

Assessment of Organochlorine Pesticide in Water and Sediment Samples Collected from El-Rahawy Drain, Egypt

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Abstract: The concentrations of organochlorine pesticides were determined in surface water and bed sediments from El Rahawy drain in the south-western part of Nile Delta. Results obtained show that the concentration of Σ DDT compounds in surface water range from 0.008 to 0.239 $\mu\text{g L}^{-1}$ and from 0.011 to 3.10 $\mu\text{g kg}^{-1}$ (dry weight) in bed sediments during wet and dry seasons. Hexachlorocyclohexanes (HCHs) have also been widely used in the region but the current environmental concentrations are slightly higher than those of DDT's, which is due to the less persistence of those compounds. Cyclodienes (Cds) were measured, for example as endosulfan II, in concentrations range from 0.021 to 0.823 $\mu\text{g L}^{-1}$ and 0.09 to 1.73 $\mu\text{g kg}^{-1}$ (dry weight) in surface water and bed sediments, respectively. The investigation of OCPs in the surface water and sediments are still within safety margins compared to Canadian guidelines.

Key words: Organochlorine pesticides · El Rahawy drain · Water · Sediments · Canadian guidelines

INTRODUCTION

A large number of man-made chemicals, organochlorines pesticides such as dichlorodiphenyl ethane (eg, DDT, DDD and DDE), cyclodiene (example: aldrin, dieldrin, heptachlor and endosulfan) and chlorocyclohexane (eg, α , β , γ and δ -HCH) are of great concern due to their highly persistent nature and global occurrence [1]. These chemicals are bioaccumulative in nature and induce various toxic effects in aquatic environment [2].

The presence of OCPs in the environment has been of great concern due to their persistent nature and chronic adverse effect on wildlife and humans. Despite the ban and restriction on the usage of OCPs in developed countries during the 1970s and 1990s, some developed countries are still using them for agricultural and public purposes because of their effectiveness in controlling various insects [3].

Some OCPs are highly resistant to degradation by biological, photochemical or chemical means. They are also liable to bioaccumulation and are prone to long range transport [4]. Many of these

compounds have already been listed as top-priority pollutants owing to their carcinogenic, hepatotoxic and mutagenic effects [5]. These compounds are also typically characterised as having low water solubility and high lipid solubility.

Studies conducted on OCPs in aquatic environments in Egypt [6-8], Africa [9, 10], Europe [11, 12], Asia [13, 14] and America [15, 16] have shown a widespread occurrence of residues of these pesticides in environmental aquatic systems, despite the fact that they have been banned for decades. In developing countries such as Egypt, Technical HCH and DDT were the most extensively used pesticides in Egypt, resulting in widespread contamination in various environmental compartments. These chemicals can enter aquatic environment through several ways such as effluents release, agricultural runoff, atmospheric deposition and other means. Due to the low water solubility, OCPs have a strong affinity for suspended particulates and subsequently settle down to sediments. It is believed that some group of OCPs may still be in use clandestinely under unknown trade names in agriculture due to their low cost and effectiveness for pest control.

In Egypt, El Rahawy drain is one of the most severely contaminated areas by OCPs because of its long-term usage and wastewater discharge from local domestic of El-Rahway village in addition to all sewage of El-Gieza governorate. Although the production of OCPs was officially banned in Egypt since late 1990, OCPs are still using for agricultural and public health purposes because of their low cost, easy to use and versatility against various insects [17].

The original objectives of this study were to determine the remaining residues of organochlorine compounds in surface water and sediments in water body of El Rahawy drain. Another purpose was to study the composition and distribution of OCPs residues in surface water and sediments from El Rahawy drain. Furthermore, the temporal changes and the environmental fate of OCPs were discussed.

