OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

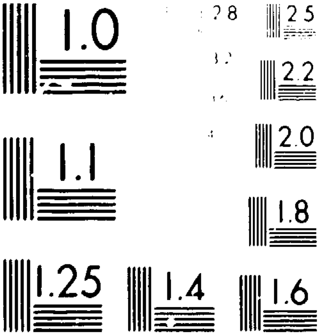
FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

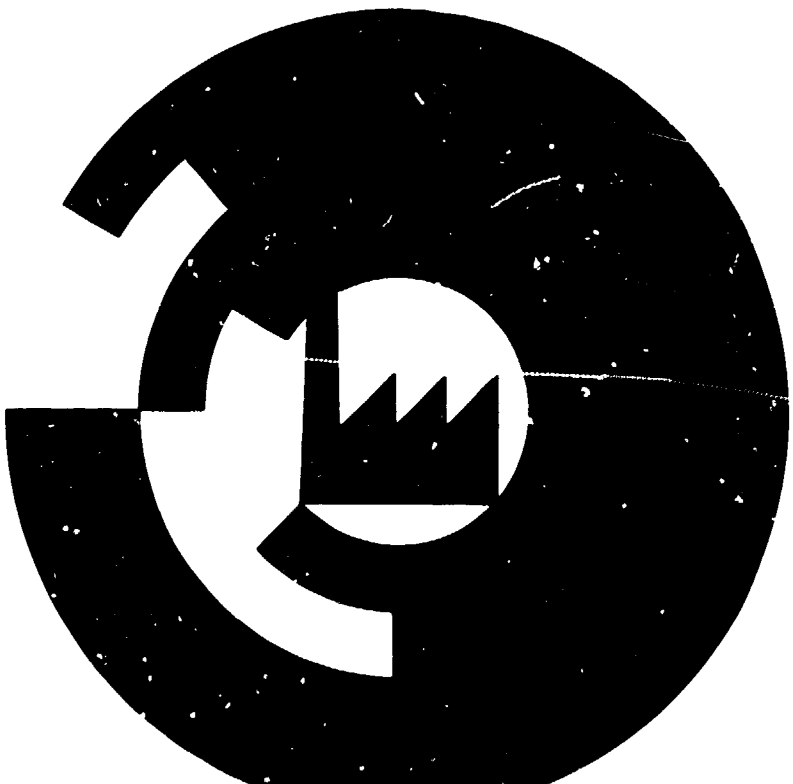
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org


1.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

11409

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ENVIRONMENTAL PROTECTION WITHIN THE CONTEXT OF THE WORK OF UNIDO



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna

ENVIRONMENTAL PROTECTION WITHIN THE CONTEXT OF THE WORK OF UNIDO

E. Joe Middlebrooks

ID/282

UNITED NATIONS
New York, 1982

ID/282

Preface

This 10-year review of the work of the United Nations Industrial Development Organization (UNIDO) as it relates to environmental issues has been prepared for the session of a special character held by the Governing Council of the United Nations Environment Programme (UNEP) at Nairobi in May 1982 to commemorate the tenth anniversary of the United Nations Conference on the Human Environment held at Stockholm in 1972.

This review was prepared by the secretariat of UNIDO with the assistance of E. Joe Middlebrooks, environmental engineer. Much of the text is based on reports of technical co-operation projects in various developing countries. Since the reports are of a restricted nature, they are not listed in the list of references or bibliography. Unpublished UNIDO papers and other items not generally available have also been used as source material. Inquiries should be addressed to the Division for Industrial Studies, UNIDO, P.O. Box 300, A-1400 Vienna, Austria.

EXPLANATORY NOTES

References to dollars ($) are to United States dollars.

LT is the symbol of the Turkish lira. During the period covered by this report the value of the lira was approximately $. .007.

The symbol t is used for the metric ton (tonne) of 1,000 kilograms (kg) or approximately 2,200 pounds. The short ton is approximately 910 kg or 2,000 pounds.

In addition to the common abbreviations, symbols and terms, and those accepted by the International System of Units (SI), the following have been used:

Technical abbreviations and symbols

BOD	biochemical oxygen demand
COD	chemical oxygen demand
DDT	dichloro-diphenyl-trichloro-ethane
GI	gastrointestinal
SS	suspended solids
t.c.e.	tonnes of coal equivalent

Other abbreviations

ECE	Economic Commission for Europe
FAO	Food and Agriculture Organization of the United Nations
GATT	General Agreement on Tariffs and Trade
IFAD	International Fund for Agricultural Development
ILO	International Labour Organisation
ITC	International Trade Centre (UNCTAD/GATT)
UNCDF	United Nations Capital Development Fund
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNDP	United Nations Development Programme
WHO	World Health Organization

CONTENTS

Tables

Introduction

The relationships between the political, social, economic and environmental conditions within all countries and for the world as a whole are becoming increasingly complex. Serious problems become more serious as the number of people grows and as the needs of the people grow. Without careful environmental control, expanding populations may deplete environmental resources and destroy ecological systems.

It is difficult to improve an environment without a strong economy, and it is difficult to improve an economy without protected natural resources and a clean environment. The abuse of natural resources in many parts of the world has made it impossible for economic growth to occur. Examples of such abuse include the consumption of wood for energy at a pace exceeding regrowth, contamination of streams such that downstream development cannot occur economically, the destruction of fisheries by pollution, and the elimination of agricultural activities in the vicinity of a chemical plant due to air pollution. It is imperative that the developing nations of the world be assisted in order to avoid irreparable environmental damage.

Complex interactions exist among natural resources, environment, populations and economic development. The results of capital investment have often been disappointing because ecological consequences and problems concerning the resource base have been ignored. Planning industrial development must be done with a holistic approach if a sustainable economy is to be developed. In the past, environmental protection and industrial development were considered to be separate goals. It is now known that the areas of the world with the most severe environmental problems are those which are not able to have development and economic growth over extended periods of time. Economic stability can be maintained only in areas where planning for ecological stability is coupled with wise management of resources.

The influence of extreme poverty, the absence of economic development and the limited possibilities within a particular area for making a living in a non-destructive way, may contribute to the abuse of the earth's renewable resource base. However, the abuses by people in developing areas are only one part of the environmental problem. The ecosystem is threatened also by the by-products of economic development and industrial growth. Industrial growth without resource and waste management produces a harsh impact on a local ecosystem and ultimately on the ecosystem of the earth. If we continue to develop without regard for the environment there will, for example, be severe changes in the composition of living marine resources because of habitat destruction and waste deposition and concentration. Attention must be directed to the protection of our oceans as cautioned in the Stockholm Conference on Human Environment [23]:

> States shall take all possible steps to prevent polluting of the seas by substances that are liable to create hazards to human health, to harm living resources and marine lifes, to damage amenities or to interfere with other legitimate uses of the sea.

There are two basic marine ecosystems: coastal and oceanic. The two ecosystems are described in table 1. Also included in the table are the types of pollution affecting both ecosystems, the effects of the pollution, and the duration of the effects. Estimates of the quantities of various metal pollutants discharged to the oceans are summarized in table 2.

Table 1. Pollution types, effects, trends and duration for the oceans

Pollution types	*Effects and pollution trends*	*Duration of effects*
Coastal waters (10 per cent of total area; 99 per cent of total fish production[a])		
Sewage; industrial wastes; litter; petroleum hydrocarbons	Living resources destroyed or rendered unusable; industrial uses of seawater adversely influenced; amenities reduced; recreational values diminished	Short-term; mainly during period of discharge
Synthetic organic chemicals; metals; radionuclides	Living resources decreased or rendered unusable	Long-term; metals and synthetic organic chemicals deposited in sediments may be released for a long time through normal leaching or dredging disturbance
Open ocean (90 per cent of total area; 1 per cent of total fish production[b])		
Synthetic organic chemicals; metals; petroleum hydrocarbons; radionuclides	Increasing concentrations in water and organisms may indicate dangerous trends	Long-term; duration depends on the residence time of pollutant

Source: Michael Waldichuk, *Global Marine Pollution: An Overview* (Paris, UNESCO, 1977), p. 12.
[a] Including fish production from upwelling area.
[b] Excluding fish production from upwelling area.

The need for planning and constant vigilance to avoid disasters brought on by the discharge of industrial wastes is illustrated by the long delay in the response to a problem by an individual country (table 3). If it has taken decades for a country to recognize a problem, how long would it take for all the countries of the world to respond if the oceans were observed to be evolving into a disaster area? As development proceeds, one must plan for the continued existence of man on the planet.

Global pollution is becoming an increasing problem. In this connection, the New Delhi Declaration and Plan of Action on Industrialization of Developing

Table 2. Estimates of amounts of metals injected into the oceans annually by geological processes and by man

(In thousands of tonnes)

Metal	*By geological processes (in rivers)*	*By man (in mining)*
Iron	25 000	319 000
Manganese	440	1 600
Copper	375	4 460
Zinc	370	3 930
Nickel	300	358
Lead	180	2 330
Molybdenum	13	57
Silver	5	7
Mercury	3	7
Tin	1.5	166
Antimony	1.3	40

Source: Michael Waldichuk, *Global Marine Pollution: An Overview* (Paris, UNESCO, 1977), p. 20.

Table 3. Timetable of societal responses to mercury pollution of the ocean, Minamata Bay, Japan, 1939–1973

Year	*Event or observation*
1939	Chemical production begins on the shores of Minamata Bay; the factory discharges spent catalysts containing mercury into the bay
1953	Birds and cats in the bay area act oddly; the behaviour disorder becomes known as "disease of the dancing cats"
1956	Neurological disorders observed among Minamata Bay fishermen and their families
1959	High concentrations of mercury ascertained in bay fish and in dead patients; an independent study shows disease was methyl mercury poisoning and factory effluent the likely source
1960	Chemical company denies relationship of mercury to the disease but finds new discharge sites for waste; several new cases break out at new site
1961-1964	Very small compensations paid by the chemical company to disease victims and to fishermen for loss of livelihood
1965	A second outbreak occurs at Niigata, Japan, where an acetyldehyde factory discharges spent mercury catalysts into the river
1967	Niigata patients initiate a civil action, presumed to be the first large civil suit brought against a polluter in Japan
1971	Niigata District Court pronounces judgment against the Niigata factory; compensation awarded the 77 Niigata victims or their families
1973	Kumamoto District Court finds Minamata Bay factory culpable and orders company to pay reasonable compensation to victims or their families

Source: Edward D. Goldberg, *The Health of the Oceans* (Paris, UNESCO, 1976), pp. 21-23; Paul R. Ehrlich and others, *Ecoscience: Population, Resources, Environment* (San Francisco, Freeman, 1977), p. 574.

Countries and International Co-operation for their Industrial Development states (paragraph 245) that it is necessary to "ensure that the disposal of industrial waste originating in developed countries be undertaken in ways that safeguard the environment of developing countries." [54] Quoting further from the New Delhi Declaration, it is equally important that nations "ensure that technological transfers from developed countries do not harm the environment of developing countries and make available to developing countries environment protection technologies. Redeployment should not be used to obtain access to abundant and low-paid manpower or transfer obsolete and polluting technologies. or exhaust the natural resources of developing countries."

Environmental damage

The number and quantity of chemical compounds that can damage the environment have increased steadily since the beginning of the industrial revolution. Individuals and governments are concerned about the known and unknown impacts of the many varieties and the great quantities of chemical pollutants to which people are exposed. Thousands of toxic chemicals are being discharged into the air, waters and soils of the world. The pollutants are dispersed throughout the world and can be concentrated by winds, ocean currents and the food chain. Chemical pollutants can vary in effect from being short-lived to being permanent sources of contamination. The heavy metals, for example, are essentially indestructable, whereas pesticides and herbicides used in agriculture can be bio-degraded; but in many cases the decay occurs over a very long period of time. Control of agricultural chemicals is gradually occurring; however, the discharge of pollutants derived from energy development, utilization and transportation is increasing dramatically with little restriction.

The physical and toxic properties of the various chemical pollutants may produce direct effects on all living things. Man depends on existing species to provide air, food, fibre, shelter and medicines. Altering the balance of the species may be devastating to all life. As pointed out in the New Delhi Declaration, "Industrial policies to be adopted to reach the Lima target should take into consideration the necessity for protecting occupational and health environment as well as the preservation of nature and the ecological balance." [54]

Water quality

Surface waters such as lakes, wet-lands, rivers and streams have served as the recipients of municipal and industrial wastes. However, most countries are beginning to consider the desirability of protecting these natural resources, and many organizations from municipal to international are giving extensive attention to cleaning and protecting surface waters. It is economically attractive to maintain the quality of water in streams. Allowing waters to deteriorate because of the discharge of industrial or municipal waste has a serious impact on the health and economy of downstream users.

Attempts are made in most parts of the world to monitor surface waters, but little attention is paid to the monitoring and control of ground water quality. A lack of effort to protect ground water can be attributed to the fact that, in the past, ground water quality has been very good and until recently few data have been collected to show that a problem exists. As more ground water samples are analysed by trace methods, it is evident that a problem with the discharge of synthetic organic chemicals to the aquifers is being created. Because ground water is widely used as a source of drinking water, it is imperative that toxic substances do not enter aquifers. Removing and treating water from an aquifer is difficult and expensive. The presence of toxic substances in ground water can be extremely dangerous if the water is used for long-term consumption. Many of the toxic chemicals found in drinking waters are known to pose unacceptable health risks (table 4). There are few, if any, international health standards for most of the organic compounds found in wells used for drinking water. Many of these chemicals are carcinogens or mutagens which can pose health risks at concentrations of 10 micrograms per litre or less. Since most of these compounds are odourless at concentrations that can cause substantial risk, the danger remains undetected until sophisticated chemical analyses are performed on samples collected from well supplies. Such samples are collected infrequently in most nations of the world, and a problem can persist for many years before detection occurs. Therefore, the only logical solution to preventing toxic contamination is to require careful handling, treatment and disposal of toxic wastes.

Toxic substances

As chemicals are necessary to society it is essential that the health effects of the chemicals be understood and an effort be made to control the handling, treatment and disposal of chemicals. Humans can be routinely exposed to toxic substances in air, in water they drink, in foods and in drugs, cosmetics and other consumer products. Toxic substances can cause cancer, lung disease and reproductive dysfunction.

Chemical contaminants present in the work place may produce serious effects because of the concentration and the extended periods of exposure. Tables 5, 6, and 7 summarize some of the effects of chemicals on workers. The long-range effect of exposure to many chemicals is still unknown.

Industry is by far the largest producer of hazardous wastes in most countries, and the chemical and allied products industry produces the greatest amounts of health-threatening industrial wastes. Industrial wastes are also produced in the manufacture of automobiles, energy, paper, plastic, clothing, rubber, paint, pesticides, medicines and many other routinely used products. The distribution of the production of industrial hazardous waste in the United States of America is shown in table 8. The most common hazardous wastes found in industry are listed in table 9.

Careful disposal is only one of the ways for managing dangerous materials. Methods suggested for the management of hazardous waste include:

(a) Modification of the industrial process to minimize the waste produced;

(b) Utilization of the material as a raw product in another industry;

(c) Utilization of the waste as a source of energy or raw material in the existing industry;

(d) Reduction of the cost of handling, transporting, and disposal by separating the hazardous from the non-hazardous wastes at the source;

(e) Treatment of the waste to reduce or eliminate the hazard;

(f) Utilization of a secure landfill designed to protect life and environment.

The costs associated with environmentally sound methods for disposing of hazardous waste are presented in table 10.

Table 4. Concentrations of selected synthetic organic compounds in raw and finished ground water

(Micrograms per litre = parts per billion)

	Number of cities sampled		Percentage with chemical present		Concentration					
					Mean		Median		Range	
Compound	Raw	Finished	Raw	Finished	Raw	Finished	Raw	Finished	Raw	Finished
Trichloroethylene	13	25	38.5	36.0	29.72	6.76	1.3	0.31	0.2–125.0	0.11–53.0
Carbon tetrachloride	27	39	7.4	28.2	11.5	3.8	11.5	2.0	3.0– 20.0	0.2 –13.0
Tetrachloroethylene	27	36	18.5	22.0	0.98	2.08	0.6	3.0	0.1– 2.0	0.2 – 3.1
1,1,1-Trichloroethane	13	23	23.1	21.7	4.8	2.13	1.1	2.1	0.3– 13.0	1.3 – 3.0
1,1-Dichloroethane	13	13	23.1	23.1	0.7	0.3	0.8	0.2	0.4– 0.9	0.2 – 0.5
1,2-Dichloroethane	13	25	7.7	4.0	0.2	0.2	NA	NA	0.2– NA	0.2 – NA
Trans-dichloroethylene	13	13	15.4	15.4	1.75	1.05	1.75	1.05	0.2– 3.3	0.2 – 1.9
Cis-dichloroethylene	13	13	38.5	30.8	13.56	9.35	0.1	0.15	0.1– 69.0	0.1 –37.0
1,1-Dichloroethylene	13	13	15.4	7.7	0.5	0.2	0.5	NA	0.5– 0.5	0.2 – NA
Methylene chloride	27	38	3.7	2.6	4.0	7.0	NA	NA	4.0– NA	7.0 – NA
Vinyl chloride	13	25	15.4	4.0	5.8	9.4	5.8	NA	2.2– 9.4	9.4 – NA

Source: Environmental Protection Agency, Office of Drinking Water, "The occurrence of volatile organics in drinking water", Briefing paper (Washington, DC, Government Printing Office, 6 March 1980).

NA = Not applicable.

Table 5. Effects of industrial chemicals and drugs on reproduction for man

Agent	*Type of study*	*Effect*
Anaesthetic gases	Reproductive history	Increased incidence of congenital anomalies in offspring
Carbon disulphide	Semen analysis, reproductive history	Impotence, loss of libido
Chloroprene	Semen analysis, reproductive history	Decreased motility and sperm count, excess miscarriages in wives
Dibromochloropropane	Semen analysis, reproductive history	Decreased sperm count, infertility
Hydrocarbons	Reproductive history	Increased incidence of cancer in children
Kepone[a]	Reproductive history	Decreased fertility
Lead	Semen analysis	Decreased motility and sperm count, increase in abnormally shaped sperm
Vinyl chloride	Questionnaire	Adverse pregnancy outcome in wives; excess foetal loss

Source: V. R. Hunt, *Work and the Health of Women* (Boca Raton, Florida, CRC Press, 1979), pp. 158, 164.

[a] Pesticide with the chemical composition: decachlorooctahydro-1, 3, 4-metheno-2H-Cyclobuta [cd] pentalen-2-one.

