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Rural Water Supply and Sanitation in Less Developed Countries

annotated bibliography

ANNE U. WHITE and CHRIS SEVIOUR



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Abstract

This bibliography lists articles written on the subject of rural water supply and sanitation in less-developed countries. They are listed according to whether they deal with general topics, technology or health and diseases. Other bibliographies on the subject of rural water supplies are also listed.

Résumé

Cette bibliographie dresse la liste des articles ou documents traitant de l'hygiène et de l'approvisionnement en eau dans les milieux ruraux des pays en voie de développement. Ils sont énumérés sous trois rubriques distinctes : thèmes généraux, technologie ou santé et maladies. Sont également mentionnées d'autres bibliographies portant sur l'approvisionnement en eau.

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Rural Water Supply and Sanitation in Less-Developed Countries

A selected annotated bibliography

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PREFACE

This selected annotated bibliography has been prepared as part of an investigation into the problems of water supply and sanitation in developing countries. The investigation aims at finding ways in which the rate of progress in improving water supply and sanitation conditions can be accelerated, partly but not exclusively, through the application of research in science and technology.

The study was initiated by the Planning Group on Science and Technology for Developing Countries of the Organization for Economic Cooperation and Development, which asked for a state-of-the-art review, and a report on research priorities. The task was accepted by the International Development Research Centre, and supplementary support was provided by Assistance Technique Suisse. A draft report has recently been completed under the title, "Technology Assessment and Research Priorities for Water Supply and Sanitation in Developing Countries."

The present bibliography proved to be a very useful tool to the authors of the above report, and it seems appropriate therefore to make it more widely available to other investigators and to administrators in water supply and sanitation programs.

Ian Burton
Consultant
to IDRC



INTRODUCTION

Much of the water in rural areas of developing countries is not pure enough for minimum health requirements, many people don't have enough of it, and waste disposal facilities are inadequate. This is of considerable concern to governments and to the international community. This bibliography presents in annotated form a selection of the available literature on the subject of water supply and sanitation.

Much of the material is of a fugitive nature — numerous short reports reproduced in small numbers, and articles in journals with varying degrees of accessibility.¹ Under the auspices of the World Health Organization, careful work has been done, some of which has been published. Other WHO reports containing data and evaluation of programs are available for limited circulation only. The same is true in many cases for national government reports, and for work done under contract to various governments. Most of the fugitive material is available to serious scholars and researchers upon request to the appropriate agency, but the unpublished form of the material often means that researchers remain unaware of its existence. For that reason this bibliography includes many items that are only available at the discretion of the issuing agency.

The items have been chosen to give a sense of the variety of experience in the rural water supply and sanitation field. They are intended to include major works and to indicate many of the people who have been working in the field, either as consultants, engineers and operators, or observers of the process. Undoubtedly some gaps exist. The items are grouped under three broad headings: a general approach to the problems, the available technology that would lend itself particularly to rural areas with small communities, and the relationship of water supply and sanitation to health, disease, and well-being.

Most of the material deals with rural areas, but discussions of urban and rural policies and practices are intermingled, for it has only been recently that rural supplies have been considered as a separate problem that might need entirely different solutions from those used in urban situations. It is a mark of recent study in the field that definitions of the type of area and population involved in a program are being made much more precisely. Distinctions between metropolitan, urban fringe, rural concentrated, and rural dispersed populations are considered to be of great importance in determining the type of program that would be useful (Donaldson, no. 36). Some of the urban fringe experience is very close to that of rural areas, and has been included.

There is little material on hydrology or related fields, as this is a separate body of literature in itself.

This selection attempts to illuminate questions of why and how many water supplies and sanitation need to be improved, what sort of people various programs would reach, and how local people are or could be involved in improving their own facilities. It includes also practical questions on the available technology and administrative and financial arrangements. It is hoped that such a broad view of the literature will be useful to planners, to administrators of programs, to engineers in charge of projects, and to community leaders.

Regions discussed

From a regional point of view, there are numerous gaps on the shelves, for the attempt here is not to provide for complete coverage of programs or the need for them in every part of the world, but to show the variety of problems, some in arid regions, others in well-watered parts of the world, some in countries just beginning programs, as in Ethiopia, others in those where programs have been in effect for some

¹ IDRC will attempt to provide microfiches or photocopies of articles not readily available in journals or unpublished papers to those who request them.

Drawing water near Matmata, southern Tunisia

time, as in several Latin American countries. There is much literature available regarding Latin America, especially for those who read Spanish or Portuguese. Perhaps because of the language barrier, the extensive body of experience in rural areas of Latin America and the considerable success of the program there does not seem to have carried over very much into discussions of other parts of the world.

Some of the Latin American literature in Spanish is included in this bibliography, but the selection has been influenced by chance contacts, and certainly has major omissions. An apology should be made for the lack of examination of the available literature in French.

One of the largest gaps concerns China, where almost nothing is available in English on the recent strides made there in rural water supplies and sanitation for over 800 million people. Nor is there much available for the Russian experience in this field.

Problems of definition

The first attempt to estimate the proportion of the population of developing countries adequately served with water was by Dieterich and Henderson (1963, no 34), where they estimated that less than 10% of the population of 75 developing nations had piped water in their homes, including both urban and rural populations. This work was especially significant as it marked the beginning of the consideration of domestic water supplies on a global basis as an element of development. In 1972 the World Health Organization (WHO, no 133) estimated the total 1970 population of the world at 3640 million people, with 1627 million of these living in rural areas of the 90 developing countries that were surveyed. About 12% of this latter group were estimated to have access to safe water supplies. China was not included. More exact data are available for the Latin American countries (PAHO 1973, no 82, Donaldson 1973, no 36), where with a rural population estimated at 131 million (46% of the total population), 24% are considered adequately supplied with safe water, and 2% with sewage disposal.

There are many terms used in discussing rural water supplies that are not consistently defined throughout the literature, and one of these is the word "rural." WHO statistics are based on

the definition in use in each country. In Latin America, the term generally includes villages of 2,000 or less people (Wolman *et al* 1972, no 126). In Kenya (WHO 1969, no 131), the term may include both areas of small scattered farms and villages of 400 people and up. In Peru, the rural water program applies to villages with 400-2,000 persons (Peru 1971, no 89), and in Chile, villages of 200-1,000 inhabitants (Chile 1971, no 26). The result is that it is difficult to tell just what is the target population of a rural water program — those people in large villages, in small villages, or on scattered farms, or if the global position is improving, and if so, by how much, and in which sectors of the population.

Other problems of definition include the words "adequate," "safe," and "accessible," terms which when applied to water supply may have very different meanings. "Accessible" for example could mean a tap in the house, one in the courtyard, or one a 10-minute or more walk away. "Adequate" is another such term, and just how much water people use under different circumstances of supply in rural areas has not often been measured, although there are plenty of rule-of-thumb guesses, many of them based on urban use. Only a few studies such as White *et al* (1972, no 121) have made careful measurements. For scattered sites in both rural and urban situations, they found a range of 4-21 litres in mean daily per capita use where people do not have connections to piped supplies, and 30-251 litres where they do have connections. Similar usage was found by Warner (1970, no 117). Lee (1969, no 67) found slightly higher mean usage for people without piped water supplies in urban areas in India, and a similar range for those with piped supplies.

Types of programs

There are three main types of approaches to programs for water supply development described in the literature. One emphasizes fiscal soundness and the improvement of institutional frameworks, a second focuses on building from simple schemes to larger ones, with emphasis on the larger rural villages, and a third provides demonstration projects using simple technology suitable for small settlements. It is hoped these will be copied elsewhere.

The first type of program has been followed by the World Bank, where emphasis on communities paying their own way and improving their institutional capacities has led to the financing of the larger urban schemes (World Bank 1971, no 128) The Bank did not rule out loans for rural development, but the institutional and financial problems in this area were considered extremely difficult Some of the questions regarding fiscal soundness versus the ability of people to pay for water appear in two articles, Shipman (1967, no 99) and Azpurua (1968, no 6) A broader approach to rural communities is presently being explored by the Bank (Saunders 1973, no 95)

The second approach is described for Latin America (Donaldson 1972 and 1973, nos 35 and 36), where the rural program generally includes villages of 500-2,000 people Great progress has been made there in the last decade, especially in the larger villages Donaldson advocates a clear distinction between programs that are aimed at dispersed populations, at semi-concentrated, and at concentrated ones It would appear that the building-block approach aimed at each of these segments of the population, using wells at the simplest level, then leading to rudimentary aqueducts and later rural aqueducts, is improving the situation in Latin America Wenner (1970, no 119) describes a program for Ethiopia along similar lines, starting with a study of the water resources of the country and then developing supplies using cheap, simple mechanisms, accompanied by an educational program designed to stimulate demand for purer water

Demonstration projects and the stimulation of the demand for purer water, as described in the UNICEF-WHO (1969, no 110) evaluation of the assistance program to governments for the improvement of rural water supplies and the sanitary disposal of excreta, represent the third type of program This emphasizes supply and equipment contributions to individual projects, and the stimulation of parallel training and health education programs Similar programs on an individual community basis have been carried on by a private organization, VITA (1970, no 149)

These types of programs have been evaluated to some extent by the agencies involved, and various reviews have been undertaken such as

that by Wolman *et al* (1972, no 126) regarding sanitary engineering facilities and services for Latin American and Caribbean countries Recently efforts have been made to evaluate improvements in terms of the total impact on a community, with more of a system approach Heijnen and Conyers (1971, no 47) suggest a number of hypotheses that could be tested in such studies There does not seem to have been a systematic attempt on a worldwide scale to determine which factors have most contributed to success or failure in bringing water to rural people, possibly because the required information is difficult to assemble

Effects on health

Many assumptions are made, and many articles written, about the health benefits of improved water supplies and sanitation But the question remains — do improved rural water supplies and sanitation improve health? If so, by how much? And with what level of improvement? Although there is no doubt about the effects of safe, large, urban supplies with regard to diseases like cholera and typhoid, there seems to be no entirely clear evaluation of the impact of better supplies on a rural community in terms of health, and even less regarding the social and economic effects It is fairly clear that more water is better, even if it is of doubtful quality (Moore *et al* 1966, no 219), but just how much more, and of what quality, would yield which health benefits remains to be determined

A study by Fenwick (no 39) in Kenya in the early 1960's was probably the first attempt to study the total impact of a new water supply system in one village as compared with a similar control area where no improvements were made Although the intent of the study was excellent, doubts about the methodology have been raised by Bradley (White *et al* 1972, no 121) The US Indian Health Division in the Department of Health, Education and Welfare (1968, no 112) also tried an evaluation, without conclusive results There are a number of studies attempting to pinpoint the effect of improved water supplies on various diseases including the incidence of diarrheal diseases (Watt *et al* 1953, no 225), and to discuss the effect of the quantity and quality of the water available (Moore *et al* 1966, no 219) The

complexity of the problem of what measures really improve the health and well-being of people is noted by many authors who cite factors such as income (Wittman *et al* 1967, no 228) and habits of hygiene (Goodwin *et al*. 1966, no. 211; Marshall 1972, no. 215) as important considerations. A study with very careful methodology was carried out in St Lucia (Weisbrod 1973, no 227) to investigate the total health and socio-economic effects of improved water supplies and sanitation, with essentially negative findings, in terms of the measurements used, as to the economic impacts of parasitic disease.

Costs and benefits

Closely related to health benefits are the economic benefits expected to be derived from improved water supplies and sanitation. The literature of the 1950's and early 1960's was optimistic. Atkins (1953, no 202) felt that costs of improvements in water supplies and disposal facilities could be amortized within 5 years in low income countries by the benefits accruing from reduction in disease. Pyatt and Rogers (1962, no 93) added the concept of debility, or an on-the-job inefficiency of effort, to more usual measures of mortality and morbidity rate in calculating the cost of disease, and concluded it might take 10 years to reach a "break-even" point. These studies were in terms of urban supplies, although Wagner and Wannom (1953, no 116) extended the concepts to rural supplies. Generally these studies used methods of calculating present values of net future earnings developed for the industrialized society of the United States, and paid little attention to the nature of the more subsistence-oriented societies of the developing countries.

Most cost-benefit analyses of this period focused on urban supplies. Logan (1963, no. 69) assumed that capital investments in public water supplies, urban and rural, are part of the social overhead capital needed to develop and maintain a technologically based society. Dietrich and Henderson (1963, no 34) assumed that improvements in rural water and sanitation would follow once urban conditions improved, and that urban development was essential for economic progress. These assumptions have not been tested thoroughly.

The earlier optimism gave way in the late 1960's to a note of perplexity as to why things were not improving more rapidly, and more recently, attention has been focused on an image of rural improvements as following a different pattern from urban ones. Irvin (1971, no 53) suggests that benefits may not be just in health or time factors, but in a set of cumulative changes that these make possible. Smith and Hogg (1971, no 102) suggest closer attention to finding out exactly who pays and who benefits, and an examination of the role of each group in society, with special attention to the nature of the society in developing countries. As noted by Kneese (1968, no 61), there is almost nothing in formal economic literature concerning the costs and benefits of water supply improvements.

There has been a pronounced shift in thinking about rural water supplies and sanitation during the past 20 years, from a rather simplistic view which held that disease was a major constraint in developing countries, and if it were lessened, increased economic development would inevitably follow. A more complicated view followed, which saw the social system in which the water system took shape as a very important factor in any planning. A more recent shift has been toward the view that the people being served are the ones who are most capable, with assistance, of choosing what levels of improvement they can best use. Systems involving choices by the users themselves and an analysis of the risks they are willing to take, weighed against the benefits they feel they will receive, are more likely to bring them lasting benefits (Bradley, no. 205; Burton, no 141; White, no. 120, 1974).

Technology and training

The technology of water supply improvements is extensive, and includes many simple devices suitable for rural schemes. Some of these methods are very ancient, such as slow sand filters (Baker 1948, no 7), whereas others involve new materials such as plastic pipe (McJunkin and Pineo 1971, no 172). Emphasis on local maintenance needs has led to attempts to develop a simple pump suitable for local manufacturing (Fannon and Frink 1970, no 163). The selection of items reported here has been

governed by considerations of low cost and simplicity of technology

Sanitation is something of a stepchild, for although it is almost always mentioned in connection with proposed improvements in water supply, it is seldom considered very thoroughly Winblad (1972, no 197) evaluates various plans for urban low-income communities in Africa, and Wagner and Lanoix (1958, no 196) give much technical data on various privy and water-carried methods of excreta disposal A comprehensive review of waste stabilization ponds by Gloyna (1971, no 189) is directed at the design engineer with limited funds and unskilled personnel

The matter of suitable technology raises the question of what is suitable training for engineers and other personnel involved, and the extent to which people trained primarily in health affairs are involved in water-supply programs

Much of the literature mentions the need for skilled manpower to design, operate, and maintain water supply systems In contrast, there is very little practical summary of what training programs are being carried on, and a modest amount of how needs could best be met (Okun and McJunkin 1967, no 76) The published information at a summary level on educational programs does not generally single out water as a classification, and at the university level water courses may be included under such subjects as agriculture, hydrology, engineering, or sanitation The kind of survey described in Haissman (1971, no 44), which lays out the expected manpower and skill levels needed for an irrigation project, is not readily found for a rural water supply project, much less for a sanitation survey

One program based in the U S for the training of sanitary engineers is described in Lamb and Luria (1967, no 64), and this has been extended for use in Lima, Peru, to remove language barriers and provide more realistic experience

An extensive area of training for both professional workers and those below the professional level is reflected in the manuals produced in many Latin American countries Argentina uses a series of these to instruct the engineer who operates a water treatment plant, or to inform the farmer who wishes to fix a leaky faucet (Rossi *et al* 1971, no 223) Peru (1971, no 89) and

several other countries have manuals regarding community involvement, showing step-by-step methods to interest community leaders in developing their own water supply program Film strips and other visual aids are used as well There seems to be no counterpart to this in other areas of the world for which information is available

Many of the general discussions of programs concern themselves with governmental organization and financial arrangements Decisions concerning these supplies are seen as primarily the responsibility of the officials concerned with health, or with public works, or with some mixture of the two either cooperating or in a separate agency Centralized versus decentralized authority is much debated, with some feeling that community involvement and self-help is one key to a solution of the problem (PAHO 1973, no 82) There is an occasional note to the effect that decisions regarding water supplies are primarily political (Chagula 1971, no 25), with numerous implications for the system

This bibliography should be regarded as a starting point It is not an attempt to fully review the field, but it will give some indication of the successes and failures, and of the growing awareness of the need for people, including those in rural areas, to determine for themselves what constitutes an "improvement" in their life, and to work toward achieving it Coupled with this is an increasing emphasis on the examination of the results of changing one part of a system on all its other parts, so that changes in water supply and sanitation come to be regarded as only one part of the total picture of the quality of life for people in rural areas

Many people and agencies cooperated to provide material for this bibliography Special thanks are due to the Community Water Supply and Sanitation Division of the World Health Organization, David Donaldson of the Pan American Health Organization, and Professors Ian Burton, Robert W Kates, and Gilbert F White Rôna Sciour was responsible for the annotation of the material written in Spanish Although the agencies and individuals cooperated in providing the materials, the annotations are of course the responsibility of the authors

Anne U White
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ANNOTATIONS

Collecting water from a village fountain in Kenya

GENERAL

- 1 **Argentina, Republic of. 1971.** *Plan nacional de agua potable rural* (National rural drinking water plan) Buenos Aires, Argentina Servicio Nacional de Agua Potable 68 pp (Spanish only)

This is a general description of the content, administration, objectives and organization of the National Rural Drinking Water Plan. Begun in 1965, the Plan aimed at the provision of drinking water to a total rural population of some 4,400,000 within 20 years. In the short term it was hoped to supply 1,700,000 persons within 6 years. A rural community is defined as being below 3,000 inhabitants. The mass approach of the Plan is discussed in the booklet together with criteria for selection of communities (initially, the areas where drinking water was known to be contaminated because of the high incidence of gastrointestinal illnesses and diarrhoea), favorable factors (such as degree of concentration of the population, economic capacity of the population, existence of abundant supplies of water, means of communication), field and community studies, erection of local organizations for operation of the projects, and the actual progress and development of the Plan. The Inter-American Development Bank contributed approximately 50% of total costs of implementing the schemes up to the end of 1970

- 2 **Argentina, Republic of. 1971.** *Guía para organización y administración de cooperativas y de sistemas de abastecimiento de agua* (Guide to the organization and administration of cooperatives and water supply systems) Buenos Aires, Argentina Servicio Nacional de Agua Potable 69 pp. (Spanish only)

This guide is primarily intended for the local community cooperatives who are responsible for the operation, maintenance and administration of their local water supply systems. Details are given of exact procedures for the presentation of accounts, of profit and loss sheets, of information on consumption levels and income from tariffs, as well as examples of the layout of documents for a variety of purposes, including application for a domestic connection, registration of consumers, account keeping, and the transmittance of income from tariffs to the provincial body. The method of tariff assessment is explained. The last section of the booklet is devoted to an example of the recommended rules and regulations for a water supply system. The important points covered are the types of supply, obligations of consumers, connections, determination of tariff, responsibilities of the community cooperative and possible sanctions that the cooperative might apply against consumers

- 3 **Argentina, Republic of. (n.d.)** *Elementos de educación sanitaria* (Aspects of sanitary education) Buenos Aires, Argentina Issued by the Ministerio de Obras y Servicios Públicos, Servicio Nacional de Agua Potable 81 pp (Spanish only)

This booklet looks at the sociological/ psychological rather than economic or technical aspects of sanitary education as part of a rural water supply plan. Sanitary education is seen as vitally important to increase the awareness of the rural population of the origins of dis-

ease and the relationship between water supply and sickness. Such awareness, it is hoped, will generate interest and participation by the rural communities in the construction, operation and maintenance of their own water systems. There is discussion of the social, cultural, and psychological aspects of sanitary education — the difficulties of transmitting information and determining its acceptance by the rural communities; appropriate methods of teaching; and the social, cultural and psychological barriers to changes in norms, values and attitudes.

- 4 **Argentina, Republic of.** (n.d.) *Manual del promotor* (Promotor's Manual), Ministerio de Obras y Servicios Públicos, Servicio Nacional de Agua Potable. 145 pp. (plus diagrams and illustrations) (Spanish only)

The main purpose of this manual is to improve the understanding of local promoters of the technical, sanitary, and administrative aspects of the National Rural Drinking Water Plan. Discussion of the Plan includes sanitary engineering, sanitary medicine, administration and accounting procedures, sociological, anthropological and social psychological inputs, the study and organization of the community in preparation for the construction of schemes, and finally the organization and administration of community water supply cooperatives. Since the National Rural Water Supply Plan is based on the decentralization of administration and organization, the role of the promotor at the community level is vitally important for the Plan's success. He is responsible for the sanitary education programs and the participation of the communities, through cooperatives, in the maintenance and operation of their own schemes. Information and diagrams are included of step-by-step procedures for sanitary education, water engineering, criteria for potability and the operation and maintenance of the systems. In addition, the manual includes a socio-psychological interpretation of social interaction and the possible changes that may result from the provision of drinking water and more especially from the organizational strategy of forming water supply cooperatives at the local level.

