

## Pesticides, volatile and semivolatile organic compounds in the inland surface waters of Cyprus

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### Abstract

The pollution of the surface waters of Cyprus from priority compounds which are included in the EU Directive 76/464/EEC was evaluated. The Directive deals with the pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. In the framework of the reporting obligations of Cyprus towards EU, a study was carried out for the Environment Service of Cyprus by the University of Cyprus in collaboration with the State General Laboratory. 19 out of the 59 surface water bodies of the country were investigated. 30 substances of List I, List I candidates and List II were examined. The analytical determination was performed by a Gas Chromatography — Electron Capture Detection for organochlorine insecticides, by Gas Chromatography — Flame Thermionic Detector for the chlorotriazine herbicides and organophosphate insecticides and finally by on line purge and trap technique followed by Gas Chromatography — Electron Capture Detection/Photoionization Detection for the volatiles and semivolatiles organic compounds. Toluene, 1,1,1-trichloroethane, 1,2-dichloropropane, vinyl chloride and 1,4-dichlorobenzene were the most frequently found among VOCs and SVOCs. In some cases non-compliance was observed for hexachlorobutadiene, hexachlorobenzene and 1,2,4-trichlorobenzene. The most commonly encountered organochlorine insecticides were hexachlorobenzene and heptachlor. This paper summarizes the work carried out, the methodologies applied and provides a discussion on the results found.

**Keywords:** Cyprus surface waters; Pesticides; Volatile and semivolatile compounds; GC-FTD; GC-ECD; On-line purge and trap — GC-ECD/PID

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Table 3  
Range of concentrations of the substances examined during 2000–2005 (concentrations are given in µg/L)

Substance	1	2	3	5	6	7	9	10	11	12	13	14	15	16	17	18	19
46 <sup>1</sup>	nd <sup>4</sup>	nd	nd	nd	nd	nd	nd	nd	nd	nd-	nd	nd	nd	nd	nd	nd	nd
77	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.014	nd	nd	nd	0.015	nd	nd	nd
83	nd	nd	nd	nd	nd	nd-	nd-	nd	0.001	nd	nd	nd	nd-	nd-	nd-	nd	nd
84	nd	nd-	nd	nd	nd	0.002	0.004	nd	nd	nd	nd	nd	4.6	0.004	0.003	nd	nd
118	nd	10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.92	nd	nd	nd	nd
100 <sup>2</sup>	nd	nd	nd	nd-	nd	nd	nd	nd	nd	nd	nd	nd	3.1	nd	nd	nd	nd
106	nd-	nd	nd-	nd	nd	nd	nd-	nd	nd-	nd	nd-	nd-	nd-	nd-	nd-	nd	nd
131	0.01	nd	0.032	nd	nd-	trace <sup>5</sup>	0.093	nd-	0.012	nd-	trace	trace	0.053	0.094	nd	nd	nd
53 <sup>3</sup>	nd	nd	nd	nd	nd	0.002	0.001	nd-	nd	0.05	nd-	nd-	nd-	nd	nd	nd	nd
54	nd	nd-	nd	nd	nd	nd	nd-	nd	nd	nd	nd	nd	nd-	nd-	nd	nd	nd
55	nd	0.024	nd-	nd-	nd	nd	trace	nd	nd-	nd-	nd-	nd-	nd-	nd-	nd-	nd-	nd-
			0.014	0.078	0.015			0.099	0.018	0.043	trace	0.046	3.3	0.013	0.03	0.073	

Table 3 (Continued)

Substance	1	2	3	5	6	7	9	10	11	12	13	14	15	16	17	18	19
65	nd	nd- 0.025	nd- 0.025	nd- trace	nd- 0.029	nd- 0.03	nd- 0.03	nd- 0.026	nd- 0.046	nd- 0.032	nd- 0.034	nd- 0.039	trace	trace	nd	nd- 0.057	nd- 0.026
79	nd	nd- 0.051	nd- trace	nd- trace	nd- trace	nd- 0.032	nd- 0.028	nd- 0.028	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace
82	nd	nd	nd	nd	nd	nd	nd	nd- 0.007	nd	nd- 0.495	nd	nd	nd- 0.021	nd- 0.015	nd	nd	nd
86	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd- 2.9	nd- trace	nd	nd	nd
96	nd	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace
110	nd	nd- 0.007	nd	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd- trace	nd	nd- 0.018	nd- trace	nd	nd- 0.008	nd	nd
112	nd	nd- 0.071	nd- 0.024	nd- 0.045	nd	nd- 0.123	nd- 0.032	nd- 0.083	nd	nd- trace	nd- 0.037	nd- trace	nd- 8.949	nd- 0.093	nd- 0.045	nd- 0.022	nd
119	nd	nd- trace	nd- 0.028	nd- 0.129	nd	nd- trace	nd- trace	nd- 0.056	nd- trace	nd- 0.032	nd- trace	nd- 0.086	nd- 0.013	nd- 0.06	nd- 0.038	nd- 0.068	nd- 0.06
128	nd	nd	nd	nd	nd	nd- 0.138	nd- 0.097	nd- 0.134	nd- 0.06	nd- 0.068	nd- 0.096	nd	nd- 0.447	nd- 0.155	nd	nd- 0.229	nd- 0.045

<sup>1</sup>List I.<sup>2</sup>List I candidates.<sup>3</sup>List II.<sup>4</sup>nd, not detectable concentration.<sup>5</sup>Trace: concentration between the detection and quantitation limit.

