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JOINT WHO/UNEP/US EPA REGIONAL SEMINAR ON THE WHO GUIDELINES FOR DRINKING-WATER QUALITY

28 NOVEMBER - 1 DECEMBER 1994
UNEP, NAIROBI, KENYA

The World Health Organization
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MONDAY 28 NOVEMBER - THURSDAY 1 DECEMBER 1994 UNEP, NAIROBI

INTRODUCTION

The World Health Organization published in 1993 the *Guidelines for Drinking-Water Quality* (GDWQ). The preparation of the *Guidelines* covered a period of four years and involved the participation of over 200 experts from some 40 different countries. The *Guidelines* thus constitute an international consensus assessment of the risks to human health from exposure to microbial and chemical contaminants in drinking-water and provide a sound scientific basis for the development of national/regional standards, and for the monitoring, protection and improvement of drinking-water quality.

In order to help countries make the best use of the new *Guidelines*, WHO in cooperation with various partners, is conducting a series of national and regional seminars in different parts of the world to present the new concepts incorporated in the *Guidelines* for the 1990s and to promote public health protection through the provision of safe drinking-water.

OBJECTIVES OF THE SEMINAR

The general objective of this Regional Seminar was to strengthen national capabilities and capacities for the provision of safe drinking-water. Specific objectives were:

(1) To introduce the 1993 WHO GDWQ: philosophy, principles used in the derivation of health-based guideline values, and for protecting and improving drinking-water quality.

(2) To strengthen the knowledge of those responsible for the protection of water resources and the supply of safe drinking-water and to promote principles and national actions for implementing and sustaining safe drinking-water programmes.

(3) To promote the application of the GDWQ through the development of national standards appropriate to the economical, social and cultural conditions of countries in Eastern Africa.

(4) To enhance exchange of information between countries in the region in order to promote regional programmes for the protection of national/international water supply sources.

OPENING SESSION

Mr. Walter Rast, Chief, Freshwater Unit, UNEP

Mr Rast opened the meeting by welcoming all participants and lecturers to the UNEP Headquarters at Gigiri. He said that the reason why UNEP was hosting this meeting was not just because the UNEP Headquarters is conveniently placed in the region, but also because the issue of drinking-water quality is of great concern to UNEP. He explained that the UNEP approach has been - and still is - to apply a wide and holistic perspective to the problem of drinking-water supply. He elaborated this through some examples on how all technical and non-technical factors in a watershed must be simultaneously considered in order to develop an effective management strategy for the sustainable supply of water. UNEP/Freshwater Unit has therefore developed a programme on Environmentally-Sound Management of Inland Waters (EMINWA), where drinking-water issues are incorporated as one part of all the considerations that need to be addressed in a management plan for a drainage basin. However, he also explained that the UNEP/Freshwater Unit had been urged by its Governing Council in May 1993, and on several occasions by country permanent representatives, to increase its activities within more specific issues of drinking-water supply and sanitation. He stressed his concern on reported numbers of diseases and deaths caused by insufficient drinking-water quality in the region. The WHO *Guidelines for Drinking-Water Quality* are seen by UNEP as a very useful tool in the process of setting national standards for drinking-water quality. UNEP had, therefore, welcomed the request by WHO to co-fund and host this regional seminar. Mr Rast ended his welcoming speech by wishing the participants a very useful seminar.

Mr. Richard Helmer, Chief, Urban Environmental Health Unit, WHO

The opening statement on behalf of WHO was made by Mr Helmer who thanked the two co-sponsoring agencies, the United Nations Environment Programme and the United States Environmental Protection Agency, for their support to this seminar. This seminar is one in a series of national and regional meetings which bring together professionals from the health and water sectors with responsibility for the supply of drinking-water and its safety. Mr Helmer then described the process leading to the revision of the WHO *Guidelines* and the content of the three volumes. The third volume particularly addresses the application of drinking-water standards through appropriate surveillance. The present Seminar is based on volume one which should allow country authorities to draft or revise national standards for drinking-water quality. WHO stands ready to provide technical cooperation in the implementation process as requested, particularly in the area of analytical methods and services and on treatment techniques to achieve desired concentration levels. The microbiological safety was highlighted as the most important requirement for any drinking-water supply system.

Mr. J. G. Kariuki, Ministry of Health, Kenya

The subject of water quality is of great importance especially when discussing water intended for human consumption. More stringent control of water contaminants and higher quality standards should be applied. The pathogenic bacteria transmitted directly by water or indirectly through water to food, constitute one of the principal sources of morbidity and

mortality in developing countries. They include the causative agents of the great epidemic diseases like cholera and typhoid and of the less spectacular but more numerous cases of infantile diarrhoea, dysenteries and other enteric infections that occur continuously, and often with fatal results among the rural and urban populations in our developing countries.

It is common knowledge to all of us that water is one of the basic human needs. It is essential to sustain life and it is important that a satisfactory supply is made available to all consumers. Therefore, considerable effort should be made to ensure that drinking-water quality of as high standard as practicable is achieved. I believe this is one of the objectives of this workshop. The protection of water supplies from contamination is of paramount importance. Source protection is almost invariably the best method of ensuring safe drinking-water and is to be preferred to treating a contaminated water supply to render it suitable for human consumption.

Although the concern in most of our developing countries is more on microbial quality of drinking-water, with the increasing number of industries and usage of chemicals, there is increased need to start monitoring the chemical quality.

