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ENVIRONMENTAL CHANGE AND RESULTING IMPACTS ON HEALTH

Report of a WHO Expert Committee

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WORLD HEALTH ORGANIZATION

GENEVA

1964

EXPERT COMMITTEE ON ENVIRONMENTAL CHANGE AND RESULTING IMPACTS ON HEALTH

Geneva, 11-17 August 1964

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ENVIRONMENTAL CHANGE AND RESULTING IMPACTS ON HEALTH

Report of a WHO Expert Committee

The WHO Expert Committee on Environmental Change and Resulting Impacts on Health met in Geneva from 11 to 17 August 1964. The meeting was opened by Dr P. Dorolle, Deputy Director-General, who defined the purposes for which the meeting was convened. He stated that the relationship between man and his environment has changed and is continuing to change at an increasing rate. The changes, particularly in highly developed countries of the world, are producing complex problems of public health and environmental health control in relation to increased density of population, accelerated urbanization, and continuous industrial expansion resulting from new developments in science and technology.

Dr Dorolle indicated that it was indeed appropriate and timely to make an exhaustive study of the nature of the changes that have taken place, to evaluate the health consequences of these changes, to formulate sound, feasible recommendations, and to suggest further investigation and research required for this purpose.

Dr Dorolle further stated that the Organization had in recent months convened several scientific groups and expert committees which had dealt with specific subjects in the field of environmental health. This Expert Committee, therefore, might wish to concentrate discussion on recent and important aspects of the specific problem areas indicated in the agenda and evaluate the probable health significance of these new developments.

He stressed the interest of the World Health Organization in studying the new problems, and called to the attention of the members of the Committee that, in spite of the technological developments of recent decades, some two-thirds of today's world population had still to solve basic environmental health problems of a strictly microbiological nature. New environmental health problems, such as pollution of the environment with new chemicals, should, therefore, be discussed with a correct sense of proportion and perspective in relation to overall changes in the environment.

Professor Abel Wolman was elected Chairman, Mr R. S. Mehta Vice-Chairman, and Mr H. P. Clifton Rapporteur.

INTRODUCTION

The Committee's task was to consider recent changes in man's environment, assess any effects on health that these changes might produce, and make appropriate recommendations concerning action and research which it thought to be necessary. To aid it in its task, a large number of recent WHO documents dealing with the subject was placed at its disposal.

The Committee wished at the outset to emphasize that in its deliberations it avoided repeating or reviewing the many findings and recommendations to be found in the reports of previous expert committees and groups. The reader is referred to the bibliography appended to this report.

Man's efforts to control his environment have in the past been sporadic and largely empirical, but the value of long-term planning has been recognized to an increasing degree in recent years.

The Committee noted that man's capacity for adaptation is great and that there is little justification for the pessimistic forecasts frequently made ; the future should be viewed with prudence rather than with alarm. While many old problems remain as yet unsolved, new ones have been emerging which are connected with increases in population, the associated expansion of urban areas, and the need for increased production of food and fuel. All these problems must be considered in relation to the character of each country and its financial resources. Care must be taken that, in implementing the recommendations made by this or other committees, the *ad hoc* approach is not neglected.

IONIZING RADIATION AND ENVIRONMENTAL HEALTH

The total irradiation to which man is exposed today

The natural irradiation to which humanity has always been exposed is due to cosmic rays, radiation from radioactive substances present in the earth's crust, run-off water, the atmosphere, and the human body itself (potassium-40, radium-226, carbon-14). All these sources together deliver an average annual gonad dose of 100 millirem per person at sea level.

Taking this inevitable exposure as a basis of reference, the sources of radiation that man has artificially added to his environment can be classified in order of importance : medical irradiation, which at present may contribute up to 100% of the natural gonad dose (i.e., 100 additional millirem per year) if control is not efficient ; radioluminescent paints (luminous watch dials, markers, electric light switches), which give an average population gonadal doses from 3% to 8% of the natural gonad dose ; radiation and radioelements

in conventional industry, which contribute 1% to 3% of the natural gonad dose; radioactive fallout, at present 1% to 2% of the natural dose; and nuclear energy, which contributes at present a very small and uncertain amount—it certainly does not cause a gonad dose higher than 1% of the natural dose.

Therefore in the developed countries man receives a total annual dose of some 200 millirem (i.e., the artificial radiation sources double the natural dose).

Public health problems posed by radiation

External or internal irradiation of the body may cause two main types of lesions: somatic lesions affecting the irradiated individual himself, and genetic lesions affecting his descendants. Further, we must consider separately the possibility of damage to children through their high consumption of milk, which may contain significant concentrations of bone-seeking radioactive isotopes.

