



Mercury Monitoring Status in Republic of Korea

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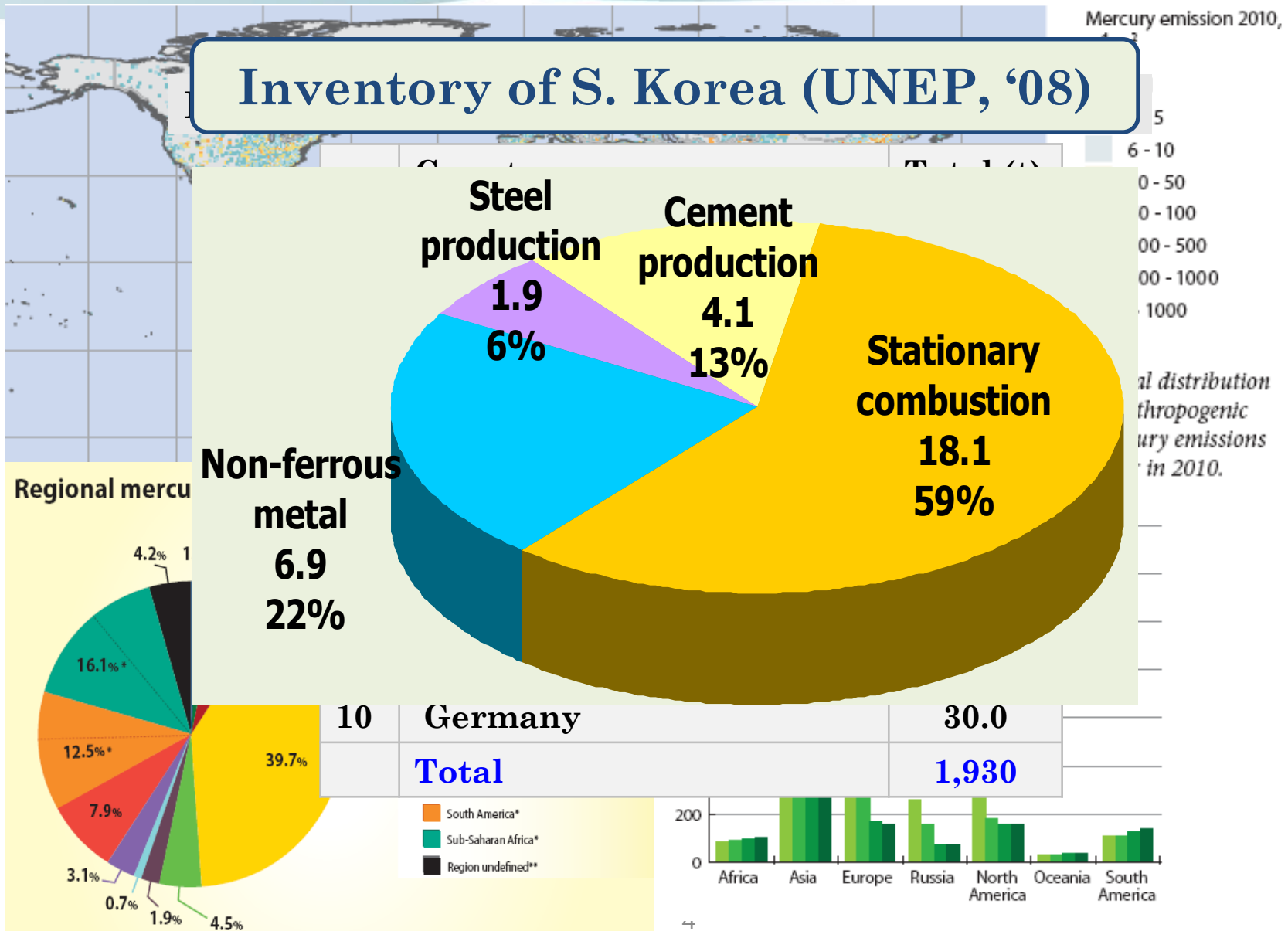
Mercury issues in Korea



Global Mercury Emission

(UNEP's Global Mercury Assessment 2013)

Inventory of S. Korea (UNEP, '08)



Hg levels in Blood

1st Korean National Environmental Health Survey ('09~'12)

