

MISDOM

5th PhD Scientific Seminar

**Some selected organic hazardous substances
in Vietnam: Usage, management,
and pollution in river systems**

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Outline

- **Review the environmental pollution issues of POPs in Vietnam.**
 - ◆ **Distribution & Sources**
 - ◆ **Time trend and magnitude of contamination
(international comparison)**
- **Pharmaceuticals in Vietnam**
- **Regulatory and policy based Activities on environmental management in Vietnam**
- **Conclusions & recommendations**

Vietnam country

Red River Delta & Mekong River Delta:

- One of the world's most densely populated areas (>30 millions people)
 - One of the most productive agricultural regions in Southeast Asia
- Asia

- *Center of Southeast Asia region*
- *3000 km coast line*



Source of literatures

- ❖ Tanabe and co-workers (Ehime University, Japan)
- ❖ Nhan & Carvalho and co-workers (Vietnam Standardization Authority & Marine Environment Laboratory Monaco)
- ❖ Hung & Thiemann (University of Bremen)
- ❖ Viet and co-workers (CETSAD, Hanoi National University)
- ❖ Fabrice and co-workers (UNU-EHS)

Comprehensive monitoring programs on hazardous pollutants in Vietnam during the last 2 decades

Core University Program (CUP): from 1999 - 2007

- *Research on POP pollution and their toxic impacts on environment, wildlife and humans; pesticides, dioxins and heavy metals in open dumping sites in major cities*
- *Arsenic contamination in groundwater in Red River Delta, North Vietnam and possible toxic effects on humans*

Environmental Science and Technology in Northern Vietnam Program (ESTNV program): from 1995 – 2007

Pollution by toxic contaminants (POPs and heavy metals including Arsenic) in Red River Delta

Environmental Monitoring and Governance in the Asian Hydrosphere (UNU program): from 1995 - 2011

Pollution by toxic contaminants (POPs) in Asian countries

Objectives of research programs

1. POPs:

- **classic compounds: organochlorine insecticides, PCBs**
- new & emerging compounds: brominated flame retardants (PBDEs, HBCD)

2. Arsenic contamination and its toxic impacts

3. Pharmaceuticals products

POPs - PCBs

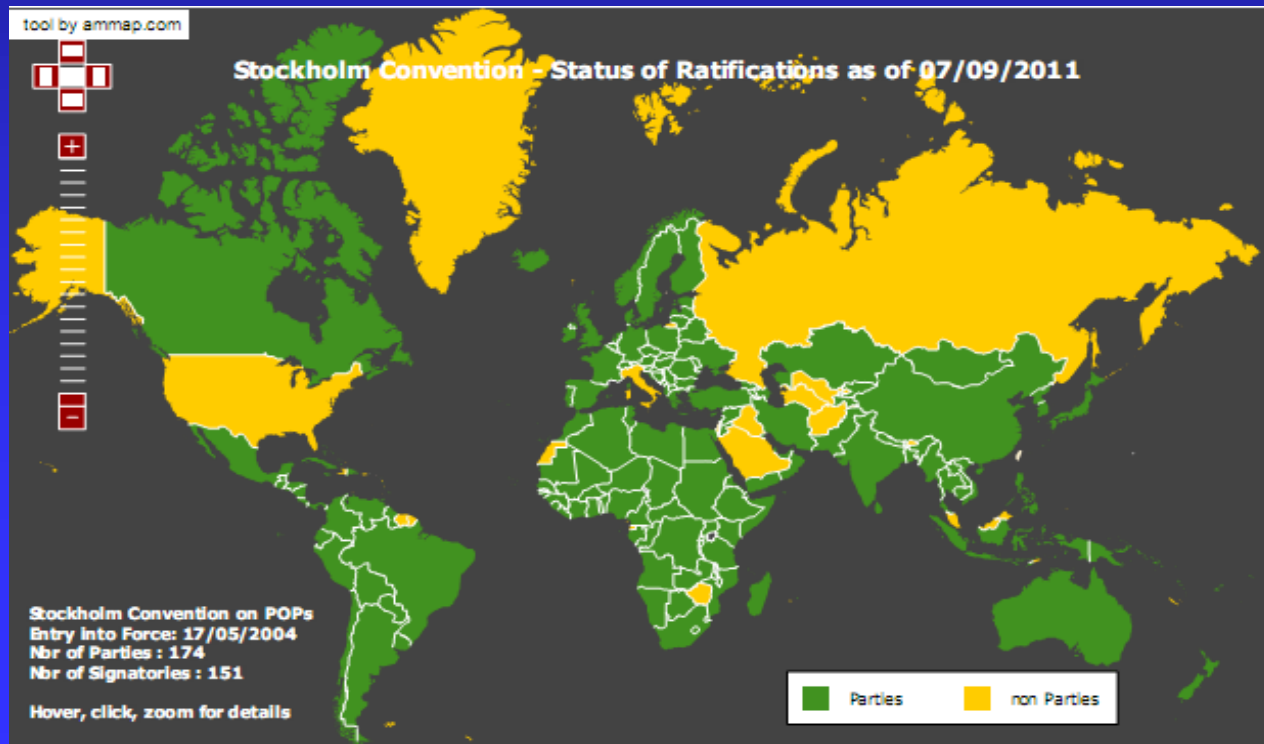
Persistent Organic Pollutants (POPs) & Stockholm Convention

POPs are chemicals

- resist to degradation**
- potential for long range transportation**
- bioaccumulation in food chain**
- cause adverse effects on human health & environment**

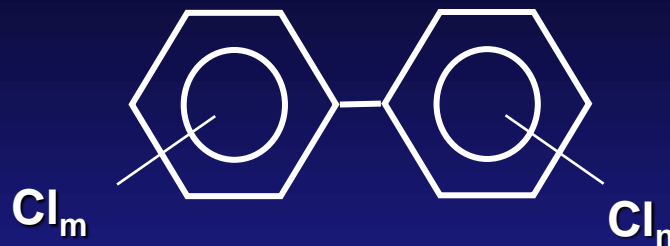
Stockholm Convention

- The global treaty to protect human health & environment against threat of POPs
- Signed on 22 May 2001, entered into force on 17th May 2004, 151 signatory parties
- Vietnam was one of the first countries to ratify the Convention (on 22th July 2002)
- PCD: Focal office of Stockholm Convention in Vietnam



Green color:
signatories

PCBs: properties, historical usage



- PCBs include 10 homologues, 209 individual congeners;
- Oral LD_{50} in rats for PCBs: 2.000 – 10.000 mg/kg body weight
(0.02 – 0.1 mg/kg for TCDD)
- PCBs: cooling agents and lubricants in electrical equipments
(capacitors, transformers);
- PCBs are complex mixtures, very persistent;
- Exhibit various toxic effects: hepatic, endocrine, immunological, neurological, reproductive, and developmental

PCB Worldwide production and production periods

Country	Manufacturers	Quantity (ton)	Years
U.S.A	Monsanto	641,246	1930-1977
Germany	Bayer AG	159,062	1930-1983
U.S.S.R	Orgsteklo	141,800	1939-1990
France	Prodelec	134,654	1930-1984
U.K	Monsanto	66,542	1954-1977
Japan	Kanegafuchi	56,326	1954-1972
U.S.S.R	Orgsintez	32,000	1972-1993
Italy	Caffaro	31,092	1958-1983
Spain	S.A. Cros	29,012	1955-1984
Czech	Chemco	21,482	1959-1984
China	Xian	8,000	1960-1979
Japan	Misubishi	2,461	1969-1972
Finland	Electrochemical Co.	1,000	1966-1970
Finland	Zaklady Azotowe	697	1974-1977
U.S.A	Geneva Industries	454	1971-1973
12 countries	14 manufacturers	1,325,810	1930-1993

Totally banned,
Industrialized Europe



1995

Banned, UK



1986

Restricted, Canada



1985

Banned, US



1977

Banned, Japan



1972

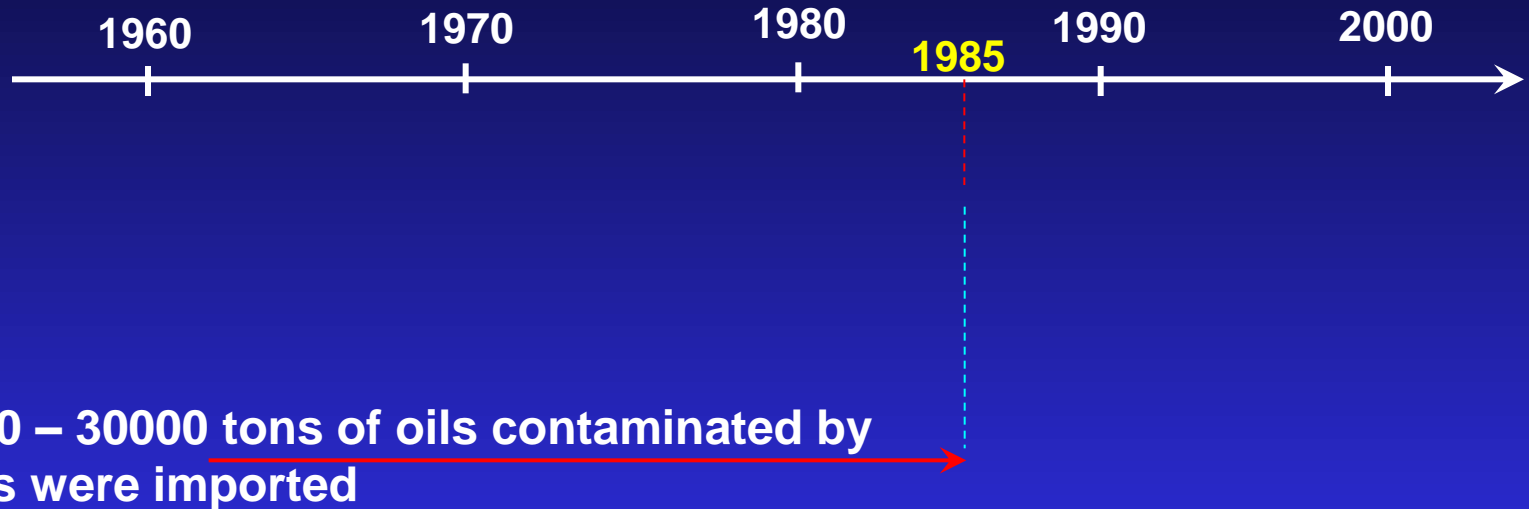
Produced



1930s



POPs usage in Vietnam



Industrial oils contaminated by PCBs were imported into Vietnam until the mid 1980s.

Source: Sinh et al., 1999. In UNEP Regional Workshop on Management of POPs, March 1999, Hanoi, Vietnam

Initial surveys

SDC Project (2006 – 2008)

- Surveys 20,000-30,000 tons of PCBs-contaminated transformer oils. PCBs levels were measured in more than 900 electrical equipment within the range of 50-1450 ppm.

