

LEVELS OF POPs IN THE SUDANESE ENVIRONMENT

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Introduction

Trials for use of pesticides in Sudan started with the introduction of DDT for the control of cotton jassid (*Jacobiasca lubica* deBerg) in the Gezira scheme in 1949. The success of the trial, which started with a single application against a single major pest, initiated the interest for expansion of the treated area and opened the way for subsequent introduction of other related compounds. The period from the early fifties to the late seventies witnessed progressive intensification and expansion in the cropped areas with a subsequent increase in insect pest's complexity and damage. This necessitated an increase in chemical treatment with a negative impact on human health and the environment. Organochlorines were the major group of pesticides used during this period, favoured for their high potency against a wide range of agricultural and public health pests, cheapness, environmental persistence and low acute mammalian toxicity. After three decades of extensive use new concern about long term effects such as bio-magnification along the food chain, deposition in body fats of higher animals, and environmental pollution caused by their chemical inertness emerged leading to severe restrictions in their use in various parts of the world, including the Sudan¹

The main purpose of this paper is to compile data on the levels of persistent organic pollutants (POPs) in the Sudanese environment. The available data is quite limited and in most cases lacks important details. Furthermore, most of the investigations were carried out for personal interest of the scientist involved or following specific incidents. There is no national plan for monitoring or researching POPs. Most of the available information was obtained from unpublished sources, some from local publications or local reports and a few from papers published in international journals. Based on the above the obtained data are fragmented and difficult to compare in most cases. The paper also review the level of contamination in one of the most affected storage sites.

Residues of POPs in the Sudanese Environment

Limited studies were done on the distribution of various organochlorine pesticides residues in the various environmental compartments in the Sudan^{1, 2}. The obtained data are fragmented and difficult to compare in most cases. The main findings can be summarized as follows; Five major organochlorines (DDT, heptachlor, aldrin, dieldrin and gamma HCH) and /or some of their metabolites) were investigated in soil, water, food and humans; DDT was Investigated in almost all compartments, its highest level was found in animal milk (about 109 ppm). The highest level of heptachlor was found in marine water (4.5 ppm). While the highest levels of aldrin (0.56 ppm), dieldrin (5.5 ppm) and gamma HCH (0.48 ppm) were found in soil, birds and human milk respectively (table 1). On the other hand no study had been carried out to examine the level of other classes of POPs (e.g dioxins and furans) in the Sudanese environment, nor is there any monitoring program in place for such work. Furthermore no adequate facilities to conduct such studies are available in the country except the few analytical chemists who could conduct such investigations after additional necessary training.

Environmental Levels around Storage Sites of Obsolete Stocks of Pesticides (Mostly POPs)

Key efforts made in Sudan were directed towards the inventory of obsolete pesticide stocks, heavily contaminated storage sites including empty containers and contaminated soils. In addition, efforts were made for finding funds for their remediation and destruction. Preliminary attempts were made towards identification of the types of contaminants and their levels in the storages and in the surrounding of the affected sites. The impact of such contaminated sites on humans and other forms of life is another challenging issue. A few initial efforts were made to identify and quantify soil contaminants and levels. For one site an assessment of the horizontal and vertical

movements were done. The following paragraphs summarize the investigations on one of the most POPs affected sites in Sudan. The disposal of obsolete pesticide stockpiles as well as the remediation of this site was given priority in the national implementation plan for the Stockholm Convention ratified by Sudan in 5. Feb 2006².

The environmental impact of pesticide dumping of 1987 in Hasaheisa town was first investigated in 1991 by Elgadi³. In the investigation Elgadi questioned witnesses, residents and neighbours about the pesticide dumped in and analysed soils covering the dumping pits for DDT residues. In these samples, total DDT residues were up to 1100 ppm (table 2). In this study Elgadi further documented several animal deaths, severe respiratory and allergy-related symptoms among neighbours. Three years later a second study⁴ reported DDT and related compounds from all soil samples within the store enclosure at maximum levels ranging from 275 to 340 ppm. Five years later a further study^{5,6} reported the presence of gamma HCH, aldrin and heptachlor epoxide near the dumping site in addition to DDT contamination (table 3). In 1998 Babiker investigated in his master thesis⁷ the levels and movement of some organochlorine insecticides from the dumping site in Hasaheisa town. He reported significant contaminations at the soil surface of the dumping site: gamma HCH in the range of ND-32.5 ppm, heptachlor ND-58.03 ppm and DDD ND-87 ppm (tables 4 and 5). The study also documented variable horizontal (up to 100 meters) and vertical movement (up to 100 cm) of these contaminants from the dumping site (table 4 and 5).

Table 1. Summary of the levels (ppb) of POPs in the Sudanese environment.