Water quality surveillance is an area that requires to be addressed more seriously. Very few developing countries have effective surveillance programme for drinking-water supplies and Kenya is no exception. Surveillance is the continuous public health assessment of the safety of water supplies. It involves the routine physical, chemical and biological quality control of water from source to consumer, together with sanitary inspection, to ascertain the proper functioning of all components of that water treatment supply system. Although these practices and guidelines are laid down by WHO, their application is not always routinely followed and strictly undertaken in most urban and rural areas.

There is also the need to decentralize water analysis to the lowest possible level as there is a lot of benefit accrued to it, in terms of decrease in distances involved and improved efficiency in bacteriological analysis. However chemical analysis often need to be carried out at a central level. Adequate supply of the necessary equipment and reagents to undertake prompt and routine examination and analysis is still a problem in most of our countries, Kenya included.

Mr Kariuki congratulated the organizers for convening this technical group from this region to discuss the very important subject of water quality.

The list of participants is given as Annex 1 and the Agenda of the Seminar as Annex 2. Alternate Chairpersons on consecutive days were Mr Kariuki, Ministry of Health, Kenya; Mr Bruce Mintz, US EPA; Mr Veli Aalto, WHO; and Ms Eva Skarbovik, UNEP. Mrs Hend Galal-Gorchev served as the Rapporteur.

TECHNICAL PRESENTATIONS

Introduction to the WHO Guidelines for Drinking-Water Quality (H. Galal-Gorchev)

As with the 1984 *Guidelines*, the new 1993 *Guidelines* place the greatest emphasis on the microbiological quality of drinking-water. The WHO-recommended guideline values (GVs) for potentially toxic chemicals in water should not be regarded as precise numbers: there are considerable uncertainties regarding these GVs, stemming from - among other things - extrapolation of toxicological data from animal to humans, and from high-dose to low-dose. Uncertainties regarding the GVs are clearly outlined in the *Guidelines*, particularly in Volume 2 "Health Criteria and other Supporting Information".

The number of chemicals evaluated in the *Guidelines* is very large. It is highly unlikely that all these chemicals will be of relevance to a given country when setting standards. Care should therefore be taken when selecting substances for which national standards will be developed. Priorities must be established to avoid wasting resources for monitoring chemicals of minor importance.

The *Guidelines* are based on international consensus assessment of the risks to human health from the presence of microbial and chemical contaminants in drinking-water and provide a sound scientific basis (although with still some uncertainties) for establishing standards with respect to health protection. It is the hope of the Organization that the *Guidelines* will be utilized by governments to set new drinking-water quality standards where they do not exist, or to update existing ones.

Drinking-water quality issues in Kenya (J.G. Kariuki, Ministry of Health and E.N. Nyaga, Ministry of Land Reclamation)

The freshwater resources of Kenya, which are estimated at 280 million km^3 available annually, are finite while their demands by the constantly growing population of 22 million are concomitantly increasing. However, the water quality of most surface water resources is still unimpaired in spite of continuous discharges of all types of effluent. To ensure protection of the water resources from pollution, an aggressive pollution control program and a water quality monitoring program were instituted. This notwithstanding and, to ensure provision of potable water, all Government operated water supplies are accorded either full treatment or partial treatment depending on the quality of raw water. In addition, all supplies should be disinfected before distribution. This is necessitated by the condition of the sources of drinking water which include rivers, lakes and dams, accounting for over 75% of all supplies, ponds, springs, bore holes, wells, laggas, pans, and the socio-economic activities which generate anthropogenic pollutants. The water is invariably treated to the WHO drinking-water quality guidelines despite the constraints in acquiring water treatment chemicals, inadequate legislation, logistical problems among many issues. This will, however, be addressed as emerging policy strategies are realized.

WHO *Guidelines for Drinking-Water Quality*: microbiological aspects (W.O.K. Grabow - University of Pretoria)

The wide variety of waterborne diseases is the most important concern about water quality, and their public health impact has far-reaching implications. The pathogens concerned include many types of viruses, bacteria, protozoa and helminths, which differ widely in size, structure and composition. This implies that their survival in the environment and resistance to water treatment processes differ significantly. However, the waterborne transmission of infectious diseases can be controlled effectively by practical and economic methods. The approach must be based on the selection of appropriate quality monitoring, fail-safe application of the treatment methods, and appropriate quality monitoring. Relatively simple and inexpensive indicator methods are available for routine monitoring of the microbiological safety of water and the efficiency of treatment processes. Most reliable results are obtained by high frequency testing for indicator organisms selected for particular purposes. For instance, routine monitoring programmes for drinking-water may be based on tests for thermotolerant coliform organisms or *Escherichia coli*. Under certain circumstances, tests for the heterotrophic plate count and coliphage may be included. These tests are simple, inexpensive and yield results in a relatively short time. More complicated and expensive tests such as those for human viruses and protozoan parasites are required only for particular purposes, including research and assessment of the efficiency of treatment processes.

Drinking-water quality in Seychelles (E. Sabury, Ministry of Health)

The Republic of Seychelles is a small island state situated on the North East of Madagascar 4^0 south of the equator. Its climatic condition is influenced by 2 main seasons namely the Southeast monsoon from May to October (dry season) and Northwest monsoon from November to April (rainy season). The population is around 70,000.

Our main water sources are run-off from various rivers with the exception of one borehole on La Digue Island. The quality of raw water is relatively high with low level of faecal coliform and virtual absence of heavy metals. Therefore a minimum treatment process is sufficient.

Presently, around 98% of the population have house connection out of which 53,000 enjoys treated water. The consumption rate is about 50-150 litres per capita per day.

