WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE
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REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REPORT

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

Kuala Lumpur, Malaysia

27 February - 3 March 1989

Kuala Lumpur, Malaysia

May 1989

ICP/RUD/001

ENGLISH ONLY

REPORT

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

Convened by the

WESTERN PACIFIC REGIONAL CENTRE
FOR THE PROMOTION OF ENVIRONMENTAL PLANNING
AND APPLIED STUDIES
(PEPAS)

PEPAS, Kuala Lumpur, Malaysia
27 February - 3 March 1989

Not for sale

Printed and distributed

by the

Western Pacific Regional Centre
for the Promotion of Environmental Planning
and Applied Studies
(PEPAS)
P O Box 12550
50782 Kuala Lumpur
Malaysia

May 1989

NOTE

The views expressed in this report are those of the participants in the workshop and do not necessarily reflect the policies of the World Health Organization.

This report has been prepared by the Western Pacific Regional Centre for the Promotion of Environmental Planning and Applied Studies (PEPAS) for Governments of Member States in the Region and for the participants in the Regional Workshop on Drinking Water Quality Monitoring and Surveillance, held in Kuala Lumpur, Malaysia, from 27 February to 3 March 1989.

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1. INTRODUCTION

The Regional Workshop on Drinking Water Quality Monitoring and Surveillance was held at the WHO Western Pacific Regional Centre for the Promotion of Environmental Planning and Applied Studies (PEPAS) on the campus of the University of Agriculture, Malaysia (Universiti Pertanian Malaysia), Serdang, Selangor, Malaysia from 27 February to 3 March 1989.

The workshop was sponsored by WHO and attended by 18 participants from 14 countries or areas in the WHO Western Pacific Region. In addition, three observers from Malaysia, Philippines and the Netherlands representing the Department of Environmental Sciences, University of Agriculture Malaysia; the Asian Development Bank; and the International Reference Centre for Community Water Supply and Sanitation in the Hague respectively also participated in the workshop.

A list of the participants, observers and secretariat members is presented in Annex 1.

2. OPENING SESSION

Following some brief introductory remarks by Dr P. Guo, Acting Director of PEPAS, the WHO Representative for Brunei Darussalam, Malaysia and Singapore, Dr L. R. Verstuyft, delivered a message on behalf of Dr S. T. Han, Regional Director, WHO Regional Office for the Western Pacific. The message stressed the importance of the workshop objectives and indicated the underlying reasons which led to its organization.

Delivering the welcoming address, Prof Dr Mohamad Khalid bin Mohamad Nor, Deputy Vice-Chancellor of the University of Agriculture, Malaysia expressed the interest of the University in the subject matter of the workshop and wished all the participants a fruitful and pleasant stay in Malaysia. The full text of these two addresses is given in Annex 2.

Dr Guo, the Operational Officer for the workshop, thanked Deputy Vice-Chancellor. He then introduced the consultants and requested the participants to introduce themselves one by one.

3. OBJECTIVES

The objectives of the workshop were:

(a) to provide a forum for the exchange of information and views on drinking-water quality monitoring and surveillance in the countries or areas of the Region;

(b) to review and evaluate problems and constraints associated with drinking-water quality monitoring and surveillance and the potential health hazards associated with the consumption of unsafe drinking-water;

(c) to familiarize the participants with the methods and procedures of drinking-water quality monitoring and surveillance (and its health implications);

(d) to promote the institution of an effective drinking-water quality monitoring and surveillance programme in the development of national water supply projects; and

(e) to develop a step-by-step workplan and methodologies for implementing national programmes for water quality monitoring and surveillance, particularly for small communities.

4. WORKSHOP PROGRAMME

The workshop agenda/timetable and list of hand-outs including working papers and country reports are given in Annexes 3 and 4 respectively.

Copies of the country reports prepared by the participants were distributed and are summarized in Annex 5. Copies of working papers prepared by WHO staff, consultants and participants were also distributed and additional copies are available on request from PEPAS library.

The first four days of the workshop were chaired by Dr P. Guo. The sessions on the last day were chaired by both Mr Hazbun and Dr B. Lloyd. Each of the two consultants, Dr Y. Magara and Dr B. Lloyd contributed four papers, and PEPAS Staff, Mr B. Fisher, Drs H. Ogawa and K. Bentley, each presented a paper at the workshop. Each participant presented his country report and Mr J. Hazbun of WHO made a summary and provided an overview of the levels of development of drinking water monitoring and surveillance in the region.

A field visit to Bukit Tampoi water treatment plant in Kuala Lumpur, was organized in the afternoon of the third day in order to observe and practise sanitary surveys. The afternoon of the fourth day was spent in working group discussions and part of the last day for presentation of the results of the group discussions and the evaluation of the workshop.

5. PRESENTATION OF PAPERS AND DISCUSSIONS

The first paper was presented by Mr B. Fisher, PEPAS Decade Engineer. He reviewed the progress made in the water and sanitation sector ever since the start of the International Drinking Water Supply and Sanitation Decade (IDWSSD) in this region. He concluded his talk by enumerating the constraints that stand in the way of reaching the targets of the Decade.

His presentation was followed by a discussion centred on community participation as means of ensuring further progress in the sector. Some participants expressed doubts as to whether it was possible to sustain community interest for a long time right after a water supply system had been built.

The rest of the session for the first day was devoted to the presentation of the individual country reports prepared by the participants. After each presentation, a question and answer period followed. The nature of the discussions showed keen interest of the participants in exchanging experience and interacting with other participants.

On the second day, three speakers covered different aspects of monitoring and surveillance in drinking water. Dr Magara's presentation on Principles of Drinking-Water Quality Monitoring and Surveillance discussed the characteristics and management of water supply systems, the drinking water quality standards, the water quality and management levels, and the planning which is underway for revising the WHO guidelines for drinking water quality.

The other presentation made by Dr Magara covered the Chemical and Physical Aspects of Drinking-Water Quality Monitoring which included topics on raw water quality, selection steps for water systems, the chemical and physical aspects of ground and surface water quality and options for water purification plants.

Dr Lloyd's first presentation dealt with Drinking Water Quality and Public Health. In this presentation, Dr Lloyd emphasized that water quality control was one of a series of integrated public health measures needed to reduce infant mortality and improve life expectancy. The combined effects of increased water supply coverage and quantity have been shown to produce an average of 25% reduction in water-related diseases in recent studies. Water quality alone accounts for an 18% average reduction of disease when supplies are significantly improved. Together these several factors were shown to produce an average of 37% reduction in diseases, whilst sanitation may add a further 22% reduction. It was thus demonstrated that although water quality is important, it should not be considered in isolation if maximum health benefits from water supply are to be achieved. This leads us to identify additional parameters, termed as water service quality parameters which also affect the health of the consumer. These are coverage, quantity, continuity, quality and cost.

It was shown that the diarrhoeal diseases were still the number one cause of morbidity and mortality amongst small children in most countries. An environmental transmission classification was presented which emphasized that this group is commonly either waterborne and/or waterwashed. The epidemiological data presented showed a clear association of diarrhoeal diseases, typhoid and hepatitis with seasonal rainfall and temperature variation.