Somatic lesions are at present exceptional and do not really pose any public health problem. On the other hand, little is as yet known of the mechanism of the genetic action of radiation, in particular as concerns small repeated doses. Extreme care is therefore necessary and everything should be done to ensure that the irradiation of the population as a whole is kept as low as possible. The efforts of bodies responsible for public health should be concentrated primarily on reducing doses of radiation of medical origin. If certain elementary precautions discussed in recent years are taken, the dose can be reduced to not more than one-fifth of the average natural background dose of 100 millirem without loss of diagnostic information. This is the most urgent problem. Energetic legislation is essential to assist public health efforts in this field.

Next, supervision is needed of the spread of radioelements and radiation applications among the general public. The widespread introduction to the public domain of radioluminescent objects of all kinds and minor applications of radioelements in industry call for special supervision to ensure that the present level, which seems acceptable, is not exceeded. Experience proves that the most unexpected applications may be suggested by industry in this field in disregard of the health of the individual (e.g., luminous markers containing 50 mc of strontium-90 in a simple plastic envelope).

Strict supervision of waste from the nuclear industry is required. The development programme envisaged for coming years (5000 MW in Europe by 1970) poses in particular the problem of water pollution by radioactive waste from nuclear energy centres. This includes: firstly, very high-activity liquid waste (more than 100 c/l), which at present constitutes only a local problem; secondly, solid waste of medium activity which, after partial decontamination by coprecipitation in large volumes of water,

yields radioactive sludge that is expected to accumulate in Europe to the extent of 100 000 tons during the next five years ; thirdly, liquid wastes of low activity (0.01 c/m^3), estimated to reach 100 000 c in Europe ; these products will have to be discharged into rivers or seas during the next five years and must be disposed of in compliance with the maximum permissible concentrations laid down by the International Commission on Radiological Protection (ICRP). It is essential that the control measures adopted should make ample provision for supervision of waste during transport.

General conclusions : the public health repercussions of radiation present an immediate problem, namely, the need for massive reduction of medical doses ; and a future problem, namely, the need for supervision of the constantly increasing waste from nuclear power stations and chemical reprocessing plants.

Important problems which remain for active research concern the biological action of irradiation, especially in the field of human genetics, and the improvement of techniques for detecting radioactive contamination.

AIR POLLUTION

In some parts of the world air pollution with its effects on human health is a serious problem. Elsewhere it is of little importance, either as a hazard in its own right or because other evils such as starvation, bad housing or water-borne diseases are of overwhelming magnitude. In yet other places the increase of industrial activities may lead to serious air pollution if the lessons to be learned from older industrial societies are ignored. While admitting that air pollution is never beneficial and is often injurious, care must be taken to preserve a sense of proportion, so that undue prominence is not given to the subject in areas where it is of comparatively little importance and where the slender technical and medical resources available are needed to combat greater evils. On the other hand, it should be remembered that in some populations, weakened by malnutrition and disease, a high concentration of pollution might constitute a final intolerable stress.

Air pollution has received much attention from WHO. Pollution of the air of towns by the products of combustion of fossil fuels is the most familiar problem and it is among the population of such towns that the effects of pollution may be demonstrated most easily. Pollution by smoke and sulfur dioxide from the burning of coal is notorious and many times in the past when freak weather has prevented the dispersion of these pollutants excess deaths have occurred among the populations of large towns. In general, those who die are either very young, old, or suffering from cardiac or respiratory disease. It seems reasonable to suppose that a high proportion of the deaths are due to the stress caused by irritation of the respiratory tract. These *acute* effects must be regarded as distinct from *subacute* effects

and the suspected *chronic* effects of lesser concentrations of pollutants. The *subacute* effects of these pollutants are manifest as increases in morbidity, as measured by various indices, which accompany or follow closely minor exacerbations in pollution in large towns. Air pollution is suspected of playing a part in the causation of chronic bronchitis and lung cancer, and these possible *chronic* effects need for their investigation the application of techniques different from those used in the case of acute effects.

