ENVIRONMENTAL AND HEALTH SITUATION WITH OBSOLETE PESTICIDES IN EGYPT

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Abstract. Obsolete pesticides are pesticides that are unfit for further use or for re-conditioning as they have been de-registered locally or banned internationally. More commonly, however, a stock of pesticides becomes obsolete because of long-term storage during which the product and/or its packaging degrade. The total quantity of potentially obsolete pesticides held in developing countries and countries with economies in transition is thought to be huge, on the order of tens or hundreds of thousands of tons. The amount can only be estimated, however, because many stocks have not been inventoried or even located. The problem of obsolete pesticides is very serious and action is urgently needed to identify and secure or eliminate existing stocks and prevent new accumulations. Stocks of obsolete pesticide that stay unmanaged can pose a serious health hazard, especially to people living near these stocks. Comprehensive information about the impact on public health is scarce and there has been no attempt to systematically document health effects. Egypt shares most of the environmental problems of developing countries. One of the most important health and environmental problems is the obsolete pesticides and this paper will shed the light on the current status of obsolete pesticides in Egypt, environmental and health impacts and efforts conducted by the country to mitigate both short-term and long term impacts.

Keywords: Obsolete pesticides, Health, Egypt, North Africa, POPs, Organochlorines, DDT

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1. Introduction

Obsolete pesticides are defined by the Food and Agriculture Organization of the United Nations (FAO) as all pesticide products not in current use because they have been banned, have deteriorated or are damaged, have passed their expiration date, cannot be used for any other reason, or are not wanted by the current owner. Obsolete pesticides are chemically complex, given that nearly 1,000 active ingredients in many thousands of formulations are used to manufacture pesticides around the world. More than 20 percent of obsolete stocks consist of Persistent Organic Pollutants (POPs): Chlorinated hydrocarbons (organochlorines) such as dichlorodiphenyl ethane (e.g, DDT, DDD and DDE), cyclodiene (e.g: aldrin, dieldrin, heptachlor) that persist in the environment; bioaccumulate in humans, wildlife, and fish; and are highly toxic, (Guruge and Tanabe, 2001; World Bank, 2010).

Obsolete pesticide stocks have been accumulating in many developing countries and economies in transition in recent decades. International organizations estimate that nearly 500,000 tons are stockpiled worldwide, about fifty percent of which are located in countries of the former Soviet Union; while, obsolete stocks total about 50,000 tons across the African continent and 30,000 tons in Latin America, (World Bank, 2010).

These obsolete pesticides represent a major hazard on human health (NEPAD, 2003). Low-level exposure to POPs such as DDT may cause endocrine disruption, lowering of disease resistance and affecting reproduction (MEA, 2006). They can also cause more acute health impacts, including poisoning. Persistent organic pollutants cause a range of health hazards, even at low levels of exposure, including reproductive and developmental disorders, damage to the immune and nervous systems, and different types of cancers (Gordon et al., 2004; MEA, 2006). Exposure during key phases of fetal development can also cause serious developmental hazards in children (IPEN, 2002).

The main causes of accumulation of obsolete pesticides in developing countries are: inadequate storage and poor stock management, banning the products, unsuitable products or packaging, donation or purchase in excess of requirements, lack of coordination between donor agencies, and commercial interests of private sector and hidden factors, (World Bank, 2002).

The condition of the stocks is highly variable. Some stocks consist of unprotected and unidentifiable amounts of mixed products, corroding containers and contaminated soils into which pesticides have leaked from containers or production plants. Many stocks are located near farm fields, homes, or water sources, as the pesticides were stored close to where they were to be used. Many stocks are abandoned, unmanaged, have no labels, and have no clear

"owner" who is responsible for them. In most cases, such stocks would be classified as hazardous waste under international laws and controlled by the Basel Convention if subject to trans-boundary movements, (FAO, 2001).

Almost every country in Africa has stockpiles of obsolete pesticides that accumulated over the past several decades. Such countries often lack the training and resources to safely manage pesticide use, storage, and destruction, particularly at remote storage sites. Many warehouses are not well secured. Over time, containers and packages become deteriorated; hence, spills and leaks find their way into surface waters from runoff or leach through soil to pollute groundwater, resulting in environmental contamination and human exposure, (World Bank, 2002).