Hg in Blood ($\mu\text{g/L}$)	Sample size	Arithmetic mean	Geometric mean	Percentile (%tile)			
				25th	50th	75th	95 th
Total	6,298	3.97	3.08	1.99	3.05	4.76	9.9
Gender							
Male	2,924	4.74	3.65	2.33	3.60	5.74	12.1
Female	3,374	3.22	2.62	1.77	2.62	3.92	7.4
Age Group (years)							
19-29	747	2.87	2.35	1.59	2.33	3.40	6.5
30-39	1,180	4.02	3.22	2.19	3.26	4.97	10.5
40-49	1,333	4.34	3.45	2.29	3.40	5.29	10.2
50-59	1,495	4.89	3.75	2.37	3.62	5.94	12.7
60-69	1,110	4.06	3.05	1.88	2.90	4.89	10.2
70 and older	433	3.36	2.58	1.66	2.56	3.92	7.6
Region							
Urban	4,966	4.00	3.11	2.00	3.07	4.79	9.99
Rural	428	3.15	2.51	1.66	2.41	3.79	7.33
Costal	177	5.97	4.80	3.07	5.04	7.41	14.19

Current issues on Mercury

- Large mercury emissions : 32.2 ton/yr ('08, UNEP)
⇒ Is it real?? Need updates on Hg emission inventories!
- **Koreans' mercury concentration in blood** : 4.34 ppb ('05) → 3.08 ('12)
(USA : 0.94 ppb, Germany : 0.58 ppb)
 - More than 20% of Korean showed higher Hg concentrations compared to guideline level of USA EPA (RfD 5.8 ppb)
 - Similar or lower Hg levels in urine than western countries⇒ Caused by high intake of fish: 74~94 g/day (USA : 17.5g/day)
- Frequent occurrence by **long-range transport** of Hg
⇒ Need regional-scaled Monitoring & Modeling !

The 2nd Mercury Action Plan (2010)

“Reduce Human health effect due to Hg exposure”

Hg Life cycle Management

- DB for Hg commodity
 - Reduce Hg containing products & waste
- ⇒ DB system & Guidelines

Management of Hg Emission

- Strengthen the Emission standard & Recharge criteria
- Develop the guidelines for waste contained Hg

Environmental Monitoring

- Enhance National Hg monitoring
- Long-range transport of Hg monitoring network

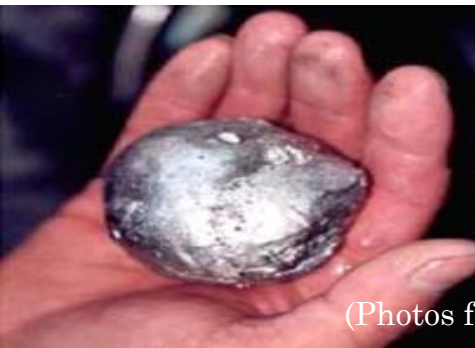
Health effects

- Reduce Hg exposure risk
- Fish consumption advisory
- Hg Risk communication

International activities

- Participation on Hg Partnership projects & Hg convention
- Hg Research & Technology development

Updates on Mercury Emission Inventories in Korea



(Photos from UNEP)

Mercury Emission Limits

- All the Hg emission facilities are controlled according to **Korean Clean Air Conservation Act**.

(Unit : mg/Sm³)

Facilities	Capacity threshold	Current	New (from '15.1.1)
1) Coal-fired power plants	All facilities	<u>0.1(6)</u>	<u>0.05(6)</u>
2) Coal-fired industrial boilers	0.5t/hr (or 309.5 Mcal/hr)	<u>5</u>	<u>1</u>
3) Primary metal production	300kw/hr (Electric arc furnace) & others	<u>0.1(15)</u>	<u>0.05(15)</u>
4) Cement clinker	0.72t of fuel usage/day	<u>0.1(13)</u>	<u>0.05(13)</u>
5) Waste incineration	600kg waste/day	<u>0.1(12)</u>	<u>0.05(12)</u>
6) Others	-	<u>5</u>	<u>1</u>

*() in emission limit : Standard oxygen concentration (O₂ %)

- All facilities should submit Hg emission data annually through SEMS (Stack Emission Monitoring System).

