

TECHNICAL DISCUSSIONS AT THE XX MEETING OF THE DIRECTING COUNCIL
OF THE PAN AMERICAN HEALTH ORGANIZATION

HEALTH-RELATED IMPACTS OF ENVIRONMENTAL CHANGE¹

The Technical Discussions at the XX Meeting of the Directing Council of the Pan American Health Organization were held on 1 October 1971 at the Headquarters building in Washington, D.C. The topic was "Environmental Pollution." The basic working document prepared for the discussions, presented below, states that the Hemisphere's environmental health problems are increasing and must be given higher priority in the years ahead. (The Final Report adopted by the discussion participants is presented on page 104).

Introduction

Environmental contamination has increased during the 1960's. This trend will continue through the 1970's and beyond, so long as populations expand and technological advances escalate the per capita production of goods and energy. "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 governments and political subdivisions.

Such issues have especially significant implications for public agencies concerned with peoples' 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 prominent array of new stresses associated with toxic chemicals, noise, ionizing radiation, mechanical hazards, and the related problems of congestion, poverty, ignorance, drug abuse, and crime—and their consequences in the form of cancer, fractures, burns, poisonings, alienation, genetic defects, and brain damage.

The statesmen of the world face a task more difficult than any facing those in responsible

positions any time in the past. Public health ministries must more clearly define 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 imminent threats. This is an extremely difficult task requiring substantial reorientation of perspectives, strategies, and health practices. Among its more difficult facets is clear definition of 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, water, and land pollution abatement programs)? How are health agencies to participate in consideration of environmental problems such as the following: control of the use and composition of fuels; design of effective pollution abatement devices; control of persistent chemicals used as pesticides, herbicides, fertilizers, etc.; surveillance of consumer products for hazardous materials (such as mercury, cadmium, and an increasing variety of organic and inorganic compounds); prevention of transport disasters such as oil spills and crashes involving radioactive or toxic substances; and economical management of solid wastes?

The variety of such problems points up the complexity of the man-environment relationship, and highlights the need for effective lines

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of communication and networks of collaboration. Such channels should exist between all governmental entities having jurisdiction over activities affecting the human environment.

The health professions today are being challenged to redirect their epidemiologic approaches and practices, and especially to gear studies to the fast pace and pervasive effect of environmental change. Many of the newer environmental problems have quite subtle, long-range impacts, with wide separation of primary agents from ultimate effects. For this reason, the epidemiologist today seeks to anticipate social and physical effects as he carefully weighs projections of environmental change.

Those responsible for public health programs have an opportunity to take the initiative in developing programs capable of meeting the challenge of the 1970's. It is important that goals be established to keep environmental pollution below levels that can disastrously affect human health and well-being through alteration of the natural ecological system. The establishment of criteria and standards, and development of means of environmental surveillance and control are central to these objectives. Public health agencies have the duty to exercise their influence and to establish such goals and criteria. Major areas of concern in the public health field have been summarized in the documents of the World Health Organization as follows:

- 1) 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 excreta, and by substances detrimental to human, animal, or plant life.

- 6) Food hygiene (including milk hygiene).
- 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 public 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 ensure that the general environment is free from risk to health (1).

The specific applicability of these 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.

Health Criteria for the Environment

A healthful environment, in essence, supports survival and enjoyment of human life with minimal exposure to destructive stresses. In general, its basic components are a water supply that is safe (one 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 sufficient nutritional allowance for each family; and air that is reasonably free of offensive or noxious substances, fumes, or biological agents. In modern times, health agencies have also become progressively concerned about the effects of stresses introduced by industrial technology, as noted previously.

Many significant environmental health problems can be identified by examining relevant

health statistics. Of particular interest are those relating to the nature and incidence of diseases caused or affected by environmental factors; correlation of environmental factors with life expectancy; and correlation of general physical, mental, and social well-being with environmental factors. Among the most important sources of such statistics are censuses; 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 health statistics may be related to environmental factors only if comparable data from other fields are available. Correlative data dealing with physical and biological factors (including conditions of air, water, soil, space, sunlight, vegetation, domestic and wild animals, and microorganisms) may be useful. Similarly, data on industry, housing, land use and planning, food, transportation, production levels and patterns, social relations, and cultural conditions may contribute heavily. The WHO Expert Committee on the Planning, Organization and Administration of National Environmental Health Programs has 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 measurement data, water resource statistics, industrial and agricultural statistics, food and nutrition statistics, consumer statistics, transportation and traffic statistics, and so on.

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 is in some cases doubtful (1).

Data on environmental health are more abundant for urban areas of the Hemisphere than for its rural regions; and outside of the United States of America and Canada, about one-half of the Region's total population is rural. Predictions of current trends in urban

health seem questionable without further knowledge about the health of rural populations tending to migrate to the cities.

Surveys related to water supply, air pollution, soil contamination, solid waste disposal, zoonoses, food control, vector control, and occupational hazards have 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, but more often the type and dependability of the data make it hard to draw definite conclusions. Furthermore, the requirements for environmental safety, comfort, and convenience vary substantially from one region to another. Therefore, 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.

Directions of Change—A Scenario for the Future

The nations of the Hemisphere differ greatly in terms of economic development, resource aggregates, ethnic and demographic composition, cultural bases, political philosophies and structures, and geographic and climatologic settings. Even within the individual nations great variation is apparent. Such variation can be presumed to govern the speed and nature of human environmental change. 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. Likewise, 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 various Member Governments of PAHO.

