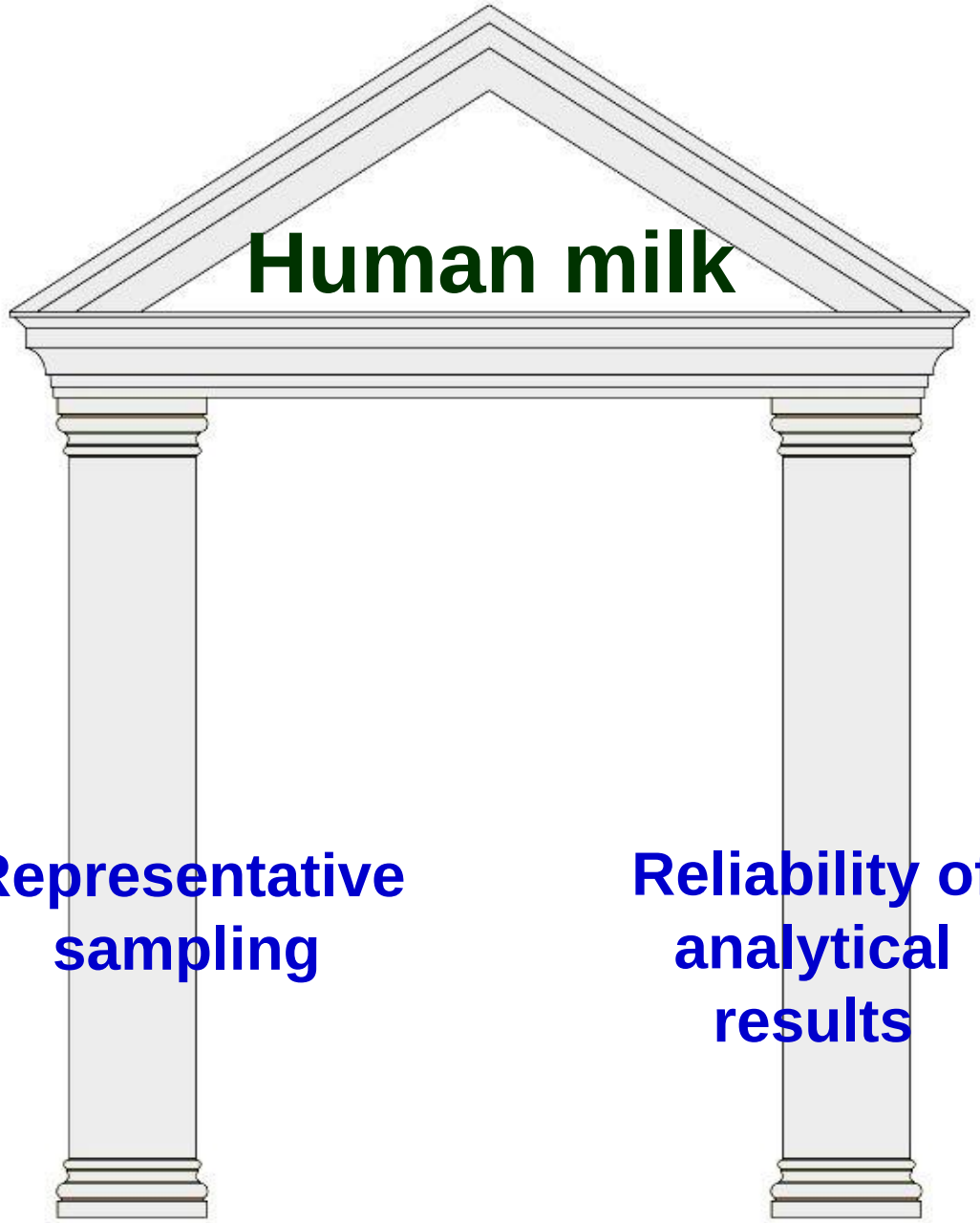
Final Results Workshop for the UNEP/GEF project
"Establishing the Tools and Methods to Include the Nine New POPs into Global Monitoring Plan"
and Inception Workshop for the UNEP/GEF project
"Continuing Regional Support for the POPs Global Monitoring Plan
under the Stockholm Convention in the Africa Region"
Accra, Ghana, 6 – 8 July, 2016.

Human milk surveys: the role of the UNEP/WHO reference laboratory

Ralf Lippold and Rainer Malisch

State Institute for Chemical and Veterinary Analysis of Food, Freiburg, Germany

WHO / UNEP Reference Laboratory
EU Reference Laboratory for Dioxins and PCBs in Feed and Food
EURL for Pesticides in Food of Animal Origin

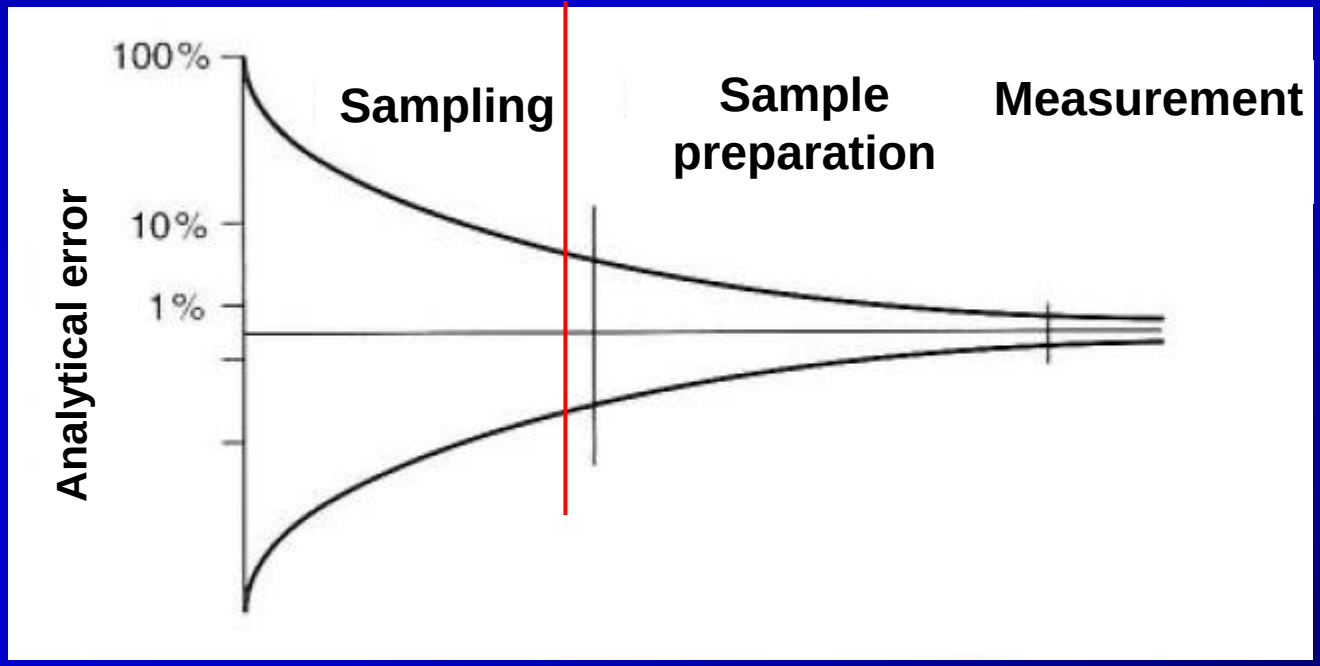


Pillars for reliability of results

Sampling

Sampling very critical part of whole analytical procedure

- Samples shall be **representative** *(examples: soil; eggs)*
- **Prevention of contamination** of sample or container during sampling
- **Prevention of change of concentrations**, change of matrix influencing the results



Human tissues as indicators of human exposure to POPs

Human samples as suitable indicators for bioaccumulation of POPs :

- ✓ **Mother's milk**
- ✓ **Blood**
- ✓ **Adipose tissues**

Comparable results on fat basis –

Possible problem: correct determination of fat

Mother's milk as tissue for exposure monitoring

Advantage of mother's milk samples

- ✓ non-invasive mean to estimate the exposure
- ✓ Less toxicological concern (AIDS virus, hepatitis) than for human blood

Mother's milk for exposure monitoring

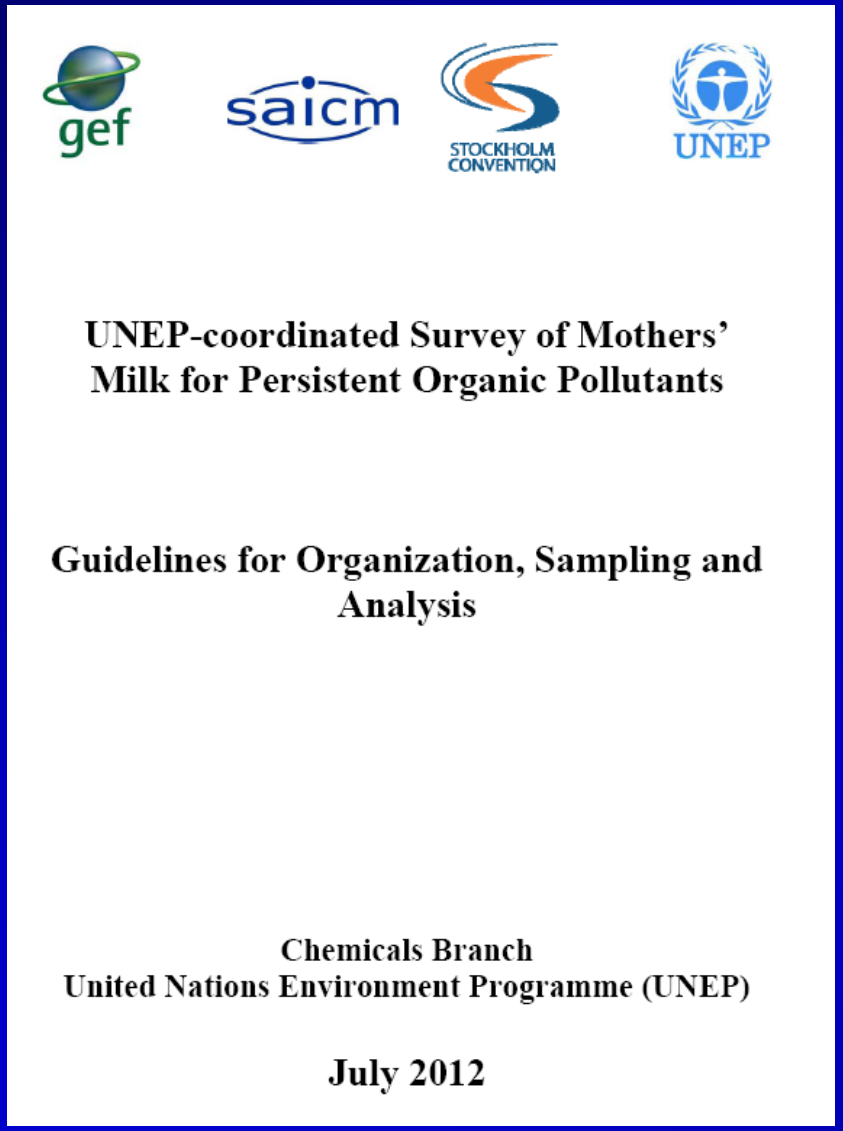
⇒ **Individual** samples

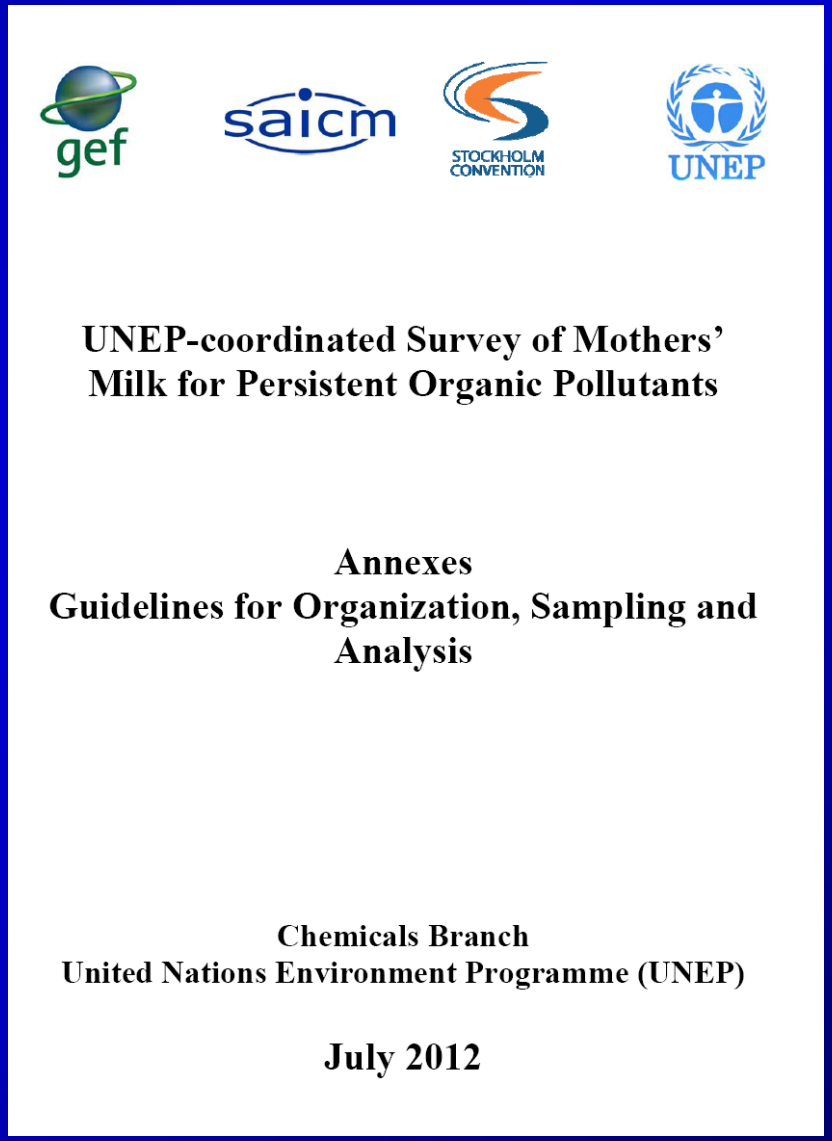
- for differentiation within a country

⇒ **Representative pooled (mixed)** samples

- to identify priority POPs and
- to follow time trends in countries

Mother's milk for exposure monitoring





Prepared by: Dr. Karin Malisch and Dr. Heidelore Fiedler

Mother's milk for exposure monitoring

- Mothers should have **first child** *(primiparae)*
- Be **under 30** years
- Mother and child be apparently **healthy**
- Breastfeeding only **one child** (i.e. not twins)
- Have resided in the represented area (country) **> 10 years**
- **Exclusion of contaminated areas**
- Sample collection within **3 to 8 weeks** of delivery

Advantage of pooled (mixed) mother's milk samples

- ✓ Possible to get a rough **estimate on the exposure** in different regions of the world with only **very few samples**

(+) **Cost-effective** and useful non-invasive mean to estimate the overall exposure of a local population

(-) Disadvantage: Lack of information about individuals

Basic Principles for Reliability and Comparability of Results (1)

Standardized protocol for sampling

- **Collection of human milk from representative individuals** *(since 2007: n = 50)*

- **Preparation of one** pooled (=mixed) sample representative for a country / region

Basic Principles for Reliability and Comparability of Results (2)

Analytical quality control:

Different concepts for

1. **Individual samples:**
   analysed by laboratory selected by National Coordinator
2. **pooled samples:**
   analysed by Reference Laboratory

WHO protocol (2008) /UNEP guidelines (2012) – 1a

- ✓ For statistically reliable data: appropriate minimum number of individual donors (50) is recommended for each country.
- ✓ Some flexibility may be necessary for countries with small populations and/or low birth rates.
- ✓ Power of the survey can be increased by the inclusion of more than 50 individual samples and is encouraged.