Table 6. Occupational exposures in industrial trades employing large numbers of women

Occupation	*Exposure*
Textile workers	Raw cotton dust, noise, synthetic fibre dusts, formaldehyde, heat, dyes, flame retardants, asbestos
Sewers and stitchers, upholsterers	Cotton and synthetic fibre dusts, noise, formaldehyde, organic solvents, benzene, toluene, trichloroethylene, perchloroethylene, chloroprene, styrene, carbon disulphide, flame retardants, asbestos
Laboratory workers (clinical and research)	Wide variety of toxic chemicals, including carcinogens, mutagens, and teratogens, X-ray radiation
Photographic processors	Caustic compounds, iron salts, mercuric chloride, bromides, iodides, pyrogallic acid, silver nitrate
Plastic fabricators	Acrylonitrile, phenol formaldehydes, urea formaldehydes, hexamethylenetetramine, acids, alkalies, peroxide, vinyl chloride, polystyrene, vinylidene chloride
Transportation personnel	Carbon monoxide, polynuclear aromatics, lead, and other combustion products of gasoline, vibration, physical stress
Sign painters and letterers	Lead oxide, lead chromate pigments, epichlorohydrin, titanium dioxide, trace metals, xylene, toluene
Clerical personnel	Physical stress, poor illumination, trichloroethylene, carbon tetrachloride and various other cleaners, asbestos in air conditioning
Opticians and lens grinders	Coal tar pitch volatiles, iron dioxide, dust solvents, hydrocarbons
Printing personnel	Ink mists, 2-nitropropane, methanol, carbon tetrachloride, methylene chloride, lead, noise, hydrocarbon solvents, trichloroethylene, toluene, benzene, trace metals

Source: Department of Health, Education and Welfare, National Institute for Occupational Safety and Health, *Guidelines on Pregnancy and Work* (Washington, DC, Government Printing Office, 1977), pp. 65–66.

Table 7. Chemicals associated with cancer induction in humans

Chemical	*Main type of exposure*[a]	*Target organs in humans*	*Main source of exposure*[b]
Aflatoxins	Environmental, occupational[c]	Liver	Oral, inhalation[c]
4-Aminobiphenyl	Occupational	Bladder	Inhalation, skin, oral
Arsenic compounds	Occupational, medicinal, environmental	Skin, lung, liver	Inhalation, skin, oral
Asbestos	Occupational	Lung, pleural cavity, GI tract	Inhalation, oral
Auramine manufacturing	Occupational	Bladder	Inhalation, skin, oral
Benzene	Occupational	Hemopoletic system	Inhalation, skin
Benzidine	Occupational	Bladder	Inhalation, skin, oral
Bis(chloromethyl)-ether	Occupational	Lung	Inhalation
Cadmium-using industries (possibly cadmium oxides)	Occupational	Prostate, lung	Inhalation, oral
Chloramphenicol	Medicinal	Hemopoletic system	Oral, injection
Chloromethyl ether (possibly associated with bis(chloromethyl) ether	Occupational	Lung	Inhalation
Chromate-producing industries	Occupational	Lung, nasal cavities[c]	Inhalation
Cyclophosphamide	Medicinal	Bladder	Oral, injection
Diethylstilbestrol (DES)	Medicinal	Uterus, vagina	Oral
Hematite mining	Occupational	Lung	Inhalation
Isopropyl oil	Occupational	Nasal cavity, larynx	Inhalation
Melphalan	Medicinal	Hemopoletic system	Oral, injection
Mustard gas	Occupational	Lung, larynx	Inhalation
2-Naphthylamine	Occupational	Bladder	Inhalation, skin, oral
Nickel refining	Occupational	Nasal cavity, lung	Inhalation
N,N-bis (2-chloroethyl)-2-naphthylamine (chlornaphazine)	Medicinal	Bladder	Oral
Oxymetholone	Medicinal	Liver	Oral
Phenacetin	Medicinal	Kidney	Oral
Phenytoin	Medicinal	Lymphoreticular tissues	Oral, injection
Soot, tars, and oils	Occupational, environmental	Lung, skin, scrotum	Inhalation, skin
Vinyl chloride	Occupational	Liver, brain,[c] lung[c]	Inhalation, skin

Source: Adapted from L. Tomatis and others, "Evaluation of the carcinogenicity of chemicals: a review of the monograph program of the International Agency for Research on Cancer (1971-1977)", *Cancer Research*, No. 38, 1978, pp. 879-889, table 2.

[a] The main types of exposure mentioned are those by which the association has been demonstrated.

[b] The main routes of exposure given may not be the only ones by which such effects could occur.

[c] Denotes indicative evidence.

Table 8. Industrial hazardous wastes in the United States

Source	*Share (%)*
Chemical and allied products	60
Machinery (except electrical)	10
Primary metals	8
Paper and allied products	6
Fabricated metal products	4
Stone, clay, and glass products	3
All others	9

Source: Environmental Protection Agency, Office of Water and Waste Management, *Everybody's Problem: Hazardous Waste* (Washington, DC, Government Printing Office, 1980), p. 14.

Table 9. Common hazardous wastes

Chemical	*Use*	*Hazard*
C-56[a]	Bug and insect killer	Acutely toxic, suspected carcinogen
Trichloroethylene (TCE)	Degreaser	Suspected carcinogen
Benzidene	Dye industry	Known human carcinogen
Curene 442[a]	Plastics industry	Suspected carcinogen
Polychlorinated biphenyls (PCBs)	Insulators, paints, and electrical circuitry	Acutely toxic, suspected carcinogen
Benzene	Solvent	Suspected carcinogen
Tris[b]	Fire retardant	Suspected carcinogen
DDT	Bug and insect killer	Acutely toxic
Vinyl chloride	Plastics industry	Known human carcinogen
Mercury	Multiple uses	Acutely toxic
Lead	Multiple uses	Acutely toxic, suspected carcinogen
Carbon tetrachloride	Solvent	Acutely toxic, suspected carcinogen
Polybrominated biphenyls (PBBs)	Fire retardant	Effects unknown

Source: Eric Sharp and Doug Hall, "Haulers fouling state with deadly chemicals", *Detroit Free Press*, 12 December 1979, p. 19A.

[a] Proprietary products.

[b] Tris (hydroxymethyl) aminomethane.

Table 10. Costs of environmentally sound methods for disposal of hazardous wastes

Method	*Cost (dollars per tonne)*
Land spreading	2–25
Chemical fixation	5–500
Surface impoundment	14–180
Secure chemical landfill	50–400
Incineration (land based)	75–2 000
Physical, chemical or biological treatment	Varies

Source: Environmental Protection Agency, Office of Water and Waste Management, *Everybody's Problem: Hazardous Waste* (Washington, DC, Government Printing Office, 1980), p. 15.

Biological fuels

For centuries, the use of biologically derived fuels has been well established in many regions of the world. The use of such materials is likely to increase with the rising costs of oil and rising costs of gas exploration and development. In response to the directive in the New Delhi Declaration (paragraph 203) that we "undertake research, development, and other measures for conservation of energy resources, their more efficient use, and recycling of materials in the energy sector", diverse forms of biomass have and are being considered as the source of fuel for the future. [54] Forest products and residues, animal manure, sewage, municipal waste, agricultural crops and residues and aquatic plants are several of the materials being considered as biomass energy. Biomass can be stored and converted to energy, whereas energy derived from solar cells, windmills and thermal collectors requires a storage facility to be built and maintained as a part of the energy-producing system. The simplicity of biomass energy leads to its world-wide acceptance. As the use of biomass fuel materials increases, it is imperative that nations consider the impact of long-term use of biomass materials. The significance of long-term effects of biomass fuels is summarized in tables 11 and 12. These tables are presented to point out the hazards which must be avoided in developing a biomass energy system and not to discourage the production of biomass energy.

Environmental philosophy

It is advantageous to consider waste materials as an additional resource to be utilized either in the form discarded or to be further processed. This approach to waste processing is economically and environmentally important. If a government or ministry considers protection of the environment and maximum utilization of the base resource important, then the production management and the employees will be more likely to do so, and take pride in recovering and utilizing as much of the by-product and waste materials as possible and in producing high-quality effluents. The importance of protecting the quality of the environment, and the impacts that improper handling of waste materials may have on the employees' life styles and the country as a whole, must be emphasized.

Environmental protection must be stressed if there are production quotas. With quotas, management tends to concentrate on product output if not reminded continually of the need for environmental protection. Environmental protection must be considered as a valuable natural resource just as are the labour, materials, and the capital investment required for the basic product.

Table 11. Significance of long-term ecosystem impacts of biomass fuel production from crop residue removal

Environmental concern	*Status (state of knowledge)*	*Likelihood of a finding adverse to technology development*	*Environmental risk of proceeding with technology development*
Soil-erosion caused by the action of wind and water on open farmland following removal of crop residues can lead to increased particulate air pollution; increased sedimentation of surface water supplies; and impaired productivity of exposed cropland due to loss of soil, organic binders, and nutrients.	Increased sedimentation from soil erosion is one of the worst water pollutants. Information is available on soil erosion as a function of soil type, slope, and degree of protection. Significant research is required to quantify permissible degree of residue removal and control strategies.	Medium. Topsoil is a non-renewable resource. Its continued loss will lead to an increased need for supplemental nutrients that compete for alternate energy resources. Good soil conservation practices should help to mitigate these impacts. Effective control over large areas may be costly.	Low. Risk centres around increased cost of control.

Source: Based on Department of Energy, *Environmental Readiness Document: Biomass Energy Systems*, DOE/ERD-0021 (Springfield, Virginia, National Technical Information Service, 1979).

The costs for environmental protection must be paid either now or in the future. The most effective method of handling waste products is to incorporate the facilities for protecting the environment and for further processing of waste into useful products. It is much less expensive to install such equipment initially than to convert a production process and add pollution control equipment later; moreover, it has proved cheaper to spend today's dollars than inflated ones at a later date. However, it is still less expensive to add the facilities for processing excess materials to existing systems than to allow these materials to be wasted as environmental pollutants. To clean these up in the future is costly and difficult. Indeed, the damage done to the environment before the installation of equipment necessary to correct a situation may be impossible to rectify. It is burdensome to assess the economic losses incurred because of delayed pollution control; however, these are real economic considerations. Losses of health, happiness and productivity of people owing to environmental pollution are the greatest costs of all.

Long-term economic effects of industrial pollution must not be neglected. If an industry is allowed to develop without pollution control facilities, eventually the

Table 12. Significance of health hazards from biomass fuels conversion

Health hazard	Status (state of knowledge)	Likelihood of a finding adverse to technology development[a]
Emissions from biomass combustion		
The impact of burning biomass is similar to, but less severe than, burning coal. The primary air pollutants are particulates and unburned hydrocarbons. Sulphur oxides are lower than for fossil fuels. High fugitive dust levels can be formed from constant turnover of storage piles.	The emissions of large-scale wood-fired boilers have been measured, and the necessary control technology has been developed for present standards. The potential hazards of storage pile contaminants are not known.	Medium for large-scale wood-fired boilers. The effectiveness of existing particulate control technologies for large wood-fired boilers is in question.
Residuals from biomass gasification		
Air pollutants may originate from a process stack, waste ponds, storage tanks, equipment leaks, and storage piles. Pollutants of concern include oxides of nitrogen, hydrogen cyanide, hydrocarbons, ammonia, carbon monoxide, and particulates. Many of the same pollutants will also be found in process water and condensates.	The pyrolysis produces potentially toxic gases and oil that may be hazardous to health and safety and to ecological communities. Research is needed to quantify the impact of gasification operations for different feedstocks and various operating conditions.	Medium. Controls could be adopted from the petroleum refining industry, which handles similar types of chemicals and pollutants.
Residuals from biomass liquefaction		
Liquefaction produces gaseous emissions similar to those from gasification. The tars produced by the thermochemical decomposition of organic substances pose a special concern. They are expected to contain polycyclic aromatics, some of which are known carcinogens.	Liquefaction produces potentially toxic gases and oil that may be hazardous to health and safety and to ecological communities. Environmental significance of gases and oil from liquefaction has not been analysed.	Medium. Controls could be adopted from the petroleum refining industry, which handles the same types of chemicals and pollutants.

Health hazard	*Status (state of knowledge)*	*Likelihood of a finding adverse to technology development*[a]
Air and water pollution from anaerobic digestion		
Odour, hydrogen sulphide, and ammonia gases are the primary contaminants affecting air quality. The effluent contains large quantities of biochemically oxygen-demanding materials, organic acids, and mineral salts.	Ongoing research will enable qualification of control costs.	Low. Anaerobic digestion provides the environmental benefit of reducing the problem of disposal of feed-lot manures.
Water pollution from fermentation processes		
The key concern is the potential degradation of water quality. The stillage contains large quantities of biochemically oxygen-demanding materials and mineral salts.	Fermentation residue from protein-rich feedstocks has proven suitable for livestock refeeding. The stillage from carbohydrate-rich feedstocks is difficult to dispose of due to high biochemical oxygen demand and alkali salt concentration.	Low. Increased treatment requirements are possible.

Source: Based on Department of Energy, *Environmental Readiness Document: Biomass Energy Systems*, DOE/ERD-0021 (Springfield, Virginia, National Technical Information Service, 1979).

[a] Low = 0.1 to 0.3 probability of occurrence; medium = 0.4 to 0.6 probability of occurrence; high = 0.7 to 0.9 probability of occurrence.

locality may deteriorate to an unacceptable level. Relocation of the population depletes the tax base resulting in further deterioration of the local living standards. With an added tax burden the community is forced to extract more support from the industry, resulting in higher product costs. Environmental pollution also influences maintenance costs for homes, public buildings and thoroughfares, as well as the industrial buildings and equipment themselves.

Pollution control is a good business practice which a country cannot afford to neglect. Maintenance of the environment is much the same as maintenance of machinery, automobiles, and other devices. If a country does not maintain the environment, it will deteriorate. Deterioration may cost the people and the government more than the industry produces. A country must not sacrifice its customs and desirable environment to short-term economic advantage.

UNIDO environmental activities

The Lima Declaration and Plan of Action called for a considerable increase in the share of global industrial production for developing countries, but it also emphasized the need to mobilize human and material resources to cope with threats to the environment. [51] The Third General Conference of UNIDO at New Delhi stressed the need for further development of activities related to industry and environment. [54]

UNIDO's environmental activities concentrate on the implementation of environmental projects dealing directly and indirectly with the development of control systems for the reduction and abatement of water, air and solid wastes. Emphasis is also placed on the development of low- and non-waste technology and re-utilization and recycling of wastes produced by chemical, refinery, petrochemical, fertilizer, pulp and paper, metallurgical as well as agro-industries. The development of an anti-desertification strategy is being pursued along with environmental training assistance.

Co-operation between UNIDO and UNEP began in 1973. Since that time joint training programmes and studies of environmental considerations in the leather producing, iron and steel, rubber, sugar, petrochemical, textiles and other industries have been made. In 1976 a Memorandum of Understanding on Co-operation between UNIDO and UNEP was signed by both parties. The agreement has become a valuable basis for further development of co-operation and collaboration between UNIDO and UNEP. To increase activity in this field, a Joint UNIDO/UNEP Committee on Co-operation has been established.

At present, UNIDO is co-operating with UNEP in the areas of chemical industries, bauxite and aluminium industries, the iron and steel industry and the pulp and paper industry, and in the implementation of an anti-desertification strategy. UNIDO is co-operating with UNEP in implementing the Regional Seas Programme, which is assessing sources, levels, effects and trends of marine pollution and conducting regional survey studies on industrial pollution control.

UNIDO has conducted numerous environmental projects independently and in co-operation with the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), United Nations Educational, Scientific and Cultural Organization (UNESCO) and other entities in the United Nations system of organizations. UNEP has co-operated with UNIDO and the above agencies in the planning of environmental projects through the activities of the Thematic Joint Programming Meetings. Meetings have been held to discuss programmes on industry and environment, technology and environment, and the working environment. UNIDO will continue to participate in these planning sessions and will endeavour to assist in the implementation of the planned activities.

A UNIDO Technical Environment Programme was recently prepared to show the types of environmental activities UNIDO is capable of undertaking at the request of governments. A description of the programme has been sent to UNIDO's Senior Industrial Development Field Advisers, and the UNDP Resident Representatives with a request to forward the information to interested government authorities.

To supplement the limited funds available for environmental activities, UNIDO has invited developed countries to participate financially in environmental projects. Certain project proposals are under consideration by the Governments of Austria, France, Japan and Sweden.

The scope of UNIDO projects has ranged from individual sectoral assessments to evaluations of environmental impact of industrial development in nations and entire regions of the world. UNIDO has been involved in environmental projects resulting in over 150 reports describing activities in 10 major geographical regions of the world. Over 50 global projects have been completed with an emphasis in over 20 industrial sectors. To aid in the interpretation of the projects completed by UNIDO and co-operating agencies, a discussion will be presented in two categories: geographical area and country studies, and global studies. If the emphasis of the study was directed towards a problem in a particular region of the world or a specific country, the study is listed in the geographical area and country studies section. If the information is of a general nature and applicable to all countries or regions, the description is included in the global studies section.

The following project descriptions are not intended to be a complete compendium of UNIDO environmental activities, but are intended to illustrate the diversity of activities in which UNIDO becomes involved. Emphasis has also been placed on activities that have been conducted since the 1972 Stockholm Conference.

Geographical area and country studies

UNIDO studies have concentrated on problems, or potential problems, in individual countries and entire regions of the world. Rather than attempt to classify all projects into general regions of the world, studies are discussed in the following paragraphs by region or country depending upon the area of concentration in the individual studies.

Africa

At a United Nations-sponsored International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas (Abidjan, 2–9 May 1978), industrial waste was identified as a major source of marine pollution in the region. The report of the meeting (Report of the Workshop, pages 8 and 9) noted that:

> Rapidly increasing industrial development of the region, particularly in the coastal zone and along the major rivers, is likely to lead to an increase in the volume and diversity of industrial wastes discharged without adequate treatment into the marine environment. Detrimental effects of these discharges have been observed in many places, and yet practically no records exist on the amount discharged, on the concentration of these

pollutants in the marine environment or on their effects on marine life and human health ... Considering that the living marine resources, which are easily damaged by these types of pollutants, constitute an important source of revenue and food for the population of the region, a pilot project to assess the magnitude of the problem caused by discharges of industrial and agricultural waste into the marine environment is recommended.

The meeting recommended that a detailed survey of land-based sources of industrial and agricultural pollutants be carried out as a first step towards the objective of establishing regionally applicable standards for the management and control of industrial and agricultural pollutants. UNIDO was then asked to carry out the industrial survey under the UNEP Regional Seas Programme. [26]

The object of the project was to provide the West African region with information on the type and quantity of industrial pollutants from major land-based sources entering the marine environment through direct coastal discharges or indirectly from rivers, as well as on the present status of industrial waste management (treatment and disposal) practices.

Most of the data utilized in this report were collected by six UNIDO experts who visited the 18 countries of the West African region during the period January–August 1980. [35–47, 61–64] Industrial operations were visited and information was collected from the various ministries involved with industrial development and environmental protection. Estimates of the mass of pollutants discharged to the ocean were based upon production rates used in conjunction with actual measurements made by the industries located in the countries visited; studies reported in the literature; and an extrapolation of the United States Environmental Protection Agency Effluent Standards for various industrial sectors.

The West African region was divided into five zones closely approximating the major currents of the Atlantic Ocean (Zone I, from Cape Blanc to Cape Verga; Zone II, from Cape Verga to Cape Palmas; Zone III, from Cape Palmas to Cotonou; Zone IV, from Cotonou to Cape Lopez; and Zone V, from Cape Lopez to Cape Frio). The estimated pollution discharged by industry was calculated for each of the zones by adding the contribution from each country assigned to a zone.

