HEALTH PROBLEMS AND THEIR RESOLUTION

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Summary

Water is a truly essential commodity, not only for domestic life but also for public activities. At the same time, wastewater must be discarded from the use point as soon as it completes its purpose. If one considers the water cycle around human or social activities, it becomes obvious that water usage means the use of its properties, such as the solubility, the thermal capacity, or the hydraulic head (potential energy), and that change in properties results in the production of wastewater. Water and wastewater are, therefore, closely related to human life or productive activities.
WHO estimates that 2.4 billion people worldwide still do not have any acceptable means of sanitation while 1.1 billion people do not have an improved water supply. To help those who are threatened by such health risks, United Nations (UN) and other organizations have launched several programs and action plans to protect and promote the health for the world population.

Due to the increase of water consumption, wastewater reuse is frequently practiced in many 'water-stressed' countries. Health protection from the use of reclaimed water is one of the most critical objectives in any water reuse project. The potential health risks associated with wastewater reclamation and reuse are related to the extent of direct exposure to the reclaimed water.

Fish cultivation, including artificial hatching, needs a great amount of water. Water reuse is, therefore, a necessary measure for economic benefits and conservation of limited water resources. It is essential, however, to pay attention to water quality, not just to prevent adverse effects on fish but also to protect the health of the public who use cultivated fish as a protein source.

1. Introduction

Water is an essential commodity, not only for domestic life but also for public activities. At the same time, wastewater must be discarded from the use point as soon as it fulfils its purpose. If one analyzes the mass balance of water around human beings, or social activities, it becomes obvious that water usage means the use of its properties, such as solubility, thermal capacity, or density, and that a property change results the production of wastewater. Water and wastewater are, therefore, closely related to human life and productive activities. Water itself supports social and economic activities, and it also has a key role in maintaining ecosystems. Polluting water or altering its properties reduces its value, and this may endanger human health by transmitting pollutants and/or pathogens.

Waterborne diseases such as dysentery infect billions of people annually, and the annual mortality is as high as five to ten million people. Inappropriate handling of excreta, or insufficient water to keep oneself clean, may pose enormous risk of ascariasis and other

helminthic diseases, or leprosy. Poor management of the water environment can result in shistosomiasis or malaria. The World Health Organization (WHO) states that 70% of disease episodes in developing countries are closely related to polluted water and/or inappropriate excreta treatment. It also remarks that six million children die of gastro-intestinal diseases annually and 500 million people suffer trachoma from lack of clean water for face-washing.

Gastro-intestinal diseases also have a big effect on infant mortality, i.e. inappropriate sanitation increases the infant mortality rate. High infant mortality rate not only means the death of babies but also creates an implicit hazard that undermines mothers' health. Especially in developing countries, partly due to the economic difficulty of purchasing fossil fuel to drive machines, a minimum level of manpower is necessary to execute social activities. This requires sufficient family members to run family life, with the result that. mothers bear so many children that they sacrifice their health, and reduce their productive capacity during pregnancies.

Water-based sanitation facilities, or simply sanitation, as we know it today, was developed in the middle of the nineteenth century. Before this, sanitation practice differed between regions or hierarchies, and archaeological remains date back several thousand years. It is probable, however, that the majority of the people then defecated on streets, in fields, and/or along rivers. Until the end of the Middle Ages, there was no significant development in sanitation facilities. Open defecation and bedpan defecation were still commonplace for ordinary people, and, consequently, epidemic diseases prevailed periodically over many cities in accordance with population growth.

The nineteenth century was a turning era in terms of sanitary systems. The first water closets were connected to water and wastewater lines in 1850s in London. Being behind the development of the sanitation apparatus for several decades, wastewater treatment technologies were developed—primarily physical and chemical treatment, then later, biological treatment.