Despite this, the Member Governments do have common interests in many fields, among them commerce, finance, transportation, subsistence-dependence, resource development, etc. Furthermore, there is no health threat to the people of any Member Country which fails

to concern all the others. Whatever scenario materializes during the 1970's, there will be individual elements of local, regional, or national responsibility; many tasks requiring coordinated action among contiguous nations; and some tasks of such dimensions that they can be dealt with only through multinational instruments. In addition, 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 and economical engineering controls.

Population and Demographic Changes

Population data are basic to any evaluation of change in living conditions during the next decade. Most Hemisphere nations conducted censuses during or before the 1960's. Data from the 1970's for 13 countries are not yet available. Six national censuses were projected for 1971 at the time of this presentation, with four more projected for 1972 and one for 1973. It is doubtful that the new data will indicate substantial shifts in demographic trends.

The population growth rate in Latin America in the past decade has been the highest of any large region of the world, averaging 2.9 per cent per year since 1960 (2), as compared with 1.4 per cent per year in Northern 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 (3). The same source estimated that by the year 2000 the Hemisphere's population would approach one billion, with nearly two-thirds of the total (638 million) in Latin America. Thus, any overall health-related plan must contemplate a long-range population increase of about 250 per cent, which must be provided for by programs undertaken in the 1970's.

Urbanization is accelerating in almost all the PAHO Member Countries. Since the second decade of the century, migration of agricultural populations into metropolitan centers has been proceeding even more rapidly in Latin America

than in Northern America. 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 enclaves of undernourished, ill-housed, and often demoralized people.

These developments have intensified problems posed by solid wastes, noise, radiation, and a wide variety of occupational risks. The urgency of regulatory or abatement programs varies widely from one location to another within the Region, and they may well constitute a set of secondary priorities in most places during the current decade. However, there is sufficient public consciousness of these matters to demand surveillance and evaluation programs as a minimum requirement.

In Northern America, less than 30 per cent of the population remains rural, and urbanization shows little sign of slackening its pace. However, agricultural productivity has improved steadily despite the loss of rural manpower, because of dramatic progress in agricultural technology. Yet in many Latin American nations, some of which have never had adequate agricultural production and distribution systems, output has steadily declined with the departure of field hands and their limited replacement by machines. In nations where the economies are largely dependent on single commodities (such as petroleum, copper, beef, or bananas) the basic need for imported food makes exploitation of the exportable resource especially urgent. The exigencies of mere existence place increasingly severe economic restrictions on the provision of basic sanitation and prevent more sophisticated education and human welfare programs from receiving priority attention.

The PAHO publication *Health Conditions in the Americas, 1965-1968* 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" (3). 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 basic sanitation needs and the increasing difficulty of coping with health problems related to unemployment 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 are already here.

A population's age composition also helps indicate a nation's capacity to generate and sustain processes of change in human and economic welfare without external assistance. The economically active population in Latin America constitutes one-third of the total population, so that the average worker will have to provide for two additional persons (3). Coupled with the Region's persistent low per capita income, this circumstance challenges the area's 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 during the 1960's. For the Region as a whole, per capita gross national product (GNP) averaged under US\$400 in 1968, with one Member State at the extreme low of about US\$86. This contrasted markedly with approximately US\$4,000 for Northern America. The Charter of Punta del Este set the goal of increasing per capita GNP by 2.5 per cent annually in each Latin American country. Actual progress seems to have been commensurate with this goal in some nations, though not in all; however, the real gains are difficult to assess because of evident wide differences in currency inflation and internal procedures of analysis and reporting.

Direct and indirect inferences about trends and rates of environmental change often result from analysis of vital and health statistics. The combination of persistently high birth rates,

declining death rates in younger and middle age groups, and increasing life expectancy clearly indicates that most Latin American nations will be faced with rapidly growing populations and increasing numbers of dependents relative to income producers during the next decade. These can be expected to cause increased environmental pollution and increased environmental stresses with significant health implications.

The Charter of Punta del Este projected similar trends for the 1960's, and there have been few apparent changes to indicate a qualitative change for some years ahead. Demographic projections, reflecting both this situation and rural-urban distributions, make it possible to foresee some basic sanitation and environmental protection requirements of the near future.

Unless provision is made for sufficient volumes and qualities of foodstuffs to maintain a reasonable nutritional level—for the present population and 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. This matter is particularly serious because 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 the extent to which private residences lack piped water and death rates from infectious-enteric and parasitic diseases. As progress is made in providing safe water to a larger part 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 permitting management of large volumes of relatively dilute sewage. If these liquids are

allowed to contaminate surface and ground water 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 destruction of sources of sea food. Enormous domestic waste disposal and treatment tasks face all the rapidly growing cities of the Hemisphere.

