

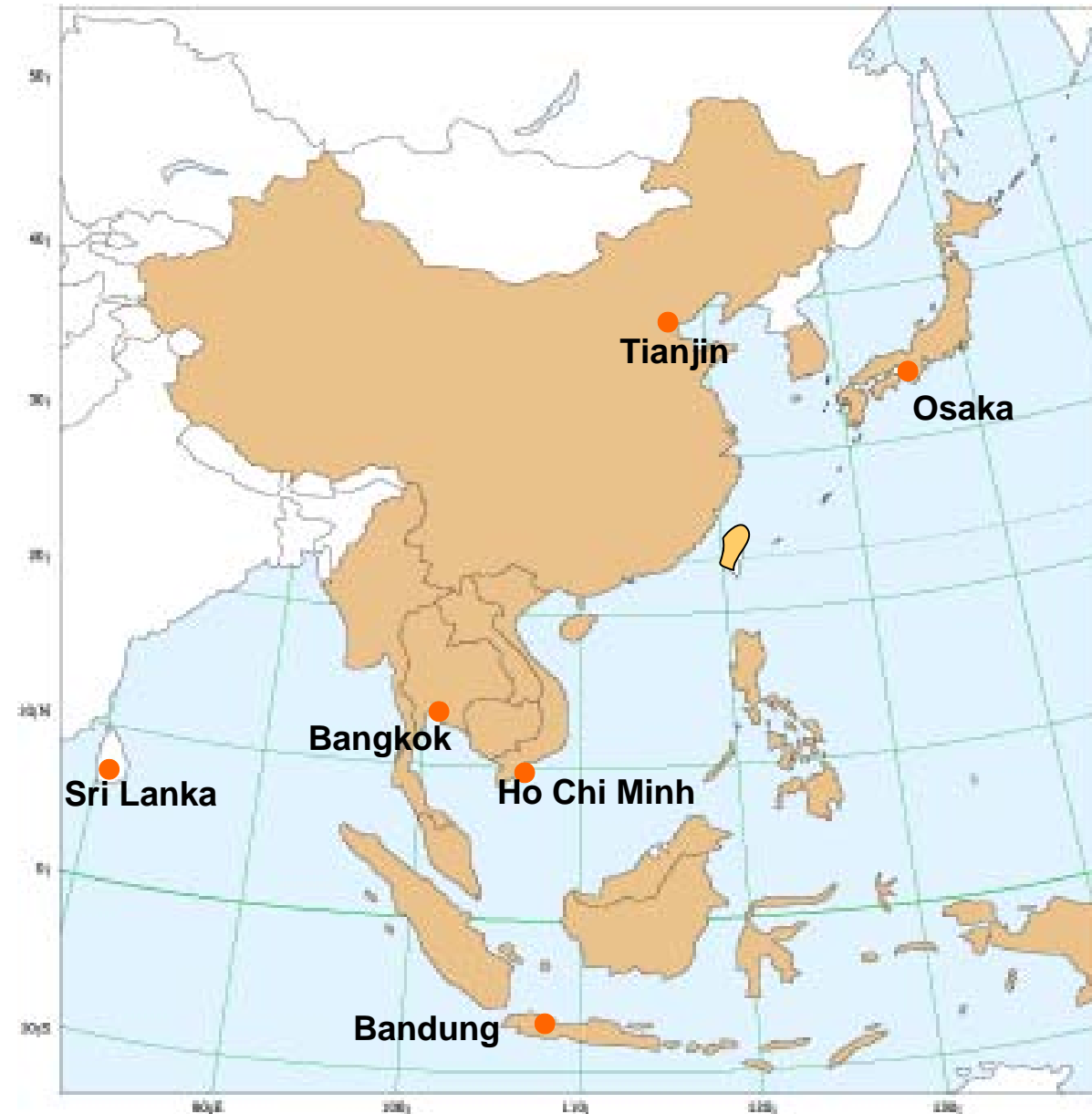
Status and Management Policy of Groundwater Quality in Asia

