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IN

DEVELOPING COUNTRIES

VOLUME II

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B.N. LOHANI

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PREFACE

The International Conference on Water Pollution Control in Developing Countries, held at the Asian Institute of Technology from 21 to 25 February, 1978 and attended by some 320 participants was a grand success. It was well established during the conference that the International Conference certainly brought into attention the problems that affect the developing countries and a conference such as this has provided an opportunity for exchanging ideas and experiences in solving some of the common problems. The success of the conference was indicated by the stated need of organizing many more conferences covering various fields of environmental engineering.

This Volume II contains additional 11 late papers accepted for presentation at the conference, 8 keynote addresses by distinguished speakers and a list of the participants who attended the conference.

The editors and organizers of the conference wish to thank the keynote lecturers, authors, participants and all those who helped to make the conference a great success,

The financial assistance of the Canadian International Development Agency, and the cooperation of the International Association of Water Pollution Research (IAWPR), National Environment Board (NEB) of Thailand and the International Water Resources Association (IWRA) are highly appreciated.

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WATER POLLUTION CONTROL PROBLEMS IN DEVELOPING COUNTRIES

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ABSTRACT

The water pollution problems in developing countries have to be regarded within the limitations of the availability of finance, manpower, or other resources. Developing Countries can also draw experiences from many other countries and take whatever methods have been proved successful or adapt to suit their own conditions. The paper deals with some of the basic water pollution problems in developing countries and suggests control measures that look appropriate for implementation.

INTRODUCTION

There are water and wastewater disposal problems that exist in many countries now in the process of developing their natural and manpower resources that differ only in degree from those that faced some of the major industrial countries during their past century of development. In many respects development today follows a much easier path than the uphill climb of the past. These industrialised countries had to undergo industrial development and at the same time make progress in the field of public health when control of waterborne diseases was ineffective because of ignorance of their causes; when methods of treating sewage had not been developed; when knowledge of such processes has to be obtained by large scale trial and error, and means for transmitting knowledge were slow; when sewering and treatment had to be financed out of local rates; when industry was financed by private enterprise which did not readily make any financial or technical contribution towards the problems it created; and when pollution control legislation was lacking because public opinion was not preoccupied with protection of the environment.

In consequence of these conditions, the mortality rate especially among infants was high, due partly to waterborne diseases and malnutrition;

coastal fisheries declined; inland waters were polluted with sewage and industrial wastes and valuable water resources were lost.

By comparison with these conditions, today's developing countries are facing their problems against a background of improving public health services; greater life expectancy, which may bring social problems but extends the productive life of the individual; better control of water-borne diseases; rapid universal dissemination of technical knowledge with increasing facilities for education and training at all levels at home and abroad, with opportunities for research and practice of the most advanced kind in research institutes, universities and by means of seminars, workshops and conferences organized by international agencies, or professional bodies. Developing countries are benefiting by the efforts of international organizations to provide expert guidance in the identification of problems, while other agencies are available to assist in financing worthwhile pollution control studies or in the execution of actual schemes. Developing countries are also fortunate in that the magnitude of the tasks that confront them in creating new towns or expanding towns for rapidly growing populations, and the large scale introduction of industries to supply their wants and earn foreign capital, have compelled governments to become an active partner in financing, planning and managing vast enterprises.

Any government that encourages urban development and industrial expansion without ensuring that water pollution control measures are introduced and implemented must accept responsibility for the problems that subsequently arise. Nevertheless, these problems may have to be disregarded for some time because of shortage of finance, manpower or more pressing needs that make demands on the nation's resources. But when they ultimately start to formulate laws, create pollution control organizations, develop standards and set up suitable administrative procedures, the governments of to-day do not have to follow the slow evolutionary trial and error methods that the present industrialised countries of the world were forced to adopt. The developing countries can now draw upon a wealth of experience from many countries and take whatever methods have been proved successful, or adapt the best to suit their own conditions. If it had not been for this availability of knowledge of legislative, administrative and technical procedures to control water pollution it is likely that today's developing countries now experiencing rapid population growth and industrial expansion would have had to go through the same traumatic history of gross water pollution and then expensive recovery from that pollution that was the lot of several of the older industrialised countries.