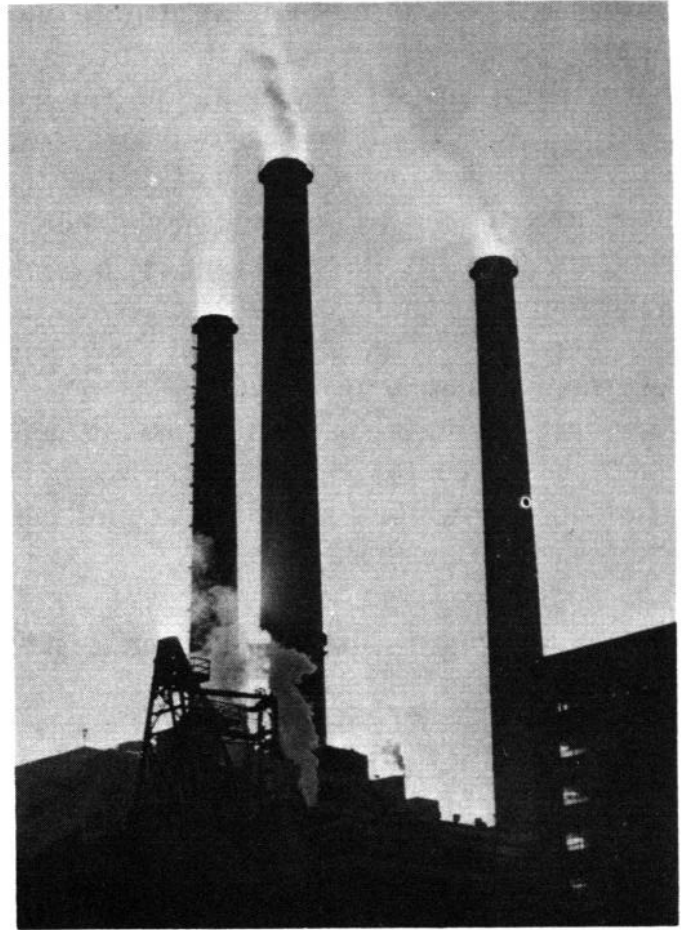
Waste discharges from burgeoning industrial, mining, refining, and agricultural operations pose another increasing threat to water quality. This problem is particularly difficult, since such operations must expand if the essential growth of the economic base is to be achieved. (Indices are available to relate units of production to volumes and qualities of wastes, and to the costs of their management and safe disposal.) While the heavily industrialized nations of the world have thus far failed to check these man-induced deteriorations in water quality, careful planning of new ventures can often substantially reduce the adverse environmental impact at reasonable cost. The widely varying quantities of surface and ground waters found in different regions of Latin America and the Caribbean obviously govern the level of priority to be applied to the protection of local receiving waters; towns in a semidesert area will naturally 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 Northern American cities, has emerged, as predicted, in urban areas of Latin America. In general, its intensity varies directly with urbanization, industrialization, and use of gasoline-powered vehicles.

The projected growth of Middle and South American cities, increased emphasis on industrial and basic resource development, and existing meteorologic and topographic data, make it possible to predict disturbing or genuinely hazardous air pollution affecting a large part of the area's people. The need for air quality surveillance and control programs (including

Air pollution is a problem of growing concern in Latin America.



policing of sources and preconstruction planning of plant sites and abatement equipment) has already been recognized; but it will require far more substantial attention during the next decade than it has received to date.

Biocides

One of the most difficult aspects of environmental health management involves hazardous substances released into the nutritional chain by actions primarily beneficial to agricultural and industrial production or pest control. Some types of chlorinated hydrocarbons, organo-metallic compounds, heavy metals (used sparingly in some methods of metal refining), and miscellaneous defoliants, insecticides, and food additives have been found to persist in the environment and to pose dangers to man if ingested in small quantities 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 with respect to the entire man-centered ecologic system. In short, 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 a result of planned transportation, industrial, agricultural, and other human interventions, will emerge more clearly during the decade of the 1970's as matters directly affecting more than one American state. Regional development of water use systems will affect water quality in various countries, and will involve the potential danger of spreading water-related parasitic disease via proliferating irrigation systems. Eventually, such regional development will alter the ecological infrasystem upon which marine fishing industries depend.

Pollution of international bodies of water and the associated coastal waters and estuaries of Hemisphere nations may command increasing attention in the future. Northern 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 in Northern America, Middle America, and contiguous portions of South America (involving petroleum drilling, release of water-borne wastes, and agricultural by-products) threaten the waters of the Gulf of Mexico. This is especially true in view of the recent history of petroleum spillage and oil drilling activities in shelf areas of the Gulf itself.

Air pollution is also an international concern. Only part of this concern results from the proximity of one nation's major polluting cities to the boundaries of another. In addition, locally generated carbon dioxide and particu-

late matter contribute to worldwide increases in these air-borne substances. Such increases are now believed to threaten significant changes in regional climatology and, perhaps, in global temperature averages.

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

Without exception, the nations of the Hemisphere are concerned about the existence of zoonoses in limited areas and their potential spread. This situation not only provides potential reservoirs of human disease but, perhaps more importantly, restricts economic development of some nations because of necessary embargoes on export of animals and animal products, and sharply reduces production of foodstuffs sorely needed to sustain a minimal nutritional level.

This partial overview of problems confronting the decade of the 1970's leaves one impressed by the complex interrelationships and overlaps involved. Environmental health, as the term is used here, denotes the concept of dynamic ecological balance between man and the 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. These problems are seldom encountered in precisely the same form, in the same order, or at the same rates as those that preceded them. The challenge will therefore be met not so much by projecting past trends as by providing agencies capable of maintaining constant surveillance, relating environmental control needs to other national priorities, setting clear policy objectives, designing appropriate legislation, and assuring effective management of environmental change.

Health Implications of Environmental Change.

The environment has been changing

TABLE 1—Demographic and economic data on 26 countries of the Americas.

Country	Population (millions)	Urban/rural pop. (%)	Density No. per mile ²	Per capita Income (US\$)	GNP (millions of US\$)	Exports (millions of US\$)	Imports (millions of US\$)
Argentina	24.3	70/30	22.4	800	18,400	1,370	1,170
Barbados3	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
Guyana7	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

TABLE 2—Demographic and environmental data on 26 countries of the Americas.

Country	Birth rate (No./1,000 pop.)	Death rate (crude) (No./1,000 pop.)	Infant Mortality (No./1,000 births)	Illiteracy (% 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

throughout mankind's history. The pace or kind of change may differ; and the influence of man on his environment and vice versa may shift markedly; 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, in terms of extending his range and increasing his numbers, man is currently the earth's most successful species.

