PCB's AND PCDD/PCDF IN SEDIMENT IN SOUTH AFRICA: AN INITIAL SURVEY.

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Introduction

South Africa participated in all the international negotiations that resulted in the Stockholm Convention on Persistent Organic Pollutants (POPs). We signed the convention on 23 May 2001 and it has been ratified during the World Summit on Sustainable Development in Johannesburg, August 2002. As many other developing countries, South Africa might well have become party to this convention without knowing the situation in its environment due to lack of data. The two authors were involved in a GEF regionally based assessment of the sources, environmental levels and long range transport data associated with the identified POPs and other chemicals with similar properties. The literature study revealed that of the 1 785 analysis on POPs done in SA in the past 30 years, 8.5% were on PCBs, 0.1% on PCDD and 0.1% on PCDF.[1] The presence of dioxins and dibenzofurans in breast milk[2] and butter[3] does indicate that there are sources, but it is not currently possible to identify these.

The release of man-made chemicals known as persistent organic substances is a major concern for human health and the environment. Of particular concern are the so-called persistent organic pollutants (POPs) that persist in the environment, resist degradation, and produce acute and chronic toxicity. Many persistent toxic substances are transported through the atmosphere or oceans over long distances and become globally distributed, detectable in areas where they have never been used. [4]

Although many POPs include pesticides the focus of this paper is on polychlorinated biphenyls, (PCB), polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). The latter two are formed as by-products of industrial activities and all combustion processes. PCBs are used in older type of transformers. Some of the toxic properties exhibited by these three categories of compounds are hormone-modulating actions, disrupting the endocrine or reproductive systems in a range of species, including humans and AhR-mediated toxic responses which include lethality, reproductive and developmental toxicity, immunotoxicity and cancer.[5]

The aim of this study was to conduct the first survey of its kind in South Africa, and establish the basis for further work.

Material and Methods

Composite sediment samples were collected from 22 pre-selected aquatic sites in South Africa. Samples were collected from the surface only with a brass grab sampler. The sites were selected on the criteria that they are close to or down stream from industrialised areas throughout the country. The aim was to form an idea of the concentrations of these substances if any. Some of the sites included harbours, sites downstream from coal mining activities, a sintering plant and

paper mills and timber processing industries (Figure 1)

