行政院所屬各機關因公出國人員出國報告書

（出國類別：國際會議）

第 7 屆亞太地區汞監測網年會

服務機關：行政院環境保護署

姓名職稱：王嶽斌副處長、呂澄洋科長、徐宏博技士、林佳慧技士及謝維紋特約環境資訊技術師

派赴國家：菲律賓

出國時間：107 年 9 月 2 日至 8 日

報告日期：107 年 12 月

摘要

為具體落實行政院環境保護署 103 年 4 月份與美國環保署共同成立「國際環境夥伴計畫」，本署、美國環保署與菲律賓環境暨天然資源部三方首次共同合作，於 107 年 9 月 3 日至 7 日在菲律賓馬尼拉辦理「第 7 屆亞太地區汞監測網年會」，本次參與之國家數及人數為歷屆最多，包括美國、菲律賓、日本、印尼、馬來西亞、尼泊爾、斯里蘭卡等共 18 個國家；另首次納入「日本環境省-大氣汞監測研習會」為會前訓練，具擴大監測網規模、促進夥伴國家之經驗交流及強化監測能量等效益，提升我國在國際上之能見度。

本次會議以擴展亞太地區汞監測網為主軸，與夥伴國就區域性汞監測進行成果及技術交流，研商網絡建構、擴展方式及期程。另持續協助亞太地區夥伴國家建立汞濕沈降採樣技術，強化我國與區域內國家之合作關係，並就未來具體之合作方式交換意見。本次菲方特意安排參訪位於呂宋島-克拉克空軍基地由我國協助新設置之汞濕沈降監測站，展示運作成果。

目錄

一、 會議背景及目的

1993 年 6 月 21 日由北美事務協調委員會及美國在台協會簽訂「駐美國台北經濟文化代表處及美國在台協會環境保護技術合作協定台美環境保護技術協定」(簡稱「台美環境保護技術合作協定」)，執行單位分別為我國行政院環境保護署及美國環保署。在該協定之架構下，臺美開始密切合作與交流，成功引進美國先進污染防治技術及環境管理經驗，包括溫室氣體減量、流域管理、廢棄物管理、毒性化學物質管理、風險評估、區域空氣品質監測預報模式、監測設備等，對於我國環境保護管理政策與能力之建構，以及改善環境品質科技之引進，助益良多。鑒於跨境環境污染物科學證據日益明顯及區域貿易活動日趨頻繁，2009 年本署與美國環保署著手研擬合作策略之調整，2010 年宣布我國區域夥伴計畫重點議題，即包含「汞監測」議題。

臺灣與美國雙邊環保合作已逾 20 年，2014 年在美國環保署長麥卡馨（Gina McCarthy）女士見證下，成立國際環境夥伴計畫(International Environmental Partnership, IEP)。藉由與創始夥伴美國環保署合作，協助我國與其他國家發展雙邊及區域性國際合作，共同推動各項國際環保合作，並與世界各國環保官員及專家進行交流。該夥伴計畫不僅為臺灣、美國雙邊環保合作的延續，其願景更超越雙邊合作，期許藉由臺灣的經驗，領導亞洲，乃至全球的環境保護發展。亞太汞監測夥伴（Asia-Pacific Mercury Monitoring Network，APMMN）專案即為執行內容之一。

汞污染為全球關注議題，近年來由於亞太地區經濟快速發展，且大量以燃煤為能源。人為產生的汞污染物，如燃煤發電、垃圾焚化、金屬製造等過程所產生的汞，在大氣中存留期長，又可藉由大氣氣流傳輸進入地表環境，或經由降雨進入水體、魚體，再透過食物網的累積，對魚類、野生動物甚至人體造成毒害，並對環境影響深遠，若轉化為甲基汞更有致癌隱憂，各國遂開始重視大氣汞污染跨境傳輸之監測課題，故聯合國於 2013 年 10 月 9 日在日本熊本市公開簽署關於汞污染防治的全球性公約：「水俣汞公約(Minamata Convention on Mercury)」，正式開始約束汞之排放。

聯合國環境署（UNEP）最新報告(Global Mercury Assessment 2013)顯示東亞及東南亞之汞排放量佔全球總排放量之 48%，可卻缺乏汞監測機制。鑑於汞對環境之嚴重影響，我國自 2007 年建立鹿林山高山背景測站同時，已開始架構大氣汞自動連續監測儀器，由於臺灣位於亞洲氣流系統之下風處，高山背景測站之監測數據極具代表性。透過臺美環保技術合作協助，鹿林山測站目前已分別加入全球大氣汞監測網 (AMNet) 及美國國家大氣沈降監測網 (NADP)，監測技術與世界先進國家同步並獲得認可。2013 年亞太地區大氣汞監測夥伴合作會議上，參與

國家為有必要共同合作監測大氣汞，藉以瞭解其環境濃度分布情形，進而訂定管制策略與控制人為排放量，亞太地區汞監測網(Asia-Pacific Mercury Monitoring Network, APMMN)因而成立。目前臺灣、泰國、越南、印尼、菲律賓及韓國皆定期執行雨水汞採樣，並寄送樣品至中央大學進行分析。

二、 會議過程及內容重點整理

本次會議在我國與美國環保署共同成立之「國際環境夥伴計畫」推動下，本署、美國環保署與菲律賓環境暨天然資源部三方首次共同合作，於 107 年 9 月 3 日至 7 日在菲律賓馬尼拉辦理「第 7 屆亞太地區汞監測網(Asia-Pacific Mercury Monitoring Network, APMMN)年會」，來自美國、菲律賓、日本、印尼、馬來西亞、尼泊爾、斯里蘭卡、泰國、越南、澳大利亞、加拿大、蒙古、韓國及新加坡、斐濟、薩摩亞及南非共計 18 個國家參與，逾 70 位環保部門及學術研究人員出席，另納入「日本環境省-大氣汞監測研習會」為會前訓練，豐富監測網技術內容、促進夥伴國家之經驗交流及強化監測能量。

本次會議主要以擴展亞太地區汞監測網為主軸，就水俣公約及汞污染跨境長程傳輸至東亞區域性之影響進行資訊交流，展示我國與美國環保署共同建構之環境監測技術聯合中心及亞太地區汞監測網全新網頁，並與夥伴國就區域性汞監測進行成果、技術交流及未來監測數據共享方式討論，研商亞太地區汞監測網建構、擴展方式及期程。另持續協助亞太地區夥伴國家建立汞濕沈降採樣分析技術，強化我國與區域內國家之合作關係，並就未來具體之合作方式交換意見。菲方更特意安排參訪位於呂宋島-克拉克空軍基地由我國協助新設置之汞濕沈降監測站，展示運作成果。

相關議程如附件 1，主要行程及內容說明如下：

第 1 天(9 月 3 日)

會前訓練-日本環境省「大氣汞採樣技術培訓課程」-1。內容包含：大氣汞採樣技術介紹，包含原理、操作方法及採樣方式；大氣汞採樣技術實地操作：包含設備組裝、現地採樣、量測及記錄方式及挑選收集物件；大氣汞採樣技術在日本之應用。

第 2 天(9 月 4 日)

會前訓練-日本環境省「大氣汞採樣技術培訓課程」-2。內容包含：大氣汞採樣技術實地操作：使用冷蒸氣原子吸收光譜法(CVAAS)分析大氣汞樣品；大氣汞採樣技術實地操作：包含數據分析及品質管理；大氣汞監測儀器及周邊配備介紹。

第 3 天(9 月 5 日) ~ 第 4 天(9 月 6 日)

進行「第 7 屆亞太地區汞監測網(Asia-Pacific Mercury Monitoring Network, APMMN)年會」開幕致詞，另包含 APMMN 組織介紹、汞污染問題之回顧、演示全新 APMMN 網站、環境監測技術聯合中心執行雨水汞分析報告、各國分享汞監測技術現況、APMMN 規劃擴展方向及監測數據及技術交流討論等議題。

第 5 天(9 月 7 日)

參訪菲律賓環境暨天然資源部位於呂宋島-克拉克空軍基地之空氣品質監測站，展示我國協助汞濕沈降採樣技術建置之運作成果。

三、 參加會議心得及建議

(一)我國、美國環保署與菲律賓環境暨天然資源部三方首次共同合作，於 107 年 9 月 3 日至 7 日在菲律賓馬尼拉辦理「第 7 屆亞太地區汞監測網年會」。

1. 歷來最大規模：本次會議參與之國家數及人數為歷屆最多，共 18 個國家參與，逾 70 位環保部門及學術研究人員出席，包括美國、菲律賓、日本、印尼、馬來西亞、尼泊爾、斯里蘭卡、泰國、越南、澳大利亞、加拿大、蒙古、韓國及新加坡等，並首度邀請斐濟、薩摩亞等太平洋島國與南非參加。

2. 納入夥伴國日本訓練：首次納入「日本環境省-大氣汞監測研習會」為本次年會之會前訓練，具擴大監測網規模、促進夥伴國家之經驗交流及強化監測能量等效益。

3. 展現我國技術協助成果：我國藉由提供汞濕沈降採樣器及相關教育訓練協助夥伴國家進行汞濕沈降技術建置作業，已於 105 年協助泰國、106 年協助越南、菲律賓及 107 年協助斯里蘭卡等國。本次菲方特意安排參訪位於呂宋島-克拉克空軍基地由我國協助新設置之汞濕沈降監測站，展示運作成果。

4. 擴大監測站網：尼泊爾對於加入 APMMN 表達高度興趣，會議後亦來函表達汞監測對該國之重要性，並檢附汞監測位置選點文件等相關資料，欲成為 APMMN 之夥伴國家之一，將持續辦理後續協助建置相關事宜；斯里蘭卡今年底前可執行汞濕沈降監測站之監測作業，並於會中報告時提出有意願於國內共建置 3 處監測點。

5. 環保合作促進交流：王嶽斌副處長、我國駐菲代表處朱曦公使及菲方環資部次長 Jonas L. Leones 於會議開幕當天 3 方另行會談，菲方次長

對我國廢棄物處理及再生能源作法表達高度興趣，並與我方代表處相約另訂時間詳談。

(二)建議事項:

1. 整理本次會議花絮及各國代表發表之簡報內容並徵得其同意後，上傳於「亞太地區汞監測網（APMMN）」網站(http://apmmn.org/)，以廣為周知。

2. 我國與美方規劃擴展 APMMN 期程，並積極輔助東南亞國家建立汞濕沈降技術，為提供後續新加入之夥伴國家所需採樣、分析及訓練等作業，我國持續以專案計畫委託國內產學機構，並評估夥伴國家對汞濕沈降採樣器需求數量、設置汞監測站址及相關技術人員之培訓，協助推動 APMMN。

3. 本署於會議中介紹之被動式大氣汞採樣技術，多個夥伴國家表達欲了解樣器架設與分析方法之意願，本技術今(107)年由加拿大引進回國內，目前為測試階段，待技術成熟後可新增為 APMMN 之專業培訓項目之一。

4. 藉由 APMMN 年會深化交流，可適度展示宣傳本署「汞監測」以外環保技術及成果，促進交流機會，強化雙邊合作。

5. 參考日本環境省作法，邀請產官學偕同參加，建立夥伴國合作關係，促進環保產業設計及輸出。

附件1、 第 7 屆亞太地區汞監測網年會會議議程

Atmospheric mercury monitoring workshop 2018 for establishing a multi-media mercury monitoring network in Asia-Pacific

Workshop Agenda

Day 1 (Monday, 3rd September)

Time	Description	Speaker /Session Moderator
8:00-9:00	Registration	
9:00-10:00	Opening / Self Introduction	Moderator: Mitsuko Yasoshima
10:00-10:30	Presentation ● Mercury Monitoring Method of Ambient Air by Gold Amalgamation Trap ➢ Method Outline ➢ Survey and Sampling	Tatsuya Hattori
10:30-10:45	Break	
10:45-12:30	Experiment ● Sampling Activity of Ambient Air ➢ Setting of the Collection Material (Gold Trap)	Yoshinobu Watanabe
12:30-14:00	Lunch	
14:00-15:00	Presentation ● Mercury Monitoring Method of Ambient Air by Gold Amalgamation Trap ➢ Measurement by AAS ➢ Quality Management ● Atmospheric Mercury Monitoring in Japan by Gold Amalgamation Trap Method	Tatsuya Hattori
15:00-15:30	Break	
15:30-17:00	Experiment ● Sampling Activity of Ambient Air ➢ Picking the collected material ➢ Recording	Yoshinobu Watanabe

Day 2 (Tuesday, 4th September)

Time	Description	Speaker /Session Moderator
9:00-10:30	Experiment ● Measurement of Ambient Air Sample ➢ Measurement by CVAAS	Yoshinobu Watanabe
10:30-10:45	Break	
10:45-12:30	Experiment (cont.) ● Measurement of Ambient Air Sample ➢ Measurement by CVAAS	Yoshinobu Watanabe
12:30-14:00	Lunch	
14:00-15:30	Experiment ● Data Calculation and Analysis ➢ Quality management ● Sampling Activity of Ambient Air ➢ Preparation (Apparatus, Instruments)	Yoshinobu Watanabe
15:30-15.45	Break	
15:45-16:30	Presentation ● Instruments for atmospheric mercury monitoring	Alvin Chua
16:30-17:00	Discussions	Moderator: Mitsuko Yasoshima

7th Annual Asia-Pacific Mercury Monitoring Network Partners Meeting
September 5-7, 2018
Seda Vertis North Hotel – Manila, Philippines

Wednesday - September 5, 2018	
Time	Activity
08:00 – 09:00	**APMMN Registration**
09:00 – 09:45	**Opening Ceremony** Welcome Remarks Metodio U. Turbella, Director, Environmental Management Bureau, Department of Environment and Natural Resources, Philippines Opening Address Mr. Jonas L. Leones, Undersecretary for Policy, Planning, and International Affairs, Department of Environment and Natural Resources, Philippines Special Remarks Mr. Yeuh-Bin Wang, Deputy Director, Taiwan Environmental Protection Administration, Taiwan Mr. James S. Chu, Deputy Representative (Minister), Taipei Economic and Cultural Office in the Philippines, Taiwan Ms. Nicole P. Fox, Chief Environment, Science, Technology and Health Unit, U.S. Embassy Manila Mr. David Schmeltz, Senior Analyst, Office of Atmospheric Programs, U.S. Environmental Protection Agency, USA
09:45 – 10:00	**Group Photo**
10:00 – 10:15	**Coffee Break**
10:15 – 10:35	**Group Introductions & Workshop Overview**, *facilitated by David Schmeltz, U.S. EPA*
10:35 – 12:00	**Session I. Overview of the Mercury Problem**, *chaired by Jean C. Borromeo, Philippines DENR*
10:35 – 10:50	Concerns over Mercury Pollution in Asia *Guey-Rong Sheu, National Central University, Taiwan*
10:50 – 11:05	Mercury Exposure and Health Impacts in the Philippines *Ana Trinidad F. Rivera, Philippines Department of Health*

11:05 – 11:20	Overview of efforts to monitor mercury and other pollutants in the Philippines *Jundy Del Socorro, Philippines DENR*
11:20 – 11:35	Minamata Convention: Perspectives on the Monitoring and Effectiveness Evaluation Plans *Sandy Steffen, Environment and Climate Change Canada* *Mick Saito, Japan Ministry of Environment*
11:35 – 11:50	Why is monitoring for mercury important? *David Gay, National Atmospheric Deposition Program, University of Wisconsin*
11:50 – 12:00	Q & A
12:00 – 13:30	**Lunch**
13:30 – 15:30	**Session II. The Asia Pacific Mercury Monitoring Network**, *chaired by Mark Olson, NADP*
13:30 – 13:50	Overview talk: What is APMMN? How'd we get here? Where are we going? *David Gay, NADP; David Schmeltz, U.S. EPA*
13:50 – 14:00	Demonstration of the new APMMN website *Jack Guen-Murray, U.S. EPA*
14:00 – 14:30	State of the network: mercury central analytical lab and site liaison reports *Guey-Rong Sheu and Da-Wei Lin, National Central University*
14:30 – 15:30	Discussion
15:30 – 15:45	**Break**
15:45 – 16:30	**Session III. APMMN Partner and Stakeholder Updates,** *chaired by David Gay, NADP*
15:45 – 16:00	Vietnam *Nguyen Van Thuy, Vietnam Environment Administration, Center for Environmental Monitoring*
16:00 – 16:15	Thailand *Hathairatana Garivait, Environmental Research and Training Center* *Nittaya Chaisaard, Pollution Control Department*

16:15 – 16:30	Indonesia *Florentinus Binsar Tumind, Ministry of Environment and Forestry* *Herman Hermawan, Research and Development Center of Environmental Laboratory Quality (P3KLL)* *Rina Aprishanty, P3KLL*
16:30	**Day 1 - Wrap-up**
18:30	**Banquet – Hosted by EPA Taiwan**

Thursday - September 6, 2018	
09:00 – 13:00	**Session III APMMN Partner and Stakeholder Updates (continued),** *chaired by David Gay, NADP*
09:00 – 09:15	Sri Lanka *Sujeewa Fernando, Ministry of Environment* *Anurudda Karunarathna, Univ. of Peradeniya*
09:15 – 09:30	Bangladesh *Md Abul Kalam Azad, Department of Environment (Invited)*
09:30 – 09:45	Australia *Tony Morrison, Macquarie University*
09:45 – 10:00	Canada *Sandy Steffen, Environment and Climate Change Canada*
10:00 – 10:15	Fiji *Vincent Vishant Lal, Univ. of the South Pacific*
10:15 – 10:30	Japan *Kohji Marumoto, National Institute of Minamata Disease*
10:30 – 10:45	Korea *Seunghee Han, Gwangju Institute of Science and Technology*
10:45 – 11:00	**Break**

11:00 – 11:15	Malaysia *Norazura Zakaria, Malaysia Meteorological Department*
11:15 – 11:30	Mongolia *Enkhtuul Surenjav, Mongolian Academy of Sciences* *Batbayar Jadamba, National Agency for Meteorology and Environmental Monitoring* *Tumenbayar Bataar, Sans Frontiere*
11:30 – 11:45	Nepal *Safala Shreshtha, Ministry of Forestry and Environment*
11:45 – 12:00	Samoa *Pousui Fiame Leo, Scientific Research Organization of Samoa*
12:00 – 12:15	Guam *Walter Leon Guerrero, Guam Environmental Protection Agency (Invited)*
12:15 – 12:25	**Break (short)**
12:25 – 12:40	South Africa *Lynwill Martin, South African Weather Service*
12:40 – 12:55	Taiwan *Cheng-Young Lyu, Environmental Protection Administration Taiwan*
12:55 – 13:10	United States *Winston Luke, National Oceanic and Atmospheric Administration*
13:10 – 14:45	**Lunch**
14:45 – 15:30	**Session IV APMMN Mercury Wet Deposition Roundtable Discussion**, *chaired by Da-Wei Lin, Site Liaison, NCU; Guey-Rong Sheu, NCU* • Feedback from partners – What's working? What's not working? What are your needs? • What do you need to join? • SOPs – Are changes needed? • Other topics: sample shipping, glassware cleaning • Presentation: Automated continuous methods to measure gaseous elemental mercury (GEM) and speciated mercury *Mark Olson, NADP*
15:30 – 17:00	**Session V Future Network Directions Discussion**, *chaired by David Schmeltz, USEPA; David Gay, NADP* • Network expansion – more cooperators, sampler distribution • Obtaining rain gage information

	• Atmospheric monitoring (e.g., manual methods, passive devices, Tekrans) • Presentation: Mercury passive air sampling *Eric Prestbo, Tekran Research and Development*
17:00	**Day 2 - Wrap-up**
18:30	**Dinner**

Friday - September 7, 2018	
08:00 – 16:30	**"Philippines Day" – Field visit to the Clark Air Base, Angeles Pampanga Urban Monitoring Station** Mercury wet deposition sampling demonstration and training: How is sampling done in APMMN? *Da-Wei Lin, NCU*

附件 2、　發布新聞「臺美合作共同拓展亞太地區汞監測網」及外電報導

臺美合作共同拓展亞太地區汞監測網

提供單位：行政院環境保護署監資處
提供日期：2018.09.05

回上頁 | 列印 | A字體 小 中 大

為具體落實環保署與美國環保署共同成立「國際環境夥伴計畫」，我國、美方與菲律賓環境暨天然資源部三方首次共同合作，於107年9月3日至7日在菲律賓馬尼拉辦理「第7屆亞太地區汞監測網年會」，共來自17個夥伴國家逾70位專家學者參與，包括美國、菲律賓、日本、印尼、馬來西亞、尼泊爾、斯里蘭卡、泰國、越南、澳大利亞、加拿大、蒙古、韓國、薩摩亞、斐濟、新加坡及南非等。

環保署表示，本次為亞太地區汞監測網年會首次納入日方培訓課程，具擴大監測網規模、促進夥伴國家之經驗交流及強化監測能量等效益。此外，我國於去年透過提供汞濕沈降採樣器，協助菲方進行汞濕沈降監測站網建置作業，本次會議菲方安排參訪新設置汞監測站，展示運作初步成果。

環保署指出，會議透過分享我國建構環境監測技術聯合中心及汞監測分析技術之經驗，宣傳我國執行汞監測成果，並配合美國環保署規劃建立亞太地區汞濕沈降監測網，以加強我國與東亞國家汞濕沈降監測合作。藉由提升各與會國家汞監測採樣及分析相關技術，並蒐集區域夥伴對未來環保技術合作協定發展方向之意見與建議，期許我國可由環保技術輸入國轉型成為環保技術輸出國。

附加檔案：

- 1070905新聞照片--年會大合照.jpg

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Regional mercury-monitoring meeting opens in Manila

2018/09/05 19:22:15 A- A A+

Photo courtesy of Taipei Economic and Cultural Office in the Philippines

Manila, Sept. 5 (CNA) The seventh annual partnership meeting of the Asia-Pacific Mercury Monitoring Network (APMMN) opened in Quezon City in the Philippines Wednesday under the joint auspices of Taiwan, the Philippines and the United States.

The three-day event, scheduled to run through Friday, brings together more than 70 experts and scholars in the relevant areas from 18 APMMN partner nations, including the Philippines, Taiwan, the U.S., Japan, Indonesia, Malaysia, Nepal, Sri Lanka, Thailand and Vietnam.

The others are Australia, Canada, Mongolia, South Korea, Samoa, Fiji, Singapore and South Africa.

One of the officials addressing the opening ceremony, Wang Yue-bin (王嶽斌), who is in charge of environmental monitoring and information management at Taiwan's Environmental Protection Administration, told CNA that Taiwan will share its mercury analysis technologies and its experience in building environmental monitoring centers.

Taiwan has the ambition to transform itself from an importer of environmental protection techniques into an exporter of such techniques, Wang said, adding that the APMMN annual meeting will allow Taiwan to collect regional partners' opinions and advice for the future development of environmental protection technique cooperation.

The APMMN is a cooperative effort by various different groups, including environmental ministries and federal government agencies, academic institutions, and scientific research and monitoring organizations, to systematically monitor mercury in air and rainwater throughout the Asia-Pacific region.

(By Emerson Lim and Elizabeth Hsu)
Enditem/J

More News

Beach in Yilan closed after five deaths

21 Taiwanese charged on suspicion of 'human trafficking' in U.S.

Cases of parents abused by children rises to 8,000 per year in Taiwan

Taipower readies 2nd batch of nuclear fuel rods for U.S. return

Stable weather forecast to continue until Saturday

Taiwan Grand Lottery top winning ticket sold in New Taipei

Winning numbers for Tuesday's Taiwan lotteries

附件 3、會議相關照片

圖 1 本署王嶽斌副處長、我國駐菲代表處朱曦公使、菲律賓環資部次長 Jonas L. Leones 與來自 18 個國家來賓合影

圖 2 本署王嶽斌副處長開幕致詞

圖 3 本署王嶽斌副處長、我國駐菲代表處朱曦公使、菲律賓環資部次長 Jonas L. Leones 合影

圖 4 本署、我國駐菲代表處及菲律賓環資部合影

圖 5 美國大氣沈降計畫(NADP)實驗室負責人 David Gay 簡報 APMMN 發展規劃

圖 6 汞監測夥伴會議討論情形

圖 7 於克拉克基地-空氣品質監測站參訪我國協助建置之汞濕沈降採樣點

圖 8 本署與菲律賓、泰國、印尼及馬來西亞專家合影

圖 9 各國專家於克拉克基地合影

圖 10　會前訓練-「日本環境省之大氣汞監測研習會」合照

圖 11　會前訓練-「日本環境省之大氣汞監測研習會」實際組裝採樣器

圖 11　會前訓練-「日本環境省之大氣汞監測研習會」展示分析方式及器材

附件 4、會議討論

Material 1

24 hours continuous sampling for mercury in ambient air by gold amalgamation method

The explanation of

Sampling Method for mercury in ambient air

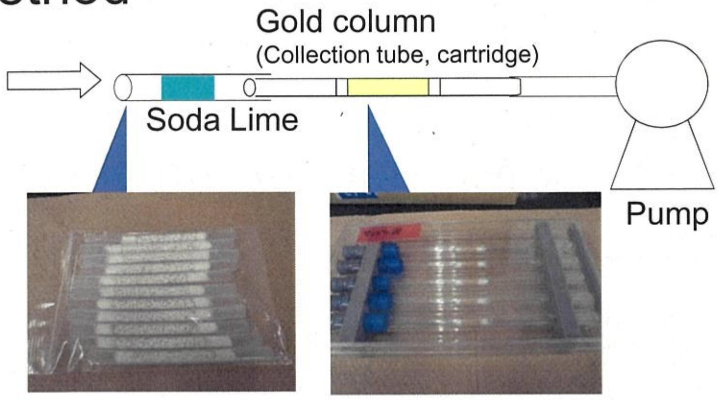
Referred Manual:
An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

Contents

2

Overview of gold amalgamation method



Flow rate : 0.5 L/min.
24 h sampling = 0.5×60×24= 720 L (total sampling valume)

3

Preparation of Gold Column

Baking gold column

With the mercury free gas at a flow rate of 0.2-0.5 L/min, heat the collection tube **at 600-700°C for 5 minutes**. After the heating, the collection tube is cooled under flowing gas and placed in a sealed container to prevent contamination. This procedure is preferably performed immediately before use.

When baking multiple numbers of collection tubes all at once, the blank value should be measured from the same baking lot at a rate of at least 10% or more of the samples with the designated method.

All gold columns before sampling have to be carried out same operation of measuring twice time (Material 2 page 14-15).

They should be checked that they have no mercury or almost zero blank by described above operation.

A gold column can be used **repeatedly** by this procedure.

4

Preparation of Soda Lime tube

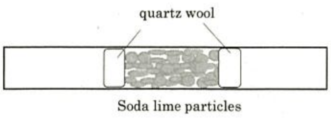


Figure: Example of a soda lime tube
Inner diameter :6 mm (because column outer diameter is 6 mm.)
Weight of filled soda lime : 0.5 – 1 g

As shown in Figure, a several centimeter length **tetrafluoroethylene tube** whose inner diameter fits the outer diameter of the collection tube should be prepared. Soda lime of few grams should be filled in the center of the tube, and both sides should be closed by quartz wool. (The quartz wool should be treated with silane.) The Soda lime tube should be refilled with new soda lime for every sampling.

5

Preparation of another tools

Mini Pump
・ Able to aspirate at 0.5L/min
→0.5 L/min×60 min×24 h = 720L

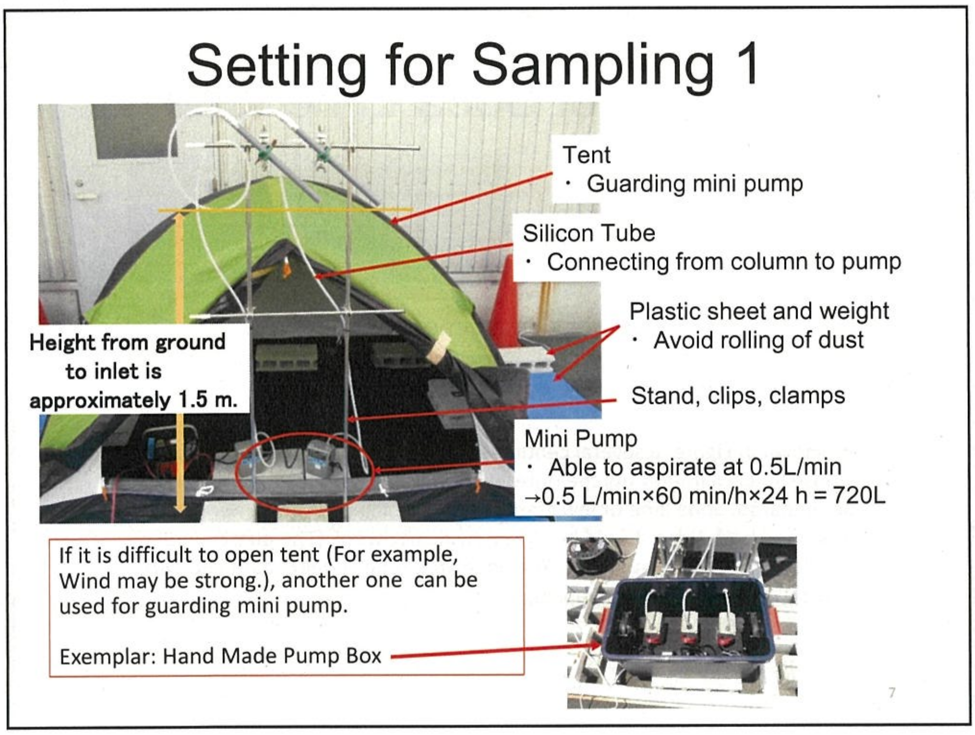
Silicon Tube
i.d. 4 mm o.d. 8 mm Length 2 -2.2 m

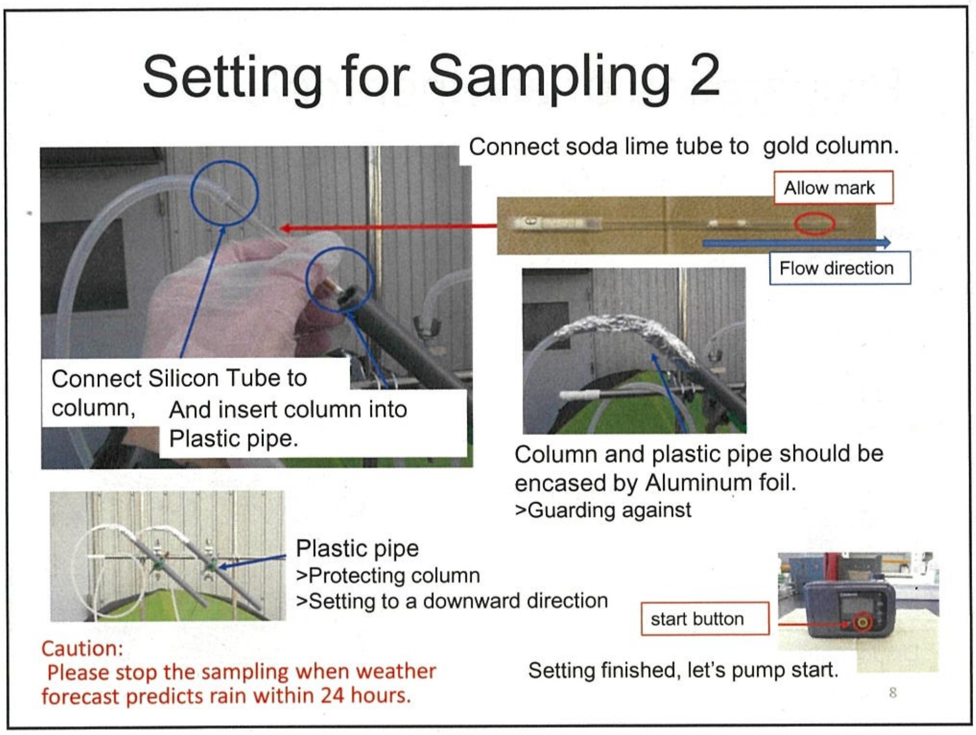
Plastic pipe
i.d. 18 mm Length 30 -33 cm

Potable Temp. and pressure recorder

Others
>Tent, Plastic sheet, Aluminum foil
Disposable gloves

Stand, clips, clamps

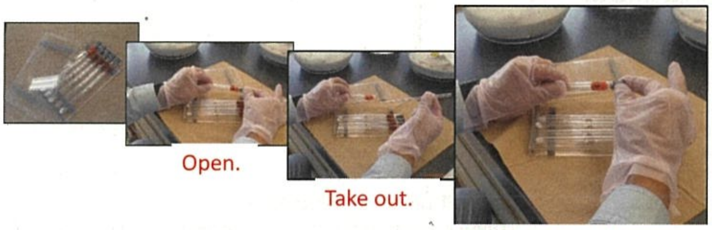

Setting for Sampling 1
Tent
・ Guarding mini pump
Silicon Tube
・ Connecting from column to pump
Plastic sheet and weight
・ Avoid rolling of dust
Stand, clips, clamps
Mini Pump
・ Able to aspirate at 0.5L/min
→0.5 L/min×60 min/h×24 h = 720L
Height from ground to inlet is approximately 1.5 m.
If it is difficult to open tent (For example, Wind may be strong.), another one can be used for guarding mini pump.
Exemplar: Hand Made Pump Box
7


Setting for Sampling 2
Connect soda lime tube to gold column.
Allow mark
Flow direction
Connect Silicon Tube to column,
And insert column into Plastic pipe.
Column and plastic pipe should be encased by Aluminum foil.
>Guarding against
Plastic pipe
>Protecting column
>Setting to a downward direction
start button
Caution:
Please stop the sampling when weather forecast predicts rain within 24 hours.
Setting finished, let's pump start.
8

Travel Blank (TBL) Test
(Quality control)

TBL: The check of **contamination of gold column.**

Except sampling, all procedure has to be carried out. (n=3)
Frequency : approximately 10% of the total number of a set of samples from the same study area



Open.

Take out.

And, bring back to case.

9

Regarding aspiration Pump
(Mini Pump)

It has a performance that it can aspirate at 0.5 mL/min for more than 24 hours continuous

One of example : Sampling Pump MP-Σ300 II N

- Constant Flow Rate setting range : 0.50-3.00 L/min.
- Point Flow Rate range : 0.20-4.50 L/min.
- Integrate flow volume displaying range : 0.0-99999 L

Able to display Point Flow Rate, Integrate flow volume with digital.
Battery : Lithium Ion battery (Battery unit)
or AC Adapter

This is produced by SIBATA SCIENTIFIC TECNOLOGY LTD.
(https://www.sibata.co.jp/english/)

Applied pump will be necessary to run within sampling.
This pump will be able to run 24 houres.
(Catalog spec: Able to run 50h over at 0.5 L/min)

10

Field Note (As one example)

Checkup of progress
(It is not always has to checkup nine times.)

At least, 3 times, it should be better to check the pump running.
>Immediately after start
>before evening
>morning

Field Note

Researcher								
Location								
Condition of Sampling start up	M/D/Y	/ /	Weather		Air temp (°C)		Atmosphere (hpa)	
Condition of sampling end	M/D/Y	/ /	Weather		Air temp (°C)		Atmosphere (hpa)	

Target : **Mercury**

Sampling No. or Name													
Pump No.													
Column No.													
Sodalime No.													
Column position Info. (If necessary)													
No.	Date & Time	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)
0	[illegible]												
1 (start)													
2													
3													
4													
5													
6													
7													
8													
9													
10 (end)													
Total sampling Vol. (L)													
Column No. of Travel Blank		Special instruction:											

This is 1 piece at 1 location.
(There is columns for when sampling multiple gold column at one location. (Max 6 gold columns)

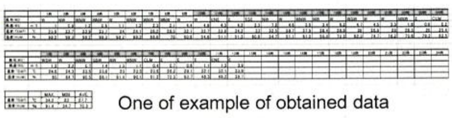
Weather Information

Generically, atmospheric concentration is reported as the correction value of *1 atm* at *20 °C*.

Ambient Temperature and *Pressure* are necessary to calculate the correction value.

1. Measure when stating and ending
2. Obtain from *nearest meteorological stations* or other *appropriate observation stations of hazardous substance*
3. Use *potable measuring instrument*

Calculate *average during the time of sample collection*



One of example of obtained data

One of example of potable measuring instrument TR-73U

This is produced by T&D corporation. (https://www.tandd.com/index.html)

In fact, It is no necessary to correct as far as to use MP-Σ300 IIN, since they show corrected total sampling volume at 1 atm and 20 °C.
Regardless, because weather Information is important, they should be recorded.

Atmospheric mercury monitoring

-Site Classification
-Quality Management
-Monitoring Data in Japan

Tatsuya Hattori
Institute of Environmental Ecology,
IDEA Consultants, Inc.

Site Classification

Classification of Monitoring Site (According to Guideline of Japan)

<table>
<tr><th colspan="2">Classification by point</th></tr>
<tr><td>National standard monitoring point</td><td>Regional special monitoring point</td></tr>
</table>

<table>
<tr><th colspan="3">Classification by attribute of point</th></tr>
<tr><td rowspan="2">General Environment</td><td>Surrounding Area of Stable Emission Source</td><td>Roadside Area</td></tr>
<tr><td colspan="2">“Surrounding Area of Stable Emission Source” and “Roadside Area”</td></tr>
</table>

Atmospheric monitoring sites

- Atmospheric mercury monitoring site in Japan is mainly focused on collecting the national / regional general situation of human residents.
- If there are any suspicious situation that serious health risk is considered (ex. the work environment using mercury such as ASGM), these sites have to be surveyed.
- But on assessment the data, it must not confused the monitoring site focused on general situation with local point that high risk is considered.

Monitoring Period

- To evaluate health risk of general population
  - It is focused on long-term Impact
- Monitoring Period: It should be enough to estimate the annual mean concentration correctly
  - Avoiding the bias of seasonal variation
- Japan: monthly monitoring (or more) is legislated

Another condition (Height and Duration)

- Height of Sampling: 1.5 - 10 m (gaseous substance)
  - Height that people ordinary live
- Sampling duration: 24hours
  - To prevent the bias of diumal variation

Quality Management of Atmospheric Mercury Monitoring

Points to note on atmospheric mercury monitoring by active sampling

- Active sampling by gold amalgamation cartridge
  - On measurement, use all collected mercury in cartridge
    - It cannot be conducted "remeasurement".
- Mercury also exists in general environment
  - In not sealed condition, gold amalgamation cartridge absorbs mercury in surrounding air little by little

Cleaning and Storage of Gold Amalgamation Cartridge

- Gold amalgamation cartridge should be measured at a certain rate and confirmed that they aren't contaminated (Confirmation of blank amount)
- It is recommended that "all" measured cartridge are measured again and confirmed that mercury is not residue in cartridge. If mercury is detected, measure that cartridge again.
- After confirmation of gold amalgamation cartridges, it should be stored in sealed glass tube.
- On same sampling procedure, cartridges they are same confirmation procedure and storage should be used.

Measurement of Standard Gaseous Mercury (Confirmation of Sensitivity)

- At least once on 10 samples, standard gaseous mercury which concentration is around the middle range of calibration curve should be measured.
- Measured concentration of standard mercury should be within ±20% (10% is recommendable).
- If concentration is over ±20%, discards the data of previous measurement and investigate the cause.

Operation Blank

- Stored gold amalgamation cartridge (prepared same procedure with the cartridge used for sampling) is measured. The operation blank should keep the concentration which is not affect the measurement data of samples.

Travel Blank

- 3 or more extra cartridges are carried to sampling(travel blank). These cartridges should open the seal of container among the same duration of sampling. After sampling procedure, the seal is closed and they carried back and measured.
- If the amount of travel blank value is considerable to affect the concentration of samples, and its(3 travel blanks) standard deviation is small, subtract the mean value of travel blank from measured value of samples. If standard deviation is large, survey should redo.

Duplicate (Dual Sampling)

- 10% of samples or more, duplicate sampling should be conducted.
- 2 sampling procedure are conducted simultaneously in same site, and measure both collected samples. If these measured values differs over 30%, data should be discarded and Survey should redo.

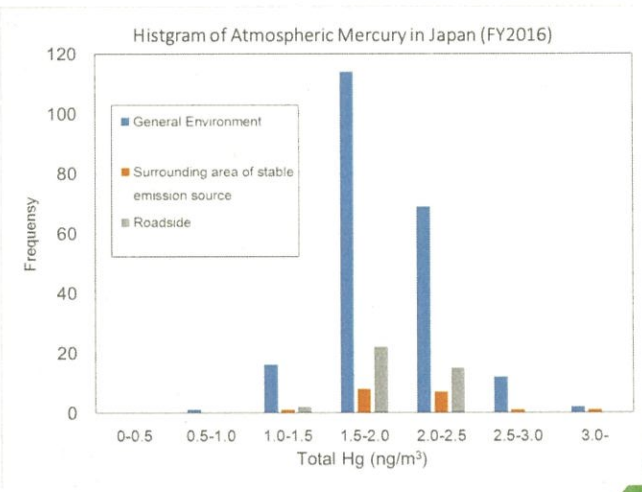
Monitoring data in Japan

Atmospheric Mercury Monitoring Data in Japan (FY1998-FY2016)

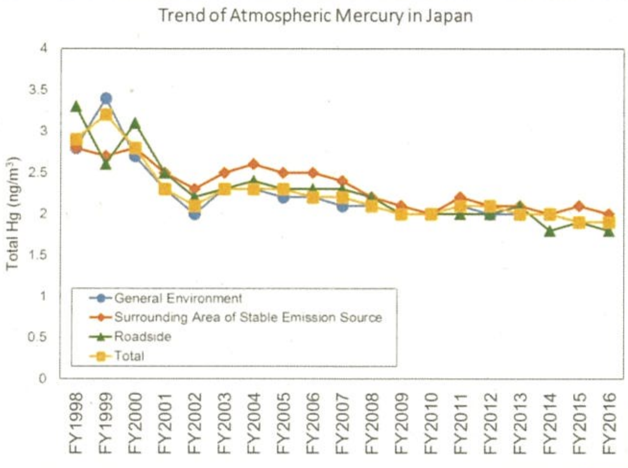
Fiscal Year	General Environment					Surrounding Area of Stable Emission Source					Roadside Area					Total				
	Site	Sample	Mean	Min.	Max.	Site	Sample	Mean	Min.	Max.	Site	Sample	Mean	Min.	Max.	Site	Sample	Mean	Min.	Max.
FY1998	68	816	2.8	0.86	8.6	16	192	2.8	1.2	5.0	10	120	3.3	1.7	6.7	94	1,128	2.9	0.9	8.6
FY1999	127	1,524	3.4	1.1	50	41	492	2.7	1.0	6.4	22	264	2.6	1.6	4.4	190	2,280	3.2	1.0	50
FY2000	155	1,860	2.7	0.14	15	40	480	2.8	1.2	6.3	24	288	3.1	1.0	15	219	2,628	2.8	0.1	15
FY2001	157	1,885	2.3	0.22	4.3	40	480	2.5	1.3	4.1	24	288	2.5	1.7	5.4	221	2,653	2.3	0.2	5.4
FY2002	170	2,040	2.0	0.32	3.8	44	528	2.3	1.2	3.5	30	360	2.2	1.2	5.4	244	2,928	2.1	0.3	5.4
FY2003	177	2,124	2.3	0.17	4.5	46	552	2.5	1.4	5.8	30	360	2.3	1.3	4.1	253	3,036	2.3	0.2	5.8
FY2004	185	2,220	2.3	0.94	3.8	45	540	2.6	1.3	4.6	37	444	2.4	1.5	4.0	267	3,204	2.3	0.9	4.6
FY2005	212	2,544	2.2	0.69	5.0	59	708	2.5	1.3	4.1	49	588	2.3	1.3	3.5	320	3,840	2.3	0.7	5.0
FY2006	200	2,400	2.2	0.73	4.8	57	684	2.5	1.1	4.2	45	540	2.3	1.1	3.5	302	3,624	2.2	0.7	4.8
FY2007	204	2,448	2.1	0.56	4.2	61	732	2.4	0.8	5.2	43	516	2.3	1.0	3.5	308	3,696	2.2	0.6	5.2
FY2008	193	2,316	2.1	0.73	3.8	58	696	2.2	1.5	4.4	42	504	2.2	0.1	8.7	293	3,516	2.1	0.1	8.7
FY2009	193	2,316	2.0	0.98	4.6	62	744	2.1	0.9	3.5	39	468	2.0	1.3	3.5	294	3,528	2.0	0.9	4.6
FY2010	186	2,232	2.0	0.98	4.0	58	696	2.0	0.8	3.3	36	432	2.0	0.9	3.0	280	3,360	2.0	0.8	4.0
FY2011	175	2,100	2.1	0.74	4.6	51	612	2.2	1.0	5.3	35	420	2.0	0.9	3.2	261	3,132	2.1	0.7	5.3
FY2012	183	2,196	2.0	0.82	6.1	51	612	2.1	1.2	3.6	36	432	2.0	1.2	4.0	270	3,240	2.1	0.8	6.1
FY2013	174	2,088	2.0	0.84	5.4	52	624	2.1	1.2	3.7	35	420	2.1	1.2	6.1	261	3,132	2.0	0.8	6.1
FY2014	204	2,448	2.0	0.95	4.9	24	288	2.0	1.0	2.9	32	384	1.8	1.2	2.4	260	3,120	2.0	1.0	4.9
FY2015	202	2,424	1.9	0.91	3.7	21	252	2.1	1.2	3.6	39	468	1.9	1.3	3.3	262	3,144	1.9	0.9	3.7
FY2016	214	2,568	1.9	0.78	12	18	216	2.0	1.4	4.1	39	468	1.8	1.4	2.4	271	3,252	1.9	0.8	12

*Fiscal Year in Japan: April to Next March (ex. FY2016: Apr 2016-Mar 2017)

Distribution of Atmospheric Mercury (FY 2016)



Trend of Atmospheric Mercury in Japan



Thank you for your attention

Tatsuya Hattori: tatsuya@ideacon.co.jp
IDEA Consultants Inc.: http://ideacon.jp/en/

Material 2

24 hours continuous sampling for mercury in ambient air by gold amalgamation method

The explanation of

Thermal Desorption Device

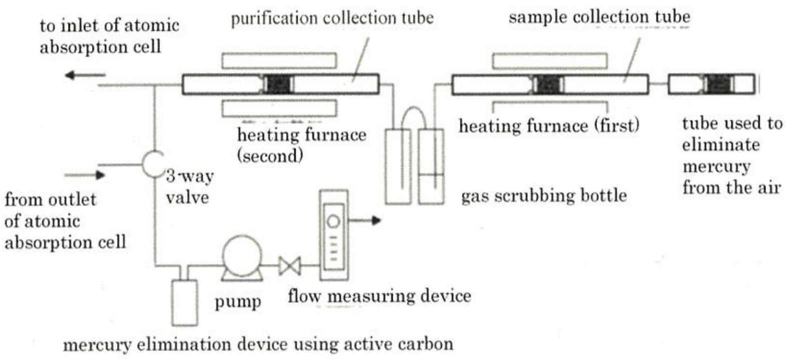
Referred Manual:
An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

Contents

Overview of

Thermal Desorption Device



3

The exemplars of products on the market

Thermal Desorption Device

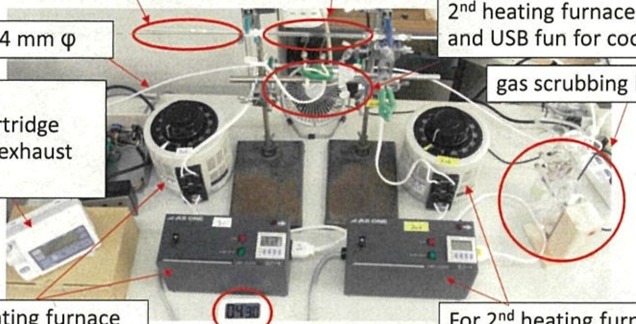
WA-5
The set of Atomic absorption spectrometer and Thermal desorption device

MA3000 (left side) : Atomic absorption spectrometer
RH-MA3 (right side) : Thermal desorption device (option)

All products are produced by Nippon Instruments Corporation (NIC.)
(https://www.hg-nic.biz/)

4

Hand made
Thermal Desorption Device



5

Hand made **Thermal Desorption Device**
Materials and Equipment


Electric transformer
Page 6


Gas scrubber (double)
Page 7


USB fun
Page 8


Timer (Labo Clock)
Page 6


Mini pump (able to aspirate at 300 - 500 mL/min)
Page 10, 13


Union
6mmϕ+6mmϕ
4mmϕ+6mmϕ

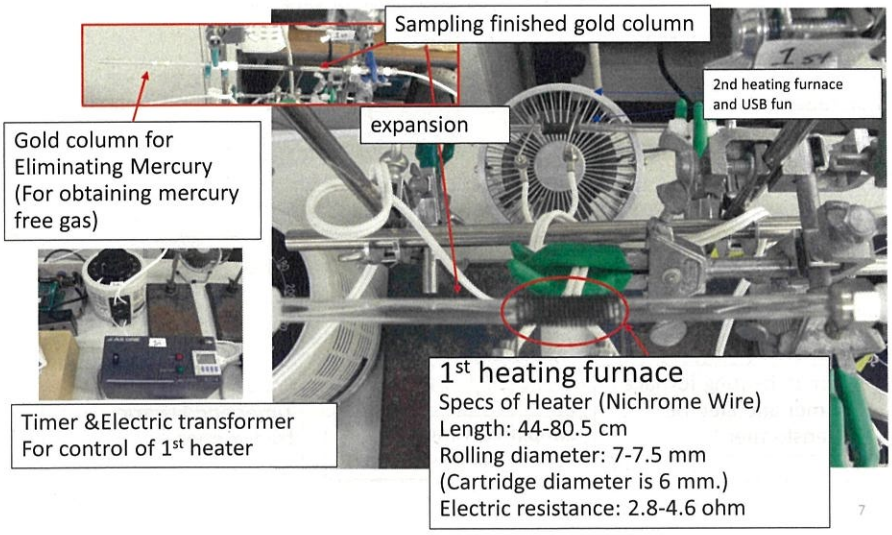

Nichrome Wire
Page 11


Simplified Timer
Page 12

And other desiderata
>Teflon tube (o.d. 4 mm ϕ and 6 mm ϕ)
>Pressure and Chemical resistance tube (For connection Teflon tube)
>Stand and clips

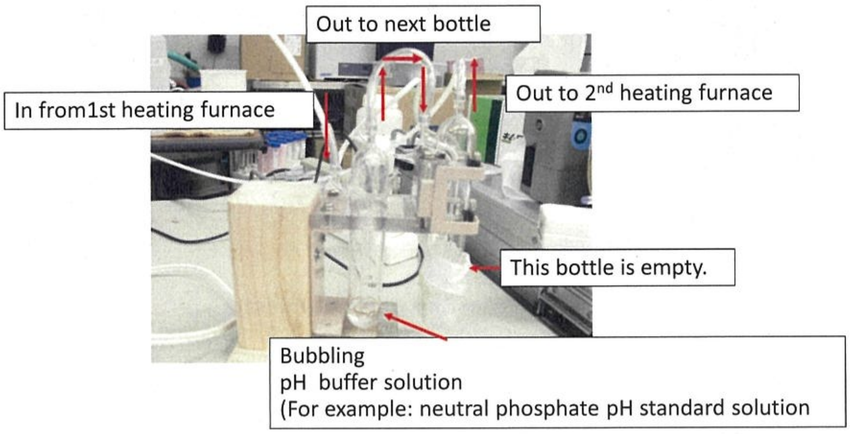
6

Hand made Thermal Desorption Device
Detail 1 : 1st heating furnace



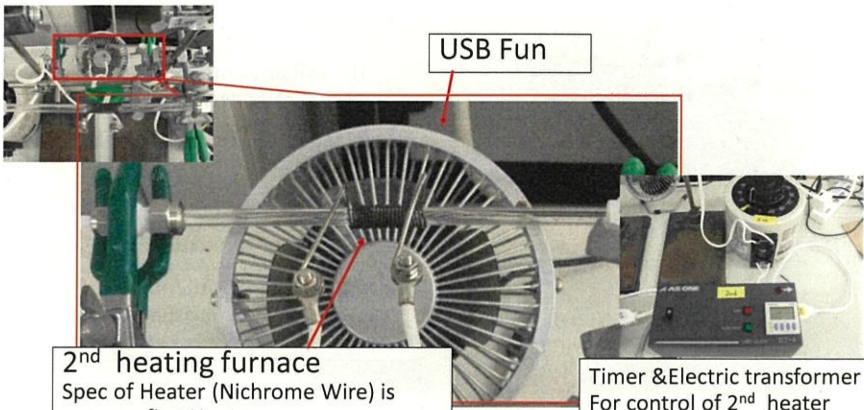
7

Hand made Thermal Desorption Device
Detail 2 : Gas Scrubbing Bottle



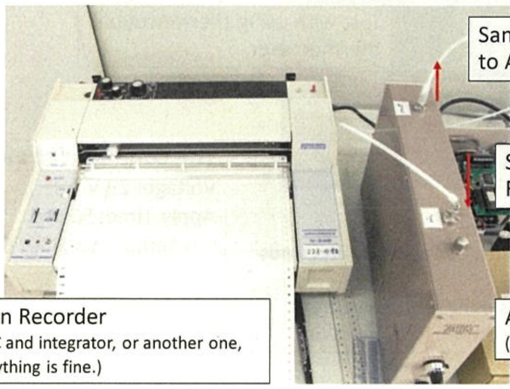
8

Hand made Thermal Desorption Device Detail 3 : 2nd heating furnace



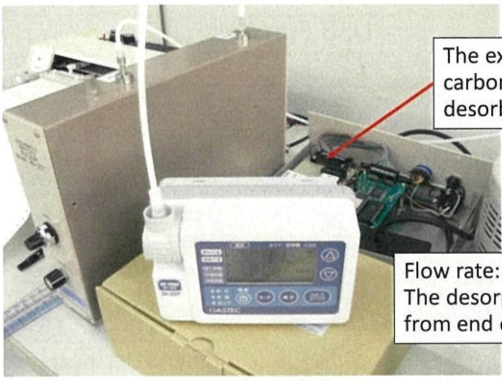
9

Hand made Thermal Desorption Device Detail 4 : Atomic absorption spectrometer and Recorder



10

Hand made Thermal Desorption Device
Detail 5 : Aspiration Pump



The exhaust outlet has active carbon cartridge for eliminating desorbed mercury.

Flow rate: 200 -500 mL/min
The desorption gas is aspirated from end of line.

11

Hand made Thermal Desorption Device
Determinate
Condition of voltage and time to apply voltage

Test with using thermocouple thermometer.

Adjust the voltage and apply time.
Max temperature: 600-700 °C **with taking 40-60 seconds**
Voltage: 15-25 V
These conditions are different as using Nichrome Wire.
Try from small number for being broken Nichrome Wire.

The condition at our Labo
Voltage: 23 V
Apply Time: 50 sec.
→ Temp. max 660 °C

12

Hand made Thermal Desorption Device
Determination of Sequence

1. Set the both Electric transformer.
2. Set the both timer (for transformer).
3. Ste the Simplified Timer at 4min 30 sec.
4. Set the pump at 300 mL/min & 5min.

Total sequence time would be **5 min**. It is suitable.

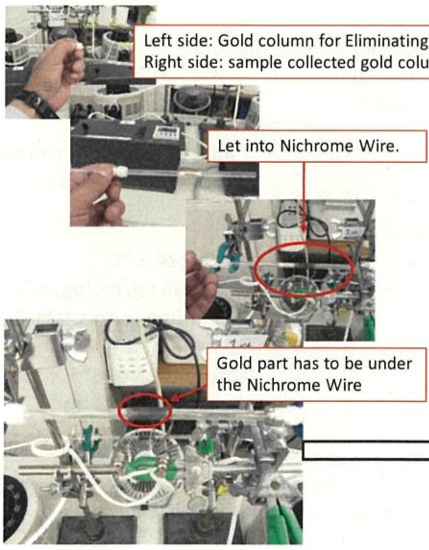
Check the sequence time with using simplified Timer .

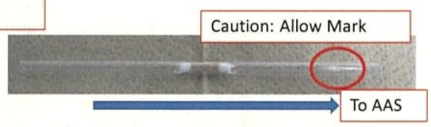
Step	Sequence time	Simplified Timer
5. Confirm stopping USB fun.		
6. Start pump and wait stabile. (It may take about 30 sec.)	0 sec.	
7. Start 1st heating, and start Simplified Timer (Push the start key of 1st timer.)	30 sec.	4 min 30 sec
8. Start 2nd heating . (Push the start key of 2nd timer.)	3 min.	2 min 30 sec
9. Start the USB fun.	4 min.	1 min.
10. Stop the USB fun.	5 min.	0 sec.
11. Change gold column and return to No.5.		

Since purge time is necessary after heating finished, it should be waited about 30 – 60 sec.

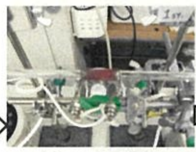
13

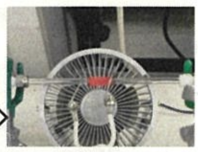
Hand made Thermal Desorption Device
Measurement Procedure 1





1. Connect sample collected gold column.
2. According to decided sequence (page 13), start measurement.

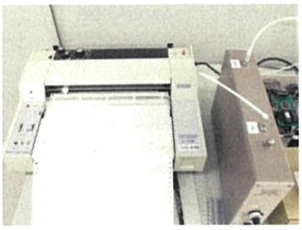

1st Cgold colume heating


2nd gold colume heating

To be continue to next page.

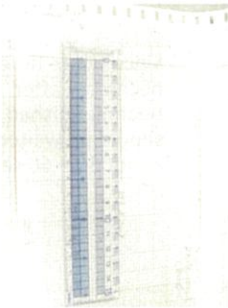
14

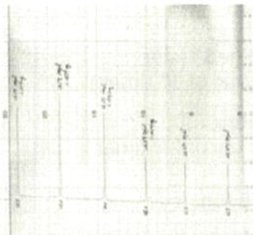
Hand made Thermal Desorption Device Measurement Operation 2



3. Each response would be recorded to pen recorder.

4. Measure peak height, and write it down on cheat.
   Another condition should be recorded.
   >Peak height (mm)
   >Sample name
   >cartridge No.

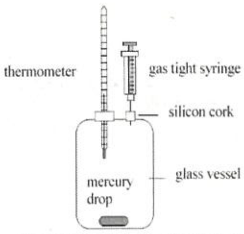




Later on, recorded peak height will be used for calculating concentration.

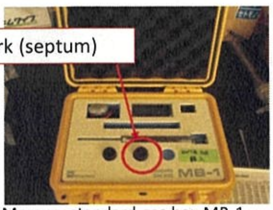
15

Hand made Thermal Desorption Device Regarding Mercury standard 1



Overview of mercury vapor saturated gas preparation device (Mercury (standard) gas box)

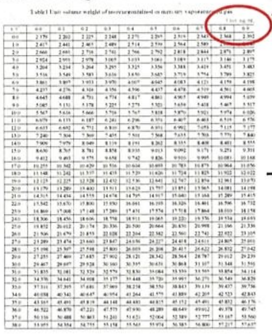
Silicon cork (septum)



Mercury standard gas box MB-1
(produced by Nippon Instruments Corporation (NIC.))

Unit volume weight of mercury contained in mercury vapor saturated gas table

Unit: µg/mL=pg/µL



Injecting amount can be known by this table.

EX.
Temp. :24.2 °C
→18.606 ng/mL(pg/µL)
(According to this table)
Taking Volume: 50µL
Amount=18.606*50/1000
=0.9303 ng

As shown these figures, mercury standard gas can be taken and injected by using this device.

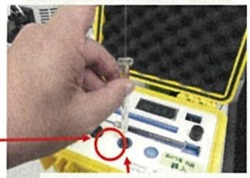
16

Hand made Thermal Desorption Device Regarding Mercury standard 2

How to take mercury gas from gas box

1. Set the pump.
Flow rate: 0.5 L/min.
Timer: 2 min.

2. Set the clean gold column for standard gas.



3. Open the gas box and power on.
Read a shown temp.

4. Take mercury gas by wiped clean gas tight syringe, and after pulling out the syringe, adjust volume.

Silicon cork (septum)

5. Start aspiration.

6. After flow is under 1mL/min., inject to gold column.

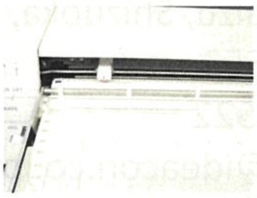
7. Connect the gold column for Eliminating Mercury

To be continue to next page.

17

Hand made Thermal Desorption Device Regarding Mercury standard 3

How to take mercury gas from gas box



8. Set the gold column and measure according to page 14 – 15.

9. Record a condition and result.
>Temp of gas box (°C)
>Injection volume (μL)
>Amount of mercury (ng)
>peak height (mm)

Caution:
Each concentration standard should be measured three times. And on calculation, average should be used.

18

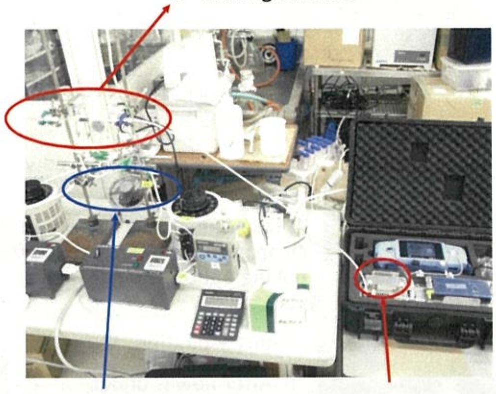
Hand made Thermal Desorption Device With another Equipment

EMP Gold+
Mercury Analyzer

Produced by
Nippon Instruments Corporation (NIC)

Because EMP Gold+ has heating furnace, it can be used as 2nd heating furnace.

1st heating furnace



No necessary to use 2nd heating furnace of this device.

2nd heating furnace

19

Our Address

1334-5 Riemon, Yaizu, Shizuoka, 421-0212, Japan
Tel: +81-54-622-9552
Fax: +81-54-622-9522
E-mail: wyoshino@ideacon.co.jp
tatsuya@ideacon.co.jp

If you couldn't measure sampled columns by yourselves, please inform and send us. We'll measure them and return you results.

20

Material 3

24 hours continuous sampling for mercury in ambient air by gold amalgamation method

The explanation of

QAQC and Calculation

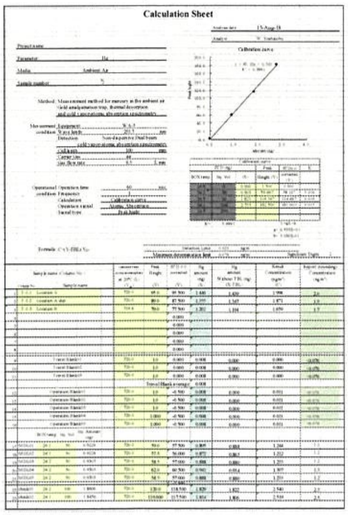
Referred Manual:
An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

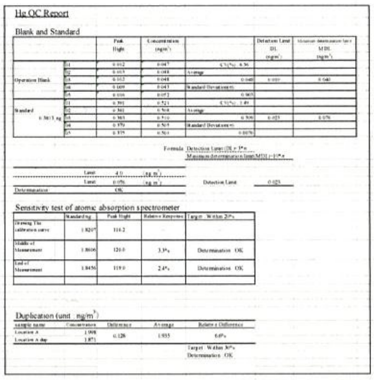
Contents

2

Calculation sheet



Exemplar of Calculation Sheet



Exemplar of QC Reported Sheet

This XLS file is passed out to you.
Exemplar data are input already, so please check formula in cell.

3

ITEMS (1) for QC

The data for drawing calibration curve

Detection limit &
Minimum determination limit

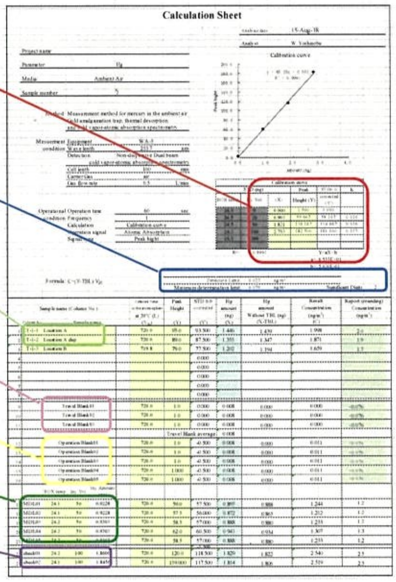
Duplication samples

Travel Blanks 3 times

Operation Blank 5 times

Serial Std. measurement 5 times
For computing detection limit

Check of Sensitivity Fluctuation
(Sensitivity test of atomic absorption spectrometer)



4

ITEMS (2) for QC

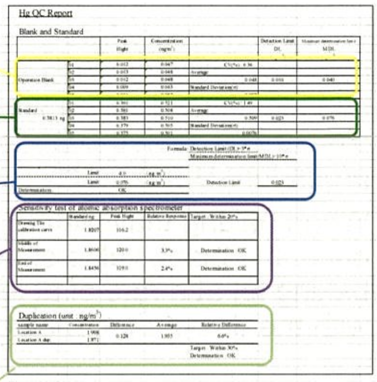
Operation Blank 5 times & Calculation of DL & MDL

Serial Std. measurement 5 times For calculation of detection limit

Detection limit & Minimum determination limit And comparison between Target MDL and calculated MDL

Check of Sensitivity Fluctuation & Comparison between first response and end response

Duplication samples & Comparison of two samples



5

Measurement Sequence (for QC)

Measurement Sequence

No	Range	Sample name
1	Low	Conditioning
2	Low	Conditioning
3	Low	Conditioning
4	Low	STD 0 μL injection
5	Low	STD 0 μL injection
6	Low	STD 0 μL injection
7	Low	STD 50 μL injection
8	Low	STD 50 μL injection
9	Low	STD 50 μL injection
10	Low	STD 100 μL injection
11	Low	STD 100 μL injection
12	Low	STD 100 μL injection
13	Low	STD 150 μL injection
14	Low	STD 150 μL injection
15	Low	STD 150 μL injection
16	Low	MDL01 50μL
17	Low	MDL02 50μL
18	Low	MDL03 50μL
19	Low	MDL04 50μL
20	Low	MDL05 50μL
21	Low	Blank 01
22	Low	Blank 02
23	Low	Blank 03
24	Low	Blank 04
25	Low	Blank 05
26	Low	Travel Blank01
27	Low	Travel Blank02
28	Low	Travel Blank03
29	Low	Sensitivity check01 100μL
30	Low	Location A
31	Low	Location A dup.
32	Low	Location B
33	Low	Sensitivity check02 100μL
34	Low	Conditioning
35	Low	Conditioning

Cleaning of passage

Standards. for drawing a Calibration curve

Standards for Calculation of MDL

Operation Blanks

Travel Blanks

Checking Sensitivity Fluctuation

Samples

Checking Sensitivity Fluctuation

Cleaning of passage

6

QC 0. Baking Gold Column

With the mercury free gas at a flow rate of 0.2-0.5 L/min, heat the collection tube **at 800°C for 5 minutes**. After the heating, the collection tube is cooled under flowing gas and placed in a sealed container to prevent contamination. This procedure is preferably performed immediately before use.

When baking multiple numbers of collection tubes all at once, the blank value should be measured from the same baking lot at a rate of at least 10% or more of the samples with the designated method.

7

QC 1. Calibration curve

At least 4 points or more (Including point 0 ng)

For example： 0, 50, 100, 150μL R^2>0.995

(Refer Graph of page 3.)

Gas box temp. 24 °C
and taking 150μL =Hg amount theoretical value 2.7459 ng

Normal collectable air value is 0.72 m^3.
2.7459 ng/0.72 m^3≒3.814 ng/m^3

We can measure almost concentration in ambient air.

8

QC 2. Detection Limit (DL, LOD) & Minimum determination limit (MDL, LOQ)

Formula : DL (LOD) = 3 σ

MDL (LOQ) = 10 σ

σ : Standard Deviation

1. The sigma (standard deviation) is computed with measurement 5 times serial minimum amount std.

(Refer page 4 green box)

And more, they should be computed with Travel Blanks (pink box) and Operation Blanks (yellow box) .

9

QC 3. Travel Blank & Operation Blank

Travel Blank (Refer Material 1 page 9) :

This procedure must be conducted on more than three samples that are approximately 10% of the total number of a set of samples from the same study area, period, transportation, or distance.

Operation Blank :

This procedure must be conducted on each measurement more than five samples .

10

QC 4. Check of Sensitivity Fluctuation
(Sensitivity test of atomic absorption spectrometer)

The Target of Relative Standard gas is injected into the first collection tube so that the weight is close to the mid-position of the calibration curve and the sensitivity fluctuation is confirmed by carrying out procedure . This confirmation should be done at least once every 10 samples.

The Target of Relative Response : Within 20%

=(1-(Peak height of Drawing The calibration curve)/(Peak height of checking Measurement))*100

Refer the calculation sheet (formula in cell) .

Caution:
Inject amount would be changed according to gas box temp.

11

QC 5. duplication

More than two collection tubes are sampled for the duplicate analysis under the same conditions. The number of samplings for the duplicate analysis is approximately 10% of the total number of a series of samples.

