

## Persistent organic pollutants and persistent toxic substances in Samoa's environment

*Taule'ale'ausumai L. Malua, Bill Cable and Dr. Paul F. Heveldt\**

### Background

Persistent Organic Pollutants (POPs) have been referred to as the toxic or “dirty dozen” worst pesticides and chemicals known to man under the Stockholm Convention which Samoa ratified in February 2002 (Interim Secretariat for the Stockholm Convention on POPs 2002). They include nine (9) POPs pesticides, an industrial chemical, and two which are “unintentionally” produced by combustion:

Table 1. Current twelve POPs under the Stockholm Convention

<b>Pesticides (largely Insecticides)</b>	<b>Pesticides (continued)</b>	<b>Industrial Chemical</b>
Aldrin	Heptachlor (1)	Poly-Chlorinated-Biphenyls (PCBs)
Chlordane 1	Hexa-Chloro-Benzene (HCB)	
DDT 2	Mirex	“Unintentional” Combustion
Dieldrin 3	Toxaphene	Dioxins
Endrin		Furans

1. Termiticide (associated);
2. Former mosquito control (unlabeled “Double Rabbit” mosquito coil), and former banana scab moth control
3. Former soaking of banana bits for weevil borer and nematode control

Persistent Toxic Substances (PTS) have similar properties to those of POPs and have been reviewed for consideration as part of a regional study (United Nations Environment Program 2002) for possible addition as POPs (United Nations Environment Program Chemicals 2003).

### What POPs are found in Samoa and where

This paper will provide insight into the extent of POPs and PTS in Samoa and the efforts that are being made to address them. How will this be done? Through answers to the questions of: What? How much is there?; Where are they?; What is the extent of the problem?; and What is being done about it?

POPs was talked about in 2000. However, not much was known about its existence and extent of its seriousness in Samoa. Earlier studies of Persistent Organic Pollutants (POPs) and Persistent Toxic Substances (PTS) were reviewed in the Samoa Environment Forum 2000 (Cable and Iakopo 2001). These studies were also referred to in a press release of the ongoing Samoa's Enabling Activity for POPs (GoS 2002). This was drafted also into Samoan and displayed and distributed during a 2002 Awareness Day of the Ministry of Natural Resources and Environment (MNRE). The press release was updated earlier in 2003 for presentations of the Assistant Director (now Chief Executive Officer) of Planning and Urban Management Agency (PUMA), in whose Sustainable Development section the Enabling Activity is sited, for the 2<sup>nd</sup> National Chemicals Awareness Day (Malua 2003).

The Samoa Environment Forum 2000 paper provided summary of analyses of POPs (and PTS; see section 4 for discussion) (Cable and Iakopo *ibid*) and is summarised here:

---

\* Mr. Malua is Assistant CEO PUMA and Mr. Cable is POPs Project Coordinator, MNRE; Dr. Heveldt is Senior Environmental Specialist, MWH NZ Ltd.

The concentration of DDT in marine sediments at the main wharf was reported as “unacceptable”, although not that of the shellfish in that area (GWS and KfW 1993). The Western Samoa Water Authority (WSWA 1996) Master Plan Study included pesticides which were below levels of detection in 11 samples taken. The latter were largely from boreholes and included those from Savaii as well as Upolu.

Table 2. Summary of POPs and PTS Found in Earlier Studies in Samoa

POPs and PTS	Study: Fryauff (1982)	GWS and KfW (1993)
POPs: DDT	+	+
Aldrin	+	Na
Heptachlor	+	Na
Dieldrin	Na	+
Chlordane	Na	+(detected at wharf & Vaiusu mangrove of 4 sites)
PCBs	Na	+
PTS: endosulfan	+(only detected in fresh water)	Na
Lindane	+	+(only Mulinuu reef of 4)
Penta-Chloro-Phenol (PCP)	Na	+(only Mulinuu reef of 4)
Polynuclear Aromatic Hydrocarbons (PAH)	Na	+