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 man's social, spiritual, and cultural well-being and to his ultimate survival. Only recently have we recognized the threat, begun to measure the effects of "progress" on people, and started to discuss ways of lessening our harmful effects upon the ecological system (by using 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 proliferation of wastes incidental to increased use of material and energy resources.

Infectious Disease

Infective and parasitic diseases have shown a marked tendency to decrease as industrialization and urbanization advance (4). Diseases prevalent a century ago are still present among us; but they are now so uncommon in many societies that they are disappearing from the awareness of the layman, if not from that of the physician. Much of this decline has been due to environmental sanitation or to modification of the human "internal environment" by immunization.

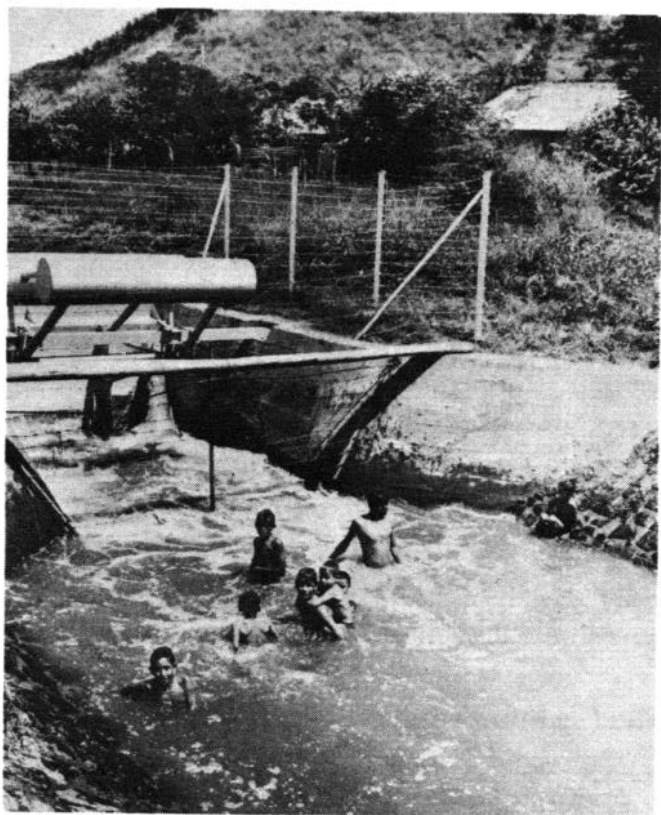
In the case of malaria, actions such as the "bonification" schemes in Italy, the clearing of large tracts of jungle in tropical regions, and similar schemes have eliminated the disease

from large areas. The congregation of man in cities has generally tended to be protective in itself. In some cases temporary flare-ups of malaria have occurred when large aggregations of workers were brought together (at large hydroelectric projects, for example), but these have generally been controlled readily and the final 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; however, an attempt to apply the same methods to Volta Lake in Africa appeared unfeasible because of different habits of the malaria vector mosquitoes in the two areas (5). On the negative side, water impoundments and irrigation ditches have also served to increase parasite populations. Attempts to improve nutrition by raising fish in some African areas increased malaria vector populations in the small fish ponds constructed for the purpose.

The growing needs of all nations, particularly developing ones, 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 as early as possible. This is important in controlling a number of other diseases besides malaria, including schistosomiasis and onchocerciasis.

Schistosomiasis is one of the most debilitating and chronic tropical diseases. It is increasingly man-propagated because water impoundments and irrigation ditches provide excellent breeding sites for the snail hosts of the parasitic flukes that cause it. This is a matter of serious concern for WHO and other health agencies, since impoundments are essential for agricultural and economic development in many tropical countries, and no simple method of controlling the disease has been developed. The problem is compounded by the tendency of human populations to cluster on the shores of newly developed impoundments. Schistosomiasis is already increasing in Latin America, although the most clear-cut instances

Lining irrigation canals is an important snail control measure.



of its extension into new areas as a result of river development projects have occurred in Africa (6).

Onchocerciasis presents an even more complicated situation. The vectors of this filarial parasite are black flies, whose immature stages live almost entirely in clear running water. Therefore, the construction of impoundments tends to eliminate breeding places in some feeder streams by raising the water level and eliminating rapids. However, dam spillways and associated channels may themselves provide breeding space for larger populations of the same or related vector species (7). In Guatemala, Mexico, and Venezuela the flies pass their immature stages in very small streams and may not pose as much of a problem for water development projects as the African forms. Nevertheless, the situation requires thorough and careful evaluation.

The spread of several infectious diseases (including microbial and parasitic infections transmitted through water) is closely related to housing quality and sanitary amenities. For example, the growth on the periphery of cities of squatter housing lacking adequate piped water or sewage systems may produce local

pockets of infection. Likewise, contaminated surface water provides excellent habitats for the mosquito vector of urban filariasis, which poses a growing problem in Africa, Asia, and South America. This problem can be expected to grow worse if tropical and subtropical populations grow more rapidly than their sanitary systems.

On a smaller scale, minor environmental changes may have important effects on human health. For example, relatively minor improvements in housing quality may decrease the exposure of man to American trypanosomiasis (Chagas' disease) by making houses inhospitable to the insect vectors (8). Similarly, undesirable effects may be generated by circumstances incidental to urbanization, migration, resource development, industrial expansion, etc. However, in some cases appropriate, comprehensive advance planning can make it easy to identify and anticipate circumstances which might inadvertently promote infectious and parasitic diseases.

Physical and Chemical Factors

On the other hand, 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 evaluate. Acutely toxic concentrations of a long list of chemicals and types of electromagnetic radiation have been reasonably well determined, and the resultant standards have been applied extensively in situations of occupational exposure. In most such cases, the agent's unique or overwhelming presence makes it possible to establish a cause-and-effect relationship. Data of this kind provide useful guides to upper limits of tolerance for specific substances in community air, water, and food resources.