The Target of Relative Duplication : Within 30 %

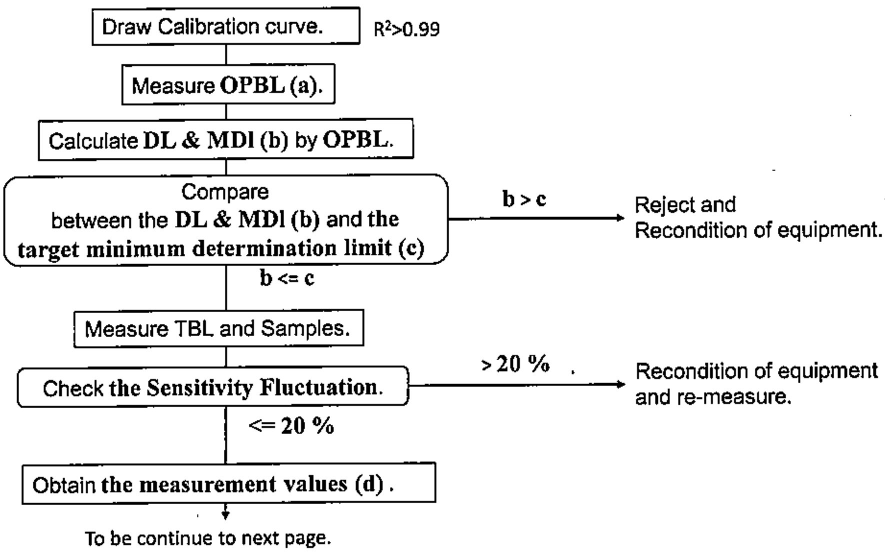
For example,
Location A : X ng/m3
Location A dup. :Y ng/m3

Average = (X+Y)/2

(X-Y)/Average x 100 < **30 %**

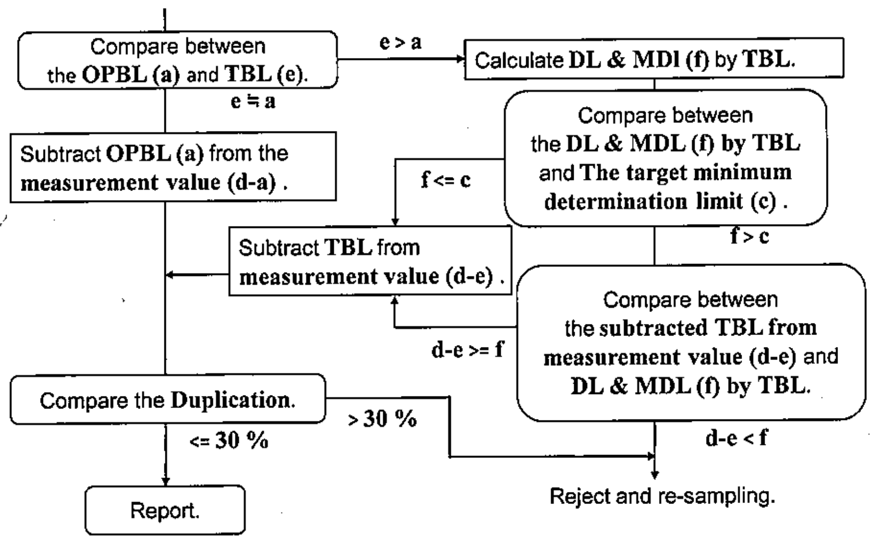
12

Flow chart for QC (1)



13

Flow chart for QC (2)

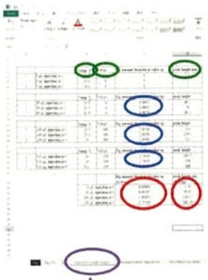


14

Calculation

(How to use Calculation sheet)

Regarding Calibration curve



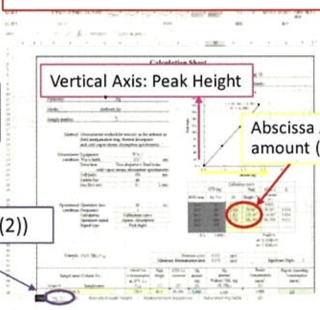
The measured peak height, Temp and taken Vol of gas box are entered.

When entering the Temp and Vol, equivalent Hg amount (ng) will be shown automatically.

The average of Hg amount and peak height will be calculated.

These results will be copied and pasted to Hg (2) sheet

Calculation XLSX sheet (Standard Peak height)



Vertical Axis: Peak Height

Abscissa Axis : Hg amount (ng)

Calculation XLSX sheet (Hg (2))

First off, Hg amount (ng) will be calculated, because abscissa axis is Hg amount.

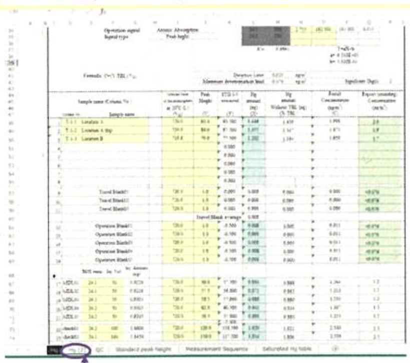
15

Calculation

(How to use Calculation sheet)

Regarding Calibration of concentration

Yellow cells should be filled by yourselves.
> Sample name, column No., Sampling volume, peak height etc...



Calculation XLSX sheet (Hg (2))

$C = (As - At) / (V \times 293 / (273 + t) \times P / 101.3)$

Where

C: mercury concentration in the atmosphere at 20°C (ng/m^3)
As: mercury amount of the sample (ng)
At: travel blank value (ng)
>Operation blank value will be used if it is regarded as being equivalent to the travel blank value.
V: collected volume measured by the flow meter (m^3)
t: average temperature at the time of sample collection (°C)
P: average air pressure at the time of sample collection (kPa)

Regardless, since "sigma 300 IIN" will be shown already corrected volume, it no necessary to correct to 20 °C and 1atm

$C = (As - At) / V_{sigma\ 300IIN}$

Where

C: mercury concentration in the atmosphere at 20°C (ng/m^3)
As: mercury amount of the sample (ng)
At: travel blank amount (ng)
>Operation blank value will be used if it is regarded as being equivalent to the travel blank amount.
$V_{sigma\ 300IIN}$: collected volume showed pump of sigma300IIN (m^3)

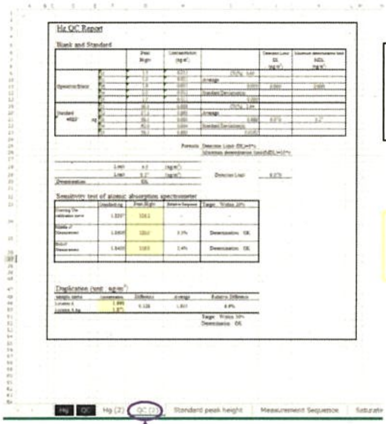
Later on, Let you check the formula in cell by yourselves.

16

Calculation

(How to use Calculation sheet)

Regarding QA/QC sheet



This sheet is referred from sheet Hg (2) sheet. And DL, MDL and other will be calculated automatically, expect Yellow cell.

In yellow cell, applicable date should be copied and pasted from sheet "Hg (2)" .

Calculation XLSX sheet (QC (2))

17

Calculation Sheet

Analysis date	15-Aug-18
Analyst	W. Yoshinobu

Project name:

Parameter: Hg

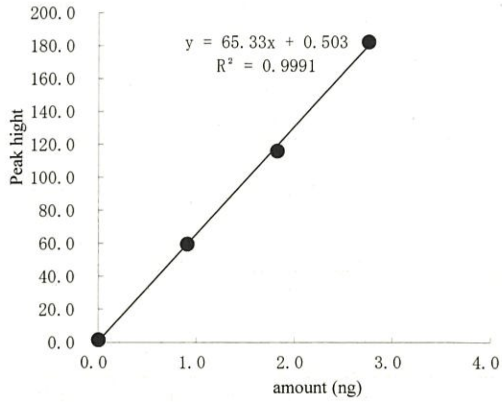
Media: Ambient Air

Sample number: 2

Method: Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption
and cold vapor-atomic absorption spectrometry

Mesuerment condition			
	Equipment	WA-5	
	Wave lenth	253.7	nm
	Detection	Non-dispersive Dual beam cold vapor-atomic absorption spectrometry	
	Cell lenth	100	mm
	Carrier Gas	air	
	Gas flow rate	0.5	L/min

Operational condition			
	Operation time	60	sec
	Frequency	1	
	Calculation	Calibration curve	
	Operation signal	Atomic Absorption	
	Signal type	Peak hight	



Calibration curve					
STD (ng)			Peak	STD0.0	K
BOX temp.	Inj. Vol.	(X)	Height (Y)	corrected (Y')	
24.5	0	0.000	1.500	0.000	
24.5	20	0.903	59.667	58.167	0.016
24.5	50	1.821	116.167	114.667	0.016
24.5	100	2.753	182.500	181.000	0.015
24.5	200				

R^2= 0.9991

Y=aX+b
a= 6.533E+01
b= 5.030E-01

Formula: $C=(Y-TBL)/V_{20}$

Detection Limit	0.079	ng/m³	
Minimum determination limit	0.270	ng/m³	Significant Digits 2

Column No.	Sample name	BOX temp.	Inj. Vol.	Inj. Amount (ng)	Collected Value in the atomosphere at 20°C (L) (V_{20})	Peak Height (Y)	STD 0.0 corrected (Y')	Hg amount (ng) (X)	Hg amount Without TBL (ng) (X-TBL)	Result Concentration (ng/m³) (C)	Report (rounding) Concentration (ng/m³)
1	T-1-1 Location A				720.0	95.0	93.500	1.446	1.439	1.998	2.0
2	T-1-2 Location A dup.				720.0	89.0	87.500	1.355	1.347	1.871	1.9
3	T-1-3 Location B				719.8	79.0	77.500	1.202	1.194	1.659	1.7
4							0.000				
5							0.000				
6							0.000				
7							0.000				
8							0.000				
9	Travel Blank01				720.0	1.0	0.000	0.008	0.000	0.000	<0.27
10	Travel Blank02				720.0	1.0	0.000	0.008	0.000	0.000	<0.27
11	Travel Blank03				720.0	1.0	0.000	0.008	0.000	0.000	<0.27
						Travel Blank average		0.008			
12	Operation Blank01				720.0	1.0	-0.500	0.008	0.000	0.011	<0.27
13	Operation Blank02				720.0	1.0	-0.500	0.008	0.000	0.011	<0.27
14	Operation Blank03				720.0	1.0	-0.500	0.008	0.000	0.011	<0.27
15	Operation Blank04				720.0	1.0	-0.500	0.008	0.000	0.011	<0.27
16	Operation Blank05				720.0	1.0	-0.500	0.008	0.000	0.011	<0.27
17	MDL01	24.1	50	0.9228	720.0	59.0	57.500	0.895	0.888	1.244	1.2
18	MDL02	24.1	50	0.9228	720.0	57.5	56.000	0.872	0.865	1.212	1.2
19	MDL03	24.2	50	0.9303	720.0	58.5	57.000	0.888	0.880	1.233	1.2
20	MDL04	24.2	50	0.9303	720.0	62.0	60.500	0.941	0.934	1.307	1.3
21	MDL05	24.2	50	0.9303	720.0	58.5	57.000	0.888	0.880	1.233	1.2
							-1.500				
22	check01	24.2	100	1.8606	720.0	120.0	118.500	1.829	1.822	2.540	2.5
23	check02	24.1	100	1.8456	720.0	119.0	117.500	1.814	1.806	2.519	2.5

Hg QC Report

Blank and Standard

		Peak Hight	Concemtration (ng/m^3)		Detection Limit DL (ng/m^3)	Minimum determination limit MDL (ng/m^3)
Operation Blank	01	1.0	0.011	CV(%) : 0.00		
	02	1.0	0.011	Average:		
	03	1.0	0.011	0.011	0.000	0.000
	04	1.0	0.011	Standard Deviation(σ):		
	05	1.0	0.011	0.000		
Standard	01	59.0	0.888	CV(%) : 2.94		
	02	57.5	0.865	Average:		
#REF! ng	03	58.5	0.880	0.889	0.079	0.27
	04	62.0	0.934	Standard Deviation(σ):		
	05	58.5	0.880	0.0262		

Formula: Detection Limit (DL)=3*σ
Minimum determination limit(MDL)=10*σ

Limit	4.0	(ng/m^3)
Detemination Limit	0.27	(ng/m^3)
Determination:	OK	

Detection Limit 0.079

Sensitivity test of atomic absorption spectrometer

	Standard ng	Peak Hight	Relative Response	Target : Within 20%
Drawing The calibration curve	1.8207	116.2	—	—
Middle of Measurement	1.8606	120.0	3.3%	Determination : OK
End of Measurement	1.8456	119.0	2.4%	Determination : OK

Duplication (unit : ng/m^3)

sample name	Concentration	Difference	Average	Relative Difference
Location A	1.998	0.128	1.935	6.6%
Location A dup.	1.871			

Target : Within 30%
Determination : OK

(Provisional Translation)

An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water & Air Environment Fields, MOEJ)

Measurement method for mercury in the ambient air

Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

1 Overview of the measurement method

Mercury in the atmosphere is collected at a constant flow rate by using a collection tube (gold column) filled with collection particles. A soda lime tube for removing moisture should be connected to the front of the collection tube. The particles are composed of diatomaceous earth particles with gold baked on their surfaces. Mercury in the atmosphere is collected as gold amalgam. During sampling, the surfaces of the collection particles may adsorb interfering gas and measured values could be compromised. In order to eliminate the influence of interfering gas, re-collect the mercury vapor generated by the collection tube attached to the thermal desorption device in the collection tube that is controlled to maintain the appropriate temperature.

The collection tube used to re-collect mercury is heated at high temperature, and desorbed atomic mercury is led to the absorption detector cell of the atomic absorption spectrometer to determine the quantity of mercury by measuring the atomic absorption at a wavelength of 253.7 nm.

With this method, analysis and collection of gaseous elemental mercury suspended in the ambient air is possible. Measurement accuracy and sampling efficiency of the other chemical forms of mercury is partly uncertain. However, because the majority exists as gaseous elemental mercury, the measured value determined by this method is considered as measured value for mercury concentration in the ambient air.

It is necessary to implement measurement quality control in order to ensure the reliability of the measured value determined by the measurement of mercury as described in this manual.

2 Reagent

(1) Standard material

Elemental mercury: more than 99% purity with assay.

(Note 1) This is used to build Figure 5 "Overview of mercury vapor saturated gas preparation device". However, commercial mercury saturated gas preparation equipment is commercially available.
(Refer page 16-17 in Material 2)

(2) Diatomaceous earth particles

Thermostable diatomaceous earth particles of 500-600 μm in diameter.

(3) Gold chloride acid

Gold chloride (III) acid tetrahydrate $HAuCl_4 \cdot 4H_2O$, CASRN 1303-50-0

(4) Collection particles

Collect 3 g of diatomaceous earth particles in a beaker (50-100 mL). Then, add a solution prepared by dissolving 1 g of gold chloride (III) acid ($HAuCl_4$) to 20-30 mL of water and stir uniformly. After heating to approximately 80°C and drying by occasionally shaking, place the collection particles in a tubular furnace and heat for 30 minutes at about 800°C with air flow.

(Note 2) Item No. (2), (3) are used for preparation of collection particles (4). However, Commercial collection particles or collection tubes filled with these collection particles are readily available, and they are useful and convenience. In this training, commercial product column are used.
(Refer page 3 in Material 1)

(5) Soda lime

Particle size (diameter) : about 1.5 to 3.5 mm

In order to eliminate mercury brank, the soda lime should be heated at 300 ℃ for 12 hours and mercury free dry air should be blown for 12 hours. And then before using sampling, it should be confirmed that the soda lime has no mercury blank.

3 Apparatus and equipment

(1) Sampling device

The sampling device is as shown in Figure 1. A soda lime tube, a collection tube, a flow control device, a pump, and a flow measuring device are connected.

It is desirable to collect samples directly within the collection tube. When, for unavoidable reasons, a conduit is used, use equipment made of clean glass or tetrafluoroethylene and/or material of equal or better property as it is less likely for mercury gas to adhere. Equipment for the sampling device should be washed thoroughly, to avoid contamination. In addition, after assembling the device prior to sampling, it should be confirmed that there are no leaks.

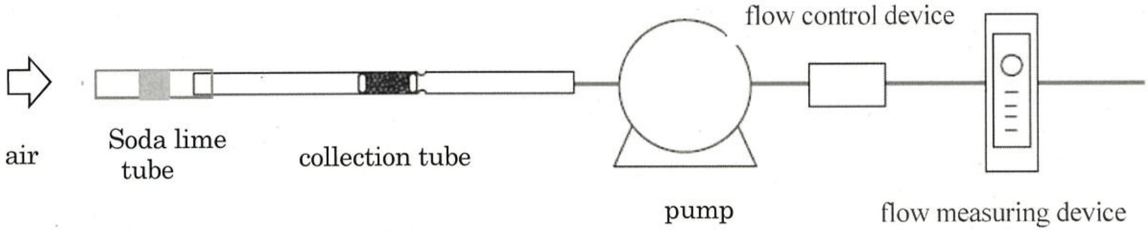


Figure 1 Overview of mercury sampling device

a) Collection tube (gold column)

As illustrated in Figure 2, a quartz glass tube with a circular recess is filled in the order of quartz wool, approximately 80 mg of collection particles, and quartz wool.
(Note 1) Refer page 3 in material 1)

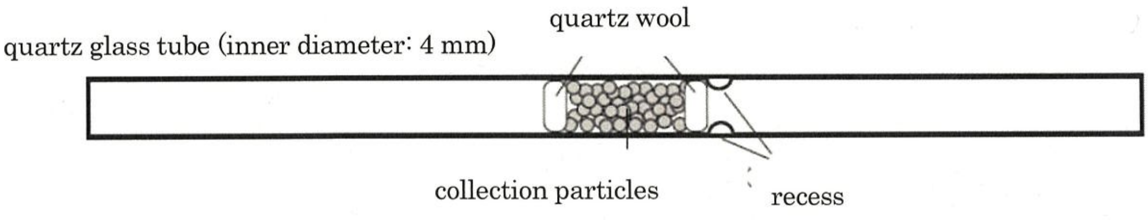


Figure 2 Example of a mercury collection tube

b) Collection tube sealed container

The container should be a glass test tube that can be hermetically sealed and stored free from mercury contamination.

c) Soda Lime tube

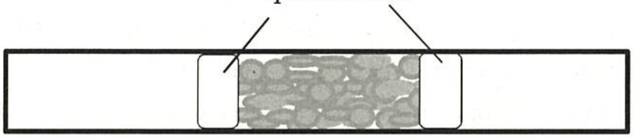


Figure 3 Example of a soda lime tube

As shown in Figure 3, a several centimeter length tetrafluoroethylene tube whose inner diameter fits the outer diameter of the collection tube should be prepared. Soda lime of few grams should be filled in the center of the tube, and both sides should be closed by quartz wool. (The quartz wool should be treated with silane.) The Soda lime tube should be refilled with new soda lime for every sampling.

d) Pump

The sealed pump, such as diaphragm type, should have a controllable gas flow rate within the range of 0.1-1.0 L/min, or be a pump of equivalent or higher performance.

e) Flow control device

The flow control device should have a controllable gas flow rate within the range of 0.1-1.0 L/min, control accuracy within ± 10% of the configuration; or, be a device of equivalent or higher performance.

f) Flow measuring device

The flow measuring device should be able to measure to 3 decimal places of 0.001 L/min with wet gas meter, dry gas meter, float shaped area flow meter, and mass flow meter, and must be operated with high accuracy within the control range of the flow control device. A unit allowing integrated flow rate measurement is desirable, or a unit of equivalent or higher performance.

(Note 3) The pump used in this training (sigma 300IIN) is installed e) flow control device and f) flow measuring device. (Refer page 10 in material 1)

(2) Sample introduction device

a) Thermal desorption device

As illustrated in Figure 4, the used collection tube with the air sample is attached to the thermal desorption device, and the heating furnace (first) is heated to 600-700°C with a flow of mercury free air. After the vaporized gas within the mercury is washed and moisture is eliminated by introducing through a gas scrubbing bottle, the samples are re-collected in a collection tube (refining collection tube) attached to an atomic absorption spectrometer set to 150°C. The gas passed through the collection tube is released to the open air. Under this condition, only mercury is trapped into the collection tube and the adsorption of other interfering gas to the collection particles is suppressed. Thus, interfering substances in the mercury analysis is eliminated.

Next, after the re-collection procedure, the valve is switched to the absorption detector cell side, and the atomic mercury released by a heating of second furnace is led to the absorption detector cell of the atomic absorption spectrophotometer.

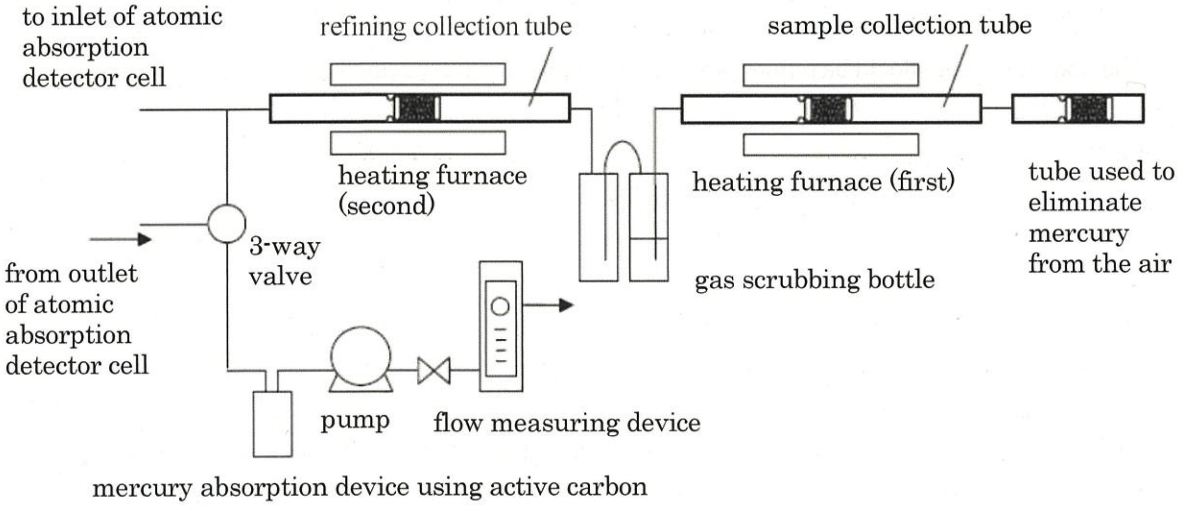


Figure 4 Example of thermal desorption device for mercury analysis

(Note 4) Regarding Gas Scrubbing Bottle: Water is used as washing solution. However, if acidic substance exists within the trapping material and the pH of the washing solution drops, a small amount of mercury may be dissolved into the washing solution. In such a case, it is preferable to use neutral phosphate pH standard solution diluted with water, instead of using water as the washing solution. Use after having confirmed that there is no mercury contamination in the washing solution. (Refer page 8 in material 2)
(Note 5) Regarding this device, refer material 2

(3) Atomic absorption spectrometer

An atomic absorption spectrometer for mercury analysis or an atomic absorption spectrometer is used. This device is composed of a light source unit, an absorption detector cell unit, a wavelength selection unit, and a photometry unit.

a) Light source unit

The light source unit is a low-pressure mercury lamp or a mercurial hollow cathode lamp.

b) Absorption detector cell unit

The absorption detector cell is a plastic or glass tube (that does not absorb mercury) of 100-300 mm length with quartz glass windows at both ends.

c) Wavelength selection unit

The wavelength selection unit for the atomic absorption spectrometer for mercury analysis is normally non-dispersive type. However, a spectrometer with a diffraction grating may also be used.

d) Photometry unit

The detector of the photometry unit is a phototube, a semiconductor detector, or a photomultiplier tube.

(Note 6) The AAS installed in your laboratory may be able to use.

e) Carrier gas

The carrier gas is air, nitrogen, etc. that is mercury free.

(Note 7) In this training, air passed through a gold column and eliminate Hg are used. (Refer material 2)

(4) Mercury standard gas

A mercury vapor saturated gas preparation device as shown in Figure 5 is used. The device should have a structure that can be sealed after putting a few grams of elemental mercury in a glass container with thermal insulation. Also, it must be equipped with a control pressure hole for balancing the pressure within the glass vessel with the external atmospheric pressure (gas tight syringe insertion hole) and a thermometer that can measure the temperature in the glass vessel measurable to 1/10°C. The amount of mercury contained in a unit volume of mercury vapor saturated gas in the preparation device is shown in Table 1.

(Note 8, 1) Commercial mercury saturated gas preparation equipment is commercially available.
(Refer page 16-18 in material 2)

(5) Gas-tight syringe

Capacity of 10 µL - 1 mL.

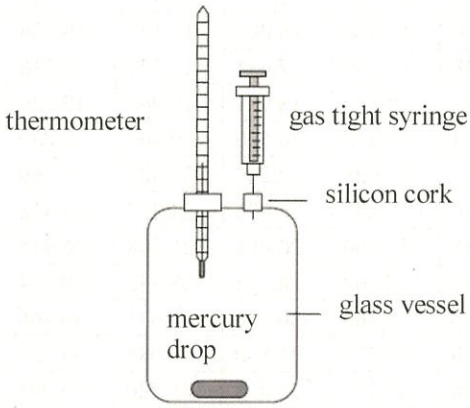


Figure 5 Overview of mercury vapor saturated gas preparation device

Table 1 Unit volume weight of mercury contained in mercury vapor saturated gas

Unit: ng/mL

t °C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0	2.179	2.202	2.225	2.248	2.271	2.295	2.319	2.343	2.368	2.392
1.0	2.417	2.441	2.465	2.489	2.514	2.539	2.564	2.589	2.614	2.640
2.0	2.666	2.691	2.716	2.741	2.766	2.792	2.818	2.844	2.871	2.897
3.0	2.924	2.951	2.978	3.005	3.033	3.061	3.089	3.117	3.146	3.175
4.0	3.204	3.234	3.264	3.295	3.325	3.356	3.388	3.419	3.451	3.483
5.0	3.516	3.549	3.583	3.616	3.650	3.685	3.719	3.754	3.789	3.825
6.0	3.861	3.897	3.933	3.970	4.007	4.045	4.083	4.121	4.159	4.198
7.0	4.237	4.276	4.316	4.356	4.396	4.437	4.478	4.519	4.561	4.603
8.0	4.645	4.688	4.731	4.774	4.817	4.861	4.905	4.949	4.994	5.039
9.0	5.085	5.131	5.178	5.225	5.273	5.321	5.639	5.418	5.467	5.517
10.0	5.567	5.616	5.666	5.716	5.767	5.818	5.870	5.921	5.974	6.026
11.0	6.079	6.133	6.187	6.241	6.296	6.351	6.407	6.463	6.519	6.576
12.0	6.633	6.692	6.751	6.810	6.870	6.931	6.992	7.053	7.115	7.177
13.0	7.240	7.304	7.369	7.435	7.501	7.568	7.635	7.703	7.771	7.840
14.0	7.909	7.979	8.049	8.119	8.191	8.262	8.335	8.408	8.481	8.555
15.0	8.630	8.705	8.781	8.858	8.935	9.013	9.092	9.171	9.251	9.331
16.0	9.412	9.493	9.575	9.658	9.742	9.826	9.910	9.995	10.081	10.168
17.0	10.255	10.342	10.429	10.516	10.604	10.693	10.783	10.873	10.964	11.056
18.0	11.148	11.242	11.337	11.433	11.529	11.626	11.724	11.823	11.922	12.022
19.0	12.123	12.225	12.328	12.432	12.536	12.641	12.747	12.854	12.961	13.070
20.0	13.179	13.289	13.400	13.511	13.623	13.737	13.851	13.965	14.081	14.198
21.0	14.315	14.434	14.553	14.674	14.795	14.917	15.040	15.164	15.289	15.415
22.0	15.542	15.670	15.800	15.930	16.061	16.193	16.326	16.461	16.596	16.732
23.0	16.869	17.008	17.148	17.289	17.431	17.574	17.718	17.864	18.010	18.158
24.0	18.306	18.456	18.606	18.758	18.911	19.065	19.220	19.376	19.534	19.693
25.0	19.852	20.012	20.174	20.336	20.500	20.664	20.830	20.998	21.166	21.336
26.0	21.506	21.679	21.853	22.028	22.204	22.382	22.560	22.741	22.922	23.105
27.0	23.289	23.474	23.660	23.847	24.036	24.227	24.418	24.611	24.805	25.001
28.0	25.198	25.397	25.598	25.800	26.003	26.208	26.415	26.622	26.832	27.042
29.0	27.255	27.469	27.685	27.902	28.121	28.342	28.564	28.787	29.012	29.239
30.0	29.467	29.697	29.928	30.160	30.395	30.631	30.868	31.107	31.348	31.591
31.0	31.835	32.081	32.329	32.579	32.830	33.084	33.339	33.595	33.854	34.114
32.0	34.376	34.641	34.908	35.177	35.448	35.720	35.995	36.271	36.549	36.829
33.0	37.111	37.395	37.681	37.969	38.258	38.550	38.843	39.139	39.437	39.736
34.0	40.038	40.341	40.647	40.954	41.264	41.575	41.889	42.205	42.523	42.843
35.0	43.165	43.491	43.819	44.148	44.481	44.815	45.152	45.491	45.832	46.176
36.0	46.522	46.870	47.221	47.575	47.930	48.289	48.649	49.012	49.378	49.745
37.0	50.116	50.488	50.863	51.241	51.621	52.004	52.389	52.777	53.167	53.560
38.0	53.955	54.354	54.755	55.158	55.565	55.974	56.385	56.800	57.217	57.637

4 Sampling

(1) Baking collection tube

With the mercury free gas at a flow rate of 0.2-0.5 L/min, heat the collection tube at 800°C for 5 minutes. After the heating, the collection tube is cooled under flowing gas and placed in a sealed container to prevent contamination. This procedure is preferably performed immediately before use.

(Note 9) Or be carried out same operation as measurement twice time. And check the response have almost nothing. (Refer page 4 in material 1 and page 7 in material 7)

When baking multiple numbers of collection tubes all at once, the blank value should be measured from the same baking lot at a rate of at least 10% or more of the samples with the designated method. The blank value converted to atmospheric concentration should be below the target minimum determination limit. If the blank value exceeds the target minimum determination limit, all collection tubes of the same lot, including the measured tube, should be re-baked, and the blank value checked again.

(2) Sampling

Take out the collection tube from the sealed container, connect the soda lime tube to the front of the collection tube. And attach the side with dents (circular recess) to the sampling device (as shown in Figure 1). After confirming that there are no leaks in the entire path of the sampling, operate the pump for 24 hours with an aspiration at a flow rate of approximately 0.1-0.5 L/min. (Note 10) Refer page 7 -8 in material 1.

After the sampling is over, seal the collection tube and place it in a sealed container until analysis.

Store the collection tube for the travel blank test in a sealed container, carry it in the same manner as the collection tube for the samples, except for the sampling procedure. In other words, open the plug of the travel blank collection tube during sample preparation (from when the plug of collection tube for sampling is opened until the start of sampling). Seal the collection tube for the travel blank again, and place it besides the collection tube for sampling during the sampling. After the sampling is completed, open the plug and seal it once again together with the collection tube for samplings, and store it until analysis. This travel blank test must be performed whenever contamination is suspected during transportation of the collected samples from the sampling site. Otherwise, it is not necessary to perform this procedure every time as long as it is confirmed that the prevention measures for contamination are carried out. However, in order to ensure the reliability of the sampling, the travel blank test should be thoroughly verified in advance and should be prepared to present the data when necessary. This procedure must be conducted on more than three samples that are approximately 10% of the total number of a set of samples from the same study area, period, transportation, or distance. (Note 11) Refer page 9 in material 1 and page 10 in material 3.

More than two collection tubes are sampled for the duplicate analysis under the same conditions. The number of samplings for the duplicate analysis is approximately 10% of the total number of a series of samples. (Note 12) Refer page 12 in material 3

5 Test procedure

(1) Setting analytical conditions of the sample introduction device, the atomic absorption spectrometer, and adjusting the equipment

Analytical conditions of the sample introduction device and the atomic absorption spectrometer are set following the example shown below.

Sample introduction device

Heating duration:	2 minutes
Carrier gas:	air passing through the mercury collection tube 0.5 L/min
Washing solution:	diluted neutral phosphate pH standard solution (1 + 1)

Atomic absorption spectrometer

Light source:	mercury discharge tube
Wavelength:	253.7 nm
Detection method:	non-dispersive two-beam-type cold atomic absorption method

(2) Sample measurement

The thermal desorption apparatus illustrated in Figure 3 is operated as follows.

Take the collection tube with the sample out from the sealed container and attach it to the first heating furnace. Attach the purification collection tube of exclusive use, of which the blank was sufficiently reduced in advance, to the second heating furnace and keep the temperature of the furnace at 150°C. Switch the three-way valve to suction pump, then, heat the first heating furnace at 600-800°C to vaporize the mercury while the mercury free gas flows at a constant flow rate of 0.2-0.5 L/min and re-collect mercury into the collection tube (as shown in Figure 3, the refining collection tube in the second heating furnace). Next, switch the three-way valve to absorption detector cell, guide the mercury vapor which vaporized by heating at 500-800°C in the second heating furnace to the absorption detector cell. Mercury is measured by an atomic absorption at spectrum analysis wavelength of 253.7 nm and weight of mercury (A_s: ng) is obtained from peak height or peak area based on the calibration curve prepared in advance in (3). (Note 13) Refer page 14-15 in material 2

(3) Creating a calibration curve

Take an appropriate amount of standard gas of mercury (0.1-10 ng of mercury) stepwise using the gas-tight syringe from the mercury vapor saturated gas preparation device, inject the gas into the collection tube of the thermal desorption-atomic absorption spectrometer (the collection tube in the first heating furnace in Figure 3), create a calibration curve based on the relationship between the absorbance obtained in (2) and the amount of mercury injected. The calibration curve is created by 5 or more different mercury injection volumes (including zero). The calibration curve is created just before the measurement.

(Note 14) Refer page 16-18 in material 2

(Note 15) Mercury standard solution can be used. Method for preparing mercury standard solution in this case is as follows.

(1) Mercury diluted solution: take 10 mg of L-cysteine into a volumetric flask (1000 mL), add water and dissolve by shaking, add 2 mL of nitric acid, then, add water to the mark line. Prepare the dilution when it is used.

(2) Mercury standard stock solution (100 μg Hg/mL): take 67.7 mg of mercury chloride (II) (HgCl2) into a volumetric flask (500 mL), dissolve in mercury diluted solution, and add additional mercury diluted solution to the mark line to make a standard stock solution. Store it in a refrigerator.

(3) Standard mercury solution (0.001-0.1 μg Hg/mL): obtain by adjusting the standard stock solution to a predetermined concentration. Dilute with mercury dilution solution when it is used.

(Note 16) If a reducing vaporization device is used, attach the collection tube to the outlet of the reduced vaporizer. The mercury standard solution is reduced, vaporized mercury is collected, and a calibration curve is made. If there is a heating furnace between the first heating furnace and the gas scrubbing bottle as shown in Figure 3, a calibration curve can be also made using a mercury standard solution. The substantial steps are as follows.
Make a standard concentration series of mercury standard solution (0.001- 0.1 μgHg/mL). Inject 100 μL of the solution into the magnetic boat or collection tube. Place it in the first heating furnace. Following procedure 5-(2), make a calibration curve based on the relationship between the mercury injection volume and the absorbance. It should be noted that contamination from the magnetic boat or collection tube should be avoided.
The calibration curve is made for standard concentration series with 4 or more stages, including zero. The calibration curve is made when a measurement is conducted.

(4) Operation blank test

For the blank test use the same baked lot tube as the sample collection tube. The operation blank value is obtained following the procedure (2). (Note 17) Refer page 10 and page 13-14 (Flowchart) in material 3.

(5) Travel blank test

The weight of the mercury is measured by procedure (2) for the collection tube used for the travel blank test described in 4-(2). More than three samples are measured, and the average is considered a travel blank value (A_t: ng). (Note 18) Refer page 10 and page 13-14 (Flowchart) in material 3.

(6) Sensitivity test of atomic absorption spectrometer

Standard gas is injected into the first collection tube so that the weight is close to the mid-position of the calibration curve and the sensitivity fluctuation is confirmed by carrying out procedure (2). This confirmation should be done at least once every 10 samples. When it is confirmed that the sensitivity fluctuation of the device is stable, the frequency of the sensitivity tests may be reduced within this range. However, there are risks in conducting sensitivity tests at longer intervals. Because the relationship between the cause of abnormal values or dual measured values exceeding the standard value and the sensitivity fluctuation cannot be confirmed, all samples in the period may be re-measured or treated as missing values. In addition, when the sensitivity fluctuation exceeds 20%, all samples measured previously should be re-measured. Thus, the frequency of the sensitivity test should be set within a practical range such that re-measurement is possible, taking these risks and sample storability into account. Prior to reducing the frequency of the sensitivity test, it should be discussed sufficiently about the test in order to ensure the reliability so that a drastic sensitivity fluctuation does not occur and that the sensitivity is kept stable during a long temporal interval. Documents or data should be prepared for presentation when necessary.
(Note 19) Refer page 11 and page 13-14 (Flowchart) in material 3.

(7) Duplicate analysis

The mercury amount for collection tubes for the dual measurement described in 4-(2) is measured by the procedure explained in (2). (Note 20) Refer page 12 and page 13-14 (Flowchart) in material 3.

6 Measurement of detection limit and minimum determination limit

Inject the standard gas which is equivalent to the lowest concentration for creating the calibration curve (near the minimum determination limit) into the baked collection tube, and obtain a measured value by conducting procedure 5-(2) (A: ng). Then, value A is substituted to (As – At) of formula (3) to calculate the atmospheric concentration. The detection limit and minimum determination limit of mercury are calculated from the standard deviation (sigma) obtained from measuring results of more than 5 samples, by using formulas (1) and (2). However, if the operation blank value exists, the operation blank value must be measured, and the calculation must be conducted by using a larger standard deviation within those of a standard gas and an operation blank value. (See Note 13)

This measurement should be carried out more than once if analytical conditions of the instruments are configured

Detection limit = 3 sigma (ng/m^3) .... formula (1)

Minimum determination limit = 10 sigma (ng/m^3) .... formula (2)

(Note 21) Refer page 9 and page 13-14 (Flowchart) in material 3.

7 Calculating the atmospheric mercury concentration

The atmospheric mercury concentration is calculated using formula (3) based on the results obtained in 5-(2).

$C = (As - At) / (V \times 293 / (273 + t) \times P / 101.3)$ .... formula (3)

Where

- C: mercury concentration in the atmosphere at 20°C (ng/m^3)
- As: mercury amount of the sample (ng)
- At: travel blank value (ng)
  Operation blank value will be used if it is regarded as being equivalent to the travel blank value.
- V: collected volume measured by the flow meter (m^3)
- t: average temperature at the time of sample collection (°C)
- P: average air pressure at the time of sample collection (kPa)

If a wet-type integrating flow meter is used, relative humidity correction is made after calculating dry gas volume using the average water temperature (°C) of integrating flow meter as "t"

and (P-Pw) as "P". Here, Pw is a saturated water vapor pressure (kPa) at average temperature "t" at the time of the sample collection.

(Note 22) The used pump (sigma 300IIN) in this training will be shown corrected volume at 20°C 1atm. The formula in this case is shown lower.

$C = (As - At) / V_{sigma300IIN}$ .... formula (4)

Where

C: mercury concentration in the atmosphere at 20°C (ng/m3)

As: mercury amount of the sample (ng)

At: travel blank value (ng)

Operation blank value will be used if it is regarded as being equivalent to the travel blank value.

$V_{sigma300IIN}$: collected volume measured by the flow meter (m3)

Concerns over Mercury Pollution in Asia

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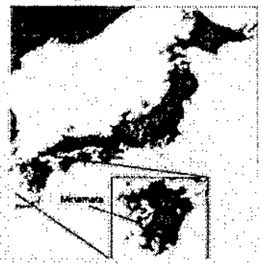
Minamata Disease and Hg Pollution

- Minamata disease, a neurological disease caused by severe Hg poisoning due to consumption of contaminated fish, was first discovered in Minamata, Japan in 1956.
- Hg-containing industrial wastewater discharge was the major Hg source to the fish in Minamata Bay.

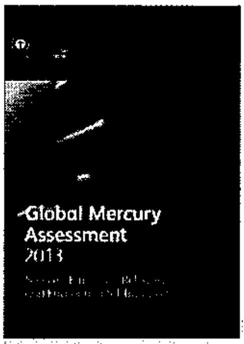


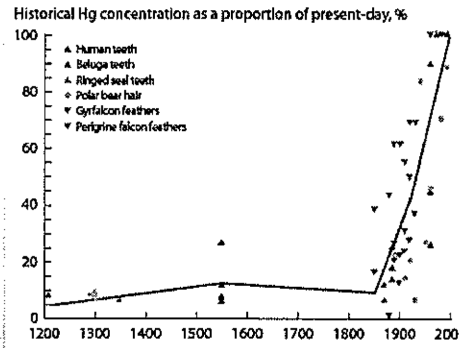
(Time, 2010)

Why Is Mercury Still A Concern?

Global Hg Pollution

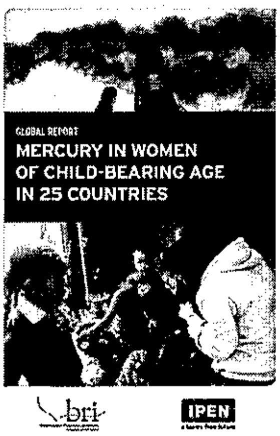
- Mercury is still a pollutant of global concern.





(UNEP, 2013)

Global Hg Pollution

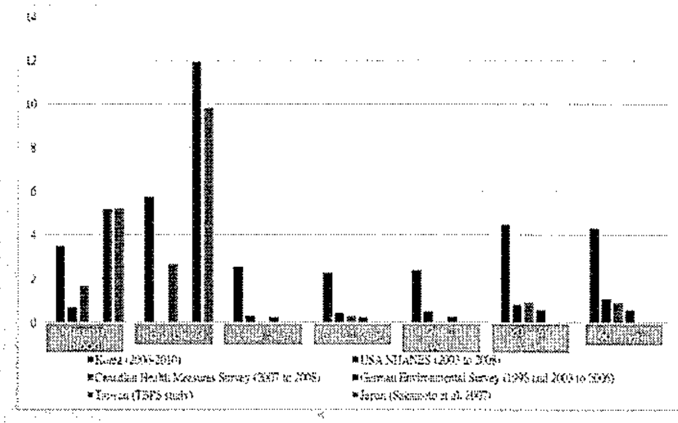


KEY FINDINGS

- 1044 women of child-bearing age from 25 countries participated in the study. 42% of them had mercury levels greater than 1 ppm – the level that approximately corresponds to the US EPA reference dose.* 55% of the women had mercury levels greater than 0.58 ppm mercury, a more recent, science-based threshold based on data indicating harmful effects at lower levels of exposure. Mercury is a health threat to women and the developing fetus.
- Women of the Pacific Islands have elevated mercury levels, likely due to a fish-rich diet. Distant air emissions of mercury from coal-fired power plants, cement kilns and other industries contaminate ocean fish that serve as a primary protein source for Pacific Islanders.
- Artisanal small-scale gold mining results in high mercury body burdens in women from Indonesia, Kenya, and Myanmar. Two likely mercury exposure sources are burning mercury amalgam and eating contaminated fish.
- Industrial mercury emissions contaminate local fish and elevate mercury levels in Thai women living nearby.
- Indigenous women in Alaska have mercury levels of concern due to their subsistence diet of sea mammals and fish. Consumption of seals may be a key source of mercury exposure.
- Women from locations in Albania, Chile, Nepal, Nigeria, Kazakhstan, and Ukraine have mercury levels of concern due to localised pollution of waterways and suspected fish contamination.
- Women using mercury to gold plate statues in Nepal have elevated mercury levels.

*This is the daily exposure that US EPA considers "likely to be without an appreciable risk of deleterious effects during a lifetime."

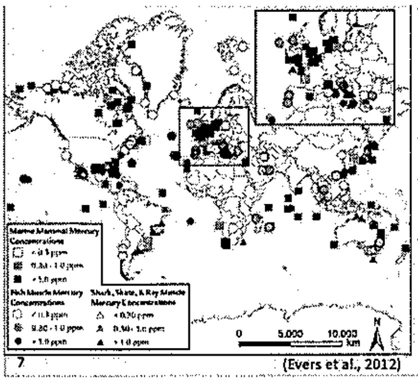
Blood Hg Concentration by Countries



Courtesy of Dr. Eunhee Ha

Global Hg Pollution

- Fish consumption is the major exposure route of Hg to many people worldwide.
- Hg concentrations in fish are elevated globally.

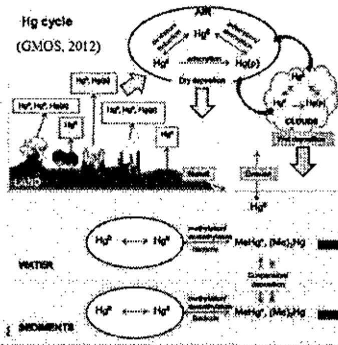


Nation	Standards
International Food Standards (Codex Alimentarius)	Fish: less than 0.5 mg/kg of methyl mercury Carnivorous fish (shark, swordfish, and tuna): less than 1 mg/kg of methyl mercury
US	Fish: less than 1 mg/kg of methyl mercury
EU	Fish: less than 0.5 mg/kg of total mercury Carnivorous fish including shark, less than 1 mg/kg of total mercury
Japan	Seafood (excluding abyssal fish and tuna): less than 0.4 mg/kg of total mercury, less than 0.3 mg/kg of methyl mercury
Australia and New Zealand	Fish: less than 0.5 mg/kg of total mercury Carnivorous fish including shark, less than 1 mg/kg of total mercury
Korea	Seafood (excluding abyssal fish and tuna): less than 0.5 mg/kg of total mercury

(Evers et al., 2012)

Global Hg Pollution

- Atmospheric deposition is the major source of Hg to many aquatic ecosystems.
- Once deposits from atmosphere, inorganic Hg can get methylated by bacteria to form MeHg then bioaccumulates through food chain, resulting in higher concentrations in large long-lived predatory fish.

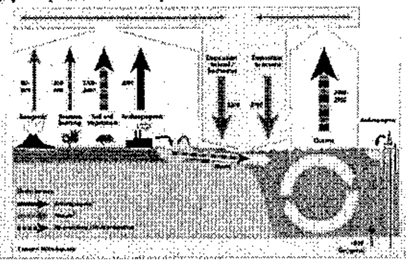




Atmospheric Mercury Cycling

Sources of Atmospheric Hg

- Natural emissions: mercury released from natural weathering of Hg-containing rocks or by geothermal activity. 80-600 Mg yr^{-1} (about 10% of total)
- Anthropogenic emissions: mercury released as a result of current human activities. 1960 Mg yr^{-1} (about 30%)
- Re-emissions: mercury released to the atmosphere that are derived from past natural and anthropogenic releases. 4000-6300 Mg yr^{-1} (about 60%)

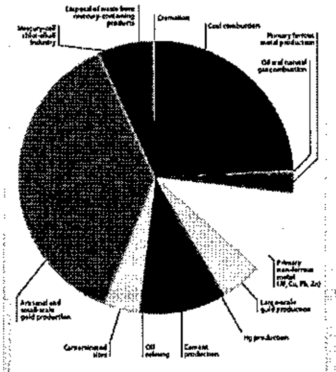


(UNEP, 2013)

Anthropogenic Hg Emissions

- Anthropogenic Hg emission is an important contributor to the Hg in the atmosphere.

Sector	Emission (range), tonnes*	%**
By-product or unintentional emissions		
Fossil fuel burning		
Coal burning (all uses)	474 (304 - 678)	24
Oil and natural gas burning	9.9 (4.5 - 16.3)	1
Mining, smelting, & production of metals		
Primary production of ferrous metals	45.5 (20.5 - 241)	2
Primary production of non-ferrous metals (Al, Cu, Pb, Zn)	193 (82 - 660)	10
Large-scale gold production	97.3 (0.7 - 247)	5
Mine production of mercury	11.7 (4.9 - 17.8)	<1
Cement production	173 (65.5 - 646)	9
Oil refining	16 (7.5 - 26.4)	1
Contaminated sites	82.5 (70 - 95)	4
Intentional uses		
Artisanal and small-scale gold mining	727 (410 - 1040)	37
Chlor-alkali industry	28.4 (10.2 - 54.7)	1
Consumer product waste	95.6 (23.7 - 330)	5
Cremation (dental amalgam)	3.6 (0.9 - 11.9)	<1
Grand Total	1960 (1010 - 4070)	100

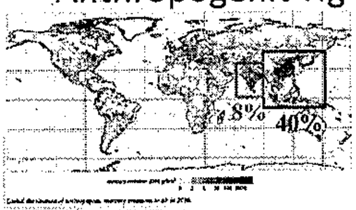


Relative contributions to estimated emissions to air from anthropogenic sources in 2010.

(UNEP, 2013)

Concerns in Asia

Anthropogenic Hg Emissions in 2010



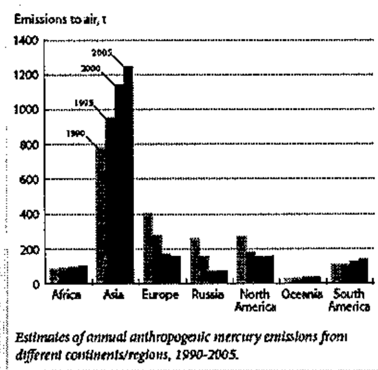
Region*	Emission (range), tonnes**	%
Australia, New Zealand & Oceania	22.3 (5.4 - 52.7)	1.1
Central America and the Caribbean	47.2 (19.7 - 97.4)	2.4
CIS & other European countries	115 (42.6 - 289)	5.9
East and Southeast Asia	777 (395 - 1690)	39.7
European Union (EU27)	87.5 (44.5 - 226)	4.5
Middle Eastern States	37.0 (16.1 - 106)	1.9
North Africa	13.6 (4.8 - 41.2)	0.7
North America	60.7 (34.3 - 139)	3.1
South America	245 (128 - 465)	12.5
South Asia	154 (78.2 - 358)	7.9
Sub-Saharan Africa	316 (168 - 514)	16.1
Undefined (global total for emissions from contaminated sites)	82.5 (70.0 - 95.0)	4.2
Grand Total	1960 (1010 - 4070)	100

Country	Emission (tonnes)
Bangladesh	1.4
Cambodia	3.9
China	575.2
India	144.7
Indonesia	78.2
Japan	17.2
Korea	7.1
Laos	1.3
Malaysia	6.1
Mongolia	6.9
Philippines	33.1
Singapore	0.9
Sri Lanka	0.6
Taiwan	5.5
Thailand	14.9
Vietnam	11.6

(UNEP, 2013)

Trends in Anthropogenic Hg Emissions

- Anthropogenic Hg emissions from Europe and North America are declining, whereas emissions from Asia are increasing.



Estimates of annual anthropogenic mercury emissions from different continents/regions, 1990-2005.

(UNEP, 2013)

Projections of Global Hg Emissions in 2050

- It is likely that Hg emission will increase in the future. The main driving force is the expansion of coal-burning electricity generation, especially in Asia.

Projections of Global Mercury Emissions in 2050

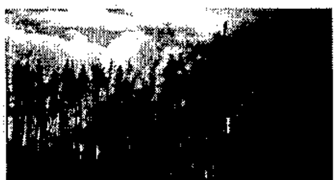
DAVID G. STREETS,*,† QIANG ZHANG,† AND YE WU‡

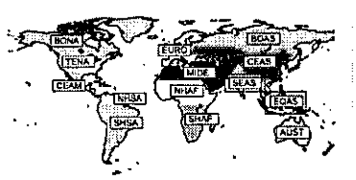
TABLE 4. Mercury Emissions in 2050 by Scenario and World Region (Mg/yr)

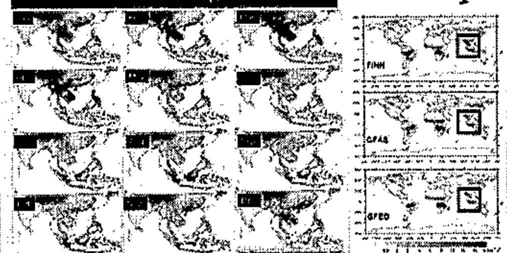
scenario	North America	Central and South America	Africa	Europe, Russia, Middle East	Asia and Oceania	world
2050 A1B	225.9	473.6	509.6	676.5	2970.0	4855.6
2050 A2	239.1	415.6	375.5	667.3	2208.5	3905.9
2050 B1	121.9	340.4	357.0	358.1	1208.9	2386.2
2050 B2	131.3	331.2	308.1	398.0	1461.4	2629.9

(Streets et al., 2009)

Biomass Burning Hg Emissions







regions	Hg emissions Mg Hg/year mean	SD
BONA	22	16
TENA	8	3
CEAM	22	25
NHSA	13	10
SHSA	95	39
EURO	2	1
MIDE	0	0
NHAF	83	13
SHAF	58	7
BOAS	99	83
CEAS	7	2
SEAS	57	35
EQAS	192	216
AUST	19	9
global	675	240
boreal[b]	121	85
temperate[c]	9	3
ROW[f]	545	224

SEAS + EQAS = 249 Mg Hg/year = 37% of global biomass burning emission

Distribution of Atmospheric Hg Concentrations and Deposition Fluxes: Modeling Results

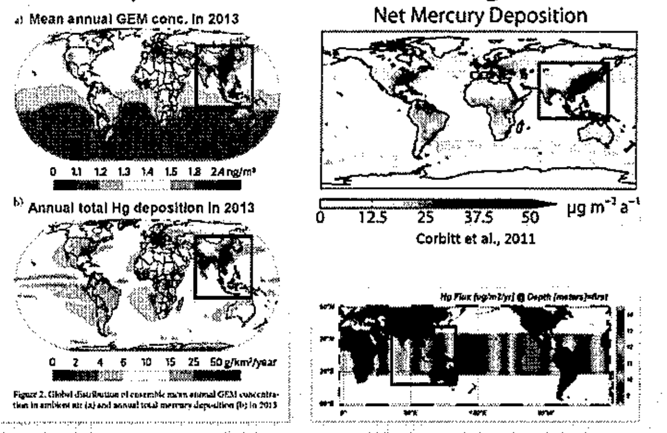
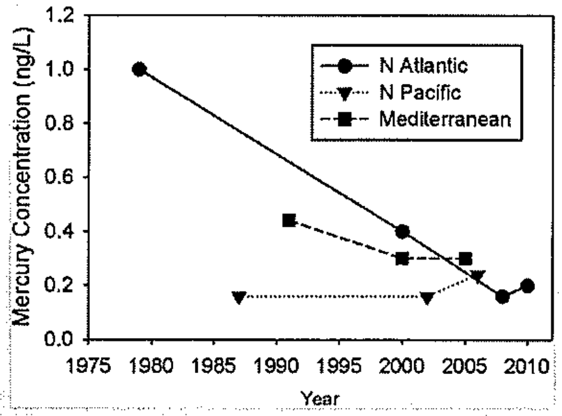


Figure 2. Global distribution of ensemble mean annual GEM concentration in ambient air (a) and annual total mercury deposition (b) in 2013

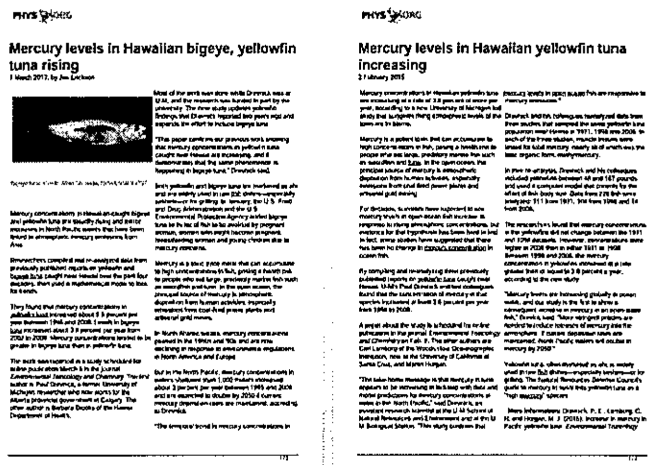
AMAP/UNEP, 2015 Costa et al., 2012

Trend in SW Hg Conc. in Surface Oceans



(Driscoll et al., 2013)

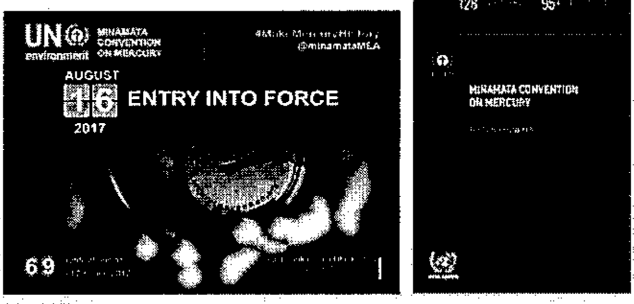
Rising Hg Levels in the Pacific Tuna



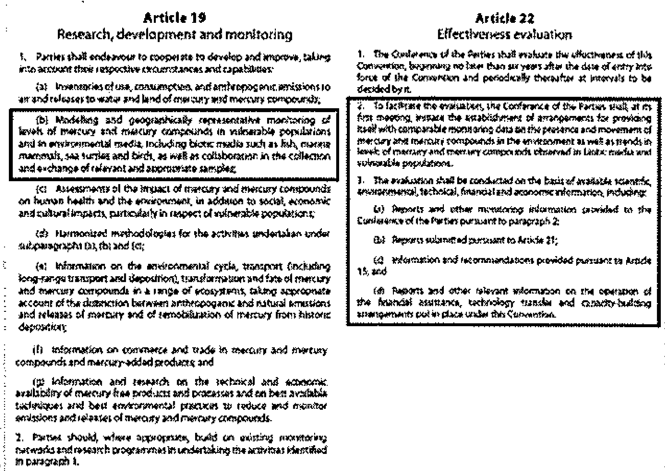
International Actions

Minamata Convention on Mercury

- The Minamata Convention on Mercury was opened for signature by governments at a Diplomatic Conference on October 9-11, 2013 in Japan.
- Minamata Convention on Mercury entered into force on August 16, 2017.



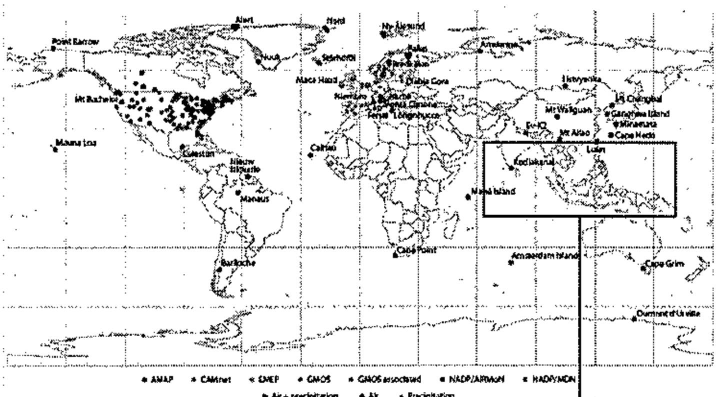
Minamata Convention on Mercury



Article 19
Research, development and monitoring

Article 22
Effectiveness evaluation

Atmospheric Hg Monitoring Worldwide



Currently, long-term or background atmospheric Hg monitoring activities in SE and S Asia are still lacking.

Asia Pacific Mercury Monitoring Network

Asia Pacific Mercury Monitoring Network

Systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region

THANK YOU!

Contact:
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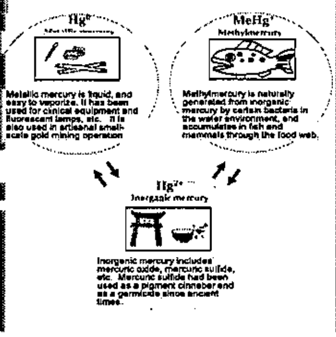
MERCURY AND HEALTH

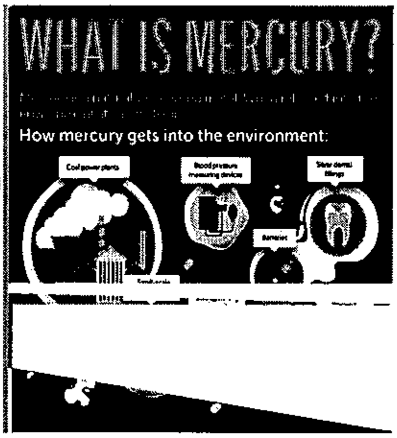
Engr. Ana Trinidad F. Rivera, MSc
Director IV
Center for Cosmetic Regulation and Research
Food and Drug Administration
Philippines

MERCURY AND USES

WHAT IS 'MERCURY' ?

Mercury has been widely used in our life. Mercury is roughly divided into three chemical forms: metallic mercury, inorganic mercury, and organic mercury (R-Hg+). Methylmercury (MeHg) is considered to be an exclusive organic mercury generated in the natural environment. The three chemical forms are inter-converted in the natural environment.





HG IN THE ENVIRONMENT

REFERENCE FOR HAIR MERCURY CONCENTRATION

1 ppm mercury means that 0.001 g mercury is contained in 1,000 g (1/1,000,000).

50 ppm: No neurological adverse effect has been found among adults below this level (WHO,1976; 1990)

14 ppm: The concentration in maternal hair reflects methylmercury exposures that would have no appreciable adverse effect on the offspring in two study populations of Faroes Islands and Seychelles (JECFA, 2004)

5 ppm: A former safe exposure level of methylmercury for adults (3.3 µg/kg/week) (WHO, 1973)

2.8 ppm: Provisional tolerable weekly intake level of methylmercury in Japan (2.0 µg/kg/week) (JECFA, 2004) **

2.6 ppm: Mean level of males in Japan*

2.2 ppm: Provisional tolerable weekly intake level of methylmercury (1.6 µg/kg/week) (JECFA, 2004) ***

1.6 ppm: Mean level of females in Japan*

1.0 ppm: Reference Dose level of methylmercury (0.1 µg/kg/day) without an appreciable risk of deleterious effects during a lifetime (US-EPA, 2001) ****

* Multi-site survey in Japan (NIMD, 2000-2004)

** The domestic provisional tolerable weekly intake (PTWI) is 2.0 µg/kg body weight/week, and was derived from the non-observable-adverse-effect (NOAEL) benchmark dose (BMDL) level, 11 ppm in maternal hair on the fetus development and uncertainty factor 4 (Food Safety Committee of Japan, 2005)

*** The provisional tolerable weekly intake (PTWI) is 1.6 µg/kg body weight/week, and was derived from the non-observable-adverse-effect (NOAEL) benchmark dose (BMDL) level, 14 ppm in maternal hair on the fetus development and uncertainty factor 6.4 (JECFA, 2004).

**** The Reference Dose (RfD) is 0.1 µg/kg body weight/day, and was derived from benchmark dose (BMDL) level, 46-79 ppb in maternal blood and uncertainty factor 10 (NRC, 2000, US-EPA, 2001)

HEALTH EFFECTS

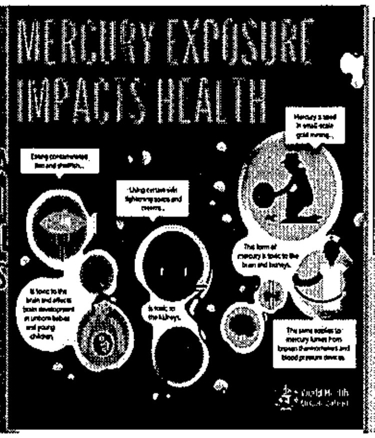


Table 1. The Major Clinical Toxicologic Features of Mercury

[illegible]

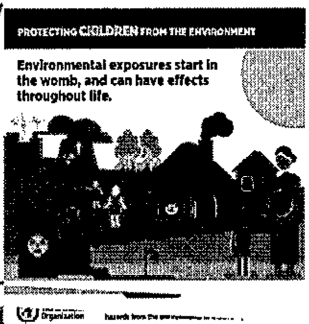
Minamata Disease is a disorder of the CNS. Various signs and symptoms include ***sensory disturbance in the distal portions of four extremities, ataxia, concentric contraction of the visual field***, etc. At the end of March 2001, 2,955 MD patients have been certified, of which 2,265 patients have been located on Yatsushiro Sea coast.

Mercury and children's environmental health

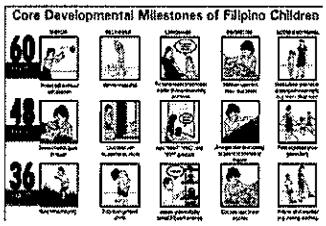
- Mental retardation
- Ataxia & cerebral palsy
- Seizures
- Vision & hearing loss
- Delayed developmental milestones
- Language disorders
- Deficits in fine motor function
- Visual, spatial disabilities
- Memory problems
- High blood pressure, low cardiac rate variability

DOSE

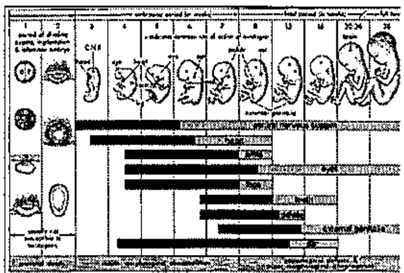
HG AND ITS EFFECTS TO RISK GROUPS



Ensure the best possible start in your child's life. Monitor your child's development.



WINDOW OF DEVELOPMENT



HEALTH EFFECTS OF HG

Mercury

SYMPTOMS AND SIGNS OF METALLIC Hg EXPOSURE

- Tremor
- Ataxia
- Coordination problems
- Excessive salivation
- Metallic taste

- Neurotoxicity
- Nephrotoxicity
- Teratogenicity: MeHg is a teratogen (Minamata disease)
- CVS: elevated risk of heart attack, hypertension
- Carcinogenicity: MeHg is a possible human carcinogen
- Mutagenesis: Hg seems not to be mutagen
- Reproduction: no clear evidence of effect
- Immunotoxicity: under scientific discussion

- Mothers often asymptomatic
- Microcephaly
- Cerebral palsy/spasticity
- Mental deficits
- Malformation of ears, heart, skeleton, eyes

MERCURY: ACRODYNIA

Uncommon syndrome "Pink disease":

- Pain in the extremities
- Pinkish discoloration and desquamation
- Hypertension
- Sweating
- Insomnia, irritability, apathy

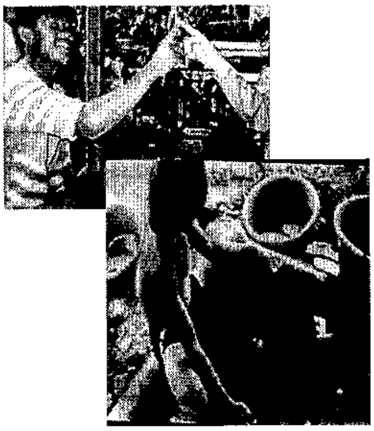
Considered as idiosyncratic reaction.

Mercury

HEALTH STUDIES ON MERCURY

Integrated Surveillance of the Health and Environmental Impacts of Mercury Exposure in Gold Processing (Maramba, N. et.al. 1988)

- 26% (60/230) of the workers use some form of protective device such as facial cover or masks, boots and gloves
- 47%(106/230) showed gray or focal deposits in the gingiva upon PE
- 16% (36/230) had decreased breath sounds
- 11%(24/230) had thyroid enlargement
- cross-sectional survey revealed that blood mercury levels were elevated in 13 of the workers examined
- Showed statistically significant association of blood mercury levels with the duration of work, eosinophil count and serum glutamic amino transferase



UPDATES

Mercury levels in hair, blood, fish, water, soil/sediment and water samples were analyzed at National Institute for Minamata Disease-Japan.

Samples were collected among 100 residents of the mining community in Mt. Diwalwal, Monkayo, Compostela Valley in collaboration with the regional and local health unit.

SUMMARY OF THE RESULTS ARE AS FOLLOWS:

Five out of 100 residents from Mt. Diwalwal are recommended to undergo further health examination, for possible detoxification.

These residents have blood mercury levels > 75 ug/ml (permissible limit: 15 ug/ml).

39 more residents with blood mercury levels > 15 ug/ml will also have to be examined.

39/92 (42.39%) persons examined have total hair mercury levels > NV of 4 ug/g.

Summary of Blood and Hair Total and Methylmercury Levels, Mt. Diwalwal, 2005

[illegible]	[illegible]	[illegible]	[illegible]
Range	0.66 – 289.21	0.52- 5.99	1.46 – 100%

MERCURY VAPOR* LEVELS IN BARANGAY PALANAS, CAMARINES NORTE FEBRUARY 25, 2010

Area	(Hg levels), ng/m³	Remarks
Ambient environment (near the barangay hall, 4;55 pm)	153 - 1262	Outside the barangay hall
Gold Processing Area – House 1	7044 – 28,890	Ballmilling and panning operations
Gold Processing Area – House 1	50,000	Blowtorching area; no activity was prevailing during the monitoring
Gold Processing Area – House 2	429 – 27,200	Ballmilling and panning operations
Threshold Limit Value (TLV)	50 ug/m3 or 50,000 ng/m3	Occupational standards were exceeded in the workplace in the blowtorching area
Ambient air monitoring guidelines in residences, USEPA	200 ng/m3	Levels were exceeded in the households/residences where the monitoring was done.