VEA, 2009

- Surveys 112 sites of 105 enterprises (storage sites, workshops);
- 33 sites recognized PCBs > 5 ppm (QCVN 07:2009):
 - + 4 sites: PCBs = 50 – 500 ppm

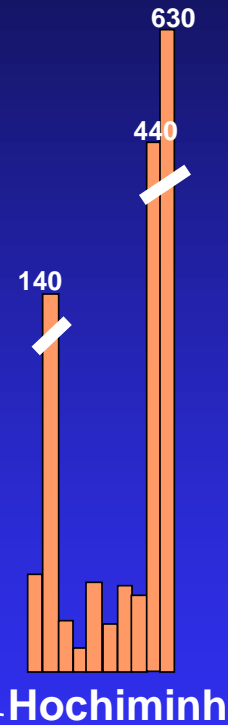
Situation of the PCB containing materials in Vietnam



Dong Anh Stockpile – Feb. 2008

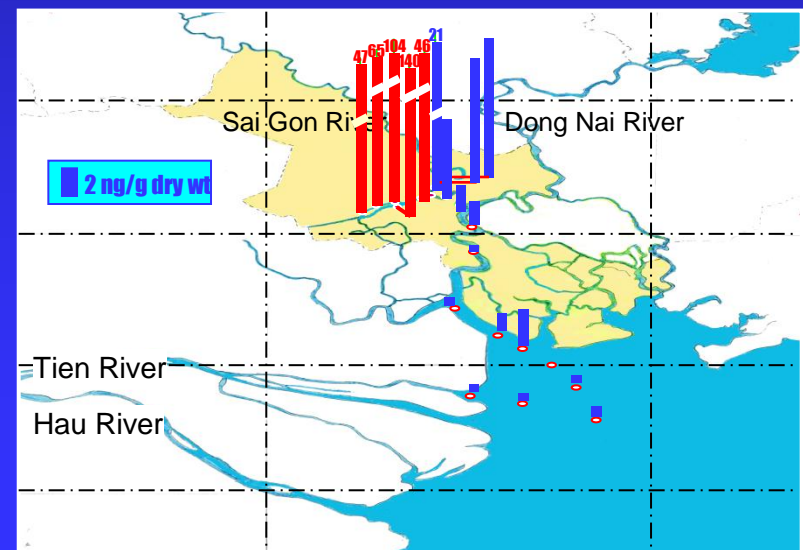


PCBs



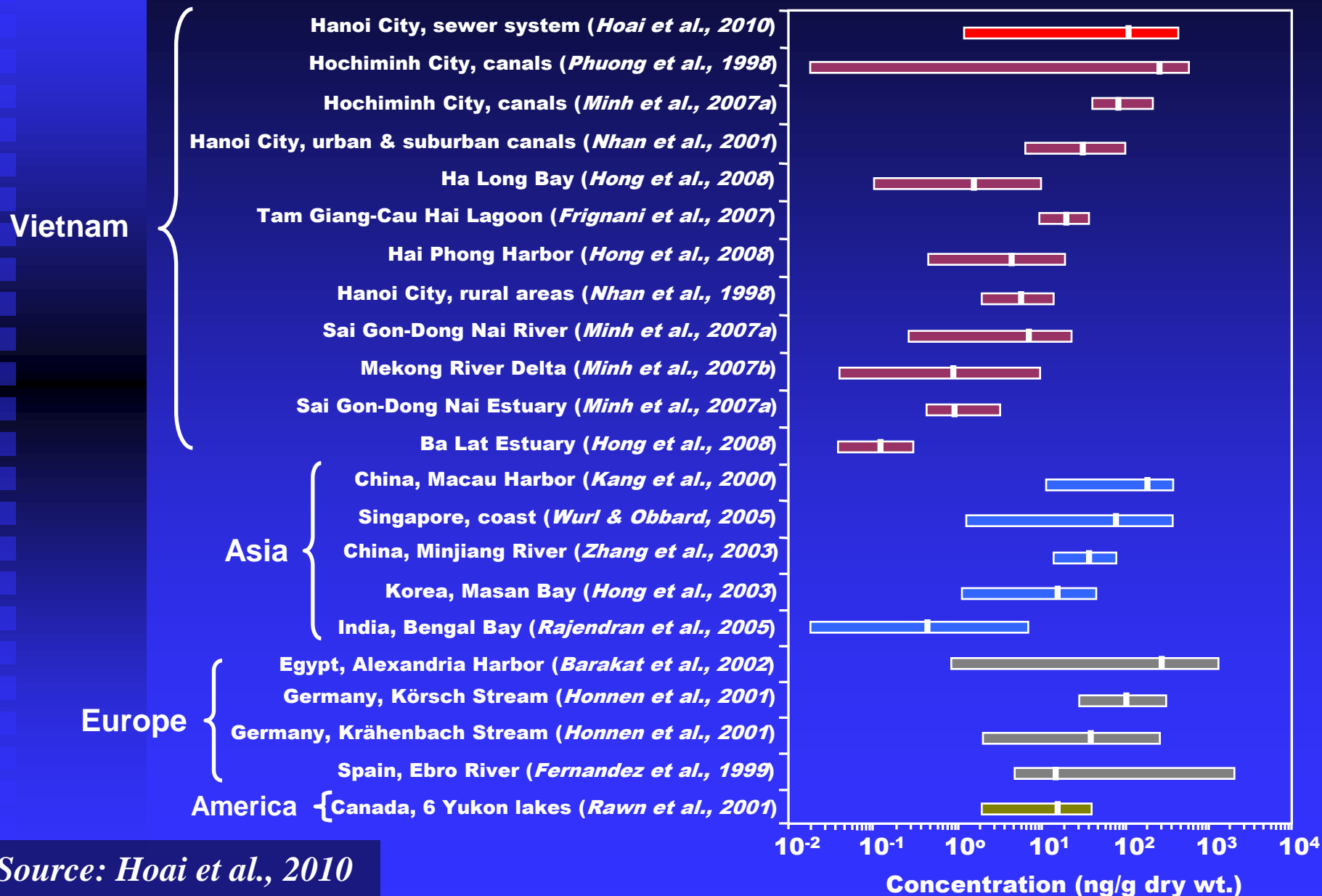
Location	Mean (ng/g)	Min (ng/g)	Max (ng/g)
Nhue River	~80	~20	~150
To Lich River	~30	~1	~60
Lu River	~70	~40	~120
Set River	~80	~30	~130
Kim Nguu River	~300	~250	~350
Yen So Lake	~130	~20	~400

