



Water treatment by solar energy

V. Kazinja, Tanzania

THE UNITED REPUBLIC of Tanzania is located on the east coast of Africa between the great lakes – Victoria, Tanganyika and Nyasa and the Indian ocean, and covers a total land area of 945,000 square kilometres, including the islands of Zanzibar and Pemba. The climate of the country is equatorial. The population of the country is 30 million increasing at an annual growth rate of 2.7%; Over 80% of the people live in rural areas in over 8000 villages (Thirkidson 1988).

Present status of water supply in rural areas

Tanzania is one among the poor countries in the world. Many districts and especially rural areas in Tanzania are unable to afford finance to buy chemicals for disinfection of water treatment. The sources of domestic water supply for rural communities are rivers and lakes, ponds, dug wells and spring which are in many cases unsafe and are at considerable distances from house holds. Water extracted from surface sources and open wells is contaminated and poses health risks as evidenced by incidences of water borne diseases such as cholera, typhoid and diarrhoea, which are more prevalent both in urban and rural areas in Tanzania. Analysis of data on the incidences of water borne, water-related and water-washed diseases has shown that these diseases are more prevalent in areas where people use contaminated water or little water. In areas which experience water shortage either because the source do not have enough water or where water sources are far from the households, people use very little water for hygienic purposes (5-10 litres per capita per day) and as a result, they suffer from water washed and other diseases.

The basic level of service for domestic water supply in rural areas is adopted as 25 litres per capita per day through public domestic water points. Many institutions in the rural areas such as schools, dispensaries, health centres and religious centres do not have satisfactory water supply services. Over 52% of rural population are yet to be served with water supply. Access to safe water is below 20% and is particularly difficult in the regions of Dar es Salaam, Shinyanga, Arusha, Mara, Tabora, Dodoma, Shingida, Lindi and Mtwara.

Main policy principles of Tanzania

Among the main policy principles some are listed below
Demand driven approach:

- Government support will be directed to communities which will show an “effective demand” for water supply services. Establishment of water committees and water funds will be the key indicators of any community’s “effective demand”.
- Women play a central role in the provision, management and safeguarding of water.
- Private sector has an important role in water supply Financing and Management.
- Appropriate Technology is essential for sustainability: In a “demand driven” programme, individual communities should decide on the type of water supply system they want and which they can afford and maintain. The decision should be based on technical advice on different water supply options and information materials easily understood by communities materials easily understood by communities, showing typical designs and costs must be made available.

Water quality improvement

Clean and safe water is essential, for life on earth. In chapter 3 of Tanzania Water policy states that the water which many people drink in the rural areas of Tanzania is not safe and they have to walk long distance to get it. Taking this problem into consideration it is important to employ different techniques to provide a source of clean and safe water to each household, because it is believed to be among the cornerstones of those environmental and social changes which produce the dramatic decline in infectious diseases. Although infectious disease mortality can be reduced by curative measures alone, morbidity can only be significantly reduced by preventive measures.

Household water treatment by utilizing solar energy

As a senior research officer of the Ministry of Water and Livestock Development, the author of this paper is to conduct research on water bodies and give suggestions to the Government and other sectors to make improvements for better quality of water.

Methodology

Research Area: This micro-research was conducted at water laboratory of Rwegarulila Water Resources Institute, Dar es Salaam. The water samples analysed were extracted from Msimbazi river, Dar es Salaam.

Study design

This micro – Research was conducted water quality and sanitation. This was done by:

1. Training 20 members which include water committee, Health committee, representatives of the community member as peer educators in water management including water pollution control and water treatment.
2. Assisting the community in providing polyethelene plastic bottles of 5 litres for solar disinfection technology in the community.

Results

In stage one author of this paper conducted a micro-research by taking surface raw water from Msimbazi river, Dar es Salaam and analysed for bacterial population at the water laboratory of Rwegarulila Water Resources Institute (RWRI).

The methodology includes

Analysis of surface raw water for estimation of Bacterial population (indicator organisms) by membrane filtration.

1. To treat water by exposing to solar radiation and analyse by taking into account the following salient features of the targeted environment:
 - The rural population lack finances which cannot support high – cost technology
 - Private sector has an important role in water supply, financing and management .
 - In a demand driven programme individual communities should decide on the type of water supply system they want and which they can afford and maintain.

Stage one

The laboratory testing to find the cheapest and low cost technology method of disinfection to the rural community for treatment of water by using solar energy, Polythelene plastic bottles for treating water. The efficacy was measured using coliform counts, standard methods were used.

Stage two

This stage was to conduct community dialogue with the objective of facilitating the improvement of treated water for Bacterial population (indicator organisms by membrane – Filtration method.

Procedures

Sample collection: The aim of collecting samples directly from a stream is to obtain samples representative of the water to be extracted.

The samples were collected in a pre-sterilized bottles according to the recommended sampling techniques in a randomly selected site from Msimbazi river. The samples were taken to the laboratory and tested within half-an-hour of sampling.