WHO protocol (2008) /UNEP guidelines (2012) – 1b

- ✓ In particular, countries with populations greater than 50 million should include at least one additional participant per one million population over 50 million.

- ✓ Countries with populations well over 50 million (or with sufficient resources) are encouraged to prepare a second pooled sample (or more) if feasible.

WHO protocol (2008) /UNEP guidelines (2012) - 2

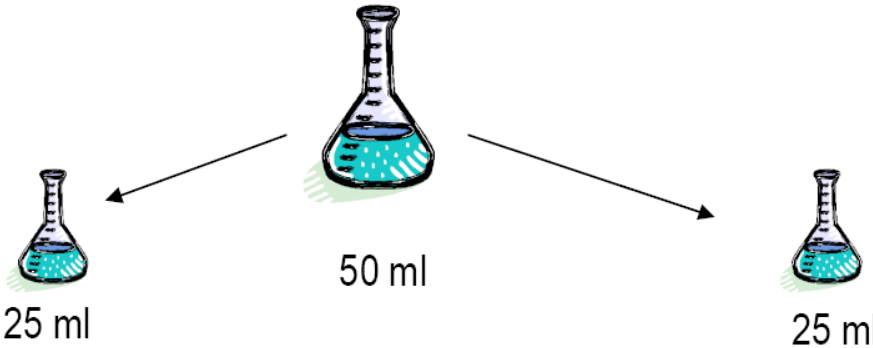
- ✓ **Responsibilities of the National Coordinator: number of samples can provide a sufficient statistical base to allow scientifically valid assessments of changes in levels of POPs over time.**

(for time trends necessary: sampling of comparable cohorts over time, if more than 1 pooled sample prepared)

Sample preparation scheme (1)

- **Collection of 50 individual samples**
- **Preparation of**
  - **individual samples for analysis of basic POPs by country**
  - **pooled (mixed) samples (analysis by Reference Laboratory)**

1. Collection of 50 individual samples of 50 ml each.
   Options for the collection of the individual samples:
   - ✓ if possible, in one collection, or
   - ✓ in portions over time (e.g. on several days), with preservation of the collected portions by freezing
2. These 50 ml have to be split into two portions of 25 ml each:



Individual samples for analysis by country for basic POPs

Pooled sample (prepared of 25 ml of each of the 50 individual samples

Sample preparation scheme (2)

Preparation of individual samples for analysis of basic POPs by country and of pooled (mixed) samples

50 ml

take 25 ml into 2000 ml bottle (50 * 25 ml ea = 1250 ml)

Send the 2000 ml bottle with frozen pooled samples to WHO/UNEP Reference Lab

25 ml

Individual samples for analysis by country for basic POPs

For (deep-frozen) storage in and analysis by country. If no analysis in country possible and no storage capacity available, contact UNEP.

Sample preparation scheme (3)

Before taking an aliquot, shake intensely at room temperature and then take the aliquot immediately.

Options:

- Taking of 25 ml aliquot directly after collection of 50 ml sample in one collection at room temperature, if possible at place of collection (without freezing before aliquotation)
- Taking of 25 ml aliquot after thawing to room temperature at appropriate location, if samples are frozen.

➢ Important:
Storage and shipment of all samples **deep-frozen**.

Stabilization of human milk samples with dichromate

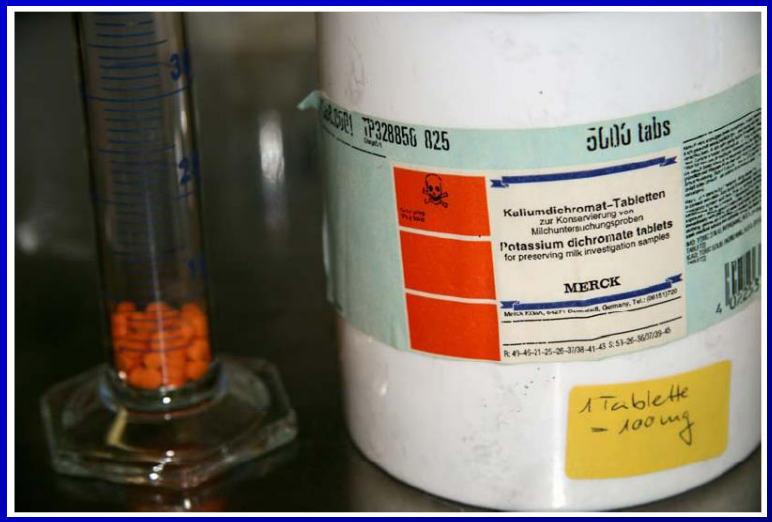
If refrigeration not available: Addition of dichromate to milk: 0.1 %
(140 mg potassium dichromate, containing about 100 mg dichromate, to 100 ml milk)
absolute accuracy is not important: finally an excess of dichromate in the milk (visible as yellow colour) which will be reduced to (green) Cr (III) before analysis.

Easiest: dichromate tablets

Merck "Kaliumdichromat-Tabletten zur Konservierung von Milchuntersuchungsproben" (potassium dichromate tablets for preservation of milk samples for analysis), 97 to 107 mg per tablet containing 32 - 24 mg dichromate per tablet.

0.1 % is equivalent to 3 tablets (= 100 mg dichromate) per 100 ml sample.

Very comfortable, avoids irritant reactions otherwise easily caused by handling of pure potassium dichromate powder



Arnold Schecter, Marian Pavuka, Olaf Päpke and Rainer Malisch
Chemosphere 57 (2004) 1-7
The use of potassium dichromate and ethyl alcohol as blood preservatives for analysis of organochlorine contaminants

Comment to collection of samples

Respect the requested amounts:

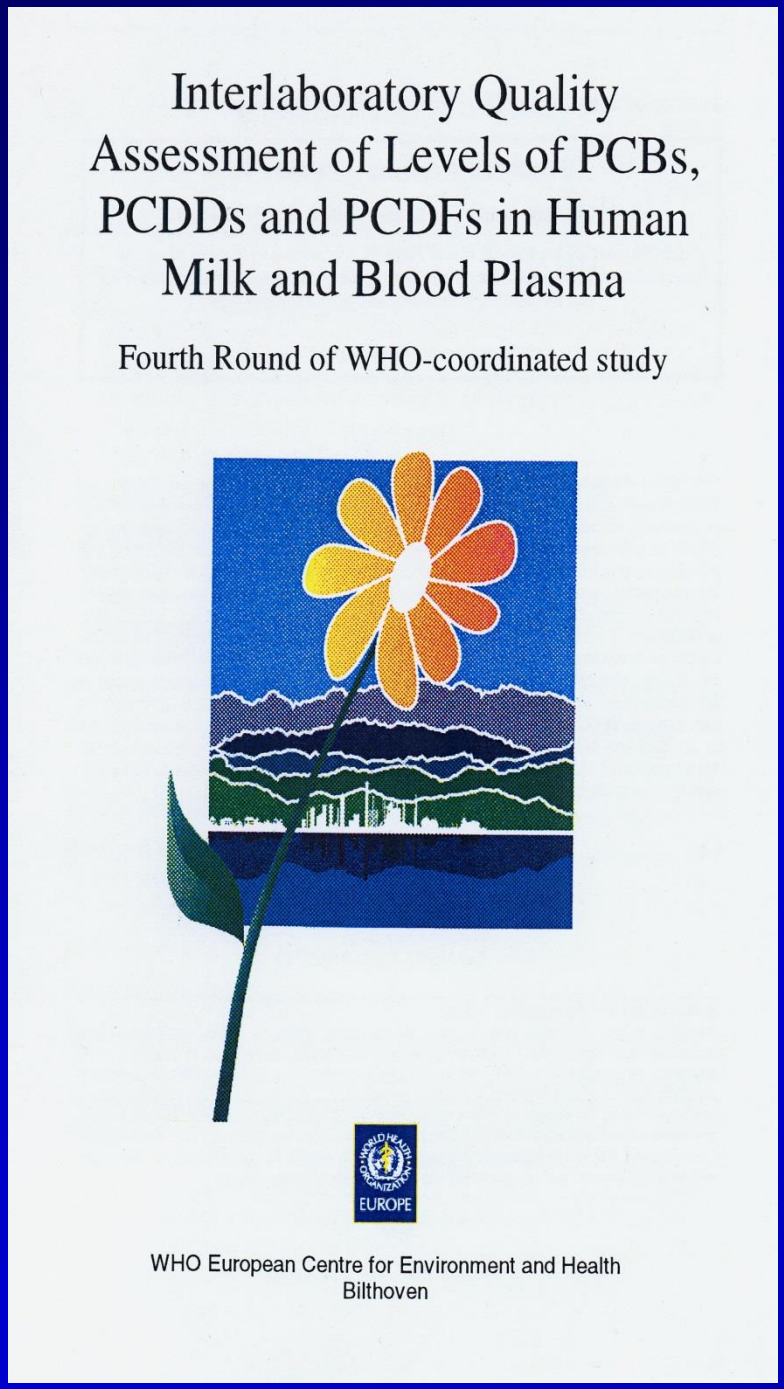
- **Minimum amount: 50 ml / individual sample**
- **Pooled sample: 1250 ml**

Analytical quality control for pooled samples

WHO-coordinated exposure studies on the levels of PCBs, PCDDs and PCDFs in human milk

1st Round	1987-1988	WHO-EURO	12 countries
2nd Round	1992-1993	WHO-EUR	19 countries

Preparation of next round (3rd round, start: 2000)



WHO quality assessment of PCB and PCDD/F analysis

Objectives of the study:

- **To assess the analytical quality of the participating laboratories based on**
  - ✓ **a statistical evaluation of between-laboratory comparability and**
  - ✓ **within-laboratory medium-term reliability of the analytical data**
- **To identify laboratories whose results can be accepted by WHO for exposure assessment studies**

CVUA Freiburg

(State Institute for Chemical and Veterinary Analysis of Food)

WHO/UNEP Reference Laboratory for dioxins, PCBs and halogenated pesticides (POPs) in human milk

EU Reference Laboratory (EU-RL) for dioxins and PCBs in feed and food

EU-RL for pesticides in food of animal origin and commodities with high fat content

WHO/UNEP-coordinated exposure studies on levels of PCBs, PCDDs and PCDFs in human milk

1st Round	1987-1988	WHO-EURO	12 countries
2nd Round	1992-1993	WHO-EUR	19 countries
3rd Round	2000-2003	WHO-EUR	26 countries
4th Round	2004-2007	WHO/UNEP	13 countries
5th Round	2008-2012	WHO/UNEP	49 countries
	2012-2015	UNEP	12 countries

Participating countries
3rd – 5th round (2000 – 2012)

Africa	Year
Congo, Dem.Rep.	2009
Côte d'Ivoire	2010
Djibouti	2011
Egypt	2001
Ethiopia	2012
Ghana	2009
Kenya	2009
Mali	2009
Mauritius	2009
Niger	2011
Nigeria	2008
Senegal	2009
Sudan	2006
Togo	2010
Uganda	2009
total no:	*15*
no of country/year entries:	*15*

America	Year
Antigua and Barbuda	2008
Barbados	2010
Brazil	2001-2002, 2012
Chile	2008, 2011
Cuba	2011
Haiti	2004, 2011
Jamaica	2011
Mexico	2011
Peru	2011
Suriname	2012
Uruguay	2009
USA	2003
total no:	*12*
no of country/year entries:	*15*

Asia	Year
Hong Kong SAR	2002, 2009
India	2009
Indonesia	2011
Israel	2012
Korea, Rep.	2008
Philippines	2002
Syria	2009
Tajikistan	2009
total no:	*8*
no of country/year entries:	*9*

Australia, New Zealand, Pacific Islands	Year
Australia	2002, 2010
Fiji	2002, 2006, 2011
Kiribati	2006, 2011
Marshall Islands	2011
New Zealand	2000, 2011
Niue	2011
Palau	2011
Samoa	2011
Solomon Islands	2011
Tonga	2008
Tuvalu	2011
total no:	*11*
no of country/year entries:	*16*

Europe	Year
Belgium *)	2002, 2006, 2010
Bulgaria	2001
Croatia	2001
Cyprus	2006
Czech Rep.	2001, 2006
Finland	2001, 2007
Georgia	2009
Germany	2002
Hungary	2001, 2006
Ireland	2001-2002, 2010
Italy	2001
Lithuania	2009
Luxembourg	2002, 2006
Moldova	2009
Norway	2001, 2006
Romania	2001
Russian Fed.	2001-2002
Slovak Rep.	2001, 2006
Spain	2001
Sweden	2001, 2007
Switzerland	2009
The Netherlands	2001
Ukraine	2001

*) in 5th round, only Flanders region

total no: *23*

no of country/year entries: *33*

Round 3: 2000 - 2003 (only)

Round 4: 2004 - 2007 (+ 3 in some cases

Round 5: 2008 - 2012 (+ 3 and/or 4 in some cases)

total number of countries:	69
total number of country/year en	88

Study	Period	No of countries	No of pooled samples
3rd round	2000 - 2003	26	102
4th round	2004 - 2007	13	18
5th round	2008 - 2012	49	54
Sum	2000 - 2012	88	174

Quality control programme (1)

Accreditation according to

- **DIN EN 17025**

(general request for accreditation of official control laboratories according to EU law)

Quality control programme (2)

Validation:

- **Blank samples**
- **Various quality control samples**
- **Participation in proficiency tests**

Quality control programme (3)

Duplicate analysis of breast milk samples as "overlapping sandwich method" (2000 – 2003)

From 69 samples, 38 as duplicates and 5 as triplicates.