Source: Hoai et al., 2010



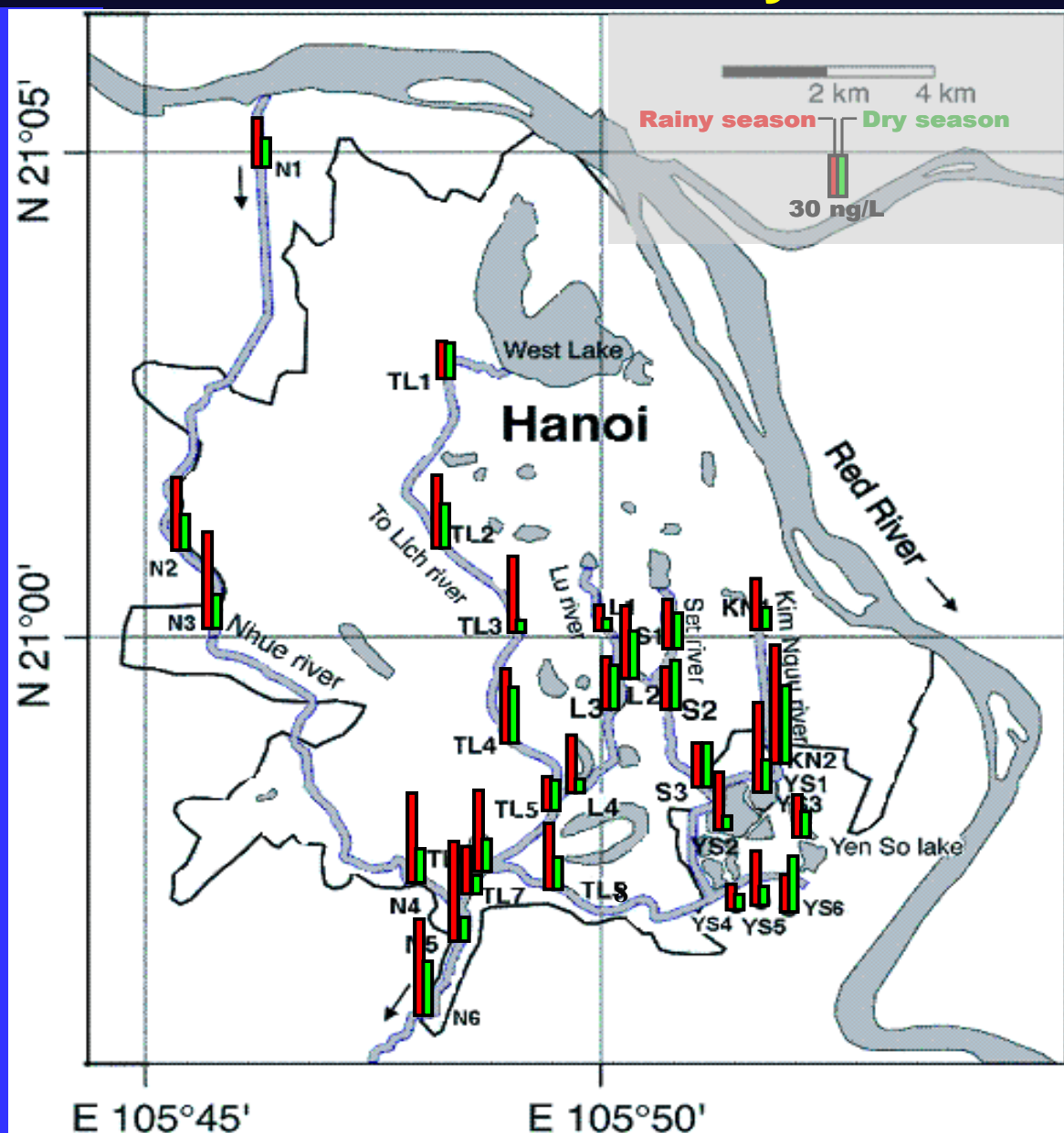
Source: Minh et al., 2005

Geographical comparison of PCBs in various sediments



Source: Hoai et al., 2010

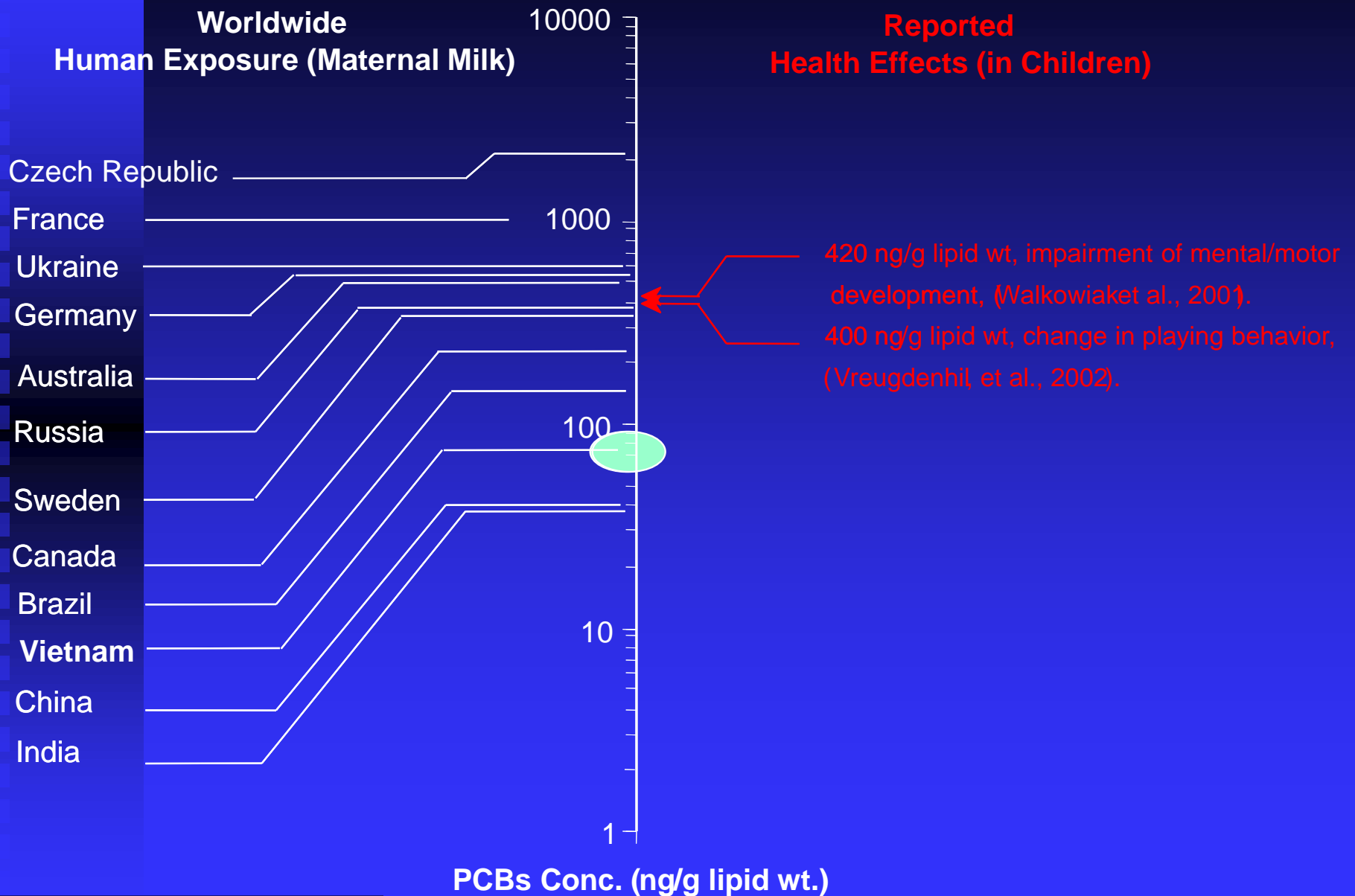
PCBs in surface water of Hanoi sewer system



Geographical comparison of PCBs in water

Research area	Sample number	Year	Isomer number	Total PCBs (ng•L-1)	Reference
Hanoi rivers, Vietnam	58	2009	6	8.6 -88	UNU project
Bay of Bengal, India	2	1998	na	1.93-4.46	<i>Environ. Inter.</i> 2005,31, 503-512
Newark Bay Estuary, USA	73	2002	114	3.45-56	<i>J. Hazard. Mater.</i> 2006, 136, 103-110
Venice Lagoon, Italy	2	2003	54	1.2-10.5	<i>Mar. Poll. Bull.</i> 2006, 52, 184-192
Okinawa Island, Japan	6	2002	na	1.59-2.58	<i>Chin. J. Oceanol. Limnol.</i> 2007, 25, 247-253
Mississippi River, USA	28	2004	6	22.2-163.4	<i>Chemosphere</i> 2007, 66, 1057-1069
Houston Ship Channel, USA	53	2003	209	0.49-12.5	<i>Chemosphere</i> 2008, 70, 593-606
Campeche, Mexico	11	2000	na	0.07-3.40	<i>Chemosphere</i> 2009, 74, 988-995
Yangtze River Delta, China	26	2009	38	1.22-16.8	UNU project

PCBs in human milk



Source: Minh et al., 2010

POPs - Pesticides

Registration of pesticides

Pesticide using in Vietnam: 2700 trade names, 800 active elements

Insecticides 437 active elements (1196 trade names);

Fungicides 304 active elements(828 trade names);

Herbicides 160 active elements (474 trade names)

Limited pesticide:

Insecticides 5 active elements (10 trade names);

Rodenticide 1 active elements (3 trade names);

Forest product preservation drug 4 active clements (4 trade names);

Disinfectant 3 active elements (9 trade names) (POP)

Banned pesticide:

Insecticides,

Forest product preservation drug 21 active clements,

Fungicides 6 active clement,

Rodenticide 1 active clements;

Herbicides 1active clements.

Import of pesticides

Year	Weight (Tons Product)	Insecticides (Tons)	Fungicides (Tons)	Herbicides (Tons)	Cost (1000 USD)
2007	75,805	28,078	21,365	22,618	352,650
2008	105,999	59,728	18,650	24,010	294,620
2009	79,896	34,451	23,302	21,130	210,770
2010	72,560	20,635	20,950	30,969	503,000

Manufacture and trade of Pesticides

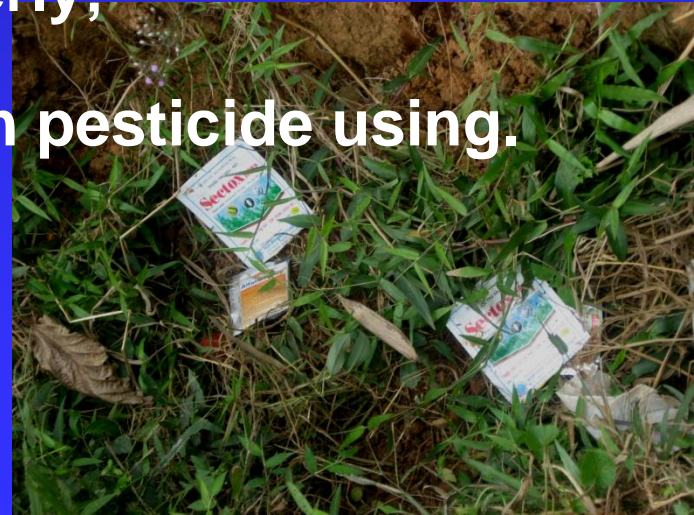
- 28,750 Pesticide agencies, trading shops
- 93 Factories/workshops (manufacturing, processing, bottling, packaging)

No	Contents/ type of violation	2007		2008		2009		2010	
		Case	Rate %	Case	Rate %	Case	Rate %	Case	Rate %
1	Total of units for testing	13.664		14.595		14.568		16.460	
2	Total of violation	1.990	14,6	2.104	14,4	2398	16,46	2388	14,5

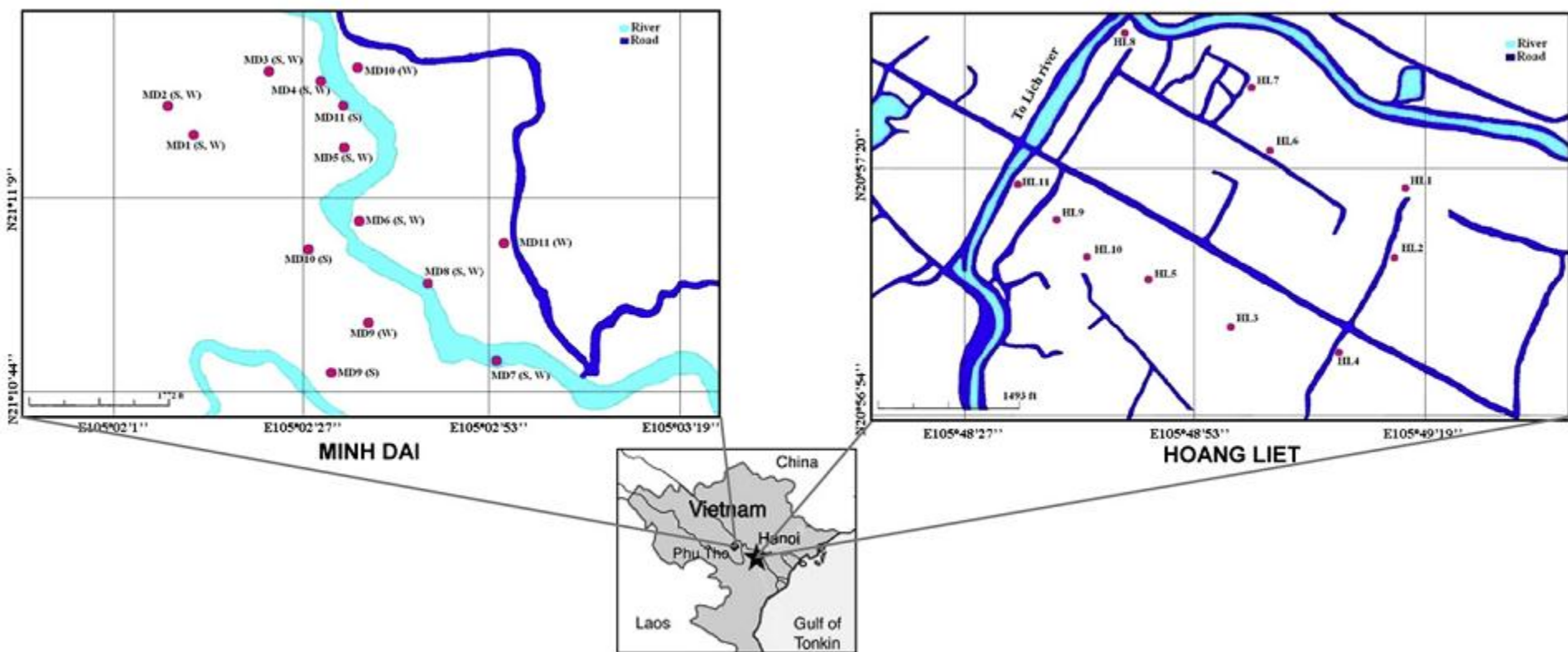
Source: Plant Protection Department, MARD

Limitations

- Remain using of banned and out-listed pesticides;
- Exceed dosage; mix pesticides in wrong way, unsure isolated time;
- Low-rate of farmers using pesticides following the introduction of technical officer;
- Pesticide packages collected improperly;
- Low-rate of rural households trained in pesticide using.



