National & Regional POPs Monitoring Data

Professor William Aalbersberg and Waisea Votadroka
Institute of Applied Sciences
University of the South Pacific

Institute of Applied Science

- Analytical Services one of 5 units—also Regional Herbarium, Environment, Food and Natural Products Units
- International accreditation and regional reference laboratory
- Assists in analyses related to health, environment and trade
- One of 6 regional centres for POPs analysis

2. Stockholm Convention on Persistent Organic Pollutants (POPs)

- Objective:

  To protect human health and the environment from persistent organic pollutants.

- Adopted in 2001
- Entered into force in 2004
- 155 Parties to date (27 May 2008)
- COP-4 May 2009 in Geneva, Switzerland

Effectiveness Evaluation

- Only international convention with EE as a requirement
- Human milk and atmosphere are core indicators of human and environmental impact
- Other types of samples can be added if important locally or regionally
- Baseline assessment underway in Fiji, Samoa, Niue, Kiribati, Solomon Islands and Tuvalu
- Waisea Votadroka, Vincent Lal and Jimaima Lako main implementers

3. PTS Characteristics

- **Resistant to chemical, biochemical, photochemical degradation**
- **Long life-time in the environment (years)**
- **Physical properties which support a high degree of mobility in the environment**
- **Can be bioaccumulated in food chains**
- **Toxic properties at low levels (ng-mg.kg-1) or metabolised to toxic compounds –toxic to humans and wildlife**
- **Persistent**
- **Main groups: technical chemicals, pesticides and industrial by-products**
- **Accumulate in fatty tissues**
- **Carbon based compounds**

Persistent Organic Pollutants (POPs) -Compounds of interest

POPs

- **Classical organochloric pesticides:**
- **DDT, Aldrine, Dieldrine,**
- **Endrine, Chlordane,**
- **Heptachlor, Mirex,**
- **Toxafen**
- **Industrial chemicals:**
- **Polychlorinated biphenyls (PCBs)**
- **Hexachlorbenzene (HCB)**
- **Unintentionaly formed products:**
- **Dioxins (PCDDs/PCDFs), PCBs, HCB**

Candidates for POPs?

- **Perfluorinated compounds (PFOS)**
- **Polybrominated compounds (PBDEs)**
- **Polybrominated biphenylethers**
- **Octyl and nonylphenols with etoxylates**
- **Chlorinated paraffines (SCCPs)**
- **Polychlorinated naphtalenes (PCNs)**
- **Polychlorinated terphenyles (PCTs)**
- **Organotin compound …….**
- **Polycyclic aromatic hydrocarbons (PAHs)**

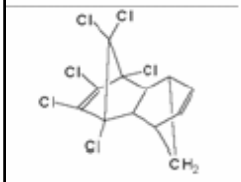
Halogenated pesticides

Examples **Sources**

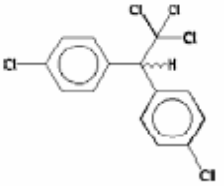
DDT, endrin, aldrin, dieldrin, Point: storage, waste disposal

Endosulfan, HCH, toxafen Non-point: agriculture

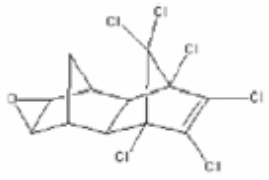
- banned in many countries, still used in developing countries, persistent



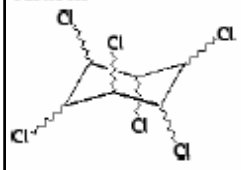
Aldrin



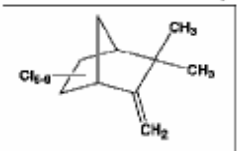
DDT (also number of derivatives – DDE,DDD..)



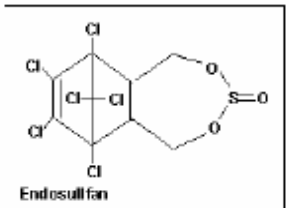
Endrin



Lindan = gamma-hexachlorocyklohexan



Toxaphene: A Mixture of Chlorinated Camphene



Endosulfan

Persistent organic halogenated compounds

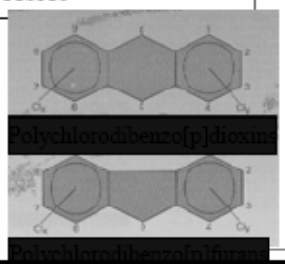
Examples **Sources**

PCBs

- Industrial products Point: industry, incinerators
- 209 structural congeners Non-point: paints, transformers,
- Banned, present in environment releases from products

