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HEALTH RELATED IMPACTS OF ENVIRONMENTAL CHANGE¹

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¹ Prepared jointly by the Pan American Sanitary Bureau and the School of Public Health, University of Texas at Houston

HEALTH RELATED IMPACTS OF ENVIRONMENTAL CHANGE

Resume

The following discussion of factors governing the health consequences of environmental change in the Americas has been composed as a background reference for the Technical Discussions of the XX Meeting of the Directing Council.

Demographic trends and available indices of the health and well-being of peoples, projections of economic growth associated with environmental alteration, and estimates of agricultural activity together imply that the next ten years will see sharply increased strains on national efforts to maintain a state of acceptable life quality within a set of rapidly changing physical, social, and, perhaps, political circumstances. The need, recognized in the Charter of Punta del Este, to affect basic sanitation through provision of clean water and effective waste management requires further response. Substantially higher priorities must be accorded not only to the condition of air, water, and food resources, but also to the stresses of overcrowded homes, occupational hazards, and cultural displacement produced by technological advance and exploitation of natural resources. All of the American nations are engaged in accelerating processes of economic growth; in consequence, all are changing the environments within which their peoples live. To understand the impact of these changes on health and well-being, and to plan and execute actions which will minimize adverse effects on people, is a major challenge of these times.

Specific needs for environmental intervention are apparent, e.g., water service and sewerage deficiencies, heavily polluted air in some large cities, and sprawling slums. In other situations, in which substantial environmental alteration is anticipated as the result of industrial growth, power production, or regional water-use developments, experience has demonstrated need for careful examination of the entire ecological complex to enable anticipation and circumvention of health consequences. Further, it must be assumed that environmental changes not presently discernible will emerge during the seventies; provision for their consideration and possible shaping by agencies concerned with health will be needed.

Because the primary initiative for and management of economic and resource development projects normally are vested in national agencies not directly concerned with health, a primary consideration of health ministries should be the nature of the planning and administrative instrumentalities for effective participation with other sectors of public responsibility. Processes of environmental management are modified locally by the nature of command, basic political philosophy, degree of public participation, and availability of funds. Their effectiveness is moderated by the adequacy

and accuracy of demographic, health, and other information available and by the skills of personnel assigned to identify associations among environmental changes and the health and well-being of people.

To provide for appropriate inclusion of health considerations in national economic development there is need for (a) a legal basis for intervention, (b) an adequate mechanism for evaluation of environmental changes and their effects, and (c) the development of a cadre of skilled analysts able to participate with representatives of other special interests in planning and applying environmental interventions affecting the prosperity of the entire nation.

The Pan American Health Organization has demonstrated the effectiveness of international cooperation as an efficient, economical means of prosecuting health-related programs.

Our purpose here is to recognize and plan the implementation of appropriate cooperative actions for the next decade. Recommended areas for consideration include:

1. Intensification of the effort to stimulate rapid development of sufficiently trained engineers, systems analysts, epidemiologists, planners, administrators, technicians, veterinarians, agricultural technologists, sanitarians, inspectors and other skilled personnel oriented toward environmental health and ecological systems analysis. For the immediate future, reliance on the relatively slow pace of academic programs will not suffice. There is urgent need for intensive short courses conducted by mobile teams at properly equipped and staffed training centers to which selected students could be temporarily transferred.
2. Organization of a centralized program of data processing and information retrieval operated in the common interest of the nations of the Region.
3. Development of a system of hemispheric environmental surveillance, including remote sensing from satellites or aircraft.
4. Provision of expert counsel to Member States in the formulation of environmental health programs and policies.
5. Initiation of patterns of organized international environmental services in response to major natural disasters.
6. Sponsorship of evaluations of environmental threats affecting more than one of the Member Governments.
7. Stimulation and encouragement of applied research with primary emphasis on simple, economical methods of environmental and health analysis, and the adaptation of local materials and levels of skill to immediate needs.

8. Intensification of the international effort to assist Member Governments in funding essential environmental health programs.

9. Provision of support for exchange of publications and organization of sources of environmental information.

Such a complex of functions could become operative with maximal effect at minimal cost through the development of a PAHO regional mechanism or center for human ecology as related to health with such functions as:

1. Acceleration of manpower development.
2. Central data processing, analysis, and application.
3. Liaison with the several existing PAHO regional centers, and with activities of international agencies in the Americas as their functions relate to environmental aspects of the health and well-being of people.

In whatever location the center is eventually developed, it should be an objective of the Organization to associate itself with academic, governmental, and private agencies in such manner as to achieve maximal progress toward its environmental health goals, so that, by functional association with groups having parallel objectives, PAHO can mobilize for the benefit of the countries of the Region resources beyond those directly available.

The challenge of the present, the next decade, and the future beyond, is to mobilize and use resources effectively to assist human adjustment to induced changes in the environment, to understand the effects of the continuing changes, to plan compensatory or protective actions, and to fulfill programs with minimal adverse feedback or economic burden: these are the keys to useful operations.

HEALTH RELATED IMPACTS OF ENVIRONMENTAL CHANGE

I. Introduction

Environmental contamination has increased during the sixties and will continue in this trend through the seventies and beyond so long as populations expand and the per capita production of goods and energy escalates with advances in technology. "Environment" and "ecology" have become key words in major issues influencing political and social decisions at all levels of government. These issues relate directly to the effective utilization of limited resources available to governmental and political subdivisions.

Of particular significance are their implications for the functions of public agencies concerned with the people's health and well-being. Problems of the human environment today go far beyond the traditional bounds of basic sanitation; challenges to public health have broadened from those related to microbiological contaminants to those generated by a newly prominent array of stresses associated with toxic chemicals, noise, ionizing radiation, mechanical hazards, and the related stresses of congestion, poverty, ignorance, drug abuse, and crime, with their consequences in cancer, fractures, burns, poisonings, alienation, genetic defects, and brain damage.

The statesmen of the world face a task more difficult than any which has faced those in responsible positions at any time in history. Public health ministries must define more clearly trends of environmental change and their projections into the future, and must adapt the content of programs and administrative structures and processes to cope effectively with the imminent threats. This is an extremely difficult task requiring substantial reorientation of perspectives, strategies, and health practices. Among its more difficult actions is to define, in clear terms, the services and regulatory steps that organized public health structures should take. How are the resources and facilities of public health agencies to be coordinated with those of entities charged with the design, construction, and operation of urban public works governing environmental change - such as urban water systems, sewer works, and air- and water- and land-pollution abatement actions? How are the health agencies to participate in consideration of environmental problems, such as controls on the utilization and composition of fuels used for heat, for energy, and for transport; the design of effective pollution abatement devices; the control of persistent chemicals used, for example, as pesticides, herbicides, and fertilizers; the surveillance of consumer products for hazardous materials, such as mercury, cadmium, and an increasing variety of organic and inorganic compounds; in the prevention of transport disasters such as oil spills and crashes involving radioactive or toxic substances; and in economical management of solid wastes?

These illustrative but by no means inclusive tasks suggest the variety of factors in the man-environment relationship, and emphasize the need

for effective lines of communication and networks of collaboration among governmental entities having jurisdiction over activities affecting the human environment.

The health professions are challenged to redirect their epidemiologic approaches and practices, especially to gear studies to the speed of environmental changes and to their pervasive effects. To an increasing extent, many of the newer environmental impacts are quite subtle, long-range, with wide separation of the primary agents from the ultimate effects. For this reason, the epidemiologist today seeks to anticipate social and physical effects as he weighs carefully the projections of environmental change.