Pesticides in agriculture areas



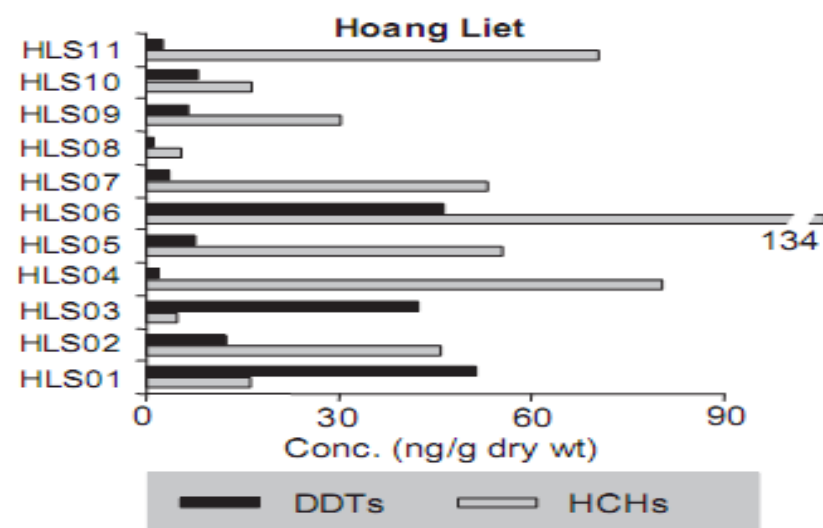
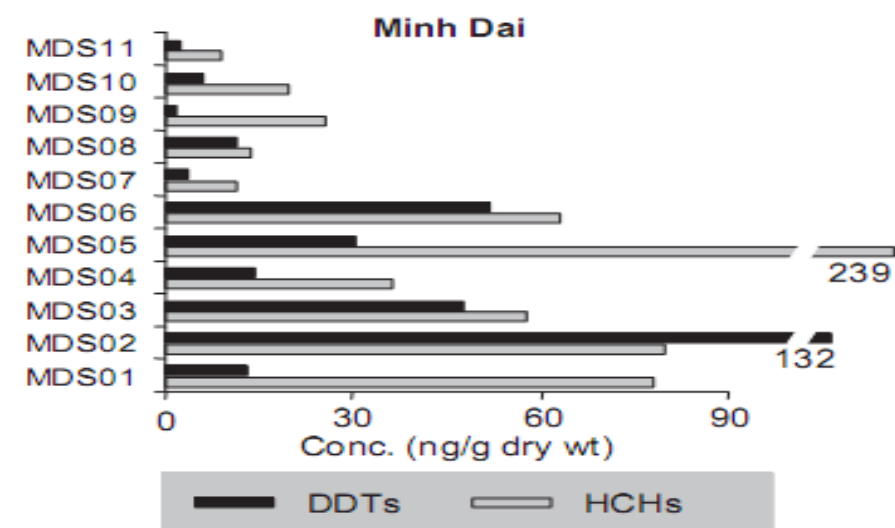


Fig. 2. Concentration of DDTs and HCHs in soil samples.

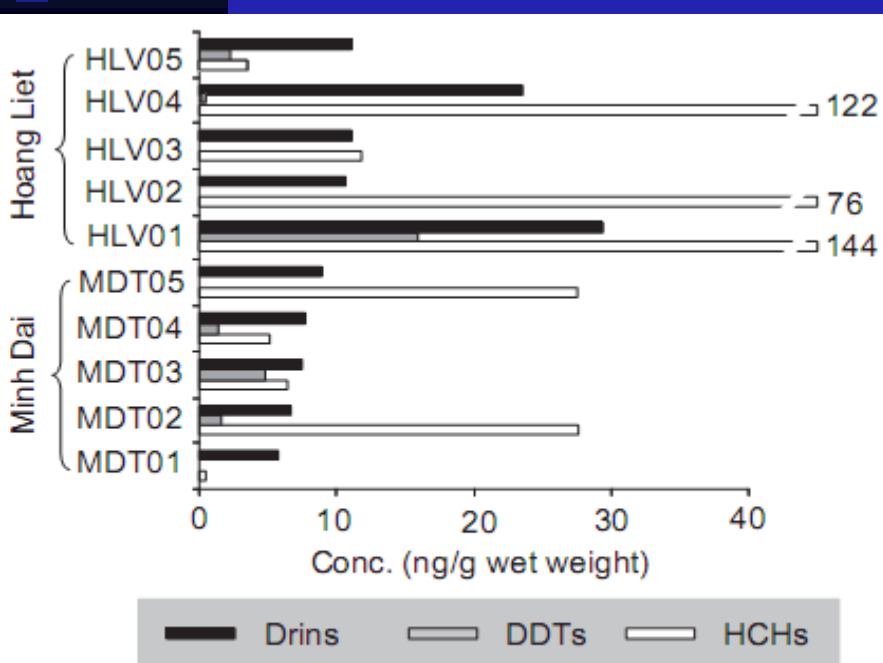


Fig. 7. Distribution of DDTs, Drins and HCHs in tea and vegetable samples.

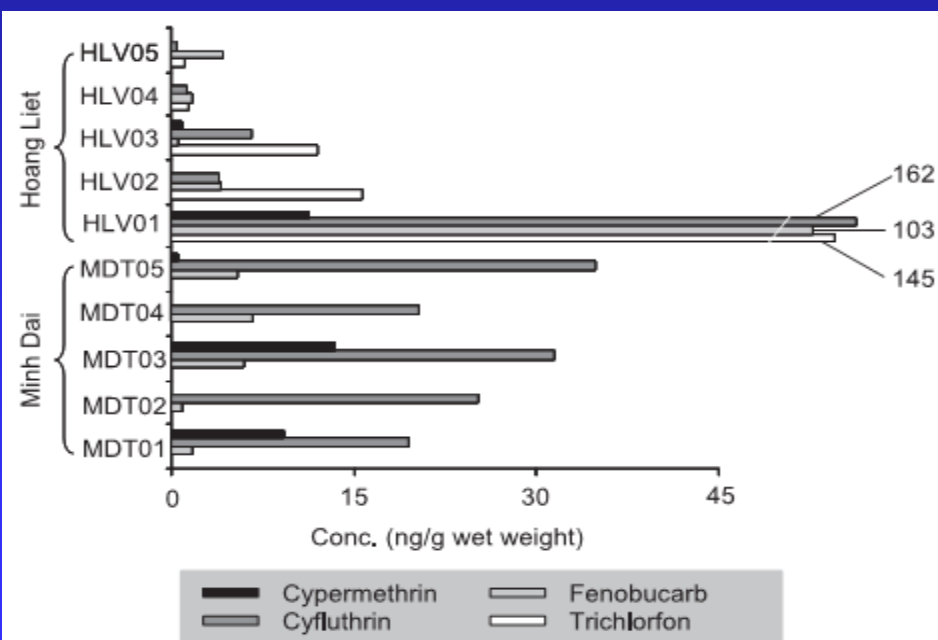
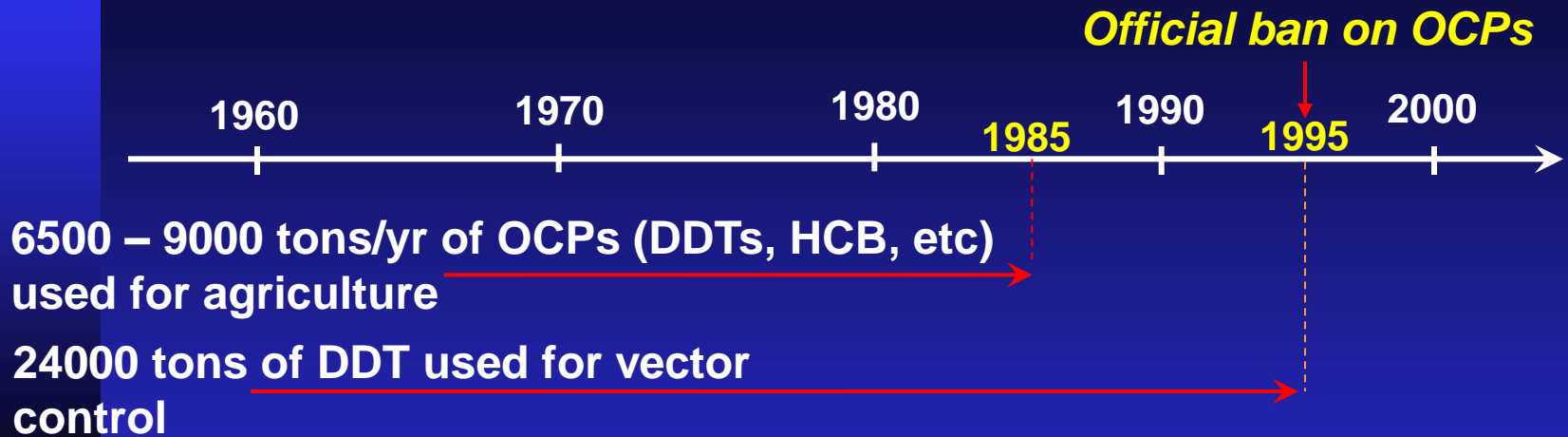


Fig. 8. Concentration of trichlorfon, fenobucarb, cyfluthrin, and cypermethrin in tea and vegetable samples.

OCs usage in Vietnam



✳ Organochlorine pesticides (OCPs) were used extensively in Vietnam since the late 1960s for agriculture and even more early for vector control.

