ACCEPTABLE DRINKING WATER

SOME PRACTICAL OPTIONS

paper presented at the Agromisa Week 1983

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INTERNATIONAL REFERENCE CENTRE FOR COMMUNITY WATER SUPPLY AND SANITATION

IRC is an internationallly operating organization dealing with information and technology support for water and sanitation improvement.

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Introduction

Water is essential for life. From time immemorial people have made their homes near rivers and springs in order to have a guaranteed source of drinking water. Unfortunately, rivers also serve the purpose of disposing of waste matter and springs may become polluted by drainage water. Therefore water found in nature may contain a wide variety of harmless and harmful substances.

Water quality criteria

The general characteristics of good drinking water may be formulated as follows: it must be free of pathogenic organisms, toxic substances and too high a content of minerals and organics; to make it pleasant it should be free of colour, turbidity, taste and odour; moreover it should contain sufficient oxygen and it shoud have a suitable temperature.

Quality standards and guidelines have been developed by various organizations. Those developed by WHO are widely spread and adopted by many developing countries. Part of the WHO guidelines is shown in Table 1.

Table 1 Guideline values for health-related inorganic constituents

Constituent	Guideline value (milligrams per litre)
Arsenic	0.05
Cadmium	0.005
Chromium	0.05
Cyanide	0.1
Flouride	1.5*
Lead	0.05
Mercury	0.0001
Nitrate (as N)	10.00
Selenium	0.01

* Guideline value may be varied depending upon climatic conditions and water consumption (7).

Bacteriological water quality

The bacteriological quality of the water is one of the most important characteristics determining whether the water is safe for drinking. Most of the diseases related to water originate from the stools of human beings. When sanitation facilities are not adequate or not adequately used, the germs in the stools will enter the water or will be transmitted directly to other human beings and so spread the disease. The main indication of the bacteriological quality can be achieved by testing the presence of coliforms. The test identifies the most probable number of coliform bacteria in the water which is an indicator of fecal pollution. The water sample has to be mixed with a nutrient medium and is incubated for a particular time at a particular temperature. The production of acid and gas then confirms the presence of coliforms. For small drinking water supplies, total coliform count should be less than 10 per 100 ml and fecal coliforms should be absent.

Diseases related to water

The diseases related to water can be divided into the following categories:

Water-borne diseases

These diseases are transmitted when the disease is in the water that is drunk by a person who may then become infected. Examples of water-borne diseases are cholera, typhoid but also infectious hepatitis and dysentery. To prevent infection by water borne diseases it is important not to drink unsafe water nor allow children to drink it.

Water-washed diseases

Water washed diseases are related to the use of too little water for personal hygiene. These diseases can be reduced considerably by using more water for washing the body and by washing the body and especially the hands more frequently with soap. Examples of these diseases are diarrhoeal diseases, infections of the body surface (the skin) such as scabies and eye infections. Also included are infections which are transmitted to a person by insects hosting on the body such as lice and fleas.

Water-based diseases

These are the diseases transmitted by worms which live in the water and which enter the human body when it is in contact with the infected water. Examples are bilharzia, guinea worm, etc. To break the transmission cycle of this category community members should use tapwater for drinking and all washing and bathing activities.

Water-related diseases

These diseases which are transmitted by insects, in particular mosquitos, which breed in water. An example is malaria. To reduce these diseases, users should be advised to keep the tap surroundings clean and dry and remove stagnant pools of water from the areas surrounding the houses. However, complete prevention requires complex measures which are beyond the limitations of the village level.

Effect of safe water supply

Safe water supply can reduce the incidence of a wide variety of diseases. Table 2 provides an example of the estimated effect of introducing safe water in East Africa. The only disease which can be eradicated by the provision of clean water is guinea worm. This disease effecting an estimated 10-50 million people in rural areas of Africa and Asia is transmitted by drinking water contaminated with a tiny water flea carrying an intermediate stage of the parasite. This stage will further develop in the human body. After an incubation period, adult female worms protrude through the skin (usually on the legs). When the infected tissue comes into contact with water (river, open well) the embryos of the parasite will be released into the water, thus allowing the life cycle to continue (3).

In addition to the use of clean water in larger quantities the proper handling and utilization of the water is essential. However many of the diseases mentioned in Table 2 are related to inadequate sanitary conditions. Only by improving water supply and sanitary conditions at the same time can a real improvement of the situation be achieved.