+ Detected [Fryauff (ibid) studied 17 fresh water, 14 human fat, 8 egg, 7 taro, 5 marine fish, 2 Chinese cabbage and 1 soil samples among others with no indication of specific sites in the report; DDT in human fat samples was very high in this study];

GWS and KfW (ibid) studied 4 shellfish and 7 marine sediment samples from the wharf to Vaitele mangrove). Note that six (6) other POPs were not analysed in these studies, including Mirex, Toxaphene and Hexa-Chloro-Benzene (HCB) not known to have been previously analysed in Samoan samples. analysed

### Preliminary inventory of POPs

The earlier analyses above were of concentrations in small samples and did not give quantitative estimates. The latter awaited the POPs in Pacific Island Countries (PICs) project of the South Pacific Regional Environment Programme (SPREP). The latter estimated 9,000 litre of old transformer oil potentially contaminated with PCBs and recommended for off island disposal (Graham 2000). In Phase 2 of that project, the transformer oil was actually routinely tested. Of 38 of 97 tested which gave a positive quick test using “Chlor-n-Oil 50”, only three (3) were confirmed by analysis at Hill Laboratories, Hamilton, New Zealand (NZ) as having more than 50 milligramme (mg) per litre (or parts per million, ppm) requiring disposal under the Stockholm Convention (Interim Secretariat for the Stockholm Convention on POPs 2002). The amount of oil in the three transformers was estimated as 465 kilogramme. No POPs pesticides were identified and, as a result of generally low amounts of POPs found in PICs, the Australian Assistance for International Development (AusAID) agreed to include non-POPs pesticides.

The MNRE’s Enabling Activity earlier in 2003 employed consultants of the Montgomery Watson Harza (MWH) NZ Ltd. (at that time represented at the Samoa Water Authority) to conduct an initial inventory of POPs. The inventory also included PTS as some are anticipated to be added as POPs and it is cost effective to analyse simultaneously. Surface soil from immediately around the transformers contaminated with PCB oil was found below international standards of concern. The two (2) contaminated transformers at Vaitele (Figure 1a) were later moved to separately enclose by 2 metre high chain link fence and labeled as hazardous chemicals to await disposal under the POPs in PICs project. A further contaminated transformer was identified at Asau (Figure 1b).

Other POPs pesticides contaminated sites were identified (Table 3). Extremely high contamination at the commercial pesticides warehouse at Vaitele (Figure 1c) was found of chlordane in 3 and heptachlor in 2 of 5 soil samples. Similarly, at the residential site of a pest control operator (Figure 1d) who formerly used chlordane termiticide, it and heptachlor were also found above and below overseas residential standards in one each of 5 soil samples. Chlordane was detected below standards at two other sites including Nuu Crop Development Centre which had been identified in earlier SPREP study and recommended for proper disposal of the buried pesticides.

Figure 1. POPs contaminated sites - Poly-Chlorinated Biphenyls (PCBs) contaminated transformers oil at Vaitele (1a-b) and Asau (1c-d)



In contrast to the earlier study finding unacceptable DDT concentration in sediments at the main wharf, DDT and its breakdown product DDE were below standards outside the main agriculture pesticides store as also DDE at the pest controller's residence. Dieldrin was also detected at the main agriculture pesticides store below standards.

In addition, eight (8) pig fat samples were also taken for analyses of POPs. The POP DDT was detected in seven (7) and its breakdown products DDE and DDD in five and one samples, respectively. The maximum concentration of 0.12 mg per kilogramme (kg) (ppm) was much below the NZ standard of 5 mg/ kg although it was recognised to be a small sample for which additional samples, if taken from contaminated sites (e.g. Vaitele warehouse and Vaivase pest control residence), could have higher concentration.