In his second presentation, Dr Lloyd covered the Microbiological Aspect of Drinking-Water Quality Monitoring. In this presentation, Dr Lloyd discussed the primordial role of E. Coli as the faecal indicator. It was pointed out that toxigenic strains of E. Coli are amongst the commonest causes of diarrhoea worldwide. It was demonstrated that the frequency of contamination of chlorinated water supplies in urban areas and the intensity of contamination of rural supplies could be used as the basis for classification of drinking water quality; and it was suggested that microbial contamination was still the most important hazard in water supplies.

An algorithm for the choice of bacteriological testing procedures was presented and the merits of the membrane filtration technique were contrasted with the most probable number method.

After each presentation, lively discussions took place where issues related to the subject matter were raised in the context of the experience of the participants.

Participants also presented their country reports during the remaining part of the day. To finally wrap-up these presentations, Mr Hazbun made an overview of the drinking-water quality monitoring and surveillance activities in the region by summarizing the activities and classifying the status of monitoring and surveillance in the various countries participating in this workshop (Annex 5).

The third day programme began with a presentation by Dr Y. Magara which covered the design of a drinking water quality monitoring network. In this presentation, the number of samples to be collected and the operating cost of sampling/testing in Japan were given. The average cost of monitoring water in Japan is approximately US$0.016 per cubic meter.

This was followed with a presentation by Dr K. Bentley, PEPAS Chemical Safety Adviser, who covered the aspect of radionuclides in drinking-water, the health impact, monitoring and control. In his presentation, Dr Bentley explained the source of these radionuclides, their occurrence in drinking-water and the WHO guideline limits set for these elements. He advised the workshop that in the event the radionuclides in the drinking water supply were found to be exceeding the WHO guideline limits, the authorities should seek help from outside bodies such as the Collaborating Centres in the Region or from the International Atomic Energy Agency (IAEA) in Vienna.

The third presentation made by Dr Magara was on sampling frequency, techniques and procedures for monitoring of drinking water quality. In his presentation, Dr Magara stressed the need for accuracy, the selection of analytical methods to be used and the sampling methods.

Drs B. Lloyd and P. Guo made a joint presentation on Sanitary Surveys that should accompany or form part of drinking water quality monitoring and surveillance programme.

For urban water supplies with conventional treatment, it was pointed out that three types of sanitary surveys could be readily identified:

1) water source - upstream of a water intake,
2) treatment plant, and
3) distribution system

The importance of a complementary sanitary survey and analysis was emphasized, as was the importance of preparedness before embarking on the survey.

For rural systems it was demonstrated that the risk of pollution of a water source could be assessed by a rapid on-site inspection check list. The correlation between intensity of faecal contamination and level of risk indicated by inspection was shown for rainwater catchments, dug wells and tubewells. A series of slides/transparencies were used to demonstrate some of the common risks in piped and unpiped water systems.

In the afternoon, the participants visited the Bukit Tampoi water treatment plant to observe first hand the operation of a conventional water treatment plant and to conduct a detailed sanitary survey at the treatment plant. The group was welcomed by Mr Hj Al-Bakry bin Hj Alias, District Water Engineer and his staff. He briefed the workshop participants on the history, unit processes and operation and maintenance of the plant.

The Bukit Tampoi water treatment plant serves 20 000 households with a population of 100 000 inhabitants. It has a treatment capacity of 34 000 m3/day (7.5 million gallon/day). The group was then taken through the plant by Dr B. Lloyd where the various aspects of the operation of the plant were explained by him and the staff of the plant. The participants were asked to use the distributed sanitary survey form to note the existing situation and any problems that existed. This exercise was very helpful to the participants who were first shown how to conduct a field sanitary survey.

The fourth day's session started with a presentation by Mr S. Pillay, the participant from Malaysia. He gave an historic account of the development of national drinking-water quality monitoring and surveillance in Malaysia. In his presentation, Mr Pillay stated that despite the lack of legislation for the enforcement of a national drinking water quality monitoring and surveillance programme, work on such a programme has been underway since 1983. This was possible due to the groundwork done by his department in coordination with the various departments involved in the water sector.

He stated that a national drinking water quality standard/guideline has been formulated with the assistance of PEPAS. This programme is divided into phases and is being implemented generally on time.

During the discussion period, a number of issues were raised and it was felt that countries and areas of the Region could use the Malaysian model in developing their own national drinking water quality monitoring and surveillance programmes. Mr Pillay stated that, if necessary, Malaysia would be pleased to assist other countries in the Region. In closing the discussion Dr Guo, the session chairman, said that this was in the true spirit of United Nations' call for technical cooperation among developing countries (TCDC).

Following Mr Pillay's presentation, Dr Saleha Abdul Aziz of the Department of Veterinary, Pathology and Microbiology, University of Agriculture, Malaysia, presented her experiences with the hydrogen sulphide (H_2S) method for bacteriological testing of water. This test is now widely used in the Philippines, Papua New Guinea, Solomon Islands and Vanuatu and interest has been growing in the use of this appropriate technology for bacteriological testing of drinking water, particularly, in rural areas.

Dr Saleha and her co-workers found that H_2S method seemed to be compatible with the MPN method. It was found that the method is simple and highly specific. However, it is less sensitive as compared to the MPN method, in testing water samples with low level of coliforms. The study concluded that the method is inexpensive, easy to perform, and could be considered as a reliable method for monitoring the bacteriological quality of drinking water. But, there are still certain aspects of the H_2S method that need further evaluation and more field trials are required before a final recommendation can be made.

Dr Saleha then briefed the participants on a proposal being submitted to PEPAS to further evaluate the method in order to:

a) determine the sensitivity and specificity of the method;
b) correlate the length of incubation period with the degree of contamination;

c) improve the test medium;
d) determine the shelf-life of the test medium;
e) determine the prevalence of H_2S producing organisms in natural water; and
f) determine the capital and operating costs under different testing conditions.

Following this presentation, a very lively discussion followed. The consensus of opinion was that PEPAS would contribute tremendously to the drinking water quality monitoring and surveillance programmes in many small Pacific Island countries if further investigation of this method could be supported.

The subsequent presentation was made by Dr Chen Changjie of the Institute of Environmental Health Monitoring of Beijing, People's Republic of China on chemical and bacteriological test kits for drinking water quality monitoring, which were developed by his Institute.

The chemical test kit which could measure 15 parameters, costs around US$200. In the studies carried out in Malaysia, it was found that the Chinese test kits performed equally well as compared to the American HACH and similar British test kits.

The bacteriological test kit is housed in 2 boxes, one for the incubator and the other for equipment and consumables for 200 determinations. The kit is based on the membrane filter technique. Its price is only one fifth of similar kits manufactured in the USA and UK.

Dr B. Lloyd demonstrated the Oxfam/DelAgua water test kit which was developed by the Robens Institute of the University of Surrey with his help. The kit is robust and is contained in a standard vanity brief-case equipped with a rechargeable 12 volt battery. It can incubate up to 5 batches of 16 faecal coliform counts. In addition, the kit contains 250 tablets each for testing pH and free and total residual chlorine as well as turbidity, temperature, and conductivity. The cost of such a kit is approximately US$1 700.

