MANAGEMENT OF THE ENVIRONMENT

By I. E. Wallen

INTRODUCTION

Mr. President, distinguished guests, it is a great privilege for me to appear before you today. I bring greetings from the United States National Academy of Sciences, the Environmental Protection Agency and the Agency for International Development in Cairo, Egypt, where I am currently serving as an advisor to the General Organization for Industrialization of the Ministry of Industry and Petroleum.

I welcome the opportunity to talk to you about a problem recently recognized as important to the survival of man. We live in a time of tremendous upheaval in science. When I first entered the field of science fresh from World War II, the world I knew was a series of separate units of scientific effort. There was little need for international exchange because the problems appeared to be relatively small and isolated from one another. My research in water pollution was of little concern outside my home state of Oklahoma. My goal was to reduce fish kills in a few relatively inconsequential rivers that during transit through the state received pollution wastes from petroleum refineries. The bioessay techniques that I used had been developed about 2500 miles away in the state of Oregon and I obtained money for research from Washington, D. C., about 1500 miles in the other direction. My research results were published either in the state or in professional journals, conveniently recording the data as possibly of interest to a few other specialists.

All too rapidly my perspective changed. I found it desirable and established an Oklahoma Petroleum Refiners Waste Control Council, because my research was found to apply and to be supported by about fifteen different refineries. I was invited to the Western Petroleum Refiners Association and my work was determined to be of some value in the western half of the United States. Then I was made a member of a Pollution Committee of the National Fisheries Society and it was demonstrated that the principles and data collected for my research were equally applicable to other U.S. areas.

Shortly thereafter, by the mid 1950's, I was invited to share the national responsibility for the environment in Washington, D. C. and there was a required change in perspective in recognition that fresh waters empty into the ocean and that water either in

large or small volumes responds to reasonable similar physical and chemical forces. For some years, I had the privilege of sharing a move from studies of several remote oceans of the world to recognition that the studies concerned a single world ocean.

With acceptance of the existence of a single global ocean has come concern with other global interactions. Weather, population pressures, fossil fuel distribution, disease control, and distribution of natural resources can no longer be considered as internal problems to be treated by national governments. They have outgrown my 1948 mind.

It was my privilege to serve science in an area clearly demonstrating these changing scientific sensibilities, that is, during the development of U. S. President Eisenhower's Atoms for Peace program. As a research project officer, I scheduled monitoring and tracer work to study the atmospheric and oceanic distribution of reaction and fallout particles from early U. S., United Kingdom and USSR nuclear tests of atomic devices. Rates and processes of a total ocean atmosphere system could be studied and reported using radioactive isotopes as tracers.

Out of the potential for nuclear destruction of the world has come a strong interest in science management for world survival. Through the title and the text of my talk today, I want to express concern for management of the global environment. We share a universe with limited resources. There are many things which can be done to assure the continued availability of renewable resources. Each of us can take responsibility for a portion of the job to which, by virtue of employment, job assignment and interest, we can contribute.

The pattern of my career has permitted me to move rather freely to and fro across the boundaries of natural and polluted environments. I apologize for the many personal references in this talk, but I hope they will illustrate the points that I want to make. Each of us is substantially a product of our backgrounds and experiences.

I want also to present a mixture of various data that have become of concern to me from time to time. I will try to interpret some of the information into meaningful packages.

A SITUATION REPORT

It has been estimated that there are in the order of two million different kinds of biological species in the world. It is believed that these were becoming extinct at a rate of perhaps one each 100 years in past centuries. Now it has been estimated that one or more species becomes extinct each year (85 since 1900).

One of the factors in reduction of these species populations is overuse or exploitation of a resource. For many years a factory on the Eastern Shore of the United States harvested its local supply of red algae for preparation of gelatins. With increasing human populations in the area, pollution, and excessive harvest, the local supply of raw material disappeared. A new supply was found in *Eucheuma*, a red algae in the Philippines. Now most of that resource is exhausted and the factory must go to Indonesia for its raw material. One wonders when good management will replace the geographic searching.