Every society has its own habits and traditional behaviour towards water supply and sanitation. Some of them are very useful while others have proven completely wrong. These are often deeply rooted and should be carefully taken into account and appreciated when considering exchanging them for modern scientific theories and practices. Modern practice is sometimes questionable as well:

"For one person for one year, the typical 5 gallon flush contaminates about 13,000 gallons of fresh water to move 165 gallons of bodily wastes. What this means is that we are taking a clean, valuable resource - water and a potentially valuable resource - human wastes - and mixing them together to pollute the water and make the fertilizer qualities of the excrement just about useless. Then we pay dearly to separate them again. Surely there must be a better way." (8)

Figure 1 Transmission cycle of bilharzia

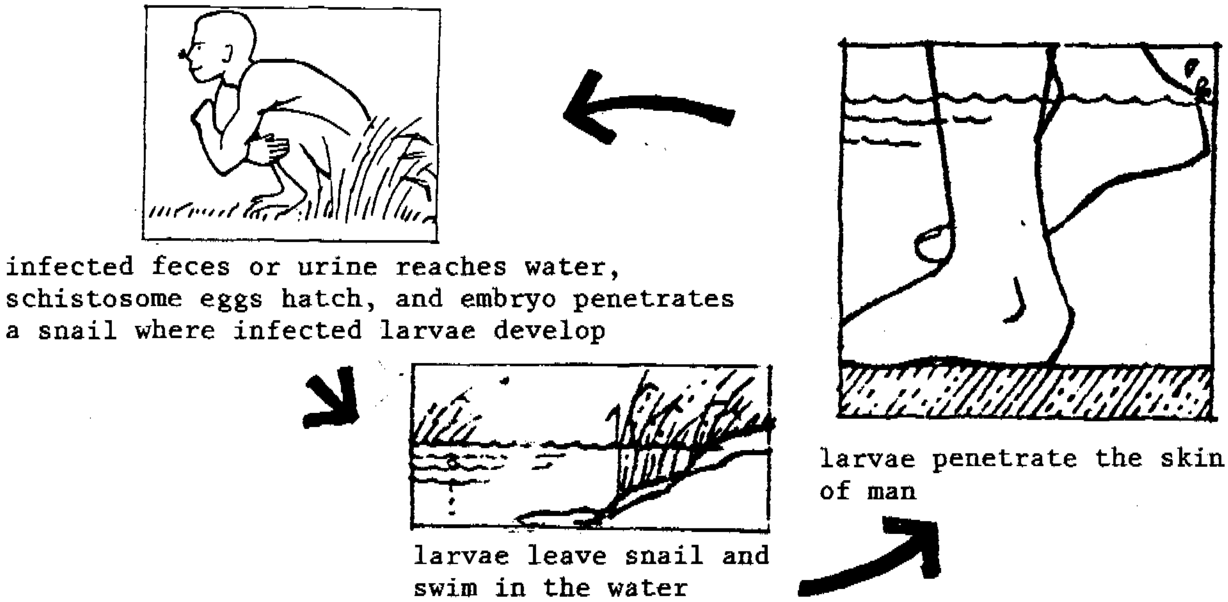


Figure 1: Snail fever (schistosomiasis) is an example of a disease caused by contact with unsafe water (8)

Table 2 Estimated proportion of preventable water-related disease in east Africa in 1966

Diagnosis	Percent reduction expected if water supply were excellent
Guinea Worm	100%
Typhoid	80
Urinary Schistosomiasis	80
Leptospirosis	80
Scabies	80
Yaws	70
Inflammatory Eye Disease	70
Schistosomiasis, unspecified	60
Trachoma	60
Bacillary Dysentery	50
Amebiasis	50
Dysentery, unspecified	50
Tinea	50
Gastroenteritis, 4 wk to 2 yr	50
Gastroenteritis, over 2 yr	50
Skin and Subcutaneous Infections	50
Diarrhea of the newborn	50
Paratyphoid and other Salmonella	40
Louseborne Typhus	40
Intestinal Schistosomiasis	40
Ascariasis	40
Louseborn relapsing fever	40
Otitis Externa	40
Classic skin (leg) Ulcer	40
Trypanosomiasis, unspecified	10
Dental caries	10
Overall	52

Source: White, et al (1972)

Quality of water sources

The various sources for water supply can be divided into three categories.

Rainwater

Rainwater, in itself, usually contains very few impurities. The rain incorporates tiny particles of dust and picks up gases from the atmosphere. Unfortunately most of the time the roof surface is not clean, so even rainwater drained from a roof needs some treatment (figure 2).

