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An Overview

A READILY AVAILABLE SUPPLY of safe water and the sanitary disposal of human wastes are essential, although not the only, ingredients of a healthy, productive life.[1] Water that is not safe for human consumption can spread disease; water that is not readily accessible takes up the productive time and energy of the water carrier—usually women or children; inadequate facilities for excreta disposal reduce the potential benefits of a safe water supply by transmitting pathogens from infected to healthy persons. Over fifty infections can be transferred from a diseased person to a healthy one by various direct or indirect routes involving excreta. Coupled with malnutrition, these excreta-related diseases take a dreadful toll in developing countries, especially among children. For example, in one Middle Eastern country, half of the children born alive die before reaching the age of five as a result of the combined effects of disease and malnutrition; in contrast, only 2 percent of children born in the United Kingdom die before reaching their fifth birthday.

Invariably it is the poor who suffer the most from the absence of safe water and sanitation, because they lack not only the means to provide for such facilities but also information on how to minimize the ill effects of the unsanitary conditions in which they live. As a result, the debilitating effects of unhygienic living conditions lower the productive potential of the very people who can least afford it.

Dimensions of the Problem

To understand the magnitude of the problem, it is only necessary to consider data collected by the World Health Organization in preparation for the United Nations Water Conference that took place in Mar del Plata, Argentina, in the spring of 1977. These figures show that only 32 percent of the population in developing countries have adequate sanitation services; that is, about 630 million out of 1.7 billion people.[2] Population growth over the span of the International Drinking Water Supply and Sanitation Decade (1981–90) will add another 700 million people who will have to be provided with some means of sanitation if the goals of the Decade—adequate water supply and sanitation for all people—are to be achieved. A similar number of people, about 2 billion, will require water supply by the same date. Thus, roughly half the world's present total population of just over 4 billion people have to be provided with water and sanitation services to meet the Decade's targets; that is, approximately half a million people per day for the next twelve years.

One of the fundamental problems in any attempt to provide the necessary sanitation services is their cost. General estimates based on existing per capita costs indicate that around $800 billion would be required to provide water supply and conventional sewerage for everyone.[3] Per capita investment costs for sewerage range from $150 to $650, which is totally beyond the ability of the intended beneficiaries to pay: some 1 billion of these unserved people have per capita incomes of less than $200 per year; more than half have incomes below $100 per year.

In industrialized countries, the standard solution for the sanitary disposal of human excreta is waterborne sewerage. Users and responsible agencies have come to view the flush toilet as the absolutely essential part of an adequate solution to the problem of excreta disposal. This method, however, was designed to maximize user convenience rather than health benefits, an objective that may be important in developed countries but has a lower priority in developing countries. In fact, conventional sewerage is the result of slow development over decades, even centuries, from the pit latrine to the flush toilet, and the present standard of convenience has been achieved at substantial economic and environmental costs.

The problem facing developing countries is a familiar one: high expectations coupled with limited resources. Decisionmakers in these countries are asked to achieve the standards of convenience observed in the industrialized world. Given the backlog in service, the massive size of sewerage investments, and the demands on financial resources by other sectors, they do not have the funds to realize this goal. Sewerage could be provided for a few, but at the expense of the vast majority of the population. As a consequence, many developing countries have taken no steps at all toward improving sanitation. The very magnitude of the task has effectively discouraged action.

At the present time the first priority of excreta disposal programs in developing countries should be the improvement of human health; that is, the accomplishment of a significant reduction in the transmission of excreta-related diseases. This health objective can be fully achieved by sanitation technologies that are much less costly than sewerage. The goals for the Decade of the 1980s intentionally do not specify sewerage, but call for the sanitary disposal of excreta, leaving the disposal method to the discretion of individual governments. Similarly, Decade targets include an adequate supply of safe water, without specifying the methods to be used to achieve the goal. To provide as many people as possible with safe water and sanitation is to find technologies which can achieve these objectives with the resources available.