FAO, United Nations Environment Programme (UNEP), international donors, aid agencies, governments of countries with stocks, pesticide producers, and non-governmental organizations have taken on projects to locate, collect and eliminate existing stocks of obsolete pesticides and to prevent the accumulation of new ones. FAO has developed written guidelines and codes of conduct to help developing countries better manage pesticides, eliminate obsolete stocks, and avoid accumulating new ones. The OECD Development Assistance Committee (OECD -DAC) has written guidelines for aid agencies that describe the problem and show how aid should be directed to avoid it. But these efforts have been able to address only a small part of the very large problem of obsolete pesticdes, (FAO, 2001).

2. Obsolete Pesticides in North African Countries

Due to many causes, almost all of the African countries have accumulated huge quantities of obsolete organochlorine pesticides (OCPs) and other persistent organic pollutants that caused contamination of different environmental compartments, and thus required actions of remediation. These hazardous pesticides are contaminating soil, water, air, and food sources. They pose serious health threats to rural as well as urban populations and contribute to land and water degradation. Poor people often suffer a disproportionate burden because, in poor communities these dangers are compounded by a other factors including unsafe water supplies, poor working conditions, illiteracy, and lack of political empowerment (ASP, 2003).

Poor communities often live in closer proximity to obsolete pesticide stocks than wealthy people and children are at a higher risk of exposure than adults. The World Health Organization (WHO) estimates that pesticides may cause 20,000 unintentional deaths per year and that nearly three million people may suffer acute and chronic effects, mostly in developing countries. The risk on

poor communities becomes maximized by inadequate access to healthcare systems; especially in farming communities, (UNEP, 2004).

North African countries could be classified under main categories based on quantity of stockpiles they hosted: More than 1000 tons (Morocco and Sudan), 500-1000 tons (Egypt and Tunisia), 100-500 tons (Mauritania), Less than 100 tons (Algeria) Countries of no available data (Libya), Table 1.

TABLE 1. Obsolete pesticides quantities in some North African countries

Country	**Quantity (ton)**
Algeria	20
Egypt	600
Libya	?
Mauritania	257
Morocco	2265
Sudan	24,418
Tunisia	882

Source: Bernstorff and Stairs, 2000.
? no FAO survey conducted in Libya up to 1999.

3. Obsolete Pesticides in Egypt

In Egypt, limited Egyptian cotton fields were treated with insecticides before 1950. Thereafter, the treated area expanded rapidly. During the period 1950-1955, some cotton fields were treated using DDT. The reported major obsolete pesticides used in Egypt during a 30-year period were toxaphene (1955-1961), endrin (1961-1981), DDT (1952-1971), and lindane (1952-1978), (Mansour, 2009).

DDT and lindane have been officially prohibited from agricultural use in Egypt since 1980, and in 1996 a Ministerial Decree prohibited the import and use of multiple pesticides including aldrin, dieldrin, endrin, chlordane, heptachlor, DDT, toxaphene and lindane, (Sallam and Morshedy, 2008).

Obsolete pesticides are no longer in use in Egypt; however, they are still being found as residues and they are occurring in food now as a result of environmental contamination. Herbivores may ingest these residues in water, plants, and grasses, so, the residues can eventually find its way into human food, (Mansour, 2009).

3.1. ENVIRONMENTAL POLLUTION BY OBSOLETE PESTICIDES IN EGYPT

In many developing countries, storage sites have been located far from residential areas; however, they become now surrounded by fast-growing urban communities. Where pesticides are stored in the open, families that live and work in the vicinity may suffer acute or chronic exposure. Long-term exposure has been linked to a range of health hazards, from disorders of the nervous, immune, reproductive, and endocrine systems and various types of birth defects to injury of specific organs of the body and cancer. Nearby such storage sites, livestock may be found grazing and contaminated water is used for drinking and land irrigation for growing edible crops (World Bank 2002).

3.2. AIR AND PRECIPITATION

The published data on the levels of obsolete pesticides in the atmospheric environment of Egypt is very limited probably due to the methodological difficulties, (Barakat, 2004).

3.3. FRESHWATERS

Previous studies on fresh aquatic environments were mainly focused on the Nile River and the four major delta lakes: Maryut, Edku, Burullus and Manzala, (Barakat, 2004), Table 2. Cyclodiene pesticides (aldrin, endrin and heptachlor) had been reported in water samples collected from the Nile river, with aldrin concentrations more than endrin (El-Gendy et al., 1991). Higher concentrations were reported at Kafr El Zayat city and at sites on the Rosetta than on Damietta branch. Total concentrations of cyclodienes were found in the range 8–21 ng/l in water samples collected from Lake Manzala, (Yamashita et al., 2000).