A comparison of the pollution loads for the five zones shows that Zone IV received the discharge of far more pollution than any of the other four zones. Of the total pollution discharged to the ocean from the 18 countries of the region, it was estimated that 43 per cent of the biological oxygen demand (BOD), 36 per cent of the suspended solids (SS), 83 per cent of the oil and grease, and 60 per cent of the chemical oxygen demand (COD), were discharged from Zone IV. Zones I and III contributed almost equally to the greater part of the remaining pollution load except for suspended solids, where Zone III contributed 38 per cent of the total. This large percentage of suspended solids was principally attributable to phosphate mining operations. Zones II and V discharged only a minor proportion of the pollution to the ocean in the region.

During the visits to the West African region (1980), pollution discharges from the industries were found to create little impact on the environment except in isolated cases. Waste treatment in the countries of the West African region was essentially non-existent. Only an occasional sedimentation basin, grease trap or intermittent sand filter was observed by the consultants as they visited industries in the 18 countries of the region. A significant change in the impact on the environment is likely to occur in the future because of the concerted efforts being made towards expanding industry in the region. Many large industries were planned in the coastal area of the West African region. Because of the extensive natural resources in the region, it is very likely that rapid development will occur in most countries of the region. The lack of a significant pollution problem in most countries of the region allows government and industry to begin a planning process that will allow them to avoid creating an environmental problem. The immediate needs in most areas were solutions to the human pollution problems. It was strongly recommended that planning begin and a long-range plan be implemented to avoid the creation of industrial pollution problems. Where localized pollution problems exist, the problems will be compounded as new development occurs unless development is co-ordinated with an environmental protection plan.

The study concluded that local universities and technical programmes should be encouraged to begin a long-range plan to produce the professionals and technicians required to protect the environment of the West African region. It is imperative that individuals become knowledgeable and begin to consider protection of the entire environment when expansion is considered. Adequate planning at this stage will ensure that the environment is not degraded beyond repair.

Bolivia

The upgrading of the technologies used by women potters in the Chochabamba Valley of Bolivia included the introduction of simple but effective technologies for raw material preparation, shaping, decorating and firing. The principal object of the project was to strengthen the position of women in the local culture. The project was designed to allow women to become involved in the more profitable aspects of pottery production.

By co-operating with the Voluntary Fund sponsored health training project and the Mothers' Club network, improvements were expected in health, education and environmental awareness. By substituting new non-poisonous glazes for the old lead-based glazes prepared from old car batteries, significant family health improvements should result, since the lead parts were frequently ground into powder in sleeping areas used by the children.

Future activities will involve modernizing the century-old technologies to technologies suited to the local culture. It is expected that as the benefits of this programme are observed by other communities, they will wish to emulate the effort.

Brazil

During May 1974, a team of two UNIDO experts studied the environmental impact of an integrated iron and steel plant (coke oven, blast furnace, open hearths and rolling mills) in Volta Redonda, Brazil (population 180,000). The plant had a rated annual capacity of 1.5 million short tons but was producing at 1.7 million short tons in 1974. About 18,000 people were employed in the plant.

The plant is located in a valley, and the township of Volta Redonda is spread over this valley and on the hillsides. The plant did not utilize any air pollution control equipment. Also there was overfiring at the boilers in the thermal power plants. Heavy smoke and brown fumes were emitted during smelting and from the power plant. The iron oxide fumes produced during the oxygen injection caused about 90 per cent of particulate emissions. About 8 to 12 short tons of SO_2 per day were emitted into the atmosphere. For example, the coke ovens were charged using cars of old design. As coal entered the hot ovens, copious brown fumes belched out of the charging holes into the atmosphere.

Prevailing winds are from the south-east and cause the bulk of the air pollution to drift over a zone to the north-west of the plant. About 3,500 people of low income live in the zone, and these people complained about the bad smell of the gases and soiling of clothes and buildings from soot and brown dust. When the direction of the wind changed, as happens frequently during the six-month rainy season, air pollutants were distributed over the entire city and caused a general nuisance. No air pollution monitoring data were available.

Another major air pollution problem occurred in the working environment inside the steel plant. The arc furnaces and cupola had no air pollution control facilities; for example, the most serious internal air pollution occurs in the production of castings during a process of shake-out in which the sand is shaken loose from the castings. This was done in an open space and the dust collector was inadequate to collect the fine, very dry SiO_2 particles. As a result, an average of seven employees working at the shake-out were absent each year from 3 to 12 months because of the lung disease silicosis.

There were limited facilities for treatment of waste water at the plant. The discharges into the River Paraiba (average flow of 300 m^3/sec) have reportedly killed all fish life at distances up to 50 km downstream from the plant. The water pollutants are produced at the blast furnace, coke ovens, and rolling and finishing mills. Toxic effluents include ammonia spent liquor, sulphuric- and hydrochloric-acid-containing effluents from galvanizing and pickling, water containing oils from the rolling mills and from blast-furnace gas-cleaning. The most toxic effluent is the ammonia spent liquor which includes about 1,000 mg/l phenols, 50 mg/l cyanide and 2,000 mg/l free ammonia. An estimated 400–500 m^3/day were discharged into the river without treatment. The blast-furnace gas-cleaning results in a discharge into the river of about 60 short tons of suspended solids plus cyanide.

The major pollution abatement process at the plant was the recovery of 340 short tons of $FeSO_4$ per month from depleted pickling solution.

The plant produced about 12,000 short tons per month of solid wastes. Much of this was either stockpiled for future resource recovery or used as fill for levelling low-lying areas around the plant. However, the plant granulates blast-furnace slag for sale to a nearby cement plant and recovers iron scrap from blast-furnace scrap and slag.

An expansion of plant capacity from 2.5 million to 4.6 million short tons per year is under way. Investments in pollution control equipment total $61.5 million which represent about 4 per cent of the total capital investment of the expansion. Nineteen million dollars will be spent on air pollution control, $11.4 million will be spent on water pollution control, and $4.2 million will be spent on noise control. The pollution control equipment will also be used to reduce pollution from the existing plant. The charging cars to the coke oven are now equipped with gas collection and burning equipment. This was previously one of the biggest sources of air pollution. In the existing plant, cyclones, scrubbers and filters have also been installed in various operations to reduce air pollution. For example, the efficiency of multicyclones in the sintering plant is 95 per cent.

A number of water reuse practices have been incorporated in various plant processes. Waste water from the coke plant is treated in settling basins. A biological treatment plant is planned for the plant expansion. There is an ammonia still for the waste waters from the blast furnace. The sludge resulting from treatment in a scrubber of the off-gas from the blast furnace is removed. Scarfing from the hot rolling mills is also separated in a settling basin and the water is recirculated. Detergents, sulphuric acids and oils are recovered from waste water from cold-rolling mills. The water is then recirculated.

Once the plant expansion is completed, a total of 31 m^3/sec of water will be in circulation whereas the withdrawal from the river for plant operations will be only 11 m^3/sec. The total consumption of water will thus total 42 m^3/sec, and the percentage of recirculation will be 73.7. After the expansion the plant will require 285 m^3 water per tonne of finished steel, whereas the net consumption will be 75 m^3 per tonne. Previously the net water consumption was 154 m^3 per tonne.

Although a complete analysis of the situation in 1981 compared to 1974 is not available, it is obvious that the company has incorporated a number of environmental measures into the operations of the works during the seven-year period and plans to include even more air, water and noise control measures in the planned facilities.

The planned extent of water recycling of about 74 per cent can be compared with similar percentages of 60 per cent, 80 per cent and slightly less than 100 per cent at three integrated iron and steel works in the United States.

Caribbean area

A UNEP-sponsored overview on energy and environment in the Caribbean area was prepared in 1979 as a preparatory contribution to the formulation of a strategy suited to the problems facing the countries of the region in the energy and environment sectors. [56] The Caribbean area was taken to include 34 countries grouped in six subregions. The energy resources are unevenly distributed throughout the area and, consequently, prospects of the countries vary. The gulf coast of the United States is atypical for the Caribbean energy scenario because of the high level of present industrial development. The other countries have at least one common feature in that all are developing countries, albeit at different levels. Most of their potentials remain to be developed, above all in the energy sector. Some common approaches were identified, mainly with respect to energy conservation and with respect to the organization of research into the development of alternative energies. These approaches offer a basis for common action.

Since the development of each country hinges upon the availability of energy, different rates of development can already be envisaged. It is conceivable that, independent of the present rate of development, the problems faced by countries rich in energy will be different from those faced by the others. The first set of problems will be mainly related to the exploitation and management of resources, the second set will be concerned with energy supply.

In general, energy production has gradually decreased in the wider Caribbean region over the past decade while energy consumption has gradually risen. The energy consumption was 213 million short tons of coal equivalent (t.c.e.) in 1978 and is expected to reach 270-300 million t.c.e. by 1985 if present trends continue. To meet the energy needs of the region the first priority suggested is further development of hydropower, which could represent an additional energy equivalent of about 35 million t.c.e. Energy conservation and development of other new and renewable sources of energy (NRSE) such as production of alcohol and methane from agricultural wastes and solar and wind energy utilization are other recommended courses of action at regional, subregional and national levels. An annex to the study contains a summary of technical assistance projects on NRSE under way in the region.

Cyprus environmental contamination caused by industrial and some municipal-related operations was examined during a two-month period in May and June of 1974 by a UNIDO consultant requested by the Ministry of Commerce and Industry and the Council of Ministers. Typical air, water and land contaminants were found to exist in this rapidly developing country. The air contaminants were largely dust and smoke; the water contaminants were various untreated industrial plant and boat waste waters and raw municipal sewages; the lands were being damaged by improper refuse disposal practices and poor mining and quarrying operations. Seven significant categories of environmental problems which directly or indirectly involve industrial operations are:

Sea harbour pollution
Burning of refuse
Scarcity of industrial water
Lack of knowledge about industrial wastes
Lack of adequate administrative laws and organization for environmental protection
Several industrial estate waste-water disposal situations
Several separate industrial plant waste-water treatment of air contamination situations

The consultant gave specific advice in personal interviews, conferences, plant visitations and written material towards the solution of these problems. The consultant recommended that the following overall actions be undertaken to cope with the seven environmental problems:

(a) Intercept, treat and preferably reuse all sea-shoreline domestic, commercial and industrial waste waters;

(b) Enact and enforce substantive sea and harbour regulations with appropriate fees and fines for discouraging and prohibiting sea or harbour contamination of shoreline waters;

(c) Cease burning and commence burying all solid wastes in refined, modern-designed and operated, regional sanitary landfills;

(d) Begin studies leading to the proper selection of industries, conservation practices, treatment and reuse of industrial estate waste waters;

(e) Investigate an immediate technical education programme of a suitable number of government personnel in the industrial environmental engineering area;

(f) Establish a nucleus of environmentalists in the governmental service with basic knowledge and capabilities in the control and prevention of air, water and land pollution, housed in a separate agency and responsible directly to the Council of Ministers;

(g) Prepare an environmental protection law which clearly delineates the environment to be protected and its best usage, as well as the quality level of various contaminants allowed in the air, water and land environments;

(h) Design and construct, after adequate preliminary studies, industrial estate waste-water treatment plants to produce water either for direct reuse in the factories of the estate or for discharge into municipal sewage systems.

Careful preselection of industries for the estates may optimize and enhance these solutions;

(i) Qualified consultants should be employed by vital Cyprus industries located outside industrial estates to study and design remedial systems for minimizing environmental consequences of production. These include, but are not necessarily limited to, canneries, tanneries, mining, quarrying and cement plants. Total environmental studies should be made of the effects of other industrial plant operations such as power plants and oil refineries;

(j) Terminate production in certain antiquated, poorly designed and operated, and erroneously located industrial plants such as certain slaughterhouses.

Democratic Yemen

In 1971 UNIDO conducted a feasibility study on the production of compost from the municipal wastes of Aden. The study was updated and modified by an evaluation mission in March 1975. It was recommended that a pilot plant be built and that the Government request the necessary capital from the United Nations Capital Development Fund (UNCDF). UNCDF allocated the sum of $87,000 for the equipment. In February 1978 UNIDO approved a project providing expert services for a period of four months.

The mission was divided into two parts of two months each. The first part of the mission was conducted in January and February 1979. The object was to assist the Government in the design of the pilot plant and to improve the garbage collection system so that an adequate and regular supply of raw material could be supplied to the compost plant.

The expert recommended that the proposed pilot plant evaluation be abandoned and full-scale composting facilities be developed in a four-phase programme. The proposed plant site, type of equipment and manpower requirements were discussed by the expert. Methods of improving garbage collection were also discussed.

Ghana

The Ghanaian Government requested UNEP to provide assistance in the improvement of rural water supply, prevention of food loss, promotion of cottage industries through rural electrification, and mass education on environmental protection. [59] A team composed of UNEP and UNIDO experts visited Ghana from 9 to 17 September 1981.

The UNIDO expert recommended the establishment of small hydropower plants near the rural communities to provide the energy for the development of cottage industries. Although Ghana has a very large hydropower dam, difficulties in transmitting and distributing the power have occurred. The use of localized power-generating systems will be more economical and reliable. Solar drying was also recommended as a means of preserving the seasonal surplus of fruits, tomatoes, and other vegetables. The advantages of mechanical solar drying were discussed. Baker's yeast was recommended as a product that could easily be produced from the molasses by-product of sugar production. Dried granulated yeast would be particularly attractive in an area with a shortage of refrigeration. Increases in sugar production appeared to be an excellent possibility in Ghana. Great potential exists for increases in sugar plantations, and with increased sugar cane production opportunities will develop for marketing, employment and higher incomes. The potential for an oil recycling industry in Ghana was great and offers many advantages. Recycling will protect the environment and at the same time conserve a non-renewable resource.

The mission also provided information on methods of improving sanitary conditions and educating the population towards protecting the environment.

India

The chemical industry in India represents the fourth largest industrial sector. The fastest growing branches are petrochemicals, plastics, synthetic fibres, pharmaceuticals and fertilizers. The work in this environmental study consisted of surveys of 13 specific plants in the Bombay, New Delhi and Calcutta areas in June 1974.

The 13 chemical plants included inorganic and organic chemicals manufacturing, insecticides, polymers, and plastics production. Six of these plants incorporated some form of effluent treatment but in only one case was the treatment more than primary. Of the seven factories with substantial emissions of air pollutants, only three incorporated treatment by scrubber or cyclones. Five of the factories practised some form of resource recovery from waste streams for recycling, such as separation and reuse of waste oils and regeneration of spent acid. Health problems were reported owing to poor in-plant working conditions at two of the chemical plants visited.

The following examples were chosen to give a representative sampling of environmental conditions at the 13 firms.

A brewery in the Bombay area does not treat its effluent but rather utilizes the sewage and industrial waste waters to irrigate and fertilize about 120 ha planted with wheat.

A nylon factory produced 2,000 short tons per year of Nylon-6. About 10 per cent of the nylon produced is waste. This is reprocessed into caprolactam and recycled, thus minimizing pollution. This plant represents a good example of the beneficial effects of industrialization. A small village in a poor rural area has been developed into a prosperous little town with a health centre and cultural facilities.

A chemical works at Najafgarh (Bombay) includes a chlor-alkali electrolysis plant, a bleaching powder plant, sulphuric acid and hydrochloric acid plants, a fertilizer (superphosphate) plant, and a fat-hardening plant. The chlor-alkali plant used diaphragm cells which thus avoid the mercury pollution so frequently associated with mercury cells. The hydrogen produced was used in the manufacture of hydrochloric acid and for fat-hardening. Solid wastes were sun-dried and landfilled. The waste water contained about two grams of solids per litre and was discharged into the main sewer. A major environmental hazard with this plant was that the mechanism for filling chlorine cylinders had neither an alarm system nor an automatic shut-off valve to prevent overfilling. However, no incidents of chlorine poisoning have occurred since the factory began operations in 1949. In the case of the fertilizer plant, the major hazard appears to arise from the use of primitive hand-operated sieves which cause large clouds of dust. Material transport, on the other hand, used slow-moving belts and was practically dust-free at the discharge points.

In the New Delhi area an insecticides plant was visited. This is a Government-run enterprise and officials were concerned about pollution problems. The workers' representatives, however, were unaware of possible long-term health hazards from pollutants and were concerned instead that pollution-abatement measures might affect employment. This area of the country has traditionally suffered from unemployment. The insecticides plant produces DDT as a 50 per cent wettable powder and utilized cyclone separation and bag filter to prevent dust losses. The effluent from the process was highly acidic and contained a high DDT concentration. Prior to discharge the effluent was neutralized to a pH of 8–8.5 and the DDT was removed by a filtration system which included activated carbon. The treatment system was recommended by the National Environmental Engineering Research Institute. The spent sulphuric acid used in the DDT manufacture was recycled after regeneration.

Poor environmental practice was in evidence at a dyestuffs plant. This plant produced about 80 different dyestuffs and several intermediates, including aluminium chloride and sulphuric acid. Most of the batch equipment had vents to the open air. No information had been gathered regarding gaseous discharges from this equipment. The equipment for making aluminium chloride had a washing device to prevent escape of chlorine.

A total of 28,000 m^3/day of liquid effluent was being discharged. The only treatment was occasional neutralization of highly acid wastes. Within the factory, poor production techniques resulted in spillage of all kinds of liquids. Both the floors and equipment were left wet. Also the workers were constantly exposed to the products because equipment was loaded and unloaded by hand. About 300 to 400 workers suffer annually from dermatitis caused by contact with the chemicals. The total work force is 1,800.

Indonesia

Recycling organic wastes to improve sanitary conditions and promote energy production from biomass has received high priority in Indonesia. The Government of Indonesia participates in an FAO regional project to improve soil fertility through organic recycling. The project is mainly concerned with on-farm recycling techniques. The Government considers composting of urban solid wastes for use as fertilizers an important activity and requested that UNIDO provide expert assistance to improve and further develop the national composting programme in Indonesia.

An assessment and evaluation of cash and benefits of a national composting programme were made. As part of the assessment, a survey of the collection and disposal of household refuse in Indonesia was conducted, and the characteristics of the wastes were determined. Recommendations for the design and cost estimates for composting facilities were presented along with maintenance and repair procedures, training needs, and marketing procedures.

Iran

The study of the environmental effects of the cement industry in Iran consisted of a general survey of pollution problems encountered in the manufacture of cement and the results of case studies of six Iranian cement works.

Cement manufacture begins with limestone and clay-like raw materials which are dust-initiating in nature; the cement itself is a fine powder. A dust problem is, therefore, present at nearly every stage of manufacturing in both the wet and dry processes.

In the wet process, water is added during the grinding of raw materials. The homogenized slurry is then kiln dried. Less dust is produced in this process, but the process is very energy consuming in the stage of water evaporation (total energy consumption of 1,200-1,500 kcal/kg of product).

In the dry process, the raw materials are ground to a powder in the absence of water. Dry-process techniques have recently advanced considerably in the blending and homogenization of the raw mix. Here the energy consumption is only 730 kcal/kg of product.

Best control measures for dust depend on the stage of operation and include cyclones, bag filters and electrostatic precipitators.

The six case studies of cement works were chosen to represent the full range of environmental impact. One cement works (Plant 1), for example, operates with minimum pollution levels because the best practicable pollution control technology was skilfully employed. At the other extreme, another cement works (Plant 2) operated with very high dust levels. Furthermore, recent advances in pollution control technology were not well known or understood so that future developments were viewed from an old-fashioned technological standpoint.