Compartment\ chemical	Intentional POPs pesticides ^a					Unintentional POPs (dioxins, furans & PCBs)
	DDT metabolites	or Heptachlor or heptachlor epoxide	aldrin	dieldrin	HCH	
Soil	ND-5530	ND-1000	ND-560	ND-2.21	ND-20	NDA
surface water ^c	0.01-4.05 ^b	0.04-5.5 ^b	0.02-0.05		ND	NDA
Ground water ^c	ND	ND	ND	ND	ND	NDA
Marine water	ND-350	ND-4500	NDA	NDA	ND	NDA
Sea sediments	ND	ND	NDA	NDA	ND	NDA
Air	NDA	NDA	NDA	NDA	NDA	NDA
Fishes	270-16000	NDA	NDA	NDA	NDA	NDA
Birds	50-5560	NDA	NDA	70-5500		NDA
Cotton seeds	20-4000	NDA	NDA	NDA	NDA	NDA
Sorghum	3-120	NDA	NDA	NDA	NDA	NDA
Wheat	20-2160	NDA	NDA	NDA	NDA	NDA
Fruits & vegetables	ND-70	NDA	NDA	NDA	NDA	NDA
Animal milk	10-109000	30-1280	10-30	ND-120		NDA
Animal fats	470-1210	ND	ND	ND		NDA
Human milk	8-71830	40-3250	2-470		2-480	NDA
Human blood (occupationally exposed)	10-2010	1280 (average)	10 (average)	10-384	34- 120	NDA
Human blood (general population)	4-618	1-170	NDA	ND-82	ND- 92	NDA

Source: ^{1,2}; ^aThe POPs pesticides mentioned in the table where the only ones which were studied in the Sudan.

^b Total metabolites; ^c Excluding water sources near highly contaminated storage areas (Qurashi pesticide store).

NDA: No data available; ND: Not detected.

Table 2. DDT and its metabolites in the soil of Qurashi dumping site in 1991.

Pesticide/ level (ppm)	O,P DDT	P,P DDT	P,P DDE	Total DDT
Sample analyzed	12	12	12	36
Maximum	383	351	605	1172
Minimum	180	ND	ND	451
Average				
Sample tested positive (%)	100	92	92	100

Source: ⁴; ND: Not detected

Table 3. Organochlorine insecticide residues in soils samples from Qurashi pesticide store in Hasaheha (1996).

Pesticide/ level (ppm)	γ HCH	Aldrin	Heptachlor	DDT	Dieldrin	Total OC level
Maximum	0.39	ND	1.87	8.75	ND	11.01
Minimum	ND	ND	0.13	6.08	ND	6.21
Average	0.13	ND	0.77	7.57	ND	8.47
Sample tested positive (%)	33	0	100	100	0	

Source: ^{5,6}; ND: Not detected; OC: Organochlorines

Table 4. Levels (ppm) of Organochlorine insecticides in soils samples from the dumping site in Qurashi pesticide store, Hasaheha (1998).

Pesticide/depth		0-5	0-10 cm	10-50 cm	50-100 cm	Average
		4	4	4	4	
Samples analyzed						
γ HCH	Average	14.36	21.86	10.21	10	14.11
Heptachlor	Average	3.66	49.34	18.65	6.22	19.47
	Range	1.67-5.45	25-58.33	ND-57.45	2.91-8.46	
DDD	Average	ND	58.02	ND	ND	14.51
	Range	ND	ND-87.04	ND	ND	
Total OC conc		18.02	147.24	28.86	16.22	48.09

Source ⁷; ND: Not detected; OC: Organochlorines

Table 5. Levels (ppm) of organochlorine insecticides in various directions from the dumping site in Qurashi pesticide store, Hasahesa (1998).

Direction		Pit1	Pit2	Pit3	Pit4	Average	North		South		West		East	
Pesticide	Level (ppm) /Distance (meters)						50	100	50	100	50	100	50	100
γHCH	Max	13.5	32.5	26.1	15.35	21.86	1.5	1.5	ND	ND	4.38	20	30	1
	Min	ND	19.01	5.02	9.95	8.5	1	0.5	ND	ND	3.41	15	24	1.02
	Average	6.49	23.61	15.58	13.15	14.71	1.25	1	ND	ND	3.89	17.5	27.5	1
Heptachlor	Max	25	57.69	57.45	58.33	84.73	3.41	2.32	ND	ND	2.1	6.7	ND	2.5
	Min	1.67	5.45	2.91	ND	2.51	2.73	1.05	ND	ND	1.82	5.25	ND	0.5
	Average	10.17	19.95	30.01	17.74	19.47	3.07	1.69	ND	ND	1.96	11.95	ND	1.5
DDD	Max	87.04	70.02	ND	75.03	58.02	ND	ND	ND	ND	30	2.5	175	8
	Min	ND	ND	ND	ND	ND	ND	ND	ND	ND	20	3	14	2.5
	Average	21.67	17.5	ND	18.75	14.48	ND	ND	ND	ND	25	6	94.5	5.25
Total	OC level	38.33	61.06	45.59	49.64	48.66	4.32	2.69	ND	ND	30.85	35.45	122	7.75

Source / ; ND: Not detected; OC: Organochlorines

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