Key outcomes from the human milk surveys

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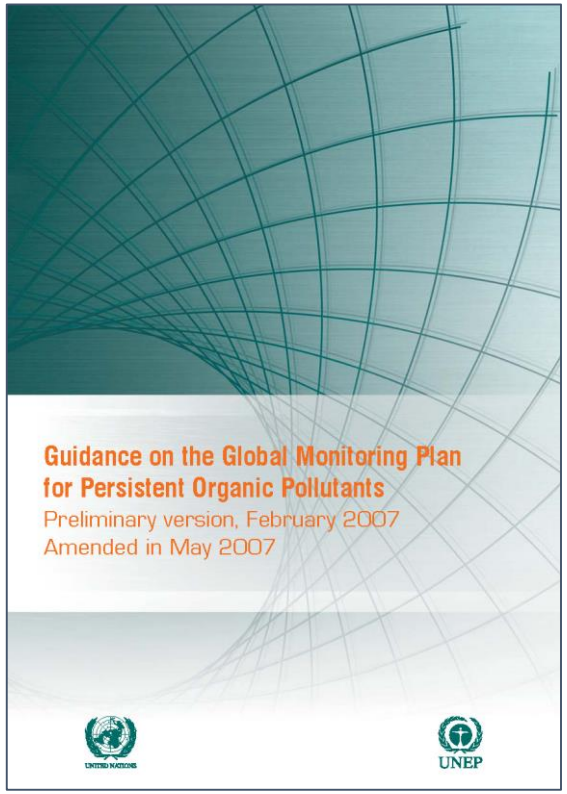

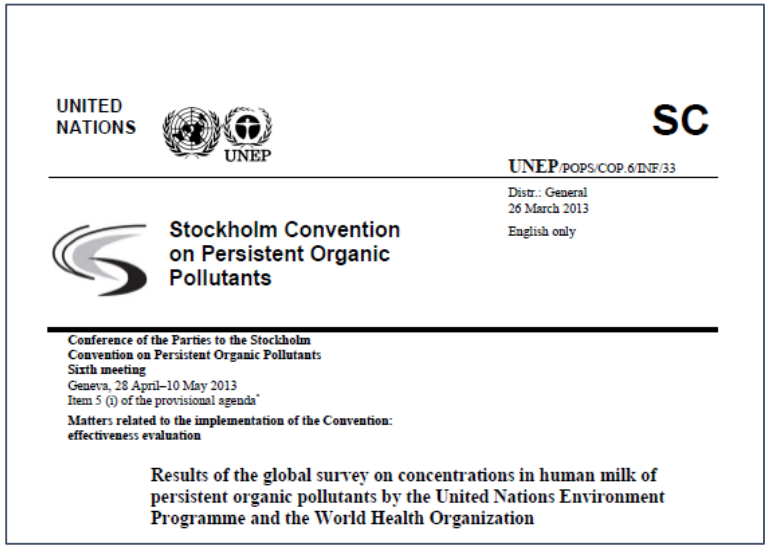
UNITED NATIONS

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UNEP/POPS/COP.6/INF/33

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Stockholm Convention on Persistent Organic Pollutants

Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants
Sixth meeting
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Item 5 (i) of the provisional agenda*

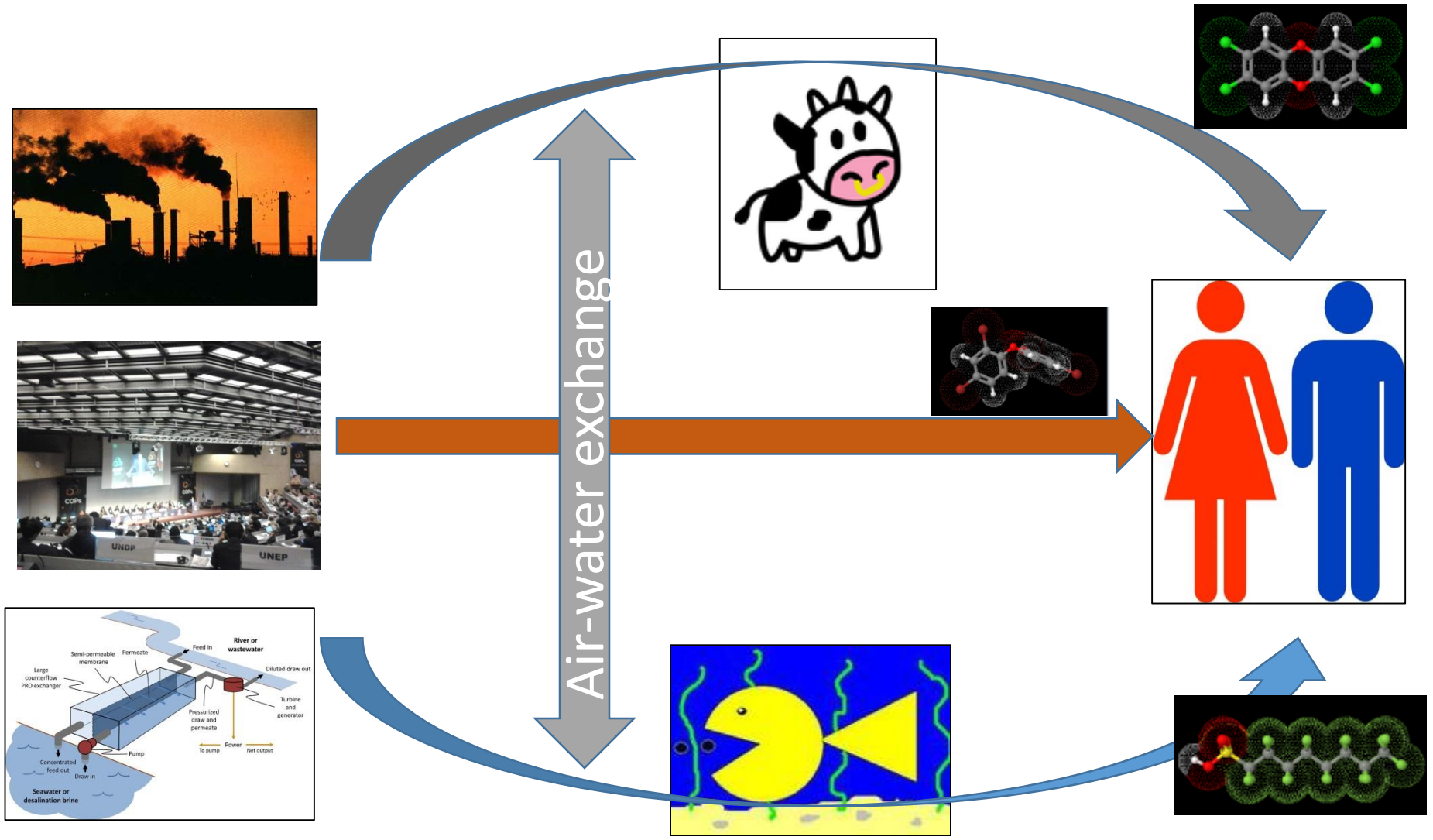
Matters related to the implementation of the Convention: effectiveness evaluation

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

Context:

- The Stockholm Convention on Persistent Organic Pollutants under article 16 ”effectiveness evaluation” established a Global Monitoring Plan (GMP) on POPs;
- The GMP has three core matrices:
  - Environment and long-range transport: Ambient air
  - Humans: Mothers´ milk and mothers´ blood
  - Environment: Surface water
- Analytes (subject to updates):
  - Air and human milk/blood: All POPs that are listed in annexes A, B, or C; and transformation products or precursors (list of recommended chemicals)
  - Water: PFOS

Source ⇒ environment ⇒ body burden



WHO and UNEP/WHO-coordinated exposure studies on POPs 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
• 6th Round	2012-2017	WHO/UNEP	12 countries

Selection of mothers and collection of national samples

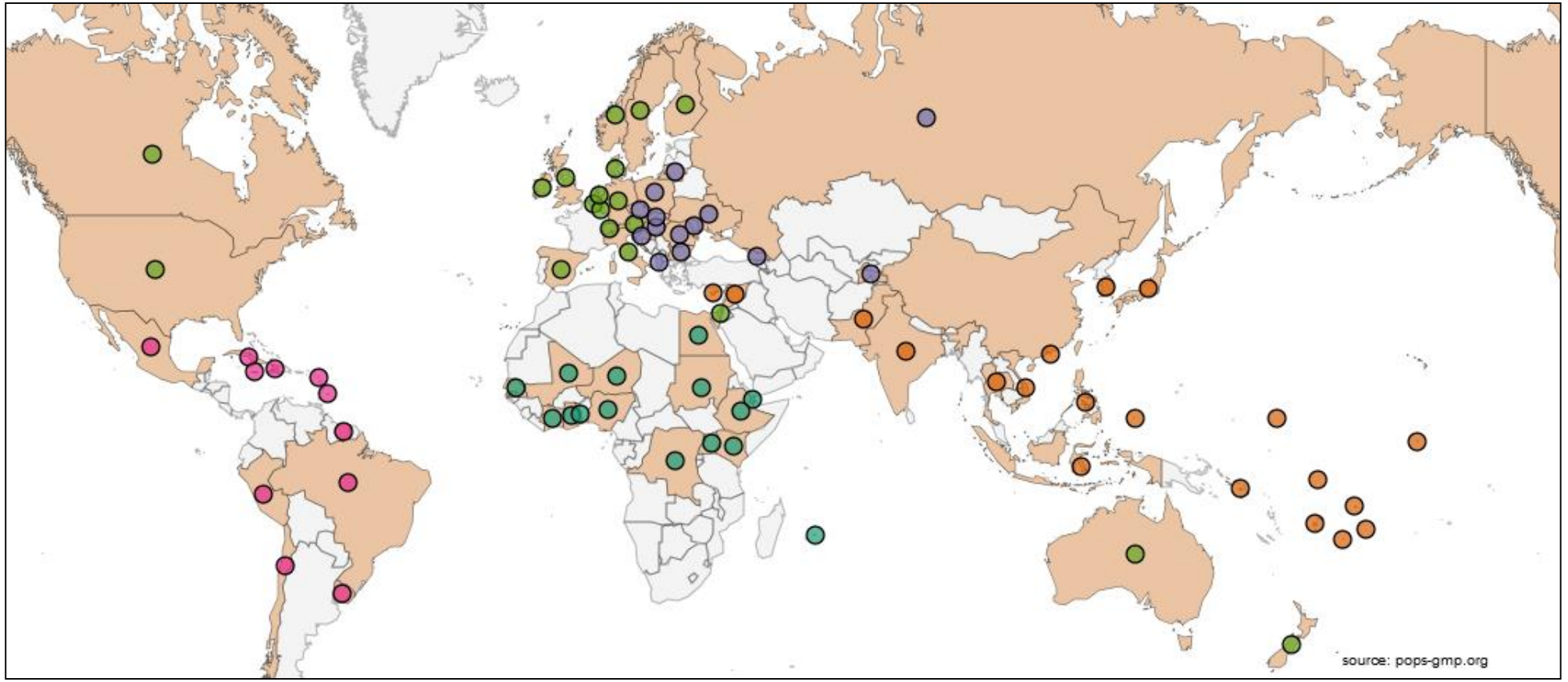
- Mothers should have first child (*primiparae*)
- Be under 30 years
- Mother and child be apparently healthy
- Breastfeeding only one child (*i.e.* not twins)
- Have resided in the represented area (country) > 10 years
- Exclusion of contaminated areas

Human milk samples: individual *vs.* pooled

- Individual samples
  - for differentiation within a country
- Representative pooled (mixed) samples
  - to identify priority POPs and
  - to follow time trends in countries
- At global level: National pools are compared
  - Allows to estimate exposure in different regions of the world with only very few samples
  - (+) Cost-effective, non-invasive sampling
  - (-) No information about individuals (but protection of identity of mothers)

Human milk surveys

- More than 9200 datapoints generated;
- Pooled samples: one country one datapoint *per* sampling round



Scope of the survey

Round 6 (ongoing)