- 5 **Atkins, Callis H. 1969.** "Global water supply development," *Journal of the American Water Works Association* 61, 49-51

This brief summary of the WHO Community Water Supply program as of 1969, and the role of collaborating agencies both within and outside the UN provides a useful background for later developments.

- 6 **Azpuruá, Pedro Pablo. 1968.** "Water supply management in Latin America" *Journal of the American Water Works Association* 60, 743-748

This comment on an article by H. R. Shipman (1967) on water rate structures in Latin America raises the question of the philosophy behind a rate structure for water. He emphasizes the need to consider the social aspects, i.e. the ability of the people to pay, as well as the fiscal soundness of the enterprise. A rebuttal from Shipman emphasizes the need to generate the revenues required to cover costs and create reserves. Shipman believes that loans against new construction from national funds will benefit the poor much more than the subsidizing of operation and maintenance.

- 7 **Baker, Moses N. 1948.** *The quest for pure water: the history of water purification from the earliest records to the twentieth century*. New York: American Water Works Association. 527 pp.

The criteria of purity have become more complex and more quantitative, but the principles, methods and materials for purifying water have changed remarkably little since the earliest recorded data in 2,000 BC. Boiling and filtering through sand were both used this early. Purification of urban supplies was not undertaken until the latter part of the 18th century. The author points out that many ways of purifying water were known long before there was much demand for a higher quality.

- 8 **Bangladesh. Government of the Peoples Republic of. 1972.** *Public Health Engineering Department Specification DPHE No. 007/72.* 14 pp
- A series of short paragraphs covering the technical, construction, and legal aspects of well-sinking and the standards for the water extracted in Bangladesh
- 9 **Barnstead basic book on water. 1971.** Boston, Mass Barnstead, 225 Rivermoor St. 100 pp
- A sort of primer on water, this book provides easy access to basic information about the chemical and physical nature of water, how it can be analyzed and treated, the uses to which it can be put, and its central role in man's existence on earth
- 10 **Bhat, S.P. 1971.** "UNICEF assisted programme in Mysore " Three-day discussion with State Chief Public Health Engineers World Health Organization, Regional Office for Southeast Asia New Delhi, December 6-8, 1971 11 pp
- The report describes the Government of India and UNICEF joint program for improvements in rural water supplies in Mysore State. The population to be affected by the well-drilling operations will be about 7% of the total rural population
- 11 **Berry, L., and D. Conyers. 1971.** "Planning for rural water development in Tanzania " In *Water Supply*, ed G Tschannerl, Dar-es-Salaam University of Dar-es-Salaam, BRALUP Research Paper 20 pp 35-45.
- Emphasizes the need for a Tanzanian master plan for water development which is integrated with regional and national plans for overall development Relevant information is needed concerning the quality of existing supplies, the development potential with regard to regional aims and hydrological conditions, and the manpower and financial resources The national task is to determine priorities
- 12 **Bertsch, Howard. 1966.** "Administration of rural water supply program," *Journal of the American Water Works Association* 58, 997-982
- This paper discusses the initiatives made by the US Congress in 1965 to tackle the problem of making clean and constant water supply a universal advantage in the national standard of living He estimated that at the time of writing some 30,000 smaller communities were without modern water supply systems The cost of correcting this situation was estimated at about \$60 billion The bulk of the paper constitutes a discussion of the Farmers Home Administration and its authority to lend money for the financing of rural water projects for both agricultural and domestic purposes
- 13 **Board, Leonard M., Robert R. Harris, and G. Lamar Hubbs. 1968.** *Evaluation of community water supply programs and capabilities in Brazil.* Washington, D C Department of Health, Education and Welfare 115 pp
- This study is a continuation of the World Wide Water Supply Project authorized by a Participating Agency Service Agreement between the United States Agency for International Development (USAID) and the Public Health Service (PHS) of the Department of Health, Education and Welfare signed on December 30, 1966 In general, PHS responsibilities covered two main items first, to evaluate the ability of developing countries to carry out a community water supply program on a national basis, and second, based on these evaluations and other information, to prepare a "Manual on the Guidelines and Criteria for AID's Community Water Supply Activities " This report covers the twelfth and last country evaluated under the first part of the contract, and is good source material for the study of mid-twentieth century United States policy

- 14 **Bonis, Samuel B. 1967.** "A basic critique of foreign assistance programs in the light of Guatemala's present water needs" *International Conference on Water for Peace* 5 pp 1057-1059 Washington, D C USGPO

The author concludes that while most foreign assistance programs stress education and training on the contractual level, few actually leave behind them any trained and responsible local technical staff. He proposes as solutions the adoption of a philosophy that the training, experience and responsibility for local personnel is as important as the technical objectives of a project, a use of experts adjusted to the capacities of local technicians, informal and continuing contact of experts with local professional staff, and that governments cultivate their own professional staff with higher salaries and properly financed programs.

- 15 **Brown, James C., and Daniel A. Okun. 1965.** "An international program in sanitary engineering design," *Ingenieria Sanitaria*, October 1965, 11-20

The authors describe the International Program in Sanitary Engineering as developed at the University of North Carolina. The emphasis is on designs which strive for the most economic application of available capital, material and human resources of the country rather than those using the latest technology. Local decision-making is felt to be very important, and engineers are trained for work in their own countries through lectures, field trips and decision-making opportunities.

- 16 **Bureau of Resource Assessment and Land Use Planning. 1970.** Water development — Tanzania: a critical review of research. University of Dar-es-Salaam, BRALUP Research Paper no. 12. 100 pp

This paper reviews briefly the present status of knowledge and research effort in water development in Tanzania, including the national data collection program for water resources. Much of Tanzania has been covered by some sort of river basin survey, and a bibliography of these is attached. Some examples of project type studies are examined and this approach evaluated. Finally a fairly detailed account of existing impact studies of water development on rural Tanzania is given.

- 17 **Burton, Ian. 1971.** "Toward a rationale for water supply policy in developing countries." In *Water Supply*, ed. G. Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp. 47-51

Proposes several stages of water development: the subsidized meeting of minimal needs to realize potential health benefits, beyond this, investment would be based on ability and willingness of the consumer to pay, thus making the systems financially self-sufficient.

- 18 **Burton, Ian. 1973.** "Water for the well-being of rural people." International Development Research Centre Seminar, Lausanne, Switzerland, 29 May-1 June, 1973. Working paper no. 1. 20 pp

This paper examines the prospects for rapid improvement in rural water supply and sanitation, and was designed to help in the formulation of research goals and directions, and the specification of priorities among them. It concludes that there is need for increased research on appropriate technology for water supply and sanitation systems in rural areas, and for a redirection toward a basic philosophy which assumes a risk-benefit approach with a substantial role for the users in choosing the level of improvement they desire at a cost and scale which they find suitable. These two approaches then need to be combined into an expanded and coordinated program.

- 19 **Burton, Ian, and Yves Maystre. 1972.** *Rural water supply and sanitation in developing countries identifications and assessment of obstacles to rapid improvement* International Development Research Centre, 22 September 1972 8 pp.

The paper is critical of the WHO image of, and action priorities concerning, the problem of rural water supply. Differing images of the problem are attributed to the different standards that are set for water quality, quantity and accessibility. If different standards are accepted then it may be possible for greater and more rapid improvements to be made than those of the WHO program of July, 1972. Some of the major obstacles to a more rapid development are identified and areas for research which might aid in overcoming them are suggested.

- 20 **Carruthers, I.D. 1969.** *Issues in selection and design of rural water projects* Discussion Paper No. 88, Institute for Development Studies, University College, Nairobi 15 pp

In Kenya there has recently been conceived a policy of providing basic communal water supplies throughout the country within 20 years. This program will require an average annual investment of K£2 million. It is the purpose of this paper to discuss issues raised by this expanded program and set criteria by which the priority of the program and projects within the program can be assessed. Six closely interlinked criteria are identified — technical, economic, financial, social, political and administrative. The body of the paper consists of a discussion of each of these criteria.

- 21 **Carruthers, I.D. 1970.** "Assessing the contribution of rural water investment to development" *East African Journal of Rural Development* 3(2), 96-110

The paper consists of an introduction, a brief historical survey and a review of current policy in rural water investment. The bulk of the paper consists of an examination of the most important problem areas with limited empirical evidence. This paper attempts to make explicit the assumptions and hypotheses that are accepted by implication but go untested in formulation and implementation of the rural community water supplies for domestic use, stock watering and minor irrigation programs. The author suggests that it is the responsibility of planners to specify the types of gain they anticipate may result from their investment allocations and, further, to attempt to quantify where conceivable. It may be concluded that there is an *a priori* case for investing in rural water supplies in that direct and indirect benefits may be anticipated. The author concludes that it is important that these *a priori* notions and implied hypotheses that are presently used to formulate policy are made explicit, critically examined and subjected to empirical testing. This lack of empiricism and use of untested propositions is seen as a fairly general fault in current policy formulation in East Africa.

- 22 **Carruthers, I.D. 1972.** *Rural water investment in Kenya Impact and economics of community water supply* Wye College, University of London 165 pp

Rural water supply improvement is viewed by the Kenya Government as an important component of a new broad rural development strategy. This emphasizes employment, availability of economic and social services, as well as increased per capita income. Water development is expected to bring health benefits, new agricultural and other economic gains and to promote social welfare. This study examines the rationale for the new policy, the evidence supporting the premises, and appraises the means being adopted to achieve the program objectives, setting the whole in a systems analysis framework. Recommendations are made on ways to improve the cost-effectiveness of the investment. It includes a case study of the first major water scheme with a critique of the administrative, technical and economic aspects.

- 23 **Cassel, John, et al. 1970.** *The education and training of engineers for environmental health* Geneva. World Health Organization. 152 pp

The general objective of this book is to provide guidelines for the education of the kind of engineer who will be needed in environmental health in the latter third of the 20th century. The changing concepts of environmental health and how these are reflected in a new approach to sanitary engineering are first discussed, followed by a review of certain important trends in engineering education, such as the use of mathematical models and systems analysis and the role of computers. New developments in the field will have to be incorporated into educational programs in the future. Examples are given of present environmental health education programs in Asia, Europe, and North and South America.

- 24 **Central Public Health Engineering Research Institute. 1971.** *Annual report 1971* Nagpur, India. CPHERI 72 pp

The report includes a short account of the major events of the year by the CPHERI director, and short descriptions of current research work. In the field of water supply and sanitation this included work on coagulant aids, defluoridation, iron and manganese removal, reverse osmosis and stabilization ponds. A list of the Institute's 1971 publications and patents is also given.

- 25 **Chagula, W.K. 1971.** "Opening address by the Minister for Water Development and Power, Tanzania." In *Water Supply*, ed. Gerhard Tschannerl, Dar-es-Salaam, University of Dar-es-Salaam, BRALUP Research Paper 20. pp 7-10

He emphasizes the political nature of decisions on water supply, and the lack of communication among engineers, economists and other professionals and policy makers.

- 26 **Chile, Republic of. 1971.** *Prestamo 74/TF — CH, agua potable rural, informe final* (Loan 74 TF—CH, rural drinking water, final report) Santiago, Chile. Servicio Nacional de Salud, Oficina de Saneamiento Rural 26 pp (Spanish only)

This report is a statement of progress during the period 1964-70 in which the Chilean Government was in receipt of a US loan of \$2,500,000 from the Inter-American Development Bank for a rural water supply program. The plan at first aimed at the provision of drinking water, mainly by house connections, to 300 localities with populations of 200-1000 inhabitants. The expected cost of this program was US \$5,000,000. However, the adoption of new technical norms in 1966 led to an increase in the cost of each installation, and the goal was amended to provide for 200 localities. By 1970, a total of 199 projects had been constructed. Lack of experience, initial miscalculations and lack of appreciation of possible difficulties contributed to a slow pace for the program. Tables at the end of the booklet list each locality in which a system has been constructed, estimated and real costs of the system, actual and expected population size, number of dwellings in each locality, number of domestic connections installed and number of public standpipes. In addition, organizational structures and changes occurring within the period are discussed as well as methods of supervision of the program, establishment of tariffs, operation and maintenance, level of financial participation of the communities, general improvements resulting from provision of water, names of national consulting firms engaged and chief personnel involved, and sources of technical assistance.

- 27 **Cleary, Edward J., and John A. Logan. 1971.** *International Program in Sanitary Engineering Design report on observations in Southeast Asia* Prepared for the AID, US Department of State 57 pp

The authors note that potable water supplies are rather far down on the list of priorities in most developing countries, and that waste-water disposal is near the bottom. While there is considerable interest in supplies for large cities, competition for development funds may result in neglect of the rural areas. In this setting, the IPSED program, an effort to improve the quality of training of sanitary engineers, was evaluated through interviews with 90 people in Southeast Asia. Recommendations were made for various parts of the program. IPSED is considered unique in its specialization in sanitary engineering design primarily for small communities, and it is felt that the future of the program will probably depend on continued emphasis on this characteristic.

- 28 **Commission on Rural Water. 1973.** *Water and wastewater problems in rural America* Washington, D.C. Commission on Rural Water 97 pp

The Commission was created to provide coordination for the Demonstration Water Project national program and to serve as the recognized center of competence for improvement of the national delivery system for rural water and wastewater disposal. It is felt that existing water and wastewater disposal facilities in rural areas of the US are inadequate with many community water supplies contaminated and many sewage systems ineffective. Thousands of communities have no facilities at all. The social and economic costs of inadequate facilities are examined and the major problem areas in the national delivery system are discussed, including funding, development, operation and maintenance.

- 29 **"Community water supply — the next ten years." 1971.** *WHO Chronicle* 25, 70-78.

In the developing countries of the world less than 10% of the rural population of some 1250 million people are supplied with adequate and safe water. This article summarizes the World Health Organization efforts to assist in meeting the target of raising this proportion to 20 percent in the next decade. The advisory role of WHO is stressed in planning, training and cooperation with other agencies such as UNICEF and the Special Fund. The report envisions no new departures from established practices except greater emphasis on rural programs.

30. **"Cost of rural and village sanitation in the South-East Asia region." 1967.** *WHO Chronicle* 21, 309-310.

Expected water withdrawal is estimated at 18 litres per person per day for a hand-operated pump in a small locality with a population of less than 2,000. For villages of 2,000-10,000 a piped water supply should provide 68 litres per person per day. Standpipes can serve 150 people each. Installation costs (without water treatment) range from (US) \$0.70 per person for a dug well to \$0.45 for a driven well, with maintenance costs of \$0.72 per person per year for any well. Piped water systems range from \$8.00-14.00 per person, with operation costs of \$1.80 per person per year. Sewage disposal installation costs range from \$5.00 per person for a latrine to \$20.00 per person for a sewage system for a small community.

- 31 **van Damme, J.M.G. 1973.** "Functioning of the international network for community water supply." International Development Research Centre Seminar, Lausanne, Switzerland, 29 May-1 June, 1973 Working paper no. 14. 16 pp

This describes the objectives and functioning of the International Reference Center for Community Water Supply, created in 1968 under the auspices of WHO. A network of collaborating institutions in 24 states, 16 classified as developing countries, was set up to exchange information, determine priorities for research and aid in education and training programs.

32. **Dave, V.M. 1971.** "Review on community water supply in the State of Gujarat " Three-day discussion with State Chief Public Health Engineers. World Health Organization, Regional Office for Southeast Asia New Delhi, December 6-8, 1971 10 pp

The program in the State of Gujarat in India for the provision of safe water supplies to urban areas and to rural villages and towns is described Some costs, financial arrangements and manpower requirements are given Funds provided for other environmental health programs are noted

33. **Dieterich, B.H. 1974.** "The water supply situation in developing countries," in *Human rights in health* (CIBA Foundation Symposium no 23, new series) Ed Katherine Elliott and Julie Knight London and New York Associated Scientific Publishers

This paper reviews the unsatisfactory condition of water supply and sanitation in the developing countries where a 1972 WHO survey of water supply conditions in 92 such countries found that over one billion people, some 86% of those living in the villages and rural areas, do not have reasonable access to safe water The author suggests that the most critical problem is lack of internal and external resources, followed by a need for a reduction in the per capita cost of provision of supplies, for local support for operation and maintenance, for manpower resources, and for improved design criteria He suggests that the IBRD might give more priority to investments benefiting the poorer segment of the population, and that water supply should be an integral part of development programs aimed at raising production Peripheral areas of cities and towns, he feels, should be given investment priority, followed by clustered rural conglomerates

34. **Dieterich, Bernd H., and John M. Henderson. 1963.** *Urban water supply conditions and needs in seventy-five developing countries* Geneva World Health Organization. Public Health Paper 23 92 pp

This report was the first attempt to appraise community water supplies in developing countries on a global basis It covers 75 developing nations in Africa, Latin America and Asia, presenting data about water supply and population with projections for the future The basic premises are that urban water supplies are at present unsatisfactory, that rural sanitation will improve around improved urban conditions, and that urban development is essential to economic progress It stresses the need for centralized authority in water planning, a clear definition of the role of ministries of health, and adequate financial arrangements

35. **Donaldson, David. 1972.** "Rural water supplies in developing countries " *Water Resources Bulletin* 8, 391-398

The Second UN Development Decade program seeks to increase safe rural water supply coverage from 10% to 20% of the world's rural population Latin American experience indicates two useful tools revolving funds, and the use of a mass approach Community participation is stressed, although the level and methods are not specified Other elements of a success plan are that rural water plans be part of a national or master plan, that there be specially trained staff, that payments for operation and maintenance be collected by a local organization, and that maintenance elements (local and regional) be built into the completed projects

- 36 **Donaldson, David. 1973. *Progress in the rural water programs of Latin America (1961-1971)*. Washington, D C.. Pan American Health Organization, Pan American Sanitary Bureau, Regional Office of the World Health Organization. 36 pp.**

The dynamic nature of water program development in Latin America is described, with the estimate that it takes about 8-10 years for a system to develop from water supplied to public fountains, to piped supplies, to 80% of the houses (patio connection) The author feels that key points are the focus on the concentrated rural population, the extensive use of trained technicians, and the promotion of intense local community participation He proposes three distinct programs: a well program for dispersed populations, a rudimentary aqueduct program for semi-concentrated populations, and a rural aqueduct program for concentrated or "rurban" populations. He advocates a mass approach with standardized techniques for these programs, and discusses the problems of financing and administering them

- 37 **Fair, Gordon M., John C. Geyer, and Daniel A. Okun. 1966, 1968. *Water and wastewater engineering* Vol 1 *Water supply and wastewater removal* 471 pp Vol 2 *Water purification and wastewater treatment and disposal* 583 pp.**

This comprehensive text covers material from the fields of engineering, hydrology, biology and chemistry as related to water supply and waste disposal systems The primary focus is on large water supply and waste disposal systems for urban use, but much material on water sources and several chapters in volume I specifically apply to smaller rural systems The appendixes give useful tables and terms related to water engineering. There is a bibliography of reference works and a notation of serial publications in the field

- 38 **Feachem, Richard. 1973. *Domestic water use in the New Guinea Highlands the case of the Raiapu Enga* Manly Vale, Australia Water Research Laboratory, the University of New South Wales Report No 132 54 pp**

As part of a research program investigating the environmental influences on morbidity in the New Guinea Highlands, a study was made of the water use of a Raiapu Enga clan. The study was designed to provide information for realistic design criteria for water supply improvements, and examines usage, choice of source, attitudes toward water, and environmental and health factors Total per capita usage is 0.68 litres daily, 79% of which is drunk Little washing is done and the impact of this on health is discussed Per capita use tends to decrease with increasing size of domestic group, but travel time to source has no association with water use patterns. Raiapu attitudes toward water include the fear of poison and of female contamination in the water source The author concludes from this careful study that there is no strong demand for improved supplies, and suggests that such supplies might be fully utilized only if accompanied by comprehensive educational programs

- 39 **Fenwick, K.W.H. n.d (1966?). *The short term effects of a pilot environmental health project in rural Africa the Zaina scheme re-assessed after four years* Nyeri, Kenya 50 pp**

A water supply and sanitation improvement project in Nyeri District, Kenya, was undertaken in 1961 by the Ministry of Health, with assistance from UNICEF, WHO, the Ministry of Works and Land Development, and local contributions of labour and money Various facilities were installed to serve about 5,000 people, and a health education project was started This report details the results of a survey made in 1965 for the Zaina area and for a control area five miles away Data on health, sanitation, living conditions and economic activity are compared with the results of a survey made in each area in 1961 before the installation of the water scheme. The author concludes that Zaina was a healthier place than the control area by 1965, but that both had improved since 1961 The water supply appeared to have made possible considerable expansion in livestock raising activity

- 40 **Ferguson, W.R.W. 1971.** "Related aspects of community environmental health programme " Three-day discussion with State Chief Public Health Engineers. World Health Organization, Regional Office for South-east Asia New Delhi, 6-8 December, 1971 10 pp

The health and economic benefits of improved water supplies in rural areas are emphasized, together with the consideration that piped supplies and flush toilets are not likely to be widely available in the near future. In order to make limited improvements, it is suggested that accessibility be considered as of first importance, and then quantity, and finally quality. The concept of total community participation in the planning, design, construction and operating stages of water supply and other environmental engineering projects is considered essential to success.