MATERIALS AND METHODS

Reagents and Standards: All used solvents were of the grade "for Pesticides Residue Analysis". The anhydrous sodium sulfate was heated for at least 5 h at 550°C, cooled and stored in a closed container. The Florisil was activated overnight at 550°C, cooled and stored in a closed container. The needed amount of Florisil was heated once again at 110°C for another 8 h, cooled and mixed with de-ionized distilled water to give a 7% (w/w) mixture. This mixture was shaken for 30 min and kept for 24 h in a closed container, prior to use. Other materials used throughout the experimental procedure, such as cotton wool and filter paper, were extracted using a 1/1 acetone/dichloromethane mixture in a Dionex (ASE 200) apparatus, prior to use. All primary standards of OCPs (98.2-99.9% purity) were purchased from SUPELCO (PA, USA). A standard solution of each OCP was prepared in a proper way depending on being solid or liquid, to give a 100 µg mL⁻¹ stock solution in *n*-hexane, which was stored at -20°C. Dilutions were prepared from the stock solutions and stored in the refrigerator at +4°C. A standard mixture solution containing all 18 OCPs was prepared with the appropriate concentrations of each pesticide and stored at -20°C.

Study Area and Sampling: Samples of surface water and sediment were collected in wet and dry seasons from January to June 2010. Two sampling sites along El Rahawy drain were selected. The locations of these sampling sites are located in the south-western part of Nile Delta, about 30 km north-west of Cairo at El-Kanater El-Kahyria area, Egypt as shown in Figure 1 and tabulated in Table 1. El-Rahawy drain lies between latitudes 30° 10' N to 30° 12' N and longitudes 31° 2' E to 31° 3' E passes through El-Rahway village and many villages dotted along it receiving agricultural and domestic wastes in addition to sewage of El-Gieza governorate and discharged these wastes directly without treatment into the Nile (Rossetta Branch).

Two water samples (SW1 and SW2) were collected from the surface using clean glass containers (1.5 L capacity), stored in the refrigerator at + 4°C and extracted within 24 hours. The collected water samples were filtered through 0.45 µm glass fibre (Whatman) to eliminate particulate matter.

Two bed sediment samples (SW1 and SW2) were collected using an Eckman sampling device (0-10 cm) in areas of low flow velocity (<0.3 m s⁻¹). The samples were put in glass-bottles which were kept cool in the field (4°C). Immediately after collection sediments were preserved in deep freeze in order to avoid degradation. After transportation into the laboratory they were lyophilized and grounded using a ball mill. The grinding stock was passed through a 75 µm and stainless steel sieve.

Sample Preparation: One liter of each water sample was extracted with 60 ml dichloromethane in a 2-L separatory funnel [18]. The mixture was shaken manually for 5 min, followed by collection of the lower organic layer. The extraction was repeated twice each time with 50 ml dichloromethane. The pooled 180 ml dichloromethane extracts were dried over anhydrous sodium sulfate and filtered. The solvent was evaporated to dryness under vacuum at ≤40°C and 350 mbar. The residues were dissolved in 1 ml *n*-hexane containing 1 mg L⁻¹ aldrin as internal standard. For qualitative and quantitative interpretation of results, a concentration of 1.0 ppm aldrin was used as internal standard for OCPs standard mixture and in the real sample final solutions [19].

Table 1: Locations and description of the surface water and bed sediment samples collected

Site No.	Site Name	Code	Location		
			Latitude (°N)	Longitude (°E)	
1	El-Rahawy drain at 3 km from Rosetta branch	SW1	SD1	30° 11' 13.26"	31° 02' 52.84"
2	El-Rahawy drain at 0.5 km from Rosetta branch	SW2	SD2	30° 12' 15.76"	31° 02' 04.02"

SW: surface water sample, SD: bed sediment sample.