But in most environments, chemical and physical stressors occur in combination, in concentrations that are usually well below acutely toxic values for any one of them. In these circumstances they are often capable of interacting in the carrier medium to produce secondary products, or in the human organism to produce additive or synergistic conse-

quences. Just as no one has seriously attempted to identify all of the chemical constituents of sewage or garbage, no one has found a useful approach to 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. The purpose of these indicators is to provide some measure of general carrier quality, much as the microbiological quality of water and some foods has long been evaluated roughly by the M.P.N. (most probable number) or coliform index. A large proportion of methods for assessing air, water and food acceptability are of the indicator type. For example, current standard methods for measuring air quality in the United States of America involve measurement of particulate matter, sulfur dioxide, and total oxidant. All of these indicators are non-specific (measurement of particulate matter indicates the mass per unit volume of all air-borne substances collectable by a specified filter system; the sulfur dioxide content indicates the sample's reducing capacity; and the total oxidant gives a measure of the sample's oxidative properties under specified conditions).

Attempts to correlate community air pollution with specific effects on an exposed population have generally been unsatisfactory. In most cases, this is because the raw data essential to development of precise relationships are inappropriate or unavailable. In spite of this deficiency, a number of conclusions about consequences of chemical and physical alteration of the human environment have been supported by reasonable evidence. Some of these are listed in Table 3.

The last two entries in Table 3 relate to a category of environmental changes having very great public health implications. However, they are even less susceptible to accurate evaluation than the previously listed mix of chemical and physical factors. They include the phenomena of cultural displacement induced by rural-urban migration; alterations in the composition and physical structure of emerging cities; and

changes in basic urban functions such as transportation, recreation and education. We believe that all of these environmental factors are ultimately reflected in mortality, morbidity, longevity, and related data, and that they fundamentally affect the social attitudes, behavior, and general welfare of exposed peoples.

In this regard, revised epidemiologic perspectives and fresh methodologies are urgently needed; the classical focus on causes of recognized disease states needs to be merged with a conceptual system of causes for states of human well-being. Deep concern for the afflicted should and must continue, but emphasis should also be placed on providing an environment that will minimize affliction.

The Environmental Management Process²

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 sufficiently flexible terms to permit adjustment to newly emergent needs and temporal changes in priorities. This requires provision for surveillance of the state of important environmental factors and continued monitoring to determine directions and rates of change.

In parallel with the assembly of dependable environmental measurements, methods are needed to assess the impact of recognized changes on physical, mental and social well-being. Periodic gathering of census data provides a useful base, but much more sophisticated epidemiologic data are desirable and usually essential. In all cases, the reliability and comparability of statistical information used to point out environmental management needs will be only as good as the degree of precision

²For a more comprehensive summary of environmental health management and administration, attention is directed to the World Health Organization *Technical Report Series* No. 439, which has served as the primary source of this section.

TABLE 3. Known effects of environmental exposure to chemical and physical agents on human health and well-being.

(Nonoccupational community exposure only)	
I. Air pollutants	Effects
1. Sulfur dioxide, sulfur trioxide, or sulfuric acid	Aggravation of asthma and chronic bronchitis; impairment of pulmonary function; possible sensory irritation
2. Sulfur dioxide plus particulate matter	Mortality and morbidity from acute exposure; aggravation of bronchitis and cardiovascular disease; contributory role in chronic bronchitis, emphysema, and respiratory disease in children; possible contributory role in lung cancer
3. Particulate matter	Reduction of incident sunlight
4. Oxidants (including ozone)	Cause eye and respiratory irritation; aggravate emphysema, asthma, bronchitis; impair lung function
5. Carbon monoxide	Impaired oxygen transport function
6. Lead	Cumulative poison causing anaemia, colic, brain damage, and death
7. Cadmium	Lung, liver, and kidney damage; possible contribution to increased cardiovascular disease mortality
8. Mercaptans	Sensory irritation
9. Asbestos	Pleural calcification; malignant mesothelioma; asbestosis
10. Beryllium	Berylliosis with pulmonary impairment
II. Food and water contaminants	Effects
1. Metals	Lead poisoning, mercury poisoning, cadmium poisoning, arsenic poisoning, and chromium poisoning
2. Nitrites	Methemoglobinemia
3. "Softness" factor (soft water)	Possible increase in cardiovascular disease
4. Sulfates	Gastrointestinal hypermobility
5. Fluorides	Mottling of teeth (when in excess)
6. Chlorinated hydrocarbons	Storage in fatty tissues; possible impairment of learning and reproduction
7. Oil-petroleum	Impaired potability of water
8. Phenols, dissolved solids	Impaired potability of water
9. Phosphates	Algal blooms; impaired potability of water
III. Land pollutants	Effects
1. Human excreta; sewage	Schistosomiasis, teniasis, hookworm; urban filariasis; flies and other vectors; odors
2. Garbage and domestic refuse	Rat, rodent, fly, and other vector infestation; odors; secondary pollution of air and water
3. Industrial wastes	Accumulations; effects from toxic metals and other substances passing through food chains
4. Fertilizers	Ground and surface water pollution
5. Pesticides	Contamination of secondary foodstuffs

TABLE 3. Known effects of environmental exposure to chemical and physical agents on human health and well-being. (cont.).