Following presentation of these two papers, the discussions centred on several issues related to the use of such field kits and price comparisons.

The next speaker was Dr H. Ogawa, PEPAS Environmental Systems Engineer, who discussed the information management and data processing in drinking water quality monitoring and surveillance. In his paper, Dr Ogawa described the components of information management and data processing systems, the design consideration, the use of modern communication devices and statistical analysis of data generated by drinking water monitoring and surveillance programmes.

The afternoon session was taken up by the working group discussion. The 21 participants/observers were divided into three groups each dealing with one subject matter. The issues discussed were as follows:

- Policy, legislative and institutional aspects of drinking water quality monitoring and surveillance

- Methodology and procedure of drinking water quality monitoring and surveillance (frequency, method, sampling technique, analytical method, laboratory facilities etc.)

- Data management (processing, presentation, reporting, etc.)

The first paper presented on the 5th and the last day of the workshop was by Dr B. Lloyd on pilot projects in drinking-water quality monitoring and surveillance.

The main common components of the three WHO sponsored pilot projects for drinking water quality monitoring and surveillance implementation were presented. These projects were carried out in Indonesia, Zambia and Peru. They were each subdivided into phases referred to as (a) preplan activities followed by evaluation, (b) pilot diagnostic programmes and (c) rehabilitation activities and routine surveillance. It was demonstrated that all 3 projects failed initially to identify the risk associated with contamination because the sanitary survey procedures were poorly formulated. These deficiencies were later rectified. The development of laboratory capacity at national, regional and local level was described as was the development of institutional capacity necessary for the effective transfer of information at the three levels.

The final presentation was made by Mr T. K. Tjiook of IRC, Holland, on the DIP-CELL system for on-site generation of sodium hypochlorite (Na OCl) from the electrolysis of salt as a potential appropriate technology for disinfection of community water supply. The need for a reliable power supply was noted and the possibility that solar panels could be used was discussed. It was pointed out that similar systems using various electrodes were being promoted by Pan-American Health Organization (PAHO) for the on-site generation of mixed oxidants including chlorine gas and ozone. It was also noted that tablets, liquid and gas are all used for chlorination of community supplies and that most rural supplies are not chlorinated or their disinfection is poorly controlled. Training for disinfection control is widely lacking and fundamental principles are often ignored.

It was noted that Malaysia would test this technology very soon. The chairman in thanking Mr Tjiook for his contribution suggested that the results of this testing be communicated to PEPAS, so that this technology could be transferred to the other Member States in this region. The chairman further suggested that testings using solar panels be carried out, since in many remote areas of the region electricity is not available, and that a cost benefit study be conducted to assess the cost of generating chlorine gas.

6. REPORT ON GROUP DISCUSSIONS

The three groups presented their reports in the second session on the last day. These reports were discussed and merged into a single report and a set of recommendations at the final plenary session of the workshop.

A majority of the participants said that as a result of the workshop they would recommend to their authorities follow-up technical collaboration with PEPAS in support of their drinking water quality monitoring and

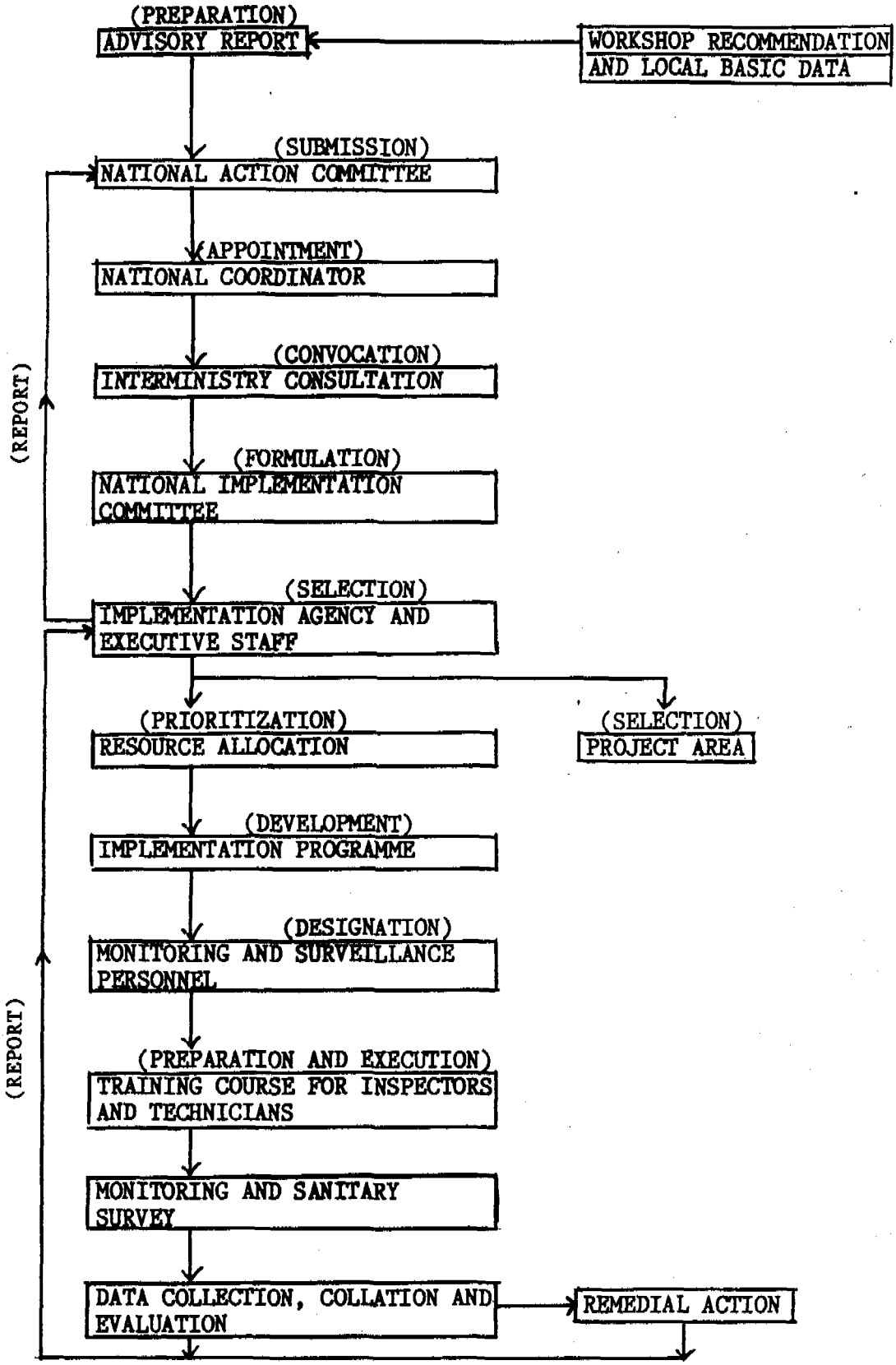
surveillance activities. In particular many participants were now more aware of the expertise PEPAS has and could offer. Participants generally felt that they now had greater confidence in dealing with their drinking water quality problems. In the technical area they would recommend the implementation of sanitary surveys for both urban and rural water systems based on the models provided during the workshop. A number of participants commented on their increased awareness of the importance of drinking water quality monitoring and surveillance. As a result, they would recommend a more systematic approach in the planning and implementation of these activities within the often limited resources available to their departments.