Tetsuo Kuyama

Institute for Global Environmental Strategies



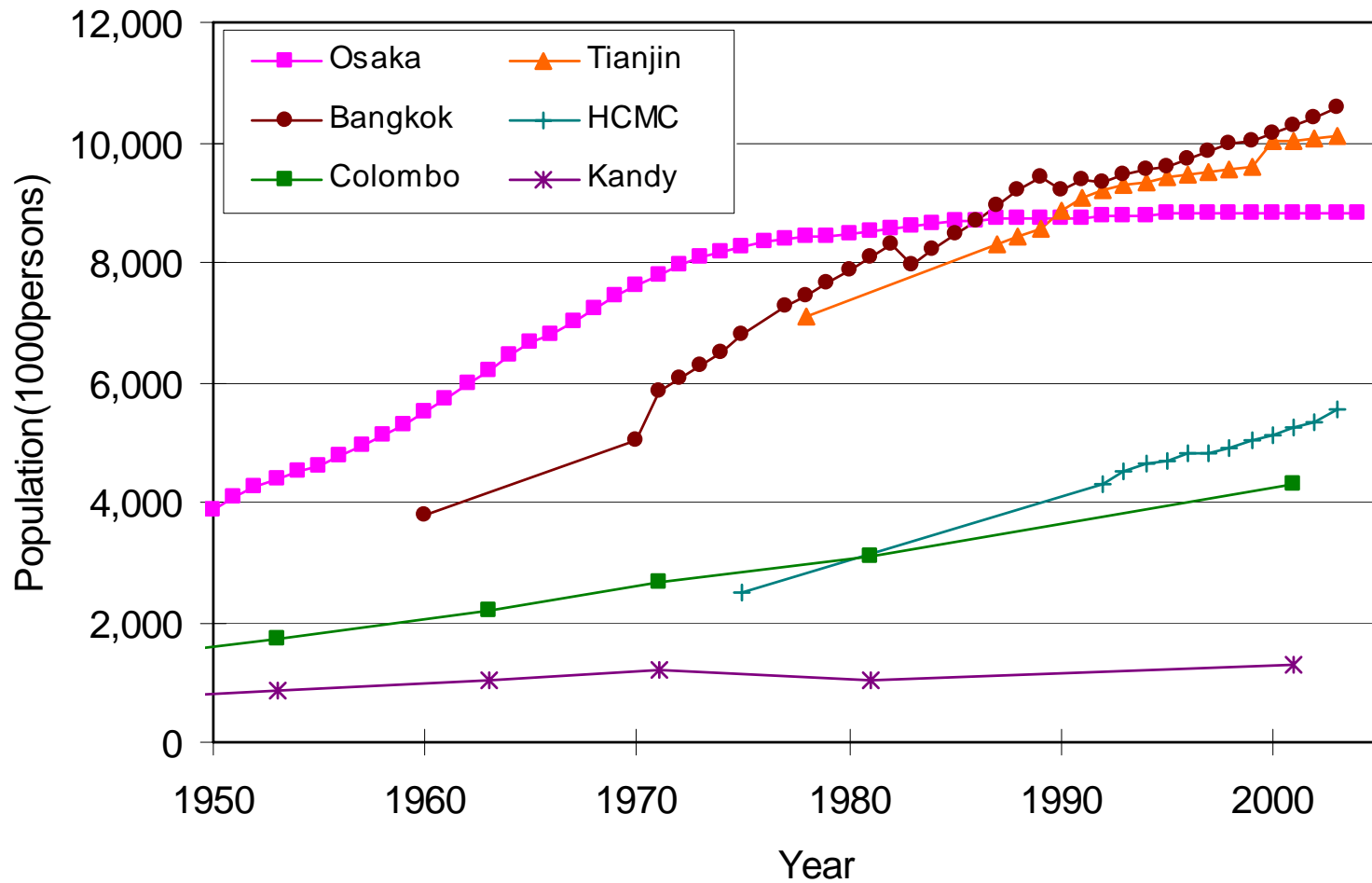
Background: Study area



● case study cities

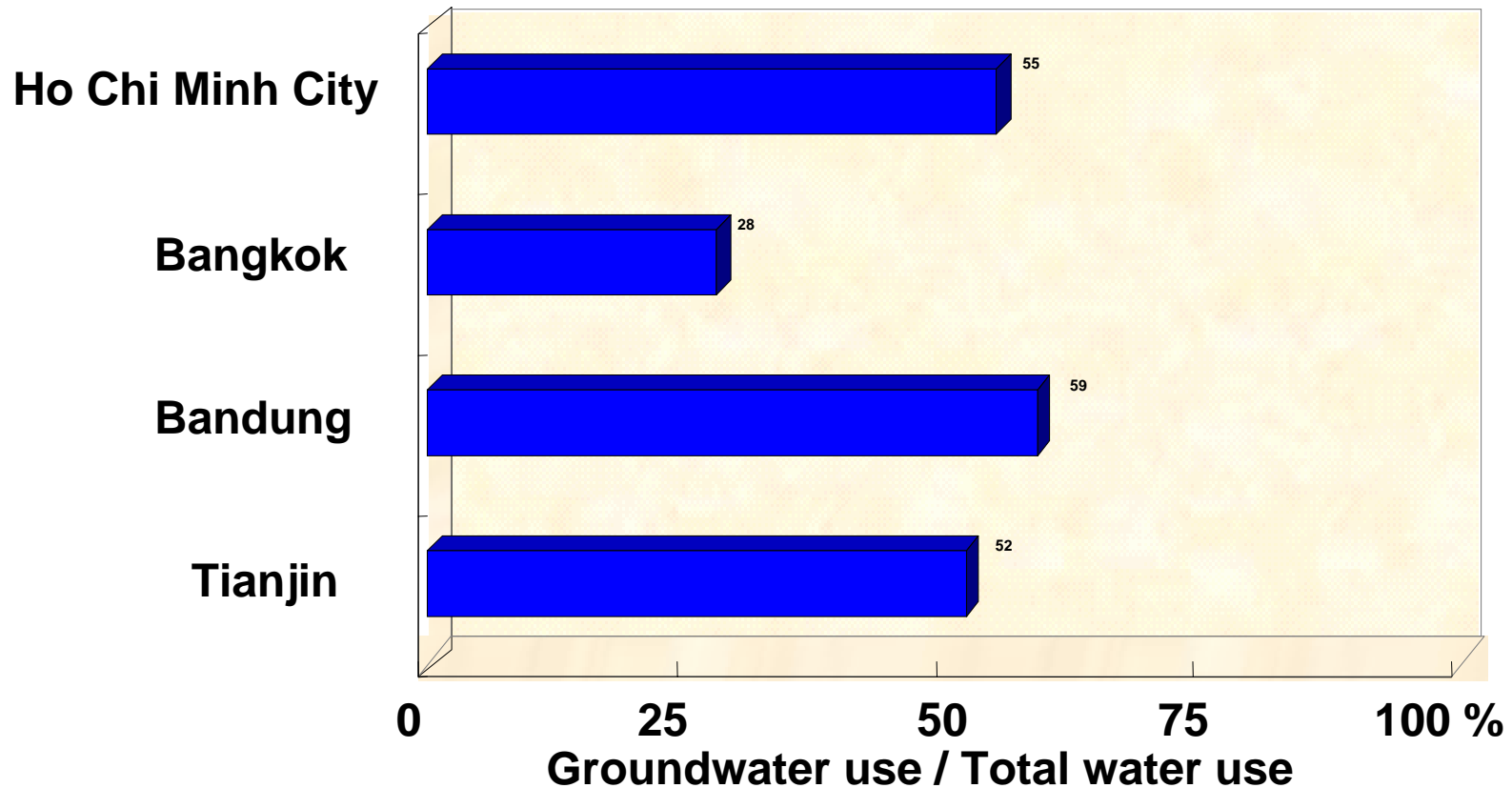
by
Freshwater Resources
Management Project,
Institute for Global Environment
Sustainability, Japan