Those responsible for public health programs have an opportunity to take the initiative to develop programs to meet the challenge of the decade of the seventies. It is important that goals be established to keep environmental pollution below levels that can be identified as altering the natural ecological system to an extent that is disastrous to human health and well-being. The establishment of criteria and standards and the development of the means of environmental surveillance and control are central to these objectives. Public health agencies have the duty and responsibility to exercise their influence and to establish such goals and criteria. It is in the light of these considerations that some factors are set forth below for the use of the participants in the Technical Discussions. The scope of environmental health has been summarized in WHO Techn. Rep. Ser., 1970, No. 439 as follows:

- (1) World water supplies, with special reference to the provision of adequate quantities of safe water that are readily accessible to the user, and to the planning, design, management and sanitary surveillance of community water supplies, giving due consideration to other essential uses of water resources.
- (2) Waste water treatment and water pollution control, including the collection, treatment and disposal of domestic sewage and other water-borne wastes, and the control of the quality of surface water (including the sea) and ground water.
- (3) Solid waste management (including sanitary handling and disposal).
- (4) Vector control (including the control of arthropods, mollusks, rodents and other alternative hosts of disease).
- (5) Prevention or control of soil pollution by human, animal or plant life.
- (6) Food hygiene (including milk).
- (7) Control of air pollution.
- (8) Radiation control.
- (9) Occupational health (in particular, the control of physical, chemical and biological hazards).
- (10) Noise control.
- (11) Housing and its immediate environment (in particular the health aspects of residential, public and institutional buildings).
- (12) Urban and regional planning.
- (13) Environmental health aspects of air, sea or land transport.
- (14) Accident prevention.
- (15) Public recreation and tourism (in particular, the environmental aspects of public beaches,

swimming pools, campsites, etc.). (16) Sanitation measures associated with epidemics, emergencies, disasters and migrations of populations. (17) Preventive measures required to insure that the general environment is free from risk to health.

The specific applicability of these several categorical areas to the regional problems of the Americas is to be determined soon. A major task of the Member Governments of PAHO is to identify environmental forces or conditions requiring immediate attention.

II. Health Criteria for the Environment

A healthful environment, in essence, is one which supports the survival and enjoyment of human life with the least exposure to destructive stresses. In general, its basic components are a safe water supply, low in radioactive, toxic, and pathogenic agents or their carriers, and sufficient to support the cultivation of food and to dilute or wash away pathogenic agents or their feeding and breeding places; a basic nutritional allowance for each family; and air reasonably free of offensive or noxious substances, fumes, or biologic agents. In modern times, health agencies have become progressively concerned also with stresses introduced by industrial technology, noted above.

Many significant problems of environmental health can be identified by examination of health statistics relating to the nature and incidence of diseases that are caused or affected by environmental factors; the correlation of environmental factors with life expectancy; and the general state of physical, mental, and social well-being, again correlated with environmental factors. While the necessary data may be drawn from many available sources, among the most important are the census; registrations of births, deaths, and marriages; field surveys; clinical studies; hospital and clinical records; records of insurance benefits for occupational or traffic injuries; and epidemiologic investigations by government departments, universities, or other agencies. Trends revealed by analysis of these data may be interpreted in relation to environmental factors only if comparable data from non-health-related fields are available. Correlative data with respect to the physical and biological factors in the environment, including conditions of air, water, soil, space, sunlight, vegetation, domestic and wild animals, and microorganisms may be useful. Similarly, data on housing, land use and planning, transportation, levels and patterns of production, food, industries, social relations, and cultural conditions may contribute heavily. The WHO select committee on national environmental health programs declared, "Information on these elements of the environment must be sought from a variety of sources in government departments and elsewhere and will include environmental pollution measurements, water resource analyses and industrial and agricultural trend analyses, food and nutrition statistics, consumer statistics, transportation and traffic statistics, etc. Such data will reveal a broad and complex pattern of man's relationship to his environment. Environmental

health epidemiology will supply important numerical information for the problem-defining process. Nevertheless, the amount of data available is sometimes limited and the accuracy of data in some cases is doubtful."

The requirements for safety, comfort, convenience, and other qualities in the living environment vary substantially from one region to another. The "needs" oriented approach is sometimes more workable as a means of defining problems and influencing officials who make decisions than is the careful analysis of surveillance and epidemiologic data.

Surveys of environmental health related to water supply, air pollution, soil contamination, solid waste disposal, zoonoses, food control, vector control, and occupational hazards have in common revealed the need to develop more relevant epidemiologic bases for identifying environmental priorities. In a few cases, the information available shows an incontrovertible need for action. More often, the type and dependability of information are such that conclusions derived from the data may be questioned.

Data on environmental health are more abundant for urbanized areas of the Americas than for the rural regions, although, outside of the United States of America and Canada, about one-half of the total population of the Member Countries is rural. Predictions of current trends in urban health would seem to be questionable without further knowledge of the health of rural populations tending to migrate into the cities.

III. Directions of Change - A Scenario for the Future

The several American nations represent a wide variety of stages of economic development, aggregates of resources, ethnic and demographic compositions, cultural bases, political philosophies and structures, and geographic and climatologic settings. Even within the individual nations great variation is apparent and may be presumed to govern the speeds and qualities of emergence into new levels of interaction among men and the environments they exploit. No single pattern of priorities in the several aspects of environmental management can be expected to meet the specific requirements of each element within so heterogeneous a group. No plan of action can assume that the manifest existence of a community of interests guarantees uniformity in the extent or quality of action by the several Member Governments of PAHO.

The Member Governments have common interests in commerce, finance, transportation, subsistence-dependence, resource development, and others; there is no aspect of threat to the health of population within Member Countries which fails to concern all the others; but, whatever scenario materializes during the decade of the seventies, there will be individual elements of local, regional, or national responsibility, many tasks requiring coordinated action among contiguous nations, and some of such hemispheric

dimensions as to be dealt with only through multinational instruments. In any event, it is assumed that individual Member States will benefit from common association in analysis of alternative strategies, education of essential manpower, environmental surveillance, data analysis information sharing, and research on effective economical engineering controls.

Population and Demographic Changes

Basic to any evaluation of change in the circumstances of living during the next decade are population data. Most of the American nations have conducted censuses in the 1960's and earlier. Data from the 1970's for 13 countries are not yet available; six countries will act in 1971, four in 1972, and one in 1973. It is doubtful that the new data will indicate substantial shifts in demographic trends.

Population growth rate in Latin America in the past decade has been the highest of any large region of the world, reaching 2.9 per cent per annum in the years since 1960,¹ as compared with 1.4 per cent per year in North America. In 1970, the estimated population of the United States of America and Canada (227 million) was 45 per cent of the regional total, and that of Latin America (283 million) was 55 per cent.² The same source estimated that by the year 2000 the projected populations would approach one billion for the Region, nearly two-thirds of the total (638 million) in Latin America. Thus, any plan of action relative to health must contemplate a long-range increase to about two-and-a-half times the number of human units for which provision must be made through programs completed or initiated in the 1970's.

Almost all the Member Countries of PAHO are experiencing an accelerating process of urbanization. The migration of agricultural populations into metropolitan centers is proceeding in Latin America even more rapidly than it has in North America since the second decade of the century. Housing shortages, lack of employment opportunities commensurate with the generally low educational level, and lack of skills among the migrants have combined to create huge central or peripheral enclaves of undernourished, ill-housed, semidesperate, and often hopeless people.

Growth in population and its supporting activities, especially as organized into cities, has intensified problems of solid waste disposal, noise, radiation, and a wide variety of occupational risks. The urgency of need for regulatory or abatement programs in these areas varies widely from one location to another within the Region and may well comprise a group of secondary priorities in most places during the current decade. But they are sufficiently in the public consciousness to demand surveillance and evaluation programs as a minimum.

¹The Monthly Bulletin of Statistics, U.N., January 1970.

²PAHO Sc. Pub. No. 207.

In North America, less than 30 per cent of the population remain rural, and urbanization shows little indication of slackening its pace. The sanitation and welfare burdens imposed on the cities are threatening city finances, protective facilities, and desirable levels of civil order to such an extent that there is general acceptance that part or all of the welfare payments will have to be assumed by the national government.