IV. Radiation	Effects
1. Sunlight	Fatality from acute exposure; morbidity; skin cancer; interaction with drugs in susceptible individuals
2. Diagnostic X-ray	Skin cancer and other skin changes
3. Therapeutic radiation	Skin cancer; acute radiation illness; increase in leukemia
4. Nuclear power and reprocessing plants	Thermal pollution of water; possible contamination of air and water
V. Other	Effects
1. Noise and vibration	Temporary to permanent loss of hearing; impairment of rest; sensory irritation; impairment of communication
2. Household agents and housing	Accidental fatalities and injuries; spread of acute and chronic diseases (related to crowding); adverse effects on privacy, mental health, behavior, and social interaction

and standardization of measurement units permits.

Sufficient environmental and epidemiologic data, analyzed perceptively by skilled personnel, will reveal various degrees of environmental change having various impacts. Those responsible for overall community management planning must then determine priorities among the challenges revealed, within the framework of previously established objectives and in the context of other national development needs, such as agricultural expansion and improvement, industrial development, education, and social services.

A WHO committee of experts has summed up 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 program?
- 2) Is it reasonable from the economic viewpoint?
- 3) How does it fit in with the country's prevailing needs?
- 4) How much political support is it likely to receive?

From the technical point of view the performance and theoretical benefits of a program 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.(9)

Where environmental health programs are planned early enough to be more than emergency actions, they are by nature preventive. Such programs require action and expenditures well in advance of any emergence of favorable public opinion or extensive communications media coverage. 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."(9)

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; others are not so well prepared. The WHO expert committee which drafted the

report "National Environmental Health Programs: Their Planning, Organization, and Administration," has set forth three principles that it believes should govern legal frameworks:

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 should be reasonable.

3) Laws should be enforced and obeyed.(9)

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 possible cooperative actions among contiguous jurisdictions as needed, and should allow such associated units to work within an appropriate administrative framework. The usual basic legislative pattern for environmental health control sets forth policies and responsibilities for designated governmental agencies and the public at large; authorizes essential functions such as research, planning, development of regulations, setting of standards, and enforcement; establishes legal procedures for the conduct of authorized functions and program administration; provides for interrelationships among the government's various agencies and administrative levels; and provides for financing of these functions. Normally a body of regulations is developed, to supplement the laws, which specifies technical requirements and other details.

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

Participants in Environmental Health Management

By definition, it is a function of the ministry of health to recognize environmental services of consequence to public health (including the design and construction of essential facilities

for basic sanitation) and to initiate appropriate action. As program objectives broaden, its activities inevitably impinge on traditionally or legally established provinces of other governmental departments or agencies. For example, ministries or departments of public works, sewerage, and waterworks; various local authorities; and ministries dealing with 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 fact that several different agencies have direct or peripheral responsibilities affecting environmental health suggests that efficiency might be achieved by consolidating the various 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; reciprocal splintering of the affected non-health departments' overall areas of concern; and (especially) the traditional investiture of old-line agencies with the support of their respective public clienteles.

In any event, the health ministry has responsibility for the nation's health and well-being. It must therefore bear such a relationship to other departments and agencies that its view on desirability and adequacy of any proposed work is sought and incorporated in design considerations. In reality, various patterns of health ministry involvement have emerged. These have included a firm legal mandate to review the health implications of all projects; project programming, planning, and standard-setting; and essential epidemiological and environmental surveillance and monitoring.

Similarly, a variety of administrative entities have emerged to deal with circumstances peculiar to the different nations' economies, political philosophies, degree of public involvement, and other factors. In some cases there has been a tendency to establish environmental quality boards at upper levels of the Executive branch (through provision for advisory bodies at Cabinet or Executive levels) and to authorize the various ministries and agencies involved to

maintain effective communication. In all cases, the goal is to sustain unity of purpose and economy of effort in achieving environmental health objectives. The following excerpt (from the previously cited WHO technical report) points up the importance of maintaining flexibility with respect to administrative organization.

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 behavior 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. These "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.(9)

Economic and Resource Consequences of Environmental Control

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

Elements of the community with narrow interests have been known to influence decisions on major projects to the ultimate detriment of the national economy and the general welfare. With respect to another matter, a recent example of well-intended action without adequate prior analysis of collateral impacts on the national ecology was construction of the Aswan Dam across the Nile. The dam 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 sharply 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 ecological alterations. Some analysts estimate that overall national welfare will be affected adversely, although Egyptian officials challenge this judgement.

In the effort to improve Latin American nations' economic bases and provide for improvements in public welfare, many public and private works are being planned or are already being carried out. In view of every government's dual concern for economic development and protection of health, some governmental instrument capable of making continuous, objective cost-performance-benefit analyses on a broad base would be useful to each country.

Such instruments could perhaps be developed through regional or international organizations.

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

During the decade of the 1970's, 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 studies (10) clearly set forth the magnitudes of funding necessary to achieve the initial goals and to remain abreast of the most elemental water supply and sewerage needs. However, other protection programs are not likely to receive high budgetary priority unless a net national economic gain can be demonstrated. This conclusion is based on realistic recognition of the reciprocal relationship between concern for human status and concern for economic growth.

Several general means become available to governments in the process of providing funds for public works or nationally beneficial programs. Where the benefit is bestowed chiefly 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 directed at the pollution generated by industry, agriculture, transport, or commerce, 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., those

providing water and sewerage systems, can be financed through rate schedules imposed on users. In this case initial capital outlays and operating costs can be financed through a revolving fund, which in principle is eventually self-amortizing. However, the beneficial impact of some other types of programs is so diffuse or delayed that the only internal national recourse is a general tax pool or special tax levy.

Substantial international financial support is also available, through regional development banks and the International Bank for Reconstruction and Development. However, it is usually necessary to demonstrate the ability to repay (either by showing a reasonable prospect of economic gain or by using a revolving fund to provide a repayment base) in order to secure capital from these sources.