It was considered that the WHO drinking water quality guidelines were most valuable as background manuals for water quality monitoring inspite of the enormous difference in size and culture of the countries within the Western Pacific Region. It was suggested that the Malaysian manuals, prepared with substantial input from PEPAS were valuable models which complemented the WHO guidelines. A majority of participants would consider the adoption of these for implementation in their own countries.

Although some participants emphasized the difficulties imposed by financial constraints, it was generally agreed that regional development banks, such as ADB, were able to provide funds for the development of water surveillance and monitoring activities. What was really lacking, in many cases, were adequate workplans and project proposals. It was felt that the workshop had provided valuable guidance which would enable participants to prepare technical proposals with a better chance of being accepted by both government and development banks. It was therefore recommended that WHO technical cooperation should provide additional guidance in the detailed costing of project proposals on drinking water quality monitoring and surveillance. It was agreed that the WHO guidelines on developing water quality laboratories were a vital adjunct to this activity and the guidelines were well received by the participants.

Participants agreed that they now had a more comprehensive view of drinking water quality monitoring and surveillance and appreciated that this was not confined to analytical quality in the narrow sense, but encompassed quality of water service. As a result, some participants said they would recommend an increased range of monitoring activities on their return to home countries. These participants would also be recommending that reporting should include at least annual assessment of coverage, quantity, quality, continuity, cost and risk assessment in order to achieve improved services and the ultimate objective which is improved health. It was recommended that the number of workshops on water quality should, if possible, be increased, and should involve participants at a higher managerial and decision making level. For the level of staff involved in the present workshop it was felt by some participants that more time was needed to allow for more practical activities such as the field sanitary survey of the treatment plant. The more developed and larger countries wished for visits to large and complex treatment plants whilst the small island participants recommended the inclusion of rural facilities to test out the survey forms presented during the workshop.

The algorithm below summarizes the important steps for the planning and implementation of a national drinking water quality monitoring and surveillance programme:



7. RECOMMENDATIONS

The following recommendations were developed by the participants and consultants/resource persons in the final session of the workshop and represent a concensus of opinion of the participants.

1. Key recommendations

WHO(PEPAS) should continue to play a key role in drinking water quality monitoring and surveillance in order to provide potable drinking water to the people of this region at a reasonable cost by facilitating collaboration, encouraging training and applied studies whenever required.

The technical collaboration in developing project proposals for drinking water monitoring and surveillance to donor agencies/countries is urgently needed, in view of the financial constraints encountered by Member States in general, and South Pacific States in particular.

2. Policy, legislative and institutional aspects of drinking water quality monitoring and surveillance

a) The Member States should establish policies for drinking water quality monitoring and surveillance so as to develop national programmes taking into consideration their social, economical, cultural and logistical situations.

b) WHO(PEPAS) should organize an increased number of workshops on water quality monitoring and surveillance, and provide training opportunities for participants at a higher managerial and decision making level.

c) The Member States should establish the legislation for providing safe drinking water by referring to WHO drinking water quality guidelines as soon as possible.

d) The Member States should establish their drinking water committees for coordination in the implementation of their national programmes with all relating agencies.

3. Methodology and procedures of drinking water quality monitoring and surveillance

a) WHO(PEPAS) should collaborate with Member States in developing manuals of drinking water quality monitoring and surveillance for both urban and rural supply systems including cost information. The Malaysian manuals, prepared with substantial input from PEPAS, could be used as models to develop the manuals for other countries in the region.

b) In small community water supplies, the bacteriological quality (total and/or faecal coliform tests), turbidity, residual chlorine (if chlorination is applied), pH, colour, taste and odour, should be regularly monitored.

c) Field test-kits using simple methods should be promoted for on-site testing of drinking water.

d) The Member States should evaluate the usefulness and reliability of the field test kits currently available.

e) A simple bacteriological test method to serve as a rapid indication of faecal contamination of drinking water should be initiated/developed as soon as possible. The H_2S method provides a qualitative test for preliminary survey. It should be further studied and its limitations be assessed both in the laboratory and in the field with the collaboration of PEPAS.

4. Data management of drinking water quality monitoring and surveillance

a) WHO(PEPAS) should collaborate with Member States to develop information management manuals for drinking water quality monitoring and surveillance.

b) The information required for drinking water quality monitoring and surveillance should include at least coverage, quantity, quality, continuity of service, cost and risk assessment in order to assess drinking water supply system and to improve services. This requirement should also be made a part of all future plans.

c) A centralized and computerized data management system should be established so as to mobilize and utilize the information generated from the water quality monitoring and surveillance activities.

8. EVALUATION OF THE WORKSHOP

The participants and observers were satisfied that the objectives of the workshop had been achieved. Two participants felt that more emphasis should have been placed on the development of workplans and methodologies for the implementation of national drinking water quality monitoring and surveillance programmes. All participants but one responded that they had acquired new skills and concepts at this workshop and only two said that some of these concepts could not be applied in their countries due to lack of an institutional/legislative machinery to enforce such a programme.

Nineteen participants felt that the workshop had offered them a good opportunity to interact with other participants and to exchange and learn from the experience of other participants, consultants and secretariat members of the workshop. Nevertheless, some participants felt that they were hampered by language difficulties and others expressed the desire that future workshops should be held for longer duration (7-8 days) with greater opportunities for field visits and hands-on exercises.

All participants expressed satisfaction with the administrative arrangements for the workshop. They expressed the desire that PEPAS should undertake follow-up activities in collaborating with them in the implementation of their national drinking water monitoring and surveillance programmes through the provision of further training opportunities to other categories of people involved in such programmes.

The participants were satisfied with the working papers provided. Some of the participants felt that advance circulation of the working papers and country reports would have been more beneficial.

The majority of participants felt that methods of introduction and presentation of working papers were commendable; some of the participants were of the opinion that less time should have been given to the presentation of country reports and more time devoted to hands-on exercises and field visits.

9. CONCLUDING SESSION

Dr P. Guo thanked the participants for their cooperation and active participation which contributed to the success of the workshop.

He urged the participants to continue to share their experience with other countries of the Western Pacific Region and to use the services and facilities provided by PEPAS. He hoped that all participants after going back, would take action to initiate or strengthen their national drinking water quality monitoring and surveillance programmes.

He wished the participants a pleasant and safe journey home and declared the workshop formally closed.

10. ACKNOWLEDGMENTS

Thanks and appreciation are expressed to the authorities of the University of Agriculture, Malaysia for their assistance and cooperation and also to the Selangor Water Works Department and their staff for their efforts in making the field visit to the Bukit Tampoi water treatment plant a great success.