* Air Monitoring using Lumex Mercury Vapor Analyzer

RESULTS OF THE BLOOD MERCURY MONITORING, PARACALE, CAMARINES NORTE, 2010

Name of Patient	Blood Mercury levels* (ug/L)	Remarks
1. NS	82.7	Elevated, blood Hg level 17 yo, 2mos as small-scale miner
2. RD	51.3	Elevated Hg blood level 53 yo. housewife, residence with SSGM operations
3. VD	39.4	Elevated Hg blood level 51 yo,20 years-oversee SSGM operation)
4. AA	36.4	Elevated Hg blood level 20 yo. 6 mos as small-scale miner
5. WT	35.9	Elevated Hg blood level 27 yo, 5 mos as small-scale miner
6. MV	23.1	Elevated Hg blood level 25 yo, 1 yr. as small-scale miner
7. AE	19.2	Elevated Hg blood level 16 yo, 2 yrs as small-scale miner
8. EG	18.6	Elevated Hg blood level 34 yo. 10 yrs as small-scale miner
9. PH	5.2	60 yo.20 years as small-scale miner
10. MD	ND:DL=1	21

HEALTH STUDIES ON MERCURY

Health Impact of Mercury Among Small-scale Gold Miners in Camarines Norte (1991)

- 7 out of 99 (7%) were found to have elevated mercury blood levels
- 4 miners detoxified

Health and Environmental Impact of Mercury Among Schoolchildren in Apokon, Davao del Norte (2000)

- Blood and hair samples from 162 schoolchildren aged 5-17 years were collected and analyzed at the NIMD
- Summary of physical examination results showed that predominant findings include underheight, gingival discoloration, adenopathy, underweight and dermatological abnormalities among children examined

HEALTH STUDIES ON MERCURY

- Mercury as a health hazard due to gold mining and Mineral processing activities in Mindanao/Philippines (UNIDO, 2001)
  - Clinical symptoms among those examined showed that a fair amount of workers from Diwalwal showed severe symptoms that could be very well related to the classical picture of mercury intoxication
- Symptoms include fatigue, tremor, memory problems, restlessness, loss of weight, metallic taste and sleeping disturbances
- Intentional tremor, mainly fine tremor of eye lids, lips and fingers, ataxia, hyperreflexia and sensory disturbances as well as bluish discoloration of the gums
- More than 70% (73 /102) of the occupationally-burdened population suffer from chronic mercury intoxication
- Higher percentage among amalgam smelters (85.4%)
- 1/3 of the non-occupationally burdened is intoxicated

HEALTH AND ENVIRONMENTAL MONITORING

Mercury levels in hair, blood, fish, water, soil/sediment and water samples were analyzed as part of the continuing collaboration with the National Institute for Minamata Disease-Japan.

Samples were collected among 100 residents of the mining community in Mt. Diwalwal, Monkayo, Compostela Valley in collaboration with the Center for Health Development for Southern Mindanao and the local health unit.

Samples were analyzed February-March, 2005

Split sampling analysis with the EOH Collaborating Center

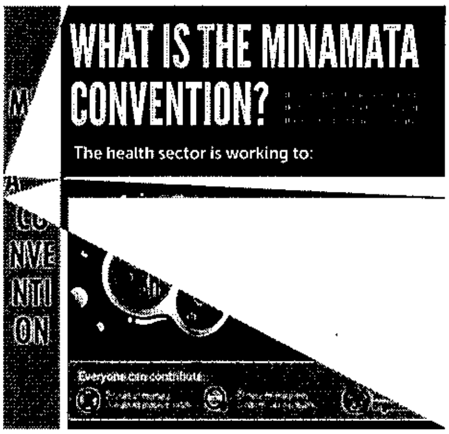
Summary of Blood and Hair Total and Methylmercury Levels, Mt. Diwalwal, 2005

[redacted]

Range	0.66 – 289.21	0.52- 5.99	1.46 – 100%

SUMMARY OF THE RESULTS ARE AS FOLLOWS:

The results of the laboratory tests showed that <u>inorganic/elemental mercury is the predominant mercury specie in the blood samples</u> and this is indicative of the environmental and occupational exposure of residents to the small-scale gold mining operations in the area rather than their dietary intake from contaminated fish.



Highlights of operational articles

- Controls on all lifecycle stages of mercury covered by different articles of the Convention

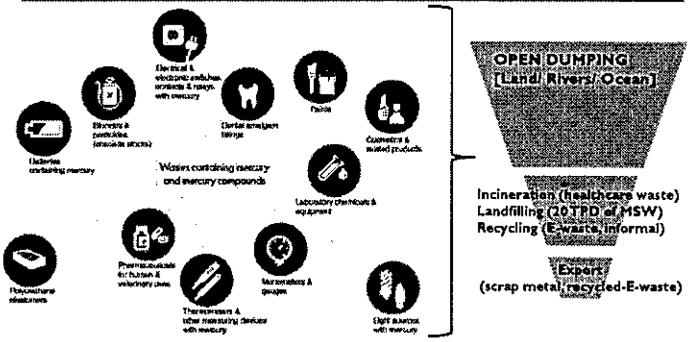
Controls on supply and on international trade in mercury (Article 3)
Phase-out and phase-down for mercury use in products and processes (Articles 4, 5 and 6)
Controls on artisanal and small scale gold mining (Article 7)
Control measures on air emissions and releases to water (Articles 8 and 9)
Storage, waste and contaminated sites (Article 10, 11 and 12)

Partner and Stakeholder Updates from Sri Lanka
"The Need for Mercury Monitoring"

Anurudda Karunarathna, PdD

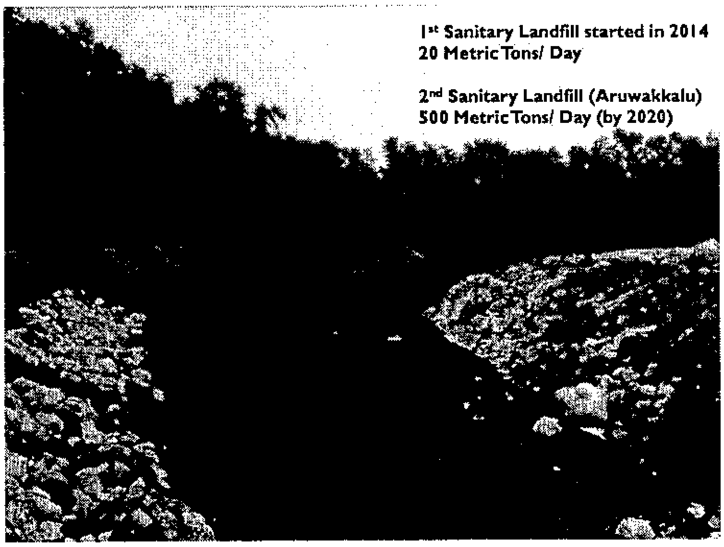
Senior Lecturer in Environmental Engineering, University of Peradeniya, SRI LANKA

PRESENT STATUS OF WASTE MANAGEMENT



MUNICIPAL SOLID WASTE OPEN DUMPS

~ 300 dumpsites in the country



ISSUE & CHALLENGES

1) **Insufficient infrastructure for MSW, Hazardous, Industrial waste management**
   - Collection & Transport
   - Treatment, processing and
   - Disposal
2) **Policy & Regulations**
   - Gaps in monitoring and regulating (prioritization)
   - Implementation
3) **Lack of Research and Development initiatives**
   - Research and development infrastructure
   - Research funds
4) **Knowledge / Awareness**
   - Academics, researchers, administrators
   - Public

RESEARCH, ASSESSMENT AND MONITORING

Heavy metal concentrations in landfill leachate and the maximum tolerance limits of heavy metals. Values are in μg L⁻¹

Sample	Cr	Fe	Ni	Cu	Zn	As	Se	Cd	Pb
Matale	345	60762	115	573	6876	522	1935	100	1777
Hambantota	80	5341	226	166	19909	678	2522	172	492
Kataragama	11	1117	89	58	638	106	400	50	123
Bandargama	329	7167	912	227	5362	722	2607	90	479
Kolonnawa	1968	346930	4473	55	11759	705	2443	15	421
Gampola	220	5546	335	734	462	164	461	4	34
Gohagoda	139	3004	331	334	389	148	465	1	19
Wennappuwa	363	2501	399	431	409	939	2812	53	87
Rathnapura	439	56343	1311	627	1685	1551	4922	52	168
Negombo	330	20111	666	535	2062	846	2184	51	333
Matara	830	7528	571	464	500	1219	3705	48	60
Galle	486	15477	673	564	593	1796	5947	52	169
Max. permissible level	100	3000	3000	3000	5000	200	500	100	100

Mercury ?

WAY FORWARD: RESEARCH COLLABORATIONS

MEMORANDUM OF UNDERSTANDING
FOR RESEARCH COLLABORATION ON INVESTIGATION OF MERCURY RELATED ISSUES AND MONITORING IN SRI LANKA
BETWEEN
MINISTRY OF MAHAWELI DEVELOPMENT & ENVIRONMENT, SRI LANKA
AND
UNIVERSITY OF PERADENIYA, SRI LANKA

This MOU made on March 2017, by and between Ministry of Mahaweli Development & Environment, Sri Lanka, whose address is 82, Sampath Paya, Rajamalwatte Road, Battaramulla, Sri Lanka, hereinafter referred to as "MoMD&E" and University of Peradeniya, Sri Lanka whose address is University of Peradeniya, Peradeniya herein referred to as "University".

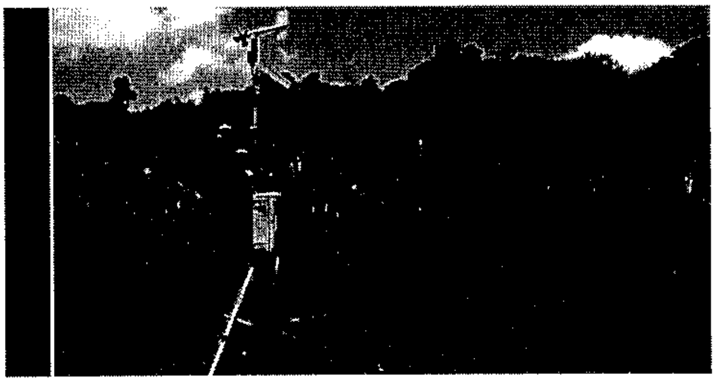
1. MoMD&E and University seek to enhance relations between Institutes by developing Research Collaboration on Investigation of mercury related issues and monitoring in Sri Lanka.

2. Within each Institute's framework of the regulations applying in each Institute, and subject to the availability of resources, the following programmes and activities will be encouraged:

- Collaborative Study on Technical Needs of Mercury Management in Sri Lanka by MoMD&E and University

1ST STEP- WET DEPOSITION SAMPLING

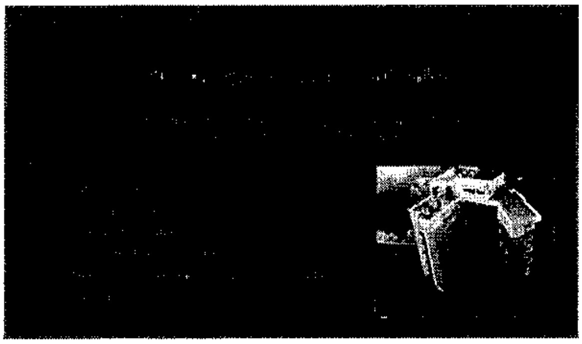
- Establish "wet deposition collector" station at University of Peradeniya
  - Weather station (7°15'7.19"N 80°35'40.86"E) ~500 m above MSL

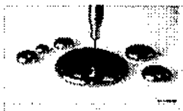


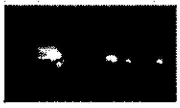
CAPACITY DEVELOPMENT

- **Our Strength:** Human resources, basic facilities, multidisciplinary & collaborative research
- **Training Needs:** Mercury Monitoring (for academics, researchers, technicians)
- **Collaborative Research & Development:** Policy & legislation formulation, environmental assessment, monitoring
- **Knowledge & Technology Transfer:** Recovery and recycling, alternative technologies
- **Networking:** APMMN

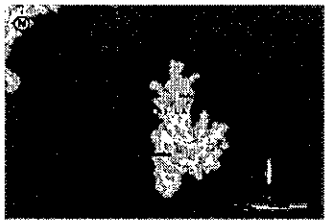
END







Sri Lanka Country Status



Land Area – 65,610 km2
Population - 20.9 million
Capital – Sri Jayawardenapura Kotte
Middle level income
Literacy rate 92.2%
Per Capita GDP – 3842 US$
Currency – Rupees (Rs)

Minamata Convention

Convention Details

- Date of Signature - 08-10-2014
- Date of Ratification -19-06-2017(as 60th member country)

Mercury Initial Assessment (MIA) ***Project Details***

- Date of Commence - 9th September 2016
- Duration - 24 months

Sources of Mercury Emission in Sri Lanka

- Compact florescent lights and mercury vapor lights
- • Thermometers, manometers, and sphygmomanometers
- • Batteries
- • Dental amalgams
- • Some skin lightening creams
- • Emissions from coal power plants
- Cement Industry

Current Status

- Mercury Initial Assessment – Health, Industry, Education sectors completed – pending validation and submission
- Institutional capacity needs identified
- Reviewed existing legislation. legal gaps identified
- Generated National Mercury Profile Report
- Conference Room Paper (CRP)submitted on Small scale jewelry sector – COP 1 (Article 07)
- Conducted awareness programmes to minimize health and environmental impacts in education, health and industry sectors
- In the process of identifying new (better) technologies to minimize health and environmental hazards caused due to mercury.

II Phase Mercury Management

- Agreement Signed with UNIDO to initiate Study on Small Scale jewelry sector (3000 jewelers)
- Objective :
- Improve their practices and introduced more environmental friendly alternatives and technologies

Health Sector

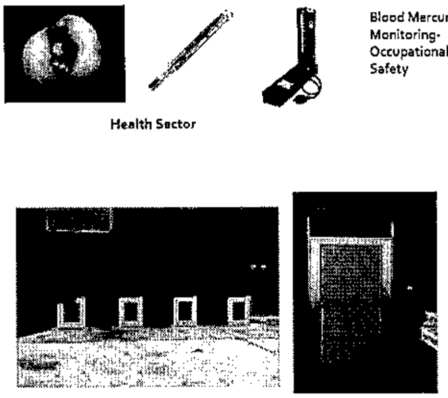
1. National Hospital	01
2. Teaching Hospitals	20
3. Provincial General Hospitals	03
4. District General Hospitals	18
5. Base Hospital Type – A	22
6. Base Hospitals Type – B	46
7. Divisional Hospital type –A (More than 100 patients beds)	42
8. Divisional Hospital Type –B (Between 50 to 100 patients Beds)	129
9. Divisional Type – C (Less than 50m patient Beds)	322
10. Primary Medical Care Unit (Central Dispensaries & Maternity Homes)	474
11. Board Managed Hospitals	02
12. Special Hospitals	05
TOTAL	1084

Private Hospitals -204,
Laboratories 632,
1880 Clinics,
MOOH 330,
12 universities

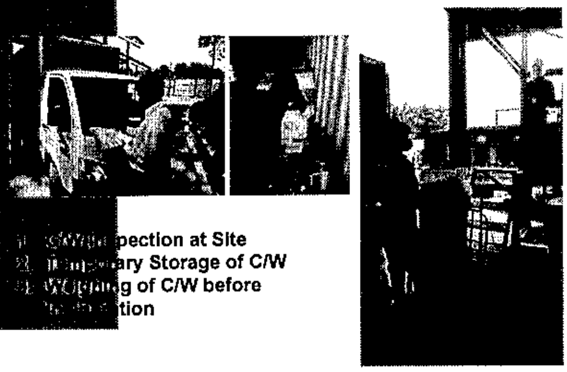
Actions taken to minimize emissions and environmental health impacts

- Health Sector
  - Procurement of Mercury containing Blood Pressure Apparatus to Health Institutions banned
  - Expects to phase out Dental Amalgum from 2019
  - Mercury Separators procured for dental clinics
  - CFL bulbs collected for recycling
  - Mercury Spill Management trained.
  - Relevant Circulars guidelines issued

Mercury Usage



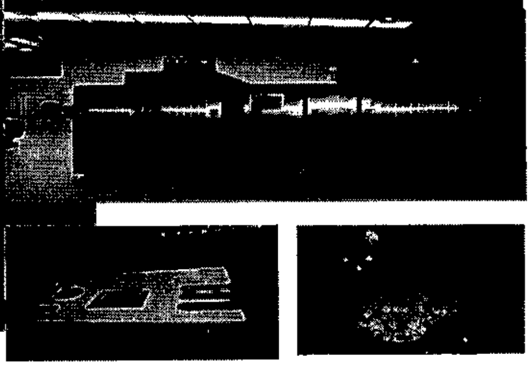
Incinerator Operations

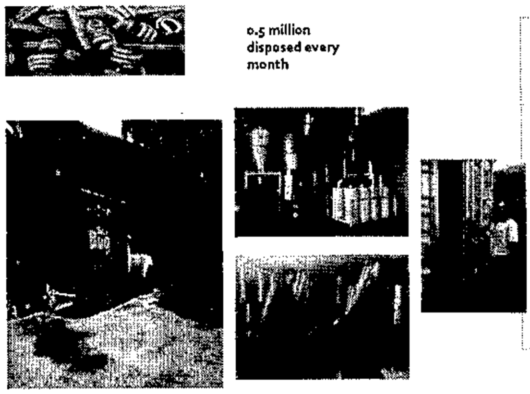


pection at Site
ary Storage of C/W
g of C/W before
tion

Incineration of Clinical Waste – Sisili Hanaro

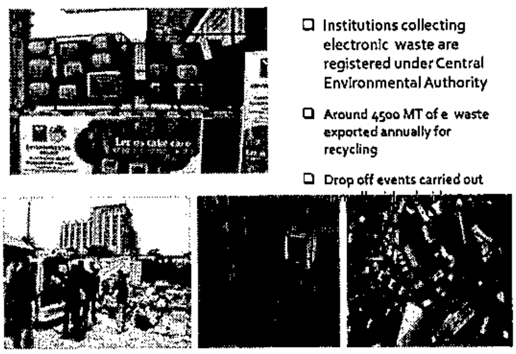
(MetaMizer - Steam Sterilizer)





Electronic Waste Management

- Institutions collecting electronic waste are registered under Central Environmental Authority
- Around 4500 MT of e waste exported annually for recycling
- Drop off events carried out



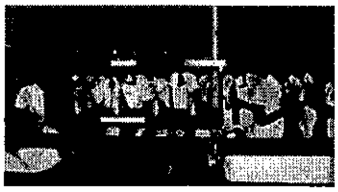
SKIN WHITENING CREAMS

Cosmetic product	Sample No.	Level of Mercury(mg/kg)	Level of Lead (mg/kg)
XIN JIAOLI 10 WHITENING SP. RE2	CA04	1506.52	<0.05
XIN JIAOLI 10 WHITENING SP. RE2	CB04	1218.53	<0.05
PAI MEI WHITENING SPOT CRM	C007	30167.66	<0.05
CAIKE GINSENGWHITEN CREAM	C008	19699.1	<0.05
LOREAL WHITE PERFECT DAY	C012	<0.02	<0.05
EMAMI FAIR AND HANDSOM	C014	<0.02	<0.05
FAIR N LOVELY C.FAIRNESS C.	C019	<0.02	[redacted]
THAI ROSE WHITENING CREAM	C023	4.17	<0.05
FAIREVER FAIRNESS CREAM	C024	0.45	<0.05
EVE FAIRNESS	C030	25.46	<0.05
VASELINE HELTHY WHITE (BCD3:49)	C031	<0.02	<0.05
NATURE SECRETS MULBERRY FAIRNESS CREAM	C032	1.92	<0.05
NATURE SECRETS MULBERRY FAIRNESS CREAM	C033	<0.02	<0.05
VASELINE HELTHY WHITE (BCD3:48)	C034	<0.02	<0.05

Actions Taken

- Ministry of Health Nutrition & Indigenous Medicine is responsible
- Cosmetic Devices and Drugs Act
- Standards are developed (Consumer affairs Authority, Sri Lanka Standard Institute)
- Awareness creation

Education Sector



Around 10,000 schools/
16 Govt. Universities

Progress

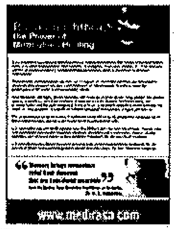
Education Sector:

- Mercury procurement for laboratory purposes minimized

Mercury Emissions/ Usage in Sri Lanka

Lakwijaya Coal Power Plant – Norocholai – 300x3 MW (01 plant)

3000 small scale jewelry makers



Storage, Usage to be improved

Fish

- Certain Species of Fish in Deep sea has been found contaminated with mercury
- Needs further Research

Mercury Testing

- Blood
- Waste
- Waste water carried out (Discharge standards available)

Central Environmental Authority

Air Quality Monitoring

- Regulator
- One station in Colombo
- Mobile Station
- Measures Air quality in other districts.

Air Quality Regulations – Central Environmental Authority

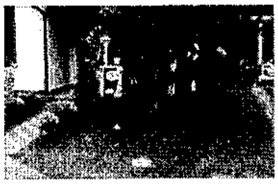
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	Amended Regulations published under the Gazette Notification No. 1887/20 dated 05.11.2014 with the corrected Gazette Notification No. 1895/43 dated 02.01.2015

The National Environmental (Ambient Air Quality) Regulations,

Pollutant	Averaging Time*	Maximum Permissible Level		Method of measurement
		µgm-3	ppm	
3.	Annual.	50	-	
	24hrs.	100	-	
4.	Annual.	25	-	
	24 hrs	50	-	

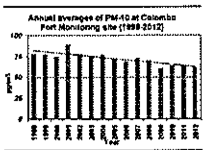
Pollutant	Averaging Time*	Maximum Permissible Level		Method of measurement
		µgm-3	ppm	
3. Nitrogen Dioxide (NO2)	24 hrs.	100	0.05	Colorimetric using saltzmen Method or equivalent Gas phase chemiluminescence
	8 hrs.	150	0.08	
	1hr.	250	0.13	
4. Sulphur Dioxide (SO2)	24 hrs.	80	0.03	Pararosanilene Method or equivalent Pulse Flourescent
	8 hrs.	120	0.05	
	1hrs.	200	0.08	
5. Ozone (O3)	1 hr.	200	0.10	Chemiluminescence Method or equivalent Ultraviolet photometric
6. Carbon Monoxide (CO)	8 hrs.	10,000	9.00	Non-Dispersive Infrared Spectroscopy*
	1 hr.	30,000	26.00	

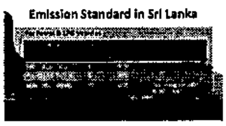
National Building Research Organization (NBRO)



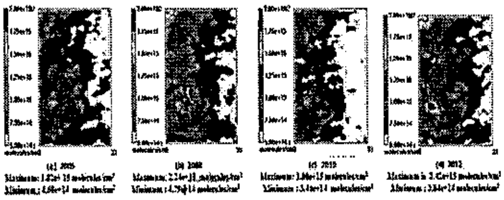
10 Districts – Air quality measuring is carried out.
It will be expanded to cover the rest of the districts

Activities

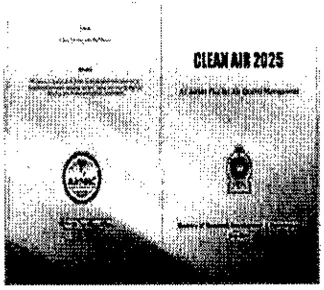




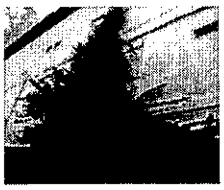
Saterlight Images showing Air Pollution



Clean Air Action Plan



Vertical Forest garden



Stakeholders (BRSM Co-ordinating Committee)

- Science, Technology and Research
- Ministry of Education
- • Ministry of Finance
- • Ministry of Fisheries • Ministry of Health, Nutrition and Indigenous Medicine
- • Ministry of Higher Education
- • Ministry of Industry and Commerce
- • Ministry of Local Government and Provincial Councils
- • Ministry of Mahaweli Development and Environment
- • Ministry of Power and Renewable Energy •
- Central Environment Authority
- • Centre for Environmental Justice • Consumer Affairs Authority
- • Coordinating Secretariat for Science, Technology and Innovation
- • Cosmetic Devices and Drugs Regulatory Authority • Dental Institute
- • Department of Meteorology • Faculty of Chemical and Process Engineering, University of Moratuwa
- • Gem and Jewellery Research and Training Institute
- • Import and Export Control Department
- • Industrial Development Board of Ceylon
- • Industrial Technology Institute

Stakeholders

- Institute of Indigenous Medicine
- • Institute of Oral Health
- • Marine Environmental Protection Authority
- • National Aquatic Resource Authority (NARA)
- • National Aquatic Resources Research and Development Agency (NAARA)
- • National Cleaner Production Centre • National Engineering Research and Development Centre of Sri Lanka
- • National Gem and Jewellery Authority
- • Post Graduate Institute of Agriculture, University of Peradeniya
- • Sri Lanka Customs
- • Sri Lanka Standards Institution
- • Sri Lanka Sustainable Energy Authority

Issues

- ❑Lack of Mercury Disposal Facility
- ❑Lack of emission standards for Mercury
- ❑Alternative Technology

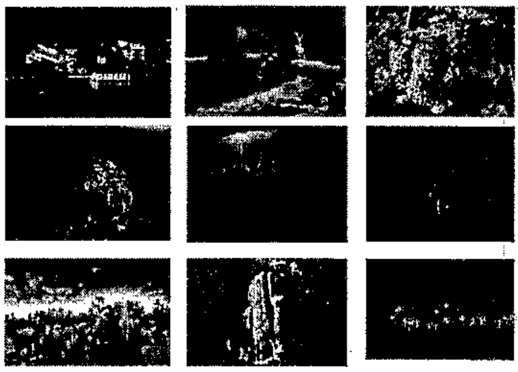
Atmospheric Mercury Monitoring

- **Asia- Pacific Mercury Monitoring Network (APPMN)**
  APPMN has supported Sri Lanka in providing 03 Mercury Monitoring Machines. (Wet Deposition Sampler)
- Already 01 machine received

The four Institutions identified are

- Central Environmental Authority (CEA)
- National Building Research Organization (NBRO)
- Department of Meteoriology
- University of Peradeniya

Thank You



Dr Anuruddha Karunaratne

Way Forward

Mercury Monitoring

Collaboration

Training Requirement

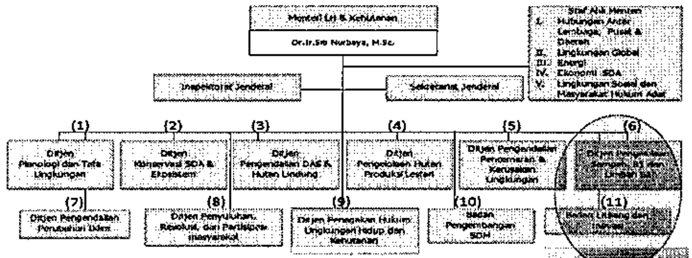
UPDATE YEAR 2018:

MERCURY MONITORING IN INDONESIA

INTRODUCTION

- Herman Hermawan, Director in Research and Development Center for Environmental Quality and Laboratory, Ministry of Environment and Forestry, P3KLL or EMC;
- Rina Aprishanty, Senior Technical Staff in EMC, MoEF;
- Florentinus Binsar Tumind, staff in Hazardous and Toxic Substances Management Department, MoEF, PB3.

STRUKTUR ORGANISASI KEMENTERIAN LINGKUNGAN HIDUP & KEHUTANAN



KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN

OUTLINE

- Background
- Current status
- Progress Data
- Next Step

BACKGROUND

Monitoring History of MoEF Indonesia

Monitoring activities running under the coordination from Hazardous Toxic Substance Management Department MoEF

- Mercury Monitoring in ASGM Hotspot for soil and surface water sample (2012 – 2014)
- Mercury Monitoring in Energy Sector for coal, fly ash, bottom ash and emission source in 2017 (UNEP Project with MoEF)

Mercury Monitoring in ASGM Hotspot

(conducted by MEMR, MoH, MOEF) (2012)

No	Lokasi		River	Sludge	Clean Water	Ambient	Fish
			BM: 0,002 mg/L	BM: 0,13 mg/Kg	BM: 0,001 mg/dL	BM: -	BM: 0,40 mg/Kg
1	South Solok District, West Sumatera	KESDM					
2	West Lombok District, West Nusa Tenggara	KESDM		0,13 mg/Kg			
3	Bolaang Mangondow District, North Sulawesi	KESDM		7,34 mg/Kg			
4	Palu City, Central Sulawesi	KESDM	0,0114 mg/L	9,09 mg/Kg			
5	Tasikmalaya District, West Java	KESDM	0,049 mg/L	5,54 mg/Kg			
6	Aceh Jaya District, Aceh	KLH					
7	Dharmasraya District, West Sumatera	KLH					
8	Palangkaraya District, Central Kalimantan	KLH					
9	Banyuwangi District, East Java	KLH					
10	Minahasa District, North Sulawesi	KLH					
11	Banyumas District, Central Java	KLH					
12	Lebak District, Banten	KLH					

Samples below the quality standard
Samples over the quality standard
Sample not taken

Standards:
- River water : Government Regulation No. 82 Year 2001
- Clean Water : Ministry of Health Regulation No. 416 Year 1990
- Biota:
  Provisional Standards for Mercury in Fish" (notification for Ministry of Health and Welfare, Japan in July of 1973)
- Sediment:
  Canadian Sediment Quality Guidelines for Threshold Effect Level (TEL)
- Soil:
  Canadian Soil Quality Guidelines for the Protection of Environment and Human Health (Residential/Parkland)

Mercury Monitoring in ASGM Hotspot
(conducted by MEMR, MoH, MOEF) (2013)

No	Lokasi		River	Sludge	Clean Water	Ambient	Soil	Fish
			BM: 0,002 mg/L	BM: 0,13 mg/Kg	BM: 0,001 mg/dL	BM: -	BM: 8,6 mg/Kg	BM: 0,40 mg/Kg
1	South Solok District, West Sumatera	KESDM						
2	West Lombok District, West Nusa Tenggara	KESDM						
3	Bolaang Mangondow District, North Sulawesi	KESDM						
4	Palu City, Central Sulawesi	KESDM						
5	Tasikmalaya District, West Java	KESDM						
6	Aceh Jaya District, Aceh	KLH		4,019 mg/Kg			10,168 mg/Kg	
7	Dharmasraya District, West Sumatera	KLH		86.669 mg/Kg				
8	Palangkaraya District, Central Kalimantan	KLH						
9	Banyuwangi District, East Java	KLH	0,002 mg/L					5,53 mg/Kg
10	Minahasa District, North Sulawesi	KLH		2 mg/Kg				
11	Banyumas District, Central Java	KLH						0,91 mg/Kg
12	Lebak District, Banten	KLH						

Samples below the quality standard
Samples over the quality standard
Sample not taken

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Mercury Monitoring in ASGM Hotspot
(conducted by MEMR, MoH, MOEF) (2014)

No	Lokasi		River	Sludge	Clean Water	Ambient	Soil	Fish
			BM: 0,002 mg/L	BM: 0,15 mg/Kg	BM: 0,001 mg/dL	BM: -	BM: 6,8 mg/Kg	BM: 0,40 mg/Kg
1	South Solok District, West Sumatera	KESDM						
2	West Lombok District, West Nusa Tenggara	KESDM						
3	Bolaang Mangondow District, North Sulawesi	KESDM						
4	Palu City, Central Sulawesi	KESDM						
5	Tasikmalaya District, West Java	KESDM						
6	Aceh Jaya District, Aceh	KLH						
7	Dharmasraya District, West Sumatera	KLH						
8	Palangkaraya District, Central Kalimantan	KLH						
9	Banyuwangi District, East Java	KLH						
10	Minahasa District, North Sulawesi	KLH						
11	Banyumas District, Central Java	KLH	0,0029 mg/L	0,28 mg/Kg				
12	Lebak District, Banten	KLH		7,00 mg/Kg				5,10 mg/Kg

Samples below the quality standard
Samples over the quality standard
Sample not taken

Standards:
- River water : Government Regulation No. 82 Year 2001
- Clean Water : Ministry of Health Regulation No. 416 Year 1990
- Biota:
  Provisional Standards for Mercury in Fish" (notification for Ministry of Health and Welfare, Japan in July of 1973)
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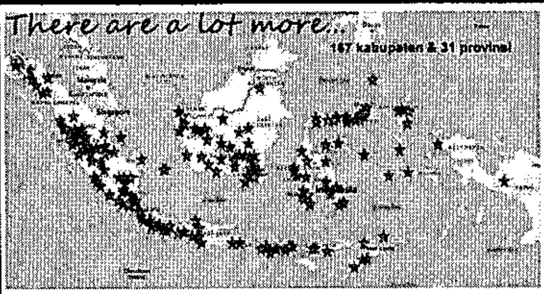
- Soil:
  Canadian Soil Quality Guidelines for the Protection of Environment and Human Health (Residential/Parkland)

MERCURY MEASUREMENT FROM POWER PLANT
(concentration in µg/M³)

No	UNIT	ASTM METHOD D6784	USEPA METHOD 29
1	SURALAYA CFPP	1.07	1.00
2	CIREBON CFPP	0.60	0.57
3	INDRAMAYU CFPP	3.02	2.93



Gambar 1.1 Peta Sebaran Pertambangan Emas Skala Kecil di Indonesia (Sumber: Kementerian ESDM, 2017)

CURRENT STATUS

INDONESIAN GOVERNMENT COMMITMENT

- Indonesia ratified Minamata Convention through Law No 11 year 2017;
- Indonesia established National Action Plan under President Regulation that would be applied later this year;
- Indonesia established Ministry Decree No 340 year 2018 about Committee for Research and Monitoring on Mercury;
- Pilot Project Plan for Non Mercury Gold Processing in Lebak West Java.

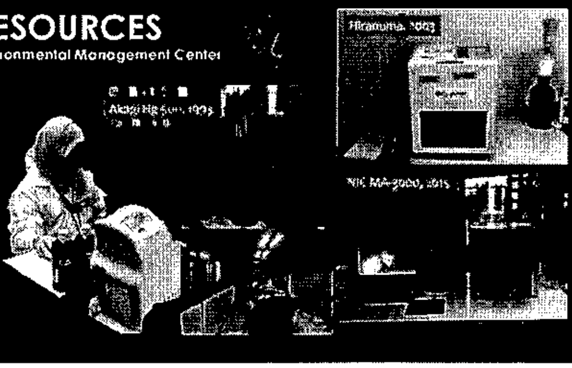
Wet Deposition Sampler for Mercury in Rain Water in East Jakarta Station

Regular sampling done by Hazardous and Toxic Substance Management Department MoEF

Proposed EMC Station at Serpong Banten

RESOURCES

Environmental Management Center



MONITORING ACTIVITIES UPDATE

Mercury Concentration in Indonesia

No	Location	Total Mercury Concentration			
		Water (mg/L)	Sediment (mg/Kg)	Soil (mg/Kg)	Paddy (mg/Kg)
1.	Ds.Cicadas	< 0,00005		1,8	< 0,03
2.	Dsn Langkop		196		
3.	Ds.Pasir Baru	< 0,00005		0.038	
	Quality Standard	0,002[a]	75[b]		0,03[d]

Mercury Concentration in Indonesia

No	Location	Total Mercury Concentration			
		Air (mg/L)	Sedimen/lumpur (mg/Kg)	Tanah (mg/Kg)	Padi (mg/Kg)
1	Ds.Cilantung	< 0,00005	101	0.58	
2	Ds.Loji	< 0,00005		0,036	< 0,03
	Quality Standard	0,002[a]	75[b]		0,03[d]

Mercury Concentration in Man Hair

No	Nama	Usia	Lokasi	Pekerjaan	Konsentrasi T-Hg (mg/Kg)	Standar normal WHO
1	Pak Pitra	38 tahun	Ds.Sukarame	Pemilik glundungan	2,4	1 – 2 mg/Kg
2	Pak Ikma	50 tahun	Ds.Cicadas	Karyawan kantor kecamatan, tetapi pernah bekerja tambang selama 20 tahun	3,4	
3	Pak Beni	29 tahun	Ds.Pasir Baru	Pekerja tambang	2,4	
4	Pak Sunandar	43 tahun	Ds.Sukarame	Sopir	3,6	
5	Pak Mahedin	60 tahun	Ds.Pasir Baru	Petani	5,02	
6	Fadhil (suspect)	10 tahun	Ds.Pasir Baru	Pelajar SD	2,8	

Mercury Concentration in Woman Hair

No	Nama	Usia	Lokasi	Pekerjaan	Konsentrasi T-Hg (mg/Kg)	Standar normal WHO
1	Bu Juhaeni	52 tahun	Ds.Cicadas	Ibu Rumah tangga	2,8	
2	Bu neng	37 tahun	Ds.Cicadas	Ibu Rumah tangga	5,8	1 – 2 mg/Kg
3	Bu yayah (istri Pak Pitra)	36 tahun	Ds.Sukarame	Ikut bekerja bersama suami	17	
4	Bu Eny	37 tahun	Ds.Sukarame	Ibu rumah tangga	12	
5	Bu Euis	39 tahun	Ds.Sukarame	Ibu rumah tangga	12	
6	Amira	6 tahun	Ds.Sukarame	Pelajar SD	4,5	
7	Bu Reni (ibu fadhil)	35 tahun	Ds.Pasir Baru	Ibu rumah tangga	7,7	

Mercury Concentration in Woman Hair

No	Nama	Usia	Pekerjaan	Konsentrasi T-Hg (mg/Kg)	Standar normal WHO
1	Bu pumpur	47 tahun	Stone Crusher	4,2	1-2 mg/Kg
2	Bu ningsih	45 tahun	Stone Crusher	2,2	
3	Bu Sari	50 tahun	Stone Crusher	1,3	

Source: P3KLL-KLHK 2018

Mercury Concentration in Paddy

No.	Lokasi	Konsentrasi T-Hg	Baku Mutu (mg/Kg)
		Padi (mg/Kg)	
1	Ds.waluran	0,14	0,03*

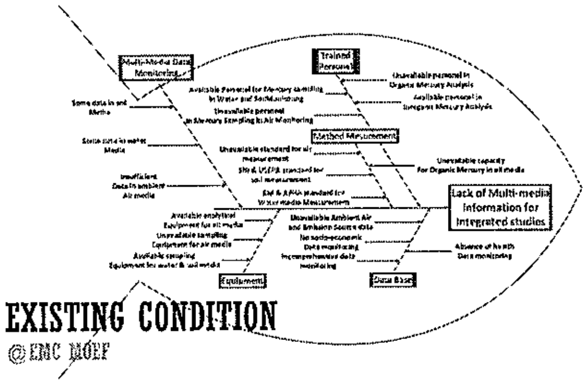
Source: P3KLL-KLHK 2018

Mercury Concentration in Fish

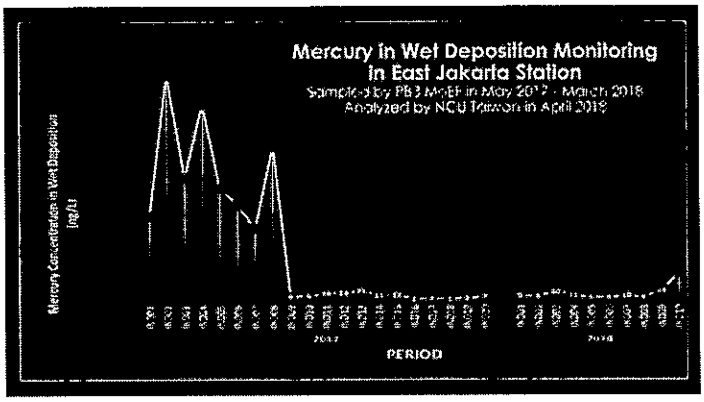
No	Nama Ikan	Konsentrasi T-Hg (mg/Kg)	Baku Mutu*
1	Ikan gondongan	0,13	0,5 mg/Kg
2	Ikan ekor kuning	0.064	
3	Ikan tuna	< 0,03	
4	Ikan kembung	0,27	

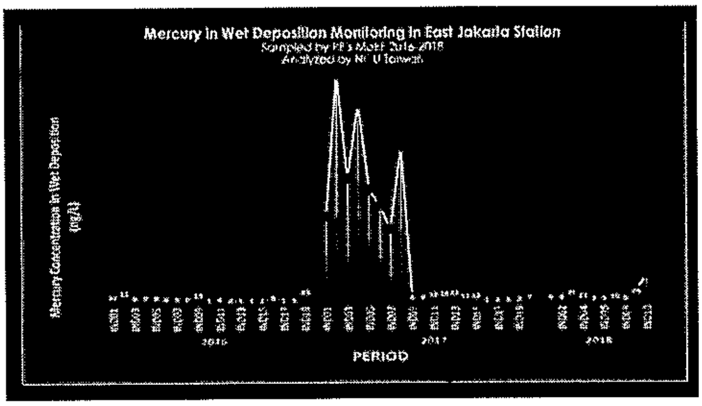
SAMPLING WITH IDEA CONSULTANTS

Sampling in Land Fill at Bantar Gebang Bekasi West Java July 2018



PROGRESS AND REVIEW APMMN PROJECT IN INDONESIA



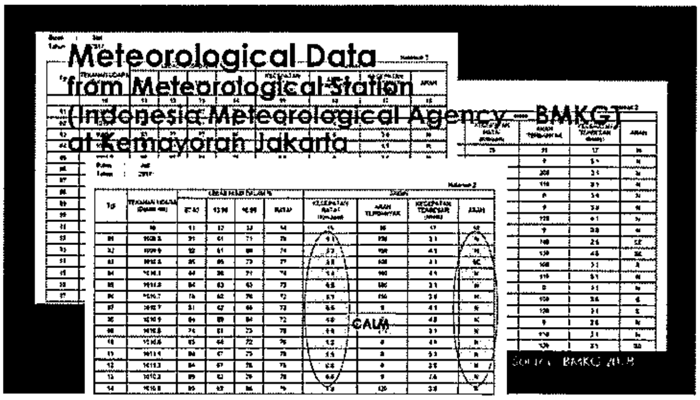


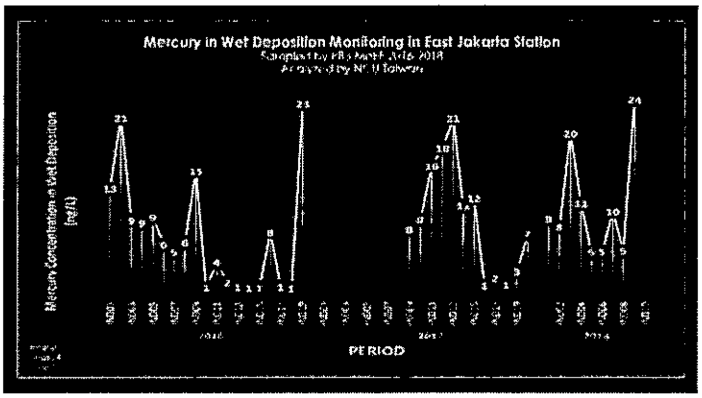
DATA EVALUATION

The presumption for high concentration data:

1. Sample contamination due to handling and exceeding holding time
2. Construction close to the sampling site, by means of mixing cement with fly ash (special permit)

GIS FOR SITE LOCATION





NEXT STEP APMMN IN INDONESIA

NEXT STEP

- Applying QA/QC in place for next monitoring
- Developing the system for mercury sampling from ambient air by means of gold amalgamation
- Reestablish the sampling point for both mercury wet deposition and dry deposition

NEXT STEP EMC

- Developing Method standardization so that the monitoring could be applied widely in local laboratory in Indonesia
- Gathering information on existing mercury research studies to support Pilot Project Plan for Non-Mercury Gold Processing in Lebak West Java
- Strengthening the Committee in Research and Monitoring through coordination among sector involved:
  - Energy and mining sector
  - Health sector
  - Science and Technology sector
  - Academic sector

Regulation on mercury level standards	Enhance community participation	Data and information management
• Establishing criteria of mercury contaminated site • Establishing quality standards in some media • Method Standardization	• Campaigning of health risks from mercury exposure • Campaigning for mercury free environment	• Conducting comprehensive study in contaminated site for multi-media mercury monitoring • Regular and long term monitoring • Establishing integrated data management

Committee of Mercury Research and Monitoring

Progress on atmospheric and wet deposition mercury monitoring in Thailand

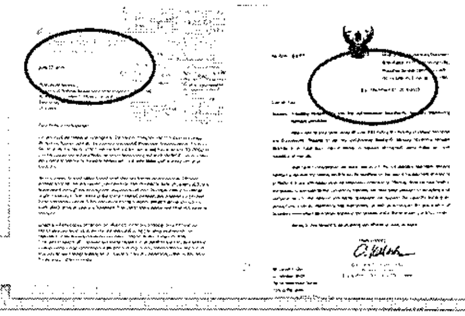
Hathairatana Garivait
Environmental Research and Training Center
Department of Environmental Quality Promotion

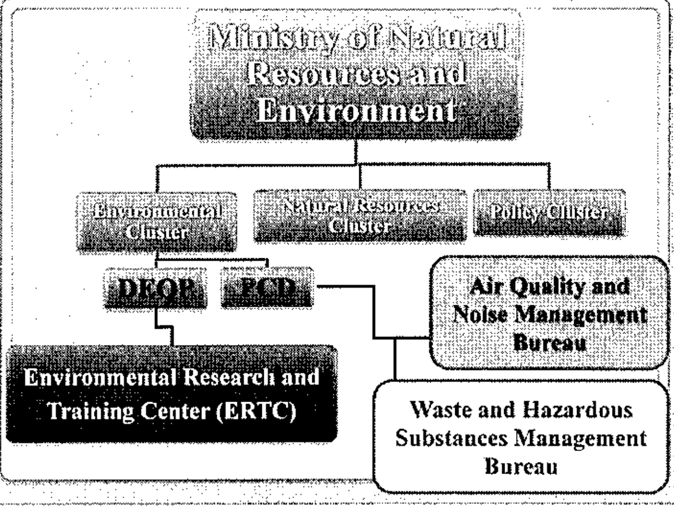
Nittaya Chaisaard
Air Quality and Noise Management Bureau
Pollution Control Department

Ministry of Natural Resources and Environment, Thailand

APMMN is supportive network for Minamata Convention on Mercury

Thailand has officially collaborated with APMMN since 26 November 2015 by Ministry of Natural Resources and Environment (MONRE)





- Pollution Control Department (PCD)
  - Air Quality and Noise Management Bureau: "Air Quality Monitoring"
  - Waste and Hazardous Substances Management Bureau: "Minamata Convention"
- Department of Environmental Quality Promotion (DEQP)
  - ERTC: "Research & Development"

Participation in the APMMN Meetings

The 5th APMMN Meeting in Bangkok 2016

The 6th APMMN Meeting in Taiwan 2017

APMMN is supportive network for Minamata Convention on Mercury

- Thailand ratified MC since 23 June 2017. We are the 66th country.
- Since 2012, MONRE continuously progress the capability on atmospheric and wet deposition mercury measurement through monitoring and research.

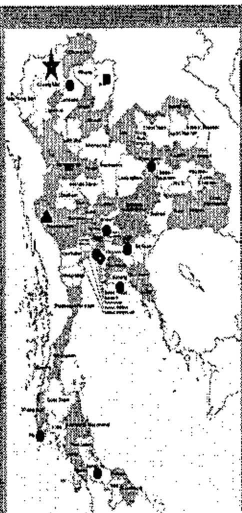
Progress in atmospheric mercury monitoring

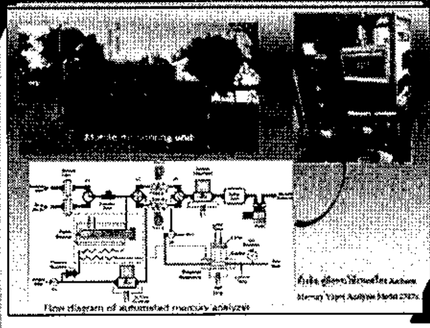
In Thailand, we have two methods to monitor atmospheric mercury:

1. Automatic method: PCD use TEKRAN model 2537X

2. Gold amalgam tube method: ERTC use Mercury Analyzer (NIC WA-5F) and US.EPA IO-5 method as guideline.

Atmospheric Mercury Monitoring by PCD



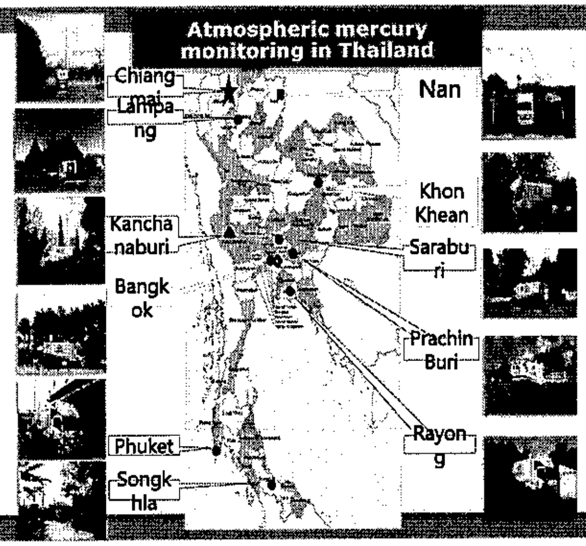


Monitoring classification:
● Industrial sites ◇ Urban site ★ Rural site
▲ Remote site ■ Special purpose

Sampling: ~2 weeks/site

- Establish a baseline of ambient mercury level in Thailand,
- Provide the basis for the long term monitoring station,
- Evaluate long term atmospheric mercury trend , from which to formulate policy,
- Report atmospheric mercury situation to the public,
- Support further implementation of the Minamata Convention in the future.

Atmospheric mercury monitoring in Thailand



Location (near industrial sources)	Sampling	Total Gaseous Mercury (TGM) 1-hr avg. (ng/m³)					
		Sample size	Min.	Median	Mean	Max.	SD
I. Industrial sites (hot-spot sites)							
1. Prachin Buri (sub-bituminous coal-biomass power plant, pulp and paper industry)	18 Nov. - 1 Dec. 2014	398	1.24	2.16	2.27	4.42	0.66
- Wat Lang Tham, Si Maha Phot	6 - 25 Jan. 2018	402	0.91	2.5	3.2	14.76	2.22
	13 Jan. -13 Feb. 2017	735	1.48	2.13	2.29	6.03	0.54
- Wat Bu Yai Bai, Si Maha Phot	20 Dec. 2017 - 4 Jan. 2018	369	1.43	2.63	2.71	4.72	0.62
2. Rayong							
- Ban Nong chok Health Promoting	2 - 25 Dec. 2014	531	1.12	2.95	3.08	9.26	0.98
Hospital, Amphoe Muang (refinery)	16 Feb. - 8 Mar. 2017	483	1.25	2.02	2.02	3.57	0.36
- Herb Garden Princess Maha Chakri Sirindhorn, Nikhom Phatthana (gas separation plant, power plant)	17 Dec. 2015 - 4 Jan. 2016	412	0.72	1.91	1.94	8.02	0.92
- Wat Pluak Ket, Amphoe Muang		492	0.78	1.48	1.53	2.91	0.34
(refinery)	7 - 28 Jan. 2016	337	0.66	1.59	1.69	3.04	0.38

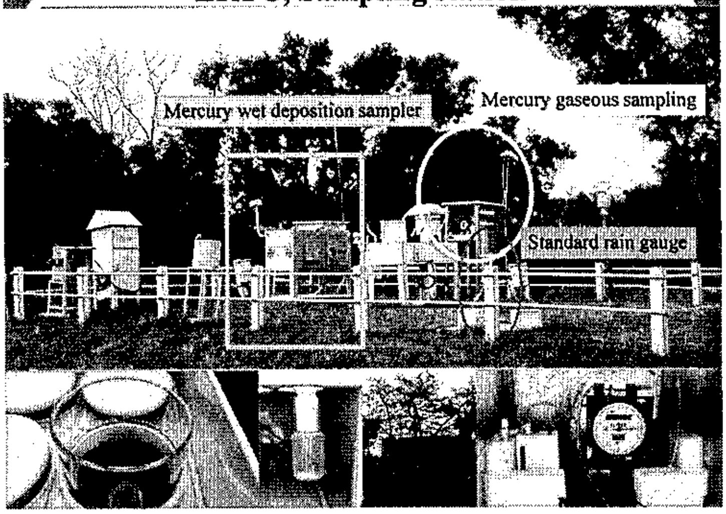
Location (near industrial sources)	Sampling	Total Gaseous Mercury (TGM) 1-hr avg. (ng/m³)					
		Sample size	Min.	Median	Mean	Max.	SD
3. Lampang (coal-fired power plant)	14 Jan. - 17 Feb. 2015	790	0.83	1.45	1.57	8.23	0.57
- Wat Hang Hung Sathatham , Mae Moh	15 Aug. - 13 Sep. 2015	651	0.56	0.88	0.99	3.01	0.28
4. Saraburi (cement clinker production facility)	2 - 20 Nov. 2016	413	1.39	2.44	2.43	7.67	0.71
- Wat Phu Krang, Phraputthabath	22 Nov. - 6 Dec. 2016	344	1.15	2.44	2.34	3.68	0.51
- Wat Tham Mongkut , Phraputthabath							
5. Songkhla (waste incineration facility)	23 Apr. - 1 May 2015	206	0.90	1.81	1.92	2.97	0.46
- Baansuan Isara, Hat Yai	11 - 23 May 2016	298	0.36	1.33	1.39	4.42	0.52
6. Phuket (waste incineration facility)							
- Regional Environment Office 15, Amphoe	4 - 12 May 2015	207	0.42	0.79	1.15	3.70	0.72
Muang	26 May - 7 Jun. 2016	288	0.73	1.5	1.87	5.37	0.90
7. Khon Kaen (waste incineration facility)							
- Khonkaenwittayayon school, Amphoe	16 - 25 May 2017	218	0.82	1.62	1.67	4.96	0.43
Muang	25 Aug. - 4 Sep. 2017	253	1.04	1.24	1.26	2.8	0.17
8. Bangkok (waste incineration facility)							
- Sarasas Witaed Nongkhaem School	3 - 9 May. 2017	162	0.9	1.55	1.94	10.51	1.24

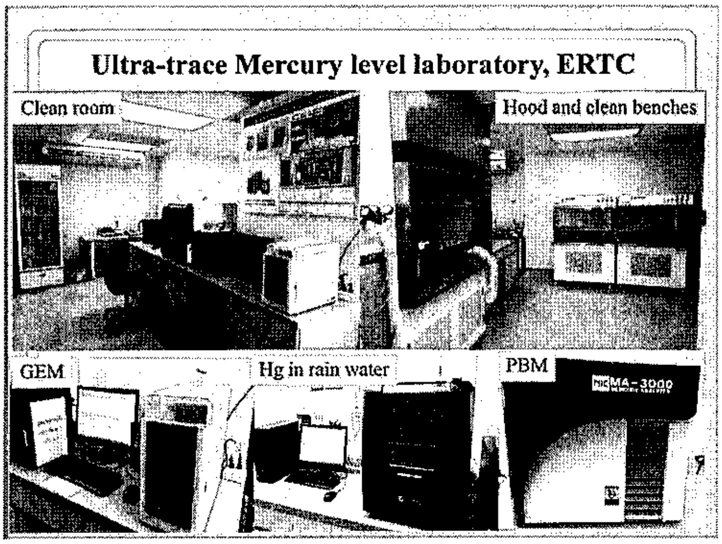
Location (near industrial sources)	Sampling	Total Gaseous Mercury (TGM) 1-hr avg. (ng/m³)					
		Sample size	Min.	Median	Mean	Max.	SD
II. Urban site (Bangkok)							
- The Government Public Relations Department,	25 Nov. - 15 Dec. 2017	483	1.85	2.67	2.82	6.13	0.71
III. Rural site (Chiang Mai)							
- Mea Hai, Amphoe Muang	3 Mar. - 1 Apr. 2017	613	0.84	1.61	1.67	3.05	0.47
IV. Remote site (KanchanaBuri)							
- Vajiralongkorn Dam, Thongphaphum	12 Nov. - 26 Dec.	295	0.36	0.77	0.77	1.14	0.15
	2015	481	0.72	1.26	1.29	2.20	0.27
	29 Mar. - 8 Apr. 2016	138	1.11	1.39	1.45	2.17	0.18
	12 - 17 Apr. 2017						
V. Special Purpose (Nan) (air quality surveillance to assess air pollution from the coal fire power plant in Lao PDR)							
- District Office, Chaloem Phra Kiat	19 Feb. - 25 Mar.	575	0.85	1.58	1.7	3.70	0.47
- Chaloem Phra Kiat Hospital, Chaloem	2015	344	0.9	1.2	1.21	2.57	0.16
Phra Kiat	12 - 26 May. 2017	445	0.71	1.16	1.16	2.59	0.13

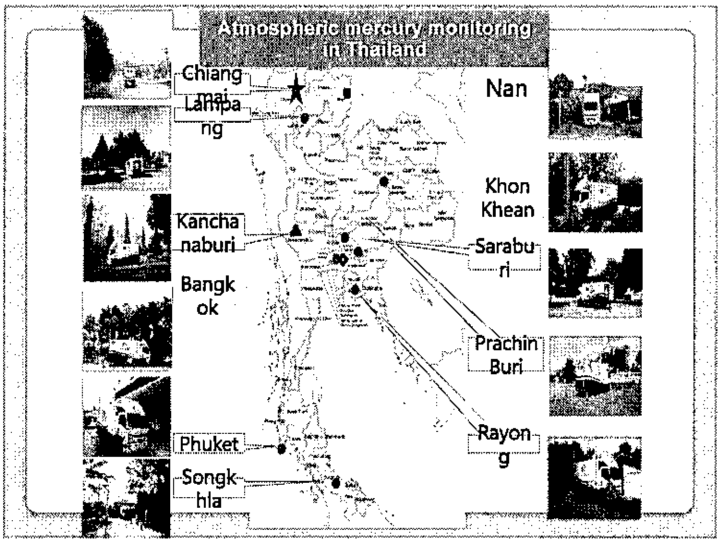
ERTC: Atmospheric mercury measurement

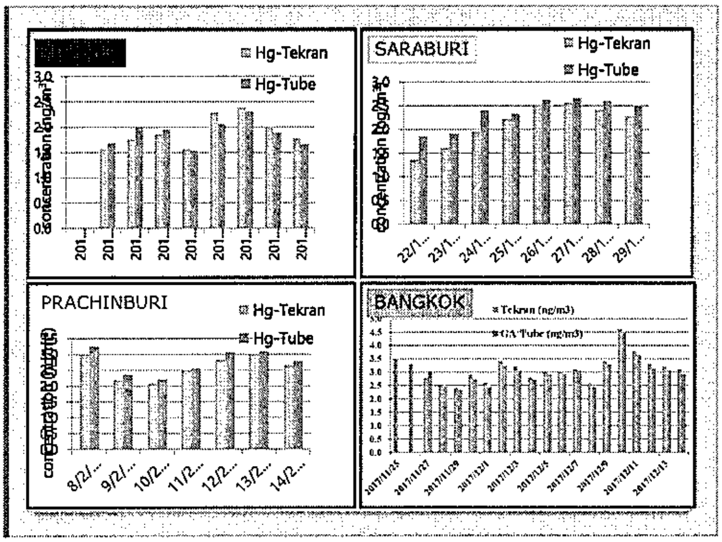
- ERTC has established Ultra-trace Mercury Level Laboratory for atmospheric and wet deposition mercury analysis since 2016
- Atmospheric mercury measurement using Gold Amalgam Tube method analyzed by CVAFS technique
- Study level of mercury in air in different areas (rural, urban, industrial, contaminated site, etc.)

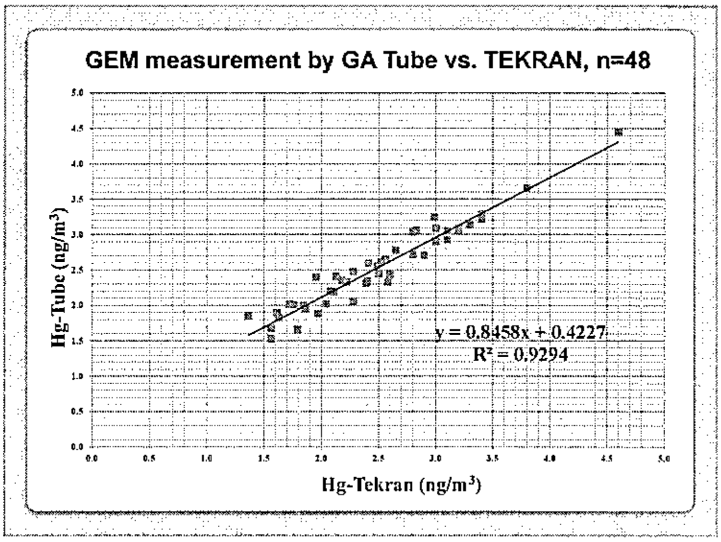
ERTC, Sampling station

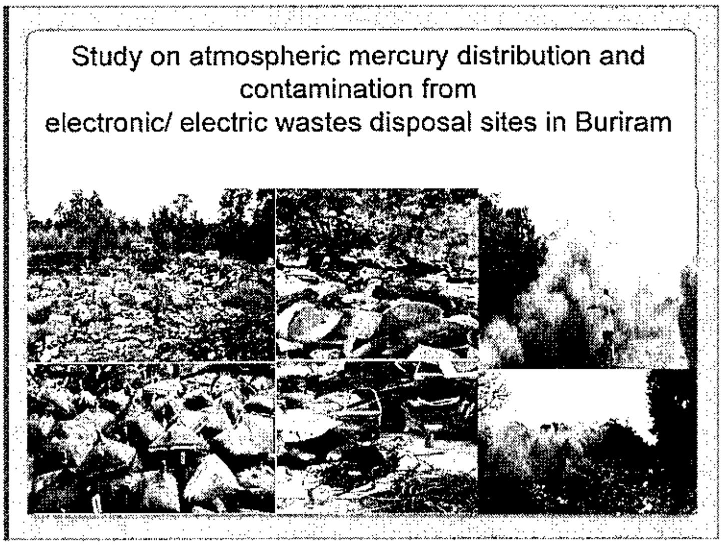


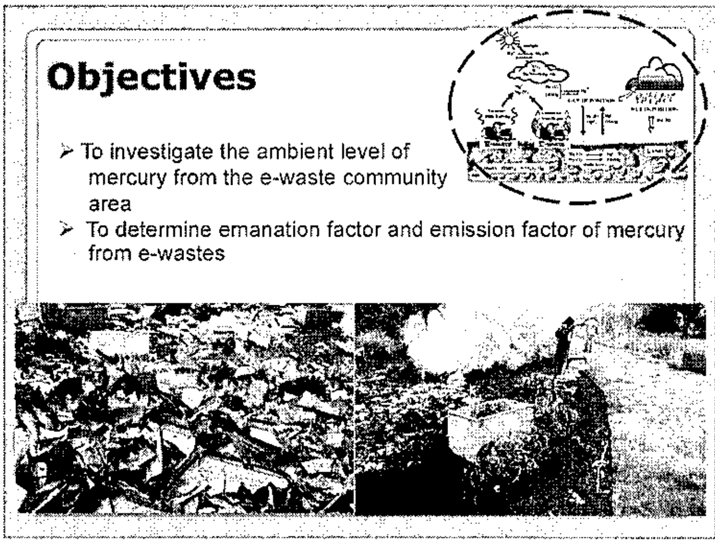

Ultra-trace Mercury level laboratory, ERTC
Clean room
Hood and clean benches
GEM
Hg in rain water
PBM
MA-3000

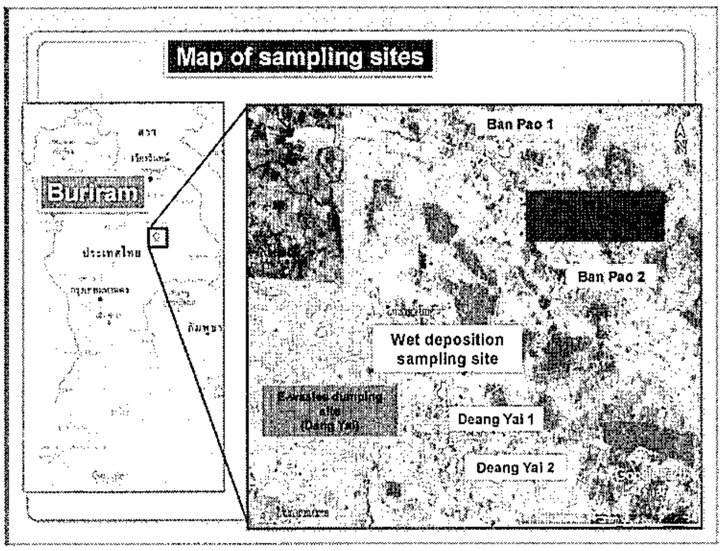

Atmospheric mercury monitoring in Thailand
Chiang mai
Lampang
Nan
Khon Khean
Kanchanaburi
Sarabu ri
Bangkok
Prachin Buri
Rayong
Phuket
Songkhla

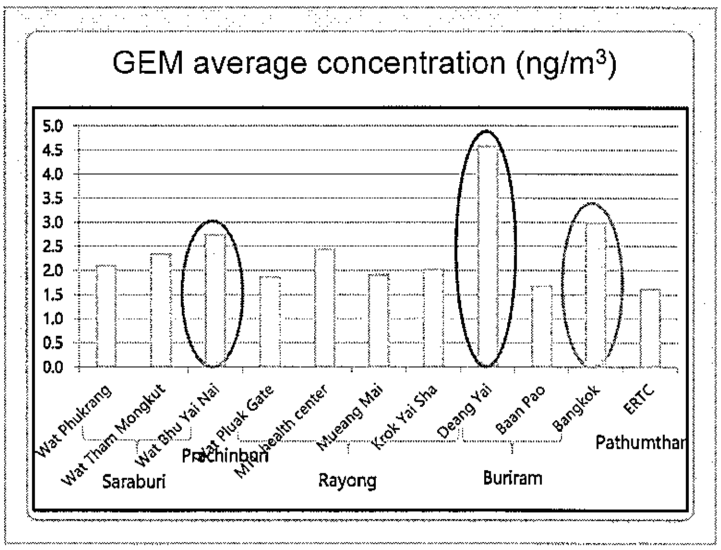

[redacted]
Hg-Tekran
Hg-Tube
concentration (ng/m³)
SARABURI
Hg-Tekran
Hg-Tube
PRACHINBURI
Hg-Tekran
Hg-Tube
BANGKOK
Tekran (ng/m3)
GA Tube (ng/m3)


GEM measurement by GA Tube vs. TEKRAN, n=48
Hg-Tube (ng/m³)
Hg-Tekran (ng/m³)
y = 0.8458x + 0.4227
R² = 0.9294

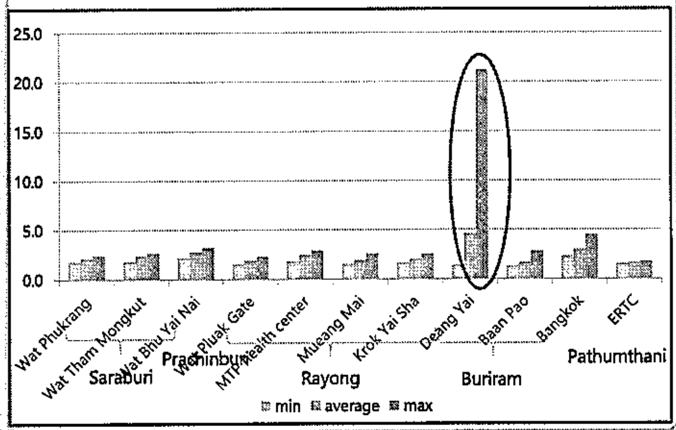

Study on atmospheric mercury distribution and contamination from
electronic/ electric wastes disposal sites in Buriram


Objectives
➢ To investigate the ambient level of mercury from the e-waste community area
➢ To determine emanation factor and emission factor of mercury from e-wastes


Map of sampling sites
Buriram
Ban Pao 1
[redacted]
Ban Pao 2
Wet deposition sampling site
Deang Yai 1
Deang Yai 2

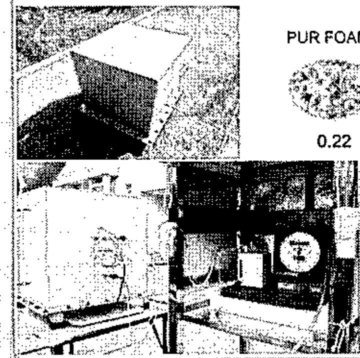

GEM average concentration (ng/m³)
Wat Phukrang
Wat Tham Mongkut
Wat Bhu Yai Nai
Wat Pluak Gate
MR health center
Mueang Mai
Krok Yai Sha
Deang Yai
Baan Pao
Bangkok
ERTC
Saraburi
Prachinburi
Rayong
Buriram
Pathumthani

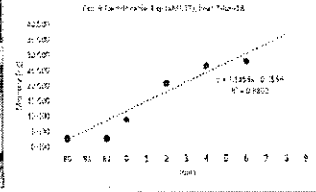
GEM concentrations (ng/m³)



Emanation factor of Hg from e-waste

$$Emanation\ Factor\ (\frac{ng}{kg \cdot h}) = \frac{Total\ Hg\ (ng/h)}{Weight\ of\ waste\ (kg)}$$

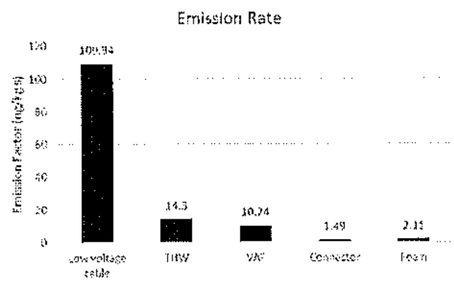


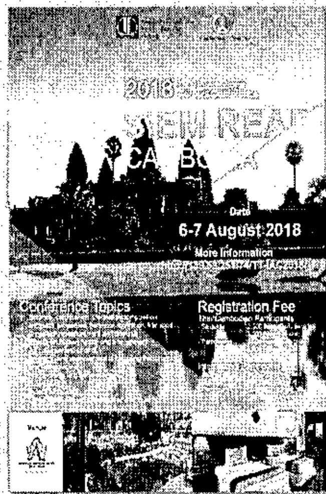


Emission factor of Hg from e-waste

$$Stack\ conc.\ (ng/m^3) = \frac{Total\ Hg\ (ng)}{sampling\ rate\ \left(\frac{m^3}{min}\right) \times sampling\ time\ (min)}$$

$$Emission\ Factor\ (\frac{ng}{kg \cdot s}) = \frac{Stack\ conc.\ (ng/m^3) \times flow\ rate\ (m^3/sec)}{Weight\ of\ waste\ (kg)}$$





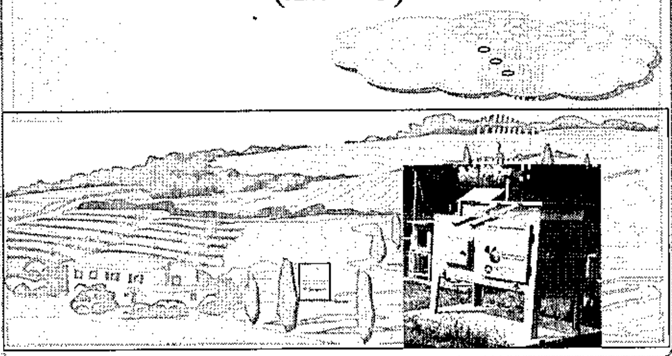
Emanation and Emission Factors of Mercury from E-Waste in Thailand

Hathairatana Garivait[1], Prapat Pongkiatkul[2]

[1]Environmental Research and Training Center, Department of Environmental Quality Promotion,
[2]King Mongkut University Technology Thonburi

Mercury vapor is commonly classified as a highly toxic gaseous pollutant. One of major concerned source of mercury is from an electronic waste (E-waste). Due to its own property (low vapor pressure), mercury vapor can be evaporated under a room temperature and will be released more at higher temperate. Illegal E-waste management causes huge amount of mercury vapor released to the air, which cause highly damage to human health and environment. This study attempted to develop an emanation and emission factors of mercury from E-waste that usually found in the North East of Thailand. The emanation experiment was conducted under a controlled environment (air tight box coated with Teflon), whereas the emission test was performed in an open area. Highest emanation rate was found for a broken fluorescent lamp (174.183 ng/kg•h), whereas electric cable and PUR foam (from refrigerator) also released mercury vapor at a rate of 0.242 and 0.219 ng/kg•h, respectively. However, a glass and aluminium case from CRT television were not observed any released mercury vapor. Electric cable is normally burned openly in the filed to separate coppers. The low-voltage cable generated the highest mercury emissions at a rate of 109.34 ng/kg•s. THW and VRF cables also released at a rate of 14.30 and 10.24 ng/kg•s, whereas lower emissions were found for plastic electronic connector and foam (1.49 and 2.11 ng/kg•s)

Mercury wet deposition monitoring (ERTC)



Hg wet deposition sampling with automatic rain sampler donated by Taiwan EPA has started since 27 September 2016

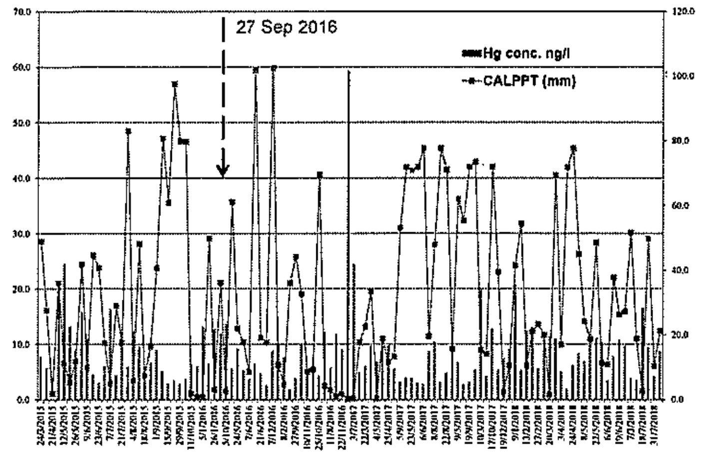
Guidelines for sampling

- APMMN Field Sample SOP
- EPA method: Method 1631 revision E

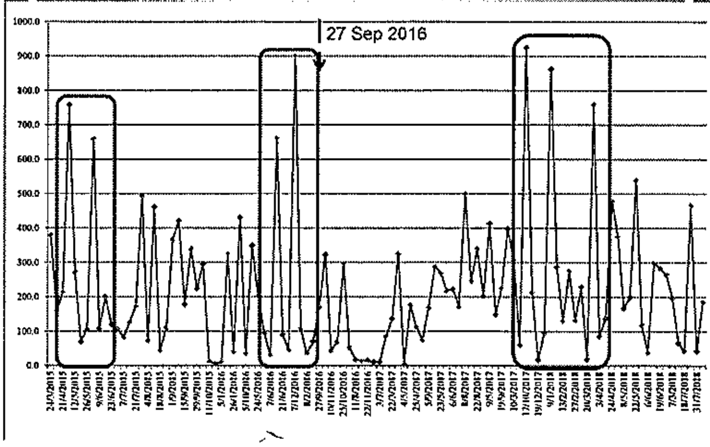
Acknowledgement

- ERTC would like to acknowledge the National Central University, Taiwan, especially Prof. Sheu and Mr. Da-Wei, for their kind support as always to analyze mercury wet deposition samples from ERTC.