Groundwater

In principle groundwater is safe to be used as drinking water. But it may not always have a pleasant taste due to its mineral content and therefore special treatment may be needed. When groundwater is present at a shallow depth (e.g. fewer than 10 meters) it may be unsafe because of pollution from nearby pit latrines, septic tanks or cattle ponds.

Surface water

Surface water generally contains the greatest concentration of impurities. Especially where human beings have free access to the water or the water may be heavily polluted downstream of human settlements.

Water source selection

The process of chosing the most suitable source of water depends largely on local conditions. However from the presented information it may be clear that when groundwater is available it is the most suitable water source if the taste and chemical quality are acceptable and is found at a reasonable depth. A simple means which can be produced locally to lift the water from a well is the rope pump. However, some contamination of the water may occur when this pump is used. If springs are present, simple spring protection may provide for the necessary safe water (figure 3). Dug wells or drilled wells equiped with a pump are a very appropriate solution for rural areas if proper maintenance can be guaranteed (figure 4).

Figure 2 Rainwater Harvesting (Convenio Colombo Holandes)

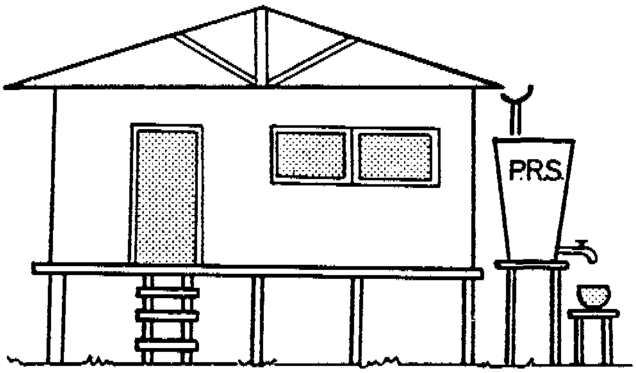
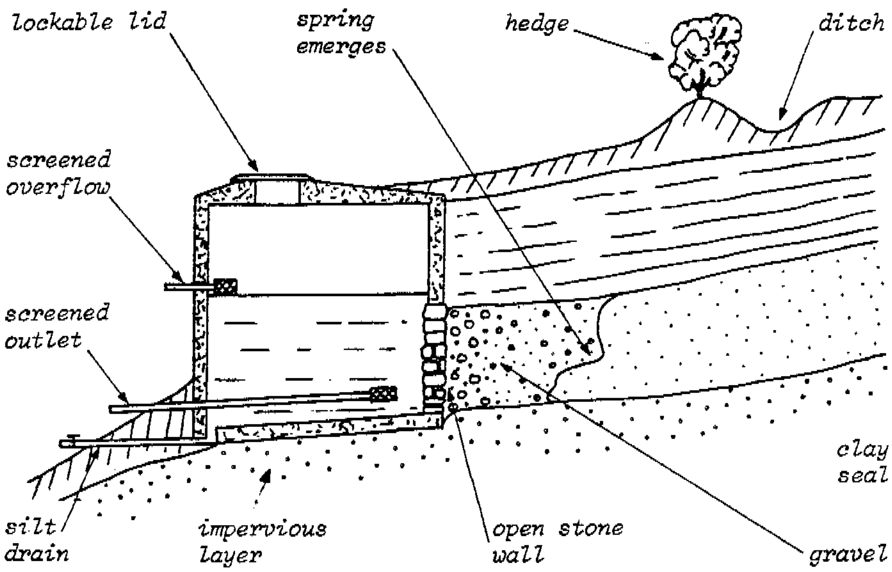


Figure 3 Protected Spring (5)



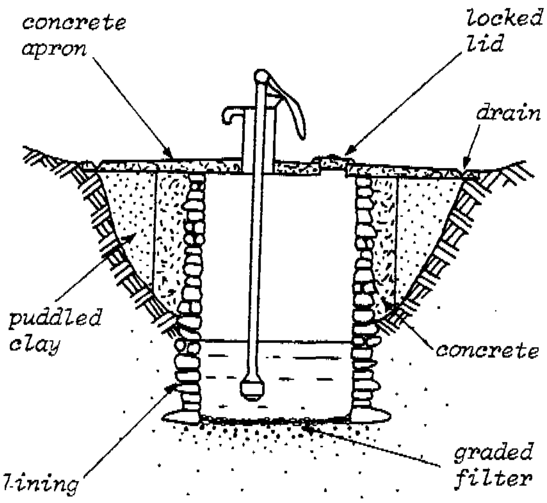


Figure 4 Handpump installations (5)

Water treatment

If the selected water source does not contain safe drinking water, treatment will be necessary. The purpose of water treatment is to convert the water in such a way that it becomes safe and pleasant to drink. Various water treatment processes have been developed and often a treatment result can be obtained in different ways.