In addition, the mutual concern of PAHO Member Governments can 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.

The Challenge of Urbanization

Unfortunately, the records of cities which have grown explosively in response to the technological drive toward urbanization provide little in the way of tested managerial innovation. 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 citizens; but reports of successful anticipation of 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 health and well-being as in the contrasting neighborhoods of a large community. Higher rates of

Fast-growing metropolitan centers in Latin America give rise to a host of environmental problems.



mortality, infant and maternal death, morbidity, homicide, suicide, drug addiction, and deviant behavior have been associated repeatedly with inadequate or crowded housing, lack of essential public utilities, failure of sanitation services, and lack of recreational and educational opportunities.

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

In addition, Member Governments have the option of planning newly emerging cities so as to avoid repetition of earlier urban experiences. They can also intervene in developed urban communities, through reconstruction and substitute programs relatively free of known defects. Obviously, consideration must be given to special cultural, organizational, financial, and political circumstances; the particular health

profiles of migrant populations involved with each urban development; and the more broadly applicable principles of urban planning.

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

Institutional Arrangements for Environmental Control

The general pattern of health ministries' functions at the national level has already been discussed. 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 reasonable to expect that they should be the primary representative participants in any international environmental health activities (multinational, regional, or worldwide), and that they should assume responsibility for the education or training of appropriate manpower within their own areas.

A critical need throughout the Region served by PAHO 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 Latin American institutions, with respect to the engineering requirements set forth in the Punta del Este Charter. But the requirement for diverse skills coupled with "systems consciousness" has not been met or well anticipated by more than a few academic institutions or other training centers in any Member Country.

To assure production of needed manpower in sufficient numbers, endowed with the requisite skills and perspectives, it will be helpful for the few hemispheric educational centers presently competent and those in process of development to exchange teaching staffs and students. However, for the immediate future it will not suffice to rely on the relatively slow pace of regular academic programs. There is therefore an urgent need to continue and expand programs of short and intensive courses adapted to the numerous disciplinary areas related to the environmental health programs at all levels of operation. Some of these courses are best conducted by mobile teams traveling from site to site, but effective courses in depth are often provided through fellowship programs that transfer selected students to centers equipped to teach, demonstrate methods, and assure first-hand participation in special control and surveillance operations.

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

In addition to educational cooperation between the Region's health ministries, other activities related to environmental health provide logical areas for continuing international cooperation. These include:

- 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) Development of a system of hemispheric environmental surveillance, possibly utilizing the current capabilities for remote sensing from satellites or conventional aircraft.

- 3) Provision of expert counsel to Member States in formulating environmental health programs and policies.

- 4) Organization of international environmental services in response to major natural disasters.

- 5) Sponsorship of evaluations of environmental threats involving more than one PAHO Member Government, including threats associated with water supply and waste management, regional economic development proposals, degradation of air resources, agricultural and other resource development practices, activities affecting the spread of zoonoses, population movements, and other relevant activities.

- 6) Stimulation and encouragement of applied research in the several areas pertinent to environmental health (with primary emphasis on development of simple, economical techniques of environmental and health analysis, and adaptation of local resources and levels of skill to needs of individual nations).

- 7) Continuation and intensification of the international effort to assist Member Countries in funding essential environmental health programs.

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

Research Requirements, Challenges, and Opportunities

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

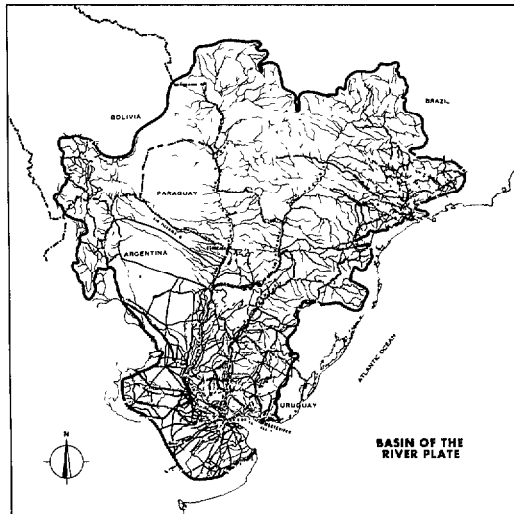
On the other hand, there is much to be gained by adaptation of existing knowledge and

methods to the specific requirements of particular localities or regions. Efforts to use locally available materials, reduce costs, and expedite programs under conditions that often differ markedly from those for which current technologies were devised should pay handsomely. Similarly, there may be need to modify standards for measuring environmental quality in light of climatic and other idiosyncrasies of different localities.

Teams of investigators, functioning in association with the central data retrieval and analysis effort and central educational and advisory staffs may supplement and stimulate activities by national, regional, or local governments. Such investigative services should be developed as far as possible by national authorities; however, international cooperation will probably continue to help in assuring region-wide impact and maximal economy of effort.

Recent developments in remote sensing techniques open the prospect of short-cutting many surveillance needs by employing photographic, spectrometric, radar-reflecting, and other sensors carried in satellites or aircraft. Such methods have proved their value in forestry, agricultural productivity surveys, plant disease control, urban structural analysis, marine and terrestrial heat distribution studies, water pollution source location, and other pertinent pursuits. These new sensing capabilities, while rooted in earlier origins, are 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 correlating the data with terrestrial health indices, will employ highly sophisticated equipment, even in this age of computers.

A tremendous variety of specific areas of inquiry pertinent to the role of PAHO could be cited. These could most certainly include environmental health evaluation of the changes



occurring or projected in relation to waste discharges into the Gulf of Mexico; pollution of waters overlying the Hemisphere's coastal shelves; the development program in the lower River Plate area; hemispheric changes in air quality; insect eradication and zoonoses control programs; situations involving international waterways; and other environmental matters of multinational concern.

