Sanitation in Developing Countries

Archiv 45805

Proceedings of a workshop on child in Lobatse, Botswana, 12 August 1980
The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

©1981 International Development Research Centre
Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

IDRC, Ottawa CA


IDRC publication, sanitation, waste waters, waste disposal, appropriate technology, health education, Africa — sanitation services, waste treatment, methane, disease transmission, water supply, water pollution, health services, auxiliary health workers, civil engineering, vocational training, resistance to change, financial aspects.


Microfiche edition available
Sanitation in Developing Countries

Proceedings of a workshop on training held in Lobatse, Botswana, 14–20 August 1980

Sponsored by:
Government of The Republic of Botswana
International Development Research Centre
Canadian International Development Agency
Contents

Foreword  6
Participants  7
Technology
   Use of dry pit latrines in rural and urban Ethiopia
      K. Kinde  9
   Pit latrines in Botswana
      J.G. Wilson  13
   Pit latrines in Malawi
      A.W.C. Munyimbili  16
   Housing sanitation, Mozambique
      B. Brandberg and M. Jeremias  21
   The PIP and REC II latrines
      J.G. Wilson  24
   On-site excreta disposal technologies
      E.K. Simbeye  27
   Anaerobic digestion as a rural sanitation option
      R. Carothers  34
   Zambia’s experience with aqua privies
      J. Kaoma  41
   The Botswana aqua privy
      J.G. Wilson  48
   Septic tanks
      Beyene Wolde-Gabriel  50
   Sanitary situation in Addis Ababa
      Aragaw Truneh  52
   Sewerage and low-cost sanitation: a solution to sanitation problems in
developing countries
      Frederick Z. Njau  56
   Sullage disposal in urban centres
      Frederick Z. Njau  59
   Technology: discussion  61
Software

Disease transmission
G.P. Malikebu  64

Sanitation and disease transmission
J.B. Sibiya  68

Water pollution and sanitation in Botswana
L.V. Brynolf  71

Primary school health education in Tanzania
I.A. Mnzava  75

Health education in primary schools in Malawi
I.K. Medi  79

Health education delivery system in environmental health programs in Malawi
Winson G. Bomba  81

Rural health services in Ethiopia
Araya Demissie  84

Health education, an essential component in the promotion of health, with emphasis on rural sanitation
Saidi H.D. Chizenga  88

Water supply and sanitation in Lesotho
M.E. Petlane  94

The role of health education in sanitation programs
Winson G. Bomba  101

Some sociological aspects of sanitation provision (with particular reference to Botswana)
Nomtuse Mbere  105

Problems of acceptability of low-cost sanitation programs
P.M. Matiting  111

Community/household participation
A.W.C. Munyimbili  113

Applied community participation in sanitation provision
Nomtuse Mbere  118

Financial aspects of sanitation
Dawit Getachew  123

Financing of low-cost sanitation schemes in the urban areas of Botswana
Brian Bellard  131

Training implications within the sanitation sector in Tanzania
H.W. Rutachunzibwa  135

Health manpower planning and training
P.A. Chindamba  139

Software: discussion  143
Training

Training of civil engineers in Kenya
J. Gecaga 148

Sanitary engineering education in the Faculty of Technology, Addis Ababa University
Alemayehu Teferra 152

The training of health inspectors in Malawi
P.A. Chindamba 153

Training of health assistants in Malawi
G.P. Malikebu 155

Training of primary health care workers: a personal account
Fred K. Bangula 157

Brigades in Botswana 161

Botswana Polytechnic and its involvement in the teaching of sanitation
J.E. Attew 163

Ethiopian sanitation sector institutional responsibility
Beyene Wolde-Gabriel 165

Training: discussion 166

Workshop Conclusions 167
Water Pollution and Sanitation in Botswana

L.V. Brynolf

Water Supply and Sewerage in Urban Areas

About 150,000 people or about 18% of the population of Botswana live in the urban centres of Gaborone, Lobatse, Francistown, and Selebi Pikwe. The Water Utilities Corporation (WUC), a wholly state-owned parastatal organization, is responsible for water supply in these centres. In addition to the urban centres, there is a small mining town, Orapa, with a considerable water consumption due to the presence of a mining company. The water source for these urban water supplies is mainly surface water, contained in dams and given adequate treatment before use. Francistown is an exception to this rule. At present, it utilizes water from boreholes within the township. However, a new water source, the Shashe Dam, will soon be in use.

