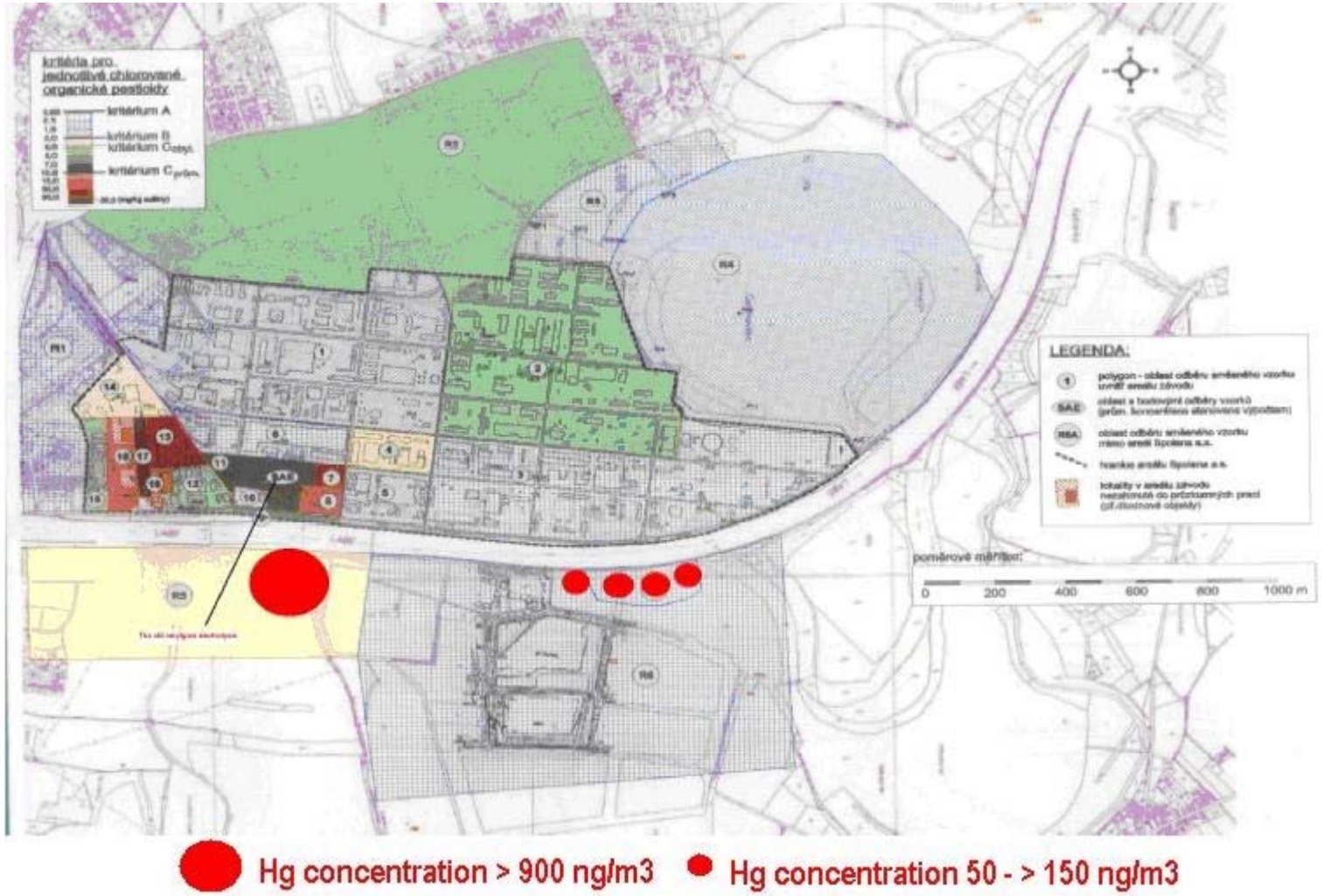


Figure 4: The highest concentration on the river bank opposite Spolana location

ANNEX C – ITALY

Italian report prepared by Legambiente, Rome, Italy.
http://www.legambiente.com/documenti/2006/0612_Stop_Mercurio/index.php

Air monitoring was performed by Legambiente, using equipment provided by Lumex, during June 2006. Mercury was monitored in air around six mercury cell chlor-alkali plants:

Background on the plants

PORTO MARGHERA (Veneto) – Polimeri Europa and Syndial (formerly EniChem S.p.A.). The Porto Marghera industrial area is one of the largest in Europe and is administered by the Municipality of Venice. Chlorine production in Porto Marghera started in the 1950s. The first plants ceased operations 1994, while the ones currently in operation were built in the 1970s. Syndial currently produces 200,000 tonnes of chlorine per year at this location. An agreement signed in 1998 anticipated the substitution of the amalgam cells with membrane ones. In September 2006 a project proposal to convert to membrane technology, submitted by Syndial, was approved by the national EIA (Environmental Impact Assessment) Commission, following a positive judgment from the regional EIA Commission.