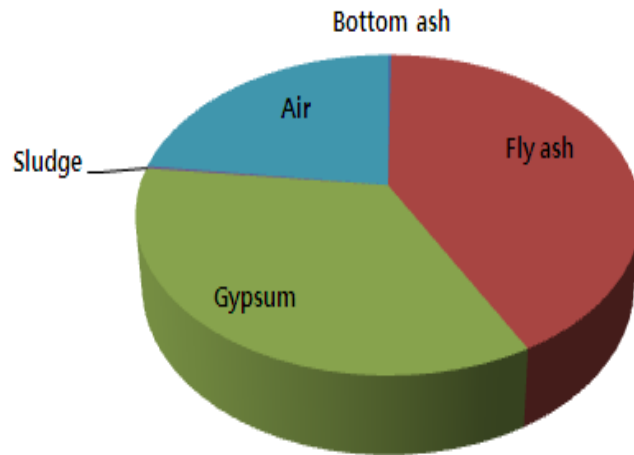
Mercury Emission Inventories

Facilities	Activities (ton/yr)		APCDs	Emission Factors (mg/ton)	Hg emission (ton/yr)
Coal-fired power plant	bituminous	76,402,994	SCR-ESP-FGD	17.66	1.35
	anthracite	2,404,050	ESP	25.81	0.06
Non-ferrous metal smelters	Zinc	830,000	ESP-VS-Dry tower-GS	9.15	0.0076
	Copper	526,000	WS-ESP-Dry tower-FGD	4.18	0.0022
	Lead	416,000	ESP-VS-Dry tower-GS	12.60	0.0052
Waste incineration	Municipal	8,125,128	SDR-BF-SCR-PF	47.20	0.38
	Specific waste	1,102,528	ESP-VS-WS-SCR	296.73	0.33
	Medical waste	1,460,950	CC-SDR-BF-WS	773.24	1.13
Cement clinker	45,280,000		BF	62.22	2.82

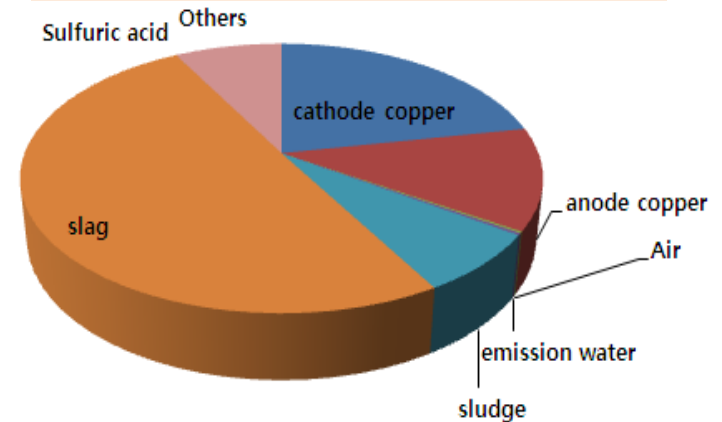
* note : SCR : Selected Catalytic Reduction, ESP : Electrostatic Precipitator, FGD : Flue Gas Desulfurization, BF: Bag Filter, VS : Venturi Scrubber, WS : Wet Scrubber, GS : Gas Scrubber, SDR: Semi Dry Reactor, CC: Cooling Chamber

Output Distribution of Mercury in Sources

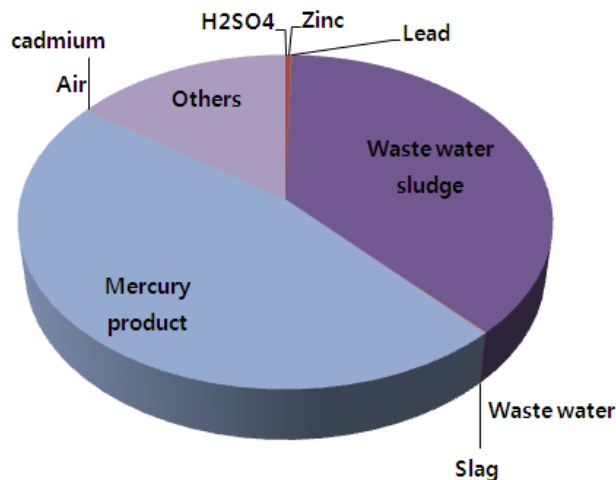
Coal-fired power plant (106.8%)



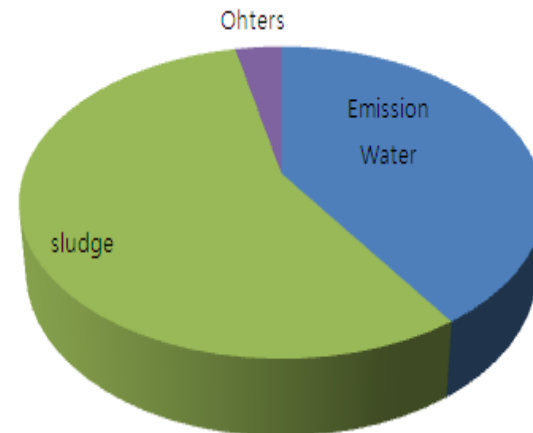
Cu refining facility (92.1%)