The Constraints

The primary constraints to the successful provision of sanitation facilities in developing countries are the lack of funds, the lack of trained personnel, and the lack of knowledge about acceptable alternative technologies. Where high-cost systems developed in industrialized countries have been used to solve waste disposal problems in developing countries, access to the facilities has been limited to the higher income groups, who are the only ones able to afford them. Little official attention has been paid to the use of low-cost sanitation facilities to provide health benefits to the majority of the population. This situation exists because officials and engineers in developing and developed countries alike are neither trained nor experienced in the consideration or design of alternative sanitation systems or in the evaluation of the effects of these alternatives on health. Waterborne sewerage is designed to satisfy convenience and local environmental, rather than health, requirements. The lesson commonly (but erroneously) drawn from the historical development of sanitation technology is that the many less costly alternatives formerly used should be abandoned rather than improved. Therefore, few serious attempts have been made to design and implement satisfactory low-cost sanitation technologies. The implementation of such alternatives is complicated by the need to provide for community participation in both the design and operating stages of the projects. Few engineers are aware of the need to consider the sociocultural aspects of excreta disposal, and fewer still are competent to work with a community to determine the technology most compatible with its specific needs and resources.

Given these constraints, it is not surprising that sanitation service levels in developing countries have remained low. A major effort is needed to identify and develop alternative sanitation technologies appropriate to local conditions in developing countries and designed to improve health rather than raise standards of user convenience. Clearly the solutions must be affordable to the user and reflect community preferences if they are to find acceptance.

Incremental Sanitation

An examination of how conventional waterborne sewerage came about reveals three facts very clearly. First, excreta disposal went through many stages before sewerage. Second, existing systems were improved and new solutions devised whenever the old solution was no longer satisfactory. Third, improvements were implemented over a long period of time as funds became available to meet conditions of crowding and demands for convenience. Sewerage was not a grand design implemented in one giant step, but the end result of a long series of progressively more technologically sophisticated solutions. For example, the collection of night soil from bucket latrines in eighteenth century London was a step toward reducing gross urban pollution. This was followed by piped water supplies and the development of combined sewerage, then separate sanitary sewerage, and eventually sewage treatment prior to river discharge. This particular series of improvements spanned over 100 years—a time frame necessitated by historical constraints in science, technology, and capital. Present levels of knowledge enable sanitation planners to select from a wider range of options and to design a sequence of incremental sanitation improvements. The choice of proceeding with sequential improvements is the user's, who also decides the time frame over which improvements are to be made and higher levels of convenience achieved in step with his increasing income. Most important, a user can start with a basic low-cost facility without the need to wait for greater income, knowing that he will have a choice to provide for greater convenience when he has the funds and wishes to do so at some future date.