- 41 **Frankel, Richard J. 1973.** "A system approach to assessment of rural water supply program effectiveness." International Development Research Centre Seminar, Lausanne, Switzerland, 29 May - 1 June, 1973 Working Paper No 12 9 pp

The paper reports on an evaluation of the impact of improvements in water supplies in some 357 communities in Northern Thailand. The entire Thai potable water program was viewed from a systems approach, and the methodology is described. One principal conclusion is that such projects must be designed and assessed in a more comprehensive manner, with greater attention to the complementary inputs such as villager education and operator training.

- 42 **Ginn, H.W., M.W. Corey, and E.J. Middlebrooks. 1966.** "Design parameters for rural water distribution systems " *Journal of the American Waterworks Association* 58, 1595-1602

The author suggests that the standards for instantaneous demands (15 US gallons per minute per residence) and average daily demands (280-500 US gallons per day per residence) used for water supply systems in US urban areas are unnecessarily high for rural areas. Because of their lower demand rural systems impose different design requirements. According to the authors the peak instantaneous flow of 9.5 US gallons per minute for a single residence has a probability of one in 10,000 of occurrence and that this probability level of occurrence is sufficient for the design of rural water systems for future years. A study of consumption in Bel-Aire, Mississippi, during the hottest and driest part of the year showed average daily demands well below 500 US gallons per day per residence.

- 43 **Gysi, Marshall. 1971.** "The effect of price on long run water supply benefits and costs " *Water Resources Bulletin* 7, 521-528

The long time effects of presently used and alternatively proposed water pricing policies were studied using some tools of operations research and economics. Policies studied included constant unit rates, decreasing or increasing block rates, and summer differential rates. Conservational pricing policies are advocated as lowering the long run cost of water. The study is concerned with urban supplies, but the concept of flexible pricing aimed at conservation might have wide applicability. The assumption is that consumers will buy less water if the price is raised, but the author points out the need for further research regarding this idea.

- 44 **Haissman, I. 1971.** "Generating skilled manpower for irrigation projects in developing countries: a study of Northwest Mexico " *Water Resources Research* 7, 1-17

This paper defines the occupations most important for post-construction implementation of irrigation projects in developing countries, and develops, for this Northwest Mexican case, coefficients relating manpower requirements in every occupation to other project parameters. It could be suggestive for other kinds of water projects as it describes a network flow model developed to determine training systems needed to supply given projects with adequate skilled personnel.

- 45 **Harlaut, Andre. 1971.** "Basic considerations for the design of rural water supplies " In *Water Supply*, ed G. Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20. pp. 209-214.

The paper stresses that the final objectives of any public water supply system are to supply safe and wholesome water, to supply water in adequate quantity; and to make water readily available. Unfortunately full satisfactory water supply systems are expensive and beyond the financial means of most rural water supply programs. Alternative solutions must be compromises between economic realities and public health necessities. The first step toward developing a more comprehensive water system could be a piped supply with limited distribution facilities, but with the main structures designed so that future extensions could be easily carried out. The paper discusses how such compromises can be made in the design and construction of other components of the system — e.g. in selection of sources, pump capacity, storage capacity and dams and charcos

- 46 **Harlaut, Andre. 1971** "Investigation, surveys and design of rural water supplies " In *Water Supply*, ed G. Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp. 99-106

The paper puts forward a schematic procedure for the facilitation of comprehensive overall planning of rural water supplies. 1) All work involving knowledge of local conditions should, in the first place, be the responsibility of a Regional Office. 2) All work involving special knowledge or equipment should be carried out by Specialist sections. 3) All design work involving calculations, economic studies, detailed design and standard design should be the responsibility of the Head Office. 4) The project work should be divided into three main phases. The first should include all activities in connection with the selection of the projects and the overall planning. The second, resulting in a Project Report, should include all investigations and studies necessary for the implementation decision. The third should include all surveys and drawings necessary for the construction. The paper consists of a brief discussion of the various points in this schema.

- 47 **Heijnen, J.D., and Diana Conyers. 1971.** "Impact studies of rural water supply " In *Water Supply*, ed G. Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp. 53-63

The article discusses existing East African papers on the impact of improved water supplies in rural areas, and sets forth fourteen hypotheses in need of testing by further studies. Considering the current investment in water supplies, the rate of return for such studies is thought to be potentially high.

- 48 **Henderson, John M. 1961.** *Report on global urban water supply costs in developing nations 1961-75*. International Cooperation Administration, Washington, D.C., USA. 128 pp.

This report is concerned with the extent of need for urban water supply construction over the period 1961-75 and the costs of construction relative to the capacity of national economies to provide the necessary financing from internal and external resources.

- 49 **Hite, James C., and Eugene A. Laurent. 1971.** "Empirical study of economic-ecological linkages in a coastal area " *Water Resources Research* 7, 1070-1078

An adaptation of a Leontief input-output model was made to estimate the environmental repercussions of some changes in the economic structure of the Charleston, S.C., metropolitan area. While the article deals with urban economic activities and an urban ecosystem, the methods might have some application for smaller, less developed communities.

The conclusions are that there are no "clean" industries, that all economic activity directly or indirectly produces residuals that are potential pollutants of the natural environment, and that evaluation of the direct linkages alone may seriously underestimate the environmental repercussions of economic activity.

- 50 **Idelovitch, Emanuel. 1973.** "Interdisciplinary training of national engineers and technicians for the implementation of rural water supply programmes " International Development Research Centre Seminar, Lausanne, Switzerland, 29 May - 1 June, 1973 Working paper no 15 7 pp

The paper seeks to identify some limitations in the training of personnel for rural water supply systems in developing countries. It is suggested that there is a need for courses combined with field work for engineers specifically dealing with the problems of rural water supply and sanitation, and for the exchange of information between engineers and research workers. For technicians a comprehensive program is needed combining a minimum of theoretical background with a maximum of field work, preferably in a pilot project for simple technology in rural areas.

- 51 **Idelovitch, Emanuel. 1973.** "The technological frontier a state-of-the-art review " International Development Research Centre Seminar, Lausanne, Switzerland, 29 May - 1 June, 1973 Working paper no. 6 13 pp

This is a preliminary review of two of the technical components available for water supply systems in rural areas. Pumping, and water quality and treatment are examined as to the characteristics and suitability of different technical solutions for rural areas. Preliminary conclusions are that further research is needed on the construction of simple and cheap protected hand dug wells, and on cheap and durable pumps for both man and animal operation.

- 52 **India, Government of, Ministry of Health. 1960-61.** *Report of the National Water Supply and Sanitation Committee 1960-61*, New Delhi. 167 pp

The purpose of the report was to make a comprehensive assessment of the urban and rural water supply and sanitation requirements in the country, and to compile a realistic forecast of the requirements then as well as in the future. The report came at a time when the National Water Supply and Sanitation Programme had been in operation for five years.

- 53 **Irvin, George. 1971.** "Problems of benefit-cost analysis in planning of rural water supply " In *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp 67-79

The author points out the complexity of assessing costs and benefits of improved rural water supplies, adding that real benefits may not be in health or more available time, but in the set of cumulative changes which these make possible. He discusses the assessment of redistributive effects of schemes, and the risks involved in stressing minimum costs per capita.

- 54 **Jalon, Z., and D. Mezer. 1971.** "Some problems of water resource development in developing countries " In *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20. pp 241-245

Discusses very briefly some of the problems encountered in planning, implementation and management of water resources specific to developing countries. The normal stages of planning are outlined and illustrated by three examples from Tanzania, Nigeria and Iran from the practice of Balasha-Jalon, Consultants and Engineers Ltd.

- 55 **Jha, U.N. 1971.** "Review on community water supply in the State of Bihar " Three-day discussion with State Chief Public Health Engineers World Health Organization, Regional Office for Southeast Asia. New Delhi, 6-8 December, 1971 6 pp.

Outlines the organization and funding of the water supply program in the State of Bihar in India It is estimated that 70% of the urban population and 2% of the rural population in 1970-71 were served with piped water, and that 47% of the rural people have access to safe water supplies such as tube or sanitary wells.

- 56 **Kally, Elisha. 1965.** "Determination of water supply investment priorities in developing countries " *Journal of the American Waterworks Association* 57, 955-964

The method of investment priority grading proposed in this paper is based on an evaluation of the benefit that would result from a water supply scheme, expressed as the volume of water supplied to consumers, whereas future supply is given lower valuation than present supply, in accordance with the present-value principle The present-value factor is a magnitude typical for any given undertaking, and is therefore subject to variation from one project to another The proposed priority grading method is aimed at ensuring the maximum benefit from capital investment in a domestic water supply system The basic data for determining this grading are the result of concrete non-standard engineering computations, in which the output of different projects is evaluated according to the capital invested The determination of priority gradings is a standard procedure by which the data can be processed by electronic computer and in which numerous alternative possibilities can be investigated.

- 57 **Kates, Robert W. 1971.** "Flexibility, coordination and choice in water resource planning The utility of recent planning innovations for water development in Tanzania " In: *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRAI UP Research Paper 20. pp 13-33.

The paper argues that some of the recent innovations in comprehensive water resource planning, particularly in North America, are relevant to Tanzania Tanzanian planners do not have to operate within a capitalist framework nevertheless innovations related to three apparently universal problems of longer-term comprehensive regional planning exercises are thought relevant problems of flexibility, coordination and choice. The paper discusses the innovations in these areas and suggests some adaptations of the new techniques that could be realistically applied in the Tanzanian context to help meet these problems. The major conclusion is that the Tanzanian desire for improved water for all deserves the very best of consultant advice

- 58 **Kates, R.W. 1973.** "Experience in user-choice from Kenya and Tanzania." *International Development Research Centre Seminar, Lausanne, Switzerland, 29 May-1 June, 1973* Working paper no. 5 10 pp

The paper describes people and situations in Kenya and Tanzania to illustrate the on-going process of user-choice and risk-benefit assessment with regard to water supplies in rural areas. The author suggests the need for developing a methodology for examining distinctive environments and institutional settings, packaging a range of appropriate technologies, and helping the people who will use these to choose wisely among them

- 59 **Kepinski, Alfred. 1972.** "Community water supply research" *Ingenieria Sanitaria* 26, 8-13

The author, research coordinator for the World Health Organization International Reference Centre for Community Water Supply, proposes two steps for coordinating community water supply research. The first would be collecting and disseminating information about research in the biological and medical, technical, physical and social sciences, establishing a data bank, and publishing bulletins and project inventories. Second would be the publishing of research findings and the defining of gaps in existing information and of research needs.

- 60 **Kirkby, Anne. 1973.** "Towards a user-choice philosophy" International Development Research Centre Seminar, Lausanne, Switzerland, 29 May-1 June, 1973. Working paper no. 17. 15 pp.

The author suggests that rural water supply projects would be more likely to succeed if the users were allowed to decide to a much greater degree on the type of system, if any, that they want. There is already a traditional user-choice system in operation, and she points out that these traditional beliefs can be learned from and used in the process of bringing about change. The implications for rural water systems are that the administrative system should be flexible, so that it can be adapted to existing management structure. A social scientist, a health education/medical expert and an engineer could then design a total technical, management and educational user-choice system for water supply and sanitation which would meet the requirements of the local populace. Illustrations of community decision-making styles are given from Iran and Mexico.

- 61 **Kneese, Alan V. 1968.** "Water quality in economic development." Paper presented at the Seminar on Development of Water Resources, Maracaibo, Venezuela, Feb. 11-15, 1968, Central University of Venezuela and WHO/PAHO. 25 pp. Published in Spanish, *Bol. Ofic. Sanit. Panamer.* 69, 36-49.

In the context of a broad consideration of water resource development and use in relation to economic progress, the author summarizes the inconclusive debate in the literature as to exactly what are the economic benefits associated with water supply. He notes the absence of a discussion of this question in formal economic literature. He refers to earlier attempts to calculate the capital value of human beings and the effect on it of disease and premature death. He suggests the need for an adequate study of the economic value of alternative water supply programs, with a broad investigation of the indirect health effects.

- 62 **Kreysler, J. 1970.** "Uhuru na Maji" *Journal of Tropical Pediatrics* 16, 116-123

Mayo village in the densely populated Usambara mountains of Tanzania was selected as a place to institute measures of environmental sanitation and preventive medicine. Following President Nyerere's aim of self-government, objectives were formulated by the village leaders with the expectation of planning, financial and other contributions by the villagers, with the expatriate and Tanzanian experts present fulfilling an informal, non-authoritative advisory role. After mothers of the village were led to question how best to improve the health of their children, a self-help feeding program was instituted, and a water supply system was built by the villagers themselves using their own plans. Local people have been trained in construction and maintenance, and the system is being extended. An irrigated field and a brick production unit have grown out of the project.

- 63 **Krouse, Michael R. 1972.** *Quality of life and income redistribution objectives for water resource planning* Washington, D C Center for Economic Studies, Institute for Water Resources, Corps of Engineers, US Department of the Army IWR Report 72-4 55 pp

This report considers measures of social well-being as an objective of water resource planning, including effects on incomes, life, health, safety and emergency preparedness. While written in a sophisticated context of water resource planning, it is suggestive of methods for examining alternative income effects of a water project on various user groups and income classes. A project's income redistribution or "well-being" effect can then be compared with the present way all benefits are distributed and with the effects of alternative projects.

- 64 **Lamb, James C., and Donald T. Lauria. 1967.** "An international program in sanitary engineering design." *International Conference on Water for Peace* 5, 1035-1042 Washington, D C USGPO

This paper describes the activities of the International Program in Sanitary Engineering Design (IPSED), conducted by the Department of Environmental Sciences and Engineering of the School of Public Health at the University of North Carolina at Chapel Hill. Begun in 1962, it later included courses offered at the Universidad Nacional de Ingenieria, Lima, Peru. About 50 sanitary engineers from developing countries had been trained under this program by 1967, with emphasis on design decisions as related to the student's own country, and its needs and resources. A series of publications is a related IPSED activity.

- 65 **Lauria, Donald T. 1972.** "Water supply planning in developing countries: a general statement." Paper presented at the Annual Conference of the American Water Works Association, Chicago, Illinois, 8 June 1972. 16 pp

The problem of allocating national water budgets in developing countries is seen as involving decisions as to when and how much to invest in individual communities. For these decisions it is felt that planning on a regional basis yields best results. Mixed integer programming models are considered useful in indicating optimal construction timing and scale. The need for data on water supply benefits is stressed, as at present in models constructed for water supply planning the benefits must be estimated by value judgement or political fiat. Market studies and collection of data on community water demand and supply costs are recommended.

- 66 **LeBosquet, M. 1967.** "Health aspects of water resource development." *International Conference on Water for Peace* 6, 922-926 Washington, D C. USGPO

A brief summary of some diseases associated with rural water supplies is given, and some of the control measures which may be used. The health authorities are felt to have primary responsibility in this field, aided by cooperation and assistance from WHO and other international agencies.

- 67 **Lee, Terence R. 1969.** *Residential water demand and economic development* University of Toronto Department of Geography Research Publication no. 2. Toronto University of Toronto Press 127 pp

This study attempts to measure and define the relationship between economic development and the provision or need for public water supply systems through the examination of domestic water consumption and patterns of use in 13 sites in Calcutta and New Delhi. In households with piped water connections and in those using water from sources outside the house, measurements were made of amounts used, the nature of the use, and judgements obtained from the users as to the quality of the water. He concludes that the demand for domestic water supply is a function of accessibility to water, housing conditions, level of income, and water-using habits. Beyond a basic supply needed for health, he feels there is little evidence that increased supplies will lead to greater economic growth.

- 68 **Lee, Terence R. 1972.** *Community water supplies and economic development, the scale and timing of development* Canada Centre for Inland Waters, Burlington 25 pp

Stresses the need for an evaluation of the nature of the role of urban water supplies in the development process and of the priority which should be given them among the multitude of necessary services and activities the under-developed countries so critically lack. Water supply should not be planned in isolation from the wider effort to raise the level of urban housing conditions. It is argued that systems should not necessarily be designed around western standards, and that the problem of urban water supply should be integrated into a total development program.

- 69 **Logan, John A. 1963.** "The quantitative relationship between community water supply and economic development" *International Review of Tropical Medicine* 2, 27-40

The author defends the thesis that capital investments in public water supplies, urban and rural, are part of the social-overhead capital needed to develop and maintain a technologically based society, and reviews attempts to translate the benefits of public health measures into monetary values. He believes that the effect of water supply on morbidity and mortality has been amply demonstrated.

- 70 **Ludwig, Harvey F., and Alfred W. Jorgensen. 1967.** "Package approach for development of village water supply systems" *International Conference on Water for Peace* 7, 80-87. Washington, D C USGPO

A set of standardized packaged modules of equipment for mass-scale rural village water supply improvement is proposed, with manuals explaining design, installation and maintenance. A design could be made from aerial photographs, and a package of selected equipment sent to a village for local assembly, installation, operation and maintenance, with occasional technical assistance. Cost of preparation of trial designs and manuals for ten villages, perhaps 6,000 households, is estimated at US \$100,000, not including any equipment or installation costs.

- 71 **Lwegarulila, F.K. 1972.** *Forecasting water requirements in developing countries with special reference to Tanzania* UN Ad Hoc Group of Experts on Water Requirements Forecasting, Budapest, 10-17 May 1972 17 pp

The author points out that whereas it may be easy to forecast the physiological water requirements for a given country in so far as the people and livestock are concerned, the forecast becomes vague and merges into guess-work as attempts are made to estimate water requirements for a developing country whose socio-economic complex cannot be precisely predicted. Nevertheless, he does produce forecasts of the urban, rural and cattle population growth between 1970 and 2000 together with the estimated growth of total water demand in this period. The latter he expects to rise from 50 million litres per day in 1970 to 480 million litres per day in 2000. He concludes by stressing the need for developing countries to prepare Water Master Plans as a basis for forecasting.

- 72 **Mathur, G.L. 1971.** "Review on community water supply in the State of Rajasthan" Three-day discussion with State Chief Public Health Engineers World Health Organization, Regional Office for Southeast Asia New Delhi, 6-8 December 1971. 13 pp

This report outlines for the State of Rajasthan in India the organization and funds provided for urban and rural water supplies and sanitation facilities. It is estimated that 21% of the total population is served by safe water supplies.

- 73 **McJunkin, Frederick E. 1969.** *Community water supply in developing countries* Chapel Hill, N C US Agency for International Development and US Public Health Service. 83 pp

Focusing primarily on urban situations, the report emphasizes the health and economic benefits of improving water supplies and sanitation. It cites institution building as an important aspect of aid to developing countries, as well as educational assistance, technological improvement, capital and planning aspects. A summary is given of USAID assistance for improved rural and urban water supplies in various countries.

- 74 **Mexico, Republic of. 1972.** *Cartilla de la salud* (Health Booklet). Issued by Secretaria de Salubridad y Asistencia, Comisión Constructora e Ingeniería Sanitaria. 103 pp (Spanish only)

This booklet is intended to provide a basic education in various aspects of sanitation for the Mexican rural population. It contains sections on sanitation related to food and water, the environment and waste disposal. Instructions and diagrams are included in the first section on food and water about the measures recommended for the avoidance of contamination, procedures for taking water samples, the process of chlorination and filtering of water, the causes of contamination and how these can be avoided and the advantages of daily exercise. The second section on the environment is divided into three subsections, on the care of public thoroughfares and community facilities, the recommended organization of the home, with instructions for the internal layout, and on human relations. Finally, the section on waste disposal contains recommendations for situation and type of latrines and their distance from the house and water sources, methods of latrine construction and appropriate materials and measurements, and the disposal and treatment of animal and domestic wastes.

- 75 **Morfitt, R.P. & Associates. 1969.** A report to the Pan-American Health Organization. *A non-conventional mass approach to rural village water projects*. Corvallis, Oregon. 48 pp

This report prepared for PAHO highlights various techniques and methodology necessary for the implementation of a coordinated packaged total rural community water program. The ability of a community to provide self-financing is seen as the predominant factor in electing the approach to the design of a total water system. In the case of most rural communities the community lacks the ability, through conventional methods, to finance a potable water system. Therefore there is a demand for a non-conventional approach providing partial self-financing of construction; community participating through self-help in construction, community responsibility for operation and maintenance; reduced costs through use of realistic design criteria and standards, acceleration of design and construction. The paper discusses the necessary considerations for such a mass approach to the problem and suggests how the concept may be tested through a pilot project.

76. **Okun, Daniel A., and Frederick E. McJunkin. 1967.** "Planning and developing water supply programs in developing countries." *International Conference on Water for Peace* 7, 35-45 Washington, D.C. USGPO

The thesis of this paper is that standards and policies for community water supplies should be developed within their own environmental framework. Although considerable assistance, guidance and information are available from the more developed nations, the development of appropriate standards and policies should ultimately be a task of local engineers and administrators. Although outside expertise is available, this is a situation where money cannot buy everything. The development of at least a cadre of local talent is a necessity, regardless of the source of fundings, if local objectives are to be efficiently met. It is also suggested that the attitude of the engineer and the administrator should be one of open-minded and continuous questioning of alternative means of achieving realistic goals.