This report is concerned with *change* in the environment. There are indeed notable alterations in the nature and amounts of these " traditional " pollutants, and their effects, demonstrable or suspected, are changing. In coal-burning communities the extravagant use of this fuel is happily becoming less common, and the inefficient use of coal on open domestic grates, with the inevitable production of tarry smoke, is being abandoned ; industrial furnaces burn their fuel with greatly increased efficiency, and electric and diesel traction is replacing steam locomotion on railways. As a result of all these improvements pollution by smoke is declining in many places. Sulfur compounds are, however, common impurities in fossil fuels and are difficult or impossible to remove economically. Pollution of the air by oxides of sulfur therefore continues largely unabated and may even increase as the amount of fuel burned per unit area or *per capita* rises due to greater population density and higher standards of living. The effects on health of these changes are as yet uncertain, but it must be said that the abolition of one notorious pollutant, smoke, cannot be other than beneficial. The important question is whether the effects hitherto attributed to air pollution in general have, in fact, been due to smoke, sulfur dioxide, or combinations of the two. The changing situation must be watched with great care since it is a natural, and welcome, experiment which may well provide the answer needed for future planning of industrial communities. We can at least expect to have from the observations currently being made some reliable estimate of the need to abate or abolish pollution by sulfur dioxide, though this is technically a formidable task.

In attempting to assess the changing impact on health that may follow the abatement of smoke it must be remembered that the nature of the population is altering both in age structure and in respect of the diseases from which its members suffer. Advances in therapy have led to prolongation of life, which in some cases has enabled new diseases to emerge ; we have developed and applied specific remedies for many diseases, leaving an increasing proportion of the community susceptible to non-specific stresses against which we have not yet provided adequate protection. In view of these demographic changes, the effect of changes in pollution are very difficult to assess with confidence.

The increasing use of the motor car and diesel traction is altering the environment in many parts of the world. The petrol engine, by its very nature, emits unburnt hydrocarbons and carbon monoxide. This latter

pollutant may reach concentrations in the air of streets well in excess of those permitted in industry, and its effects in concentrations far smaller than those needed to produce symptoms compatible with mild asphyxia merit urgent consideration. Fuel additives such as lead are emitted by these engines and, while they do not as yet constitute a hazard to health, need continual study.

In certain places, notorious among which is Los Angeles, the hydrocarbons emitted by petrol engines are of great importance. In bright sunlight and still air, they take part in photochemical reactions producing a lachrymatory haze which is a grave nuisance if not actually productive of structural damage to the body. There are many regions of the world where this problem cannot arise, but it is a new one and will certainly occur in many places as the spread of motor traffic continues. Pollution by smoke from ill-adjusted or badly maintained diesel vehicles is popularly supposed to be the cause of many ills. It is wholly avoidable, and it must be pointed out that the diesel engine, when properly adjusted and used, is free from many of the disadvantages of other forms of traction. There is no evidence that it causes disease.

Pollution of the air by newer synthetic chemicals seldom occurs and, when it does, is almost always accidental, since the synthetic chemicals are usually prime products which are not allowed to escape. Health officials should be given an opportunity to examine plans for the control of atmospheric discharges or occupational exposures to ensure that as far as possible no hazards to health will result therefrom. In addition, a close watch must be kept on possible effects on the community of the chemical industry's many new products ; this may best be done by the study of industrial populations as well as by orthodox toxicological techniques.

Occasionally, pollution of the communal air by exotic substances, such as beryllium and asbestos, has unforeseen dramatic and unwelcome effects among the general population. Not only must the community be protected by constant vigilance, but such exposures as might occur either accidentally or in ignorance of their possible consequences should be studied minutely, since they may yield clues as to the fundamental mechanisms by which diseases are produced. The importance of this principle is illustrated by the modern approach to work on the effects of asbestos.

Similarly, the occurrence in a few parts of the world of outbreaks of non-infective respiratory disease in relation to air pollution deserve intensive study. The epidemics of " asthma " in New Orleans and in the Tokyo-Yokohama area are clinically distinct syndromes, and are undoubtedly caused by air pollution. While the New Orleans syndrome seems to be essentially an " asthmatic " response to an irritant or allergen, the source of which has been identified, Tokyo-Yokohama " asthma " is a much more complex disease in which some of the changes produced are sometimes irreversible. The cause has not yet been identified, but the relevance of this

clinical syndrome in the study of the etiology of chronic non-specific respiratory disease is obvious. Because of this, and in view of the serious nature of the disease, it merits urgent and exhaustive study.

Throughout current and future work on changes in air pollution and its impact on health, special care must be devoted to methods of measurement of the pollutants, some of which may be difficult to determine by orthodox chemical analysis. The use of biological indicators, e.g., plants including lichens, deserves thorough investigation.

WATER AND WASTE WATER

Water supply

Changes are occurring throughout the world in the water situation. An assessment of water supply problems and their effect on health reveals that the provision of a safe water supply is an urgent and unmet need in much of the world. This need is made more urgent because the rate of migration of people into cities is exceeding the ability to supply them with water. As a result, water-borne diseases take a major toll and overshadow other environmental health needs in importance; the enteric diseases, including cholera, typhoid, dysentery, the diarrhoeal diseases, and others of viral origin, are the leading causes of death and disability in areas occupied by more than two-thirds of the world population.