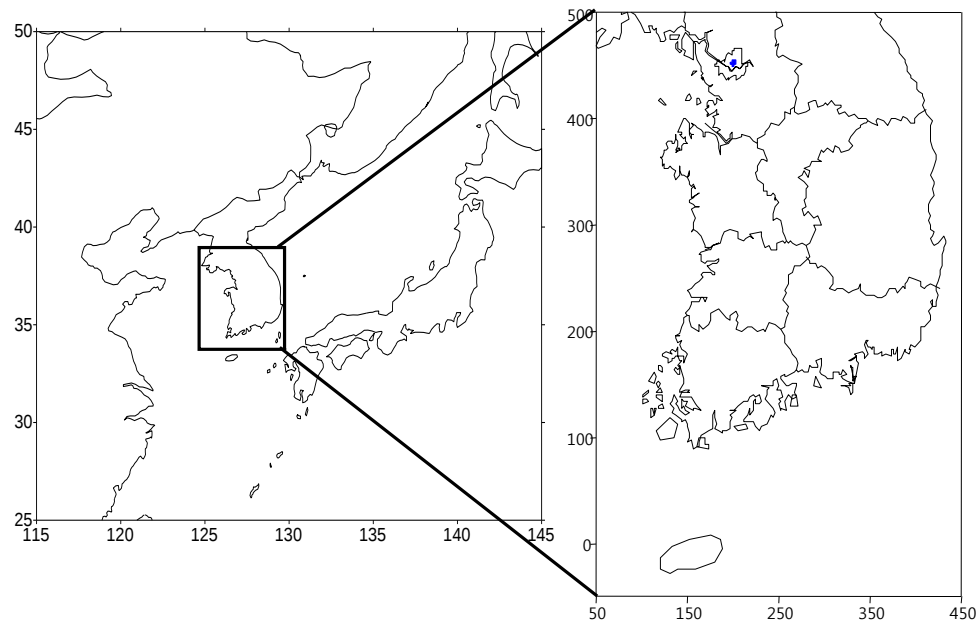
Zn & Pb refining facility (85.1%)



Wastewater-treatment plant (96.5%)



Introduction of Atmospheric Mercury Monitoring Network in Korea



Atmospheric Mercury Monitoring Network of Korea

● Objective

- To monitor the atmospheric mercury concentration levels in Korea
- To evaluate the long-range transports of mercury between nations