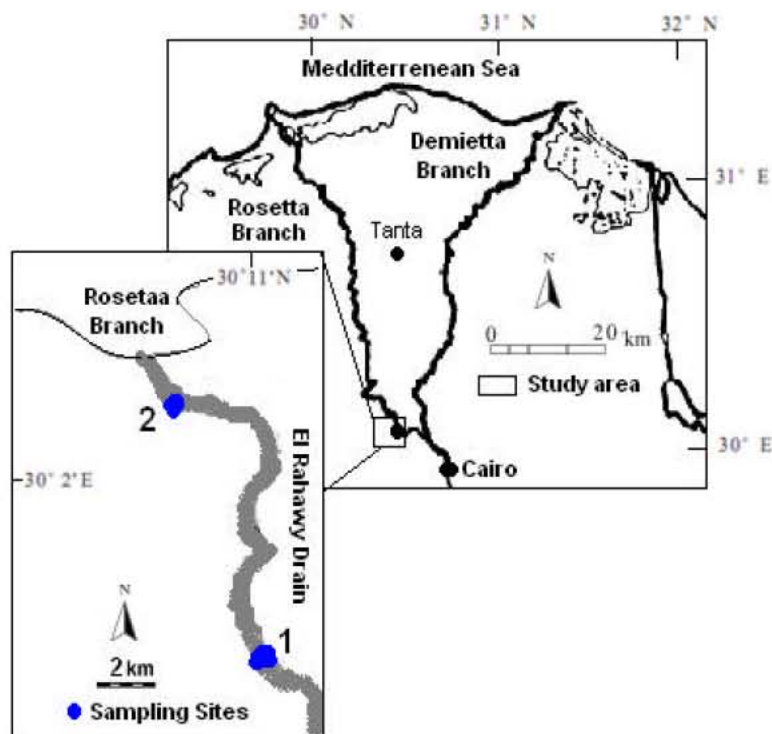


Fig. 1: Map of the study area and sampling sites

Homogenized bed sediment samples (10 g) were extracted by pressurized solvent extraction (PSE), using a Dionex ASE 200 Accelerated Solvent Extractor (ASE) (Dionex, Sunnyvale, USA) in combination with a solvent controller (Dionex) was used for extraction of the sediment samples. The ASE 200 conditions were: oven temperature 100°C, oven heat-up time 5 min, static time 5 min, flush volume 60 % of the extraction cell volume (11 ml), extraction pressure 10 MPa and as extraction solvent a mixture of *n*-hexane/acetone (1:1, v/v) was used. The obtained extracts were concentrated under reduced pressure to a volume of 5.0 ml hexane [20].

The residue of the extraction step of each sediment sample was transferred to a Florisil mini-column (8 mm ID, filled with 3.5g of 7% deactivated Florisil with distilled water and a 1 cm layer of anhydrous sodium sulfate used to cup the Florisil from both sides) [19]. The Florisil column was washed with 20 ml *n*-hexane before use. The sample was eluted from the column first with 20 ml of hexane followed by 20 ml of an acetone/hexane mixture (1+99, v/v). After the solvent of the eluate was evaporated at $\leq 40^\circ\text{C}$ and 350 mbar, the final residues were dissolved in 1 ml *n*-hexane containing 1 mg L⁻¹ aldrin as internal standard [20]. 2.0 μl of each final residue solution were injected onto the GC column under the above mentioned conditions.

Based on a signal-to-noise ratio of 3:1, the calculated detection limits were as follows: The detection limits of the methods for OCPs residue in water and sediment Based on a signal-to-noise ratio of 3:1, the calculated detection limits is 0.01 ng L⁻¹ for water and 0.01 ng kg⁻¹ for sediment samples [21].

Instrumental and Operating Conditions: Each final residue solution of the sediment and water samples was prepared and analyzed in duplicate throughout the described analytical procedure (GC capillary column under optimized chromatographic conditions and detection with the ⁶³Ni-ECD).

A Hewlett Packard 5890 series II gas chromatograph equipped with an electron capture detector (⁶³Ni-ECD) was used for analysis. GC separations were performed on a fused silica capillary column (DB-XLB; film thickness 0.17 μm ; 30 m \times 0.32 mm I.D. (J&W, Folsom, USA). The GC operating conditions were: injector temperature 300°C, detector temperature 320°C and carrier gas (nitrogen) flow-rate 40 ml min⁻¹. The GC temperature program conditions for the analysis on OCPs were: initial oven temperature 110°C, initial time 0.5 min, heated to 150°C by a temperature ramp of 25°C min⁻¹ followed by a second temperature ramp of 12°C min⁻¹ to a temperature of 260°C and a third temperature ramp of 15°C min⁻¹ to an end