CV for repeated analysis:

- **2.3 % for WHO-PCDD/F-TEQ**
- **4.0 % for WHO-PCB-TEQ**

Advantage

Comparable analytical performance over long period (> 15 years)

Selection of laboratories for individual samples

1. Capacity building: focus on quality control programmes

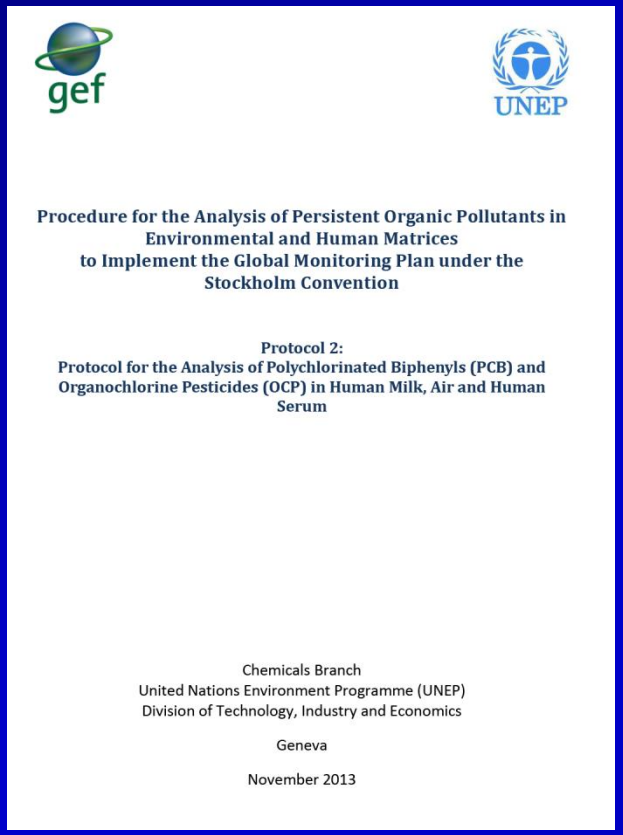
- Blank samples
- Various quality control samples
- Participation in proficiency tests

2. Contract laboratories:

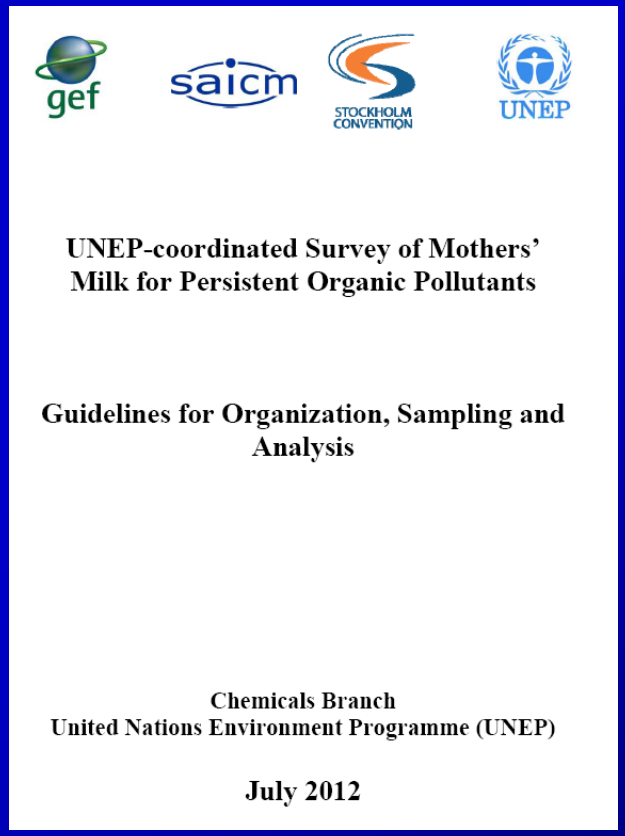
- Accredited?
- Successful participation in proficiency tests?

Harmonized methods – performance criteria

Two examples for established methods:



19 pages; air – human milk – human serum



p. 19 – 21 (basic POPs; PCDD/F+dl-PCBs)

Harmonized methods – performance criteria

Conclusion:

- Understand the methods and critical points
- validate, evalidate, validate …
- meet the analytical performance criteria
  (e.g. EU criteria for analysis of food and feed)

Project Cooperation Agreement (PCA) between UNEP and CVUA (2016 - 2019)

3 years project (2016 – 2019)

(planned according to state of play as of 01.06.2016)

- **Delivery of glassware containers *by 31.12.2016***
- **Milk from donor mothers collected and sent the pool sample to CVUA Freiburg for POPs analysis *by 31.10.2017***
- **Analysis in pooled samples by *31.01.2019***

Project Cooperation Agreement (PCA) between UNEP and CVUA (2016 - 2019)

1. Preparation (cleaning) and shipment of glassware containers to countries according to UNEP project:
   - 50 x 100 ml
   - 1 x 2 l

Project Cooperation Agreement (PCA) between UNEP and CVUA (2016 - 2019)

Project Cooperation Agreement (PCA) between UNEP and CVUA (2016 - 2019)

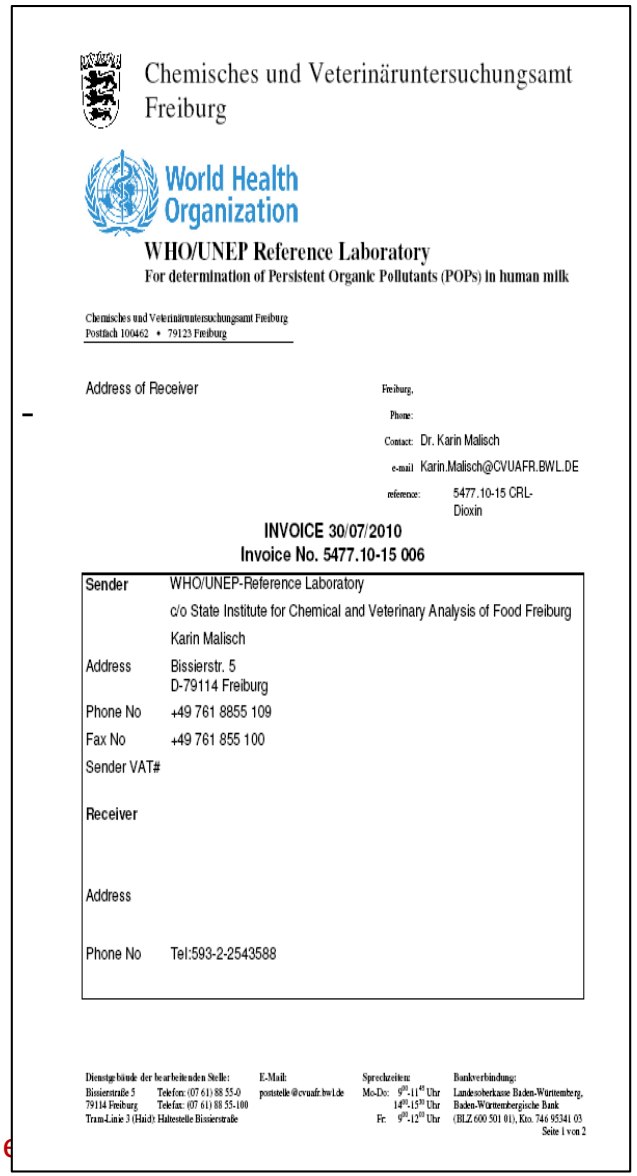
Project Cooperation Agreement (PCA) between UNEP and CVUA (2016 - 2019)

3 years project (2016 – 2019)

- **Delivery of glassware containers by 31.12.2016**

- Requirement:
  - ✓ Identification of participating countries
  - ✓ nomination of national coordinators
  - ✓ contact to CVUA Freiburg:
    Dr. Karin Malisch
    karin.malisch@cvuafr.bwl.de

Official letters to facilitate custom clearance



Chemisches und Veterinäruntersuchungsamt Freiburg

World Health Organization

WHO/UNEP Reference Laboratory
For determination of Persistent Organic Pollutants (POPs) in human milk

Chemisches und Veterinäruntersuchungsamt Freiburg
Postfach 100462 • 79123 Freiburg

Address of Receiver

Freiburg,
Phone:
Contact: Dr. Karin Malisch
e-mail Karin.Malisch@CVUAFR.BWL.DE
reference: 5477.10-15 CRL-Dioxin

INVOICE 30/07/2010
Invoice No. 5477.10-15 006

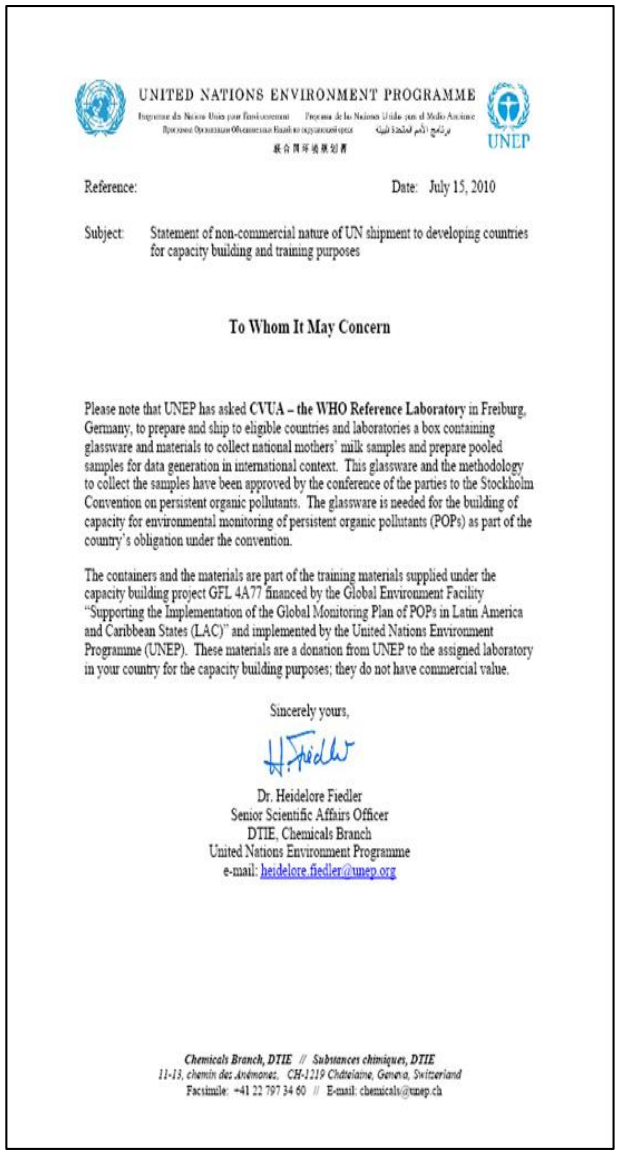
Sender	WHO/UNEP-Reference Laboratory
	c/o State Institute for Chemical and Veterinary Analysis of Food Freiburg
	Karin Malisch
Address	Bissierstr. 5 D-79114 Freiburg
Phone No	+49 761 8855 109
Fax No	+49 761 855 100
Sender VAT#	
Receiver	
Address	
Phone No	Tel:593-2-2543588

Dienstgebäude der bearbeitenden Stelle: Bissierstraße 5, 79114 Freiburg, Tram-Linie 3 (Haid) Haltestelle Bissierstraße
Telefon: (07 61) 88 55-0
Telefax: (07 61) 88 55-100
E-Mail: poststelle@cvuafr.bwl.de
Sprechzeiten: Mo-Do: 9[00]-11[45] Uhr, 14[00]-15[30] Uhr; Fr: 9[00]-12[00] Uhr
Bankverbindung: Landesoberkasse Baden-Württemberg, Baden-Württembergische Bank (BLZ 600 501 01), Kto. 746 95341 03
Seite 1 von 2

incoming

Materials/ Sample

Outgoing



UNITED NATIONS ENVIRONMENT PROGRAMME
UNEP

Reference: Date: July 15, 2010

Subject: Statement of non-commercial nature of UN shipment to developing countries for capacity building and training purposes

To Whom It May Concern

Please note that UNEP has asked **CVUA – the WHO Reference Laboratory** in Freiburg, Germany, to prepare and ship to eligible countries and laboratories a box containing glassware and materials to collect national mothers' milk samples and prepare pooled samples for data generation in international context. This glassware and the methodology to collect the samples have been approved by the conference of the parties to the Stockholm Convention on persistent organic pollutants. The glassware is needed for the building of capacity for environmental monitoring of persistent organic pollutants (POPs) as part of the country's obligation under the convention.

The containers and the materials are part of the training materials supplied under the capacity building project GFL 4A77 financed by the Global Environment Facility "Supporting the Implementation of the Global Monitoring Plan of POPs in Latin America and Caribbean States (LAC)" and implemented by the United Nations Environment Programme (UNEP). These materials are a donation from UNEP to the assigned laboratory in your country for the capacity building purposes; they do not have commercial value.

Sincerely yours,

Dr. Heidelore Fiedler
Senior Scientific Affairs Officer
DTIE, Chemicals Branch
United Nations Environment Programme
e-mail: heidelore.fiedler@unep.org

Chemicals Branch, DTIE // Substances chimiques, DTIE
11-13, chemin des Anémones, CH-1219 Châtelaine, Geneva, Switzerland
Facsimile: +41 22 797 34 60 // E-mail: chemicals@unep.ch

Project Cooperation Agreement (PCA) between UNEP and CVUA (2016 - 2019)

3 years project (2016 – 2019) – cont'd

- **Collection of samples and shipment to CVUA Freiburg 31.10.2017**
- Exchange of information on State of Play on collection of samples and shipment of pooled sample
  - **Close contact to Karin Malisch, CVUA Freiburg:**
    - **Clarification of customs clearance**
    - **Express delivery: Deep frozen, cooling elements, no dry ice**
- **Analysis in pooled samples by 31.01.2019**

Project Cooperation Agreement (PCA) between UNEP and CVUA

ECD amenable compounds: efficient cleanup?
AQC-Document SANTE 11945/2015 for pesticide analysis: confirmation using 2 different columns possible

Compounds to be analysed in pooled national mothers milk samples by CVUA under this Agreement	
Initial POPs	
Aldrin	Aldrin
Chlordane	*cis*- and *trans*-chlordane; and *cis*- and *trans*-nonachlor, oxychlordane
DDT	4,4'-DDT, 2,4'-DDT and 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, 2,4'-DDD
Dieldrin	Dieldrin
Endrin	Endrin
HCB	HCB
Heptachlor	Heptachlor and heptachlorepoxide
Mirex	Mirex
PCB	ΣPCB_6 (6 congeners): 28, 52, 101, 138, 153, and 180
	PCB with TEFs* (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189
PCDD/PCDF	2,3,7,8-substituted PCD/PCDF (17 congeners)
Toxaphene	Congeners P26, P50, P62

Project Cooperation Agreement (PCA) between UNEP and CVUA

POPs listed at COP-4	
Chlordecone	Chlordecone
α-HCH	α-HCH
β-HCH	β-HCH
γ-HCH	γ-HCH
Hexabromobiphenyl	PBB 153
Pentachlorobenzene	PeCBz
c-penta BDE	BDE 47, 99, 153, 154, 175/183 (co-eluting)
c-octa BDE	Optional: BDE 100
POPs listed at COP-5	
Endosulfan	α-, β-endosulfan; and endosulfan sulfate
POPs listed at COP-6	
HBCD	α-HBCD, β-HBCD, γ-HBCD

UNITED NATIONS

UNEP

SC

UNEP/POPS/COP.6/INF/33

Distr.: General
26 March 2013

English only

Stockholm Convention on Persistent Organic Pollutants

Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants
Sixth meeting
Geneva, 28 April–10 May 2013
Item 5 (i) of the provisional agenda*