Only the high- and medium-priced housing areas of Gaborone, Selebi Pikwe, and Orapa are connected to waterborne sewerage systems, with subsequent treatment of the wastewater in oxidation ponds. The remainder of the urban population is served by individual facilities such as septic tanks or pit latrines. In squatter areas, a large part of the population does not have access to any toilet system. The limited sanitary facilities available in these areas are likely to pollute the groundwater under the towns and the surface water at the outlet points of ponds. However, they will normally not pose any threat to the water supply systems of the urban areas.

Water Supply and Sewerage in Rural Areas

The rural population in Botswana amounts to approximately 700,000 people. There are 15 major villages with about 150,000 people and there are another 110 intermediate villages (with more than 500 people) and perhaps 200 small villages with an estimated population of 250 people in each village. The remainder of the rural population stays at the lands and cattle post areas.

Water supplies have now been provided by the Department of Water Affairs for all of the major villages and about half of the smaller villages. According to the development plan, all villages will be supplied with water by 1985. Nearly all these water supplies are dependent upon groundwater.

In the villages, there is no waterborne sanitation except within some government buildings, schools, and hospitals. Methods of human waste disposal range from aqua privies and pit latrines to retreats in the bush, the latter method being the most common. It should be noted that there are also plenty of cattle in and around the villages and as a result there is a considerable risk of pollution to the public water supply that is drawn from boreholes. In fact, a number of boreholes have been abandoned because the water in them is polluted.

---

1Senior Water Engineer (Pollution), Department of Water Affairs, Gaborone, Botswana.
Indicators of Pollution in Water Supplies

The greatest danger associated with drinking water is that it may recently have become contaminated by sewage or by human excrement; even the dangers of animal pollution must not be overlooked. If such contamination has occurred very recently and if it has been caused by any carrier of such infectious diseases as enteric fever or dysentery, the water may contain the living pathogens of these diseases. Cases of these diseases may then result from the drinking of such water.

Although modern bacteriological methods have made it possible to detect pathogenic bacteria in wastewater, it is not practicable, as a routine procedure, to attempt to isolate them from samples of drinking water. When pathogenic organisms are present in faeces or sewage, they are almost always greatly outnumbered by the normal excremental organisms, and these organisms are easier to detect in water. If they are not found in the water it can, in general, be inferred that disease-producing organisms are also absent, and the use of normal excremental organisms as an indicator of faecal pollution in itself introduces a margin of safety.

The organisms most commonly used as indicators of pollution are E. coli and the coliform group as a whole. E. coli is undoubtedly of faecal origin, whereas other members of the coliform group may or may not be of faecal origin. From a practical point of view, it should be assumed that they are all of faecal origin, providing a further margin of safety. Faecal streptococci may be of value in confirming the faecal nature of pollution in doubtful cases. It has been stated that it would be possible to differentiate between faecal pollution from animals and humans due to the ratio between faecal coliforms and faecal streptococci. Humans would have a ratio of above 4, whereas animals would have a ratio of less than 0.7. There is no reason to believe that this is a general rule. Differences in nutrition will distort this ratio, as well as differences between various groups of humans and animals.

Nitrate is another important indicator of faecal pollution in drinking water. In particular, changes in nitrate concentration (as well as the concentration of chlorides) could be suspected as being a sign of pollution that may be of faecal origin. In some countries, heavy soil fertilization may be the cause of nitrates spreading, but this is not the case in Botswana. The nitrate could also be of mineral origin. In some cases, increased nitrate levels will only indicate contamination with bovine faeces, which will constitute a relatively small risk of humans contracting animal diseases. In the villages, however, the presence of nitrate may indicate human faecal pollution.

Standards and Control of Water Quality

An acceptable public water supply should not have any faecal coliforms and not more than 10 total coliforms per 100 ml. If total coliforms appear repeatedly, it should be considered as an indication of pollution and the source of the total coliforms should be determined and removed.

Nitrate is to be considered not only as an indicator of pollution but also as a health hazard itself, among other things, through the possible formation of methemoglobin in the blood. Unless the nitrate concentration in the water is very high, the substance will not be toxic enough to endanger the health of adults and older children. However, formula-fed infants younger than 3–6 months of age are very susceptible to being affected by nitrates. The World Health Organization (WHO) has set a standard of a maximum of 45 mg NO₃/litre in drinking water for children below the age of 1 year. In a WHO report published in 1962, the maximum acceptable daily intakes of nitrite and nitrate were set at 0.4 mg NaNO₂ and 5 mg NaNO₃ per kilogram body weight.

