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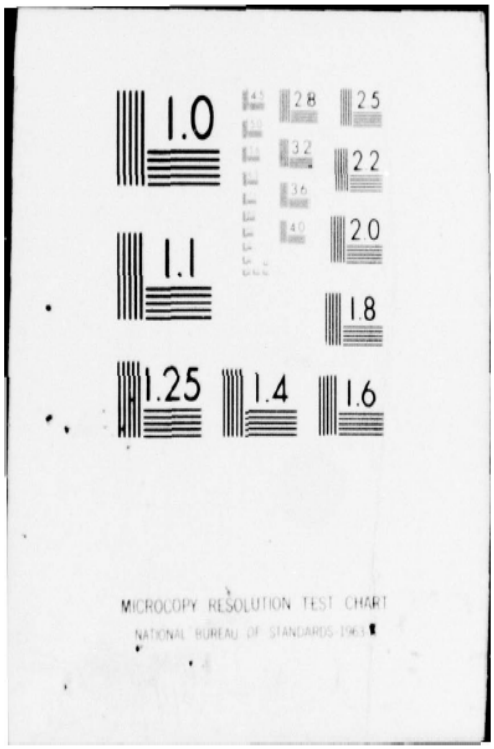
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PESTICIDE MONITORING SPECIAL STUDY NO. 44-0102-77
ENVIRONMENTAL SAMPLING IN THE
PANAMA CANAL ZONE
1 DECEMBER 1976

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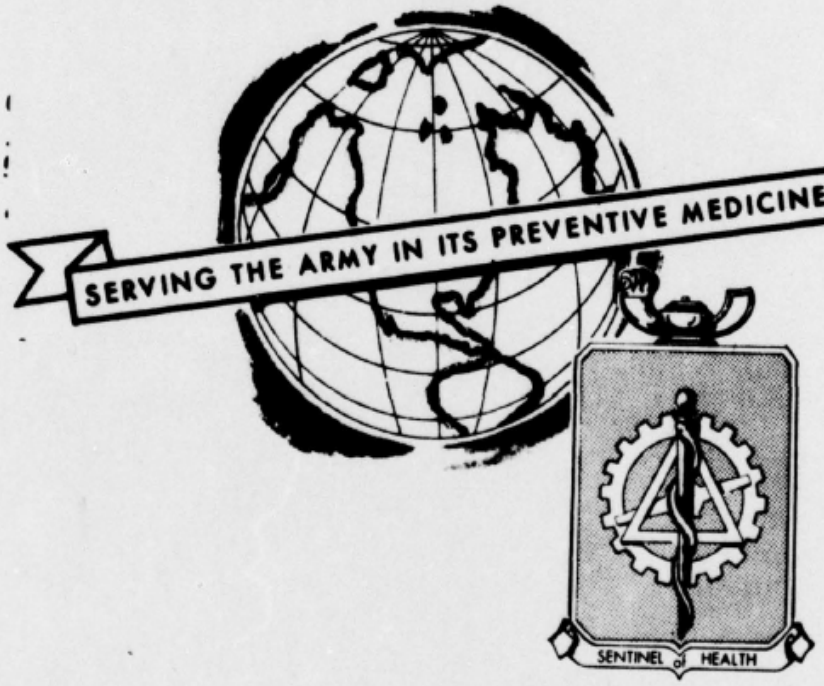

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DEPARTMENT OF THE ARMY
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HSE-RE/WP

20 JAN 1977

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ABSTRACT

This is a report evaluating the pesticide residue data obtained from environmental samples of water, sediment, and soil collected during CY 73 - CY 75 from the Canal Zone for their adequacy in preparing an environmental pesticide profile. The water and sediment data do not indicate any significant contamination of the aquatic environment by persistent pesticides. The soil data, although not sufficiently complete, tentatively indicate that the disappearance of even persistent pesticides may be exceptionally rapid in the tropical climate of the Canal Zone. It was recommended that (1) biological specimens, including fish and nonmigratory birds be collected during CY 77; and (2) additional soil samples be collected during CY 78 utilizing a stratified sampling plan. This report also discusses the nature and scope of pest management operations in the Canal Zone.