Mercury concentration in rain water at ERTC (ng/L)



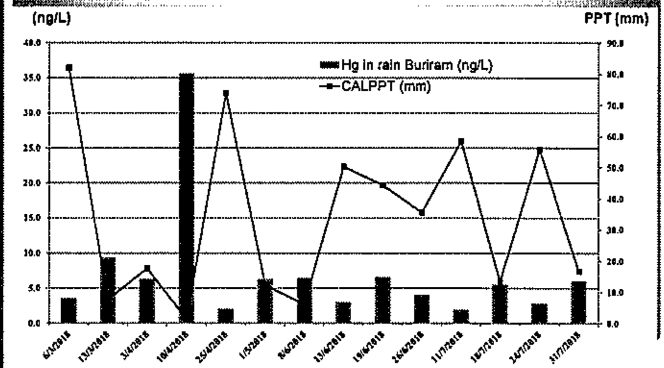
Mercury wet deposition at ERTC (ng/m²)



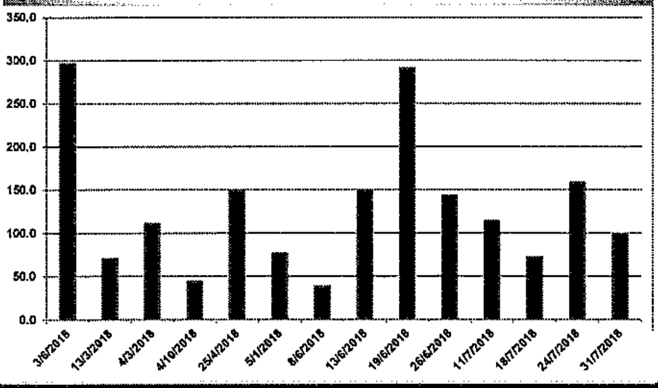
Volume weighted average concentration

	Total Hg dep.(ng/m²)	Total PPT (mm)	VWA (ng/L)	Number of samples
	6557.9	952.2	6.89	28
	4433.2	669.1	6.63	25
	6355.1	1112.3	5.71	29
	6679.3	812.9	8.22	26

Mercury concentration in rain water at e-waste community area (ng/L)



Hg wet deposition in e-waste community area (ng/m²)



Future plan (ERTC)

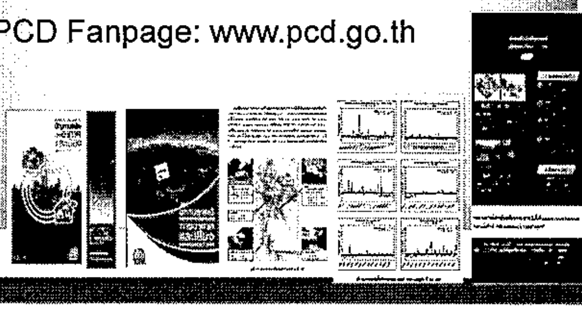
- ERTC will be able to measure Particulate Bound Mercury (PBM)
- Continue putting the effort to analyze mercury wet deposition samples at ERTC and be able to make the inter-lab comparison with NCU, Taiwan
- Research project in the 2019 fiscal year will be to evaluate the dispersion of mercury from e-waste and municipal solid wastes dumping sites using the emanation and emission factors
- Collaborate closely with PCD for investigation of atmospheric Hg to assist the establishment AQS for mercury in Thailand.
- Collaborate with APMMN countries in the future, e.g. Passive sampler ???

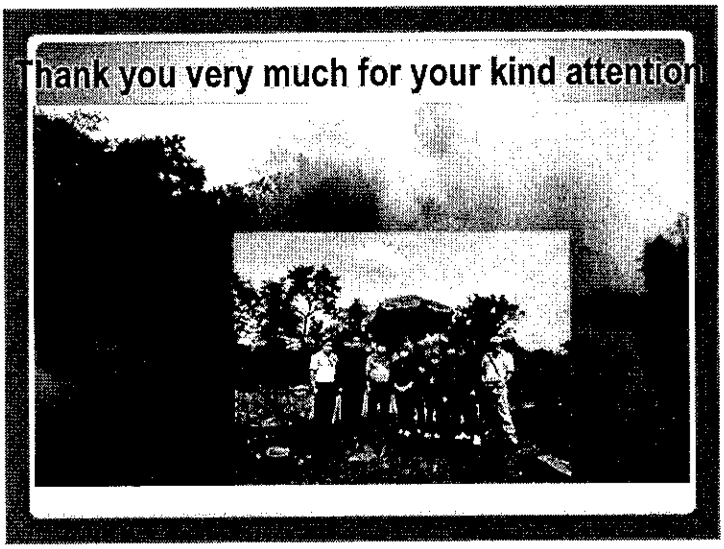
Future plan (PCD)

- **Continuous atmospheric mercury monitoring**
  - ✓Monitor more urban and rural site (EANET sites)
  - ✓Plan to purchase the Mercury Vapor Calibration Unit
- **Gold amalgamation trap method** (Japan's standard method)
  - ✓Join "the Atmospheric air monitoring of mercury and data sharing in Asia-Pacific region"
- **Design for long-term mercury monitoring network**
  - ✓ **Continuous monitoring stations?** How many sites? Location? Objectives? Comparable? Urban sites?
  - ✓ **Gold amalgamation trap site?** How many sites? Location? Objectives? Comparable? Rural and Remote sites?
  - ✓ **Mobile unit?** Hot spot sites? Compliant? Research?

Report to the public

- State of Air and Noise Pollution Report Year 2015, 2016, 2017
- PCD Fanpage: www.pcd.go.th




Thank you very much for your kind attention

VIETNAM ENVIRONMENTAL ADMINISTRATION (VEA)
CENTRE FOR ENVIRONMENTAL MONITORING (CEM)
Website: http://www.quantracmoitruong.gov.vn/

MERCURY MONITORING IN VIETNAM

Vietnam Environmental Administration

Manila, September 2018

CONTENTS

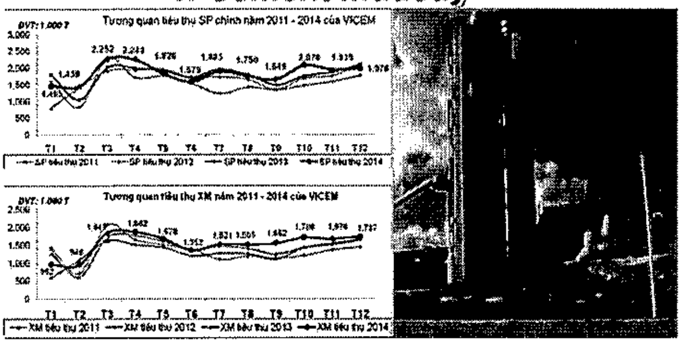
SOURCES OF MERCURY

Industries with mercury emissions to the environment

In Vietnam, some mercury sources are found as below:

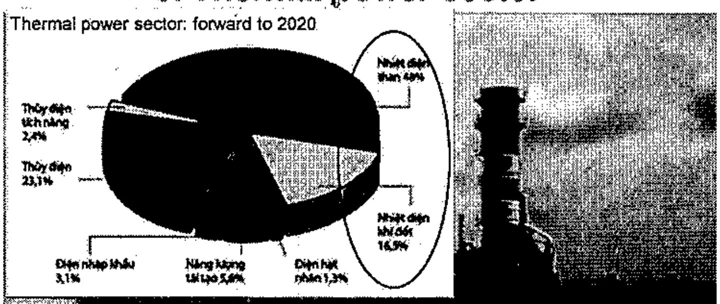
- *Coa-fired thermal power plants*
- *Cement factories/plants*
- *Steel production plants*
- *Waste incinerator*
- *Gold mining*
- *Other sources:* Oil refinery, thermometer, Compact fluorescent lamp, dentistry, electric components, metallurgy, e-waste, landfill, chemistry…
- In Vietnam, currently, Hg has not been managed well and strictly.

1. Cement Industry



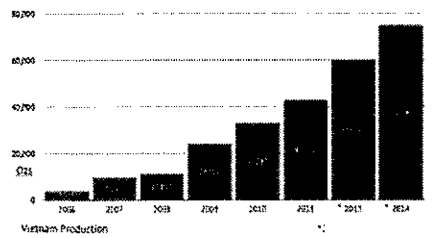
In 2014, Vicem has produced 16.5 million tons of clinker and 18.46 million tons of cement, Production increase over 2013: 0,7% and 10,3% respectively

3. Thermal power sector

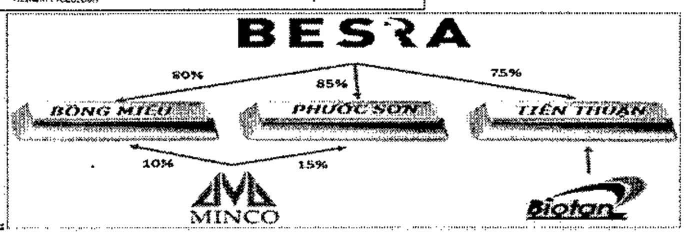


The co…
- 2015: needed 2? million tons
- 2020: need up to 67 million tons
- 2030: about 150 million tons

2. Gold mining



Gold mining production increased every year



RESULTS OF MERCURY SURVEYS (2009)

- Cement production:
  - Mercury was discovered in cement with small content (0.02 – 0.08 mg/kg)
- Iron and steel production:
  - Mercury was also discovered in coke coal (0.032 – 0.384 mg/kg)

MERCURY MONITORING IN VIETNAM

Mercury monitoring in the air in Vietnam

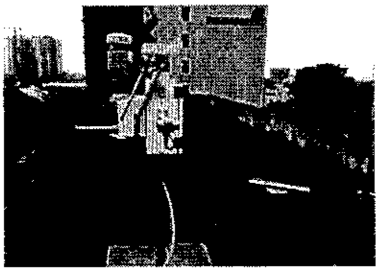
- **2010**: Joint the 7-SEA program.
- **2012**: workshop in Taiwan.
  - 01 automatic station for air quality monitoring in Hanoi *(including Hg parameter).*
- **2013**: Workshop in EPA, Washintong DC.
- **2014**: Vietnam has joined the Asia-Pacific Mercury Monitoring Pilot Network.
  - 01 wet sampler in Hanoi *(for Hg analysis).*
- **2015**: Pilot of mercury monitoring for Coal Power Plants
- **2016**: workshop in Taiwan and Thailand.

Mercury monitoring in the air in Vietnam

2017: Research and design of the program of mercury monitoring in the air.
2018: The designed programm is submited to MONRE for approving.
2019: to do monitoring mercury in the air.

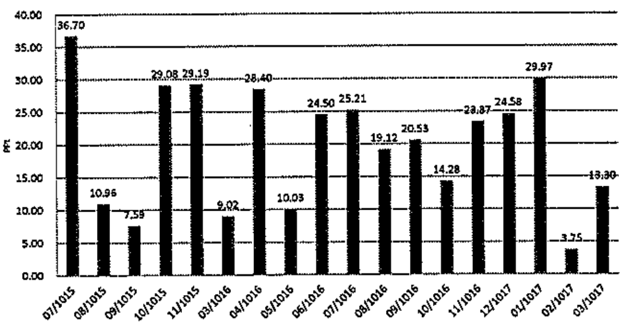
Updated atmospheric mercury level in Hanoi

Location: building No.556, Nguyen Van Cu, Gia Lam, Hanoi
(North of Vietnam)

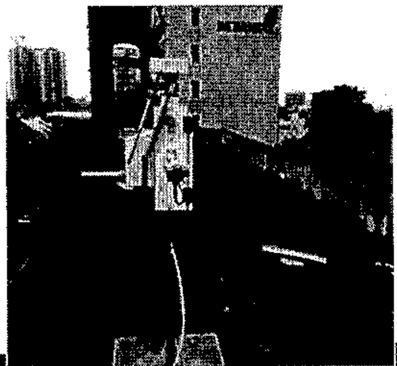


The wet samples are send to National Central University (NCU) of Taiwan for mercury analysis

Vietnam Rainwater Hg data



Installatoin of the second wet desition sampler in Danang city, in central of Vietnam



Updates on current mercury monitoring from emission sources

- Monitoring and emission control activities (2016):
  - CEM carry out manual monitoring Hg emission from waste incineration follow Vietnam Technical Regulation (QCVN 02; QCVN 30; QCVN 61). US EPA 29 has been used as a standard method for heavy metal sampling and analysis.
  - Mercury particle bound phase range from N.D to 0.3 ng/Nm³ in which close to Vietnam Technical Regulation.

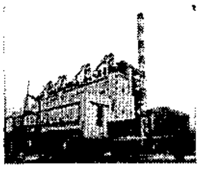
Incineration type	Number of sample	Concentration (mg/Nm3)	Duration
Municipal waste	05	Nd-0.2	From Jan 2016
Hospital waste	02	0.2-0.3	From Jan 2016
Industrial waste	03	0.1-0.3	From Jan 2016

Updates on current mercury monitoring from emission sources

- Monitoring and emission control activities (2016):

-CEM is collaborating with Pollution Control Dept (PCD) in order to monitoring of Hg emission from 03 thermal coal power (TCP) plants. This activities had be completed in August 2016.

-Total 84 samples will be collected for total Hg analysis which include flue gas, fly ash and coal powder samples. Flue gas samples was be collected by both of US EPA 29 and US EPA 30B.



Hai Phong TCP plant

Mong Duong 2 TCP plant

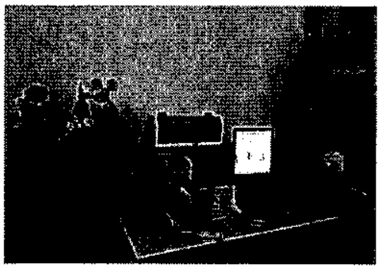
Ninh Binh TCP plant

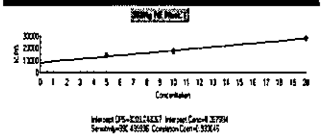
Updates on capacity building of mercury monitoring for CEM - VEA

Updates on equipment capacity for mercury monitoring

Equipment	Method	Quantity
Wet deposition sampler	APMMN SOP	01 sampler (USEPA sponsor)
Isokinetic sampler	US EPA 29	03 sampler
Mercury on-site sampling and analysis (Apex Ainstruments)	US EPA 30A	01 MODULE (US MOFA sponsor)
AAS	US EPA 29	01 analyzer
ICP-MS	US EPA 200.8	02 available
Mercury analyzer (SMS 100)	US EPA 1631	01 available

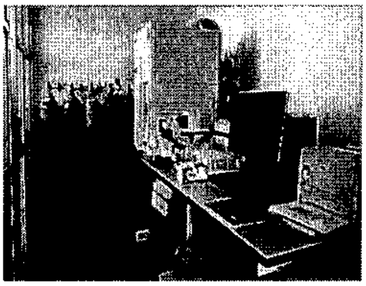
Updates on capacity building of mercury monitoring for CEM - VEA





Laboratory analysis of Mercury in water and flue gas matrix samples (2016)

Updates on capacity building of mercury monitoring for CEM - VEA



ICP-MS

Plan and Propose

PLAN FOR THE FUTURE

- Monitoring Mercury in the air, 2019;
- Completion of methods for monitoring and analyzing mercury in the air;
- International collaboration for academic exchange and technical supporting;
- QA/QC guarantee in sampling, analysis and data processing

WHAT IS NEXT ?

- Technical support for Hg monitoring and analysis;
- Sharing data among APMMN contry partner.

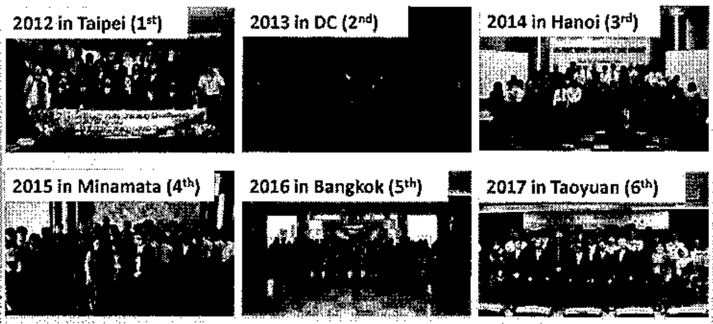
State of the Network : mercury central analytical lab and site liaison reports

Guey-Rong Sheu and Da-Wei Lin

Department of Atmospheric Sciences
National Central University, Taiwan

Background

NCU has been working closely with Taiwan EPA, USEPA and NADP since 2012 to establish the collaborative Asia-Pacific Mercury Monitoring Network (APMMN).



2

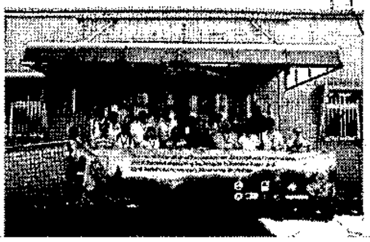
Background

- NCU Hg Lab serves as the center for ultra-trace level Hg analysis and training
  - To help analyze rainwater samples, and to train researchers from other Asian countries for capacity building on ultra-trace level Hg sampling and analysis
- EPAT funded the establishment of the Center for Environmental Monitoring and Technology on NCU campus in 2016
  - Administrative offices and lab expansion to support the operation of Asia-Pacific Mercury Monitoring Network

3

Center for Environmental Monitoring and Technology

Center Opening Ceremony in June 2016



5

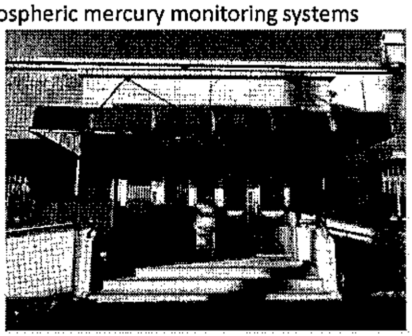
Administrative Area

6

Trace-Level Mercury Analytical Lab

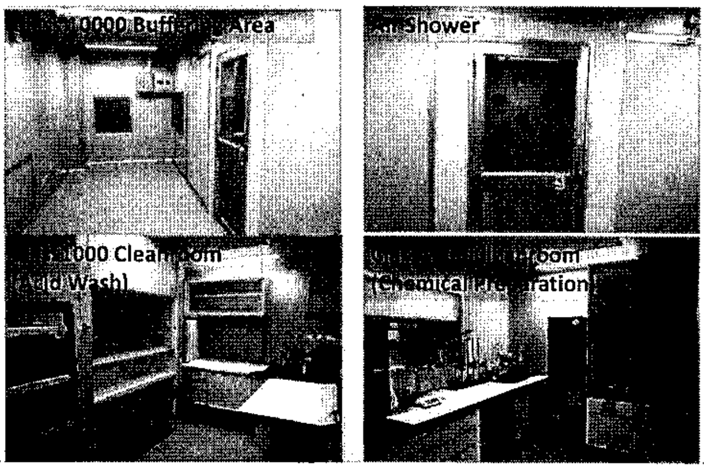
Established in 2007. Expanded in 2016.

- 2 class 1000 cleanrooms
- 3 Tekran 2600 CVAFS mercury analyzers
- Tekran and Gardis atmospheric mercury monitoring systems
- 2 clean benches
- 2 DI water systems
- 2 analytical balances
- 4 chemical hoods
- UHP Ar supply
- Chemical furnace
- Labware furnace
- pH/conductivity meter



7

Expansion of Lab Space and Equipment

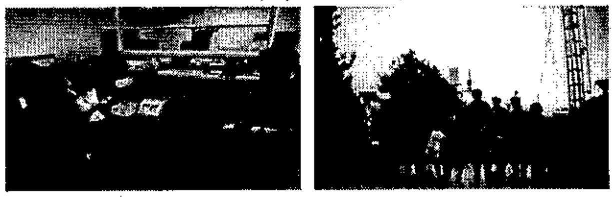


Expansion of Lab Space and Equipment

Atmospheric and Rainwater Mercury Monitoring Training

Training Activities

Visit of Vietnam CEM (April 2017)



Training Workshop (May 2017)

Training Activities

Site visit, Thailand (February 2017)

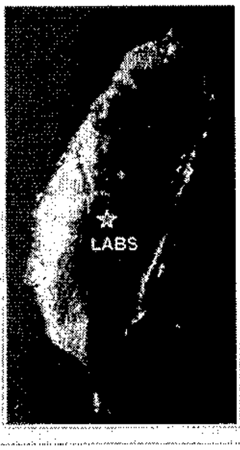
Site visit, Vietnam (October 2017)

Training Activities

Site survey and training, Philippines (June 2018)

New APMMN Site at the Lulin Atmospheric Background Station (LABS)

Location of Lulin Atmospheric Background Station(LABS)

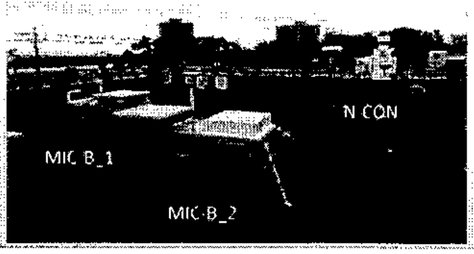


- LABS is located atop Mt. Front Lulin in central Taiwan, with an elevation of 2862 m above sea level.
- Continuous speciated atmospheric Hg monitoring started since April 13, 2006.
- Wet Hg deposition monitoring since January 2017.

Wet Sampler Inter-comparison

Inter-comparison of Wet Deposition Samplers

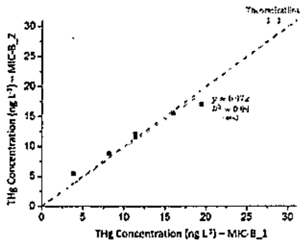
- There is no "standard" wet deposition sampler.
- APMMN uses MIC-B type sampler, whereas NADP/MDN uses N-CON sampler
  - MIC-B vs N-CON : since January 2017
  - MIC-B vs MIC-B : since April 2018



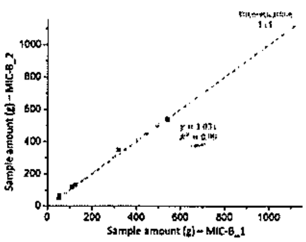
Inter-comparison of Wet Deposition Sampler

MIC-B vs MIC-B: 6-pair of samples in 2018/04-06

THg concentration



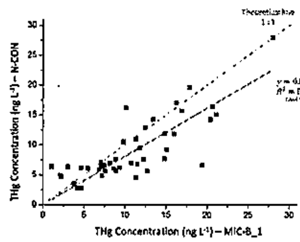
Sample amount



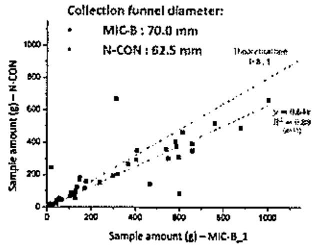
Inter-comparison of Wet Deposition Sampler

MIC-B vs N-CON: 43-pair of samples until 2018/06

THg concentration



Sample amount



- Lid opening/closing time difference (sensor/motor difference)
- Raindrop bounce/splash
- Evaporation of water and/or Hg
- Wind speed and direction
- Other factors

Literature Review-Collocated Samplers

Wetherbee et al., 2006

Environ Monit Assess
DOI 10.1007/s10661-006-9156-6

Estimated Variability of National Atmospheric Deposition Program/Mercury Deposition Network Measurements Using Collocated Samplers

Gregory A. Wetherbee · David A. Gay · Robert C. Brunette · Clyde W. Sweet

Received: 23 February 2006 / Accepted: 23 August 2006
© Springer Science + Business Media B.V. 2007

Literature Review-Collocated Samplers

Wetherbee et al., 2006

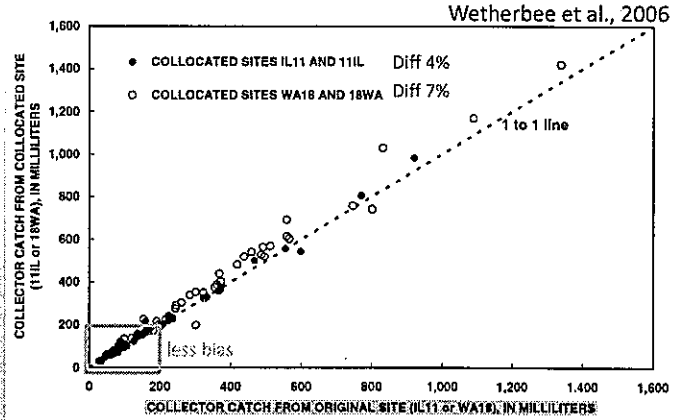


Fig. 8 Comparison of collector catch (sample volume) obtained from collocated wet-deposition collectors at Mercury Deposition Network at sites IL11/11IL and WA18/18WA during 1998–2002. *Points* represent data pairs, not differences

Literature Review-Collocated Samplers

Variation of Collocated Site Total Mercury Concentration with Original Site Mercury Concentration

Wetherbee et al., 2006

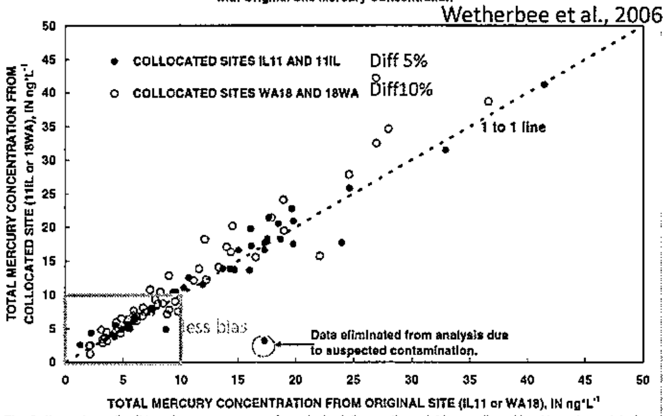


Fig. 3 Comparison of valid total mercury concentrations obtained from collocated Mercury Deposition Network precipitation collectors at sites IL11/11IL and WA18/18WA during 1998–2002. *Points* represent data pairs, not differences

Literature Review-Evaporation Test

USGS

Effects of Equipment Performance on Data Quality from the National Atmospheric Deposition Program/National Trends Network and the Mercury Deposition Network

By Gregory A. Wetherbee and Mark F. Rhodes

Open-File Report 2013–1031

U.S. Department of the Interior
U.S. Geological Survey

USGS, 2013

Literature Review-Evaporation Test

Table 7. Results from evaporation tests with N-CON single-chimney collector.

[%, percent; ng/L, nanograms per liter; MPV, most probable value; Hg, mercury]

Dates samples deployed in collectors	Sampling Period (days)	Mass Loss (grams)	Volume Loss (%)	MPV (ng/L)	Measured total Hg concentration (ng/L)	Hg concentration difference[1] (%)	Hg mass loss[2] (%)
7/05/11 – 7/12/11	7	1.7	1.1	15.2	14.4	-5.3	6.5
7/12/11 – 7/19/11	7	2.4	1.6	15.2	12.7	-16.2	17.7
7/19/11 – 7/26/11	7	1.4	0.9	20.8	12.8	-38.3	38.9
7/26/11 – 8/02/11	7	0.9	0.5	14.2	13.5	-6.1	5.6
8/02/11 – 8/09/11	7	1.7	0.9	9.03	8.62	-4.5	5.4
8/09/11 – 8/16/11	7	0.8	0.5	9.03	8.16	-9.6	10.1
8/16/11 – 8/23/11	7	0.9	0.4	14.2	14.3	1.0	-0.5
8/23/11 – 8/30/11	7	0.0	0.5	20.8	19.8	-4.8	5.1
8/30/11 – 9/06/11	7	1.1	0.7	9.03	7.4	-18.1	18.7
9/06/11 – 9/13/11	7	0.8	0.4	15.5	14.3	-7.9	8.4
9/13/11 – 9/20/11	7	0.3	0.2	14.2	14.1	-0.6	0.8
9/20/11 – 9/27/11	7	0.7	0.4	15.5	13.8	-10.8	11.1
9/27/11 – 10/04/11	7	1.6	1.1	15.5	15.1	-2.9	4.1
10/04/11 – 10/11/11	7	4.1	2.2	6.02	4.91	-18.4	20.3
10/11/11 – 10/18/11	7	0.8	0.5	6.02	5.32	-11.6	12.1
10/18/11 – 11/01/11	14	0.8	0.4	6.02	5.34	-11.3	11.7

[1]((Measured – MPV)/MPV) × 100

[2]((MPV – Measured)/MPV) × 100

USGS, 2013

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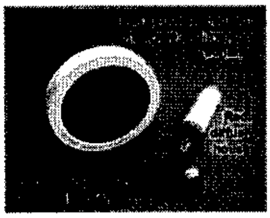
Passive Atmospheric Hg Sampler

Passive Atmospheric Hg Sampler

Advantages:

- Lower cost
- No need for electricity and gases
- Easy to use and deploy
- Improved spatial resolution



Environmental Science & Technology Letters

A High-Precision Passive Air Sampler for Gaseous Mercury

Atmospheric Chemistry and Physics EGU

Global evaluation and calibration of a passive air sampler for gaseous mercury

Environmental Research Letters

Identifying and evaluating urban mercury emission sources through passive sampler-based mapping of atmospheric concentrations

Atmospheric Measurement Techniques EGU

The effects of meteorological parameters and diffusive barrier reuse on the sampling rate of a passive air sampler for gaseous mercury

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Passive Atmospheric Hg Sampler

- Visited to Professor Frank Wania's lab at the University of Toronto Scarborough in June 2018
- Trained in lab: sampler assembly, field setup, sample analysis, applications.

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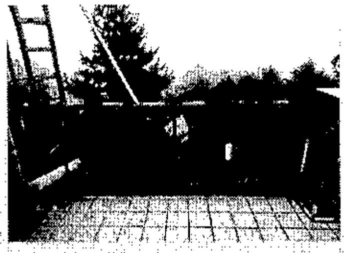
Passive Air Sampler Test in Taiwan

- Began since July 2018
- Deployed at site on NCU campus (suburban) and at the Lulin Atmospheric Background Station (remote)
- Side-by-side with Tekran systems
- Various temporal resolution (1, 2, 4 and 13 weeks)

NCU Site

LABS Site



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Progress on Wet Deposition Sample Analysis: QA/QC and Data Summary

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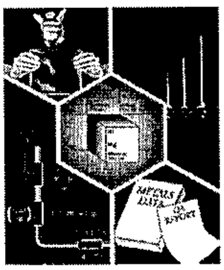
Rainwater Hg Analysis

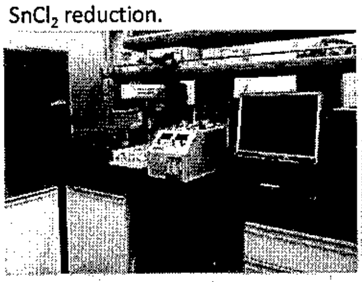
EPA

Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

August 2002



Total Hg is quantified by dual amalgamation Cold Vapor Atomic Fluorescence Spectrometry (CVAFS) after BrCl oxidation, $NH_2OH \cdot HCl$ neutralization, and $SnCl_2$ reduction.



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Method Detection Limit

The detection limit and minimum level of quantitation in this Method usually are dependent on the level of interferences rather than instrument limitations. The method detection limit (MDL; 40 CFR 136, Appendix B) for Hg has been determined to be 0.2 ng/L when no interferences are present. The minimum level of quantitation (ML) has been established as 0.5 ng/L. An MDL as low as 0.05 ng/L can be achieved for low Hg samples by using a larger sample volume, a lower BrCl level (0.2%), and extra caution in sample handling.

Lowest Ambient Water Quality Criterion for Mercury and the Method Detection Limit and Minimum Level of Quantitation for EPA Method 1631

Metal	Lowest Ambient Water Quality Criterion[1]	Method Detection Limit (MDL) and Minimum Level (ML)	
		MDL[2]	ML[3]
Mercury (Hg)	1.3 ng/L	0.2 ng/L	0.5 ng/L

1. Lowest water quality criterion for the Great Lakes System (Table 4, 40 CFR 132.6). The lowest Nationwide criterion is 12 ng/L (40 CFR 131.36).
2. Method detection limit (40 CFR 136, Appendix B)
3. Minimum level of quantitation (see Glossary)

MDL of the NCU lab is 0.12 ng/L

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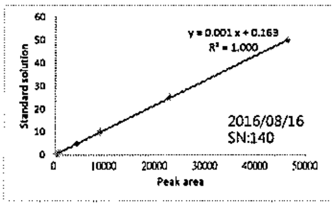
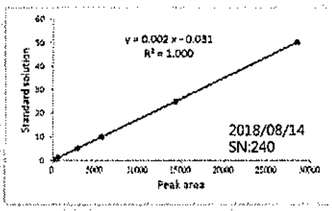
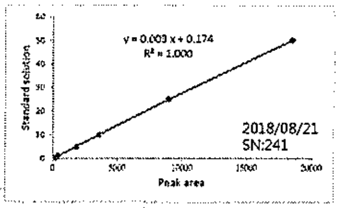
Calibration Curve







Blanks

System blank

	Freqency	Mean (ng L^{-1})	Min. (ng L^{-1})	Max. (ng L^{-1})	1631 rev. E
2016 – 2017	127	0.18	0.05	0.53	< 0.5 ng L^{-1}
2018 (Jan – Jun)	34	0.07	0.03	0.15	

Bottle blank

	Freqency	Mean (ng L^{-1})	Min. (ng L^{-1})	Max. (ng L^{-1})	1631 rev. E
2016 – 2017	83	0.12	0.00	0.48	< 0.5 ng L^{-1}
2018 (Jan – Jun)	20	0.38	0.02	1.95	

Duplicate Analysis and Matrix Spike

Duplicate analysis

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016 – 2017	128	1.0	0.0	4.9	RPD < ±20 %
2018 (Jan – Jun)	29	3.8	0.1	10.9	

Matrix spike/duplicate

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016 – 2017	130	101.5	96.5	119.6	Recovery 71 – 125 %
2018 (Jan – Jun)	32	98.5	78.5	110.0	

Recovery of QCS and CRM

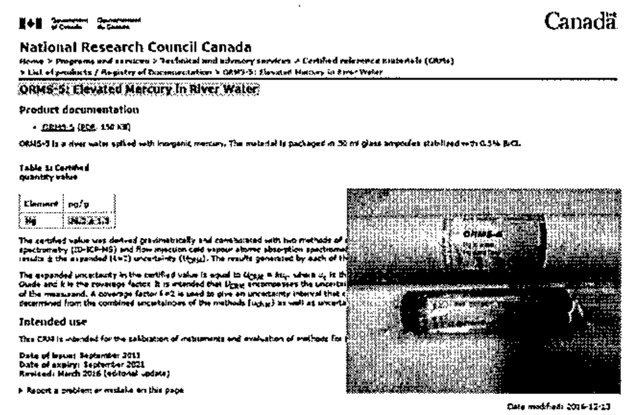
Quality control sample (QCS)

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016 – 2017	83	100.5	95.6	106.3	Recovery 80 – 120 %
2018 (Jan – Jun)	33	102.5	91.7	113.7	

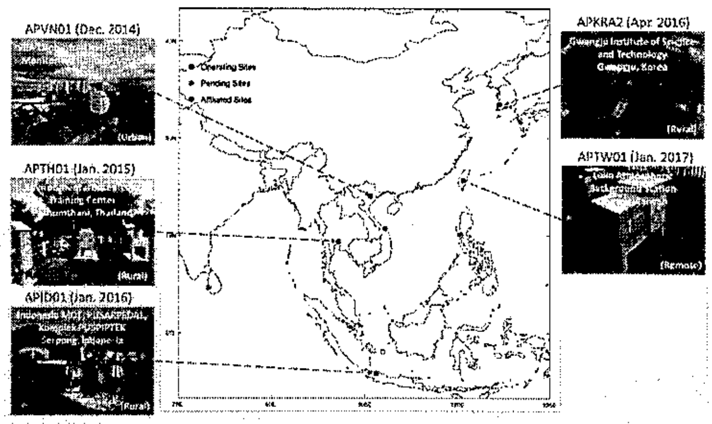
Certified reference material (CRM)

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016/12 – 2018/06	24	94.1	87.5	99.6	–

Source of CRM



APMMN Site Information



Samples Received and Analyzed

Rain water sample
From 2016 to June 2018

Site ID	City	Number of samples			Subtotal
		2016	2017	2018	
APID01	Jakarta	19	20	10	49
APTH01	Pathum Thani	44	44	20	108
APTW01	Nantou	-	44	22	66
APVN01	Hanoi	12	13	6	31
APKRA2	Gwangju	29	28	15	72
Summary		104	149	67	326

Samples Received and Analyzed

QC sample (Reagent blank, bottle blank, ...)
From 2016 to June 2018

Site ID	City	Number of samples			Subtotal
		2016	2017	2018	
APID01	Jakarta	-	-	-	-
APTH01	Pathum Thani	14	8	6	28
APTW01	Nantou	-	45	20	65
APVN01	Hanoi	4	1	-	5
APKRA2	Gwangju	-	-	-	-
Summary		18	54	26	98

Samples Received and Analyzed

Other samples (e.g. surface water)
From 2016 to June 2018

Site ID	City	Number of samples			Subtotal
		2016	2017	2018	
APID01	Jakarta	-	-	-	-
APTH01	Pathum Thani	11	9	12	32
APTW01	Nantou	-	-	-	-
APVN01	Hanoi	-	-	-	-
APKRA2	Gwangju	-	-	-	-
Summary		11	9	9	32

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Data Summary of January-June 2018

Site ID	Location	Number of Sample	Rainwater Hg Conc. (Mean±S.D; ng/L)
APID01	Jakarta	10	16.8±19.6
APTH01	Pathum Thani	14	11.1±5.3
APTW01	Nantou	22	12.7±9.1
APVN01	Hanoi	6	32.9±4.8
APKRA2	Gwangju	14	6.2±4.7
OVERALL		66	11.8±11.1

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Summary of Rainwater Hg Conc. Worldwide

Location	THg conc. (ng L^{-1})	References
APMMN	6.2-32.9	January – June, 2018
12 sites in Taiwan	6.6-14.3	Lin et al., 2016
10 sites in Japan (estimate)	5.2-9.5	Sakata and Marumoto, 2005
EMEP (2013)	2.6-12.5	EMEP, 2015
NADP/MDN (2016)	2.0-21.5	NADP 2016 Annual Summary
Chuncheon, Korea	8.8	Ahn et al., 2011
Seoul, Korea	10.1-16.3	Seo et al., 2012
Nam Co, China	4.8	Huang et al., 2012
Mt. Leigong, China	4.0	Fu et al., 2010
Chongqing, China	30.7	Wang et al., 2012
4 sites in Xiamen, China	11.4-14.0	Xu et al., 2014
Nanjing, China (9 months)	52.9	Zhu et al., 2014
Monterey Bay, CA, USA	5.8	Conaway et al., 2010
CBL, MD, USA	11.4-15.0	Mason et al., 2000
Moffett Field, CA, USA	11.6	Steding and Flegal, 2002
Bermuda	4.7	Gichuki and Mason, 2014
10 sites in UK	1.6-5.1	Rowland et al., 2010
2 sites in South Africa	10.6-15.8	Gichuki and Mason, 2013
2 sites in Mexico	7.9-8.2	Hansen and Gay, 2013

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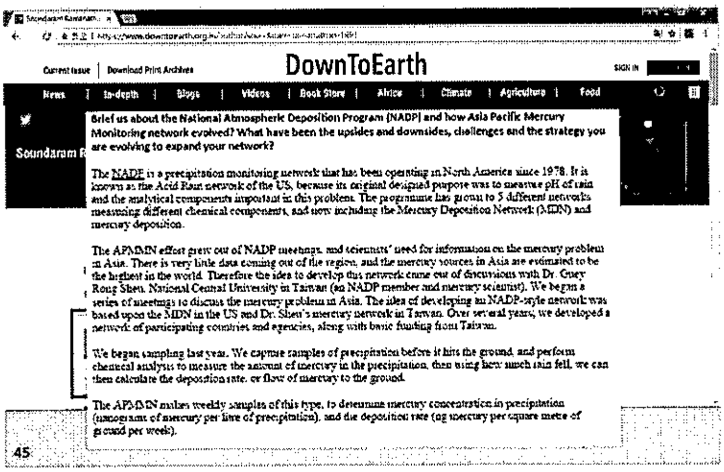
Publicity of APMMN

Publicity of APMMN



Brief us about the National Atmospheric Deposition Program (NADP) and how Asia Pacific Mercury Monitoring network evolved? What have been the upsides and downsides, challenges and the strategy you are evolving to expand your network?

The NADP is a precipitation monitoring network that has been operating in North America since 1978. It is known as the Acid Rain network of the US, because its original designed purpose was to measure pH of rain and the analytical components important in this problem. The programme has grown to 5 different networks measuring different chemical components, and now including the Mercury Deposition Network (MDN) and mercury deposition.

The APMMN effort grew out of NADP meetings, and scientists' need for information on the mercury problem in Asia. There is very little data coming out of the region, and the mercury sources in Asia are estimated to be the highest in the world. Therefore the idea to develop this network came out of discussions with Dr. Guey Rong Sheu, National Central University in Taiwan (an NADP member and mercury scientist). We began a series of meetings to discuss the mercury problem in Asia. The idea of developing an NADP-style network was based upon the MDN in the US and Dr. Sheu's mercury network in Taiwan. Over several years, we developed a network of participating countries and agencies, along with basic funding from Taiwan.

We began sampling last year. We capture samples of precipitation before it hits the ground, and perform chemical analysis to measure the amount of mercury in the precipitation, then using how much rain fell, we can then calculate the deposition rate, or flow of mercury to the ground.

The APMMN makes weekly samples of this type, to determine mercury concentration in precipitation (nanogram of mercury per litre of precipitation), and the deposition rate (ng mercury per square metre of ground per week).

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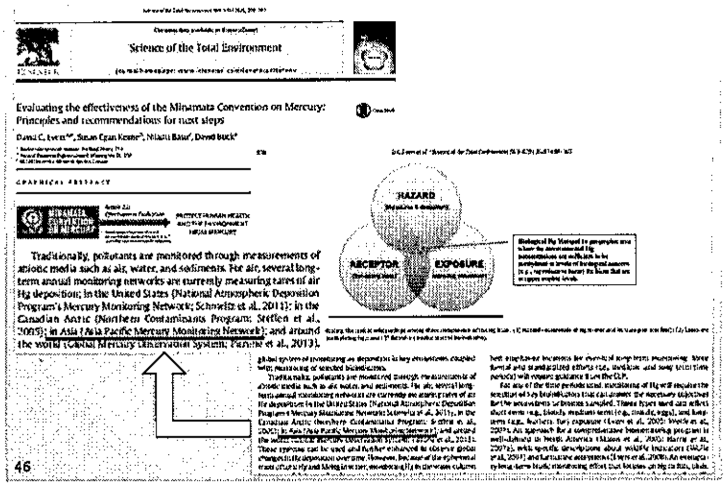
Publicity of APMMN



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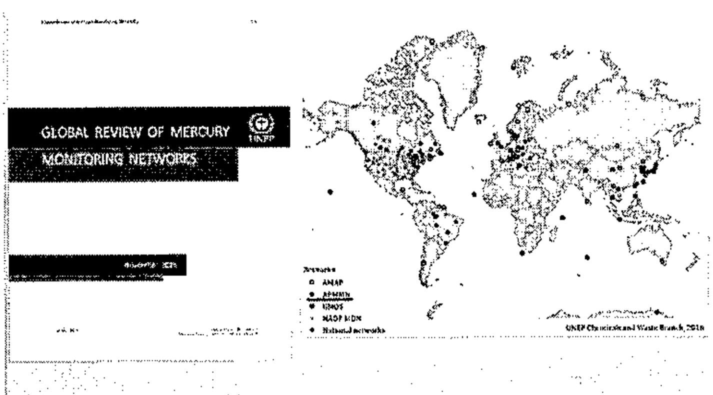
Publicity of APMMN



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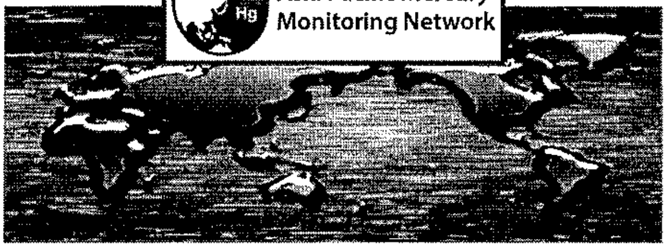
Introduction to the Asia Pacific Mercury Monitoring Network (APMMN)

Asia Pacific Mercury Monitoring Network



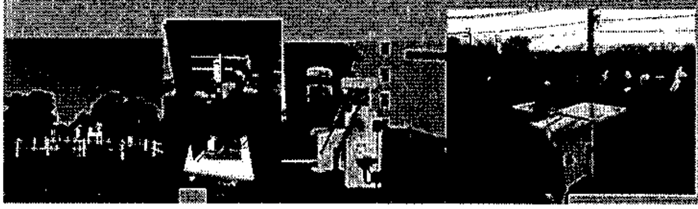
The Asia Pacific Mercury Monitoring Network (APMMN) is....

- a cooperative effort to systematically monitor mercury in air and rainwater throughout the Asia-Pacific Region
- and involves many different and voluntary groups, including environmental ministries and federal government agencies, academic institutions, and scientific research and monitoring organizations.

APMMN Goal and Objectives

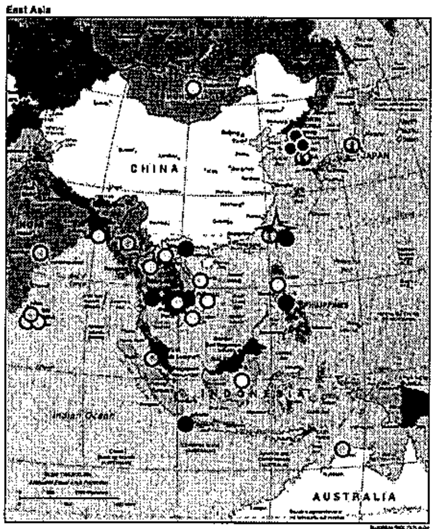
- Goal
  - Systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region
- Objectives
  - Determine the status and trends in concentrations of ambient mercury species, and wet, dry, and total atmospheric deposition of mercury
  - Develop a robust dataset for regional and global modeling
  - Assist partner countries in developing monitoring and assessment capacity
  - Share data and monitoring information

- **Our first step was mercury in precipitation**
  - Loadings to ecosystems
  - The atmosphere is the first place to identify changes in emissions
- Lots of monitoring experience; many experts regionally/globally
- We have an opportunity to help
  - Improve monitoring coordination
  - Assist countries with limited experience and build capabilities



Specifics of the APMMN for Wet Deposition

Sampler:	Automated wet only precipitation collection systems
Sampling Schedule:	Sample bottles and glassware are changed every Tuesday
Chemical Analysis:	Cold vapor atomic fluorescence spectroscopy (CVAFS)
Lab Location:	National Central University, Taiwan (Dr. G. R. Sheu)
Mercury Forms:	Total mercury wet deposition and precipitation concentrations
Site Locations:	Regionally representative; rural, urban, and suburban areas with estimated high levels of mercury emissions and deposition; and sensitive ecosystems

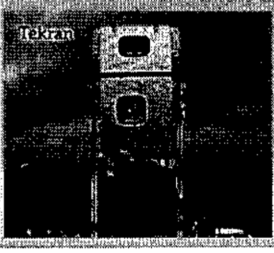


Asia Pacific Mercury Monitoring Network

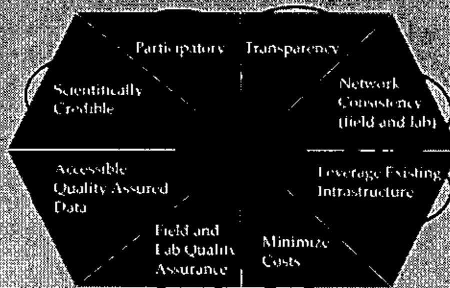
Phase 1
Wet Deposition Sites

- Operating
- Operating (sampling splits)
- Affiliated Network
- Pending Sites (waiting equipment)
- Initial Interest/Acceptance
- Central Laboratory (NCU)

- **Our second step was mercury in the atmosphere**
  - Loadings to ecosystems
- Lots of monitoring experience; many experts regionally/globally
- Multiple types of measurement systems available
  - Automated Tekran Instruments
  - Manual methods, provided by Japan MOE



APMMN Network Principles

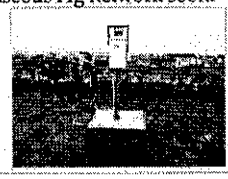


Asia Pacific Mercury Monitoring Network

What Progress Have We Made?

Progress Made

- A 3-year pilot wet deposition network established
  - sites in Indonesia, Thailand, and Vietnam
  - Established Standard Operating Procedures
  - One Laboratory; National Central University of Taiwan
  - New Site in Philippines (last week)
  - 7 new monitors available for distribution
- Data reported back to operating country
- U.S. led capacity building and site operator training workshops
- Transition to fully-operational continental wet deposition and gaseous Hg network soon.



APMMN Milestones 2012-2017

2012 Identified key data gaps in the region and articulated a need for a coordinated network to monitor mercury transport and deposition

2013 Agreed to develop a standardized pilot network to monitor mercury in rainwater and in air; established a network Science Advisory Group (SAG) to guide network activities

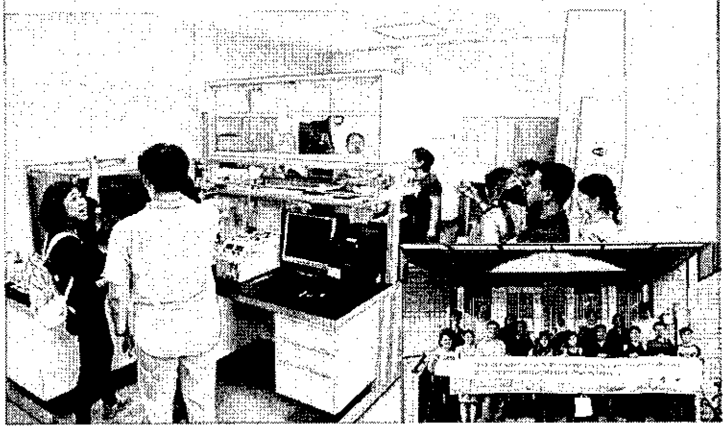
2014 Developed and adopted APMMN SOPs to monitor mercury in rainwater. Established three mercury wet deposition pilot sites; central mercury analytical lab at National Central University, Taiwan

2015 Expanded network partners; further developed network infrastructure; hired a network site liaison; website

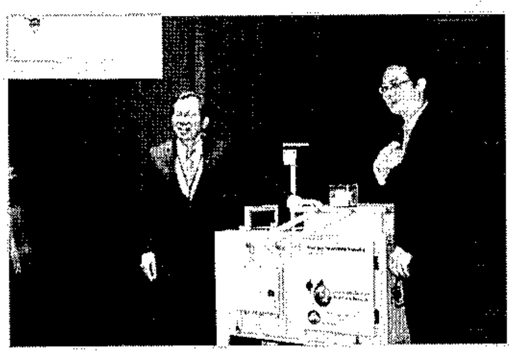
2016 Expanded lab, launch monitoring and technology center; EPAT committed to providing 15 samplers to APMMN partners; plans for monitoring atmospheric mercury concentrations; training

2017 New wet deposition samplers delivered to Vietnam, Thailand, Indonesia, Sri Lanka; Japan commits to training and samplers for gaseous measurement.

APMMN Laboratory and APMMN Offices at NCU Taiwan



APMMN Samplers are Available



Participation in the APMMN workshops

More Information Here

http://apmmn.org/

On Your Data Stick

- Folder: "APMMN_Hg_ Documents"
  - Network documents, like the wet deposition SOP, summary, information worksheet
  - 30 mercury journal articles, basic papers, and papers from Asia research (by country) including the Philippines
  - UNEP documents; Hg assessment from 2013
  - Sampling justification documents, to help you if you are looking to join this effort

Asia Pacific Mercury Monitoring Network

What is Next?

What's Next?

1. Bring in new partners and expand existing wet network
   - Deploy new mercury wet deposition collectors in Philippines NOW
   - Next sites: Sri Lanka, Mongolia 12/2018
   - Bangladesh, India, Cambodia, Laos in 2019
2. Continue training and network organizational development
   - Training (last week)
   - Will be more in the Future, in Taiwan
3. Network atmospheric mercury monitoring stations
   - Just introduced a manual method (Japan MOE) las week to APMMN
   - Continue to explore networking atmospheric mercury monitoring systems into a harmonized network
   - Will consider passive methods
4. Data acquisition, management and distribution
   - Assist Taiwan in developing a database of measurements;
   - Share data eventually
   - Invite monitoring stations and data streams into APMMN (e.g. Korea, Japan)

Summary

The Asia-Pacific Mercury Monitoring Network (APMMN) is...

- A group of countries, agencies, academics and monitoring groups
- Making measurements of mercury
  - Wet deposition
  - Atmospheric mercury in the future (for dry deposition)
- Using the same instruments and standard operating procedures across Asian countries and consistent with NADP
- Sharing data to solve the mercury problem

Asia Pacific Mercury Monitoring Network

Thanks!

Why is it Important to Monitor For Mercury?

David A. Gay

Associate Scientist
National Atmospheric Deposition Program
1.217.898.1444, dgay2@wisc.edu

National Atmospheric Deposition Program

Summary: Why is it important to Monitor For Mercury?

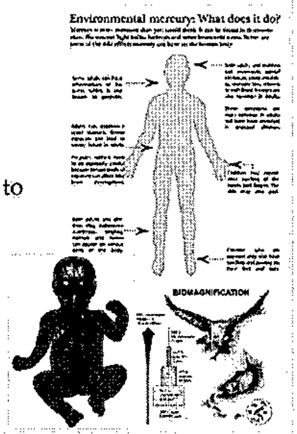
- Human Health
- Health of Animals and Insects
- General Environmental Health, Hg Cycling in the Environment
- Policy Ramifications
  - Local regulations
  - Minamata Convention on Mercury
- Scientific/Research, cycling of metals

Measuring Mercury For Human Health

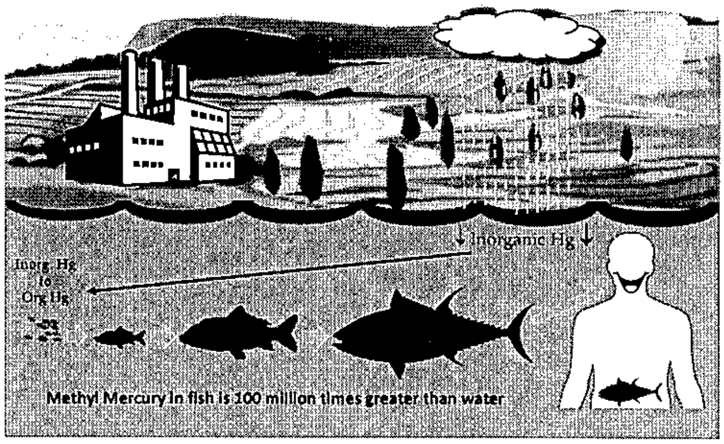
Mercury is a health concern, particularly to children and developing fetuses

A Human Health Concern

- Neurological Disorders
  - Persistent bioaccumulative neurotoxin
  - Large problem in children up to about 7-12 years
    - » Birth defects
    - » learning disabilities
  - Problem in adults under certain conditions



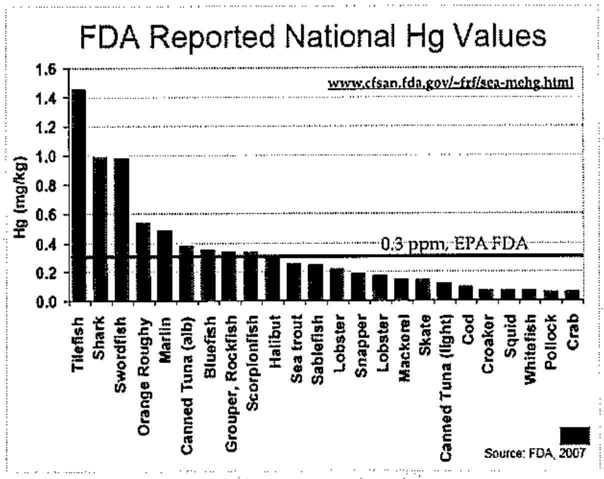
Human Health: Accumulation of Methyl Mercury in Fish and Shellfish



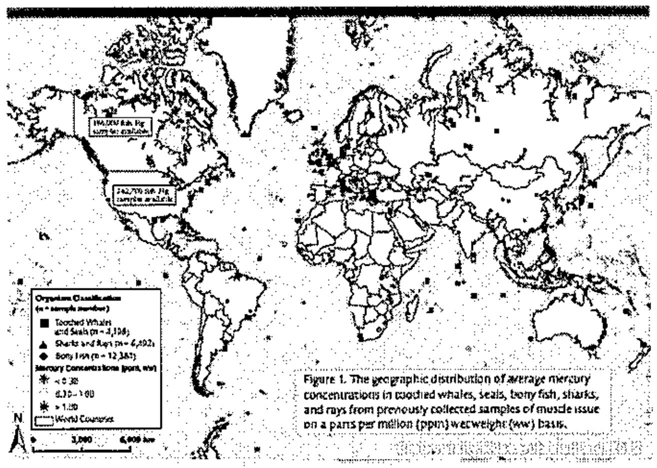
Measuring Mercury For Human Health

Asians in particular, along with Indigenous peoples

Mercury exposure to humans is primarily through the consumption of fish



Mercury in fish and marine mammals



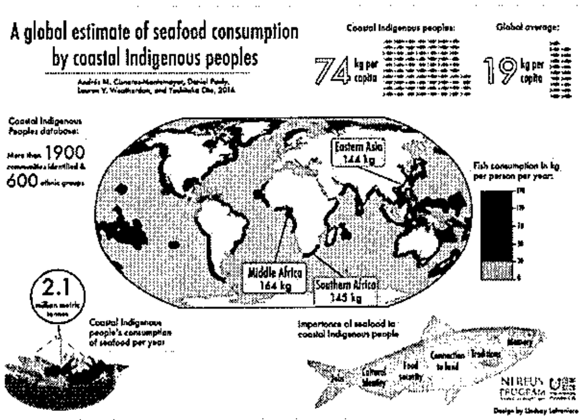
Asian Fish Consumption is High and Growing

TABLE 15
Per capita fish consumption (kg/person/year) in Asia and Europe

Country	[illegible]	1990	1995	2000	2003	Average growth (%)
Bangladesh	7.0 (6.0)	7.0 (6.0)	8.0 (7.0)	11.0 (10.0)	11.0 (9.0)	57 (83)
China	7.0 (2.0)	11.0 (4.0)	20.0 (7.0)	25.0 (10.0)	25.0 (10.0)	257 (400)
India	3.0 (1.0)	3.0 (1.0)	4.0 (2.0)	4.0 (2.0)	4.0 (2.0)	33 (100)
Indonesia	13.0 (3.0)	14.0 (3.0)	17.0 (4.0)	20.0 (4.0)	20.0 (4.0)	54 (33)
Japan	69.0 (4.0)	71.0 (5.0)	71.0 (5.0)	67.0 (5.0)	66.0 (5.0)	-4 (25)
Myanmar	14.0 (1.0)	15.0 (1.0)	14.0 (2.0)	18.0 (2.0)	18.0 (3.0)	29 (200)
Philippines	33.0 (5.0)	36.0 (5.0)	32.0 (4.0)	29.0 (4.0)	28.0 (5.0)	-15 (0)
Thailand	20.0 (3.0)	20.0 (4.0)	33.0 (6.0)	30.0 (7.0)	30.0 (7.0)	50 (133)
Viet Nam	12.0 (3.0)	13.0 (3.0)	16.0 (5.0)	19.0 (7.0)	17.0 (6.0)	42 (100)
Asia	10.0 (2.0)	12.0 (3.0)	16.0 (4.0)	17.0 (6.0)	17.0 (6.0)	70 (200)
South Asia	3.0 (1.0)	4.0 (2.0)	4.0 (2.0)	5.0 (3.0)	5.0 (3.0)	67 (200)
East and Southeast Asia	21.0 (3.0)	22.0 (3.0)	24.0 (4.0)	25.0 (4.0)	25.0 (5.0)	19 (67)
Europe	18.0 (1.0)	20.0 (1.0)	19.0 (2.0)	19.0 (2.0)	20.0 (2.0)	11 (100)
Western Europe	21.0 (1.0)	24.0 (1.0)	25.0 (2.0)	25.0 (2.0)	26.0 (2.0)	24 (100)
Eastern Europe	8.0 (1.0)	6.0 (1.0)	6.0 (1.0)	7.0 (1.0)	8.0 (1.0)	0 (0)
World	12.0 (2.0)	13.0 (2.0)	15.0 (3.0)	16.0 (4.0)	16.0 (4.0)	33 (100)

The number in parenthesis within the table denote freshwater fish consumption.
Source: Adapted from Laurenti (2007).

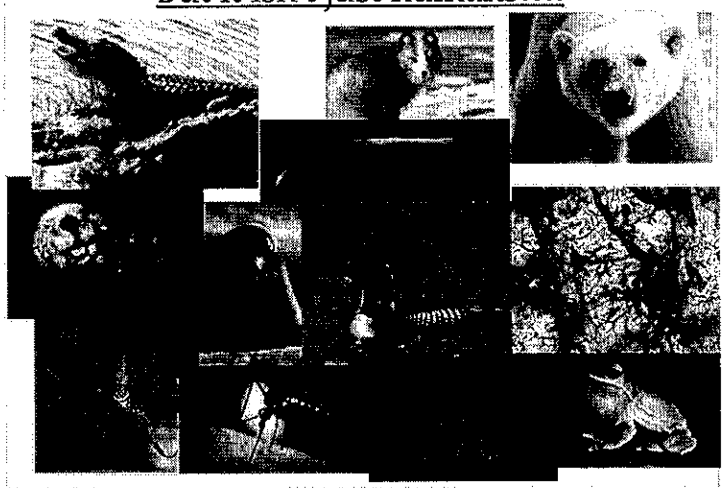
Fish Consumption High In Asia



Mercury is damaging to wildlife exposed to mercury

(eating within the same food chain)

But it isn't just humans….