Some of the developing countries that have experienced very rapid increases of population were primarily agricultural countries, but of late, in their search for high living standards and for attaining self-sufficiency in economy, they have established large new industries. This has resulted in the expansion of urban communities. Existing water services, already strained at the outset, have been stretched beyond the limit, and in many cases are now totally inadequate to cope with present needs. New slums have formed in the cities and a serious problem of fringe areas has developed where thousands of squatters occupy land adjacent to cities. Basic facilities for water supply and waste disposal are lacking. With the numbers of people, water requirements *per capita* and industrial demands also steadily increase. These changes have caused the meagre resources of many local communities to be outstripped. It is most desirable that where land is being reclaimed and industry expanded funds for water supply and waste water disposal should be provided from the outset as part of the project.

Little change is occurring in rural areas where a large part of the population of the developing countries lives. Water supplies are generally inadequate in quantity and quality and people spend much of their time and energy in collecting water. In many places a disproportionate amount of water is brackish, containing high amounts of dissolved solids, high fluorides

or iron that have a direct effect on health. In very small rural communities and isolated groups shallow groundwater sources and roof water may sometimes offer cheaper and safer supplies than surface water. Where the only source is a stream or irrigation canal it may be necessary, for reasons of economy, to limit treatment initially to sedimentation and disinfection: filtration is always desirable but may often be impracticable.

The change in these areas is so far a change in attitudes—there is overwhelming dissatisfaction with the poor environmental conditions because people living under such conditions now know that there are better services elsewhere; they also realize the deleterious effect the present environment has on their health.

In many parts of the world the need for more food and fibre has given impetus to the building of water reservoirs and the extension of irrigation. In Asia and Africa particularly, much emphasis has been placed upon watering the arid lands and reclaiming and draining land in humid areas. Irrigation or the provision of water without adequate drainage may give rise to diseases the vectors of which depend upon water for survival or reproduction. In humid zones, land reclamation can improve health by eliminating breeding places for mosquitos and bilharziasis snails. Such engineering improvements always carry with them the danger of secondary problems or side-effects and, for example, the possibility of unintentionally increasing arthropod vector and pest population through the construction of earth dams, irrigation channels, fish farms or oxidation/stabilization ponds must always be kept in mind—in so far, of course, as they threaten to outweigh the benefits to be obtained.

Water supply patterns in the developed countries are also changing. The dependence upon surface water sources is increasing. Less water is collected upon protected watersheds and more attention is given to providing a high degree of treatment for contaminated waters. More water is being re-used and piped water supplies are being extended to rural areas. The world depends upon industrial growth to provide a higher standard of living, and growing industries constantly require increasing quantities of water. This should not give cause for undue alarm, however, as industry is often capable of reducing its demands when water happens to be costly or scarce. Long-term planning for water resources and requirements is essential.

Waste water

Water pollution is a major public health problem, and plans for supplying water should include corresponding provisions for carrying away and treating waste water, even if the latter plans cannot be implemented immediately. The nature of microbiological pollutants may vary because of shifting populations and patterns of disease. However, present methods

of water treatment, provided that they include an adequate disinfection process, can remove the potential pathogens so that waste treatment, while important, must generally have a lower priority than the provision of safe domestic water supplies. This should not obscure the fact that water pollution occurs in every country and that corrective steps are inadequate over much of the earth.

Attention has been given to chemical pollutants, especially those which are toxic or non-degradable. Pesticides have been singled out for special attention. At present, the accumulation of pesticides in water does not appear to constitute a major hazard to the health of man. As in the case of pollution by detergents, the trend is to encourage the use of more readily degradable compounds. In 1964 England markedly reduced the use of aldrin and dieldrin in agriculture, horticulture, animal husbandry and food storage practice. The effects of chemical pollution from land run-off require investigation. The picture is not so clear with respect to the discharges from petrochemical plants, pharmaceutical factories, and similar sources of chemical pollutants, but immediate improvements may be obtained through good housekeeping and by treatment of strong wastes at source. Throughout the world the provision of underground sewerage has lagged behind the provision of water supplies, and the provision of sewage treatment plants lags behind the construction of sewer systems. In areas without sewer systems the water flows into open drains and has created serious problems such as radical increases in the density of the mosquito *Culex fatigans*, the vector of urban filariasis.