Matters related to the implementation of the Convention: effectiveness evaluation

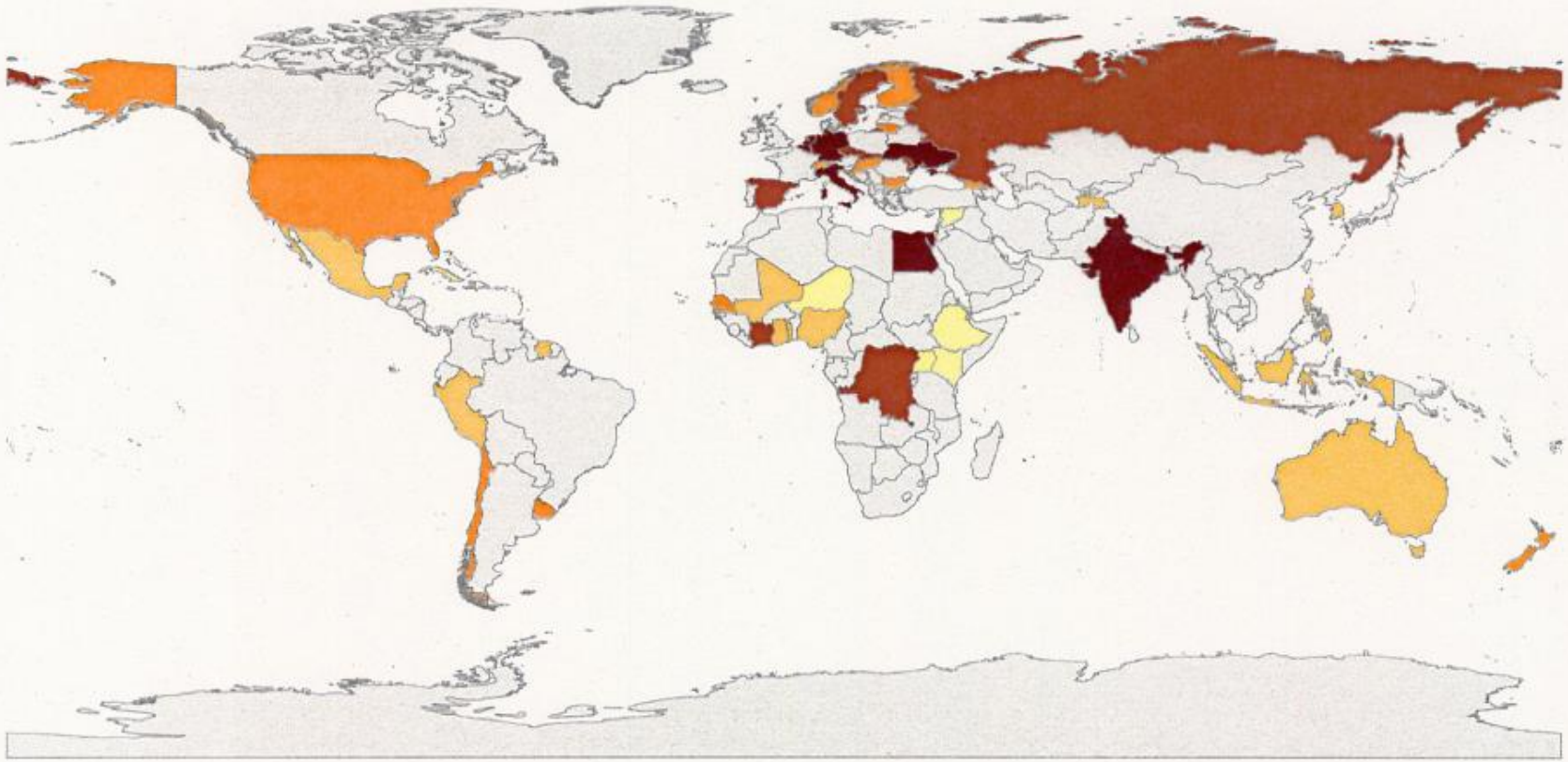
Results of the global survey on concentrations in human milk of persistent organic pollutants by the United Nations Environment Programme and the World Health Organization

- ✓ **Parameters**
  12 old, 9 new POPs
  = 21 parameters
  (without congeners, metabolites …)
- ✓ **Regions**
  - ➢ **Continents**
  - ➢ **Countries**
- ✓ **Time trends**

Aspects for differentiation

WHO-PCDD/F-PCB-TEQ

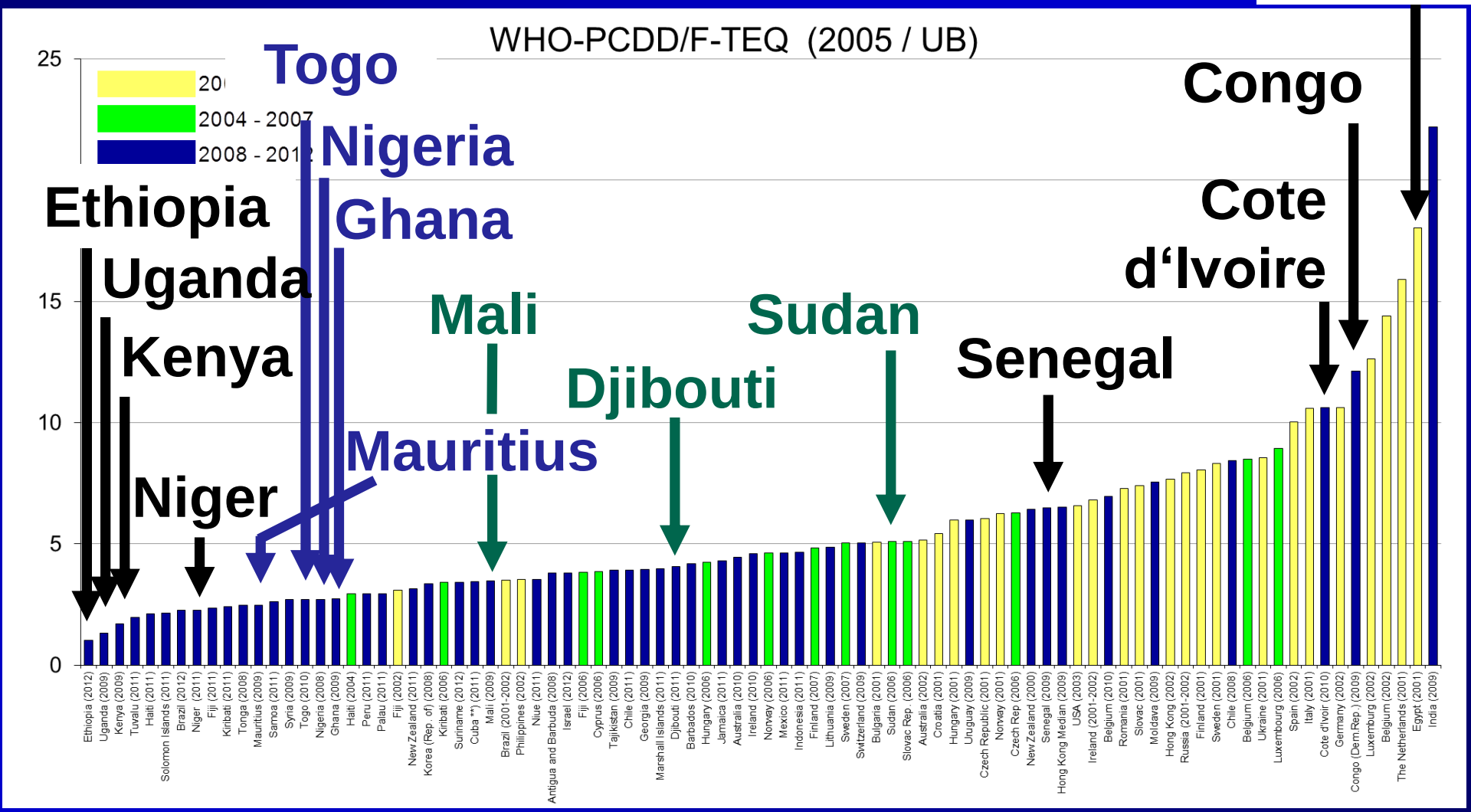
Breast milk (2000 – 2012)



Comparison of levels between countries

- NO „ranking“ between countries
- But identification of lower / middle / upper ranges
  - ✓ **Goal: findings allow setting priorities in different regions and countries**

Africa



pg WHO-PCDD/F-TEQ (2005) / g lipid

Egypt

Ministry of State for Environmental Affairs
Egyption Environmental Affairs Agency
EEAA-EIMP

- **Main source of dioxins is waste incineration**

Geophagia

- **Consumption of clay** quite common among ethnic minorities in the Netherlands, UK and certain parts of the population in Africa

- Consumption of clay by **pregnant women**
  - use against morning sickness, but also source of minerals

Clays collected from Africa (n=20)

- Increased dioxin levels in some of the clays with a **highest observed level of 103 ng TEQ/kg**

RIKILT
INSTITUTE OF FOOD SAFETY
WAGENINGEN UR

Ball clay / caolinitic clay I

Food and Drug Administration (USA), 1997:

- **Ball clay** (bentonite) **as source of dioxin contamination** in poultry, commercial catfish and eggs
- Used as **feed additive** (to soybean meal, as flowing or anticaking agent)
- Origin: mine in Mississippi

Ball clay / caolinitic clay II

EU, 1999:

- ✓ **Caolinitic clay as source of dioxin contamination**
- ✓ **Feed additive** (anticaking agent)
- ✓ Origin: mine in Germany
- ✓ Same PCDD/F pattern as in clay from Mississippi (OCDD-dominated; no furans; similar to PCP)
- ✓ Range of contamination:
  > 100,000 to > 500,000 pg WHO-TEQ/kg

Ball clay / caolinitic clay III

Obvious: natural source

- Possibly, geological processes formed this unique pattern of dioxins over time from organic material and chlorine.

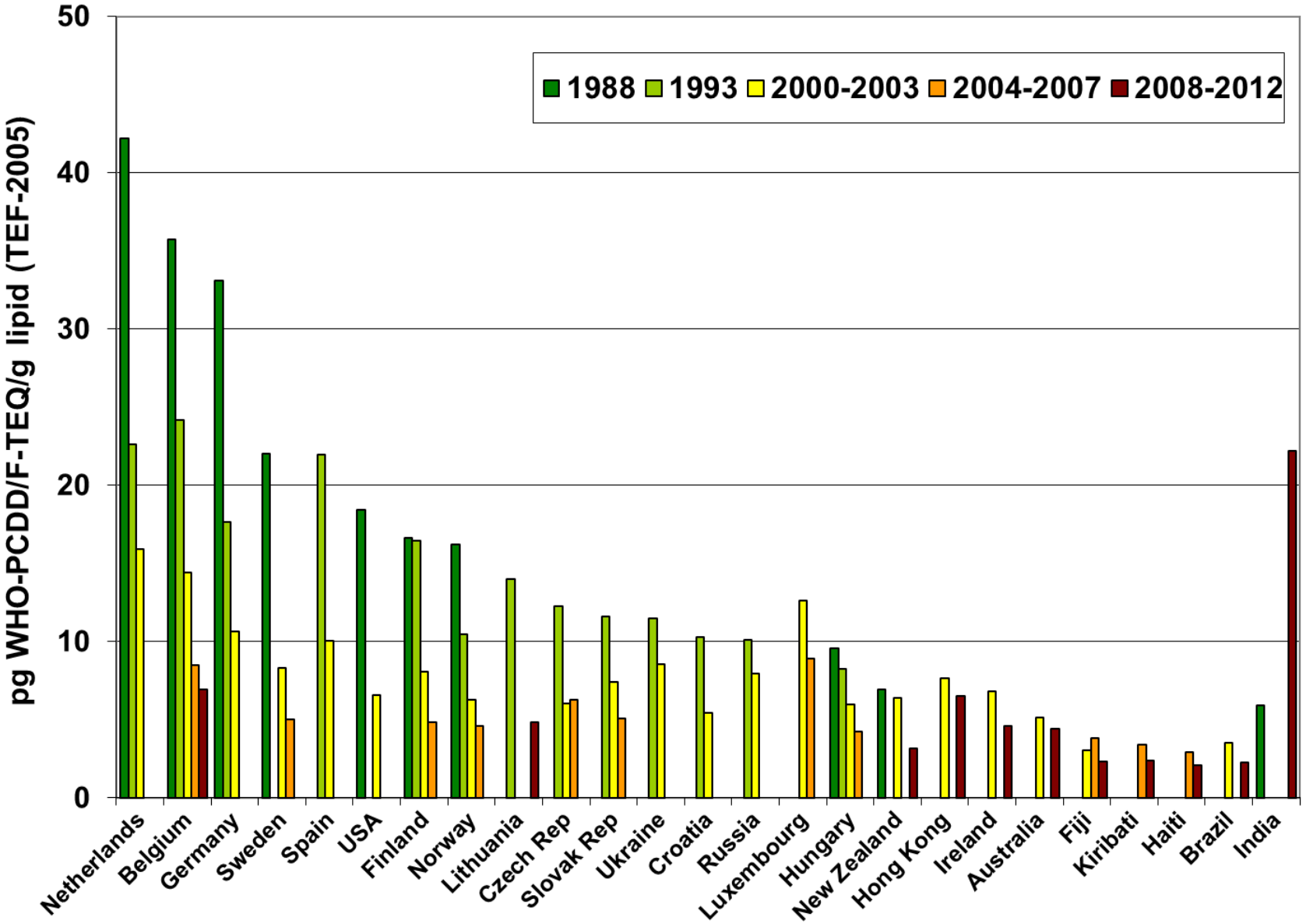
Conclusions for breast milk from Ivory Coast and Congo

- Dioxin pattern in clays can explain pattern in human milk
- Use of clay likely to be responsible for elevated dioxin levels in breast milk from some African countries
- Potential risk