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1. AUTHORITY.

a. AR 40-5, Health and Environment, 25 September 1974.

b. AR 200-1, Environmental Protection and Enhancement, 7 December 1973.

2. REFERENCES.

a. Letter, HSE-RE, this Agency, 7 August 1975, subject: Pesticide Monitoring Program - Canal Zone.

b. Letter, HSE-RE/WP, this Agency, 18 March 1976, subject: Pesticide Monitoring Program - Subtest II - Analysis of Water, Sediment and Soil Samples for Pesticide Residues, US Army Installations - Canal Zone.

3. PURPOSE. To evaluate the pesticide data obtained from environmental samples in the Canal Zone for their adequacy in preparing an environmental pesticide profile.

4. BACKGROUND. The necessity for pesticide use as a component of pest management programs is generally well established and is particularly recognized in a tropical area such as the Canal Zone.

a. Although specific data regarding recent pesticide use has not been made available, a consolidated report from USA Forces Command for FY 72 indicates an estimated 88 productive man-years expended in survey, labor, and supervision of pest management operations. Fragimentary data for CY 75 indicate 76 productive man-years committed to pest management operations.

b. Selected data from two installations in the Canal Zone for CY 75 appear in Table 1. Although the precision of the quantitative data may be low, these data support the generalization regarding the importance of pest control in this region.

TABLE 1. PANAMA CANAL ZONE, SELECTED PESTICIDE USE DATA FOR CY 75

	Corozol	Ft Davis
Man-hours	78,690	58,898
Acres treated	155,056	68,308
Total number of operations	694	620
Total gallons* of pesticide	237,778	168,688
Total gallons of chlordane	39,844	31,542
Total gallons of DDT†	942	754
Total gallons of insecticides	65,800	19,800
Percent survey	9	15
Percent supervision	9	7

* Reported as formulated ready to use.
† Reported primarily for bat control.

(1) In contrast to a random sample of CONUS installations, the use of survey and supervision in pest management operations (and pesticide application) appears to be above average in the Canal Zone.

(2) On the control of arthropod pests, over 26 percent of the labor effort was devoted to nonchemical means of control compared to the CONUS value of less than 1 percent. In view of the preponderance of mosquito problems in this area and the historical dependence on environmental management, this use of resource is consistent.

c. The pesticides reported used for these two Canal Zone installations in CY 75 ranged from persistent chlorinated hydrocarbon insecticides, organophosphorus and carbamate insecticides, chlorophenoxy and uracil herbicides, and aluminum phosphide to the anticoagulants.

d. The pests reported included ants, bats, broad-leaved weeds, bedbugs, birds, brush, culiocids, drywood termites, filth flies, fleas, foodpests, leaf chewers, lice, mice, mites, mosquitoes, rats, roaches, sapsuckers, scorpions, spiders, subterranean termites, ticks, wasps, and bees. This list represents nearly the entire spectrum of pests for which reporting provisions are made.

5. RESULTS AND DISCUSSION. The environmental samples received from the Canal Zone during the period CY 73, 74, and 75 were comprised of soil, sediment, and water. Fish and bird samples have not been received from this area. The field information accompanying these samples does not indicate a definitive sampling plan. Even though the extent of representativeness may be questioned, a very generalized profile can be obtained.

a. Water. Nine water samples were submitted over the period CY 73 to CY 75. All of these samples were negative with respect to the pesticides and concentrations listed in the Appendix. Concurrent experience with surface water samples indicate that these qualified negative results are to be expected.[1]

b. Sediment. Fourteen sediment samples were submitted during the period CY 73 - CY 75. Only five of these contained any reportable pesticides. The total of all pesticides in three of these was less than 1 part per million (ppm). The fourth sample contained a total of 62.33 ppm of pesticides with the major portion being DDD. This high concentration of pesticide came from Farfan, an area that has been notorious for the production of pest diptera of the genus Culicoides.