Plant 1 was a new plant. One evidence of the lack of pollution emission was the abundance of fertile terrain in the plant vicinity. This plant operated with the most up-to-date dry-process technology. Energy consumption at this plant was 800 kcal/kg of product. The daily capacity of the works was 3,500 short tons. Both the kiln and the two cement-grinding mills were equipped with electrostatic precipitators. The flue gases of the kiln were also monitored for pollution control. The efficiency of the electrostatic precipitator on the kiln was said to be 99.97 per cent. This project was developed by Iranian engineers, starting with raw materials prospecting and continuing through engineering design and evaluation of quotations from the equipment companies. The equipment from various manufacturers had been well co-ordinated in the production lines.

The initiatives taken at Plant 1 to improve the environment included the planting of fruit trees and crops such as wheat and barley. These have created more liveable surroundings for the workers and have stimulated the growth of the newly founded village.

Plant 2 is a Government-owned plant established in 1959. There was a single production line with an annual capacity of 100,000 short tons of Portland cement. This is a dry-process plant with an energy consumption of 950 kcal/kg of product. The dust loss was at least 5 short tons/day through a 45-metre chimney. The dust arrestment equipment consisted of five kiln cyclones and six inadequately maintained cloth bag filters. Plant personnel had the erroneous impression that no suitable electrofilter was available for the works and that the use of electrofilters caused explosion risks. Thus, expansion projects do not include plans for utilization of an electrofilter.

Israel

At the request of the Government of Israel, UNIDO sent an expert in 1976 to discuss the use of earth minerals in waste-water treatment. In Israel large deposits of bentonite and kaolite exist in the Ramon Crater and deposits of porcellanite exist in the Zin Valley. Utilization of these earth materials is limited because of the poor quality. Treatment of these materials by activation and the development of new uses could result in an export and local market.

Clay minerals are used extensively in industry, agriculture, medicine and engineering. The adsorptive, ion exchange, adhesive, expansive, resistance to high temperature and special rheological properties of clay minerals made these materials very versatile and result in wide application.

In 1974–1975 an earth materials unit was formed within the market research and commercial development department of a government chemical enterprise with the intention of initiating commercial and technical development of local earth minerals. Development of materials for export was one of the principal objectives of the programme. Both bentonite and porcellanite are by-products of other operations, and because of the low quality the by-products are not marketable in the natural state. Treatment of these by-products could produce a product useful to industry and agriculture. Development of new uses would also enhance the marketability of the materials.

The major objective of this project was to assist in the development and evaluation of waste-water treatment procedures using bentonite and porcellanite. Coagulants and coagulant aids normally used in water and waste-water treatment such as alum, ferric compounds and polyelectrolytes are expensive, and it is possible that the utilization of clay minerals as coagulants can be substituted for the conventional materials. Costs for clay minerals are approximately an order of magnitude less than the charges for alum, ferric compounds and polyelectrolytes. Expenditures to activate or treat poor quality clay minerals so that an acceptable product can be produced appears to be feasible where clay minerals are applicable to waste-water treatment.

The shortage of farm land in Israel makes it attractive to convert sand dunes to agricultural lands. Sludges produced in waste-water treatment with clay minerals would be ideal as a soil conditioner, and this application would eliminate the main objection to the application of clay minerals to waste-water treatment. Porcellanite has potential as a filter medium in water and waste-water treatment operations.

A detailed literature review on the use of clay in the treatment of waste water was conducted prior to presenting a seminar on the use of clay minerals in the treatment of waste waters to the personnel of the chemical enterprise, Hebrew University, and the Volcani Center. The history and future application of clay minerals to waste-water treatment were discussed.

Potential markets for the clay minerals and needed research and evaluation were discussed with university, research institute, and the chemical enterprise personnel. Activation of the raw materials to improve the properties needed in waste-water treatment were considered. The written literature review was completed and made available to the chemical enterprise.

Kuwait

Large industrial plants presently operating in Kuwait, such as the petroleum plant, fertilizer plant or petrochemical industries plant, cause air and water pollution problems.

The industrial complex authority hoped to increase industrialization and was studying industries suitable for the area. The most important of these were a steel mill, a gas utilization project, a second refinery and an ethylene/polyethylene plant.

Existing air and water pollution data showed that the measured concentrations of pollutants were high enough to cause problems. Before attempts can be made to improve the existing situation, it is necessary to collect basic information about the waste gas emissions and waste-water discharges. Meaningful information could be obtained only by establishing an air and water pollution monitoring system.

Following the collection of the basic data, the next step would be to design and put into operation air and water pollution control systems. Before constructing other industries in the area, pollution studies were encouraged during the preliminary stage of design of future industries.

Mediterranean Sea

As part of the UNEP Regional Seas Programme, a study of the pollutants from land-based sources entering the Mediterranean Sea was conducted by UNIDO. [57] The Mediterranean Sea was an ideal place to begin the Regional Seas Programme of UNEP, since the sea is subject to pollution of every variety. The Mediterranean has been studied and is relatively well known and it has great importance because of the dependence of millions of the coastal inhabitants on the sea resources. In 1977, 830,000 t of fish worth $1.3 billion were caught in the Mediterranean. More than 100 million tourists migrate to the coast each year, to join the 100 million people inhabiting the coastal zone.

The Mediterranean Sea receives the waste waters from at least 18 countries. Each of these countries has different philosophies relating to pollution control, and consequently a wide range of pollution monitoring data availability. Production and pollution control data in the various countries varied from none to complete production information.

UNIDO consultants visited the countries bordering the Mediterranean on the south and east and collected all available data. Consultants from the ECE calculated pollution loadings for the other countries. These data were then compiled and used to project the pollution loading being received by the Mediterranean Sea.

The main pollution problems of the Mediterranean coastal areas are caused by a general lack of adequate treatment or disposal of domestic sewage and industrial wastes, the use of pesticides in agriculture and oil pollution from accidental and operational discharges. Those factors contribute to a general pollution load of toxic chemicals in sediments and biota, and overload of nutrients in certain areas with a resulting increase in BOD, and occurrence of pathogenic organisms in waters and shellfish. The state of the open waters is not yet critical, but many coastal zones are considered badly polluted.

Morocco

To solve the increasingly serious problem of municipal garbage disposal, the Moroccan Government established compost plants for the cities. Between 1962 and 1973, plants were installed at Rabat, Marrakesh and Tetouan, and construction was started on two others at Meknes and Casablanca. The total investment was over $7 million.

By 1973 the plants were not working, principally because of managerial problems which were the result of inexperience and inadequate planning. Towards the end of 1973, realizing the seriousness of the problem and the need for new measures, the Moroccan Government requested UNIDO to provide an expert to assist them in rehabilitating the compost plants and to lay the foundations for a national composting programme.

To achieve these objectives the UNIDO expert began restoring the Rabat plant with the intention of using it as an on-the-job training school for personnel from other plants in the country. Inventories were made for spare parts and supplies, experiments carried out to determine the optimum conditions for composting the Rabat garbage which differed significantly in composition from the wastes of industrialized countries, and administrative bottle-necks removed regarding the adequate and timely provision of operating funds for the compost plant. One recurrent problem was the lengthy procedure and delays in financial sanction for the procurement of supplies and repair services by the municipality to whom the compost plant belonged.

Within the first year of assistance by the UNIDO expert, the Rabat plant was fully rehabilitated, producing 90 t of compost from 160 t of refuse per day. The plant was later expanded to treat 300 t per day of refuse from the entire city of Rabat and a neighbouring town. All the compost produced was sold without any difficulty to market gardeners in the region. Experimental data on varying dosages of compost and crop responses were collected. A training programme for local personnel was implemented at the Rabat plant with the intention of making the operation efficient and self-reliant.

In planning and operating compost plants, the management aspects are at least as important as the technical considerations. Unless carefully planned to reduce capital and operating expenditures and to overcome the many problems of infrastructure, organization and marketing, compost plants will not become viable ventures in developing countries. Before embarking on a huge capital expenditure for a full-scale plant, developing countries should establish pilot-scale facilities to determine the necessary process adaptations. These adaptations may range from labour-intensive methods to mechanical systems, market development, and local fabrication of compost plant machinery. This development work will also ensure that the wastes are processed according to established methods and standards so that the product is environmentally safe, hygienic, and beneficial for land application. The results of this development work should be used in a national programme for waste management and organic recycling, involving standardized plants largely of local fabrication.

Sierra Leone

According to an estimate from the World Health Organization (WHO), 7,000 short tons of household wastes are produced annually in the greater Freetown area. Garbage collection in Freetown deteriorated, and more than 30,000 short tons of waste materials have accumulated on the streets. Rodents and flies have proliferated and parasitic diseases are rife. Since 1977, two cholera outbreaks have taken place in Freetown with a significant death toll.

The Government obtained assistance for refuse collection trucks, and wished to organize garbage collection and processing of compost for the dual purpose of improving public sanitation and returning organic material to the soil to improve its fertility. Compost is a good organic complement to chemical fertilizers, which the country has to import at a substantial cost.

The Government requested the technical assistance of UNIDO to evaluate the feasibility of a pilot plant for the manufacture of compost. The purpose of the mission was to assess the technical and economic feasibility of establishing a pilot plant, or the smallest technically and economically operative plant, for the production of compost from the municipal garbage of Freetown.

Thailand

A study of the textile industry in Thailand was undertaken in 1974 as one of a series of case studies under the UNIDO/UNEP co-operative programme.

Three textile mills were selected for study. At Factory I where no dyeing was carried out, studies were confined to effects on plant personnel. At Factory II where neither spinning nor weaving was performed, the study was based exclusively on the external pollution caused by the plant. Factory III was selected for a complete investigation because the plant performs spinning and weaving (greatest potential for damage to the workers' health) and also dyeing (greatest potential for environmental damage). Some studies were also conducted in a fourth factory. A major health problem in the textile industry is noise. Government data on 33 factories indicated that noise greater than 90 decibels occurred in both spinning and weaving operations.

In Factory III a total of 137 workers in a work force of 1,601 (8.6 per cent) received clinical treatment for respiratory ailments in April 1964. Smaller numbers reported dermatitis (61) and auditory problems (24).

The team concluded that approximately 50 per cent of the workers exposed to those factory environments would be likely to suffer respiratory damage, and another 15 per cent would likely suffer hearing damage. The costs of prevention were calculated to be about 20 per cent of the cost of lost wages and productivity.

In the matter of water pollution, the small canals, called klongs, are of great importance to the well-being of the people. Fish consumption in Thailand is about three times that in the United States and most fish are caught in fresh water. Thus, industrial pollution of the klongs has serious implications.

Two factories were selected for study of water pollution effects. One (Factory II) had primary and secondary treatments which reduced the BOD and SS to below 20 and 30 mg/l, respectively. The other factory (Factory III) had only primary treatment (alum dosing and sedimentation) which was insufficient to avoid pollution of the receiving waters.

In the case of Factory II, the catch of fish in the klong had remained about the same as before the factory was built. In the case of Factory III, the klong downstream from the plant was black and turbid and the villages have complained in the newspaper that Factory III has seriously degraded the klong. Before the implantation of the factory, one hundred families had engaged in fish farming with ponds filled with klong water. Afterwards all families have apparently ceased production and all fishing in the klong has been eliminated.

There are four alternative approaches to the problem of wastes from the textile industry:

No treatment
Conventional primary, secondary and tertiary treatment
Maximum reutilization of water and chemicals
Selection of different process chemicals

Only the first two have been considered as alternatives in Thailand.

A large section of this report deals with technology transfer. Japan was by far the largest foreign investor, holding over 80 per cent of the total foreign capital. The dominant motive was developing and maintaining overseas markets. The overwhelming majority of technology transfers occurred through joint ventures. Transfers were usually in the form of knowledge. The level of product and process technology transferred was relatively low. Factory III has especially benefited from technology transfer. The company was started in the mid-1960s and carried out both weaving and dyeing processes. The firm was successful and able to meet the high quality demands of the European market. All machinery was Japanese. Top and middle management in the firm was almost exclusively Japanese in the beginning and remains dominated by the Japanese.

The problem of pollution as related to technology transfer was recognized in all the factories visited. However, very little attention was given to local conditions when solutions were sought, and often solutions were not pursued until outside pressure was applied (usually complaints). Several companies sought help from a Japanese water-treatment firm with offices in Bangkok. This firm appeared not to have considered local conditions in deciding on treatment methods.

In the case of Factory III an approximate cost of water pollution was calculated for an average family living on the klong. A net economic loss of about $130 per family per year was estimated. If these losses were added to factory running costs, then the internal rate of return for Factory III would be reduced from 25 per cent to about 20 per cent.

Factories II and III exceeded the average profits of all firms in Thailand by a considerable margin. This indicated that at least these two factories could adopt more effective environmental programmes without much effect on the level and composition of investment.

The conclusion was that the net impact on society of the textile plants was not as beneficial as the effect reflected in the company accounts. There were obvious effects of pollution which have not been taken into account. The long-range effects of the pollution of the Thai textile industry must be recognized.

Turkey

Chemical industry survey

As part of the co-operative effort between UNIDO and UNEP, a study of environmental effects of the chemical industry in Turkey was concentrated on factories in the Izmit and Bandirma areas. Both areas are highly industrialized. In general, the management personnel of the factories were not aware of the negative effects that the various effluents had on the environment.

Seven chemical plants were visited as part of this study, including manufacturers of inorganic chemicals and a pulp and paper mill. Water pollution problems existed at all seven plants. In no cases were any waste-water treatment facilities present. In two plants heavy discharges of mercury were observed. Discharges of air pollutants presented problems at three plants. Five plants had equipment for air pollution abatement including bag filters, cyclones, wet scrubbers, and electrostatic precipitators. Poor factory working conditions resulted in health problems at two plants.

Izmit Bay was found to be seriously polluted by effluents from local industry, especially a pulp and paper mill. In Bandirma, atmospheric pollution by heavy industry may be the cause of reduced crop yields in the area.

Within the Izmit area, the chemicals industries were second in importance in all manufacturing. This industry occurs mostly along one bank of Izmit Bay and its effluents are discharged into the Bay. The major polluter of the Bay was a pulp and paper mill. The discharged wastes were of high strength and acidity (biochemical oxygen demand of 4,600 mg/l, pH of 2.4). However, this plant will be closed in five years and a new plant on the south coast of Turkey will replace it. The new plant will include a biological waste treatment plant.

Another heavily polluting factory in the Izmit area was a chemical plant. The plant produces chlorine, caustic soda, DDT, benzene hexachloride, hydrochloric acid, sodium hypochloride and sulphuric acid. Major pollution occurs from the mercury cells in the chlor-alkali plant. Losses are 120 g of mercury per short ton of caustic produced. This amounts to one short ton of mercury discharged per year. The effluent discharge is into Izmit Bay. The laboratory is well staffed and equipped to analyse mercury concentrations but these facilities are rarely used and personnel show no interest in the mercury concentrations of discharges or products. In addition, about 350 kg of SO_2 are emitted daily from a stack only 18 m high. This occurs in the sulphuric acid production unit. The DDT production was designed with a spent-acid recovery unit. However, this unit has never functioned properly, and the spent acid containing chlorinated products was discharged into the Bay. This was a serious source of pollution. In contrast, the benzene hexachloride unit was of modern design and functioned without hazard to the workmen or the environment. The reaction vessel was well sealed and there was no exposure to the ultraviolet light. Work was remote-controlled from outside. Unreacted benzene was evaporated and recycled.

In summary, there were instances of bad environmental practice observed at most of the industries visited. Several instances of mercury discharge occurred with no monitoring or attempts at control. There were, however, a number of individual cases of modern, well-designed reaction vessels for particular products that were operating without causing environmental degradation.

Remedial measures were often suggested in the report. For example, one plant used rapidly moving belts to transport the superphosphate, and heavy clouds of dust were produced at discharge points. The experts recommended the use of wide belts moving at low speeds equipped with cyclones and dust bags at the discharge points. Unfortunately, this plant discharged waste fluoride without treatment into Izmit Bay.

Fishing catch data obtained by the team in the Bandirma area indicated a relative constancy of catch over the period 1965–1973 even though a greater number of larger boats enable the commercial fishermen to travel farther out to fish in 1973 than in 1965. The experts suspect that pollution was the reason for the need to fish a greater area to obtain the same catch.

A number of crops in the Bandirma area have reduced yields per ha in 1972 compared to 1965. The experts concluded that the effects of pollution on crop yields were likely, but cannot be directly traced. However, pollution has been shown to contribute to the decreased yield of wild apricots in the Bandirma area.

There was a chemical industries group at the Government-financed Tübitak Institute. This group was concentrating on pesticides in food products and on environmental contamination by boron compounds. There were large spillages and effluent discharges containing boron in the Bandirma area. In the future, this group will also study the effects of the heavy losses and discharges of mercury by the Turkish chlor-alkali industries.

In 1972 the chemicals and fertilizer sectors contributed 15.5 and 2.3 per cent respectively to the Turkish manufacturing output of about LT 180 billion. The expected percentage figures for 1977 are 14.8 and 3.9 respectively. The average growth rates projected are 13.3 per cent for chemicals and 28 per cent for fertilizers.

With regard to pollution legislation in Turkey, there is one law on pollution control and general hygiene. This is a regulation which permits the closing of factories that are causing excess environmental damage.

In 1974 the Government of Turkey, which was committed to a policy of rapid industrialization in its third five-year development plan (1973–1977), was endeavouring to minimize environmental damage and pollution. Government departments held seminars on various aspects of the environmental situation with the aim of clarifying the departmental viewpoints and, by disseminating the seminar results, of keeping the general public and industrialists aware of the need for action and vigilance in this sector. The five-year plan stressed the need for extensive public education in this field.

Environmental seminars

In September 1974 the Government of Turkey requested the participation of UNIDO in a seminar on Environmental Dimension in the Choice of Industry and Technology. The seminar was organized by the Ministry of Industry and Technology and was held in the Conference Hall of the Standards Institute of Turkey, at Ankara, from 17 to 19 December 1974.

Two UNIDO experts prepared papers on the environmental impact of the chemical and the leather industries. Both experts discussed the short- and long-term environmental protection needs of Turkey in the chemical and leather industries. A staff member of UNIDO attended the seminar to speak on the general environmental considerations of industrial development.

In the course of their presentation, the UNIDO experts suggested:

(a) That immediate studies should be made of existing and proposed emission and discharge standards in other countries. The results of such studies together with studies of the economic and ecological position of Turkey would provide a methodology for national standards in this field;

(b) That minimum environmental control and improvement plans could be initiated economically. The philosophy proposed was that acceptance of even the lowest standards accepted elsewhere could be useful and lay the basis for future improvements;

(c) That future seminars on the environment in Turkey should include more technical discussion;

(d) That Turkish research on environmental problems should be elaborated and presented publicly (e.g. lignite production, Izmit Bay pollution and the proposed nuclear power plant);

(e) That there was a strong case for an in-depth study (technical/economic) of the Turkish tanning industry to assess at what level the balance of environment/economy would be best served.