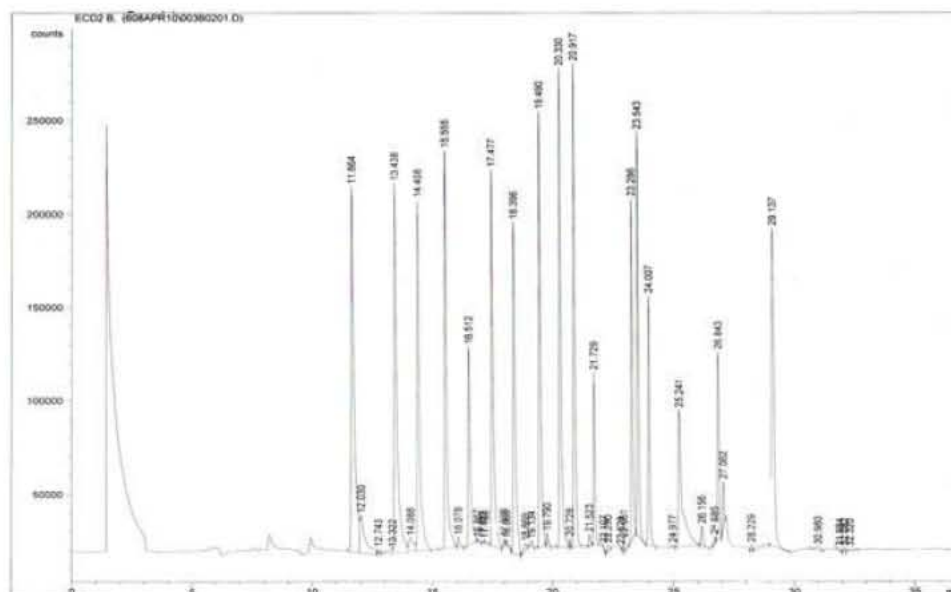


Fig. 2: GC/ECD Chromatogram of standard OCPs ($0.05 \mu\text{g L}^{-1}$)

temperature of 320°C which was hold for 2 min at 320°C . The hexane extracts of water and sediment samples were used for OCPs analyses by gas chromatography in combination with an electron capture detector (GC-ECD) applying aliquots of $3 \mu\text{l}$. Injections were splitted (1:10) without and after column clean-up, respectively [22]. Each sample was analysed twice by GC-ECD. Typical chromatogram of standard sample is presented in Figure 2.

Calibration curves were prepared from a stock solution of 10.0 mg L^{-1} OCPs dissolved in hexane by serial dilution to reach calibration concentrations of 5, 10, 20, 40 and $50 \mu\text{g L}^{-1}$. Each calibration solution was analysed in threefold by GC-ECD. The peak areas of the corresponding analytes were plotted against the calibration concentrations and the regression coefficient was calculated reaching a mean of $r^2 = 0.9993$ for all analytes [23]. The retention times obtained for the components of the mixture are as follows:

α -HCH (11.511 min), γ -HCH (13.288 min), heptachlor (14.514 min), aldrin (16.215 min), β -HCH (16.38 min), δ -HCH (17.311 min), heptachlor epoxide (18.221 min), endosulfan I (19.282 min), p,p'-DDE (20.145 min), dieldrin (20.721 min), endrin (21.523 min), p,p'-DDD (23.112 min), endosulfan II (23.337 min), p,p'-DDT (23.887 min), endrin aldehyde (25.037 min), methoxychlor (26.597 min), endrin ketone (26.786 min) and endosulfan sulfate (28.824 min).

To evaluate the whole analytical procedure, the percent recovery of each OCP under study was determined for each analytical procedure concerning each sample type. This was performed by spiking with

known concentrations of organochlorines' mixture. The analysis of each sample was performed according to its specific analytical procedure. The recoveries were 92.8-99.5% for the sediment samples and 89-100% for the water samples.