Agricultural productivity in the United States of America and Canada has steadily improved despite the loss of rural manpower, as there has been simultaneously dramatic progress in agricultural technology. In many Latin American nations, in contrast, agricultural production and distribution, never adequate to the nutritional needs of some, has steadily declined with departure of field hands and limited replacement by machines. In nations where the economies are dependent largely on single commodities such as petroleum, copper, beef, or bananas, the basic need for imported food puts additional urgency upon the exploitation of the exportable resource. The exigencies of mere existence place more and more severe economic restrictions on the provision of basic sanitation and relegate expenditures for more sophisticated programs of education and human welfare to low orders of priority.

The PAHO publication, Health Conditions in the Americas 1965-1968 (Sc. Pub. No. 207), points out that "the age composition of a population helps to project the principal health problems and the population groups for which health services must be provided." High percentages in the under-15 age group throughout most of Latin America favor a high priority for maternal and child health services. They also make painfully apparent the rapid acceleration of need for basic sanitation and the increasing difficulty of coping with health problems related to lack of employment opportunity and consequent nutritional, psychological, and social deterioration. For one Latin American area it has been estimated that, with the realization of the most optimistic projections of economic and industrial development, the fact that 49 per cent of the present population is under 15 years of age assures 10 new job seekers for every three new job opportunities during the next decade. Obviously, many of the problems of the next decade cannot be solved by population control programs, for the workers and consumers of the next generation already are here.

Age composition of the populations also contributes important indices of the capacity of a nation to generate and sustain processes of change in human and economic welfare without external assistance. The economically active population in Latin America, constituting one-third of the total population, will have a dependent group for which to provide, on an average, two persons for each worker (PAHO Sc. Pub. No. 207, 1970). Couple this expectation with the persistent low per capita income within the Region (cf. Annex X), and the result challenges the ability to generate locally the large capital and operating funds necessary to achieve those sanitation goals set forth in the Charter of Punta del Este that were not achieved within the decade of the sixties. For the Region as a whole, the GNP per capita averaged

under US\$400 (1968), with one Member State at the extreme low of about US\$86. This compares with approximately US\$4,000 for North America. The Charter of Punta del Este set a goal of 2.5 per cent per capita per year increase in the GNP for each country in Latin America. Actual progress seems to have been commensurate with this goal in some states, though not all; however, the real gain in the indicated trends is difficult to assess because of evident wide differences in currency inflation and in internal procedures of analysis and reporting.

Direct and indirect inferences as to trends and rates of environmental change often result from analysis of vital and health statistics (cf. Annex X). The combination of persistently high birth rates, declining death rates in younger and middle age groups, and increasing life expectancy clearly indicates that most of the Latin American nations will be faced with rapidly increasing growth rates (2.9 per cent per annum), heavier population burdens, and increasing numbers of dependents relative to income producers during the next decade. These lead directly to increased environmental pollution and to increased environmental stresses with specific disease outcomes.

The Charter of Punta del Este projected similar trends for the sixties; there have been few apparent changes to indicate a qualitative change for some years ahead. From the numbers contemplated and their distributions (e.g., rural-urban populations), it is possible to project some aspects of the basic sanitation and environmental protection requirements for the near future.

Unless provision is made for foodstuffs in sufficient volume and of satisfactory quality to maintain a reasonable nutritional level for the present populations plus an equal number to be added, hunger will severely handicap environmental management programs designed to prevent disease and promote higher orders of human well-being.

A number of Latin American nations do not now produce enough food for their own needs. In some, the available agricultural areas are insufficient, while in others much arable and potentially productive land remains idle.

Water

Among the nations of the Region there is a strong correlation between absence of water piped in residences and death rates from infectious enteric diseases and parasitic diseases. As progress is made toward provision of safe water to larger fractions of the population, proportionate reductions in morbidity and death rates may be expected.

However, the availability of water will alter human waste disposal practices, with a shift from burial and land surface deposition of semisolids to soak-fields or sewerage connections to permit management of large volumes of relatively dilute sewage. If these liquids are permitted to contaminate

surface and ground waters and to discharge into lakes, streams, and estuaries without treatment, the potential benefits of water availability may be offset by wider dissemination of disease agents and by destruction of sources of sea food. Enormous tasks of disposal and treatment of domestic wastes face all the rapidly growing cities of the Hemisphere.

A simultaneously developing threat to water quality is that of waste discharges from the burgeoning industrial, mining, refining, and agricultural operations which must expand if the essential rise in economic base is to be achieved. Indices are available to relate units of production to volumes and qualities of wastes and to the costs of their management and safe disposition. While the heavily industrialized nations of the world have thus far failed to check these man-induced deteriorations in quality of water supply, careful planning of new ventures can often substantially reduce their environmental impact at reasonable cost. The wide variation in quantities of surface and ground waters from one geographic region to another in Latin America and the Caribbean countries will obviously govern the level of priority to be applied to the protection of local receiving waters; towns in a semidesert area will be more scrupulous in conserving water quality than will a city at the mouth of a large river system.

Air

Air pollution, already a matter of major concern in North American cities, has emerged, as predicted, in urban areas of Latin America, generally in direct relationship to the degree of urbanization and industrialization and use of gasoline-powered vehicles.

The projected growth of cities in Middle and South America and the increasing emphases on industrial and basic resource development, together with local meteorologic and topographic data, make it possible to predict disturbing or genuinely hazardous emergences of air pollution affecting a large part of the peoples of Latin America. The need for air quality surveillance and control programs, including policing of sources and preconstruction considerations of plant sites and abatement equipment, has already been recognized but will require far more substantial response during the next decade.

Biocides

Among the difficult aspects of environmental management in the interest of public health is that relating to the introduction of hazardous substances into the nutritional chain by actions primarily beneficial to agricultural and industrial production and pest control. Materials such as some chlorinated hydrocarbons, organo-metallic compounds of some types, heavy metals used sparingly in some methods of metal refining, and miscellaneous defoliants, insecticides, and food additives have been found successively to persist in the environment and to remain hazardous per se with

continued human ingestion over long periods. Some accumulate in man at the apex of natural food pyramids in acutely toxic concentrations.

There is and will continue to be great pressure to restrict or abolish the use of such substances (e.g., DDT). Such restrictions may lead to increased mortality from insect-borne diseases or to starvation due to reduced agricultural production with damage far beyond the consequences of continued use. Rational environmental regulation will require careful benefit-cost consideration relative to the entire man-centered ecologic system. Will more be gained by use than by restriction of hazardous products or other forms of pollution?

Multinational Concerns

A variety of environmental changes now in progress or predicted in the near future, as results of planned industrial, agricultural, transport, and other human interventions, will emerge more clearly during the decade of the seventies as matters directly affecting more than one American state. Regional developments of water use systems will affect water quality in the several political divisions in the system, will have the potential to spread water-related parasitic disease paralleling the proliferation of irrigation ditches, and will eventually alter the ecological infrasystem upon which marine fishing industries are dependent.

Pollution of the air is also an international concern. This concern results not merely from the proximity of major polluting cities of one nation to the boundaries of another but also from local contributions of carbon dioxide and particulate matter to the worldwide increases in these air-borne substances now believed to threaten significant changes in regional climatology and even in global temperature averages.

Pollution of international bodies of water and the associated coastal and estuarine waters of the several nations may command increasing attention during the new decade and beyond. North America has witnessed the "death" of at least one of its Great Lakes and must take prompt, drastic, and costly action to prevent destruction of others. Expected intensification of industrial activities involving release of water-borne wastes and agricultural by-products in North America, Middle America, and contiguous portions of South America threaten the waters of the Gulf of Mexico, especially when added to the petroleum spillage and oil drilling activities in shelf areas of the Gulf itself (1 M³ of Middle East oil can spread to form a circle of 48 M in diameter in 10 minutes).

With the prospective growth of tourism and other forms of interchange among the Member States, there may be need for intensification of programs to prevent the spread of a variety of infectious diseases and their vectors. Eradication, immunization, and quarantine programs will demand evaluation and perhaps major improvement.