Remarkable changes have been made in those species cultivated for human consumption during my lifetime. The cropping of rice was revolutionized here in the Philippines by work of the International Rice Research Institute. In my field of fisheries the North Pacific Salmon has been bred to produce an extraordinary improvement in growth and survival. Vegetables, flowers, and fruits of today hardly resemble those of the 1920's.

During the same time period we have discovered that fallout from northern hemisphere nuclear reactions can be found all too abundantly in the Antarctic. The world's supply of whales has become so limited that drastically reduced quotas were set for their harvest. Migratory bird populations may be greatly reduced by man's activities. Large mammals in Africa have mostly been destroyed outside of preserves. The removal of forests may have very adversely affected climates and resulted in vast increases in the sizes of deserts of the world.

In the United States and in the rest of the world a concentration of human populations in cities has followed industrialization. And industrialization has permitted survival of more individuals. But, solid waste from commercial and residential sources in the U. S. has been estimated at 130 million metric tons per year. About 70,000 different commercial chemicals are produced from a known inventory of more than 4 million different combinations of elements. Common industrial pollution problems of oxygen depletion, excess suspended solids, oil and grease, heavy metals, and toxic chemicals adversely affect 72 percent of United States water basins. About 2 to 2½ percent of the U. S. Gross National Product is spent on pollution control. Air pollution results in up to 37,000 excess deaths per year in the United States alone.

More than 220 federal data systems have been established in the U. S. to keep track of the state of the environment. Eight million tons of waste paper are recovered and recycled each year. Hazardous industrial wastes are generated in the U. S. at an annual rate of 20 million tons, and this does not include radioactive wastes and residues.

In Manila, as in most major cities of the world, clean air has become a luxury rather than a normal way of life. Five types of recognized pollutants are generally treated in setting air pollution standards: carbon monoxide, nitrogen dioxide, sulfur oxides, photochemical oxidants and total suspended particulates.

Carbon monoxide pollution mostly comes from incomplete combustion of fuel in automobiles, trucks, and other types of internal combustion engines. Traffic congestion is a strong contributing factor in pollution with carbon monoxide. Local traffic control strategies tend to reduce concentrations and effect of this pollutant, which directly interferes with the efficiency of breathing in humans.

Nitrogen dioxide and related nitrogen oxides tend to accumulate as a regional problem from combustion engine operation. These chemicals have been associated with increased incidence of respiratory infections, particularly in children. The chemicals contribute to the corrosion of electrical components and they have been found to damage the growth of plants. They are formed in fixed or mobile engines, and especially in high temperature combustion of any fossil fuel. Their abundance seems to relate to the quantity of fuel consumption.

Since most crude oil contains quantities of sulfur, the amount of sulfur dioxide and other oxides of sulfur varies with the type of refined produce used. High sulfur fuel on burning releases particulates and sulfur dioxide to produce the black smoke that is highly offensive to the eye and is believed to be harmful to health, causing respiratory and circulatory problems in man. In the presence of water vapor, sulfuric acid is formed and may harm plants and corrode surfaces of all but the most resistant material.

In the presence of nitrogen dioxide the imperfectly burned hydrocarbons in fuel react especially in light to form photochemical oxidants, including ozone. These chemicals produce respiratory irritation, particularly in asthmatic or other sensitive persons. Inefficient burning of fuels may be corrected through the use of better combustion chambers, however, the level of these pollutants continues to be of concern.

Total suspended particulates provide a useful measure of pollution, but do not identify the different effects of exposure to different chemicals. Lead particles have been demonstrated to be a hazard to health and, where possible, lead exposure is controlled. Arsenic, iron, mercury and other heavy metals are present in most natural fuels and in low concentrations can produce health problems. Although an attempt has heen made to develop controls for particles, it seems likely that in the long run it will be necessary to identify the specific metals and toxic chemicals for individual control.