GENERAL CONSIDERATIONS

We are concerned with water pollution problems in all developing countries. In these, a wide variety of climatic conditions are to be found. Arid conditions limit the availability of water for public supply and dilution of wastes. To prevent pollution of dry watercourses and underground waters, stringent water quality standards are necessary and

water reclamation for agricultural and other uses are highly desirable. Where there are semi arid conditions, with rain occurring for short periods and wet tropical conditions we find high turbidity in rivers, overflows from sewers and conditions that are associated with accelerated biological activity in all aquatic environments. These may include intense algal and plant growth under aerobic conditions and sewer corrosion resulting from hydrogen sulphide production under anaerobic conditions.

In some rural areas high temperatures, inadequate safe water supplies and fairly widespread lack of excreta disposal facilities are associated with a high incidence of some diseases, especially those borne by cysts, ova and insects in water polluted with excreta or even unpolluted waters. These matters are receiving urgent attention in the programmes of the United Nations and active support under schemes promoted by the World Bank.

Rapid population growth, brought about by public health measures, growing industrial activity, improved agricultural practices resulting from the use of fertilizers, better crop protection, greater use of mechanical equipment, improved marketing techniques have resulted in an ever-increasing demand for water and with the production of a corresponding increase in the discharge of effluents. The effluents derived from some agricultural products are particularly strong by any standard and some are particularly offensive both to the nose as well as to the eye. And this fact, together with the growth of towns and the development of new industries around cities may lead to the discharge of industrial effluents in areas that are inadequately unsewered or totally unsewered. These problems will become more acute if the history of population movements in the developed countries is repeated, i.e., 80% or more of the total population will dwell in urban areas instead of, as at present in many developing countries, in rural areas.

A general problem associated with water and wastewater treatment schemes in developing countries is the lack of home produced specialist equipment, and the shortage of foreign currency which restricts its importation. However, if the history of, for example, the textile industry and consumer goods industries are any guide, the demand for equipment will eventually result in arrangements first for the manufacture under licence of foreign equipment, then for the manufacture of certain basic parts and ultimately, perhaps, as in Japan, of highly competitive, efficient home based industries with export potential.

The wide variety of conditions in developing countries makes it difficult to state even in general terms what the present water pollution problems are. The prime consideration is that of public health, which presupposes that safe, adequate supplies of water will be made available in all rural and urban areas. Hence, sewers or some system of excreta collection will be required and plant for treatment of sewage. The problem of sewer corrosion will have to be overcome. For some time to come the bulk of the impurity will be organic, derived from domestic or agricultural sources. Since these will pollute water resources, endanger health,

threaten fish life and cause nuisance their treatment will be essential. Given availability of land, the climatic conditions are well suited to low cost methods of treatment, using the minimum of equipment, energy or mechanically skilled personnel. Some industries, especially those concerned with the separation of minerals, the manufacture of dyes, explosives, pharmaceuticals, chemicals, oils and petrochemicals, certainly will require special treatment, possibly at source if they are not to cause damage out of proportion to their volume. New problems from micro-organic pollutants, to which reference will be made later, can be expected as industry develops and agriculture increases its use of them.

A question that is sometimes asked but seldom convincingly answered is "How does one justify on economic grounds the treatment of all wastewaters including industrial effluents"? Now although the economic gain cannot be stated precisely in quantitative terms, one cannot question the fact that improved public health, longer life expectancy, reduced infant mortality, better water resources, greater availability of fish in rivers and estuaries, cleaner surface waters usable for recreational purposes are very real benefits even though they may defy quantification. However, in water scarce regions the use of purified sewage effluent for agricultural uses and the reclamation of effluents for more extensive purposes are possibilities that are likely to become realities as available supplies of water are exhausted. Then there will be no doubt about the economic value of processes that produce re-usable effluent. Again, if it becomes unnecessary to develop a new water resource at great expense by rescuing an existing resource from pollution, that also makes it possible to put a price on the value of the pollution control measures.

RECOGNITION AND DEFINITION OF POLLUTION

Most countries have now passed from the stage where awareness of water pollution has resulted or will result in abatement measures. That is to say water pollution is recognised as a problem, laws to prevent it have been passed and an organization has been set up to deal with the problem. However, I must point out that even in highly developed countries systematic measurement of pollution aimed at co-ordinating relevant information in order to produce a national plan and establish orders of priority for remedial work has not been attempted until quite recently. In some countries there is little evidence that the importance of this knowledge is appreciated, and therefore no provision has been made to obtain it. Therefore, I wish to emphasize that only by systematic monitoring of chemical, physical and biological parameters, together with flow monitoring, is it possible to assess the extent of pollution for control purposes or to determine the best, most economical strategy, in the management of a country's water resources. If money is tight, and it always is, it is difficult to know how best to spend any on water pollution control. In that case it becomes even more important to use national resources to best advantage by obtaining the kind of overall picture that systematic monitoring will reveal.