- 77 **Olinger, Colleen E. 1970.** *Domestic water use in the Española Valley, New Mexico a study in resource decision-making* Master of Arts Thesis The Department of Geography, University of Chicago, Chicago, Illinois

Domestic water is seen as an essential resource requiring basic management decisions. A model framework developed by White was used to examine the choices made by 65 households in sample communities in the Española Valley regarding participation in a community water supply and sewerage program. When rated as to the manager's estimate of the capability of the resource to meet his or her needs, of the technological knowledge required, of the economic feasibility, of the spatial factors involved, and of the social pressures present, the single family pump received the highest score, followed by the community water system.

- 78 **Orozco, G. 1972.** *Proyecto Argentina 2200, informe final 1965-72* (Final information 1965-72) Buenos Aires, Argentina Organizacion Panamericana de la Salud 51 pp (Spanish only)

This report discusses the Argentinian rural drinking water plan begun in 1965. Two loans totalling \$17 million (US) were obtained from the Inter-American Development Bank to complement government, provincial and community contributions, and a National Revolving Fund was created to aid the development of the plan. Particular emphasis is made on the degree of community participation and the locally based sanitary education schemes. Provision of supplies is mainly through house connections, daily supplies of 300, 500, 800 or 1,000 litres being offered to consumers. Each installation is provided with an asbestos-cement tank of either 300 or 500 litres in size, depending on the daily requirements. For domestic connections a volume regulator of the "Skolnick" constant head opening type is used, which limits daily consumption and prevents excess usage. Commercial and industrial supplies are fitted with a meter. The paper includes a description of the operation and advantages of "dynamic filters." Plastic pipes were used widely, although initial difficulties required the use of asbestos-cement pipes. Problems with the high fluoride content of some ground water led to the erection of the first defluoridation plant in Latin America. Some difficulties were lack of suitably trained personnel, low output of contractors because of inexperience, and administrative problems.

- 79 **Panamericana de la Salud, Organización. March 1966.** *Conferencia regional sobre abastecimiento de agua en las Américas, Washington, D C, 18-20 octubre de 1965* (Regional conference on water supply in the Americas, Washington, D C, 18-20 October 1965). Publicación Científica No 132, Washington, D C., USA 106 pp (Spanish only)

The general conclusions and recommendations that emerged out of this conference were that there is a special need to improve rural water supply in Latin America, that simple designs and technologies are preferable to more complex and costly systems, that self-financing schemes should be implemented, that local materials should be used where possible for construction, that education and training programs should be established to improve the administrative and technical competence of personnel, that community participation in schemes should be encouraged, that both external and internal sources of finance should be utilized, and that investigative programs should be developed to enquire into new materials, methods of construction, quality control, etc. Finally, the conference recommended the setting up of a committee to enquire into the state of water supply in Latin America. The booklet contains articles on topics including institutional structures, the financing of the programs and the work of the Inter-American Development Bank in Latin American programs, the training of personnel and problems of education in sanitary engineering, resources for investigations on water supplies, rural programs, materials and equipment used in the schemes and a discussion of the state of progress in the programs of the countries of Central and South America.

- 80 **Pan American Health Organization. 1969.** *Community water supply and sewage disposal programs in Latin America and Caribbean Countries* Department of Engineering and Environmental Sciences, ES Technical Series 5 97 pp

This document discusses the steps which led to the goals established in the charter of Punta del Este for community water supply and sewerage, the situation in 1961, progress made from 1961 to 1968 and projections for 1971. There are useful annexes dealing with the methodology of data collections for water supply units, the financing of projects, advisory services and training.

- 81 **Pan American Health Organization. 1972.** Pan American Sanitary Bureau, Regional Office of the World Health Organization *Annual Report of the Director, 1971* 293 pp

Records the progress made toward reaching the goals of the ten year Public Health Program of the Charter of Punta del Este, 1961. The total of US \$599.54 million invested in urban and rural water supply and sewerage services during 1971 was the highest figure for a single year. In the aggregate approximately \$365 million have been invested in rural water supply, with service reaching approximately 24% of the total rural population either through house connections or easy access to public hydrants. The status of water supply and sewerage system services is tabulated for each Latin American country.

- 82 **Pan American Health Organization. 1973.** *Ten-year health plan for the Americas final report of the III Special Meeting of Ministers of Health of the Americas* Washington, D.C., Pan American Health Organization, Pan American Sanitary Bureau, Regional Office of the World Health Organization. 136 pp.

The recommendations of the Ministers of Health for environmental health goals for the next decade include increasing the provision of water supply and sanitary excreta disposal facilities to include 50% of the rural population, or as a minimum, reducing the population without service by 30%. In 1971 water services reached 24% of the rural population. Techniques of "mass approach" and concepts of community self-help are recommended to provide water in rural areas, and the use of revolving funds to finance rural water supply programs.

- 83 **Paranjpye, V.K. 1971.** "Review on community water supply in the State of Maharashtra." Three-day discussion with State Chief Public Health Engineers. World Health Organization, Regional Office for Southeast Asia. New Delhi, December 6-8, 1971. 13 pp.

The organization and cooperation of the community water supply program in the State of Maharashtra is described, as are financing and the involvement of international agencies. Costs, rates and estimated consumption are given. As of 1971, 94% of the urban population and 4% of the rural population are estimated to have safe water supplies. Other environmental health programs are described briefly.

- 84 **Peru, Republic of. 1967.** "Country situation report," *International Conference on Water for Peace 1*, 283-292. Washington, D.C. USGPO.

This paper gives the basic information regarding water resources in Peru, including the potable water and sanitation situation. As of 1966, 63.5% of the rural population in communities of 200-2000 was estimated to have access to potable water supplies, with a goal of 37% to be supplied by the end of 1974. The operation and administration of the system is described, including a Revolving Fund for financing, and an agreement with local communities in which they contribute 12% of the total cost in cash, labor, and local materials and transportation facilities.

- 85 **Peru, Republic of. 1967.** *Plan nacional de agua potable rural* (National rural drinking water plan) Lima, Peru Ministerio de Salud Pública y Asistencia Social 17 pp (Spanish only)

This paper outlines the format, objectives, financing and achievement of the National Rural Drinking Water Plan initiated in Peru in 1964. It describes the lack of rural water supply and waste disposal before the beginning of the National Plan and the efforts of the Government to improve this situation. The Rural Sanitation Law of 1962 gave to the Ministry of Public Health and Social Assistance the task of executing and administering a 10 year plan of rural water supply and waste disposal. The involvement of the communities in the execution of local works and in their operation, administration and maintenance is particularly stressed. The first stage of the Plan between 1964 and 1966 provided water and waste disposal services to 150 rural localities. Encouraged by this success and especially by the involvement of the communities through the local Administrative Committees for the services, the government initiated stage 2 in 1966. In this stage the aim was to provide water systems in approximately 307 localities with a population estimated at 240,000. Finances for the Plan came from the Inter-American Development Bank, the Government and from the communities themselves. It is hoped that 40% of the rural population by 1974 will have been provided with drinking water.

- 86 **Peru, Republic of. 1967.** *Juntas administradoras de los servicios de agua potable rural* (Rural water services administrative committees) Lima, Peru Servicio Especial de Salud Pública 10 pp (Spanish only)

This brief pamphlet outlines the functions and duties of the Administrative Committees which operate at the local level in Peru, and are responsible for the administration, operation and maintenance of water services in each community. Details are also included of tariffs for water consumption and the uses to which these funds are put.

- 87 **Peru, Republic of. 1968.** *Realizaciones del plan nacional de agua potable rural* (Achievements of the national rural water plan) Peru Servicio Especial de Salud Pública. 10 pp (Spanish only)

This gives a comprehensive list of the names of places where projects have been initiated and/or completed, brief details of the administration of services and a table illustrating the sources of finances for the plan. Between January 1964 and September 1968, 42.5% of the national rural drinking water plan was financed by the Inter-American Development Bank, 11.5% by the communities themselves, 30% by the local governments and 16% by various government agencies.

- 88 **Peru, Republic of. 1969.** *Plan nacional de agua potable rural*, (National rural drinking water plan) Peru Ministerio de Salud 18 pp (Spanish only)

This booklet describes the National Rural Drinking Water Plan up to October 1969, particular stress being placed on the increased participation of the communities not only in the operation and administration of the schemes, but also in their financing. Details are given of a proposed National Revolving Fund which will operate to grant loans to the rural communities, the rate of interest not exceeding 6% per annum. Up to October 1969, 604 localities were provided with water, leaving the provision of services for 650 localities for the third stage of the plan (1971-74) and the construction of systems for 1070 localities for the fourth stage (1974-79). There are lists of projects, constructed works, works in construction, administrative committees within each region, proposed investment levels of the Revolving Fund and the origins of capital up to October 1969. Tables are also given of levels of investment within each region, the proportion of localities within each region which have benefited from the plan, the geographical locations of works and of the extent of rural drainage.

- 89 **Peru, Republic of. August 1971.** *Curso de adiestramiento para inspectores de juntas administradoras y promoción de comunidades, Desarrollo del programa de estudios*, (Training course for inspectors of administrative committees and community advancement, Development of program of studies) Lima, Peru Ministerio de Salud, Dirección General de Programas Especiales de Salud, Dirección del Programa de Ingeniería Sanitaria 139 pp (Spanish only)

This handbook was compiled for trainees in courses set up as part of the National Rural Drinking Water Plan. The training courses cover a wide range of topics as shown in the five section headings of the handbook — the National Rural Drinking Water Plan, activities for community advancement, organization and supervision of administrative committees, the program of domestic connections, and the operation and maintenance of drinking water services. Information is included under these headings on the objectives, development and financing of the plan, on the preparation, education and participation of the communities, the functions of the administrative committees, the technical aspects of the Plan, the national organization of equipment and location of stores, and finally, information on the types of systems, the operation and maintenance of treatment plants, and possible causes of malfunctioning. The aim of the Plan is to supply drinking water to 2,600 communities of 400-2000 inhabitants, which comprise about one-third of the total rural population. Local funds constitute 43.5% of total costs, the other 56.5% being met by a loan from the Inter-American Development Bank. This book illustrates the general approach of the Plan to include the communities in the financing, administration, operation and maintenance of their own systems.

- 90 **Pescod, M.B., and Daniel A. Okun. 1971.** *Water supply and wastewater disposal in developing countries — Proceedings of a water supply and sanitation seminar held in Bangkok 19-23 January 1970*. Asian Institute of Technology, Bangkok, Thailand. 309 pp

These proceedings consist of 38 individual papers under the headings of the importance of water, the Asian situation, planning water projects, water resources development, water quality management, wastewater management, system operation and management, and new developments. Most of the papers deal with problems of urban supplies, with the exception of a discussion of the rural supply program in Thailand.

- 91 **Pickford, John, ed. 1972.** *Economics and management in public health engineering*. Fifth public health engineering conference. Loughborough University of Technology. 80 pp

The Loughborough Public Health Engineering Conference in its fifth annual Conference followed the lines of those held previously, which dealt with the following topics: 1967, surface water and storm sewage, 1969, tertiary sewage treatment and water reuse, 1970, industrial waste water, 1971, sludge treatment and disposal. The four papers in the 1972 proceedings are on the topics of cost effectiveness in the design of waste treatment schemes, economic aspects of water management, some economic aspects of industrial waste treatment plant design and the economics of industrial effluent disposal.

- 92 **Pinto, Luis Emilio. 1972.** "Public relations and promotional activities for water supply and sewerage programs — a sociological outlook." *Boletín de la Oficina Sanitaria Panamericana* 78, 281-293 (Spanish with English abstract)

The lack of participation of citizens in the area of social development is cited as a reason for the chronic deficit in water supply systems in Latin America, despite improved technologies, administrative procedures and excellent governmental support. A program of public relations activities is recommended, with emphasis on clearly defined internal relations in the organization, to help the citizen attain conscious awareness of the problems and initiate action required to attain desired objectives.

- 93 **Pyatt, Edwin E., and Peter P. Rogers. 1962.** "On estimating benefit-cost ratios for water supply investments " *American Journal of Public Health* 52, 1729-1742.

A search was made for a methodology applicable to the benefits and costs accruing to the development of a municipal water system Using the selected method with data from Puerto Rico, the authors conclude that an economic "break-even" point accrues about 10 years after the installation of a water supply program The mortality and morbidity rate of typhoid, diarrhea, and enteritis were used, and also debility, a measure of on-the-job inefficiency of effort Projections were made for population growth, and present values of net future earnings by age were computed using a discount rate of 4%

- 94 **Rose, Cecil W. 1967.** "Common sense designs for rural water systems." *International Conference on Water for Peace* 7, 119-124 Washington, D C USGPO

The paper relates some of the experience gained by the Farmers Home Administration (FHA) of the US Department of Agriculture in the design and construction of rural community water supplies. Great emphasis is placed on the virtues of self-help and on the importance of utilizing locally elected community leaders for management positions in the construction and maintenance of water projects Also stressed is the need for projects to be based on realistic design criteria For instance, small rural communities often cannot afford to install, operate and maintain sophisticated treatment equipment but most water contaminants can be removed simply by aeration, chlorination and filtration, which requires relatively unsophisticated equipment and is therefore much less expensive The use of new materials, such as plastic pipe, can also reduce costs It is the hope of the author that the FHA experience will benefit water project design in the developing countries

- 95 **Saunders, Robert J. 1973.** "Village water supply in developing countries problems and policies " Report submitted to the International Bank for Reconstruction and Development Washington, D C 192 pp

This report outlines the major factors which should be considered by a country or an international agency when it invests in potable water supply systems in rural areas of developing countries. It seeks to identify the relevant factors to be considered in allocating resources to rural water supply investment, to analyze these factors in view of such goals as fostering better health, economic development, income redistribution, and slowing rural to urban migration, and to suggest the effects of geography, climate, political philosophies, income, education and culture on different methods which might be used to achieve these goals

- 96 **Saunders, Robert J. 1973.** "Economic benefits of potable water supplies in rural areas of developing countries " Revised form of paper presented at the 93rd Annual Conference of the American Water Works Association, May 17, 1973 15 pp.

The fact that rural village populations of less developed countries are in many cases unable to pay the full costs of piped water supply systems has led to an increased effort to identify quantifiable benefits of the systems Experience thus far has shown that the level of economic benefits resulting from improved rural water supplies depends on how local health and employment are effected, which villages are selected to receive water first, and whether the improved water supply effects population location and migration. Particularly important, however, with regard to the probable realization of benefits, are the ways in which rural water supply programs are administered and financed The author also discusses the redistributive income effects of water supplies, concluding that from a health and income distribution point of view, higher income rural villages are probably less in need of assistance than the urban slums

- 97 **Schmoyer, Richard. 1967.** *Decision-making in the development of domestic water systems in Prowers County, Colorado* Master of Arts Thesis The Department of Geography, University of Chicago, Chicago, Illinois.

The author analyzed the factors of decision-making in the development of domestic water systems by applying two descriptive frameworks to the views of 64 resource managers in Prowers County, Colorado. A modified framework was developed from the work of Bowden and White which attempts to identify the significant factors and their interrelationships. The factors considered are the range of choice of water source open to the manager, his estimation of the quality of the resource, of the technology required, of the economic efficiency, and of the spatial linkages with other managers.

- 98 **Sethi, J.L. 1971.** "Review on community water supply in the State of Haryana." Three-day discussion with State Chief Public Health Engineers. World Health Organization, Regional Office for Southeast Asia. New Delhi, December 6-8, 1971. 11 pp.

The organization, operation and financing of the water supply program in the State of Haryana is described. Figures on manpower involved, estimated consumption and cost are given. An estimated 18% of the urban population and 10% of the rural population had access to safe water supplies in 1971.

- 99 **Shipman, Harold R. 1967.** "Water rate structures in Latin America." *Journal of the American Water Works Association* 59, 3-12.

This report on an examination of the methods of water rate determination in Latin America finds that they differ widely from country to country, but that in all countries water projects are characterized by subsidies of up to 100% for initial construction. Frequently higher rates are charged to the consumers who can pay more. Seldom is there provision for creating a reserve for expansion or providing for depreciation. The author notes the concern for providing water for those less able to pay for it, and concludes that the assignment of a uniform rate is more equitable than the setting of minimum charge for a certain amount of water. He emphasizes the need for a level of rates which will provide fiscal soundness for the enterprise. Azpura (6) comments on this article, noting the need to consider ability to pay as well as fiscal soundness.

- 100 **Shipman, Harold R. (n.d.).** *Policies affecting the financing of urban water supply in developing countries*. International Standing Committee on Problems of Water Supplies in Developing Countries. Subject No. 2. International Bank for Reconstruction and Development. 5 pp.

Because ability to finance water systems is one of the concerns expressed by those looking to the problems confronting urban growth in the developing countries, two viewpoints are examined which bear on the approaches to be considered in meeting the problem. One concerns the proposal that standards to which systems are being built and operated are too high and will have to be reduced, the other that the solution lies not in blaming and changing standards, but rather in better engineering, better financial policy, and better management. It is the author's contention that a reduction in standards of water quality, quantity and service are not only impracticable but more significantly will result in little savings, if any. He suggests that the problems can be better overcome by reducing costs, rather than standards, and this means good engineering, planning, operation, financial policy and management. He discusses briefly each of these five points.

- 101 **Singal, D.R. 1971.** "Community water supply in Punjab " Three-day discussion with State Chief Public Health Engineers World Health Organization, Regional Office for Southeast Asia New Delhi, December 6-8, 1971 8 pp

This report covers briefly the organization, financing and operation of the community water supply program in the State of Punjab in India Estimates of cost and consumption are given

- 102 **Smith, Courtland L., and Thomas C. Hogg. 1971.** "Benefits and beneficiaries contrasting economic and cultural distinctions " *Water Resources Research* 7 (2), 254-263

Benefit-cost analysis is a largely American evaluative process for determining the ratio of benefits to costs in economic terms The authors point out that those receiving the benefits play the role of beneficiaries, and those paying the costs are benefactors, and that the importance of each role varies according to the cultural values of the people involved. The implications for water supply in developing countries are that benefit-cost decision-making cannot be transferred to other cultures without knowing the roles and cultural values of the society regarding resource development, and without defining closely who the beneficiaries and benefactors are, and their roles in the socio-cultural system

- 103 **Swamy, T.S. 1971.** "Review on community water supply in the State of Andhra Pradesh " Three-day discussion with State Chief Public Health Engineers World Health Organization, Regional Office for Southeast Asia New Delhi, December 6-8, 1971 9 pp.

The report describes problems of salinity, pollution and scarcity in the water supply in the State of Andhra Pradesh The organization, financing and operation of the water supply program is described for urban and rural areas In 1971 an estimated 60% of the population had access to safe water supplies

- 104 **Tanzania, United Republic of.** Ministry of Agriculture, Food and Co-operatives, Water Development and Irrigation Division 1970 *Tanzania rural water supply development, volumes 1 & 2* Dar-es-Salaam 200 pp

This report prepared for the Tanzanian Government by Olle Rimer and Associates, Management Consultants, of Sweden, sets out a new approach to water supply development in rural areas The construction of water supplies is proposed to be concentrated largely in one area in each region every year Instead of splitting up the investment money on a series of water projects scattered all over the region the efforts are concentrated in one area in which all people are provided with water A certain part of the investment money (about 20%) allotted to the region could be reserved for urgent needs outside the selected area All aspects of water supply development in Tanzania based on this general approach are outlined in the report

- 105 **Taylor, Floyd B. 1967.** "Functional design for effective operation of water supply systems in developing countries " *Journal of the American Waterworks Association* 59, 150-155

The paper stresses the importance of designing water supply systems for developing countries with due regard for the cultural, social and economic practices of the people for whom the supply is being provided Also in view of the low per capita incomes of these people the systems must be as cheap as possible if local residents are to be expected to help finance them. The paper discusses briefly some aspects of sources, quality, quantity and distribution in relation to these two premises

- 106 **Taylor, George C. 1971.** *Techniques for assessing water resource potentials in the developing countries with emphasis on streamflow, erosion and sediment transport, water movement in unsaturated soils, ground-water and remote sensing in hydrologic applications* Washington, D C US Dept. of the Interior, Geological Survey 70 pp.

For each technique the paper discusses the established methodology and the likely instrument and investigation costs. Current research on each technique is also evaluated. The author concludes that with respect to economic growth goals in developing countries, there are few identifiable gaps in existing hydrologic instrumentation and methodology insofar as appraisal, development and management of available water resources are concerned. What is needed is acceleration of institutional development and professional motivation toward more effective use of existing and proven methodology. Moreover, much sophisticated methodology can be applied effectively in the developing countries only when adequate levels of indigenous scientific skills have been reached and supportive institutional frameworks are evolved to viability. The author concludes that the greatest gaps lie in the socio-economic realm and not strictly in the scientific or technical. Eight priority areas for technical research are pointed out.

- 107 **Thomas, H.A. 1964.** "The animal farm a mathematical model for the discussion of social standards for control of the environment." *Journal of the American Water Works Association* 56, 1087-1091.