Samples from ground water, Nile River and tap water were collected from Kafr El Zayat governorate, which has one of the largest pesticide factories in Egypt, and DDT residues were found at levels below the maximum allowable limits set by the WHO for drinking water (Dogheim et al., 1996). In addition, the levels of DDTs detected in the groundwater underlying the sludge and solids disposal facility for the sludge, scum and screenings generated at the East and West Wastewater Treatment Plants in Alexandria, Egypt have been found

at levels below the drinking water standards set by the U.S. Environmental Protection Agency (EPA), (Metcalf and Eddy, 1999).

TABLE 2. Residues of obsolete pesticides (ng/L) in water samples collected from different locations along the River Nile[a]

Sampling site	Total DDTs	Total Cyclodienes
Rosetta	98.51	32.39
Damietta	90.87	65.57
Al-Mansoura	102.67	48.43
Edfina	10.13	228.11
Dessouk	37.21	186.82
Kafr El-Zayat	29.75	415.37
Delta Barrage	2.65	29.75
Beni Suef	56.83	26.5
El-Menia	82.42	16.77
Assuit	100.56	75.28
Naga Hammady	297.72	40.65
Esna	586.3	75.37
Kom Ombo	1035.25	41.27
Aswan	1048.24	28.5
Lake Nasser	841.47	20.86

DDT, dichlorodiphenyltrichloroethane;
Cyclodienes, include aldrin, dieldrin, endrin
a, Adapted from Wahaab and Badawy, 2004.

3.4. SEAWATER

In Egypt, El Rahawy drain is one of the most severely contaminated areas by OCPs because it has been used for a long time and it receives wastewater discharge from all sewage of Giza governorate in addition to local domestic of ElRahway village. The production of OCPs was officially banned in Egypt since late 1990; however, OCPs are still being used for agricultural and public health purposes because of their low cost, easy to use and versatility against various insects (Jahin et al., 2008).

3.5. SEDIMENTS

It was reported that high concentrations of total DDT were encountered at locations within Alexandria inner harbor and at sites located near ship activities and storm sewer outfalls. The concentrations of DDT in the Inner Harbor were

at levels suspected to cause detrimental biological effects for benthic organism and the ratios of DDTs/DDTs plus their metabolites in sediment samples from certain sites were 0.86 or higher, indicating recent input of DDT, (Barakat et al., 2002).

3.6. FOOD STUFF POLLUTION BY OBSOLETE PESTICIDES IN EGYPT

During the past 20 years, Cyclodiene pesticides have been determined in a large number of fish in coastal areas in Egypt. Concentrations were lower than the acceptable tolerance levels for human consumption and temporal trends showed decreasing levels of cyclodiene pesticides in Abu-Quir Bay. Fish samples (Mugil cephalus) collected from Abu-Quir, Gamasa and Damietta exhibited concentrations in the range 4–9 ng/g ww that suggests a decline in DDTs concentrations during the last decade, (Abd-Allah et al., 1998).

The following tables summarize the levels of obsolete pesticides reported in Egypt in food stuff samples collected from meats (Table 3), dairy milk products (Table 4), vegetables (Table 5) and medicinal plants (Table 6):

TABLE 3. Obsolete pesticides in meats (muscles, livers, kidneys) from camel, cattle, and sheep taken from Sharkia Province, Egypt[a]

Contaminant	% of contaminated samples
DDTs	54.4
Lindane	47.8
Aldrin	44.4
Dieldrin	33.3
Endrin	15.6
Toxaphene	<10.0

DDT, dichlorodiphenyltrichloroethane
a, Adapted from Sallam and Morshedy, (2008)

TABLE 4. Residue levels of obsolete pesticides in dairy products[a] (ng/g dw lipid) and in cattle meat[b] (mg/kg fat) reported in Egypt

Foodstuff	Cyclodienes	Total DDTs
Buffalo milk	140.03	1014.19
Milk powder	8.56	38.83
Damietta cheese	10.00	80.5
Cattle meat	84.60	67.00

a, Adapted from Barakat et al., 2002.
b, Adapted from El-Kady et al., 2001

TABLE 5. Residue of obsolete pesticides (mg/kg) in vegetables and soil from an organic farm at El-Sadat city, Egypt[a]

Pesticide	Root beet	Soil	Green onion	Soil	Potatoes	Soil
Total DDT	2.02	6.90	2.82	6.77	1.78	6.18
Lindane	0.61	1.35	0.84	1.27	0.60	1.27
Aldrin	ND	ND	ND	ND	ND	ND
Dieldrin	0.35	0.77	0.70	0.58	0.30	0.64
Endrin	ND	0.71	ND	0.85	ND	0.93
Endosulfan	0.27	0.83	0.66	1.03	0.23	0.64