The principal agency directly responsible for drinking-water quality is the Public Utilities Co-operation (PUC) which ensures the effective treatment of raw water before supply to consumers, and the screening of all development plans during their planning stage. The Environmental Health Section in the Ministry of Health is involved with the formulation of general guidelines and legislation concerning drinking-water quality standards and its monitoring. The Division of Environment on its part is mandated to ensure non-pollution of all sources of potential/actual drinking-water.

The main sources of pollution are unapproved construction development, defective waste water disposal systems, farming activities and turbidity during period of heavy rain. Even though we do have some pollution problems, statistics shows that we do not have any

serious problem in relation to water-related infections except for occasional cases of diarrhoeal diseases and parasitic diseases, but death never results from them.

Legislation available for drinking-water quality are the Public Health Act, the Water Examination (Regulations) of 1994 and the Environmental Act which will be enforced in March 1995.

Our main constraints at the moment is the relatively high cost for the effective operation of water work, lack of manpower, unavailability of adequate transport, lack of fund to finance future treated water supply projects in new areas and the improvement of existing systems and also difficulties in obtaining financing from International Agencies without forgetting the lack of qualified technicians working in this field. Of course for all of the above, Seychelles depends greatly on funding from International Agencies and Organization.

The PUC ambitions is to ensure that 95% of the population of Seychelles is provided with an efficient and potable water supply and that the used water is returned to the environment in a safe manner. Main priorities concerning the improvement of drinking-water quality in Seychelles is the implementation of the Mahe Integrated Water Supply Project (MIWS) so as to ensure that most of the inhabitant will have a chance to enjoy treated water by the year 2000.

WHO *Guidelines for drinking-water quality* - pesticides: health effects and basis of recommendations (H. Galal-Gorchev)

Pesticides are used for agricultural and public health purposes. Good agricultural practice in the use of pesticides can prevent many water contamination problems.

Pesticides evaluated in the *Guidelines* include many organochlorine compounds and herbicides since these are persistence in the environment and/or easily migrate in drinking-water.

In deriving GVs for pesticides, their environmental effects have not been taken into consideration.

For organochlorine pesticides, only 1% of the tolerable daily intake (TDI) was allocated to drinking water since exposure from food can be substantial. For the other pesticides, little is known about the different sources of exposure and therefore a default value of 10% of the TDI was used to derive the GVs.

In developing national standards for pesticides care should be taken to select first the pesticides that are used in high quantity in the country.

The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) has evaluated some 240 pesticides and established tolerable daily intakes for a number of these. Countries wishing to establish drinking-water standards for pesticides not evaluated in the *Guidelines* may find JMPR evaluations useful for this purpose.

In establishing national standards for pesticides, rigorous risk-benefit analysis must be conducted. For instance, the risk from pesticides in drinking-water might be far lower than the risk from not controlling malaria.

Drinking-Water Quality in Tanzania (M. Swai, Ministry of Health and D.M. Ishengoma, Ministry of Water)

The paper notes the need to update the 1974 temporary Tanzanian Standards for Drinking Water and review and reinforce the Water Utilization, Control and Regulation Act of 1974 and its Amendment Act No. 10 of 1981 in order to improve water quality.

The paper further observes continual deterioration of water quality resulting from weaknesses in water quality monitoring due to the poor state of water quality laboratories. It recommends consolidation of resources through establishment of Water Basin Laboratories and their strengthening (as well as the Central Water Laboratory at Ubungo) so as to bring about improvements in the control and regulation of effluent discharge, source protection and water supply delivery.

It emphasizes the training and sensitization of communities as well as their involvement in water quality issues so as to bring about improvements in water quality from source to the household.

In view of the various actors, the paper calls for speeding up the establishment of an intersectoral coordination committee and a secretariat towards a holistic approach on water supply and sanitation delivery in the country.

Drinking-Water Quality in Uganda (N. Senfuma, Directorate of Water Development)

Uganda is one of the three East African Countries with a total land area of 235 880 km^2 of which 39 460 km^2 is surface water. Besides the huge water resources, the country has plenty of rainfall ranging from 700-2000 mm/per annum. Uganda has a population of 17 millions (1989) out of which 15 millions are rural and 2 millions are urban.

Although the country is endowed with huge water resources, these are unevenly distributed leading some communities in rural areas to walk long distances to look for water. Presently the water supply coverage is 37% for the rural and 65% for the urban population. The Government strategy is to increase the coverage to 75% rural and 100% urban by the year 2000.

Generally Uganda surface waters are not polluted except in localized areas. These are the urban, mining areas and large agricultural estates.

Underground water in localized areas is also of poor quality. It contains fluorides, high iron content, salinity, is corrosive and has high counts of *E. Coli* in shallow wells.

Uganda water resources are faced with a number of problems such as:

- Semi-treated sewage is discharged into water bodies. This is common in all urban areas;
- The quality and quantity of industrial effluent which are discharged from agro-based industries into water bodies are not known;
- Poor sanitation and poor land management lead to siltation and colouring of the water bodies;
- The concentration of minerals in mining areas is unknown;
- Generally poor water quality and quantity is responsible for the high diarrhoeal and intestinal worm diseases.

There is no comprehensive water quality monitoring in the country. Where it is done, only physico-chemical parameters and bacteriological analysis are carried out.

The mandate to manage, conserve and develop the water resources in Uganda is vested in the Ministry of Natural Resources through the Directorate of Water Development. While executing this mandate, the Ministry collaborates with other line Ministries of Health and Local Government.