PRIOLO (Sicily) – Polimeri Europa and Syndial (formerly EniChem S.p.A.)
The Augusta-Priolo-Melilli industrial area covers about 30 kilometres of Sicilian coast, in the Syracuse province. The Syndial-owned chlor-alkali plant used to employ mercury cell technology, and produced 28 Kt/y of chlorine and 30 Kt/y of soda. The mercury cell operations have now closed.

This plant was at the centre of a national scandal in January 2003 when a criminal investigation known as “Operation Red Sea” triggered the arrest of 17 between managers and employees of the Syndial. The allegations included illegal traffic of large quantities of hazardous waste containing mercury, concealment and burying of waste and falsification of certificates. Those arrested allegedly disposed of liquid waste containing mercury from the chlor-alkali plant by pouring it directly into the sea. The operation owed its name to the colour the sea turned to when the discharges from the Syndial plant were discovered.

ROSIGNANO (Tuscany) – Solvay S.p.A.
Rosignano Solvay is an important industrial centre located on the coast of Tuscany. The plant in Rosignano was established in 1941 and is Solvay’s largest installation in Italy with 803 employees. The mercury electrolysis plant, operating since 1939, produces 116.000 tonnes of chlorine, 130.000 tonnes of caustic soda (sodium hydroxide) and 3.300 tonnes of hydrogen annually.

It is estimated that at least 500 tonnes of mercury are deposited on the beach near the plant and up to 14 km from the shoreline. The mercury is not “buried” or “inert,” it actually circulates due to sea storms and solar radiation. A study carried out by the Pisa branch of the National Research Council has found that solar radiations during the hottest hours cause each sea square metre to emit 164 ng of mercury in the atmosphere.

On the 31st of July 2003 a Programme Agreement to reduce the environmental impacts of Solvay’s plant productions was signed; according to the Agreement Solvay commits to substitute mercury cells with membrane cells by the 31st of

December 2006 and to completely stop the mercury cells by the 31st December 2007.

Meanwhile, the EU has earmarked 13.5 millions euro (towards an envisaged investment total of 48 millions euro) to convert the Rosignano Solvay plant to membrane cells. On the 6th June the start of work to convert the chlor-alkali plant was announced by the company. By the end of 2007, 50 mercury cells will be closed. The surplus 200 tonnes of Hg will be gradually sent to Spain between 2008 and 2010.

PIEVE VERGONTE (Piedimont) – Tessenderlo Italia S.p.A.
The industrial area is located in an alpine valley downstream from the small Pieve Vergonte village, along the river Toce which then flows in the Maggiore Lake. Production activities started in 1915. Tessenderlo S.p.A. (a Belgian multinational corporation) has owned the plant since 1997, while previously, since 1948, it was owned by Rumianca S.p.A. and Sir, then by EniChem. Chlorine production is up to 40.000 tonnes per year. Mercury, arsenic, ammonia and hundreds of DDT can be found on the lakebed. In 2004 Tessenderlo committed to substitute the old mercury cells technology with membrane cells within two years. However, in the past few months it has surfaced, unofficially, Tessenderlo's intention to abandon the conversion plan.

TORVISCOSA (Friuli Venezia Giulia) – Industrie Chimiche Caffaro (Caffaro Chemical Industries)
Opened in 1938 by the company Snia, in 1950 the mercury cells plant started the production of chlorine and soda for use in the production of cellulose and artificial fibres (this production ceased in 1990). In 1996 the plant was purchased by Caffaro, for use in the production of chloroparaffins. In 2002 Caffaro presented its proposal for the conversion to membrane cells but nothing has been done so far. Chlorine production is estimated at 69.000 tonnes per year.

The pollution of the Grado and Marano lagoon is primarily attributable to the discharge of mercury coming from the cellulose plants, where about 20 kg of mercury were discharged daily. These emissions were reduced in 1984 with the implementation of the new mercury recover techniques. The site is included in the National Remediation Programme of the Ministry of Environment, due to the emergency state of the lagoon's pollution. Local health agencies have prohibited farming, trade and consumption of clams and of certain fish species found in the lagoon, which pose high health and environmental danger.

BUSSI (Abruzzo) – Solvay
The work towards the conversion of the Bussi site has been going on for a few years, as part of the strategy of the Pescara Province Authority regarding the chemical giant Solvay. A Provincial Chemistry Observatory was constituted in 2006. On the 3rd of August 2006 the Bussi sul Tirino Solvay Company, the Ministry of Environment, the Abruzzo Regional Authority, the Pescara Province Authority, the Regional Environmental Protection Agency (ARPA) of Abruzzo and the trade unions signed a Programme Agreement about the conversion of the Solvay chlor-alkali plant production to a process without mercury. This represents a huge step towards reducing the environmental impact and promoting the sustainable development of the industrial processes. The agreement includes funding from the Environmental Ministry for about 2.263.000,00 € (21% of the total cost of the operation) that has yet to be approved from the European Commission.