Background: Increase of urban population



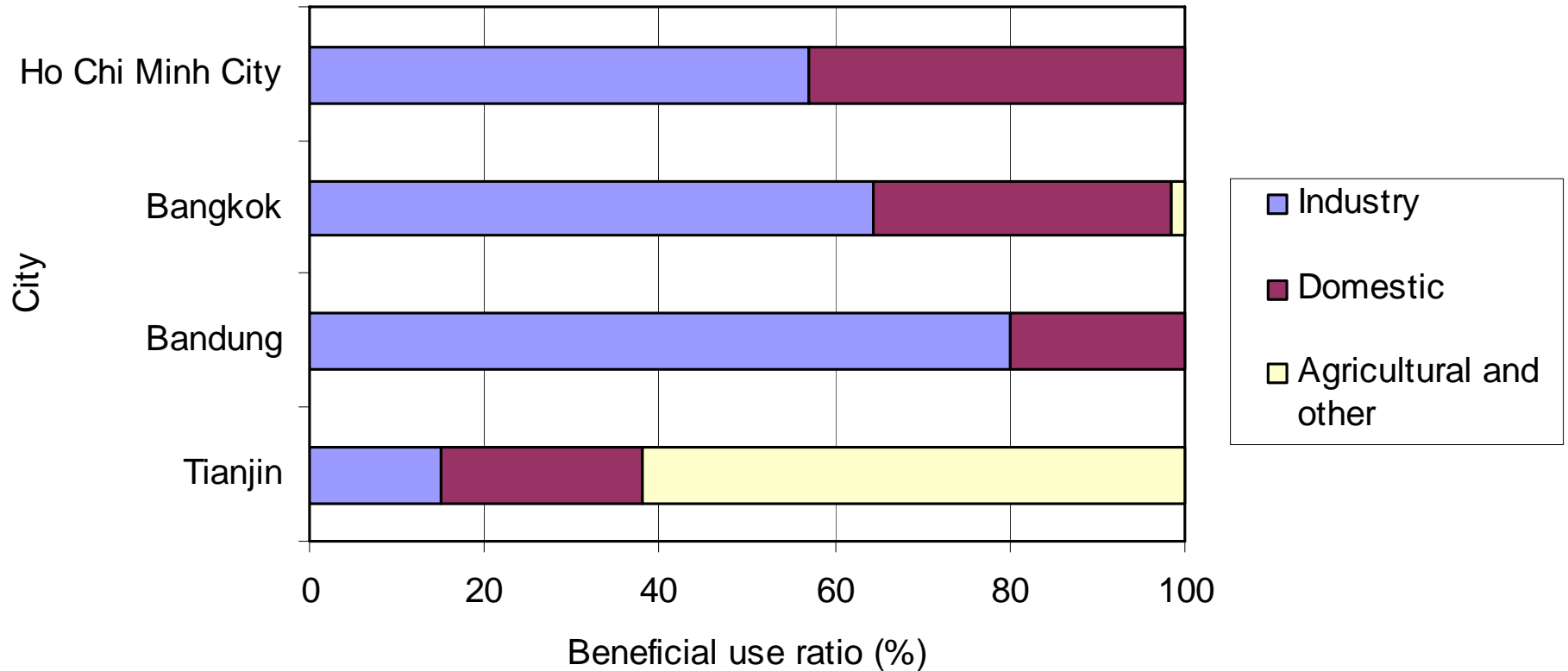
Population of case study cities has increased for decades

Background: Recent dependency on groundwater in 4 case study cities



Groundwater has played an important role in development of cities.

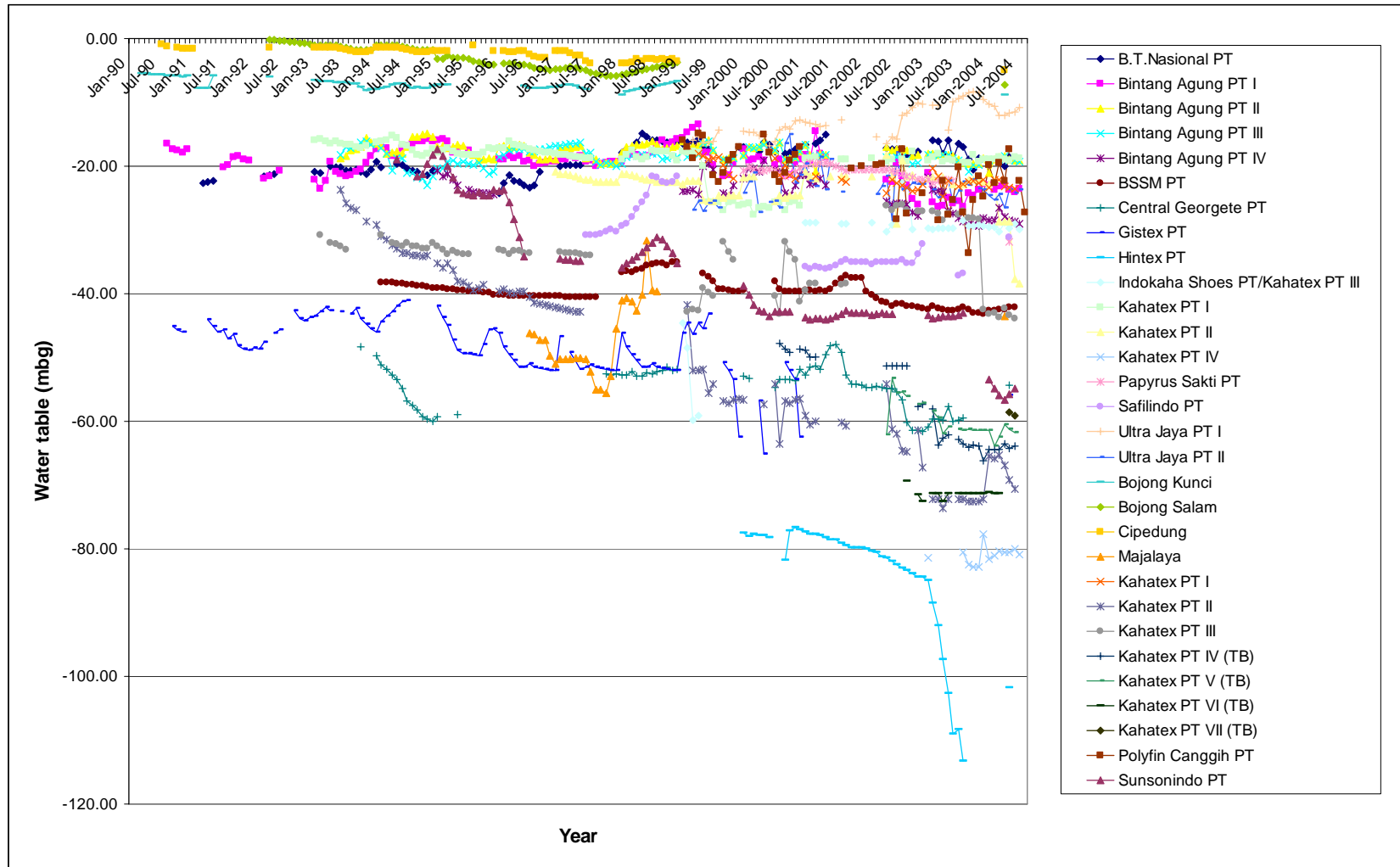
Background: Groundwater use in case study cities