A number of Non-Governmental Organizations (NGOs) also play a part in the provision of water. There is a Central Water Quality and Pollution Control laboratory in the Directorate of Water Development in addition to small ones at regional levels.

There are several Acts that relate to water in Uganda. The most relevant are the Public Health Act and the Water Resource and Water Supplies Act which provide for the establishment of multi-sectoral Water Policy Committee. These acts provide the enabling environment not only for water supply but also for the overall resource management.

Drinking-Water Quality in Zimbabwe (S.S. Musingarabwi, Ministry of Health)

Zimbabwe's water drainage system runs from the South West along the high veld across the country to the north east. The river systems originate from the high veld to drain either to the Zambezi River Basin to the north or the Limpopo River Basin to the south. Most of the major towns are situated on the high veld and it is in this area where agricultural activities are mostly found.

Sources of water include rivers, dams, wells, boreholes and springs. Possible sources of pollution are agrochemicals, industrial waste, sewage effluent, towns runoffs, refuse and latrines. It is with this background that sanitary protection of water sources can be instituted taking into consideration location of water point, distance from sources of contamination, protection of water sources. In addition to the above, water purification plant can be established where large quantities of water are required to be used by a large population. Health and hygiene education on the transport and storage of water in the homes should be

emphasized.

In Zimbabwe, a number of agencies are responsible for water resources development. Ministries of Health, Agriculture, Local Government and Local Authorities, Mines, Estates and Farmers are taking part in water development. However, the guidelines for drinking-water quality are set by Ministry of Health and Child Welfare. The guidelines stipulate that all water intended for human consumption should be free of *E. coli* per 100 ml sample. This may not be achievable with untreated water supplies, as a result, 10 *E. coli* per 100 ml sample or less, would be considered satisfactory. The chemical content is as stipulated in WHO *Guidelines*.

In view of the aforementioned, accessibility to safe water supplies remains a major problem. Urban population and other built up rural areas enjoy treated piped water supplies. In non- built up rural areas, the population depends on underground supplies such as boreholes, wells or springs. A borehole should supply at least 250 people, a deep well 150 people and a shallow well 50 people. The water source should not be farther than 500 metres away from consumers. As of now, the national coverage is 78%. While the urban coverage is 100%, the rural coverage is 43%.

There are also legal instruments which are used to protect water bodies from pollution, such as the Public Health Act, Water Act and Inland Water Act. Public Health officials within the Ministry of Health, enforce these statute Acts and liaise with other sector ministries where necessary. The water quality monitoring is the responsibility of the Ministry of Health.

Random sampling is carried out on all water supplies. Water samples may be collected in order to determine suitability of the supply, investigate illness, complaint or following request. A regular monitoring mechanism, has not been put in place due to logistical problems. If laid down standards are to be observed, a systematic water quality surveillance has to be established with adequate laboratory infrastructure being made available including adequate staff for sampling.

Disinfectants and disinfectants by-products, and Organic Chemicals (B. Mintz, US EPA)

The World Health Organization *Guidelines for Drinking Water Quality* were established to provide guidance on levels of drinking-water contamination that should be considered "safe". The guideline values are based on results from toxicity studies using laboratory animals or from human epidemiological studies. To account for the scientific data gaps regarding the toxic effects that could possibly occur in humans from relatively low levels of exposure, the guidelines values were established using statistical modelling for carcinogens, uncertainty factors (UFs) for non-carcinogens and exposure assumptions that provide a margin of safety. The UFs for these organic chemicals and disinfectants and disinfectant by-products (DDBPs), which range from 100 to 10,000, are used to help account for incomplete toxicity information and for possible increased toxic responses in more susceptible individuals. The guideline values are derived with a margin of safety to account for variability and uncertainty in dose-response and exposure data; therefore, exceeding a guideline value by a minor amount is generally unlikely to result in adverse health effects. The risk associated with exceeding a guideline value should be evaluated on a case-by-case

basis. While there is great scientific certainty that inadequately disinfected water can result in microbial disease outbreaks, there is relatively great uncertainty regarding the health risks from use of disinfectants.

Drinking-Water Quality in Zambia (S. T. Chisanga, Ministry of Environmental Health Issues and W. Shawa, Lusaka Water and Sewerage Company)

Zambia's population stands at 7.8 millions with annual growth rate of 3.2% (1990 census). The responsibility for the provision of water services is divided among several ministries i.e. National Commission for Development Planning, Ministry of Energy and Water Development, Ministry of Local Government and Housing, Ministry of Works and Supply, Ministry of Health, Ministry of Environment and Natural Resources, Ministry of Environment, Ministry of Community Development and Social Welfare, and the Ministry of Agriculture, Food and Fisheries. The level of coverage indicates that 58% of the total population have access to potable water supplies and 42% to sanitation. Generally, most Municipal Councils carry out their own water quality tests. Nationally, water control is monitored by the Ministry of Health and the Environmental Council. The Ministry of Health has embarked on a National Drinking Water Quality Control Programme to incorporate both urban and rural areas. Under the Environmental and Pollution Control act, Zambia has formulated regulations setting effluent standards and is further formulating those that should come under the Zambia Bureau of Standards Act.

Zambia is a copper mining country. Studies and tests carried out by the National Council for Scientific Research have shown that copper concentration found in natural water courses are within acceptable limits.

The Ministry of Health has proposed provision of 100 litres per capita per day from the health point view but this view will the discussed with other organizations in water supply and a consensus will be reached.