Impacts on wildlife include

- reduced reproduction,
- changes to egg incubation times,
- behavioral changes, and
- neurological problems
- *From Wright et al, 2018; Aerosol and Air Quality Research, 18: 1953–1992*

- Immunotoxicity
- nephrotoxicity
- diminishes neurological capacity and neurobehavioral function
- alters functioning of three major endocrine axes and impairs reproduction and
- alters offspring quality
- *From Eagles-Smith et al., 2018 Ambio 47, Issue 2, pp 170–197*

Why

It Is Important To Monitor For Atmospheric Mercury

Atmospheric Deposition is the key input of Mercury in water bodies

Environ. Sci. Technol. 2006, 40, 6261–6268

Mercury in Soils, Lakes, and Fish in Voyageurs National Park (Minnesota): Importance of Atmospheric Deposition and Ecosystem Factors

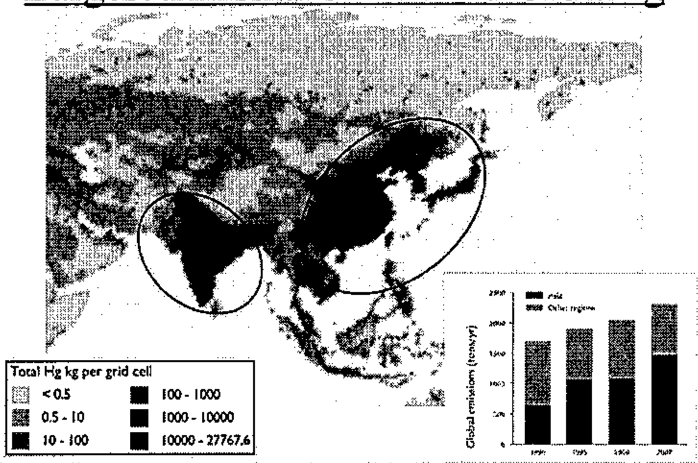
J. G. WIENER, B. C. KNIGHTS, M. B. SANDHEINRICH, J. D. JEREMIASON, M. E. BRIGHAM, D. R. ENGSTROM, L. G. WOODRUFF, W. F. CANNON, AND S. J. BALOGH

- Hg source to water bodies is *overwhelmingly atmospheric deposition and anthropogenic*

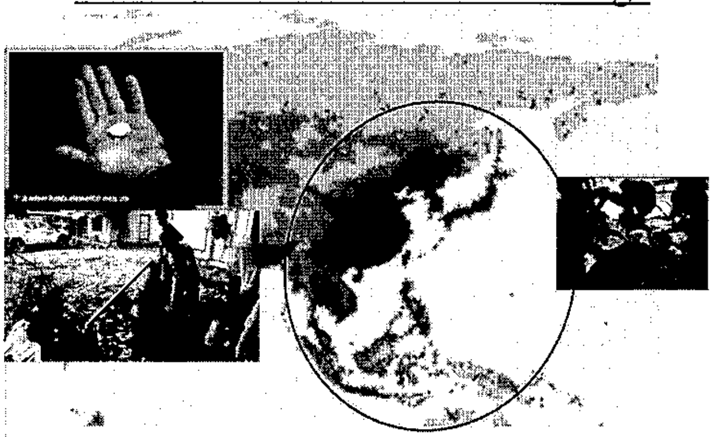
"We conclude that nearly all of the mercury in fish in this seemingly pristine landscape was derived from atmospheric deposition, that most of this bioaccumulated mercury was from anthropogenic sources, and that both watershed and lacustrine factors exert important controls on the bioaccumulation of methylmercury."

Asia is the world's largest atmospheric mercury source region

Largest Emissions Area and Growing



Small Scale Artisanal Gold Mining?



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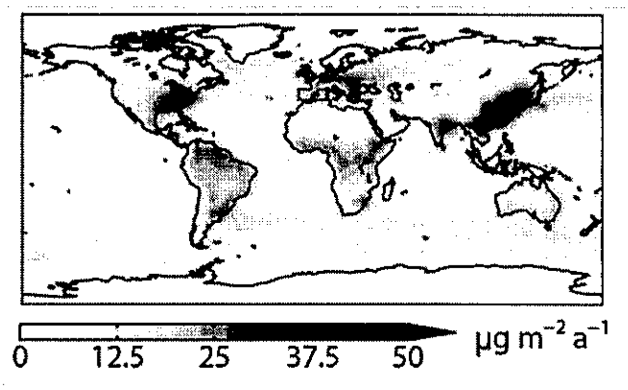
Mercury stays in the atmosphere for at least 6 months (as elemental)

so regardless of whether your country emits mercury, you are receiving mercury as wet and dry deposition.

A true global pollutant........

Estimated Global Wet Deposition of Mercury

Modelled Net Mercury Deposition, Corbitt et al, EST 2011



Responding to the Minamata Protocol

Minamata Convention On Mercury

- 128 signatories, 95 ratifications
- Controls emissions and releases
- Calls for *data and cooperative monitoring*

Many Asian Countries have signed onto this agreement

Minimata Convention Participants (APMMN Area)	Signature Date	Ratification, et al
Afghanistan		Feb-17
Australia	Oct-13	
Bangladesh	Oct-13	
Cambodia	Oct-13	
Canada	Oct-13	Jul-17
China	Oct-13	Aug-16
India	Sep-14	Jun-18
Indonesia	Oct-13	Sep-17
Japan	Oct-13	Feb-16
Korea (Republic of)	Sep-14	
Lao People's Democratic Republic		Sep-17
Malaysia	Sep-14	
Mongolia	Oct-13	Sep-15
Nepal	Oct-13	
New Zealand	Oct-13	
Philippines	Oct-13	
Samoa	Oct-13	Sep-15
Singapore	Oct-13	Sep-17
Sri Lanka	Aug-14	Jun-17
Thailand		Jun-17
United States of America	Jun-13	Nov-13
Palau	Sep-14	Jun-17

UN environment MINAMATA CONVENTION ON MERCURY

Brand New Article (on your data stick)

Environmental Science & Technology

A Critical Time for Mercury Science to Inform Global Policy

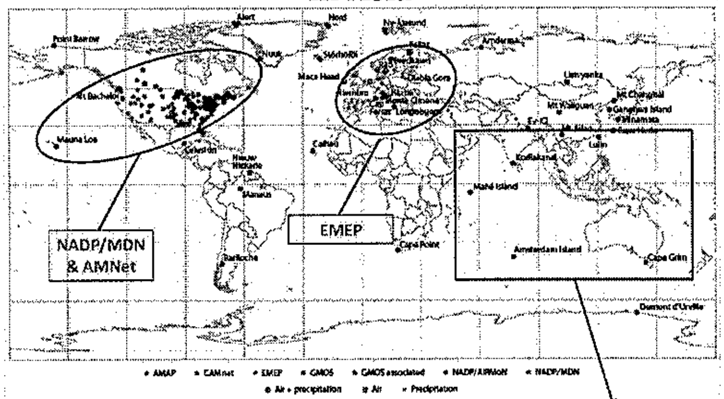
Celia Y. Chen, Charles T. Driscoll, Collin A. Eagles-Smith, Chris A. Eckley, David A. Gay

- Review of history to the Minamata Convention on Mercury and its aim to protect human health and the environment from human-generated Hg;
- Quick review of Mercury 2017 (ICMGP) in Providence Rhode Island;
- Human activities have the potential to enhance mercury methylation,
  - Larger scope changes driving alterations of mercury cycling, methylmercury bioavailability and trophic transfer due to climate and land use changes;
- Important policy and management actions are needed now to control Hg release including adequate monitoring and communication on risk from exposure to various forms of inorganic mercury as well as methylmercury from fish and rice consumption; and
- Successful management of global and local mercury pollution will require integration of mercury research and policy in a changing world.

Much of Asia Deposition

is not currently being recorded or measured consistently

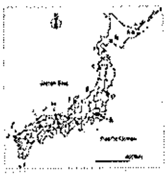
Few Long-Term Mercury Measurements Made in Asia



Currently, there is no long-term or background atmospheric Hg monitoring activity in SE Asia; few measurements in East Asia; limited accessible data; no regional network

Several East Asia Countries Have Monitoring Programs

- **Korea** – National Institute of Environmental Research (NIER)
- **Japan** – Dr. Maramoto, Dr. M. Sakata, et al., wet deposition
- **Taiwan** – Mt. Lulin and other stations – see work by Guey-Rong Sheu
- **China** - see work by Xinbin Feng, others
- **Thailand** = Dr. Hathairatana Garivait, part of APMMN
- **Vietnam** = Ms. Linh, part of APMMN

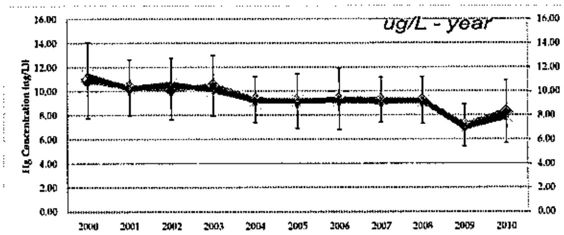


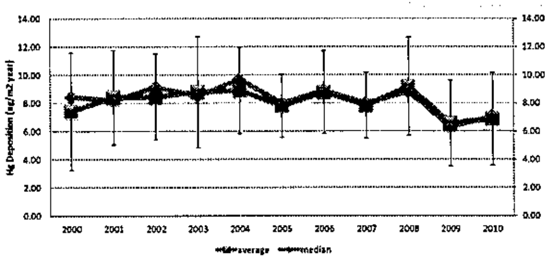
Scientific Needs for Understanding the Mercury Problem

Trends in Concentrations

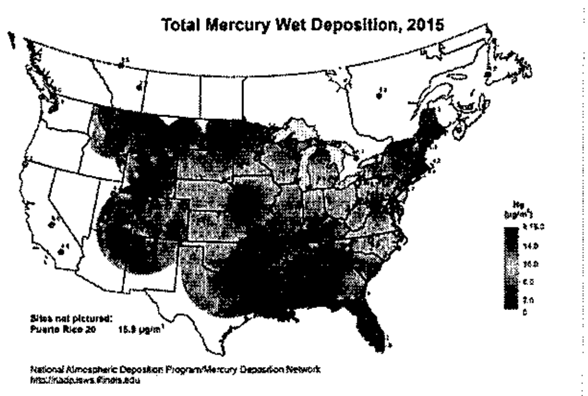
- Measurements are needed..
  - to determine if deposition is being reduced
  - How fast deposition is being reduced
  - If deposition is going down in all areas
  - If fish concentrations are also being reduced
  - If human exposure is decreasing
- Mercury reduction is proceeding in some countries, and the Minamata Convention should continue this trend.

Great Lakes Mercury Wet Concentration and Deposition



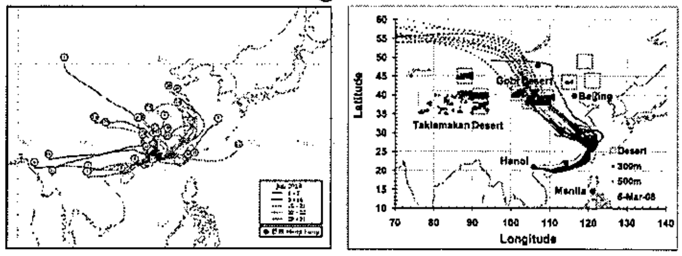


Determining Rates of Deposition over Space

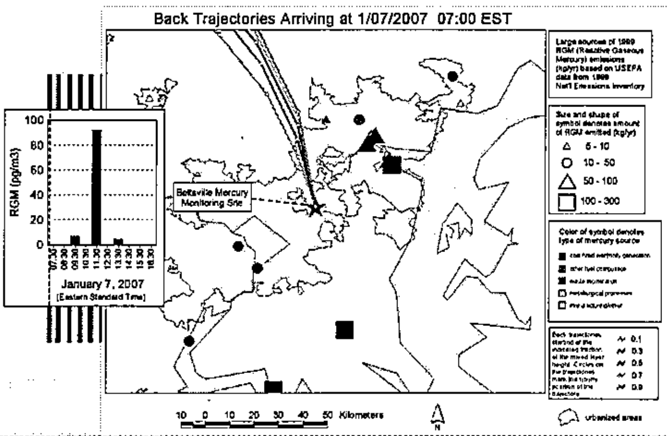


Given Measurements, you can determine where the Hg comes from...

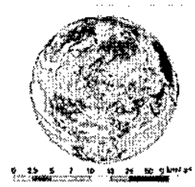
Local
regional
or global



Impacts of Mercury Emitting Sources



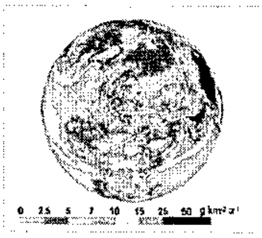
- All Scientists need sound measurements from everywhere, particularly in Asia
  - To understand the global problem...
  - To run global models...
  - To track results of the Minamata Convention



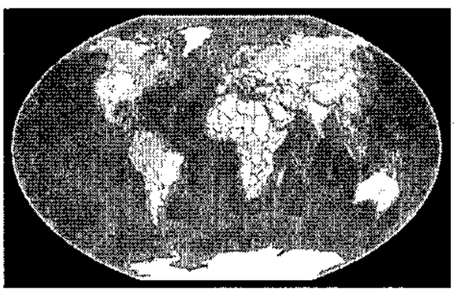
Strength in Network Design

The Value of Monitoring

- Using same methods!!!
  - "apples to apples"
  - on a global basis
  - Harmonization of measurements
- Long term monitoring is required to see small changes.
- Sharing Data
  - We need global data to understand a global pollutant
  - Working together is the *best way forward*
- Understand the problem through science
- Is Policy Working?
  - Put legislation in place
  - But is it working
  - Is the problem improving



The Asia-Pacific Mercury Monitoring Network could provide these measurements*!*



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Minamata Convention: Perspectives on the Monitoring and Effectiveness Evaluation Plans

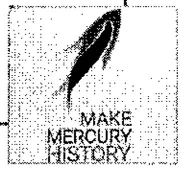
Alexandra Steffen
Air Quality Research Division
Science and Technology Branch

Minamata Convention on Mercury

Objectives of the convention

To protect the human health and environment from anthropogenic emissions and release of mercury and mercury compounds

- ✓ October 2013, the Minamata Convention on Mercury opened for signature and was signed by 128 governments
- ✓ Canada ratified and became a Party April 7, 2017
- ✓ **Convention come into force August 16, 2017**
- ✓ First Conference of the Parties (COP1) September 2017
- ✓ Convention comprises of 35 articles



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Ad hoc Group of Mercury Experts

First Conference of the Parties (COP1)

- Agreed to: Create an ad hoc group of experts to provide the COP with recommendations for arrangements for comparable monitoring data, and the elements of an effectiveness evaluation framework (*article 22)*

The ad hoc expert group was given a mandate by the COP

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Mandate

a) Develop monitoring arrangements, taking into account the experience of other multilateral environmental agreements, including the Stockholm Convention, for consideration by the COP at its 2nd meeting.

b) Develop elements of an effectiveness evaluation framework, taking into account the experience under other multilateral environmental agreements, including the Stockholm Convention, for consideration by the COP at its 2nd meeting, inter alia.

c) Prepare a report on its work for submission to the COP for consideration at its 2nd meeting, including recommendations on monitoring arrangements and effectiveness evaluation.

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a) Mandate continued

i. An outline of the types of data that could be comparable on a global basis, as well as their availability;

ii. A draft plan for future monitoring may be done by:
   a. Reviewing existing monitoring programmes
   b. Assess if the existing monitoring is sufficient to me our needs;
   c. Be practical about what kinds of data we will need;
   d. Identify how we can model mercury to assess changes in mercury levels within and across different media;
   e. Identify how we define a baseline;
   f. Identify how the monitoring can be used for EE

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b/c) Mandate continued

b) Develop elements of an effectiveness evaluation framework by:

i. Identifying the steps required to undertake an effectiveness evaluation;

ii. Suggesting a process flow (schedule) for the effectiveness evaluation planning;

iii. Identifying arrangements for conducting the effectiveness evaluation;

iv. Drafting terms of reference for the committee developing the first effectiveness evaluation;

v. Assessing potential approaches to the development of performance indicators

c) Prepare a report

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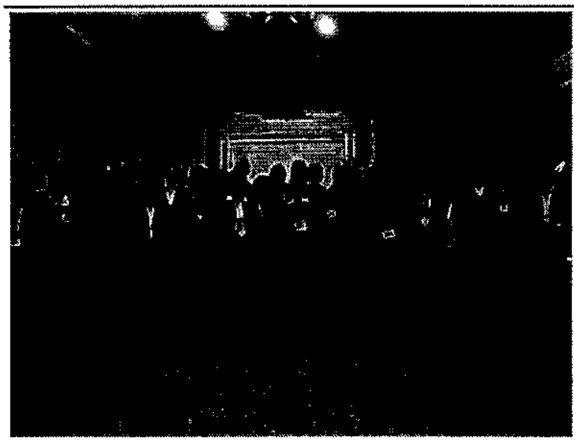
March 4-9, 2018 Ottawa, Canada



Ad hoc expert group

Presentations by each expert on their role, expertise and information from country/region

Group 1: Monitoring Program

Group 2: Effectiveness Evaluation of the treaty

Article by Article recommendations on what information could be used to evaluate effectiveness

Submitted report June 2018

Out for public consultation

UNEP review and prepare for COP2 (November 2018)

Results presented to COP2 for discussion/negotiation

Report

- Comparable monitoring data on a global basis
  - Air, Biota and Human tissue
  - Air (total gaseous mercury and wet deposition)
  - Humans (scalp hair and cord blood)
  - Biota (3 types of outcomes: human exposure (HE), environmental health (EH),temporal trends (TT))
- Review of existing monitoring
  - Air (GMOS, EMEP, APMMN, AMAP, ECCC-AMM, NADP, Korea, Taiwan, Japan, China, Norway)

Initial assessment: The data available through existing monitoring programs partially meets the needs for monitoring under Article 22 of the Minamata Convention on Mercury; **however, a number of limitations and gaps were identified.**

Monitoring Gaps

- There is not coverage of **air levels** in:
  - Africa
  - Latin America
  - Parts of Asia
  - Australia and New Zealand (the Pacific)
  - The Caribbean

  - Asia is the largest source region for Hg and is the worlds largest fish consumers; so, important to fill these gaps

Cost effective considerations

- Air:
  - Use and build upon current networks and methodologies
  - Engage countries where expertise exists
  - Employ passive mercury samplers to fill gaps at lower costs
  - Canadian passive sampler
    - Now employed in the Arctic network
    - Being used in South American network
    - Will be deployed at GAPS global network sites
    - Is being considered in APMMN
  - Link databases together to have one stop where anyone can find the data but maintain regional work (GOS[4]M)

Modelling capabilities

- Air – we are in good shape
  - GEOS-Chem
  - GLEMOC
  - ECHMERIT
  - CMAQ-Hg
  - WRF/Chem-Hg
  - GEM-MACH-Hg

√ Several intercomparisons have been done
√ Will be able to assess levels going up or down
√ Will be able to assess source receptor relationships
√ Will be able to look at transboundary transport

Defining a baseline

The baseline can be considered as the state of knowledge

- A lot of mercury data exits - should we use only existing data??
- We need to determine which media will be used (TGM and wet)
- Significant time variability in current data sets
- Should we consider the date of entry into force? Should we consider the date of the 1st EE assessment? Should it be a random date?

Currently there is not a formal process under the convention to establish a baseline within the COP

So...?

Overall effectiveness evaluation : Potential indicators for individual articles of the Convention

Article	Potential indicators	Potential source of information	Discussion
Overall indicator/ Article 1	*Outcome indicator* • Outcome of analytical assessment of the whole set of article-by-article indicators • Further indicators will be considered •	•	
Article 3	*Process indicator* • Total number of primary Hg mines. *Outcome indicator* • Total amount of Hg mined from primary mercury mines.	• Article 21 report. • UNEP report on supply and trade. • Project reports.	• Data on non-parties are important
	Process indicator • Number of parties that have developed an inventory of stocks and sources of supply.	• Article 21 report.	•
	Process indicator • Number of parties that have excess Hg from Chlor Alkali. • Number of parties that have taken measures that such mercury is subject to final disposal.	• Article 21 report. • Report to other relevant chemicals and waste MEAs	• Also see indicators on trade and waste.
	Outcome indicator • Amount of Hg traded (broken down for specific purposes) *Process indicator* • Number of parties trading in mercury	• Collected PIC forms • Article 21 report. • UN trade data • ASGM NAP • UNEP supply and trade report.	• Can compare the amount of legally traded Hg with other data e.g. Hg use in ASGM. – shed light on illegal trade and disposal. – link with other articles.

Recommendations put to the COP

- Develop a global monitoring plan (including recommendations in regard to the gaps in available information)
- **For air, a combination of both active and passive sampling and wet deposition (where feasible)**
- Encourage Parties to develop and improve research to include and validate models (include gaps i.e. ASGM)

Final recommendation...

How does monitoring fit into assessing how effective the convention is?

Article	Description of how global monitoring data (air, human, biota) can contribute to evaluation of the effectiveness of the Convention.
Article 1 Objective of the convention	• Level of mercury in air, human and biota • Attribution of levels of Hg in environment and human from anthropogenic emissions and releases estimated by modelling information
Article 7 ASGM	• Mercury levels in humans (note that for miners, urine mercury may be appropriate) • Mercury levels in fish and other biota downstream of ASGM activities • Mercury levels in air
Article 8 Emissions	• Mercury levels in ambient air • Mercury levels in biota to consider local impacts and long-range transport
Article 12 Contaminated sites	• Mercury levels in air, human and biota
Article 18 Public information, awareness and education	• Number of parties that have public information on mercury levels in air, humans and biota
Article 19 Research, development and monitoring	• Number of parties that cooperate to develop and improve information available for inclusion in the global monitoring report (including through existing data sources)

Proposed schedule for effectiveness evaluation

Year	Available Information	Monitoring	Effectiveness evaluation
2017 Entry into force, COP1			
2018 COP2	GMA Most MIAs completed	COP2 considers result of intersessional work and how to address gaps and organize future monitoring including organizational arrangements	COP2 considers result of intersessional work and considers how to establish EE framework
2019 COP3	Article 21 reporting: First biennial short report by 31 Dec	Approve monitoring arrangements, including timeline for submission of data	EE framework adopted EE committee members nominated
2020	First NAP submission starts Submission on release source categories		
2021 COP4	Article 21 reporting: First full report by 31 Dec	COP4 initiates the first monitoring report, which will feed into effectiveness evaluation	All Stage 1 reports to be submitted to the Secretariat (except for global monitoring report)
2022	Article 21 national reports compiled. Emission/ release inventories start to be submitted	Prepare monitoring report and submission to EE group to feed into EE report - to address Art 22 para 2 in facilitating the evaluation	June: stage 1 completed December: Secretariat to develop preliminary analysis. Committee meets to review the information.
2023 COP5	Biennial report NAP review	COP5 welcomes monitoring report.	COP5 welcomes EE report.

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Path Forward

- Present report to the COP in November
- Parties will negotiate the new path forward
- Continue to inform APMMN to ensure inclusion and input to the global monitoring plan
- Lead to the success of the goals of the Minamata Convention – reduce global mercury

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Thank you!

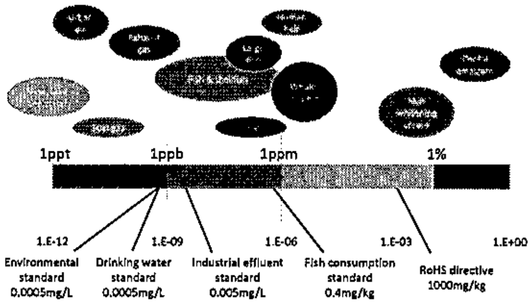
Outlines of Minamata Convention

Article	Description
Preamble	Recall risk of mercury, recognize substantial lessons of Minamata disease
Objective (Article 1)	Protect human health and environment from anthropogenic emission and releases of mercury and mercury compounds
Supply and trade (Article 3)	Regulate mercury mining and international trade
Mercury-added products (Article 4)	Regulate manufacturing, import, export of mercury-added products (batteries, switches, lamps, thermometers, sphygmomanometers, etc.)
Manufacturing process (Article 5)	Regulate mercury use in specific manufacturing processes
ASGM (Article 7)	Mercury use reduction in artisanal and small-scale gold mining
Emissions, releases (Article 8, 9)	Regulate atmospheric emissions, releases to water and soil
Interim storage (Article 10)	Environmentally sound interim storage of mercury and mercury compounds
Mercury waste (Article 11)	Environmentally sound management of mercury waste
Contaminated sites (Article 12)	Identify and assess sites contaminated by mercury and mercury compounds
Finance, technical assistance (Article 13, 14)	Financial sources and mechanism, technical assistance and capacity building
Research, development, monitoring (Article 19)	Cooperation for developing and improving inventories, monitoring, modelling, impact assessment
Reporting (Article 21)	Report on measures taken to implement the provisions of the Convention
Effectiveness evaluation (Article 22)	Evaluate the effectiveness of the Convention

3

Mercury Levels in Various Media

- Emissions standards: 5 emission categories (Annex D)
- Mercury waste thresholds: under discussions in COP (Article 11)
- Mercury-added products: mercury levels for products (Annex A)



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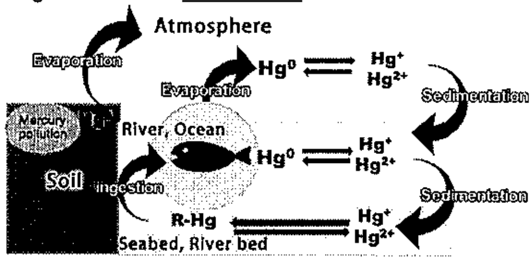
Annex A Part I: Mercury-added Products

Types of products	Description
Batteries	Zinc silver oxide: >=2%, zinc air: >=2%
Switches and relays	Very high accuracy: >20mg
Compact fluorescent lamps for general lighting	<= 30watts: >5mg
Linear fluorescent lamps for general lighting	Triband phosphor < 60watts: >5mg, Halophosphate phosphor <= 40watts: >10mg
High pressure mercury vapour lamps for general lighting	All
Cold cathode fluorescent lamps, external electrode fluorescent lamps for electronic display	<= 500mm: >3.5mg, >500mm and <=1500mm: 5mg, >1500mm: >13mg
Cosmetics	>1ppm
Pesticides, biocides, topical antiseptics	All
Non-electronic measuring devices	Barometers, hygrometers, manometers, thermometers, sphygmomanometers

Fate of Mercury in the Environment

- Mercury is released to the environment from <u>various sources</u> including natural ones in <u>various forms</u>.



- As it does <u>not discompose but circulates globally</u> and may impact wild biota and human by accumulating via food web, global actions to reduce anthropogenic emissions are necessary.

7

Comparison Article 19 vs Article 22

Article 19: Research Development and Monitoring	Article 22. Effectiveness Evaluation
Responsible subject: <u>Parties</u>	Responsible subject: <u>Conference of Parties</u>
○<u>Shall endeavour to cooperate</u> to develop and improve: - Inventories - Modelling and geographically representative monitoring - Assessment of impact on human health and environment - Harmonized methodologies for activities - Information ○<u>Should build</u> on existing monitoring networks and research programmes.	○<u>Shall evaluate</u> the effectiveness of this convention. ○<u>Shall initiate</u> the establishment of arrangements for providing itself with comparable monitoring data ○The evaluation <u>shall be conducted</u> on the basis of available scientific, environmental, technical, financial and economic information
"…modelling and geographically representative monitoring of levels of mercury and mercury compounds in <u>vulnerable populations</u> and in <u>environmental media</u>, including <u>biotic media</u> such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples…"	"…arrangements for providing itself with comparable monitoring data on the presence and movement of mercury and mercury compounds in the <u>environment</u> as well as trends in levels of mercury and mercury compounds observed in <u>biotic media</u> and <u>vulnerable populations</u>…"
Eligible to GEF	Not eligible to GEF

8

Asia Pacific Mercury Monitoring Network

Overview on the effort to monitor Mercury and other Air Pollutants in the Philippines

JUNDY TIGLEY DEL SOCORRO

7th Asia Pacific Mercury Monitoring Network
Seda Vertis North, Quezon City

REPUBLIC OF THE PHILIPPINES DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES ENVIRONMENTAL MANAGEMENT BUREAU · United States Environmental Protection Agency · EPA TAIWAN

Air Quality Guideline Values under Philippine Clean Air Act (RA 8749) & its IRR DAO2000-81

National Ambient Air Quality Guideline Values

Pollutants	Short Term: µg/Ncm	Short Term: ppm	Short Term: Averaging Time	Long Term: µg/Ncm	Long Term: ppm	Long Term: Averaging Time
Suspended Particulate Matter – TSP	230		24 hours	90		1 year
PM-10	150		24 hours	60		1 year
Sulfur Dioxide	180	0.07	24 hours	60	0.03	1 year
Nitrogen Dioxide	150	0.08	24 hours			
Photochemical Oxidants as Ozone	140	0.07	1 hour			
	60	0.03	8 hours			
Carbon Monoxide	35 mg/Ncm	30	1 hour			
	10 mg/Ncm	9	8 hours			
Lead	1.5		3 months	1.0		1 year

(b) The applicable methods for sampling and measurement of the above pollutants are as follows:

- TSP - High Volume – Gravimetric, USEPA 40 CFR, Part 50, Appendix B
- PM-10 - High Volume with 10 micron particle size inlet, Gravimetric, USEPA 40 CFR, Part 50, Appendix J
- Sulfur Dioxide - Gas Bubbler and Pararosaniline Method (West and Gaeke Method) or Flame Photometric Detector, USEPA 40CFR, Part 50, Appendix A
- Nitrogen Dioxide - Gas Bubbler Griess-Saltzman, or Chemiluminescence Method, USEPA 40 CFR, Part 50, Appendix F
- Ozone - Neutral Buffer Potassium Iodide (NBKI), or Chemiluminescence Method, USEPA 40 CFR, Part 50, Appendix D
- Carbon Monoxide - Non-dispersive Infra-red Spectrophotometry (NDIR), USEPA 40 CFR, Part 50, Appendix C
- Lead - High Volume and Atomic Absorption Spectrophotometry, USEPA 40 CFR, Part 50, Appendix G

(c) An analyzer based on the principles and methods cited above will be considered a reference method only if it has been designated as a reference method in accordance with 40 CFR, Part 53.

Department of Environment & Natural Resources Environmental Management Bureau

Ambient Air Quality Standards for Source Specific Air Pollutants under Philippine Clean Air Act (RA 8749) DAO-2000-81

National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations

Pollutants	Concentration: µg/Ncm	Concentration: ppm	Averaging Time (min)	Method of Analysis/Measurement
Ammonia	200	.028	30	Nesselerization / Indo Phenol
Carbon Disulfide	30	0.01	30	Tischer Method
Chlorine and Chlorine cmpds expressed as Cl_2	100	0.03	5	Methyl Orange
Formaldehyde	50	0.04	30	Chromotropic Acid method or MBTH Colorimetric method
Hydrogen Chloride	200	0.13	30	Volhard Titration with Iodine solution
Hydrogen Sulfide	100	0.07	30	Methylene Blue
Lead	20		30	AAS
Nitrogen Dioxide	375	0.20	30	Griess-Saltzman
	260	0.14	60	
Phenol	100	0.03	30	4-Aminoantipyrine
Sulfur Dioxide	470	0.18	30	Colorimetric-Pararosaline
	340	0.13	60	
Suspended Particulate Matter – TSP	300	–	60	Gravimetric
PM-10	200	–	60	Gravimetric
Antimony	0.02 mg/Ncm	–	30	AAS
Arsenic	0.02 mg/Ncm	–	30	AAS
Cadmium	0.01 mg/Ncm	–	30	AAS
Asbestos	2×10^{4} Particulates/Ncm (over 5 micrometer in size)	–	30	Light Microscopy
Sulfuric Acid	0.3 mg/Ncm	–	30	Titration
Nitric Acid	0.4 mg/Ncm	–	30	Titration

Department of Environment & Natural Resources Environmental Management Bureau

Emission Standards for Source Specific Air Pollutants under Philippine Clean Air Act (RA 8749) DAO2000-81

National Emission Standards for Source Specific Air Pollutants (NESSAP)

POLLUTANT	STANDARD APPLICABLE TO SOURCE	MAXIMUM PERMISSIBLE LIMITS (mg/Ncm)	METHOD OF SAMPLING	METHOD OF ANALYSIS
Antimony and its Cmpds.	Any source	10 as Sb	USEPA Methods 1 through 5 or 29	AAS or per sampling method
Arsenic and its Cmpds.	Any source	10 as As	USEPA Methods 1 through 5 or 29	AAS or per sampling method
Cadmium and its Cmpds.	Any source	10 as Cd	USEPA Methods 1 through 5 or 29	AAS or per sampling method
Carbon Monoxide	Any industrial source	500 as CO	USEPA Method 3 or 10	Orsat Analysis or NDIR
Copper and its Cmpds.	Any industrial source	100 as Cu	USEPA Methods 1 through 5 or 29	AAS or per sampling method
Hydrofluoric Acid and Fluoride Compounds	Any source other than manufacture of Aluminum from Alumina	50 as HF	USEPA Method 13 or 14 as appropriate	As per sampling method
Hydrogen Sulfide	i) Geothermal power plants ii) Geothermal Exploration And Well Testing iii) Any source other than (i) and (ii)	7 as H_2S	USEPA Method 11, 15 or 16 as appropriate	Cadmium Sulfide Method or per sampling method
Lead	Any trade, industry or process	10 as Pb	USEPA Methods 1 through 5 or 12	AAS or per sampling method
Mercury	Any source	5 as elemental Hg	USEPA Methods 1 through 5 or 29 or 101	AAS Cold-Vapor Technique or Hg Analyzer

Limits for Metals, Dioxins and Furans - Treatment Facilities Using Non-burn Technologies

Item	Average Values
Cadmium and its compounds, expressed as cadmium (Cd)	total 0.05 mg/Ncm
Thallium and its compounds, expressed as thallium (Tl)	
Mercury and its Compounds, expressed as mercury (Hg)	0.05 mg/Ncm
Antimony and its compounds, expressed as antimony (Sb)	total 0.5 mg/Ncm
Arsenic and its compounds, expressed as arsenic (As)	
Lead and its compounds, expressed as lead (Pb)	
Chromium and its compounds, expressed as chromium (Cr)	
Cobalt and its compounds, expressed as cobalt (Co)	
Copper and its compounds, expressed as copper (Cu)	
Manganese and its compounds, expressed as manganese (Mn)	
Nickel and its compounds, expressed as nickel (Ni)	
Vanadium and its compounds, expressed as vanadium (V)	
Tin and its compounds, expressed as tin (Sn)	

Department of Environment & Natural Resources Environmental Management Bureau

Department of Environment & Natural Resources Environmental Management Bureau

Policies in Hg Chemical Control and as Waste

DENR ADMINISTRATIVE ORDER NO. 38
Series of 1997

Subject: CHEMICAL CONTROL ORDER FOR MERCURY AND MERCURY COMPOUNDS

Section 1. Legal Authority

This Chemical Control Order (CCO) is being issued on the basis of authorities given to the Department of Environment and Natural Resources under Republic Act 6969 of 1990 and DENR Administrative Order (DAO) No. 29, Series of 1992.

The requirements and procedures presented in this CCO are in addition to all the other requirements of Title II and Title III of DAO 29 as they pertain to the importation, manufacture, distribution and use of mercury and mercury compounds and the storage, transport, and disposal of their wastes.

Section 2. Policy

It is the policy of DENR to minimize hazards to human health and the environment from the improper use, management, disposal, and subsequent release and exposure to harmful substances.

Section 3. Definition & Rationale

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City

DEC 0 4 2013

DENR ADMINISTRATIVE ORDER
No. 2013-22

Subject: REVISED PROCEDURES AND STANDARDS FOR THE MANAGEMENT OF HAZARDOUS WASTES (REVISING DAO 2004-36)

Revised Procedures and Standards for the Management of Hazardous Wastes (Revising DAO 2004-36)

Class	Description	Waste Number
Chromium compounds*	analysis of an extract. Includes all wastes with a total Cr concentration > 5 mg/L based on analysis of an extract	J405
Lead compounds*	Includes all wastes with a total Pb concentration > 1 mg/L based on analysis of an extract	J406
Mercury and mercury compounds*	Includes all wastes with a total Hg concentration > 0.1 mg/L based on analysis of an extract. These also includes organomercury compounds. Refer to CCO.	J407

Efforts to monitor Ambient Air Mercury (Hg) Monitoring

Mercury is one of the most potent neurotoxins

It bioaccumulates in food chain, inorganic and ionic mercury can convert to methyl mercury.

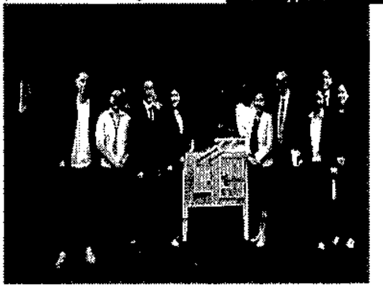
Sub-ppt levels in air can accumulate to toxic ppm levels in fish

Mercury in air ; Elemental (GEM) , Reactive (RGM) , Particulate Bound (PBM)

Minamata Convention and APMN

Department of Environment & Natural Resources Environmental Management Bureau

Department of Environment & Natural Resources Environmental Management Bureau · Taipei Economic and Cultural Office in the Philippines · EPA TAIWAN



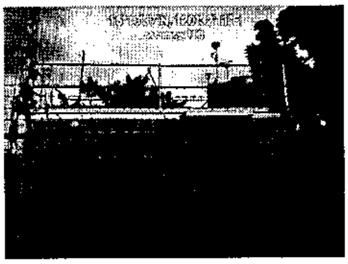
Wet Deposition Mercury Sampler

Turn Over Ceremony, DENR-EMB, AQMTC
March 7, 2013

Technical Assistance / Training to operate the Hg Deposition Sampler (US-EPA, EPAT, TECO)

June 27-28, 2013

Department of Environment & Natural Resources Environmental Management Bureau

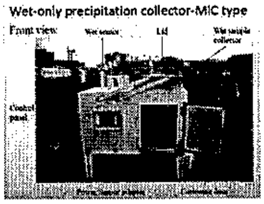



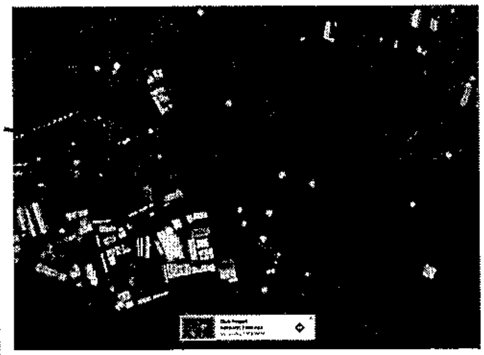
Hg Deposition Mercury Sampler

Urban Area Station, Clark , Angeles

Department of Environment & Natural Resources
Environmental Management Bureau

- Commitment of the Philippines to the Asia Pacific Mercury Monitoring Network (APMMN)
- To be located beside the EU SWITCH Clark, Pampanga Ambient Air Monitoring Station





Department of Environment & Natural Resources
Environmental Management Bureau

Efforts in Mercury Monitoring in Coal Fired Power Plants , Mining Sites other Contaminated and Background Areas

Asia Pacific Mercury Monitoring Network

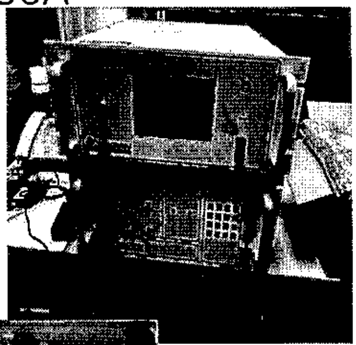
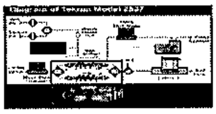
United States Environmental Protection Agency

EPA TAIWAN

Tekran 2537X 1130A

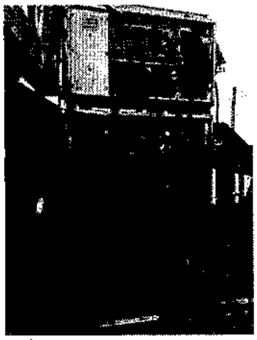
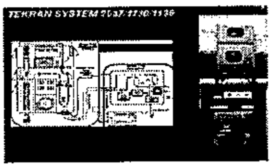
Department of Environment & Natural Resources
Environmental Management Bureau

Analyte: TGM (Total Gaseous Mercury)
Principle: Gold preconcentration with atomic fluorescence detection.
Sensitivity: < 0.1 ng/m3 (5 min samples)
Dual channel gold trapping for uninterrupted sampling
Pure Gold as Hg Adsorbent


Tekran 1135-Particulate Hg Monitor

Allows simultaneously monitor particulate bound mercury (Hg^p), elemental mercury (Hg^0) and reactive gaseous mercury (RGM) in ambient air.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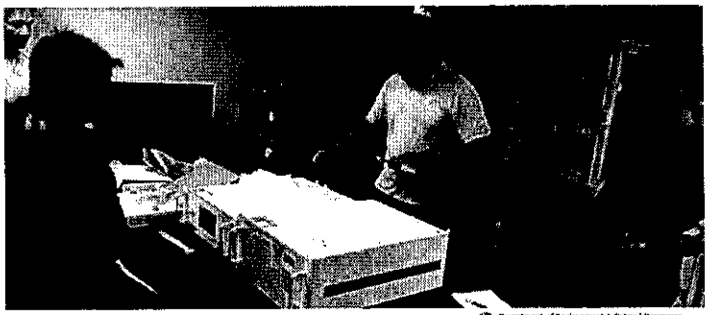
Environmental Management Bureau

Taiwan Assistance in operating Tekran 2537X and 1130



Da-Wei Lin

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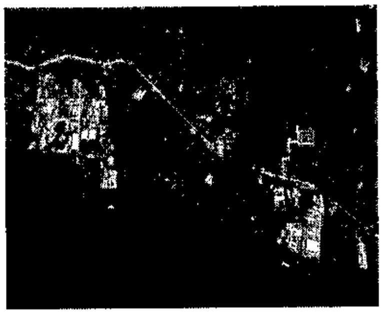
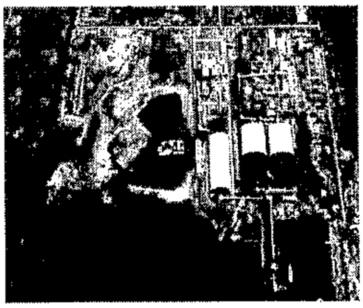
Environmental Management Bureau

Proposed Location of the TEKRAN 2537X, 1135 in Coal Fired Power Plants in Calaca, Batangas

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Mercury Monitoring in Mining site

Puerto Princesa, Palawan
August 16 – 19 2017

Asia Pacific Mercury Monitoring Network

United States Environmental Protection Agency

EPA TAIWAN

Sampling Site Locations

Site	Total Gaseous Mercury (in ng/m3)	
	Minimum	Maximum
Sta. Lourdes National High School	0.82	1.73
Sanitary Landfill	1.48	2.84
Pit Lake	2.67	5.84
Basketball Court, Purok Matahimik	3.05	5.77
Basketball Court, Tagburos-Irawan Road Plaza	2.26	3.1
Sta. Lourdes, Honda Bay Wharf	2.35	3.09
PEMO Office, near City Proper	0.73	1.07

	Matahimik	downwind of sanitary landfill
5	Basketball Court, Tagburos-Irawan Road Plaza	Near roadside
6	Sta. Lourdes, Honda Bay Wharf	Inter- island hopping terminal of boats
7	PEMO Office	200 meters away from the road, trees and plants surrounds the area

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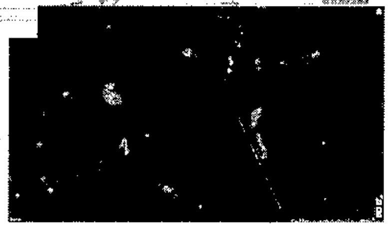

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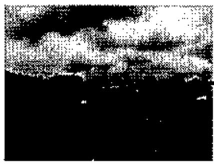
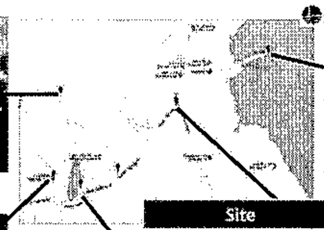
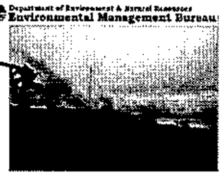

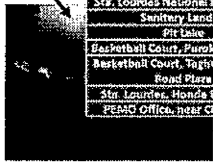

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PEMO Office, near City Proper	0.73	1.07

Equipment Setup



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Environmental Management Bureau

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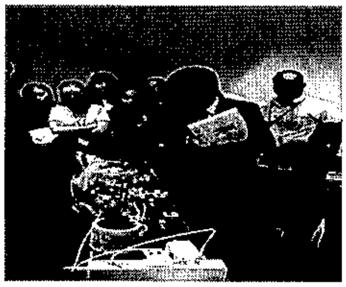
Environmental Management Bureau

環境省 Ministry of the Environment

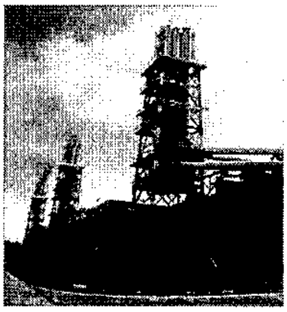
Atmospheric Mercury monitoring by gold amalgamation trap

Management of Stationary Sources

- US EPA Stack Emission Testing Methods





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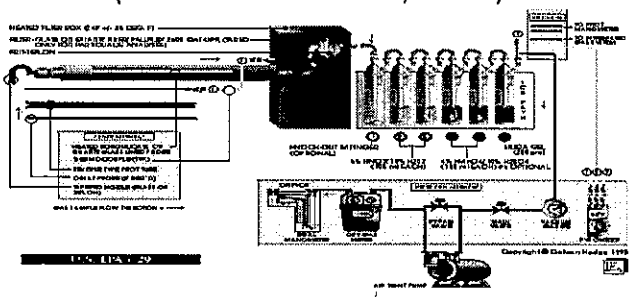
Point Source Monitoring in Coal Fired Power Plants (US EPA Method 29 ,101-A)



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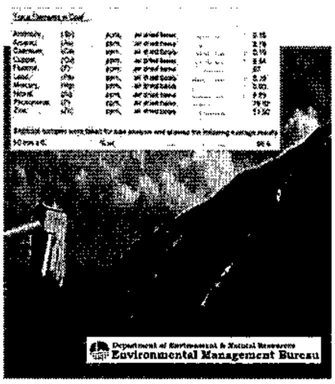
Coal Analysis in a Coal-fired Power Plant

Parameter	Indonesian HHV Coal	Indonesian Indonesia
	AVERAGE (%)	
Ash (%)	5.39	2.31
Sulfur (S)	0.66	0.11
Moisture (%)	15.15	2.31
Fixed Carbon (C)	43.48	27.7
Mercury (Hg) ppm	0.04	0.02
Mercury (Hg) %	3.86E-06	1.95E-06



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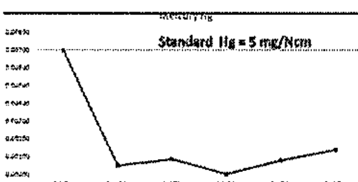
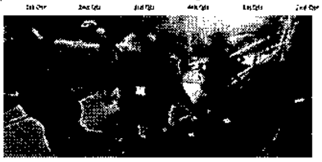
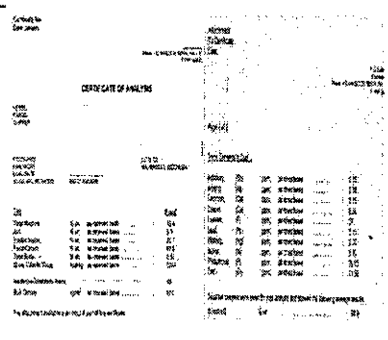
Environmental Management Bureau

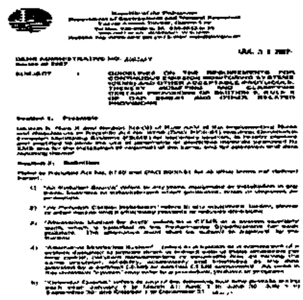
Department of Environment & Natural Resources
Environmental Management Bureau

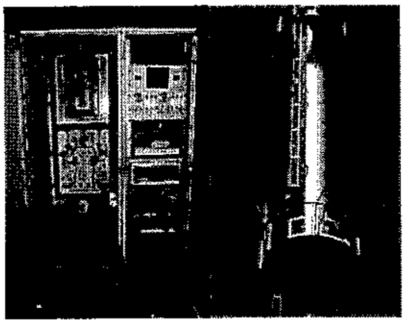
STACK EMISSION MONITORING IN A COAL-FIRED POWER PLANT



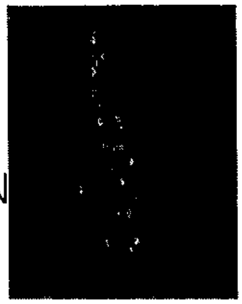



Continuous Emission Monitoring System (CEMS) US EPA Performance Specifications (PS)





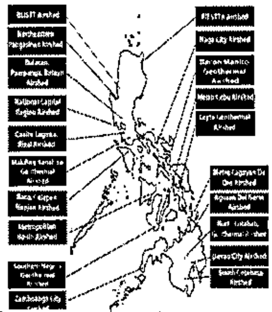
AIR QUALITY MONITORING NETWORK



- National Air Quality Monitoring Network
- Total Suspended Particulates (TSP)
- Particulate Matter 10 & 2.5
- Gaseous Air Pollutants (SO_2, NO_2, O_3)

Airsheds in the Philippines

Under the Philippine Clean Air Act of 1999, the *DENR is mandated to designate* ***AIRSHED*** *within the entire country.*



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National Air Quality Monitoring Network

MANUAL	Total Suspended Particulates
NCR	7
OUTSIDE NCR	12

MANUAL	Particulate Matter 10
NCR	5
OUTSIDE NCR	25

MANUAL	Particulate Matter 2.5
NCR	0
OUTSIDE NCR	2

Continuous Ambient Air Monitoring Station	Monitors Particulate Matter 10 (PM10), Particulate Matter 2.5 (PM2.5) and Meteorological Data (CAMS)
NCR	11
OUTSIDE NCR	12

Continuous Ambient Air Monitoring Station (DOAS) Monitors Particulate Matter 10 (PM10) and 2.5 (PM2.5), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), Photochemical Oxidants as Ozone (O3), Carbon Monoxide (CO), Meteorological Data and other gases such as Benzene, Xylene and Toluene	
NCR	7
OUTSIDE NCR	13

Continuous Ambient Air Monitoring Station (Conventional) Monitors Particulate Matter 10 (PM10) and 2.5 (PM2.5), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), Photochemical Oxidants as Ozone (O3), Carbon Monoxide (CO), Meteorological Data	
NCR	2
OUTSIDE NCR	2

TOTAL NUMBER NATIONWIDE: 98

行政院環境保護署 Environmental Protection Administration Executive Yuan, R.O.C.(Taiwan)

United States Environmental Protection Agency

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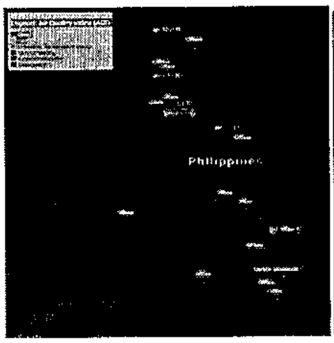
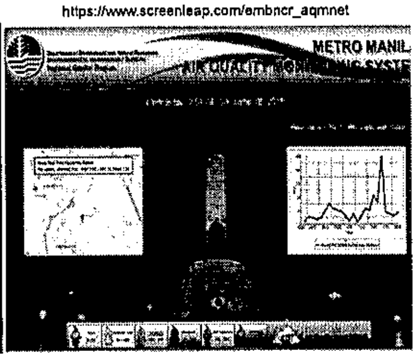
AIR QUALITY SYSTEMS IN THE PHILIPPINES PER TYPE AND POLLUTANTS MONITORED

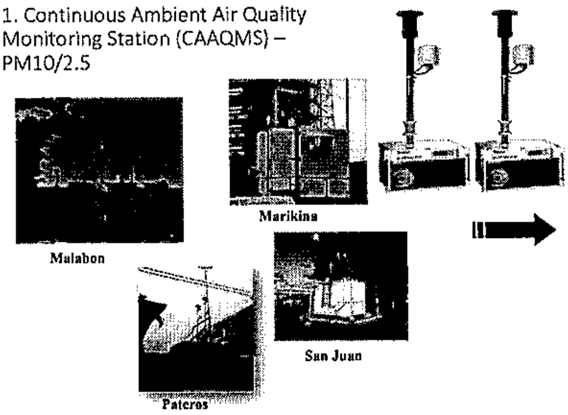
http://denr-dashboard.herokuapp.com/



https://www.screenleap.com/embncr_aqmnet



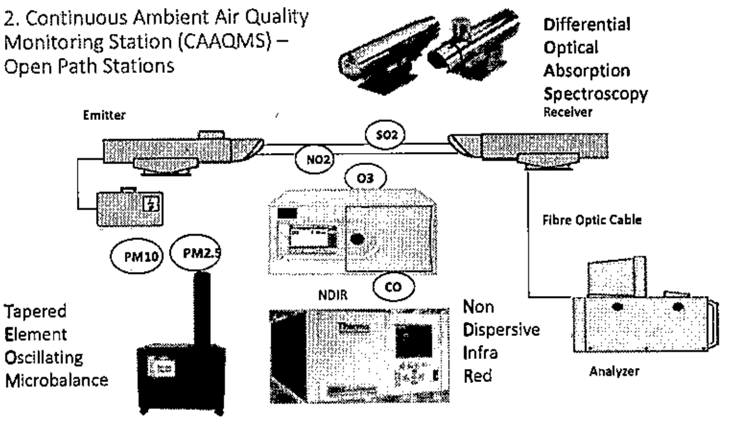
1. Continuous Ambient Air Quality Monitoring Station (CAAQMS) – PM10/2.5



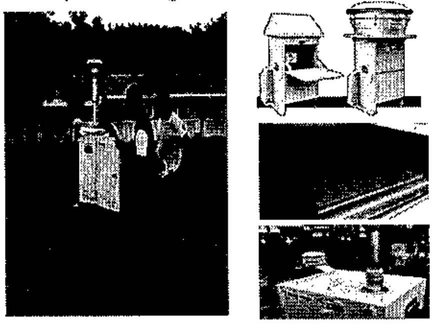
Beta Attenuation Monitor

+ EMB Regional Offices

2. Continuous Ambient Air Quality Monitoring Station (CAAQMS) – Open Path Stations



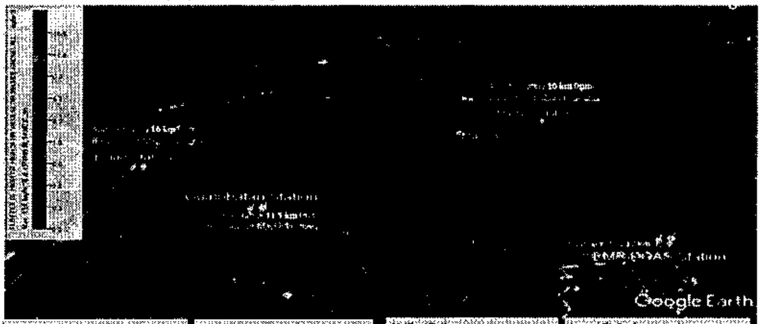
3. Manual TSP/PM10 Ambient Air Quality Monitoring Station



HI VOLUME SAMPLER

The sampler uses a continuous duty blower to suck in an air stream. When fitted with a particle size classifier, it separates particles greater than 10μm size from the air stream. The air stream is then passed through a filter paper to collect particles lesser than 10μm size (PM10). Gravimetric measurements yield values of suspended particulate matter (SPM), as the sum of the two fractions, and PM10, the material retained on the filter paper.

Actual Ambient Air Quality Monitoring and Predicted (AERMOD Ver.9.5) Concentration of Total Suspended Particulates (TSP) 24-Hour Average



Ligao Station: Minimum concentration: 200 ug/m3 Maximum concentration: 500 ug/m3 (888 ug/m3*)

Guinobatan Station: Minimum concentration: 500 ug/m3 Maximum concentration: 800 ug/m3 (796 ug/m3*)

Malilipot Station: Minimum concentration: 200 ug/m3 Maximum concentration: 500 ug/m3

Legazpi City Station: Minimum concentration: 200 ug/m3 Maximum concentration: 500 ug/m3

Legend: * Actual Concentration as of January 22-23, 2018 Monitoring

Actual Ambient Air Quality Monitoring and Predicted (AERMOD Ver.9.5) Concentration of Sulfur Dioxide (SO2) 24-Hour Average

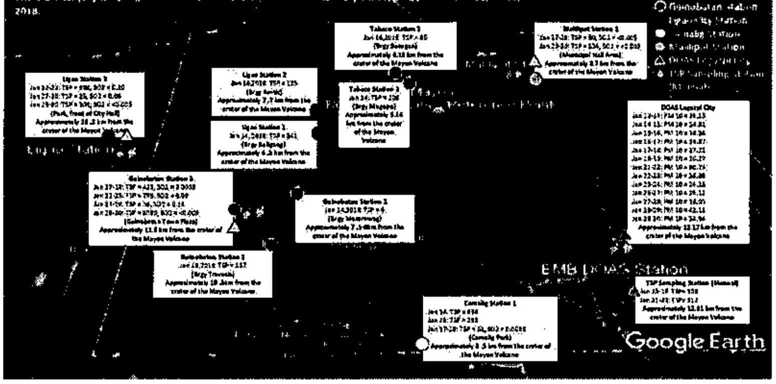
Ligao Station: Minimum concentration: 0.1 ug/m3 Maximum concentration: 0.5 ug/m3

Guinobatan Station: Minimum concentration: 1 ug/m3 Maximum concentration: 3 ug/m3

Malilipot Station: Minimum concentration: 0.1 ug/m3 Maximum concentration: 0.3 ug/m3

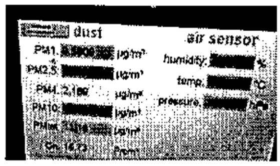
Legazpi City Station: Minimum concentration: 0.5 ug/m3 Maximum concentration: 0.8 ug/m3

VOLCANO AMBIENT AIR QUALITY MONITORING

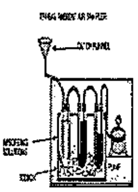


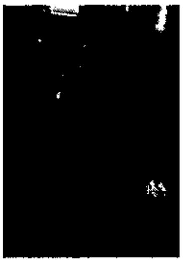
Volcano Ambient PM Monitoring

The APDA-372 dust monitor is specifically designed for indoor and outdoor air quality measurements and provide continuous and simultaneous measurements of PM1, PM2.5, respirable fractions (PM4), thoracic fractions (PM10), inhalable fractions (TSP), the particle number, and (upon request) the particle size distribution in 32 size classes per decade within the particle size range of 0.18 – 18 µm.



4. Gaseous Ambient Air Quality Monitoring Station (CAAQMS) –





TRI GAS AMBIENT AIR SAMPLER

- Used for gaseous sampling procedures. It has absorbers with bubblers in series. An air pump is connected which is capable of drawing at least 0.2 to 2.5 L/min of air for 60 min.
- Separate particles from the air stream by using inertia of particles. Forces deposition into liquid collection medium (usually a dilute buffer)by aggregating cells.

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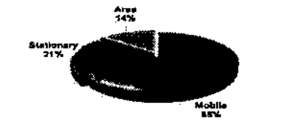
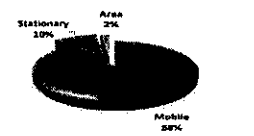
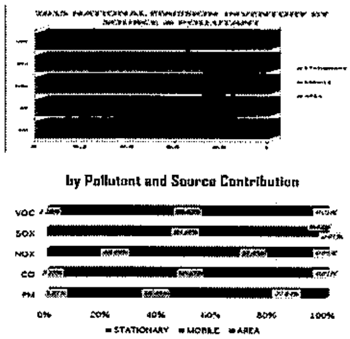
Emission Inventory



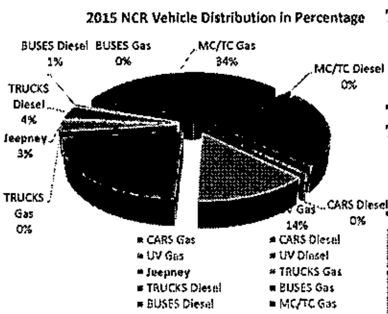
National Emissions Inventory, by source, 2015



NCR Emissions Inventory, by source, 2015



Vehicle Distribution in Metro Manila 2015



PUJ Modernization

Total No. of Vehicles in Metro Manila

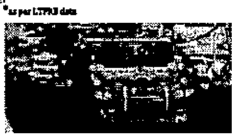
2015 NCR UV	Estimated Emissions in Tons/Year			
No. of Vehicles	TOG	CO	NOX	PMTotal
525,867*	14,930	54,785	30,054	39.714

*as per EI data of EMB NCR

Total No. of Jeepenys in Metro Manila

2016 NCR UV
No. of Jeepneys
67,775*

*as per LTFRB data



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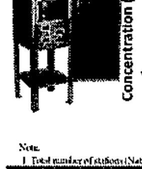
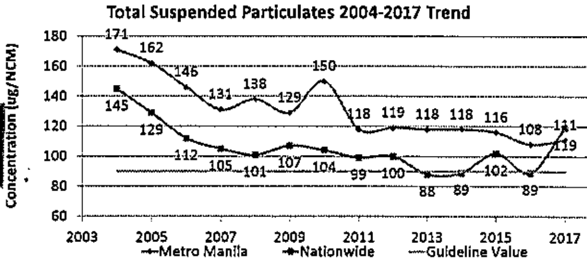
Total Suspended Particulate (TSP)





Note:
1. Total number of stations (National) in 2016: 14; 2015: 22; 2014: 24; 2013: 24; 2012: 49

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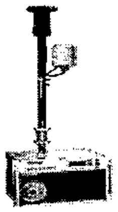
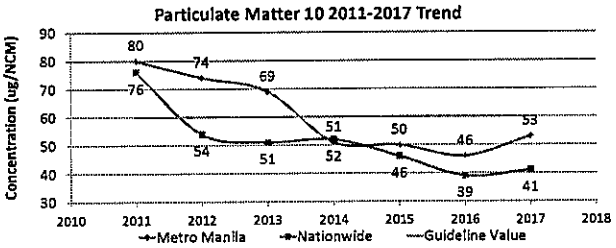
Particulate Matter (PM10)





Note:
Monitoring stations are combination of Continuous Ambient air quality Monitoring Station (CAMS) and Manual Reference Method.
Number of Stations in 2016: 41; 2015: 34; 2014: 34; 2013: 32; 2012: 25; 2011: 19.
Stations in 2015 are combination of Manual, CAMS PM10 Stations and Complete Criteria Pollutant Stations

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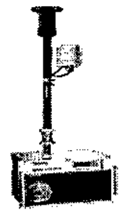
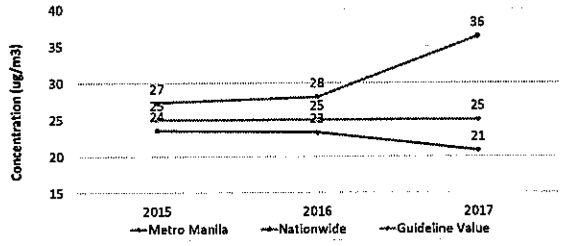
Particulate Matter (PM2.5)





Note:
- Monitoring stations are combination of Continuous Ambient air quality Monitoring Station (CAMS) and Manual Reference Method.
- Number of Stations in 2017: 44; 2016: 38; 2015: 38

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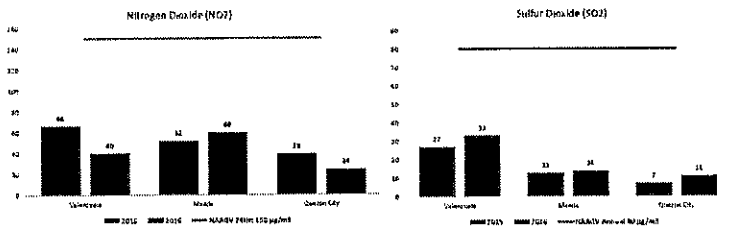
Annual Changes of Air Quality (Gases)

National Capital Region (Metro Manila)



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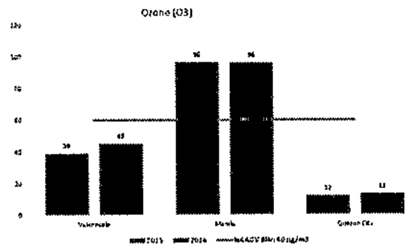
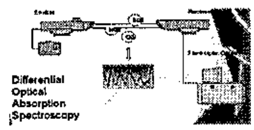
Annual Changes of Air Quality (Gases)

National Capital Region (Metro Manila)





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Thanks for Your Attention

Contact Information
- Telephone: (632) 927-15-17 / (632) 928-37-35
- E-mail: mail@emb.gov.ph
- Website: http://www.emb.gov.ph

United States Environmental Protection Agency
Asia Pacific Mercury Monitoring Network
EPA TAIWAN

MOSTI

WET DEPOSITION MONITORING IN MALAYSIAN METEOROLOGICAL DEPARTMENT (MMD)

Norazura Zakaria
Malaysian Meteorological Department
Ministry of Energy, Science, Technology, Environment & Climate Change

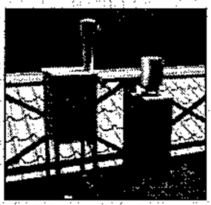
Outline

- Wet Deposition Monitoring in MMD
- Sampling & Chemical Analysis
- Constraints

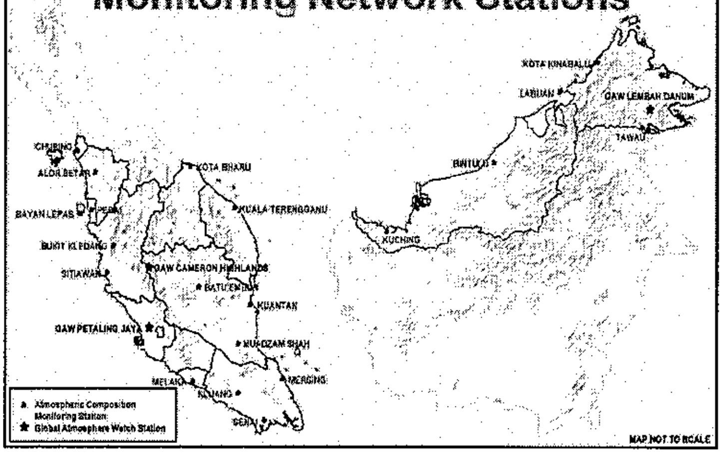
Wet Deposition Monitoring in MMD

- Started since year 1984.
- involve 23 stations under Atmospheric Composition Monitoring Network over Malaysia.
- current instrumentation use are:
  i. Tisch Acid Precipitation Sampler (APS) – collect **both wet and dry deposition** by using two different collector.
  ii. Ecotech Wet Only Sampler - collect **wet deposition only**.
- Samples are then analyzed by Department of Chemistry.


Acid Precipitation Sampler (APS)


Ecotech Wet Only Sampler

Atmospheric Composition Monitoring Network Stations



Sampling & Chemical Analysis

Instruments	Sampling Period	Parameter Analyzed	Chemical Analysis Instrument
Acid Precipitation Sampler (APS)	Wet Deposition: 1 week	Wet Deposition: Conductivity, pH, Anions(Cl^-, NO_3^-, SO_4^{2-}, organic acids), Cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+) & Metals (Cd, Cu, Fe, Pb, Mn, Hg, Ni & Zn).	Wet Deposition: Ion Chromatography, Inductively Coupled Plasma Mass Spectrometry (ICP-MS), pH meter & Conductivity Meter
	Dry Deposition: 1 month	Dry Deposition: Dust weight, Metals (Mg, Ca, Cu, Fe, Pb, Mg, Mn, Hg, Ni & Zn)	Dry Deposition: Ion Chromatography
Ecotech Wet-Only Rainwater Sampler	1 week	Conductivity, pH, Anions(Cl^-, NO_3^-, SO_4^{2-}, organic acids), Cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+) & Metals (Cd, Cu, Fe, Pb, Mn, Hg, Ni & Zn).	Ion Chromatography, ICP-MS, pH meter & Conductivity Meter

Wet Deposition Data

1. Monthly Wet Deposition Data - Petaling Jaya GAW Station (Urban Site)

JABATAN METEOROLOGI MALAYSIA

Wet Fallout WEF
Wet Fallout WEF results

Station: PETALING JAYA
Period: 2017-01-01 00:00 - 2017-12-31 23:59
Latitude: 3° 06' 07" N
Longitude: 101° 38' 42" E
Elevation: 58.6 m
Unit: umol/L

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CALCIUM_WETK	5.54	[redacted]			2.81	8.37	4.50	4.59	3.42	2.73	3.69	4.22
CHLORIDE_WETK	7.27				6.97	12.34	10.67	13.47	6.31	15.90	6.56	12.24
CONDUCTIVITY_WETK	2.33				1.93	3.53	1.81	2.22	0.94	1.40	1.15	2.09
FLOURIDE_WETK	0.40				0.39	0.68	0.45	0.43	0.41	2.63	1.52	2.35
IRON_WETK	0.21				0.19	<0.070	<0.070	0.13	0.01	0.01	0.03	0.13
MAGNESIUM_WETK	0.79				0.02	1.03	0.83	0.47	<0.070	1.00	<0.070	1.01
MSA_WETK	<0.03				<0.03	<0.03	<0.03	<0.03	<0.03	0.09	0.03	<0.03
NH4_WETK	12.41				16.04	25.92	29.38	18.71	10.03	8.02	10.07	25.91
NO3_WETK	34.61				27.59	61.13	28.86	29.49	12.73	21.64	19.57	35.91
PH_WETK	4.40				4.49	4.24	4.61	4.50	4.79	4.67	4.68	4.57
POTASSIUM_WETK	1.68				1.07	2.92	1.63	2.05	1.06	1.57	1.24	2.06
SO4_WETK	18.64				12.41	21.90	17.76	16.50	8.87	7.14	7.44	14.02
SODIUM_WETK	5.34				3.30	5.27	5.54	8.60	3.67	11.79	3.50	6.58
ACETATE_WETK	0.132				0.074	2.025	<0.050	0.510	0.375	<0.050	<0.050	<0.050
COPPER_WETK	0.024				0.034	<0.005	0.025	0.027	0.010	0.067	0.024	0.029
LEAD_WETK	0.006				0.004	<0.001	0.006	0.015	0.002	0.065	0.008	0.013
MANGANESE_WETK	0.122				0.104	<0.003	0.024	0.089	0.030	0.013	0.015	0.047
MERCURY_WETK	<0.001				<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NICKEL_WETK	<0.050				<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
VOLUME	1.360				3.593	1.626	1.150	2.470	2.820	4.660	1.980	1.650
ZINC_WETK	0.246				0.133	<0.010	0.422	0.240	0.130	0.153	0.182	0.340

Constraints

1. Lack of facilities for mercury chemical analysis:
   - Current instrument use are limited up to trace level detection only.
   - Minimum Detection Limit (MDL) for each instruments are as follow:
     i. Inductively Coupled Plasma Mass Spectrometer (ICP-MS) - 0.0001mg/L
     ii. Cold Vapor-Atomic Absorption Spectrometer (CV-AAS) - 0.0008 mg/L
     iii. Flow Injection Mercury System (FIMS) - 0.005 mg/L
   - No Clean Room Class 100
2. Not able to fulfill the mercury sampling procedure:
   - Technnical Manual for Wet Deposition Monitoring in East Asia by Acid Deposition Monitoring Network (EANET)
   - Current rainwater monitoring instrument is not suitable for mercury monitoring.