Bacteriological analysis

Samples were analysed for the presence of indicator organisms i.e. Faecal coliforms and *Escherichia coli*. These bacteria belong to the family Enterobacteriaceae which are most important group in sanitary engineering. They are generally defined as Gram negative, oxidase negative, non sporing rods that ferment lactose at 37 + .5°C for 24 – 48 hrs. Faecal coliforms are a sub-group of total coliforms. Measurement of faecal coliforms specifically is a better indicator of pollution. They are thermotolerant coliforms having the same properties of total coliforms except they tolerate and grow at higher temperature of 44 + .5°C.

The Primary objective of the search for indicator organisms instead of for pathogens themselves is universally accepted for monitoring the microbial pollution of water supplies. Ideally, finding these indicator bacteria denote the potential presence of pathogens. They are more resistant than pathogens. The indicator organisms are usually estimated by the multiple tube or by the membrane Filtration techniques. However, in this micro-research the author used membrane filtration techniques for enumeration of *E. coli* and Faecal coliforms. 100 mls of the sample water was measured and filtered through a sterile membrane filter with grid marks of 47mm in diameter, with a pore – size of 0.45 µm which retains all the bacteria. The membranes were transferred to the petri-dishes containing m- Endo media for *E. coli* and M-FC media for Faecal coliforms in duplicate and incubated at 37°C and 44°C for 24 hrs. and 48 hrs. respectively for the isolation of indicator organisms from the water sample. These bacteria in turn developed into visible colonies which were counted to give a definite number of bacteria which were filtered.

The samples were collected for 3 consecutive days and analysed for Bacteria. The results were as follows.

Treatment of water by solar Energy: Plastic bottles of 5 litres were taken and painted with black paint on one side and allowed to dry. The raw water was filled in the painted bottles and exposed to the sunlight for 8 hours i.e. from 9

Table 1. Bacteriological analysis results

Days	Type of water	No. coli colonies	No. of Faecal caliform colonies	Remarks
Day 1	Raw water	1700	1000	Polluted
Day 2	Raw water	1800	1100	Polluted
Day 3	Raw Water	1600	900	Polluted

Table 2. Treatment of water by solar energy

Days	Types of water	No.of colonies of E.coli per 100m/s	No. of colonies of Faecal coliform per 100m/s	Remarks
1	Treated water	2	0	satisfactory
2	Treated Water	1	0	satisfactory
3	Treated Water	1	1	unsatisfactory

a.m to 4 p.m. The painted side of the bottle was placed on the tray and the unpainted area was exposed towards the sunlight. The atmospheric temperature for the first day was around 39°C–48°C, second day 39°C–49°C, the third day 38°C–47°C respectively after 8 hrs of exposure to sunlight, the water was once again analysed for indicator organisms. The results were as in table 2.

Results and discussion

According to Bacteriological Drinking water Quality criteria shown in Table 3.

Drinking water should not contain any bacteria of faecal origin. The presence of coliform organisms should be considered as dangerous condition if the indicator organisms are present in consecutive samples of water tested. The results shows that the water is satisfactory according to WHO standards.

Community dialogue

OXFAM an international organisation by conducting community Dialogue with the rural community at ward level is trying to disseminate the solar disinfection technology to the population of Shinyanga region. It is done by participatory approach i.e the participants at the ward level include members of water committee, Health committee and representative of community are first trained on this technology and they in turn train each household members. OXFAM provide the plastic containers for each household. Both men and women are involved in this training to meet the Gender balance for the sustainability of the project. The community has responded to this technology as it does not involve high costs and technical expertise.

At present several other NGO's like Water, Environment, Projects Maintenance Organization (WEPMO) to transfer this technology to rural and peri – urban areas.

Conclusion

In conclusion conventional water treatment methods need money and skills, but solar disinfection in tropical country such as Tanzania is affordable and can be carried out effectively by community of low educational and economic status. Significantly community – oriented water projects should always have a practically demonstrable component rather than simply health education and training.

References

- American Public Health Association “standard methods for the Examination of Water and Waste water, 18th edition 1992, USA.
- D. D. Mara, “Bacteriology for Sanitary Engineers” 1974. USA
- Guidelines for Drinking – Water Quality Vol. 3. Drinking Water Quality control in small – community supplies control in small – community supplies WHO 1985, Geneva, Switzerland.
- “The Bacteriological Examination of Drinking Water supplies 1982” HMSO Books (PC 13A/1), publication centre, London. Her Majesty stationary office. Pages 6–10.
- Rural Water Policy Ministry of Water. Revised version 1997.

VICTORIA KAZINJA, Senior Research Officer,
Rwegarulila Water Resources Institute, Dar es Salaam,
Tanzania.

Table 3. Bacterial drinking water quality criteria

Coliform count per 100m/ at 30oC	Faecal caliform per 100m/at 44oC	Remarks
0	0	Excellent
1 – 3	0	Satisfactory
4 – 10	0	Suspicious
10	1	Unsatisfactory