ANNEX 1

LIST OF PARTICIPANTS, OBSERVERS AND SECRETARIAT

	Participants	Designation and address
1.	Dr Chen Changjie	Director Institute of Environmental Health Monitoring 29 Nan Wei Road Beijing 100050 People's Republic of China
2.	Dr Geng Jingzhong	Deputy Director Environment Health & Radiation Division Sanitary & Antiepidemic Department Ministry of Public Health Hou-Hai, Beijing People's Republic of China
3.	Mr Uraia N. Lesu	Chief Health Inspector Ministry of Health Box 2223 Suva, Fiji
4.	Dr Yang Soo Lee	Junior Sanitary Official c/o Public Health & Sanitation 31 Taepyung-ro 1 ga Chung-gu, Seoul Republic of Korea
5.	Dr Nouantha Manipousay	Deputy Director Directorate of Water Supply and Sanitation Vientiane Laos
6.	Mr Oth Keomanivong	Water Supply Services of Vientiane (Nam Papa) Vientiane Laos
7.	Mr Mukundan Sugunan Pillay	Chief Public Health Engineer Engineering Division, Ministry of Health Jalan Dungun, Block E 50490 Kuala Lumpur Malaysia
8.	Mr Foo Seng Chow	Chemist Selangor Water Works Department Jalan Pantai Baru 59990 Kuala Lumpur Malaysia
9.	Mr Jose Xavier	Safe Drinking Water Specialist Environmental Protection Agency P.O. Box 178 Colonia, Yap Federated States of Micronesia 96943

Participants	Designation and address
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12. Ms Eleonor C. Corpuz	Senior Sanitary Engineer Regional Health Office No. XI Bajada, Davao City Philippines
13. Mr Samuel Kafukese	Health Inspector Ministry of Health & Medical Services P.O. Box 349 Honiara Solomon Islands
14. Mr Lelea Tuitupou	Senior Health Inspector Public Health Division P.O. Box 59, Ministry of Health Nuku' alofa Tonga
15. Mr Filipe Fatongia Koloi	Manager-Engineer Tonga Water Board P.O. Box 92 Nuku'alofa Tonga
16. Mr Elison Sese Bovu	Senior Environmental Health Officer Environmental Health Section Health Department Private Mail Bag, Port Vila Vanuatu
17. Dr Hoang Thi Nghia	Head, Laboratory of Environmental Microbiology Department of Hygiene and Environment National Institute of Hygiene and Epidemiology 1 Yersin Street, Hanoi Viet Nam
18. Mr Ainini Tiumalu	Health Inspector Public Health Division Health Department Apia, Western Samoa

Representatives

1.	Mr Ranjith Wirasinha	Senior Project Engineer Water Supply Division Asian Development Bank, Philippines
2.	Mr T. Kien Tjiook	Adviser IRC International Water and Sanitation Centre, The Netherlands
3.	Mr Mohd Pauzi Zakaria	Lecturer Department of Environmental Sciences, University of Agriculture Malaysia, Serdang, Malaysia

Secretariat

1.	Dr Paul Guo	Acting Director/Water Quality Management Adviser, PEPAS
2.	Dr Keith Bentley	Chemical Safety Adviser, PEPAS
3.	Dr Bruce Fisher	Decade Engineer, PEPAS
4.	Dr Hishashi Ogawa	Environmental Systems Engineer, PEPAS
5.	Mr J. Hazbun	Technical Officer, WHO, Vila
6.	*Dr Barry Lloyd	WHO Consultant
7.	**Dr Yosumoto Magara	WHO Consultant
8.	Mr Satya Sardana	Administrative Officer, PEPAS
9.	Ms Tan Yit May	Special Assistant, PEPAS

Guest lecturer

Dr Saleha Abdul Aziz	Universiti Pertanian Malaysia

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ANNEX 2

INAUGURAL ADDRESSES

Opening address by the WHO Representative on behalf of the Regional Director, WHO Regional Office for the Western Pacific

On behalf of Dr Han, WHO Regional Director for the Western Pacific, I have pleasure in welcoming you to PEPAS for this Regional Workshop on Drinking Water Quality Monitoring and Surveillance.

It is estimated that approximately 80% of all illnesses in the world are due to unsafe and insufficient water supplies and sanitation, and that about 25 000 people die daily because adequate safe drinking water is not available. Epidemiological studies indicate that unsafe water is the major cause of waterborne diseases, such as cholera, typhoid, paratyphoid, diarrhoea and hepatitis. Also, many chronic heart and kidney problems are associated with the long-term consumption of water of poor chemical quality.

In recognition of these problems, the United Nations inaugurated the International Drinking Water Supply and Sanitation Decade on 10 November 1980 with the goal that all people should have access to safe drinking water and adequate sanitation by 1990. WHO considers water supply and sanitation to be critical components of primary health care; the availability of clean water and adequate sanitation are essential to achievement of WHO's goal of "Health for All by the Year 2000".

Since the inauguration of the Decade programme, many countries have made special efforts to construct safe water supply systems. Yet statistics show that the incidence of waterborne-related illnesses is still very high. While a water supply system may be considered safe when initially constructed, there are many factors which can make the water unsafe while it is in operation. It is therefore extremely important to monitor the water quality of a system regularly, to ensure that it remains safe and protects the health of consumers.

Drinking water is considered safe if it is free of harmful microorganisms, and if it does not contain chemicals in concentrations which are harmful to the consumers. In order to ensure that there is always good quality drinking water, an effective water quality monitoring and surveillance programme must be instituted and rigorously carried out.

The two major components of such a programme are monitoring and sanitary surveys. Monitoring involves regular sampling of water supplies to determine their physical, chemical and bacteriological quality and sanitary surveys involves on-site inspection and evaluation of equipment, facilities and practices associated with water supply systems. These two components complement each other and will be the focus of discussions throughout the workshop.

While some Member States in the Western Pacific Region have already formulated comprehensive national programmes on drinking water quality monitoring and surveillance, there are still some which have not done so. Additionally, some of those which have established programmes are facing difficulties in implementing them, particularly in the rural areas where there is a lack of trained manpower and adequate laboratory support.

Since financial resources are very limited in most developing countries, it is important to make every effort to maximize the output and benefit of the existing water supply systems, and to minimize the health risks associated with the consumption of water. In this regard, the implementation of an effective national drinking water quality monitoring and surveillance programme is essential.

One of the main objectives of this workshop is to familiarize you with procedures and methodologies which will enable you to carry out all the necessary monitoring and surveillance activities yourselves, and to train the environmental health personnel in your own country to do the same. This workshop will also serve as a forum for the exchange of ideas and experiences gained in various countries. It will provide you with a good opportunity to discuss the problems and constraints associated with drinking water quality monitoring and surveillance, and to find ways of overcoming these problems

I wish you a successful meeting and trust that your deliberations will be productive. Thank you.

Welcome address by Associate Prof Dr Khalid Mohd Noor Deputy Vice Chancelor, Universiti Pertanian, Malaysia

On behalf of Universiti Pertanian (UPM) Malaysia, I would like to extend to each and every one of you a very warm welcome to our "green campus" in Serdang on the occasion of the Regional Workshop on Drinking Water Quality Monitoring and Surveillance. For those of you who have come from overseas, "Selamat Datang ke Malaysia" (Welcome to Malaysia) and I hope your stay here will be a fruitful and enjoyable one.