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[1] Letter, HSE-RE, this Agency, 15 October 1976, subject: Entomological Special Study No. 44-019-75/76 Pesticide Analysis of Surface Water Samples Collected in the Department of the Army Pesticide Monitoring Program, 1 September 1972 - 31 December 1974.

(1) Although the quantity of pesticide found as a residue at this site is unusually high, the topography does not make it likely that such pesticide will be widely distributed into other parts of the aquatic environment.

(2) This area is very likely to be subjected to alternate flooding and drying which is a condition that will contribute to the dissipation of such pesticide residues.[2]

c. Soil. Forty soil samples were submitted during the period CY 73-CY 75. Only three of these samples were negative for the pesticides listed in the Appendix. A general summary of these data appear in Table 2. If the disparity in the number of samples available is ignored and representativeness assumed, a remarkable disappearance of stable pesticide residues occurs in a tropical environment. Unfortunately the data for the range in concentrations detected in the 2 sampling years does not add confidence to the concept of representativeness. The overall rate of disappearance in less than 1 year is wholly inconsistent with classical laboratory investigations or temperate zone field studies.[3] Two tentative conclusions, not mutually exclusive, must be examined. The sample collection plans in the 2 years in question were inadequate. The other conclusion is that pesticide residue behavior in tropical zone soils differs drastically from that of temperate zone conditions.

(1) Comparison of Data from Similar or Identical Sampling Areas. Only three areas can be identified as having been sampled in both CY 74 and CY 75. Data from these samples are presented in Table 3. Even these data suggest a remarkably rapid disappearance of persistent pesticide residues. The collection sites for these samples are quite restricted. These data support a conclusion that the consolidated data of Table 2 represents rapid disappearance of persistent pesticides in a tropical environment. This disappearance rate tends to minimize the possible effects of sampling errors.

(2) Comparison of Data for Specific Isomers and Metabolites of DDT. In general DDE is regarded as being more stable in most environments than is DDT. The data in Table 2 indicate that in the interval between sampling periods, there was only a 32 percent decrease in soil DDE in contrast with a 90 percent loss of DDT. Although the overall comparative losses from the three specific sites in the same sampling period are similar, the loss of DDE was only 84 percent in comparison to a 96 percent loss of DDT. The trend, at least, is consistent. The fact that a major environmental metabolite of DDT is DDE and the exceptionally high value of DDT in the 1974 Davis sample may have contributed materially to the equally excessive concentration of DDE at this time and location.

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[2] Guenzi, W. D., Pesticides in Soil and Water, 562 pp; Soil Science Society of America, Inc., Madison, Wisconsin, 1974.
[3] Edwards, C. A., Insecticides in Soil. Residue Reviews, 13:83-132, 1966.

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TABLE 2. AVERAGE CONCENTRATIONS (ppm or pounds/acre) OF PESTICIDE RESIDUES IN CANAL ZONE SOILS IN 2 SAMPLING YEARS

Year	Number Samples	DDD	DDE	DDT	Chlordane	Dieldrin	Other Cydodienes	Total Pesticide
1974	24	2.25	4.22	10.65	1.27	.44	.001	18.93
Range		nr*-18	nr-61	nr-92	nr-21	nr-5.8	nr-.21	nr-152
1975	16	.44	2.86	1.02	.13	.43	.16	3.58
Range		nr-3.7	nr-15	nr-5.5	nr-2	nr 6.5	nr-.93	nr-34
Percent Decrease		80	32	90	90	2	(+1600)	81

*nr = not reportable (See the Appendix for definition)

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TABLE 3. PESTICIDE RESIDUE DATA (ppm or pounds/acre) FOR THREE AREAS SAMPLED IN CY 74 AND CY 75