Safe water supply and appropriate sanitation are essential components for healthy and prosperous life, but, at the same time, harnessing safe water and discarding wastewater must be carefully considered. Where no water is available in the proximity of a household, the family must consume much time and energy collecting and transporting water. This work trades off other productive activities. Some research has shown that a water supply line can create more time to be spent in the field, and in family, social and educational activities. If no measures are taken to treat human excreta in an appropriate fashion, this waste can degrade the traditionally used water resource; it will then require additional cost to treat the contaminated water or to secure uncontaminated water.

2. Constrains to improving water and sanitation services

2.1. Historical brief

WHO estimates that 2.4 billion people worldwide still do not have any acceptable means of sanitation, while 1.1 billion people do not have an improved water supply. For those who are threatened by the health risks, United Nations (UN) and other

organizations have launched several programs and action plans which protect and promote the health for the world population. One of the major turning points came in 1976, at the UN Conference on Human Settlements (Habitat) in Vancouver. The Conference impressed on the many governmental delegations that the improvement of water supply and sanitation services in poor countries was the emerging priority task for all people. Habitat then recommended realistic targets and programs to provide water and sanitation for unserved urban and rural people.

Two years later, the International Conference on Primary Health Care was held in Alma-Ata, USSR. This called for urgent and effective action to develop and implement primary health care throughout the world. The Declaration of Alma-Ata adopted during the Conference aimed at attainment of an acceptable level of health for all the people of the world by the year 2000, and included adequate supply of safe water and basic sanitation as essential element, as well as nutrition, immunization, etc.

The 1980s, the International Drinking Water Supply and Sanitation Decade (IDWSSD), saw big strides made in finding affordable technologies and participatory approaches to help serve those without access to improved water and sanitation services. But that Decade also demonstrated conclusively that "business as usual" would never bring improvements quickly enough to cope with the backlog and provide access to growing populations.

In 1990, the Water Supply and Sanitation Collaboration Council (WSSCC) was established in order to maintain the momentum of the IDWSSD. The mission of the WSSCC is to accelerate the achievement of sustainable water, sanitation and waste management services for all people, with special attention to the unserved poor. WSSCC covers technical, regional, tactical, networking and other activities, providing a bridge between professional associations and international NGOs.

VISION21 was launched by the WSSCC at the Second World Water Forum and Ministerial Conference in the Hague in March 2000. VISION21 is based on the "Water for People" initiative and aims at halving the number of people without access to hygienic sanitation facilities and adequate quantities of affordable and safe water. This will mean delivering improved water services to almost 280 000 people every day for the next 15 years, and improved sanitation facilities for around 384 000 per day. The ultimate goal to achieve universal access to hygiene, sanitation and water services is set at 2025.

Simultaneously, VISION21 emphasizes the importance of developing the options in concordance with regional needs and resources. This indicates the use of appropriate technology—the technology applicable and affordable for countries in every development stage.

The World Summit on Sustainable Development held in Johannesburg in 2002 included in its Plan for Implementation the target of halving the unserved people by 2015. Today, world people should have a will to support eradication of poor health and improvement of living conditions.

2.2 Global water supply and sanitation assessment 2000

The Global Water Supply and Sanitation Assessment 2000 presented the findings of the fourth assessment by the WHO and UNICEF Joint Monitoring Programme. Previous reports were produced in 1991, 1993 and 1996. The *assessment* has found that:

- Around a quarter of the 4.8 billion people in developing countries are without access to improved sources of water, while half of them are without access to improved sanitation services.
- Of the 4.9 billion people worldwide who have access to water supply services, around three billion have the convenience of access through house connections or yard taps.
- There are four billion cases of diarrhoea in the world every year, with 2.2 million deaths, mostly among children under five. Safe water, adequate sanitation and hygiene can reduce diarrhoeal disease by between one-quarter and one-third of these cases.
- Rural services still lag far behind urban ones, but delivering affordable services to the rapidly growing numbers of urban poor remains a formidable challenge.
- There are huge inequities in the amounts invested in improving services to the better-off sections of urban society compared with investments in providing basic services for the unserved poor