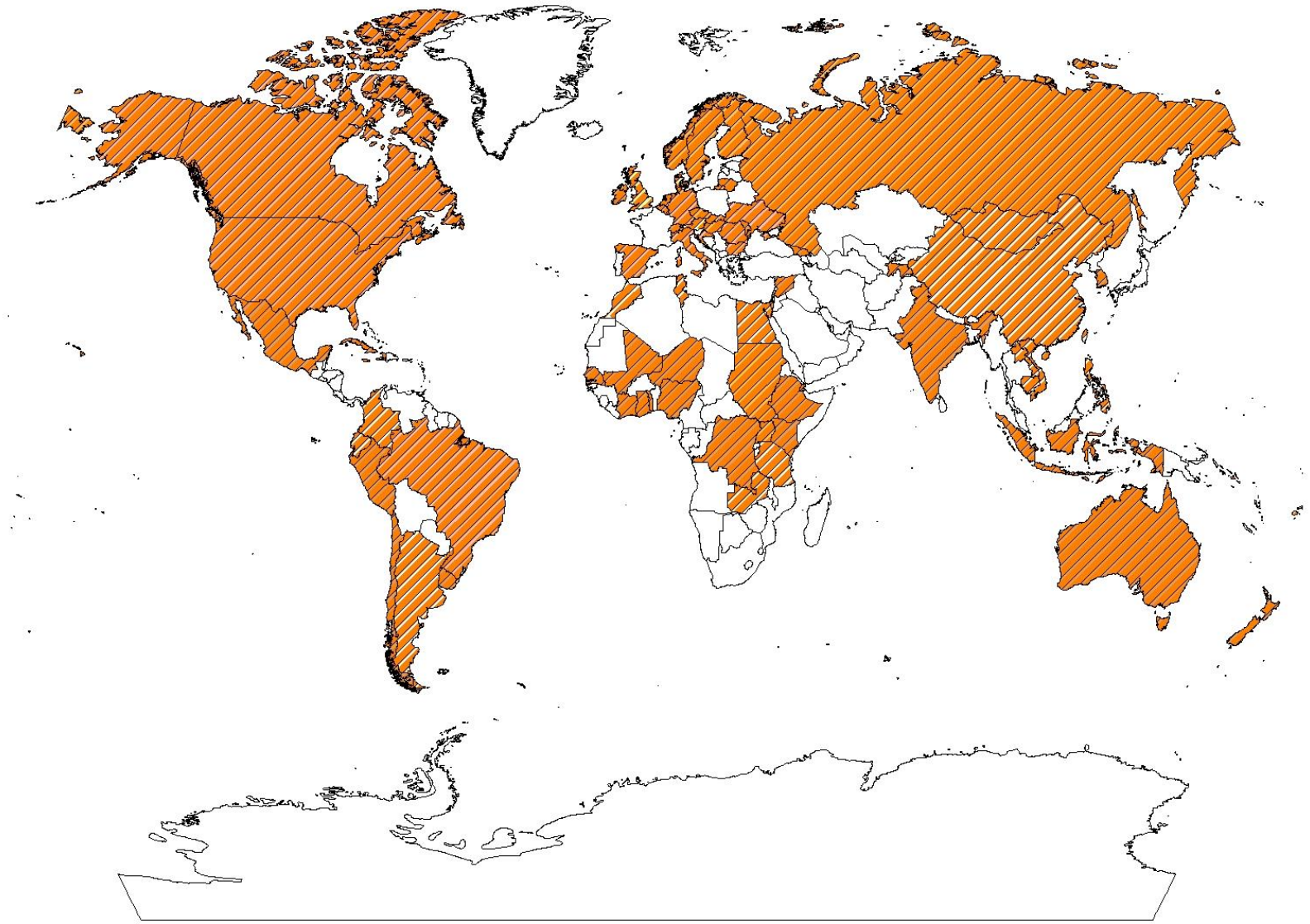
Round 5 (2008-2012)

Round 4 (2004-2007)

Round 3 (2000-2003)

Round 2 (1992-1993)

Round 1 (1987-1989)



UNEP/WHO reference laboratories for POPs in human milk

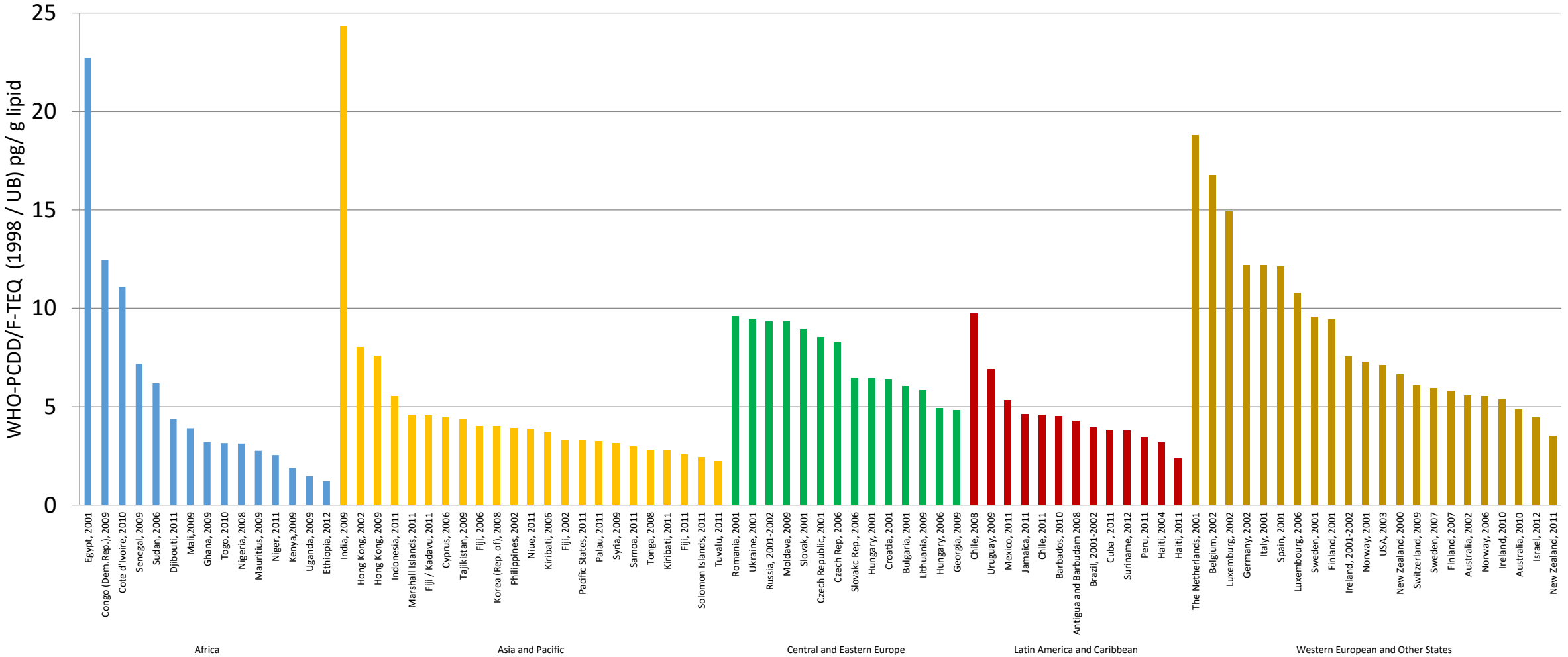
1. CVUA Freiburg

(State Institute for Chemical and Veterinary Analysis of Food)