Using an ingenious model involving water supply and waterborne disease, the author discusses problems involved in calculating benefits and costs as a base for decision-making in the management of the environment. He argues that it is possible to identify and classify problems of environmental control on the basis of the mathematical structure, and to ascertain the type of utility or disutility pertaining to people and their well-being. Following appropriate calculations, these utilities could be compared within classes and established norms and ranges, and then used as rational guidelines for criteria for the control of the environment.

- 108 **Tschannerl, Gerhard. 1971.** "The use of mathematical models in water supply planning." In *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp 81-98.

The author discusses three levels of decision-making: engineering, design input, and policy, needed to prepare a master plan for water supply. He presents a mathematical model which should optimize the design of each project according to certain criteria, and a process for ranking the projects among geographical zones.

- 109 **United Nations.** Economic Commission for Asia and the Far East 1968 *Proceedings of the Eighth Session of the Regional Conference on Water Resource Development in Asia and the Far East* United Nations, Water Resources Series 38

A biennial review (1966-68) is given for the state of water resources development in 13 countries of Asia and the Far East, plus the Soviet Union. A brief description of available water resources is included for each country, and a few comments on the public water supply. There is some estimate of the proportion and extent of rural and urban domestic use and service. The role of WHO in improving rural water supply systems in this region is described. The grants and loans made by government in Australia for water schemes for small rural communities are also reported.

- 110 **UNICEF-WHO, Joint Committee on Health Policy. 1969.** *Assessment of environmental sanitation and rural water supply programmes assisted by the United Nations Childrens Fund and the World Health Organization (1959-1968)* JCI6/UNICEF-WHO/69 2 43 pp. Also JCI6/UNICEF-WHO/WP 69 1 through 69 7. WHO Geneva

A summary is given of data from 73 countries, and of the reports of selected intensive field studies, supporting the concept that the UNICEF program has had qualified success in its attempts to assist environmental health programs. It is felt that its contribution to demonstration projects, coupled with training and educational programs, can serve as a catalyst for improved national programs. Recommendations include that projects should serve as demonstrations, that training is particularly important, that health education needs to be more effective, that excreta disposal should be included with water supply improvements if possible, and that studies should be made as to how to increase community participation in planning, construction and use. Cost data is included, and a discussion of criteria and guidelines. Country reports from Taiwan, India, Kenya, Pakistan, Paraguay, Peru and Senegal are in the subsequent documents.

- 111 **US Department of Health, Education and Welfare. 1963.** *Manual of individual water supply systems* Washington, D C.: US Government Printing Office. 121 pp

The manual is intended for the US consumer who needs to construct his own individual water supply. It covers the selection of a water source, with sections on ground and surface water, the treatment of the water, and the pumping, distribution and storage, with considerable detail on most aspects of design, construction and operation. Special emphasis is placed on sanitation aspects, particularly for quasi-public systems such as those serving tourist accommodations.

- 112 **US Department of Health, Education and Welfare. 1968.** *Health program evaluation. impact study of the Indian Facilities Construction Act* Health Program Systems Centre, Division of Indian Health, Tucson, Arizona 28 pp

This study was designed in the autumn of 1967 for the purpose of identifying and evaluating the effect on the health of the persons served by the installation in their homes of basic sanitation facilities as provided by the Act. Six years facility utilization and morbidity experience data were collected for 952 members of homes equipped with sanitary water and waste disposal facilities and for 991 members of houses not so equipped, living in three areas of the Division of Indian Health. These data were analyzed for two years before, two years during, and two years after the introduction of these facilities into the homes. Analysis showed that the morbidity rates of the members of equipped homes were significantly lower than the morbidity rates of members of non-equipped homes for a combined period of time, during and after the installation of sanitation facilities, while not being significantly different before the installation of these facilities.

- 113 **US Department of Health, Education and Welfare. 1969.** *Manual for evaluating public drinking water supplies* Public Health Service Publication No 1820 62 pp

The manual is designed to provide guidance to health and waterworks officials in determining whether a public drinking water supply satisfies modern health requirements. It sets out the standards with which all US potable water supplies should comply, the sanitary requirements for the protection of the various types of water source and for water treatment, and distribution systems. An appendix contains excerpts from the US Public Health Service Drinking Water Standards which relate to acceptable bacteriological, physical and radioactive standards of potable water.

- 114 **US Department of Health, Education and Welfare. 1969.** *Guidelines and criteria for community water supplies in the developing countries* Rockville, Md Agency for International Development and Public Health Service 101 pp

A team of consultants evaluated the community water supply programs of 12 developing countries. Successes were attributed to political and managerial leadership, competent technical personnel, realistic goals and good training programs. Failures arose from poor management, especially in operation and maintenance. From this experience guidelines and criteria are established with regard to objectives and planning, policies, financing, manpower and training, technical standards, project development, contracts, operation and maintenance, and community support.

- 115 **Wagner, E.G., and J.N. Lanoix. 1959.** *Water supply for rural areas and small communities* Geneva World Health Organization. Monograph Series, No 42 340 pp

The whole system of improved water supplies is examined, beginning with the assumptions about health benefits to be derived from it, and continuing through planning, examination of source of water, available technology, treatment, distribution and use. The management of the system is also considered in terms of personnel and training, administration, finance, operation and maintenance. This is a handbook with considerable description and illustration of simple technologies of spring protection methods, dug wells, treatment facilities etc. with some emphasis on consideration of the needs and preferences of the consumer.

- 116 **Wagner, Edmund G., and Luis Wannoni. 1953.** *Anticipated savings in Venezuela through the construction of safe water supplies in the rural areas* World Health Organization, WHO/ENV San 40

By calculating the value of lives lost and illnesses due to water-borne diseases plus water costs, the authors conclude that the annual cost of poor water supplies is over \$60 million for two million people. They calculate that one-tenth of this is sufficient to pay for a safe water supply which would eliminate at least 75% of the sickness and death associated with water-borne diseases. Assumptions are that the value of a person's time is the same in rural areas as in urban ones, and that each death represents over 25 years of productive work lost.

- 117 **Warner, Dennis. 1970.** "A preliminary assessment of the impact of rural water supply upon households and villages." In *East African Agricultural Economics Society Conference Proceedings*, Dar-es-Salaam, 31 March-4 April, 1970 23 pp

This paper outlines the objectives and operational format of the determination of the impact effects of improved rural water supplies in Tanzania. Six types of likely benefits from improved supplies (those which had been identified as being national goals) were formulated into thirty separate hypotheses for testing in the field. The benefits examined were in health, education, productivity, self reliance, modernization and *ujamaa socialism*. The paper also contains a presentation of the preliminary findings of a comparison of the impact effects between six villages in the Morogoro and Singida Districts, and concludes by outlining the methods of analysis that were expected to be used in subsequent reports.

- 118 **Warner, Dennis. 1970.** "Formulating guidelines for rural water investment the case of Tanzania." *East African Journal of Rural Water Development* 3, 69-91. Or, in slightly extended form *The economics of rural water supply in Tanzania* Economic Research Bureau, University of Dar-es-Salaam, ERB Paper 70 19 64 pp

This paper is presented in eleven sections, the first three provide general data relating to the nature and scope of past rural water development in Tanzania. The following four

describe the present situation relative to program, finance, regional allocations, project selections and project economics. The future tendencies in both long and short term programs are outlined in section 8-10. Major emphasis in section 10 is on issues confronting the government at the present time. The final section raises some questions regarding future investment guidelines. The author concludes that program planning of rural water investment should contain three major aspects: 1) a well-defined set of objectives linked to national development goals, 2) a workable definition of adequate water supplies applicable to the various conditions in the country, and 3) comparative costs of several investment alternatives starting with the minimum acceptable water supply situation. To some extent, these aspects are mutually dependent, whereby the formulation of one modifies the other. Therefore all three need to be determined anew for each major program. Overall program decisions should be made only after the formulation of these aspects is completed.

- 119 **Wenner, Carl Gosta. 1970.** *A master plan for water resources and supplies within CADU's first project area*. Chilalo Agricultural Development Unit, Ethiopia, Swedish International Development Agency. CADU publication no. 53. 137 pp.

This detailed report of investigations of water resources and preparation for water supply projects in the Chilalo district of Ethiopia is intended to serve as a model for similar work. It envisions a careful investigation of water resources over the whole country, as was done in this area, the development of cheap simple mechanics for developing supplies, and an educational program through extension agents so that a rising demand for purer water accompanies its accessibility. Simple, locally adapted techniques such as a household well collecting rainwater are sketched, and much cost data is included.

- 120 **White, Gilbert F. 1974.** "Domestic water supply: right or good?" In *Human rights in health* (CIBA Foundation Symposium no. 23, new series). Ed. Katherine Elliott and Julie Knight. London and New York: Associated Scientific Publishers.

Unless there is some change in the policies of responsible nations and international organizations dealing with water supply improvements, most people in developing nations will be only a little better off at the end of the next decade in enjoying a potable supply than in 1973. This paper suggests that to effect rapid improvement the concept of water as an economic good needs to be replaced by a view of potable water as a right available to be claimed by all. This could lead to a more humane standard of potability, to rural improvements undertaken primarily by self-help rather than by central design, and to a reduction in costs as affected communities are involved more directly.

- 121 **White, Gilbert F., David J. Bradley, and Anne U. White. 1972.** *Drawers of water: domestic water use in East Africa*. Chicago: University of Chicago Press. 299 pp.

Based on detailed field investigations in 34 rural and urban sites in East Africa, this study examines the amount of water used in each household and the factors affecting use, the social cost, including monetary and energy, of obtaining it, the relationship between the quantity and quality of water and the health of the user, and the way users choose among alternative water sources, including why they reject some sources. It gives classifications of types of water improvements, habitats, and health improvements as related to water improvements. Health benefits are not found to increase significantly as additional quantities of water of good quality are provided. The study suggests that changes in standards and in public policy will be required to assure that improvements in water supply keep ahead of population growth. The need to examine the full range of alternative policies for meeting health needs is emphasized.

- 122 **Wiener, Aaron. 1972.** *The role of water in development an analysis of principles of comprehensive planning* New York, McGraw Hill. 464 pp

The author looks at the role of water in development programs with the general thesis that specified programs should fit into the aim of generating self-sustained growth, and should make the most effective use of scarce resources. For community water supplies he emphasizes the need to minimize idle investments, and to create a rational ranking procedure for allocating available funds according to economic and social objectives. He cites the importance of determining the proper planning space, not necessarily present administrative or geographical boundaries, and then determining program objectives, with stress on the contribution of current programs toward the fulfillment of long-term aims.

- 123 **Wolman, Abel. 1972.** *The importance of supplying water to rural communities and related problems* Baltimore John Hopkins University 25 pp

The paper discusses the health benefits to rural populations from improved domestic water supplies. The major constraints are seen to be lack of motivation, money (both internal and external), institutional structure for planning, execution and management, skilled manpower and innovative use of materials and equipment. The author believes that these constraints may be overcome, provided that state and national governments decide unequivocally to place rural objectives high in the priority targets. The major requirement is the creation at Federal level of some form of automatic savings system which will serve as a revolving fund for continuing construction and which will be regularly fed by various forms of reimbursal.

- 124 **Wolman, Abel. 1972.** *Assessing water uses and minimal requirements* Ad Hoc Group of Experts on Water Requirements Forecasting, Budapest, 10-17 May, 1972. United Nations, ESA/RT/AC.3/14 134 pp

The author reviews the present basis used in determining the amounts of water used for various purposes in different countries throughout the world, and the possibilities for forecasting the amounts needed for domestic and municipal purposes, industry, agriculture, energy production, recreation and instream necessities for quality control. He argues that decisions as to quantitative requirements should be geared to the planner's objectives, and that responsibility for improved forecasting lies jointly with the water project designer, the economist and the sociologist. He concludes that improvements in the art of forecasting wait upon the accumulation of relevant data and the rapid development of various forms of pricing and econometric modeling systems.

- 125 **Wolman, Abel, and Herbert M. Bosch. 1963.** "US water supply lessons applicable to developing countries." *American Water Works Association Journal* 55, 946-956

The evolution of the water supply systems in the United States is traced, showing the rapid spread of municipally owned systems of supply, the rise in per capita daily use, and the reduction in waterborne diseases. Applying this experience to developing nations of the world, the authors feel that the most important consideration is that local governing bodies and citizens comprehend that urban water supplies and sewerage schemes should be self-paying operations, like electrical undertakings. Rural supplies are included in the same context.

- 126 **Wolman, Abel, Mark D. Hollis, and Charles S. Pineo. 1972.** "A generation of progress in sanitary engineering facilities and services for Latin America and Caribbean countries." *Boletín de la Oficina Sanitaria Panamericana* (English edition) 6, 9-25

This article reviews the sanitary engineering situation in Latin America and the Caribbean since the 1940's. It emphasizes the key role of international organizations in stim-

ulating training facilities and research, and in providing loans for improved water supply and sanitation programs. Indicators of progress are organizational and educational improvements, and the acceptance of the concept that water and sewage services must be paid for by the users. Efforts made by the national governments to provide funds and facilities are described, as are current training and research programs in Peru, Colombia, Brazil, Argentina, and Central American countries.

- 127 **Wood, W.E. 1970.** "National rural water supply programmes" Paper presented by the WHO at the ECA Working Group of Experts in Water Resources Planning, Addis Ababa, 15-25 June 1970 WHO Geneva. 34 pp

This general paper on the planning of rural water supply program covers technical aspects, financing, recruitment, training and health education. The two appendices provide a brief review of some of the literature on the relationship between health and water supply and a discussion of the financing of rural water supplies with sections on external, national and local financing.

- 128 **World Bank. 1971.** *Water supply and sewerage sector working paper* 15 pp

This brief summary of the World Bank policies regarding loans for water and sewerage system improvements stresses the need for consumers to pay the full costs of service as for any other public utility. Urban supplies are emphasized as more likely to yield benefits in health and development stimulation than are rural ones, with more scope for institution building and financial improvement.

- 129 **World Health Assembly. 1972.** *Community water supply* Twenty-fifth World Health Assembly, 24 May 1972 WHA 25 35

This document endorses the Director General's proposed targets for community water supplies during the United Nations Second Development Decade, which include an increase from 12% to 20% in the proportion of the rural population which would have reasonable access to safe water. In summarizing the current WHO programs, it emphasizes the needs of the rural sector, including country-wide programs, information collection, pre-investment planning, training, surveillance of drinking water quality and provision for waste-water disposal.

- 130 **World Health Organization. 1969.** *Community water supply* Technical Report Series 420 Geneva WHO 21 pp

This report identifies continuing and new problems in water supply, evaluates progress and trends in the community water supply program in the world, indicates broad areas in which research and developmental work on the scientific, technical, administrative, financial and economic aspects are required, and makes recommendations for national and international action.

- 131 **World Health Organization. 1969.** *National development programme for community water supplies in Kenya report of the World Health Organization to the government of Kenya* WHO CWS 69 6 97 pp.

This report of a WHO team of consultants proposes that a comprehensive national Community Water Supply Programme be drawn up, with emphasis on the rural community sector, and that an agency be designated to implement it. The aim would be complete water supply coverage by the year 2,000. Present estimates are that 11% of the estimated 4.9 million rural population have piped water supplies, and that the current rate of construction is not keeping up with population increase. Much background information is included, and also a summary of the prior reports and recommendations bearing on water supply development since 1957.

- 132 **World Health Organization. 1972.** *Techniques for the collection and reporting of data on community water supply* Report of a WHO Scientific Group. Geneva WHO Technical Report Series 490 24 pp.

A careful analysis is made of the need for collecting data about water supply systems, the type to be collected, and the uses to which it could be put. The report includes discussion of methods of collection, the question of coordination among different agencies, and the need for special training of personnel. A specimen report form is included, and a checklist of subjects on which data collection are required, including technical, economic and financial and managerial aspects

- 133 **World Health Organization. 1972.** *Community Water Supply Programme progress report by the Director General* Twenty-fifth World Health Assembly A25/29 Geneva WHO 24 pp

This reports progress in improvement of community water supplies over the last decade as determined from a survey of 90 developing countries. Baseline estimates put the 1970 population of the world at 3,640 million, and of the 90 countries at 1,627 million. The former is expected to increase 23% by 1980, and the latter by 32%. In the 90 developing countries, 72% of the 1970 population live in rural areas, and only 12% of these are considered adequately served with water. Suggested targets for 1980 are 60% of all urban population to be served by house connections (current target 40%), 40% by public standpost (current target 60%), and 25% of the rural population to have reasonable access to safe water (current target 20%, 1970 figure 12%)

- 134 **World Health Organization. 1973.** *The WHO programme of research and development in community water supply and wastes disposal* Community Water Supply Section, CWSS/73 1 21 pp

The report notes the inadequate state of rural water supply and sanitation among rural people of developing countries. It identifies two problems: the difference between the cost of the services and the ability to pay for them, and the lack of people with the necessary skills to design, construct, operate and manage the systems. The WHO program of research and development in community water supply and sanitation is described. Communication with member countries is maintained through the International Reference Center for Community Water Supply, the Hague, Netherlands, and the International Reference Center for Wastes Disposal at Dubendorf, Switzerland, together with two regional centers. A summary of their activities is given, and an index of proposed projects on waste disposal research, with priorities indicated.

- 135 **WHO International Reference Centre for Community Water Supply. 1971** "Community water supply research 1971" *WHO-IRC-CWS Bulletin No 1* The Hague *WHO-IRC-CWS* 74 pp

This bulletin consists of an inventory of research projects of the Institutions collaborating with the WHO International Reference Centre for Community Water Supply. Its aim is to enable research workers in the field of community water supply to get into contact with their colleagues about problems of mutual interest. A general classification of community water supply topics is elaborated and all the research projects have been classified according to this. Next to the research project the name of the project leader is given and an indication if papers or reports are available for dissemination. Twenty-eight collaborating institutions and several hundred individual projects are mentioned.

- 136 **WHO International Reference Centre for Community Water Supply. 1971.** "Training courses in community water supply, 1971." *WHO-IRC-CWS Bulletin No 2* The Hague WHO-IRC-CWS 46 pp

This bulletin gives information on training courses and programs offered by institutions collaborating with the WHO International Reference Centre for Community Water Supply. Altogether courses from twenty-five different institutions from all parts of the world are covered. They are divided into four groups: university-grade courses, courses for engineering and professional staff, courses in operation of plants and courses for skilled labor. The information given includes the name of the course, duration and fees, language it is taught in and the qualifications required for admission.

- 137 **WHO International Reference Centre for Community Water Supply. 1972.** "The story of C-PHERI," *WHO-IRC-CWS Bulletin No 4* The Hague: WHO-IRC-CWS 24 pp

In the 12 years since its official establishment C-PHERI has come to occupy a major position both at the national and international level in respect of investigation, counsel and planning for water supplies and for waste treatment and disposal. The Institute has worked upon immediate solutions for specific problems in water and waste water treatment and other areas of public health engineering, both within India and in adjoining countries. This booklet describes the inception of C-PHERI and outlines the scope of its current research program.

- 138 **WHO International Reference Centre for Wastes Disposal. 1971.** *Annual report, 1 July 1970 to 30 June 1971* Dubendorf: Federal Institute for Water Resources and Water Pollution Control 30 pp

The report briefly describes the work done by the Centre during 1970/71, in its three main activities — documentation, training and research projects. Projects underway at this time included ones on the compilation of legislation on solid wastes management and the segregation of household refuse. The future plans of the Centre are mentioned and a list of its staff is supplied.

- 139 **WHO Regional Committee for Africa. 1972.** Twenty-second session, Conakry, 20-27 September 1972. *Long-term planning in environmental health* Geneva: WHO/AFR/RC22/8 55 pp.

The document discusses some important quantitative and qualitative factors with regard to the trends during the decade 1960-1970 in the development of environmental health activities in the region. It covers community water supply, disposal of wastes, food hygiene and town planning among other aspects of environmental health. Consideration is given to the main difficulties which include the establishment of realistic objectives and priorities, the adoption of modern concepts of rational legislation, proper understanding of the multi-disciplinary approach to environmental health problems, and the financing of capital projects. An attempt is made to outline the activities necessary in the field of environmental health up to the year 2,000.

- 40 **Zimmerman, Stanley, and Edwin L. Cobb. 1973.** *Guide for the development of local water projects* Washington D C: Commission on Rural Water 323 pp

Evidence is cited to show that millions of Americans, particularly those in poor rural areas, do not have safe drinking water or sanitation facilities. The guide is directed to the local resident who might assume leadership in developing a rural water project, and suggests a basic method involving multi-level organization, local participation, and comprehensive water systems. It covers a number of overlapping phases including assessing need, organizing the development team, obtaining approvals, securing financing, establishing the water companies, constructing facilities, and supporting company operation. It is an action manual attuned to US conditions, suggesting ways of dealing with both community residents and bureaucrats to obtain the desired results, but the approach might be transferred to other societies.