Monitoring Results

Mercury concentrations in air around all of the plants monitored exceeded the US EPA health benchmark of 300 ng/m3, except for the Priolo site, where operations of the mercury cell chlor-alkali production have ceased. The highest concentrations were measured outside of the Bussi plant, where the concentrations exceeded 7500 ng/m3, on a public road that runs along the side of the plant outside of the cell room. At the remaining four plants, maximum concentrations were measured between 750 and 1500 ng/m3, levels which are between two to five times the EPA health benchmark. These concentrations were detected in public locations about 100 to 200 meters downwind of the cell room.

In Priolo, the highest concentrations noted inside of the plant were nearly 17,000 ng/m3; although this concentration does not exceed occupational limits, it is notable that these concentrations in air were measured around decommissioned mercury cells, where most of the mercury had already been removed and shipped to Almadén for storage. The Priolo site measurements are a stark reminder that even after decommissioning, plants remain sources of mercury contamination that need to be addressed.

Mercury Concentrations Measured Around Chlor-Alkali Plants In Italy

Plant Location	Company	Plant production capacity Cl_2 tonnes/year	Current rate of production	Peak emissions recorded ng/m^3	Comments
Tor Viscosa	Caffaro Chemical Industries	69.000	70%	1208.13	Outside the plant, around 200m from cell-room, Downwind
Porto Marghera	Syndial	200.000	60%	1493.05	Big complex, inside complex, outside plant, around 100m from cell-room.
Pieve Vergonte	Tessenderlo	40.000	60-70%	Around 750	Concentrations inside plant, outside the door of cell-room, were measured at 34,720.70 ng/m3
Rosignano	Solvay	120.000	n.a.	1211,43	Outside the plant.
Bussi	Solvay	70.000	n.a.	7695.85	Measurements taken 2m from cell room, cell-room window on public road.
Priolo	Syndial	190.000	0%	Around 50-60	Plant closed. Mercury has been removed and sent to Almadén. Inside the plant, peak measured at 16,885.40