Except Tianjin, Groundwater is used for Industrial and domestic purpose.

Background: Groundwater level depletion

Bandung

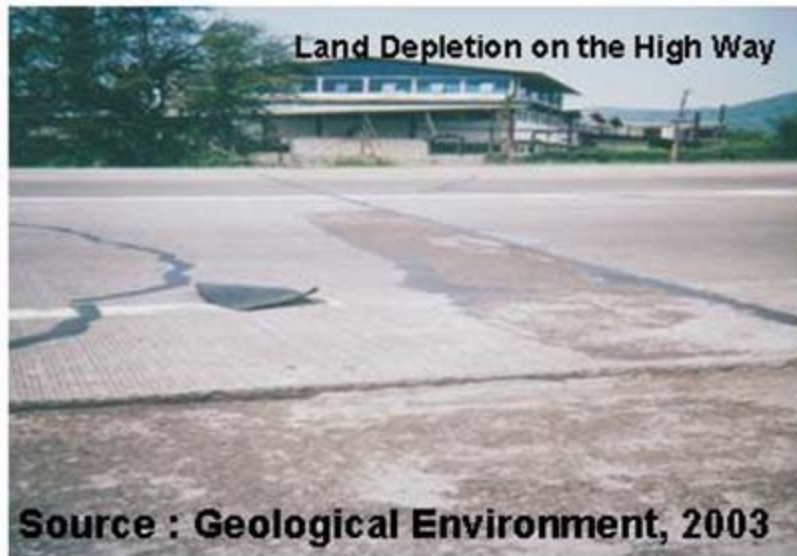


Water Table Depletion in Several Monitoring Well in Bandung

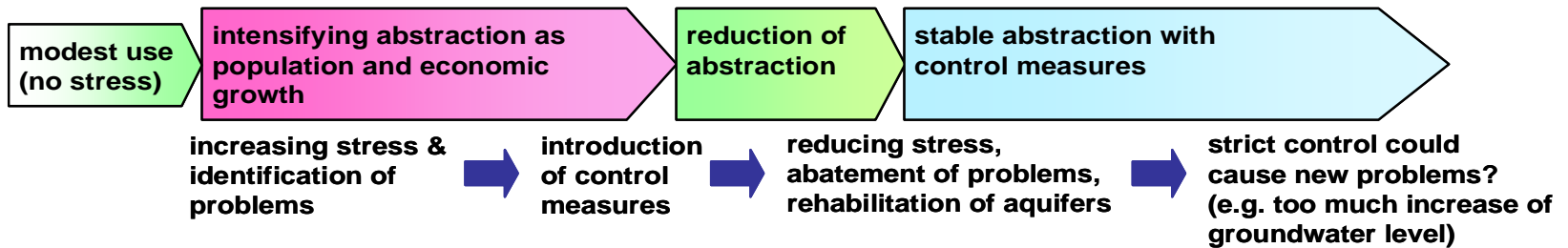
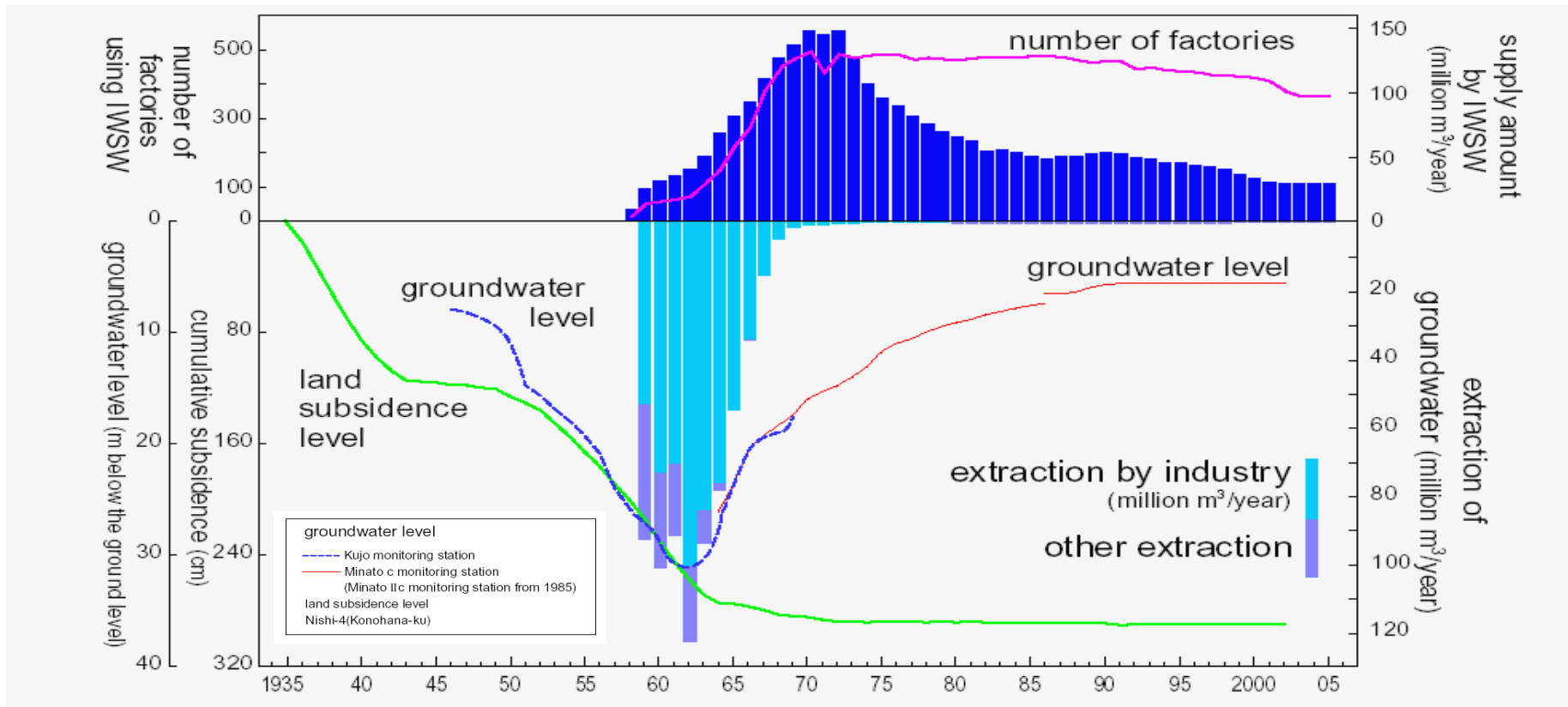
Background: Land subsidence due to groundwater overuse