Without exception, the American states have concern with the existence and potential spread of zoonoses in endemic form in several parts of the Hemisphere. Not only do these constitute potential reservoirs of human disease but, perhaps more importantly, they (a) restrict full economic development of some nations because of necessary embargoes on export of animals and animal products, and (b) sharply reduce production of foodstuffs sorely needed to sustain a minimal nutritional level in the human population. For example, it has been estimated that the 30 per cent average annual loss in milk production caused by bovine tuberculosis in one Latin American country is the economic equivalent of all the foreign aid received by that country.

It is obviously possible to continue this categorization of problems of the seventies ad infinitum. But most of the types of emerging change have been dealt with in detail in earlier WHO and PAHO publications. From a rapid overview, one is impressed by the interrelationships and overlaps encountered even in a general consideration of their natures. Environmental health, as used here, denotes the concept of dynamic ecological balance between man and his environment necessary to his physical, mental, and social well-being. As communities achieve higher levels of organization and complexity, they generate new ranges of environmental problems which are seldom in precisely the same form, encountered in the same order, or at the same rates. The challenge will therefore be met not so much by projection from past trends as by provision of instrumentalities competent to maintain constant surveillance, relate environmental control needs to other national priorities, set clear policy objectives, design appropriate legislation, and assure effective management of environmental change.

DEMOGRAPHIC, ENVIRONMENTAL, AND ECONOMIC DATA ON TWENTY-SIX COUNTRIES

Part I

Country	Population (Millions)	Urban/Rural Pop. (%)	Density No. Mi ²	Per Capita Income (US\$)	GNP	Exports (Millions US\$)	Imports
Argentina	24.3	70/30	22.4	800	18,400	1,370	1,170
Barbados	.3	35/65	1,517.	428	--	40	84
Bolivia	4.6	35/65	11.3	165	719	153	152
Brazil	93.3	46/54	27.6	350	32,000	2,270	1,660
Canada	21.4	74/26	5.5	2,087	62,300	13,860	13,240
Chile	9.8	70/30	32.	465	6,200	933	920
Colombia	21.2	53/47	46.5	262	5,000	558	644
Costa Rica	1.8	35/65	82.	380	745	193	254
Cuba	8.4	60/40	180.	310	--	465	1,100
Dominican Republic	4.3	---	---	212	1,030	162	195
Ecuador	6.1	36/64	54.	183	1,650	210	209
El Salvador	3.4	39/61	399.	245	930	220	214
Guatemala	5.1	34/66	123.	264	1,660	259	241
Guyana	.7	34/66	8.1	250	221	128	118
Haiti	5.2	12/88	480.	75	346	40	29
Honduras	2.7	25/75	60.	209	617	172	188
Jamaica	2.0	30/70	445.	431	950	219	383
Mexico	50.7	53/47	64.2	600	30,000	1,170	1,960
Nicaragua	2.0	44/56	37.	347	728	161	185
Panama	1.5	47/53	48.	477	772	120	234
Paraguay	2.4	36/64	15.	192	50	48	62
Peru	13.6	47/53	26.5	241	3,970	865	601
Trinidad and Tobago	1.1	18/82	527.	515	685	466	420
United States of America	204.6	70/30	56.9	3,680	970,000	36,500	35,800
Uruguay	2.9	80/20	40.	537	1,558	179	165
Venezuela	10.8	72/28	28.	902	8,700	2,900	1,460

DEMOGRAPHIC, ENVIRONMENTAL, AND ECONOMIC DATA ON TWENTY-SIX COUNTRIES

Part II

Country	Birth Rate (No./1000 Pop.)	Death Rate (Crude)	Infant Mortality (No./1000 Births)	Illiteracy (% of Pop.)	Life Expectancy (Years)	Water Supply		Sewer Connections
						Urban	Rural	
Argentina	22.	8.	58	9	65	71	10	24
Barbados	22.	8.2	46	3	63-68	100	100	--
Bolivia	44	20.	108	68	50	73	1	10
Brazil	41.5	13.	112	39	55	52	5	12
Canada	17.7	7.4	22	0-3	72	--	--	--
Chile	34.	11.	100	20	59	82	8	25
Colombia	31.4	9.4	90	30	55	82	48	44
Costa Rica	45.	8.	70	15	63	100	61	10
Cuba	28.	8.	38	22	--	90	60	21
Dominican Republic	48.	15.	73	36	58	68	8	4
Ecuador	47.	13.	90	32	54	70	8	21
El Salvador	48.	13.	63	51	58	79	25	21
Guatemala	46.	16.	89	62	50-60	86	10	14
Guyana	40.	10.	40	15	70	100	36	11
Haiti	45.	20.	130	90	47	44	3	2
Honduras	49.	16.	86	55	49	93	11	15
Jamaica	39.	8.	30	15-20	65	99	70	4
Mexico	44.	10.	64	22	60	79	18	30
Nicaragua	47.	16.	103	50	54	87	6	13
Panama	42.	10.	43	20	61	89	19	28
Paraguay	45.	12.	90	26	58	17	6	5
Peru	44.	12.	62	39	53	64	1	26
Trinidad and Tobago	38.	8	42	20	65	100	92	16
United States of America	17.7	9.5	21	2	71	--	--	--
Uruguay	24.	9.	43	9	71	83	10	38
Venezuela	46.	10.	46	24	66	100	60	25

IV. Health Implications of Environmental Change

The environment has been changing throughout the history of mankind, and change will continue in the future. The pace or kind of change may differ; the influence of man on the environment and of the environment on man may shift markedly in different places and at different times; but we may be certain that we will always have to respond to change. While some of the environmental modifications which most interest us today appear to be potentially damaging, if not catastrophic, we cannot conclude that environmental change per se is inimical to man. In fact, by a purely biological measure, that of ability to extend its range, and the concomitant measure of population increase in number, man is the most successful species in the present environment of the earth.

However, the competitive biological success of our species has been achieved largely through environmental manipulation and exploitation. The completeness of our technological dominance of the earth has itself become a threat to the social, spiritual, and cultural well-being of man, and to his ultimate survival. Only recently have we recognized the threat, begun to measure the effects of "progress" on people, and initiated dialogue as to means of lessening our harmful effects upon the ecological system by employment of the intellectual, scientific, engineering, and other skills which created the imbalance in the first place. We now seek continued acceleration of environmental change, but we also seek the means to maintain restorative processes sufficient to cope with the growing demand for material and energy resources, and with the growing rates of proliferation of wastes incidental to their processing.

Infectious Disease

The infective and parasitic diseases have shown a marked tendency to decrease as industrialization and urbanization advance.¹ Diseases prevalent a century ago are still present among us, but at such a low rate in many societies that they are disappearing from the awareness of the layman, if not the physician. Much of the decline in these diseases is due to environmental sanitation or to modification of the human "internal environment" by immunization.

In the case of malaria, the "bonification" schemes in Italy, the clearing of large tracts of jungle in tropical areas and similar schemes have eliminated the disease from large areas. The congregation of man in cities has generally tended to be protective in itself. There have been instances where temporary flare-ups of malaria have occurred when large aggregations of workers were brought together, such as in large hydroelectric projects, but these are generally readily controlled, and the final

¹R. G. Puffer and G. W. Griffith, 1967. Patterns of Urban Mortality.
Sc. Pub. PAHO No. 151, 336 pp.

effect of the environmental change in the area has usually been positive as far as malaria goes. Malaria was eliminated from the vast area served by the Tennessee Valley Authority in the United States of America, largely through managed fluctuations of water levels, but an attempt to apply the same methods to the Volta Lake in Africa did not appear to be feasible due to the varying habits of the malaria vector mosquitoes in the two areas.¹ On the other hand, impoundments or irrigation ditches have also served to increase parasite populations. Attempts at fish culture to improve the nutrition in some African areas resulted in increases in the populations of malaria vectors in the small fish ponds constructed for the purpose.