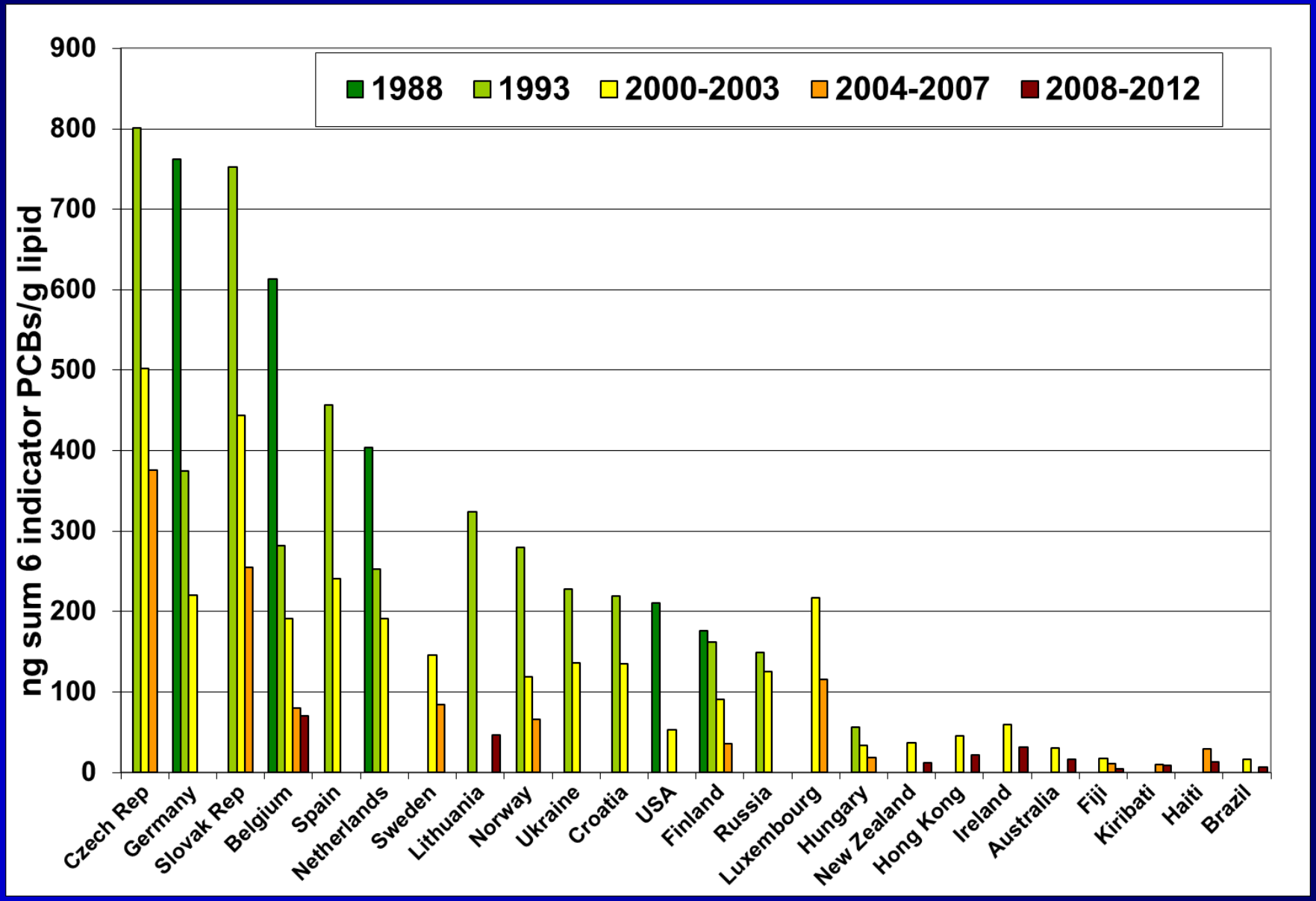
Time trends

Temporal trend of PCDD/F in human milk

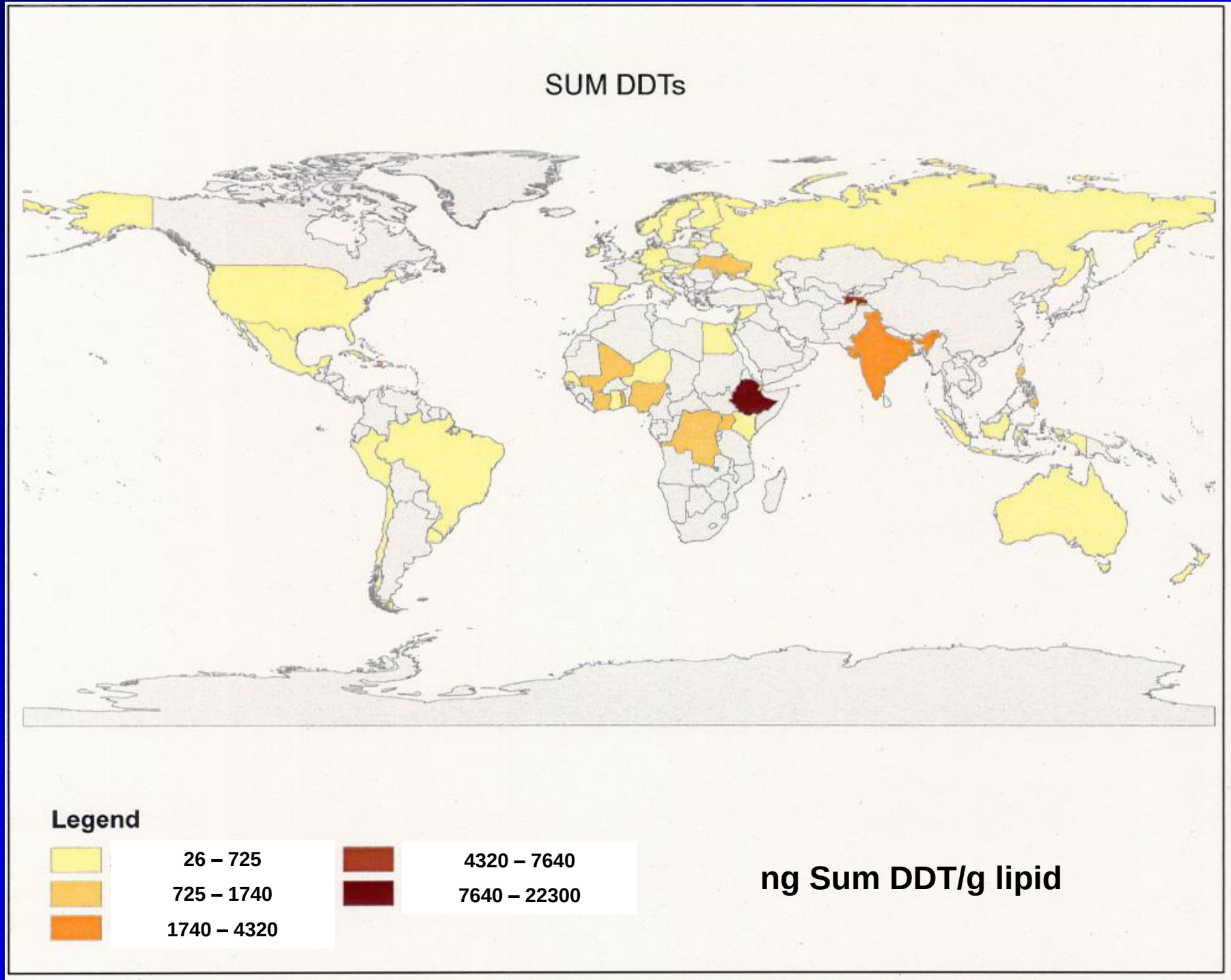
(pg WHO-PCDD/F-TEQ/g lipid; TEF-2005)



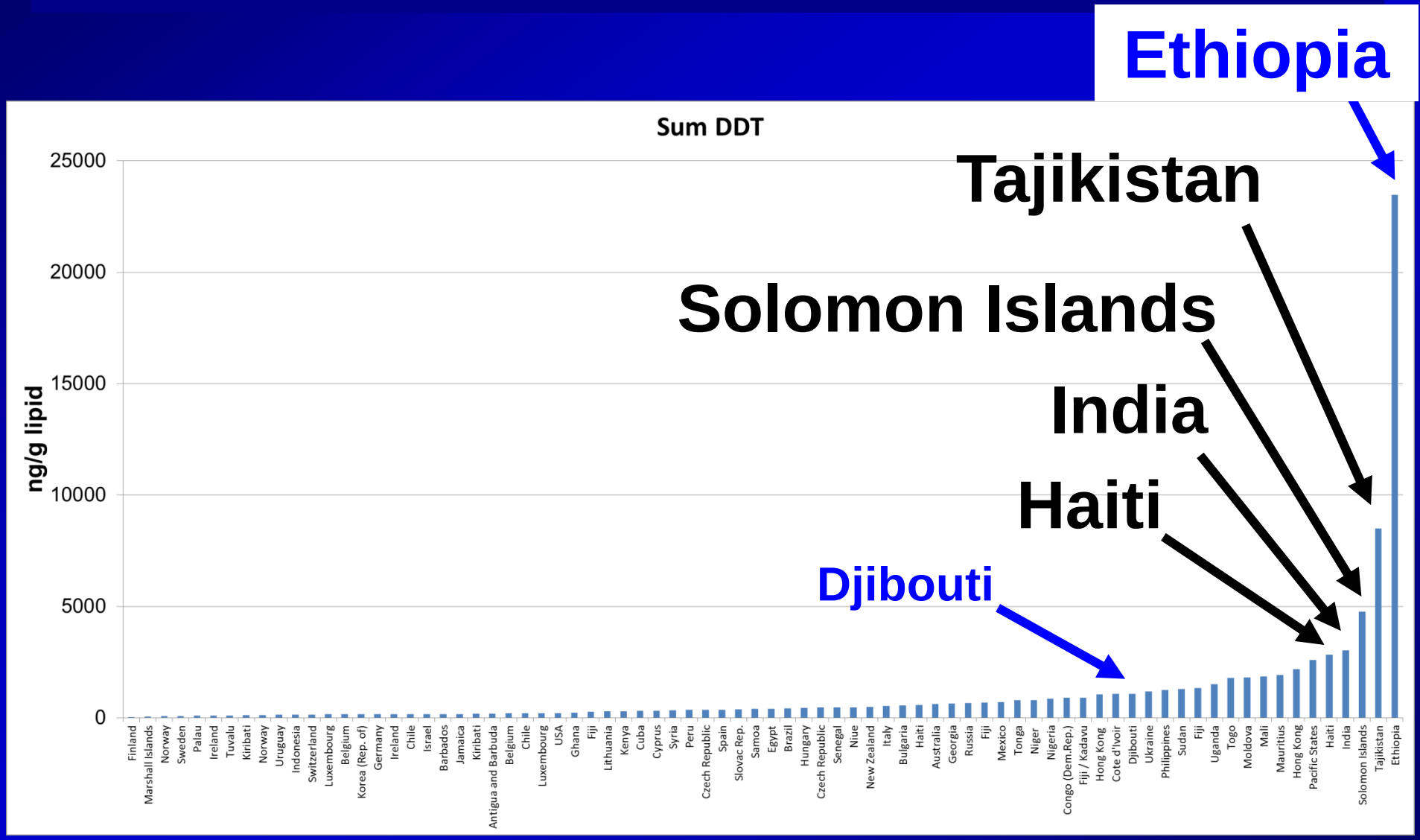
Sum 6 Indicator PCB



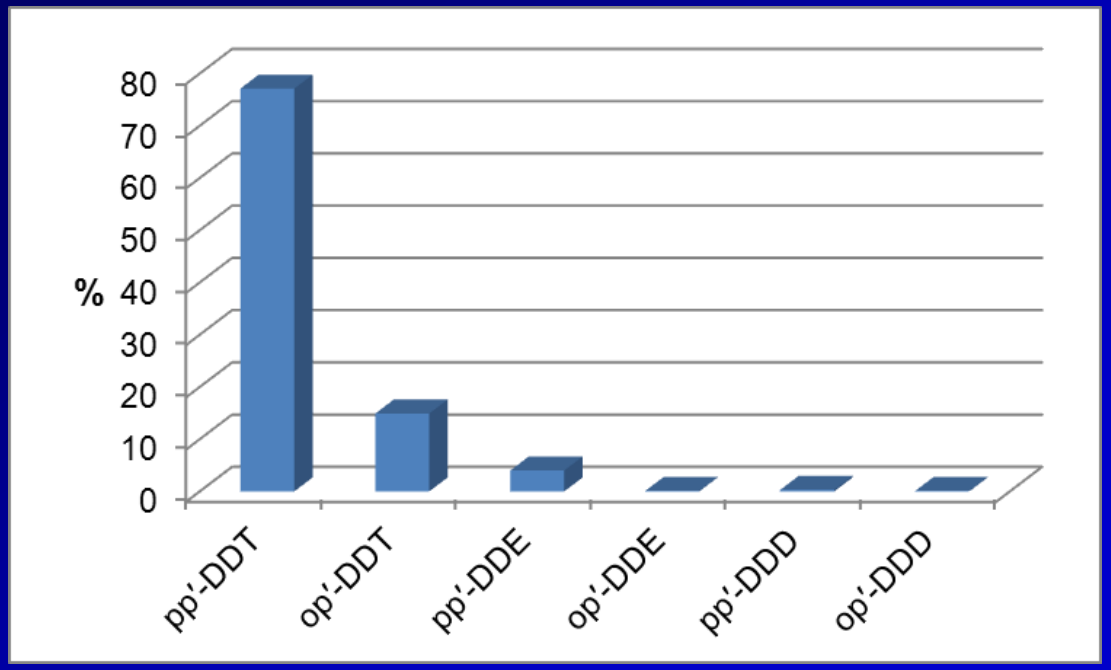
DDT


SUM DDTs
Legend
26 – 725
725 – 1740
1740 – 4320
4320 – 7640
7640 – 22300
ng Sum DDT/g lipid

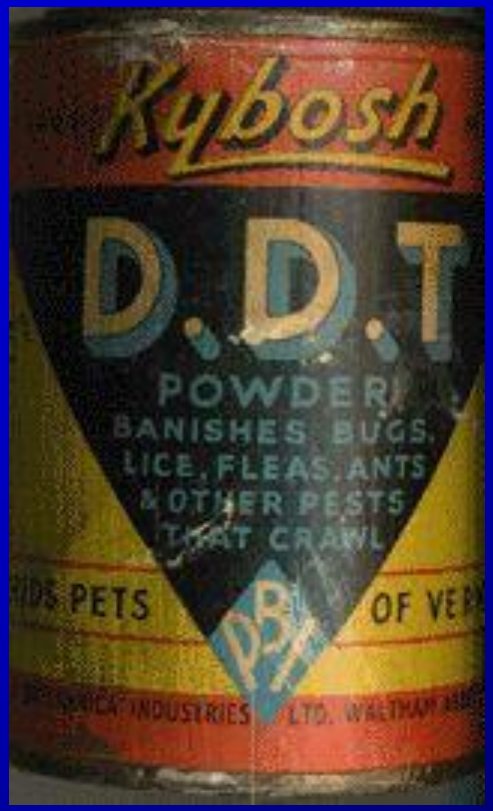
Median levels of DDT (ng/g lipid)



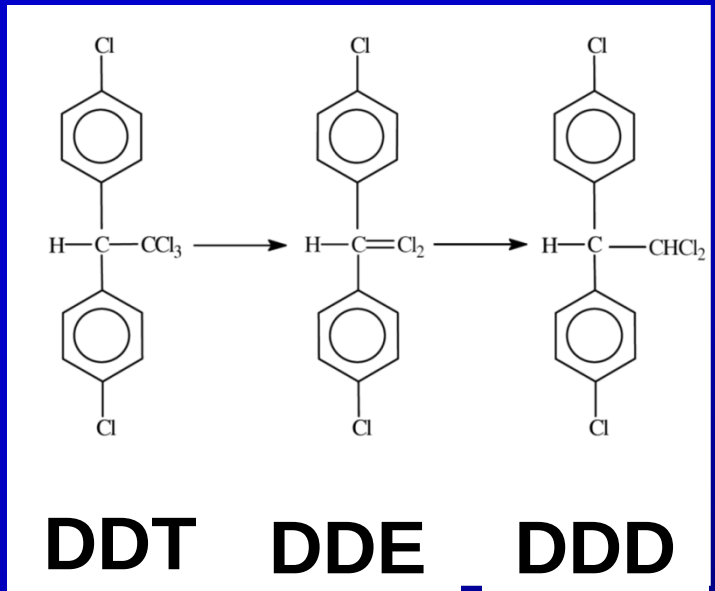
Max: 23500 ng sum DDT/g lipid *(= 23.5 mg/kg)*