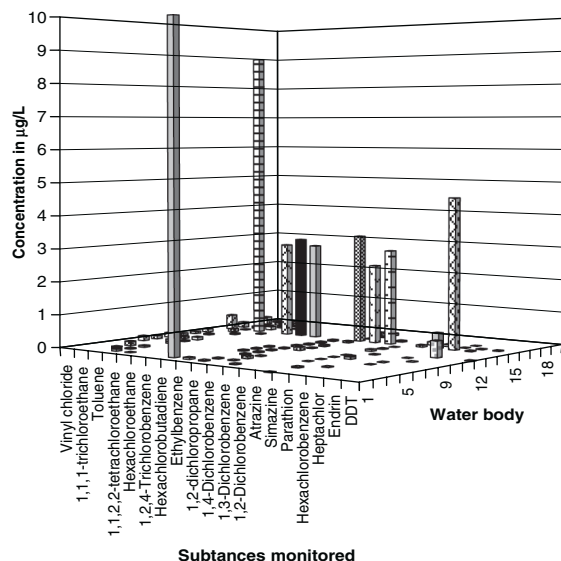


Fig. 2. Range of substances concentration in  $\mu\text{g/L}$  found in water bodies in Cyprus during the period 2000–2005.

The water bodies where most of substances examined were present are Garyllis River (1943 675 80) and Polemidia dam (1943 675 90). Garyllis River flows downstream towards Polemidia dam. A more detailed investigation is needed in order to examine the exact pollution sources in that area. The operation of the monitoring network is continuing and new legislative measures will be enforced if the results show that such additional measures should be taken. Finally it must be pointed out that more detailed studies have to be carried out covering a wider spectrum of substances to get clear baseline data for the entire areas of the water bodies including a bigger number of sampling points.

The comparison between substances in the different water bodies is shown in Fig. 3. It is clear that volatile compounds are present in almost all the samples examined and are present in higher concentrations compared to those of pesticides. Organochlorine pesticides were mostly present in Kalavassos Dam (1897 510 50). Dhiarizos River (1124 931 95) and Dhipotamos

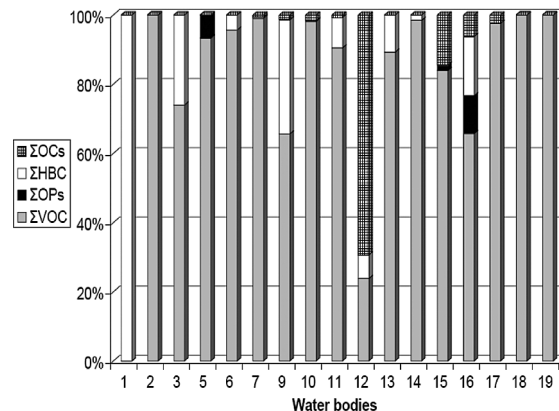


Fig. 3. Comparison of substances concentration in different water bodies in Cyprus during the period 2000–2005.

$\Sigma\text{OCs}$  = DDT + endrin + hexachlorobenzene + heptachlor

$\Sigma\text{OPs}$  = Parathion

$\Sigma\text{HBCs}$  = Simazine + atrazine

$\Sigma\text{VOCs}$  = Hexachlorobutadiene + 1,2,4-trichlorobenzene + 1,2-dichlorobenzene + 1,3-dichlorobenzene + 1,4-dichlorobenzene + 1,2-dichloropropane + ethylbenzene + hexachloroethane + naphthalene + 1,1,2,2-tetrachloroethane + toluene + 1,1,1-trichloroethane + vinyl chloride.

Dam (1873 514 95) have the highest concentrations of herbicides investigated.

#### 4. Conclusions

Though, it cannot be seen from the datasets presented in this paper since the data refer to the range of the concentrations of the various compounds investigated, during the years a remarkable decrease is observed for all the substances.

The results obtained showed that the most commonly encountered organochlorine insecticides were hexachlorobenzene (in Garyllis river, 1943 675 80) and heptachlor (in Kalavassos Dam, 1897 510 50). Atrazine and simazine which are chlorotriazine herbicides were identified in most of the water bodies examined in low concentrations. Parathion was the only organophosphate insecticide which was identified at three of



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