WHO *Guidelines for Drinking-Water Quality*: inorganics, acceptability aspects and aesthetics (H. Galal-Gorchev, WHO)

Many of the inorganic and aesthetic constituents evaluated in the *Guidelines* are known to be essential for life. Chromium, copper, fluoride, iodine, manganese, molybdenum, and selenium are essential elements in human nutrition; arsenic and nickel are considered by some researchers as essential elements. Of the aesthetic constituents, iron, chloride, calcium and magnesium (hardness), sodium and zinc are essential elements. No attempt has been made in the *Guidelines* to define a minimum desirable concentration of essential elements in drinking-water. The *Guidelines* are concerned with the quantification of the toxic effects of chemicals.

Health-related contaminants of importance to several countries were discussed. These included asbestos, fluoride, nitrate and nitrite, lead, copper and manganese.

Contrary to the 1984 *Guidelines*, the 1993 *Guidelines* do not propose guideline values for substances and parameters that affect the acceptability of drinking-water to consumers. The Review Groups were of the opinion that guideline values should be recommended only for those substances that are directly relevant to health. On this basis no GVs were

established for total dissolved solids, turbidity, iron or other aesthetic parameters.

In the case of characteristics based on human sensory evaluation, judgement is often subjective. Aesthetic/organoleptic characteristics are very much subject to social, economic and cultural considerations, and the establishment of standards for the aesthetic quality of drinking-water should take into consideration implementation possibilities, and the existing socio-economic and environmental constraints. When resources are severely limited, establishment of priorities becomes even more important, and such priorities should be set in relation to their direct impact on health. Some countries have elected to set enforceable standards for constituents of health significance, whereas recommendations only are made for aesthetic and organoleptic characteristics.

Drinking-Water Quality in Ethiopia (A.H. Mariam and M. Husen, Ministry of Health)

The status of water quality in both rural and urban areas of Ethiopia is far from satisfactory. The high prevalence of waterborne, water-washed, water-related and water-based disease is the causal factor of contaminated water sources. In mid-1992, it was estimated that only about 26 percent of the total 42 million population had access to potable water supply. The present analysis of urban water supply coverage reveals that, of the estimated total of around 5.2 million urban population (excluding Addis Ababa), around 3.5 million, or 67.4% are supplied with potable water. The water supply and sanitation sector, like other sectors of the economy, suffers from the political crises in the country as well as from environmental degradation, recurrent drought, low level of per capita external resource flow and a rapid and accelerating population growth which are among the major issues to be addressed. In addition, lack of inter-sectoral coordination, lack of practical and applicable regulations for water supply and sanitation, and unavailability of Regional Public Health Laboratories are some of the major constraints.

Drinking-Water Treatment Technology (V. Aalto, WHO)

The best treatment is no treatment and the second best is minimum treatment. To minimize treatment needed, special emphasis must be given to the choice of the water source, intake structures and sites, and to the protection of present and potential future sources.

In certain cases, pre-treatment of raw water is necessary, for example due to excessive turbidity. It can be dealt with by using several weeks storage, infiltration through riverbed or sand dunes, or roughing filtration. Excessive iron or manganese contents can be reduced with pre-aeration. Pre-aeration has been used also to reduce objectionable taste and odour. Such problems can emanate from defective dam and intake designs and can be minimized or avoided at that stage. Pre-disinfection by chlorination is not recommended due to possible odour problems and formation of haloforms and other potentially harmful compounds.

Coagulation, flocculation, sedimentation and rapid sand filtration is common treatment for most waters. It gives usually good results but requires a high level of supervisory skills and secured supply of chemicals. A common problem with coagulation/flocculation systems has been in the mixing of flocculating chemicals; mixing is often not adequate. Usually it is advisable to stay with proven technology with secured spare part supply when making choices of equipment and technology for treatment plants.

Slow sand filtration (SSF) uses no chemicals and requires limited operation and maintenance demands. Supervision is nevertheless necessary. SSF usually demands higher capital investment than conventional water treatment plants due to the large surface area required for the filters, but its operation costs are much lower. High or medium turbidity in raw water blocks slow sand filters and therefore requires pretreatment such as roughing filtration.

Disinfection of water is necessary to ensure the microbiological safety of treated drinking-water leaving the plant. Chlorination is usually the recommended method due to economic reasons, although it can produce some potentially harmful compounds in water. The potential adverse health effects from these compounds are negligible compared to the health risks emanating from pathogens in drinking-water.

Drinking Water Quality in Mozambique (M. Dos Anjos Havengue, Ministry of Health)

To provide sufficient and safe water for the people is essential for safeguarding health. In 1984, WHO published the *Guidelines for Drinking-Water Quality*, but these are very strict and many countries cannot achieve them. Mozambique is not an exception.

The total population in Mozambique is about 16 million people (census, 1993), 40% are urban population and 60% rural. Only 55% of the total population receive treated water. The rest obtain water from boreholes, shallow wells and rivers.

Related to water quality in Mozambique, the Ministry of Water is responsible for all water management and the Ministry of Health for water quality. There are other institutions that contribute in this area which are the National Environmental Commission, Ministry of Industry and Energy and NGOs.

For water quality control, Mozambique has 10 laboratories which do routine analyses (total and faecal coliforms, nitrate and pH).

In 1981, National Standards were developed (not official). These are described in the Manual for Water Analyses (1987, Mozambique).