Yugoslavia

The purification of industrial waste waters in the region of Vrbas, Yugoslavia, was discussed in a report on a field mission to Vrbas by a UNIDO expert. An agro-industrial complex located in the city of Vrbas and on the DTD Bezdon–Becej channel requested assistance from UNIDO to evaluate the waste-water treatment needs of the co-operative to control pollution in the channel and canals entering the channel. The co-operative consists of several industries discharging large quantities of essentially untreated waste waters. The channel flows slowly and has little capacity to assimilate organic wastes of the nature discharged by the majority of the industries adjacent to the channel. The major discharges of waste water come from a swine production facility, a meat packing house, a beet sugar refining operation and an edible oil refinery.

A study of waste-water treatment needs was conducted for the four industries (swine production, meat packing house, beet sugar refining, and edible oil refining) and a proposed study of the characteristics of waste waters and the waste-water treatment needs was evaluated. Suggested solutions to water pollution problems at the beet sugar refining and the edible oil factories were reviewed, and suggestions and comments were provided in the report. Seminars and discussions with various personnel at the Institut za Gradevinarstvo sap Vojvodina u Subotici were conducted on water pollution control practices in the United States.

Detailed design calculations outlining possible alternatives available for applications at the complex were preliminary and must be refined upon completion of the characteristics study for each industry. Options presented included land application systems, waste-water stabilization lagoons, conventional waste-water treatment systems and various solids handling techniques. The optimum system for the industries at the complex can be determined only after more detailed study, which was being conducted.

General studies

UNIDO guidelines

The secretariat of UNIDO distributed a report at the United Nations Conference on the Human Environment held in Stockholm in June 1972 entitled "Industrial Development and the Environment". The report indicated that in fulfilling its mandate with regard to stimulating the industrial development of the developing countries, UNIDO must be aware of the policies, programmes and activities that bear on any aspect of the complex task. Consequently, UNIDO is concerned with the environmental benefits and problems associated with industrial development and especially with environmental activities of direct industrial origin. At the request of governments or approval of the Industrial Development Board, UNIDO expressed its willingness to provide assistance in environmental policies, programmes and activities as they relate to industrial development. The report presented a brief description of the areas in which UNIDO had provided, or was prepared to provide, expert services and other assistance.

New Delhi General Conference of UNIDO

The UNEP secretariat with the co-operation of ILO, WHO and UNIDO presented a paper entitled "The Impact of Industrialization on Environment and Health" at the Third General Conference of UNIDO held in New Delhi, India, from 21 January to 8 February 1980. The paper emphasized that an integrated approach is required in development and consideration must be taken of the interrelationship between development, environment, population and resources. It was concluded that efforts being made to realize the Lima target of 25 per cent industrial capacity in developing countries by the year 2000 should be guided *inter alia* by consideration of the needs for environmentally sound development. Specific, pragmatic industrial development alternatives which would enable efficient mutual attainment of social, economic and environmental objectives need to be identified.

Methods for assessment of social costs and benefits of industrial projects must be broadened to include a proper evolution of the environmental implications. Finally, international co-operation at both the technical and the financial levels is essential in order to realize an industrial development consistent with sound environmental management.

Anti-desertification

UNIDO, in co-operation with the Centro de Investigación en Quimica Applicada, Mexico, has conducted basic and applied research in natural resources and agricultural chemistry. [34] The object of the work has been to develop crops adaptable to arid zones and to train personnel to recognize industrial applications of renewable resources grown in arid areas. Many plant species grow in deserts that can be used as antioxidants, fungicides, pesticides, or provide rubber etc. Fibres produced from many plants that flourish in the desert can be used to produce composite materials that can in turn be employed in the construction of houses, silos, water tanks etc.

UNIDO has conducted study tours to Mexico for two groups from the Sahel region to investigate the possibilities of co-operation among the countries interested in developing arid area industries.

UNIDO participates in the Inter-Agency Group on Desertification. Through these group activities, UNIDO personnel are informed and, in turn, inform other entities of the United Nations system of organizations of activities in anti-desertification.

Biogas production

Technical consultations among developing countries on large-scale biogas technology in China were held in Beijing, China, 4–19 July 1980. [1, 2, 3, 5, 6, 10, 12, 13, 15, 16, 17, 29] Extensive discussions of the technical and managerial aspects of the anaerobic fermentation of human, animal and crop residue were presented.

The history of biogas production in China was emphasized, and construction and operation details of the most successful digesters employed in China were presented. Both individual family digesters and communal digesters were discussed. Emphasis was placed upon the advantage and disadvantage of both sizes of systems. The application of biogas production at a distillery served as a means of energy recovery and waste treatment. The biogas was used to produce electricity and the organic residue was used as a fertilizer.

Discussions were also presented on the influence of low ambient temperatures on gas production in anaerobic digesters. Implementation of the process at low temperature and description of the initial operating stages were provided. The concepts were presented from the systems engineering approach to processes.

The approach to biogas production is similar in most countries of the world; however, the enthusiasm for biogas production and support by governmental agencies can strongly influence the development and use of this concept of energy savings, waste disposal and fertilizer production.

A summary of the conclusions, recommendations, and suggested action plan for UNIDO was prepared. Demonstration projects were encouraged. Continuing improvements in technology should be pursued through exchange of technical information and research. Training programmes for technical personnel from developing countries were suggested as a means of propagating biogas usage.

Compost production

As part of the programme, supported by FAO and UNEP, of promoting the use of organic materials as fertilizers, UNIDO has, since 1970, been providing technical assistance to developing countries in the production of compost from municipal garbage. [28, 52, 65]

In addition to carrying out feasibility studies for compost plants at Aden, Bamako, Bujumbura, Conakry, Cotonou, Damascus and Ouagadougou, UNIDO has provided a comprehensive programme of assistance to Morocco to rehabilitate and improve the efficiency of existing compost plants at Rabat, Meknes, Tetouan, Marrakesh, and to train Moroccan personnel in the operation, maintenance and repair of compost plants. Advice is also given in the marketing and application of compost. In addition, UNIDO has assisted in rationalizing and improving the efficiency of garbage collection in Casablanca to ensure a regular supply of raw materials for its new compost plant.

Since both garbage and compost are high-bulk, low-value materials, it is imperative that capital and production costs should be low, particularly in view of the fact that the quality of the product often bears no relation to the degree of sophistication of the machinery and the process. Composting technologies available in developed countries are generally too sophisticated and expensive for developing countries, and this is the reason why many plants had to be shut down.

Process adaptation is therefore an important factor in ensuring the viability of a compost plant. This can be achieved, as experienced by the UNIDO project in Morocco, through insistence on simplicity in process and plant design, maximum local fabrication of equipment and standardization of plants for different cities within the country for ease of maintenance and repairs.

Following feasibility studies carried out by UNIDO, a pilot compost plant is being established at Aden, Democratic Yemen, and another is being planned for Conakry, Guinea.

Environmental impact assessment of coastal area development

As UNIDO's contribution to a joint project directed by WHO and UNEP, a case study was completed describing the development and construction of waste-water treatment facilities at a petrochemical complex in Venezuela. [24] The petrochemical complex, which will ultimately include more than two dozen individual process units, has been constructed on the banks of Lake Maracaibo in Venezuela. The complex employed the first industrial waste treatment facility of its kind in Venezuela. A comprehensive system had to be designed because of the diversity of plants scheduled to go on stream, yet the system had to be economically practical.

Lake Maracaibo is a large estuary approximately 150 km in length located in the northern part of Venezuela. Fishing was still productive in the estuary at the time of planning the petrochemical complex although the lake was eutrophied by several discharges of pollution including untreated municipal waste waters from the city of Maracaibo and smaller cities surrounding the lake. Uncontrolled discharge of storm waters and leaks from the approximately 1,200 oil wells and pipelines located in the eastern part of the lake were contributing significant organic pollution.

The first step was to conduct a base line survey to determine the quality of the water in the estuary before construction of the plant. Water samples were taken from the lake at different locations and depths in various seasons. Analyses of the samples provide a bench-mark against which future measurements of effects of effluent discharge can be compared. Dispersion studies were conducted to determine the mixing characteristics of the estuary and to assess the impact of discharging the treated waste water into the lake.

To develop the pollution control system, different treatment processes were evaluated. Bench-scale studies were carried out using waste-water samples collected from operating plants in the United States that use the same processes as those used at the petrochemical complex. Results indicated that the most effective and economical process to treat the waste waters to the desired quality level was the activated-sludge process.

The activated-sludge system was designed to achieve an overall reduction of 60 per cent COD and over 90 per cent BOD. Design requires that each process unit effluent be pretreated if necessary, prior to discharge to the activated-sludge plant. The plant presently handles a design flow of about 21,000 m^3 per day and incorporates provision for expansion to three times that capacity. A holding basin with a volume of 68,000 m^3 provides surge capacity for incoming waste water not suitable for treatment, discharged storm water, or any effluent not suitable for discharge into the lake. An oil recovery system is provided in the basin. Sludge from the waste-water treatment plant is thickened, aerobically digested and trucked to a 20 ha land farming area where it is dried, spread and disked into the soil.

A cost allocation programme distributed the costs proportionately for waste-water treatment to the different process operations. The major incoming waste streams are continuously sampled and charges for treatment are computed based on the quantity and relative treatability of the waste. The cost allocation is based on the BOD and COD. Waste streams are also analysed for certain toxic substances which could reduce removal efficiency and increase treatment costs.

By taking into account both presently planned facilities and potential expansion, the waste-water treatment system will allow the petrochemical complex to make an important contribution to the economy of Venezuela without harming the valuable resources of Lake Maracaibo.

Environmental management

A paper on environmental management in industry was presented by a UNIDO representative at the WHO-sponsored Interregional Symposium on Consideration of Environmental Quality in Policy and Planning of Developing Countries held in Geneva, 26 July–1 August 1977. [30] A methodology to evaluate the environmental impacts of industrial development was presented, and case histories were presented of examples of flagrant disregard for environmental conditions resulting in serious health hazards and environmental change in developed and developing countries. Emphasis was placed on the economic importance of sound environmental protection practices. Examples of the impact of pollution discharges on downstream and downwind industrial development were cited.

Fuel and fertilizer from organic wastes

A monograph on the use of organic wastes for fuel and fertilizer in developing countries has been developed by UNIDO. [55] Solid wastes are a resource that can be converted to compost, or methane or hydrolyzed into glucose. The various methods of utilizing organic wastes are described in the monograph. Information in the monograph is general in nature and it is intended as an aid in decision making.

The monograph is not designed as a handbook or engineering design book, and when the design stage is reached the employment of competent engineers is stressed.

Information systems

A Directory of Industrial Information Services and Systems in Developing Countries was prepared for the UNIDO Industrial and Technological Information Bank in 1981. The directory was prepared to publicize and promote the use of existing industrial and technological information facilities in developing countries.

A Directory of United Nations Information Systems has been prepared in 1980 by the Inter-Organization Board for Information Systems as a two-volume document. Volume 1 is available in English, French and Spanish, and it gives particulars of United Nations family organizations and their information systems and services. [7] Volume 2 is available in a single trilingual version which gives, by country, the addresses of United Nations family organizations, United Nations Information Centres, input centres or focal points of the systems described in volume 1, and depository libraries where collections of United Nations family publications can be found. [8] The Directory is intended to tell users what information systems and services are provided by the United Nations family of organizations. It also indicates how to find further details by consulting the relevant source either at the address given for the system in volume 1 or at a country address given in volume 2.

Both directories referred to above describe sources of environmental information. Also, the UNIDO Industrial and Technological Information Bank has numerous environmental references.

Integrated industrial complexes

In 1975 a study was commissioned to evaluate the feasibility of developing integrated industrial complexes with the intention of minimizing pollution. The objective was to study the material flow (inputs and outputs including present waste products) in three industrial complexes in order to: identify and determine the feasibility of establishing additional production units to conserve raw materials and reduce pollutants; and evaluate collective actions for waste disposal. Three sites located in Teheran, Iran, Rotterdam, the Netherlands, and Manila, the Philippines, were visited and studied. Because of the shortage of data, it was difficult to fully evaluate the potential of integrated industrial complexes, but the potential for such complexes appeared most promising.

Social cost-benefit analysis

A guide has been produced emphasizing that in selecting projects a country must consider a number of different and often conflicting objectives before choosing the best project or project design. [19] The manual also stresses that, while each of these objectives, such as financial viability, economic efficiency and social equity, has merit in its own right, there is often very little consensus on exactly what weight should be applied to each. Some people will be most concerned about earning or saving foreign exchange, some with establishing a heavy industry base for future economic growth, and others with the distribution of income, to mention only a few. Most methods of economic project appraisal proposed in the past attempted to derive one number representing a balance of all these factors.

If there were any real possibility of obtaining a true consensus on the weights to be applied to the objectives, it would be difficult to fault the approach.

In practice, however, decision makers are many and agreements few. It is, therefore, much more realistic to develop a variety of insights into the merits of a project and to present these concisely so that all decision makers can explicitly see the various impacts a project will have. Such an explicit statement of the inherent advantages and disadvantages of a project allow the benefits of pursuing one objective to be judged against the benefits that would accrue by pursuing a different objective.

The approach in the guide has been designed explicitly to provide and develop this type of information. The project summary matrix pulls together the key data generated during the various analytical stages in a comparative multi-objective appraisal matrix. The key indicators of project desirability at each stage of analysis are then summarized graphically.

Feasibility studies

UNIDO has prepared a Manual for the Preparation of Industrial Feasibility Studies to assist planners from both developing and developed countries. [21] The manual is practical; it aims to make feasibility studies more comparable than in the past. Industrial development centres, investment promotion centres, industrial development banks and public and private consulting firms in developing countries should benefit especially from the manual. The numerous individual experts assigned to project planning authorities in developing countries should also be able to benefit from it.

Sectoral studies

Agro-industries

A UNIDO Sectoral Study on the Agro-industries was prepared in 1976, and a summary of environmental pollution control was incorporated. [31] Agro-industry pollutants are generally bio-degradable and amenable to biological treatment. Brines and whey are two cases of waste from agro-industries which cannot be treated by conventional biological techniques.

Water requirements vary widely in the various segments of agro-industries. Water consumption depends not only upon the type of food processed but also upon manufacturing practice. In the dairy products industry, the flow rate has been reported to vary from 0.1 to 20 m^3/t of product, whereas the fish and seafood segments may require from 1 to 175 m^3/t of product. In general, water consumption can be reduced in a plant by water conservation practices and use of modern equipment and processes.

Some form of waste-water treatment is important for most agro-industries because high strength waste waters, even if biologically degradable, can exert a substantial oxygen demand upon a water course. Since agro-industry is usually high in bio-degradable matter, disposal on land can be very effective when sufficient areas are available near the site of the agro-industry.

Solid wastes can produce serious environmental problems for the agro-industries. Large quantities of hulls, shells, stalks and meals are produced by the removal or extraction of raw products for refining, storage or packaging. Frequently this by-product will represent half the weight of the raw material processed. Fortunately, with a few exceptions, these materials can be utilized as animal feed or fertilizer or further refined to produce useful and marketable products.

Significant quantities of sludge are produced by waste-water treatment facilities. The disposal of these solids must also be considered along with the disposal of solids produced by the manufacturing or refining operations.

UNIDO recommends that an environmental impact evaluation procedure be part of the planning procedure for any new major agro-industrial plant. The purpose of evaluating environmental impact is to prevent the deterioration of natural resources, such as a river which may receive plant waste waters, so that these resources can continue to provide a basis for further economic development.

UNIDO further recommends that developing countries should develop pollution control regulations. A problem specific to the developing countries when endeavouring to protect the environment through pollution regulations is a lack of experience. As environmental problems due to industrial pollution are new, many of the developing countries have no pollution regulations. Such regulations are, however, indispensable to the contractor for the design of pollution-control systems and should be in effect at the time the tender documents are sent out. It is recommended, therefore, that the ministries concerned, such as those of industry, health or development, should draw up the relevant regulations, referring as necessary to the experience of other countries.

Environmental considerations should not limit the expansion of processing and refinement of foods and other agricultural products in the developing countries. Economic and environmental advantages can result from a complete processing facility including by-product utilization. Recovery of by-products from solid wastes and waste water is more economical at a large-scale central processing plant.

Cement industry

An interregional seminar on cement technology was sponsored by UNIDO in Beijing, China, 9–24 October 1980. Papers were presented discussing the technical aspects of cement production. The papers discussed the pollutional aspects of the industry and the use of waste materials from other operations as raw products in the manufacture of cement. [4, 11, 14] Energy conservation in the production of cement was also discussed.

Emphasis was placed upon atmospheric pollution in one paper, and regulations and trends in the discharge of particulate material were summarized. Philosophical issues to be considered by developing countries were discussed. The costs associated with environmental protection were summarized.

Spoil from coal mining is a major problem in China, and concerted efforts were being made to find uses for these materials. Cement manufacture from spoils containing carbonaceous rocks was being practised. The chemical composition of the rocks and a summary of the difficulties encountered in producing Portland cement were presented.

Fly ash has been used in France in the manufacture of various cements since 1952. The use of fly ash has been the result of both economic requirements and the improvement of the cement. Fly ash is used extensively in road construction.

The only critical resource in the manufacture of cement is energy. Approximately 2 per cent of the world's total electricity consumption is used in the cement industry. Ways of accomplishing energy savings were summarized at the seminar.

Dust control in a shaft-kiln cement plant was discussed. Emphasis was placed on kiln gases, dust control and the utilization of cyclones, multicyclones, scrubbing towers, bag filters and electrostatic precipitators. Noise control was also discussed.

Dyeing and finishing industry

A set of lecture notes discussing the economic effect of water conservation and concern for the environment in the dyeing and finishing industry were prepared for presentation at UNIDO training courses in 1974. A brief historical perspective was presented of water usage in the textile industry. Effluent disposal alternatives and the costs associated with effluent disposal were discussed along with examples based upon actual field experience being presented. Stream standards in the United Kingdom of Great Britain and Northern Ireland were discussed, and the possibility of using recycled effluents was evaluated. Disposal of poisonous solid wastes, machinery design, and water conservation were also considered. Examples of ways to institute water conservation in the dyeing and finishing industry were presented.

Edible oil industry

As part of a UNIDO Sectoral Study, a review of pollution control in the edible oil industry was prepared. [58] In the production and refining of edible oils some form of industrial waste treatment must be practised if degradation of environmental quality is to be prevented. Complete treatment at the industrial site may be necessary; pre-treatment prior to discharge to a public sewer, or discharge to a treatment facility serving an industrial complex may provide the effluent quality needed. The degree of treatment required will vary with local and national standards and the economy of by-product recovery.

Water pollution is the most serious environmental problem in the edible oil production and refining industry. Most of the waste water results from cleaning operations, and the quantity of pollutants in the wash waters varies with the operation in the grinding, extraction and refining processes. Certain process waste-water streams can be separated from the total discharge and be further refined to recover reusable materials. Large quantities of cooling water are used, but these are generally kept separate from the waste-water treatment facility and handled in cooling towers.

The process or series of processes selected to treat waste water will vary with the quality of effluent required, the location of the industry, and the degree of recycle, reuse and recovery operations economically feasible. Gravity separation and dissolved air flotation with chemical addition is the most used process to produce an effluent for discharge to a municipal sewer.

In most cases it is possible to recover enough oil from the waste waters to offset better than 50 per cent of the cost of treating the waste waters. The percentage of the cost recovered varies with the price obtainable for the recovered by-product, or treatment necessary to prepare it for shipment.