RESULTS AND DISCUSSION

The analysis of OCPs present in $\mu\text{g L}^{-1}$ or $\mu\text{g kg}^{-1}$ concentrations in environmental samples is not quite easy because often analysis will be disturbed by other matrix compounds also present in the sample extracts [24].

Concentrations of OCPs in surface water and bed sediments from El Rahawy drain are shown in Tables 2 and 3. Compounds identified included hexachlorocyclohexane (α -HCH, β -HCH, γ -HCH, δ -HCH), cyclodiene (aldrin, dieldrin, endrin, endrin aldehyde, endrin ketone, heptachlor, heptachlor epoxide, endosulfan I, endosulfan II and endosulfan sulfate) and diphenyl aliphatic (p,p'-DDE, p,p'-DDD, p,p'-DDT and methoxychlor) pesticides.

The results revealed fairly low levels of pesticide residues, mainly organochlorines as shown in Table 2. The concentrations varied between samples of different matrices, with the lowest levels detected, as expected (due to the hydrophobicity of most OCPs) in water samples. However, there was a marked difference in levels between wet and dry seasons, with higher levels in the former. Alarmingly high levels were detected in sediments collected from the same sites. Some pesticides were dominant in many samples while in other samples they were found to be below the method detection limits.

Table 2: Mean levels of OCPs observable in surface water samples collected from El Rahawy drain during wet and dry seasons

Items	Surface water ($\mu\text{g L}^{-1}$)				CWQGs ($\mu\text{g L}^{-1}$)	
	Wet season		Dry season		Irrigation water	Fresh water
	SW1	SW2	SW1	SW2		
p,p'- DDT	0.029	0.064	bdl	0.011	-	-
p,p'- DDE	0.051	0.084	0.006	0.028	-	-
p,p'- DDD	0.048	0.091	0.002	0.027	-	-
Σ DDTs	0.128	0.239	0.008	0.066	-	0.001
α - HCH	0.0016	0.008	bdl	bdl	-	-
β - HCH	bdl	0.001	bdl	bdl	-	-
γ - HCH	0.042	0.225	0.006	0.1	-	0.01
δ - HCH	bdl	bdl	bdl	bdl	-	-
Σ HCHs	0.0436	0.234	0.006	0.1	-	0.01
Aldrin	bdl	bdl	bdl	bdl	-	0.004
Dieldrin	0.001	0.001	bdl	bdl	-	0.004
Endrin	0.0038	0.0087	bdl	bdl	-	0.0023
Endrin aldehyde	0.001	0.001	bdl	bdl	-	-
Endrin ketone	bdl	bdl	bdl	bdl	-	-
Heptachlor	0.018	0.148	bdl	0.065	-	0.01
Heptachlor epoxide	0.06	0.7	0.01	0.35	-	0.01
Endosulfan I	0.083	0.823	0.021	0.375	-	0.02
Endosulfan II	0.001	0.001	bdl	bdl	-	0.02
Endosulfan sulfate	0.001	0.001	bdl	bdl	-	-
Methoxychlor	bdl	bdl	bdl	bdl	-	-
Σ Cyclodienes	0.1688	1.6837	0.031	0.79	-	-
Σ OCPs	0.3404	2.1567	0.07	0.977	-	-

CWQGs: Canadian water quality guidelines for the protection of agricultural water uses.

bdl: below the detection limit, -: No guideline available.

Pesticide Residues in Water: Pesticides detected in water were DDT and its metabolites (DDD and DDE), HCH isomers and dieldrin (Table 2). These residues were dominant in the wet season samples while in the dry season most of the residues were below their average method detection limit. The concentrations of Σ OCPs were in the range of 0.07-2.1567 $\mu\text{g L}^{-1}$. Cyclodienes compounds were the most often found OCP compound, followed by DDTs and HCHs. The concentrations were 0.031–1.6837 $\mu\text{g L}^{-1}$ for cyclodienes, 0.008–0.239 $\mu\text{g L}^{-1}$ for DDTs and 0.006–0.234 $\mu\text{g L}^{-1}$ for HCHs.