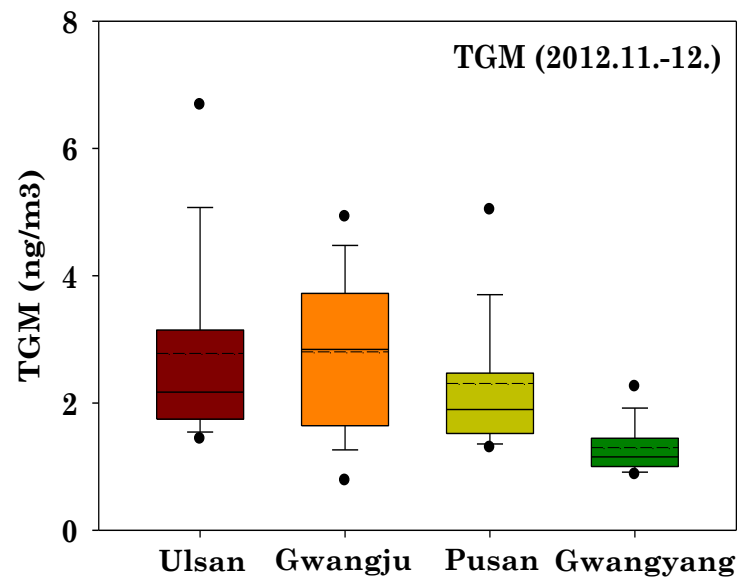
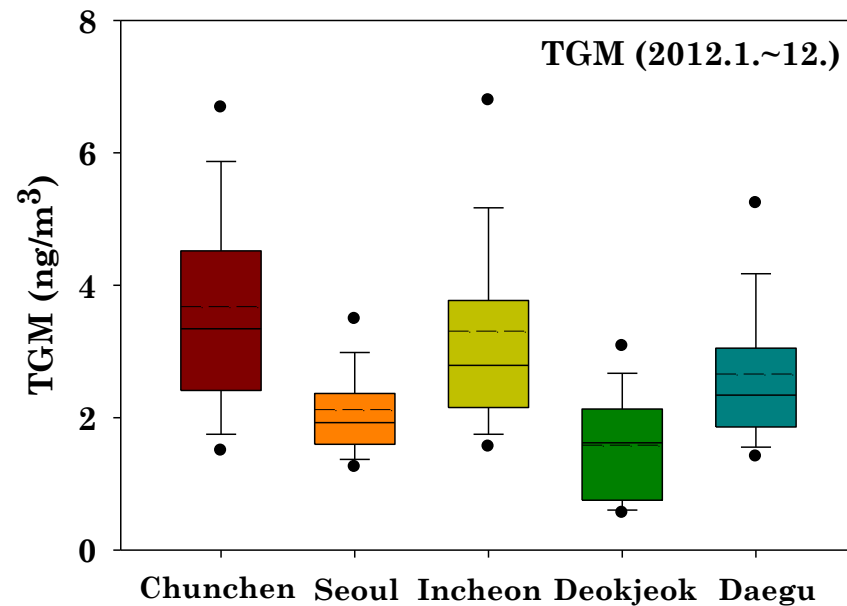
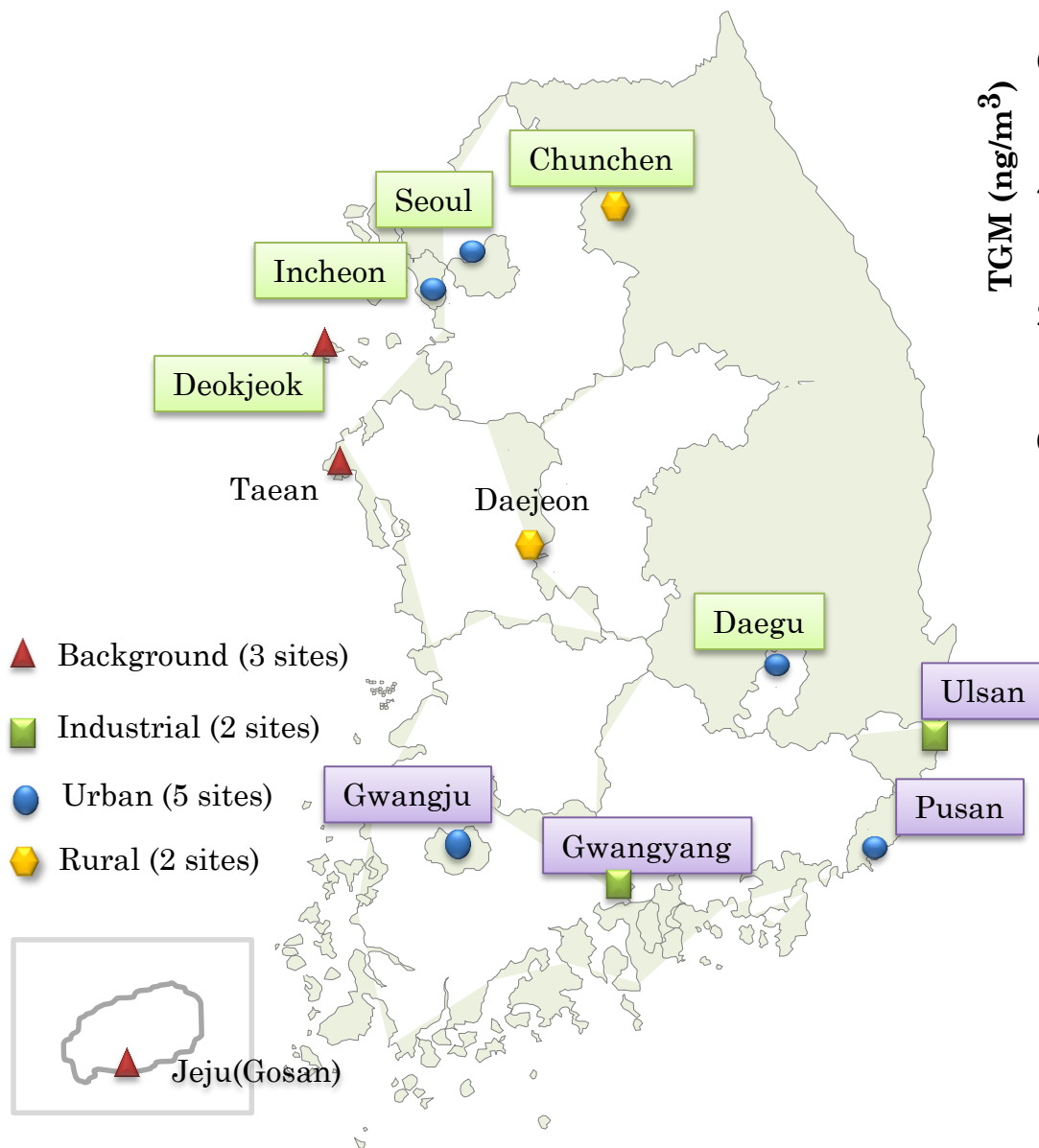
● Status