Solid wastes can produce serious environmental problems in the production and refining of edible oil. Meal or pomace is a by-product of the oil extraction process, and frequently represents half the weight of raw material processed. Most extracted meals contain less than 1 per cent oil. Fortunately, with a few exceptions, the meal can be utilized as animal feed or fertilizer. When residual meal is poisonous to animals (castor beans and tung nut), it can be used as an organic fertilizer. Soybean meal is used in plywood adhesives and increasing amounts of protein are utilized in the manufacture of synthetic fibres.

The major source of air pollution in the edible oils industry occurs during the handling of the seeds or nuts before processing. The oil extraction procedures are essentially the same for all oil seeds and nuts, and the extraction procedures cause little air pollution.

There appears to be no environmental reason to limit the processing and refining of edible oils to certain areas of the world. More economical advantages are gained with a complete processing facility utilizing all by-products. Transportation costs frequently offset the advantages of by-product recovery; therefore, the more operations available at a central location, the more economically attractive recovery and environmental protection become.

Fertilizer industry

As part of the programme of work of UNIDO for 1974, an Expert Group Meeting on Minimizing Pollution from Fertilizer Plants was held at Helsinki, Finland from 26 to 31 August 1974 in co-operation with the Government of Finland. The main objectives of the meeting were to discuss and promote the transfer of technology in identifying pollution problems attendant upon fertilizer and captive-acid production and to recommend ways and means of reducing pollution and its effect upon the environment by proper design and control as well as the location of captive-acid and fertilizer plants.

A long-range objective of the meeting was to contribute to the formulation of suitable international standards and guidelines to minimize effluents (particulate, gaseous and aqueous) from production facilities, to reduce the pollution load on the environment and to determine whether existing standards in developed countries were suitable and could be adapted to developing countries.

Additionally, the meeting had as a most important objective the discussion and evaluation of the role of UNIDO in international collaboration on the problems affecting the environment and solutions in the fertilizer industry.

Supplemental specific objectives of the meeting were:

(a) To illustrate by case history and environmental evaluation of specific plants, the pollution effects of a fertilizer production complex on its environment;

(b) To make a comparative analysis of the costs of installing adequate pollution abatement equipment in new facilities as opposed to making changes in existing plants;

(c) To suggest guidelines for site selection for new "grass-roots" fertilizer complexes with due regard for environmental considerations;

(d) To examine known ways and means to control gaseous, particulate and solid effluents from fertilizer plants not only to meet the lowest cost principle for design but to minimize the pollution satisfactorily; this would include waste/reuse recovery schemes, which could offset additional investment costs;

(e) To examine the possibilities of training engineers and chemists from developing countries in the field of control of pollution during design stages;

(f) To evaluate the need and possibility of alternative processes and equipment technologies to minimize pollution;

(g) To assess the effect of pollutants on workers, habitation, air and water quality;

(h) To investigate the possible economic effects of including environmental considerations in existing and planned fertilizer complexes;

(i) To examine legal measures which might be relevant to the problem of minimizing pollution from fertilizer plants.

An overview of environmental problems in the fertilizer industry and their effective management was presented as a part of the UNIDO Sectoral Study in 1978. [33] An environmental impact evaluation procedure was used to raise the key environmental issues that should be dealt with in the initial stages of planning a new fertilizer plant. Pollution regulations and the importance of maintaining pollution control standards were discussed. Air and water pollution problems were summarized and some costs of pollution abatement were given.

In general, pollution control measures taken by the fertilizer industry should aim to:

(a) Protect the health and welfare of employees in the plant by controlling in-plant atmospheric quality and minimizing contact with toxic substances;

(b) Prevent damage from atmospheric pollution to crops, animals and people;

(c) Preserve the quality of rivers, lakes and other bodies of water so that fishing and other industries as well as the people who use the water will not be adversely affected.

An environmental impact evaluation procedure should form part of the planning procedure for any new fertilizer plant. The purposes of evaluating environmental impact are two-fold:

(a) To prevent the deterioration of natural resources, such as the river which will receive plant waste waters. Thus these resources can continue to provide a basis for further economic development;

(b) To give ample warning of deleterious side-effects which may produce unexpected economic or social costs.

The environmental impact procedure sets out a series of analytical steps applicable to environmental problems that may occur during the raw materials phase right through to the final disposal of materials produced. These steps are:

(a) Raw materials linkage. Environmental considerations beginning with extraction of the raw materials or their arrival in a country through to the project under evaluation;

(b) Site assimilative capacity. Present or baseline analysis of air, land and water carrying capacity to determine original conditions and effects of the project;

(c) Project design and construction. Analysis of alternative possibilities for unit operations and energy sources;

(d) Operations. Maintenance of project and monitoring (analysis of outputs, including by-products and wastes for treatment and reuse; monitoring waste discharges);

(e) Social aspects. Social implications of the project;

(f) Health aspects. Safety and welfare of the work force and the population affected by the plant;

(g) Place of ultimate deposit. Recycling, reuse or disposal of wastes.

The subject of pollution in fertilizer plants was presented in a 1977 monograph (UNIDO Fertilizer Industry Series, Monograph No. 9) published by UNIDO. [18]

The monograph outlines the type of chemical, gaseous or liquid effluents that originate from fertilizer plants. In many cases, when corrective steps are taken to reduce or completely eliminate the gaseous effluents by scrubbing, aqueous effluents are produced with varying concentrations of the contaminants. Unless economic recovery is available to recycle these effluents in the process stream, steps have to be taken to neutralize their impact on public waters. This study gives an account of the measures taken at the production facilities of both the nitrogen and phosphate fertilizer industry to prevent or minimize pollution. The disposal of solid gypsum and other solids such as those from potash-processing plants is also described briefly.

The criteria for selecting the site for a new "grass-roots" plant and a guide to engineering contractors' specifications to enable effective in-plant control of effluents are summarized. A description of appropriate surveys to measure the environmental impact of fertilizer plants is included to guide policy makers and investors in establishing a new industry.

The monograph summarizes the guidelines without going into case histories or details for solving pollution control problems associated with the fertilizer industry.

Iron and steel industry

A study of water use and treatment practices and other environmental considerations in the iron and steel industry was completed in December 1981 by UNIDO in response to a directive resulting from the 1981 meeting of the UNIDO Industrial Development Board. [66] The secretariat indicated that it would begin a programme of collecting and disseminating information on technological developments in water · ·e and treatment practices in certain key industries. The Board noted the growi..g importance of techniques of conservation, reuse and recycling of water, linked with effluent treatment methods.

The efforts of the United Nations to disseminate information and promote good environmental practice in the iron and steel industry have been manifold. In 1970 the Economic Commission for Europe published a review of the sources of pollution in the iron and steel industry as well as air and water pollution control devices and associated costs. [22] In 1973 UNIDO sponsored an international meeting on the iron and steel industry at which several presentations were devoted to environmental problems. In 1978 UNEP organized a workshop on the environmental aspects of the iron and steel industry. In 1981 the Economic Commission for Europe published a study on low-waste and non-waste technology in the iron and steel industry. [20]

In addition to optimal pollution control, occupational safety and health is a major concern in the iron and steel industry due to the hazardous aspects of many operations. Accident risk is presented by molten metals, high temperatures and worker contact with heavy machinery. A variety of toxic and explosive gases as well as high levels of particulate matter are generated in many of the processes. Hazards are presented by significant quantities of toxic substances such as cyanides, chromium salts, and acids. Some processes are inherently noisy.

The following recommendations were reported:

(*a*) In the case of the many developing countries without reserves of coking coal, UNIDO recommends the establishment of mini mills (from 200,000 to 1 million tonnes of finished steel product per year) using direct reduction and an electric arc furnace followed by continuous casting and finishing processes. Fewer pollutants are generated by this method;

(b) A site for a new plant should be chosen with a sufficient buffer zone to assimilate air pollutants and to serve as a receptacle of solid residuals. An adequate source of water is necessary as well as a transportation network for the flow of raw materials and finished products. Frequently a coastal site would be preferred;

(c) Three separate water systems (rain-water run-off, drinking and sanitary waters, process waters) should be established for a new plant. Domestic waste waters can be recycled after treatment to the process water system if the plant is in a water-scarce region;

(d) For a new plant, the alternatives for water recycling should be examined. A cost study should examine the alternatives of using once-through water (raw water costs) compared with recycling (treatment and pumping costs) keeping in mind that environmental quality restrictions on effluent discharges may be more stringent in the future;

(e) Oxygen blowing should be minimized to reduce air pollution from the plant;

(f) When setting up integrated works on a greenfield site, at least base-level pollution control technology should be incorporated to reduce pollution;

(g) Governments should make available low-interest loans, subsidies and special tax benefits for pollution control measures taken at both new and existing plants;

(h) Where a new or existing plant is located near a population centre, the government should insist on installation of efficient air pollution control equipment in order to meet strict air quality standards;

(i) Governments should establish water quality standards for streams receiving waste-water discharges from iron and steel mills and the manufacturers should be required to remove sufficient pollutants, especially toxic pollutants, in order to meet the water quality standards.

Metallurgical industry

UNIDO presented a paper on the disposal and utilization of bauxite residues at the UNEP/UNIDO Workshop on the Environmental Aspects of Alumina Production held in Paris, France, in January 1981. [25] UNIDO will issue further reports on environmental aspects of bauxite processing as a result of the workshop. At the workshop, sources of bauxite residues were identified and the disposal and utilization of the residue were discussed. Environmental impacts of the disposal and utilization of bauxite residues were evaluated. Present and future economic solutions to the disposal and utilization of bauxite residues were presented.

Bauxite residues, called red mud or grey mud, are formed in the processing of bauxites by the Bayer method, sintering, or a combination of techniques. Red mud consists mainly of various forms of iron and aluminium oxide minerals, calcium and sodium aluminium silicates, titanium compounds and other assorted minerals. The mass of mud formed per tonne of alumina varies from 0.3 to 3.5 t depending upon the grade of bauxite and the process technology used. Red mud is generally pumped from the plant as a slurry containing 200 to 350 g of solids per litre. Upon settling, the mud compacts to 40–60 per cent solids. If filtered, the solids content of the mud cake will be 60 to 70 per cent.

The liquid phase of the red mud contains 0.5 to 8 g/l of both Na_2O and Al_2O_3.

Seepage of this liquid into ground waters can cause serious environmental harm. Storage ponds containing red mud must be sealed to prevent seepage of the liquid. Red mud is disposed of in impoundments that are frequently poorly constructed and not sealed and cause environmental problems.

Red mud can be disposed of on land, as mentioned above, or to the marine environment. Land disposal can be accomplished in holding ponds, in properly shaped valleys with dams, by stacking filtered red mud, or placing filtered mud in mine excavations no longer in use. Marine disposal of red mud has a harmful effect on marine life, and this effect cannot be completely eliminated. The effect can be lessened by proper site selection, but there is always a significant impact on the environment. Shore lagooning of red mud appears to offer a partial solution to disposal. The muds do not enter the sea, and the pH value of the liquor is effectively neutralized by the sea water.

Utilization of red muds has had some success in certain locations, but in most cases the quantities used are small. Using red mud in the production of heavy ceramics by mixing 50–90 per cent red mud with additives at the alumina plant and processing the mixture at ceramic factories appears promising. Large quantities are consumed.

All of the points discussed above were summarized and in some instances expanded upon in the UNEP Secretariat Report on the Environmental Aspects of Alumina Production. [25] The record of the workshop at which the UNIDO paper was presented, UNEP/WS/Al. 7 (Final), also summarizes the main points of the discussion, outlines the issues identified and defines the areas calling for further investigation.

Non-metallic minerals

The UNIDO–Czechoslovakia Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals-based Industries prepared a detailed report on the state-of-the-art and the possibilities of energy conservation in non-metallic minerals-based industries. The study was conducted within the action programme of the UNIDO Energy Task Force. The report focuses on three segments of the industry: industrial ceramics, cement, and glass. These three segments were selected because:

(a) Most developing countries possess deposits of raw materials applicable to these three industries;

(b) The products manufactured by these three industries are used in the building industry, and these products are essential for the development of housing and an increased standard of living in developing countries;

(c) The products serve as a basis for the development of other industries;

(d) Significant economic advantages accrue to the nation;

(e) These industries have been established or are being planned in most developing countries; therefore, local producers should be interested in the transfer of experience in energy conservation.

Energy conservation is discussed for each step in all three industries. Proven energy saving methods as well as theoretical considerations were evaluated. Examples of energy savings accomplished through improved maintenance, changes in technology or adaptations implemented within a short period of time were presented. Energy savings achievable only by reconstruction or new construction were also discussed. Recommendations strongly encouraged the consideration of energy conservation in all new construction projects.

Organic and inorganic chemical plants

A paper presented at the Workshop on the Environmental Aspects of the Chemical Industry sponsored by UNEP and held in Geneva, 22–25 May 1979, emphasized that in industry generally two main approaches to the problem of pollution and environmental damage warrant careful examination. [50] The first is the development or adoption of new technologies which reduce pollution and other undesirable side-effects; the second is the location for new industrial plants in areas where there is no large concentration of industry and the environment therefore retains its capacity to absorb and dispose of pollutants. UNIDO in its programme to assist developing nations with their programme of industrialization gives consideration to these matters which require the attention of policy makers and industrial management. In that paper, both corrective and preventive measures were discussed as main strategies for environmental management to be pursued within an organic chemical producing plant and an inorganic chemical producing plant. Two case histories were presented, one for the control of liquid effluents from a petroleum refinery and the other for the control of gaseous effluents from a fertilizer plant. In-plant control, that is control at the source of pollutants, was emphasized as the most important control for pollution from industrial production plants.

It is the responsibility of industrial policy makers and plant managers to maintain close control of their operations. Control measures recommended for adoption include:

Engineering and process design considerations
Recovery and utilization
Local treatment
Good housekeeping
Effluent treatment

These methods may serve as guides for the chemical industry in developing countries so as to avoid making the same mistakes as industrial countries have made.

Petrochemical industry

A discussion of the environmental impact of the petrochemical industry along with descriptions of the waste materials and methods of treatment and disposal was presented in 1975. An extensive description of allowable concentrations of pollutants, air pollution control techniques, surface water pollution, soil and ground water pollution, noise control and case histories of two petrochemical complexes was presented.

A second presentation designed to give an overview of environmental problems in the petrochemical industry and their effective management was prepared for the UNIDO Sectoral Study in 1977. The document was intended for those officials of national and local authorities responsible for planning and managing petrochemical plants. An environmental impact evaluation procedure (see Fertilizer industry) raises the key environmental questions that should be dealt with in the initial stages of planning a new petrochemical plant. Pollution regulations and the importance of maintaining pollution control standards were briefly discussed. Sources were given for detailed regulations as applied by developed countries.

The problems of air and water pollution were covered in depth, as were the technical means of combating these problems. Economic costs of reducing pollutant emission levels were indicated for many air pollution solutions used in certain chemical processes, and the overall costs of treating plant waste water in activated sludge and anaerobic or aerobic treatment procedures were given.

Pharmaceutical industry

As part of a UNIDO Sectoral Study, a review of pollution control in the pharmaceutical industry was prepared in 1978. [32] The presentation was designed to give an overview of environmental problems in the pharmaceutical industry and their effective management. An environmental impact evaluation procedure was presented that raised the key environmental issues that should be dealt with in the initial stages of planning a new pharmaceutical plant. Pollution regulations and the importance of maintaining pollution control standards were discussed. The report also presented a description of waste characteristics, current waste treatment and control practices in the industry, and information from four companies on the economics of pollution control systems.

The pharmaceutical industry employs a vast array of complex processes, many of which are proprietary. Wastes from pharmaceutical operations are usually strong and concentrated, difficult to handle, and require some of the most complex and expensive treatment and control systems of any industry.

An annex on environmental problems was presented for technical persons responsible for planning and managing pharmaceutical plants in developing countries. In the annex, the environmental impact evaluation procedure was considered in depth; key questions were posed with respect to each of the nine steps in the procedure. The problems of air and water pollution were also covered in depth, as were the technical means of combating these problems. A series of case studies covering different catalogues of pharmaceuticals manufacture was presented.

Pulp and paper industry

A paper on the environmental aspects of the pulp and paper industry was presented in June 1974 in Sweden at an In-plant Group Training Programme for engineers in the field of the pulp and paper industries. The paper is essentially a primer in the basic properties of water, impacts of water pollution and description of the various paper-making processes. Emphasis was placed on the sulphate process and bleaching processes. Pollution control by closing the water cycle in the paper-making process was discussed from present practice to anticipated future developments. Conventional waste-water treatment processes employed in the pulp and paper industries were also discussed.

In addition to the assistance provided in the establishment of the pulp and paper industry in developing countries, UNIDO has participated in the activities of the UNEP Environmental Consultative Committee on the Pulp and Paper Industry since its inception in 1975. UNIDO assistance has been provided in the preparation of the three-part UNEP manual entitled *Effluent and Emission Control in the Pulp and Paper Industry.* This will be an extensive document describing in detail the control and prevention of pollution from the pulp and paper industry.

Rubber industry

An expert group meeting on the study of synthetic versus natural products was held in Vienna, Austria, 16–20 September 1974. Twelve papers were published describing the environmental impact of the rubber industry. The purpose of the meeting was to establish the extent to which environmental considerations should influence the world in future choice between natural and the synthetic rubbers. Equal priorities were given to technical, sociological, economic, and waste disposal problems.

Descriptions of the technological processes used in the manufacture of various rubber and synthetic rubber products were presented along with discussions of the sources of pollution. Comparison of the natural and synthetic rubber industries in terms of production costs, profitability and selling prices was presented.

Stone industry

In an unpublished paper prepared for UNIDO, a strong case is made for the use of stone as a building material. [60] The case is based on energy savings, environmental protection and technological developments. Avoiding the breaking, blasting, grinding and sawing activities involved in the use of stone would result in savings in all areas and would result in a more attractive structure. Even considering all the preparations required for conventional stone construction it is ironic that one attempts to return to the original form by producing simulated solid stone in the form of concrete, cement blocks or pavement slabs.

The use of more stone would reduce the need for cement, resulting in energy and environmental savings. Stone is also a recyclable material. Well-planned stone extraction causes little if any environmental or pollution problems, whereas brick production can be a major contribution to deforestation. Energy consumption in the traditional brick kilns using forest products for firing is estimated to reach 1 kg of wood per brick. An average rural house with 10,000 bricks would require that 10 t of wood be burned.

Stone deposits *in situ* are often capable of providing building materials of superior quality at an attractive price. Integrated planning can avoid many environmental problems and save energy and construction costs.

Sugar industry

The Joint UNEP/UNIDO Seminar on the Implication of Technology Choice in the African Sugar Industry was held at Nairobi, Kenya, 18–22 April 1977, as part of the project "Development and application of appropriate technology for the sugar industry in Africa", for which UNIDO acts as executing agency. The main objective of the seminar was to indicate some basic guidelines for selecting environmentally sound technologies. A further objective was to promote the exchange of ideas and experience relating to research and development in the sugar industry. To facilitate this exchange, formal presentations were made on work currently in progress by groups concerned with technological issues and by those addressing broader social, economic and physical environmental questions. [9, 48]

Few African countries are self-sufficient in the production of sugar and many are actively contemplating major expansion plans. The choice of technology and scale of production, therefore, are questions of considerable interest. While the current trend of the development of the sugar industry in Africa emphasizes medium- to large-scale projects, generally designed and managed by a few large companies, the results of these projects may not always closely correspond to the development goals.