Table 3. Summary of POPs Contaminated Soils Exceeding Standards in Sub-samples Within Various Sites (GOS 2003)

POPs:	Site: ASCW*	VRB	FMS	ASC	N1	SC
Chlor-dane	3/ 5	1(+1)/ 5	1/ 5	-	(1/ 5)	(1/ 5)
Hepta-chlor	2/ 5	1(+1)/ 5	-	-	(1/ 5)	-
DDT + DDE	-	(1)/ 5	-	(1+2)/ 5	-	-
Dieldrin	-	-	-	(1)/ 5	-	-

\* ASC = Agriculture Store Corp. main store, and ASCW = warehouse (Figure 1c);

VRB = Vaivase pest control operator (Figure 1d);

FMS = Fugalei marine sediment;

N1-3 = Nuu main buried pesticide site 1;

SC = Samoa College

( ) number of samples with detectable POPs but below standards

- below levels of detection

### Persistent toxic substances

The PTS residues found in earlier studies are also indicated in Table 1 above. Lindane is still sold by pharmacies for treatment of scabies and pediculosis while three other competitively priced non-PTS alternatives are also available which could allow phase out by the Ministry of Health et al.

At a regional workshop, potential PTS were suggested (Cable 2002).

Endosulfan as Thiodan 35 was identified in the POPs in PICs project for disposal of only 0.8 litre of this obsolete pesticide from Vaitele warehouse. Disposal may be as early as December 2003.

Figure 2. Persistent Toxic Substances (PTS) contaminated marine sediments - (2a) Tri-Butyl Tin (TBT) contamination at main wharf and (2b) Poly-nuclear Aromatic Hydrocarbons (PAHs) contamination at Sogi



The first known analysis in the MNRE study of Tri-Butyl Tin (TBT) confirmed contamination above overseas standard at three (3) of five sites at the main wharf (Figure 2a). At Sogi, marine sediment on the margin of mangroves contamination above overseas standards was found from drainage from the adjacent oil tank farm of PAHs (dibenzo[a,h]anthracene, fluoranthene, fluorene, naphthalene/ phenanthrene) (Figure 2b; Table 4).

Because of the association of Penta-Chloro-Phenol (PCP) with Copper-Chrome-Arsenic (CCA) timber treatment, it was analysed at the badly CCA contaminated site at Asau. It was at the limit of detection in three (3) of six samples.

Table 4. Summary of PTS found in Soils Samples Within Various Sites (GOS 2003)

PTS:	Site: AHS*	SOGM	TVC
Tri-Butyl Tin (TBT)	3/ 5	na	Na
PAHs	Na	1(+2)/ 5	na
PCP	Na	na	(3)/ 6

\* AHS = Apia harbour sediment;  
 SOGM = Sogi marine sediment;  
 TVC = Tui Vaai Corporation code used for old Samoa Forest Products site

Na not analysed

() number of samples with detectable POPs but below standards

## Some suggestions for addressing the POPs/ PTS problem

### a. POPs

As a Party to the Rotterdam Convention, Samoa has committed to obligations under it. The main one for which Samoa is receiving assistance under the Enabling Activity is to develop a National Implementation Plan (NIP) including Action Plans for elimination or reduction of the three (3) main classes of POPs, i.e.: 1 PCBs; 2 pesticides; and “unintentional” dioxins/furans. Pacific Environment Consultants Ltd. (2003) consultants are contracted to complete the NIP including other activities by 2004.

To facilitate elimination of PCBs, the Enabling Activity continues to test transformers manufactured before 1987. A representative of the Electric Power Corporation to the National Task Team for POPs in 2002 estimated that about 70 per cent of transformers were still on-line. Under the Convention, Parties have until 2028 to dispose of PCB contaminated transformers. Samoa should not require that long to identify and hopefully dispose of them and/ or the oil, but an Action Plan will be needed for continuing testing following the end of Enabling Activity now expected in 2004.

Likewise, the action plan for pesticides may consider a call-in by the Ministry of Agriculture, Forestry, Fisheries and Meteorology and/ or Agriculture Store Corp. to dispose of possible obsolete POPs pesticides. Most likely, the pesticides would be non-POPs and, if labels are intact, could be used by others or disposed by spraying at recommended rates.