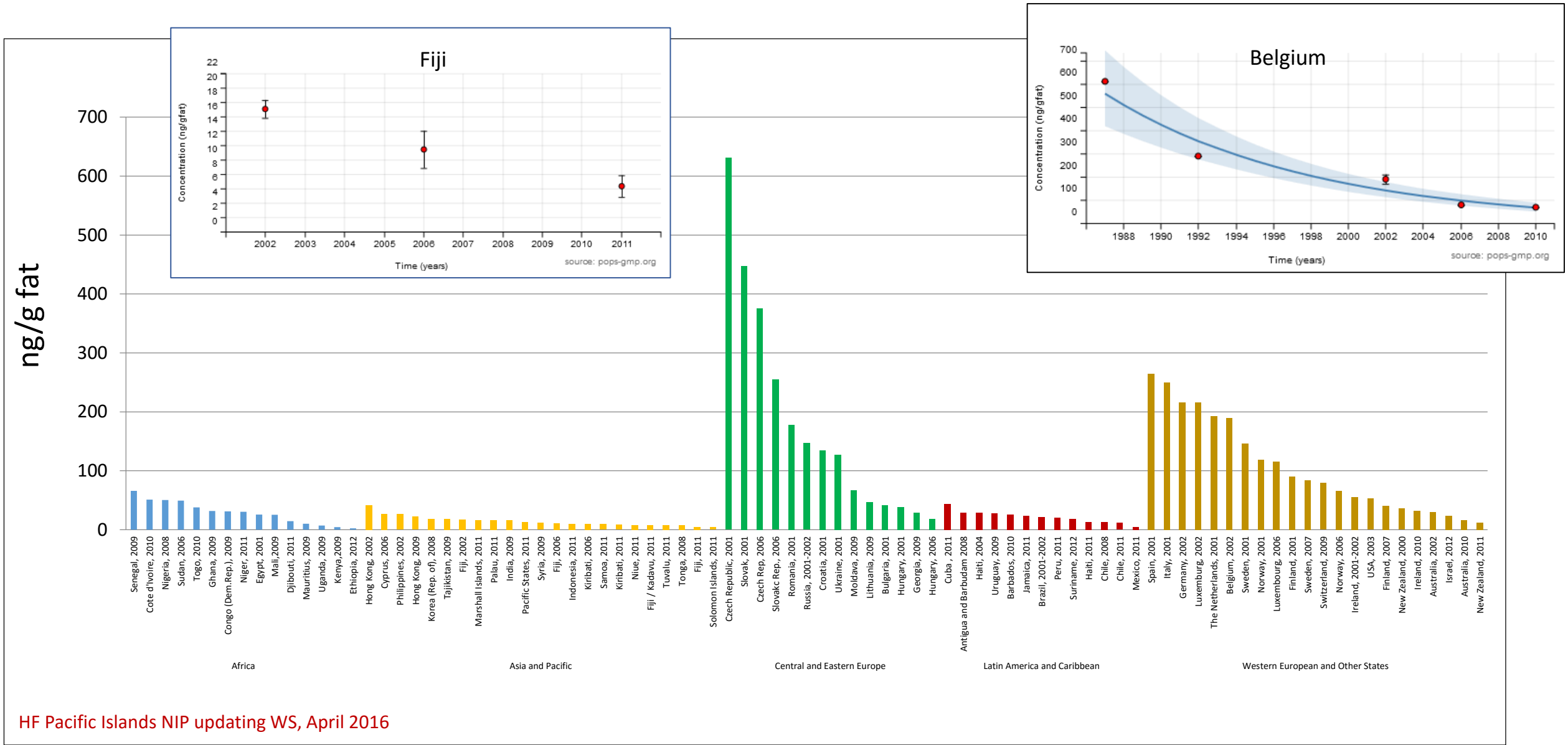
2. Örebro University

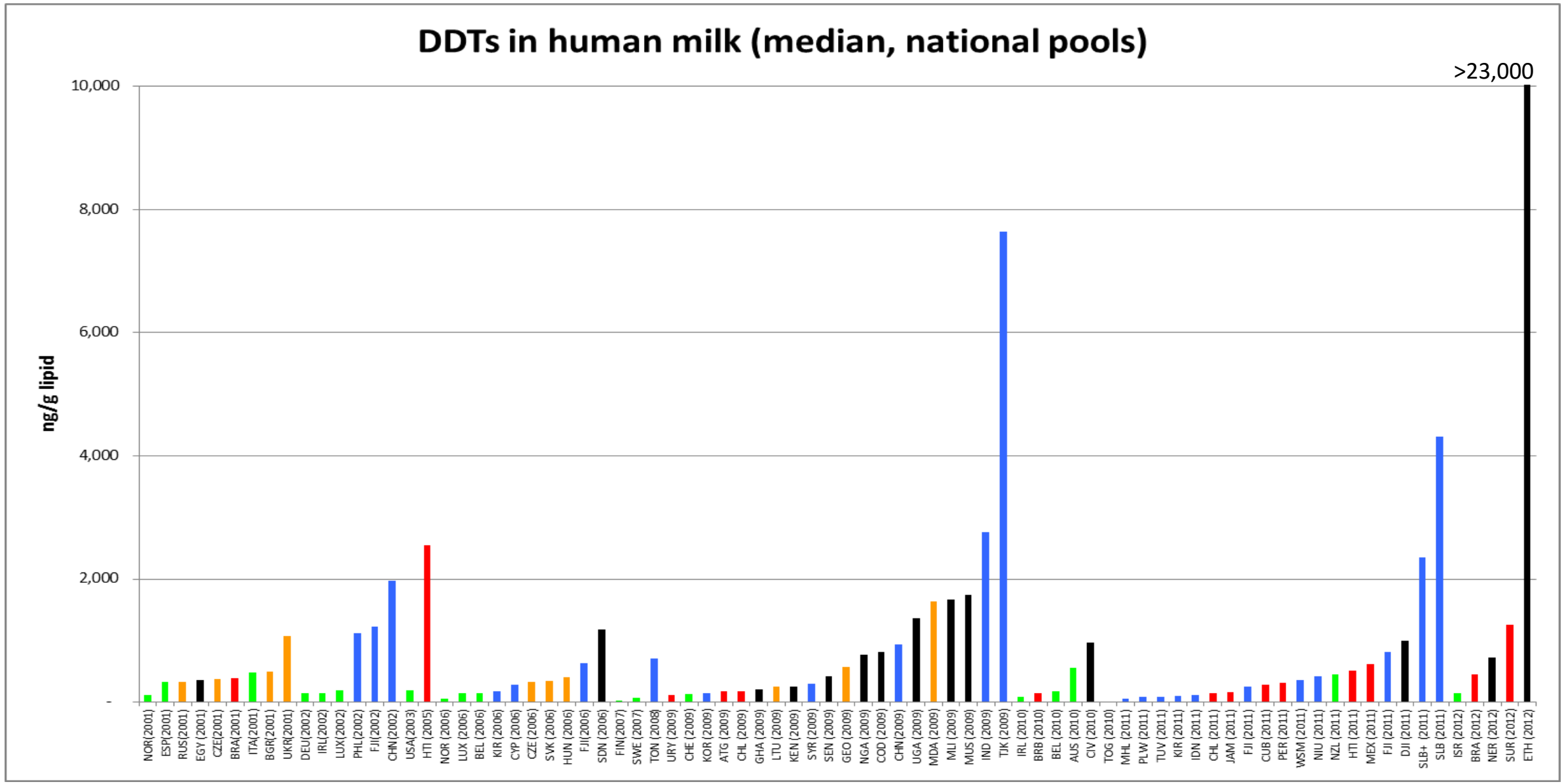
Man-Technology-Environment (MTM) Research Centre

Concentration of PCDD/PCDF in human milk

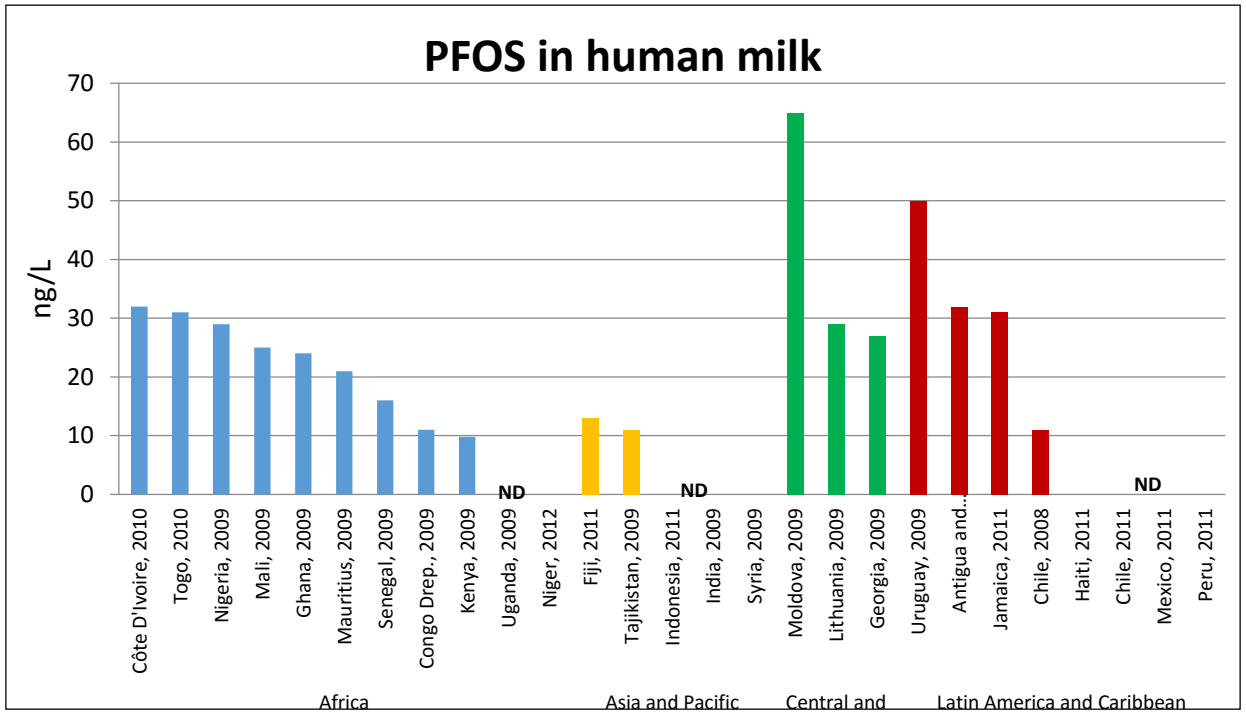


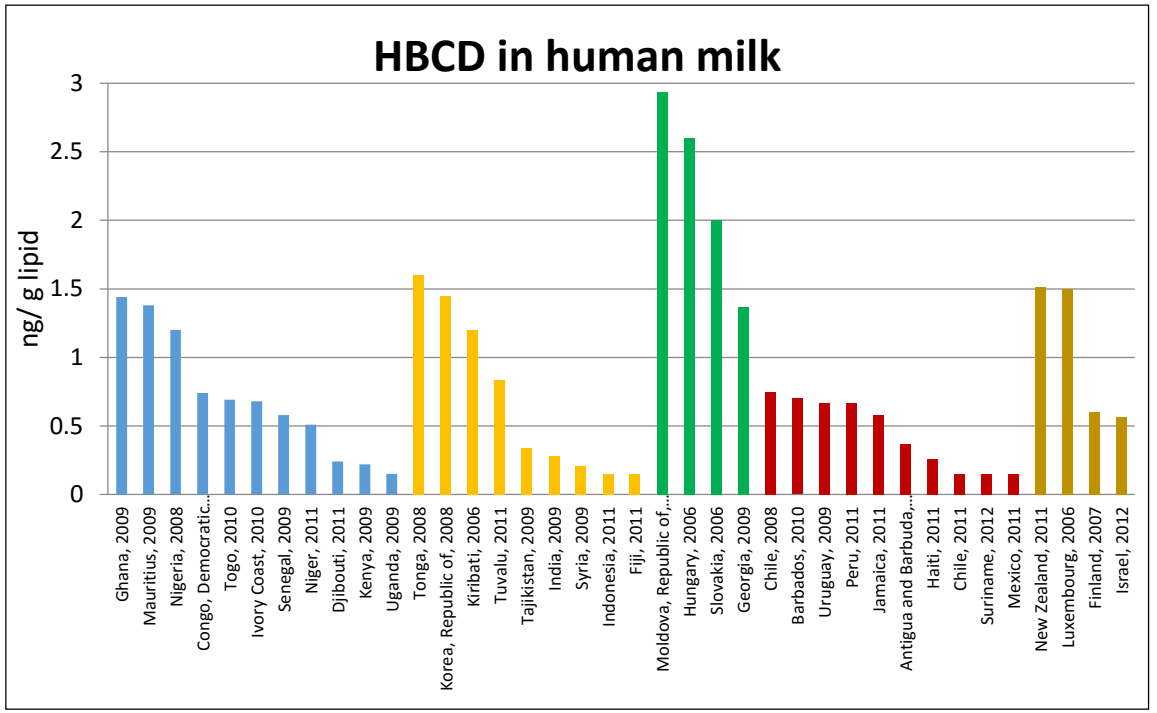
Concentrations of PCB_6 in human milk

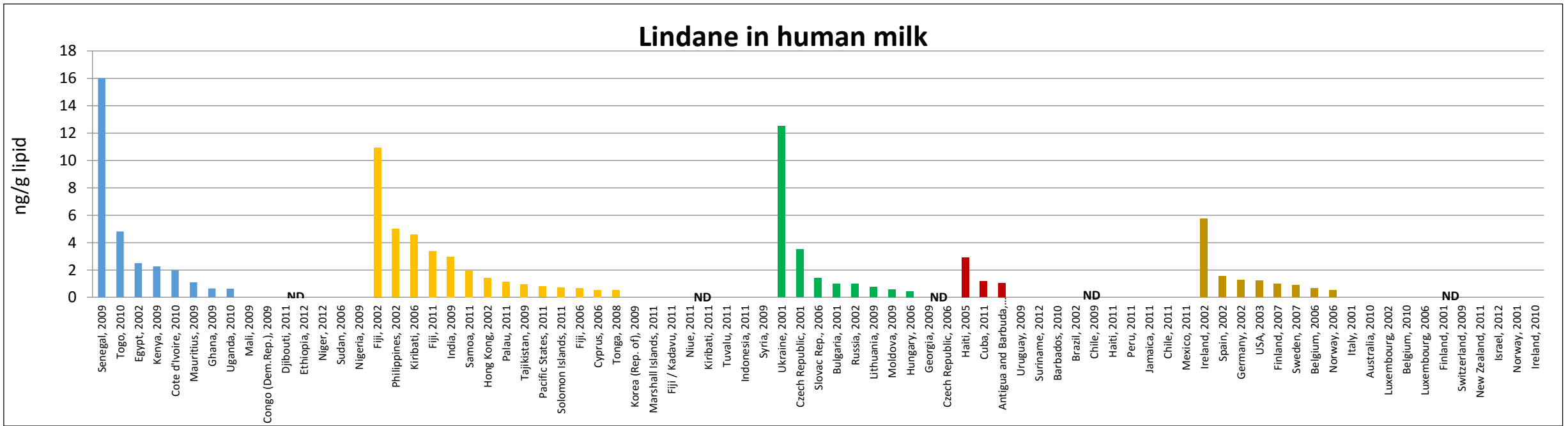




HF Pacific Islands NIP updating WS, April 2016


PFOS in human milk
ng/L
70
60
50
40
30
20
10
0
Côte D'Ivoire, 2010
Togo, 2010
Nigeria, 2009
Mali, 2009
Ghana, 2009
Mauritius, 2009
Senegal, 2009
Congo Drep., 2009
Kenya, 2009
Uganda, 2009
ND
Niger, 2012
Fiji, 2011
Tajikistan, 2009
Indonesia, 2011
ND
India, 2009
Syria, 2009
Moldova, 2009
Lithuania, 2009
Georgia, 2009
Uruguay, 2009
Antigua and...
Jamaica, 2011
Chile, 2008
Haiti, 2011
Chile, 2011
ND
Mexico, 2011
Peru, 2011
Africa
Asia and Pacific
Central and
Latin America and Caribbean


HBCD in human milk
ng/ g lipid
3
2.5
2
1.5
1
0.5
0
Ghana, 2009
Mauritius, 2009
Nigeria, 2008
Congo, Democratic...
Togo, 2010
Ivory Coast, 2010
Senegal, 2009
Niger, 2011
Djibouti, 2011
Kenya, 2009
Uganda, 2009
Tonga, 2008
Korea, Republic of, 2008
Kiribati, 2006
Tuvalu, 2011
Tajikistan, 2009
India, 2009
Syria, 2009
Indonesia, 2011
Fiji, 2011
Moldova, Republic of,...
Hungary, 2006
Slovakia, 2006
Georgia, 2009
Chile, 2008
Barbados, 2010
Uruguay, 2009
Peru, 2011
Jamaica, 2011
Antigua and Barbuda,...
Haiti, 2011
Chile, 2011
Suriname, 2012
Mexico, 2011
New Zealand, 2011
Luxembourg, 2006
Finland, 2007
Israel, 2012