The growing needs of the developed and particularly the developing nations for hydroelectric and irrigation resources will undoubtedly lead to more and larger river basin development schemes. Biologists, ecologists, and epidemiologists must be brought into planning for these at as early a moment as possible. This is important not only because of malaria, but for a number of other diseases, including schistosomiasis and onchocerciasis.

Schistosomiasis is one of the most debilitating and chronic diseases of the tropics, and it is increasingly man-made because impoundments and irrigation ditches provide excellent breeding sites for the snail hosts of the flukes. This is a matter of serious concern for WHO and other health agencies, since water impoundments are essential for the agricultural and economic development of many tropical countries, and no simple method of control of schistosomiasis has been developed. The problem is compounded by the tendency of human populations to aggregate on the shores of newly developed impoundments. Schistosomiasis is already increasing in Latin America. The most clear-cut instances of extension of schistosomiasis into new areas as a result of river development projects have occurred in Africa.²

Onchocerciasis is even more complicated. The vectors of this filarial parasite are black flies which live their immature stages almost entirely in clear running water. Therefore, the construction of impoundments tends to eliminate breeding in some feeder streams due to a general raising of the water level and the elimination of rapids. However, the spillways and associated channels of the dams themselves may provide breeding space for larger populations of the same or related vector species.³ In Guatemala, Mexico, and Venezuela the flies pass their immature stages in very small streams and

¹B. B. Waddy, 1966. Medical Problems Arising from the Tropics. In Man Made Lakes. New York, Academic Press.

²W. H. La Rich, 1967. World Incidence and Prevalence of the Major Communicable Diseases. In The Health of Mankind. CIBA Foundation 100th Symposium. G. Wolstenholme and M. O'Connor, eds., Little Brown, Boston.

³John N. Raybould, 1968. Change and the Transmission of Onchocerciasis. East African Medical Journal, 45:292-294.

may not pose as much of a problem in water development projects as the African forms, but the situation requires serious evaluation.

The spread of several infectious diseases is strongly related to the quality of housing and sanitary amenities. These include the microbial and parasitic infections transmitted through water. Examples: the growth of squatter housing on the periphery of cities not supplied with sufficient piped water or sewage systems may produce local pockets of infection; the presence of contaminated surface water provides excellent habitats for the mosquito vector of urban filariasis - a growing problem in Africa, Asia, and South America. If populations grow more rapidly than sanitary systems in tropical and subtropical cities, this problem may be expected to continue to increase.

On a smaller scale, minor environmental changes may have important effects on human health for good or bad. Relatively minor improvements in housing quality may decrease the exposure of man to American trypanosomiasis (Chagas' Disease) by making the houses inhospitable for the insect vectors.¹

The possibilities of inadvertent exacerbation of infectious and parasitic disease through circumstances incidental to urbanization, migration, resource development, and industrial expansion are sometimes easy to identify and anticipate through appropriate and comprehensive advance planning.

The direct toxicologic effects of physical and chemical changes in the human environment on the physiological, behavioral, and social functioning of exposed populations may be very difficult to identify and to evaluate.

The acutely toxic concentrations of a long list of chemicals and types of electromagnetic radiation have been reasonably well determined and the resultant standards extensively applied in situations of occupational exposure. In most such cases, the agent is uniquely or overwhelmingly present, making possible the recognition of a cause-effect relationship. Toxicologic data of this kind provide useful guides to upper limits of tolerance for specific substances in community air, water, and food resources.

Chemical and physical stressors present in most environments, on the other hand, are in combinations (not one at a time), occur in concentrations that are usually well below acutely toxic values for any one of them, and often are capable of interacting in the carrier medium to produce secondary products, or in the human organism to produce additive or synergistic consequences. Even as no one has attempted seriously to identify all of the chemical constituents of sewage or garbage, no one has found a useful approach to

¹C. M. Chinchilla and C. M. Montero-Gei, 1967. Observaciones sobre las condiciones de la vivienda en relación con la presencia de los transmisores de Trypanosoma cruzi en el Cantón de Santa Ana. Acta Med. Costarric., 10:19-30.

specificity in categorizing the components of a community's water, air, or food intake.

As an alternative to precise identification and specific correlation with human response, we have resorted extensively to nonspecific indicators to provide some measure of general carrier quality, quite as the microbiological quality of water and some foods has long been evaluated roughly by the M.P.N. or coliform index. A large proportion of methods of assessment of air, water, and food acceptability are of the indicator type. For example, current standard methods and reportable items relative to air quality in the United States of America include (a) particulate matter (mass/unit volume of all air-borne substances collectable by specified filter system); (b) total oxidant (a measure of the oxidative property of the sum of atmospheric constituents under specified conditions); and (c) sulfur dioxide (actually a measure of the reducing capacity of the complex by a prescribed method).

Attempts to correlate community air pollution with specific effects on exposed population have been generally unsatisfactory. The raw data essential to development of precise relationships are, in most cases, inappropriate or unavailable.

In spite of this informational deficiency, a number of specific and general consequences of chemical and physical alteration in the human environment have been derived and supported by reasonable evidence. Some of these are listed in the following data:

KNOWN EFFECTS OF ENVIRONMENTAL EXPOSURES
TO CHEMICAL AND PHYSICAL AGENTS ON HUMAN HEALTH AND WELL-BEING
(Community Exposures Only; Nonoccupational)

I.	<u>Air Pollutants</u>	<u>Effect</u>
a.	Sulfur dioxide, trioxide, or sulfuric acid	Aggravation of asthma and chronic bronchitis; impairment of pulmonary function; sensory irritation
b.	SO ₂ plus particulate matter	Acute mortality; acute morbidity; aggravation of bronchitis and cardiovascular disease; contributory role in chronic bronchitis, emphysema, and respiratory disease in children
c.	Particulate matter	Reduction in incident sunlight
d.	Oxidants (including ozone)	Eye and respiratory irritation; aggravates emphysema, asthma, bronchitis; impaired lung function

<u>Air Pollutants (cont.)</u>	<u>Effect</u>
e. Carbon monoxide	Impaired oxygen transport function
f. Lead	Increased storage in body
g. Cadmium	(Possibly contributes to increased cardiovascular disease mortality)
h. Hydrogen sulfide	Sensory irritation; increased mortality from acute exposure
i. Mercaptans	Sensory irritation
j. Asbestos	Pleural calcification; malignant mesothelioma; asbestosis
k. Beryllium	Berylliosis with pulmonary impairment
II. <u>Food and Water Contaminants</u>	
a. Metals	Lead poisoning Mercury poisoning Cadmium poisoning Arsenic poisoning Chromium poisoning
b. Nitrites	Methemoglobinemia
c. "Softness" factor	Increase in cardiovascular disease
d. Sulfates	Gastrointestinal hypermobility
e. Fluorides	Dental fluorosis (when in excess)
f. Chlorinated hydrocarbons	Storage in fatty tissues (ecological damage)
g. Oil-petroleum	Impaired potability
h. Phenols, etc.	Impaired potability
i. Phosphates	Algal blooms; impaired potability

III.	<u>Land Pollutants</u>	<u>Effect</u>
	a. Human excreta; sewage	Schistosomiasis, teniasis, hookworm; urban filariasis; flies and other vec- tors; odors
	b. Garbage and domestic refuse	Rat, rodent, fly, and other vector in- festation; odors; secondary pollution of air and water from disposal prac- tices
	c. Industrial wastes	Accumulations and effects from toxic metals and other substances through food chains
	d. Fertilizers	Ground and surface water pollution
	e. Pesticides	Contamination of secondary foodstuffs
IV.	<u>Radiation</u>	
	a. Sunlight	Fatalities from acute exposure; mor- bidity; skin cancer; interactions with drugs
	b. Diagnostic X-ray	Skin cancer; contributory to leukemia
	c. Therapeutic radiation	As above; acute radiation illness; accelerated aging; mutagenesis
	d. Nuclear power and reprocessing plants	Ecological damage from thermal pollu- tion of water; contamination of air and water
V.	<u>Noise and Vibration</u>	
		Temporary to permanent loss of hearing; impairment of rest; sensory irritation; impairment of communication
VI.	<u>Housing and Household Agents</u>	
		Accidental fatalities and injuries; spread of acute and chronic diseases (related to crowding); effects on social interaction, privacy, mental states, and behavior

The last two general headings tend to merge into a category of environmental changes having very great implications for the health of the people, but even less susceptible to accurate evaluation than the mix of chemical and physical entities. These include (1) the phenomena of cultural displacement induced by rural-urban migration, (2) the composition and physical structure of emerging cities, and (3) their functional characteristics including transportation, recreation, education, and public participation. We believe that all of these environmental factors are ultimately reflected in mortality, morbidity, longevity, and related data, and that they affect fundamentally the social attitudes, behavior, and general welfare of exposed peoples.