Researchers have discovered that asbestos accumulation in humans may cause lung cancer, mesothelial cancer, gastrointestinal cancer and cancer of the larynx. Asbestos may reach the human body from air, food, beverages, drinking water, pharmaceutical and dental products, and other sources. Cadmium causes skin cancer in rats and possibly in man. Prostate and respiratory cancer in man have been described as a result of cadmium exposure. Certain pesticides and herbicides have been banned as probably causing liver cancers, and other adverse long-term effects. Certain geographic areas are found to contain anomalous and harmful quantities of potentially harmful metals, such as selenium.

Many other chemicals have been found to produce permanent damage to humans, even in minute quantities.

ENVIRONMENTAL ASSESSMENT

In attempting to determine the effects of new polluting activities of man on the environment, a program of environmental assessment has been developed. The Environmental Assessment is a detailed study of the consequences, both positive and negative of completion of a project or action affecting a particular piece of real estate on the Earth. Many types of projects may be undertaken, such as construction of a new factory or mine or their reconstruction, acquisition of property as a park or preserve, or installing a structure such as a breakwater for a harbor that is interposed into some portion of the natural environment. The environmental assessment is an evaluation of the effect of a land use choice as considered in comparison with other potential land use choices.

The purpose of the environmental assessment document is to provide decision makers with a comprehensive review of the reasonable foreseeable environmental effects of proposed actions and information concerning their reasonable alternatives so that fewer decisions will be made detrimental to future commitments of resources. Environmental assessments will describe the proposed action and the environment affected, including data, maps, and diagrams as necessary and relevant to any environmental issues that may arise. The goals of such an assessment is to achieve environmental benefits and reduce negative consequences of the action.

Population and growth characteristics of the affected area should be identified. The relationship of the proposed action to plans for land and resources use, policies and controls should be examined. It is essential that the sources of data used to identify, quantify, or evaluate any and all enviromental consequences will

be noted. The attention given to different environmental characteristics will vary according to the nature, scale and location of the proposed action. The assessment will be intended to identify such adverse environmental effects as water, air or noise pollution, undesirable land use patterns, damage to life systems, urban congestion, or threats to health. Alternatives should be considered in raw materials use, mining supply, and transport as well as in plant operation and wastes disposal. There should be a reasonable statement of materials use balance from the beginning to the end of the projected action.

Legal requirements have been prescribed for environmental assessments in the United States including those projects financed by such U. S. organizations as the Agency for International Development. Similar requirements have been adopted by the World Bank for its major financing in many countries.

The goal of all of this activity is to reduce pollution in the environment. There have been many attempts to set standards as levels of individual pollutants. Such standards have sometimes been viewed as allowable floors below which pollution could proceed at will. The principal industrial actions have generally been to set standards at as high levels as possible and then to relax within the safety of such numbers. I do not agree with this philosophy. There always should be a goal of zero pollution and no one should be permitted to relax short of that goal.

Recognizing that many so-called pollutants, such as lead, mercury, cadmium, etc., are natural components of the environment, it may often be necessary to live with less than zero pollution. That means to me only that most of us will *never* "relax" but will continue to move in the direction of zero pollution, perhaps without achieving it. Any standards set at less than zero become working numbers that must be subject to change as additional knowledge is gained from research and experience by the World's scientists, engineers, and factory managers.

Pollution, like any other changing process, requires continuous management. A factory may continue to be operated even though it is polluting the environment whenever the decision is made that the benefits in employment, products and profits sufficiently exceed the harm from such pollution. A portion of a forest will be used and trees will be replanted for future generations of users. Fossil fuels are used while research is intensified into the use of solar or other forms of energy as a potential replacement. Many managers must adjust their goals in an assessment of the environmental consequences of their actions.

BIOLOGICAL ENGINEERING

We have entered a period of complex management problems. In management of the environment we must become biological engineers. The American bison proved inefficient as compared to cattle in production of beef in the United States, and the bison was nearly exterminated before a few areas were set aside as preserves. Now we have sufficient sophistication in animal breeding to cross bison and cattle in order to develop even more efficient production of beef. It is important to note that the current breeding program was never envisioned by those who decided years ago to maintain an herd of American bison.