Area	Year	DDD*	DDE*	DDT*	DDTR†	Chlordane	Dieldrin	Tota Pestic
Davis	74	23.7	16.8	97.66	142.74	9.28	9.19	156.21
Davis	75	0.79	1.48	4.55	7.08	2.03	0.05	9.16
Percent Decrease		97	91	95	95	78	99	94
Dock 45	74	1.01	1.18	28.26	30.7	nr$	0.03	30.73
Dock 45	75	nr	0.12	0.31	0.44	nr	nr	0.44
Percent Decrease		100	90	99	99	-	100	99
Sherman Tower	74	0.25	10.82	10.13	24.46	nr	nr	24.46
Sherman Tower	75	0.57	2.61	0.62	4.16	nr	nr	4.16
Percent Decrease		(228)	91	94	83	-	-	83
Average	74	8.36	9.6	45.35	65.97	3.09	1.41	70.47
Average	75	0.45	1.4	1.83	3.89	nr	0.02	4.59
Percent Decrease		95	84	96	94	100	100	93

* Total of both isomers.
† DDTR = DDT + 1.114 (DDE + DDD).
$ Not reportable.

d. Comparison with Preliminary Data From Temperate Zone Installations. Pesticide residue data on 283 soil samples collected from 14 CONUS installations in CY 75 indicate that the average total pesticide residue concentration is 28.73 ppm (28.73 pounds/acre). The variety of pesticides making up this value range from the general chlorinated hydrocarbons (DDT; chlordane; dieldrin, etc.); the organophosphorus compounds and a chlorophenoxy herbicide. This concentration, 28.7 pounds per acre, is made up of 22 pesticides and metabolites. By contrast, the Canal Zone data for C 75 indicate 3.58 pounds per acre comprised of only 11 pesticides. The CY 74 data from the Canal Zone indicated a residue of 18.93 pounds per acre comprised of only 12 pesticides and/or metabolites. These values are still remarkably lower than the CONUS data.

6. CONCLUSIONS.

a. Sampling Plans. The use of a conservatively designed stratified sampling plan would increase the efficiency of both field and laboratory operations associated with environmental monitoring.

b. Water. The data for pesticides in surface water support the decisio to eliminate surface water collections from the scheduled sampling program. No further water samples should be scheduled.

c. Sediment. The sediment data do not indicate contamination of the aquatic environment with persistent pesticides that represent a significant impact. No further sediment samples should be scheduled.

d. Soil. The soil data, although admittedly incomplete, indicate that the disappearance of even persistent pesticides may be exceptionally rapid in a tropical environment. In addition to temperature and rainfall, the factors of soil chemistry and physics (in themselves affected by climate factors) may be significant in apparent residue disappearance. Environmental soil sampling should be suspended pending the design of an efficient sampling plan.

e. Biological Specimens. The absence of biological samples such as fish and a nonmigratory omniverous bird constrains the use of presently available data in the preparation of an environmental pesticide profile.

7. RECOMMENDATIONS.

a. All environmental sampling of soil, sediment, and water should be suspended until biological samples are evaluated to determine the extent, if any, of bioaccumulation of pesticides.

b. Appropriate vertebrate material must be obtained for evaluation regarding pesticide residues.

(1) Fish, preferably an omnivore. Not less than five individuals and a total of not less than one kilogram. Not less than five samples should be submitted. The areas from which the samples are collected should be described in sufficient detail to permit location on a map of 1:100,000 scale.

(2) Nonmigratory, omnivorious, pest bird samples should be provided. A sample generally consists of 10 birds. One sample from the Pacific side of the Continental Divide and one sample from the Atlantic side would be adequate for an initial appraisal. If some other type of bird must be submitted, its feeding habits and normal range should be stated.