Small-scale open-pan sugar production is of marginal interest for a number of African countries, particularly those that have already established or are planning to establish large-scale vacuum-pan sugar mills. Labour-intensive, small-scale operations with lower investment, if not subsidized, can hardly match the better yields, higher heat economy and benefits of by-products offered by large-scale operations. There may be hope, however, for developing simplified vacuum-pan mills with a smaller capacity (e.g. up to 1,000 t of cane per day) in areas unsuitable for large-scale operations. The environmental impact of the sugar industry should be adequately studied in each case and corresponding steps should be taken to prevent deterioration of the environment.

Tanning industry

As part of the joint work programme within the environmental field between UNIDO and UNEP, a project was undertaken in 1975 to study the leather industry in depth and assess the environmental considerations which have an impact upon operation and development. Meetings were held to solicit suggestions from representatives of several developing countries having a leather industry or having the potential to develop such an industry. These suggestions were used to formulate a work plan that would maximize the utility of the final report of the developing countries.

Because of the large amount of material collected and the diversity of the areas of interest, the report was divided into two volumes. Volume I describes the more general situation, including the potential environmental impact of the industry based upon three case studies. The financial implications of the installation of process modifications and pollution control equipment is also discussed.

Volume II presents a more technical treatment of the subject with the objective of mitigating the harmful environmental effects of the leather industry. Details are presented of the best process modifications available to lessen the environmental consequences of discharges, and outlines are presented of the possible effluent treatment system applicable in various circumstances.

Thus volume I is addressed to governmental and industrial decision makers, and volume II is of more concern to the entrepreneurs and technologists, as well as the planners. Both volumes, however, are closely interrelated, and should be read in conjunction with each other by those who wish to implement any specific proposal.

In general the report is directed towards the developing countries where the tanning industry in many cases is undergoing expansion. Much of the discussion is pertinent to the more developed nations, although in these areas more sophisticated and costly treatment schemes may be employed.

The recommendations outlined in volume II are given as general guides. Treatment plants have not been operated under the exact conditions quoted, but international authorities in this field agree that in most instances the proposed treatment plants should operate efficiently, subject to some minor local modifications.

A report designed to give an overview of environmental problems in the tanning industry and their effective management was presented at the Second Leather and Leather Products Industry Panel Meeting held at Vienna, Austria, from 5 to 7 February 1979. The report presented a description of waste characteristics, current waste treatment and control practices in the industry, and information from several countries on the economics of pollution control systems. Pollution regulations and the importance of maintaining pollution control standards were discussed. An environmental impact evaluation procedure raising the key environmental issues that should be dealt with in the initial stages of planning a tannery was discussed.

Pollution problems from the leather industry arise from tanned and untanned solid waste, waste waters (as well as the sludge separated therefrom), and some air pollutants.

Solid wastes from the leather industry include cuttings of untanned hides with hair, cuttings of limed, untanned hides without hair and leather shavings, as well as splits and cuttings, both chrome-tanned and vegetable-tanned.

Within Europe the practice is to send some of the untanned waste to glue and gelatine factories for further processing and also to carcass disposal plants. Sometimes it is disposed of in special dumps, in which each day's wastes are covered with a layer of earth (sanitary landfill).

Chrome-tanned and vegetable-tanned wastes can be used for making leather board (leather fibres bonded together with glues) or disposed of in sanitary landfills.

The composition of the liquid effluent from leather factories is very complex and depends upon the manufacturing procedure used in the particular factory concerned and on the starting materials. The particular characteristics of effluent from leather factories which start with the green, or fresh, hides are sulphides (from the liming), high alkalinity, a high concentration of dissolved organic compounds (mainly partially decomposed protein from the liming and bating processes, but also unbound tanning materials dyestuffs and fat-liquoring oils) and, in the case of chrome-leather factories, chromium compounds.

The effluent also contains certain amounts of organic and inorganic suspended solids. These form as a result of co-precipitation when the effluents from the various processing stages are mixed.

In Europe, official regulations, which vary from country to country, generally require that before any effluent is discharged into public waters (rivers, lakes, the sea), it must be purified sufficiently to ensure that there is no risk of major disturbances to the biological equilibrium or damage to the public health. Where effluents are to be treated in public waste-water treatment plants, any constituents which might impair the functioning of these plants must first be removed prior to discharge of the effluents into the public sewers. Often a charge is levied by the public authority. This charge is typically assessed according to both the strength and volume of the waste water discharged.

In tanneries, the problem of air pollution is a minor one and is limited almost exclusively to the waste air from the finishing process. This waste air may contain solvent vapours and formaldehyde, depending on the finishing process used in the particular tannery concerned. The most suitable purification process (e.g. wet scrubbing, absorption by activated charcoal, combustion of the waste stream) can only be determined after studying each individual case carefully.

A paper entitled "Means of improving environmental standards in the tanning industry with guidelines for developing countries", was presented by UNIDO to the International Symposium on Water Resources Management in Industrial Areas, Lisbon, Portugal, 7–11 September 1981, sponsored by the International Water Resource Association. [53]

Future activities

Environmental activities planned for UNIDO until the year 1989 have been described in the draft Medium-term Plan for the Period 1984–1989 submitted by the Executive Director. [27] The following summary of activities was extracted from the draft of the Executive Director's plan, and from work plans of sections and units for the near future; however, the summary should not be construed to be all-inclusive nor a direct quote of the Executive Director's intentions with regard to the environmental activities of UNIDO.

The International Strategy for the Third United Nations Development Decade emphasized industrialization as a major element. Developing countries are encouraged to expand manufacturing output at an average annual rate of 9 per cent, thereby making a significant contribution in the 1980s towards increasing their share of world manufacturing production. Thus, they can prepare a base from which it will be possible to achieve the target of a 25 per cent share by the year 2000 as proposed in the Lima Declaration and Plan of Action. Industrialization should be planned to meet the overall requirements of national development, and to increase the developing countries' share of world exports of manufactured goods. Improved access to markets for the products of developing countries and the formulation and implementation of positive adjustment policies in the industrialized countries are important objectives of international co-operation. The policy measures have to be elaborated at all levels: national, regional and international.

The strategy declares that the encouragement of labour-intensive, medium-scale and small-scale industries, the use of appropriate technology, and the development of human resources, productive employment generation, the integration of women in industrial development programmes and environmental aspects of industrialization should all be given consideration in industrial policies and plans. The highest priority is to be accorded to measures, including adequate finance, for the Industrial Development Decade for Africa (1981–1990).

It is also necessary to undertake jointly devised and executed programmes which lead to projects with UNIDO's partners, i.e. FAO, the International Fund for Agricultural Development (IFAD), ILO, the International Trade Centre UNCTAD/GATT ((ITC) a jointly sponsored body, established by the General Agreement on Tariffs and Trade (GATT) and jointly sponsored by GATT and the United Nations, the latter acting through the United Nations Conference on Trade and Development (UNCTAD)), UNEP, UNESCO or WHO. A formal agreement has been entered into with UNEP. An agreement on economic co-operation among developing countries has been reached with UNCTAD.

Special programme for least developed and other disadvantaged categories of developing countries

Special programmes will be developed between the governments of recipient countries and potential donors of voluntary contributions to UNIDO, including non-governmental organizations. Projects relating to the Sudano-Sahelian zone will be formulated in the course of expanding industrial activities related to water management and irrigation, crop protection and preservation, and the local production of fertilizers, pesticides, and agricultural machinery and equipment.

Technical co-operation activities connected with the Industrial Development Decade for Africa, will be intensified in that region, which contains 20 least developed countries. These activities will focus on the creation of a solid base for self-sustained industrialization. Careful consideration will be given to the priorities set in the Lagos Plan of Action calling for self-sufficiency in food, building materials, clothing and energy.

Co-operation among developing countries for industrialization

Co-operation will be established between UNIDO and those developing countries which have established policies and formal programmes for techno-economic co-operation with other developing countries. Efforts will be expended to determine the specific areas in the developing countries, especially the least developed countries, where co-operation from other developing countries is required.

In co-operation with UNCTAD, an operational programme for the establishment of multinational production enterprises will be established. The industrial sectors initially considered will be fertilizers, rubber products and paper. The programme will be expanded to cover six industrial sectors. The intentions of the programme are to make more rational use of existing and potential resources, the expansion and diversification of production capacities, the encouragement of specialization and the identification of complementary industry.

System of Consultations

Consultations will be held in the food processing, vegetable oils and fats, leather and leather products, pharmaceuticals, petrochemicals, fertilizers, iron and steel, capital goods and agricultural machinery sectors. Consultations will also be held on two topics common to all industrial sectors: the training of industrial manpower, and industrial financing. Initially four of the sectors will be the subject of Consultations, while the other seven will have to be discussed at following Consultations.

Contingent upon future decisions by the Industrial Development Board and the General Assembly and the availability of resources, additional sectors such as textiles and wearing apparel, wood and wood products, building materials, electronics and non-ferrous metals will be considered.

The System of Consultations will continue to develop on global, regional and interregional levels. Though the emphasis will continue to be placed on the Consultations on sectors or topics common to all industrial sectors, more and more attention is expected to be paid to holding regional and interregional Consultations in order to use the System of Consultations as an instrument to promote industrial co-operation among developing countries.

Global and conceptual studies and research

Internal and external constraints confronting developing countries endeavouring to achieve industrial growth commensurate with the targets set in the Lima and New Delhi Declarations and Plans of Action require analysis before policies are formulated. Progress towards the restructuring of world industrial production has to be monitored and conclusions offered to the developing countries on possible strategies for overcoming the obstacles encountered. Policies and mechanisms of international co-operation for industrial development, and particularly the analysis of various aspects of economic co-operation among developing countries, will require further elaboration in the light of the Industrial Development Strategy for the Third Development Decade. Special attention will have to be given to assessing the concept of endogenous industrialization and to supporting the industrialization of the least developed countries, including their participation in the process of redeployment, as well as to the industrial development of Africa. On a global plane, critical areas such as the social and environmental aspects of industrialization, and human resource development will have to be analysed, while the overall scope of the subprogramme will need to be extended to include a global scenario up to the year 2025, in the light of which these and other socio-economic and techno-economic problems might be analysed.

In close consultation with national policy makers in both the developing and developed countries, the programme will be built up to serve as a focal point for collecting and disseminating pertinent information on structural change, quantitative projections, and relevant policies, while its scope will be extended to include a scenario for world industrialization up to the year 2025. Furthermore, work will continue on the social and environmental aspects of industrialization, on the development of human resources and on the energy-related aspects of industrialization.

Sectoral studies and research

Alternative strategies will be developed for intermediate and capital goods industries (iron and steel, engineering, and agricultural machinery), chemical industries (petrochemicals, fertilizers, and pharmaceuticals) and agro-industries (food-processing, vegetable oils and fats, leather and leather products industries). Studies will have been initiated in respect of certain aspects common to all industrial sectors, such as energy supply, environmental implications, industrial water, industrial transport and communications. During the plan period, the scope of the sectoral studies will be widened to cover all important industrial sectors and major common topics in support of the corresponding widening of the scope of the System of Consultations. In close co-ordination with other UNIDO activities, the development of broad sectoral plans for international action in the short term (1986–1990) will be initiated. These sectoral plans relating to the intermediate and capital goods industries, chemical industries and agro-industries will focus on international, regional and subregional co-operation in such areas as technology transfer and development, training, financing and trade policies—particular attention being devoted to Africa. Broad sectoral plans will be developed for the medium term (1991–2000) for the intermediate and capital goods industries, chemical and agro-related industries as well as other important, technologically advanced industries as may be decided by the appropriate decision-making authorities. These sectoral plans will focus on joint action required in major areas of common interest at the international, regional and subregional levels. These short-term and medium-term plans will constitute major inputs into the System of Consultations.

Development and transfer of technology and advisory services

Under certain circumstances, technologies used in developed countries can be applied without modification in developing countries, thus reducing the problem to one of selection, acquisition and assimilation. In general, however, technologies have to be modified or adapted. In many instances, the interests of the developing countries would best be served by the development or upgrading of endogenous technologies, including rural industrial technologies. However, such development is often constrained by the lack of basic skills. Problems of acquisition may be compounded by a relatively weak bargaining position. The developing countries' capacity to negotiate and acquire technologies on reasonable terms, such as licensing and know-how, needs to be strengthened, since the terms have a decisive impact on manufacturing operations.

Technological developments in such advanced fields as bio-technology, micro-electronics, communications and energy have far-reaching implications for the industrial, technological and institutional structure of the developing countries. The problem in many cases is that governments may be unaware of these implications for lack of the technological capacity to assess their technological developments. Strengthening of this capacity can be enhanced by the exchange of knowledge and experience of those technologies. Emphasis will be placed on the transfer of this information.

Industrial and technological information bank and general information services

Despite the volume of information generated throughout the world, a critical deficiency facing many developing countries, in particular the least developed countries, is the lack of access to appropriate industrial and technological information. Such information, including that on environment and energy-related technologies, is fundamental to the establishment of manufacturing activities and essential to the selection of technologies which, in turn, govern the industrial development pattern of a developing country and its balance of payments. The efficient organization and dissemination of a greater volume of industrial and technological information to and in the developing countries must be accomplished. Better methods must be developed to identify and formulate the information requirements of the users. In addition, many users need advice on how to use and interpret the information they receive so as to be able to improve their decision-making processes and broaden their industrial and technological options in general.

Examples of the joint activities in the environmental area are anticipated with the following members of the United Nations family:

(a) FAO for studies relating to the linkages between agriculture and industry and on dissemination of industrial and technological information relevant to agro-industries, including energy;

(b) ILO for research relating to human resource development and the social aspects of industrialization;

(c) UNESCO for research relating to human resource development and particularly to the relationship between education and industrialization;

(d) UNEP for studies and information related to the environmental aspects of industrialization;

(e) WHO for studies related to health and occupational safety;

(f) The World Bank for industrial sector studies and surveys;

(g) United Nations Department of Technical Co-operation for Development, for matters related to industrial water use and treatment practices;

(h) United Nations Centre for Human Settlements (Habitat) for the development of appropriate technologies.

Planning and programming operations

In order to expand or consolidate the industrial sector, most developing countries have to make extensive use of planning and programming techniques. In formulating industrial development strategies in harmony with national objectives and policies, linkages between industry and such key sectors as agriculture, energy and social services must be considered. Local resources have to be channelled into selected fields in keeping with resource allocations, and time sequences established. Options have to be defined and tools developed to select the most acceptable. Despite the progressive development of capabilities in some of these fields, most developing countries need external advice in drawing up industrial development plans and strategies and, given the growing importance of industry, the need continually increases.

Training operations

In developing countries, the need for an institutional infrastructure with effective linkages is particularly critical in order to compensate, at least in part, for the absence of a long tradition of industrial development. The planning and strengthening of this infrastructure has to be fully integrated in the industrial development process. Each country has its unique characteristics, which have to be taken into account in this task.

In most developing countries, it is desirable that there should be institutions concerned with standardization and quality control, industrial research, small-scale industry, rural development, and environmental protection, to name only a few areas. Among the problems to which industrial institutions should address themselves are the underutilization of production facilities in developing countries, which often arises out of the general lack of qualified personnel at the managerial level and the application of outdated management techniques; failure to avoid long delays and cost over-runs in the construction of new plants; and the absence of local management consultancy services. The general scarcity of technical skills of many kinds is one of the major constraints on industrial development, which can only be overcome by the provision of training, ensuring that women are included in its scope.

Examples of specific future projects

Examples of specific projects and programmes that will be developed at UNIDO in the near future are described in the following paragraphs. This set of examples gives only a brief idea of the magnitude of the effort at UNIDO, but it does show the diversity of environmental activities.

A UNEP/UNIDO meeting of experts on environmental aspects of the direct reduction route to steelmaking will be held at Puerto Ordaz, Venezuela, in April 1982. UNIDO will contribute a paper at the meeting. In selecting the appropriate direct reduction technology for a particular location, consideration must be given to the availability of natural resources and environmental questions. Because of the lack of past attention devoted to environmental protection in the vicinity of direct reduction facilities, the meeting has an emphasis on environment.

The first edition of the Manual for the Preparation of Industrial Feasibility Studies has been used extensively throughout developing and developed countries. Because of the wide acceptance of the manual and the need to update the manual, a new edition is being prepared which will more fully emphasize environmental and occupational safety and health considerations. The emphasis in the revised manual will remain practical with the intention of bringing the various feasibility studies into a similar framework to make them more comparable.

In response to resolution 1981/81 of the Economic and Social Council, UNIDO will co-operate with the United Nations Department of Technical Co-operation for Development on the technical and managerial aspects of industrial waste discharges in the context of development, use and protection of international water resources. UNIDO will further co-operate in a programme of exchange of information and experience among international river organizations and interested governments in various regions of the world. UNIDO's location on a major international river (the Danube), places the Organization in a unique position to provide co-ordination and serve as liaison with the Danube Commission.

The secretariat intends to initiate a programme that will consist of collecting and disseminating information on technological development in water use in certain key industries. Water management planning is an essential input of the industrial infrastructure. [49]

Studies will emphasize the growing importance of techniques of conservation, reuse and recycling of water, linked with effluent treatment methods.

UNIDO is planning, with the Economic Commission for Africa and the Organization of African Unity and in co-operation with UNEP, to formulate proposals to implement the Industrial Development Decade for Africa. The Lagos Plan of Action for the Implementation of the Monrovia Strategy for the Economic Development for Africa, adopted by the Assembly of Heads of State and Governments of the Organization of African Unity at its second extraordinary session held at Lagos on 28 and 29 April 1980 will be used as a frame of reference and guide.

Requests for technical assistance on environmental aspects of industrial development are received regularly and carefully considered by UNIDO. Many of these requests result in the preparation of technical assistance projects to provide help to the requesting countries. The development of technical assistance projects is a continuously evolving process.