Relatively high levels of total DDT in environmental samples can be related to past use of the pesticide in agricultural fields. Substantial amounts of pesticides have been reported to be used in agricultural fields along El Rahawy drain in Egypt. DDE and DDT were more dominant in wet season samples from El Rahawy drain indicating some elapse of time from application to sampling. DDE is an aerobic degradation product of DDT and this degradation is assumed to take place in aerated

soils. Thus it is suggested that DDE is transferred from treated soils to water bodies [25]. The p,p'-DDE levels is the most dominant with lower levels of DDT and DDD during wet season, indicating more recent use of the technical pesticide.

Most of the environmental samples showed the domination of γ - and α -HCH isomers implying the use of technical HCH rather than β -HCH > δ -HCH. Despite the fact that technical HCH has been banned from use in many developing countries including Egypt [26]; studies have indicated residual concentrations of these chemicals. Dieldrin, endosulfan II, endosulfan sulfate and endrin aldehyde were detected at low concentrations in surface water samples during both seasons. Other pesticides such as δ -HCH, endrin ketone, methoxychlor and aldrin were found to be below the method detection limits (0.1 ng L^{-1}). From the compounds examined endosulfan I, heptachlor, heptachlor epoxide, endrin, γ -HCH, DDT and its metabolites are above Canadian water quality guidelines for irrigation and fresh water [27]; as shown in Table 2.

Table 3: Mean levels of OCPs observable in bed sediment samples collected from El Rahawy drain during wet and dry seasons

Items	Bed sediment ($\mu\text{g kg}^{-1}$ dry wt)				CSQGs ($\mu\text{g kg}^{-1}$)	
	Wet season		Dry season		ISQG	PEL
	SD1	SD2	SD1	SD2		
p,p'- DDT	0.0113	0.88	bdl	0.25	1.19	4.77
p,p'- DDE	0.0105	1.34	bdl	0.60	1.42	6.75
p,p'- DDD	0.04	0.88	0.011	0.33	3.54	8.51
Σ DDTs	0.0618	3.10	0.011	1.18	6.15	20.03
α - HCH	0.21	1.62	0.07	0.76	-	-
β - HCH	0.001	0.001	bdl	bdl	-	-
γ - HCH	1.01	3.65	0.09	1.55	0.94	1.38
δ - HCH	bdl	0.001	bdl	bdl	-	-
Σ HCHs	1.221	5.272	0.16	2.31	0.94	1.38
Aldrin	bdl	bdl	bdl	bdl	-	-
Dieldrin	0.59	2.25	bdl	0.46	2.85	6.67
Endrin	0.0113	0.0165	bdl	bdl	2.67	62.4
Endrin aldehyde	0.001	0.001	bdl	bdl	-	-
Endrin ketone	bdl	bdl	bdl	bdl	-	-
Heptachlor	0.46	1.16	0.16	0.79	-	-
Heptachlor epoxide	0.53	2.11	0.13	0.65	0.6	2.74
Endosulfan I	0.27	1.73	0.09	0.84	-	-
Endosulfan II	0.001	0.001	bdl	bdl	-	-
Endosulfan sulfate	0.013	0.37	bdl	0.05	-	-
Methoxychlor	bdl	bdl	bdl	bdl	-	-
Σ Cyclodienes	1.8763	7.6385	0.38	2.79	-	-
Σ OCPs	3.1591	16.0105	0.551	6.28	-	-

CSQGs: Canadian sediment quality guidelines for the protection of aquatic life

ISQGs: Interim freshwater sediment quality guidelines, PEL: probable effect levels