In many developing countries the question of collection and disposal of sewage remains almost unsolved and the handling of "night soil" is wholly unsatisfactory. With increasing levels of education it is becoming daily more difficult to obtain personnel willing to carry out this type of work. Unsatisfactory waste handling has caused a high incidence of worm disease and many cases of gastro-intestinal disease in rural communities. Adoption of a sewer system with central treatment works is recommended as soon as financial and other priorities permit.

Technological aspects of water supply

The technological problems associated with water supply in the developed countries include the provision of water where fresh raw water is scarce. For these special cases the reclamation of sewage and the conversion of highly mineralized water offer important challenges; improvements can also be made in establishing a legal basis for water rights.

Conflict of interest between demands for irrigation and domestic water occurs when the flow available is small in relation to total requirements. In some situations government action is necessary to allocate new priorities

and to ensure the supply of sufficient water for existing and future domestic requirements of communities and for industries. In all new schemes for the development of water resources, allowance should be made for municipal and industrial water requirements. Investigations should continue for the improvement of total water resources by any practicable techniques aiming at suppression of evaporation, desalinization or cloud seeding. Prevention of all forms of water wastage must, of course, be emphasized. Re-use of water by tertiary treatment of wastes, ground recharge, or combinations of both, is coming to be more widely recognized in modern communities. With continuous re-use of water, provision must be made for partial demineralization unless adequate means of dilution are available.

Prevention and control of water pollution

The removal of biological pollutants from wastes remains a primary objective. A choice can be made of methods of treatment from several proven processes ranging from land irrigation and lagooning to highly mechanized and intensified systems that take up little land area. The self-purification capacity of streams that are not overloaded can be utilized where this does not interfere with other uses, and in some cases, the storage of water for dilution in times of drought may be justified. By the use of these various methods, either with some preliminary conventional treatment or without, depending on industries, waste waters may be brought back to the quality of raw waters and be used again by the community.

While the transition is being made to the use of more easily degraded pesticides, much pollution may be avoided by selection of the compound and by careful and minimal application. For example, the application of sprays over bodies of water should be avoided (unless, of course, considered necessary for control of a vector-borne disease affecting man), and application might be suspended when it rains. Monitoring facilities are needed to measure the amount of pollutants in water and soil. The experience gained from the recent history of detergents and pesticides, in developing more readily degraded compounds or obtaining the actual removal of certain products from use, points the way to the solution of problems involving other pollutants, e.g., fertilizers, which should be produced in a form which will cause minimal pollution of groundwater. Every effort should be made to instruct the chemical fertilizer industries in this approach.

There is an urgent need for the introduction of legislation to provide effective control of surface and groundwater pollution in many countries. The laws should contain, besides preventive and penal measures, suitable technical and administrative instructions for their effective implementation. Education and persuasion will continue to play an important initial part in pollution abatement and control.

Survey of countries' water resources is essential if total requirements are to be met. This would mean detailed investigation of both surface and sub-surface waters. Very little hydrological information is available at present on sub-surface resources and such surveys may well have to be more heavily relied upon for rural communities demanding community water supplies. In the surveys the quality and quantity of the waters would be noted. Programmes should also be developed to ensure the protection of groundwater quality.

Need for research

The above circumstances indicate the need for research with a view to developing:

(*a*) suitable economical water treatment and re-use processes in which indigenous materials may be used and in which a minimum of skilled maintenance is required;

(*b*) new economical methods of sewage treatment for all sizes of communities suited to their local conditions of temperature and climate, as well as utilization of by-products, effluents, gas, and sludge as fertilizer;

(*c*) physical, biological and chemical methods of waste water treatment and re-use for industries;

(*d*) methods and processes that will reduce waste at the source and will make use of reclaimed waste materials.

Fundamental and applied research are needed. Research organizations and universities should hold refresher courses for engineers and scientists working in the field and courses for the guidance of research students working in universities and industries where appropriate qualified technical staff may not be available. Training courses are a continuing need for operators of water and sewage plants.

SOLID WASTES

Solid wastes are in many ways similar to other community wastes, for example those handled in a sewer system, and the essential difference is one of concentration rather than composition; all consist of a mixture of mineral and organic matter. Changing patterns in man's life and activity inevitably result in changes in the production and composition of solid wastes, notably refuse, " night soil " and sewage sludge. While in the past solid wastes were produced mainly in the home and only to a slight extent from commercial activities, today's problems are created by the movement of people into rapidly organized communities and by advances in industrial

technology. During the last few decades changes took place chiefly in developed areas across the world, but they are expected to appear soon in developing countries, and at an increasing rate. The most significant change occurred with the introduction of sewer systems to collect domestic wastes and to transport " night soil " and disperse it in a large amount of water. This change continues in all parts of the world where communities are growing, and intensifies the problem of disposal of " night soil ", rendering this system impractical and unsafe.