Revised perspectives and fresh methodologies in epidemiology are urgently needed; the classical focus on causes of recognized disease states needs to be merged with a concept of a system of causes for states of human well-being. We will continue a deep concern for the afflicted but emphasize provision of an environment to minimize affliction.

V. The Environmental Management Process*

The processes of environmental management are broadly similar to other governmental functions; they are modified by the nature of command, basic political philosophy, degree of public participation, and availability of funds. The objectives of a program must be clearly understood and defined in terms sufficiently flexible to permit adjustment to newly emergent needs and temporal changes in priorities. To effect this requires provision for surveillance of the state of important environmental factors and continued monitoring to determine directions and rates of change.

Parallel with the assembly of dependable environmental measurements, methods to assess the impact of the recognized changes on physical, mental, and social well-being are needed. While periodic gathering of census data provides a useful base, much more sophisticated epidemiologic data are desirable and usually essential. In all cases, the reliability and comparability of statistical information as guides to environmental management needs will be only as good as the degree of precision and standardization of measurement units permit.

Sufficient environmental and epidemiologic data, analyzed perceptively by skilled personnel, will reveal a variety of degrees of environmental change and impact. Those responsible for overall community management planning must then determine priorities among the challenges revealed in the framework of

*For a more comprehensive summary of environmental health management and administration, attention is invited to WHO Technical Report Series, No. 439, which has served as the primary source of Section V.

objectives previously established and in the context of other national developmental needs, such as those for industrial development, agricultural expansion and improvement, education, and social services.

A WHO expert committee sums up the nature of the priority planning function as follows:

. . . there is no universally applicable rule for establishing priorities and making decisions. Choices are based on various facts and considerations which may vary from country to country according to local conditions. In general, the setting of priorities may be based on a series of assessments common to any priority-deciding process. These include:

1. What are the benefits of the programme?
2. Is it reasonable from the economic viewpoint?
3. How does it fit in with the country's prevailing need?
4. How much political support is it likely to receive?

From the technical point of view the performance and theoretical benefits of a programme may be emphasized, but from the standpoint of public executives, who are in a position to make financial decisions, the economic aspects such as financial feasibility, repayment possibilities, and the most effective and efficient use of the available funds deserve more attention. (WHO Tech. Rept. Series, No. 439).

Where environmental health programs are planned early enough to be more than emergency actions, they are by nature preventive, requiring action and expenditures well in advance of any emergence of favorable public opinion or serious consideration by the communications media. Because priority decisions are frequently determined by management participants other than health workers and public administrators, "related groups including politicians, members of advisory committees, professional organizations, the press, and the general public should be kept well informed, so as to create a favorable climate for environmental health planning." (Ibid.)

A legal basis is required for any effective environmental health program. Some Member Countries have well-developed bodies of civil and criminal law pertinent to environmental control; some are not so well prepared. The WHO expert committee which drafted the report "National Environmental Health Programmes: Their Planning, Organization, and Administration," has set forth three principles which they believe should govern the legal framework:

1. Laws should guide and help people, and establish a trend of acceptance; they should not be considered exclusively as restrictive and punitive.

2. Laws must be reasonable.
3. Laws must be enforced and obeyed.

Legislation, whether designed to establish authority, to implement social guidelines, or to delineate administrative control and response patterns, ideally should reflect the desire of the community to act, should be broad but with clear intent, should provide for the possibility of cooperative actions among contiguous jurisdictions when required, and should allow such associated units to work within an appropriate administrative framework. The usual basic legislation pattern in environmental health control (1) sets public policies and responsibilities for designated governmental agencies and for public compliance; (2) authorizes essential functions such as research, planning, development of regulations, setting of standards, and enforcement; (3) sets legal procedures for the conduct of authorized functions and program administration; (4) provides for interrelationships among cognate levels and agencies of government; and (5) provides for financing of functions. Normally a body of regulations, embodying technical requirements and other details, is developed in relation to but not within the laws themselves.

A variety of other legal patterns is operative in various parts of the world; those reasonably effective have common qualities of local political acceptability, administrative feasibility, and compatibility with the national economy.

VI. Participants in Environmental Health Management

By definition it is a function of the ministry of health to recognize and initiate action on any of the environmental services of consequence to public health, including the design and construction of essential facilities for basic sanitation. As the program objectives broaden, their activities inevitably impinge on the traditionally or legally established provinces of other governmental departments or agencies. For example, ministries or departments of public works, sewerage, water works, various local authorities, and ministries of finance, agriculture, labor, and other areas of public concern will have real or understood areas of responsibility within the total scope of environmental health management.

The existence of direct or peripheral responsibilities affecting environmental health within numbers of different agencies has suggested the possible efficiency to be derived from consolidation of the several health related functions in a single agency. However, such consolidation has not proved feasible in most national settings. Factors adversely affecting consolidation include the need for congeries of skills and operational objectives, the obvious creation of a reciprocal splintering of overall areas of concern of the several affected departments other than health,

and especially the traditional investiture of old-line agencies with the support of their respective public clienteles.

In any event, the ministry of health has responsibility for the health and well-being of the nation, and must, therefore, whatever distribution of functions emerges, be in such relationship to other departments and agencies that its view on the desirability and adequacy of any proposed work be sought and incorporated in design considerations. Various degrees of involvement of ministries of health have evolved, ranging from a firm legal mandate to review all projects from the health standpoint, through the processes of programming, planning, and standard-setting, to essential epidemiological and environmental surveillance and monitoring.

Similarly, a variety of administrative instrumentalities have emerged in relation to circumstances peculiar to the economies, political philosophies, degree of public involvement, and other factors in the national structure. In some cases these tend toward the establishment of environmental quality boards at upper levels of executive function, through provision for advisory bodies at cabinet or executive level, to authorization of the several cognate ministries and agencies to maintain effective communication. In all cases, the objective is to sustain unity of objective and economy of effort in the achievement of environmental health objectives.

Public administration in the next two decades will be concerned with (a) scientific and technical development, (b) the physical environment, (c) social values and life styles, and (d) economic and political development. Problems of public administration are often more political than technical. The aim of modern administration is to administer public departments on a rational basis rather than on traditional hierarchical lines or by intuition. Newer approaches to public administration are based on human behaviour and on ways of motivating all levels of personnel to achieve departmental and personal goals. The keys to efficient public administration are rational planning and control of implementation. According to H. Simon, a leading U.S. expert on public administration, almost all the so-called "principles" of organization are contradicted by others, equally plausible and acceptable, e.g., "Look before you leap" and "He who hesitates is lost." It is easy to demonstrate the incompatibility of such elements as specialization, unity of command, span of control, and the grouping of workers by purpose, process, clientele, and place. The "principles" cannot stand critical analysis; they are only ways of describing and diagnosing various administrative situations.

The guiding criterion in administration must be overall efficiency. It is necessary to know what decisions each person in the organization makes, what factors influence those decisions, and

what systems of communication are available. It is quite inadequate to describe administrative organization in terms of functions and lines of authority.