Investigated Chloro-Alkali plants in Italy

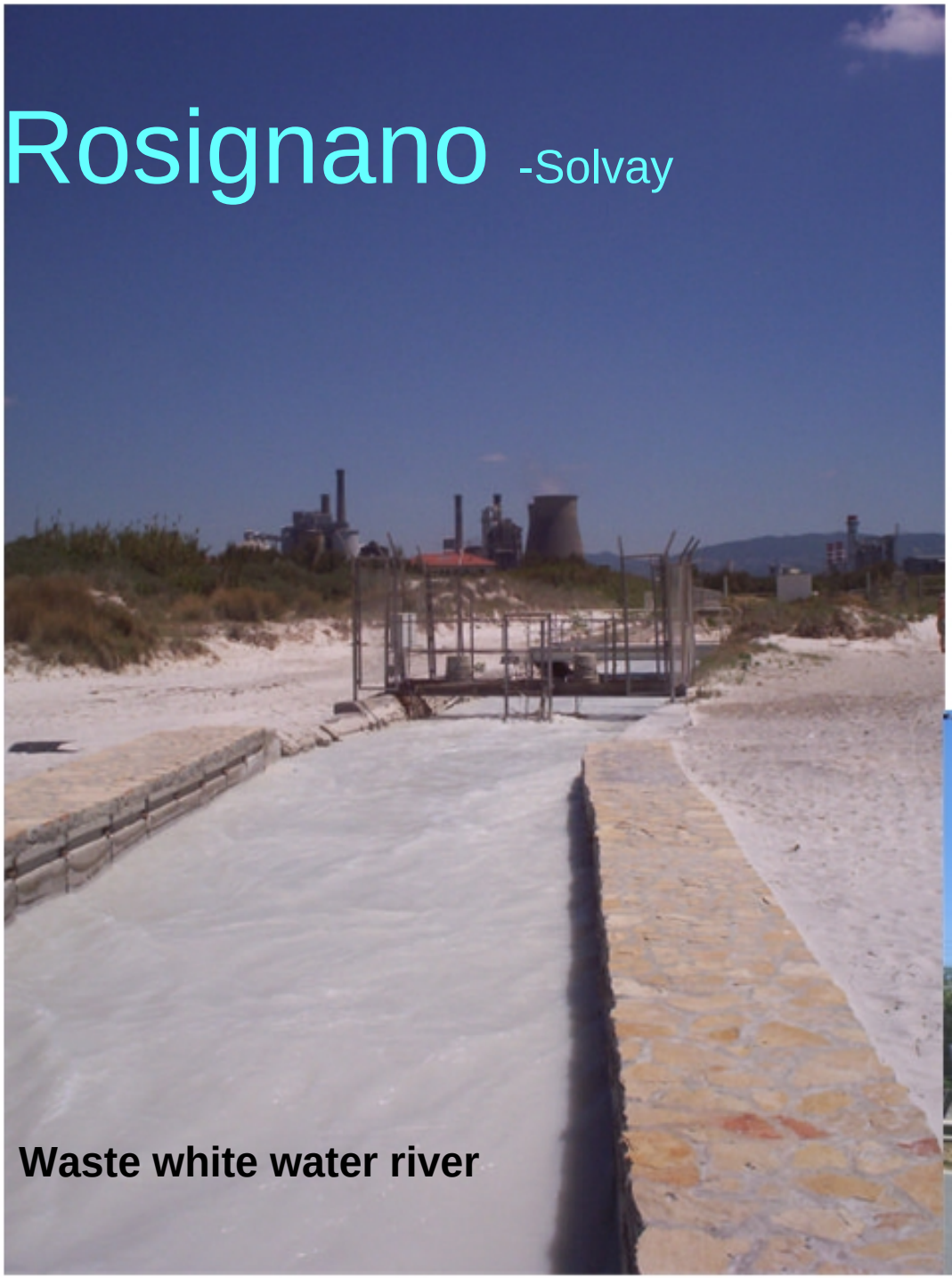

SS 14
Ca' Bolani
Hot Spot of 1700 ng/m3
via dei Banduzzi
TORVISCOSA
SS 14
Plant enter
Spin s.p.a.
Viale Roma
Via Vittorio Veneto
Antonio Vivaldi
Public road
via dei Banduzzi, rail way
On the background
Cells room