The *Assessment* makes clear that many people are being deprived of this right. It has further found that:

- The tariff charged by the water agencies in developing countries is not sufficient to cope with the costs of producing and distributing water. In Africa, Asia, and Latin America and the Caribbean the ratio between the unit average tariff and the unit production cost is respectively 0.8, 0.7 and 0.9.
- In Africa, 30% of the rural water supplies are not functioning at any one time. In Asia, and Latin America and the Caribbean, the numbers are, respectively, 17% and 4%.
- In the developing regions of the world, treatment of wastewater is applied in only a small number of systems. Only about 35% of the wastewater is treated in Asia, while the figure is 14% in Latin America. Only a negligible percentage of treatment has been reported in Africa. Even in industrialized countries, sewage is not universally treated.
- In large cities of developing countries, the percentage of unaccounted-for water is very high, around 40%. Most of this water is simply lost before reaching the potential user. The consequences are particularly serious to the poor living in marginal areas where the water will be wasted before reaching them.
- Not all the water distributed in large cities is safe. A number of cities reported that most samples violated water quality standards.

The constraints identified by the *Assessment 2000* included:

- Financial difficulties
- Institutional problems
- Inadequate human resources
- Lack of sector coordination
- Lack of political commitment

- Insufficient community involvement
- Inadequate operation and maintenance
- Lack of hygiene education
- Poor water quality
- Insufficient information and communication.

In addition, there are many barriers to expanding access to improved sanitation services, including (1) lack of political will, (2) low prestige and recognition, (3) poor policy at all levels, (4) weak institutional framework, (5) inadequate and poorly used resources, (6) inappropriate approaches, (7) failure to recognize defects of current excreta management systems, (8) neglect of consumer preferences, (9) ineffective promotion and low public awareness, and (10) women and children last. The reasons for apparent low demand need to be understood, to determine whether changes can be brought about through political, financial or technical means, or simply by improving information. People may want sanitation very badly, yet be powerless to express that desire in financial or political terms. Some may want safe excreta management facilities, but not at the prevailing price. Others may not want the available "improvements" at any price. Cultural beliefs have a strong impact on sanitation, and even on the possibility of talking about sanitation. In many cultures, the handling of excreta is considered a taboo and viewed as disgusting or a dangerous nuisance, not to be discussed. No one wants to be associated with excreta. Those who reduce its offensive characteristics for others may be stigmatized by association. Problems cannot be solved if people do not want to talk about them and be associated with their solution. In many contexts, taboos—including modern technological ones—block the safe recovery of valuable agricultural resources from human wastes. To counter the excreta taboo, education promoting sanitation and hygiene should link the value of excreta (feces and urine) to fertility and health protection.

Three principles are fundamental to the creation of socially, economically and ecologically sustainable sanitation systems:

I. *Equity*. All segments of society have access to safe, appropriate sanitation systems adapted to their needs and means,
II. *Health promotion and protection from disease.* Sanitation systems should prevent users and other people from contracting excreta-related diseases and should interrupt the cycle of disease transmission,
III. *Protection of the environment.* Sanitation systems should neither pollute ecosystems nor deplete scare resources.

There are four major challenges facing the water supply and sanitation sector in the years to come:

- Keeping pace with a net population growth of more than a billion people over the next 15 years.
- Closing the coverage and service gap, with emphasis on sanitation which lags considerably behind water supply.
- Ensuring sustainability of existing and new services.
- Improving the quality of services.

2.3. VISION21

The VISION 21 "Water for People" initiative, launched in March 2000, aims to:

- By 2015, reduce by half the number of people without access to hygienic sanitation facilities and adequate quantities of affordable and safe water.
- By 2025, achieve universal access to hygiene, sanitation and water services.