SEVERAL EVIDENCE FOR LAND SUBSIDENCE AT BANDUNG BASIN



Background: Impact of groundwater level recovery



For assessment of availability of groundwater as safe drinking water

Review of

- current groundwater quality in Asian urban cities**
- quality management policy**

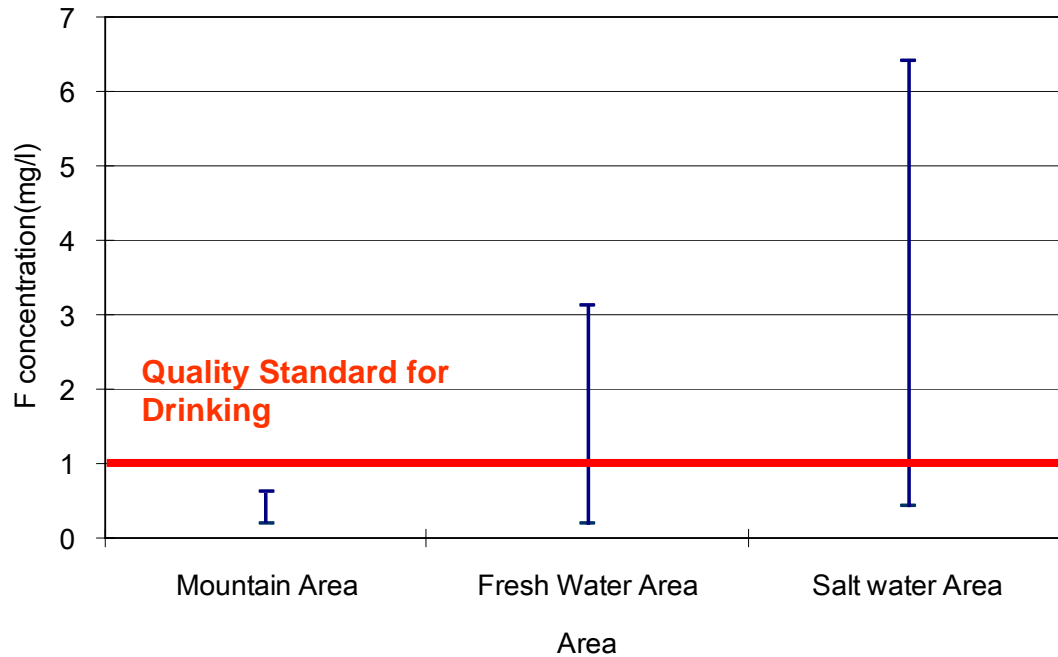
Status: Summary of the groundwater quality in case study cities

Items	Tianjin	Bandung	Colombo	Kandy	Bangkok	HCMC	Osaka
Fluorine	●	-	-	○	-	-	◎
Arsenic	◎	-	-	-	-	◎	◎
Hardness	◎	-	-	-	●	-	-
Salinity	●	-	○	-	●	●	-
Coliforms	-	●	-	○	-	●	-
Nitrate	○	◎	-	◎	◎	○	◎
Metals	○	◎	-	○	●	○	-
Heavy Metals	◎	-	-	-	-	◎	◎
VOCs	- (future risk)						●
Pesticide	- (future risk)						◎