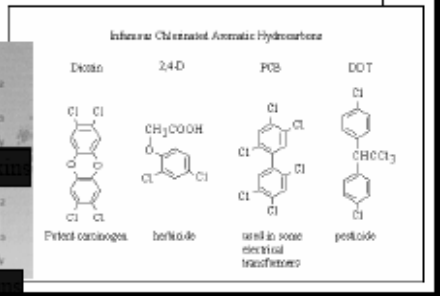
PCDD/Fs (75 and 135 possible isomers)

- Side products of combustion and industrial processes



Polychlorodibenzo[p]dioxins

Polychlorodibenzofuranes



Persistent organic halogenated compounds PCBs, PCDD/Fs

Molecular mechanism of toxicity	Specific mechanisms (AhR, endocrine disruption…) Narcotic acute toxicity
Effects – producers	Changes in photosynthesis, growth, lethality
Effects – consumers	Carcinogenity, chronic effects linked to AhR activation - imunotoxicity, neurotoxicity, dermal toxicity – chloracne, reproductive effects, endocrine disruption, teratogenicity
	AhR-independent effects (nonplanar *ortho*-substituted PCBs) – neurobehavioral, carcinogenic, endocrinal changes
Effects – destruents	Acute toxicity, changes in growth, metabolic activity, lethality

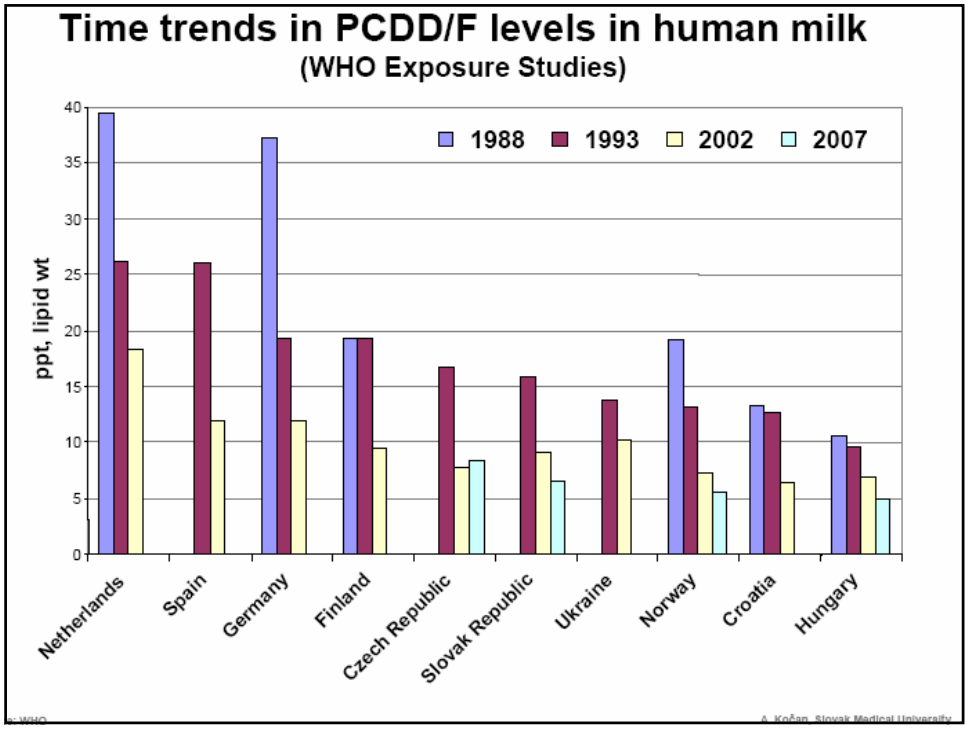
Important:
Great persistence and bioaccumulation, long-range atmospheric transport !!

PTS in Regional Use

USP
THE UNIVERSITY OF THE SOUTH PACIFIC

- PTS use in the region is low by world standards include – crop production, termite control, general household and public health applications and vector control
- UNEP Pacific Islands Regional Report (2002) lists regional uses:

-Aldrin (Solomon Islands,Fiji, Tonga,Vanuatu);
-Atrazine (French Polynesia, Samoa);
-Chlordane (French Polynesia, Samoa);
-DDT (Solomon Islands-for malaria control)
-Dieldrin (Solomon Islands);
-Endosulfan (Cooks, FSM, FP, NC, Vanuatu,,Fiji);
-Heptachlor (FP);
-Lindane(FP, Kiribati, NC & Solomon Islands);
-Organo mercury (Solomons – as phenylmercury acetate);
-Organotin compounds (FP, Guam, NC, Vanuatu, Wallis & Futuna,)
-Pentachlorophenol (Fiji)