REFERENCES

1. Biogas Experimental Station of Nanhui County, Shanghai Municipality, Institute of Industrial Microbiology. Report of utilization of waste heat from biogas power generation. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 12 p. (ID/WG.321/4)
2. Chengdu Biogas Scientific Institute. A summary of the economic benefits of production and utilization of biogas at De-Yang County horticultural farm. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 6 p. (ID/WG.321/11)
3. Chengdu Institute of Biogas Research. Design and construction of large-scale biogas digesters in China. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 25 p. (ID/WG.321/5)
4. Hillenmeyer, J. Atmospheric pollution in cement plants: international points of view. Interregional Seminar on Cement Technology. Beijing, China, 9–24 October 1980. 6 p. (ID/WG.326/16)
5. Hollingdale, A. C. Design and operation for low ambient temperature biogas production. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 14 p. (ID/WG.321/7)
6. Institute of Soil and Fertilizer. The utilization of biogas fermentation residue-sludge and effluent. Technical Consultation Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 16 p. (ID/WG.321/10)
7. Inter-Organization Board for Information Systems. Directory of United Nations information systems. 1980. 465 p. (Information systems and data bases, v. 1) (G.V.E.80.0.1)
8. —— Directory of United Nations information systems. 1980. 215 p. (Information sources in countries, v. 2) (G.V.80.0.2)
9. Kiravanich, P. *and* Y. Unkulvasapaul. Pollution control in sugar industry. Joint UNEP/UNIDO Seminar on the Implication of Technology Choice in the African Sugar Industry. Nairobi, Kenya, 18–22 April 1977. 31 p. (ID/WG.247/21)
10. Martinez, A. M. Biogas technology in Mexico. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 22 p. (ID/WG.321/8)
11. Meric, J. P. History of PFA use in France. Interregional Seminar on Cement Technology. Beijing, China, 9-24 October 1980. 14 p. (ID/WG.326/17)
12. National Office for Biogas Development and Extension. Biogas development in China. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 8 p. (ID/WG.321/2)
13. Ru-Chen, C., H. Cong *and* X. Zhi-Ping. A biogas power station in Foshan: energy from night soil. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 9 p. (ID/WG.321/9)
14. Janssens, P. F. Pollution control in shaft kiln factories. Interregional Seminar on Cement Technology. Beijing, China, 9–24 October 1980. 13 p. (ID/WG.326/13)
15. Sichuan Provincial Office for Biogas Development. Biogas utilization. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 23 p. (ID/WG.321/6)
16. —— How the Rongxian County distillery in Sichuan exploits biogas. Technical Consul-

tations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 10 p. (ID/WG.321/3)
17. Southwest Architectural Designing Institute. Collection of simple biogas digester designs. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 54 p. (ID/WG.321/1)
18. United Nations. Guide to pollution control in fertilizer plants. 1977. 22 p. (Fertilizer industry series, Monograph No. 9) (ID/SER.F/9)
    Sales No.: 77.II.B.2.
19. —— Guide to practical project appraisal. Social benefit-cost analysis in developing countries. 1978. 121 p. (ID/SER.H/3)
    Sales No.: E.78.II.B.3.
20. —— Low waste and non-waste technology in the iron and steel industry. 1981. (ECE/Steel/32)
    Sales No.: E.81.II.E.4.
21. —— Manual for the preparation of industrial feasibility studies. 1979. 266 p. (ID/206)
    Sales No.: 78.II.B.5.
22. —— Problems of air and water pollution arising in the iron and steel industry. 1970.
    Sales No.: E.70.II.E.6.
23. —— Report of the United Nations Conference on the Human Environment, Stockholm, 5–16 June 1972. (A/CONF.48/14/Rev.1)
    Sales No.: E.73.II.A.14.
24. United Nations Environment Programme (UNEP). Case study C. El Tablazo Petrochemical Complex. Environmental Impact Assessment of Coastal Area Development. Model Workshop. [*By* E. J. Middlebrooks] 1981. 47 p.
    Unpublished.
25. —— Secretariat report on the environmental aspects of alumina production. UNEP/UNIDO Workshop on the Environmental Aspects of Alumina Production. Paris, France, 20–23 January 1981. 138 p. (UNEP/WS/AI.2 Final)
26. —— Survey of marine pollutants from industrial sources in the West African region. [*By* E. J. Middlebrooks *and others*] 1980. 126 p. (UNEP/IG.22/INF.3)
27. United Nations Industrial Development Organization (UNIDO). Activities of UNIDO. Medium-term plan for the period 1984–1989. 1981. 70 p. (ID/B/C.3/107)
28. —— Composting of urban wastes in developing countries. 1980. 14 p.
    Unpublished.
29. —— Conclusions, recommendations and action programme for UNIDO. Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China. Beijing, China, 4–19 July 1980. 8 p.
    Unpublished.
30. —— Environmental management in industry. Interregional Symposium on Consideration of Environmental Quality in the Policy and Planning of Developing Countries. Geneva, 26 July–1 August 1977.
    Unpublished.
31. —— Environmental pollution control in the agro-industries. 1976. 53 p.
    Unpublished.
32. —— Environmental pollution control in the pharmaceutical industry. 1978. 9 p.
    Unpublished.
33. —— Environmental problems in the fertilizer industry. 1978. 13 p.
    Unpublished.
34. —— Estudios toxicológicos de alga *spirulina* planta piloto productora de proteína de alga *spirulina* de Sosa Texoco S.A. Mexico. [*By* G. C. Cevallos] 1980. 206 p. (UNIDO/IO.387)
35. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission en Angola [*By* A. Margola] 1980. 15 p. (UNIDO/ICIS.157)
36. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission au Bénin. [*By* M. R. Mounier] 1980. 20 p. (UNIDO/ICIS.168)

37. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission au Congo. [*By* A. Margola] 1980. 18 p. (UNIDO/ICIS.158)
38. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission en Côte d'Ivoire. [*By* A. Margola] 1980. 20 p. (UNIDO/ICIS.172)
39. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission au Gabon. [*By* A. Margola] 1980. 18 p. (UNIDO/ICIS.155)
40. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission en Guinée 1980. 27 p. (UNIDO/ICIS.171)
41. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission en Guinée-Bissau. [*By* J. P. Schifini] 1980. 22 p. (UNIDO/ICIS.169)
42. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission en Guinée équatoriale. [*By* A. Margola] 1980. 8 p. (UNIDO/ICIS.154)
43. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission en République-Unie du Cameroun. [*By* A. Margola] 1980. 19 p. (UNIDO/ICIS.156)
44. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission à Sao Tome-et-Principe. [*By* A. Margola] 1980. 9 p. (UNIDO/ICIS.174)
45. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission au Sénégal. [*By* J. P. Schifini] 1980. 45 p. (UNIDO/ICIS.170)
46. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission au Togo. [*By* A. Margola] 1980. 34 p. (UNIDO/ICIS.173)
47. —— Etude des polluants marins d'origine industrielle dans la région de l'Afrique de l'ouest. Rapport de mission au Zaire. [*By* A. Margola] 1980. 13 p. (UNIDO/ICIS.153)
48. —— Final report of the joint UNEP/UNIDO Seminar on the Implication of Technology Choice in the African Sugar Industry. Nairobi, Kenya, 18–22 April 1977. 19 p. (ID/WG.247/22)
49. —— Industrial water use and treatment practices. 1981. 8 p. (ID/B/262)
50. —— In-plant pollution control work in an organic and inorganic chemical plant. 1979. 21 p. (UNIDO/IOD.259)
51. —— Lima Declaration and Plan of Action on Industrial Development and Co-operation. (PI/38)
52. —— Management aspects of composting urban wastes. 1976. 8 p.
Unpublished.
53. —— Means of improving environmental standards in the tanning industry with guidelines for developing countries. International Symposium on Water Resources Management in Industrial Areas. Lisbon, Portugal, 7–11 September 1981. 10 p.
Unpublished.
54. —— New Delhi Declaration and Plan of Action on Industrialization of Developing Countries and International Co-operation for their Industrial Development. (PI/78)
55. —— Organic wastes for fuel and fertilizer in developing countries. [*By* C. G. Golueke *and* L. F. Diaz] 1981. 276 p. (UNIDO/IO.410)
56. —— Overview on energy and environment in the Caribbean area. 1979. 238 p.
Unpublished.
57. —— Pollutants from land-based sources in the Mediterranean. 1977. 75 p.
Unpublished.
58. —— Pollution problems in the edible oil industry. 1976. 29 p.
Unpublished.
59. —— Report to the inter-agency mission to Ghana on environment and rural development. 1981. 24 p.
Unpublished.
60. —— Stone technology and resource development. [*By* A. Shadmon] 1982. 28 p.
Unpublished.

61. —— Survey of marine pollutants from industrial sources in the West African region: Nigeria. [*By* M. R. Mounier] 1980. 27 p. (UNIDO/ICIS.179)

62. —— Survey of marine pollutants from industrial sources in the West African region: Liberia. [*By* E. J. Middlebrooks] 1980. 63 p. (Project number FP/0503-79-18) Unpublished.

63. —— Survey of marine pollutants from industrial sources in the West African region: Sierra Leone. [*By* E. J. Middlebrooks] 1980. 45 p. (Project number FP/0503-79-18) Unpublished.

64. —— Survey of marine pollutants from industrial sources in the West African region: Gambia. [*By* A. G. Rozanov] 1980. 28 p. (UNIDO/IS.188)

65. —— UNIDO for industrialization. Fuels, fertilizers from renewable resources. 1980. 8 p.

66. —— Water use and treatment practices and other environmental considerations in the iron and steel industry. 1981. 40 p. (UNIDO/IS.263)

BIBLIOGRAPHY

Almasy, A. D. Influence of environmental protection on the fertilizer production technologies. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 25 p. (ID/WG.175/7)

Avila, G. J. The fertilizer industry in Mexico and the pollution problem. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 12 p. (ID/WG.175/23)

Behari, B. Environmental implications of different sugar technologies with special reference to India. Joint UNEP/UNIDO Seminar on the Implication of Technology Choice in the African Sugar Industry. Nairobi, Kenya, 18–22 April 1977. 36 p. (ID/WG.247/4)

Berriola, T., G. Gramatica *and* L. Mariani. Environment and plant protection in the operation of centrifugal compressors of a large ammonia plant. Interregional Meeting on Safety in Production, Transportation and Storage of Fertilizers. New Delhi, India, 8–10 December 1980. 18 p. (ID/WG.333/7)

Bingham, E. C. Solutions for minimum pollution in nitrogen fertilizer plants. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 47 p. (ID/WG.175/10)

Brazzel, J. R. The role of pesticides in modern pest management practices. Workshop on Pesticides. Vienna, Austria, 28 May–1 June 1973. 25 p. (ID/WG.154/14)

Codd, I. Pollution control and the iron and steel industry. Third Interregional Fertilizer Symposium on the Iron and Steel Industry. Brasilia, Brazil, 14–21 October 1973. 50 p. (ID/WG.146/114)

Connor, J. M., G. J. Dell *and* D. J. Newman. Pollution control in acid plants. Second Interregional Fertilizer Symposium. Kiev, USSR, 21 September–1 October 1971; New Delhi, India, 2–13 October 1971. 41 p. (ID/WG.99/28)

Dave, J. M. Environmental pollution from fertilizer production in India—some case studies. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 42 p. (ID/WG.175/9)

Dijkastra, F. Measures to minimize aqueous waste pollution from fertilizer plants situated in an integrated chemical complex. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 32 p. (ID/WG.175/11)

Enkegaard, T. Conservation of energy in cement manufacture: fuel and power consumption. Interregional Seminar on Cement Technology. Beijing, China, 9–24 October 1980. 43 p. (ID/WG.326/9)

Fritz, M. Governmental responsibility in energy and environmental politics. Workshop on Fermentation Alcohol for Use as Fuel and Chemical Feedstock in Developing Countries. 1979. 21 p. (ID/WG.293/9)

Geyer, F. Fume cupboards and exhaust system. Expert Group Meeting on Building and Facilities, Design and Lay-out for Industrial Research and Development Centres. Innsbruck, Austria, 23–27 September 1974. 5 p. (ID/WG.181/7/Add.1)

Hatfield, W. R. The purification of gaseous waste streams from nitric acid plants which contain nitrogen oxides. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 24 p. (ID/WG.175/6 and Rev.1)

Huq, A. Pollution from fertilizer plants in Bangladesh. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 26 p. (ID/WG.175/13)

Jojima, I. *and* T. Sato. Pollution abatement in an urea plant. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 21 p. (ID/WG.175/14 and Summary)

Kivela, I. Minimizing pollution from phosphate fertilizer plants including captive acid plants. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 37 p. (ID/WG.175/12)

Lora, F. *and* A. Masia. The influence of effluent standards on the economics of alternative wastewater treatment designs. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 13 p. (ID/WG.175/4)

Mackay, P. W. *and* J. M. Pena. Economic aspects of using a gaseous direct-reduction process in a developing country. Third Interregional Symposium on the Iron and Steel Industry. Brasilia, Brazil, 14–21 October 1973. 28 p. (ID/WG.146/86)

McGill, W. A. *and* M. J. Winbaum. The use of the alonizing process in sulfuric acid plant construction. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 22 p. (ID/WG.175/5)

Miller, J. R. *and* T. M. Barnes. Steel making and the environment in the developing nations. Third Interregional Symposium on the Iron and Steel Industry. Brasilia, Brazil, 14–21 October 1973. 35 p. (ID/WG.146/58)

Olivares, D. J. Notes on the elimination of NO_x in tail-gas in medium-pressure nitric acid plants. Preliminary study of a new absorption process. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 15 p. (ID/WG.175/2)

Pickett, J. Measuring the environmental and economic impact of alternative technologies. Joint UNEP/UNIDO Seminar on the Implication of Technology Choice in the African Sugar Industry. Nairobi, Kenya. 1977. 20 p. (ID/WG.247/14)

Pickett, J. *and* F. Duguid. Environmental and economic impact of alternative agricultural sugar technologies. Joint UNEP/UNIDO Seminar on the Implication of Technology Choice in the African Sugar Industry. Nairobi, Kenya, 18–22 April 1977. 24 p. (ID/WG.247/12)

Popovici, N. Fertilizer industry—environment pollution source. Technical solutions and technological advances made in Romania to control environmental pollution effects. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 46 p. (ID/WG.175/18)

Rees, T. D. Impurities in water: some industrial implications and methods of removal. ***Industrial research and development news*** (United Nations publication) 7:2:12–17, 1975. (ID/SER.B/20)

Reynolds, J. Environmental regulations confronted by fertilizer producers in the United States. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 20 p. (ID/WG.175/25)

Sander, G. Economic evaluation of chip and dust exhaust equipment. Seminar on Wood Processing Industries. Cologne and Hannover, 16–30 May 1979. 29 p. (ID/WG.296/4/Rev.1)

Shabab, M. Hydrodesulphurization of fuel oil using Co-Mo catalysts. Expert Group Meeting on the Transfer of Know-How in the Production and Use of Catalysts. Bucharest, Romania, 26–30 June 1972. 6 p. (ID/WG.123/10)

Steininger, E. Utilization of by-products from the wet phosphoric acid production to prevent environmental pollution. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 19 p. (ID/WG.175/15)

Swank, R. R. Federal legislation and discharge limits (air–water) for fertilizer manufacturing plants in the United States. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26–31 August 1974. 25 p. (ID/WG.175/21)

United Nations. Industrialization and productivity, Bulletin 4.
Sales No.: E.60.II.B.2

United Nations Environment Programme (UNEP). The system-wide medium-term environmental programme. Note by the Executive Director. Presented at Governing Council, Ninth Session, Nairobi, 13-26 May 1981. 36 p. (UNEPO/GC.9/7)

—— Workshop on the environmental aspects of the iron and steel industry. 1978.

United Nations Industrial Development Organization. Agenda and programme of work. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26-31 August 1974. 5 p. (ID/WG.175/1/Rev.2)

—— Air pollution by aluminium plants in developing countries. [*By* D. Altenpohl *and* R. E. Frankenfeldt] UNIDO/ECE Seminar on the Control of Emissions from the Non-ferrous Metallurgical Industries. Dubrovnik, Yugoslavia, 1973. 42 p.
Unpublished.

—— Co-ordination. Co-ordination of activities with other United Nations bodies and organizations in the field of industrial development. Presented at the Industrial Development Board Permanent Committee, 16th session, Vienna, 16-20 November 1981. 13 p. (ID/B/C.3/110)

—— Determinación de residuos de plaguicidas en alimentos por cromatografia gas-liquido. [*By* J. A. Matoses] 1977. 14 p. (UNIDO/IOD.75)

—— Directory of industrial information services and systems in developing countries. 1981. 103 p. (UNIDO/IO.205)

—— Dust control (quarrying). 1975.
Unpublished.

—— Energy conservation in non-metallic based industries. [*By* J. Drevo *and others*] UNIDO-Czechoslovakia Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals-based Industries. 1980. 217 p.

—— Environmental aspects of the pulp and paper industry. [*By* C. G. Geijer] 1975. 173 p. (UNIDO/ITD.349)
Restricted distribution.

—— Environmental problems of the petrochemical industry. 1977. 58 p.
Unpublished.

—— Expert Group Meeting on the Study of Synthetic versus Natural Products. Vienna, Austria, 16-20 September 1974. (UNIDO/ID/WG.188/1-12)

—— Fermentation and wastes disposal. Expert Working Group Meeting on the Manufacture of Chemicals by Fermentation. Vienna, Austria, 1-5 December 1969. 5 p. (ID/WG.50/9)

—— Final report. [*By* C. G. Martin] Seminar on Industrial Development and Environmental Pollution. Baghdad, 14-16 November 1976. 27 p. (UNIDO/IOD.53)

—— Industrial and technological information bank helps developing nations choose technology. 1979. 9 p. (PI/68)

—— Industrial effluents and trade waste disposal, Thailand. Terminal Report. 1971.
Unpublished.

—— Light-weight aggregate from urban sewage slime. *In* Technologies from developing countries, vol. II. 1978. p. 63. (ID/WG.282/65)

—— Locating industry: environmental considerations. *Industrial research and development news* (United Nations publication) 8:2:8-11, 1975. (ID/SER.B/20)

—— Man-made fibre developments—raw materials and the environment. [*By* W. Albrecht] Group Training Programme in the Field of Production and Application of Synthetic Fibres. Vienna, Austria, 1979. 27 p.

—— Means of achieving improvements in environmental standards in the tanning industry—environmental assessment and management. Second Leather and Leather Products Industry Panel Meeting. Vienna, Austria, 5-7 February 1979. 21 p. (ID/WG.290/5)

—— Minimizing pollution from fertilizer plants. Report. Expert Group Meeting, Helsinki. 1974. 38 p. (ID/WG.175/19) (ID/140)

—— Report concerning the enlargement of the industrial steam power station and principal design of biological treatment of waste waters from Fabrika Celuloze I Viskoze, Banja Luka, Yugoslavia. [*By* G. Berg *and* J. Rennerfelt] 1973.
Unpublished.

—— Small scale chemical recovery units. Survey of highly efficient chemical recovery units for small pulp and paper mills in developing countries. [*By* P. Benziner *and* F. Opderbeck] 1980. 44 p. (UNIDO/IOD.350)
—— Study on the disposal and utilization of bauxite residues. Final report. [*By* J. Csutkay *and others*] 1980. 137 p. (Project number UC/INT/79/222)
Unpublished.
—— Tannery effluents: Brazil. [*By* D. Winters] 1979. 29 p. (UNIDO/IOD.323)
—— The impact of industrialization on environmental health. 1979. 27 p. (ID/CONF.4/13)
Whalley, L. Modern technology for minimizing pollution from fertilizer plants. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26-31 August 1974. 25 p. (ID/WG.175/8)
Wirjoasmord, A. Some environmental problems in developing fertilizer industry with reference to Indonesia. Expert Group Meeting on Minimizing Pollution from Fertilizer Plants. Helsinki, Finland, 26-31 August 1974. 2 p. (ID/WG.175/22)
Zhigang, Q., J. Zhigan *and* W. Yiguin. Methods of evaluation and prospects of utilization of waste and brown coal as fuel and raw materials in the cement industry. Interregional Seminar on Cement Technology. Beijing, China, 9-24 October 1980. 17 p. (ID/WG.326/1)

Printed in Austria
V.82-21491—April 1982—3,000

ID/282