- Started from 2009 and currently operated at 12 sites to monitor TGM.
- Operated by KECO (Korean Environmental Cooperation) and data are reported to NIER
- Extended to the monitoring of wet mercury deposition at all sites and the monitoring of speciated mercury at 4 sites until 2015.

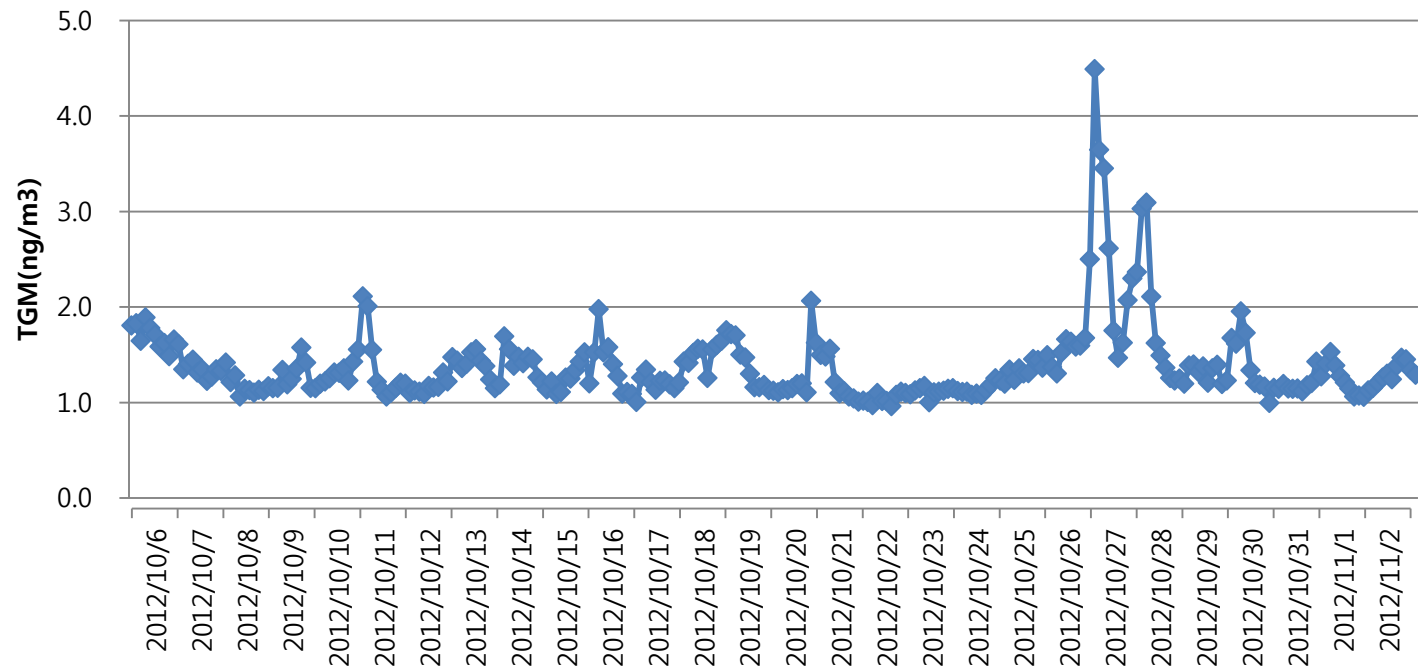
● TGM monitoring methods

- Instrument : Teckran 2537
- Sampling frequency : Every 5 mins.
- Frequency of data report : Every 2 hours

< Sites of Hg monitoring network >



Jeju Gosan : TGM $1.38 \pm 0.40 \text{ ng/m}^3$ (‘12.10.6~11.2)





Designing Korean Mercury Monitoring Program (KMMP)



Project Design of KMMP

● Objectives

- To build up integrated Hg monitoring network in Korea
- To evaluate the ecological responses to changes in atmospheric Hg deposition
- To monitor current national status and trends

● Yearly Plans

(STAGE 1 : '13 ~ '15) Program design. Site selection, Methods, QA/QC programs.