Porto Marghera - Syndial


Chlor-Alkali plant
Porto Marghera industrial area
Venice
Sant'Erasmo
Sant'Erasmo

Inside plant

Rosignano -Solvay

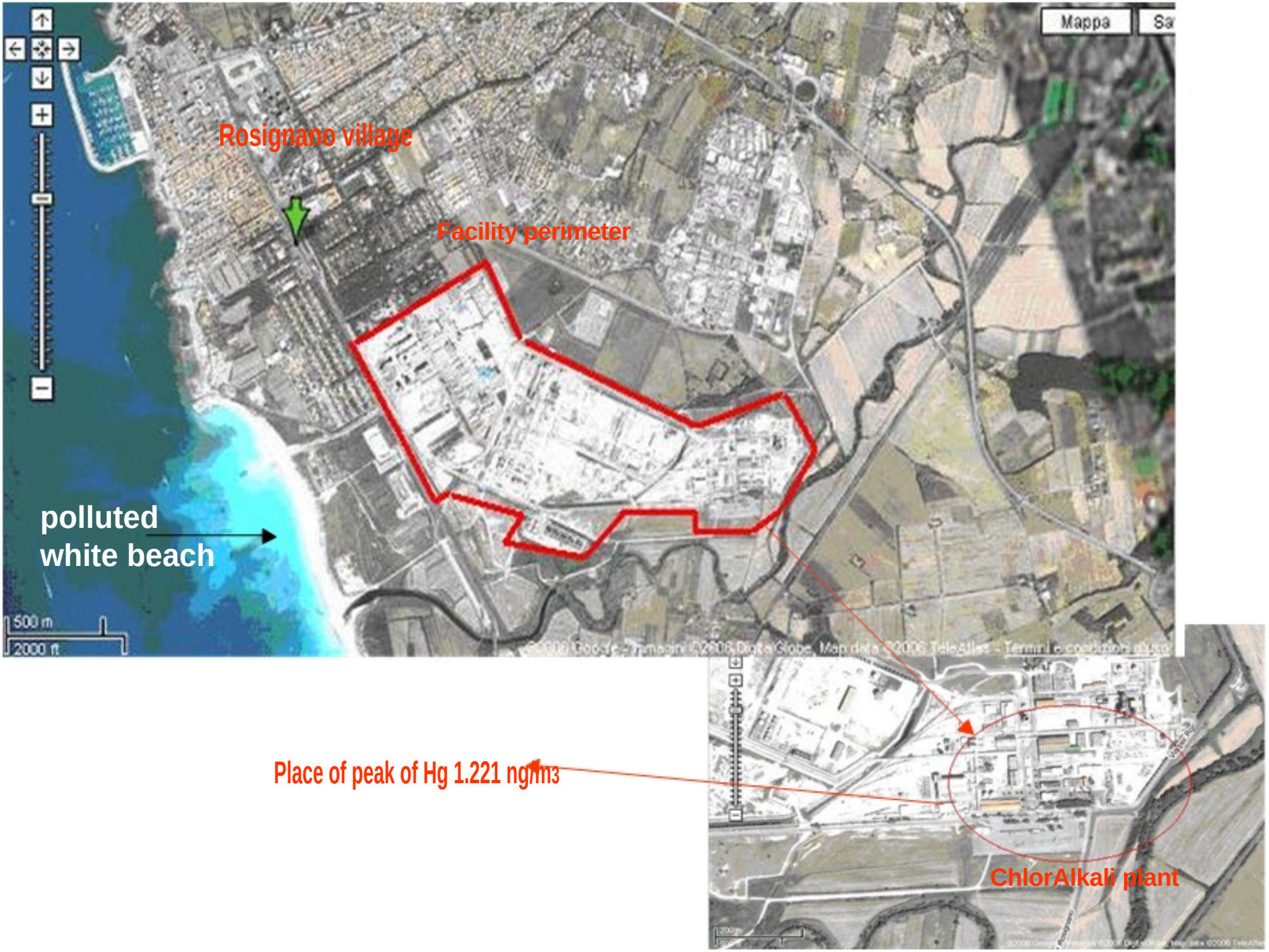


Waste white water river

10 - 11th June 2006

T: min 12°C - max 26°C
Wind speed: 10 Km/h
Wind direction: SW

Chloro -Alkali plant


Mappa
Rosignano village
Facility perimeter
polluted
white beach
500 m
2000 ft
Place of peak of Hg 1.221 ng/m3
ChlorAlkali plant


Bussi - Solvay


Bussi village
Bussi sul Tirino
SS153
Bussi Officine
Facilitiy perimeter
Autostrada dei Parchi
A25
E80
Tiburtina
SS5
SS153
Via Tiburtina Valeria
500 m
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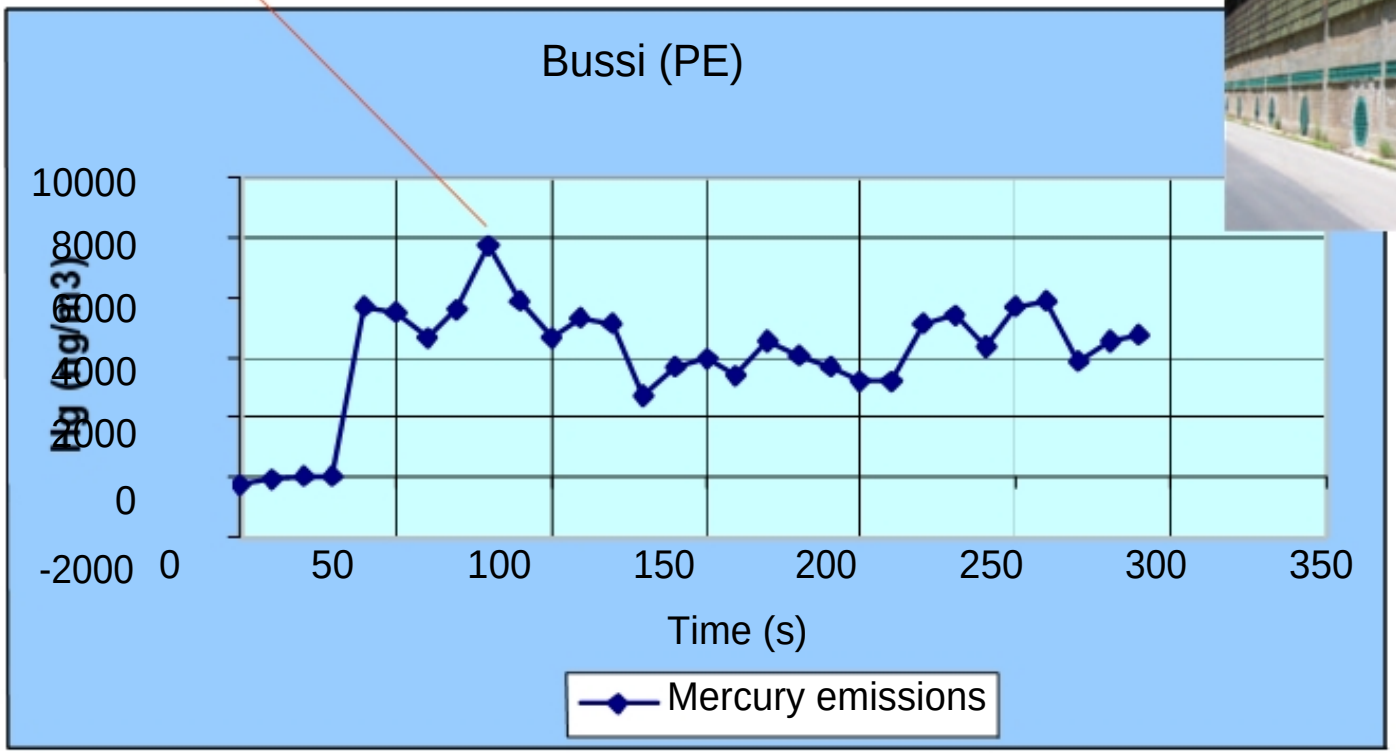
Peak zone