About ten years ago, while a member of the Pacific Science Board, I joined others in urging a breeding program for Philippines Milkfish patterned after the earlier U. S. success with Pacific Salmon. Before being sidetracked to other matters, I sent a specialist on artificial breeding of fishes to Manila to study the artificial propagation of Milkfish but his visit did not coincide with the natural ripening of fish eggs. However, with this procedure followed not long afterward in Taiwan and interest continues and will expand.

Some success has been achieved in the control of agricultural pests without the use of harmful pesticides. A so called "Bot fly" in the southern United States was eliminated as a serious pest through biological means. Millions of male flies were raised and sterilized before release over a large natural environment. They successfully mated with wild females (which mate only once) to the extent that eventually no young were produced and the pest disappeared.

Although unsuccessful thus far in showing practical results, a project in marine biological engineering has been approved for funding in Florida in the U. S. About fifteen years ago a group of us proposed that it would be practical to use marine animals to seal the breakwaters in harbors and present a self-maintaining resistant force to the oncoming ocean waves. Our original idea was to use coral in this way, but this use still depends on research not yet accomplished. However, a marine worm was found that produces a honeycomb-type reef more rapidly than coral in Florida, U. S. and an underwater reef has been designed which we expect will demonstrate the use of a biological breakwater to reduce the enormous loss of recreational seashore sand from the U. S. coast. In order to move from local to international application, work has begun to understand both the engineering structure and survival of the reef and the survival and breeding of the organism.

The same type of processes in biological engineering are required on a much larger scale. I want to mention two of them, endangered species and migratory animals. In both cases multinational solutions must be found to the problems. An International Convention on endangered species of wild flora and fauna came into force in 1975. Nations agreed to cooperate in stemming the tide of elimination of many discrete types of plants and animals. Although the primary beneficiary species of this action were the large mammals, it is apparent that there must be concerted action to preserve the genetic variability that has permitted living organisms to survive major climatic changes in ages past and to be expected on Earth in the future.

The migratory bird problem is also severe as only recently recognized. With increased human populations have come severe agricultural demands for new cropland to be taken ordinarily from wetlands, forests, or deserts, generally at great financial toll. Generally these actions serve to reduce the habitat available for migratory birds. In other cases, intensive hunting and trapping and in still others poisoning of food and pollution of the environment are the major factors in the reduction of populations.

Along with the increasing capability to breed captive species, the existing wetlands of the world are of enormous importance, not only for the marsh and water birds which breed locally, but for the untold millions of migratory birds which cross from southern wintering grounds to northern nesting grounds. There is an urgent need to establish a list of marshes, swamps and other wetlands and to evaluate their use. Many of the remaining wetlands are vital to the continued survival of large migratory populations.

As a problem of similar nature there have been actions to preserve whales and to control the harvest of migratory fishes such as the tuna and the salmon, both of which travel great distances; one tuna species is believed to circumnavigate much of the North Pacific Ocean during its lifetime.

Pollution is being attacked on the international front as well. An example of the most effective effort may be taken from an action plan adopted by the Mediterranean countries for that Sea. A central part of the action plan is a coordinated program for monitoring and research, including seven pilot projects:

- baseline studies and monitoring of oil and petroleum hydrocarbons in cooperation with UNEP
- monitoring and baseline studies of heavy metals, such as mercury and cadmium, in marine organisms
- studies and monitoring of chlorinated hydrocarbons, including DDT and PCB's in the fishes and other marine forms

- evaluations of the effects of pollutants on marine species and populations
- transport of pollutants along the coastal areas
- reduction of coastal pollution
- actions to combat oil spills.

A BASIS FOR ACTION

Management of the Global Environment has been given great emphasis since the 1972 Stockholm Conference and the establishment of the United Nations Environmental Program. There are notable actions in the sharing of information and practices among nations adhering to international bodies. Rather than dwell on these accomplishments, I want to embrace them, but consider what can be done on a much smaller scale; a project by project basis. I want to have you consider possible answers to the question, what can I do as an individual interested in preservation of the environment?