DDT

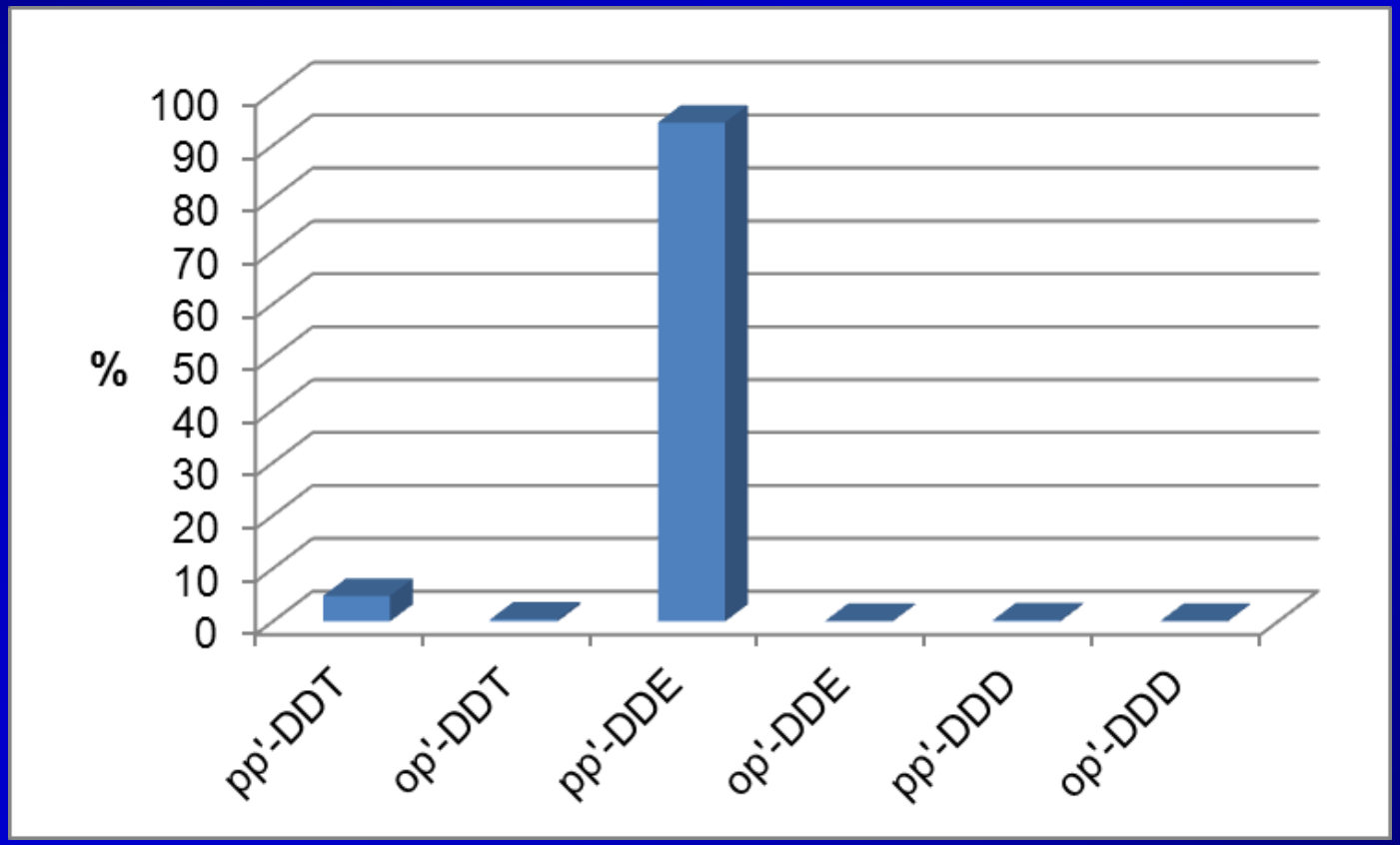


Composition of technical DDT (%)

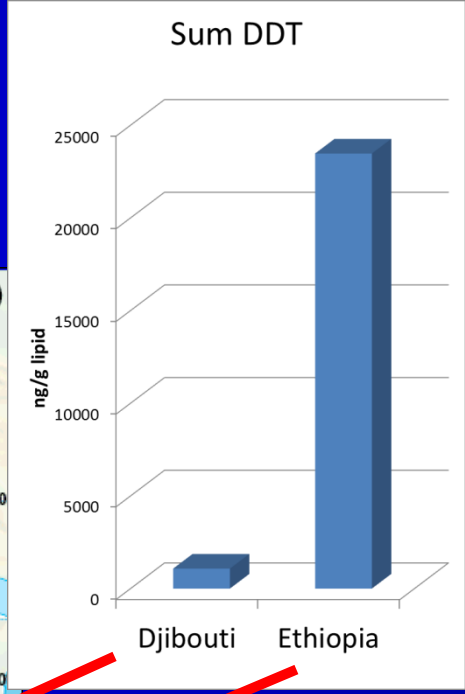


Contribution (%) to Sum DDT in humans

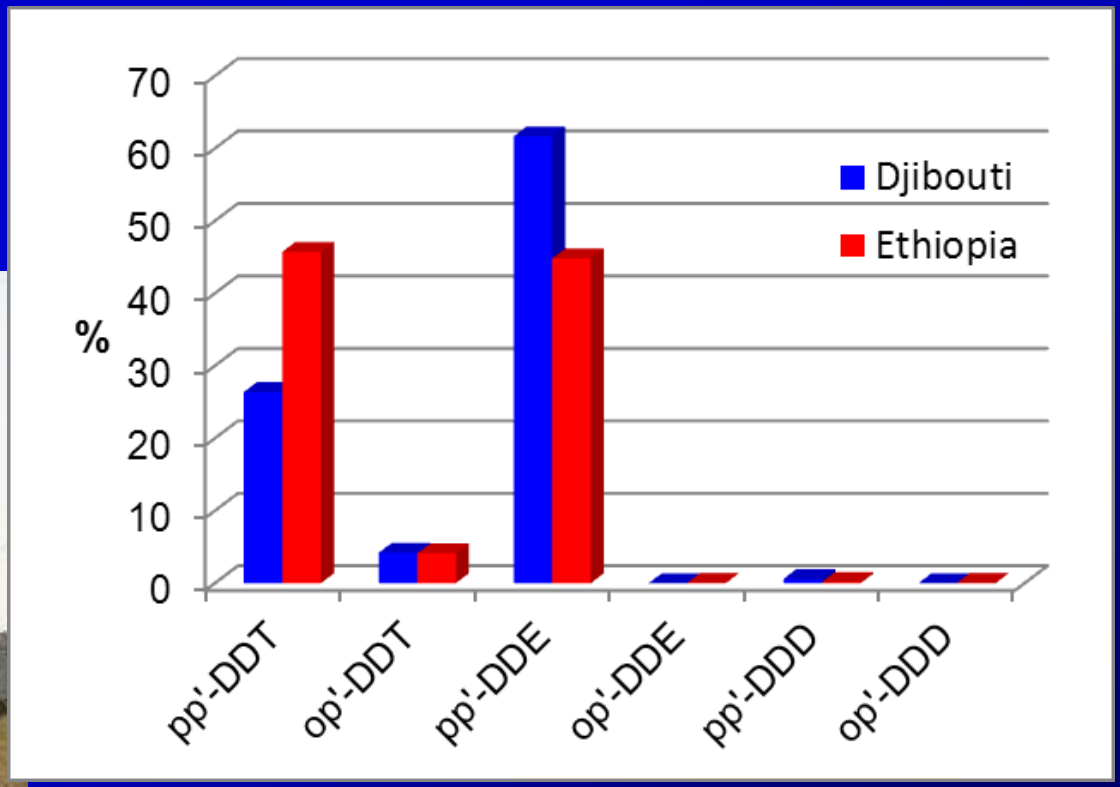
(all samples except from Ethiopia and Djibouti, median of 97 samples)



Sum DDT (ng/g lipid) in breast milk from Ethiopia and Djibouti



Contribution (%) to Sum DDT in breast milk from Djibouti and Ethiopia

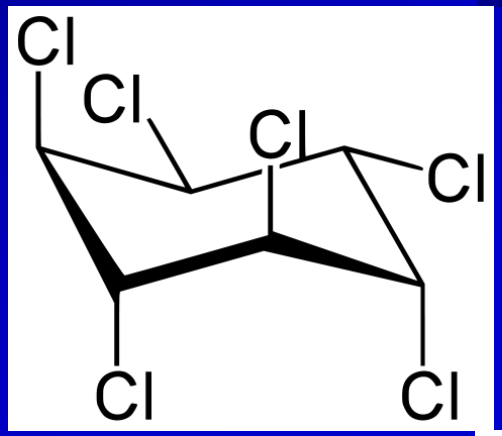


HCH

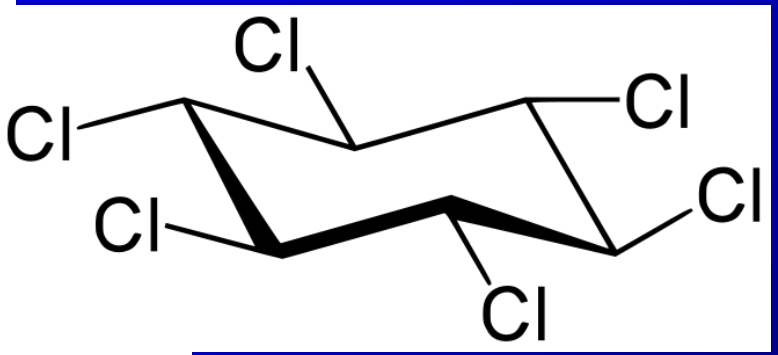
Technical HCH:

HCH

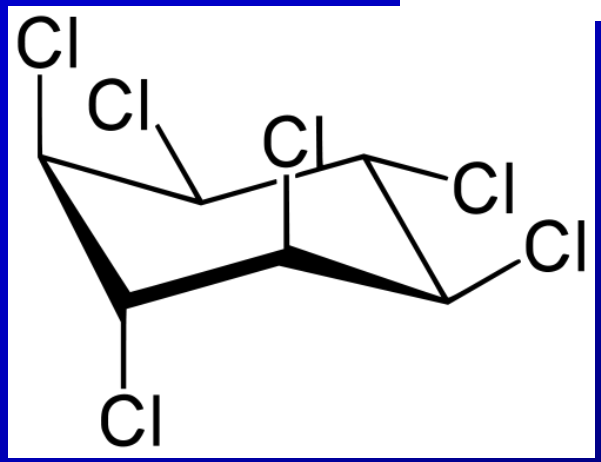
- ✓ **Alpha-HCH** (65 – 70 %)



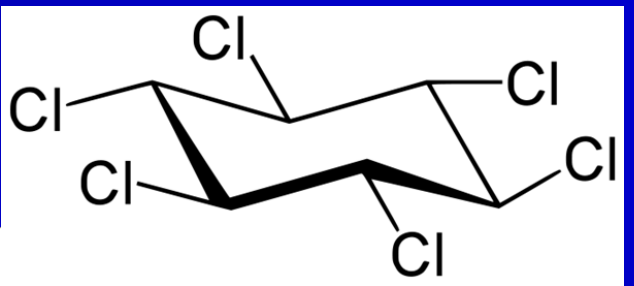
- ✓ **Beta-HCH** (7 – 20 %)

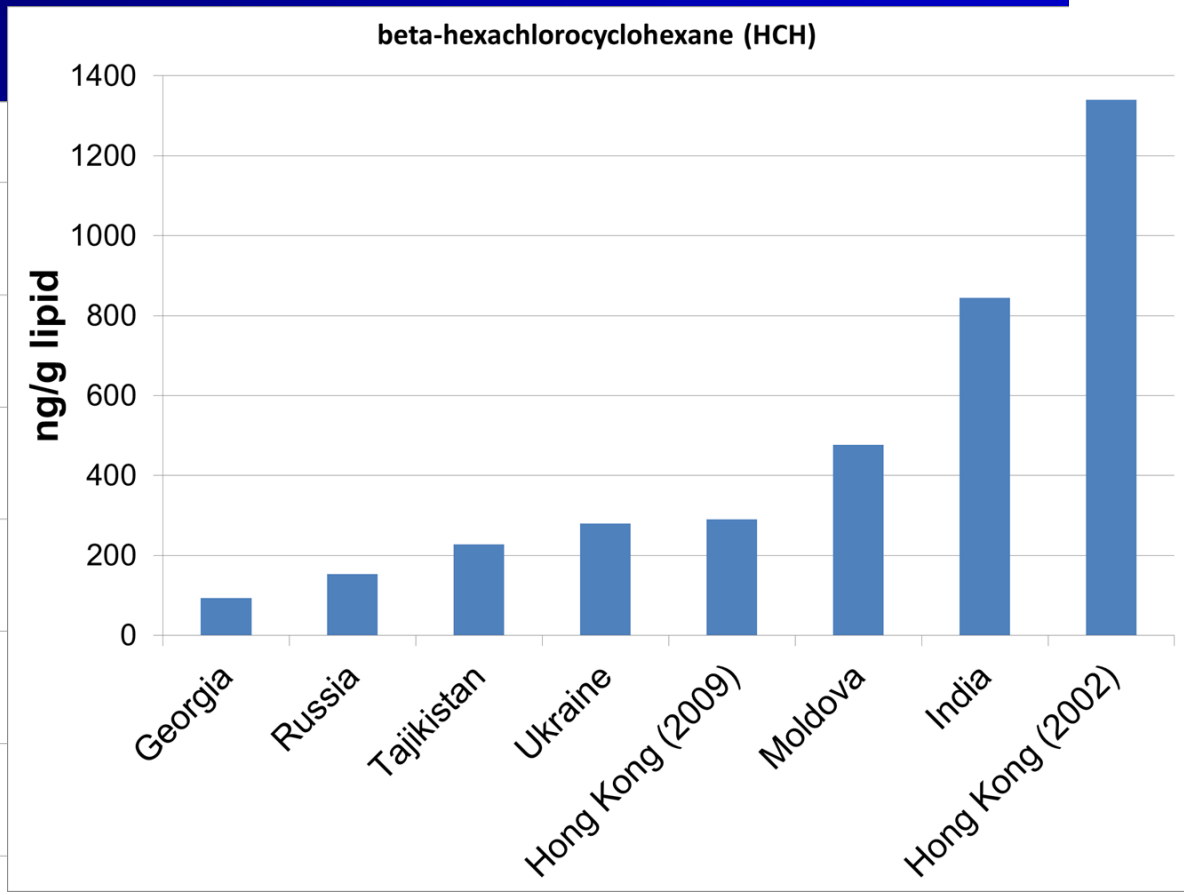


- ✓ **Gamma-HCH** (14 – 15 %)