In Bussi we monitored always outside the plant

Hg cell fans

Peak recordered near Hg cell

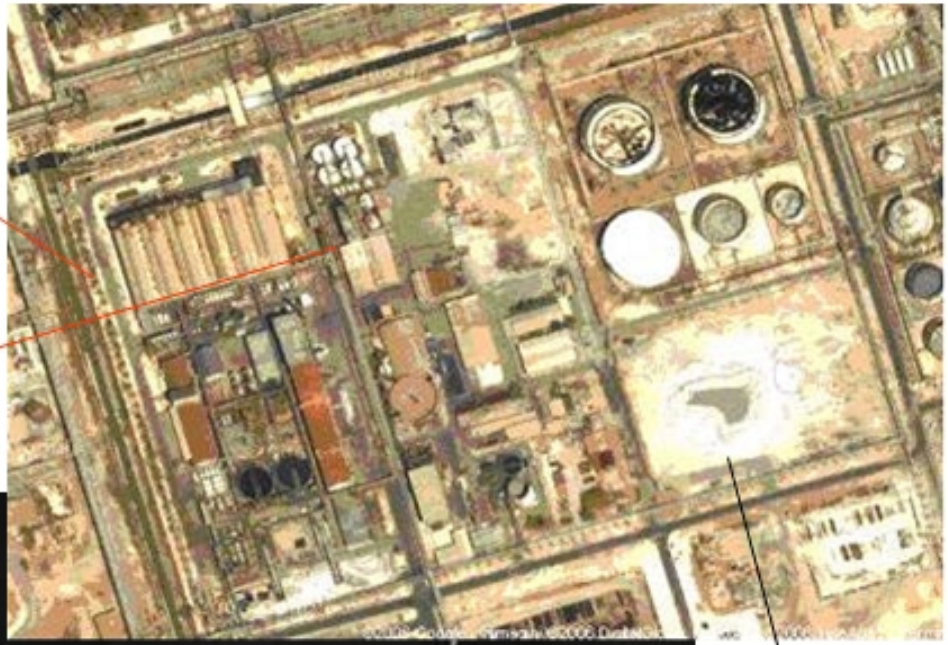
fan at south of the plant: 7.695 ng/m3



Priolo - Syndial

1st hot spot near cells room:
16.885 ng/m3 of Hg

2nd hot spot near Hg storage:
7.231 ng/m3 of Hg



salt storage

ANNOTATED BIBLIOGRAPHY OF MERCURY STUDIES IN ITALY

The bibliography below describes some studies of mercury and other environmental contaminants that have been conducted in and around the areas where the six chlor-alkali plants included in the EEB monitoring study. Also provided is a list of general references regarding mercury contamination.

For more information about these references, please contact Legambiente (www.legambiente.com).

PIEVE VERGONTE

Environmental Science Degree Thesis, Milan University, on the presence of mercury in Lake Maggiore's fish; Official data from ARPA, past years; Analytical data from Swiss laboratory, 2001.

Summary of findings: This group of studies found arsenic, mercury, chlorinated aromatic hydrocarbons, chlorinated pesticides contained in pyrite ashes, chalk, inert waste, mud and natural soil. The heaviest contamination was from Hg and DDT that has been discharged from industries in the area, polluting soil, rivers and the bed of the Lake Maggiore. Some of these findings are contradictory; the ARPA data indicate that mercury is declining, while the Swiss survey finds that mercury is increasing.

TORVISCOSA

Study on the environmental impact of the Caffaro s.p.a. "Plants for the production and the processing of chlorine in the Torviscosa facility".

Summary of findings: The [mercury cell chlor-alkali plant], despite some modifications, continues to have total loss of mercury in air, in water and in the production wastes of about 0.2-0.5 g per tonne of productive capacity per year. The Isonzo river, polluted by effluents from a cinnabar mine in Idrija (Slovenia), has made this situation even worse.

Lagoon sediments analysis by ICRAM (Central Institute for Scientific Research and Technology on the Sea).

Summary of findings: This study looked at the reclamation of the Laguna di Grado e Marano, a designated national site. The mercury concentration in the mud bottom of the Grado lagoon ranged from 5 ppm to 20 ppm, depending on depth, while the Marano lagoon was "only" 1-2 ppm. The study indicates that contamination comes from the Isonzo, Aussa and Corno rivers, which traverse very important industrial areas. Similar concentrations were also found near the mouth of Lovato, Cialisa, Marano, Natissa, Belvedere and Barbarana channels.

Giorgio Matassi, ARPA, publication presented during the Ecotoxicology congress in Torino.

Summary of findings: This presentation described analytical data collected during the past 15 years of monitoring in the lagoon. The data confirm that significant mercury contamination of the sediments has occurred, and mercury has accumulated in the filterer mussels (especially in Tapes type), even over legal

limits, demonstrating that bioaccumulation and mercury methylation continue. The presentation recommended that an epidemiological study is necessary.

Report by Carlo Dapelo, Trieste' Court of Appeal president

Summary of findings: Grado and Marano lagoon containS a lot of methylmercury, and the aquifer under the plant is contaminated. High atmospheric emissions of mercury are caused by the absence of an appropriate air pollution abatement system and improper landfill management.

Ministerial Decree n°468/2001

Summary of findings: Ministerial Decree n°468 (8 sept 2001) declares the Grado and Marano lagoon as a huge sanitary and environmental risk area.

PORTO MARGHERA

Lagoon sediments analysis by ICRAM

Summary of findings: This study looked at the reclamation of the Venice Lagoon, a designated national site. The study points out that polluted sediments are a reserve of contaminants, which can act as possible source of a future release.