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

Provisional safety standards*

Source		Safety Standard	Concentration in Milk	Endpoint
PCDD/PCDF/PCB (TEQ)				
WHO (2000) **WHO (2002)**	TDI PTMI	1-4 pg/kg bw day 70 pg/kg bw/month	0.2 – 0.9 pg/g lipid	Perinatal effects rodents and monkeys
US EPA (2010)	RfD (proposed)	0.7 pg/kg bw day	0.2 pg/g lipid	Postnatal/child-hood exposure humans
ATSDR (1998)	MRL subchronic	1 pg/kg bw day	0.2 pg/g lipid	Postnatal effect monkeys
Total PCB				
ATSDR (2004)	MRL subchronic	0.03 µg/kg bw d	7 ng/g lipid	Postnatal effect monkeys
DDTs				
WHO (2001)	TDI	10 µg/kg bw day	2300 ng/g lipid	Developmental toxicity in rats

*Jointly developed by IRAS, UNEP and WHO; UNEP/POPs(COP.6/INF33)

Risk assessment ”Safe levels”

	unit	safety standards as "Equivalent milk level"	Ranges in human milk (pooled samples)						
			Min	25th perc.	Median	75th perc.	90th perc.	95th perc.	Max
WHO-PCDD/F-PCB-TEQ (2005 / UB)	pg/g lipid	0.2 – 0.9	1,5	5,6	9,4	14,3	20,3	23,7	49,0
Total PCBs *)	ng/g lipid	7	2	18	38	121	223	347	1009
Sum DDT **)	ng/g lipid	2300	23	171	396	1015	1849	2616	23472

*) in human milk as sum of 6 indicator PCBs
**) in human milk calculated after correction of metabolites for molecular weight

Van den Berg (2013); UNEP, WHO

Risk-benefit assessment for PCDD, PCDF, PCB, and DDTs

- Concentrations of PCDD, PCDF, and PCB in human milk are still significantly above those considered safe;
- ΣDDTs are below or around those considered safe in most countries;
- With respect to potential adverse health effects, *in utero* exposure is more important than lactational exposure;
- If potential adverse effects are balanced against positive health aspects for (breast-fed) infants, the advantages of breastfeeding far outweigh the possible disadvantages;
- In view of the importance of *in utero* exposure due to maternal body burdens, efforts should still be directed to further reducing human dietary and environmental exposure to POPs.

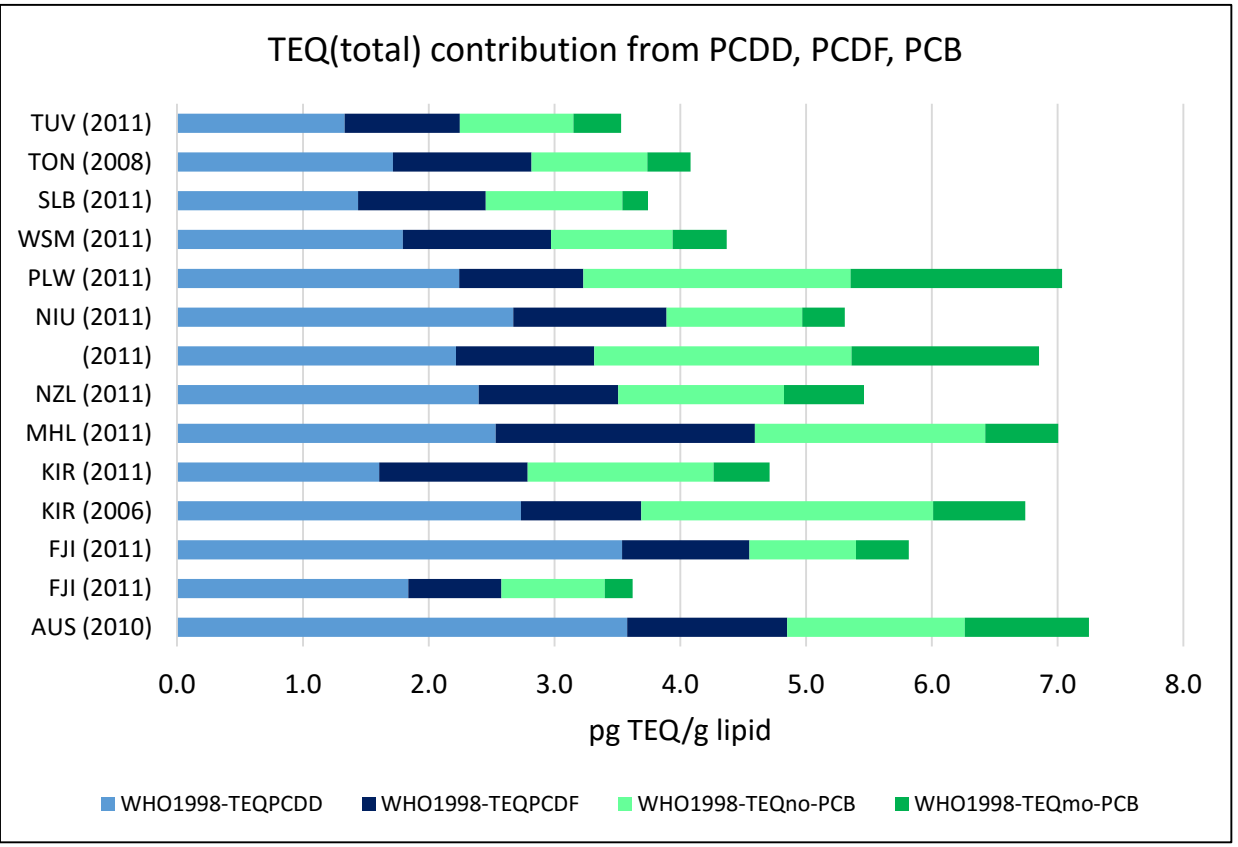
Pacific Islands Results

PCDD/PCDF

Round-Year	3-2002	3-2002	3-2002	4-2006	4-2006	4-2006	5-2011	5-2011	4-2006	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2008	5-2011	5-2010	5-2011
Fat content (%)	3,30	3,50	3,40	3,10	2,70	2,90	2,70	2,20	2,50	3,40	3,10	3,20	1,10	2,50	1,80	2,20	4,60	3,30	3,05	3,70
Country ISO-3	FJI	FJI	FJI	FJI	FJI	FJI	FJI	FJI	KIR	KIR	MHL		NIU	PLW	WSM	SLB	TON	TUV	AUS	NZL
Location	Nausori	Suva		Rural	Urban			Kadavu				NIU, SLB, PLW								
Location 2	Nausori	Suva	National pool	Rural	Urban	National pool	National pool	National pool*	National pool	National pool	National pool	National pool*	National pool	National pool	National pool	National pool	National pool	National pool	National pool	National pool
Sample ID	FJI (2002)	FJI (2002)	FJI (2002)	FJI (2006)	FJI (2006)	FJI (2006)	FJI (2011)	FJI (2011)	KIR (2006)	KIR (2011)	MHL (2011)	(2011)	NIU (2011)	PLW (2011)	WSM (2011)	SLB (2011)	TON (2008)	TUV (2011)	AUS (2010)	NZL (2011)
Unit	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid
2378-Cl_4DD	0,94	0,54	0,74	0,53	0,80	0,67	0,37	0,70	0,57	0,45	0,55	0,40	0,72	0,43	0,49	0,65	0,43	0,32	0,70	0,55
12378-Cl_5DD	1,2	1,3	1,2	2,1	1,2	1,7	1,1	1,9	1,3	0,82	1,3	1,2	1,3	1,3	0,89	0,59	0,90	0,69	1,9	1,3
123478-Cl_6DD	0,67	0,66	0,66	2,4	0,59	1,5	0,99	2,2	0,70	0,39	0,87	0,61	0,65	0,47	0,46	0,23	0,47	0,26	1,0	0,58
123678-Cl_6DD	2,5	2,6	2,5	4,2	3,6	3,9	1,6	4,4	3,7	1,7	3,3	3,4	3,4	3,1	2,1	0,98	2,2	1,7	6,4	3,4
123789-Cl_6DD	0,85	0,99	0,92	3,0	3,1	3,1	0,63	1,3	2,9	0,78	1,7	1,1	1,3	1,0	0,89	0,46	0,66	0,75	1,87	0,89
1234678-Cl_7DD	8,3	9,6	9,0	14	8,8	11	4,6	10	16	5,5	8,9	8,8	9,3	8,2	6,5	2,7	5,1	4,3	8,3	6,0
Cl_8DD	38	43	41	116	37	76	45	186	66	32	46	52	59	53	48	30	27	27	50	36
2378-Cl_4DF	0,50	0,33	0,42	0,46	0,54	0,50	0,30	0,75	0,64	0,69	0,58	0,40	0,66	0,56	0,67	0,50	0,38	0,32	0,42	0,17
12378-Cl_5DF	0,21	0,16	0,18	0,25	0,14	0,19	0,17	0,24	0,27	0,37	0,28	0,19	0,25	0,24	0,29	0,22	0,20	0,17	0,17	0,11
23478-Cl_5DF	1,4	1,2	1,3	1,1	1,2	1,2	1,1	1,5	1,5	1,8	3,1	1,7	1,8	1,4	1,7	1,6	1,7	1,5	2,1	1,8
123478-Cl_6DF	0,51	0,54	0,53	0,47	0,42	0,44	0,49	0,70	0,50	0,65	1,4	0,71	0,73	0,66	0,85	0,50	0,86	0,52	0,62	0,66
123678-Cl_6DF	0,53	0,52	0,53	0,35	0,39	0,37	0,48	0,68	0,56	0,60	1,6	0,82	0,81	0,67	0,84	0,57	0,78	0,56	0,71	0,65
123789-Cl_6DF	0	0	0	0	0	0	0,03	0	0	0,04	0	0,04	0,06	0	0,06	0	0	0,04	0	0,03
234678-Cl_6DF	0,23	0,24	0,23	0,20	0,19	0,20	0,22	0,40	0,18	0,32	0,88	0,35	0,49	0,37	0,37	0,23	0,32	0,25	0,34	0,36
1234678-Cl_7DF	0,98	0,95	0,97	1,1	1,4	1,2	0,60	0,91	1,7	0,90	2,6	2,1	3,4	3,1	1,5	1,4	1,4	1,0	1,2	1,6
1234789-Cl_7DF	0	0	0	0	0	0	0,04	0	0,02	0,05	0	0,07	0,08	0	0,11	0,04	0	0,06	0	0,03
Cl_8DF	0,30	0,27	0,28	0,27	0,38	0,32	0,24	0,35	0,29	0,24	0	0,22	0,49	0,83	0,61	0,17	0,20	0,15	0,14	0,15
WHO$_{1998}$-TEQ$_{PCDD}$	2,6	2,4	2,5	3,8	2,8	3,3	1,8	3,5	2,7	1,6	2,5	2,2	2,7	2,2	1,8	1,4	1,7	1,3	3,6	2,4
WHO$_{1998}$-TEQ$_{PCDF}$	0,9	0,8	0,8	0,7	0,8	0,7	0,7	1,0	1,0	1,2	2,1	1,1	1,2	1,0	1,2	1,0	1,1	0,9	1,3	1,1
WHO$_{1998}$-TEQ$_{PCDD/PCDF}$	3,5	3,2	3,3	4,5	3,6	4,1	2,6	4,6	3,7	2,8	4,6	3,3	3,9	3,2	3,0	2,5	2,8	2,2	4,8	3,5
WHO$_{2005}$-TEQ$_{PCDD}$	2,6	2,4	2,5	3,8	2,8	3,3	1,8	3,6	2,7	1,6	2,5	2,2	2,7	2,3	1,8	1,4	1,7	1,3	3,6	2,4
WHO$_{2005}$-TEQ$_{PCDF}$	0,60	0,55	0,58	0,49	0,54	0,51	0,51	0,71	0,66	0,80	1,43	0,76	0,86	0,70	0,83	0,69	0,76	0,62	0,85	0,75
WHO$_{2005}$-TEQ$_{PCDD/PCDF}$	3,2	2,9	3,1	4,3	3,4	3,8	2,4	4,3	3,4	2,4	4,0	3,0	3,5	2,9	2,6	2,1	2,5	2,0	4,4	3,2