Pesticide Residues in Bed Sediments: Pesticide residues found in bed sediments were the same as those detected in water samples and generally reflected a similar pattern. Endosulfan I and heptachlor epoxide were dominant in the samples, both in dry and wet seasons (Table 3). Higher levels of the residues were found in sediments than in their corresponding water bodies, which is an indication of their hydrophobicity. The results indicated relatively high residue levels at site (SD2) with mean levels were to 0.84 and 0.65 $\mu\text{g kg}^{-1}$ dry mass of endosulfan I and heptachlor epoxide, respectively, in the dry season (Table 3). The mean levels in the wet season were 1.73 and 2.11 $\mu\text{g kg}^{-1}$ for endosulfan I and heptachlor epoxide, respectively (Table 3). Surprisingly, very high levels of endosulfan I and heptachlor epoxide were detected in sediments which could probably suggest that endosulfan I and heptachlor epoxide have been massively used in vegetable crops, rather than the "drin" pesticides in the study area. Whereas sediments from El Rahawy drain showed no significant differences in detection

frequencies and levels of residues between the two seasons, samples from the study area showed a notable difference. Some pesticide residues in dry season samples from the study area were generally below the detection limits, but there was a massive enrichment of pesticide-containing sediments run off during the wet season (Table 3).

DDTs and HCHs showed high concentrations and were detected in almost all sediment samples. This could be attributed to their high persistency, high stability and their used in Egypt for a long time [26]. The concentration of DDE and DDD was much higher than that of DDT, which could be attributed to high stability of DDE in the aquatic environment as compared to the parent compound DDT and to other metabolites. Normally, we expect to find more DDD and DDE than DDT; however, here we found that the total DDT levels were higher than that of its metabolites DDD and DDE. This could be explained; that new DDT was measured in the environment is probably not from very recent applications or was previously degraded in soils before entering the aquatic environment.

All these findings indicate that the DDT pesticide is currently used in remote villages, especially in the more populated areas. This means that the DDT pesticide has been used not for controlling insect pests in the agriculture fields but for sanitary purposes, to control mosquitoes and flies in the houses.

Concentrations of Σ HCHs in bed sediment samples from El Rahawy drain are slightly higher than concentrations of Σ DDTs (Table 3). At first glance this may seem surprising because the technical mixture of HCHs was largely used years ago in Egypt as well as in most of Middle East, in particular in China, Japan and India, the largest world producers [27]. In later years the world production of technical HCH substantially decreased [28]. There is no quantitative information on the cumulative use of DDT and HCH in El Rahawy area over the years. However, there is no reason to believe that the amount of technical HCH used has been smaller than that of DDT. The most likely explanation for the currently higher concentrations of HCHs in water of El Rahawy drain is related to the relatively short environmental half-lives of HCHs in soils and higher water solubility which is 3 to 4 orders of magnitude higher than that of DDT's [29]. Higher concentrations of HCHs in sediments as compared to those of DDTs, is thought to be due to the rapid rate of mineralization and formation of organic volatile compounds of HCHs. Results shown in Table 3, indicate that the proportion of three HCHs, i.e. alpha, beta and gamma isomers in sediments are approximately similar to those of the technical HCH mixture.

The levels of OCPs in the study area for bed sediment samples are still within safety margins compared to Canadian sediment quality guidelines for toxic and deleterious substances [31]; as shown in Table 3.

Concentrations of OCPs in the sediments are considered as a reflection of the applications of pesticide in Egypt, especially for agricultural purposes. The major sources of OCPs in the investigated sediments: exposure to sewage disposal of Greater Cairo pumped into El Rahawy drain, the storm water runoff and residential wastes directly discharged into the drain [8].

The accumulation of organochlorine compounds in sediment is roughly proportional to the level of the same pesticides in Surface water as tabulated in Tables (2 and 3). There is a statistically significant positive correlation between the concentration of Σ DDTs, Σ HCHs and Σ Cyclodienes in sediments and in the Surface water from El Rahawy drain (Figures 3 and 4). Similarly, a positive correlation exists for DDTs, HCHs and Cyclodienes. These correlations indicate that the reservoir of OCP's in sediments is the main source of these contaminants to water and the high bioconcentration is a direct consequence of the high K_{ow} of organochlorine compounds [31].