Sanitation Program Planning

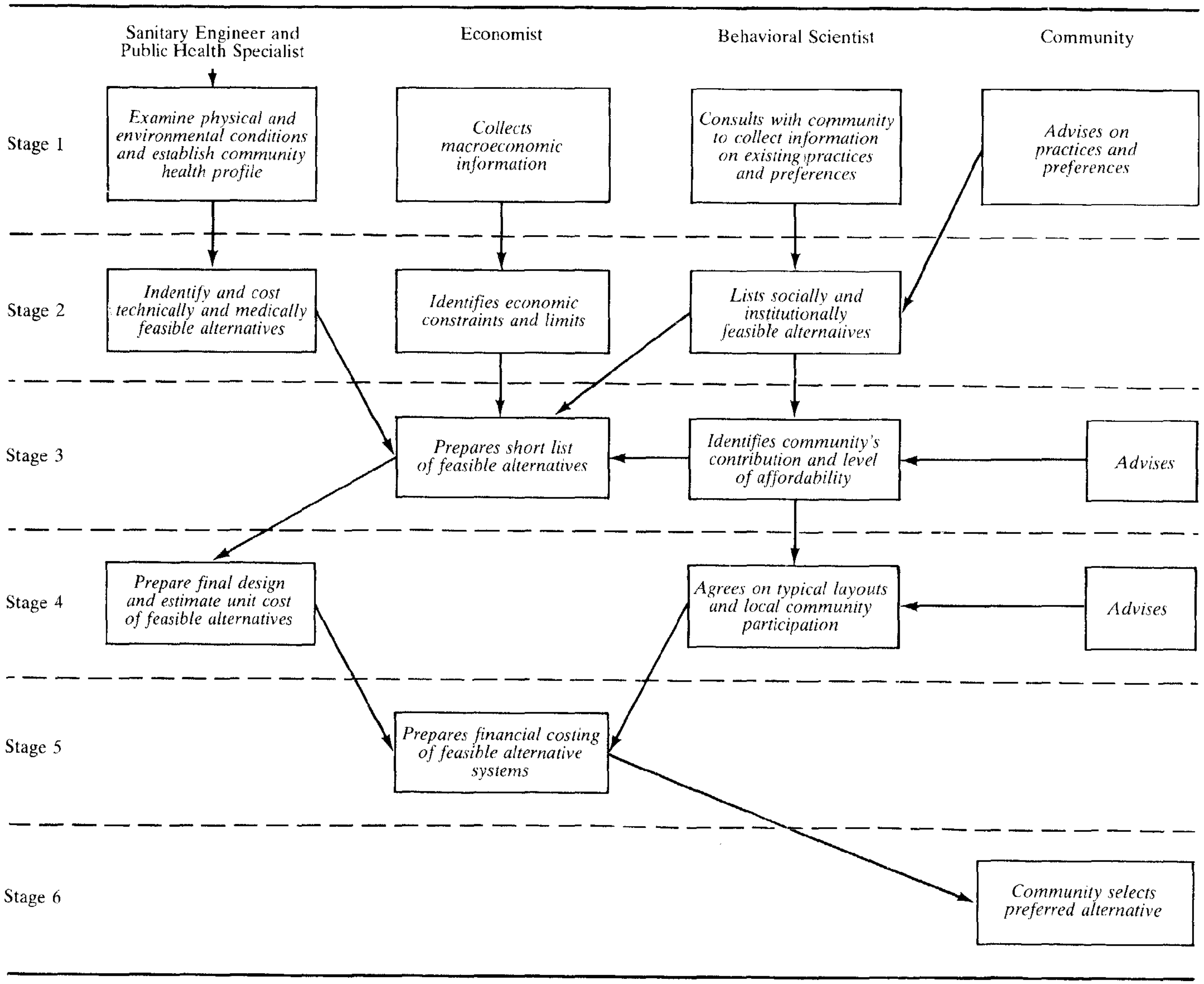
Sanitation program planning is the process by which the most appropriate sanitation technology for a given community is identified, designed, and implemented. The most appropriate technology is defined as the one that provides the most socially and environmentally acceptable level of service at the least economic cost.

The process of selecting the appropriate technology begins with an examination of all of the alternatives available for improving sanitation; these are described in Part Two of this book. There will usually be some technologies that can be readily excluded for technical or social reasons. For example, septic tanks with large drainfields would be technically inappropriate for a site with a high population density or with bedrock near the ground surface. Similarly, a composting latrine would be socially inappropriate for people who have strong cultural objections to the sight or handling of excreta. Once these exclusions have been made, cost estimates are prepared for the remaining technologies. These estimates should reflect real resource cost to the economy, and, as described in chapter 4, this may involve making adjustments in market prices to counteract economic distortions or to reflect development goals such as employment creation. Since the benefits of various sanitation technologies cannot be quantified, the health specialist must identify those environmental factors in the community that act as disease vehicles and recommend improvements that can help prevent disease transmission. The final step in identifying the most appropriate sanitation technology rests with the intended beneficiaries. Those alternatives that have survived technical, social, economic, and health tests are presented to the community with their attached financial price tags, and the users themselves decide what they are willing to pay for. An algorithm for technology selection that incorporates economic, social, health, and technical criteria is presented in chapter 6.

Figure 1-1 shows how the various checks are actually coordinated in practice. The checks themselves, of course, are interrelated. A technology may fail technically if the users' social preferences militate against its proper maintenance. The economic cost of a system is heavily dependent upon social factors, such as labor productivity, as well as on technical parameters. Because it is operationally difficult to use simultaneous (or even iterative) decision processes, a step-by-step approach with feedback across disciplines is suggested.