The problems that affect Mozambique are: water quantity and quality, transport, and inadequate legislation. Therefore, priorities should be given to the following:

- provide enough water supply of good quality
- enforce the capital investment and legislation
- monitoring of other pollutants
- increase sanitation facilities
- community involvement

Drinking-Water Quality in Malawi (R.D. Kafundu, Ministry of Irrigation and Water Development)

The Malawi Government has developed a "Water Resources Management Policy and Strategy" document that aims at safeguarding the water resources of the country as the country is experiencing drought from time to time.

Policy on coverage is 160 litres per head per day with house connections of fully treated water and waterborne sanitation for the urban population. In the rural areas it is advocated that a water point should be within 500 metres one way. At least 27 litres per head per day of water should be supplied from partially treated or protected sources such as gravity schemes, boreholes, shallow wells and springs.

The peri-urban dwellers are either supplied from urban sources through stand points or from boreholes drilled in their vicinities.

The Malawi Government has also developed temporary guidelines for drinking-water based on WHO *Guidelines*. There are two temporary guidelines. The first one was developed by the Water Department and a second one is being refined by Malawi Bureau of Standards (MBS) from the first guidelines.

Water supply in Malawi is the responsibility of the Water Department, Parastatals and NGOs. The Water Department supplies water to small towns and institutions which meets WHO *Guidelines*. There are 53 schemes of this type. Supply of water to the rural areas is also the responsibility of the Water Department. Here water is supplied to the rural population using the temporary guidelines developed within the country.

In the big cities of Blantyre and Lilongwe, water is supplied by parastatal water boards. Other players in the water sector are the Ministry of Health that provides health education and sanitation programmes, the Ministry of Local Government which carries out sanitation and the Ministry of Community Services which provides community mobilization logistics. There are also quite a few NGOs in the water sector.

Water supply coverage is 84% in urban and 48% in rural areas. It is important that the systems are sustainable, especially in the rural areas and this is being done by developing village level operation and maintenance.

Surface water is deteriorating both in quality and quantity due to poor land use practices such as deforestation, application of agrochemicals, industrial pollution and human settlements close to streams.

In Malawi, groundwater constitutes 75% of the supplies in rural areas. This source is also being threatened by pollution as described above. Other pollutants are from natural chemicals such as iron, fluoride, sulphates, nitrates and total dissolved solids.

The policy of the government is to supply urban population with fully treated water in sufficient quantity. In the rural areas the same applies except that the water is either partially treated or the source protected.

The Water Resources Act of 1969 and the complimentary Water Works Acts for Blantyre (1971) and Lilongwe (1987) govern the water resources development of the country. These acts are currently being reviewed.

Coordination in the water sector is done through the Water Resources Board with members from Ministries of Health, Local Government, Agriculture, Office of the President,

Finance and Environmental Affairs. Stake-holders are also represented.

As recommended in the WHO *Guidelines*, the development of temporary guidelines for drinking-water in Malawi is a step in the right direction for problem water sources.

Surveillance of Drinking-Water Quality (R. Helmer, WHO)

The most immediate task for the implementation of national drinking-water quality standards is the establishment of an effective surveillance and control mechanism. Responsibilities should be shared among water supply agencies (in charge of routine control) and public health agencies (in charge of surveillance). Suitable arrangements and lines of communication need to be established at national, regional/provincial and district/local levels. Two concurrent activities have to be undertaken, sanitary inspection and microbiological testing. Sanitary risk scores emanate from the completed and evaluated inspection forms. The faecal coliform test results can be classified in groups from 0-10, 10-100, etc. numbers of faecal coliforms per 100 ml. Each water system can then be inserted in a health risk assessment diagram which can provide a simple but easy to communicate means of evaluating all water supplies in a given area. A colour-coded system could also be used to present surveillance results and to demonstrate trends over several years.

WHO *Guidelines for Drinking-Water Quality* and the National Standards-setting Process (B. Mintz, US EPA)

The process of developing national drinking-water standards can be broken down into the following discrete steps: chemical selection (priority setting), development of health-based goals (risk assessment), consideration of technical/economic feasibility and risk trade-off (risk management), and characterizing for decision makers and the public the possible risks and the predicted risk reductions (risk communication). The WHO *Guidelines for Drinking-Water Quality* (GDWQ) are health-based goals. They can be used as valuable tools, along with other considerations, to establish national standards. They can also be used to make case-by-case risk management decisions for specific water supplies. In addition to the standards setting process, adequate drinking-water quality can only be assured by monitoring, treatment and preventing contamination of water sources.

Water Pollution Control and Protection of Drinking Water Sources (R. Helmer,WHO)

The protection of water sources for community supply requires rigorous pollution control measures. Three aspects have to be considered: health, water and environment. Pollution of water resources requires often expensive treatment works before supplied to the population or, alternatively, clean sources have to be used with long and costly transport pipelines. As a consequence, the price for additional supplies of large cities becomes rather high. Thus water pollution control emerges as an economical long-term solution. The health impacts of water pollution can be dramatic in terms of morbidity and mortality due to waterborne diseases, and also in terms of economic losses. There are a variety of approaches to prevent and/or control pollution at the source: technical measures such as cleaner production technologies, effluent treatment or industrial recycling; regulatory measures such as effluent standards; and economic measures such as effluent charges, tax incentives, or other financial incentives. Implementation of any pollution control measure requires

competent institutions and effective enforcement programmes.