Known pesticide contaminated sites were visited under Phases 1 and 2 of the POPs in PICs project. However, they were not agreed by AusAID for inclusion for disposal. The Action Plan will need to consider especially the badly contaminated Vaitele warehouse and residential pest control sites as also marine sediments off Fugalei stream.

### b. PTS

Those that come under POPs will also have to be dealt with. As this may be with some delay, those which exceed standards should nonetheless be dealt with and may be included as

a part of Action Plans. The TBT and PCP are pesticides while PAHs are from “unintentional” burning. In developing a plan to reduce dioxins and furans, PAHs should also be reduced.

### c. Standards for POPs and PTS

The Government of Samoa report provides international standards for shellfish and animals, soil and marine sediments (GoS 2003; Table 5a-c) which should be considered. It is noted that those for soil have considerable difference of US-EPA industrial and NEPM commercial samples which requires special consideration when analysis falls in the range.

Table 5. Standards for POPs and PTS in various circumstances

#### a. DDT (Organo-Chlorine) in shellfish and animal samples

Sample:	NZ-FSA (2002)
Shellfish	0.1 mg/ kg (also Organo-Chlorine)
animal (e.g. pig)	5.0 mg/ kg

#### b. POPs and PTS in soil

POPs or PTS:	US EPA(1993): residential	industrial	NEPM (1999): residential	commercial	MfE (1997): timber
POPs: chlordanes	1.6	8.1 (10 no dermal contact)	50	250	-
Heptachlor	0.1	0.48 (0.79)	10	50	-
“ epoxide	0.053		-	-	-
DDT or DDE	1.7	8.8	-	-	-
DDD	2.4	12	-	-	-
DDT + DDE + DDD	-	-	200	1,000	-
Dieldrin	-	0.13	-	50	-
PCBs	-	1.8	-	50	-
PTS: PCP	-	30	-	-	570 (agriculture 0.7)

- None given

#### c. Chlordane and TBT in Marine Sediments

POP or PTS:	ANZECC (2000): ISQC low	ISQC high	Canadian ESQ (1999)
Chlordane	0.0005	0.006	0.00226
TBT	0.05	0.07	-

- none given

### d. Heavy metals

In developing the Regionally-Based Assessment for PTS, it was stressed that for heavy metals only organic forms have POPs properties. The find of concentrations of total lead above standards in water samples (Samoa Drinking-water Standards Working Group 1999) near the former Vaitoloa dump and Fugalei market could include some contamination from former use of organic tetra-ethyl and tetra-methyl lead additives now excluded from petrol import to Samoa but are most likely to be from lead-acid batteries. The UNDP’s Programme Specialist has provided information of Occupational Knowledge (OK) International (2003) assistance to NGOs, and a proposal drafted by O Le Si’osi’omaga Society Inc. (2003) if supported would provide needed awareness for affected communities.

## Conclusion

This paper has provided a summary of the pre-2002 literature, and a preliminary inventory of POPs in Samoa. It stresses that work continues with dioxins and furans as well as PTS.