Much pollution results from carelessness on the part of the individual. A few people living in a large open land area can discard occasional items of trash, that is, solid wastes, without a problem. When many people live in close proximity, what was normal for an open area easily becomes a severe pollution problem. Solutions are often sought through trash removal industries paid for in the common good. These "industries of civilization" are necessary when individuals lack the space within accessible distance to remove a no longer useful item. Recycling becomes more difficult under crowded conditions. To resolve this problem, each individual must deliver trash to collection stations. In the absence of at least some individual action, there is no solution to solid wastes pollution.

Generally the solid wastes problem requires attention from many aspects. Industrial employees can assure the use of minimum packaging for a product, government employees must locate appropriate trash disposal sites and provide incentives. Housewives, children and all consumers must deliver wastes to collecting stations.

Industries must be innovative in pollution control. A break with the tradition of burning dirty coal can come with burning cleaner oil or still cleaner natural gas. Care can be exercised during the manufacture of automobiles to adjust the fuel mixture for minimum pollution, which often occurs with maximum efficiency of performance of the engine. Extra steps in removal of chemicals from wastes often are profitable based on the recovery of additional useful materials.

Until recently, brick manufacturers in Iran burned a highly polluting mixture of heavy fuel oil, coal dust, sawdust and dried animal manure. A change to natural gas as fuel not only eliminated serious pollution, but resulted in a much better brick and multiplied profitability.

Also in Iran, the local Payhan automobile manufacturer found that changing the air/fuel mixture in the combustion chamber to that appropriate for Tehran's altitude could result in a 70 percent reduction in loss of carbon monoxide and a saving of 12 to 18 percent in fuel consumption.

QUALITY OF DATA

Many management problems arise because of the lack of accuracy of data. Samples are taken at the wrong place, at the wrong time, by the use of an inadequate technique, or even for the wrong reasons. The samples may be incorrectly preserved or improperly stored. They may be examined only superficially, or with a technology that is inadequate for the purpose.

New emphasis must be given to quality control. Generally quality control means that the results of the analyses may be repeated and found to be approximately the same by the same investigator at different times or by different experienced investigators. In order to assure that data are of good quality international efforts have frequently been developed to compare results and to develop comparable procedures and standards of measurement.

Polluting materials often are very difficult to analyze and special new techniques and equipment must be produced. Because of these problems the exchange of information on methods and techniques is not only desirable, but necessary. Any manager of pollution control authorities must first resolve the issues of accuracy and reliability of data, before important decisions can be made in control of factory pollution.

HOUSEKEEPING ASPECTS

Effectively, pollution control can often be equated with good housekeeping. The managers of plants can use existing employees on cleanup assignments or provide on-site park and recreation areas, perhaps with benches and tables for use by the employees. The collection of oil and grease from leaks and process losses can often be made profitable with resale or recycling for use in soap or in alternative industries. Sedimented waste materials can at least

be used to fill low places for expansion of factory sites or in improving the natural beauty. Composted sludges often can be recycled to agricultural use. Trucks between assignments can carry trash and unusable materials to non-polluting disposal sites.

Through incentives, awards and bonus programs, managers can encourage their employees to participate in corrective actions to reduce pollution. Efficiency studies often result in important suggestions in removing pollution, sometimes at a profit.

Governmental actions may be required to assist with purchase of trash trucks, to approve a charter for a trash hauling firm, or to establish a dumping site with fence and guard at an appropriate location, perhaps for subsequent leveling and use as a filled industrial "park." Governments may need to provide training for managers or perhaps only need to supply trash vehicles.

Industry usually benefits from a program to improve housekeeping by increased labor productivity, reduction or recycling of wastes, replacement of outdated equipment of simply by enjoying an aesthetically improved environment.

REGULATION

Regulation of industry should be a last choice alternative in pollution control. Many approaches should be tried first, including private certification of products, voluntary standards, economic incentives, revised production practices, controlled trading, performance bonds, innovative technology, and direct consumer action such as petitions, product boycotts, retraining, advertising and operational and maintenance strategies.