(3) Arrangements are being made for these collections in conjunction with other surveys in the Canal Zone by this Agency.

c. After these biological specimens have been evaluated, a stratified sampling plan will be prepared. The following ancillary information should be provided to facilitate preparation of a sampling plan for CY 78.

(1) Summaries of current pesticide use (CY 77).

(2) Maps indicating the location of:

(a) Pesticide Shops

(b) Pesticide Storage Areas

(c) Sewage Treatment Plants

(d) Golf courses

(3) Topographic maps of the Canal Zone.

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APPENDIX

US ARMY PESTICIDE MONITORING PROGRAM
PRIMARY PESTICIDE LIST AND LIMITS OF DETECTABILITY OF
PRIMARY PESTICIDES IN WATER, SOIL, SEDIMENT, FISH AND BIRDS (as of 1 July 1976)

Pesticide	Amts for 10% Deflection with EC Detection (Based on 5µl Injection Volume)	Limits of Detectability (ppm)* Water	Soil & Sediment	Fish & B
α-BHC	3.1 pg	0.00003	0.003	0.002
δ-BHC	12.5 pg	0.00010	0.010	0.005
aldrin	10.0 pg	0.00008	0.008	0.004
chlordane	75.0 pg	0.00060	0.060	0.030
o,p'-DDD	25.0 pg	0.00020	0.020	0.010
p,p'-DDD	20.0 pg	0.00016	0.016	0.008
o,p'-DDE	25.0 pg	0.00020	0.020	0.010
p,p'-DDE	20.0 pg	0.00016	0.016	0.008
o,p'-DDT	25.0 pg	0.00020	0.020	0.010
p,p'-DDT	37.5 pg	0.00030	0.030	0.015
dieldrin	15.0 pg	0.00012	0.012	0.006
endrin	26.5 pg	0.00021	0.021	0.011
heptachlor	4.0 pg	0.00003	0.003	0.002
heptachlor epoxide	10.0 pg	0.00008	0.008	0.004
lindane	5.0 pg	0.00004	0.004	0.002
methoxychlor	100.0 pg	0.00080	0.080	0.040
mirex	25.0 pg	0.00020	0.020	0.010
toxaphene	1000.0 pg	0.00800	0.800	0.400

See footnotes on page 11

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Pesticide	Amts for 10% Deflection with EC Detection (Based on 5µl Injection Volume)	Limits of Detectability (ppm)* Water	Soil & Sediment	Fish & Birds
chlorpyrifos	15.0 pg	0.00012	0.012	-
	200.0 pg (FPD - 10 µl)	-	-	0.004 (FPD)
diazinon	65.0 pg	0.00052	0.052	-
	160.0 pg (FPD - 10 µl)	-	-	0.0032 (FPD)
malathion	100.0 pg	0.00080	-	-
	250.0 pg (FPD - 10 µl)	-	0.010 (FPD)†	0.005 (FPD)
methyl parathion	37.5 pg	0.00030	0.030	-
	150.0 pg (FPD - 10 µl)	-	-	0.003 (FPD)
parathion	25.0 pg	0.00020	0.020	-
	175.0 pg (FPD - 10 µl)	-	-	0.0035 (FPD)
cis-chlordane	10.0 pg	0.00008	0.008	0.004
trans-chlordane	10.0 pg	0.00008	0.008	0.004
oxychlordane	10.0 pg	0.00008	0.008	0.004
2,4-D (as methyl ester)	25.0 pg	0.00010	0.010	‡
2,4,5-T (as methyl ester)	10.0 pg	0.00004	0.004	‡
silvex (as methyl ester)	10.0 pg	0.00004	0.004	‡

* a. Pesticides not appearing on this qualitative list are not presently being analyzed for; however, they may or may n
been present in a sample.
b. Of the pesticides on this list, only those present at or above the concentration listed for the minimum detection
have been reported; pesticides not meeting this criteria are designated as nr (not reportable).
† Sample extracts concentrated 10 to 1 immediately prior to injection.
‡ Not analyzed for in fish and birds.