Purification methods at household level

A number of simple treatment methods which improve the quality of the water but usually do not make it completely safe are:

Long term storage

During the long term storage a self purification process takes place. Suspended matter will settle and the number of bacteria will be reduced. Storage is also useful for preventing bilharzia because the cercariae can only live for 48 hours after leaving the infected snail if they cannot reach a human being.

Coagulation

By adding a coagulant to the water, small particles will cling together and settle. A wide variety of natural and chemical coagulants are available for use. However, the application of certain natural coagulants may raise the level of toxic elements. Therefore, imprudent use of particular locally available coagulants is not advisable.

Filtration

Various materials are used as a straining device. Traditional ones are cloth and porous pottery. A modern application is the ceramic water filter. Water which has passed through an ordinary ceramic filter must be given a bacteriological test since it is usually not completely safe.

Household sand filter

The slow sand filtration process described in the next chapter can also be used at household level (figure 5).

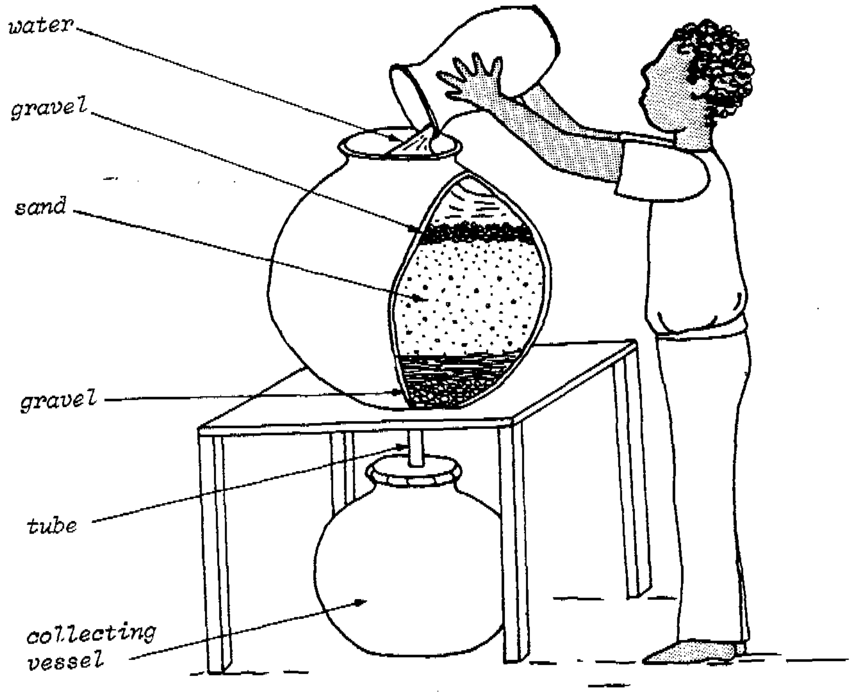


Figure 5 Household sand filter (5/Chatiketu, Dabo)