ND, not detected
a Adapted from Salim, (2006)

TABLE 6. Mean concentration levels (mg/kg) of obsolete pesticides in samples of some medicinal plants collected from Egyptian market[a]

Pesticides	Peppermint	Chamomile	Anise	Caraway	Tilio
Total DDT	0.384	0.039	0.575	0.352	0.241
Lindane	0.028	0.501	0.346	0.311	0.081
Aldrin + Dieldrin	0.072	0.006	0.255	0.196	0.048
Endrin	0.068	0.089	0.091	0.016	0.015

DDT, dichlorodiphenyltrichloroethane
a Adapted from Abou-Arab et al., 2001.

3.7. LEVELS OF OBSOLETE PESTICIDES IN HUMANS

Human milk samples that were collected from 20 governorates showed that DDTs were the most frequently found pesticide in human milk studied in Cairo area. Nearly 51% of the samples had DDT levels below the detection limit. In none of the samples where DDT was detected, the WHO recommended limits were exceeded, (Saleh et al., 1999).

In a following study, 292 mother's milk samples collected from 10 Egyptian governorates representing rural, metropolitan and newly reclaimed desert areas. The percentage of samples exceeding the acceptable daily intake for children (ADIs) set by the FAO/WHO ranged from 7% to 48% in all governorates. Higher percentages of unacceptable samples were recorded in Kaliobia and Menoufia governorates, which can be attributed to the higher agricultural activity in the Delta region. Nevertheless, the results suggest the absence of recent DDT sources, and prove the effectiveness of the restrictions imposed on

the use of DDT in agriculture, vector control and in household since the early 1970s, (Barakat, 2004).

Average residues levels were recorded for aldrin, dieldrin, endrin in 292 mother's milk samples collected from 10 Egyptian governorates; while, Lindane was detected in 95% of human milk samples. The higher levels of lindane were a reflection to its use in agriculture and in control of cattle ecto-parasites. The percentages of samples that exceeded theADIs were 15% mostly from the Delta Nile area (Saleh et al., 1999).

However, even with the observed decreasing trend of organochlorine pesticides in mother's milk, the current information on levels in food and humans of some obsolete pesticides appears to be scarce to make an evaluation of health risk assessment at the actual levels of contamination, (Barakat, 2004).

3.8. RECENT EFFORTS TO MANAGE OBSOLETE PESTICIDES IN EGYPT

The World Bank’s current portfolio of projects to eliminate obsolete pesticides gives a special attention to Africa and to high priority countries with large amounts of obsolete pesticides as Egypt. The Bank is administering US$60 million in funds to support the first phase of the Africa Stockpiles Program (ASP). This continent-wide initiative aims to safely eliminate obsolete pesticide stocks from African countries and build capacities to prevent further buildup and the current challenge is to eliminate these pesticides from the continent in an environmentally sound and safe manner within 12–15 years, (World Bank, 2010).

Egypt’s National Implementation Plan (NIP) has established national priorities for completing inventories of POPs materials, planning their disposal and launching a large-scale public awareness campaign. To assist Egypt in implementing the priority POPs activities identified in its NIP, the Canada POPs Trust Fund has supported a project to: i) to identify obsolete pesticides in Egypt; ii) safeguard high-risk stocks of obsolete pesticides, (World bank, 2009).

Cement kilns are occasionally used to treat hazardous waste in a number of countries. The high temperatures of the kilns are very suitable for the total breakdown of these pesticides and would also ensure no emission of dioxins and furans if it was efficiently implemented. The use of cement kilns offers a very competitive and cost-effective alternative for the elimination of obsolete pesticides, especially in countries like Egypt with few waste management facilities, (Ahmed and Loutfi, 2011). A pilot project funded by the Government of Finland is being conducted for assessment and monitoring the disposal by incineration of obsolete pesticides in cement rotary kilns in Egypt, (BCRC Egypt, 2010).

4. Conclusions

Egypt has many ongoing efforts and projects to elaborate a comprehensive inventory for obsolete pesticides and to eliminate and secure the available amounts; however, those efforts aren't yet sufficient. The reported levels of contamination by obsolete pesticides in the environment, food stuff and samples from humans are not exceeding the maximum allowable levels; but, there are still health hazards that can occur on the long term and they are not yet well documented by the available literature on Egypt. One of the top priorities issues should be finding alternative non-combustion technologies for disposing obsolete pesticides

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