Considering that the current urban and rural populations without improved water service are 173 million and 926 million respectively, and that by 2015 the urban and rural populations will grow by 972 million and 127 million, respectively, it is obvious that the past pace of providing improved services will be insufficient to cope with the projected population growth. Unless the pace is increased, the number of people without access will increase sharply.

To achieve the 2015 target, the annual investment in water supply should be increased by 31% (39% for the urban water sector and 19% for the rural water sector). In sanitation, the numbers are even more drastic as the current coverage level is low. In urban areas, 1.085 billion additional people should be provided with sanitation service, requiring a 28% increase in effective annual expenditure. In rural areas, the global target is to provide an additional 1.1 billion people with sanitation service, implying a quadrupling of the annual progress achieved over the 1990s. To achieve the total sanitation target by 2015 would require that the annual expenditure of the 1990s should almost double.

The integrated development of waterworks and sanitation is important not only in urban areas, but also in rural areas. In general, it is more important in rural areas, since they are economically handicapped. After the development of the water supply and sanitation facilities, the most important issue is the sustainability of water supply and sanitation services in order to encourage community willingness to pay.

2.4. Investment and management for development projects

Proper investment in water supply and sanitation is said to be about one fifth of the total necessary. Furthermore, the amount that can be given by a non-charge monetary assistance is limited to only a proportion of total investment, and project selection should be made very strictly. In line with WHO's slogan "Some for all rather than more for some" for their aiding approach, projects with more beneficiaries for smaller cost should be selected.

The level of government that manages waterworks projects varies depending on the country. In many cases the right to manage is left to the cities, but the country provides loan guarantees, low-interest loans, and aid to assist construction investment. There are examples of maintenance/management costs for waterworks in small cities and local villages being assisted by national government or by a commercial waterworks company.

The problem here is that there are many ambiguous matters, such as what legal background such aid is based on and how rules are set in detail for them. Sometimes the costs of loan guarantees or interest for loan redemption are set in favor of the government, and sometimes there is over-assisting in maintenance/ management costs.

It is thought that in developing countries, the legal administration is postponed and only the political transactions are proceeding.

In a longer view, the goal for a waterworks project is to run independently. The national, local and municipal governments should prepare the legal administration system and give financial aid so that in the end the waterworks company can achieve the goal of independence in which residents/users pay for the proper cost and the company makes efforts for rationalization of management.

A master plan to develop the legal administration system is therefore necessary, and in it the regulations should be made in relation to local autonomy, administration and finance in cities and local regions, public officials, government enterprises, etc.

2.5. WID viewpoint

Development of waterworks has a close relationship with women because in most countries, water carrying and housework related to water, such as cooking and washing, are regarded as jobs for women. Furthermore, since women do housework and raise children, keeping their children clean and houses sanitary depends largely on women's awareness.

In other words, development of waterworks benefits women the most, and therefore without women's cooperation, sustainable development of waterworks is difficult to achieve. Especially in many rural areas, where communities maintain small-scale waterworks facilities, women are very often responsible for the facilities, from maintenance to usage. Water supply projects in rural areas are also considered as projects of Women in Development (WID).

Development of waterworks in urban areas is generally considered as a kind of development of infrastructure, and so it seems to have nothing to do with women. However, considering WID's primary object—taking every project from women's point of view— it will be obvious that there is a relationship. It is women who use water, and waterworks should benefit them the most.

Therefore, women's opinions and experiences are particularly useful as basic research items necessary for waterworks projects, such as the quantity of water in daily use, the frequency and the purpose of fetching water, the type of useful facilities, and the affordability of water.

Small-scale waterworks facilities in rural areas, such as utilization of shallow wells or spring water, are more deeply related to women. In most areas where there is no waterworks, it is women who fetch water from distant sources.

Additionally, as described above, women consume most of the water, and in most areas, women are responsible for maintenance of the facilities and collection of water charges. Recent water supply projects in rural areas have adopted community-participated methods as follows, in which development of water-supply facilities, hygiene education, and WID are integrated.