Water Pollution Control and Protection of Drinking-Water Sources-Lake Chivero (E. Khaka, UNEP)

Lake Chivero, a man made lake on the Manyame river, is the water supply for the City of Harare. Harare was built in the catchment of the lake and discharged its sewage water into the Manyame river which flowed into Lake Manyame. The lake became eutrophic in the mid-1960s and recovered in the mid-1970s after some rehabilitation measures were carried out. The measures consisted of (i) diverting nutrient-rich sewage effluent to irrigate crops (ii) improving sewage treatment methods (iii) spraying water hyacinth with chemicals and (iv) introduction of pollution control legislation and some standards.

During the 1980s the lake became eutrophic again because of (i) sewage effluent from Chitungwiza which is also in the catchment of Lake Chivero (ii) urban runoff from Harare and Chitungwiza and (iii) occasional spills from the Harare sewage works. This led to outbreaks of water hyacinth and algal blooms. The weed was controlled by spraying with the herbicide 2,4-D. Biological control using beetles failed. Control measures introduced are upgrading sewage treatment plants in the two cities in the catchment and re-introducing of the weed control unit.

ISSUES AND RECOMMENDATIONS

a. One of the highest regional priorities is adequate disinfection of microbially contaminated surface water supplies. Open water supply sources should be disinfected. A major barrier is the lack of adequate supplies of chlorine. The cost of chlorine disinfection more than compensates for the cost in lost lives, reduced work productivity, malnutrition and medical treatment resulting from the prevalence of waterborne diseases and potential epidemic outbreaks. Governments should allocate the needed resources to provide adequate chlorine supplies.

b. Water sources need to be protected by:

   i. Preventing/minimizing discharge of untreated sewage and industrial effluent, and

   ii. Minimizing and controlling runoff and leaching of agricultural chemicals (pesticides and fertilizers), animal and human faecal waste products (nitrate/nitrite), mining discharges and runoff.

   National/local government support is needed to provide incentives or legal enforcement mechanisms to prevent/minimize discharges.

c. In several countries of the Region, several ministries and other national authorities are involved in water quality issues. There is a need to establish coordinating mechanisms, possibly in the form of an Intersectoral Water Coordinating Committee, to avoid duplication of effort, to clearly identify responsibilities, and allow

coordinated efforts. Equally, there is a need for improved coordination between UN agencies, NGOs and other external support group involved in national water supply programmes.

d. Provision of safe drinking-water in adequate quantity, sanitation, food hygiene, proper nutrition, immunization and health education are all important factors in the prevention of diseases. Therefore, drinking-water quality should not be looked at in isolation but rather a holistic public health approach should be adopted in attempting to solve the problem of infectious and parasitic diseases.

e. Public education is needed to ensure proper household water and food handling hygiene practices (e.g. storage, point-of-use chlorination, filters, boiling).

There is a need for community participation and a public health education programme to understand the risk from microbial and chemical contaminants. WHO, UNEP and NGOs, in collaboration with Governments, could assist in preparing and transmitting such information.

f. Technical and financial assistance is needed to help provide training and equipment to carry out needed sampling, analysis, risk assessment, treatment and control strategies. Particular emphasis on microbial indicators is needed.

g. Although of relatively lower priority compared to microbes, organic chemicals, including pesticides in drinking-water are likely to be a problem in the Region. However, because of lack of knowledge of the nature of chemicals used by industry (trade names are often used), quantities discharged in wastewater and limited or inexistent capability to monitor for these chemicals, the magnitude of the problem is largely unknown and, therefore, very difficult to assess. Technical and financial assistance is needed to assess the nature and quantity of chemicals discharged.

Governments should make it mandatory that agrochemical and other industries reveal to them the chemical composition of their products. Such information should be made available to those involved in water supply programmes.

h. WHO should develop a manual for the treatment of water at the household level and in small communities, including disinfection and control of naturally occurring chemical contaminants. Fluoride is of particular health concern and there is a need for appropriate fluoride removal technology. This manual should also address the control of other inorganic chemicals such as nitrate, iron and manganese.

i. Provision of drinking-water is not sufficient in itself. Programmes for water quality monitoring and surveillance are also needed to ensure the continuous delivery of safe drinking-water to the public. Consistent and reliable sampling and analysis with prioritization is needed.

In all water supply projects, proper consideration should be given to water quality monitoring requirements and high priority should be given to allocating the necessary resources, for effective monitoring programmes. Governments should seek

sustainable funding for monitoring.

WHO and UNEP should provide support for establishing drinking-water quality surveillance programmes in developing countries, including training, equipment and chemicals. Drinking-water quality monitoring programmes should be integrated with other monitoring programmes such as GEMS/Water.

j. WHO should seek advice from developing countries on how useful Volume 1 of the *Guidelines* is and how it can be improved.

k. WHO should find ways and means of assisting countries in the Region in obtaining information on the safety of water treatment chemicals such as polyelectrolytes and newly introduced chemicals.

SEMINAR EVALUATION

A summary of the participants' evaluation of the Seminar is given as Annex 3, together with the form used for this purpose.