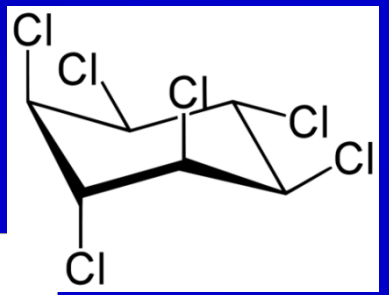
Beta-HCH

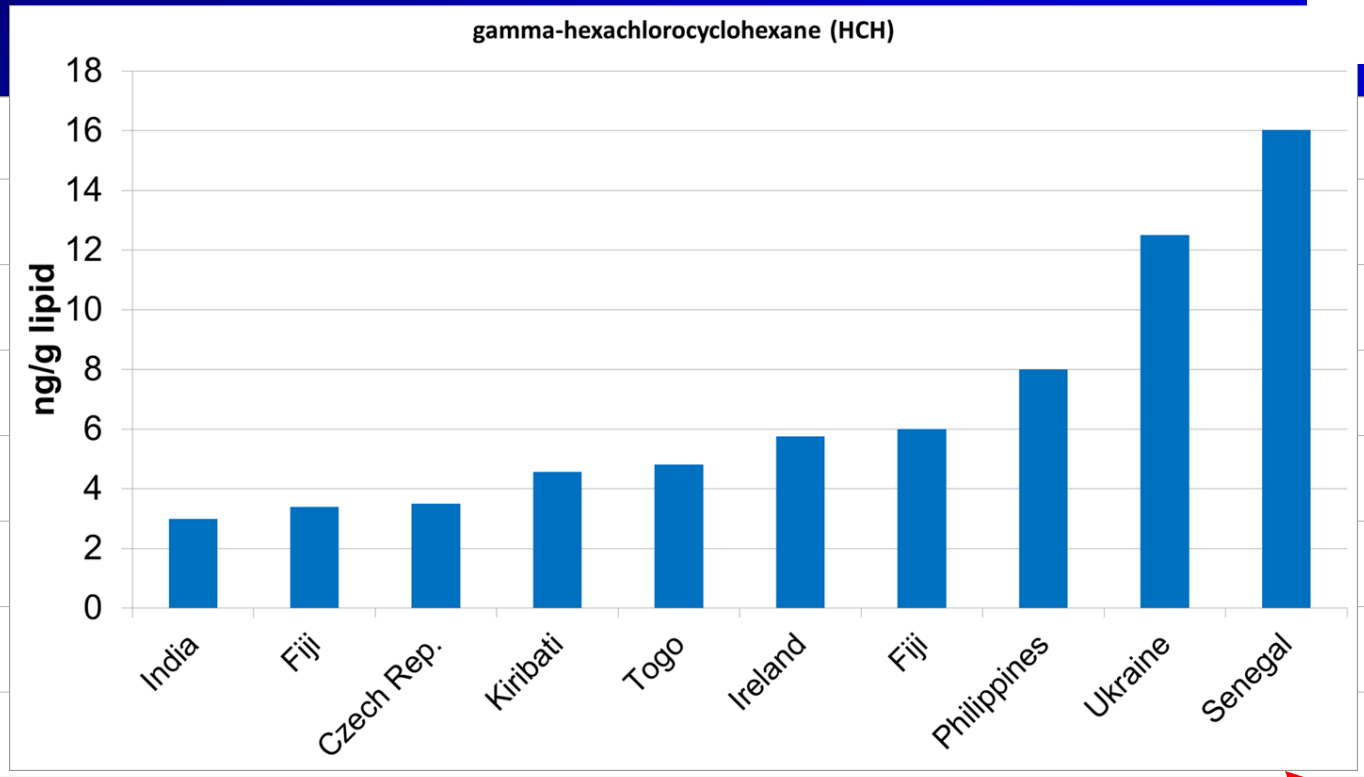

Cl
Cl
Cl
Cl
Cl
Cl


beta-hexachlorocyclohexane (HCH)
ng/g lipid
1400
1200
1000
800
600
400
200
0
Georgia
Russia
Tajikistan
Ukraine
Hong Kong (2009)
Moldova
India
Hong Kong (2002)

ng/g lipid
1400
1200
1000
800
600
400
200
0
Haiti (2005)
Haiti (2011)
Chile (2011)
Ethiopia (2013)
Tonga (2008)
Jamaica (2011)
Togo (2010)
Tuvalu (2011)
Samoa (2011)
Fiji / Kadavu (2011)
Mexico (2011)
Fiji (2011)
Congo (Dem.Rep.) (2009)
Niue (2011)
Marshall Islands (2011)
Fiji (2006)
Kenya (2009)
Palau (2011)
Uganda (2009)
Ghana (2009)
Indonesia (2011)
Finland (2001)
Antigua and Barbuda (2009)
Switzerland (2009)
Kiribati (2011)
Pacific States (2011)
Solomon Islands (2011)
Barbados (2010)
Fiji (2002)
Norway (2006)
New Zealand (2011)
Kiribati (2006)
Cuba (2011)
Chile (2009)
Sweden (2007)
Djibouti (2011)
Niger (2012)
Philippines (2002)
Slovak Rep. (2006)
Belgium (2010)
Norway (2001)
Israel (2012)
Australia (2010)
Cote d'Ivoire (2010)
Belgium (2006)
USA (2003)
Lithuania (2009)
Ireland (2010)
Luxembourg (2006)
Hungary (2006)
Germany (2002)
Korea (Rep. of) (2009)
Czech Rep. (2006)
Mauritius (2009)
Cyprus (2006)
Peru (2011)
Luxembourg (2002)
Ireland (2002)
Brazil (2002)
Mali (2009)
Czech Rep. (2001)
Syria (2009)
Nigeria (2009)
Uruguay (2009)
Sudan (2006)
Senegal (2009)
Egypt (2002)
Bulgaria (2001)
Italy (2001)
Spain (2002)
Georgia (2009)
Russia (2002)
Tajikistan (2009)
Ukraine (2001)
Hong Kong SAR (2009)
Moldova (2009)
India (2009)
Hong Kong SAR (2002)

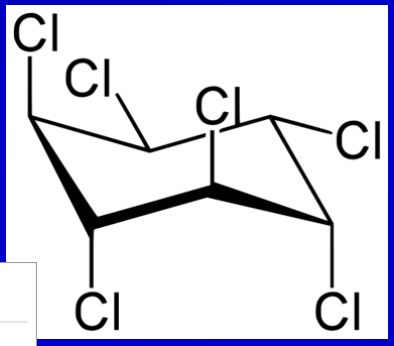
Gamma-HCH

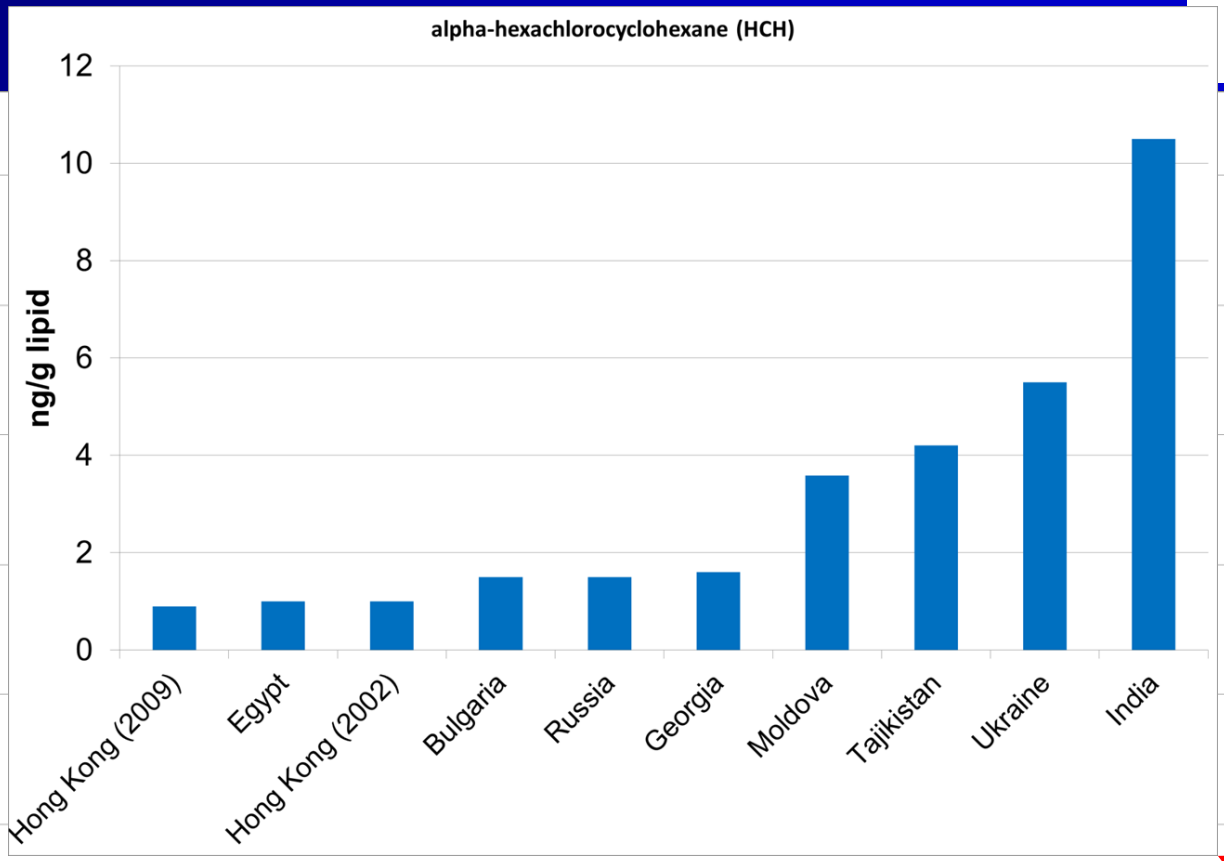

Cl
Cl
Cl
Cl
Cl
Cl


gamma-hexachlorocyclohexane (HCH)
ng/g lipid
0
2
4
6
8
10
12
14
16
18
India
Fiji
Czech Rep.
Kiribati
Togo
Ireland
Fiji
Philippines
Ukraine
Senegal

ng/g lipid
0
2
4
6
8
10
12
14
16
18
Australia (2010)
Barbados (2010)
Belgium (2010)
Brazil (2002)
Chile (2011)
Chile (2009)
Congo (Dem.Rep.) (2009)
Czech Rep. (2006)
Djibouti (2011)
Ethiopia (2013)
Fiji / Kadavu (2011)
Georgia (2009)
Haiti (2011)
Hong Kong SAR (2009)
Hungary (2006)
Indonesia (2011)
Ireland (2010)
Israel (2012)
Italy (2001)
Jamaica (2011)
Kiribati (2011)
Korea (Rep. of) (2009)
Luxembourg (2006)
Luxembourg (2002)
Mali (2009)
Marshall Islands (2011)
Mexico (2011)
New Zealand (2011)
Niger (2012)
Nigeria (2009)
Niue (2011)
Norway (2001)
Peru (2011)
Sudan (2006)
Switzerland (2009)
Syria (2009)
Tuvalu (2011)
Uruguay (2009)
Tonga (2008)
Norway (2006)
Cyprus (2006)
Moldova (2009)
Uganda (2009)
Ghana (2009)
Belgium (2006)
Fiji (2006)
Solomon Islands (2011)
Lithuania (2009)
Pacific States (2011)
Sweden (2007)
Tajikistan (2009)
Finland (2001)
Bulgaria (2001)
Russia (2002)
Antigua and Barbuda (2009)
Mauritius (2009)
Palau (2011)
Germany (2002)
Cuba (2011)
USA (2003)
Slovak Rep. (2006)
Hong Kong SAR (2002)
Spain (2002)
Samoa (2011)
Cote d'Ivoire (2010)
Kenya (2009)
Egypt (2002)
Haiti (2005)
India (2009)
Fiji (2011)
Czech Rep. (2001)
Kiribati (2006)
Togo (2010)
Ireland (2002)
Fiji (2002)
Philippines (2002)
Ukraine (2001)
Senegal (2009)

Alpha-HCH


Cl
Cl
Cl
Cl
Cl
Cl


alpha-hexachlorocyclohexane (HCH)
ng/g lipid
12
10
8
6
4
2
0
Hong Kong (2009)
Egypt
Hong Kong (2002)
Bulgaria
Russia
Georgia
Moldova
Tajikistan
Ukraine
India

ng/g lipid
12
10
8
6
4
2
0
Antigua and Barbuda (2009)
Australia (2010)
Barbados (2010)
Belgium (2010)
Belgium (2006)
Brazil (2002)
Chile (2011)
Chile (2009)
Congo (Dem.Rep.) (2009)
Cote d'Ivoire (2010)
Cuba (2011)
Cyprus (2006)
Czech Rep. (2006)
Czech Rep. (2001)
Djibouti (2011)
Ethiopia (2013)
Fiji (2011)
Fiji (2006)
Fiji (2002)
Fiji / Kadavu (2011)
Finland (2001)
Germany (2002)
Ghana (2009)
Haiti (2005)
Haiti (2011)
Hungary (2006)
Indonesia (2011)
Ireland (2010)
Ireland (2002)
Israel (2012)
Italy (2001)
Jamaica (2011)
Kenya (2009)
Kiribati (2011)
Kiribati (2006)
Korea (Rep. of) (2009)
Lithuania (2009)
Luxembourg (2006)
Luxembourg (2002)
Mali (2009)
Marshall Islands (2011)
Mauritius (2009)
Mexico (2011)
New Zealand (2011)
Niger (2012)
Nigeria (2009)
Niue (2011)
Norway (2006)
Norway (2001)
Pacific States (2011)
Palau (2011)
Peru (2011)
Philippines (2002)
Samoa (2011)
Senegal (2009)
Slovak Rep. (2006)
Solomon Islands (2011)
Spain (2002)
Sudan (2006)
Sweden (2007)
Switzerland (2009)
Syria (2009)
Togo (2010)
Tonga (2008)
Tuvalu (2011)
Uganda (2009)
Uruguay (2009)
USA (2003)
Hong Kong SAR (2009)
Egypt (2002)
Hong Kong SAR (2002)
Bulgaria (2001)
Russia (2002)
Georgia (2009)
Moldova (2009)
Tajikistan (2009)
Ukraine (2001)
India (2009)

