AN EGYPTIAN-UNITED STATES PROJECT FOR THE STUDY OF POLLUTION IN SALINE WATERS OF EGYPT[1]

Gerald E. Walsh
U.S. Environmental Protection Agency
Gulf Breeze, Florida, USA

"This paper describes a joint Egyptian-United States research project on pollution of the saline waters of Egypt. The project, which began in 1977 and will continue into 1983, conducts studies in the saline lakes and Abu Qîr Bay near Alexandria, Faiyum Governorate, and the northwestern Red Sea near Al-Ghardaqa. Each area has unique problems of pollution, but all studies address physical, chemical, and biological aspects of the environment, detection and quantitation of pollution in natural systems, and use of toxicity tests on algae and animals to evaluate pollution potential from municipal and industrial wastes (Alexandria), pesticides (Faiyum), and oil (Al-Ghardaqa). Although the purpose of the studies is to evaluate pollution effects in Egypt, data and descriptive and predictive models derived from them should be of value in similar geographical areas."

Introduction

Within recent years, the saline waters of Egypt have become polluted by a variety of substances, which include industrial and municipal wastes, heavy metals, agricultural chemicals, and oil. Although pollution has been occurring in the Mediterranean and Red seas and in saline inland waters, there have not been any extensive systematic studies to identify pollutants and their concentrations and effects until recently.

In 1977, the governments of Egypt and the United States began a joint research project on pollution of the saline waters of Egypt. The research, funded through the U.S. Special Currency Program (P.L. 480) and administered through the U.S. Environmental Protection Agency, addresses pollution problems of interest to both nations. Research by scientists of the Egyptian Academy of Scientific Research and Technology, Institute of Oceanography and Fisheries, in laboratories at Alexandria, the Faiyum Governorate, and Al-Ghardaqa is part of an integrated program of field and laboratory studies that address both basic and applied research in biology and environmental chemistry. Chemical analyses for pollutants in water, sediment, and marine organisms are conducted at a central laboratory in Cairo, and chemical and biological data are stored in and analyzed with computers at the laboratory in Alexandria.

Research

Research at each laboratory is dictated by local problems, i.e., industrial and municipal wastes near Alexandria, pesticides in Faiyum, and oil at Al-Ghardaqa.

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Alexandria

The laboratory at Alexandria employs biologists, chemists, and oceanographers, who work together on common projects to generate descriptive and predictive models of effects and behavior of pollutants. Industrial, municipal, and agricultural sources contribute to pollution of the saline waters near Alexandria. Research at the laboratory is concerned mainly with nonpoint agricultural pollution of saline Lake Burullus and industrial pollution of Lake Idkes and Abu Qîr Bay.

In 1978, concentrations of the heavy metals, copper, iron, mercury, and cadmium in water, sediment, and fish in Lake Burullus were similar to those from uncontaminated sites. The chlorinated hydrocarbon insecticides DDT, DDE, dieldrin, aldrin, heptachlor, and BHC were found in water, sediment, and fish. Pesticide concentrations were high in some areas of the lake and low in others. El-Bogaz, the pass between the Mediterranean Sea and Lake Burullus, contained the greatest amount of pesticides in water and fish, but the highest concentrations in sediment were found at Sidi Yousef. Extensive hydrographic studies on water exchange and the current regime have been completed and will be used to develop models that explain the distribution of pesticides in bodies of water similar to Lake Burullus and to estimate the rate of flushing of pesticides from the system. Such models could be used to predict the rate of recovery from organochlorine pesticide pollution when those substances are no longer used in the area.

Lake Idkes and Abu Qîr Bay receive, directly and indirectly, outfalls from 26 industrial sites that discharge complex wastes from point sources, such as textile mills and paper pulp plants. The project at Lake Idkes and Abu Qîr Bay has only just begun, and its objectives are to:

(a) conduct an inventory of all industrial point source discharges that contribute wastewater to the lake and bay;

(b) characterize chemically the wastewater of each industrial outfall;

(c) identify the outfalls that discharge toxic wastewater by use of acute toxicity tests;

(d) determine the wastewater treatment necessary to reduce the amount of toxicants in the waste streams;

(e) analyze sediments of the lake and bay to estimate the extent of contamination;

(f) conduct in-situ studies in the lake and bay to monitor for lethality and bioaccumulation of selected toxic compounds; and

(g) use models to relate behavior and effect of pollutants to hydrographic dynamics of the lake and bay.

These studies are designed to define the pollution problem in the saline lakes and estuarine waters of the Mediterranean coast of Egypt, to aid administrators with decisions that relate to pollution abatement, and to yield methods and data that can be used by researchers in other parts of the world.

Faiyum

A large portion of the agricultural products of Egypt comes from the Faiyum, where water from the Nile River is diverted for growing crops. The area has been used for food production since ancient times, and Lake Qârûn,

located in the lowest part of the Faiyum Depression of the Western Desert, has become progressively saline as a result of high evaporation rate and accumulation of salts washed from neighboring agricultural land. Salinity of the lake exceeds 30 parts per thousand, and marine crustaceans and fish are grown there for food. Between July 1, 1979 and April 15, 1980, more than 3.5 tons of prawns were harvested from Lake Qârûn, including *Penaeus kerathurus* Forskal, *P. semisulcatus* de Haan, *P. japonicus* Bote, *Metapenaeus monoceros* Fabricius, and *M. stebbingi* Nobili. *Tilapia zilli* Gerv. is the main foodfish harvested from the lake, which also yields the mullets *Mugil cephalus* L., *M. capito* Cuvier, *M. saliens* Resso, *M. chelo* Lowe, and *M. auratus* for 21.9 percent of the catch and *Solea vulgarus* for approximately 20 percent.