TECHNOLOGY

Drawing water from shallow well with rope and pulley, Shoa province, Ethiopia

General Technology

141. **Burton, Ian. 1974.** "Domestic water supplies for rural peoples in the developing countries. the hope of technology" In *Human Rights in Health* (CIBA Foundation Symposium no 23, new series) Editors, Katherine Elliott and Julie Knight London and New York Associated Scientific Publishers

It is argued that technological research and development can bring much better water supplies within reach of all the world's population by the end of the century. No spectacular breakthrough is anticipated, but research and development is needed to develop more appropriate forms of technology that would be low-cost, labor intensive, use local materials, be easy to operate and maintain, and fit harmoniously with local values and preferences. The difficulties encountered in present programs arise from attempts to transfer modern technology which is too costly, expensive to maintain and operate, too demanding in its requirements for skilled manpower, organization and management, and insensitive to local needs and conditions. Technology can help to ensure that a set of appropriate choices is available by blending the best of modern science with what is irreplaceable in the traditional way

142. **Cambell, Michael D., and Jay H. Lehr. 1973.** *Rural water systems planning and engineering guide* Washington, D C.: Commission on Rural Water 142 pp

This guide is designed to provide project directors and concerned officials engaged in developing a rural water supply system with enough information to enable them to understand some of the technical problems and to communicate effectively with engineering consultants. In the context of rural US conditions and available technology, it provides a very readable discussion of water systems, including the concept of the cluster-well system as an alternative to the traditional one-source central system. It also covers well construction, well pump systems, water treatment facilities, pumping storage and distribution systems, plus a section on cost analysis and cost comparisons. There are practical tips on the maintenance of jet and submersible pump systems, and a considerable bibliography.

143. **Diamant, B.Z. 1972.** WHO Community Water Supply Research and Development Programme *A portable unit for the supply of drinking water in emergencies* (as used in Kenya) WHO/CSW 72.3.5 pp

A simple unit was designed for the supply of drinking water in rural areas under emergency conditions such as in areas threatened by cholera. A pump draws water from an open surface water source and delivers it to a portable tank where it is chlorinated, one tankful at a time, using bleaching powder, then delivered to consumers through siphon pipes. The design emphasizes simplicity of erection and operation, and minimum size and weight of individual components so that the unit could be easily carried, or transported in a light plane.

144. **Engelfriet, D.W., and P. Merkus. 1972.** *Intermediate technology* The School of Education, University of Zambia 39 pp

After a brief introduction on the necessity of intermediate technology in the developing countries, this paper gives a short description of many devices listed under the headings

water lifting devices, water storage, irrigation; wells, agricultural implements; power, home making, food storage. The paper makes no claims to originality — all the listed devices have been collected from other sources

- 145 **Instituto de Ingenieria Sanitaria, July 1971.** *Abastecimientos de agua potable a comunidades rurales* (Supplies of drinking water to rural communities) Argentina, University of Buenos Aires Instituto de Ingenieria Sanitaria, Publication No 7 419 pp (Spanish only)

The Institute of Sanitary Engineering with the support of both the Panamerican Health Organization and the Argentinian National Government has offered since 1966 a training course on "Design of Drinking Water Supply Systems to Rural Communities" for engineers engaged in the Servicio Nacional de Agua Potable y Saneamiento Rural (SNAP). This manual, various sections of which have been written either by practicing engineers working for SNAP or by teachers at the Institute of Sanitary Engineering, outlines the general objectives of the National Rural Water Supply Plan, but is mainly concerned with clarifying and outlining the technical aspects of water supply, such as norms of potability, design criteria, disinfection of water, the use and types of wells and the raising of groundwater, collection of surface water and treatment processes, transportation, storage and distribution methods, and details on the presentation of projects. The last section of the manual provides an outline of technical design norms as well as procedures that should be followed (especially regarding the collection of geographical, social, economic and demographic data) in the preliminary stages of project design.

- 146 **Intermediate Technology Development Group Ltd. 1972.** *Interim report of a research project on low-cost water technologies* 40 pp

This report covers the field investigation phase of a research project on low cost water technologies in the Volta region of southeast Ghana. After a first phase of research into documentation on the subject, which came to the conclusion that the literature was very limited, the field investigations were carried out to examine all aspects of an existing rural situation and collect data for planning and designing low-cost solutions to its water problem. The significant conclusion reached at this stage of the investigations was that the most effective means of augmenting supplies is by storing surface run-off of rainfall.

- 147 **Panamericana de la Salud, Organización, Inter-American Development Bank. 1972.** *Manual de referencia, medidores de agua domiciliar* (Reference book on domestic water meters) Lima, Peru 603 pp (Spanish only)

The first part of this lengthy manual discusses theoretical aspects of the types of domestic water supply meters that are available and have been developed. Many diagrams are included showing the exact method of operation of each type of meter, their characteristics, the principles on which they function, and the various constituent parts. The second part contains details on all meters manufactured in the continent of America, together with diagrams, illustrations and photographs of each.

- 148 **Ross Institute — Information and Advisory Service at the London School of Hygiene and Tropical Medicine. 1967.** "Small water supplies" *Ross Institute Information and Advisory Service Bulletin* 10 68 pp

This paper consists of a series of notes on some technical aspects of rural water supply grouped under the headings: sources of water, the basic requirements of a water supply, selection of a source of supply, sanitary collection of water, purification of water under rural conditions and purification of water on a domestic or individual scale.

- 149 **VITA, 1970.** *Village technology handbook* Schenectady, New York Volunteers for International Technical Assistance and US Agency for International Development 387 pp

This handbook of village technology devotes about half its pages to water resources, including simple technology for developing water sources, lifting and transport, storage and power development, and water purification. There is also a section on sanitary latrines, including pit and water privies, and one on the control of bilharziasis. Illustrations and additional references are included. The aim is to enable villages in different parts of the world to learn from each other's experience.

Water Supply

WELLS

- 150 **East Pakistan, Government of.** (n d) *Facts about a tube well* Dacca The Chief Engineer, Directorate of Public Health Engineering 23 pp

A booklet written primarily for the mechanics and other field staff who were engaged in the execution and maintenance of the Rural Water Supply Scheme Programme of the province. It is a brief and simply written outline of where to sink, how to sink, how to prevent contamination of, and how to maintain a tube well.

- 151 **"Estimating well costs."** 1970. *Industrial Water Engineering*, April, 1970, 30-32.

A method for constructing graphs to be used in estimating the costs of wells at a confidence level of 80% is described. The wells were divided into categories according to the nature of the materials tapped. Data used included costs of setting up and removing drilling equipment, actual drilling, all casings and linings, screens and fittings, gravel-pack material and installation, and developing the well, exclusive of blasting costs or pumping equipment. Cost of wells was found to be directly related to depth.

- 152 **Gibson, Ulric P., and Rexford Singer.** 1971. *Water well manual* Berkeley, California. Premier Press 156 pp

This manual is intended to serve as a basic introductory text book and to provide instruction and guidance to field personnel engaged in the construction, operation, maintenance and sanitary protection of small diameter, relatively shallow wells used primarily for individual and small community water supplies. It is aimed particularly at those persons who have had little or no experience in the subject. Its scope is limited to the consideration of small tube wells up to 4 inches in diameter, a maximum depth of approximately 100 feet and yields up to about 50 US gallons per minute. Bored, driven, jetted or drilled tube wells are considered the most efficient and the easiest to protect and a method of converting existing dug wells into tube wells is discussed.

- 153 **Lal, Deepak.** 1972. *Wells and welfare* Paris Development Centre of the OECD 162 pp

This is a detailed cost-benefit study of the economics of small-scale irrigation (more specifically open wells) in the Ahmednagar district of Maharashtra state in India. The author balances the rates of return on sugar-cane production with those of irrigated jowar production and assesses the rate of return on a geophysical survey program given that the present success rate of well siting is only 30%. No mention is made of well sinking for potable water.

- 154 **McJunkin, Frederick E. ed. 1967.** "An inexpensive, truck-mounted, jetting-driving well drilling rig" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item 17* US Agency for International Development and University of North Carolina 6 pp

Construction and operation of a simple, inexpensive, truck-mounted well drilling rig suitable for jetting and driving 2-inch (5-cm) diameter well pipe in alluvial soils are described. The cost to make such a rig in Cambodia is about US \$100, exclusive of the truck, and each rig can drill about 9 wells per month at an average depth of 100 feet (30m)

- 155 **McJunkin, Frederick E. ed. 1967.** "Jetting small tubewells by hand" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item 15* US Agency for International Development and University of North Carolina 6 pp

The "sludger method," primitive but effective, for construction of small tubular wells is described. Where the soils to be penetrated are fine, the maximum depth of the well does not exceed 250 feet (80 m), and labor is plentiful and cheap, "sludging in" is a simple, economical, dependable method that can be accomplished entirely with hand tools

- 156 **US Department of Agriculture. 1971.** *Water supply sources for the farmstead and rural home* Farmers' Bulletin 2237 Washington, D C US Government Printing Office 17 pp

This pamphlet explains in fairly simple language concepts of water quality, and describes possible ground and surface water sources. Wells are considered the preferred source. The need for testing of water is stressed, and a desirable quantity is set at 30-70 gallons per day per person. There are estimates also of animal use. Standards for well depth are included, and simple diagrams of constructions in different geological formations

RESERVOIRS AND CATCHMENT TANKS

- 157 **Grover, Brian. 1971.** *Harvesting precipitation for community water supplies.* International Bank for Reconstruction and Development 110 pp

The first part of this report describes the design, construction, operation and maintenance of a rainwater catchment scheme at Manda Island, Kenya. The scheme was designed for an agricultural settlement of 200 families and consisted of three identical tanks with asphalt catchment areas and butyl-lined excavated reservoirs, each capable of supplying 2,400 gallons per day for an estimated construction cost of \$35,000. Precipitation harvesting schemes are then discussed more generally. Alternative methods of construction are outlined with particular reference to new cost reducing and simpler to work materials. Attention is focused on the water demand and meteorological data which forms the basis for the design of such schemes and on the quality of water which can be provided

- 158 **Intermediate Technology Development Group Ltd. 1969.** *The introduction of rainwater catchment tanks and micro-irrigation to Botswana* 74 pp

The first part of this report describes trials held at the Bamangwato Development Association's farm at Radisele, Botswana, on the adoption of catchment tank design and construction to suit local conditions, and assessment of the benefit in terms of fresh vegetable produce. A full account of all stages of the design and construction of the trial tanks is given along with the results of the micro-irrigation experiments. The second part of the report outlines the pilot project which was designed to test whether the rural schools could be used as a channel for showing the population how to construct the tanks. Although this study was concerned with catchment tanks for irrigating small vegetable plots, tanks of a similar design would be used for storing drinking water. The major disadvantage of the design is its cost per gallon stored

- 159 **Parker, R. Neil. 1972.** *The introduction of catchment systems for rural water supplies a benefit/cost study in a S E Ghana village* Department of Agricultural Economics and Management, University of Reading, England 47 pp

A socio-economic study was made of a village in S E Ghana during 1970-71. The village is located one-half mile away from its main source of water, a seasonally flowing stream. Water consumption patterns were measured, and a range of catchment systems using local materials was suggested, such as corrugated tin roofs for catchment areas and concrete tanks for storage. Calculations of the potential time saved for the women by such systems were linked with an estimate of the value of their time to yield benefit/cost ratios. Small individual household improvements in water supply were calculated to give ratios of up to 3.0 when 100% of the time saved is used for productive work, or up to 1.7 when 57% of it is utilized. Construction of a year-round community supply would give a benefit/cost ratio of 2.3 (at 100% utilization) or 1.3 (at 57%).

- 160 **United Nations Educational, Scientific and Cultural Organization. 1966.** *Recommendations concerning reservoirs* Paris UNESCO 35 pp

This engineering study on the safety of reservoirs was undertaken in the light of recent major disasters in the hope that the recommendations made might be taken into account on designing new reservoirs and thus might contribute to reducing the hazards. The recommendations contain the basic principles taken from the laws and regulations enforced by countries which have found it necessary to supervise, inspect and control these reservoirs, so as to provide the best possible conditions for the safety of human beings and property in the area that is liable to be flooded. Problems of responsibility and jurisdiction are not covered but only the technical aspects of the question. The recommendations are intended to give general information which will be of use in preparing regulations concerning dams and reservoirs and in supervising them, or in revising existing regulations.

- 161 **US Department of Agriculture. 1966.** *Rain traps for intercepting and storing water for livestock* Agriculture Research Service, Agriculture Information Bulletin No. 307 10 pp

A simple method of constructing a small rainwater catchment tank from butyl sheeting and a few feet of butyl pipe is described with the aid of diagrams. The author believes that normally water harvested with rain traps will be more costly than water from wells or from farm ponds, but that there are areas in both high and low rainfall regions where the rain trap will be the most economic means of providing water for livestock, human consumption and possibly irrigation.

- 162 **World Health Organization. 1969.** *The village tank as a source of drinking water* Community Water Supply Research and Development Programme, WHO/CWS/RD/69.1. 17 pp.

Noting the difficulties arising from the sheer size of the water supply problem for millions of people, WHO has undertaken to coordinate activities designed to promote the utilization of existing knowledge and experience, and to stimulate research aimed at solving practical problems. The village water tank, source of domestic water for many communities, is thus examined to see how the water quality can be improved for drinking and domestic purposes. Possible methods of construction and operation of intake tanks, filters, and several types of simple hand pumps are described, as are methods of disinfection using simple ways of controlling the amount of chemicals added.

PUMPS

- 163 **Fannon, Robert, and D.W. Frink. 1970.** *Final report on the continued development and field evaluation of the AID hand-operated water pump to Office of the War on Hunger, Health Services Division, Agency for International Development, Contract No. AID/CSD-2174.* Columbus, Ohio. Battelle Memorial Institute. 37 pp.

In Battelle's final report to AID on the development of a water pump for under-developed countries (Contract AID/csd 1434) dated 1967, one of the recommendations made for future work was for further research on valves, cup seals and cylinders. This report outlines the subsequent work undertaken as a result of this recommendation. Included are sections on plunger valve development, selection of optimum cup material, evaluation of cylinder coatings and information dissemination.

- 164 **Fannon, Robert, and John Varga. 1972.** *Task I report on a water supply reconstruction program in Bangladesh to United Nations Children's Fund.* Columbus, Ohio. Battelle Memorial Institute. 40 pp.

The objective of this program was to provide technical assistance to the government of Bangladesh and to personnel of the United Nations International Children's Education Fund in implementing the large-scale drinking water project based on hand pumps operated on tube wells. The scope of Task I was to (a) assist in the evaluation of the quality of hand pumps currently being manufactured there and to affect all changes possible to improve the efficiency and life of the pumps being manufactured, including the introduction of better machining and foundry practices and the use of plastic cylinder linings and an evaluation of the quality and availability of raw materials, (b) assess the current production capacity of the major manufacturers in Bangladesh, (c) examine the feasibility of using plastic instead of galvanized iron piping in the tube wells, (d) determine the acceptability and possibility of producing the Agency for International Development pump in Bangladesh. The report outlines Battelle's findings in these areas.

- 165 **Frink, D.W., and Robert Fannon. 1967.** *Final report on the development of a water pump for under-developed countries to Agency for International Development, Contract AID/CSD-1434.* Columbus, Ohio. Battelle Memorial Institute. 61 pp.

This report describes the development of a hand-operated water pump suitable for both use and manufacture in developing countries. Design specifications were (a) long life under severe conditions, (b) low production cost; (c) easy maintenance; (d) suitable for shallow or deep-well installation with only minor changes, (e) capable of manufacture in developing countries with minimum capital investment, (f) easily operated by women and children, (g) discouraging to vandals. First part of report gives analysis of surveys and observations drawn from US and overseas, the second outlines the results of the pump testing program. Recommendations for future work are made.

- 166 **McJunkin, Frederick E. ed. 1967.** "Characteristics of the unknown pump." *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item II* US Agency for International Development and University of North Carolina. 8 pp.

A method of approximating performance characteristics and determining power requirements and safe operating pressures by an analysis of the physical measurements of a centrifugal pump is presented.

DISTRIBUTION

- 167 **Borjesson, E.K.G., and Carlos M. Bobeda. 1964.** "New concept in water service for developing countries" *Journal of the American Water Works Association* 56, 853-862

A spring-loaded faucet device for interior household use which delivers approximately 1 litre for each downward push has proved successful in limiting use and eliminating waste in three low-income neighborhoods of Asuncion, Peru. Average use in 1962 tests by the authors ranged from 32-40 litres per capita per day at an operating cost of \$1.19 per family per month with a per capita installation cost averaging \$5.35. Public acceptance was very good.

- 168 **McJunkin, Frederick E., and Gerrit V.R. Marais. eds. 1966.** "Reduction of water waste by the use of constant-flow valves" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item 2.* US Agency for International Development and University of North Carolina 3 pp

Installation of inexpensive constant-flow valves rated at 2 UK gpm (9.1 lpm) in the supply lines to individual houses in Kitwe, Zambia reduced the water use by 25-30%. No complaints regarding inadequate supply were received.

- 169 **McJunkin, Frederick E. ed. 1966.** "The elbow meter for measuring the flow rate of water in pipes" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item 13.* US Agency for International Development and University of North Carolina 6 pp

The construction and operation of a simple meter for measuring the rate of flow of water in pipes is described. The meter may be constructed using an existing pipe elbow and a simple manometer. The accuracy of the meter is within 2% when calibrated in place, but calibration is not necessary if some accuracy can be sacrificed.

- 170 **McJunkin, Frederick E., and Gerrit V.R. Marais. eds. 1966.** "Water supply using bamboo pipes" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item No 3.* US Agency for International Development and University of North Carolina 8 pp

Bamboo pipe is extensively used for small water supply systems in Indonesia. This report briefly describes the salient features of design and construction of elements of the system.

- 171 **McJunkin, Frederick E. ed. 1967.** "Field expedients (gimmicks and gadgets) in water distribution systems" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item 14.* US Agency for International Development and University of North Carolina. 8 pp

Several special tools and methods developed in the field for construction, maintenance, or operation of water distribution systems are described, including techniques for installing service pipes, detecting and repairing leaks, disinfecting mains, operating valves, patching pavements and cleaning meters.

- 172 **McJunkin, Frederick E., and Charles S. Pineo. 1971.** *The role of plastic pipe in community water supplies in developing countries* US Agency for International Development, Washington, D C 150 pp

It is the thesis of this booklet that in the most common diameters pipe made of plastics is competitive in cost and performance and in many circumstances, costs less than pipe of other material. Plastic pressure pipe can be readily manufactured in developing countries with a minimum of hard-currency capital investment, skilled labor and expenditure for imported materials, relative to production of other types of pipe. The authors give a comprehensive discussion of plastic pipe manufacture and utilization with chapters on the uses of plastic pipe, the standards and codes for its manufacture, the methods of its manufacture and its marketing, and appendices covering a bibliography, a glossary of terms, a directory of manufacturers, plastic pipe installation and its uses for sewers and gas supply.

- 173 **Todorov, P.M. 1971.** "Field investigation on friction losses of 'Simba' plastic pipes." In *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp 251-257

Outlines the method and results of field experiments to determine the friction coefficient of various diameters of "Simba" plastic pipes

TREATMENT

- 174 **Cleasby, John L. 1972.** *New ideas in filter control systems* Washington, D C · Pan American Health Organization 16 pp.

The paper first discusses the functioning of deep granular filters — how the solids are removed, the hydraulic characteristics of the flow through the filter media and through the underdrain system, the effects of changes in filtration rate — and then compares the merits of different filter rate control systems. The author concludes that two little used systems of influent rate control are available that have many advantages over the traditional effluent rate control system. These are influent flow splitting and variable declining rate. The latter can be adopted by many existing plants with malfunctioning constant rate controllers. Operating data are presented to show that declining rate control will produce better water quality than conventional constant rate control. The declining rate system also reduces the available head loss and the depth of filter box needed. Its wider use is strongly recommended.

- 175 **Cox, Charles R. 1969.** *Operation and control of water treatment processes* Geneva World Health Organization Monograph Series No 49 392 pp

This authoritative text on all aspects of the treatment of domestic water supplies brings together a body of information on water treatment and control. It could be useful to public health officials who are concerned with maintaining a suitable system of controls, but its primary purpose is to serve the needs of plant superintendents, operators and laboratory personnel. Sufficient theory is presented to provide a basic understanding of the processes described, with the main emphasis on practical operating problems. Designers will find much of value, but the approach used has been not to present standards of design, but rather to reveal how to get the most from a plant already built. The section on laboratory procedures describes each test in a simplified form for those with only limited facilities, training and experience.