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Annex 1

JOINT WHO/UNEP/USEPA
SEMINAR ON THE WHO GUIDELINES FOR DRINKING-WATER QUALITY
NAIROBI, 28 NOVEMBER - 1 DECEMBER 1994

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Annex 2

Joint WHO/UNEP/US EPA Seminar on the WHO Guidelines for Drinking-Water Quality
UNEP Headquarters, Nairobi, 28 November - 1 December 1994

AGENDA

Monday 28 November

Morning

1. **Opening session**

   - Mr Walter Rast, Chief, Freshwater Unit, UNEP, Nairobi
   - Mr Richard Helmer, Chief, Urban Environmental Health WHO, Geneva
   - Mr J.G. Kariuri, Senior Public Health Officer Ministry of Health, Kenya

2. **Election of Chairpersons, appointment of Rapporteur, introduction of participants**

3. **General introduction to the WHO Guidelines for Drinking-Water Quality (GDWQ)** (Mrs H. Galal-Gorchev, WHO)

4. **Drinking-water problems in Kenya** (Mr J.G. Kariuki, Ministry of Health, and Mr E.N Nyaga, Ministry of Land Reclamation)

Afternoon

5. **WHO GDWQ: Microbiological aspects** (Mr W.O.K. Grabow, University of Pretoria)

6. **Drinking-water quality in Seychelles** (Ms E. Sabury, Ministry of Health)

7. **WHO GDWQ: Pesticides** (Mrs H. Galal-Gorchev, WHO)

Tuesday 29 November

Morning

8. **Drinking-water Quality in Tanzania** (Ms M. Swai, Ministry of Health, and Mr D.M. Ishengoma, Ministry of Water)

9. **WHO GDWQ: Inorganics** (Mrs H. Galal-Gorchev, WHO)

10. **Drinking-water quality in Uganda** (Mr N. Senfuma, Directorate of Water Development)

11. **WHO GDWQ: Organic constituents** (Mr B. Mintz, US EPA)

Afternoon

12. **Drinking-water quality in Zimbabwe** (Mr S.S. Musingarambwe, Ministry of Health)

13. **WHO GDWQ: Disinfectants and their by-products** (Mr B. Mintz, US EPA)

14. **Drinking-water quality in Zambia** (Mr S.T. Chisanga, Ministry of Health)

Wednesday 30 November

Morning

15. **WHO GDWQ: Acceptability and aesthetic aspects** (Mrs H. Galal-Gorchev, WHO)

16. **Drinking-water quality in Ethiopia** (Mr A.H. Mariam and Mr M. Husen, Ministry of Health)

17. **Drinking-water treatment technology** (Mr V. Aalto, WHO)

18. **Drinking-water quality in Mozambique** (Ms M.dos Anjos Havengue, Ministry of Health)

Afternoon

19. **Drinking-water quality in Malawi** (Mr R.D. Kafundu, Ministry of Irrigation and Water Development)

20. **Surveillance of drinking-water quality** (Mr. R. Helmer, WHO)

21. **Roundtable discussion, Seminar recommendations.** Secreteriat to prepare draft report

Thursday 1 December

Morning

22. **WHO GDWQ and the National standards-setting process** (Mr B. Mintz, US EPA)

23. **Water pollution control and protection of drinking-water** (Mr R, Helmer, WHO and Ms E. Khaka, Ministry of Health, Zimbabwe)

24. **Discussions and adoption of draft report**

25. **Seminar evaluation**

26. **Closure of Seminar**

Annex 3

Joint WHO/UNEP/US EPA Seminar on the WHO Guidelines for Drinking-Water Quality

28 November - 1 December 1994
Nairobi

Summary of Evaluation Forms

In general very positive responses:

- Items of particular interest : Asbestos, other chemical contaminants, and bacteriological quality (all deemed to be well covered).

- Many expressed the views that the seminar and the guidelines will be used in developing national standards.

- Positive to gain insight into other countries problems and helpful to share information, but many felt that more time should have been allocated to more specific group discussions.

- Almost all participants had made specific plans on how to share the experiences gained at this seminar in their home countries.

Issues inadequately treated at seminar:

- problems related to insufficient amount of trained personnel;

- financial limitations (because these may affect the implementation of quality standards);

- institutional and legal arrangements that may not be adequate in the respective countries and therefore could have been addressed at the seminar;

- community-based interventions could have been discussed

- guidelines for raw water quality;

- guidelines for rural communities (large part of the population drink water directly derived from source, with no treatment);

- involvement of private sector in water quality management.

Suggestions for improving future seminars:

- Field visits (case studies; alternatively video films of case studies);
- Relevant international publications should have been made available;
- More emphasis on discussions, with discussion facilitators or group discussions on main issues;
- Guidelines and other documentation should have been distributed before the seminar;
- More information on the required contents of the country papers, and earlier notice of participants desired;
- Follow-up workshops suggested.

QUESTIONNAIRE FOR PARTICIPANTS OF WORKSHOP ON THE APPLICATION OF WHO DRINKING WATER QUALITY GUIDELINES; EAST AFRICAN REGION

UNEP, NAIROBI, NOV. 28 - DEC. 1, 1994.

1. GENERAL INFORMATION

Name of Participant: _____

Place of employment: _____

Address: _____

_____

Position: _____

2. BENEFITS DERIVED FROM THE WORKSHOP

2.1 Personal benefits:

Did the seminar help you become more aware and more knowledgeable about quality criteria for drinking water? _____

Please elaborate your answer below:

_____

_____

_____

_____

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_____

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_____

2.2 Benefits for your workplace or country:

Do you intend to share the knowledge you gained at the seminar with your collegues?

If Yes How do you intend to do it?

3. EVALUATION OF THE SEMINAR:

Do you have any suggestions as to how such seminars can be improved?

Do you feel that country participants were given enough time?

Do you feel you were given enough time to discuss your country's particular problems?

Do you feel that the lecturers covered issues of importance for the region?

In case not, which issues were missing?

Do you have any suggestions as to alternative ways of organizing such seminars?

Please elaborate on this issue:

4. General Comments:

Thank you for your kind cooperation.