Another lake, Wâdi el-Rayan, is used to store water and is potentially an important resource for seafood production. Studies are just beginning there.

Lake Qârûn and Wâdi el-Rayan receive from surrounding agricultural lands drainage water that contains salts leached from the land, nutrients from fertilizers, and pesticides, all of which constitute a hazard to the fisheries. The molluscicide, Bayluscide, used for eradication of snails that serve as hosts for the bilharzia parasite, and the insecticides, Lannate and Dimethoate, wash into the lakes with drainage water or during crop dusting and aerial spraying.

Intensive studies on both lakes include descriptions of their physical, chemical, and biological characteristics. Project scientists will describe the chemistry of the water and substratum, analyze the biota (zooplankton, phytoplankton, and benthos), and study the potential pollution of fisheries resources in detail.

The following studies are part of the continuing research to assess effects of pollutants on the lake fisheries:

1. Long-term chronic toxicity tests are being done on selected crustacean and fish species. Algal toxicity tests are done on a regular basis.
2. No-effect concentrations on the pesticides will be determined, with death, reproduction, bioaccumulation, and histological evaluations as criteria, in studies on invertebrates and fish.
3. The spawning areas for commercially important species will be identified and monitored for concentrations of pesticides.
4. Ongoing investigations on the physical and chemical environment and fisheries biology will continue. Seasonal variations in concentrations of some heavy metals and other trace elements in water and selected fish species will be studied and related to water circulation and bottom sediments.

Data from these studies on the basic biology and fisheries of saline lakes will be used for construction of models that describe that type of ecosystem and suggest methods for its management for food production.

Al-Ghardaqa

Studies in the northwestern Red Sea are done at Al-Ghardaqa Marine Biological Station in an area that extends from Râs Ghârib to Quseir. The study area presents an excellent opportunity to analyze the effects of pollutants on the reef and shore fauna of the Red Sea and to correlate field studies with laboratory toxicity tests. The research approach to Red Sea studies includes detailed descriptions of seasonal hydrographic and chemical conditions in the

study area, descriptions of the littoral and reef environments, detection and quantification of pollutants, and development of sensitive bioassays to determine potential effects of local pollutants.

In order to interpret the biological data, investigators had to describe the physical and chemical conditions of the study area in relation to circulation and currents. The area is highly saline, greater than 40 parts per thousand to approximately 20 meters in depth. Concentrations of orthophosphate suggested the likelihood of input of this nutrient from adjacent phosphate mines and ore ports at Safâga and Quseir. For example, the average winter concentrations of orthophosphate at Râs Ghârib and Al-Ghardaqa were 0.33 and 0.24 µg per liter, respectively. At Quseir and Safâga, concentrations in seawater were 0.50 and 0.75 µg per liter, respectively. There are also seasonal variations in concentrations of nitrate and silicate.

A detailed descriptive analysis of the benthos (algae, seagrass, and animals), coral reefs, and fish has begun. This work includes the first survey of the biota between Râs Ghârib and Quseir. There is a rich benthic algal flora in the study area, including 6 species of Chlorophyta, 13 species of Phaeophyta, and 9 species of Rhodophyta, whose numbers vary seasonally. Initial studies have identified and enumerated common species of Porifera, Polychaeta, Crustacea, Mollusca, Echinodermata, Ascidia, and Cephalochordata. Common fish of the reefs and inshore areas have been identified.

Before the current studies, no research was done in the area of Al-Ghardaqa on pollution due to oil or phosphate mines. In 1979 tar balls with weights between 0.6 and 1.9 mg were common, and dissolved petroleum hydrocarbon concentrations ranged from nondetectable at Al-Ghardaqa to 95 µg/l at Ras Shukheir. Other areas contained between 10 and 80 µg petroleum hydrocarbons/l. Since toxic effects of crude oil on fish begin at about 10 µg/l, marine populations in the northwestern Red Sea may be under pollution stress.

In an effort to assess possible effects of pollutants on marine life, researchers developed methods for acute static and flow-through bioassays on *Modiolus modiolus* L. (Mollusca), *Sergestes lucens* Hansen (Crustacea), and *Aphanius dispar* Rupp (Teleosti). The tests have been used with cadmium and are now being modified for use with oil in water and sediment. In addition, effects of chronic exposure of benthic algae to oil are being studied in the laboratory.

Organisms collected in the field and exposed in the laboratory will be analyzed for pollutant content, and field distributions of biota will be related to pollutant concentrations. Since oil pollution is common throughout the tropics, data gathered in this work on the Red Sea should aid in understanding effects of oil pollution on reefs and inshore areas in general.

Conclusion

Although specifically designed to describe pollution problems in Egypt, this research effort should aid in understanding pollution problems elsewhere. The approach is designed to yield descriptive and predictive models that will aid in formation of guidelines for pollution abatement in various types of saline environments.