dl-PCB

Round-Year	3-2002	3-2002	3-2002	4-2006	4-2006	4-2006	5-2011	5-2011	4-2006	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2008	5-2011	5-2010	5-2011
Fat content (%)	3,30	3,50	3,40	3,10	2,70	2,90	2,70	2,20	2,50	3,40	3,10	3,20	1,10	2,50	1,80	2,20	4,60	3,30	3,05	3,70
Country ISO-3	FJI	FJI	FJI	FJI	FJI	FJI	FJI	FJI	KIR	KIR	MHL		NIU	PLW	WSM	SLB	TON	TUV	AUS	NZL
Location	Nausori	Suva		Rural	Urban			Kadavu				NIU, SLB, PLW								
Location 2	Nausori	Suva	National pool	Rural	Urban	National pool	National pool	National pool*	National pool	National pool	National pool	National pool*	National pool	National pool	National pool	National pool	National pool	National pool	National pool	National pool
Sample ID	FJI (2002)	FJI (2002)	FJI (2002)	FJI (2006)	FJI (2006)	FJI (2006)	FJI (2011)	FJI (2011)	KIR (2006)	KIR (2011)	MHL (2011)	(2011)	NIU (2011)	PLW (2011)	WSM (2011)	SLB (2011)	TON (2008)	TUV (2011)	AUS (2010)	NZL (2011)
Unit	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid	pg g^{-1} lipid
PCB 77	4,8	4,4	4,6	5,7	8,2	6,9	6,3	9,8	6,7	8,4	9,4	5,8	10	16	15	7,5	4,5	5,2	3,9	3,0
PCB 81	1,5	1,4	1,4	0	0	0	0,73	1,4	5,5	1,3	1,4	1,5	1,6	2,8	1,4	1,1	0	0,65	1,3	0,83
PCB 126	11	11	11	0	10	5,1	7,6	7,6	22	13	16	20	10	21	8,5	10	8,5	7,8	13	12
PCB 169	6,1	4,2	5,1	5,9	7,5	6,7	5,6	8,8	8,1	13	21	7,4	6,2	6,5	11	7,4	7,1	13	7,7	6,8
PCB 105	484	540	512	317	420	369	180	314	717	407	435	2147	285	2608	403	192	272	203	635	385
PCB 114	76	62	69	251	319	285	23	57	204	47	71	243	0	250	41	35	46	32	173	77
PCB 118	1731	1766	1748	1252	2156	1704	611	1122	2477	1417	1426	5596	1050	6804	1284	565	925	720	2297	1407
PCB 123	0	0	0	0	0	0,00	7,9	12	0	21	9,7	82	0	82	13	15	0	8,4	43	23
PCB 156	612	476	544	492	857	674	219	428	520	373	554	942	345	965	382	182	327	438	967	686
PCB 157	144	119	131	64	124	94	38	60	96	97	141	220	63	230	87	35	66	93	225	135
PCB 167	253	230	242	139	244	192	75	137	218	175	245	306	124	348	143	76	109	119	250	191
PCB 189	43	29	36	0	0	0	14	0	0	22	83	38	0	57	33	14	38	31	59	52
WHO$_{1998}$-TEQ$_{no-PCB}$	1,2	1,1	1,1	0,06	1,1	0,57	0,82	0,85	2,3	1,5	1,8	2,0	1,1	2,1	0,97	1,1	0,92	0,90	1,4	1,3
WHO$_{1998}$-TEQ$_{mo-PCB}$	0,64	0,56	0,60	0,56	0,91	0,74	0,22	0,42	0,73	0,45	0,58	1,49	0,34	1,68	0,43	0,21	0,34	0,38	0,99	0,64
WHO$_{1998}$-TEQ$_{PCB}$	1,8	1,7	1,7	0,6	2,0	1,3	1,0	1,3	3,1	1,9	2,4	3,5	1,4	3,8	1,4	1,3	1,3	1,3	2,4	2,0
WHO$_{2005}$-TEQ$_{no-PCB}$	1,3	1,2	1,2	0,18	1,2	0,71	0,93	1,0	2,5	1,7	2,3	2,2	1,2	2,3	1,2	1,2	1,1	1,2	1,6	1,5
WHO$_{2005}$-TEQ$_{mo-PCB}$	0,10	0,10	0,10	0,08	0,12	0,10	0,04	0,06	0,13	0,08	0,09	0,29	0,06	0,34	0,07	0,03	0,05	0,05	0,14	0,09
WHO$_{2005}$-TEQ$_{PCB}$	1,4	1,3	1,3	0,25	1,4	0,81	1,0	1,1	2,6	1,8	2,3	2,5	1,3	2,6	1,3	1,3	1,1	1,2	1,7	1,5
WHO$_{1998}$-TEQ$_{PCDD/PCDF/PCB}$	5,3	4,9	5,1	5,1	5,6	5,4	3,6	5,8	6,7	4,7	7,0	6,9	5,3	7,0	4,4	3,7	4,1	3,5	7,2	5,5
WHO$_{2005}$-TEQ$_{total}$	4,6	4,2	4,4	4,5	4,7	4,6	3,3	5,4	6,0	4,2	6,3	5,5	4,8	5,5	3,9	3,4	3,6	3,2	6,1	4,7
% PCB to Total TEQ$_{1998}$	34%	35%	34%	12%	36%	24%	29%	22%	45%	41%	34%	52%	27%	54%	32%	34%	31%	36%	33%	36%
% PCB to Total TEQ$_{2005}$	30%	31%	30%	6%	29%	17%	29%	20%	43%	43%	37%	45%	26%	47%	32%	37%	31%	38%	28%	33%

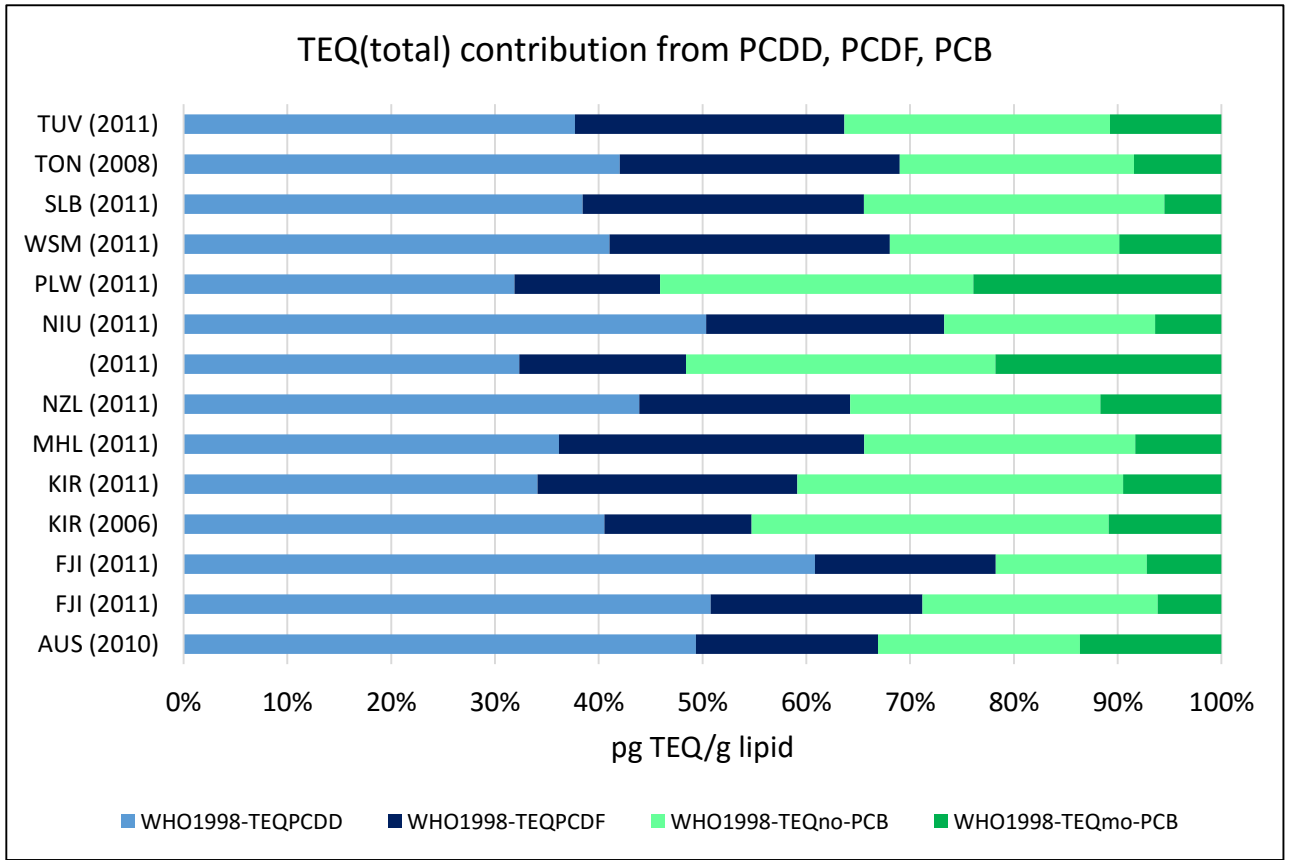


PCDD/PCDF/PCB (pg WHO_{1998}-TEQ/g lipid)

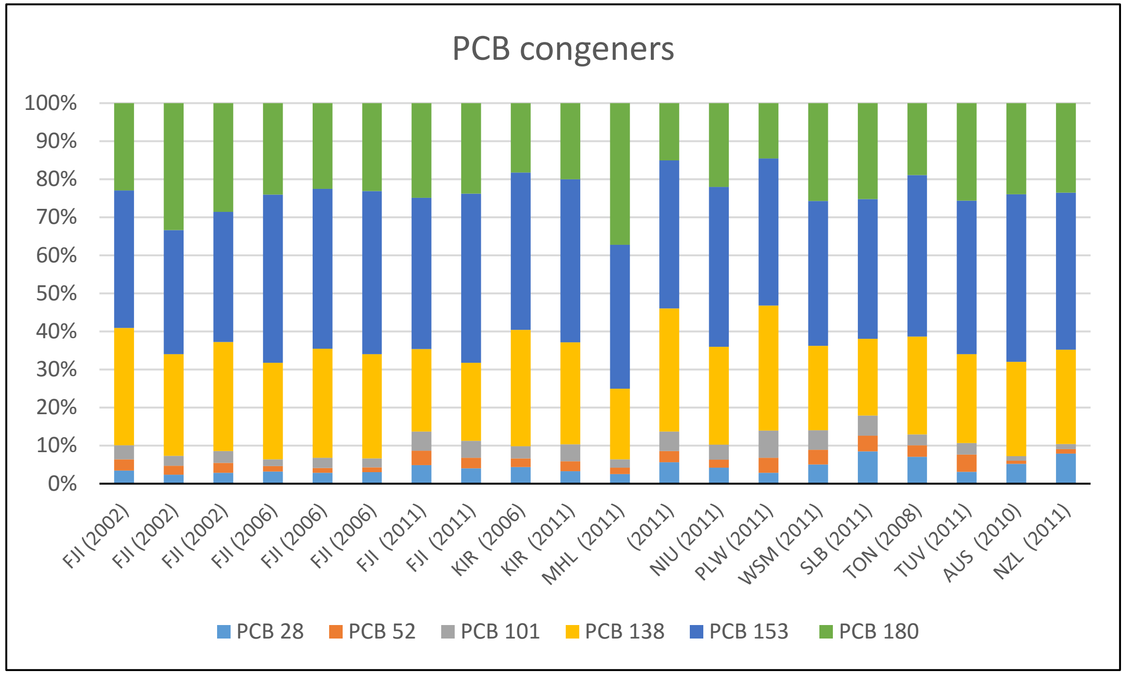
	Min	Max
Global	1.5	49
Pacific Islands	3.5	7.0

PAC concentrations (pg WHO_{1998}-TEQ/g lipid)

	Min	Max
PCDD/PCDF	2.2	4.6
dl-PCB	1.0	3.8
PCDD/PCDF/PCB	3.5	7.0



ndl-PCB



Narrow range of concentrations (4-8 ng/g lipid)
Safe level: 7 ng/g lipid
Min-max: 2-1009 ng/g lipid