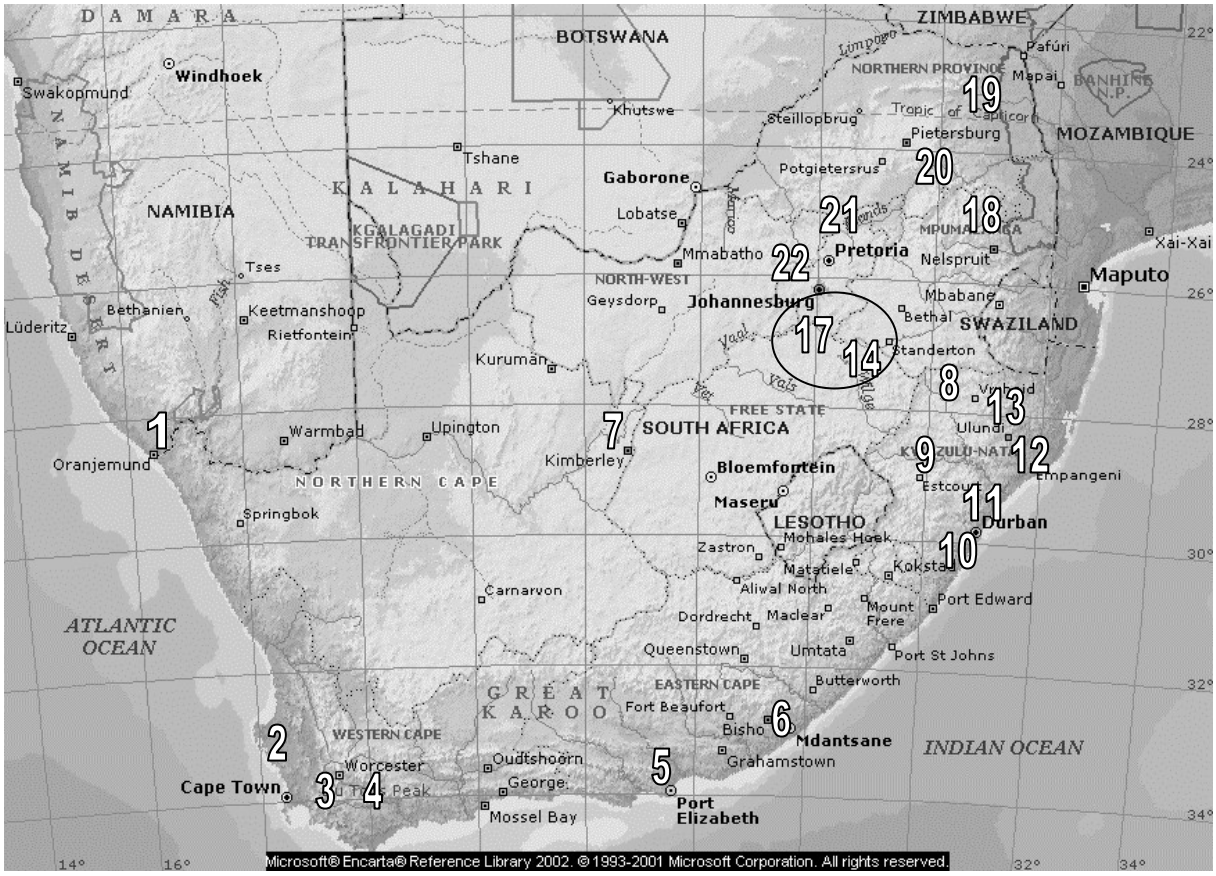

Fig 1. The positions of the selected sites are indicated on the map.

Freeze dried sediment samples were chemically analysed and the WHO-TEQ was calculated for the total PCDD/PCDF and the total PCB for each site. This was done by Oekometrics in Germany. The total organic content of each sample was also determined (Table 1).

Results and Discussion

The highest toxicity equivalent (TEQ) for the PCBs (10.01 ng/kg d.w.) was at a small stream immediately downstream from an iron and steal refinery in Vanderbijl Park (Site #16, Fig 1). This site also proved to have the highest PCDD/PCDF TEQ of 11.9 ng/kg d.w. The site with the next highest PCB TEQ was in the Crocodile River (Nelspruit) with a value of 1.74 ng/kg (d.w.) (Site #18, Fig 1). The sediment with the next highest PCDD/PCDF TEQ of 2.25 ng/kg d.w. was collected in the Loch Vaal Barrage (Site #17, Fig 1)(Table 1).

Table 1 The WHO-TEQ's of PCDD/PCDF and PCBs for each of the selected sediment

sampling sites in South Africa.

Site	%C in sample	WHO-TEQ PCDD/F (ng/kg d.w.)	WHO-TEQ PCB (ng/kg d.w.)
1 Orange River (mouth)	0.06	0.22	0.01
2 Saldanha Bay - harbour	0.00	0.27	0.01
3 Berg River	0.00	0.26	0.02
4 Theewaterskloof Dam	0.81	0.30	0.02
5 Groot River (mouth)	1.66	0.22	0.02
6 Zwartkops Estuary	1.14	1.58	0.61
7 Vaal River (before confluence with Orange River)	1.21	0.21	0.03
8 Buffalo River	0.16	0.23	0.01
9 Mooi River	1.92	0.32	0.02
10 Umlazi River (mouth)	0.96	0.90	0.30
11 Umgeni River (mouth)	0.68	1.19	0.32
12 Richard's Bay (harbour)	0.17	0.24	0.01
13 Thulazihleka Pan (Richard's Bay)	4.83	0.49	0.04
14 Vaal Dam	0.00	0.23	0.01
15 Rietspruit Stream	1.82	0.84	0.31
16 Rietspruit (diverted stream)	7.24	11.90	10.01
17 Vaal River	2.16	2.25	0.65
18 Crocodile River	1.21	0.78	1.74
19 Olifants River	0.89	0.23	0.02
20 Loskop Dam	0.18	0.20	0.01
21 Hartebeespoort Dam	0.45	0.54	0.47
22 Modderfontein Stream	2.48	4.41	1.58

The results show that PCB's and PCDD/F occur in all the sites that were sampled, also in samples from relative pristine areas. It also appears that the concentrations of the PCB's, PCDD/F are lower than the Agency for Toxic Substances and Disease Register's (USA)[4] recommendation that a screening level of 50 parts per trillion (50 ng/kg TEQ) is used to determine whether further site specific evaluation is needed. What is notable is that the higher levels were associated with industrial areas. These sites need further investigation, as localised polluted sites are likely to occur, especially in aquatic biota and in soils close to the sediment sampling sites, since this is the first such survey to be done for South Africa.

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Literature

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