With the right organizational foundation, it is possible to build management procedures that result in both efficiency of operations and effectiveness in achieving organizational goals.

Management is considered by some to be a science, by others to be largely an art in the allocation, use, and accounting of resources; perhaps it is best conceived as a combination of the two, varying according to time and place.¹

VII. Economic and Resource Consequences of Environmental Control

While the provision of capital and operating funds for any public or private work is a major consideration of responsible managements, estimates of direct monetary costs are seldom indicative of the net gain or loss to be realized by a nation from actions designed to alter energy production, improve agricultural output, provide water, encourage tourism, eradicate insects, or improve the educational level or general welfare of human communities. Furthermore, the net gain or loss to the nation because of failure to act needs reasonable delineation; it may be enormously greater than an apparently insufferable capital expenditure.

Elements of the community having narrow interests in one or more of the multiple outcomes inherent in any manipulation of the environment have been known to influence decisions on major projects to the ultimate detriment of the national economy and the general welfare. A recently reported example of well-intended action without adequate prior analysis of collateral impacts on the national ecology is the construction of the Aswan Dam across the Nile. It has created a vast new reservoir of continental waters, has opened new agricultural lands, and has begun to generate much-needed electric power; it has also vastly restricted the productive potential of downstream agricultural areas, has begun to affect fishing industries of the Delta and beyond, has apparently assured the spread of water-borne parasitic diseases, and has produced a variety of other costly ecologic alterations. Some analysts estimate that national welfare will, in balance, be affected adversely, although Egyptian officials challenge this judgment.

In the effort to improve the economic bases of Latin American nations and to provide for improvements in the well-being of their peoples, many public and private works are being planned or are under construction. In view of the dual concerns of every government for economic development and

¹WHO Tech. Rept. Series, No. 439, p. 35.

for protection of health, some instrument of government, capable of continuing objective cost/performance/benefit analyses on a broad base, would be useful to each country, and perhaps could be developed through regional or international organizations.

Only after a calculation of net national benefit, including health and welfare consequences, should the difficult problem of financing ecologic interventions be initiated. Numerous engineering studies of a wide variety of environmental, industrial, and technologic developments (relative to water systems, sewerage, waste treatment, irrigation systems, transport, refining, the several pertinent industries, housing, pollution monitoring and surveillance, survey and census methodology, morbidity and mortality, etc.) provide detailed bases for cost estimation. Often these costs seem very high to governments perennially seeking to restrain investments in public works.

During the decade of the seventies, most Member Governments of the Pan American Health Organization may well be able to activate mainly those environmental protection programs necessary to achieve and extend somewhat the limited objectives originally set forth in the Charter of Punta del Este. PAHO studies¹ clearly set forth the magnitudes of funding necessary to achieve the initial goals and to remain abreast of the most elemental needs for water and sewerage systems. Unless other programs can be demonstrated to provide a net economic gain to the nation, they will not likely be given a high priority in the budgeting process. This conclusion is based on a realistic recognition of the reciprocal relationship between concerns for human status and concerns for economic growth.

Several general principles become available to governments in the process of providing funds for public works or nationally beneficial programs. Where the benefit is chiefly bestowed on a local community or on some private sector, the costs can be assumed by the beneficiary insofar as possible. If a control program is related to the pollution generated by industry, transport, commerce, or agricultural activity, the costs should be assumed initially by entrepreneurs with full realization that they will ultimately be picked up by consumers in the form of increased commodity or service costs. Some types of environmental health programs, e.g., provision of water supply and sewerage systems, can be financed through rate schedules imposed on users with initial capital outlay and operating costs paid through a revolving fund which, in principle, is eventually self-amortizing. Other categories of beneficial programs will have their ultimate payoff so diffuse in impact or so distant in time that the only internal national recourse is the general tax pool or a special tax levy.

Substantial financial support is available through regional development banks and the International Bank for Reconstruction and Development.

¹Tech. Series of the Dept. of Eng. and Env. Sci., No. ES5, 1969.

Revolving funds which provide a repayment base or demonstration of a reasonable prospect of economic gain sufficient to assure ability of the national government to repay are usually necessary to secure capital from these sources.

Finally, the mutual concern of Member Governments of PAHO may assure continuing pursuit of financing for environmental health programs from external sources. In the long run, of course, the financial costs of each project must be amortized by the country receiving its benefits.

VIII. The Challenge of Urbanization

Unfortunately, the records of change in size of cities which have responded explosively to the technological drive toward urbanization provide little in the way of tested managerial innovation in reaction to the rapid growth. We have histories of accumulating problems of environmental pollution, increasing social and psychological deviations and dislocations, and difficulties in financing programs essential to the health and well-being of the citizens; but reports of successful anticipation of the predictable problems and implementation of ameliorative actions are rare.

The stake of health agencies in planning is very large, and the pressing need for recognition of the human consequences of urban composition, structure, and function in the design, construction, and operation of cities is very urgent. Nowhere else is there so clear a demonstration of how the environment affects risks to health and well-being as in the contrasting neighborhoods of a large community; higher mortality, infant and maternal death, morbidity, homicide, suicide, drug addiction, and deviant behavior rates have been associated repeatedly with inadequate or crowded housing, lack of essential public utilities, failure of sanitation services, and lack of recreational and educational opportunity.

With the growth of urban population, there has come simultaneously in many Latin American countries a proportional decline in rural population and in agricultural production. These changes focus attention on the interaction between urban and rural development. They suggest also that the qualities and magnitudes of urban health problems may be modified substantially by direct planning and vigorous action toward resettlement on the land and restoration of rural life. The design of humanly acceptable, agriculturally productive environments for the rural population could offset some of the drives toward urban concentration and at the same time sustain a schedule of food supply commensurate with the total national growth. It is probable that the ills of the cities can be attacked successfully by ministering to the needs of the countryside.

Among other choices open to Member Governments, one is to plan newly emerging cities to avoid repetitions of earlier urban experiences. Another

is to intervene in developed urban communities through reconstruction and substitute programs relatively free of known defects. Obviously, special cultural, organizational, financial, and political circumstances, and the particular health profiles of migrant populations referable to any one urban development, will require consideration, together with the more broadly applicable principles of urban planning.

As a special, and sometimes dominant, case of environmental maladjustment, urban life needs special emphasis. Local, national, and international health agencies, through the vigor and effectiveness of their association with planning bodies, can influence greatly the magnitudes of their future direct public health burdens.

IX. Institutional Arrangements for Environmental Control

The general patterns of intranational functions of ministries of health have been discussed earlier (Sec. VI). The single principle universally operative in their relationship to environmental health is their responsibility for the health and well-being of their constituent populations. It is therefore a reasonable expectation that they be the primary representative participants in any international environmental health activities (multinational, regional, or worldwide), and that they assume responsibility for the education or training of appropriate manpower within their own areas.

Throughout the Region served by PAHO, one of the critical needs is for a sufficient pool of engineers, systems analysts, epidemiologists, planners, administrators, technicians, veterinarians, agricultural technologists, sanitarians, inspectors, and other skilled personnel oriented toward environmental health and ecological systems analysis. Sanitary engineering education has been significantly expanded and upgraded in many institutions in Latin America in relation to the engineering requirements set by the objectives of the Punta del Este Charter. But in none of the Member Countries (north or south) has the requirement for diversity of skills coupled with "systems consciousness" been met or well anticipated by more than a few academic institutions or other training centers.

To assure production of needed manpower in sufficient numbers and endowed with the requisite skills and perspectives, it will be helpful to exchange teaching staffs and students among the few hemispheric educational centers presently competent and those in process of development. For the immediate future, reliance on the relatively slow pace of academic programs will not suffice. There is urgent need to continue and expand programs of short and intensive courses adapted to all levels of operation and to the numerous disciplinary areas related to the environmental health programs. Some of these are best conducted by mobile teams traveling from site to

site, but effective courses in depth are often provided through fellowship programs by transfer of selected students to centers equipped to teach, demonstrate methods, and assure first-hand participation in special control and survey operations.