Trace Metal Biogeochemistry Laboratory TMBL

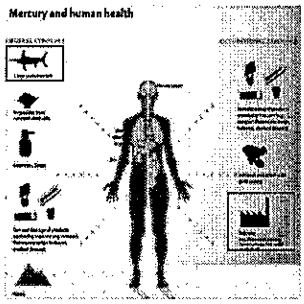
광주과학기술원

2018 APMMN meeting

National mercury monitoring activities in Korea

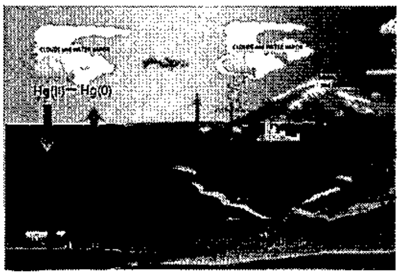
Seunghee Han and Eunji Jeong
School of Environmental Sciences and Engineering
Gwangju Institute of Science and Technology (GIST)
Gwangju, Korea

1. Introduction



Zero-valent mercury, Hg(0)

- <0.01% bioavailability after ingestion
- After inhalation it easily cross blood-brain barrier
- Disorder of central nervous system
- Nervousness, erethism

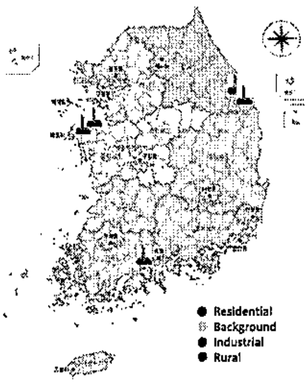


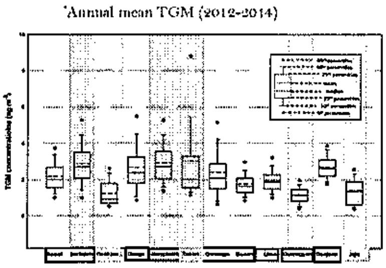
Divalent mercury, Hg(II)

- 7–15% bioavailability after ingestion
- Kidney damage
- Renal tubule damage
- Nephritis

2. National monitoring network for TGM

- TGM has been monitored using CVAFS (Tekran system) at the 12 acid precipitation monitoring sites from 2012 (2 hr mean).



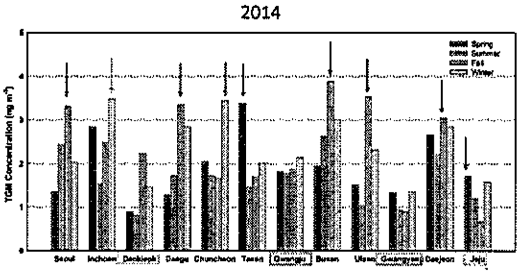


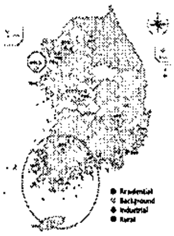
Courtesy of Youngji Han and NIER

Sources: Air Korea (http://www.airkorea.or.kr)

2. National monitoring network for TGM

- The lowest TGM is found from the southwest area (Jeju, Gwanyang and Gwangju).
- Peak conc is commonly found in fall and winter in the other sites with large seasonal variations.

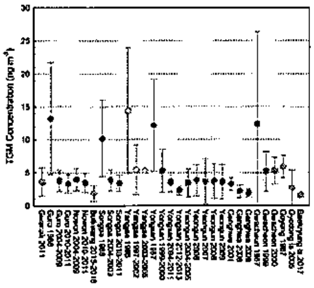


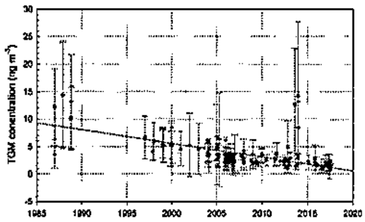


Courtesy of Youngji Han and NIER

2. National monitoring network for TGM

- TGM shows relatively steady trend after 2005.

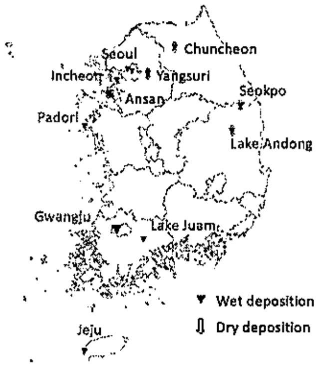




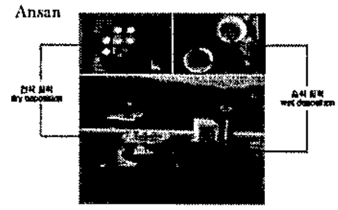
Courtesy of Youngji Han

3. National monitoring network for wet deposition

- Jeju, Padori, Incheon, Seoul: national monitoring, weekly sampling, 2015-present
- Andong, Seokpo: event sampling, 2009-2011
- Ansan, chuncheon: event sampling
- Gwangju: APMMN supported, 2016-present



Ansan

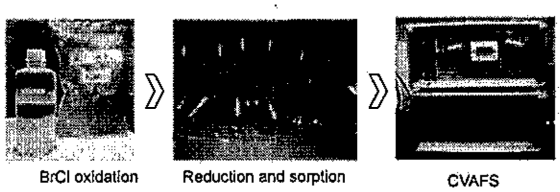


Gwangju

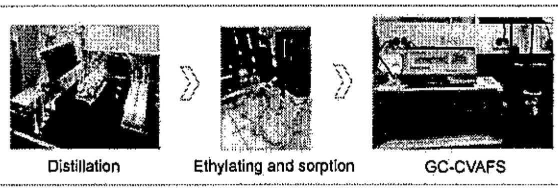
3. National monitoring network for wet deposition

- Gwangju site has been operated from April 2016.
- THg is measured at the Dr Sheu's lab in Taiwan and MeHg at the GIST lab.

THg

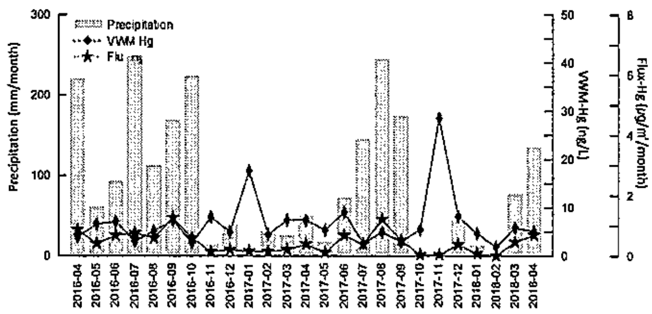


MeHg



3. National monitoring network for wet deposition

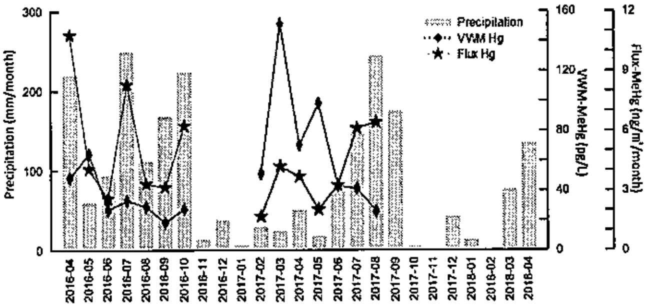
- VWM THg is peaked in winter (November and January) and wet deposition is peaked in summer (August).



April 2016-March 2017, VWM THg: 4.7 ng/L, THg flux: 6.0 μg/m²/yr
April 2017-March 2018, VWM THg: 4.9 ng/L, THg flux: 4.3 μg/m²/yr

3. National monitoring network for wet deposition

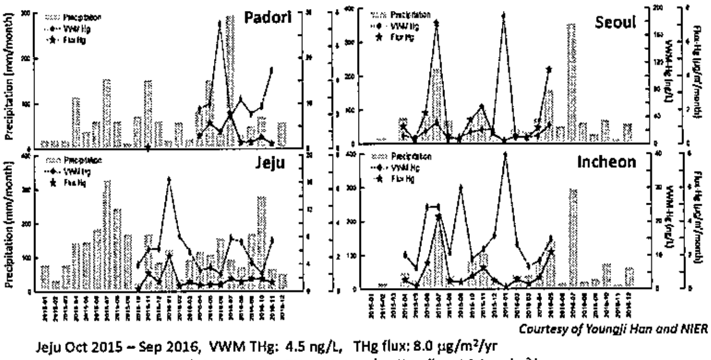
- VWM MeHg is highest in spring (March) and wet deposition follows the precipitation trend.



April 2016-March 2017, VWM MeHg: 31 pg/L, MeHg flux: 40 ng/m²/yr (0.67% of THg)

3. National monitoring network for wet deposition

- VWM is highest in January and wet deposition is highest in July except Jeju.

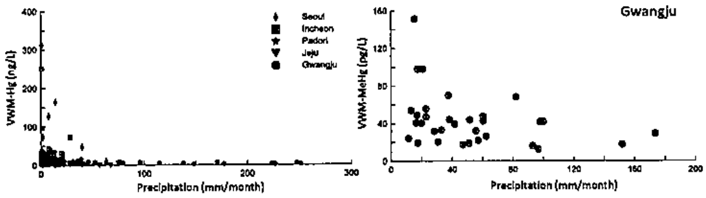


Courtesy of Youngji Han and NIER

Jeju Oct 2015 – Sep 2016, VWM THg: 4.5 ng/L, THg flux: 8.0 μg/m²/yr
Seoul April 2015 – March 2016, VWM THg: 21.1 ng/L, THg flux: 16.1 μg/m²/yr
Incheon April 2015 – March 2016, VWM THg: 13.9 ng/L, THg flux: 11.0 μg/m²/yr

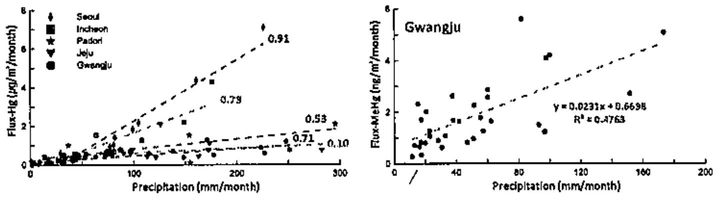
3. National monitoring network for wet deposition

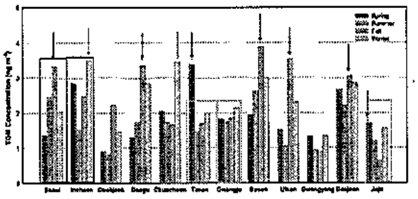
- VWM concentrations of THg and MeHg were negatively correlated to precipitation.



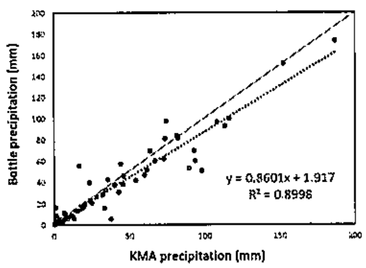
3. National monitoring network for wet deposition

- Wet deposition/precipitation: Seoul > Incheon > Padori > Gwangju, Jeju





3. National monitoring network for wet deposition



- Hg and MeHg deposition fluxes of Gwangju site might be underestimated by ~14%.

3. National monitoring network for wet deposition

Site	Type	Sampling period	Annual prec (mm)	VWM (ng/L)		Wet deposition (μg/m²/yr)		Reference
				THg	MeHg	THg	MeHg	
Chongqing China	Industrial	Dec 2010-Nov 2014	1104.4	34.3	0.48	37.8	0.53	Qin et al., 2016
Chongqing China	Urban	Jul 2010-Jun 2011	921	30.7	0.31	-	-	Wang et al., 2012
Lhasa, Tibetan, China	Urban	Jan-Dec 2009	359	24.8	-	8.2	-	Huang et al., 2013
Seoul Korea	Urban	April 2015-March 2016	766	21.1	-	16.1	-	This study
Three Gorges Reservoir, China	Rural	Nov 2012-Oct 2013	743	18.0	0.23	13.0	0.17	Zhao et al., 2015
Xiamen, China	Suburban	Jun 2012-May2013	1137	12.3	0.053	14.0	0.058	Xu et al., 2014
Pengjiayu Taiwan	Remote	Jan-Dec 2009	1438	8.8	-	10.2	-	Sheu and Lin, 2013
Minamata Bay Japan	Costal	Sep 2009-Aug 2010	-	5.9	0.061	13.7	0.14	Marumoto and Matsuyama, 2014
Gwangju Korea	Urban	April 2016-March 2017	1274	4.7	0.031	6.0	0.040	This study
Tibetan Plateau, China	Alpine	May 2010-Oct 2012	978	4.0	0.11	3.9	0.11	Huang et al., 2015

4. Conclusions

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- The median TGM concentration of each monitoring site ranged from 1.0 to 2.8 ng m^{-3} and peak concentrations were found in fall and winter (national network, 2012-2014).
- The concentration range of TGM was low and seasonal variation was small in the southwest part Korea including Jeju island (Seoul, Busan and Incheon) (national network, 2012-2014).
- The wet deposition of THg normalized to precipitation (Seoul > Incheon > Padori > Gwangju, Jeju) follows the trend of TGM (national network 2015-2016 and Gwangju 2016-2017).
- VWM of THg and MeHg was highest in winter and spring, respectively. MeHg production and scavenging should be better understood with extensive data collection (Gwangju, 2016-2017).

5. What happens after deposition?

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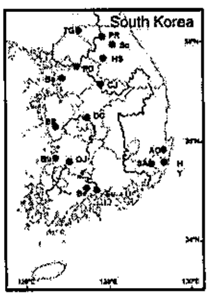
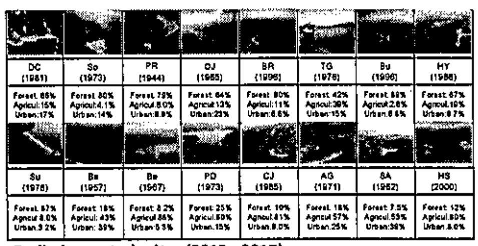
Pilot project for the comprehensive mercury monitoring network in Korea

(1) Preliminary study (2013-2015)

(2) Pilot project (2016-2020)

(3) Operation of the national monitoring network (2021-)

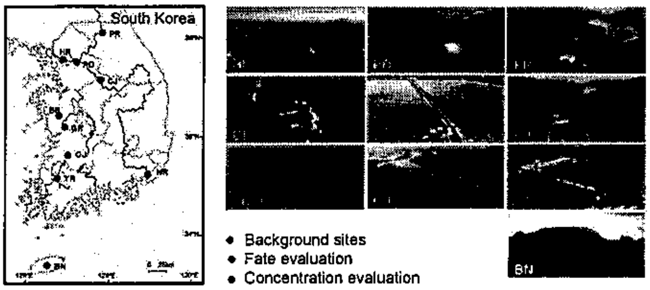




Preliminary study sites (2013 - 2015)

5. What happens after deposition?

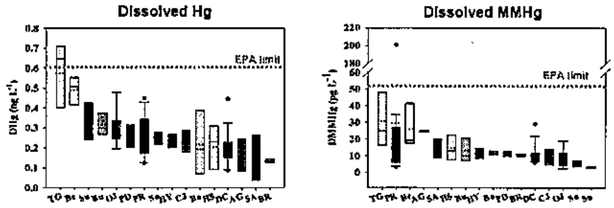
Pilot project (2016 - 2020)



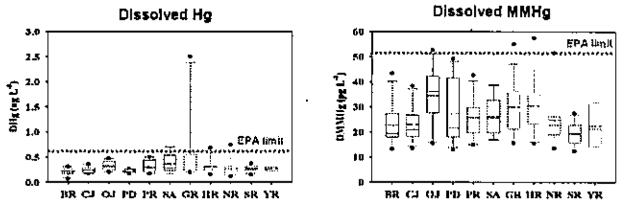
- Background sites
- Fate evaluation
- Concentration evaluation

5. What happens after deposition?

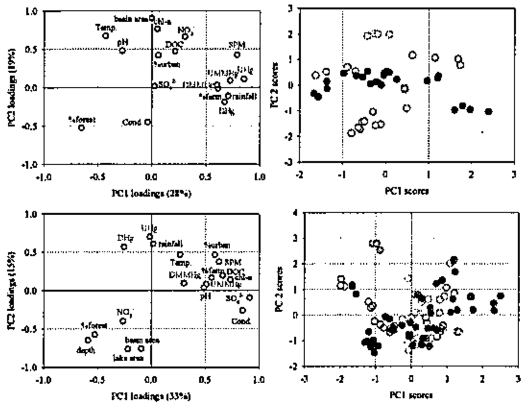
Preliminary study (2013 - 2015)



Pilot project (2016 - 2020)



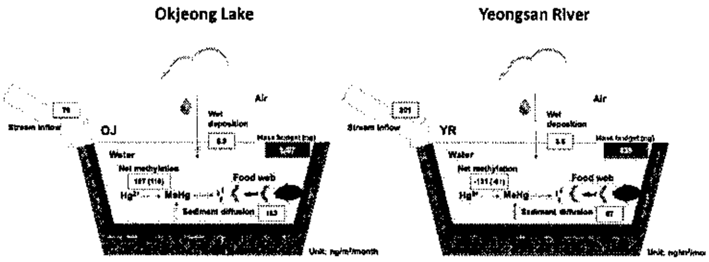
5. What happens after deposition?



2016-2017 rivers (excluding winter, n=48)

2013-2017 lakes (excluding winter, n=112)

5. What happens after deposition?



Okjeong Lake: sediment diffusion > in-situ methylation > stream

Yeongsan River: stream > sediment diffusion > wet deposition

Acknowledgements

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환경부

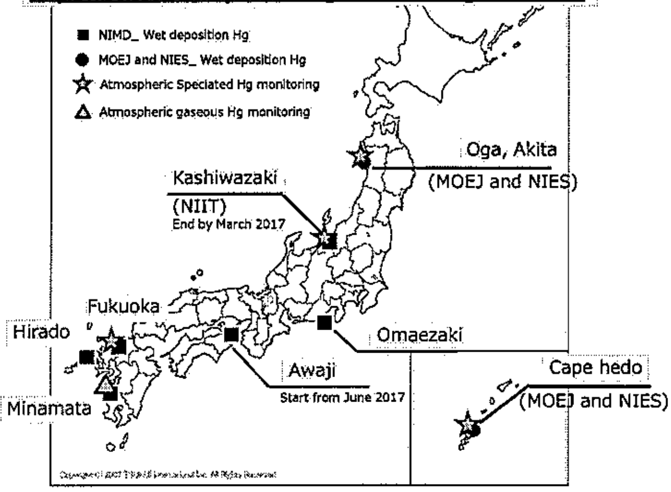
Update on recent mercury monitoring activities in Japan (2018)

Monitoring project for atmospheric mercury & other heavy metals in Japan
by Ministry of the Environment , Japan and National Institute for Minamata Disease

Objectives:

- Monitor current levels of mercury and other heavy metals in air, particles, and precipitation;
- Obtain useful information on the long-range transportation of trace elements in Asia-Pacific region;
- Develop monitoring methodologies;
- Contribute to the international efforts in mercury monitoring

Japanese Atmospheric Hg monitoring network



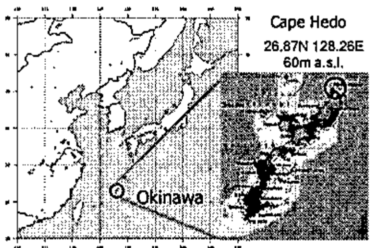
Measurement of mercury in atmosphere and wet depositions at Cape Hedo, Oga Peninsula conducted by MOE of Japan

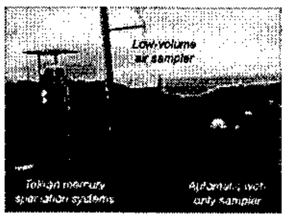
Measurement items, sampling, and analytical method

Component	Measurement items		Sampling and analytical methods	site
Atmosphere	Mercury	Mercury speciation (GEM, GOM, PBM)	Continuous measurement with Tekran® mercury speciation system	Cape Hedo, Oga
	Particulate matter	Pb, Cd, Cu, Zn, As, Cr, V, Ni, Se, Sb, Ba, Co, Mn, Sn, Te, Tl, Be, Al, Fe, Ca, Na, K,Mg	7 days continuous sampling by the low-volume sampler and analyzed by ICP/MS	Cape Hedo
Precipitation	Hg		Sampling by the automatic wet-only sampler and analyzed by CVAAS (EPA method 1631)	Cape Hedo, Oga

GEM: Gaseous Elementary Mercury
GOM: Gaseous Oxidized Mercury
PBM: Particle-Bound Mercury
CVAAS: Cold Vapor-Atomic Absorption Spectrometry

Cape Hedo Atmosphere and Aerosol Monitoring Station (CHAAMS)

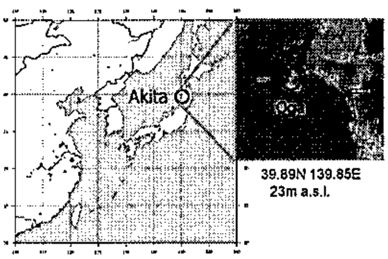


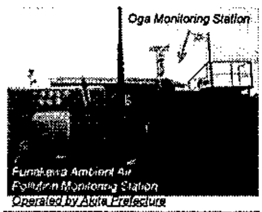


CHAAMS operated by National Institute for Environment Studies

Tekran mercury speciation analyzer and other heavy metals monitoring systems

Mercury monitoring station in Oga , Japan

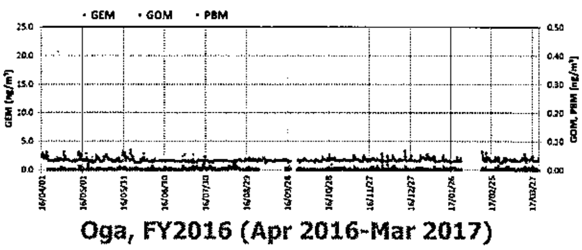




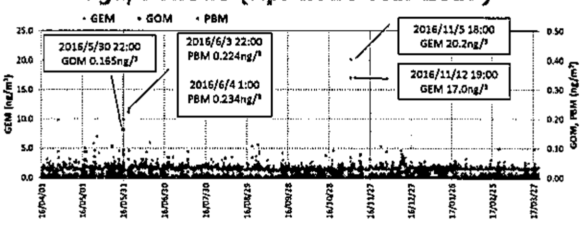
To strengthen the capacity of the mercury-observation network in Japan, a new observation site was set up at Oga city, Akita Prefecture, in September 2014.

Observations of mercury species

Cape Hedo, FY2016 (Apr 2016-Mar 2017)



Oga, FY2016 (Apr 2016-Mar 2017)



Observations of mercury species

Annual variations of GEM

Statistics
Hourly Mean of GEM
Unit: ng/m³

Cape Hedo / **Oga**

	Cape Hedo FY2010 (Apr 2010 - Mar 2011)	FY2011 (Apr 2011 - Mar 2012)	FY2012 (Apr 2012 - Mar 2013)	FY2013 (Apr 2013 - Mar 2014)	FY2014 (Apr 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)	Oga FY2014 (Aug 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)
Mean	1.9	2.1	2.0	1.7	1.7	1.6	1.7	1.6	1.6	1.6
Median	1.8	2.0	1.9	1.6	1.7	1.6	1.6	1.6	1.6	1.6
Min	1.2	1.1	1.3	0.9	1.2	1.0	1.2	0.9	0.7	0.7
Max	6.0	4.7	7.3	4.8	3.9	3.4	3.5	6.7	21.8	20.2
Standard Deviation	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.4	0.4	0.5

Observations of mercury species

Annual variations of GOM, PBM

Statistics
Hourly Mean
Unit: ng/m³

Cape Hedo / **Oga**

GOM	Cape Hedo FY2010 (Apr 2010 - Mar 2011)	FY2011 (Apr 2011 - Mar 2012)	FY2012 (Apr 2012 - Mar 2013)	FY2013 (Apr 2013 - Mar 2014)	FY2014 (Apr 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)	Oga FY2014 (Aug 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)
Mean	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.003	0.002
Min	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.058	0.044	0.024	0.039	0.047	0.044	0.046	0.048	0.152	0.165

PBM	Cape Hedo FY2010 (Apr 2010 - Mar 2011)	FY2011 (Apr 2011 - Mar 2012)	FY2012 (Apr 2012 - Mar 2013)	FY2013 (Apr 2013 - Mar 2014)	FY2014 (Apr 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)	Oga FY2014 (Aug 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)
Mean	0.002	0.002	0.002	0.004	0.004	0.002	0.003	0.009	0.009	0.011
Min	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.048	0.041	0.027	0.071	0.044	0.020	0.030	0.144	0.557	0.234

Observations of mercury species

Monthly variations of GEM

Cape Hedo, FY2016 (Apr 2016-Mar 2017) Unit: ng/m³

FY2016	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean	1.9	1.8	1.7	1.6	1.6	1.7	1.7	1.8	1.8	1.7	1.8	1.8
Median	1.8	1.7	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.6	1.7	1.7
Min	1.4	1.3	1.2	1.2	1.3	1.2	1.3	1.4	1.5	1.3	1.4	1.2
Max	3.2	3.3	3.5	2.7	2.1	2.1	2.6	2.6	3.4	2.8	3.3	2.8
Standard Deviation	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2
Samples (Hours)	460	457	464	468	457	431	407	457	444	465	187	462

Oga, FY2016 (Apr 2016-Mar 2017) Unit: ng/m³

FY2016	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean	1.6	1.8	1.7	1.7	1.6	1.5	1.4	1.6	1.8	1.6	1.6	1.6
Median	1.5	1.7	1.7	1.7	1.5	1.4	1.3	1.5	1.6	1.6	1.6	1.6
Min	1.1	1.1	0.7	0.9	0.8	0.8	1.0	0.8	1.2	1.3	1.4	1.3
Max	3.0	7.0	6.0	4.5	3.5	5.6	4.6	20.2	4.6	2.8	3.2	5.0
Standard Deviation	0.3	0.5	0.5	0.3	0.3	0.4	0.3	1.2	0.4	0.2	0.2	0.3
Samples (Hours)	463	481	454	480	463	465	479	444	480	478	433	480

Observations of mercury species

Monthly variations of GOM and PBM

Cape Hedo, FY2016 (Apr 2016-Mar 2017) Unit: ng/m³

	FY2016	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
GOM	Mean	<0.001	0.002	0.002	0.003	0.004	0.001	<0.001	0.001	0.002	0.002	<0.001	0.002
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max	0.009	0.019	0.012	0.046	0.028	0.006	0.008	0.008	0.007	0.011	0.005	0.007
PBM	Mean	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.004	0.005	0.002	0.002	0.004
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
	Max	0.013	0.008	0.006	0.007	0.008	0.013	0.019	0.012	0.030	0.013	0.011	0.015

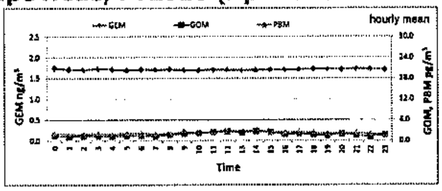
Oga, FY2016 (Apr 2016-Mar 2017) Unit: ng/m³

	FY2016	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
GOM	Mean	0.002	0.008	0.003	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max	0.019	0.165	0.033	0.032	0.014	0.026	0.008	0.021	0.012	0.018	0.012	0.014
PBM	Mean	0.012	0.010	0.008	0.005	0.004	0.005	0.014	0.012	0.016	0.022	0.008	0.010
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.002	0.003	0.002	<0.001
	Max	0.196	0.199	0.234	0.063	0.035	0.087	0.075	0.079	0.106	0.057	0.042	0.098

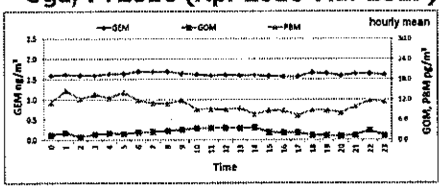
Observations of mercury species

Diurnal variations of GEM, GOM and PBM

Cape Hedo, FY2016 (Apr 2016-Mar 2017)



Oga, FY2016 (Apr 2016-Mar 2017)



Observations of precipitation

Mercury concentration in precipitation (Annual mean)

♦**Cape Hedo** Unit: ng/L

FY2008 (Apr 2008 - Mar 2009)	FY2009 (Apr 2009 - Mar 2010)	FY2010 (Apr 2010 - Mar 2011)	FY2011 (Apr 2011 - Mar 2012)	FY2012 (Apr 2012 - Mar 2013)	FY2013 (Apr 2013 - Mar 2014)	FY2014 (Apr 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)
3.4	3.1	2.4	3.0	1.9	2.2	1.4	2.0	4.3

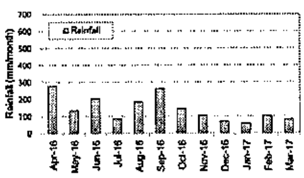
♦**Oga** Unit: ng/L

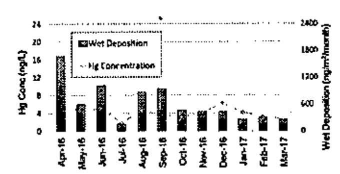
FY2014 (Apr 2014 - Mar 2015)	FY2015 (Apr 2015 - Mar 2016)	FY2016 (Apr 2016 - Mar 2017)
2.5	2.9	4.7

Observations of precipitation

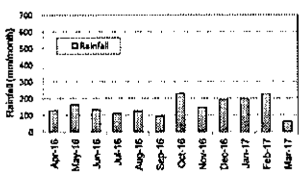
Wet deposition of mercury

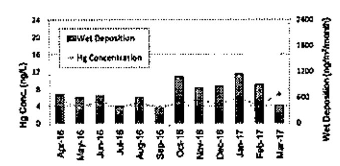
Cape Hedo, FY2016 (Apr 2016-Mar 2017)





Oga, FY2016 (Apr 2016-Mar 2017)





Thank you!

For more information:
https://www.env.go.jp/en/chemi/mercury/bms2016.html

Mercury monitoring activities and plans in Fiji

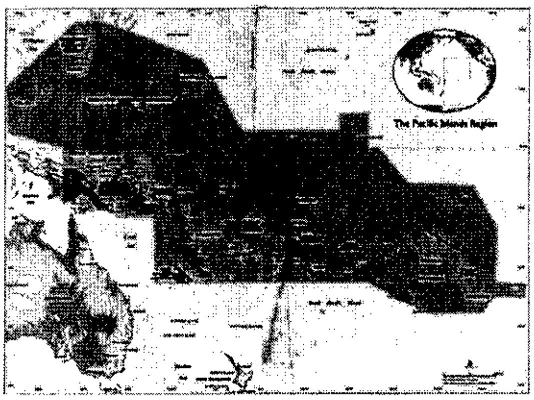
University of the South Pacific
Institute of Applied Sciences

6th September 2018

Dr. Vincent Vishant LAL
Manager Analytical Services

Overview

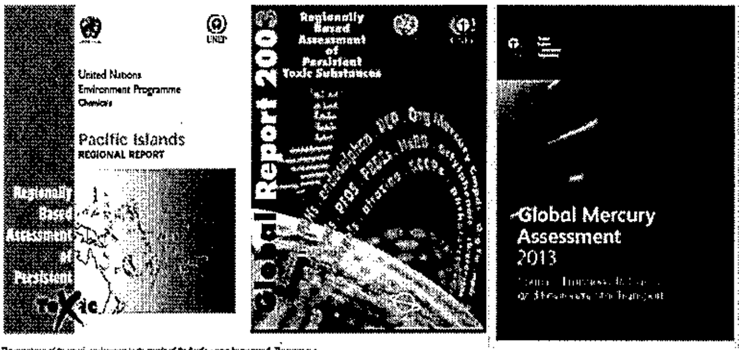
- Introduction
- Limitation and knowledge GAPs
- Future activities
- Concluding remarks

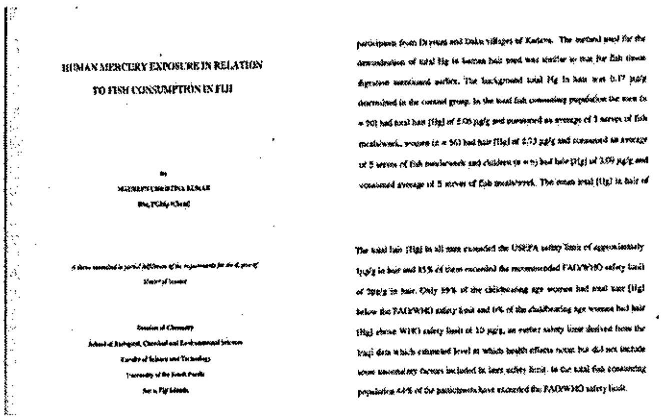


Introduction

- **Background**

- The Institute of Applied Sciences (IAS) of the University of South Pacific is a research and commercial entity of the university that provides service to its 14 Pacific Island member Countries in the Pacific Island Region (PIR)
- One of six regional reference laboratories for POPs under the Stockholm Convention (ambient air, human milk, plasma and water)
- The Analytical Laboratory of IAS has 4 units (Water, Food, Microbiology and Biofuel) that is accredited under ISO17025 and IANZ (International Accreditation of New Zealand).
- Total mercury (accredited test under compliance with IANZ requirements)





HUMAN MERCURY EXPOSURE IN RELATION TO FISH CONSUMPTION IN FIJI

Table 8a. PIC HEAVY METAL ANALYSES

Location & Reference	Substrate & Sample Numbers	Level (Range, Median)		Units[a]
		Pb	Hg	
Solomon Islands Naidu et al, 1991	sediment (12)	18.7 - 79.5 53.1	-	ppm DW
Fiji Tamata & Thaman, 2000	sediment (5)	0.03 - 0.08 0.03	<0.001	ppm WW
Fiji, contaminated site Naidu & Morrison, 1994	sediment (5)	0.21 - 116,000	0.2 - 1.34	ppm DW
Fiji Gangaiya et al, 1988	sediment (6)	6.8 - 10 7.7	<0.2	ppm DW
Fiji Morrison et al, 1997	sediment (7)	3 - 17 5	0.029 - 0.240 0.034	ppm DW
Fiji Morrison et al, 2001	sediment (25)	3.32 - 13.25 7.54	0.061 - 0.185 0.111	ppm DW
American Samoa AECOS, 1991	sediment (6)	25 - 54 27	0.02 - 0.09	ppm WW
Fiji Naidu et al, 1991	sea water (35)	<10 - 19 <10	<3 - 8.8 1.0	µg/L
Fiji Tamata & Thaman, 2000	sea water (21)	<1 - 1.3 <1		µg/L
Fiji Morrison et al. 1997	sea water (36)	0.3 - 3.0 0.6	<2	µg/L

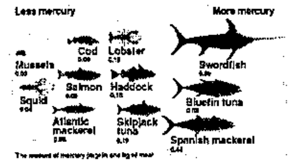
Fiji Naidu et al, 1991	*Crassostrea mordax (32)*	<0.5 - 5.48 0.63	<0.001 - 0.061 0.017	ppm WW
Vanuatu Naidu et al, 1991	*Anadara sp. (2)*	<0.5 - 0.6	0.02 - 0.04	ppm WW
Vanuatu Naidu et al, 1991	*Crassostrea mordax (4)*	0.72 - 0.94 0.90	0.01 - 0.04 0.02	ppm WW
Kiribati Naidu et al, 1991	*Anadara sp. (3)*	0.2 - 0.5 0.2	<0.1 - 5.6 5.5	ppm WW
Tonga Naidu et al, 1991	*Gafrarium tumidum (5)*	<0.50	0.022 - 0.191 0.043	ppm WW
Fiji contaminated site Naidu & Morrison, 1994	*C. mordax (5)*	5.6 - 12.7	0.55 - 0.95	ppm DW
Fiji Gangaiya et al, 1988	*G. tumidum (20)*	0.45 - 0.90 0.60	0.05 - 0.20 0.10	ppm DW
Fiji Morrison et al, 1997	*Anadara sp. (4)*	<5	0.32 - 0.56 0.34	ppm DW
Fiji Morrison et al, 2001	*Anadara sp. (5)*	2.9 - 4.6 3.7	0.037 - 0.099 0.046	ppm DW
American Samoa AECOS, 1991	fish (11)	0.1 - 7.9 2.1	<0.01 - 0.08 0.03	ppm WW
"Acceptable" levels	soils[b]	400	6.1	ppm
	drinking water[c]	15	3.6	µg/L
	shellfish[c]	2.0	0.5	ppm

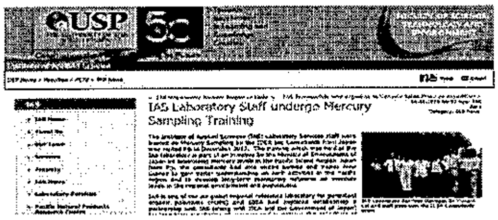
Notes:
(a) WW = wet weight, DW = dry weight
(b) Preliminary Remediation Guidelines, USEPA Region 9
(c) Australia New Zealand Food Standards Code

Fiji IAS, 1992	canned tuna (15)	-	0.07 - 0.97 0.21	-	ppm WW
Fiji IAS, 1992	canned tuna (13)	-	0.01 - 0.27 0.12	-	ppm WW
Solomon Islands Kannan et al, 1995	fish flesh (3) fish liver (2)	-	-	0.2 - 1.4 0.8 89 - 120	ppm WW
Tonga Morrison & Brown, 2000	shellfish (80)	<2	<2	<2	ppm DW
Samoa Govt. of Samoa, 1993	shellfish (4)	0.005 - 0.30	<0.002 - 0.03	0.13 - 0.45	ppm DW
Guam USEPA, 2001	fish (30)	0.16 - 6.01	<0.009 - 0.045	<0.42 - <0.79	ppm WW
"Acceptable" levels	soils[b]	400	6.1	190	ppm
	drinking water[b]	15	3.6	110	µg/L
	Shellfish[c]	2.0	0.5	25	ppm

Notes:
(a) WW = wet weight, DW = dry weight
(b) Preliminary Remediation Guidelines, USEPA Region 9
(c) Australia New Zealand Food Standards Code

IANZ
ACCREDITED LABORATORY





Limitation and knowledge GAPs

- Lack of capacity (air quality assessment for Hg)
- No monitoring program in place for Hg
- No baseline on wet deposition (levels of Hg)
- Lack of capacity methyl mercury (biological and environmental)
- Lack of inventory (storage, disposal and emission sources of Hg)
- Trends for Hg in Fiji and the PIR

Future activities

- Networking (joining the APMMN and "expert laboratories")
- Capacity building and training (Hg in air and wet deposition)
- Establishment of Hg monitoring sites (active and passive samplers)
- USP-IAS service to regional member Islands Countries that are signatories to the "Minamata Convention"
- Article 19 (*Research Development and Monitoring*)
- Article 22 (*Effectiveness Evaluation*)
- Extension of compliance for Hg accredited tests
- Data towards "baseline" for Hg in fish, water, air and population

Conclusion remarks

- The amount of available data on Hg in Fiji and other PICs is very limited
- Capacity building (sampling and testing Hg and methyl mercury)
- Developing monitoring and assessment capacity in a regional centre

Thank you...any questions.

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Atmospheric mercury monitoring in Canada

Alexandra Steffen
Geoff Stupple, Ashu Dastoor, Andrei Ryjkov, Andrea Darlington and Deyong Wen
Air Quality Research Division
Science and Technology Branch

Mercury (Hg) in Canada

- Hg remains a risk to Canadian ecosystems and human health
- Certain Canadian populations are at higher risk of exposure
- Methyl Hg levels can be high enough to pose a risk to the reproductive health of fish and fish-eating wildlife
- Most annual provincial/territorial fish consumption advisories are for Hg (~90%)
- Canada is a net recipient of mercury
  - 95% of anthropogenic Hg deposited in Canada comes from external source regions
- List of Toxic Substances in CEPA – mercury and its compounds
- Contaminant of Mutual Concern (GLWQA)
- Current Hg issues in Canada
  - Wabigoon-English River (Grassy Narrows and Whitedog First Nations)
  - Muskrat Falls, Labrador

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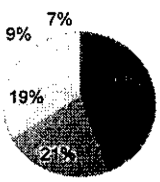
What are the major emission source regions contributing to Canada's burden?

Long range transport
ECCC Global Hg Model

Total deposition in Canada results from:
35% global terrestrial
25% oceanic
40% anthropogenic

95% anthropogenic Hg deposited in Canada is from outside of Canada

Relative contributions from individual source regions to net Hg deposition



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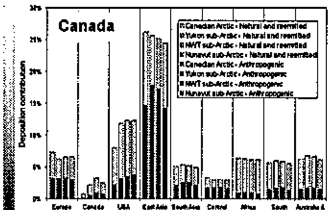
Hg deposition regional contribution

Global/Regional Atmospheric Heavy Metals Model for 2005



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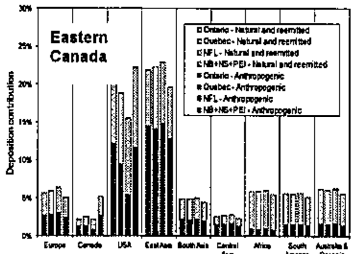
Ontario
Quebec
Newfoundland
NB+NS+PEI



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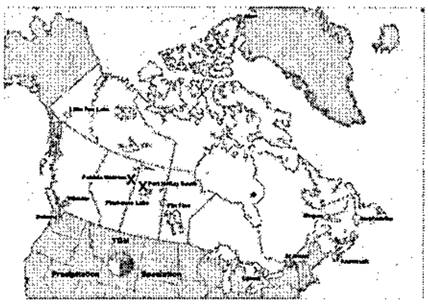
What factors have we considered for Hg monitoring in Canada?

Air monitoring

1) input levels of Hg to ecosystems
2) ambient levels from domestic and regional emission sources
3) transboundary transport of Hg into Canada



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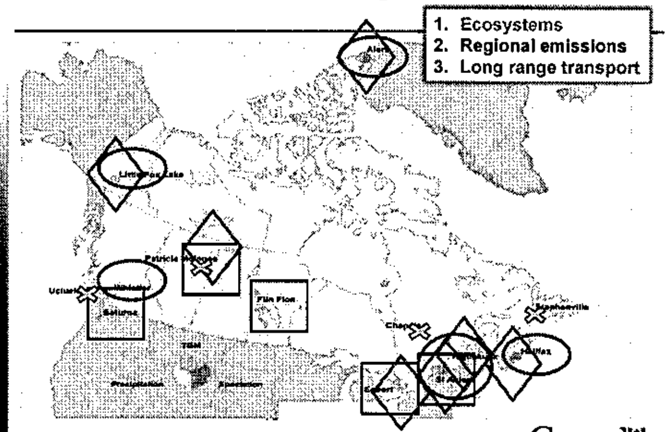
Site selection to meet goals

1. Ecosystems
2. Regional emissions
3. Long range transport



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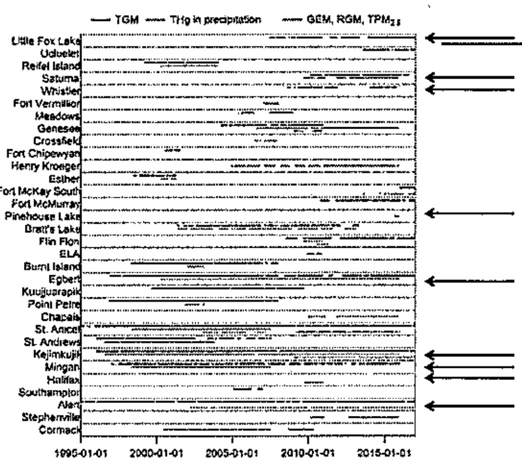
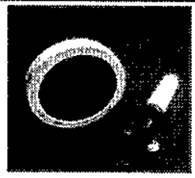
Data coverage in Canada

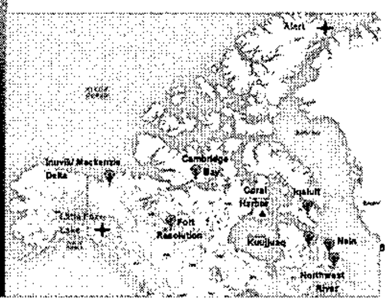


Canada

How do we fill the gaps?

- Passive mercury sampling
- New method developed at University of Toronto, Canada in collaboration with Environment Canada





- New Project in Canadas Arctic
- Address large spatial gaps
- 9 sites
- 2 locations active and passive monitoring

Canada

Pilot project – global Hg passives

Global Atmospheric Passive Sampling (GAPS) Network

- 1 year of sampling
- Samples collected every 3 months
- Sent to Environment Canada for analysis
- Demonstrate feasibility, show ease of use
- Identify gaps, hot spots etc.
- Use POPs GAPS network as a start
- Want to initiate with governments/collaborate with researchers
- Use current infrastructure

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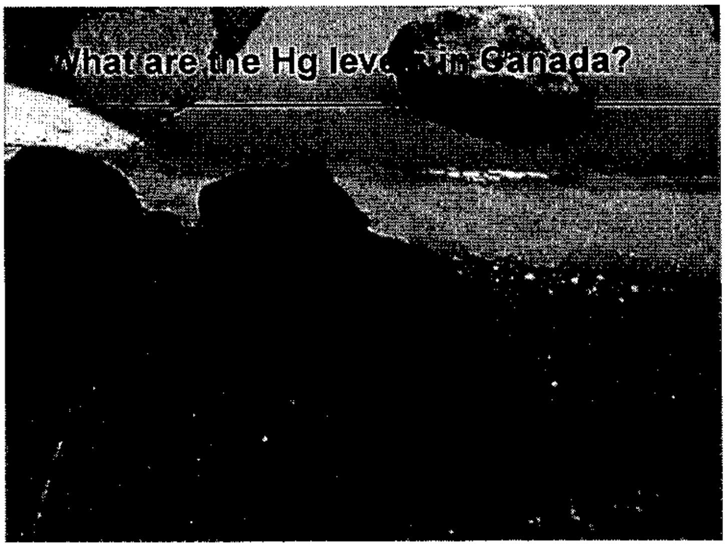
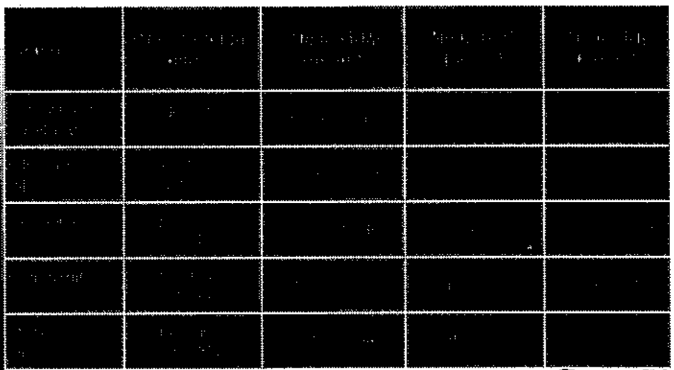
What are the Hg levels in Canada?



Total gaseous mercury and mercury in precipitation

Station	Measurement period TGM	Mean TGM (ng m⁻³)	Measurement period in rain	Mean Total Hg (ng L⁻¹)
Little Fox Lake YK	Jun 2007 – Dec 2016	1.39 ± 0.15		
Saturna BC	Feb 2010 – Aug 2016	1.31 ± 0.16	Sep 2009 – Dec 2015	5.2
Whistler BC	Aug 2008 – Dec 2015	1.26 ± 0.20		
Fort McKay South AB	Jan 2016 – Dec 2016	1.24 ± 0.38		
Patricia McInnis AB	Oct 2010 – Dec 2016	1.32 ± 0.22		
Pinehouse Lake SK			May 2015 – Dec 2015	8.4
Flin Flon MB	Jul 2008 – Dec 2016	3.23 ± 1.57	Sep 2008 – Dec 2010	59.9
Egbert ON	Dec 1996 – Dec 2016	1.51 ± 0.31	Mar 2000 – Dec 2015	8.1
St Anicet QC	Aug 1994 – Dec 2016	1.53 ± 0.35	Apr 1998 – Aug 2007	8.0
Kejimkujik NS	Jan 1996 – Dec 2016	1.36 ± 0.28	Jul 1996 – Dec 2015	5.1
Mingan QC	Jan 1997 – Dec 2015	1.42 ± 0.23	Apr 1998 – Aug 2007	5.1
Alert NU	Jan 1995 – Dec 2016	1.47 ± 0.38		
Stephenville NL			Feb 2010 – Dec 2015	5.2

Speciated Mercury



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Trends (annual)

Station	Measurement period TGM	Trend TGM (% yr⁻¹)	Measurement period wet deposition	Trend Total Hg (THg) in precip
Little Fox Lake YK	Jun 2007 – Dec 2016	+1.3 (+0.7 to +1.9)	-	-
Saturna BC	Feb 2010 – Aug 2016	-4.1 (-5.1 to -2.2)	Sep 2009 – Dec 2015	NS (-2.5 to +6.7)
Whistler BC	Jan 2008- Dec 2015	+1.29 (-2.1 to + 6.4)		
Genesee AB	Mar 2004 – Dec 2010	-0.4 (ns) (-1.4 to +0.1)	Jul 2006 – Dec 2015	Ns (-6.6 to +0.3)
Patricia McInnis AB	Oct 2010 – Dec 2016	-3.8 (-5.4 to -2.1)	-	-
Flin Flon MB	Jul 2008 – Dec 2016	-4.2 (-6.5 to -2.4)	-	-
Egbert ON	Dec 1996 – Dec 2016	-1.7 (-1.9 to -1.5)	Apr 2000 – Dec 2015	NS (-1.2 to +0.6)
Chapais QC	-	-	Dec 2009 – Dec 2015	-6.4 (-10.8 to -1.8)
Mingan QC	Jan 1997 – Dec 2016	-1.1 (-1.4 to -0.9)	Apr 1998 – Aug 2007	NS (-5.1 to +0.5)
St. Anicet QC	Jan 1995 – Dec 2016	-1.5 (-1.6 to -1.3)	May 1998 – Aug 2007	-3.0 (-5.3 to -1.0)
Kejimkujik NS	Jan 1996 – Dec 2016	-0.9 (-1.1 to -0.7)	Jul 1996 – Dec 2015	-1.5 (-2.3 to -0.8)
Alert NU	Apr 1995 – Dec 2016	-0.9 (-1.1 to -0.7)		

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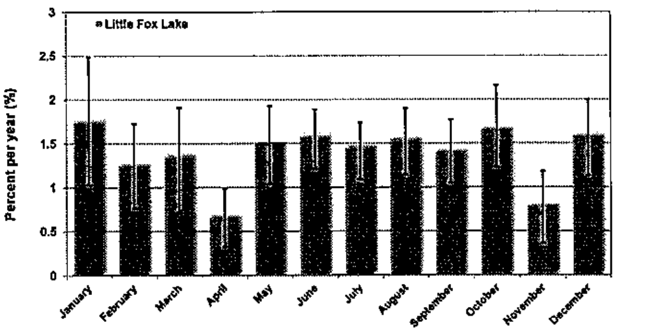
Overall Trend

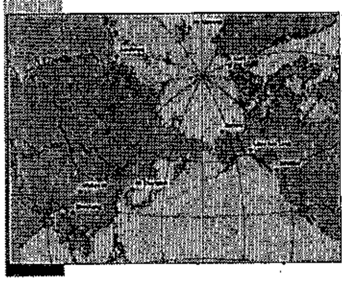
Overall trend (2007-2016): +1.37 ±0.33 %

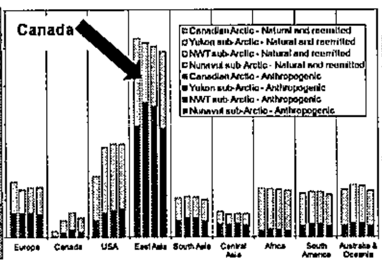


Environment and Climate Change Canada · Environnement et Changement climatique Canada · Canada

Little Fox Lake, Yukon

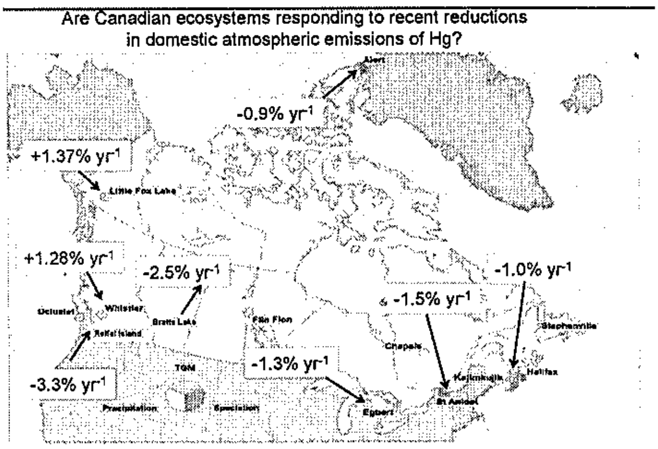
- Measuring TGM since 2007
- Initiated and continued from the International Polar Year (2007-2009)
- Long range transport of Hg from the Pan Pacific Area
- LFL good site for LRT from Asia





Overall trends of atmospheric Hg in Canada

Are Canadian ecosystems responding to recent reductions in domestic atmospheric emissions of Hg?



Why are we seeing this trend?

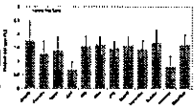
It is the only region in Canada with an increasing trend in Hg concentration

Little Fox Lake

What can affect the concentration of Hg at this site?

- Increase in Hg in the area
- Changes in meteorology
- Increase in Hg transported in

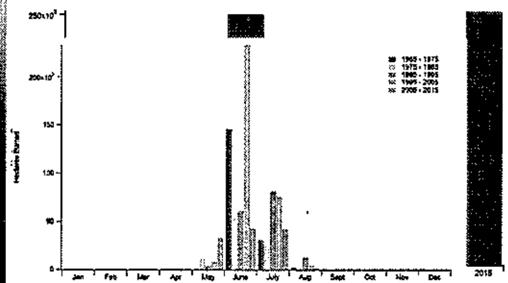
Forest Fires around Little F



Biomass burning is a source of Hg to the atmosphere

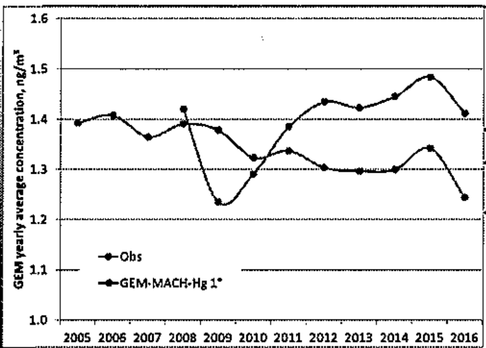
Forest fires emitted 6-14 tonnes of Hg in Canada between 2010 and 2015* (May-Sep)

1. Hectares burned within 500 km around the site in the last 10 years
2. Monthly distribution of hectares burned around the site



Fraser et al., ACP 2018

Measurement/Model comparison of meteorology and Hg trends

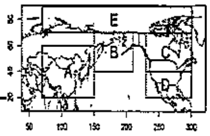


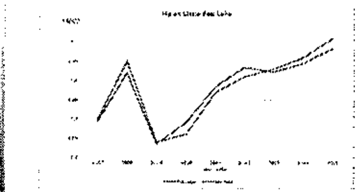
GEM-MACH-Global-Hg model configuration:

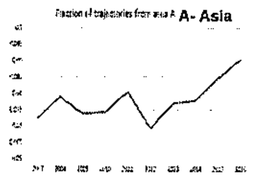
- Horizontal resolution – 1° latitude/longitude
- Meteorological fields – ECMWF ERA-Interim for 2005 – 2015
- Emissions – AMAP 2010, constant for all years

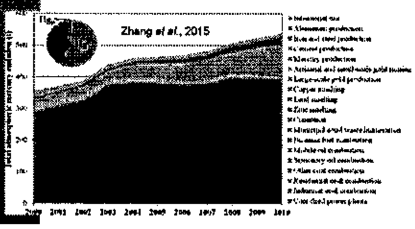
Conclusions:
Appears to be impacted in more recent years by inter-annual variability of meteorology

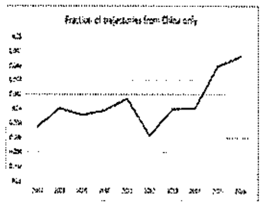
Is there a dominant area?











East Asian Contribution to Hg concentrations in Canada

East Asian emission impacts only on Hg levels using GEM-MACH- Hg

Summary

- Canada continues to monitor atmospheric Hg
- Some locations have closed but working on filling gaps with passive samplers
- New project with passive samplers to get global snapshot of Hg levels
- TGM levels are going down in Canada except in the west
- Attributed primarily to emissions from China

Keep going and monitor Hg and perform research studies to better refine our understanding of transport, transformation and deposition

Thank you!!!

MERCURY IN AUSTRALIA

Anthony Morrison, Peter Nelson, Grant Edwards
Students: Kelli Cook, Upma Dutt, Dean Howard, Matthiew Miller and Dan Sawyer
Department of Environmental Sciences
Macquarie University
Sydney Australia

APMMN September 2018

MACQUARIE University

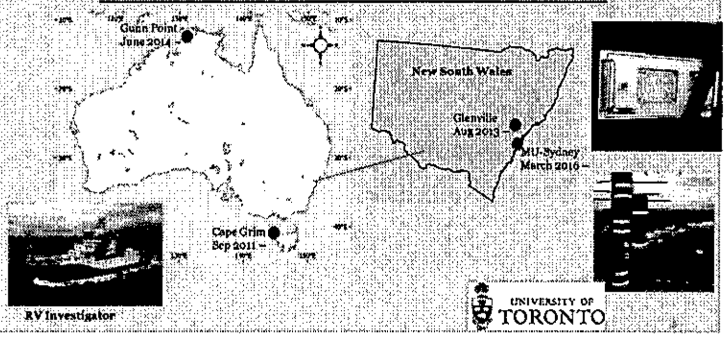
Mercury in Australia- background for group at MU

- *First Australian Power Station Measurements of mercury species*
- *Australian inventory from all sources- informing response to Minamata Convention*
- *First gas phase concentrations of mercury in Australia - Almost no SH data, providing constraints and tests of global mercury modelling and mercury atmospheric chemistry*
- *Invitation to join the Global Mercury Observing System (GMOS) led by EU*
- *First measurements of mercury in wet and dry deposition samples*
- *First mercury measured in fires in Australia; emission factors, and firefighter exposure*
- *Member UNEP Expert Group on Global Inventory (2010 Global Inventory, 2018 Assessment)*
- *Peter Nelson, Lead author (non ferrous smelting and roasting), UNEP Expert Group on Minamata Convention*
- *Long-term measurements and modelling in Sydney, Hunter Valley and Northern Australia - Included in Global Mercury Observing System*
- *Peter Nelson, Co-lead UN Environment Partnership on Mercury from Coal Combustion (with Dr Lesley Sloss, IEA Clean Coal Centre)*
  - *Currently negotiating large project with the Global Environment Facility (GEF) to demonstrate mercury control in industrial processes in developing countries*

Atmospheric Mercury

AUSTRALIAN LONG-TERM MONITORING SITES

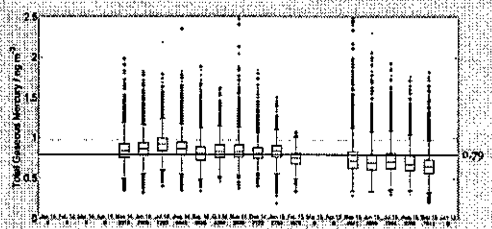
MACQUARIE University



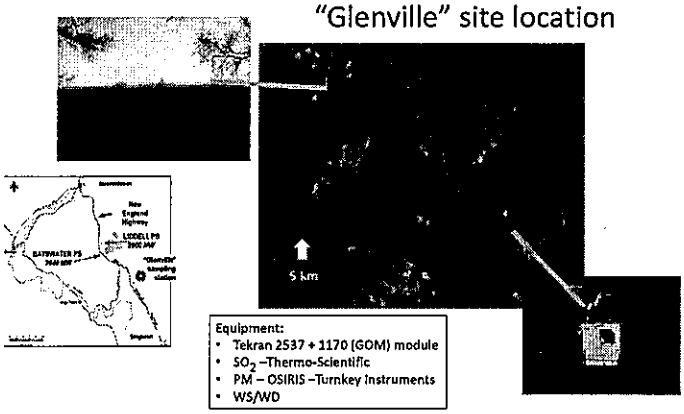
Seasonal Variation

GLENVILLE, NSW (32.4° S, 151.1° E)

MACQUARIE University

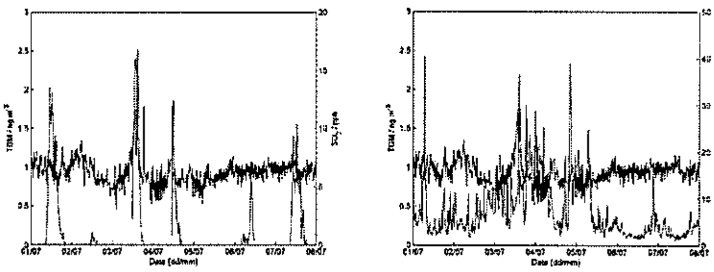


"Glenville" site location



Equipment:
- Tekran 2537 + 1170 (GOM) module
- SO_2 –Thermo-Scientific
- PM – OSIRIS –Turnkey Instruments
- WS/WD

Mercury concentration during plume strike events

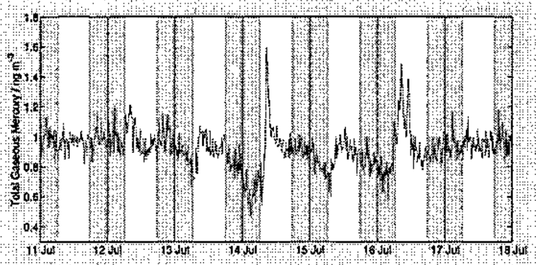


Changes in TGM, SO_2 and $PM_{2.5}$ concentrations (5 min averaging period) at "Glenville" in the period 1-8 July, 2014

Daily Variation

GLENVILLE, NSW

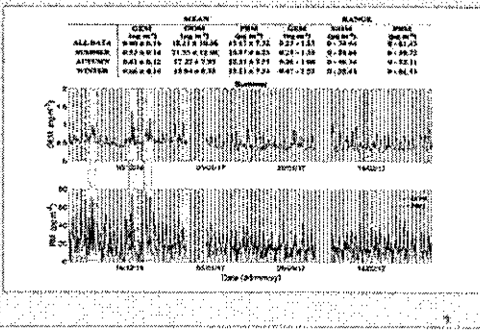
MACQUARIE University



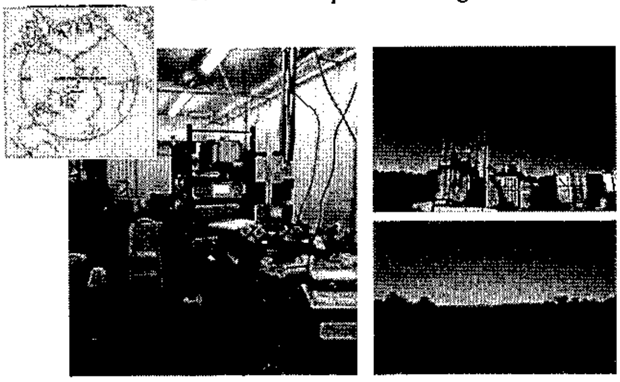
Seasonal Variation

MACQUARIE UNIVERSITY WEATHER STATION, MARSFIELD, NSW

MACQUARIE University

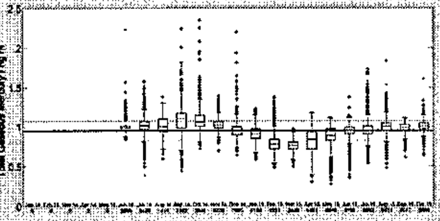


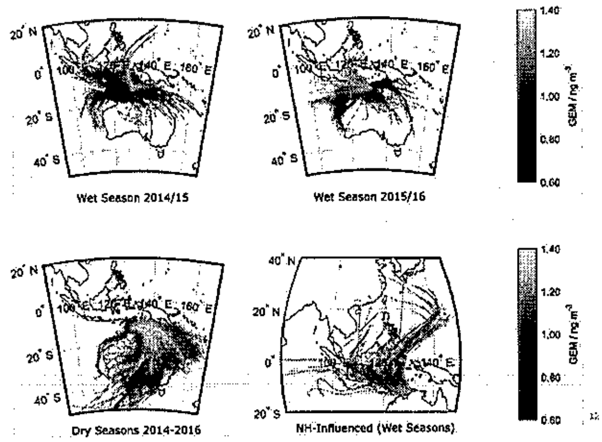
Gunn Point: Tropical savanna grass



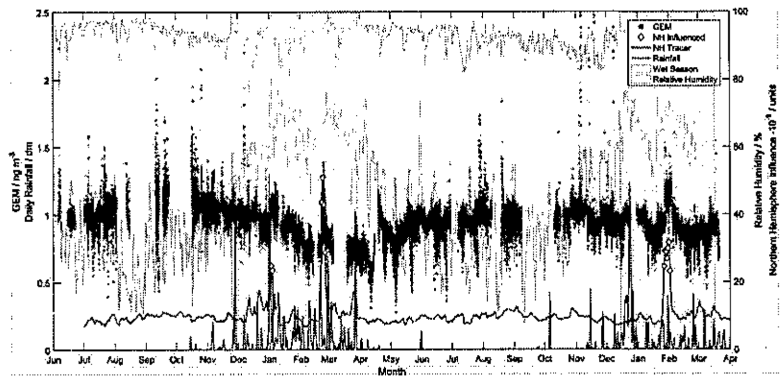
Seasonal Variation

GUNN POINT, Northern Territory (12.2° S, 131.0° E)



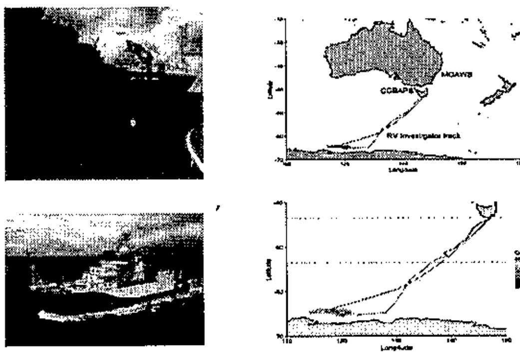


GUNN POINT, NORTHERN AUSTRALIA



GUNN POINT, NORTHERN AUSTRALIA

Voyage: RV Investigator



Challenges

AMBIENT MERCURY LONG TERM MONITORING

- **Tyranny of distance;**
  - lack of co-location of research staff with mercury sampling sites has meant that sites can often only be visited on a monthly (Glenville) or quarterly (Gunn Pt) basis.
  - breakdown of either instruments or communication to instruments results in considerable cost and inconvenience, due to travel distances.
  - has led to development of the Macquarie University (MU) Weather Station site in close proximity to the University which can be more regularly serviced and maintained.

