SEVERE PESTICIDE POLLUTION DESPITE CLEANUP OF OBSOLETE PESTICIDES AT VIKUGE, TANZANIA

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Introduction

Current estimates suggest that there are up to 500 000 tonnes of unwanted and expired pesticides in non-OECD countries[1]. A large part of these obsolete stocks consist of persistent organochlorine pesticides[1,2]. This is regarded as one of the major environmental hazards and a severe threat to human health in developing countries[3]. A recent initiative of the World Bank to remove this problem from the African continent calls for at least 60 million dollars US to be donated from international bodies and donor countries for remediation measures[4].

Some of these obsolete stocks are simply remains of stock that the governments of developing countries have built up for use in agriculture. Some are remains of pesticide that have been stored in preparation for major infestations of pests and locust invasions, or leftovers from discontinued vector control programs. However, in the worst cases they are remains of “smart” donations from industrialized countries aimed more at solving a potential problem in the donor country than in the receiving country.

At the government owned Vikuge farm, some 60 km west of Dar es Salaam, Tanzania, is stored a consignment of pesticides that was donated from Greece in 1987. The consignment was stored in a makeshift shed with the intention to distribute it to other farms. Most of the consignment was DDT, but remains packaging of several other pesticides, both organochlorines, organophophates and others, can be found at the site. Most of the consignment was left unused, at least in part because of problems with understanding the nature of the products in the containers. Part of the problem was that much of the material was in small, household scale, packaging, not suitable for large-scale agricultural use. Another problem was that most of the labeling was in Greek, a language not many people in Tanzania are able to read. Among the pesticides in the consignment were telodrin in original packaging from Shell. Shell discontinued production of telodrin in 1965, 22 years before the consignment was sent from Greece, because of its high toxicity to mammals. In 1992 the makeshift shed collapsed and the pesticides were left under the open sky until 1997 when a new, concrete storage facility was built with the help of foreign aid. In the mean time at least one bush fire had passed over the pesticide stock. The soil around the old storage shed still lacks vegetation and has a strong smell and scattered fragments of pesticide packaging and dead insects. At present an area of about 50 x 70 m is devoid of vegetation.

We here present some results from a first screening of the situation at Vikuge.

Materials and Methods
Soil samples were collected at three different depths and seven locations within the contaminated site. Water samples were taken from two local wells, a pond and drinking water from a pipe that runs through the area. Samples were solvent-extracted. Water samples (1 L, two replicates) were extracted as whole water without filtration. Extracts of soil samples (1 g) were subject to gel permeation chromatography as clean up before injection into the GC. Extracts were screened for 86 pesticides and metabolites and analysis was performed on GC-ECD and GC-NPD, using two columns of different polarities for confirmation of the identity of the contaminants.

Results and Discussion
High levels of DDT and its metabolites (DDTs) hexachlorocyclohexanes (HCHs) were found in all types of samples. Particularly the soil samples had high contamination levels (Tables 1). Extremely high concentrations of DDTs were found in the samples of surface soil - up to 28% (yes, percent!) of the soil dry weight (12 to 280 g/kg soil). The levels of HCHs were up to 7%, and of pendimethalin up to 4%. Residues of DDTs and HCHs were found at a soil depth of 50 cm. Also, metazachlor, γ-chlordane, heptachlor and aldrin were detected in soil. From the packaging material other compounds should also be present, but the high levels of mainly DDTs and HCHs make the detection of anything else very difficult.

Table 1. Maximum pesticide concentrations (mg kg^{-1} dry weight) of pesticides in surface soil samples from Vikuge Farm.

Compound	Concentration
α-HCH	50 000
β-HCH	6 400
γ-HCH	7 200
δ-HCH	2 400
p,p'-DDT	172 000
o,p'-DDT	36 000
p,p'-DDD	70 000
p,p'-DDE	4 100
γ-Chlordane	820
Pendimethalin	41 000
Heptachlor	36
Aldrin	110
Metamitron	3 500
Hexazinone	1 100
Azinphos-methyl	360
Metazachlor	5.9

The worst contaminated area at Vikuge is about 30 x 30 m and most of the pesticides are within the top 20 cm soil layer. This gives about 180 m^3 soil contaminated with an average DDT concentration of 40 g/kg as a rough estimate.

All water samples had high concentrations of organochlorine pesticides (Table 2). At one sampling occasion the levels of HCHs and DDTs in water samples from a dug groundwater well were 6µg/L and 30µg/L, respectively. The local inhabitants complain that the water often has a 'chemical' taste and gives them headaches. Although 'clean' drinking water is supplied via a tank to the villagers, the PVC-pipe leading the water from the tank to the village runs straight through the most contaminated soil. The contaminated site is also on top of a small hill with all surface runoff leading down towards the local village.

Table 2. Mean concentrations (µg L^{-1}, n = 2) of DDT and its degradation products and HCH isomers in tap water from a pipe (sampled in August 2000), surface water from a pond and water from two dug wells (March and May 2001) at Vikuge Farm.

	Tap	Pond		Well 1		Well 2	
	August	March	May	March	May	March	May
α-HCH	0.37	0.01	0.15	0.04	0.02	0.01	4.5
β-HCH	0.54	<0.004	0.25	<0.004	<0.004	<0.004	1.4
γ-HCH	0.02	<0.001	0.01	<0.001	<0.001	<0.001	0.002
δ-HCH	0.02	<0.002	0.02	<0.002	<0.002	<0.002	0.04
∑HCH	*0.95*	*0.01*	*0.43*	*0.04*	*0.02*	*0.01*	*5.9*
p,p'-DDT	1.5	0.28	<0.006	0.64	0.22	0.21	21
o,p'-DDT	0.2	0.03	<0.006	<0.006	0.02	0.01	7.9
p,p'-DDD	0.03	0.04	0.01	0.04	0.04	0.02	1.1
p,p'-DDE	<0.001	<0.001	0.02	<0.001	<0.001	<0.002	0.13
∑DDT	*1.7*	*0.33*	*0.03*	*0.68*	*0.28*	*0.24*	*30*

Many remediation activities in developing countries concentrate on removing the visible remains of the obsolete stocks and little investigations of the sites are undertaken after the pesticides have been removed. Although the visible stock of pesticides has been removed at Vikuge, the remaining soil is in itself hazardous waste and poses a risk to the environment and the inhabitants of the surrounding villages. These findings show the necessity to follow up the environmental situation at former storage sites of obsolete stocks of pesticides, and that the environmental problems are not necessarily solved by removing the visible stock.

References

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