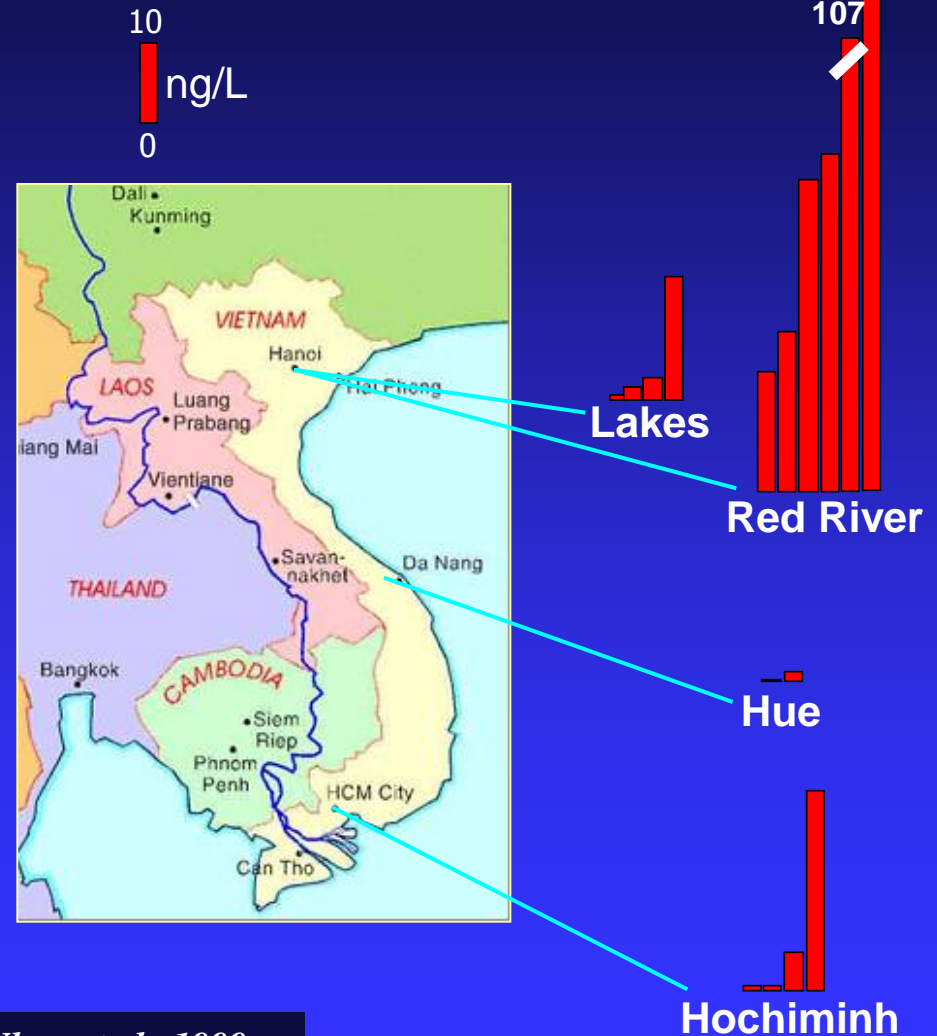
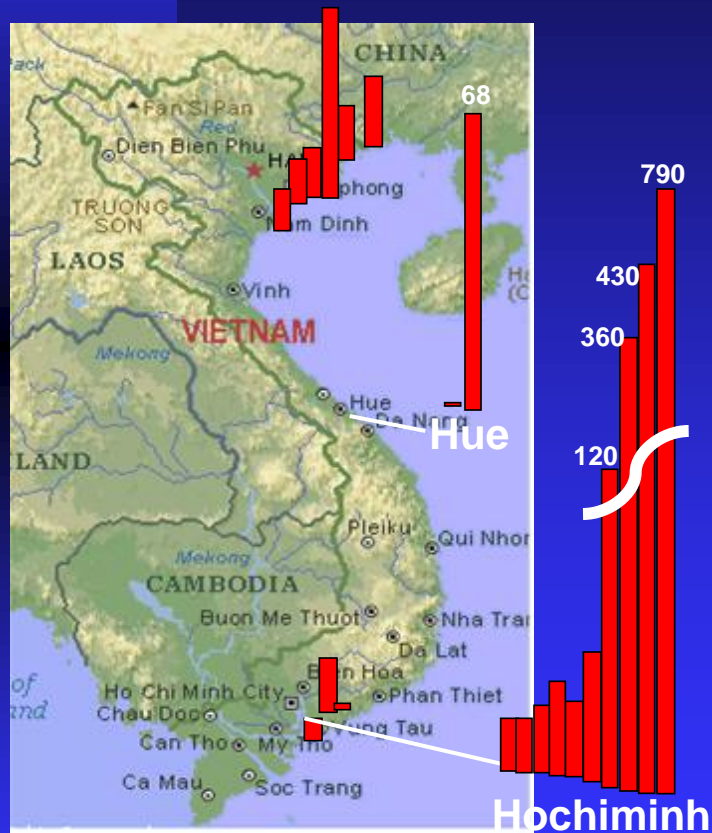
Source: Sinh et al., 1999. In UNEP Regional Workshop on Management of POPs, March 1999, Hanoi, Vietnam

Old stockpiles - Investigation results

Over 1,153 polluted points (39 provinces and cities)



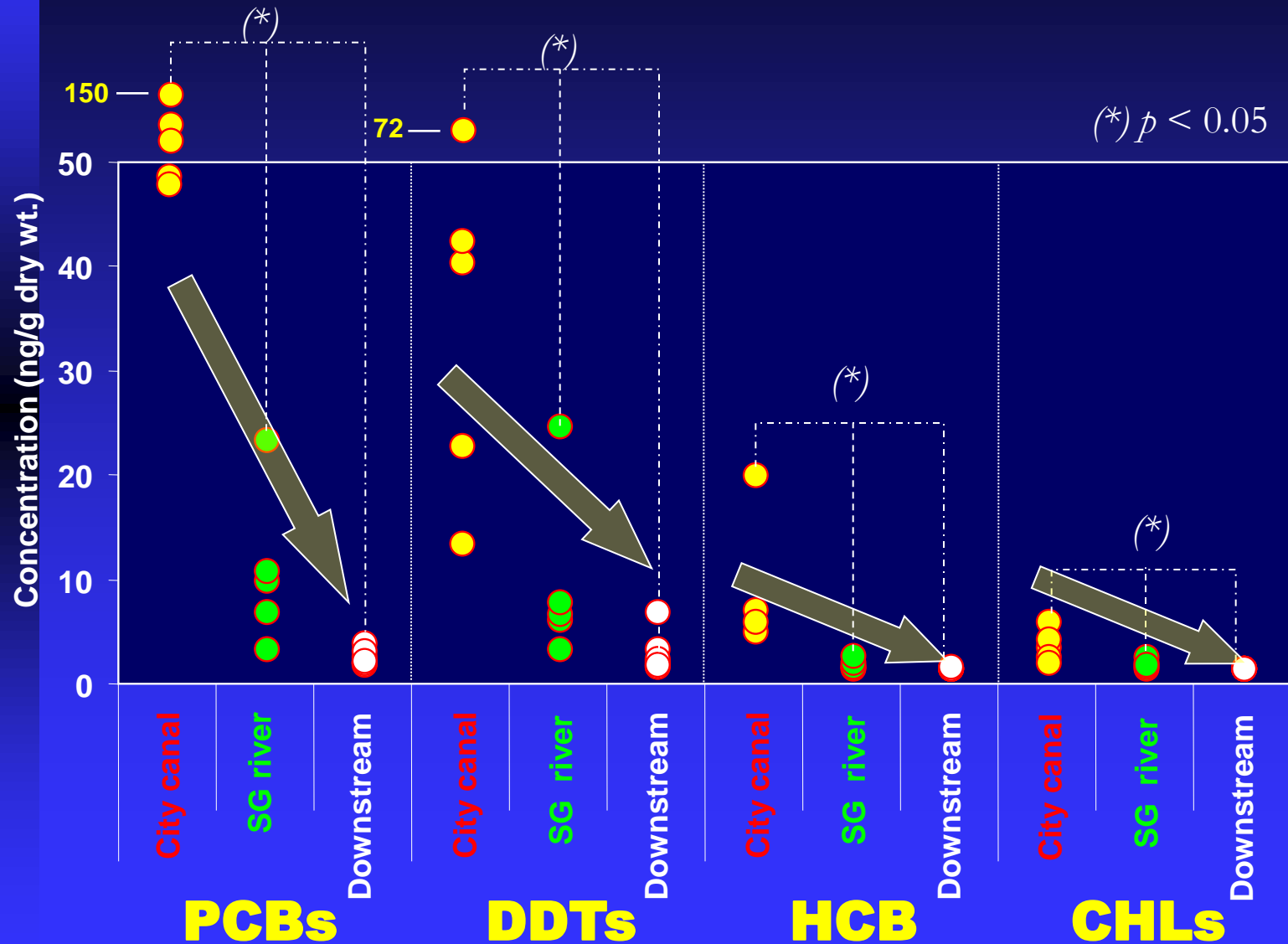
Widespread occurrence of DDTs in surface water and sediments