Potential

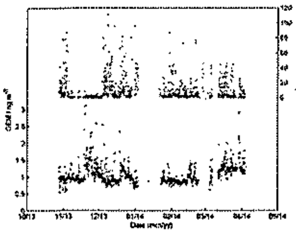
AMBIENT MERCURY LONG TERM MONITORING

- **Wet sampling**
  - with establishment of the MU Weather Station site and its location near to the University campus potential exists for some wet sampling to be commenced.
- **Lack of ongoing longer term funding;**
  - funding has always been intermittent which has meant that as a team it has been a struggle to maintain sites over the long term

In Summary

- Australia's emissions relatively low and dominated by industrial sources particularly non-ferrous sector
- Natural and re-emitted sources dominate over anthropogenic sources; fires significant particularly in northern Australia
- Atmospheric mercury measured at several sites since 2011
- Power Stations not the source of above background mercury at a site near two large coal fired power stations
- Both Glenville and Gunn Point show intermittent periods of TGM *depletion*
  - Generally only under calm, stable, nocturnal conditions
  - Large spikes at Glenville may be due to fumigation into overlying weak mixed layer, or advection from nearby sources

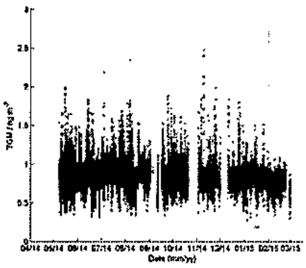
Outcomes-long term



Speciated mercury concentrations (hourly averages) at "Glenville" sampling site, November 2013-April 2014 (n=1393)

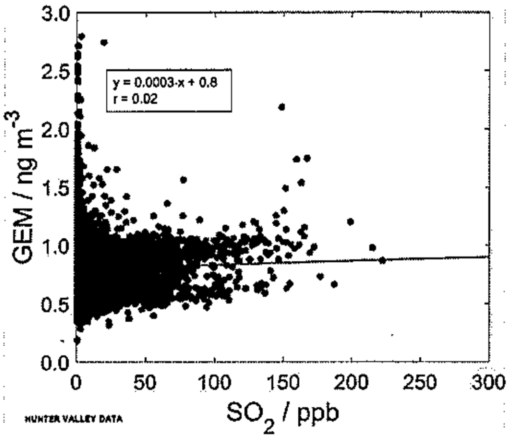
Species	Mean	Median	Range
GEM	1.05 (ng/m³)	0.97 (ng/m³)	0.54-3.10 (ng/m³)
GOM	11.28 (pg/m³)	4.31 (pg/m³)	0 -164.21 (pg/m³)

Outcomes-long term



Total gaseous mercury concentrations (five min collection period) at "Glenville" sampling site, April 2014 – April 2014 (n=45005)

Species	Mean	Median	Range
TGM	0.86 (ng/m³)	0.85 (ng/m³)	0.19-2.48 (ng/m³)



In Summary

AMBIENT MERCURY AND POWER STATIONS

MACQUARIE University

- Ambient mercury concentrations in the Upper Hunter are low by world standards;
- Many times lower than no observable adverse effect levels (NOAELs);
- Likely health effects of ambient mercury at the site are negligible;
- Power stations appear to have little impact on the concentrations measured at the site;
- Further work is needed to explain high and low concentration periods.

- National Pollutant Inventory gives emission estimates for SO_2 and Hg
- Using these estimates and the peak SO_2 concentrations observed suggest that power station mercury would only increase atmospheric mercury by ~0.07-0.15 ng/m³

MQ: Urban, Sydney NSW

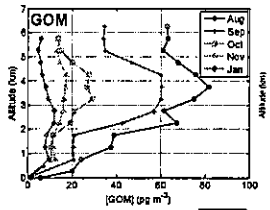
Atmospheric Mercury Measurements at NOAA's Air Resources Laboratory (ARL)

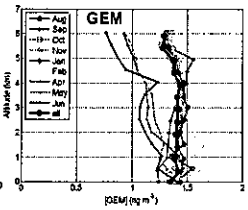
Winston Luke, Mark Cohen, Paul Kelley, and Xinrong Ren
NOAA/ARL, College Park, MD

Prepared for the Asia-Pacific Mercury Monitoring Network Meeting
September 5-7, 2018
Manila, Philippines

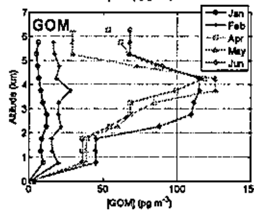
Process Studies and Field Intensives

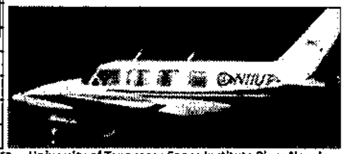
Airborne Mercury Measurements





- GOM concentrations peak spring to summer
- Max. [GOM] at ~3-4.5 km
- Relatively uniform GEM profiles from Aug. 2012 to Feb. 2013. Slight GEM depletion above 4 km.
- Flights from Apr. to Jun. 2013: GEM levels decreased as altitude increased





University of Tennessee Space Institute Piper Navajo

ARL's Long-term Mercury Monitoring: NADP

What is the National Atmospheric Deposition Program?

A cooperative effort among many groups -federal, state, tribal, local governmental agencies, educational institutions, private companies, and non-governmental agencies.

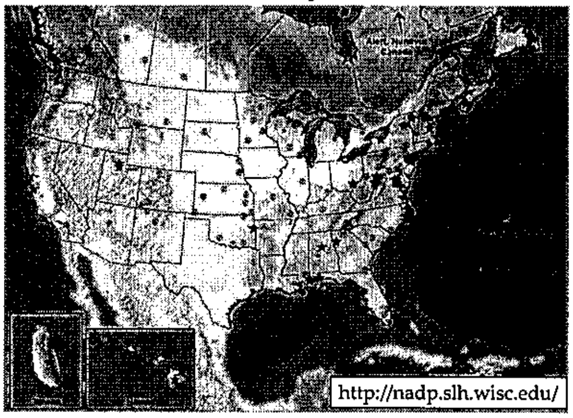
Program Office and Central Analytical Lab at University of Wisconsin's State Laboratory of Hygiene

Determine the pollution flux out of the atmosphere/into the biosphere by measuring wet deposition ("acid rain network") and estimating dry deposition of atmospheric pollutants

North America, active in Asia

Now in its 40th year

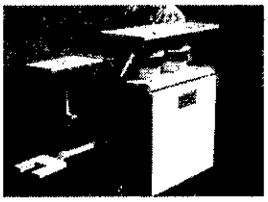
NADP's Mercury Networks

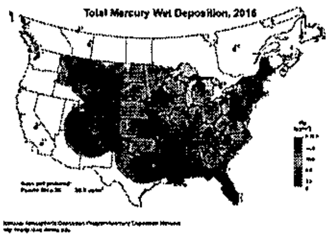


http://nadp.slh.wisc.edu/

Mercury Deposition Network (MDN)

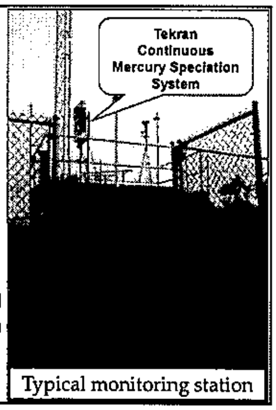
- Since 1996
- Weekly wet deposition of Hg
- 94 active North American sites
- Total and methyl Hg





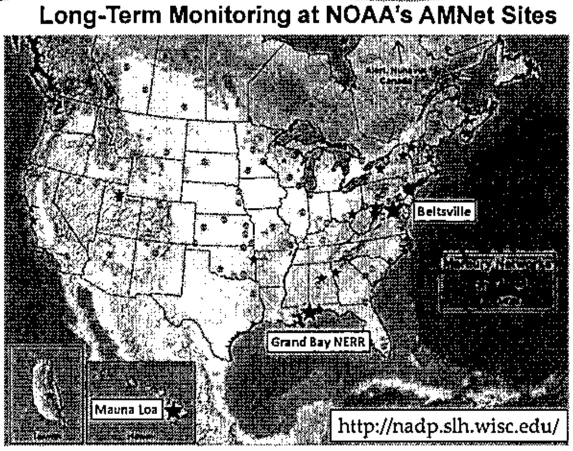
Atmospheric Mercury Network (AMNet)

- Mercury speciation in the atmosphere
  - elemental, reactive gaseous, particulate Hg (GEM, GOM, $PBM_{2.5}$)
- *Estimates* dry deposition flux
- Meteorology, leaf wetness, land cover variables
- Usually co-locates with wet deposition flux (MDN)
- As in all NADP Networks, standardized protocols for operation, data reduction
- ~ 20 Active sites ; Since 2009



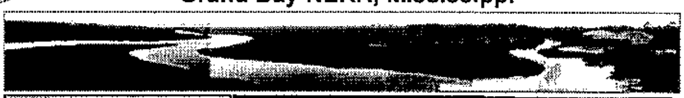
Typical monitoring station

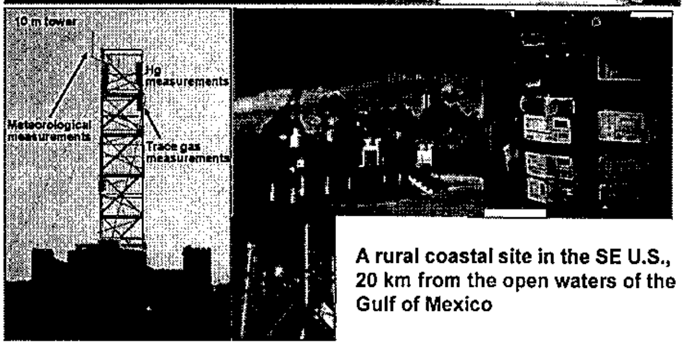
Long-Term Monitoring at NOAA's AMNet Sites



http://nadp.slh.wisc.edu/

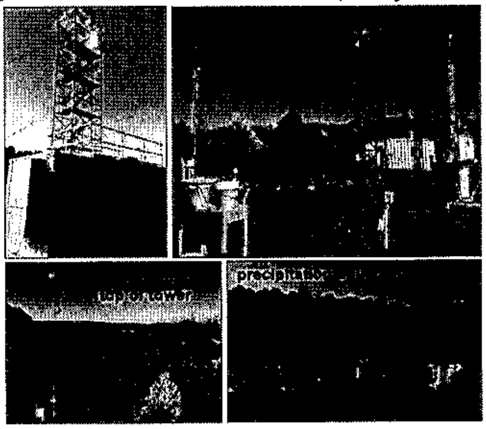
Grand Bay NERR, Mississippi





A rural coastal site in the SE U.S., 20 km from the open waters of the Gulf of Mexico

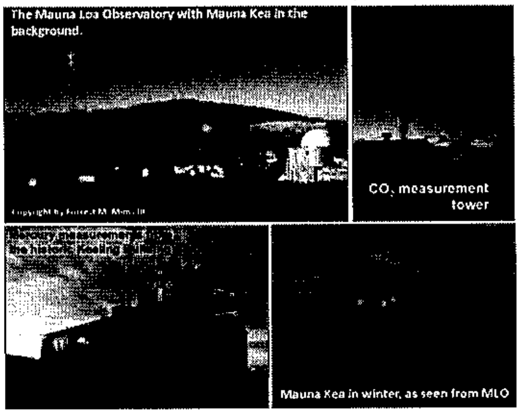
Beltsville, Maryland



Since 2007:
A suburban site NE of Washington, DC

Also an EPA Clean Air Status and Trends Network site

Mauna Loa, Hawaii

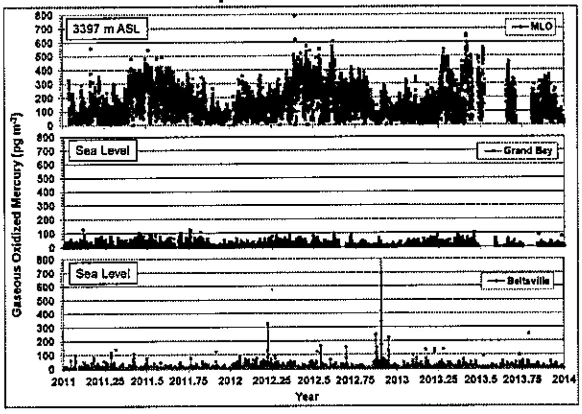


Since 2011: Located at 3,397m on the north slope of the Mauna Loa volcano

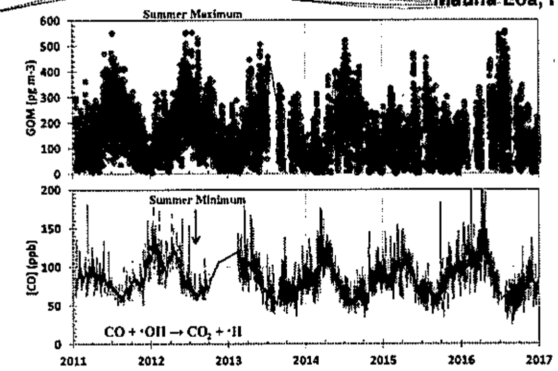
Premier site for the study of background atmosphere (NOAA ESRL)

Often samples clean air from the remote middle troposphere,

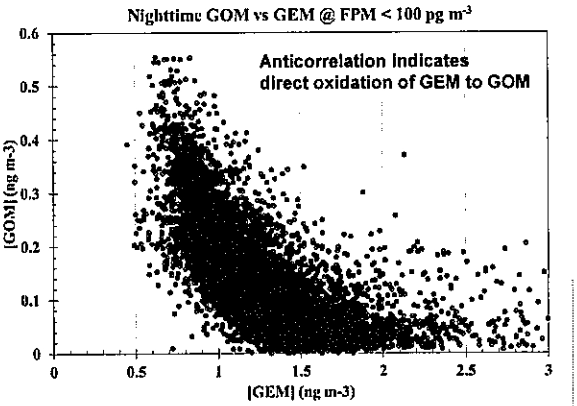
GOM Comparison Across Three Sites



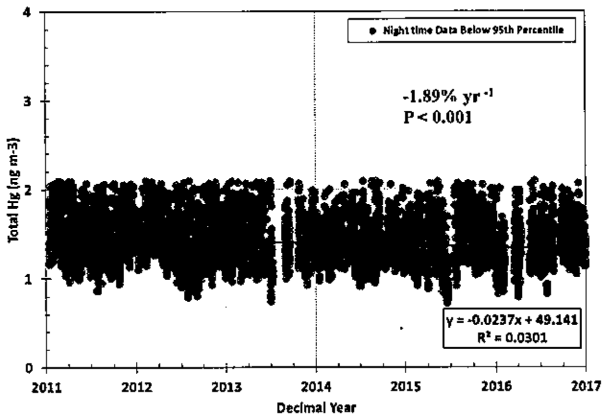
Mauna Loa, Hawaii



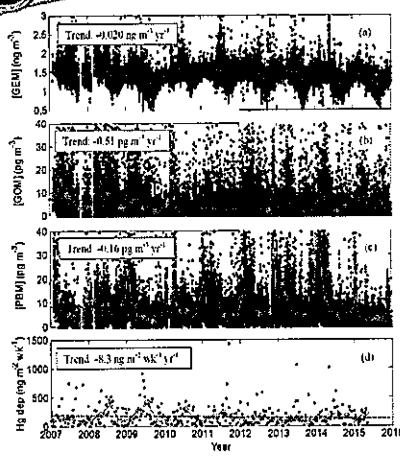
Summer maxima of GOM correspond to minima in CO (driven by increased ·OH oxidation) and suggest a photochemical origin of GOM from direct oxidation (O_3? ·OH? Br·?) of GEM in the free troposphere



Trend Detection



Trend Detection at Beltsville, Maryland



Trends in concentrations of GEM, GOM, and PBM, and in total mercury deposition from 2007-2015 at the Beltsville, Maryland AMNet site

Mercury: Measurements and Modeling

MEASUREMENTS

- speciated atmospheric mercury
- other air pollutants, e.g., SO_2, O_3, CO
- wet deposition
- air-surface exchange

Modeling used to aid in data interpretation and measurement planning

Measurements used for model evaluation and improvement

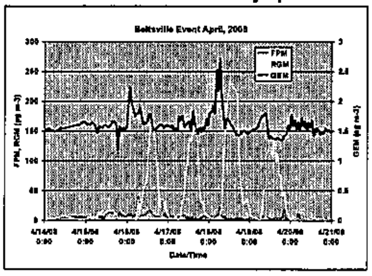
MODELING

- back trajectories
- comprehensive fate and transport
- source-attribution for deposition

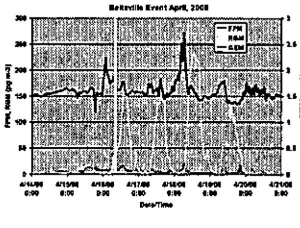
Back Trajectory Analysis – Episodes

Beltsville, Maryland
AMNet site

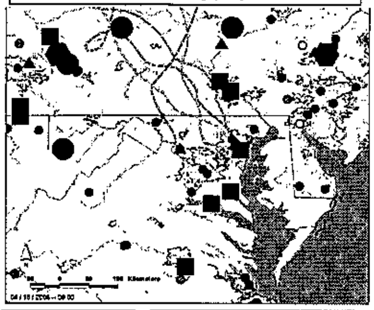
Reactive Gaseous Mercury episode



Back trajectories run with 12 km resolution met data



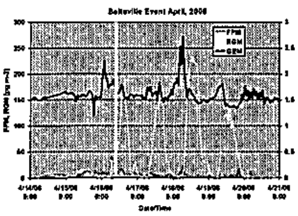
Large Point Sources of Reactive Gaseous Mercury (RGM) Emissions Based on the 2002 U.S EPA National Emissions Inventory (NEI)

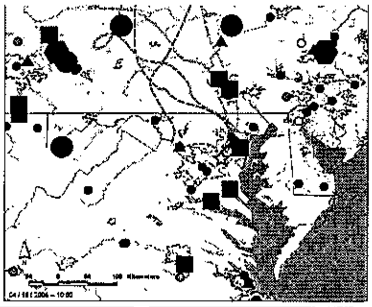


size/shape of symbol denotes amount of mercury emitted (kg/yr)
○ 10 - 50
△ 50 - 100
□ 100 - 200
◯ 200 - 400
⬡ 400 - 600

color of symbol denotes type of mercury source
coal-fired power plants
other fuel combustion
waste incineration
metallurgical
manufacturing & other

Back-trajectories starting at the indicated fraction of the mixed layer height. Circles on the trajectories mark the hourly positions
0.1
0.3
0.5
0.7
0.9





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color of symbol denotes type of mercury source
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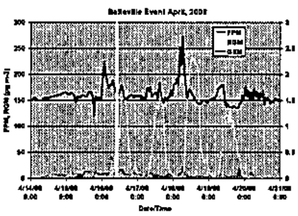

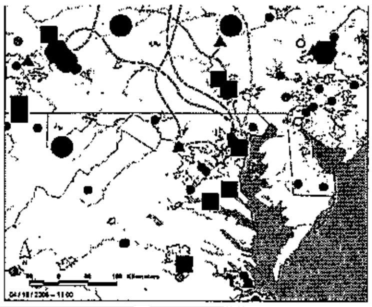

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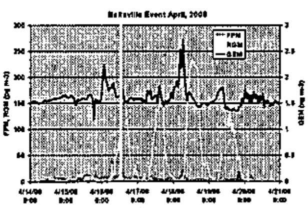

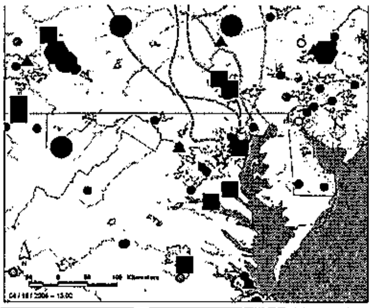

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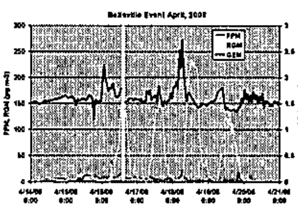

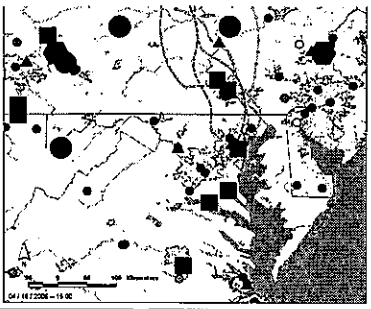

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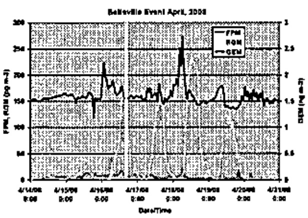

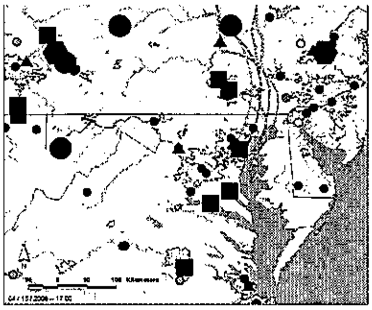

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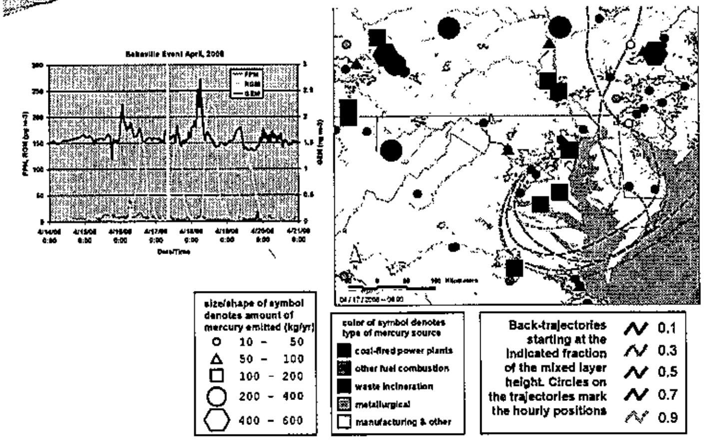

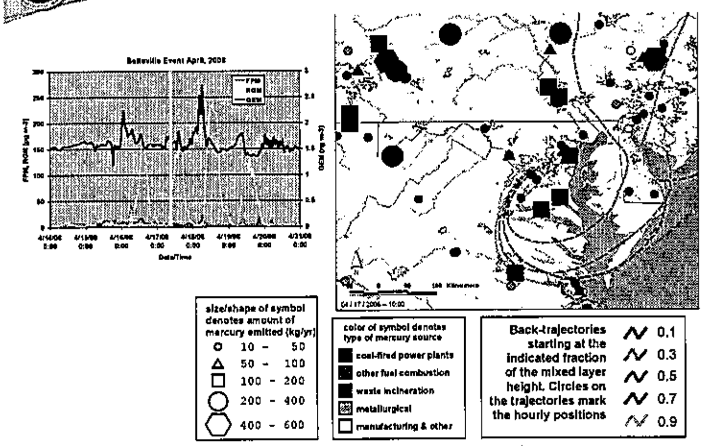

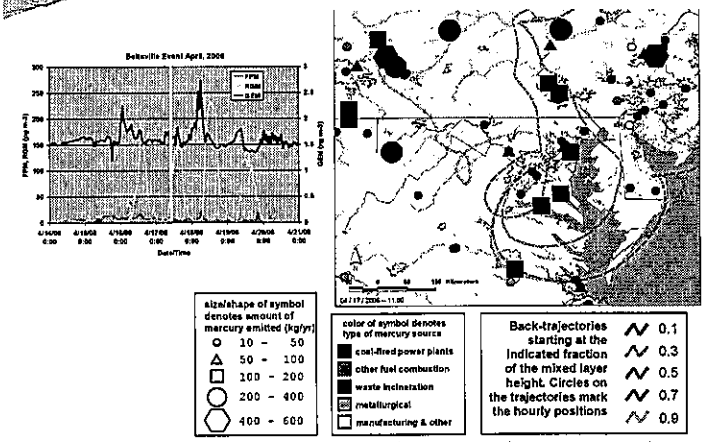

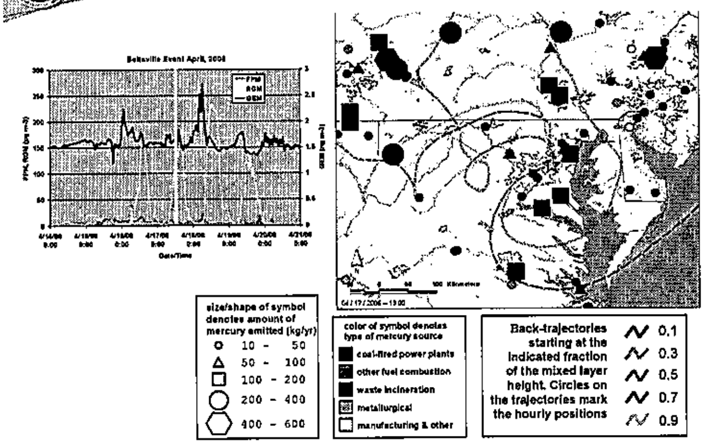

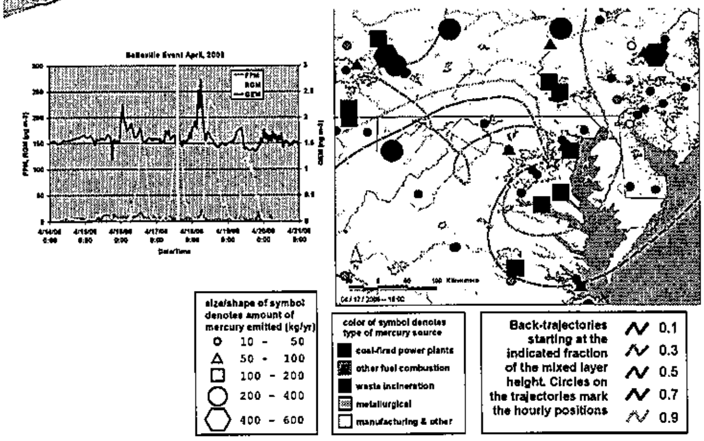

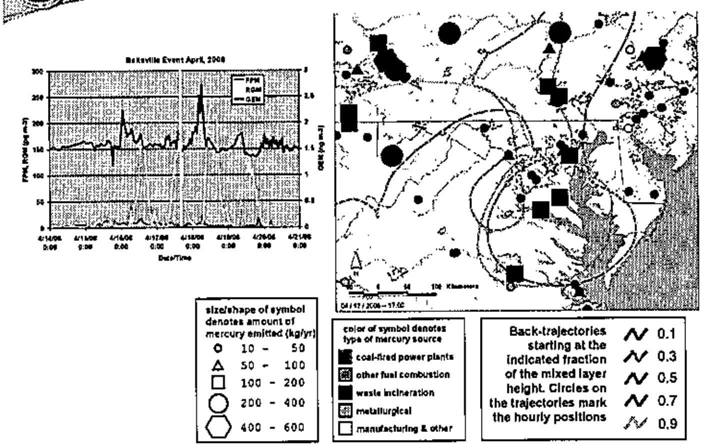

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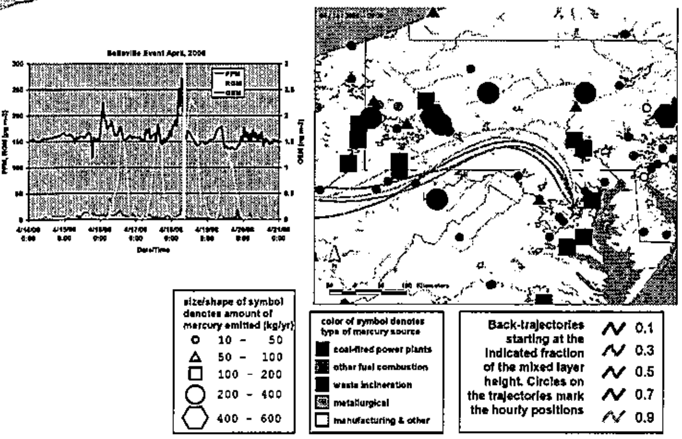
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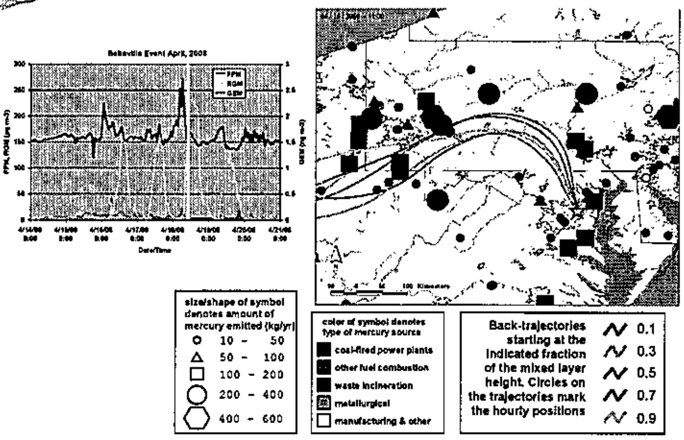
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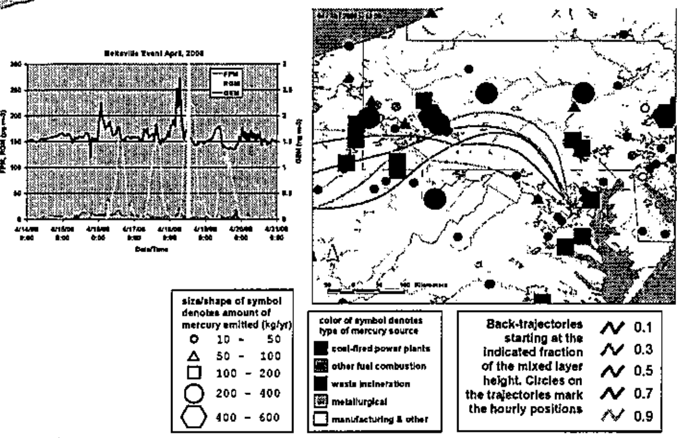
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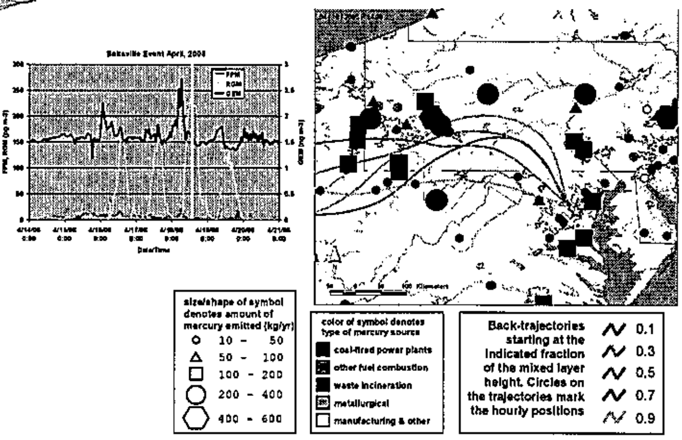
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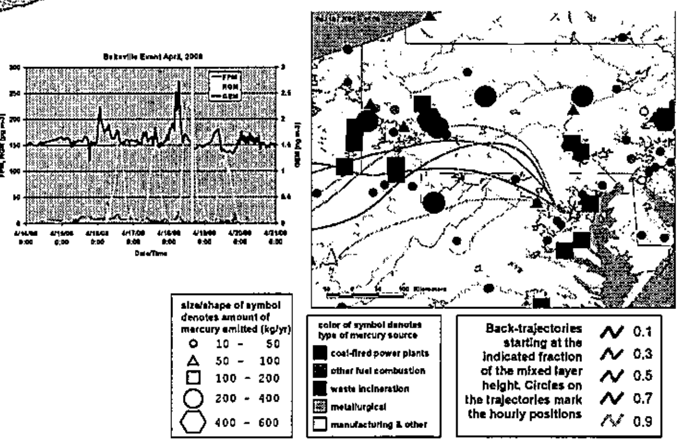
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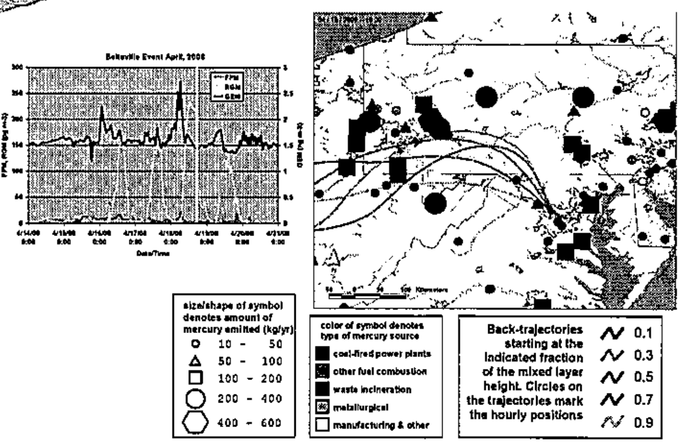
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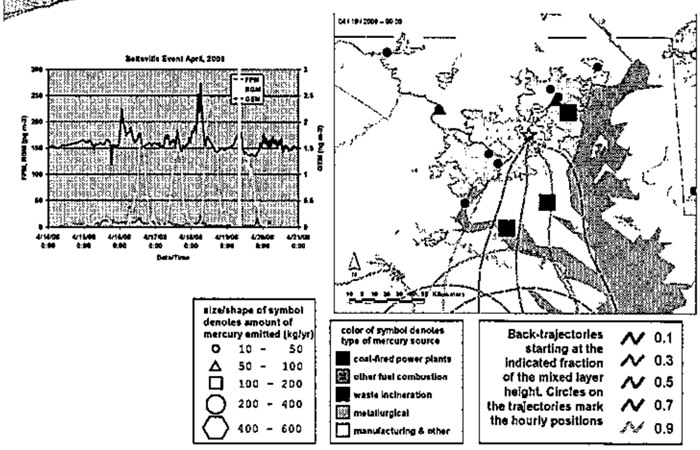
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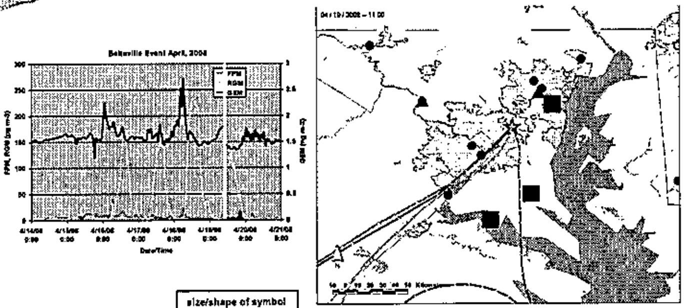

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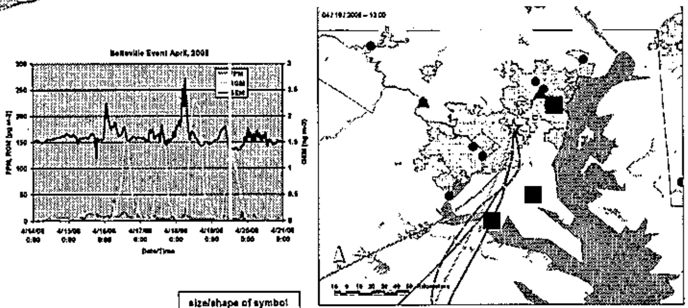

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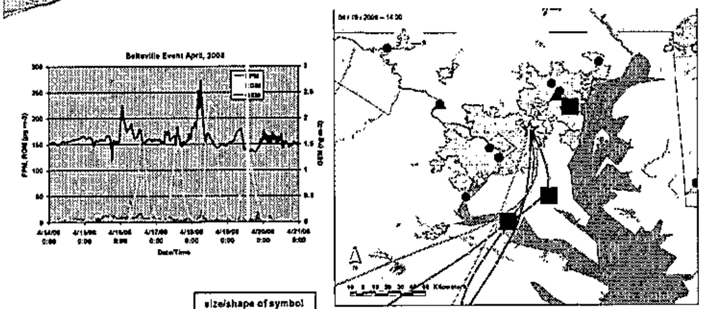

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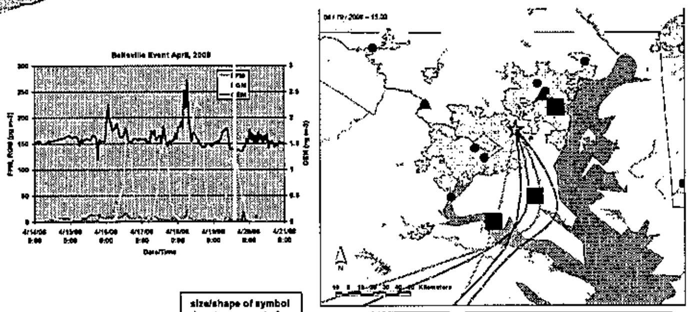

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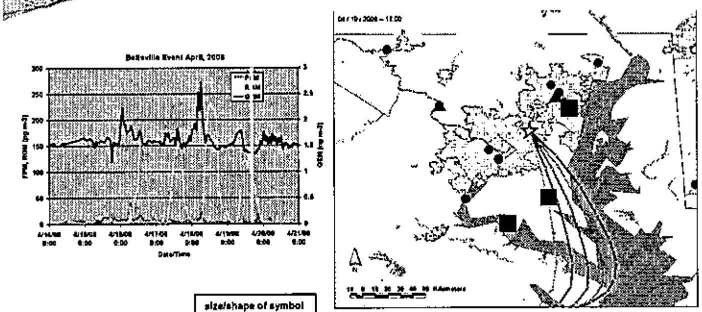

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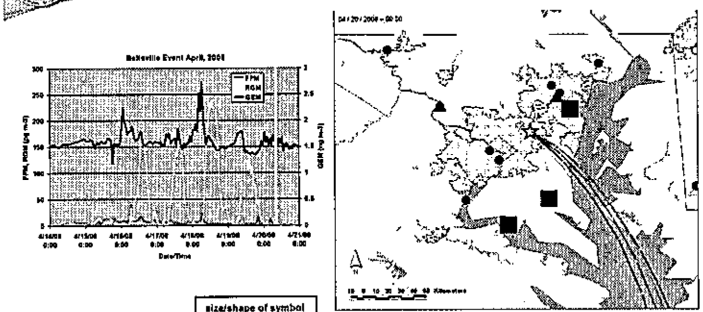

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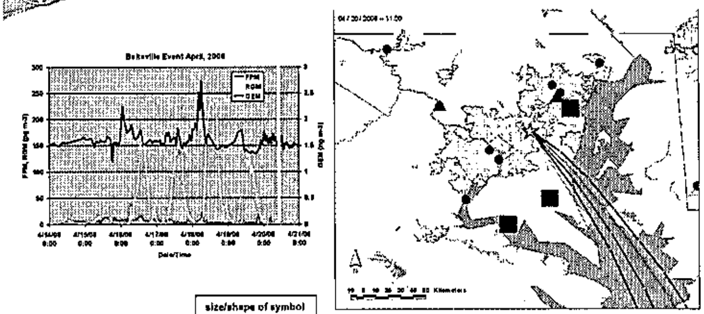

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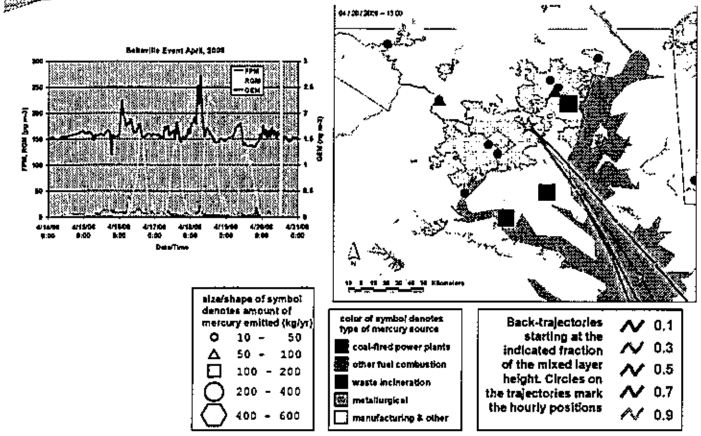
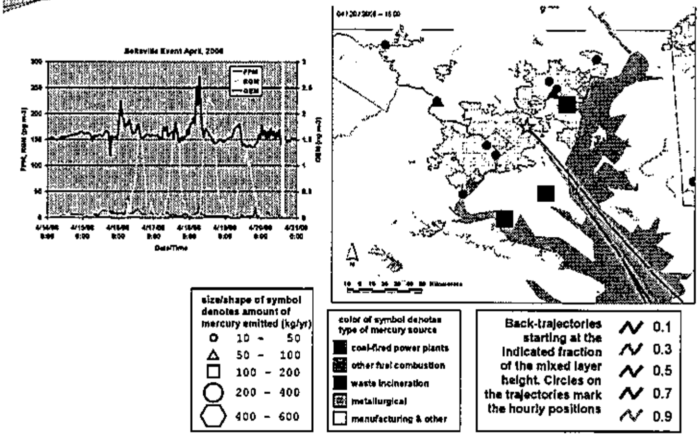
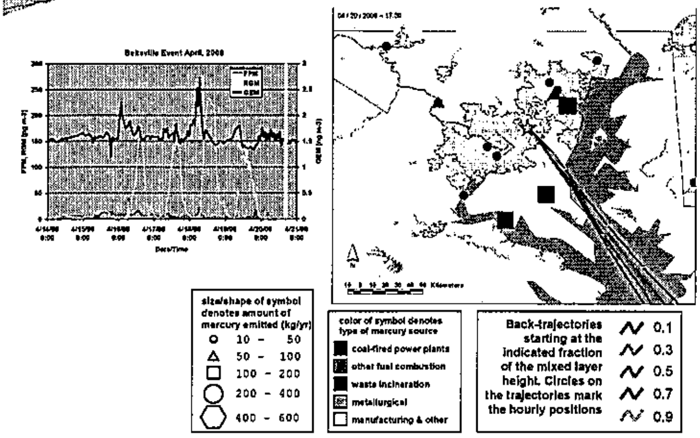
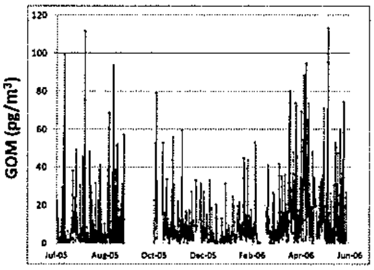






Back Trajectory Analysis – "Gridded Trajectory Frequencies"

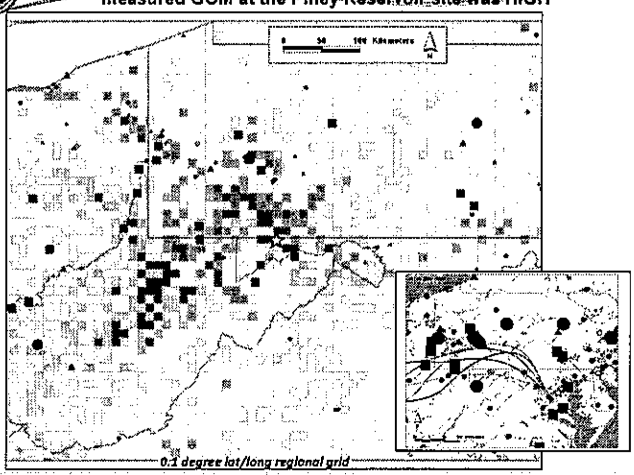
Instead of single-event analysis, a way to analyze a more extensive data record at a given site



One year of hourly Gaseous Oxidized Mercury (GOM) measurements at the Piney Reservoir site in Western Maryland, courtesy of Dr. Mark Castro, University of Maryland

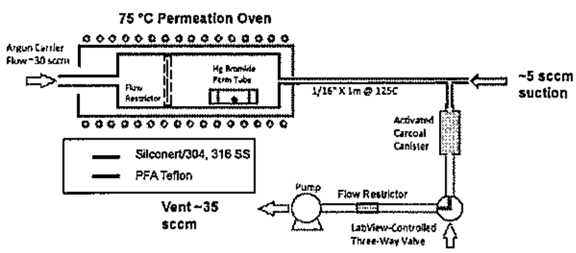
- When measured concentrations at a given site are relatively high (or low), where do the air masses arriving at the site tend to come from?
- How does this geographical "trajectory gridded frequency" pattern compare with locations of known mercury air emissions sources?

Where the air tended to come from when the measured GOM at the Piney Reservoir site was HIGH



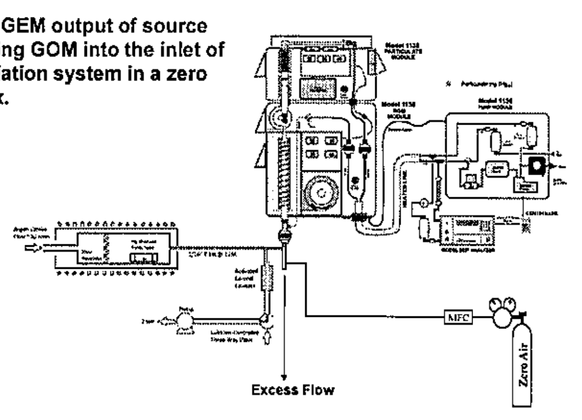
Thank you for your attention (let's eat)!

GOM Permeation Source

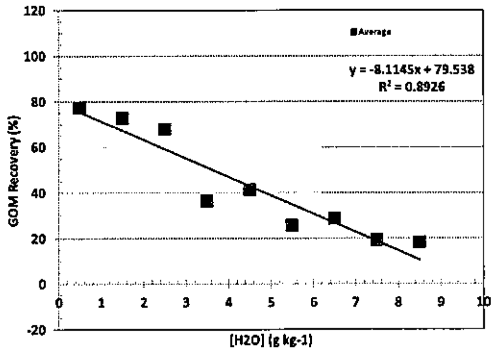


GOM Source Testing

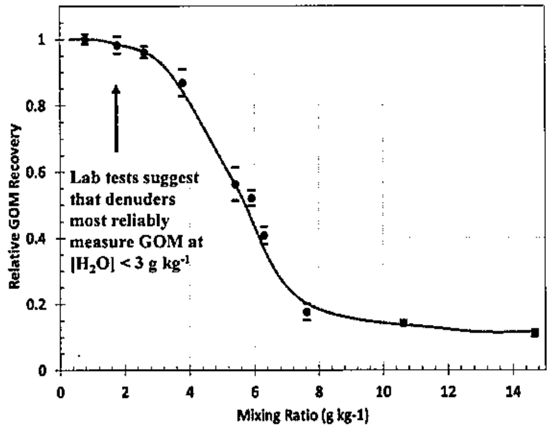
Measure GEM output of source by injecting GOM into the inlet of the speciation system in a zero air matrix.



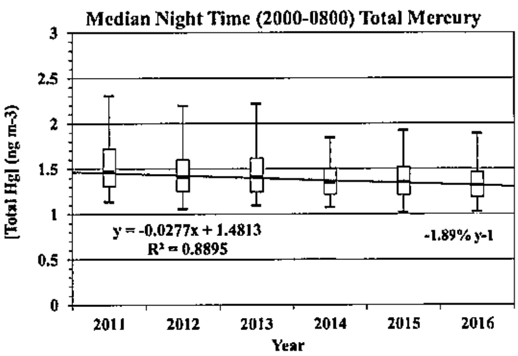
Humidity Effects on GOM Recovery



Water Vapor Effects on GOM Recovery: $[O_3]$ = 60 ppb



Trend Detection



Trend in night time (2000-0800 hours) total Hg at Mauna Loa is approximately -1.9% per year from 2011-2017

Environmental Mercury Monitoring in Taiwan

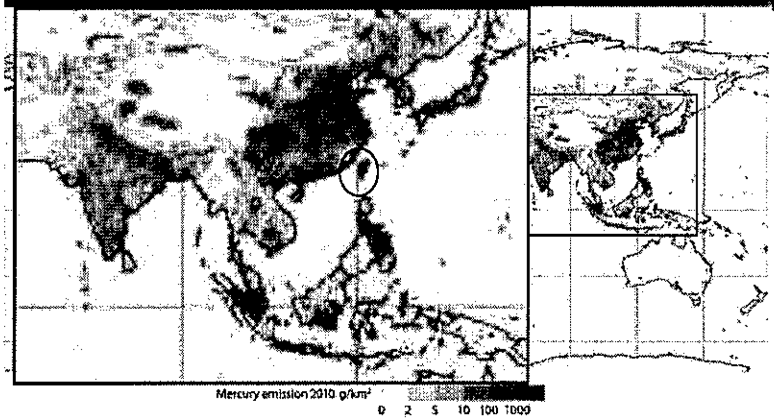
Environmental Protection Administration
TAIWAN

2018.9.6

Outlines

1. Background
2. Mercury monitoring of Environmental Medium in Taiwan
3. The recycling experience of mercury lamps and batteries

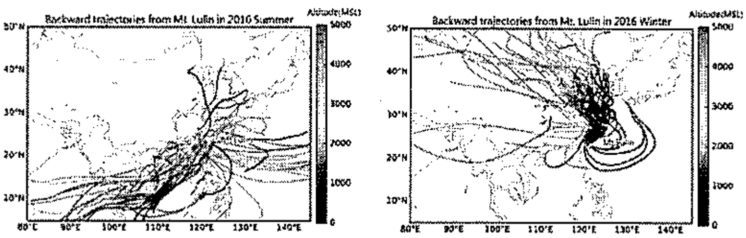
Background



Global distribution of anthropogenic mercury emissions to air in 2010. (US EPA website)

Background

Backward Trajectories from middle Taiwan (Mt.Lulin) in 2016

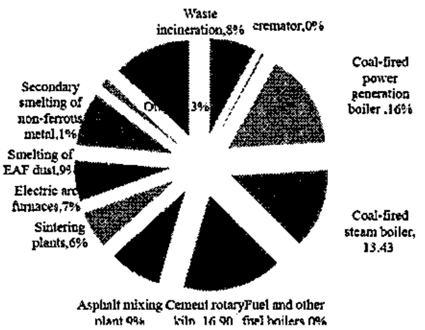


In summer In winter

Background

Mercury emissions inventory (2016)

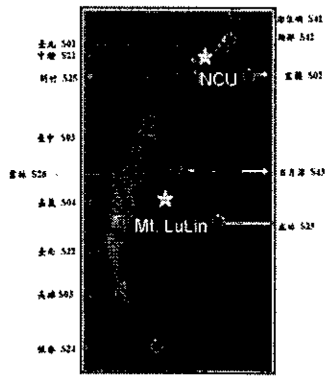
category	mercury emission (ton/y)
Waste incineration	0.156
cremator	0.004
Coal-fired power boiler and Cogeneration Boiler	0.318
Coal-fired steam boiler	0.267
Fuel and other fuel boilers	0.001
Cement rotary kiln	0.336
Asphalt mixing plant	0.176
Sintering plants	0.123
Electric arc furnaces	0.137
Smelting of EAF dust	0.181
Secondary smelting of non-ferrous metal	0.028
Others	0.261
Total	1.989



Major sources: cement rotary kiln, coal-fired stream boiler, coal-fired power generation boiler, and smelting of EAF dust

Mercury Monitoring of Environmental Medium

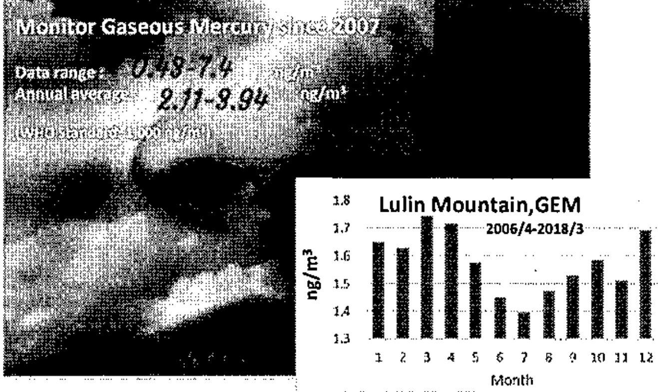
Atmospheric Hg Monitoring
- -Gaseous Element Hg, gaseous oxidized Hg, and particulate-bound Hg (Mt.LuLin Monitoring Station)
- -Wet Deposition (Mt. LuLin and NCU by MIC-B samplers, another 12 sites based on acid rain sampler)



Locations of sites

Mercury Monitoring of Environmental Medium

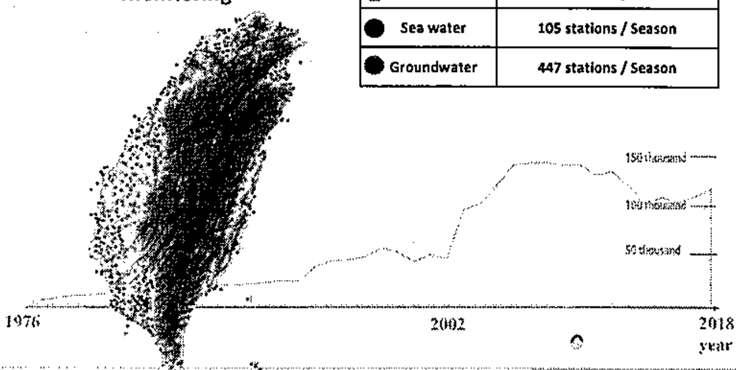
Mercury in Air



Mercury Monitoring of Environmental Medium

Mercury in Water Monitoring

Water Body	Monitoring Frequency
River	303 stations / Month
Sea water	105 stations / Season
Groundwater	447 stations / Season

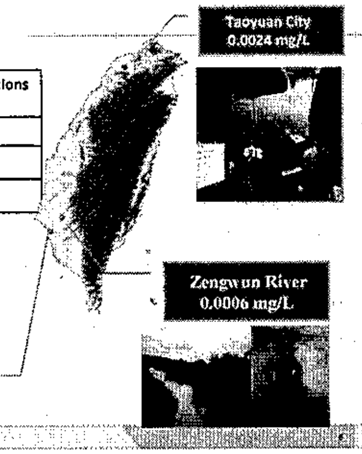


Mercury Monitoring of Environmental Medium

Mercury in Water Monitoring

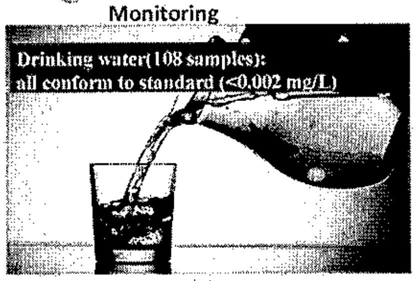
Water Body	Measured range (mg/L)	Number of stations detected
River	ND ~ 0.0007	2
Sea water	ND	0
Groundwater	ND ~ 0.0024	1

Detection Limit : 0.0003 mg/L
Regulatory standards:0.001mg/L

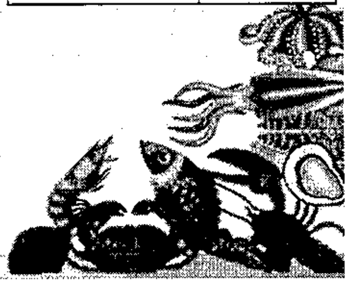


Mercury Monitoring of Environmental Medium

Mercury in Dringing Water & Organism Monitoring

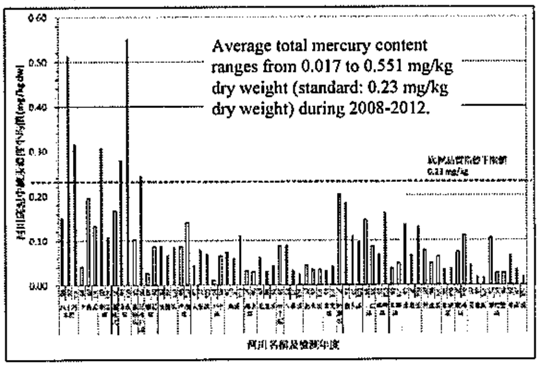


Mercury average of Organism in River (mg/kg)	
2011 Wu River	0.043
2012 Xindian River	0.019



Mercury Monitoring of Environmental Medium

The distribution of total mercury content in the river sediments



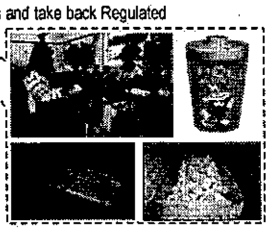
The Recycling Experience of Mercury Lamps and Batteries

(5)Sellers and Collection Channels

A. Sellers

a. Based on the Article 15 of Waste Disposal Act, Sellers shall bear the responsibility of collection.

b. Sellers designated by TEPA shall install collection facilities and take back Regulated Recyclable Wastes.



B. Collection Channels

a. Batteries：Supermarkets, Wholesale Stores, Chain Convenient Stores, Village/Community Collection Stands, Municipal Collection Trucks, Telecommunications, Chain Pharmacies, Schools, Convenient Stores in Traffic Station and Collectors

b. Lamps：Lamp Sellers, Village/Community Collection Stands, Municipal Collection Trucks and

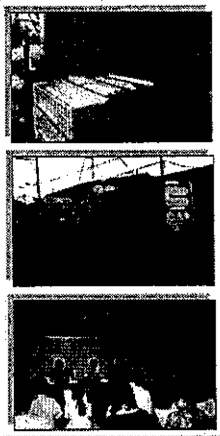
The Recycling Experience of Mercury Lamps and Batteries

(6) Municipal governments and grants

A. Local governments have the responsibility of collecting RRW (including waste lamps and batteries) from the household.

B. Recycling Fund Management Board (RFMB) provides grants for local governments to：
   a. build or run collection, storage and sorting facilities.
   b. procure collecting trucks and equipment.
   c. implement educational and promotional programs.

C. The local governments can reimburse part of the educational programs and equipment costs by selling or auctioning off the collected RRW.



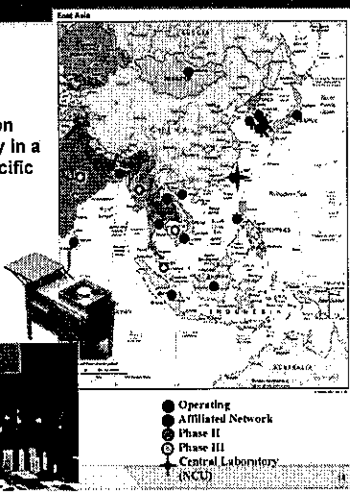
educational and promotional activities

What's the next?

APMMN Promotion

APMMN

- Initiator : Taiwan EPA, USEPA since 2012 to establish
- Goal : Systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region
- Samplers deployed from TEPA: Vietnam, Thailand, Philippine and Sri Lanka so far
- The 7th APMMN Annual meeting :NOW
- Center For Environmental Monitoring and Technology(2016)



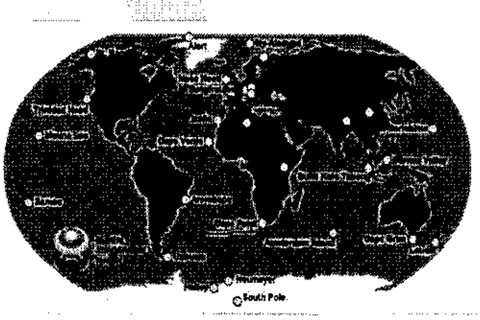
Mercury Monitoring at the Cape Point GAW Station in South Africa

Lynwill G Martin (PhD)

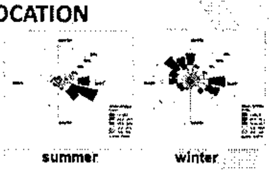
Senior Scientist

Cape Point
Global Atmosphere Watch
SA Weather Service (SAWS)

Cape Point location, Location, LOCATION



31 GAW Stations with WMO Network



Background & History

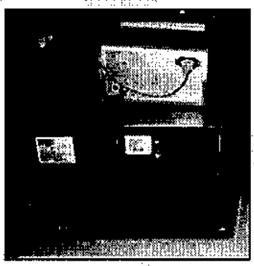
During subsequent years, more measurement added:

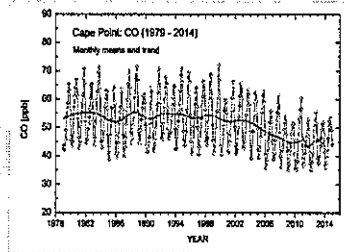
- Greenhouse gases
- CO_2 (1992); CH_4 (1984), N_2O (1994); SF6 (2009)
- Other trace gases – CO (1978); O_3 (1983); ^{222}Rn (1999)
- Halo/Fluorocarbons: $CFCl_3$, CCl_4, CH_3CCl_3, CCl_2F-$CClF_2$ and CCl_2F_2 (1979)
- Total Gaseous Mercury (1995)
- Aerosol optical properties (AOD) (2008)
- Solar radiation – (UVA, UVB, Global, Total & Diffuse)
- Met parameters: Wind, Pressure, Temperature, Relative humidity, Rainfall (early 90's)
- Regional Dobson - Irene (1989) & Springbok (1995)

Background & History

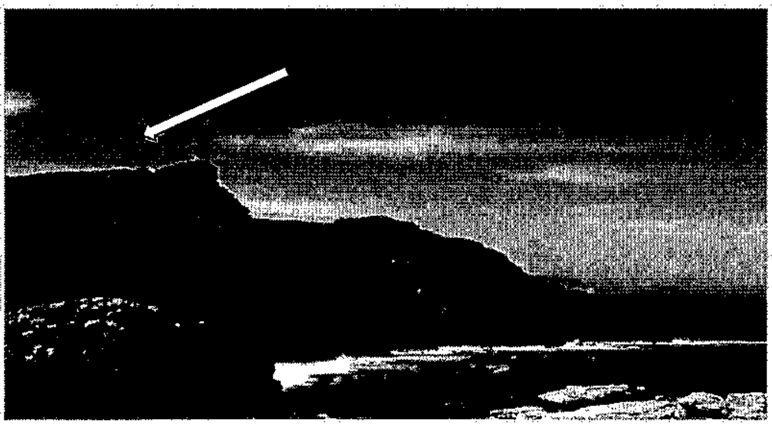
➤First measurement made in 1978 - Carbon monoxide (CO)

As collaboration with Max Planck Institute, Germany

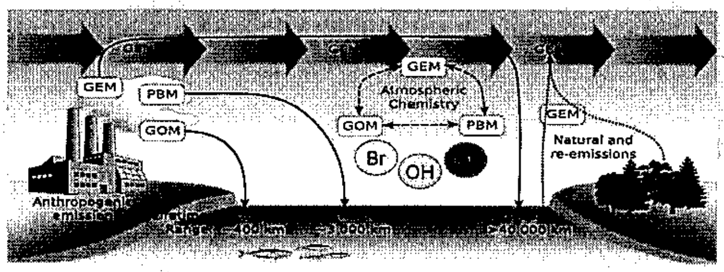




Reduction Gas Analyzer discontinued in Dec 2015

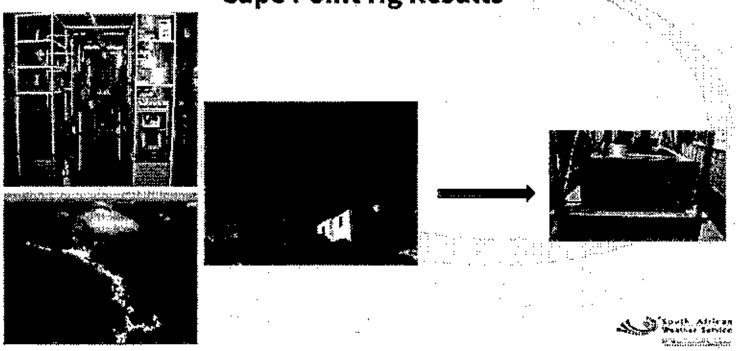


Atmospheric Chemistry of Hg

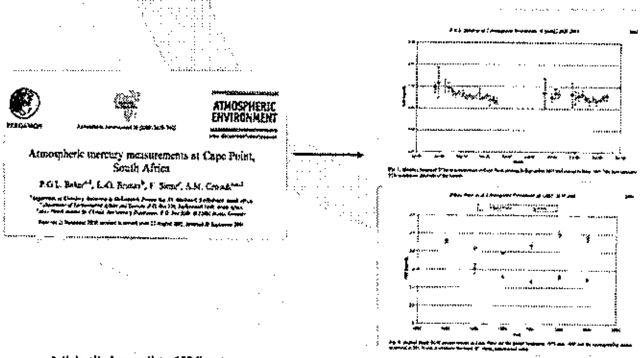


GEM (Gaseous Elemental Mercury)
GOM (Gaseous Oxidized Mercury)
PBM (Particulate Bound Mercury)

Cape Point Hg Results



First Results of CPT Hg Program published in 2002



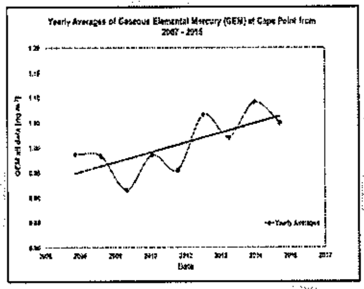
Article cited more than 150 times

Cape Point Mercury Monitoring Key Findings

- ➢ CPT GAW Station is suited for long term monitoring of background trends in SH
- ➢ CPT is representative for the Southern Atlantic Ocean
- ➢ GEM trends in SH similar to that observed in NH but 6-12 month lag (Mt. Wank Comparison)
- ➢ Continued measurements at CPT will provide information on the North-South distribution of natural and anthropogenic Hg emissions

South African Weather Service

Current Status of CPT GEM Background Concentrations



Atmos. Chem. Phys.

Atmospheric Chemistry and Physics EGU

Trend of atmospheric mercury concentrations at Cape Point for 1995–2004 and since 2007

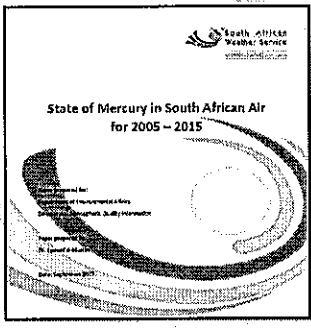
South African Weather Service

CPT Latest Hg Publication

nature geoscience ARTICLES

A vegetation control on seasonal variations in global atmospheric mercury concentrations

APRIL 2018



Mercury in Rainwater SAWS & CSIR (2007-ongoing)

Atmospheric Environment

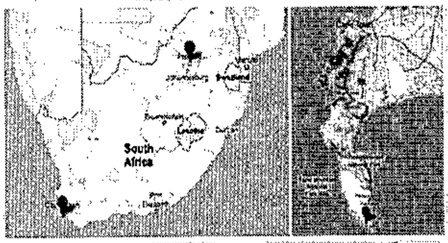
Mercury and metals in South African precipitation

Atmospheric Environment

Mercury in the atmosphere and in rainwater at Cape Point, South Africa

South African Weather Service

Mercury in Rainwater 2007 – 2009 data CPT and PTA

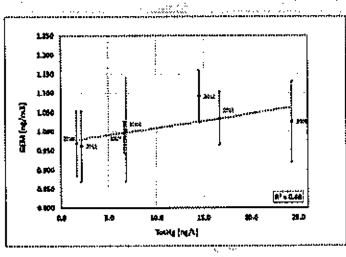


- ➢ Hg in rainwater SA is comparable to NH-Sites.
- ➢ Hg concentrations higher in urban PTA than CPT.
- ➢ VWM for Hg CPT 10.6 ng/L PTA 15.8 ng/L
- ➢ CPT impacted by both marine air and local course

South African Weather Service

Gichuki & Mason 2013, Atmospheric Environment

Mercury in Rainwater (2007-2013) at CPT



- ➢ Observed a positive correlation between GEM vs TotHg.
- ➢ Positive correlation between GEM vs TotHg indicates that both are a function of Hg emissions.

Clear Influence of El Nino Southern Oscillation (ENSO) on GEM

South African Weather Service

Brunke et al.,2016, Atmospheric Environment

Outputs of CPT Hg Monitoring Programme

- ➢ Hons Project 2005 LG Martin, Stellenbosch University
- ➢ 2x MSc- PGL Baker 1999
- ➢ LG Martin 2007, Mercury Speciation in Coal (Funded by ESKOM)
- ➢ 1x PhD A Venter 2016 North West University (Funded by SASOL)
- ➢ ± 20 Hg Publications since 2002 on CPT data only
- ➢ Several Oral and Poster presentations at SASAS, NACA, ICMGP and ICHMET.
- ➢ CPT Hg data set the longest Hg data set in the SH and 2nd longest in the World.