I am appreciative of the honour in having been invited to be with you this morning which marks the beginning of what I am sure, will be an interesting week of deliberations and discussions. Only late last week PEPAS celebrated it's tenth anniversary and judging by the discussions and chats among the dignitaries in attendance, PEPAS has been well received and has gained strength as the technical arm of the WHO in the Western Pacific Region. The organization of this workshop just immediately after their anniversary celebration shows that PEPAS is not one to reminisce and dwell on successes of the past. I congratulate you for your fine efforts and offer you our full cooperation in your endeavors.

Ladies and Gentlemen,

The organization of this workshop is indeed timely considering the spate of water-related health problems which we have encountered recently, and also the rehabilitation of water supply systems in our country. It is also likely that many water supply organizations will expand several fold in the next few years. Since water is a basic necessity of life, both, it's quantity and quality has to be ensured to protect the masses. Unsafe water has been identified as the main cause of diseases such as cholera, typhoid, diarrhoea and hepatitis, especially in developing economies. However, it is well known that the desired goals of the International Drinking Water Supply

and Sanitation Decade may not be fully realized for a variety of reasons. Quite often this is due to a lack of proper water supply resource protection or poor maintenance of a perfectly good system.

Ladies and Gentlemen,

It is a great waste to have a well design water supply system that is expensive to implement and then left not properly maintained. On looking through the Workshop programme for the week, I can see that detailed topical areas will be discussed which are very practical in approach and with an impressive list of presenters who have first hand knowledge of what happens in the field. Hopefully you will use this opportunity to obtain the techniques and methodology to carry out monitoring and surveillance work so that this practical knowledge can be implemented in your home situations. I would like to stress that agencies carrying out water quality monitoring should ensure standardization of procedures for sampling, analysis and reporting of data so that data collected is useful for future planning for the improvement of water supply services.

May I wish you every success in your deliberations in the coming days and wish you a pleasant stay in Malaysia.

Thank you.

ANNEX 3

AGENDA AND TIMETABLE

Monday, 27 February

0810	Overseas participants assemble in Holiday Inn lobby
0815	Departure of bus to PEPAS
0900 - 0930	Introductory remarks Acting Director, PEPAS Opening speech Dr L. R. Verstuyft, WHO Representative for Brunei Darussalam, Malaysia and Singapore on behalf of the Regional Director Welcome address Prof Dr Mohd Khalid bin Md. Nor Deputy Vice-Chancellor University of Agriculture, Malaysia
0930 - 0950	Introduction of consultants and participants P. Guo
0950 - 1030	Break and group photograph
1030 - 1050	Administrative briefing S. P. Sardana
1050 - 1100	Introduction to workshop sessions P. Guo
1100 - 1130	International Drinking-Water Supply and Sanitation Decade (IDWSSD) B. Fisher
1130 -1200	Country reports
1200 - 1300	Lunch
1300 - 1450	Country reports (Cont'd)
1450 - 1510	Break
1510 - 1700	Country reports (Cont'd)

Tuesday, 28 February

0900 - 0940	Principles of drinking-water quality monitoring and surveillance Y. Magara
0940 - 1020	Drinking-water quality and Public Health B. Lloyd
1020 - 1040	Break
1040 - 1200	Country reports (cont'd)
1200 - 1300	Lunch
1300 - 1340	Microbiological aspects of drinking-water quality monitoring B. Lloyd
1340 - 1420	Chemical and physical aspects of drinking-water quality monitoring Y. Magara
1420 - 1440	Break
1440 - 1630	Country reports (cont'd)
1630 - 1700	Overview of the drinking water quality monitoring and surveillance activities in the region J. Hazbun

Wednesday, 1 March

0900 - 0940	Design of drinking-water quality monitoring network Y. Magara
0940 - 1000	Radionuclides in drinking-water, the health impact, monitoring and control K. Bentley
1000 - 1020	Break
1020 - 1100	Sampling frequency, techniques and procedures Y. Magara
1100 - 1200	Sanitary surveys P Guo/B. Lloyd
1200 - 1300	Lunch
1300 - 1700	Field visit to the Bukit Tampoi waterworks plant for sanitary surveys Hj Al-Bakry bin Hj Alias, District Water Engineer/B. Lloyd

Thursday, 2 March

0900 - 0940	Drinking-water quality monitoring and surveillance - a case study in Malaysia S. Pillay
0940 - 1020	Evaluation of the Hydrogen Sulphide (H2S) method for microbiological testing of drinking-water Saleha Abdul Aziz, University of Agriculture, Malaysia
1020 - 1040	Break
1040 - 1120	Chinese field test kits for drinking-water quality monitoring Chen Changjie
1120 - 1200	Information management and data processing in drinking-water quality monitoring and surveillance H. Ogawa
1200 - 1300	Lunch
1300 - 1320	Introduction to subjects for working groups B. Lloyd/Y. Magara
1320 - 1450	Working groups on: 1. Policy, legislative and institutional aspects of drinking-water quality monitoring and surveillance 2. Methodology and procedure of drinking water quality monitoring and surveillance (frequency, method, sampling technique, analytical methods, laboratory facilities, etc.) 3. Data management (processing, presentation, reporting, etc.)
1450 - 1510	Break
1510 - 1700	Working groups (cont'd)

Friday, 3 March

0900 - 0940	Presentation of pilot projects in drinking-water quality monitoring and surveillance B. Lloyd Presentation on a Simple Hypochlorite Unit for Disinfection of Water Supplies T. K. Tjiook
0940 - 1030	Group presentations and discussions P. Guo/Y. Magara/B. Lloyd/J. Hazbun

1030 - 1050	Break
1050 - 1200	Group presentations and discussions (cont'd) P. Guo/Y. Magara/B. Lloyd/J. Hazbun
1200 - 1300	Lunch
1300 - 1500	Plenary session on the development of workplan and methodologies for implementing national programmes for drinking-water quality monitoring and surveillance Y. Magara/B. Lloyd/J. Hazbun/P. Guo
1500 - 1530	Break
1530 - 1600	Workshop evaluation P. Guo/J. Hazbun
1600	Concluding remarks P. Guo

ANNEX 4

*LIST OF HAND-OUTS

Workshop papers

International Drinking-Water Supply and Sanitation Decade (IDWSSD). By Mr B. Fisher

Principles of drinking-water quality monitoring and surveillance. By Dr Y. Magara

Drinking-water quality and Public Health. By Dr B. Lloyd

Water surveillance and improvement programme. By Dr B. Lloyd

The relationship between water-related disease and water quality with particular reference to urban water supply in a developing country. By Dr B. Lloyd

Chemical and physical aspects of drinking-water quality monitoring. By Dr Y. Magara

Design of drinking-water quality monitoring network. By Dr Y. Magara

Radionuclides in drinking-water, the health impact, monitoring and control. By Dr K. Bentley

Sampling frequency, techniques and procedures. By Dr Y. Magara

Sanitary survey. By Dr P. Guo

The Chemical and bacteriological test kit for drinking water monitoring. By Dr Chen Changjie

Information management and data processing in drinking-water quality monitoring and surveillance. By Dr H. Ogawa

Extracts from institutional development of water supply and sanitation with particular reference to implementation of water surveillance and improvement strategies in Bengkulu and Lampung Provinces, Indonesia. By Dr B. Lloyd