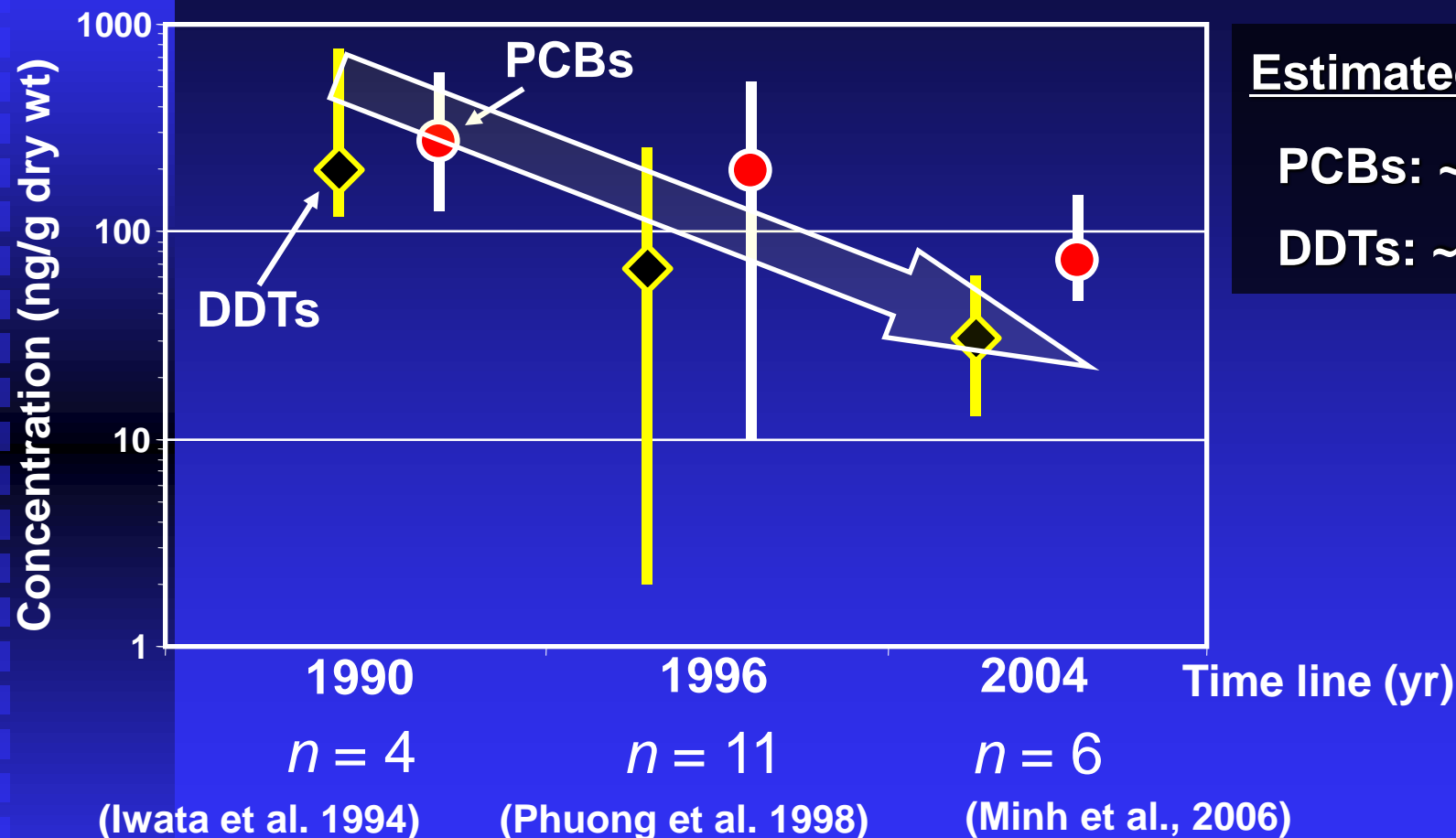
10
ng/g dry wt
0

Source: Iwata et al., 1994, Nhan et al., 1999;
Viet et al., 2000, 2002; Hung & Thienan, 2002

Contamination patterns of POPs in sediment from 3 different locations from Saigon - Dong Nai River



Temporal trends of PCBs and DDTs in sediment from Hochiminh City, south Vietnam



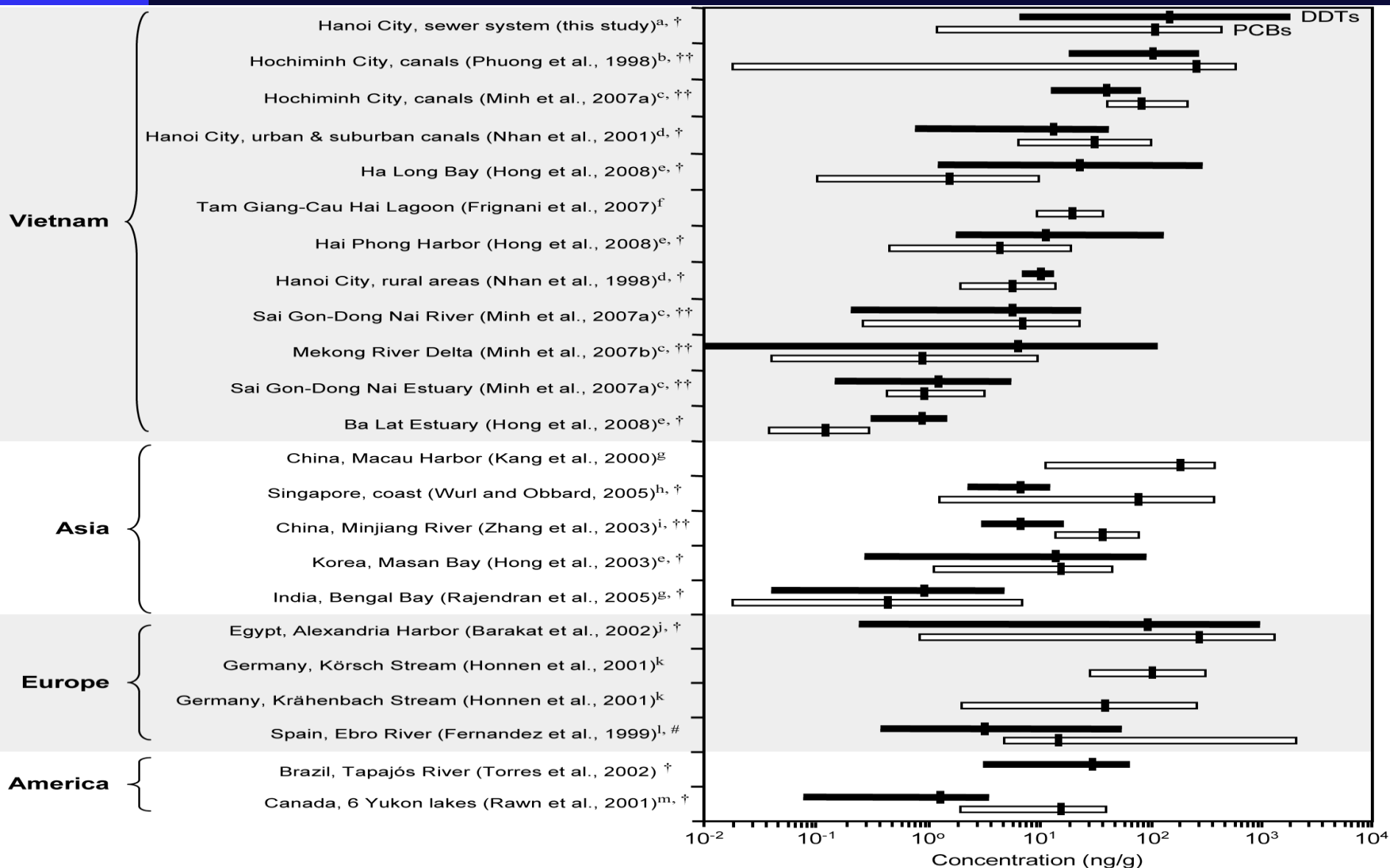
Estimated half-life:

PCBs: ~ 8 years

DDTs: ~ 5 years

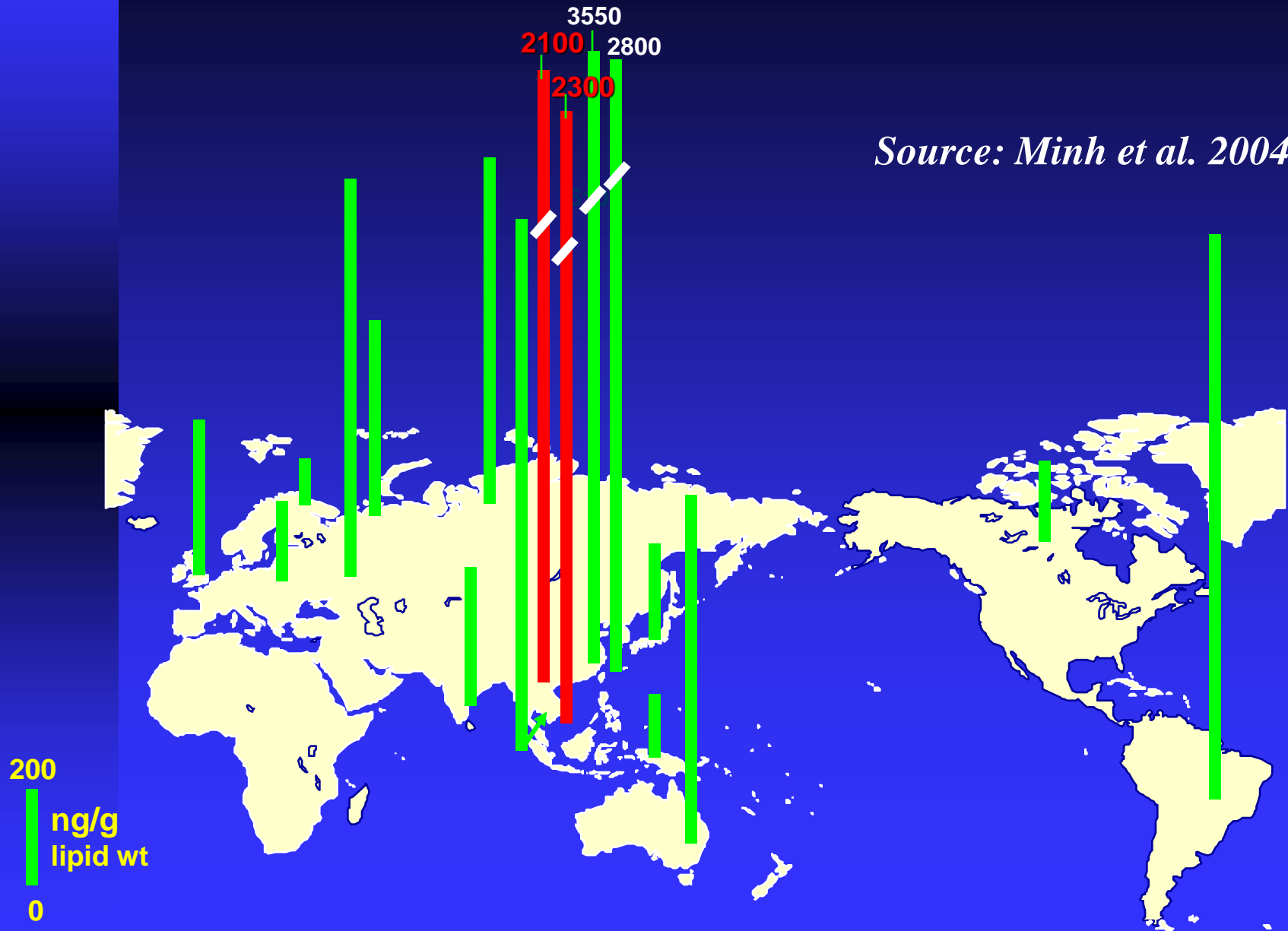
PCBs and DDTs residues have consistently decreased over the last 15 years

Geographical comparison of DDTs and PCBs in various sediments



Source: Hoai et al., 2010

DDTs residues in human breast milk from Vietnam & other countries



Antibiotics

POPs and Pharmaceuticals

POPs

- Persistent in the environment
- High bioaccumulation potential (high affinity to fat tissues)
- Semi-volatile, ubiquitous due to long range transport via atmosphere
- Ban/regulation of usage in most of developed countries & developing world due to toxic effects on environment and humans
- Attention given during the past 4 decades

Pharmaceuticals (incl. antibiotics):