(STAGE 2 : '16 ~ '20) 1st Environmental Hg monitoring Campaign

(STAGE 3 : '21 ~ '25) 2nd Environmental Hg monitoring Campaign

● Monitoring matrices

- Atmospheric deposition
- Sediment (Core profile, surface)
- Fish & Plankton (including food web survey & isotopes analysis)
- Water

Monitoring framework of KMMP

Monitoring sites	Objective	Site	Ecological component (Frequency)
Intensive monitoring sites	Long-term variation of Hg input	Mountain-top	- Ambient Hg (Continuously)/ Wet (weekly) - Sediment core Hg profile: 5-10 years - Biota (annually)
	Influence by LTPs	Remote Islands	
	The mechanisms contributing to the biological Hg hotspot	Lakes listed as biological Hg hotspot sites from previous study	- Ambient Hg (Continuously)/ Wet (weekly) - Sediment & soil, water chemistry (Quarterly, semi-annually(soil)) - Hg & isotope in benthic & pelagic food chain (semi-annually to quarterly)
National status & trends monitoring sites	Local point source Identify Hg point source	Coal-fire power station & Industrial complex	- Sediment chemistry (annually) - Fish (annually)
	Geographical coverage : National distribution	Major watersheds	

DB of Hg levels in freshwater fish

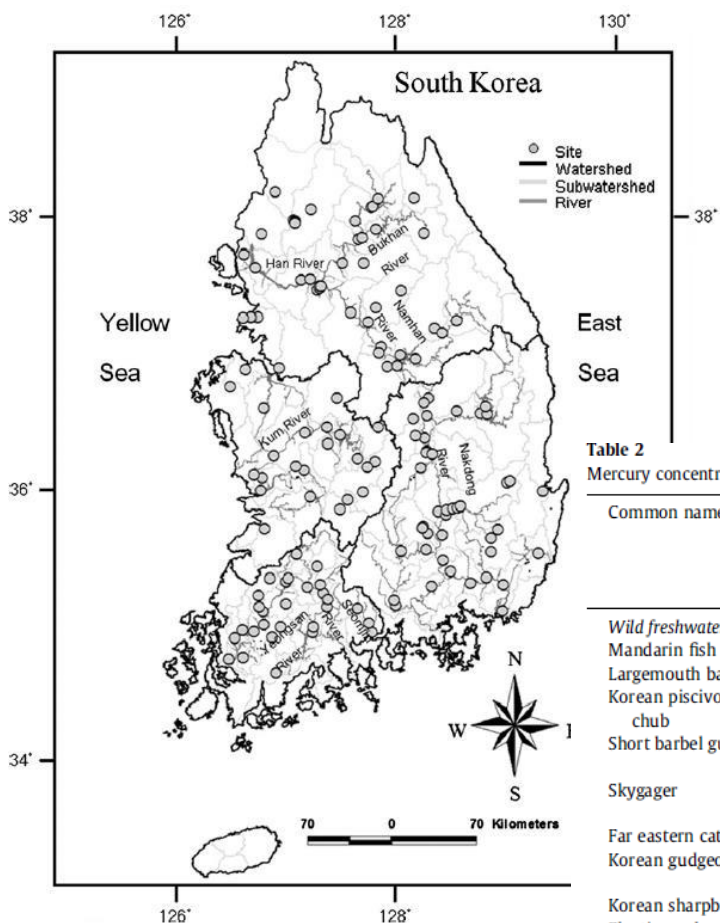


Fig. 1. Mercury measurement sampling sites in fresh and coastal

Table 1

Fish samples collected from freshwater and coastal waters throughout the southern Korean Peninsula.

Sample		Number of			Year sampled
		Species	Sample	Site	
Freshwater fish	Wild	55	3626	92	2006–2008
	Farm	9	502	23	2006–2007
Marine fish	Wild	18	686	13	2007
	Farm	7	229	5	2007
Total		78	5043	133	2006–2008

Table 2

Mercury concentrations, weight, and length for wild and farmed fish from fresh and coastal waters in Korea.