Report "Water and water discharged quality in Porto Marghera Area" (Magistrate of the water, 2003 Report).

Summary of findings: Inorganic micro-pollutants are the most serious problem for the water quality, with mercury discharges that have increased from 0.05 t/y in 2000 to 0.4 t/y in 2001 and to 0.06 t/y in 2002.

ROSIGNANO

Prof. Ferrara, Pisa CNR (National Research Centre).

Summary of findings: This study evaluated atmospheric emission from the bay sediments caused by sun irradiation. The study found that in the year 2000, at least 500 t of Hg were located on the bottom layer of Rosignano bay, covering an area from the coast line to 14 km offshore. This mercury in not safely buried or inert; rather, it remains in circulation due to sea storms and the sun's irradiation. It was estimated that each m^2 of the marine surface emits 164 ng of Hg to the atmosphere, during the hottest time of the day.

EPER register

Summary of findings: In 2001 Rosignano Solvay emitted 84 kg of Hg to the air, and 71 kg to the water.

Press release of Ministry of Environment 2003

Summary of findings: Until 1973 the Solvay plant in Rosignano discharged at least 14 tonnes/year of Hg to the sea. At the time, there were no limits on discharging waste to the sea.

No summaries are available for two other studies in the Rosignano area: medical monitoring of Solvay workers who are completing the reclamation activity, and an epidemiological survey on the population and the workers of the Solvay facilities, as requested in 2005 by the Livorno Province Authority, led by the local sanitary public agency ASL.

BUSSI

Diffusion of Mercury from Pescara river mouth (central Adriatic sea), studied by a point source spatial model, 2003 – Mario Giaccio, Department of Science University "G. D'Annunzio" Pescara, Antonella Del Signore, Department of Economy Theory and Quantitative Methods University "G. D'Annunzio" Pescara, Tonio Di Battista.

Summary of findings: This study evaluated the environmental effects of a dam, built at the mouth of the Pescara river. The study measured the mercury content of sediments, mussels and algae. The study found concentrations of mercury of 1.1 ppm, compared to natural average concentrations of 0.03 ppm. The concentration of mercury in mussels was higher than the typical background concentration of 0.5 ppm wet weight.

PRIOLO

Article by Pino Guastella about the results found by the experts of the Siracusa Prosecution Authority about the mercury amount discharged in the sea since '60;

Summary of findings: Siracusa Prosecution Authority estimated that since 1958 till 1980 Montedison (past owner of the facility) discharged in the sea water about 500 tonnes of Hg. Montedison knew clearly that the practice was dangerous.

Fish morphological alteration: bio indicator of heavy metal?", by Maria Nicotra, Animal Biology department, Catania University;

Summary of findings: This study shows the different types of malformations of two species of fishes the *Seriola dumerilii* (pic1 dorsoventral and dorsosacral deformity) and the *Pagellus erythrinus* (pic2 vertebra deformity). The study asserts that these malformations are good bioindicators of mercury damage.

pic 1

pic2

"Marine environment health conditiosn in front of the industrial triangular area Melilli-Priolo-Augusta report", by Maria Nicotra, environmental district ARPA department of Siracusa and Algology laboratory of the Botanic department of Catania University.

Summary of findings: This study found very high metal concentration levels, especially mercury, which was found at 22 times more than the allowable limit near the Syndial plant.

Neonatal deformities in the Augusta Hospital register;

Summary of data: Since 1980 the rate of neonatal deformities in the Augusta Hospital was much higher than the national average and than the WHO typical values. The terrificant rate of malformation was 5.6% in the year 2000.

Editorial by Fabrizio Bianchi, Pisa CNR, n°2 - 2006 of the Epidemiology and Prevention magazine about the congenital malformations and the terminations of pregnancy nearing the Siracusa Province.

Summary of findings: High rates of congenital deformities, nervous systems disturbances, face malformations and miscarriages suggest a link between health problems and the consumption of fish and mussels from Augusta bay. In May 2006, Syndial (the actual owner of the facilities) paid voluntarily compensation for damages to the victim's families.

The experts' investigation for the Siracusa Prosecution Authority on the discharge in the sea of liquid mercury waste, January 2003

Summary of findings: The Siracusa Prosecution Authority conducted an investigation called "Red Sea Operation." By the end of this investigation 17 persons, among them former EniChem (now Syndial) managers, office-workers, director, assistant directors, and even the Province functionary responsible for the management of the toxic waste landfill in the industrial area, were all arrested. The accusation: illegal trafficking of toxic waste, especially wastes containing mercury. For years, mercury was freely discharged in the urban water drain, which reached the sea, or placed in unauthorized landfills, thanks to false certificates.

MONITORING DATA COVERING FOUR SITES

"Monitoring Program of the Coastal Marine Environment" (2001-2003 Environmental Ministry).