## References

- AUSTRALIAN AND NEW ZEALAND GUIDELINES FOR FRESH AND MARINE WATER QUALITY, 2000. National Water Quality Management Strategy. Australian and New Zealand Environment and Conservation Council (ANZECC) and Agricultural and Resource Management Council of Australia and New Zealand.
- CABLE, W.J., 2002. Potential Persistent Toxic Substances (PTS) in Samoa: Sources and concentrations, issues and related activities. *In: GEF Regional Based Assessment of Potential Toxic Substances Region IX Technical Workshop: Sources and concentrations of PTS in the environment, ecotoxicology and major pathways of contamination and transport.* 14-17 May 2002. Apia, Samoa.
- CABLE, W.J. and IAKOPO, A.I., 2001. Samoa's fresh waters: a need to protect its quantity and quality. *In: Samoa Environment Forum 2000*, pp 11-15
- CANADIAN ENVIRONMENTAL QUALITY GUIDELINES, 1999. Canadian Council of Ministers of the Environment. Canadian Sediment Quality Guidelines for the protection of Aquatic Life (updated 2002). Available from: <http://www.ccme.ca>
- DEPARTMENT OF LANDS, SURVEYS AND ENVIRONMENT, 2002. Press Release: POPs
- FRYAUFF, D.J., 1982. Pesticide use and regulations in Western Samoa. Samoa-German Crop Protection Project. [Nuu, Western Samoa]
- GOVERNMENT OF SAMOA (GoS), MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT (MNRE), 2003. Preparation of an initial inventory of persistent organic pollutants (POPs) and persistent toxic substances (PTS) presence, levels and trends in humans and the environment in Samoa. 107 pages + Appendix
- GOVERNMENT OF WESTERN SAMOA (GWS), PUBLIC WORKS DEPARTMENT (PWD) and KREDITANSTALT FUR WEIDERAUFBAU (KfW), 1993. Apia Sewerage Project: Water Quality & Biological Studies. GWK Consult, Mannheim, F.R.G[ermany; sub-consultant Bioresarches, Auckland, New Zealand] in association with G.M. Meredith & Associates Ltd., Apia, Western Samoa.
- GRAHAM, B., 2000. Country Report A.9 Samoa. *In: BURNS, T. et al. Management of Persistent Organic Pollutants in Pacific Island Countries.* South Pacific Regional Environment Programme (SPREP), Apia. Pp A43-A47.
- INTERIM SECRETARIAT FOR THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPs), 2002. Stockholm Conventions on Persistent Organic Pollutants: Texts and Annexes. Reprinted by United Nations Environment Programme, Geneva, Switzerland GE.02-03027 (<http://www.pops.int>)
- MALUA, T.L., 2003. Status of Persistent Organic Pollutants ("POPs") in Samoa. *In: 2<sup>nd</sup> National Chemicals Awareness Day*, 1 and 3 April 2003, Salelologa and Apia, Samoa.
- Ministry for the Environment (NZ), 1997. Health and Environmental Guidelines for Selected Timber Treatment Chemicals. Available from: <http://www.mfe.govt.nz>
- NATIONAL ENVIRONMENTAL PROTECTION (Assessment of Site Contamination) MEASURE (NEPM), 1999. Available from: <http://www.ephc.gov.au.nepms>
- NEW ZEALAND FOOD SAFETY AUTHORITY (NZ-FSA), 2002. Food Standards Australia New Zealand. Available from: <http://www.foodstandards.govt.nz>
- OCCUPATIONAL KNOWLEDGE INTERNATIONAL (OKI), 2003. Available from: [okintl@aol.com](mailto:okintl@aol.com)

- PACIFIC ENVIRONMENT CONSULTANTS LTD. (PECL), 2003. Consultancy for the Development of a National Implementation Plan (NIP) for Meeting Samoa's Obligations Under the Stockholm Convention for Persistent Organic Pollutants.
- SAMOA DRINKING-WATER STANDARDS WORKING GROUP, 1999. Samoa Drinking-water Standards Manual. Final Draft. [Apia, Samoa]
- UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP), 2002. Regionally-Based Assessment of Persistent Toxic Substances: Pacific Island Regional Report. Geneva, Switzerland. 66 pages.
- UNEP CHEMICALS 2003. Regionally Based Assessment: Global Report 2003. Geneva, Switzerland. 211 pages.
- UNITED STATES FOOD AND DRUG ADMINISTRATION (US EPA), 1993. Center for Food Safety and Applied Nutrition. Guidance Documents for Trace Elements in Seafood. *Available from:* <http://www.epa.gov/region06>
- WESTERN SAMOA WATER AUTHORITY, 1996. National Master Plan Study (Stage 1) Vol. 1 – Final Report. Rofe, Kennard and Lapworth in association with G.M. Meredith & Associates Ltd., Apia, Western Samoa and Sutton, Surrey, England.