● : Seriously polluted, ○ relatively polluted, ◎ not polluted, - no data

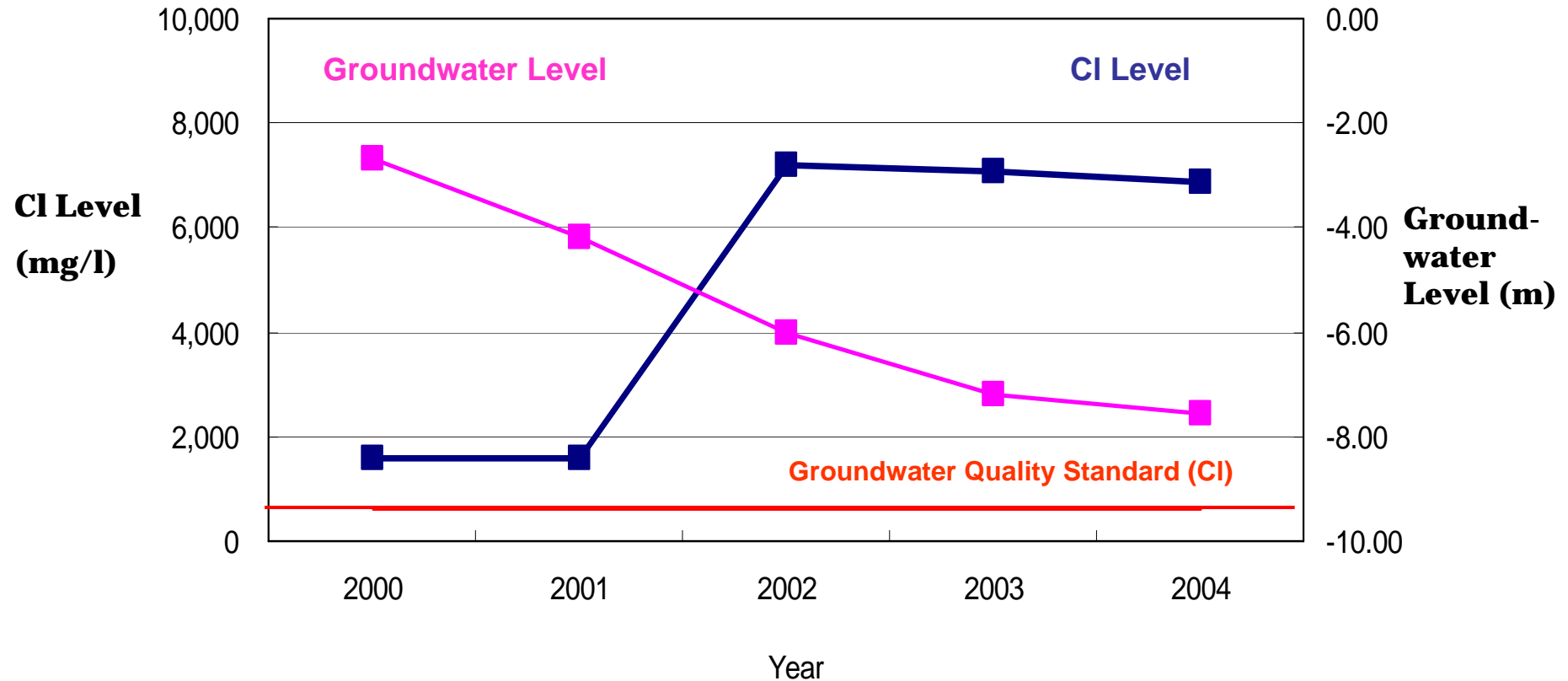
Status: Fluorine Pollution

Tianjin



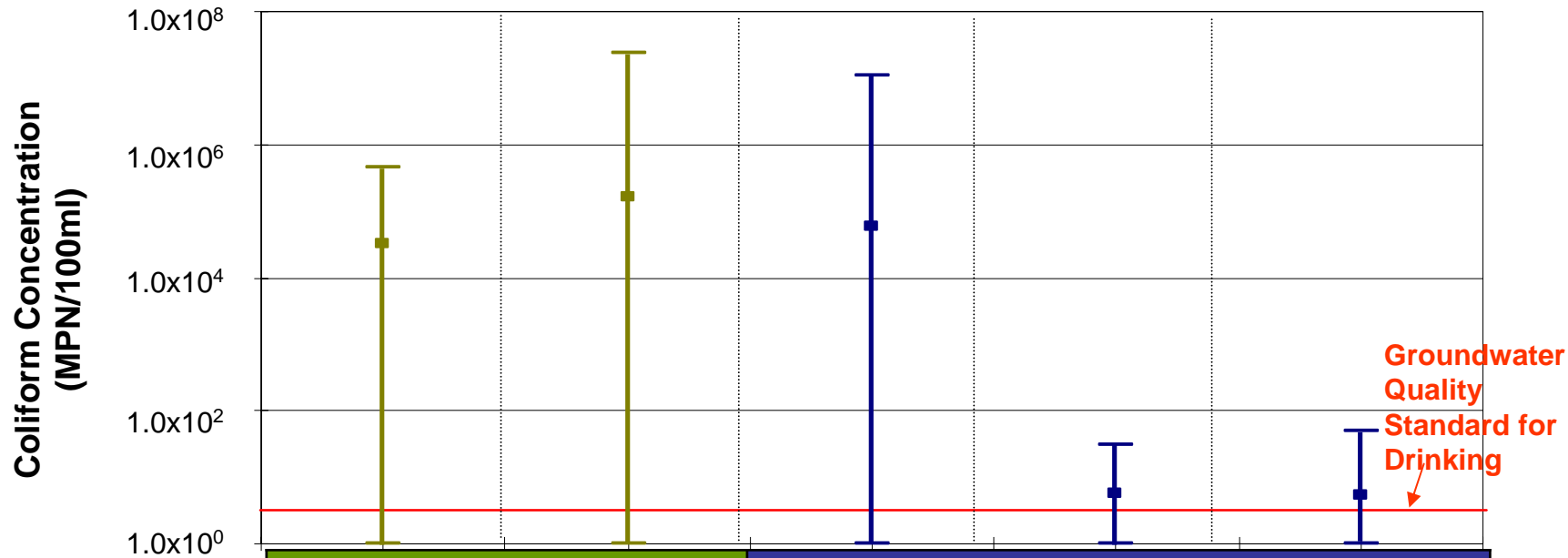
High concentration of Fluorine Level in Tianjin

Status: Salinization of groundwater



Overexploitation of groundwater is one factor of seawater intrusion

Status: Coliform Contamination



	Surface Water		Groundwater		
	Dong Nai River	Saigon River	Pleistocen Aquifer (20-50m)	Upper Pliocen Aquifer (50-100m)	Lower Pliocen Aquifer (100-140m)
Potential Capacity (m ³ /day)	6,000,000	940,000	796,000	952,000	753,000
Current Water Use (m ³ /day)	847,000	303,000	284,700	323,300	2,960