The WUC controls the quality of water in urban water supplies by chlorinating the water before its distribution. The water supplies in the major villages are operated...
and maintained by the Department of Water Affairs (DWA). Chlorination has been carried out in these supplies since studies revealed that high levels of nitrate and varying numbers of coliforms might occur. The water supplies in smaller villages are managed by the district councils and they are not, generally, chlorinated. Staff from the Department of Water Affairs (water quality laboratory) carry out routine sampling and testing of the untreated and the distributed water in the major villages. This monitoring of drinking water is extended to the smaller villages as far as manpower constraints permit. The analyses normally carried out by the DWA water quality laboratory are: pH, conductivity, total dissolved solids (TDS), chloride, nitrate, free chlorine (on site), total coliforms, and faecal coliforms.

Some Studies on Sanitation and Water Pollution

Several studies on sanitation, water supply, and pollution have been carried out in Botswana. In May and June 1977, an evaluation was made by SWECO of the water schemes in 9 major villages and 22 rural villages. Water samples from 29 of the villages were analysed. In 9 of the 29 villages, water with more than 45 mg NO₃/litre was found. Low values were found in 10 villages and were found to correspond with low concentrations of TDS and very low hardness values. High nitrate values were found mainly in hard waters with relatively high amounts of TDS. The first group included mainly river and sandy river waters, whereas the second group consisted of groundwater. It should be noted that high levels of nitrate also contribute to the TDS and that acidification caused by nitrification is usually compensated for by an increase in hardness. Bacteriological examination of water from boreholes did not show any correlation between high nitrate concentrations and bacterial contamination.

In June 1978, a detailed study was carried out of one borehole in Mochudi. The water from the borehole had a high nitrate content (over 500 mg NO₃/litre) and pit latrines were found to be situated nearby. The study showed an extremely high transportation rate into the borehole of tracers, such as lithium chloride, that were put into the pit latrines.

Bacteriological investigations were carried out in July 1978 on water from boreholes, well points, and standpipes in Ramotswa, Molepolole, Kanye, Palapye, Serowe, and Mahalapye, all of which are major villages in eastern Botswana. Almost without exception, the water contained unacceptably high levels of faecal bacterial contamination. Despite the fact that E. coli was largely absent from the water, Salmonella and some other possible pathogens were reported.

In conjunction with the bacteriological study, water samples were collected simultaneously and tested for nitrate, nitrite, and ammonia. The survey was conducted in order to establish the relationship between chemical and bacterial contamination of selected groundwater supplies. The results of the study indicated that there was no positive correlation between nitrate and faecal coliform concentrations in the water supplies tested. The study clearly demonstrated that some of the worst bacterial pollution occurred in waters with very low nitrate concentrations.

At the end of 1978, a group of consultants studied the correlation between nitrate in drinking water in Botswana and the health of the consumers. According to the findings of the team, nitrate contamination of drinking water did not seem to have any serious impact on health. Bacterial pollution, however, was considered to be a more serious health hazard and quite prevalent. A recent study in Namibia proved that in that country nitrate pollution had an impact on health. Obviously, this field must be studied further.

A new microbiological water quality study has now been proposed and will, if
approved, be carried out between 1980 and
1982. It has been proposed that a country-
wide study of the degree of faecal
contamination of different sources of water
in Botswana be carried out. The study would
include the relationship between different
indicators of faecal bacteriological pollution
and their correlation to different
waterborne/water-related pathogens, their
survival, and transportation characteristics
in water and soil. The study would also
include the role of water-spread diseases
related to other methods of transmission in
communities with limited sanitation
facilities.

Conclusions

There is probably widespread contam-
ination by sanitary waste in the ground-
water supplies of Botswana and remedial
action is urgently needed. New bore-
holes will have to be sited away from the
villages and they will require adequate
protection areas. Boreholes that are already
polluted will have to be protected against
further pollution or be replaced. There is
also a need for a competent assessment of
the existing state of pollution, of the effect of
pollution on human health, and of a pro-
posal for relevant indicators of pollution.