The methods of carrying out surveys have been described by the World Health Organization and other bodies or individuals. Such surveys may serve a variety of purposes such as the identification of sources of discharges to public sewers, measurement of the performance of sewage, measurement of the performance of sewage or industrial effluent treatment plants, the surveillance of pollution control measures in a large region, the determination of the effect of specific pollutants, especially harmful pollutants on sewers, treatment plants, rivers, estuaries and marine environments. And several of these objectives may be combined and they may each have several objectives such as public health, biological or chemical information. It is desirable to initiate national or regional survey schemes before an urgent need for the information becomes a mammoth task. This does not necessarily mean that large, well trained survey teams should be built up at the expense of a country's limited trained manpower resources. Skeleton survey teams can be recruited in advance of a comprehensive service, laying plans for the establishment of gauging and monitoring stations and the training of staff in data acquisition and determining the best methods of storing and using data. Use can also be made of graduate or undergraduate student help, provided adequate preliminary training and constant supervision are ensured in sampling and analytical techniques as well as flow measurement procedures.

TREATMENT PROCESSES AND THE RE-USE OF EFFLUENTS

Established methods of treating sewage and industrial wastes need not be considered in this address. These subjects are to be covered by papers to be given at the Conference. Low cost methods, particularly appropriate to the region, are also being described. The value of such processes is that they offer a real alternative to processes that do not require imported or any other major pieces of equipment, permit the use of local labour, take advantage of warmth and sunlight to provide free energy for supplying oxygen and they are often suitable for the treatment of agricultural wastes which are usually strong in relation to the value of the crop. Although irrigation and spraying are used in special circumstances where agriculture or forestry can be combined with wastewater treatment, careful cropping and management or pumping costs are involved and dry conditions are necessary or arrangments have to be made to deal with wet weather flows. Based on work in India, Australia, South Africa, and Israel and elsewhere the general design parameters required have been established, although for specific wastes it is still necessary to undertake pilot scale investigations on actual wastes. For strong wastes containing biodegradable material in solution and suspension there is plenty of scope for research work in order to maximise the rate of decomposition of organic matter, so that with rising costs of land in the neighbourhood of cities or for crops of increasing value, lagoon treatment does not have to give way to more accelerated treatment processes using conventional methods.

An indication of the savings to be made by the lagoon treatment of sewage was given by C.D. Parker in 1965 at a seminar of the World Health

Organization in Delhi for representatives of developing countries. The assumed quality of effluent from these processes was also given. The costs per 1000 inhabitants and the expected results are given in the Table 1.

Table 1. Cost of Treatment and Results Expected from Several Processes (Results of C.D. Parkers)

Process	Cost per 1000 inhabitants: Australian Dollars. 1965 prices.	Analysis of Effluent			
		BOD mg/l	SS mg/l	Coliform per ml	Algae per ml
Settlement, activated sludge, sludge digestion.	1350	15	25	104	0
Land irrigation, 4000 gal/acre/d	720	3	10	102	0
Grassland treatment, 20000 g/a/d	144	20	25	104	0
Lagoons 150 lb BOD/acre/d	25	10	30	0.1	104
Oxidation ditch	400	15	25	104	0

Agricultural Use of Effluents

Health regulations in many countries restrict the use of sewage effluents in agriculture to certain crops. The reason is that from 1-10% of the coliforms (or bacterial pathogens) may still be present in purified sewage effluent. Pathogens such as salmonella are viable for a considerable period in moist soil. Clearly, sewage treatment processes and their supervision must satisfy stringent public health requirements to permit the extensive use of effluents in agriculture. Consequently, the conclusions of J. Kott and his associates from the technical university of Haifa, Israel (to be published in Water Research and Progress in Water Technology during 1978) that prolonged pond treatment and disinfection produces a bacteriologically and virologically safe effluent, fit for unrestricted agricultural use, must be regarded as of great significance for water-scarce countries. Prolonged exposure in ponds, of course, leads to an increase in salts concentration proportional to the loss of water by evaporation.