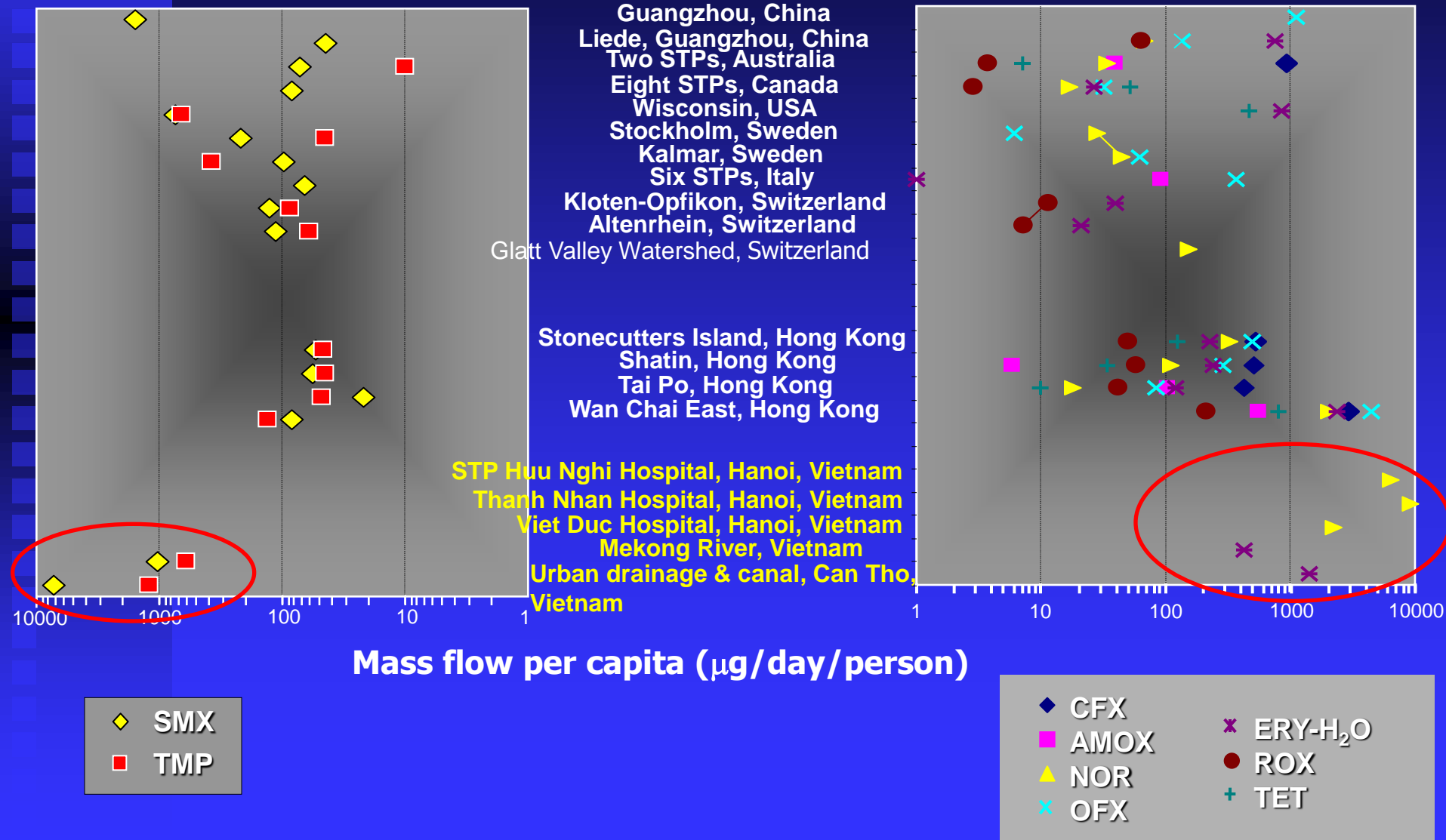
- Less persistent: lower K_{ow}
- Lower accumulation in animal bodies (shorter half life)
- More stable in dissolved (aqueous) phase
- Continuous release in considerable quantities to the environment through various pathways
- Attention given only very recently from mid – end of 1990s.

Antibiotics investigated in the present study

Antibiotics	Usage
β-lactam Cefalexin (CFX) Amoxicilin (AMOX) Cefotaxim (CTZ)	Human livestock
Fluoroquinolones: Norfloxacin (NOR) Ofloxacin (OFX)	Human Human, livestock
Macrolides: Dehyro Erythromycin (ERY-H ₂ O) Roxithromycin (ROX) Tylosin (TYL)	Human, cattle, beef, chicken, turkey, swine
Sulfonamides Sulfamethoxazole (SMX) Sulfamethazine (SMZ) Sulfathiazole (STZ)	Human Human, cattle, beef
Tetracyclines: Tetracycline (TET) Oxytetracycline (OCT) Chlorotetracycline (CTC)	human, horse, sheep, swine human, cattle, beef, sheep, swine Cattle, beef
Trimethoprim (TMP) Chloramphenicol (CAP)	Human Human, livestock

Antibiotics in the sources (wastewaters)



Comparison of antibiotics loads (mass flow) in wastewater from different locations in the world



(Ban hành kèm theo Quyết định số 07/2005/QĐ-BTS ngày 24 tháng 2 năm 2005 của Bộ trưởng Bộ Thủy sản)

(Ban hành kèm theo Quyết định số 07/2005/QĐ-BTS ngày 24 tháng 2 năm 2005 của Bộ trưởng Bộ Thủy sản)


Thứ tư, 17/8/2005, 14:54 GMT+7

3 tiểu bang của Mỹ cấm bán thủy sản từ VN

Tiểu bang Louisiana, Alabama và Mississippi của Mỹ vừa ban bố lệnh cấm bán một số mặt hàng thủy sản của VN như cá tra, basa do lo ngại về an toàn thực phẩm.

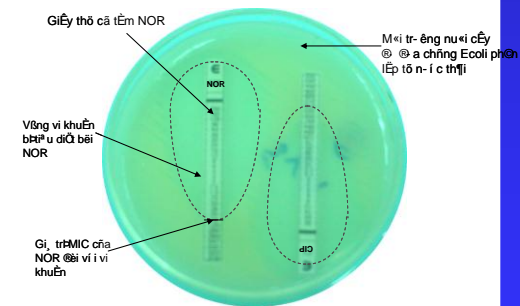
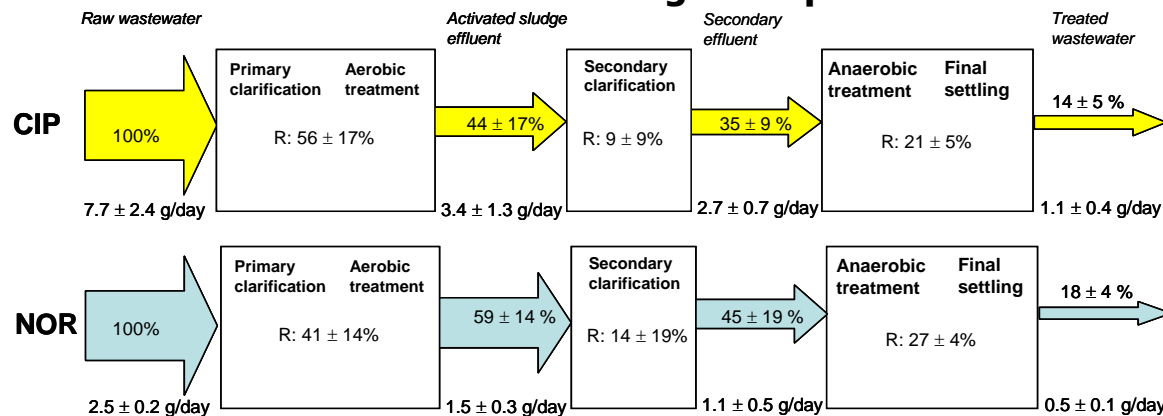
K.G. (theo AP)



Theo đề nghị của Cục trưởng Cục quản lý Chất lượng an toàn vệ sinh và Thú y thủy sản, ngày 18 tháng 8 năm 2005, Bộ trưởng Bộ Thủy sản đã ký ban hành Quyết định số 26/2005/QĐ-ST về việc cho phép nhập khẩu và sử dụng thuốc kháng sinh nhóm Fluoroquinolones vào danh mục kháng sinh được phép sử dụng trong sản xuất, kinh doanh thủy sản xuất khẩu vào thị trường Mỹ và Bắc Mỹ, có hiệu lực từ ngày 20 tháng 8 năm 2005.

Hospital	Concentrations ± STD (µg/L)		Load ^a ± STD (g/d)			Estimated FQ consumption ^b (mg/day/patient)		Ref.
	CIP	NOR	CIP	NOR	Total FQs	CIP	NOR	
<i>Hanoi, Vietnam</i>								
1. Thanh Nhan hospital ^c	7.0 ± 0.1	15.2 ± 0.3	2.1 ± 0.0	4.6 ± 0.1	6.7 ± 0.1	7.6	30.7	This study
2. Viet Duc hospital ^c	10.9 ± 0.8	3.4 ± 0.4	10.9 ± 0.8	3.4 ± 0.4	14.3 ± 1.2	13.2	7.5	This study
3. Hanoi K hospital ^c	1.2 ± 0.2	<LOQ	0.4 ± 0.1	-	0.4 ± 0.1	0.5		This study
4. Central Obstetric hospital ^c	2.1± 0.1	13.6 ± 0.3	0.7 ± 0.0	4.6 ± 0.1	5.3 ± 0.1	1.8	21.8	This study
5. Hanoi Obstetric hospital ^c	1.1 ± 0.1	< LOQ	0.3 ± 0.0	-	0.3 ± 0.0	0.9		This study
6. Huu Nghi hospital ^d								This study
raw wastewater	25.8 ±8.1	8.4 ± 2.5	7.7 ± 2.4	2.5 ± 0.2	10.2 ± 2.6	34.3	20.9	
treated wastewater	3.7 ± 1.3	1.5 ± 0.3	1.1 ± 0.4	0.5 ±0.1	1.6 ± 0.5			
<i>Zürich, Switzerland</i>								
University hospital ^e	21.2 ± 3.6	5.6 ± 1.8	12.7 ± 2.1	3.3 ± 1.1	16.0 ±	23.1 ^f	11.0 ^f	(Alder et al., 2004)
<i>Kalmar, Sweden</i>								
County hospital ^g	3.6 – 101							(Lindberg et al., 2004)
<i>Germany</i>								
Five different hospitals	0.7 – 124.5							(Hartmann et al., 1999)
University hospital, Würzburg ^h	2 – 51	44						(Ohlsen et al., 2003)