Shallow aquifer of groundwater is contaminated in HCMC

Status: Availability of groundwater for Drinking

City	Year	Number of Sample	Compliance Ratio with Water Quality Standard for Drinking (%)										
			pH	F	As	Hardness	Cl	Coliforms	NO3	Mn	Fe	Hg	Cr
Tianjin (Mountain Area)	2002	unknown	100	100	100	100	40.9**	-	100	100	100	100**	-
Tianjin (Freshwater Area)	2002	unknown	96	54	100	96	40.9**	-	100	75	93	100**	-
Tianjin (Saltwater Area)	2002	unknown	56	24	99	99	40.9**	-	74	95	92	100**	-
Bangkok (Nonthaburi Aquifer)	2000	37	58	86	-	67	67	-	100	78	41	-	-
Bangkok (Nakhon Luang Aquifer)	2000	31	48	94	-	64	68	-	100	68	35	-	-
Bangkok (Phra Pradaeng Aquifer/Bangkok Aquifer)	2000	24	79	100	-	29	17	-	100	33	17	-	-
HCMC (Holocen Aquifer)	2004	14	75	-	-	-	38	67	100	-	88	-	-
HCMC (Pleistocen Aquifer)	2004	103	38	-	100	-	89	75	72	75	77	88	-
HCMC (Upper pliocen Aquifer)	2004	64	46	-	100	-	78	-	96	61	57	89	-
HCMC (Lower pliocen Aquifer)	2004	30	53	-	-	-	63	-	93	-	60	-	-
Bandung (Shallow Aquifer)	2000*	35	100	-	-	-	-	0	100	100	97	-	-
Kandy	2004	14	0	-	-	-	-	-	100	-	71	-	-

Compliance ratio

■ 75-100%
 ■ 50-75%
 ■ 50-75%
 — No data

Groundwater can not be used for drinking purpose without treatment

Future risk: VOCs

Type of Industry	Tianjin	Bangkok*	Bandung**	Sri Lanka*
	(2004)	(1998)	(2003)	(2000)
Percentage (%)				
Food, beverages and tobacco	3.7	15.5	11.3	36.7
Textile, wearing apparel and leather	13.1	19.7	56.3	23.1
Wood, wood products and furniture	4.1	3.8	1.2	8.0
Paper products, printing and publishing	6.3	5.9	5.0	2.7
Chemicals, petroleum, rubber, plastic products	19.1	12.1	9.4	7.9
Non - metallic mineral products	4.6	10.5	0.9	14.2
Basic metal industries	5.7	2.0	0.0	0.1
Fabricated metal products, machinery and equipment	21.2	14.0	6.2	5.0
Manufacture of office, accounting and computing machinery	2.2	0.1	0.2	0.0
Manufacture of electrical machinery and apparatus n.e.c.	5.7	1.7	0.7	0.0
Manufacture of radio, television and communication equipment and apparatus	5.4	0.9	1.4	0.0
Manufacture of medical, precision and optical instruments, watches and clocks	0.0	0.4	0.3	0.0
Manufacture of motor vehicles, and trailers and semitrailers	7.4	4.2	0.7	0.0
Manufacture of other transport equipment	0.0	0.7	1.0	0.0
Manufacture of furniture, manufacturing n.e.c.	1.6	8.2	5.4	0.0
Recycling	0.1	0.1	0.0	0.0
Others	0	0	0	2.2
Number of Industry	5,093	20,807	577	12,163

* Data for Whole country

** Data only for Bandung city

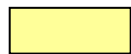
*** Number of Factory in Bangkok is 397 in 2003