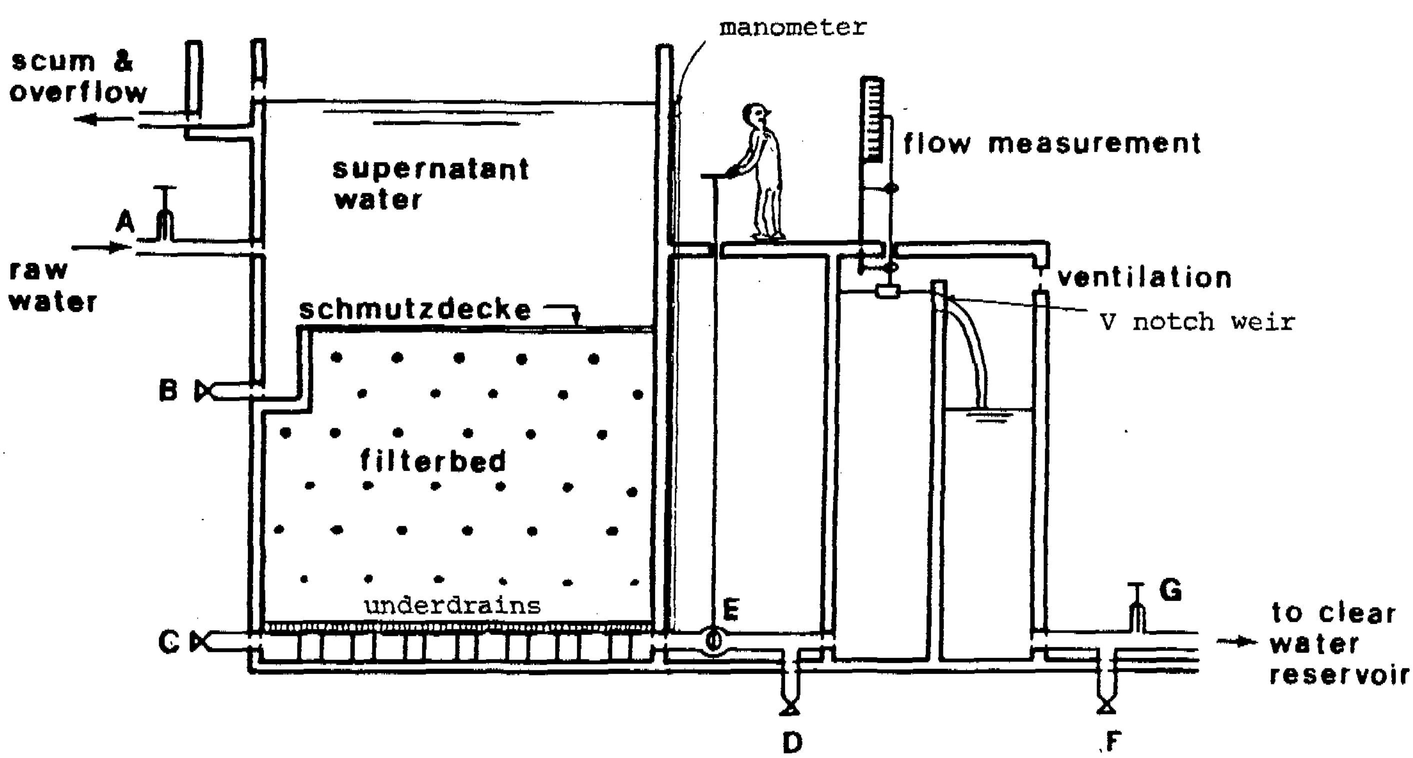


Figure 6 Basic elements of a slow sand filter (schematic)

Disinfection

The methods described will usually not provide bacteriologically safe water. However this does not mean that one become ill from drinking it. The local consumers will have developed a natural immunity to certain types of bacteria. During an outbreak of a water-borne disease, the weaker, non-immune consumers such as children, visitors from neighboring villages and foreigners, may find it necessary to make the water safe for drinking by:

Boiling

Boiling for a few minutes radically reduces the number of bacteria. Boiling it for 20 minutes makes it bacteriologically safe. Yet, this simple method is not feasible in many situations because of the high price and scarcity of fuel.

Chlorination

The addition of a chemical containing free chlorine to water will inactivate all bacteria after 30 minutes. This simple and reliable method is widely used, however the western world is cutting back on chlorination because of the long-term health risk. It must be noted that the chance of recontamination is rather high. Therefore safe water has to be handled carefully.

Village water supply

The provision of any form of treatment at village level will rais the cost and expand the problems in operation and maintenance of the water supply system. Introduction of a water supply should be based on the assessments of the needs in the village and the discussion on potential benefits and drawbacks of the new system. It is not always easy to reach all sections of the community. Women, for example, often are not involved in the information and decision making process. Yet women are usually the main users and therefore should certainly be included in these processes. Participation in the actual construction can lower construction costs, when it is well organized, and may increase the skills of the villagers. It may be the begining of an active role of the villagers in operation and maintenance of the system. However, participation should never be based on false promises. The effect on the health situation in the village will be increased when improved sanitation and drainage facilities are prepared concurrently with the construction of the water supply system.

Slow sand filtration

In a slow sand filter (figure 6) water is allowed to percolate slowly through the sand. During this passage the quality of the water improves considerably. In a mature bed a thin layer forms on the surface of the bed. This filter-skin, usually called schmutzdecke, consists of a great variety of biologically active micro-organisms which break down organic matter, while also straining out a great deal of suspended inorganic substances. When after some months the filter gets clogged, the filtration capacity can be restored by cleaning the filter i.e. by scraping off the top few centimeters of the filterbed including the filter skin.

Some notable features of slow sand filtration are:

- No other single process can effect such an improvement in the physical, chemical and bacteriological quality of normal surface waters as accomplished by slow sand filtration.
- The fairly simple design of slow sand filters makes it easy to use local materials and skills in their construction. Little special pipework or equipment is required and a greater variety of construction materials can be permitted.

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