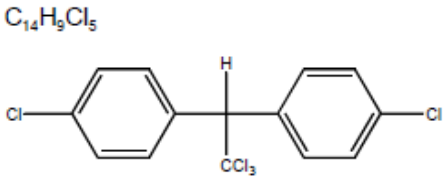
Round-Year	3-2002	3-2002	3-2002	4-2006	4-2006	4-2006	5-2011	5-2011	4-2006	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2008	5-2011	5-2010	5-2011
Fat content (%)	3,30	3,50	3,40	3,10	2,70	2,90	2,70	2,20	2,50	3,40	3,10	3,20	1,10	2,50	1,80	2,20	4,60	3,30	3,05	3,70
Country ISO-3	FJI	FJI	FJI	FJI	FJI	FJI	FJI	FJI	KIR	KIR	MHL		NIU	PLW	WSM	SLB	TON	TUV	AUS	NZL
Location	Nausori	Suva		Rural	Urban			Kadavu				NIU, SLB, PLW								
Location 2	Nausori	Suva	National pool	Rural	Urban	National pool	National pool	National pool*	National pool	National pool	National pool	National pool*	National pool	National pool	National pool	National pool	National pool	National pool	National pool	National pool
Sample ID	FJI (2002)	FJI (2002)	FJI (2002)	FJI (2006)	FJI (2006)	FJI (2006)	FJI (2011)	FJI (2011)	KIR (2006)	KIR (2011)	MHL (2011)	(2011)	NIU (2011)	PLW (2011)	WSM (2011)	SLB (2011)	TON (2008)	TUV (2011)	AUS (2010)	NZL (2011)
Unit	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid
PCB 28	0,54	0,43	0,49	0,27	0,41	0,34	0,23	0,32	0,44	0,28	0,41	0,74	0,34	0,46	0,47	0,34	0,51	0,24	0,85	0,94
PCB 52	0,46	0,43	0,44	0,12	0,18	0,15	0,18	0,23	0,23	0,22	0,27	0,38	0,17	0,63	0,36	0,17	0,22	0,36	0,13	0,15
PCB 101	0,59	0,48	0,54	0,15	0,39	0,27	0,24	0,36	0,32	0,38	0,36	0,67	0,33	1,1	0,49	0,21	0,21	0,24	0,20	0,16
PCB 138	4,8	4,9	4,9	2,2	4,1	3,1	1,0	1,7	3,1	2,3	3,0	4,2	2,1	5,2	2,1	0,8	1,9	1,8	4,1	3,0
PCB 153	5,7	6,0	5,9	3,8	6,0	4,9	1,9	3,6	4,2	3,6	6,1	5,1	3,4	6,2	3,6	1,5	3,1	3,2	7,2	5,0
PCB 180	3,6	6,2	4,9	2,1	3,2	2,7	1,2	1,9	1,8	1,7	6,0	2,0	1,8	2,3	2,4	1,0	1,4	2,0	3,9	2,8
Sum PCB_6	16	18	17	9	14	11	5	8	10	8	16	13	8	16	9,4	4,0	7,3	7,9	16	12

Basic POPs

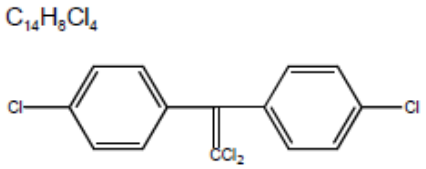
Round-Year	3-2002	3-2002	3-2002	4-2006	4-2006	4-2006	5-2011	5-2011	4-2006	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2011	5-2008	5-2011	5-2010	5-2011
Fat content (%)	3,3	3,5	3,40	3,1	2,7	2,90	2,7	2,2	2,5	3,4	3,1	3,2	1,1	2,5	1,8	2,2	4,6	3,3	3,1	3,7
Country ISO-3	FJI	FJI	FJI	FJI	FJI	FJI	FJI	FJI	KIR	KIR	MHL		NIU	PLW	WSM	SLB	TON	TUV	AUS	NZL
Location	Nausori	Suva		Rural	Urban			Kadavu				NIU, SLB, PLW								
Location 2	Nausori	Suva	National pool	Rural	Urban	National pool	National pool	National pool*	National pool	National pool	National pool	national pool*	National pool	National pool	National pool	National pool	National pool	National pool	National pool	National pool
Sample ID	FJI(2002)	FJI(2002)	FJI(2002)	FJI(2006)	FJI(2006)	FJI(2006)	FJI (2011)	FJI (2011)	KIR (2006)	KIR (2011)	MHL (2011)	(2011)	NIU (2011)	PLW (2011)	WSM (2011)	SLB (2011)	TON (2008)	TUV (2011)	AUS (2010)	NZL (2011)
Unit	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid	$ng\ g^{-1}$ lipid
Dieldrin	5,0	2,5	3,8	1,6	2,8	2,2	0,87	0,81	1,6	0	0,61	0,77	3,7	1,9	1,8	1,0	2,2	0,67	17	9,4
Sum drins	5,0	2,5	3,8	1,6	2,8	2,2	0,87	0,81	1,6	0	0,61	0,77	3,7	1,9	1,8	1,0	2,2	0,67	17	9,4
Oxychlordane	2,7	3,3	3,0	1,7	1,7	1,7	0	1,8	1,5	0	0	1,1	0	0	0	0	1,15	0	7,6	0,56
Sum chlordanes	2,7	3,3	3,0	1,7	1,7	1,7	0	1,8	1,5	0	0	1,1	0	0	0	0	1,15	0	7,6	0,56
o,p'-DDT	24	36	30	5,5	4,8	5,1	3,4	3,8	5,2	3,1	0,86	4,3	7,9	0	3,6	14	4,0	0,81	0,85	0
p,p'-DDT	168	239	203	61	85	73	32	68	27	10	5,1	225	21	5,7	17	426	48	4,2	5,4	13
p,p'-DDD	4,0	4,0	4,0	1,3	1,3	1,3	1,4	1,8	0,89	3,2	0,99	2,5	3,8	4,7	1,4	12	0	0	1,3	0
o,p'-DDE	0,00	3,5	1,8	0	0	0	0	0	0	0	0	0	0	0	0	0,48	0	0	0	0
p,p'-DDE	886	1087	987	453	639	546	214	739	140	91	44	2 117	389	69	333	3 864	664	85	544	434
Sum DDTs	1 082	1369	1 225	521	731	626	250	812	173	107	51	2 348	422	80	355	4 316	716	90	552	447
cis-Heptachlorepoxide	0	0	0	0	0	0	0	0	0	0	0,45	0	0	0,85	0	0	0,31	0	4,0	0
Sum heptachlors	0	0	0	0	0	0	0	0	0	0	0,45	0	0	0,85	0	0	0,31	0	4,0	0
HCB	3,75	3,50	3,63	2,38	3,78	3,08	4,9	7,8	3,2	6,6	5,8	2,8	6,0	6,7	6,5	16	5,7	3,6	6,1	5,1
Mirex				0	0	0	0,57	0	0	0,59	1,6	0			0,62		0	0	0	0
Parlar 26	0	0	0	0	0	0	0	0	0,48	0	0	0	0	0	0	0	0	0	0,39	0
Parlar 50	0	0	0	0	0	0	0	0	0,89	0	0,65	0	0	0	0	0	0	0	1,15	0
Sum toxaphenes	0	0	0	0	0	0	0	0	1,4	0	0,65	0	0	0	0	0	0	0	1,54	0
b-HCH	5,5	6,0	5,8	3,1	2,3	2,7	2,2	2,2	6,1	4,1	2,6	4,2	2,6	2,8	2,0	4,9	1,3	1,8	11	6,1
g-HCH	5,0	7,0	6,0	0,7	0,7	0,7	3,4	0	4,6	0	0	0,80	0	1,12	1,96	0,72	0,51	0	0	0
Sum HCH	10,5	13,0	11,8	3,9	3,0	3,4	5,6	2,2	11	4,1	2,6	5,0	2,6	3,9	3,9	5,7	1,8	1,8	11	6,1
Pentachlorobenzene							0	0		0	0	0			0,45			0	0	0

N.D: Aldrin, endrin, a-chlordane, g-chlordane, heptachlor, trans-heptachlorepoxide, endosulfans, *o,p'*-DDD

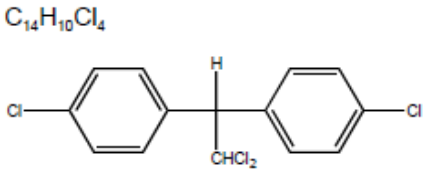
1,1,1-trichloro-2,2-bis (*p*-chlorophenyl)ethane