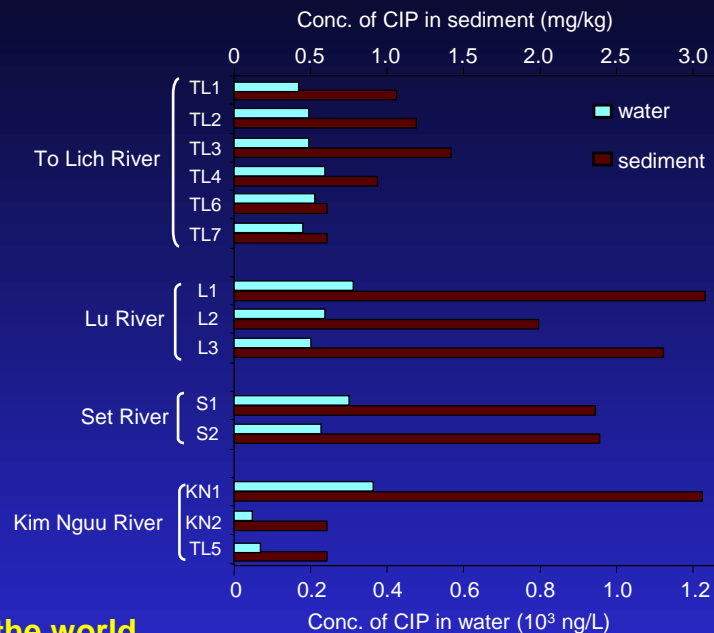
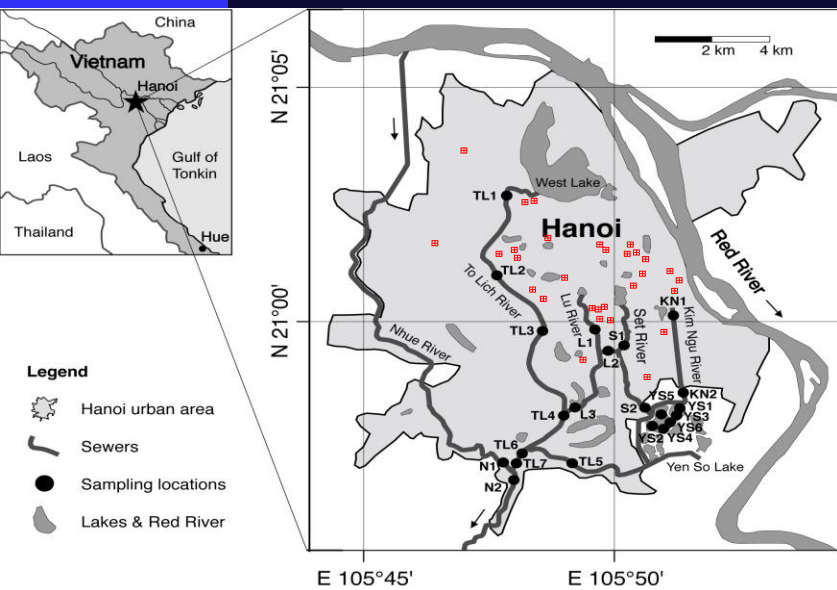
WWTP in Huu Nghi Hospital



Result

1 report in National Conference, 1 draft publication (FQs in hospital and antibiotic resistance) for International journal

CIP in surface water and sediment



CIP in surface water and sewage sludge from various locations in the world

Country	Year	Surface water		Sediment/sewage sludge		Reference
		n	Concentration (ng/L)	n	Concentration (mg/kg)	
Vietnam (Hanoi sewer system)	2006	22	145 (<50-370)	22	<0.60-3.1	Present study
China (Major Pearl River)		8	73 (<35-459)			Peng et al. (2008)
China (Tonghui River)	2007	4	12 (7.1-20)			Xiao et al. (2008)
						Tang et al., 2009
India (Kazipalli Tank)		1	72			Rao et al. (2008)
Italy (Po and Lambro rivers)	2001	8	5.2 (<0.3-26)			Calamari et al. (2003)
Sweden	2002-2003			10*	0.5-4.8	Lindberg et al. (2005)
Switzerland (Glatt River)	2001	6	5-18	4*	1.40-2.42	Golet et al. (2002)
U.S. (Arkansas streams)	2004	18	27-39			Haggard et al. (2006)

n: number of sampling sites

*: Sewage sludge from wastewater treatment plants

Laws and regulations

National Implementation plan (NIP) for Stockholm Convention on POPs

- **Development & finalizations of policies, legislative and institutional frameworks for management, reduction, treatment & elimination of POPs**
- **Strengthening POPs management capacity**
- **Promotion activities for safe management, reduction, disposal & elimination of POPs**
- **Raising awareness for management, reduction and management of POPs**
- **Diversification of investment sources**
- **Enhancement of international cooperation for implementation of Stockholm Convention**

15 National Priorities Programs Defined by NIP

- Policy, legislations for POPs management
- Management, disposal & phase out of POPs pesticides
- Isolation & treatment of dioxins from contaminated hotspots during US – VN War
- Management of healthcare wastes to reduce POPs
- Treatment of PCBs and POPs pesticides from contaminated hotspots
- Management, disposal & phase out of PCBs from electrical and industrial products
- Capacity building for POPs analysis & monitoring
- Best available techniques (BAT) & Best environmental practices (BEP) for reduction & eliminate of unintentionally produced POPs releases from industry
- Impacts of POPs on human health from contaminated environment
- Education, training & public awareness
- Enhancement of technical & financial support to implementation of Stockholm Convention
- Capacity strengthening for controlling production, import-export, use & transports of prohibited chemicals including POPs
- Development of emission and technological standards/criteria for POPs
- Development of national information system, working network on POPs
- Assessment of POPs management in whole country

GEF4 cycle Projects on POPs Area in Vietnam

Development of NIP: GEF UNDP Project (Enabling Activity)



15 National priority programs



GEF funded projects

Building capacity
to eliminate POPs
pesticides stockpiles
IA: UNDP, full sized

PCBs management,
safe disposal
IA: WB, full sized

Remediation of dioxin
contaminated hotspots
IA: UNDP, full sized

Introduction of BAT/BEP to
demonstrate reduction UP-POPs
release from industry
EA: UNIDO, medium sized

Demonstration of Best techniques
for reducing dioxins & mercury
from healthcare wastes
IA: UNDP, full sized, global

National Action Plan

- **Revise Law on Environmental Protection, plan issued in 2013**
- **Revise and update NIP, new NIP submitted in 2012**
- **Development of inter-ministerial circular on environmental protection regarding hazardous chemicals (MONRE and MOIT)**
- **Development of circular on PCB management**



Summary

- **Predominant contamination was found in urban areas with high industrial and human activities**
- **High contamination of pesticides, DDTs, PCBs, antibiotics**

Recommendations, directions for future research to further address the hazardous pollution problems and mitigate their emissions

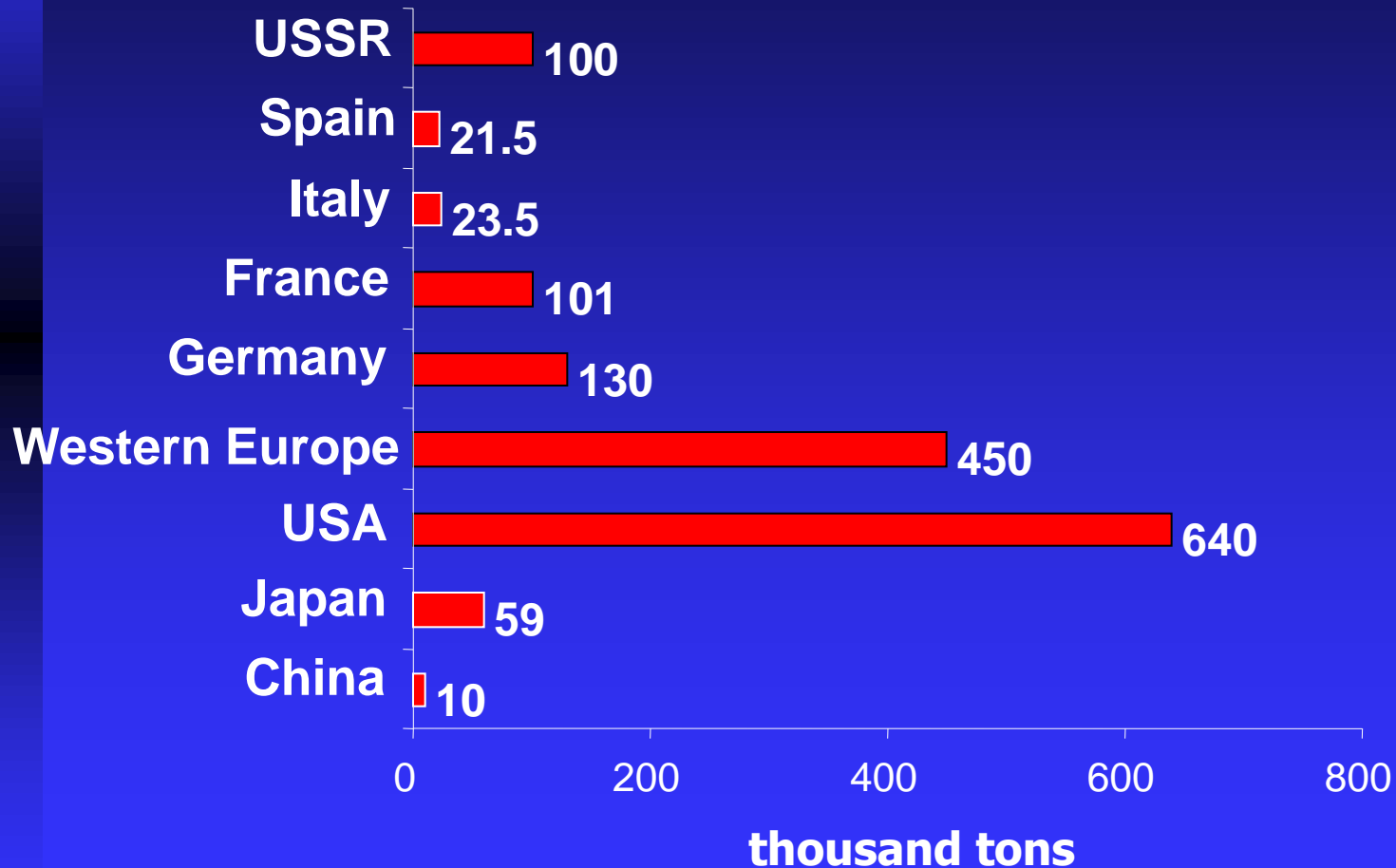
- * Temporal trends studies to trace the ultimate sources and long term fate**
- * Ecotoxicological studies to make clear possible toxic impacts and risk assessment on human and wildlife**
- * Effective counter measures and legislations on pesticide usage and stockpile managements**
- * Replacement of alternative pesticides that are effective, economic and bio-degradable**
- * International cooperative with developed nations and capacity building in developing countries**

THANKS FOR YOUR ATTENTION!



Sản lượng PCBs của các nước công nghiệp phát triển trên thế giới

PCBs production in industrialized countries



POPs in soils from open dumping sites for municipal wastes in Vietnam



Open dumping sites are significant sources of POPs

Source: Thao et al., 2007; Minh et al., 2006