The next most significant change is associated with the development of new industries producing disposable products for use in many different branches of industry. Also, some types of solid wastes formerly produced in small amounts by traditional industries are now found to have increased in volume and changed in nature. In the developing areas these changes accelerate the emergence of new problems and intensify existing ones. In other parts of the world the evolution of industrial technology produces new and exotic types of wastes. An increase in volume of refuse (rubbish plus garbage) *per capita* and a gradual change in its composition also occurs. Rubbish in modern cities contains more and more bulky material. Abandoned household fittings constitute an increasing portion of solid domestic wastes, while less and less kitchen wastes are produced because of improvements in food processing. Paper and packing materials, including a great amount of plastic and building material, constitute an increasing portion of wastes. In many countries the disposal of old cars and rubber tyres is a problem.

A large variety of solid and semi-solid waste products is discharged from petrochemical industries, and these are of particular importance because they constitute the base materials for so many secondary industries. Nuclear establishments and research laboratories supply and use radioisotopes and produce solid waste material contaminated by radioactive substances. More and more chemical sludge is to be disposed of from the many factories adopting internal waste-water treatment. Plastic waste comes from many different branches of the chemical industry. All these produce new disposal problems to which practicable solutions will have to be found for each locality.

Impact

As these changes in waste production and composition take place, so their impact on health may alter. For instance, as " night soil " collection and disposal is replaced by the use of modern sewer systems, many diseases associated with human waste products may become waterborne, instead of being transmitted as before by direct contact or through food. Solid industrial wastes also change in chemical composition, concentration and in volume, requiring variation in waste disposal methods. As the material

becomes less and less putrescible, more is burned where sanitary landfill is impracticable; air pollution must then be avoided, as must offensive smoke or odour. There is also a need for separate treatment of certain types of industrial solid wastes by incineration.

Significant impacts on health may well be associated with these changes if the rapid expansion of growing communities overloads existing collection and disposal services, with resulting unsatisfactory removal of these wastes from the inhabited areas, or if these services break down. Water pollution —notably pollution of groundwater—and fly and rodent infestations may follow. Apart from any demonstrable risk to health, the importance to the community of satisfactory waste removal is self-evident.

In industrialized countries, where more and more solid wastes are burned, local problems of air pollution occur; excessive amounts of smoke may be discharged if combustion is incomplete. This is a particular danger in areas where trash and bulky wastes are not collected by the municipality but are burned on private premises. Harmful gases, such as hydrochloric acid (from polyvinyl chloride plastics) and sulfur dioxide, may be discharged from incinerators as solid wastes come to contain more new materials. Lead batteries are burned in many places and add another dangerous constituent to the air, although this practice is prohibited in some countries. The disposal of new types of chemical solid wastes from industry must also be controlled carefully to avoid introducing new constituents into water resources and thus into drinking water. In tropical countries where certain diseases are transmitted by container-breeding mosquitos, bulky wastes such as old cars and their tyres provide additional breeding places for the vectors of these diseases.

Control

It still appears desirable to repeat that solid-waste disposal should form an integral part of urban development. Planning, design and operation of collection and disposal services should be under the control of the authority dealing with public services in general. Health personnel must, of course, have a role in the planning, approval and supervision of such services in order to prevent hazards to health introduced by improper design or operation.

The best method of control consists in rapid removal of solid wastes from inhabited areas, and reduction of their volume and their potential for creating a health hazard. Mechanized collection of " night soil " and its disposal by a proper method such as anaerobic digestion or composting will reduce hazards to health in communities where sewer systems are not available. Refuse should be stored and collected sufficiently frequently in standardized containers designed to minimize propagation of odours, flies and invasion by rodents. Combustible material may be burned in the

house, but this provides only a partial solution and contributes to local air pollution. Household grinders have provided a major step forward in domestic hygiene; they also reduce, to some extent, the load on the refuse collection and transport system.

Lack of information

Qualitative and quantitative surveys are needed to determine the best solutions to local problems and the present position as regards solid waste disposal. Increased technical knowledge, gained through research and investigation, should disclose safe and improved methods of waste collection, transport, treatment, disposal, and utilization to be adapted to old and new types of waste, and more efficient and economical methods of "night soil" disposal. There is also a need for more specially trained personnel in this branch of engineering. Methods of financing collection and disposal systems remain to be worked out for many parts of the world.