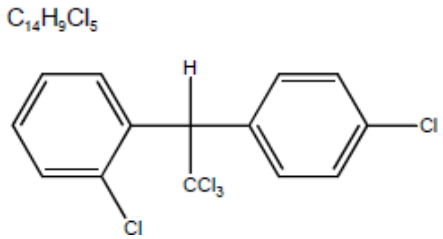
4,4´-DDT



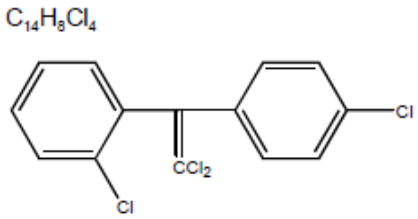
4,4´-DDD



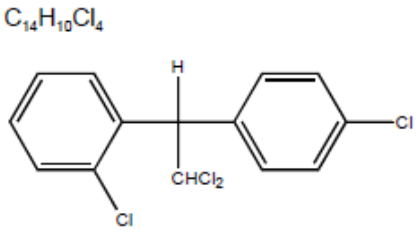
4,4-DDE



1,4´-DDT



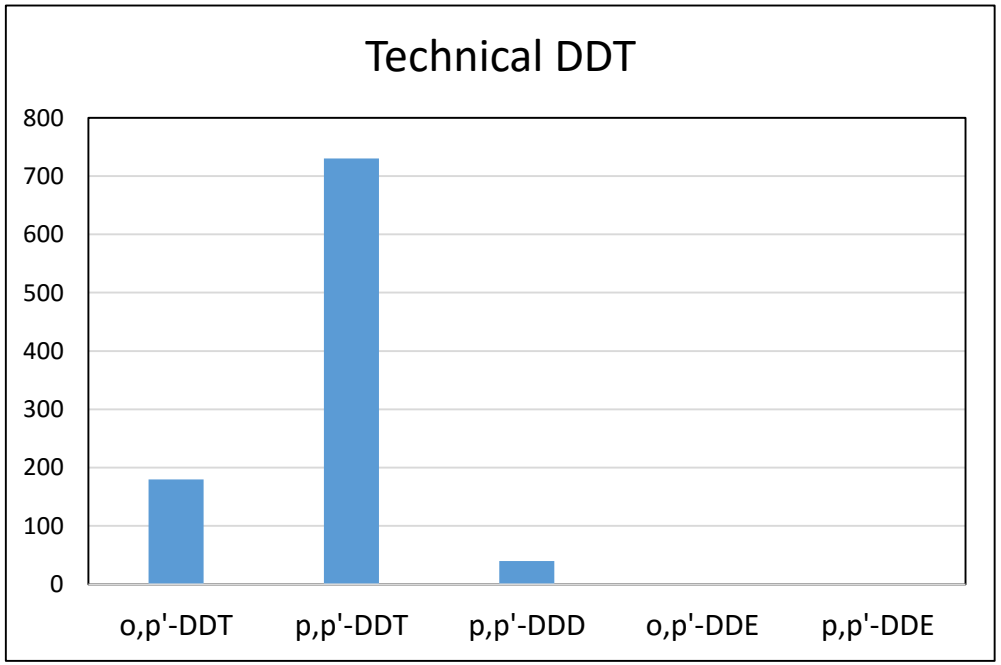
1,4´-DDD

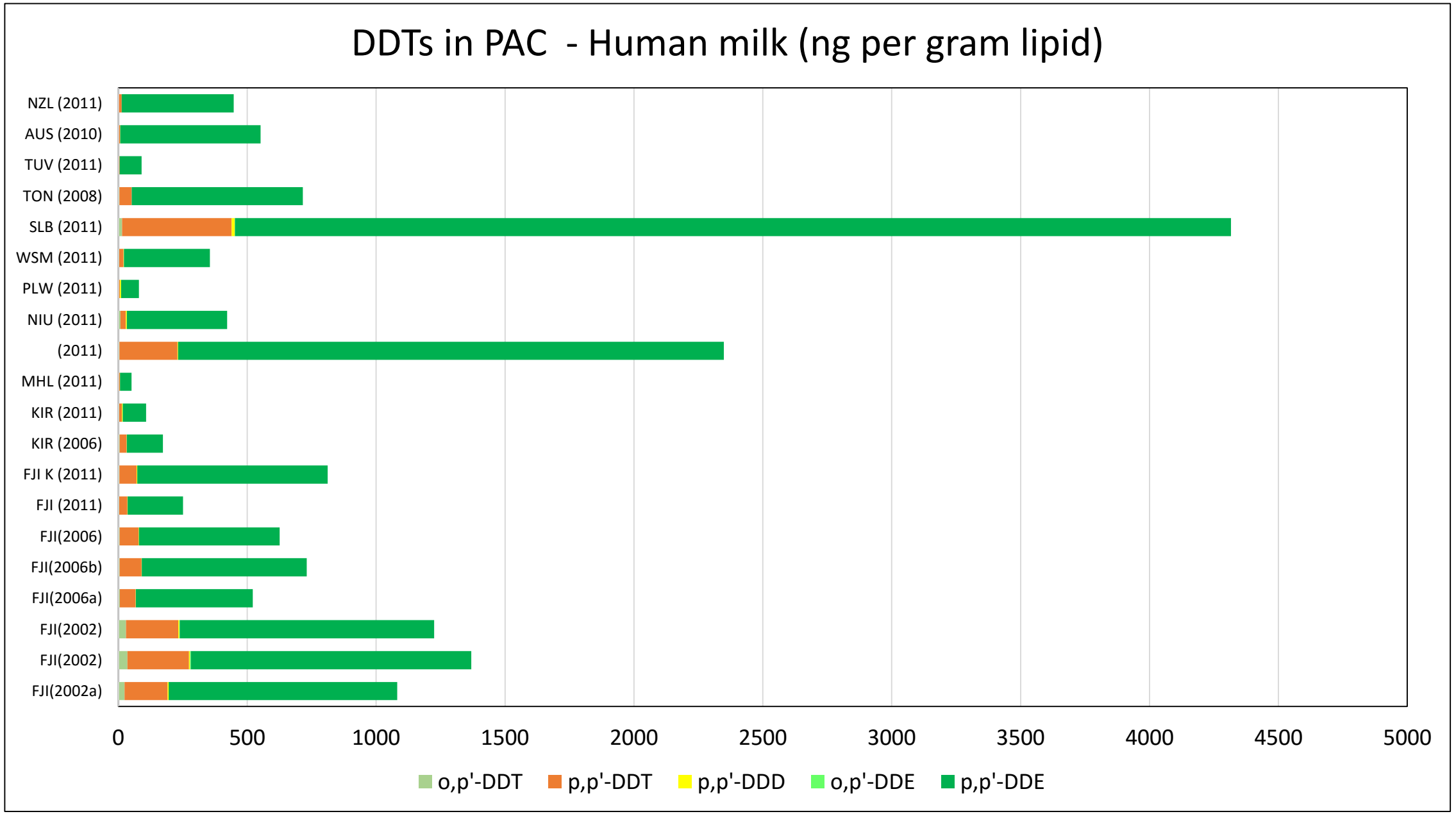


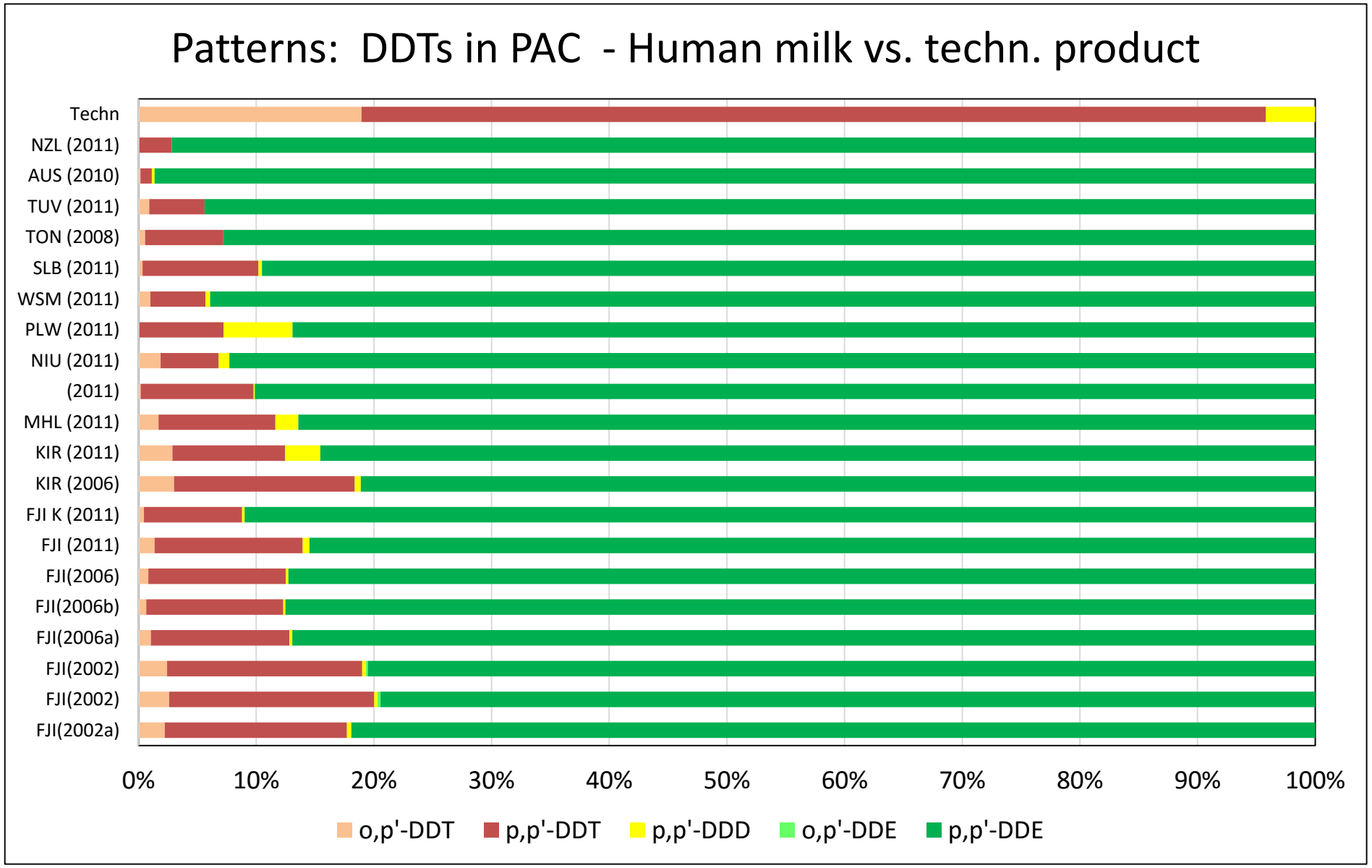
1,4-DDE

Technical grade DDT was used as an insecticide, main components were:

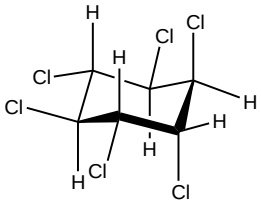
- 4,4´-DDT or *p,p´*-DDT: 65%–80% (=active ingredient)
- 1,´4-DDT or *o,p´*-DDT: 15%–21% (nearly inactive)
- 4,4´-DDD or *p,p´*-DDD: up to 4%, and
- Up to 1.5% of 1-(*p*-chlorophenyl)-2,2,2-trichloroethanol



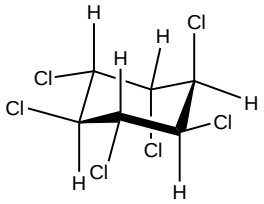

DDTs in PAC - Human milk (ng per gram lipid)
NZL (2011)
AUS (2010)
TUV (2011)
TON (2008)
SLB (2011)
WSM (2011)
PLW (2011)
NIU (2011)
(2011)
MHL (2011)
KIR (2011)
KIR (2006)
FJI K (2011)
FJI (2011)
FJI(2006)
FJI(2006b)
FJI(2006a)
FJI(2002)
FJI(2002)
FJI(2002a)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
o,p'-DDT
p,p'-DDT
p,p'-DDD
o,p'-DDE
p,p'-DDE


Patterns: DDTs in PAC - Human milk vs. techn. product
Techn
NZL (2011)
AUS (2010)
TUV (2011)
TON (2008)
SLB (2011)
WSM (2011)
PLW (2011)
NIU (2011)
(2011)
MHL (2011)
KIR (2011)
KIR (2006)
FJI K (2011)
FJI (2011)
FJI(2006)
FJI(2006b)
FJI(2006a)
FJI(2002)
FJI(2002)
FJI(2002a)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
o,p'-DDT
p,p'-DDT
p,p'-DDD
o,p'-DDE
p,p'-DDE

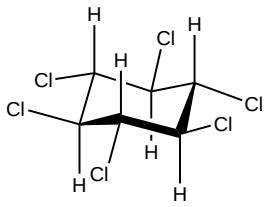
Hexachlorocyclohexanes (HCHs)