Finally, the obtained results regarding the water-sediments distribution pattern of the detected compounds reflect the great capacity of the sediments to adsorb and accumulate such compounds. Seasonal variations in the detected pesticide residue levels in water and sediments were observed in almost all sampling sites of the study area with the highest concentrations during wet season and the lowest during dry season. The sediment concentrations have a similar but less marked seasonal trend than the water concentrations. During our monitoring in this study, the presence of organochlorine compounds in a stable level of concentrations in the sediments during the sampling periods could be proved, indicating that the screened sedimentary reservoir could

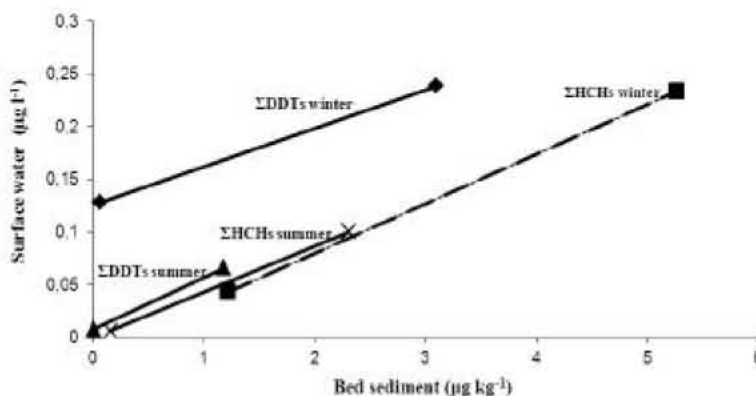


Fig. 3: Concentrations ($\mu\text{g kg}^{-1}$ dry weight) of Σ DDTs and Σ HCHs in bed sediments plotted against concentrations in surface water from the same sites during wet and dry seasons. DDTs and HCHs show a positive correlation statistically significant at $P < 0.05$.

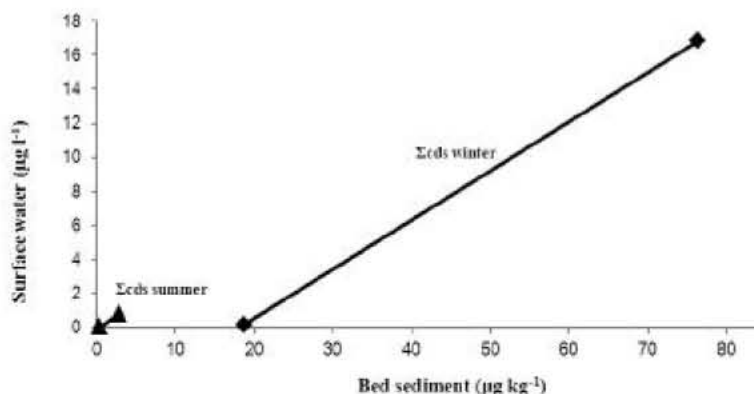


Fig. 4: Concentrations ($\mu\text{g kg}^{-1}$ dry weight) of Cyclodienes in in bed sediments plotted against concentrations in surface water from the same sits during wet and dry seasons. The bulk of OCds shows a linear positive correlation, statistically significant at $P < 0.001$

act as a potential release source of the compounds and consequently sustain aqueous contamination. The concentrations and distribution of the detected OCPs in sediments and water samples from El Rahawy drain reflect this assumption. The measured concentrations of OCPs residues in bed sediments are higher than surface water in both seasons. In comparison with water samples there was less noticeable difference between the sampling sites for sediments.

CONCLUSION

The presence of organochlorine pesticides (OCPs) in the environment has been of great concern due to their persistent nature and chronic adverse effect on wildlife and humans. Despite the ban and restriction on the usage of OCPs in developing countries during the 1980s and 1990s, some developing countries are still using them for agricultural and public purposes because of their effectiveness in controlling various insects. This study documented the composition and distribution of OCPs in surface water and bed sediment collected from El Rahawy drain. The investigation OCP concentrations were generally low to medium relative to other areas of the world. The high detection concentration of the biological metabolites, such as endosulfan II, DDE and DDD from the parent OCPs in sediments depict that the OCP contamination was mainly from the aged and weathered agricultural soils as well as, sanitary purposes, to control mosquitoes and flies in the houses.

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