- 176 **Frankel, Richard J. 1972.** "Series filtration using local filter media." Paper presented at the Annual Conference, American Water Works Association, Chicago, Illinois, 8 June 1972 15 pp

An inexpensive simple filtration system, making use of local materials, was sought to provide potable water supplies in developing countries of Asia. The most successful filtering material for a roughing filter was found to be shredded coconut husks, and for a secondary polishing filter, burnt rice husks. The bacteriological efficiency of the combined roughing and polishing filters was generally on the order of 99%. With a minimum dose of chlorine, they produced clear and potable water at a considerable savings in operation and maintenance costs such as materials, labour, and level of training for the operator

- 177 **Kwata, Kazuyoshi. 1967.** "Providing a safe water supply in the African bush" *U S Public Health Reports* 82, 1057-1062

When a geographic epidemiology unit of the Johns Hopkins University was in the bush in the Republic of Chad, it needed treated water for 15 persons at 11 gallons per person per day for 3½ months. Criteria used were freedom from pathogenic bacteria, viruses, protozoa and the cercariae of shistosomes. Adequate treatment could not be accomplished readily by boiling or addition of halogen tablets. This problem was solved by prechlorination, coagulation, sedimentation, post-chlorination and adjustment of pH, all done within 36 gallon Lyster bags. Advantages and disadvantages are outlined

- 178 **McJunkin, Frederick E., and Gerrit V.R. Marais, eds. 1966.** *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Items 4, 5, 7, 8, 9, 10* US Agency for International Development and University of North Carolina

No 4 "Float valve hypochlorite solution feeder" 3 pp

A solution feeder to apply solutions of calcium and sodium hypochlorite to water supplies, built from local supplies, is described

No 5 "A proportional chemical feeder for small water purification plants." 4 pp

An installation in a small water works for feeding chemicals proportional to the raw-water inflow is described. The influent flow turns a paddle wheel which drives a shaft to which arms carrying the dosing cups are attached. The rotating arms sweep through the chemical solution, fill, and empty a chemical dose into the raw water. The installation can be made locally

No 7 "Floating platform hypochlorite solution feeder" 4 pp

No 8 "V notch constant-head solution feeder" 4 pp

No 9 "Floating bowl hypochlorite solution feeder" 4 pp

The simple chlorinators are readily made from local materials and suitable for disinfection of small water supplies. They can be pre-set to feed solution at a given uniform rate

No. 10 "Bottle hypochlorite solution feeders" 4 pp

Three simple chlorinators are described which are particularly useful in emergencies or for small water supplies, and which can be quickly and cheaply made from local materials

- 179 **McJunkin, Frederick E. ed. 1967.** "Use of alum-cake in water treatment" *Water Supply and Sanitation in Developing Countries AID-UNC/IPSED Series Item No 12* US Agency for International Development and University of North Carolina. 10 pp

Construction and operation of a device for feeding alum solution, prepared from alum-cake (alum in large lumps or blocks) in a water treatment plant is described. The feeder consists essentially of a wooden tower for storage of alum-cake. An overhead spray spreads water over the top of the tower. As water trickles down, the lumps of alum are dissolved and an alum solution is discharged at the base. The feeder may be assembled at the plant, using local materials and labour, and requires no mechanical equipment other than weighing scales and flow-meters. A low-grade, unpurified, unground alum may be used. The system described has been successfully operated since 1959 in Santiago, Chile at the Las Vizcachas Water Treatment Plant, a rapid sand filter plant treating up to 6 cubic meters per second (137 million gallons per day). Similar feeders have also been used in small plants.

- 180 **US Department of Agriculture. 1972.** *Treating farmstead and rural home water systems* Farmers' Bulletin 2248. Washington, D.C. US Government Printing Office. 16 pp.

Water testing is described, and common water quality problems. Disinfection by chlorinators is recommended, and positive displacement, suction, aspirator and tablet types are discussed. Boiling, pasteurization, ultra-violet light and ozone disinfection are also described, as are methods of neutralizing acidity, controlling corrosion, and reducing tastes and odors by filtering or aeration. Considerable technological capacity is assumed.

- 181 **de Vries, Egbert. 1972.** "Potable water for rural areas" *International Development Review* 14(3), 21-22

The author has developed a simple method for producing liquid chlorine (hypochlorous acid), using only salt (NaCl) and electricity. The cost is \$695 for the system with daily operating costs of about \$ 40 per day for salt and electricity.

- 182 **World Health Organization. 1970.** "Biological" or "slow sand" filters. Community Water Supply Research and Development Programme. Background paper WHO/CWS/RD/70-1. 24 pp

The paper argues against the idea that biological or slow sand filtration is an old-fashioned, outdated method of water treatment which has been completely superseded by rapid-gravity and various high-rate filtration techniques. On the contrary, biological filtration, under suitable circumstances, can be not only the cheapest but also the most efficient method of water treatment, simple to construct and operate. This background paper is based upon a report by Professor Huisman who visited installations in five countries of Europe, and studied data from the USA and other parts of the world. It includes sections on the theory of biological filtration, the planning, design and construction of biological filters, flow control and pipework and the cleaning and operation of the filters.

- 183 **World Health Organization. 1970.** *Health hazards of coagulant aids*. Community Water Supply Research and Development Programme. Background paper WHO/CWS/RD/70 2. 10 pp

Recent developments in the practice of flocculation, coagulation and rapid sand filtration have shown that accelerated treatment rates are often possible without impairment of efficiency, and one of the ways in which this can be achieved is by the use of chemicals known as "coagulant aids". These fall into several groups most of which have been well tried and tested but there are a number of relatively untried synthetic compounds whose long-term effects are not fully known. The paper sets out briefly the theory of coagulant aids and mentions some of their known toxicity hazards.

- 184 **World Health Organization. 1968.** *Report of the inter-regional travelling seminar on the purification and disinfection of drinking water* Moscow-Kiev, 2-24 September, 1968 Geneva WHO CWS/68 7 86 pp.

This gives a short account of 28 papers on various aspects of water treatment presented at the seminar. Brief reports summarize the state of water purification and disinfection practices in 12 countries: Afghanistan, Brazil, Bulgaria, Ceylon, India, Iran, Laos, Malaysia, Netherlands, Sierra Leone, Syria and Venezuela.

- 185 **Zoeteman, B.C.J. 1972.** *The suitability of iodine and iodine compounds as disinfectants for small water supplies* World Health Organization, International Reference Centre for Community Water Supply Technical Paper 2 The Hague 32 pp.

It is the thesis of this paper that under poorly controlled circumstances, as present in small community tanks, the low solubility of iodine, its good germicidal capability, and its relative chemical inertness make it a suitable water disinfectant. It shows several advantages over the use of chlorine, however, the qualities required for polluted water with high iodine demand may reach physiologically toxic levels. For this reason its use should be limited to emergencies and where chlorine compounds are giving too many problems. In these cases it has been found that the risks of toxic effects are minor compared to the risks of fatal enteric diseases. One diffusion dosing unit with a cellulose type membrane was tested, but found to be too delicate for practical application. A less delicate dosing unit with direct contact of water and disinfectant but probably with a less accurate dosing rate is proposed.

Sanitation

- 186 **Bhaskaran, T.R. 1962.** "A decade of research in environmental sanitation" *Indian Council of Medical Research — Special Report Series No 40* New Delhi 67 pp

The report contains the results of some of the Indian studies concluded in the period 1955-62. A clear account of the treatment processes involved and details of the type of designs and the actual construction of the plants involved is incorporated. There are chapters on investigations of industrial waste disposal and river pollution problems, on a latrine for rural areas (including one for waterlogged and high water table regions), on the maintenance of tube-wells in rural areas and on sewage treatment and removal of pathogenic organisms. A short list of relevant publications is also given.

- 187 **Butts, Thomas A., and Ralph L. Evans. 1970.** *Cost of municipal sewage treatment plants in Illinois*. Urbana, Illinois Illinois State Water Survey, Circular 99 36 pp

Regression equations are developed with which to make a reasonable comparison of the costs of constructing and equipping different types of sewage treatment plants, including primary digester and vacuum filter, activated sludge, trickling filter and oxidation lagoons. The trickling filter-Imhoff tank process, as basically the least costly and suitable for small communities, is used as the measure of comparison.

- 188 **Ellis, H.M., et al 1969.** *Problems in community wastes management* Geneva World Health Organization Public Health Paper No 38 90 pp

This collection of six papers covers topics including present and future trends in municipal disposal of solid wastes, regional approaches to integrated wastes management planning, and present research needs and health hazards in the re-use of waste water for agricultural, industrial or municipal purposes.

- 189 **Gloyna, Ernest F. 1971.** *Waste stabilization ponds* Geneva World Health Organization Monograph Series, No 60 175 pp

The monograph is directed specifically to the design engineer who has limited funds at his disposal, who has to rely on modest construction facilities and who has to provide operating instructions that can be followed by unskilled personnel. Its purpose is to summarize the available information on waste stabilization ponds it defines acceptable design criteria based on public health considerations, suggests alternative approaches to design, provides data on pond design and deals with operational problems It also provides information on the theory of biological waste treatment.

- 190 **Goldenstein, Steven N., and Walter J. Moberg. 1973.** *Wastewater treatment systems for rural communities.* Washington, D C · National Water Commission. 135 pp

This book is addressed to the unsewered 30% of the American public which depends on private, largely individual, systems for the treatment of domestic wastes After a discussion of the role of soils in wastewater disposal, it describes both the traditional approach to wastewater systems design and a variety of alternative approaches utilizing natural biological processes for stabilizing sewage About one-half the book is devoted to a survey and index of manufacturers of available equipment applicable to rural communities, with most of it concerned with individual home (on site) aerobic treatment, or with package treatment plants of subdivision size A few self-contained systems such as the Swedish multrum are described, and costs and specifications given where available The book is non-technical in the sense that terms are clearly defined, and is designed to provide the potential client with sufficient knowledge of alternatives to enable him to make an informed choice.

- 191 **McKinney, Ross E., ed. 1970.** *Second International Symposium for Waste Treatment Lagoons* Lawrence, Kansas. University of Kansas 404 pp.

Contains 48 papers covering all aspects of the design, construction, operation and maintenance of waste treatment lagoons

- 192 **Minimum Cost Housing Group. 1973.** *Stop the five gallon flush! a survey of alternative waste disposal systems* Montreal Minimum Cost Housing Studies of McGill University 60 pp

The study examines alternative waste disposal systems which will conserve resources and some which will provide low-cost service The conventional flush system is not regarded as feasible for widespread application because of the large initial investment required to supply and distribute the water, and to treat and dispose of the wastewater It classifies disposal systems as removal, destruction, infiltration or decomposition, describes types of each, and gives a catalogue of 52 waste disposal systems from 11 countries, with their costs when available

- 193 **Pakistan, Government of. 1964.** *A sanitary latrine for every home in the rural area of East Pakistan* Dacca Directorate of Public Health Engineering 8 pp.

An educational leaflet comprising a step-by-step account, with drawings, of how to build a simple pit latrine

- 194 **Pradt, Louis A. 1971.** "Some recent developments in night soil treatment" *Water Research* 5, pp 507-521

The author describes the unique and extensive body of technology developed by the Japanese to dispose of night soil. This is the most prevalent system of disposal of domestic waste in Japan, using a vacuum collection method from a concrete vault for each household. He describes three treatment plant processes: digestion, chemical and oxidation treatment, giving the requirements and process for each type. The capital cost for such a system he estimates at \$4.50 per capita, with yearly operation and maintenance costs of \$1.63 per capita. This compares with \$80.00 and \$5.00 per capita installation and operation and maintenance costs for a waterborne system. He points out the suitability of the system for many developing countries, and the acceptability of the idea in many Asian countries. Western engineers, unfamiliar with the techniques, may overlook them in favor of costly waterborne systems. Technical references are included.

195. **US Department of Housing and Urban Development. 1966.** "Sewage lagoons for developing countries" *Ideas and methods exchange* 62, 302/2/1 *Sewage Lagoons* (Prepared for AID) Washington, D.C. 35 pp

A summary of pertinent data on sewage lagoons, including their advantages and disadvantages, location, design, construction and maintenance which is aimed primarily at technicians who have to evaluate different types of facilities that may be used and the conditions under which sewage lagoons are practical.

- 196 **Wagner, E.G., and J.N. Lanoix. 1958.** *Excreta disposal for rural areas and small communities*. Geneva: World Health Organization. Monograph Series, No. 39. 187 pp

The book is addressed to the persons primarily responsible for the mechanics of getting sanitary excreta disposal facilities constructed and used properly. It contains not only technical data relating to particular rural excreta disposal facilities, but also information on activities believed to be necessary to achieve success in programs of excreta disposal in rural areas and small communities. It has sections dealing with the social and psychological implications of rural sanitation programs, the various privy and water-carried methods of excreta disposal, and with the planning of disposal programs.

- 197 **Winblad, Uno. 1972.** *Evaluation of waste-disposal systems for urban low income communities in Africa*. Copenhagen: SCAN Plan Coordinator, Scandinavian Consulting Group for Planning, Architecture and Building, Ltd. 34 pp

This report discusses the problems of waste disposal systems in low income communities, and offers the hypotheses that waterborne waste disposal of human waste is and will remain too expensive for these countries, and that such systems will have to be of a non-network variety. A third hypothesis is that systems based on micro-biological decomposition of faecal matter and household refuse will satisfy certain performance criteria, which are specified. The report classifies, describes and evaluates 15 existing systems, and concludes that those based on microbiological decomposition (as the Swedish multrum) offer the best possibilities for development, and could bring great savings in cost and practicality over waterborne or other network systems.

- 198 **World Health Organization. 1961.** *Report on the first zonal seminar on environmental sanitation, Taipei, 14 October - 1 November, 1956* Manila WHO/368/61

This report describes a range of problems and some solutions for them concerning the collection, disposal and utilization of organic wastes, principally refuse and night soil. It gives design criteria and comparative costs for various systems. It also considers collection systems, and alternative composting operations. For rural areas it recommends composting, giving examples of systems for a single family, for a community of 100 people, and for a village of 1,000. The estimated benefits from water and faecal-borne disease reduction are thought to be 13% of average annual income, plus benefits from the organic waste as fertilizer.

- 199 **World Health Organization. 1967.** *Treatment and disposal of wastes — report of a WHO scientific group* Technical Report Series 367 Geneva WHO 30 pp.

This WHO Scientific Group was convened to review present knowledge and important problems regarding the treatment of waste waters and solid wastes, and to formulate recommendations on relevant research needs. The problems of waste treatment and disposal in the developing countries are not dealt with specifically, but one of the recommendations for further research is for a study of the application of waste-water and solid-waste technology to specific situations that are characteristic of urban areas in developing countries.



HEALTH AND DISEASES

Drawing water from a handpump, "bustee-dwellers," India

Health and Diseases

- 200 **Amelvoort, V. van. 1971.** "Rural water-supply development and the recent appearance of endemic goitre " *Tropical and Geographical Medicine* 23, 304-305

Estimations of the iodine content of the underground and surface water in a Nigerian village support the hypothesis that a change from the use of surface water from the river to the use of underground well water has caused the recent appearance of endemic goiter. The author recommends that when a rural water development scheme is proposed, an estimation of the iodine content of the new sources should be made, especially in regions near those in which endemic goiter has been found.

- 201 **Assar, M. 1971.** *Guide to sanitation in natural disasters* Geneva WHO 135 pp

The Guide provides basic information on the principles of emergency sanitation and contains detailed instructions for carrying out certain tasks. It is intended primarily to assist health authorities and relief agencies in developing their relief plans and in preparing themselves to cope efficiently with the sanitation problems caused by a disaster. It supplies technical information on emergency procedures for water supply, disposal of excreta and other wastes, food and milk sanitation, disinfection and disinfestation and the rapid control of flies, mosquitoes, rats and other insect and rodent pests.

- 202 **Atkins, C.H. 1953.** *Some economic aspects of sanitation programmes in rural areas and small towns* WHO. Expert Committee on Environmental Sanitation WHO/Env San/56.

The author concludes that a sum equal to the cost of typhoid fever, diarrhoea and enteritis per year in low income countries would amortize within five years the cost of water supply and disposal facilities. The incidence of these diseases is found to be inversely related to per capita income, and the status of sanitation directly related to it. He assumes the value of lives and working time is in the same ratio to similar values in the US as the per capita income to that of the USA.

- 203 **Belcher, John C., and Pablo B. Vasquez-Calcerrada. 1972.** "Cross cultural aspects of sanitation norms " Paper presented at the Third World Congress of Rural Sociology Baton Rouge, Louisiana, August 23-24, 1972

Field observations were made regarding water and sanitary facilities use and perception of problems in the southern USA, Puerto Rico and the Dominican Republic, representing three levels of development ranging from piped water and sewage to carried water and no waste facilities. The authors conclude that sanitation practices are normative, with each society having customary procedures, and that these patterns may survive even when levels of living change. Cleanliness tended to be defined visually in all areas, with little relationship to the germ theory of disease. While epidemic diseases have been largely eliminated, endemic ones in isolated communities are less likely to be until there are changes in perceptions and patterns of life which produce norms dysfunctional to a state of health.

- 204 **Bradley, David J. 1971.** "Infective disease and domestic water supplies" In *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp 115-133

In this brief paper on the relationship between domestic water supplies and infective diseases the author classifies water-related diseases into four major categories. The first category comprises waterborne diseases of which typhoid and cholera are the classic examples. These infections can be reduced by improving water quality, but those of the second category, comprising water-washed diseases such as shigella and dysentery, can be reduced simply by increasing the availability, i.e. quantity, of water. The water-based infections such as schistosomiasis and Guinea-worm make up the third category and the infections with water-related vectors such as malaria and Gambian sleeping sickness make up the last. The author concludes that the biggest benefits will probably come with piped house connections but a significant reduction in disease will probably depend on more than just water — a change in habits and better health education are also necessary.

- 205 **Bradley, David J. 1974.** "Water supplies — the consequences of change" In *Human rights in health* (CIBA Foundation Symposium no 23, new series) Ed Katherine Elliot and Julie Knight. New York and London: Associated Scientific Publishers

The health benefits to be expected from improved water supplies are examined. The author notes that much of the evidence comes from temperate urban areas, and does not reveal the likely effects of partial improvements for rural, poor, tropical countries in advance of other progress. He points out that in rural arid areas quantity of water is more important for disease reduction, in peri-urban zones water quality may be crucial. While the levels of volume and quality needed for various levels of health gains are uncertain, a tap and shower inside the home seem to be required for maximum benefit. Safe quality standards will largely depend on community size. Where resources are adequate for only partial improvement of water supplies, the best use of resources will vary with the environment.

- 206 **Bugaisa, S.L. 1971.** "Significance of fluorine in Tanzanian drinking water" In *Water Supply*, ed G Tschannerl, University of Dar-es-Salaam, BRALUP Research Paper 20 pp 107-115

The author describes the conditions of chronic endemic dental fluorosis. Much of the Tanzanian ground water supply is affected by fluorine contamination and the toxic effects of this in man and beast are quite endemic in large tracts of land. The worst affected areas (with the level of contamination of their water supplies) are listed. The high concentration of fluorine found in Tanzania is attributed to a number of geologic and hydrological processes and conditions. The author suggests that a concentration of 2 ppm fluorine is the maximum acceptable for human consumption and that concentrations over 18 ppm are incompatible with good husbandry of cattle. As these concentrations are exceeded in many areas action is necessary to provide alternative water supplies or to purify the local water. In the latter respect the author favors treatment by tricalcium phosphate.

- 207 **Coles, G.C., and H. Mann. 1971.** "Schistosomiasis and water works practice in Uganda" *East African Medical Journal* 48, 40-43

An examination of the water purifying system at Gaba, Uganda, which supplies water to Kampala, found large numbers of molluscs present in the first stages of the water works plant. No specimens of intermediate hosts of *S. mansoni* were found, and only one species of bulimoid snail. Chlorination of 30 minutes contact time with a residual of 0.5 ppm of chlorine killed all cercariae. The investigation confirmed that sand filtration does not remove cercariae, and that chlorination is therefore essential for piped water in areas where schistosomiasis is endemic. The cercariae survived longer in alkaline chlorinated water, which might need to be taken into account in certain areas.

- 208 **Crawford, M.D. et al. 1972.** "Infant mortality and hardness of local water supplies" *Lancet* 1, 988-992

In the large county boroughs of England and Wales the softer the drinking water and the less calcium it contains, the higher the infant death rate. This study indicates that independent of social conditions and over a long period of time infant mortality in these towns has been related to an environmental factor, the softness of the water, which is in turn related to the rainfall, with the high-rainfall areas having softer water. Absorption of lead from pipes and tanks by soft water is considered a possible factor.

- 209 **Cvjetanovic, B., B. Grab, and K. Uemura. 1971.** "Epidemiological model of typhoid fever and its use in the planning and evaluation of antityphoid immunization and sanitation programmes" *Bulletin of the World Health Organization* 45, 53-73.

An epidemiological model was constructed for typhoid fever in a stable population in order to study the transmission of infection at different levels of endemicity. Parameters used represented the proportions of epidemiological subgroups in the population — such as the susceptible, the infected, and the immune — and rates of transition between the groups. Use of the model shows that a single mass vaccination reduces the incidence of disease considerably, but the gain is largely lost after a few years. Improved sanitation was estimated to decrease the incidence to a new level of stability, an effect that is long-lasting and in this respect gives better results than vaccination.

210. **Dhar, G.M., et al. 1971.** "A study of drinking water in village Rahimabad of Lucknow district" *Indian Journal of Medical Research* 59, 1922-1931

A survey was made of the drinking water sources in this rural village of about 1,000 people. Open shallow wells, mostly private, provided 88% of the drinking water, which was found to be unsatisfactory bacteriologically according to the standards recommended for rural supplies by the Indian Council of Medical Research. The water also contained excessive amounts of nitrates and chlorides. The 7 handpumps in the village yielded 12% of the village water, and this proved to be bacteriologically much more satisfactory by the same standards, although it too contained excessive amounts of nitrates and chlorides. Further provision of handpumps to the village was recommended to increase a cheap and relatively safe water supply.