For simplicity it is assumed that separate individuals or groups are responsible for each part, although in practice responsibilities may overlap. In stage 1 each specialist collects the information necessary to make his respective exclusion tests. For the engineer, public health specialist, and behavioral scientist[4] this data collection would usually take place in the community to be served. The economist would talk with both government and municipal officials to obtain the information necessary to calculate shadow rates and to obtain information on the financial resources likely to be available. The behavioral scientist would consult with and survey the potential user and community groups. Then, in stage 2, the engineer and sociologist apply the information they have collected to arrive at preliminary lists of technically and socially feasible alternatives. The public health specialist relates the most important health problems to any relevant environmental factors involving water, excreta, or both. In the third stage the economist prepares economic cost estimates for those technologies that have passed the technical and social tests and selects the least-cost alternative for each technology option. At the fourth stage the engineer prepares final designs for these remaining choices. The social information collected in stage 1 should be used in this process to determine the siting of the latrine on the plot, the size of the superstructure, the materials to be used for the seat or slab, and other details that may have low technical and economic importance but make a major difference in the way the technology is accepted and used in the community. The designs should also incorporate features necessary to maximize the health benefits from each technology. Final designs are turned over to the economist in the fifth stage so that financial costs can be determined, including how much the user would be asked to pay for construction and maintenance of each alternative. In the last stage the behavioral scientist presents and explains the alternatives, their financial costs, and their future upgrading possibilities to the community for final selection. The form that this community participation takes will vary greatly from country to country; its important elements are discussed in chapter 3.

Figure 1-1. *Recommended Structure of Feasibility Studies for Sanitation Program Planning*



As part of the sanitation planning process, the existing or likely future pattern of domestic water use should be ascertained so that the most appropriate method of sullage disposal can be selected. This is particularly important in the case of properties with a multiple tap level of water supply service, since large wastewater flows may, according to conventional wisdom, preclude the consideration of technologies other than sewerage or, in low-density areas, septic tanks with soakaways. It is not necessary, however, either for reasons of health or user convenience, for domestic water consumption to exceed 100 liters per capita daily.[5] The use of low-volume cistern-flush toilets and various simple and inexpensive devices for reducing the rate of water flow from taps and showerheads (described in the appendix of chapter 4) can achieve substantial savings in water consumption without any decrease in user convenience or any required change in personal washing habits. These savings can be as high as 75 percent in high-water-pressure areas and 30 to 50 percent in low-pressure areas. If wastewater flows can be reduced by these means, then the options for sanitation facilities are much broader than only conventional sewerage. In addition, separation of toilet wastes from other wastewater by simple modifications in household plumbing, coupled with improved designs of septic tank filters (see chapter 14), may make nonsewered options more widely feasible.

The framework suggested in this chapter for the identification of the most appropriate sanitation technology takes more engineering time and analysis than that of traditional feasibility analysis. It also requires the recruitment of staff in other disciplines, such as behavioral scientists. In addition, the concept of incremental sanitation requires municipal activity in sanitation programs to be spread over a considerably longer time because the user has the option of whether and when to proceed to the next higher level of convenience. Yet we believe that the planning format discussed above has a far greater chance of achieving operational success because the most appropriate sanitation technology is drawn from a wider range of alternatives, imposes the least cost burden on the economy, maximizes the health benefits obtainable, and is selected after extensive interaction with the intended beneficiaries. Because incremental sanitation systems are so much less expensive than sewerage (both in initial investment and total discounted cost), many more people can be provided with satisfactory excreta disposal facilities for the same amount of money, and these facilities can be upgraded as more money becomes available in the future. Given the huge service backlog and the severe investment capital constraints in developing countries, incremental sanitation may be the only, as well as the best, way to meet the sanitation goals of the International Drinking Water Supply and Sanitation Decade.

Notes to Chapter 1

1. For a more detailed discussion of the issues in this chapter, see chapters 1 and 2 of Kalbermatten, Julius, and Gunnerson (1982).
2. One billion is equivalent to one thousand million.
3. All dollar figures in this manual are 1978 U.S. dollars.
4. The term "behavioral scientist" is used to describe a person skilled in assessing community needs, preferences, and processes. The person's training may be in anthropology, communications, geography, sociology, or psychology, or it may come from a wide variety of education and experience.
5. Where water has to be carried, 20 liters per capita daily is considered a minimum acceptable level to provide all the health benefits of a safe water supply. With closer standpipe spacing and yard hydrants, consumption rises typically to 50 and, with house connections, to 100 liters per capita daily. At the higher levels of consumption, off-site disposal of sullage becomes necessary.