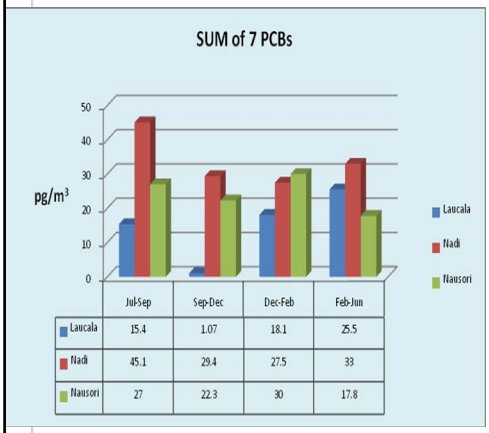


Regional Projects & Data Sources

- **$US600,000 Pacific Regional Projects –Screening of POPs in the core media of human milk and air samples in 6 countries**
- **Secured Taiwan funding to investigate the levels of POPs present in foods imported from Aust and NZ to Samoa, Kiribati, Niue, S.Isl & Tuvalu, Fiji;**
- **On-going research on the levels on pesticides in *Anadara antiquata (*kaikoso) and *Batissa violacea (*Kai) from across Fiji as a Pilot Project after completion to evolve into a Regional Shellfish Pesticides Project – to have screening every 3 years etc (with external funding);**
- **Completed a successful soils/sediments project in collaboration with the Univ. Queensland/QHSS**
- **Ongoing research on pesticides levels in tuna across the Pacific with Orebro Uni.**
- **Secretariat of the Pacific Commission/USP Sponsored Porject on the screening of pesticides in vegetables in Fiji, Tonga & Solomon Islands.**

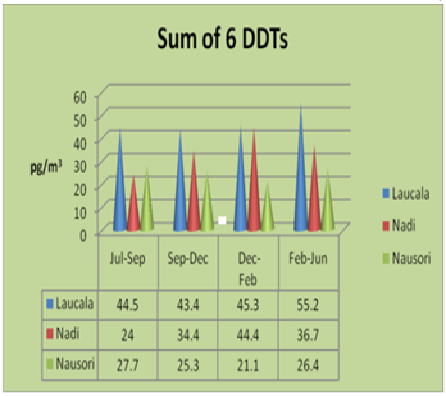
(6a.)Fiji passive air sampling data

PCBs in 3 Fiji sites



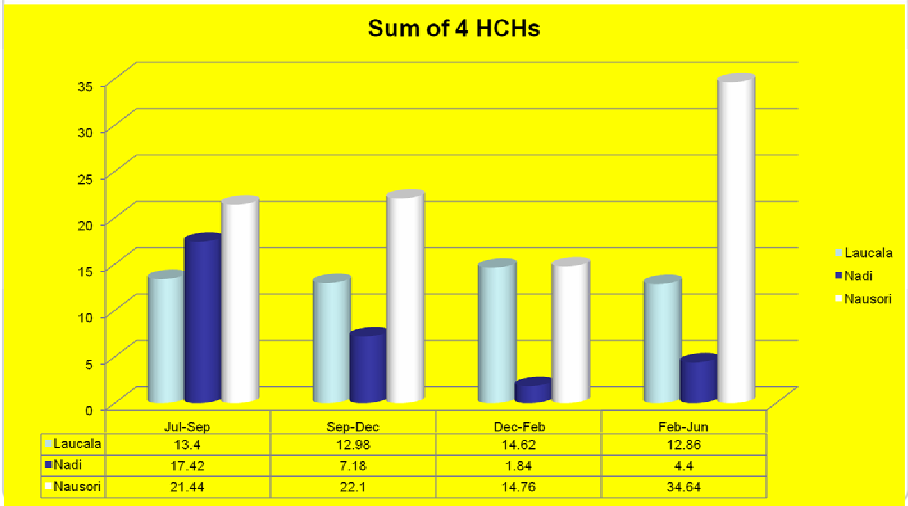
	Jul-Sep	Sep-Dec	Dec-Feb	Feb-Jun
Laucala	15.4	1.07	18.1	25.5
Nadi	45.1	29.4	27.5	33
Nausori	27	22.3	30	17.8

DDTs in 3 Fiji sites



	Jul-Sep	Sep-Dec	Dec-Feb	Feb-Jun
Laucala	44.5	43.4	45.3	55.2
Nadi	24	34.4	44.4	36.7
Nausori	27.7	25.3	21.1	26.4

The Sum of HCH at the Fiji 3 sites



	Jul-Sep	Sep-Dec	Dec-Feb	Feb-Jun
Laucala	13.4	12.98	14.62	12.86
Nadi	17.42	7.18	1.84	4.4
Nausori	21.44	22.1	14.76	34.64