The initiation of international arrangements for manpower development for the Region has been a successful service of PAHO. PAHO centers constitute an excellent and effective base for broad ecologic orientation and interdisciplinary exposure essential to future management and operation of environmental health programs.

In addition to the educational elements of international cooperation among the regional health ministries, there are other environmental health related activities which are logical fields for continuing international cooperation. Among these are:

1. Data processing and information retrieval operated in the common interest of the nations of the Region. States could link and share surveillance and monitoring systems and compare pertinent demographic, mortality, morbidity, and other health related data, along with related economic, hydrologic, meteorologic, or catastrophic data for epidemiologic or operational studies.
2. The development of a system of hemispheric environmental surveillance, possibly including the current capabilities for remote sensing from satellites or conventional aircraft.
3. The provision of expert counsel to Member States in the formulation of environmental health programs and policies.
4. Organized international environmental services in response to major natural disasters.
5. The sponsorship of evaluations of environmental threats involving more than one of the Member Governments of PAHO, including but not limited to threats associated with water supply and waste management, regional economic development proposals, degradation of air resources, agriculture and other resource development practices, zoonoses, and population movements.
6. The stimulation and encouragement of applied research in the several areas pertinent to environmental health, with primary emphasis on the development of simple, economical techniques of environmental and health analysis, and the adaptation of local resources and levels of skill to needs of individual nations.
7. The continuation and intensification of the international effort to assist Member Countries in funding essential environmental health programs.

8. Support for exchange of environmental publications and organization of sources of environmental information, including manuals, rosters, bibliographies, directories, inventories, maps, and reviews.

X. Research Requirements, Challenges, and Opportunities

The foregoing sections of this paper suggest multiple needs for new or refined understanding of most of the elements of a fully developed program of environmental health. Only the most economically affluent of the Member Countries will find it possible to engage in costly basic investigations of the systems, their multiple interaction characteristics, and novel approaches to analysis, instrumental surveillance, and regulatory technology.

On the other hand, there is much to be gained by adaptation of existing knowledge and methods to the specific requirements of localities or regions. Use of locally available materials and other efforts aimed at reducing costs and expediting programs under conditions often quite different from those for which the current technologies were devised should pay handsomely. Similarly, there may be need to modify standards of environmental quality in relation to climatic and other idiosyncrasies of different localities.

Such investigative services should be developed as far as possible by national authorities; however, it is probable that assurance of region-wide impact and maximal economy of effort will continue to benefit from international cooperation. Teams of investigators functioning in association with the central effort on data retrieval and analyses and the central educational and advisory staffs may supplement and stimulate similar activities by national, regional, or local governments.

Recent developments in the techniques of remote sensing of environmental phenomena open the prospect of short-cutting many surveillance needs by employment of photographic, spectrometric, radar-reflecting, and other sensors carried aloft in satellites or aircraft. Such methods have proved value in relation to forestry, agricultural productivity surveys, plant disease control, urban structural analysis, marine and terrestrial heat distribution, water pollution source location, and other pertinent pursuits. The sensing capability, while rooted in earlier origins, is largely a spin-off from the space exploration programs. Application of any form of regional environmental survey by remote sensing methods, with the consent and concurrence of national governments, would permit regionally coordinated, simultaneous "ground-truth" monitoring within the participating countries. Processing and analysis of the numerous types of sensing signals, and tests of correlation with terrestrial health indices, will employ highly sophisticated equipment, even in this age of computers.

Specific areas of inquiry pertinent to the role of PAHO could be cited in almost infinite variety. They could most certainly include environmental health evaluation of the changes occurring or projected in relation to waste discharges of all types into the Gulf of Mexico, pollution of waters overlying the coastal shelves of the two continents, the developmental program in the lower Rio de la Plata area, hemispheric changes in air quality, the insect eradication and zoonoses control programs, environmental aspects of international waterways, and others of multinational concern.

The emergence of net balances post facto may be far more costly than the a priori examination. For such examinations, it appears desirable that coordinating and advisory groups of experts from related disciplinary fields be assembled and endowed with sufficient freedom of operation to deal objectively and continuously with human interventions with the environment in anticipation of impending threats.

XI. Policy Issues and Possible Programs

This, or any other consideration of the challenges to the health and well-being of the peoples of the Americas to be faced in the decade of the seventies, must conclude that response to the inevitable processes of environmental change should be operative in policy formulation and program design. The fundamental necessity of economic development assumes environmental change; the basic responsibilities of health ministries demand that national and international actions anticipate the health consequences and move toward a pattern of legal and administrative, informative, technical, constructional, and service instrumentalities continuously sensitive and responsive to emergencies of new factors and persistences of the old.

Effective and economical action will require associative arrangements with organizations and disciplines not traditionally concerned with public health, since we deal with the effects of environmental changes resulting from all kinds of interventions in the ecological system - technological, social, cultural, educational, legal, and administrative. The new challenge to health ministries invites acceptance of the enormous broadening of their areas of responsible concern for the protection of human health and welfare.

The establishment of goals for the next decade will therefore be based on extension of the minimal program of basic sanitary measures adopted at Punta del Este, but should also include realistic accomplishment toward the control of environmental hazards, with particular emphasis on the urban-industrial system and the development of infrastructures, institutions, and trained manpower to cope with continuing change in the composition of environmental health challenges. Ever-present limitations of governmental and organizational budgets suggest that all operations be designed to minimize costs through innovative use of unconventional methods and through maximal cooperation among the Member Governments.

The Member Governments may desire to expand or to initiate:

1. Environmental surveillance and monitoring, with special emphasis on multinational and regional surveys and on the identification of appropriate indicators of health hazards for use within individual jurisdictions.
2. Exploitation of the possibilities of remote sensing from satellites or high-flying aircraft to effect economies in assessment of environmental variance and to sharpen our ability to relate such changes to health associated phenomena.
3. Assembly, collation, and analysis of data pertinent to environmental change, and to related health profiles, with provision for prompt retrieval and distribution to specific local, national, and regional governments and agencies on request or by prearrangement.
4. Adaptation and, if necessary, reformation of the education of technical, managerial, administrative, and other skilled manpower needed for the effective development of environmental health programs. This effort may best be in the form of on-site short courses conducted by traveling PAHO experts, longer term exchanges of faculty and students among academic institutions specifically organized to participate, and extended study in PAHO centers associated with an appropriate academic environment and other special facilities.
5. Preparation, publication, and dissemination of manuals, standards, methods, administrative and managerial guides, cost estimates, data books, and other materials useful to Member Governments.
6. Encouragement of applied research and development in the numerous aspects of environmental management, especially within academic institutions of the Region.
7. Evaluation of progress toward established goals.

These complex new functions and the complementation of those being carried out might become operative with maximal effect at minimal cost through the establishment of a mechanism or center responsible for human ecology and health. From the foregoing its functions might include:

- a. Acceleration of manpower development.
- b. Central data processing, analysis, and application.
- c. Liaison with several existing PAHO regional centers (Environmental Engineering, Nutrition, Zoonoses, Population, Health Planning with Research and Education) and liaison with activities of national and international agencies.

- d. Development of advanced methods of health and environmental survey having local, national, or regional applicability.

In whatever manner and location such a mechanism is eventually developed and located, it should be an objective of the Organization to associate itself with academic, governmental, and private agencies in such manner as to achieve maximal progress toward the goals of environmental health.

The challenge of the present, the next decade, and the future as far as can be foreseen is that of effective mobilization and use of resources to achieve human adjustment to induced changes in the surroundings of man. To understand the effects of the changes, to plan compensatory or protective actions, and to implement the plans with as little adverse feedback as possible in terms of added economic burden: these are the keys to useful operations.