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

Policy Issues and Possible Programs

Considering the challenges to health and well-being of the peoples of the Americas to be faced in the 1970's, one 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; and the basic responsibilities of health ministries demand that national and international actions anticipate health consequences of such change. This, in turn, requires movement toward a pattern of legal, administrative, informative, technical, constructional, and service instrumentalities continuously sensitive and responsive to emergence of new factors and persistence of old ones.

Effective, economical action will require association with organizations and disciplines not traditionally concerned with public health. This is because we must deal with the effects of environmental changes resulting from all kinds of interventions in the ecological system, including technological, social, cultural, educational, legal, and administrative changes. The new challenge to health ministries thus invites 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 these goals should also cite the need for realistic progress in controlling 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 environmental health challenges). Ever-present limitations on government and organization budgets suggest that all operations should be designed to minimize costs through innovative use of unconventional methods and through maximal cooperation among Member Governments.

In this context, the Member Governments may desire to expand or initiate the following actions:

- 1) Environmental surveillance and monitoring, with special emphasis on multinational and regional surveys, and on 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 related health profiles. This should include provision for prompt retrieval and distribution to specific local, national, and regional governments and agencies, either upon request or by prearrangement.

- 4) Adaptation and reformation—if necessary—of education for technical, managerial, administrative, and other skilled manpower needed for effective development of environmental health programs. This effort may best be carried out through on-site short courses conducted by traveling PAHO experts, longer-term exchanges of faculty and students by special academic institutions specifically organized to participate, and extended study in PAHO centers associated with an appropriate academic environment and special facilities.

- 5) Preparation, production, and dissemination of publications describing standards and methods, manuals, 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. The functions of such an institution might include:

- 1) Acceleration of manpower development.

- 2) Central data processing, analysis, and application.

- 3) Liaison with several existing PAHO regional centers (devoted to environmental engineering, nutrition, zoonoses, population studies, and health planning).

- 4) Liaison with other national and international agencies.

- 5) Development of advanced health and environmental survey methods applicable at local, national, or regional levels.

Wherever and however such a mechanism is eventually developed and located, one of its objectives should be to associate itself with

academic, governmental, and private agencies in such a manner as to achieve maximal progress toward environmental health goals.

The challenge of the present, the next decade, and the foreseeable future is to achieve human adjustment to induced changes in man's surroundings through effective resource mobilization and use. The key ingredients for useful operations in this field are understanding the effects of these changes, planning compensatory or protective actions, and implementing the plans, while adding as little extra economic burden as possible.

Summary

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. This conclusion is implied by current demographic trends, available indices of public health and well-being, estimates of agricultural activity, and economic growth projections associated with alteration of the environment. The need, recognized in the Charter of Punta del Este, to effect basic sanitation through provision of clean water and effective waste management, requires additional action. Substantially higher priorities must be assigned environmental concerns—not only the condition of air, water, and food resources, but also the stresses of overcrowded homes, occupational hazards, and cultural displacement produced by technological advances and exploitation of natural resources. All nations of the Americas are engaged in accelerating processes of economic growth; in consequence, all are increasingly 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 minimize adverse effects on people, is a major challenge of these times.

Water service and sewerage deficiencies, heavily polluted air in some large cities, sprawling slums, and other problems have made the need for specific environmental interven-

tion apparent. 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 a need for careful examination of the entire ecological complex, so as to permit anticipation and circumvention of health problems. Further, it must be assumed that environmental changes not presently discernible will emerge during the 1970's; provision should be made for their consideration and for possible resulting action by agencies concerned with health matters.

The primary initiative for and management of economic and resource development projects normally are vested in national agencies not directly concerned with health; therefore, a primary consideration of health ministries should be the nature of planning and administrative arrangements needed for effective participation with other sectors of public responsibility. Appropriate inclusion of health considerations in national economic development requires: a legal basis for intervention; an adequate mechanism for evaluation of environmental changes and their effects; and the development of a cadre of skilled analysts able to participate with representatives of other special interests in planning and applying environmental interventions affecting national welfare.

The Pan American Health Organization has demonstrated the effectiveness of international cooperation as an efficient, economical means of prosecuting health-related programs. Recommended areas for future international cooperation include: intensification of specialized training programs; provision of financial assistance for national environmental health programs; promotion of hemispheric environmental surveillance; organization of a central data processing and information retrieval system; provision of expert counsel for use in formulating national environmental health programs and policies; evaluation of international environmental threats; development of international environmental disaster relief services; stimulation of applied environmental research; and stimulation of publication of research-related information. A regional ecological center for the Hemisphere could provide an excellent means of promoting such activities, and could serve as a valuable liaison between both national and international agencies.

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SALMONELLA SURVEILLANCE

United States *Salmonella* surveillance reports show a marked increase in the number of strains of *Salmonella agona* isolated in 1971. Thirty strains were isolated between May and November 1971, while in 1970 only four were isolated during the entire year. (In 1969 no strains of *S. agona* were isolated, and only one was found in 1967-1968.) The *S. agona* isolated in 1971 was clustered in the following states: Pennsylvania (7 isolates), Illinois (6), California (4), Michigan (3), Wisconsin (3), Louisiana (2), Tennessee (2), Rhode Island (1), Montana (1), and Massachusetts (1).

S. agona is a common serotype in Great Britain, where it frequently causes outbreaks. Its appearance in the United States without any detectable pattern has not yet been explained. [*Weekly Epidemiological Record* of the World Health Organization 47(27)261, 1972.]