211. **Goodwin, Melvin H. Jr., et al. 1966.** "Observations of familial occurrence of diarrhea and enteric pathogens" *American Journal of Epidemiology* 84, 268-281

Intensive study was made of 41 families in Arizona of low socio-economic group which presumably have a high risk of enteric infection. All had piped water, water heater, water-borne sewage system and refrigeration. Results failed to indicate consistent relationships between the occurrence of diarrhea, association of enteric organisms and sanitational deficiencies. Occurrences of diarrhea and pathogens did not appear to be related to crowding, family size, age, or differences in socio-economic status (the latter was small). The effective use of facilities and the adequacy of personal hygiene seemed the determining factors. The presence of facilities did not assure their effective use, and the problem appears to be finding means for applying knowledge already available rather than elaboration of etiology and epidemiology.

- 212 **Gremliza, F.G.L. 1965.** "A method for measuring the quality of village conditions in less developed rural areas" *American Journal of Public Health* 55, 107-115.
- A method of rating the housing, sanitary and communal conditions in less developed rural areas is described which would enable an evaluation of the environmental conditions, and a comparison of levels of development among different villages. The base line survey considers housing, crowding, sanitary facilities, and communal conditions such as roads, schools and shops. It might be useful in evaluating the introduction of changes such as an improved water supply into a village. The criteria include many water-related facilities such as the storage of water in the house, bathing facilities, stagnant water and waste disposal, one omitted item is any storing of the water supplies of the village.
- 213 **"How many individual wells are contaminated?" 1969.** *Ground Water Resources Institute Quarterly* 2, 1-12.
- The results of a GWRI survey show that the extent of well contamination in Pennsylvania has been exaggerated but nevertheless runs at 4.2%, the reasons being improper construction and location too close to sewage disposal fields. The paper recommends that well and pump codes should include a mandatory requirement for water quality tests.
- 214 **Liang, Mathew H. et al 1973.** "Chinese health care determinants of the system" *American Journal of Public Health* 63, 102-110
- This is a comprehensive review of available information on the political, economic, cultural and legal determinants of the Chinese system for delivery of health care. The brief consideration of water supply and sanitation improvements indicates that they were undertaken after 1950 as part of an intensive application of mass education and political organization techniques to public health problems. The effort to reduce schistosomiasis is considered by the Chinese to have been successful. Environmental sanitation and health education is the responsibility of local health workers, including the "barefoot doctors."
- 215 **Marshall, Carter L. 1972.** "Some exercises in social ecology health, disease and modernization in the Ryukyu Islands" In *The Careless Technology*, ed M T Farvar and J.P. Milton. New York: Natural History Press, pp 5-18
- The rapid alteration of environmental conditions when coupled with the alteration of human habits can affect the health of a population, for a change in one part of the ecosystem may not be accompanied by compensatory change in another. Thus new water supplies plus governmental efforts to improve the hygiene of schoolchildren through hand-washing fostered the spread of trachoma. This happened because there was no money for paper towels, and the children all dried their hands on the same handkerchief. Other examples are given.
- 216 **McJunkin, Frederick E. 1970.** *Engineering measures for control of schistosomiasis*. Washington, D C: AID, 69 pp
- The author recognizes the increasingly important role of engineers in the control of schistosomiasis through the correct design and construction of irrigation and potable water supply systems. He seeks to (a) provide information to enable engineers to work effectively with other professionals in design and operation of schistosomiasis control programs, (b) summarize the present status of engineering measures for schistosomiasis control (including storage reservoirs, public water supply and sanitation), (c) improve understanding on the part of scientific personnel of the role of engineers in control of the disease, and (d) suggest some possible approaches for more effective control of schistosomiasis by engineers. It is recommended that a comprehensive design manual with emphasis on schistosomiasis control should be produced for water engineers and that short courses on the subject be provided. The author calls for more research on the effectiveness and costs of various control methods. A bibliography with about 250 entries is included.

- 217 **Miller, Arthur P. 1962.** *Water and Man's Health* US Agency for International Development, AID Community Water Supply Technical Series 5. Washington, D C

This report summarizes the literature of the 1940s and 1950s concerning water and man's health. It discusses a group of bacteria, helminths, protozoa and viruses which the author feels are directly related to water. The diarrheal diseases, pleurodynia and poliomyelitis he considers less directly connected. The quantity of water available for personal hygiene is felt to be very important, especially as related to diarrheal disorders. Many of his examples come from episodes of large urban source infections, but some are related to smaller more rural supplies.

- 218 **Molina, Gustave, and Ilana F. Noam. 1964.** "Indicators of health, economy and culture in Puerto Rico and Latin America." *American Journal of Public Health* 54, 1191-1206

The author discusses the relative utility of various indicators used to measure health and socio-economic development. The factors considered are health indicators including various death and disease rates, socio-economic conditions including income distribution, milk consumption, literacy and health services. The latter include water supply. It is pointed out that there is a serious lack of data for most developing countries. Statistics of life expectancy and various death rates are considered to give the most comprehensive picture of physical health at present available. Other important indicators are per capita national income and its distribution, per capita food intake, and education as measured by literacy and school enrollment.

- 219 **Moore, Helen A., Enrique de la Cruz, and Oscar Vargas-Mendez. 1966.** "Diarrheal disease studies in Costa Rica I, Plan and methods of investigation." *American Journal of Public Health* 56, 276-286

— 1966 "Diarrheal disease studies in Costa Rica II, The prevalence of certain enteric organisms and their relationship to diarrhea." *American Journal of Public Health* 56, 442-451

— 1966 "Diarrheal disease studies in Costa Rica III, Morbidity and mortality from diarrhea." *American Journal of Epidemiology* 82, 143-161

— 1966 "Diarrheal disease studies in Costa Rica IV, The influence of sanitation upon the prevalence of intestinal infection and diarrheal disease," *American Journal of Epidemiology* 82, 162-184

A survey was made of the sanitary characteristics of 1,202 houses of a canton in the coffee-producing area of Costa Rica. The houses were supplied with piped water (94%) and facilities for sanitary excreta disposal (89%). Meat and milk supplies and handling facilities were also examined. The level of water pollution was high, but piped water appeared to be important in reducing the amount of infection with enteropathogenic bacteria, although diarrhea morbidity and parasitism were not greatly affected. Conclusions include that the incidence of diarrhea was reduced and the prevalence of *Shigella* infections and parasitism least where a good level of sanitation was found. A bathing facility was needed to obtain the best effects from piped water. Intestinal parasites were prevalent despite the use of pit privies, possibly related to diaper-washing hygiene or other factors.

- 220 **Morag, M. et al. 1970.** "Drinking water standards." *Lancet* 2, 1079

This note suggests that drinking water standards should be redefined in terms of maximum permitted intake of substances per day rather than in terms of concentration. It is pointed out that water intake is directly related to environment, temperature and work load. Thus a stevedore on the Red Sea may drink 20 times as much as a bank clerk in Oslo, and may, for example, take in up to 20 times as much sulphate, possibly producing gastrointestinal and other disorders.

- 221 **Pan American Health Organization. 1973. *Patterns of Mortality in Childhood*** Washington, D C Scientific Publication PAHO 262 490 pp

This report of the Inter-American Investigation of Mortality in Childhood covers the multiple, complex causes and factors involved in the excessive mortality of infants and children in the Americas. Some 35,000 childhood and infant deaths in 10 countries in the Western hemisphere were investigated over a 5 year period, including several thousand neonatal deaths which had never been registered. The study took a multiple-cause approach in order to establish the synergistic action, or interrelationship, of certain infectious diseases and malnutrition. Diarrheal disease was found to be the primary underlying cause of death, with measles second in importance.

- 222 **"The prevention of waterborne viral infections." 1969. *WHO Chronicle* 23 277 pp**

Destruction of enteroviruses in water supplies may be accomplished by prolonged storage, or more practically, by flocculation followed by rapid sand filtration and disinfection of the product. Chlorination may be used, but iodination is recommended for developing countries as no complicated equipment is needed, and it is especially suited to the treatment of small water supplies. A caution is added that its long-term effects, especially in pregnant women and young children, are not known.

- 223 **Rossi, Alba G., Luis Perez Farras, and Luis F. Prado. 1971. *Contenidos educativo-sanitarios aplicables en la etapa de funcionamiento del sistema de abastecimiento de agua potable rural*** (Sanitary education content of the working stage of the rural drinking water supply system) Buenos Aires, Argentina. Issued by the Departamento de Promoción Social for the Servicio Nacional de Agua Potable y Saneamiento Rural. 71 pp (Spanish only)

This booklet is concerned with personal and domestic hygiene and technical aspects of health and sanitation which relate to the provision of water supply systems. It provides a basic education in human biology and personal and domestic hygiene with sections on personal cleanliness, bathing, handwashing, dental care, the role of the housewife with regard to food, washing and cleaning, ventilation and the elimination of rodents. The problems of rural waste disposal are outlined, and information is given on the recommended dimensions, construction materials and drainage methods for bathrooms and kitchens. Diagrams are provided of the workings of septic tank; nitrification fields and absorbing wells. The manual recommends the fluoridation of water supplies, and explains the functions of the newly constructed defluoridation plants in Argentina. It also recommends the use of clay or baked mud "sanitary vessels" for conserving drinking water in hot areas, with a diagram of the construction of these containers.

- 224 **Verhoestraete, M.D., and Ruth R. Puffer. 1958. "Diarrhoeal disease with special reference to the Americas." *Bulletin of the World Health Organization* 19, 23-51**

This article presents data on morbidity and mortality from diarrhoeal disease in infancy and childhood for selected areas of the Americas, and discusses the etiology, epidemiology and mechanism of transmission of the disease. It emphasizes the importance of breastfeeding, better nutrition at weaning, and the provision of increased supplies of domestic water in reducing morbidity from diarrhoeal disease.

- 225 **Watt, J., A.C. Hollister, M.D. Beck, and E.C. Hemphill. 1953.** "Diarrhoeal diseases in Fresno County, California " *American Journal of Public Health* 43, 728-741.

Groups of children 10 years and under in three settlements in Fresno County migrant labor camps, town fringe areas, and housing projects, were examined for Shigella and Salmonella infections. The rate of infection was found to be highest in the labor camps, and within these areas, highest for those families obtaining water from faucets outside the home which were used by more than 15 people. It was concluded that Shigellas account for the major portion of diarrhoeal diseases in labor camps and town fringe areas studied, that accessibility to water is a factor in Shigella prevalence, and that these diseases constitute a major public health problem for these populations.

- 226 **Weir, John M. 1969.** "The unconquered plague " *Rockefeller Foundation Quarterly* 2, 4-23.

The disease of schistosomiasis affects more than 200 million people in the world. The life cycle of the parasite is described, as are the debilitating effects of the disease, and the possibilities of its control through various methods including improved water supplies and sewage disposal. Lack of clear information on alternative control measures and their effects led the Rockefeller Foundation to sponsor a project on the island of St. Lucia in the Caribbean, where effects of various controls could be observed over a period of years. The project will attempt to evaluate the social and economic consequences of disease control along with the health benefits.

- 227 **Weisbrod, Burton, et al 1973.** *Disease and economic development the impact of parasitic disease in St. Lucia*. Madison, Wisconsin: The University of Wisconsin Press. 218 pp.

This study takes a systematic approach to the examination, quantitative as far as possible, of the economic and social impacts of disease through a case study of parasitic disease on the island of St. Lucia. The authors found little significant correlation between schistosomiasis or other parasitic diseases and economic performance. The combined efforts of economic, sociological and medical personnel did produce a methodology considered useful for studying the larger social effects of how man adjusts to disease. The report explores various factors which may account for the lack of findings, including the less serious aspect of schistosomiasis in this area than in some other parts of the world.

- 228 **Wittman, W., et al 1967.** "An evaluation of the relationship between nutritional status and infection by means of a field study " *South African Medical Journal* 41, 664-682.

An intensive study of the relationship between malnutrition, infection and socio-economic level was made with 120 children under 3 years in low income families living in a housing estate. The three highest income groups had piped water indoors, in the lowest group two families shared a courtyard tap and lavatory. In the lowest income group there were four times as many diarrheal episodes as in the highest. It appears there is a close association between severe recurrent diarrhea and poor socio-economic circumstances. Unfortunately it is not clear whether or not all the families in the lowest income had outside water taps. It is clear that in the three groups with inside taps recurrent diarrhea was less frequent and less severe in the highest income group.

- 229 **Wood, W.E. 1970.** *Cholera control through environmental sanitation basic considerations*. World Health Organization. WHO/EH/70.1. 11 pp.

The author sets out the basic considerations of cholera control through environmental sanitation, including safeguarding community water supplies, safe excreta disposal, food hygiene and refuse collection. He emphasizes that basic sanitation facilities are essential.

in minimizing chances of epidemics, that planning must take place well ahead of emergencies so that people will know what is expected of them, and there must be a close partnership between the medical doctor and the sanitary engineer, who together will be responsible for cholera control

- 230 **Wood, W.E. 1971.** *The control of waterborne epidemics (including cholera and other enteric infections) through the improvement of community water supply* World Health Organization WHO/CWS/71.1 45 pp

This paper describes a large number of simple and practical expedients that can be carried out by urban or rural water supply undertakings, or by the health surveillance authorities, with the minimum of funds or skilled supervision. It does not deal with the design and construction of new waterworks but restricts itself to suggesting improvements in the areas of reducing biological health hazards, maintaining bacteriological quality and controlling epidemics. A list of references to other relevant WHO publications is given at the end of the paper

- 231 **Woolley, P.O., C.A. Perry, and R.N. Eccles. 1970.** *Syncretism: the dynamics of health. An analytic series on the interactions of health and socioeconomic development I Panama* Washington, D.C. US Department of Health, Education and Welfare 300 pp.

This country profile of health conditions in the Republic of Panama was prepared by the Office of International Health for USAID. It is the first report of this type developed regarding the impact of health conditions upon socioeconomic development for a single country. It attempts to set up a model for the definition and evaluation of the health problems of a population. It first defines the health status and disease problems of the country, then calculates the costs of these problems to the society. It summarizes the resources and mechanisms used by the society to solve its health problems, and examines health planning in Panama and its relationship to total country development plans. Where possible, future trends and their impact on the health status of the population and the development of the society are projected

- 232 **World Health Organization. 1958.** *Study Group report on international standards for drinking water* Geneva WHO 152 pp

This is the first publication of WHO on international standards for drinking water, and was the result of the work of a study group which met in Geneva in 1956. The report points out that the standards of quality and methods for the examination of water are based on work done in Europe and the USA, the application of the standards and methods to other regions of different climates and with different water resources is not well known

- 233 **World Health Organization. 1968.** *Water pollution control in developing countries* Technical Report Series 404 Geneva WHO 38 pp

This WHO expert committee was convened to review the most important problems of water pollution control in developing countries. Specifically, its tasks were as follows: to examine the inter-relationship of water pollution and water resources, to evaluate the health aspects of the problem, to make recommendations for the planning of water use and pollution control in urban areas, agriculture and industry, to formulate general principles for the prevention of water pollution in relation to the management of water quality, to make recommendations for the training of personnel engaged in the management of water resources and the control of water pollution, and to point out areas in which further research is necessary

- 234 **World Health Organization. 1970.** Community Water Supply Research and Development Programme Background paper *Schistosomiasis and community water supplies* WHO/CWS/RD 70 3 9 pp

This paper comprises a number of short notes on the transmission of schistosomiasis and on the exclusion of cercariae from water supplies. It concludes that normal water treatment based upon filtration is effective against cercariae, chlorination alone should not be relied upon under field conditions to kill cercariae completely, storage alone, if maintained for 48 hours, is effective but is a clumsy device which, in any case, has little effect upon pathogenic bacteria or viruses. Exclusion of cercariae from community water supplies is a small factor in the control of schistosomiasis as complete protection of a community can only be effected by a combination of snail control, sanitation measures, medical treatment, health education and informal co-operation by the people themselves.

- 235 **World Health Organization. 1970.** *Principles and practice of cholera control* Public Health Papers, No 40 Geneva WHO 139 pp

Recent findings are brought together concerning the nature of cholera, the therapy it requires, the value of vaccines at present available, and the prevalence and importance of the carrier state. The paper stresses that immunization is only partially effective, that not all carriers can be identified, and that sanitation measures are effective. Restrictions on imported food and other goods are felt to be unwarranted, although facilities for international traffic should be carefully checked for adequate sanitary measures. The value of international cooperation in the exchange of information about cholera is noted. Emergency health measures for cholera control are described.

- 236 **World Health Organization. 1971.** *International standards for drinking water* Expert Committee on International Standards for Drinking Water Geneva WHO 1970 pp

This is a third revised edition of standards for domestic water supplies. It contains proposed bacteriological, chemical, physical and biological requirements, and a maximum permissible radioactive content.

- 237 **World Health Organization. 1972.** *Health hazards of the human environment* Prepared by 100 specialists in 15 countries Geneva WHO 387 pp

This broad survey of the environmental hazards which may threaten human health includes sections on water supply and sanitation technology, emphasizing these as particularly important to basic environmental health. With regard to water it discusses sources and types of pollution, biological hazards, water quality criteria and standards. A wide range of sanitation technology is summarized. The treatment of each subject is brief, but a selection of references is included for particular technical topics concerning water supply and sanitation.

BIBLIOGRAPHIES



Bibliographies

There are few bibliographies which bear directly on the subjects of rural water supply and sanitation, except for some of the technical components. Several relevant ones are included here. Other references may be found in literature concerned with agricultural economics, agricultural education, rural development, health, medicine, and environmental engineering

- 238 **Bateman, G.H. 1971.** *A bibliography of low-cost water technologies* London Intermediate Technology Development Group Ltd. 44pp

The bibliography concentrates on small-scale low-cost water technologies which appear potentially useful in rural areas of developing countries. Sewage and wastewater were not included except incidentally. It is not annotated, but many items are evaluated for their relevance concerning details of simple equipment and low-cost methods

- 239 **Dejene, Tekola, and Scott E. Smith. 1973.** *Experiences in rural development a selected annotated bibliography in planning, implementing, and evaluating rural development in Africa.* Overseas Liaison Committee, American Council on Education. OCC Paper no. 1 Washington, D C. 256 entries

Rural development is broadly interpreted in this bibliography so that it includes not only agricultural development, but also rural non-farm activities and supporting services in rural areas such as health, education, extension and farmer training, food and nutrition, and rural communications. About 20 of the entries have to do specifically with health and/or water supplies, and others may be useful in relation to the planning, training, educational, and evaluation aspects of projects. The material focuses on Africa, with some entries regarding experiences in Latin America, the Caribbean and Asia, and includes materials written in English and French

- 240 **Law, James P. 1968.** *Agricultural utilization of sewage effluent and sludge an annotated bibliography* Washington, D C. Federal Water Pollution Control Administration, US Department of the Interior. 284 entries

The effluent and sewage sludge from municipal and industrial treatment plants is a source of water and nutrients for agricultural uses. Considering its potential, only a relatively few instances of agricultural uses of waste water in crop production have been recorded. These references describe uses which aid crop production, make use of water that would have been wasted, decrease the pollutant load on the receiving streams, and preserve the normal stream flow for downstream users

- 241 **US Agency for International Development. 1969.** *Community Water Supply*, USAID Bibliography Series Health No. 1 24 pp.

This annotated bibliography was designed to help AID staff members and consists primarily of AID reports and documents with some material from other organizations. General subjects and reports on regional programs in Latin America and the Middle East are surveyed, as are reports on 21 countries. Much of the material was issued in limited quantities and would be difficult to obtain.

242. **WHO International Reference Centre for Community Water Supply. 1971.** *Plastic pipe in drinking water distribution practice (Introduction and bibliography up to 1970)*. WHO-IRC-CWS technical paper no. 1 The Hague. 221 entries.

The entries are grouped under the following headings: general, plastic piping materials, water quality and plastic pipe, strength properties of plastic pipe, and plastic pipe main design, laying, tapping, operation and maintenance. English, German, French, Dutch, Swedish, Russian and Polish literature are covered and although the bibliography is not annotated it does contain a six-page introduction.

ANNEX



Some Frequently Used Abbreviations

USAID	United States Agency for International Development
AIT	Asian Institute of Technology, Bangkok, Thailand
CPHERI	Central Public Health Engineering Research Institute, Nagpur, India
HEW	United States Department of Health, Education and Welfare
IBRD	International Bank for Reconstruction and Development
IDB	Inter-American Development Bank
IPSED	International Program in Sanitary Engineering Design, University of North Carolina, Chapel Hill, North Carolina
PAHO	Pan American Health Organization
SIDA	Swedish International Development Agency
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
VITA	Volunteers for International Technical Assistance
WHO	World Health Organization
WHO-IRF-CWS	World Health Organization International Reference Center for Community Water Supply, The Hague, The Netherlands

Improved water supply with public standpipe outlet and stone plinth used for washing clothes. Mayo village, Usambara mountains, Tanzania

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