***Number of Factory in Bandung Case Study Area is 1442 in 2003

***Number of Factory in Kandy is 1700, and one in Colombo and Gampaha is 3,418 in 2004



Industry which causes Heavy metal pollution in Japan

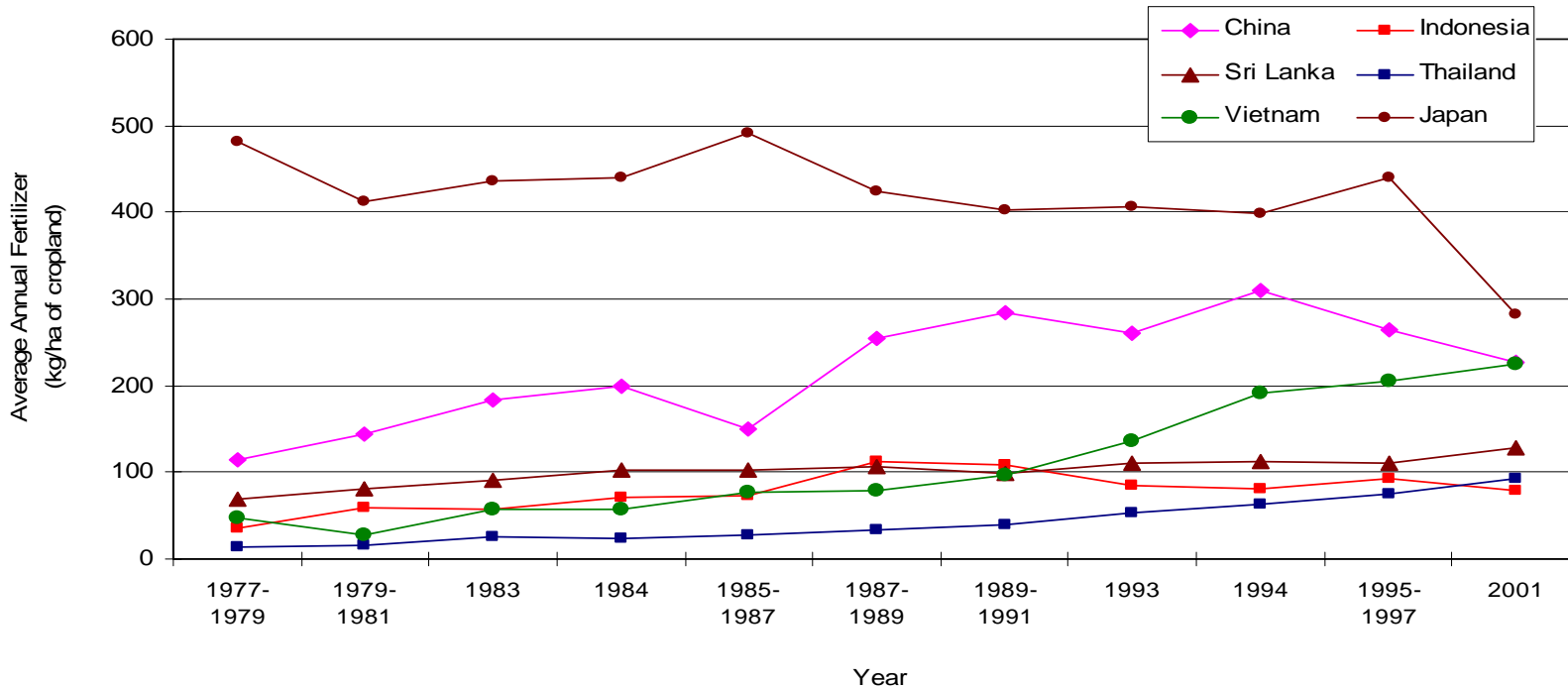


Industry which causes VOCs pollution in Japan

Tianjin and Bangkok have a risk of VOCs contamination

Future Risks: Fertilizer and pesticide

Fertilizer Consumption



Pesticide Consumption (1996)

Indonesia: 88(kg/ha), Sri Lanka: 6,261 (kg/ha), Thailand: 1,116 (kg/ha)

Source: Water Resource

There is a risk of contamination by agricultural activity

Management: National water quality standard

Type of Standard		Tianjin (China)	Bangkok (Thailand)	Bandung (Indonesia)	HCMC (Vietnam)	Kandy/Colombo (Sri Lanka)	Osaka (Japan)
Environmental Standard	Groundwater	Groundwater Quality Standard (GB/T14848-93)	General Groundwater Quality Standard	Water Quality Standard	Groundwater Quality Standard (TCVN5944-1995)		Groundwater Quality Standard
	Surfacewater	Surface water Quality Standard (GB3838-2002)	Surfacewater Quality Standard		Surfacewater Quality Standard (TCVN5942-1995)	Surfacewater quality standard for drinking purpose	Surfacewater Quality Standard
Effluent Standard	Domestic wastewater	Domestic Effluent Standard (GB18918-2002)	Building Effluents Standards Housing Estate Standards		Domestic Effluent Standard (TCVN6772-2000)		Technical standard on effluent quality
	Industrial wastewater	Industrial Effluent Standards	Industrial Effluent Standards	Quality Standards of Liquid Waste for Industrial Activity	Industrial Effluent Standards (TCVN5945-1995)	Industrial Effluent Standards (SLS652,SL S721)	Industrial Effluent Standard
	Agricultural wastewater	Effluent Standard of phosphate fertilizer (GB15580-1995)					
Water Quality Standard for Water Use	Drinking	Water Quality Standard for Drinking (GB5749-85)	a. Drinking Water Quality Standards b. Bottled Drinking Water Quality Standard c. Groundwater Quality Standard for Drinking Purpose	Requirement list for Clean Water	Domestic Supply Water-Quality Requirements(TCVN5502-2003)	Sri Lanka Specification for Potable Water(SLS614)	Water Quality for Drinking
	Fishery	Water Quality Standard for Fishery (GB11607-89)		Water Quality Standard			
	Industry						
	Irrigation	Water Quality Standard for Irrigation (GB5084-92)		Water Quality Standard	Water Quality Standard for Irrigation (TCVN6773-2000)		
	Amenity	Water Quality Standard for Amenity (GB12941-91)		Water Quality Standard			Water Quality for Swimming

There are water quality standards in every countries

Management : Implementation of monitoring

City Number of monitoring station	Tianjin		Bandung		Colombo /Kandy		Bangkok		HCMC		Osaka	
	unknown		35-100		—		117		40		83	
Items	Stan	Imple	Stan	Imple	Stan	Imple	Stan	Imple	Stan	Imple	Stan	Imple
Fluorine	○	◎	○	●	○	(◎)	○	◎	○	◎	○	◎
Arsenic	○	◎	○	●	○	●	○	●	○	◎	○	◎
Hardness	○	◎	○	●	○	(◎)	○	●	○	◎	○	●
Salinity	○	◎	○	●	○	(◎)	○	◎	○	◎	○	●
Microbe (Coliform)	○	●	○	(◎)	○	(◎)	○	●	○	◎	○	●
Nutrients (e.g, Nitrate)	○	◎	○	(◎)	○	(◎)	○	◎	○	◎	○	◎
Metals (e.g, Fe, Mn)	○	△	○	(△)	○	(△)	○	◎	○	◎	○	◎
Heavy Metals (e.g, Hg, Cr)	○	△	○	●	○	(△)	○	●	○	△	○	◎
VOCs	○	●	○	●	×	—	○	●	○	●	○	◎
Pesticide	○	●	○	●	○		○	●	×	—	○	◎

Stan (Standard)

○: regulated by standard, ×: not regulated by standard

Imple(Implementation of Monitoring)

◎: all regulated items are monitored, △: some of regulated items are monitored, ●: not monitored, (◎) : temporary monitoring or investigation are implemented

Monitoring is not implemented perfectly, enforcement of law is quite weak

Conclusion

- Case study cities use groundwater mainly for domestic and industry, but are suffering from its specific pollution
- New type of pollutants such as heavy metals, VOC and pesticides might cause future risk of groundwater contamination
- The enforcement of these laws and regulation is quite weak in case study cities.

Recommendation

Innovative and feasible groundwater quality management shall be strengthened for sustainable use of safe groundwater.

Thank you !