South African Weather Service

Importance of CPT GAW Site by involvement in GMOS

Cape Point became a Partner of the Global Mercury Observation System (GMOS)

GOAL:

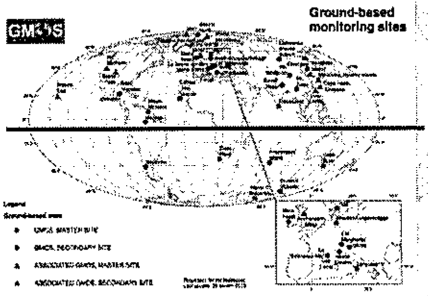
ESTABLISH

Global observation System for Mercury

FP7 Funded Project EU

Nov 2010 – Oct 2015

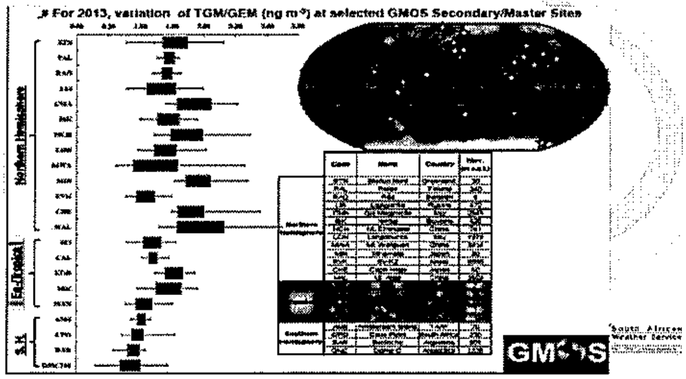
Budget of 6.8 Million Euros



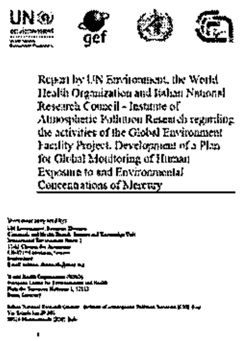
Limited number of Monitoring Sites in **Africa** and the **Southern Hemisphere**

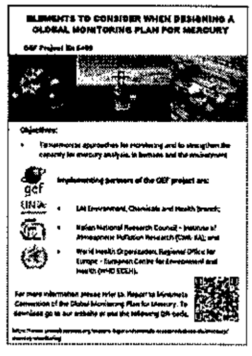
South African Weather Service

GMOS: Major Achievements

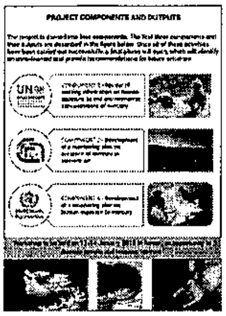


Cape Point involvement in UNEP and GEF Projects (2016-2018)





Elements to consider when designing a monitoring plan on the presence of mercury in air



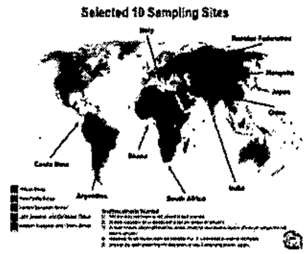
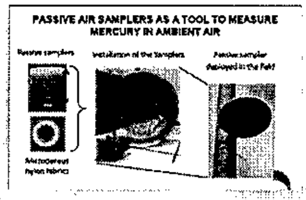
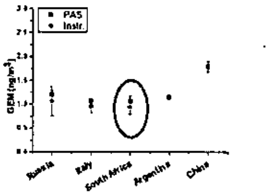


Figure 4. Pilot study of Passive air sampling of mercury showing the selected sampling sites

Project Results





GEM mean values comparison between analytical instruments and PAS's:

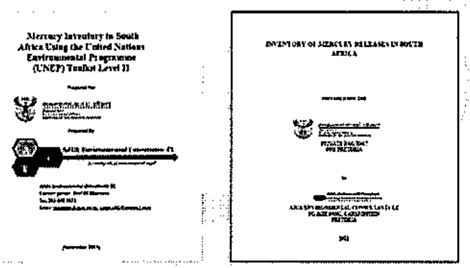
i) PAS values result within SD of instrumental data
ii) PAS could give info when electrical troubles happened on the equipment.
iii) PAS Cheap and relaible to monitor Hg in Air can easy be deploy in remote locations

Mercury Research by National Government of SA (DEA) as Part of Ratification process

UNEP LEVEL 1 TOOLKIT
2011

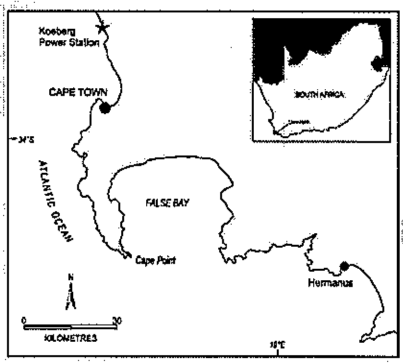
UNEP LEVEL 2 TOOLKIT
Final report due Aug 2018

MIA by the African Institute (GEF)
Oct 2016 – Sep 2018



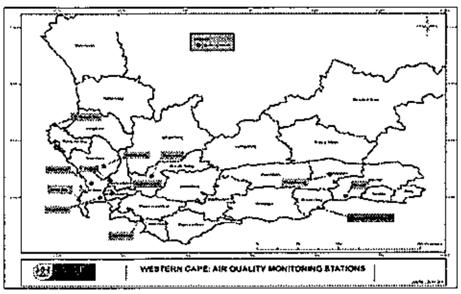
1st Draft Report UNEP Level 2 Toolkit
Apr 2018

FUTURE PLANS FOR Hg WET DEPOSITION NETWORK IN SA



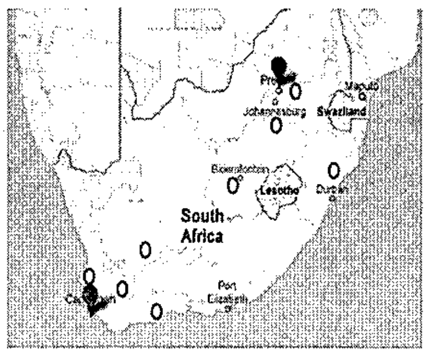
FUTURE PLANS FOR Hg WET DEPOSITION NETWORK IN SA

12 PROVINCAL AMBIENT AIR QUALITY STATIONS IN WESTERN CAPE



- PM 10 & 2.5
- Ozone
- SO_2, NO_x
- CO
- BTEX
- Deploy 4 rain collectors for 2019 rainy season (May – Sep)

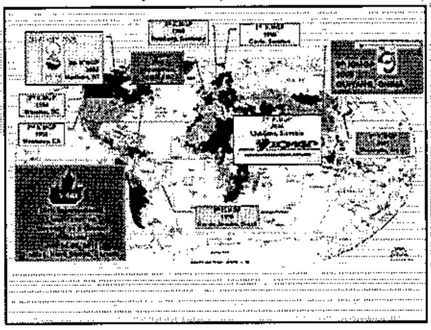
FUTURE PLANS FOR Hg WET DEPOSITION NETWORK IN SA



Univ. Pretoria
N-West Univ.
Univ. Zululand
Bloemfontein Weather office

INTERNATIONAL CONFERENCE ON MERCURY AS A GLOBAL POLLUTANT (ICMGP)

1. Sweden 1990
2. USA 1992
3. Canada 1994
4. Germany 1996
5. Brazil 1999
6. Japan 2001
7. Slovenia 2004
8. USA 2006
9. China 2009
10. Canada 2011
11. Scotland
12. S-Korea 2015
13. USA 2017
14. Poland 2019 8-13 Sep
15. ………………



South African Weather Service

ICMGP Cape Town 2021

Hg

15th INTERNATIONAL CONFERENCE ON MERCURY AS A GLOBAL POLLUTANT

CAPE TOWN | SOUTH AFRICA | 11-16 JULY 2021

15TH ICMGP coming to
CAPE TOWN | SOUTH AFRICA
11-16 JULY 2021

South African Weather Service

Theme:
From Minamata to Africa and beyond

ICMGP Cape Town 2021

Hg

Addressing Mercury challenges in Global Environmental Change

15th INTERNATIONAL CONFERENCE ON MERCURY AS A GLOBAL POLLUTANT

Cape Town | South Africa | 11 – 16 July 2021

Logo & Theme

a droplet of quicksilver, the historic name for mercury.

★ and "Cape Town" equates to the colour of the clear blue skies and oceans at the tip of Africa, the meeting place for experts to share global Hg matters.

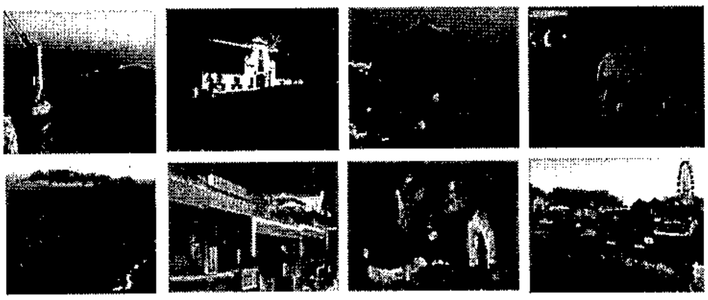
the warm Agulhas & cold Benguela currents, with directional flows from north to south and south to north, respectively, which also signifies the "north-south-north interactions" of the mercury legacy of the conference in Cape Town.

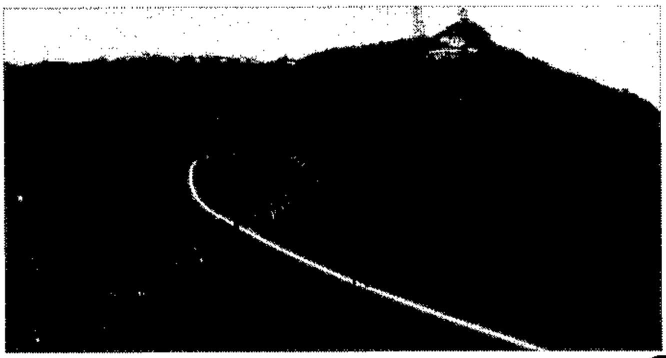
★ the location of the Global Atmospheric Watch Station at Cape Point where mercury is measured, and where tourists mistakenly think the "two oceans meet".

Hg the element symbol for mercury is placed in the ocean, as the ocean is a sink for this ubiquitous trace metal.

Hg, "ICMGP" and "2021" represents the colour of quicksilver / mercury, for the conference to be held in 2021.

We won't JUDGE you if you come for THIS instead of ICMGP 2021





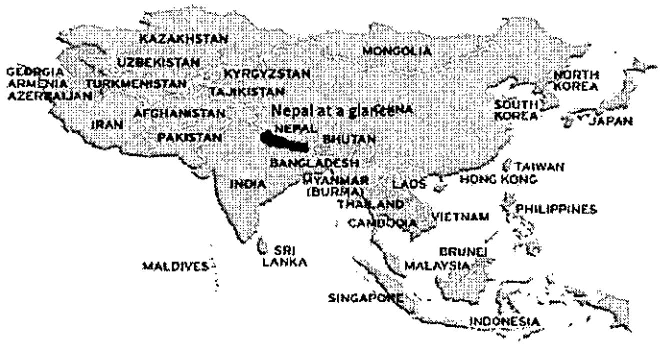
Hg

The Asia-Pacific Mercury Monitoring Network (APMMN) Meeting September 5-7

Overview of mercury hazard in Nepal

Ms. Safala Shrestha
Deparment of Environment
Nepal
Date: 2018/09/06

Map of Nepal



Nepal at a glance

- **Federal Republic of Nepal** from 2008, consist of seven provinces and 753 local government.
- **Area:** Approximately 147,000 sq km,
- **Three ecological zones**
- **Lowland:** 17 percent.
- **Midland:** 64 percent soars up to 487m.
- **The highland:** 19% ranges between 4877 m – 8848 m, (8 highest summits out of 14 summits around the world)
- **Population:** 26 million (2011est.)

Legal Practices on Controlling Mercury Emission

- Environment Protection Act, 1996 and Environment Protection Rule, 1997
- Solid waste management Act 2011
- There is no specific act/regulation for the management of mercury till date.
- Mercury and mercury compounds are listed as hazardous substances in the annex of recently drafted Hazardous Substance Management Regulation which is in the process of approval.
- The government of Nepal has set standard tolerance limit for Mercury in Effluent discharge from industries as 0.01mg/l and emission from incinerator as 0.05 mg/Nm3.

Status of Minamata Convention Implementation

- Nepal signed Minamata convention on 10 October, 2013 and is in the process of ratification by the Parliament
- Nepal is preparing for ratification to become its party and to be obliged to the convention.
- Nepal has translated Minimata Convention into Nepalese Language.

Conti...

- GoN is executing a project entitled "**Enabling Activities to Conduct Minamata Convention Initial Assessment (MIA) in Nepal**".
- The project has technical support from UNEP.
- The MIA activities will complement the country's efforts to significantly reduce the exposure of mercury to human health and the environment.

Cont..

- The overall objective of the MIA is to strengthen Nepal's national capacity to fulfil the obligations under the Minamata Convention and promote effective implementation of its provisions.
- Now it is working in collecting baseline information on mercury use and releases within the country.

Status of Mercury in the country

- Nepal does not produce Mercury. There is no mining facilities in the country.
- Mercury and mercury compounds are being imported form other countries and used for different purposes in different sectors as per the requirement.

Mercury containing product

- Thermometer
- Barometer
- Hg-Lamp
- CFL bulb
- Dry/ Wet cell batteries
- Hg-metal
- Dental Amalgam
- Hg-compound
- Electronic products
- Ritual product

Uses of Mercury

As dental filling

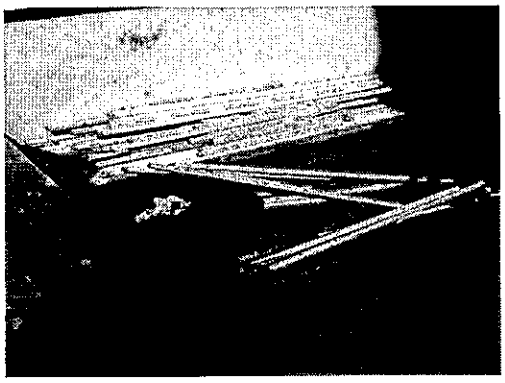
- Mercury is used as amalgam in general hospitals (Dental Departments) and dental hospitals.
- It is declining for higher income group due to the practice of alternatives like glass ionomer compomers but these types of mercury free alternatives are applicable for higher income group only.

conti.

Lamps and bulbs

- Mercury containing lamps (bulbs) like fluorescent tubes, compact fluorescent CFL, high intensity discharge lamps were used as standard for energy efficient lamps. Government of Nepal used to encourage the public to use CFL but now a days mercury free alternatives such as light emitting diodes (LEDS) are also available. The use of CFL is being phase out slowly.

Florescent lamp separately kept



conti.

Herbal Medicines

- Mercury compound cinnabar is widely used for the production of herbal drugs. Specially drugs are prepared for the relief of bone pain. Even up to 150 kg cinnabar are used per year by a single herbal drug industry .
- Many herbal products contains mercury compound.
- Cosmetics product contains mercuryare widely used.

conti.

- **Mercury / Mercury compounds in laboratories**
- Mercury / Mercury compounds are also widely used in laboratories of higher secondary schools, universities, public and private laboratories
- Many alternatives have been developed for mercury containing reagents but mercuric chloride, mercuric iodide, mercuric sulphate are still.

Existing situation of awareness

- Mercury and mercury containing products of different types are increasingly imported and consumed in Nepal.
- There is no proper information on the import and consumption.
- Even alarming is the situation that the general public does not know potential sources of Mercury,
- Unaware of mode of it's release into the environment and about its health impacts.
- Safety measures and trainings on hazards of mercury is lacking.
- Workers/assistants do not use any personal protective equipment/measures

Disposal pattern

- Mainly through hospitals and dental practices, where proper segregation of wastes at the source is not done, larger amount of mercury released into the environment.
- Health care wastes (hospitals, dental hospitals/practices, pharmacies) is the significant / potential source of mercury release.
- The academic institutions and laboratories are to be considered as major release sources.

Conti...

- Artisanal activities releases high amount of mercury to the environment. Nepal is popular for products of gold pleated idol, which is developed as household industry which add on mercury pollution.
- During the combustion of coal, elemental mercury is emitted in considerable amount. Many industries are using coal as a source of energy.
- The mercury is released from broken or just thrown fluorescent lamp which adds on increasing release of mercury to the environment.
- From incineration of dead human body.

Way forward

- There is great need to develop and execute national implementation Plan for monitoring mercury.
- Develop an inventory of import, export of mercury and mercury containing products
- develop data base of emission and release of mercury and mercury added products.
- Control and reduce mercury emissions and disposal, wherever feasible.
- Needs to work hard for Ratification of mercury convention.

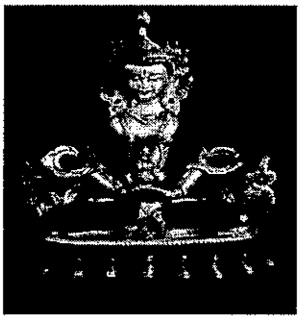
conti...

- Needs to develop guidelines, build up and enhance capacity on the environmentally sound interim storage of mercury, mercury compounds and wastes.
- Raise resources to develop, implement and monitor mercury related programs.
- Awareness generating and capacity building programs on monitoring of mercury .

Contd.

- Mercury monitoring program should be run with the support of APMMN.
- Capability development programs.
- Accreditation of Environment Laboratory.
- Developing some research program in the field of hazard Chemicals.
- Develop Collaboration with developing partners in order to develop knowledge and skill of staffs of the laboratory.

Idol with gold plated



Waste dumped in River side

Thanks for your attention!

The 7th Anual Asia-Pacific Mercury Monitoring Network Partners Meeting
5-7 September, 2018
Manila, Philippines

Air pollution and Mercury monitoring activities in Mongolia

Batbayar Jadamba
National Agency for Meteorology and Environmental Monitoring, Mongolia

OUTLINE

1. The priority areas for implementation of the Minamata Convention in Mongolia
2. Air quality monitoring
2. Acid deposition monitoring
4. Future concern of Mercury monitoring activities in Mongolia

THE PRIORITY AREAS FOR IMPLEMENTATION OF THE MINAMATA CONVENTION IN MONGOLIA

Project "Ratification and early implementation of the Minamata Convention on Mercury in Mongolia" /UNITAR 2015/

The priority areas for implementation of the Minamata Convention in Mongolia have been identified follows:

- Establish monitoring system for mercury releases to environment, training and awareness raising;
- Reduction of mercury emissions from primary anthropogenic sources;
- Reduction of usage of mercury containing products;
- Reduction of mercury emission from artisanal and small scale gold mining;

National Agency for Meteorology and Environmental Monitoring /NAMEM/

[redacted]

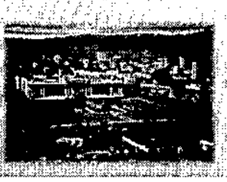
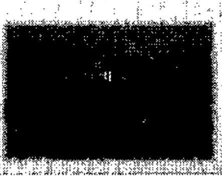
- Surface water quality monitoring stations - 137
- Waste water control points - 18
- Acid deposition monitoring sites - 2
- Ambient air quality monitoring stations - 40
- Radioactivity monitoring sites - 35 Fall out sampling sites - 22
- Soil monitoring points - 390

CURRENT SITUATION OF AMBIENT AIR POLLUTION IN ULAANBAATAR

Air pollution has been increasing intensively during last decade in Mongolia especially in Ulaanbaatar due to:

- urbanization,
- poor urban plan,
- raise of number of motovehicles,
- mainly coal for heating and cooking,
- other air pollution sources;

As result of the phenomena population health has been worsening

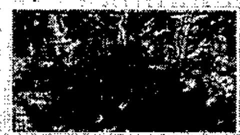
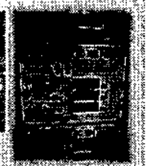




AIR QUALITY MONITORING: 40 St.

Location of AQ monitoring stations in Mongolia

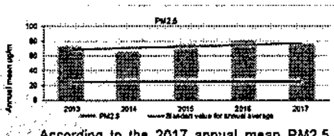
Air pollutants	Air quality monitoring stations
Sulphur dioxide SO2	All monitoring stations
Nitrogen dioxide NO2	All monitoring stations
PM10	6 stations in UB, 8 province centers
PM2.5	4 monitoring stations in UB
Carbon monoxide CO	5 stations in UB, 3 province centers
Ozone, O3	4 stations in UB,

- In Ulaanbaatar city there is a 15 station are running. 3 of them is manually operating stations, 12 is continuous automatic stations.
- The continuous automatic stations are running 24 hours online during every days.
- The chemical analyze using stations are taking short term sample twice a day.

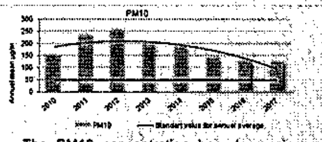




Location of AQ monitoring stations in Ulaanbaatar

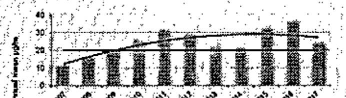
ANNUAL TRENDS OF AIR POLLUTANTS IN ULAANBAATAR CITY



According to the 2017 annual mean PM2.5 concentrations reached 75 μg/m^3 and were 3 times higher than the AQS.



The PM10 concentration has decreasing trends since year 2012. In 2017 the annual PM10 concentrations decreased to 122 μg / m^3, but 2,4 times higher than the AQS.



In 2017 the annual average concentration of sulfur dioxide was 24 μg/m3.

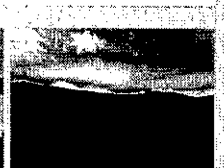
According to the 2017 annual average nitrogen dioxide content reached 39 μg/m^3 but does not exceed in AQS during last 4 years.

ACID DEPOSITION MONITORING SITES IN MONGOLIA

Sites	Characteristics	Latitude	Longitude	Altitude
Ulaanbaatar (wet & dry)	Urban	47°55'13"N	106°54'43"E	1275 m asl
Terelj (wet & dry)	Remote	47°59'00"N	107°27'04"E	1550 m asl

Ulaanbaatar site

Terelj site, Winter season



Terelj site, Summer season

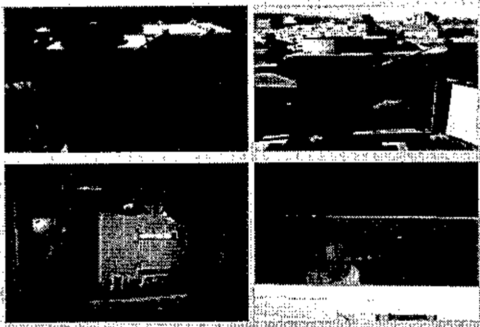
SAMPLING INSTRUMENTATION

Wet sampler

Automatic rain sampler, model US320, wet only (Ogasawara Keiki Co,. Ltd)

Dry sampler

Four staged filter pack, model MB-01T (Tokyo Dylec Co,. Ltd)



FUTURE CONCERN ON MERCURY MONITORING IN MONGOLIA

- Mongolia has great interest to establish mercury monitoring site
- Cooperation procedure with APMMN
- Site selection:
  - Option 1. CLEM site in Ulaanbaatar
  - Option 2. Acid deposition monitoring site at Terelj (National protected area, 70 km from Ulaanbaatar)
- Mercury monitoring program
- Methodology for sampling and analyzing process
- Reach to consensus on data dissemination and sharing

THANK YOU FOR YOUR ATTENTION

U.S.EPA at the Asia-Pascific Mercury Monitoring Meeting & Workshop
On September 3-7,2018 , Manila

Calculation of mercury emissions from anthropogenic sources Mongolia

(where is best place for installation wet deposition monitoring equipment ?)

Dr. TUMENBAYAR Baatar
Sans Frontiere Progres (SFP)

	North Mongolian forest steppe area	South Mongolian Gobi area
Number of days with temperature above zero on the ground surface	170-190 days	230-250 days (surface soil is heated up to 60°-65°C or more)
Average wind speed per month	2, 2 meter per sec	3, 7 – 4, 0 meter per sec
Average Humidity	50-60%	14-18%
Average monthly precipitation	30-40 mm	3,0-3,9 mm
Yellow dust transportation	Not known	by wind (sometime up to 30-40 m/sec)

Assessment of mercury emissions from anthropogenic sources Mongolia (annually)

	Mercury sources	Annual Mercury emission (Mg)		
		Global (N.Pirrone et.al,2010)	Mongolia (2017)	
1	In the global atmosphere, including re-emission -	5207	—	
2	From Anthropogenic sources	2320	—	
3	From fossil-fuel	810	0,93	
4	artisanal small scale gold mining	400	0,01 (?)	
5	non-ferrous metals manufacturing	310	No data	
6	cement production	236	No data	
7	waste disposal 187	187	No data	
8	caustic soda production -	163	No	
	TOTAL	7527	1.3	

* No production of mercury containing products; No mercury using industries; No recycling activities for mercury containing products

Capital city Ulaanbaatar in winter

Coal burning smoke (lignite from Baganuur,Nalykh deposits)

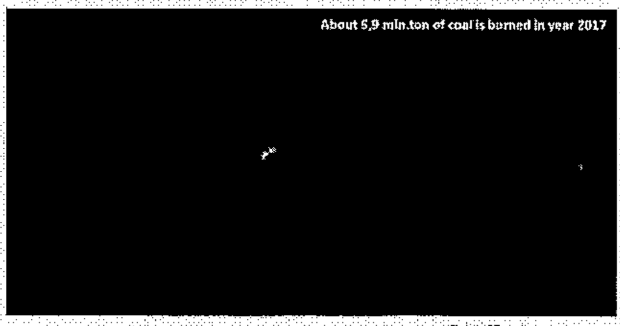


Photo by B.Tumenbayar

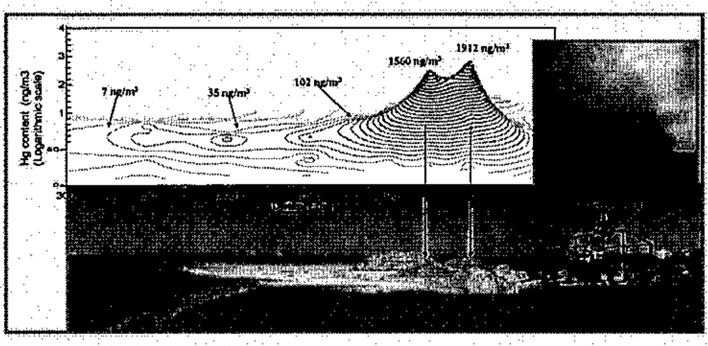
Coal consumption in Mongolia

Reserve	173 bln. tons
Deposits	300
Production	49.4 mln. tons (2017)
Sold	41.9 mln. tons
Exported	33.4 mln. tons
Burned in capital Ulaanbaatar (30km2)	5.9 mln. tons
Burned in country side (1,5 mln km2)	2.6 mln. tons

Mercury Emission to the atmosphere of Ulaanbaatar (2017)

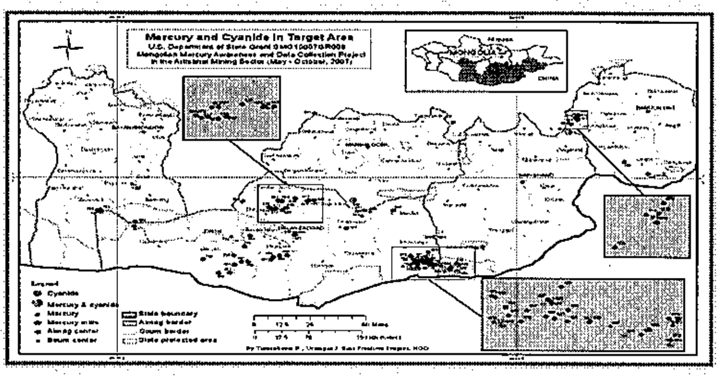
Coal Deposits	Mercury content in coal (ppm)	Burned coal in 2017 (mln.tons)	Mercury emission in to atmosphere (kg)
Baganuur	0.131 (0.23-0.032)	5.31	695
Nalaikh	0.088 (0.16-0.047)	0.59	52
	Total	5.9	747

SFP



Transport of mercury by wind, as measured by Lumex Hg detector held 5–10 cm above the ground surface to detect mercury vapour. Khuzuu tolrom, Noyon, South Gobi Aimag, (GPS 461.)

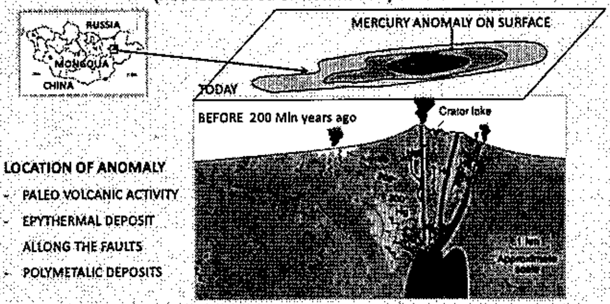
SFP



Distribution of mercury and cyanide sites visited during the SFP survey.

Surface mercury anomaly from paleo sources

(not considered on estimation)



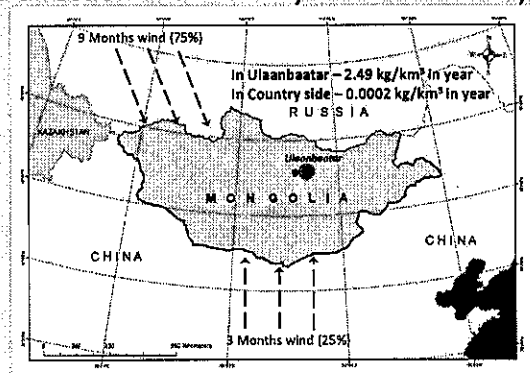
LOCATION OF ANOMALY

- PALEO VOLCANIC ACTIVITY
- EPYTHERMAL DEPOSIT ALLONG THE FAULTS
- POLYMETALIC DEPOSITS

SFP

Wind direction and Mercury emission density

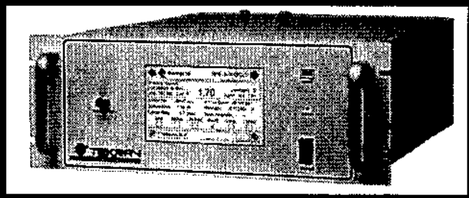
where is best place for installation wet deposition monitoring equipment for global and local mercury assessment?



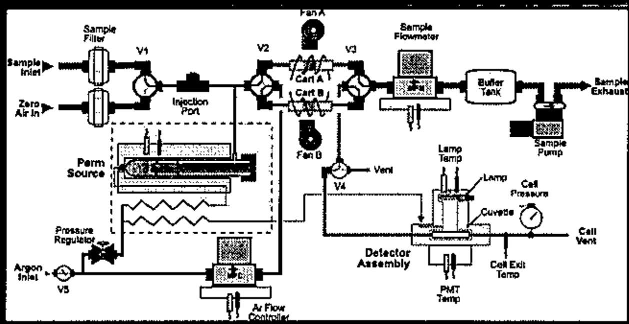
SFP

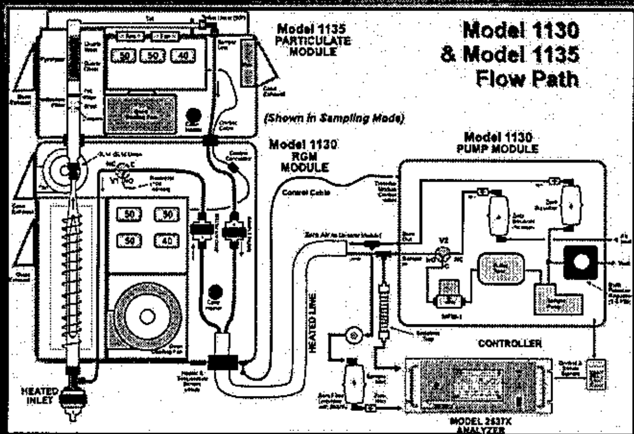
AUTOMATED CONTINUOUS METHODS TO MEASURE GASEOUS ELEMENTAL MERCURY (GEM) AND SPECIATED MERCURY (RGM/GOM & $PBM_{2.5}$)

TEKRAN 2537X ANALYZER

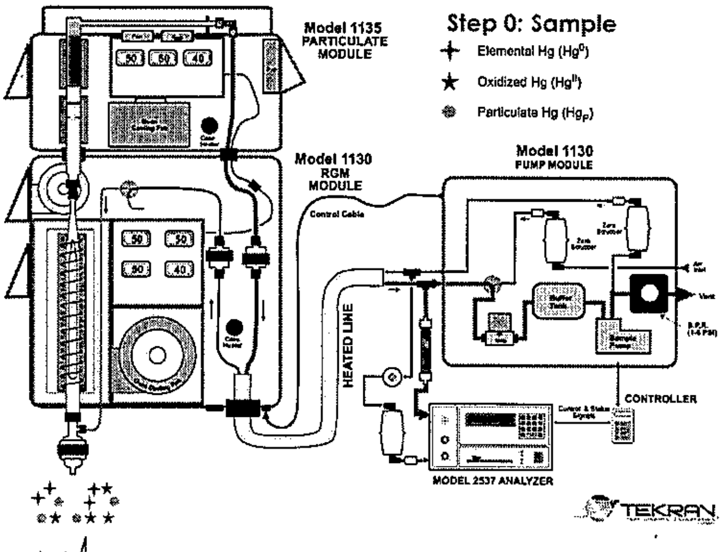


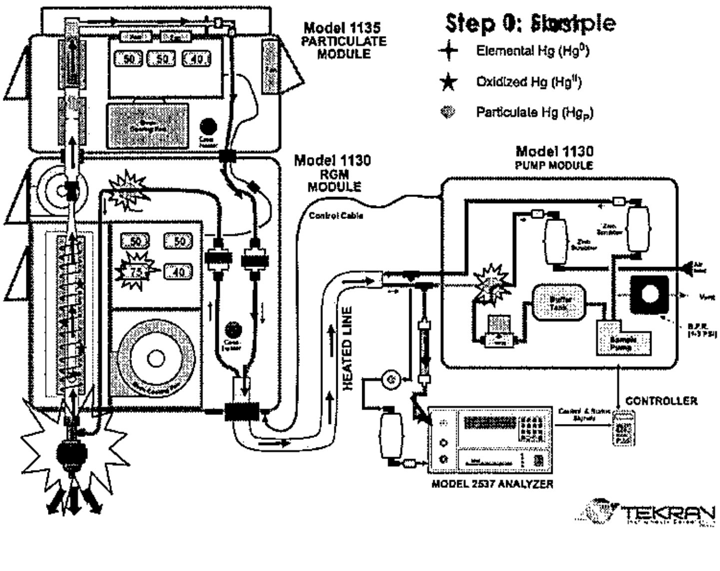
FLOW DIAGRAM OF TEKRAN MODEL 2537X AUTOMATED MERCURY ANALYZER (PAT'D)

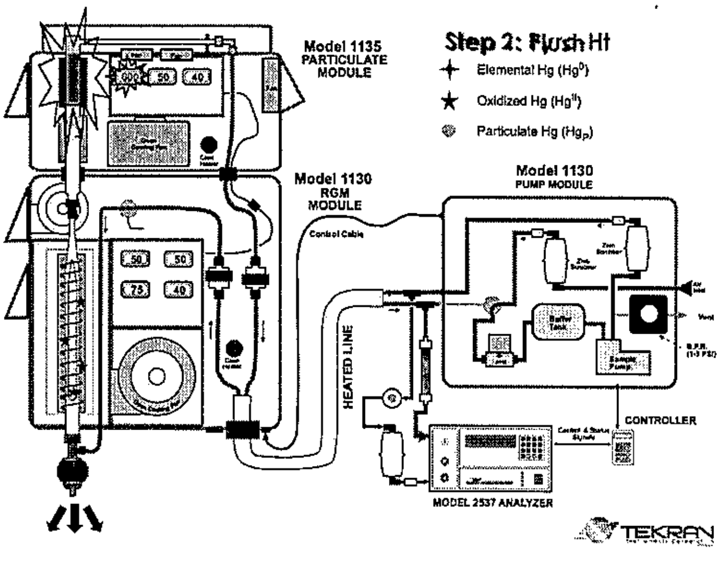


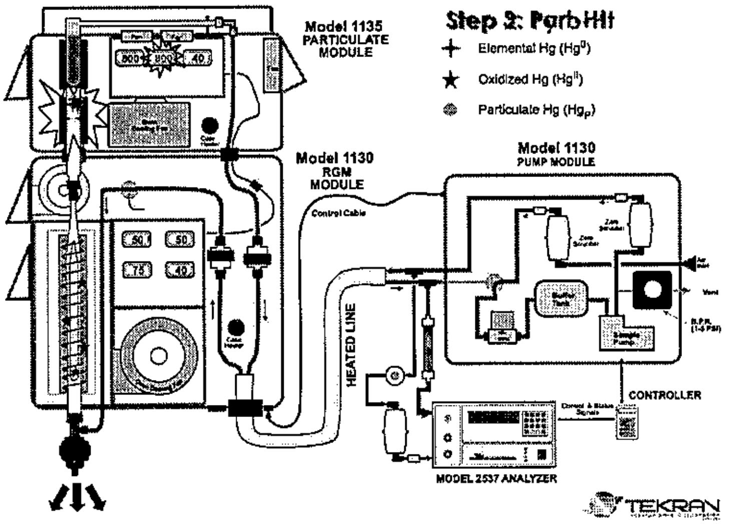


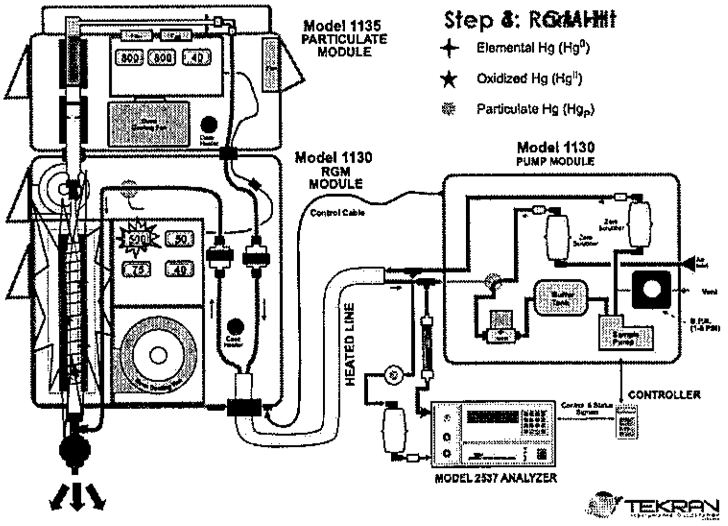
SAMPLING & ANALYSIS ANIMATION MODEL 1130 AND MODEL 1135








Model 1135
PARTICULATE
MODULE
Elemental Hg (Hg^0)
Oxidized Hg (Hg^{II})
Particulate Hg (Hg_p)
Model 1130
RGM
MODULE
Model 1130
PUMP MODULE
Control Cable
HEATED LINE
CONTROLLER
MODEL 2537 ANALYZER
TEKRAN


Model 1135
PARTICULATE
MODULE
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RGM
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Model 1130
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Control Cable
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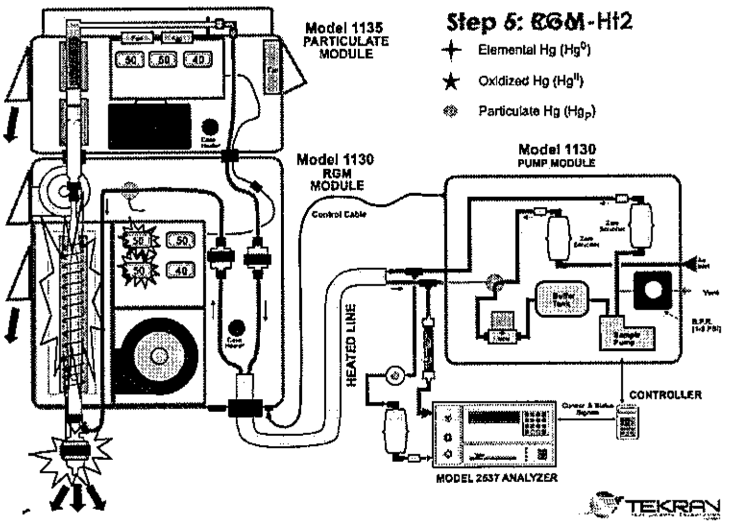
CONTROLLER
MODEL 2537 ANALYZER
TEKRAN


Model 1135
PARTICULATE
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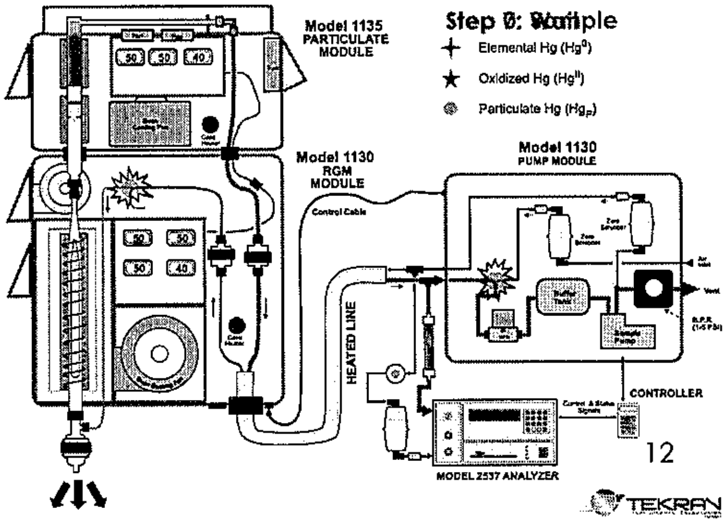
MODEL 2537 ANALYZER
TEKRAN


Model 1135
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RGM
MODULE
Model 1130
PUMP MODULE
Control Cable
HEATED LINE
CONTROLLER
12
MODEL 2537 ANALYZER
TEKRAN


QUESTIONS?

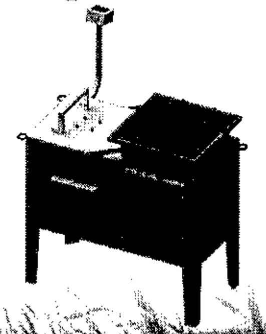
Session IV

Asia Pacific Mercury Monitoring Network

APMMN Mercury Wet Deposition Roundtable Discussion

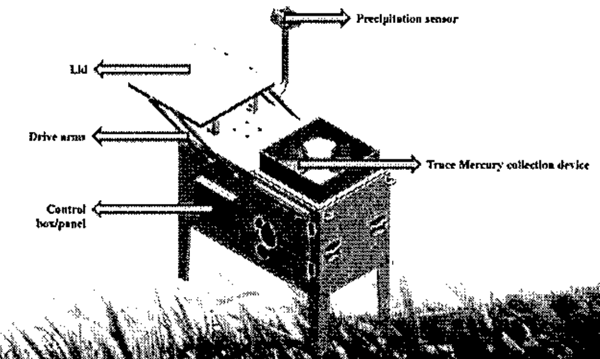
Machine Shop

Mercury Deposition Sampler



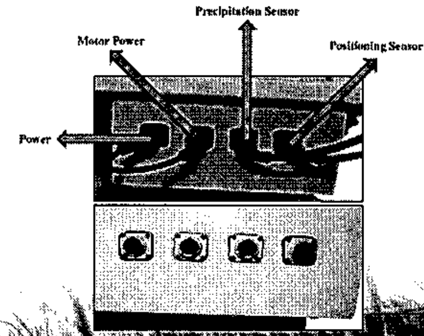
Machine Shop

External item of the equipment



Machine Shop

Internal item of the equipment



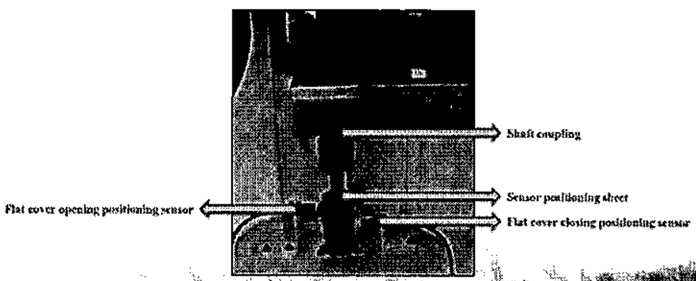
Machine Shop

Control panel

- Homepage
  - Manual/Auto switch
  - Setting
    - Lid delay, Heater delay, Heater On/Off time, Wet sensor delay, Lib alert
    - Advanced setting (pin code)
      - Proximity sensors adjustment
    - Manufacturer info
  - Stop
  - 4 indicators

Machine Shop

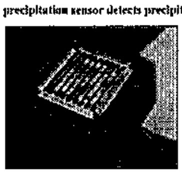
Internal item of the equipment



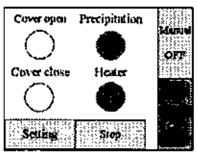
Machine Shop

Description of Operation

When precipitation sensor detects precipitation.



"Precipitation" light on controller monitor will be on. Then "Heater" will light on and shine followed by setting.

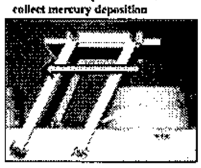


For example, set Heater ON to 10 seconds and Heater OFF to 5 seconds, "Heater" light will repeat lighting 10 seconds and then going out 5 seconds until "Precipitation" light off.

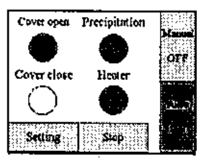
Machine Shop

Description of Operation

When "Precipitation" lights on, flat cover will open and start to collect mercury deposition



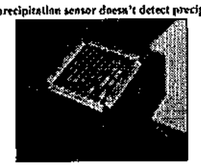
While the flat cover opening, Sensor positioning sheet will synchronously rotate with it until be detected by Flat cover opening positioning sensor with lighting on, Then flat cover will stop. "Cover open" on controller monitor will light on.



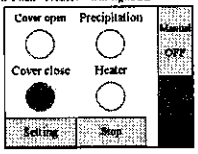
Machine Shop
兼嘉企业有限公司

Description of Operation

When precipitation sensor doesn't detect precipitation.



"Precipitation" light on controller monitor will be off. Then "Heater" will light of.

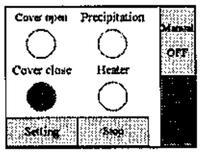


Machine Shop
兼嘉企业有限公司

Description of Operation

When "Precipitation" lights off, flat cover will close.

While the flat cover closing, Sensor positioning sheet will synchronously rotate with it until be detected by Flat cover closing positioning sensor with lighting on. Then flat cover will stop. "Cover close" on controller monitor will light on



Machine Shop
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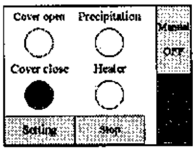
Description of Operation

When "Precipitation" lights off, flat cover will close.

While the flat cover closing, Sensor positioning sheet will synchronously rotate with it until be detected by Flat cover closing positioning sensor with lighting on. Then flat cover will stop. "Cover close" on controller monitor will light on



Machine Shop
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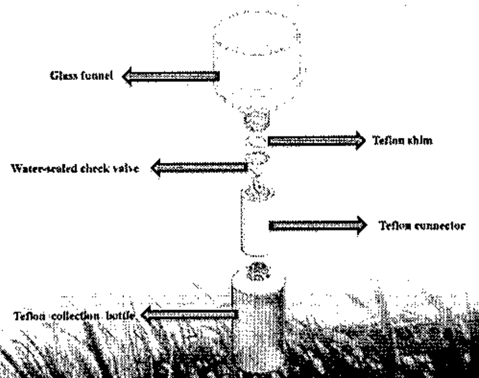
Trace mercury collection device



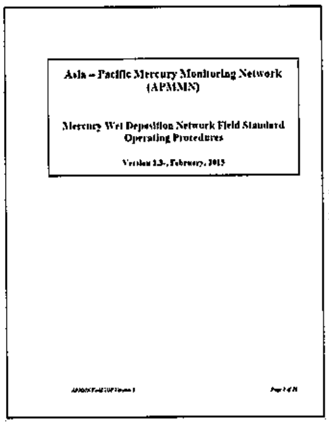
Standard Operating Procedures for APMMN

Da-Wei Lin and Guey-Rong Sheu

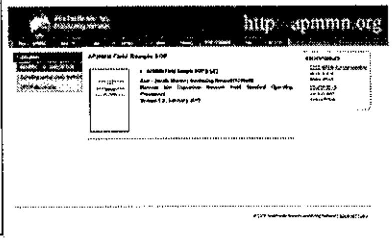
Asia Pacific Mercury Monitoring Network

Center for Environmental Monitoring and Technology
National Central University

Current SOP

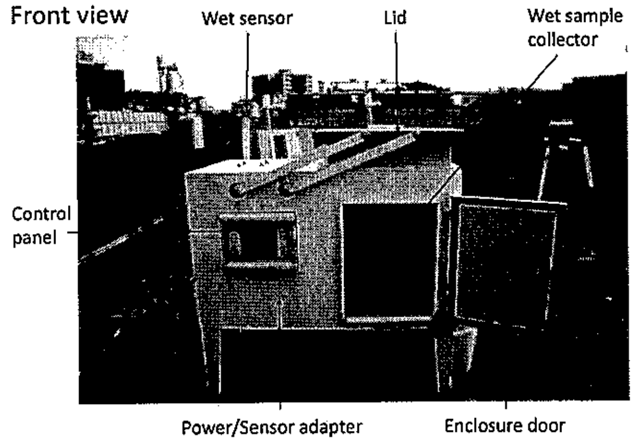


- Based on MDN/NADP SOP.
- Revised Ver. 1.3 by EPAT, USEPA, NADP, NCU, Vietnam and Thailand in 2015



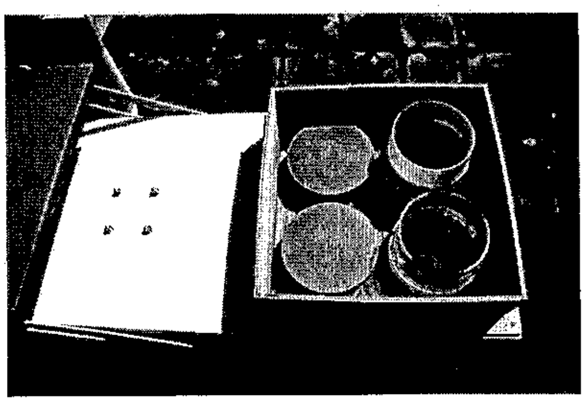
Wet-only precipitation collector-MIC type

Front view

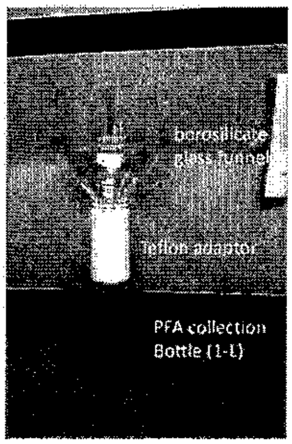


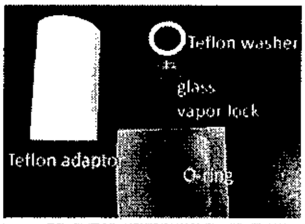
Wet-only precipitation collector-MIC type

Top view



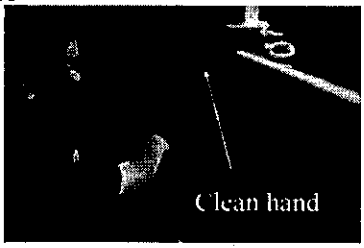
Mercury collection device





Retrieve your sample

- Changes on Tuesday morning between 8 to 10 am LT
- Approach collector facing into the wind
- Open the enclouse door
- Put ot the gloves
- Take off PFA sample bottle

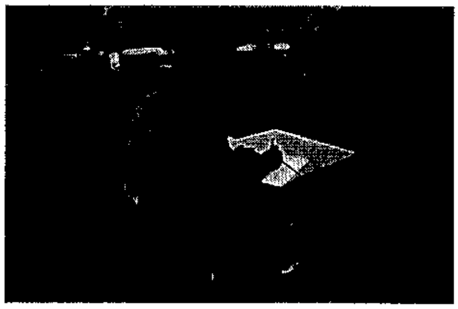


Retrieve your sample

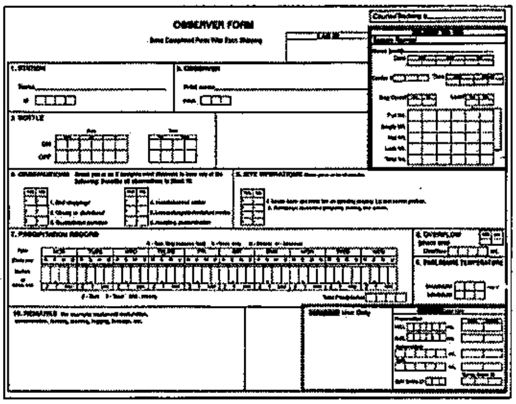
- Cap the bottle
- Take 2 plastic bags to cover bottle

Retrieve your sample

- Open the lid
- Take out the used sample collector (funnel)
- Fill in the Network Observer Form



Network Observer Form (NOF)



1. Station
2. Observer
3. Bottle
4. Observations
5. Site operations
6. Precip. record
7. Overflow
8. Enclosure Temp.
9. Remarks

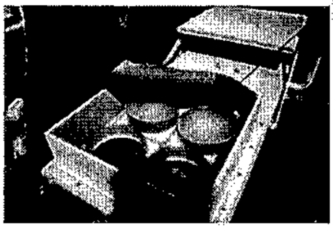
Lab/APMMN use only

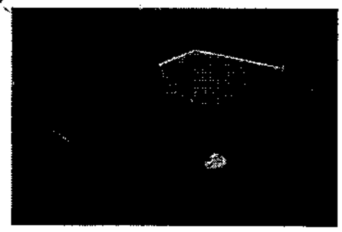
(APMMN Field SOP Ver 1.3, Page14)

Cleaning the collector

- Clean any surfaces by DI Water and paper towel
- Clean any debris off sensor by brush or compressed air

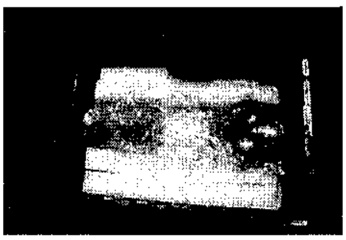
Dirty hand

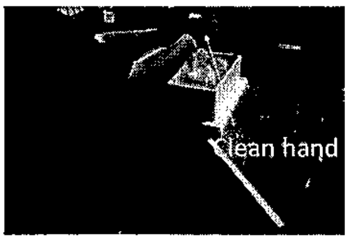




Deployment of new sample collector

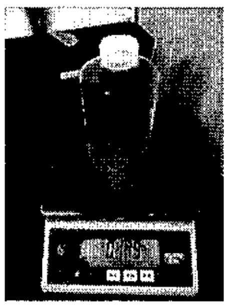
- Change your gloves !
- Deploy new sample collector
- Avoid to touch the inner surface of glass funnel
- Close the lid and enclosure door
- Write a NOF for coming sample

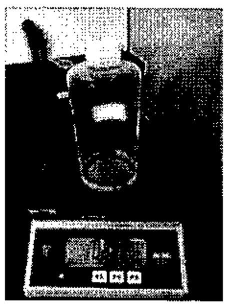




Weigh, transfer and storage

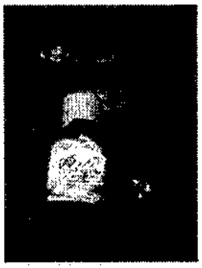
- Weigh the sample bottle and subtract the weight of empty bottle (recode it on the NOF)
- Carefully pour the sample from 1L to 125mL sample bottle





Weigh, transfer and storage

- Label the sample with sampling site ID, start/end date
- Place the sample into double sealable plastic bag
- Store the sample in a Hg-free and secure place (or refrigerator) if not shipping immediately.
- Capture rain gauge data
- Complete the NOF



Sample label

- The most important part of taking sample

Site ID
Start Date (MM/dd/yyyy)
End Date

APTW01
08/28/2018
09/04/2018

Shipping Info.

Ship samples at least **monthly** by int'l logistics service
Ex:

- Pack samples and NOFs singly or in bulk
- Cold shipping is unnecessary
- Description of goods : Rainwater

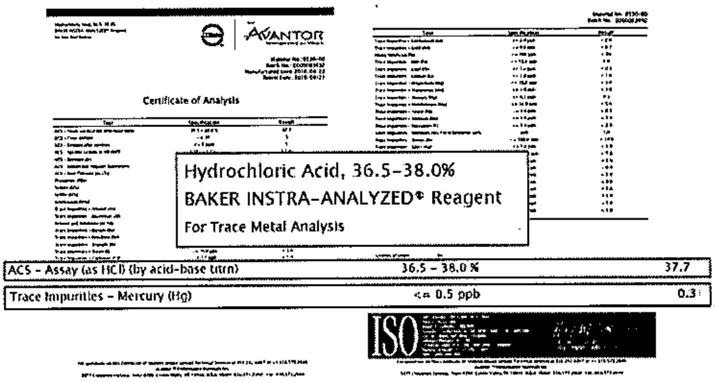
Dr. Guey-Rong Sheu
APMMN
Department of Atmospheric Sciences National Central University
300 Jhong-Da Road Jhong-Li 320, Taiwan

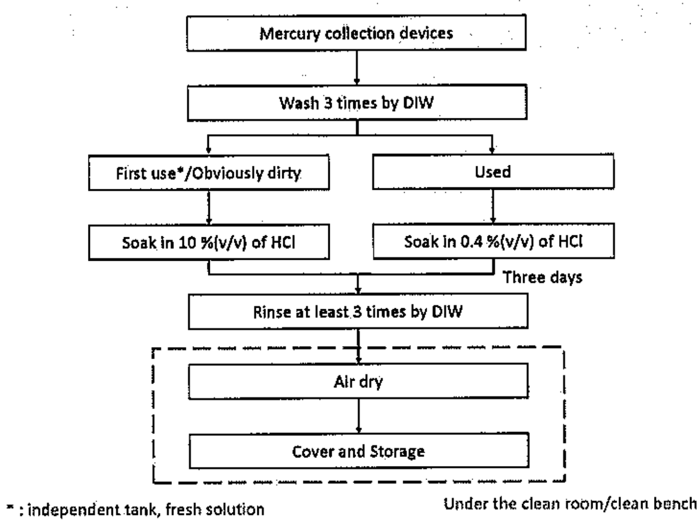
Acid Clean of Collection Devices

Material/Equipment

- Personal Protective Equipment
- Deionized water – ρ≧18.2 MΩ
- Hydrochloric acid – J.T Baker Hydrochloric Acid, 36.5-38.0%, BAKER INSTRA-ANALYZED® Reagent or equivalent
- PE box/tank

Certificate of Analysis



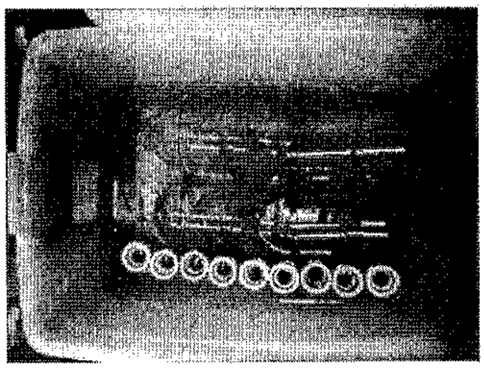


Acid Clean of Collection Devices

- Separate the collection device and wash by DIW

Acid Clean of Collection Devices

- Soak within hydrochloric acid for 72 hours (except O-ring)



Acid Clean of Collection Devices

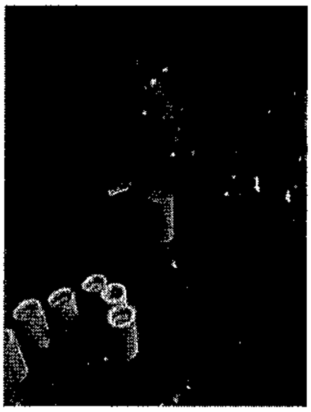
- Rinse thoroughly each component with deionized water ($\rho \geqq 18.2\ M\Omega$) at least 3 times

Acid Clean of Collection Devices

- Air dry each component in the clean bench

Acid Clean of Collection Devices

- Cover each component with clean plastic bag and store
- Assemble each component before use



Cases in the past years

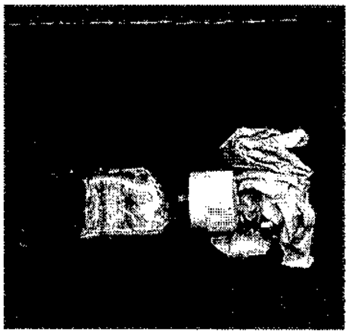
Case 1:
No sealable plastic bag (double bags)
No lable on sample bottle

Cases in the past years

Case 2:
Single sealable plastic bag only
Number of Sample bottle and NOF were unequal
Not use the suggest PETG bottle

Cases in the past years

Case 3:
No label on the bottle
No NOF



THANK YOU

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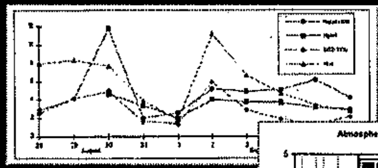
Asia Pacific Mercury Monitoring Network

Center for Environmental Monitoring and Technology
National Central University

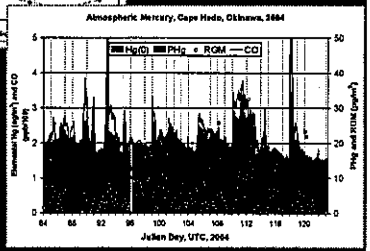
cury assive ir ampler

New methods have increase our understanding of atmospheric mercury species behavior

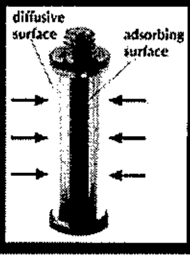


1993
24 hour manual method for TGM and Hg_p

2004
5-min automated for Hg^0, hours for RGM & Hg_p



Basics of *Mer*PAS



- Design resulted in precise, stable, robust sampling rate (SR)
- Jar provides protection, eliminates wind effects and used as a container for transport
- SR determined using the Tekran 2537 Hg Monitor

Concentration derivation equation:

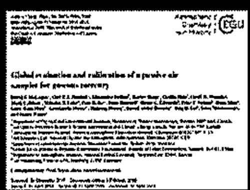
$$C = m / (SR * t)$$

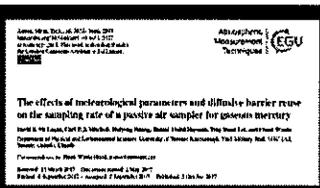
(C: gaseous Hg concentration (ng m⁻³); m: mass of sorbed Hg (ng); SR: sampling rate (m^3 day⁻¹); t: deployment time (days))

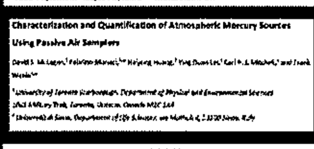
*Mer*PAS Development Summary

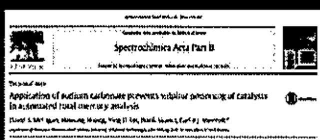
- Developed at U. of Toronto by McLagan, Wania and Mitchell
- Global study showed MerPAS is highly sensitive, accurate and precise for ambient air levels (1-5 ng/m^3). Only passive sampler capable of accurate and precise ambient air measurements.
- Study completed (in press) to quantify annual emissions at a former mercury mine (max 6.7 ug/m^3)
- Further studies underway for performance in indoor air and extreme concentrations (up to mg/m^3)
- Tekran is commercializing sampler through licensing agreement with U. Toronto and scientists

MerPAS Studies U. of Toronto









*Mer*PAS Features

- No power required
- Simple to deploy & retrieve
- Low entry cost – low temporal resolution
- Range likely unlimited (1 ng/m^3 to 10 mg/m^3)*
- Relatively immune to wind and temperature effects
- Uses well known Radiello diffusive barrier
- Highly tested and characterized

* See specifics in subsequent slide

Select Applications

- Remote sites – no power
- Artisanal gold mining
- Identifying and mapping hot spots
- Community exposure monitoring
- Contaminated site cleanup monitoring
- Indoor spill cleanup and monitoring
- Personal exposure industry, schools, workplace & homes
- Area source emission estimates (high spatial resolution and vertical gradients)

Vertical profile industry site

*Mer*PAS Sample Rate Calibration (m^3/day)

using the Tekran 2537 at 20 sites

- Global ambient air study – sensitive, precise, accurate
- From McLagan et al., (https://doi.org/10.5194/acp-18-5905-2018)

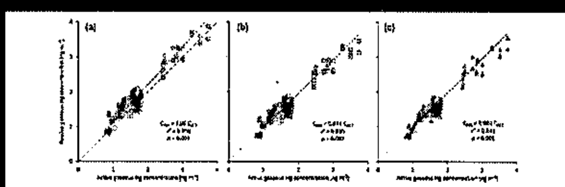
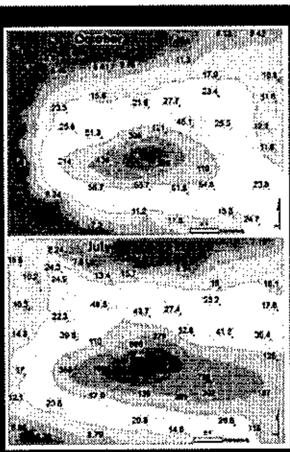


Figure 3. Comparison of active (C_{ACTIVE}; x axis) and passive (C_{PAS}; y axis) gaseous Hg concentrations derived from the original sampling rate (SR; circles in a), recalibrated SR (squares in b), and adjusted SR (triangles in c). Dotted lines represent the trend line for each dataset. Grey dashed line is the 1 : 1 relationship. Markers are coloured according to site type, red – urban sites; blue – rural sites, purple – high-altitude sites; and yellow – northern/Arctic sites. Fitted relationships are for all data combined.

Former Hg Mine Site Mapping

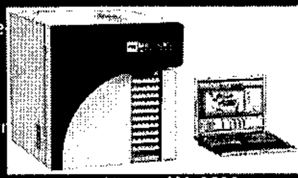
McLagan et al., 2018 (submitted)

- Values in ng/m^3
- Area of ~0.6 km^2
- Survey around mine site buildings
- 1-week sample deployment
- Seasonal differences



*Mer*PAS Analysis

- Analysis must be done in a trace clean analytical lab by skilled mercury chemists
- Direct thermal analysis is preferred, no acid digestion (EPA Method 7473)



Nippon MA-3000

- Multiple instrument vendors ~$40-50K USD
- EPA Method 1631, acid digestion may be required for very high Hg loading (e.g. artisanal gold mining)

Tekran *Mer*PAS Analysis

- Tekran is offering *Mer*PAS Analysis Service using the direct thermal analysis method (EPA method 7473)
- Our analysis team has over 90 years of experience all focused on mercury measurement
- Tekran will offer to be an independent reference laboratory for national and international networks

*Mer*PAS Analysis Challenges - I

- The sulfur rich carbon sorbent is a tough matrix that can cause low bias, catalyst failure and gold trap degradation
- Matrix issues are mitigated with addition of sodium bicarbonate and limiting amount of sorbent for each analytical run
- Typical ambient air sample split into 2 or more runs of sorbent
- Many quality assurance samples must be run to maintain high quality results

*Mer*PAS Analysis Challenges - II

- Direct thermal analysis is destructive
  - Must transfer 100% of sorbent to analysis boat for accurate results
  - Easy to spill sorbent during preparation, weighing and transfer – loss of results can cause large data gaps
  - Easy for analytical run to go bad >> data gaps
- Blank control

  Field blanks, trips blanks and material blanks are necessary to evaluate accuracy and performance of the site operator, shipping/storage and analyst.

Sample Range and Conditions

- Carbon media capable of adsorbing Hg up to 10% by weight
- Proven for ambient air (~1-20 ng/m^3). Integrated sample time of 1-week minimum up to 1 year maximum.
- Proven for former mercury mine site and surrounding area. Integrated sample time of 1-week for low ug/m^3 levels
- For sites with mean air Hg > 100 ug/m^3
  - Short sample times may be necessary (hours)
  - For longer sample times, analysis will require more analytical runs or may be done using EPA Method 1631E.
  - Depending on project goals, obtaining a representative result may necessitate using multiple *Mer*PAS samplers for each measurement location

*Mer*PAS Sampling Procedure

- Can include clean hands sampling kit
- Multiple mounting options
- Handwritten sample info or bar code may be used
- Sample location, blanks and replicates should be considered

Tekran *Mer*PAS Updates

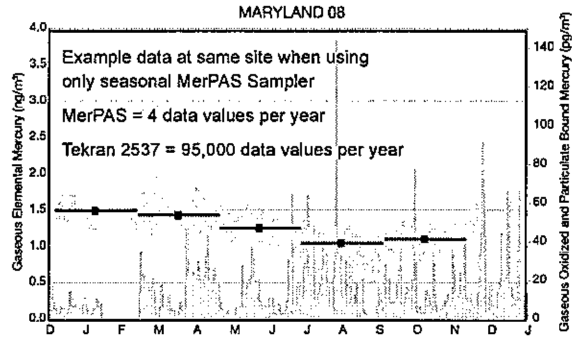
- Weatherproof plastic label
- Bar Code ID
- More versatile bracket
- Threaded plastic panel mount Radiello and bracket attachment
- Developing electronic tracking to verify sample locations, times & chain of custody

Why Use *Mer*PAS

- Radial diffusive surface has better performance than 2-D badge type passive air samplers
- Proven to be highly accurate and precise
- Media has low consistent blanks and massive uptake capacity
- Robust packaging and simple to deploy
- Direct thermal analysis can be faster, easier and lower cost compared to liquid acid digestion and analysis

AMNet Rural Site

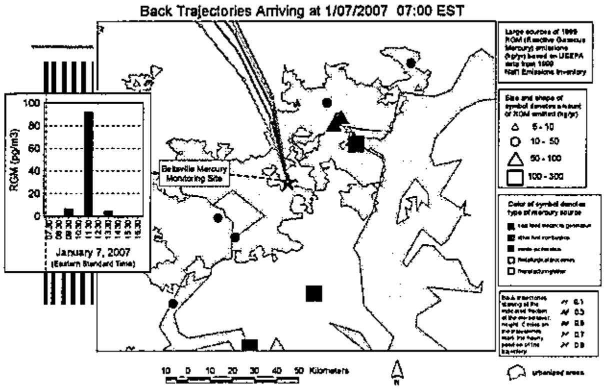
Close to high emission source region



Real-Time Hg Speciation Monitoring Example

Winston Luke & Mark Cohen NOAA-ARL

Back Trajectories Arriving at 1/07/2007 07:00 EST



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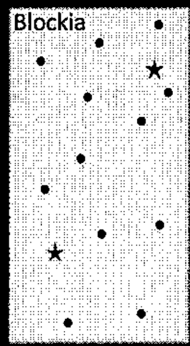
Blockia Republic National Monitoring Plan



Urban Co-Located
MerPAS + Tekran 2537

Remote Co-Located
MerPAS + Tekran 2537

MerPAS Only

Co-Located sites provides both high resolution data and ongoing calibration of the MerPAS method and results

For *Mer*PAS Project Design, Planning, and Budgeting

contact
Lucas Hawkins or Eric Prestbo
at

or call
+1-416-449-3084