Country reports

CR-001 Republic of China. By Drs Chen Changjie and Geng Jingzhong

CR-002 Fiji. By Mr Uraia N. Lesu

*Copies available on request from PEPAS

CR-003 Republic of Korea. By Dr Yang Soo Lee

CR-004 Laos. By Dr Nouantha Manipousay and Mr Oth Keomanivong

CR-005 Malaysia. By Mr Mukundan Sugunan Pillay and Ms Debbie Siru

CR-006 Federated States of Micronesia. By Mr Jose Xavier

CR-007 Republic of Palau. By Mr Lucio Abraham

CR-008 Papua New Guinea. By Mr Kaoga Galowa

CR-009 Republic of the Philippines. By Ms Eleonar C. Corpuz

CR-010 Solomon Islands. By Mr Samuel Kafukese

CR-011 Kingdom of Tonga. By Messrs Lelea Tuitupou and Filipe Fatongia Koloi

CR-012 Republic of Vanuatu. By Mr Elison Sese Bovu

CR-013 Socialist Republic of Viet Nam. By Dr Hoang Thi Nghia

CR-014 Western Samoa. By Mr Ainini Tiumalu

Publications

1. Guidelines for drinking-water quality. Volumes 1, 2 and 3 WHO, Geneva, 1984-85.

2. Establishing and equipping water laboratories. WHO, Geneva, 1986.

3. Hygienic criteria for drinking water quality. WHO/UNEP Centre for International Projects, Moscow, 1986.

4. Drinking-water quality and health-related risks. WHO Regional Office for Europe, Copenhagen, 1987.

ANNEX 5

SUMMARY OF COUNTRY REPORTS

OVERVIEW OF THE DRINKING WATER QUALITY MONITORING AND SURVEILLANCE ACTIVITIES IN THE REGION

The Country Reports presented by the participants of this workshop are useful in many ways. They permitted PEPAS and the resource persons/consultants as well as participants to form an idea of the current status, progress and constraints that face participating countries in the implementation of drinking water quality monitoring and surveillance programmes. They also provided opportunity to the participants to learn from the experiences of more developed countries than their own, and how to use more innovative approaches in drawing a monitoring and surveillance programme for their countries.

With such a diverse group of countries ranging from the most populated to one of the smallest in the world, it is not possible to find symmetrical systems nor stages of development in the monitoring and surveillance programme. Therefore, the countries were subdivided into the following four major groups in terms of the stage of development in their drinking water supply monitoring and surveillance programmes.

Group 1 includes China, Korea and Malaysia where well formulated monitoring and surveillance programmes exist. The experience of these countries in developing standards and programmes is of value to other countries in this region.

Group 2 includes Laos and Viet Nam which have few drinking water quality monitoring and surveillance programmes in operation in the country. Because of constraints in financial and human resources, the expansion and strengthening of such programmes cannot proceed as desired but every effort is made to improve the existing programmes, through dedication and perseverance.

Group 3 includes the States of Micronesia and Republic of Palau where USEPA standards have been adopted in their monitoring and surveillance programmes, but the constraints in manpower, logistical support and funds have prevented these countries from implementing an effective national programme.

Group 4 includes the Philippines which could stand as a category by itself. While drinking water standards have been enacted and national monitoring and surveillance programmes developed, much needs to be done for coverage and implementation of such programmes in intermediate and rural centres, though the situation in major urban centres seems to be satisfactory. This is due to the lack of a supporting laboratory infrastructure throughout the country as well as financial, logistical and managerial constraints.

The Pacific Islands States of Fiji, Papua New Guinea, Solomon Islands, Tonga, Vanuatu and Western Samoa could generally be classified under the

same group since they share Philippines problems in general, but with the added disadvantage of lack of manpower and remoteness of the communities to be covered by such a monitoring and surveillance programme.

1. Republic of China

The total area of the People's Republic of China is 9.6 million square kilometers and the population about 1 096 million.

With the development of public health and sanitary conditions in China, waterborne infections have decreased dramatically. The annual incidence of bacillary dysentery is 500 per 100 000 and for typhoid/paratyphoid it is 10-15 per 100 000.

China has drawn a series of drinking-water standards and regulations to protect and improve the water quality by setting protective zones around drinking water resources and by guaranteeing protection from pollution or contamination.

The drinking water quality monitoring and surveillance in rural areas is carried out by anti-epidemic stations of local village/town governments where appropriate action is taken at this level.

The Chinese Academy of Preventive Medicine was entrusted with the task of carrying a nationwide drinking water quality survey. Some 40 000 personnel took part in this survey where more than 58 000 water samples were collected in some 29 000 sampling sites. The population of the survey area was estimated at about 980 million people. A full report of the findings is expected to be published soon.

Two hundred million people of China are served by tap water which accounts for 21% of the total population. The balance of 79% drink water supplies from point sources or non-community water supplies in rural areas. It is estimated that 85% of the population uses water that does not meet the total coliform standard of China.

Most of sewage from cities (72%) is discharged into surface water without adequate treatment and this is considered as the most important cause of contamination of water sources in China.

2. Fiji

Fiji is an archipelago of 320 islands with a total land area of 18 333 square kilometers and a population of 770 000.

Waterborne diseases are not considered an important cause of morbidity or mortality in the country, as compared with other diseases prevalent in the country.

Drinking water quality monitoring through sampling, analysis and sanitary surveys is done on a regular basis. The main public supplies in urban and larger towns are treated and their standards are compatible with those recommended by WHO.

3. Republic of Korea

The Republic of Korea has a population of 42 million and the surface area of the country is close to 99 000 square kilometers.

An ordinance for drinking water supply was promulgated in 1984. It is almost identical to the WHO Drinking Water Supply guidelines.

Some 350 employees are involved in water monitoring. With the industrialization that is going on in the country, pollution of water sources is on the increase. The government is serious in tackling the problem and an ambitious programme for the expansion of sewerage and liquid waste treatment facilities is now underway aimed at preserving the water resources in the country.

4. Laos

Laos is a landlocked country with a land area of about 236 000 square kilometers and a population of 3.6 million.

Gastro-intestinal and water and sanitation related diseases are the major causes of morbidity and mortality.

The urban water sources managed by the Water Authority "Nam Papa Lao" undergo some monitoring of water. Haphazard sampling is carried out for rural areas.

5. Malaysia

Malaysia consists of Peninsular Malaya and States of Sabah and Sarawak. The land mass is over 330 000 square kilometers and the population is about 17 million. It shares the similar problems of other developing countries in the region, and waterborne diseases are widely prevalent.

An ambitious National Drinking Water Quality Surveillance Programme has been launched and is being implemented with great success. It has brought together various departments and agencies involved in the sector to enforce a water quality standard in Malaysia.

The programme which started in 1986, is being implemented in five phases and is expected to be completed in 1990, but with certain delays which are being dealt with now. The programme has adopted generally the WHO guidelines for Drinking Water Quality as a Standard, and for those parameters not included in the guidelines, standards from developed countries have been adapted and incorporated in the Malaysian Standard. Some of the difficulties encountered in the implementation of the Monitoring Programme include issues related to staffing, funding and reluctance of some State governments in adopting a State Drinking Water Quality Surveillance Programme. The Ministry of Health, responsible for the implementation of the programme, initiated a number of courses and issued a set of three documents using the WHO Guidelines as reference. Plans are underway to

expand and strengthen the programme through the use of modern technology such as computers as well as better management techniques aimed at overcoming the delays confronted in the implementation of the programme.