FOOD HYGIENE

Many significant changes affecting food hygiene have occurred since 1956, when WHO published the fourth report of the Expert Committee on Environmental Sanitation, entitled "Food Hygiene",[1] to guide and advise Member Governments on the need for establishing and implementing food sanitation programmes.

Recent changes affecting food include the use of new chemicals and substances such as antibiotics to preserve foodstuffs and to control disease in plants and animals, defoliants to make harvesting easier, herbicides, fungicides, hormones administered to poultry and animals used for food, and insecticides of all types. Radioactive contamination is also a possibility.

Rapid urbanization is producing problems in developing countries where equipment and facilities are not available to handle perishable foodstuffs in a safe manner. Where there are few refrigerators, food preservation by other means is practised. In addition to age-old methods of drying, smoking, and salting, newer processes are being utilized and developed. The most common of these is perhaps the dehydration of milk and other foods for reconstitution on a commercial scale or in the home. Meats and some other foods are both frozen and dehydrated, and closely resemble fresh products when moisture is replaced. Dehydration, food irradiation and other processes need further development to provide proper

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[1] *Wld Hlth Org. techn. Rep. Ser.*, 1956, **104.**

diets for people in urban areas lacking in local resources, in supplies, or in facilities for food refrigeration.

Review of food handling and marketing practices in developing countries reveals many situations that could adversely affect food quality and health. In such regions studies should be made to determine what improvements are practicable to protect unpackaged, moist foods from flies and contamination and to encourage hygienic practices among food handlers. This is particularly important as urbanization rapidly progresses in advance of the services necessary to feed urbanized populations safely.

Recent evidence shows that, even in developed countries, much more salmonellosis and other disease due to food pathogens occurs than is being reported or than had been previously suspected ; possibly less than 1% of such cases are reported. Epidemiological studies of food-borne illness are complicated by the fact that foods produced and processed in one country may be consumed in another. Better food hygiene and temperature control becomes increasingly necessary as the trend towards mass-cooked meals in schools, factories, institutions and homes continues.

The question of purity of waters from which shellfish are harvested should continue to receive attention. Outbreaks of infective hepatitis, alleged to have been caused by consumption of such raw foods, have stimulated fresh interest in this subject.

Packaging of pre-cooked, moist foods in plastic, transparent wrappers in an anaerobic environment creates new risks of botulism. Newly reported cases due to type E botulism organisms which withstand temperatures of smoke processing and develop toxins at below 10°C raise further questions. Cases of botulism from canned tuna in the USA and an extensive outbreak of typhoid in Scotland reportedly attributed to canned meat indicate the need for constant vigilance. Food processing errors—for example, contamination by cooling water—must also be guarded against.

Some research may be necessary on other toxins ; for example, it has been shown that certain strains of *Aspergillus flavus* and other fungi can produce toxin (aflatoxin) in groundnuts (*Arachis hypogaea*). There is evidence that this and other moulds may produce cancer in animals. Some governments have established strict controls on food additives so that, before new food chemicals or packing materials are permitted, comprehensive toxicological studies, including studies on animal feeding, are required. Authorities must protect public health without imposing unreasonable restrictions on the use of new and necessary products.

Food engineering

Urbanization and modern food practices are responsible for the appearance of more and larger food processing and serving businesses. It should be remembered that their proper functioning requires correct engineering

design, construction and operation. The health authority therefore requires adequate trained staff to provide for inspection at the planning and construction stages and, later, during operation. The normal essentials required are : exclusion of vermin, ease of hygienic maintenance, safe and adequate supplies of water at suitable pressure, temperature and location, satisfactory waste disposal, sufficient sanitary facilities for good staff hygiene, and adequate well-designed mechanical equipment for refrigeration, cooking, heat processing, hot storage, and cleaning.

Food programme administration

Developing countries need to establish those basic food hygiene controls essential in protecting public health. Developed countries need to revalue the effectiveness of their programmes ; for instance, recent evaluations in the USA show that traditional group educational lectures for food handlers and demonstrations by health officials may have little measurable effect on food sanitation.

The talents of social scientists, health educators and food hygiene specialists and technologists should be pooled to develop methods by which inspection personnel may become better staff educators. Staff management must then see that the procedures recommended by inspection personnel are regularly carried out in the day-to-day supervision of food hygiene.

In developed countries " performance standards " (e.g., microbiological) are needed to check other foods just as health administrations now check milk and water supplies. Where possible, health agencies should have available to them the service of laboratories to aid in controlling chemical and microbiological contamination. Much can be done, however, by the simple application of basic sanitation principles in countries where such laboratories are not now available.