Below are mercury contamination data taken at monitoring stations near the six mercury-cell chlor-alkali plants. These data were collected under an Italian national coastal/ marine monitoring program. All data are expressed in mg/kg; the limit for mercury in water is 300mg/kg (DM n°367/2003). The data were taken from five monitoring periods (from left to right): second half of 2001, first half of 2002, second half 2002, first half 2003, and second half 2003. The monitoring stations nearest to the relevant mercury cell chlor-alkali plant are shown with a red circle:

TORVISCOSA

FRIULI VENEZIA GIULIA					
Miramare	**1.365**	**2.443**	**2.476**	**2.460**	**3059**
Baia di Panzano	**3.709**	**7.067**	**7.413**	**6.480**	**6815**
Porto Nogaro	**2.475**	**9.173**	**10.388**	**7.090**	**7172**
Punta Sottile	**444**	**1.054**	**1.088**	**1.100**	**820**

PORTO MARGHERA

VENETO					
Pellestrina-Ca` Roman(Venezia)	**730**	**1.062**	**960**	**920**	**730**
Foce canale di Love (Caorle)	**1.640**	**1.536**	**2.120**	**1.470**	**850**
Foce del Piave (Jesolo)	230	141	**540**	260	210
Porto Caleri (Albarella)	**850**	**823**	**1.200**	**800**	**970**
Porto Lido Nord (Cavallino)	**850**	**1.755**	**960**	**740**	**490**

ROSIGNANO

TOSCANA					
Elba nord (rif.)	**760**	291	176	223	234,2
Antignano	**2.141**	**2.913**	**1.878**	**3.187**	**2333**
Carbonifera	**572**	**1.019**	**498**	**435**	**720,5**
Castagneto	**528**	**457**	205	148	**482,4**
Fiume Morto	**668**	121	35	112	116,2
Foce Ombrone	**713**	**604**	**496**	**627**	**917,3**

PRIOLO

SICILIA					
AMP Cielopi - Aciecastello	*	*	*	*	9,8
Golfo di Augusta Priolo Garg.	*	*	*	*	**369**
Golfo di Gela Seno del Priolo	*	*	*	*	37
AMP Egadi - Isola Maraone	*	*	*	*	4
Golfo di Milazzo S.Fil. Mela	*	*	*	*	4,1
Ragusa- Fiume Irminio	*	*	*	*	18
Golfo Castellammare Trappeto	*	*	*	*	4
Golfo di Palermo Vergine Maria	*	*	*	*	2,4

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Mercury, arsenic, lead and cadmium in fish and shellfish from the Adriatic Sea. D. Jures˘ a* and M. Blanus˘ a Institute for Medical Research and Occupational Health, Mineral Metabolism Unit, PO Box 291, 1001 Zagreb, Croatia. In: *Food Additives and Contaminants,* 2003, Vol. 20, No. 3, 241–246.

Cd, Hg and As concentration in fishes caught in north Adriatic sea. Ghidini, Campanini, Delbono, Science and Food Technology Institute, Parma University.

Fish for human consumption: risk of contamination by mercury. M. M. Storelli and G. O Marcotrigiano, Chemistry Institute, Fac. of Med. Vet., Bari University, Italy. In: *Food Additives and Contaminants* , 2000, Vol. 17, No. 12, 1007± 1011.

Survey of total mercury and methyl mercury levels in edible fish from the Adriatic Sea, M. M. Storelli, R. Giacominelli-Stuffler, A. Storelli, R. D'Addabbo, C. Palermo and G.O. Marcotrignano. *Food Additives and Contaminants*, 2003, Vol. 20, No. 12 pp. 1114–1119.

Project Progress Summary. European Mercury Emission from Chlor-Alkali Plants (EMECAP). June 25, 2004.

DGM (dissolved gaseous mercury) production process in presence and in absence of light in the Mediterranean basin: mercury reducing bacteria rule. Pisa University;

Heavy metal residues in Lophius Boudegassa specimens fished in the Adriatic sea. Storelli M.M., Marcotrigiano G.O. (Dip. Farmaco-Biologico, sez. Chemistry-Biochemistry Fac. Med. Vet. Bari), Giacominelli Stuffer R. (Biochemistry Institute Fac. Med. Vet. Teramo).

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Amniotic fluid as biological indicator of fetal exposure to mercury, Belloni e Ingrao (C.R. Casaccia Enea, Rome, Italy), Giardina (S.Maria delle Croci Hospital Ravenna, Italy), Santaroni (Inran, Rome , Italy).

Reports from tasks for scientific cooperation, Assessment of the dietary exposure to arsenic, cadmium, lead and mercury of the population of the EU Member States - Report of experts participating in Task 3.2.11. March 2004.

EEB PUBLICATION NUMBER 2006/006

EUROPEAN ENVIRONMENTAL BUREAU

PUBLICATIONS 2006

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With RSBP, Pond Conservation **European Environmental NGO Technical Review of the Water Framework Directive Intercalibration Process**

EEB quarterly newsletter: **Metamorphosis** (available online)

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