6. Federated States of Micronesia (FSM)

The Federated States of Micronesia consist of over 600 islands with a total surface area of nearly 700 square kilometers and a population which is just over 100 000 inhabitants. Morbidity and mortality due to gastro-intestinal diseases is high.

A National Drinking Water Quality Standard has been adopted which specifies the bacteriological, physical, chemical and radioactive parameters. It is modeled along the USEPA Safe Drinking Water Act.

The State Environmental Health Services monitor adequately the quality of the major public water supply system in the country. But further efforts are required especially in training water work operators so that safe water could be guaranteed to the public.

7. Palau

The Republic of Palau consists of over 200 islands, but only 9 are inhabited with a population of nearly 14 000. It has been estimated that gastroenteric diseases and hepatitis A are prevalent at the rate of 5.5 and 2.1% respectively.

The National Code provides for the enforcement of a drinking water regulation. The Palau Environmental Quality Protection Board adapted the Trust Territory Environmental Protection Board regulation as basis for its drinking water monitoring and surveillance activities. The regulation complies mostly with the USEPA Safe Drinking Water Act.

The problems encountered in administering the drinking water quality programme include logistical problems as well as financial and manpower issues.

8. Papua New Guinea

Papua New Guinea consists of the eastern half of the island of Papua New Guinea and a number of adjacent islands having a land mass of over 46 000 square kilometers and a population of just over 3.3 million. Gastro-intestinal diseases rank 3rd in order of priority for morbidity and mortality in the country.

Responsibility for water monitoring falls under the Public Health Drinking Water Regulation Act. This act has vested the power in the Department of Health, but a number of other associated pieces of legislation aimed at regulating and setting of construction standards for water and sewerage works as well as for the conservation of water resources, control of erosion and maintenance of wildlife, fisheries and other recreational usage have been enacted.

The drinking water quality standard has been based on the WHO Guidelines for Drinking Water Quality and the procedures followed comply with the WHO recommended code of practice.

The problems encountered include logistical problems especially in remote parts of the country, lack of reagents and the laboratory infrastructure to carry out water quality monitoring and surveillance. Finally it is anticipated that the monitoring programme would continue and the information gathered would help in implementing an appropriate improvement programme for the drinking water supply systems.

9. Philippines

The Philippines is an archipelago of over 7 000 islands with a total land area of over 300 000 square kilometers and a population of about 59 million. Mortality and morbidity data show that waterborne and sanitation associated diseases are still a major health problem.

Considerable progress has been made towards implementing new water supplies as a result of the IDWSSD planning. The implementation is shared by a number of government agencies.

Water monitoring is done by the Department of Health through its network of provincial laboratories. A Drinking Water Quality Standard exists. It classifies the systems into three levels of service ranging from the one point source, i.e. handpump to the urban piped water supply system. The standard specifies the frequency of sampling and gives a set of parameters that should be met in the nation's water supply system. These include physical, bacteriological, chemical and radioactive substances.

The monitoring and surveillance programme faces a number of difficulties, some are related to staffing, others to lack of coordination and finally to lack of resources and funding. To improve the situation, a set of recommendations are formulated which include among others the propagation of the H_2S field screening test as an appropriate technology approach in monitoring water supply systems.

10. Solomon Islands

Solomon Islands is an archipelago of approximately 30 000 square kilometers and a population of over 286 000 inhabitants. Gastro-intestinal diseases are prevalent in the same fashion as in other South Pacific Island States.

The Ministry of Health and Medical Services is the responsible body for water monitoring and surveillance of drinking water in both urban and rural water supply systems. There are two urban water supply systems in Solomon Islands serving the capital and other towns in the north of the country.

Monitoring in these communities is carried out according to the WHO Guidelines for Drinking Water Quality where the water is tested bacteriologically as well as for chlorine residual. As for the rural areas, the H_2S field screening test is used as a method of monitoring.

11. Tonga

Tonga's total population is about 100 000 with a land surface of about 300 square kilometers. Gastro-intestinal diseases are the major cause of morbidity and mortality.

The Kingdom uses the WHO guidelines for Drinking Water Quality as drinking water supply guidelines.

The Ministry of Health has a laboratory which could handle some 20 samples a week. Sampling is carried out in the capital and in some outside laboratories.

12. Vanuatu

Vanuatu consists of 80 islands with a total surface area of 12 200 square kilometers and an estimated population of 140 000. Gastroenteric diseases are the major cause of morbidity in the country.

Three government departments are involved in the drinking water supply monitoring and surveillance work, namely, Public Works Department (PWD) responsible for the construction and operation of urban systems, the Department of Geology, Mines and Rural Water Supplies responsible for the construction of rural systems, and the Department of Health, in whose portfolio falls the responsibility of monitoring of both urban and rural water supply systems.

While no drinking water supply standard is in existence, the WHO guidelines for Drinking Water Quality are used as reference point in carrying mostly routine chlorine testing in the urban areas and occasional bacteriological testing in both urban and rural areas whenever the need arises. The H_2S field screening test is used extensively as a yes or no indicator of bacteriological pollution of water supply systems.

With the assistance of WHO/UNEP, a pilot project is now underway to start a drinking water monitoring and surveillance programme in the country. It involves the provision of some hardware for the central laboratory of the Department of Health as well as for the Department of Geology, Mines and Rural Water Supply, the former with a stationary equipment for bacteriological testing and the latter with portable equipment for chemical testing.

A two month consultant assignment is also envisaged as well as on the job training, and an inservice training component is also included.

13. Viet Nam

Vietnam has a population of about 62 million and a land surface of 330 000 square kilometers. Mortality rate ranges from 1 to 2 per thousand for hospitalized patients with acute gastro-intestinal infections.

A National Drinking Water Standard was promulgated as part of the Hygiene and Health Care Regulation. The amended version entrusted the responsibility of implementing this Drinking Water Standard to the Department of Hygiene and Environment of the Ministry of Health and the National Institute of Hygiene and Epidemiology.

The Department organizes training courses and carries out water testing in various parts of the country. In a recent survey of over 1 000 systems, about 10% of the samples collected showed that the water met the standard of 20 faecal coliforms per litre.

The problems facing the country in implementing a water monitoring and surveillance programme include logistical, manpower and managerial problems but national policies are being drafted to remedy the situation.

14. Western Samoa

The land mass of Western Samoa is 2 831 square kilometers with a population of just 160 000.

There is no drinking water quality monitoring and surveillance programme but some haphazard sampling and testing takes place whenever the situation warrants this. The government departments involved in this work include the Department of Agriculture through the Observatory where bacteriological testing is carried out. The Health Department carries out sampling and Public Works Department (PWD) is in charge of construction/maintenance of the systems.

The constraints faced in Samoa in implementing a drinking water supply surveillance and monitoring programme are related to logistical, financial manpower and management issues.