Comparing Fiji Air data with other EU Countries

Site	PCB (pg/m^{-3})	HCH (pg/m^{-3})	DDTs (pg/m^{-3})	HCB (pg/m^{-3})	PAHs (ng/m^{-3})
Laucala-Fiji	17	44	45	5	7697
Nausori-Fiji	25	73	26	4	6420
Nadi	31	19	36	3	6504
Lahemaa, Estonia	27	52	8	50	18960
Kosetice, Czech Rep.	53	126	99	136	7220
Ruginesti, RO	46	281	47	54	37970
"Acceptable levels pg/m^{-3} " - USEPA	3400	6300	20000	4200	

Previous regional air data(pg/m^{-3})

Location , year	HCB	HCH	Chlordanes	DDTs	PCBs
Solomon Is Iwata et al. (1994)	-	260	250	1300	2300
Marshalls Atlas & Giam,1989	100	270	10	5	100
A.Samoa Atlas & Giam,1989	60	30	<1	2	10
Acceptable Level pg/m^{-3}	4200	6300	19000	20000	3400

(6b) Regional human milk data

	Fiji Rural (2007)	Fiji Urban (2007)	Kiribati (2007)	Tonga (2007)	Fiji (2003)	Samoa, GCPP 1980	PNG Spicer, 1993
DDT (ng/g fat)	573.5	804.3	188.9	792	1225	50-100	60-3000
HCB (ng/g fat)	2.4	3.8	3.2	5.7	4	-	
G-HCH (ng/g fat)	0.7	0.7	4.6	1.3	3	20-90	
OCDD (pg/g fat)	116	36.9	66.1			-	
OCDF (pg/g fat)	0.27	0.38	0.29			-	
Sum PCBs (ng/g fat)	8.6	14.4	10.1	7.28	16.9	-	

Table 5.2–3 Result of 4th-round WHO human milk survey

	Fiji (rural)	Fiji (urban)	Kiribati
Aldrin (ng/g fat)	ND	ND	ND
Chlordane [1] (ng/g fat)	1.7	1.7	1.5
Dieldrin (ng/g fat)	1.6	2.8	1.6
DDT [2] (ng/g fat)	573.5	804.3	188.9
Endrin [3] (ng/g fat)	ND	ND	ND
Heptachlor [4] (ng/g fat)	ND	ND	ND
HCB (ng/g fat)	2.4	3.8	3.2
Toxaphene [5] (ng/g fat)	ND	ND	1.4
Mirex (ng/g fat)	ND	ND	ND
PCB [6] (ng/g fat)	8.6	14.4	10.1
WHO-PCDD/PCDF-TEQ (pg/g fat)	4.5	3.6	3.7
WHO-PCB-TEQ (pg/g fat)	1.46	2.03	3.07

Note: ND=Not Detected (<0.5 ng/g fat)
1) sum of cis-chlordane, trans-chlordane and oxychlordane, calculated as chlordane
2) sum of o,p'-DDT, p,p'-DDT, p,p'-DDE, and p,p'-DDD, calculated as DDT
3) sum of endrin and endrin ketone, calculated as endrin
4) sum of heptachlor and heptachlor-epoxide (cis/trans), calculated as heptachlor
5) sum of parlar 26, parlar 50 and parlar 62
6) sum of PCB-28, 52, 101, 138, 153, 180

Table 5.2–4 Result of 3rd-round WHO human milk survey

	Fiji	Hong Kong SAR	Philippines	Tonga
WHO-PCDD/PCDF-TEQ (pg/g fat)	3.34	8.25	3.94	2.82
WHO-PCB-TEQ (pg/g fat)	1.75	4.67	2.38	1.27
Sum indicator PCB (ng/g fat)	17	45	26	--

Results

- Higher dioxin levels in rural Fiji sample as compared to urban sample an indication perhaps of the continual use of firewood cooking by rural women
- Higher [PCB] for Fiji urban women than rural due to the exposure of urban dwellers to industrial activities electrical transformers
- High levels DDT in Fiji urban and PNG women –need updated data for Solomons, Samoa, PNG, Niue and other regional countries

Soil at a Fiji point source- Lakena

- .[Lal,V.V.,et al. PBDE, PCBs, OC pesticides, dioxins/furans in a residential area in Lakena,Fiji Islands.] IAS-Univ. Queensland project.

	∑PCDD (PG/G)	∑PCDF (PG/G)	∑PBDE PG/G	
Lakena	6250 with OCDD 80%	287 With HpCDF at 170	3036 with PBDE 208 at 67%	

Point source data

- Lakena (Nausori) was an Open Dump Site as well as an Agri Station where volumes of pesticides were reportedly buried
- High dioxin levels in Lakena similar to international studies with high OcCDD which were near open dumpsites & areas of pesticides stockpiles (Muller et al. 2004)
- High PBDE levels with PBDE 209(DeBDE) making 67% of total.
- PCDF levels with HpCDF being the highest