Common name	Scientific name	Number of		Mercury concentration (μg kg ⁻¹ wet weight) ^a					Weight (g)		Standard length (cm) ^b		
		Sample (n = 5043)	Site (n = 133)	Mean	SD	Min.	Median	Max	Mean (Range)	Mean (Range)			
Wild freshwater fish													
Mandarin fish	<i>Siniperca scherzeri</i>	92	21	200	117	26.8	211	554	145	(8–594)	19	(8–29)	
Largemouth bass	<i>Micropterus salmoides</i>	196	32	195	264	6.91	95.7	1230	286	(6–1501)	18	(7–42)	
Korean piscivorous chub	<i>Opsarichthys uncirostris amurensis</i>	112	13	167	138	12.5	128	532	110	(5–481)	17	(8–30)	
Short barbel gudgeon	<i>Squalidus japonicus coreanus</i>	4	1	158	46.2	104	155	217	4	(4–4)	7	(6–7)	
Skygager	<i>Erythrocultus erythropterus</i>	125	18	151	115	10.0	106	588	186	(18–1640)	24	(11–51)	
Far eastern catfish	<i>Silurus asotus</i>	204	39	144	168	8.93	101	1720	211	(9–1787)	28	(10–57)	
Korean gudgeon	<i>Squalidus chankaensis tsuchigae</i>	10	4	142	63.8	38.7	168	213	11	(4–17)	9	(7–11)	
Korean sharpbelly	<i>Hemicultus eigenmanni</i>	39	3	140	74.3	16.8	129	321	41	(4–202)	13	(8–23)	
Floating goby	<i>Chaenogobius urotaenia</i>	1	1	134	–	134	134	134	8	–	9	–	
Eel	<i>Anguilla japonica</i>	13	6	121	104	23.1	95.6	423	141	(13–548)	44	(27–65)	
Japanese aucha perch	<i>Coreoperca kawamebari</i>	5	3	119	50.8	70.1	102	175	45	(17–114)	12	(9–16)	
Snakehead	<i>Channa argus</i>	30	14	113	90.2	28.2	77.1	415	842	(112–3583)	37	(21–60)	
Manchurian trout	<i>Brachymystax lenok tsinlingensis</i>	10	2	107	47.2	49.4	95.6	188	4	(2–8)	7.5	(6–10)	
Sea rundace													
Steed barbel	<i>Hemibarbus labeo</i>	370	37	101	83.5	3.63	77.1	518	136	(3–1040)	19	(6–43)	
Trout	<i>Oncorhynchus masou</i>	2	1	99.1	25.0	81.4	99.1	117	881	–	38	–	
Korean dark sleeper	<i>Odontobutis platycephala</i>	58	18	97.4	96.6	14.5	61.3	503	35	(6–93)	12	(7–17)	

Study Sites of 2013 Campaign for Mercury Monitoring

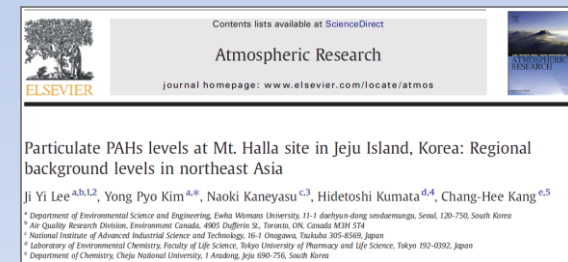
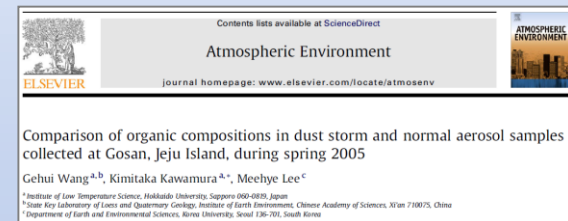
< Panorama of BaekrokDam in Jeju >



National Background Site in Je-ju

Best place for Long-range transport study!

- Je-ju Island, located on the southern end of the Korean Peninsula, is remote from direct mercury sources but can be impacted by long-range transport of mercury.
- Considering Je-ju Island is **located in the middle of a triangle comprising China, Korea, and Japan**, its geographical location is desirable for studying **long-range transport processes** influenced by strong seasonal wind patterns and other environmental conditions.
- A monitoring site at Gosan in Je-ju has been running for 'Environmental monitoring of POPs in East Asia Countries' and other pollutants.
- This site has the potential for international collaboration in order to have better understanding of atmospheric mercury behavior.



Gosan site in Je-ju



Thank You!





*See you all in Je-ju
In 2015 !*

Korea

The Hidden Beauty of Korea

Korean traditional wedding ceremony

In the olden days, the marriage of a young couple was arranged by a matchmaker. Without even seeing each other, the prospective couple's likely congeniality and their most auspicious wedding ceremony, the bride is adorned of birth.

In the wedding ceremony, the bride is adorned with a fairo, a splendid wedding robe, and scarlet spots on her cheeks and forehead.

The groom, in a blue wedding robe and black headgear, rides on horseback to the weddings, which is held in the bride's house.