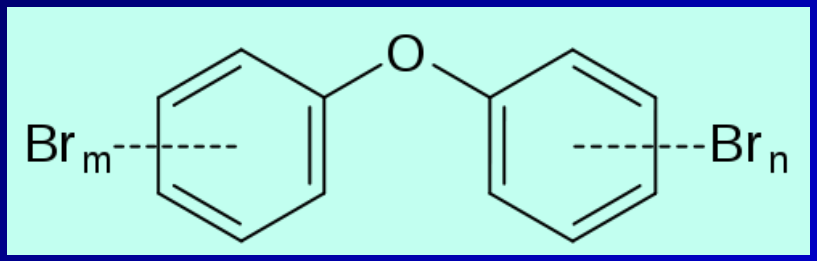
Difference environment - human

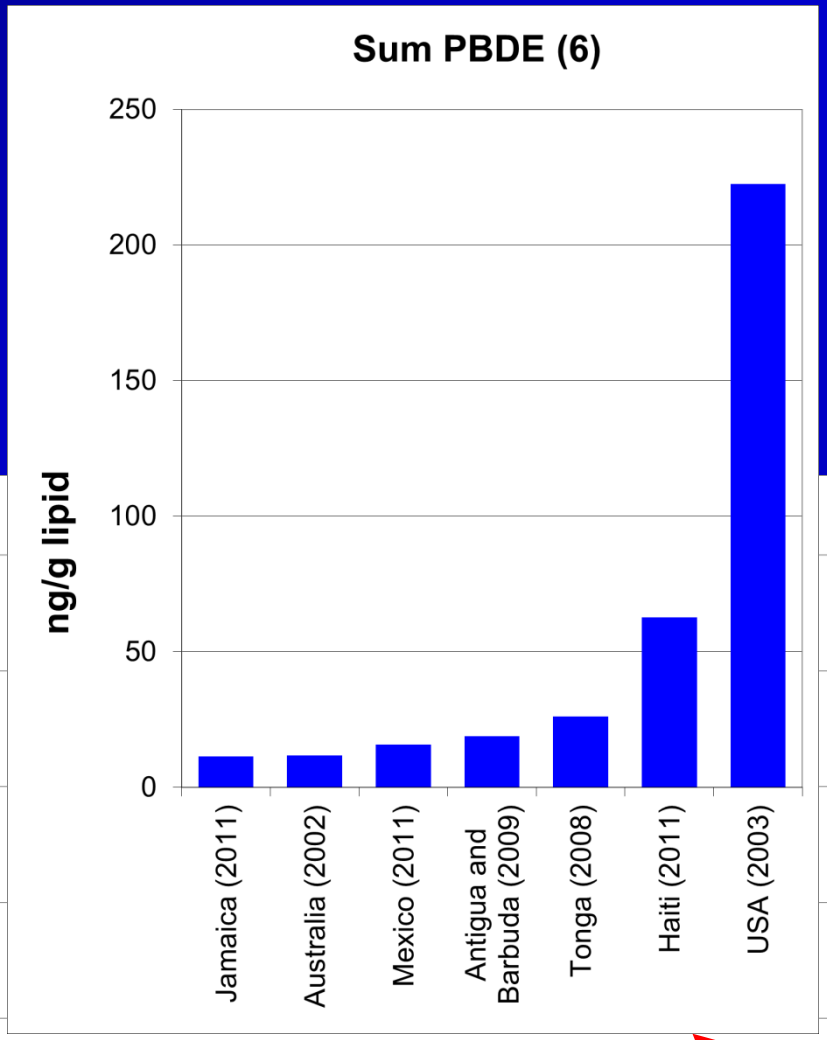
- Metabolization in mammals can change patterns of technical mixtures in comparison to the emission source, air, water or fish

  (beta-HCH; alpha-HBCDD; DDE; PCDD/F; …)

Other POPs

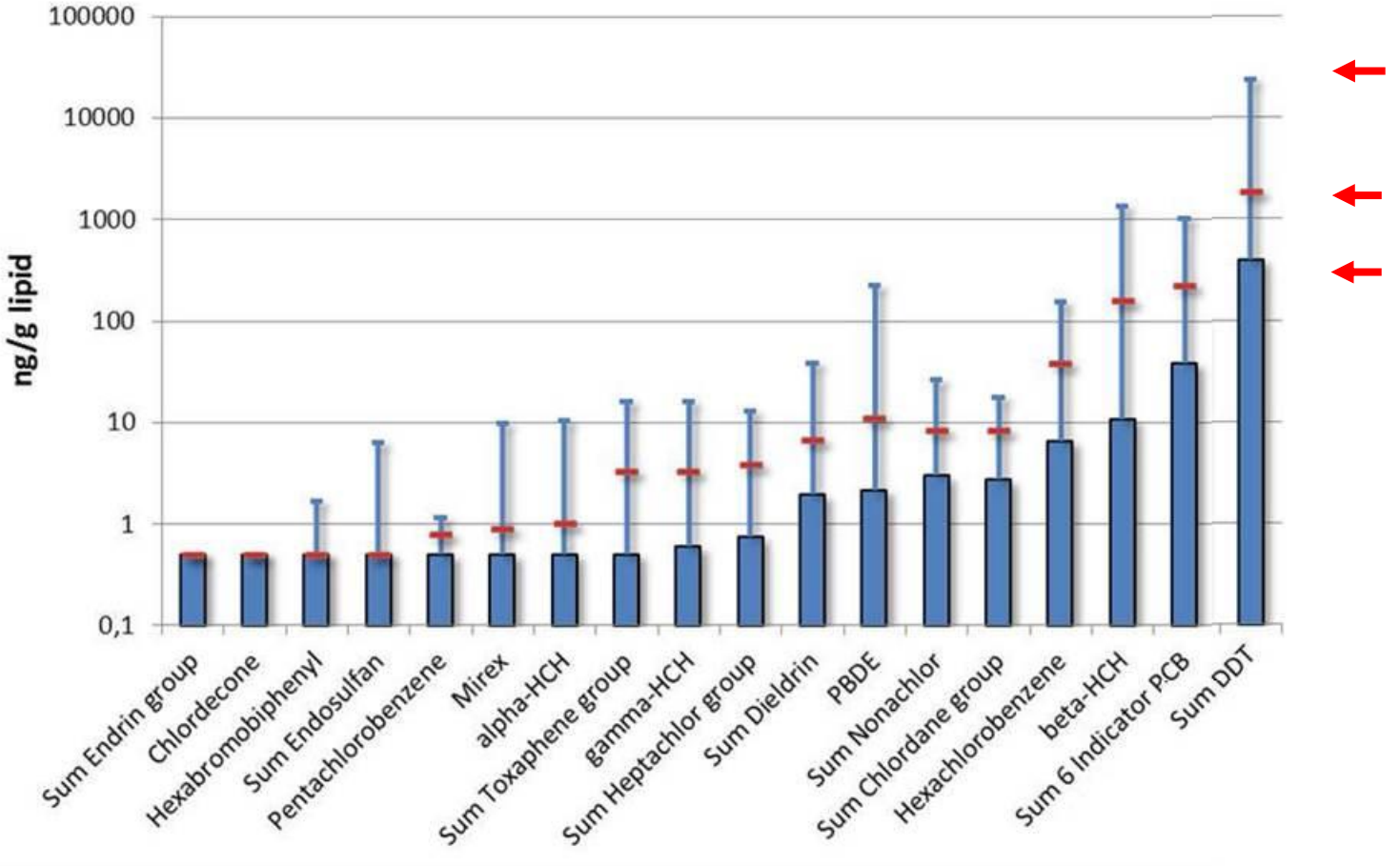
Sum PBDE





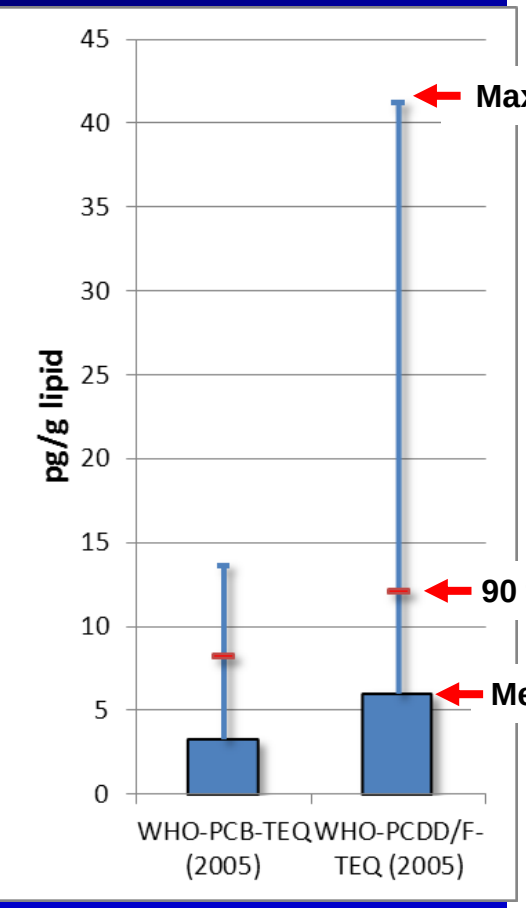
No increase of PBDD/F-levels with increasing PBDE levels

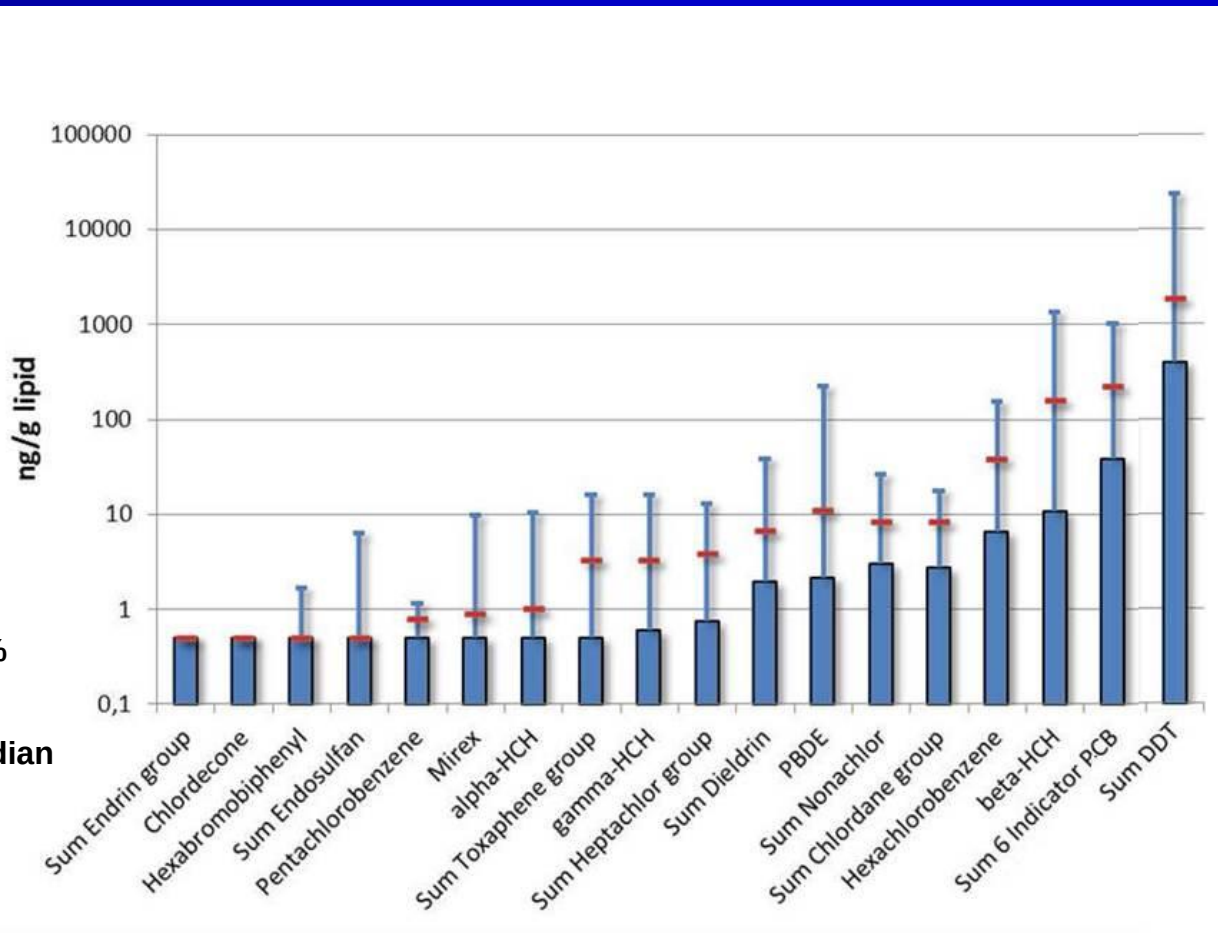
Stockholm Convention POPs in breast milk
(ng/g lipid)



Stockholm Convention POPs in breast milk

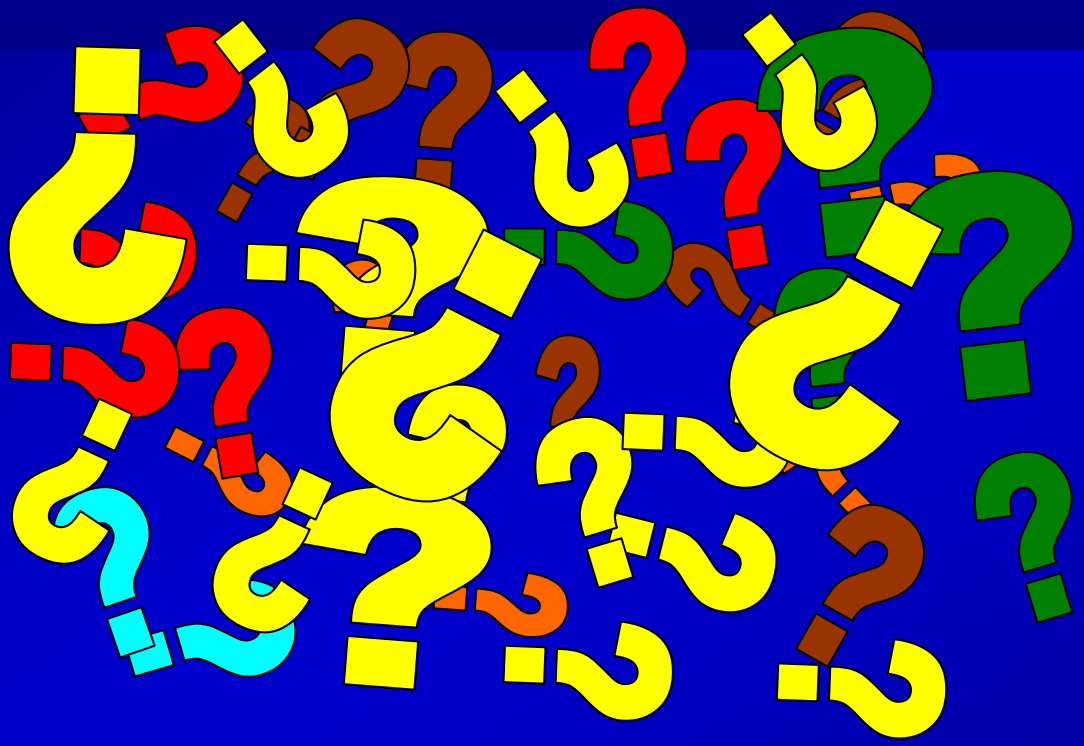
(pg/g lipid resp. ng/g lipid)





Thanks

Final



Thank you for your attention