Recommendations

In developed countries the authorities should continue to evaluate existing food hygiene regulations and controls at regular intervals and introduce the appropriate changes. In developing countries food hygiene priorities must be arrived at to determine what improvements are possible with the financial means available.

WHO should promote, in collaboration with national and international agencies, the collection, development, and dissemination of food standards and analysis for chemical and microbiological contaminants.

WHO should publish guides for food hygiene, with particular emphasis upon programmes for developing countries, of a similar type to those already produced on rural water supplies and sewage disposal. Similarly,

seminars on the administration and operation of food hygiene programmes should be arranged concentrating, for developing countries, upon minimum basic guidance and training of personnel and, for developed countries, upon evaluation of existing techniques and possible new approaches. Consideration should be given to international standards for food and food equipment.

Research is needed into methods for assessing the carcinogenic properties of substances which are added to or may develop in foods, and also into methods for controlling common food-borne illnesses, for example outbreaks of salmonellosis from eggs and egg products.

PERSPECTIVES

At the risk of over-simplification the following points may be given in summarizing the assessment of environmental changes and their relative impacts on health in different parts of the world today.

1. Owing to the great care with which the peaceful uses of nuclear energy have been developed in recent years and the continued surveillance which it is necessary to give to medical radiology and to the use of radioactive isotopes both in medicine and industry, the danger to mankind constituted by ionizing radiations is very limited in terms both of population at risk and of world area.

2. Air pollution, while a serious threat to susceptible individuals in the high-density urban or industrial areas where it occurs, is not, relative to other health problems, a major one affecting the whole modern world. Continuing efforts must, of course, be made to avoid creating fresh problems in the developing countries and, as money and priorities permit, to abate existing problems.

3. The provision of safe drinking water continues to deserve high priority as a preventive measure in relation both to morbidity and mortality. The treatment of liquid wastes is also important for reasons of health and should follow as soon as financial resources in each country permit.

4. Solid wastes are increasing in quantity and changing in quality, but for the greater part of the world their safe collection and disposal is largely a problem of administrative willingness, of finance and of priorities: the problem of "night soil", however, is an exception for which further research is required. Research should continue in developed countries into improved methods of disposal.

5. With increasing populations and food production, food hygiene will continue to represent an important branch of public health in all countries and therefore deserves high priority in health control programmes.

The exact impact on health, resulting from environmental change may be correctly assessed only by careful experimental epidemiological studies, the success of which, in turn, depends on the quality of medical statistics available. These studies, coupled with an assessment of the proportion of the population at risk, enable priorities to be listed, expediency often being an important factor. It is only in this way that unbalanced, unnecessary or abortive expenditure on combating health hazards may be avoided.

The Committee recommends that WHO and governments alike should take into consideration the above findings and conclusions when planning future environmental health programmes and the technical training of environmental health personnel.

OTHER IMPORTANT FACTORS

This report is not intended to be comprehensive. In addition to the assigned topics considered in the preceding sections the Committee was aware of other health problems associated with rapid urban expansion. Examples of these are noise from aircraft, traffic and the like, inadequate sound insulation in buildings of unsatisfactory acoustic design, inadequately silenced mechanical services, bad housing, sanitation problems associated with air and sea transport and with increased tourism, insect and rodent control, especially that associated with the transmission of urban filariasis, and stresses associated with population shift and with the fact that, all over the world, people are now living to a much older age. The greatest benefits in this sphere will follow long-term general and health education. In fact, it has been said that the greatest of current problems, and this is accentuated by change, is the inability of people to live and work happily together—not their inability to attain new and greater intellectual performances.

In developing countries changes in the environment brought about by the reclamation and settlement of arid or humid regions may create health hazards by the introduction of diseases whose vectors or intermediate hosts depend on the presence of water for their survival and reproduction. The increase in the prevalence and intensity of bilharziasis following the establishment of irrigation farming is an example of the consequences of failure to provide adequate measures to protect public health. WHO has been active in combating this problem and has had a measure of success in defining and evaluating the factors involved in the transmission and control of the disease. Again, new semi-rural communities may be brought into contact with natural reservoirs of infections (e.g., bilharziasis and such zoonoses as sylvatic plague, tularaemia and the arboviruses) no doubt

previously acquired by isolated dwellers in rural areas who made little demands on medical services. The reporting of illness and diagnosis of infection is likely to increase in these circumstances. It was also considered that industrial hygiene, with particular reference to the agricultural worker, deserved attention.

Another matter of fundamental importance in preventing undesirable changes in the environment and conditions detrimental to public health is regional planning with reference to the various activities of the communities, such as work, education, rest and recreation.

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