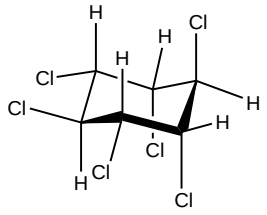
(+)-alpha-HCH



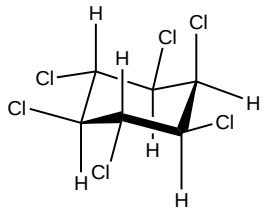
(-)-alpha-HCH



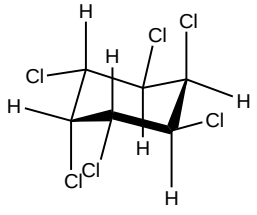
beta-HCH



gamma-HCH



delta-HCH

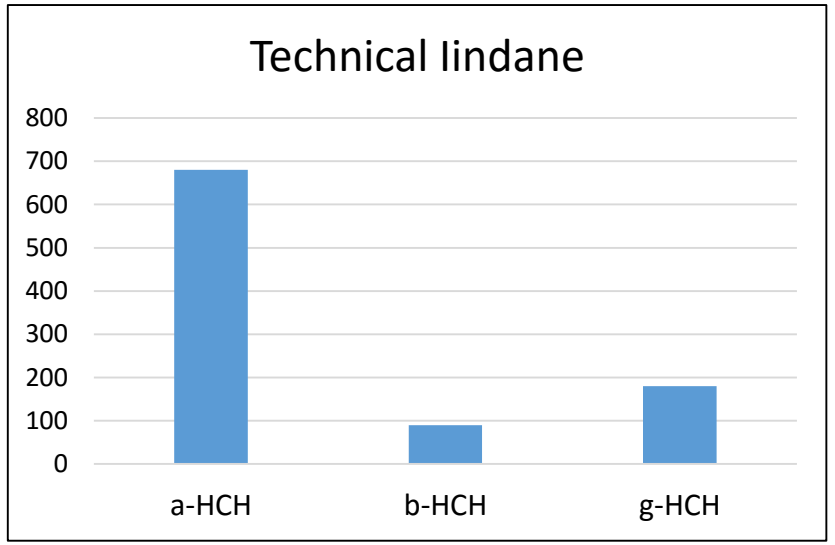


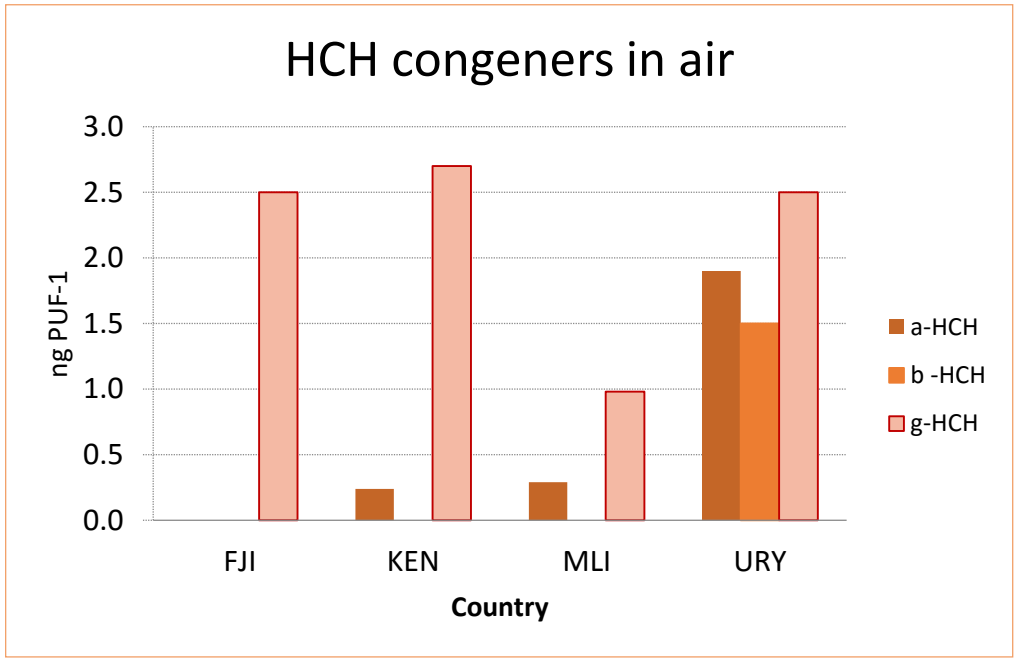
epsilon-HCH

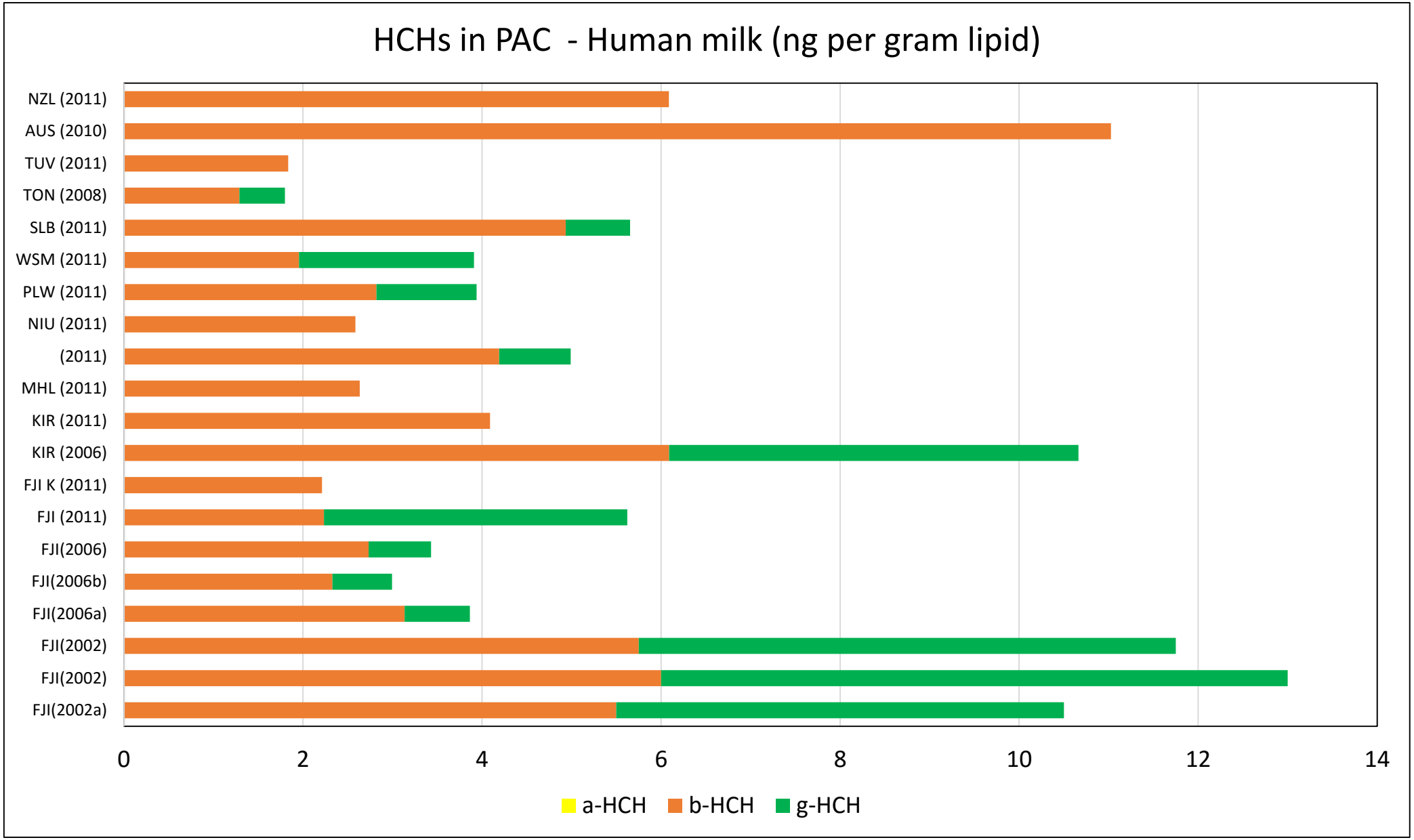
Technical grade HCH contains:

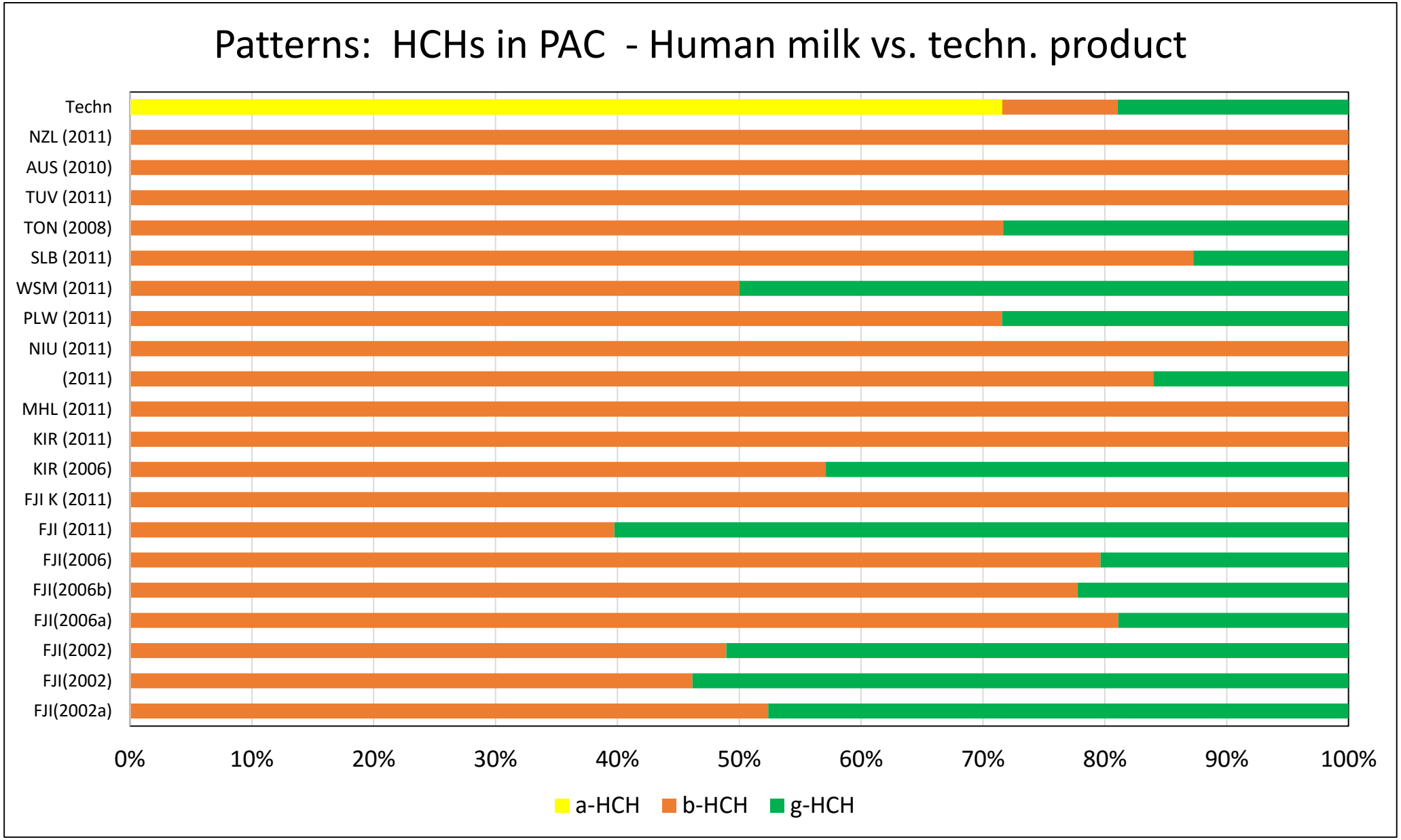
- 10%-15% lindane (g-HCH)
- 65%-70% a-HCH (60%-70%)
- 7%-10% b-HCH (5%-12%)

- After 1970s, “pure” lindane was produced and sold






HCHs in PAC - Human milk (ng per gram lipid)
NZL (2011)
AUS (2010)
TUV (2011)
TON (2008)
SLB (2011)
WSM (2011)
PLW (2011)
NIU (2011)
(2011)
MHL (2011)
KIR (2011)
KIR (2006)
FJI K (2011)
FJI (2011)
FJI(2006)
FJI(2006b)
FJI(2006a)
FJI(2002)
FJI(2002)
FJI(2002a)
0
2
4
6
8
10
12
14
a-HCH
b-HCH
g-HCH


Patterns: HCHs in PAC - Human milk vs. techn. product
Techn
NZL (2011)
AUS (2010)
TUV (2011)
TON (2008)
SLB (2011)
WSM (2011)
PLW (2011)
NIU (2011)
(2011)
MHL (2011)
KIR (2011)
KIR (2006)
FJI K (2011)
FJI (2011)
FJI(2006)
FJI(2006b)
FJI(2006a)
FJI(2002)
FJI(2002)
FJI(2002a)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
a-HCH
b-HCH
g-HCH

Brominated flame retardants

Round-Year	3-2002	5-2011	4-2006	5-2011	5-2008	5-2011
Sample ID	FJI(2002)	FJI (2011)	KIR (2006)	NZL (2011)	TON (2008)	TUV (2011)
Unit	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid	ng g^{-1} lipid
PBDE 47	3.9	1.01	2.00	2.83	15.19	1.19
PBDE 99	0.64	0.31	0.48	0.58	3.72	0.30
PBDE 100	1.40	0.21	0.40	0.63	3.20	0.22
PBDE 153	0.89	0.35	0.61	1.12	3.42	0.57
PBDE 154	0.29	0	0.05	0	0.38	0.01
PBDE 183	0.04	0.13	0.07	0	0.28	0
Sum PBDE	7.18	2.01	3.61	5.16	26.2	2.28
alpha-HBCDD		0	0	1.35	1.45	0.67
beta-HBCDD		0	0	0	0	0.11
gamma-HBCDD		0	0	0.11	0.10	0
Sum HBCDD	0	0	0	1.46	1.55	0.78

PFAS

Round-Year	5-2011
Sample ID	FJI(2011)
Unit	ng/L
PFOS	13
PFOSA	61
Sum PFAS	74

Summary with respect to Pacific Islands countries

- The Pacific Islands countries have been active partners in the human milk surveys;
- Some – Fiji, Kiribati – participated in more than one round of the surveys;
- All countries participating in UNEP/GEF GMP1 provided human milk samples;
- For industrial POPs – PCB, PBDE (exception Tonga), PFOS – and unintentionally generated POPs – PCDD, PCDF, dl-PCB – concentrations in the Pacific Islands population is comparatively low;
- For some POPs pesticides – DDTs, lindane – some Pacific Islands countries are at the higher end of the concentrations found;
- The next round of the human milk survey will provide further insight.