This is particularly true because of the extraordinary problems of setting standards. The proper management of the environment must include maximum effective use for the survival of man and the earth together. Geographic areas can be set aside for industrial use while others are preserved. In vast open areas a compromised pollution standard can be greatly different from that in areas heavily populated — or rich in agricultural production.

Alternatives in environmental pollution control are generally the alternatives in biological engineering. The use of pesticides on agricultural crops must be balanced with possible destruction of wildlife and harm to human health. The harvesting of timber must be weighed against flooding in downstream areas or desertification. Oil spills must be measured against energy needs, fish production, costs of more adequate ship navigation, recreational losses, property values, and increased costs of longer shipping routes.

One ton of crude oil can cover up to 1200 hectares of sea surface. Tankers discharge a quantity of oil equal to about one percent of the cargo in washing their tanks. About one-sixth of the oil spilled into sea water will remain in solution after coastal deposition, oxidation or bacterial action (in the Mediterranean). Emergency procedures to reduce the impact of oil spills belong in the priorities of all countries.

Integrated pest management is a new term that applies to the need to reduce the overuse of pesticides. In Egypt the use of pesticides became so extreme that as many as 40 applications of pesticides were made to one crop of cotton. This type of management is an attempt to use the life cycle of a pest in reduction of its numbers. Procedures of land use, physiological selection, behavior related treatments, technological control, and release of parasites and diseases supplement the application of pesticides and herbicides.

Timber harvest in developing countries may create such management challenges as flooding, sedimentation of lakes, crop failures, the spread of diseases and declining soil fertility. The setting aside of land preserved from such exploitation should be a goal of all nations.

TRAINING

Because of the enormous variability in environmental conditions, there must always be continuous training and the exchange of ideas. The most difficult decision for management will always be to determine which problems require treatment on a priority basis. In most cases the consideration of priorities means that management will devote heavy increments of time to planning. Training or experience in planning is vital to success of environmental improvement programs.

Training may be given to potential or actual environmental managers in either engineering or in scientific fields. The manager must somehow become adept in problem recognition as well as in problem solving. A "perfect" engineering solution in production could, for example, be developed through the use of a certain chemical with properties available as a catalyst or as a part of a production process. The selected chemical may be at the same time "perfect" for the factory production need and a highly toxic menace to the health of workers. Control of pollution may become an innovative technique for non-hazardous use of the chemical, perhaps through careful handling and containment. Training should include the acquisition of skills that permit ideas

in one area to be recognized as useful in totally different relationships.

Training must be continuous and broad across many related and unrelated fields in order that such skills will appear. Such training must continue throughout the lifetime of the pollution manager, on and off the job, in and out of his country of origin.

ORGANIZING FOR THE JOB

I believe that simple solutions still exist to most problems of environmental management. I believe that there should be a small organizational structure in each nation whose responsibility extends entirely across the environmental fields, both natural and polluted. With access and full support of the Prime Minister of a nation, the chief-bureaucrat-in-charge of the environment should have equal responsibility for natural fish, wildlife and parks and for pollution control through water pollution, air pollution and environmental assessment units.

The primary goals of the head of such an organization would be to reduce pollution to its minimum practical level in continued country development and to maintain the renewable resources of native fisheries and wildfire through reserves, preserves and parks where citizens can enjoy nature. The tools of such a trade may only be garbage trucks, sewage and industrial waste treatment plants, recycled products and wastes and the powers of persuasion appropriately backed by the Prime Minister and Cabinet Ministers.

And, finally, the successful manager must be prepared to limit his field of experience and activity to focus on certain problems of great value to the country. He can easily spread his resources over an impossible area. He should accept a limited goal of accomplishment such that he can assure success of those activities underway. He must be prepared to sacrifice some important secondary objectives in order to clearly accomplish some improvements in the quality of life. He must not shift from crisis to crisis and thus never quite finish the important priorities.

With the cooperation of its citizens, any such nation will become a proud example to the world with clean air, clean waterways and a pleasant, healthful life.

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