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Biographical Sketches

Yasumoto Magara is Professor of Engineering at Hokkaido University, where he has been on faculty since 1997. He was admitted to Hokkaido University in 1960 and received the degree of Bachelor of Engineering in Sanitary Engineering in 1964 and Master of Engineering in 1966. After working for the same university for 4 years, he moved to the National Institute of Public Health in 1970. He served as the Director of the Institute, since 1984 for Department of Sanitary Engineering, then Department of Water Supply Engineering. In the meantime, he also obtained a Ph.D. in Engineering from Hokkaido University in 1979 and was conferred an Honorary Doctoral Degree in Engineering from Chiangmai University in 1994. Since 1964, his research subjects have been in environmental engineering and have included advanced water purification for drinking water, control of hazardous chemicals in drinking water, planning and treatment of domestic waste including human excreta, management of ambient water quality, and mechanisms of biological wastewater treatment system performance. He has also been a member of governmental deliberation councils of several ministries and agencies including Ministry of Health and Welfare, Ministry of Education, Environmental Agency, and National Land Agency. He meanwhile performs international activities with JICA (Japan International Cooperation Agency) and World Health Organization. As for academic fields, he plays a pivotal role in many associations and societies, and has been Chairman of Japan Society on Water Environment.

Professor Magara has written and edited books on analysis and assessment of drinking water. He has been the author or co-author of more than 100 research articles.

Naoyuki Funamizu is Associate Professor of Engineering at Hokkaido University, where he has been in his present post since 1989. He obtained a Bachelor Degree and a Master Degree in Sanitary Engineering in 1975 and in 1977 respectively. From 1978 to 1986, he worked for Department of Sanitary Engineering as Research Associate, then as Lecturer until 1989. In the meantime, he obtained a PhD in Engineering from Hokkaido University for the thesis entitled "Analysis of Hindered Settling." His field of research covers 1) integrated watershed management, 2) wastewater reclamation and reuse, and 3) operation of wastewater treatment process. From 1994 to 1995, he worked for the Department of Civil and Environmental Engineering, University of California at Davis as Visiting Scholar.

Doctor Funamizu has written and edited books on municipal wastewater treatment and wastewater reclamation policy. He has been the author or co-author of approximately 80 research articles.

He is a member of Japan Society of Civil Engineering, Japan Water Works Association, Japan Sewage Works Association, Japan Society on Water Environment, and International Water Association (IWA).

Shosaku Kashiwada obtained a B.S. and M.S. degree in Bioresource Science from Shimane University (Japan), and holds a Ph.D. in Bioenvironmental Science from Tottori University (Japan). His specialties are ecotoxicology and environmental biochemistry; with an emphasis on the effects of pesticide exposure on aquatic organism. From 1996 to 2000 Dr Kashiwada worked for an environmental consulting company in Japan researching the influences of endocrine-disruption chemicals on medaka fish, "Development of Bioassays Evaluating Biological and Environmental Risk of Chemicals". Fundamental Research Grant from Environmental Agency of Japan supported this research. From 2001 to the present he is a research associate in the laboratory of Dr David Hinton at Duke University (USA) and focuses on endocrine modulation of environmental chemicals in fish. His interest is effects of pollution chemicals on aquatic organisms. He has focused on effects of pesticide exposure to zooplankton in natural lakes and endocrine disruption chemicals to fresh water fish, including the general environmental risk of these chemicals. He continues his investigations on biological effects of endocrine disruption chemicals on Japanese medaka in Duke University, USA.

Mitsugu Saito is Senior Researcher at Overseas Environmental Cooperation Center, Japan. He was born in 1959 in Sapporo, Japan; he grew up and was educated there. He was admitted to the Architectural Engineering Department, Hokkaido University in 1978, and graduated from it with his thesis on thermal environment. He continued his study at Graduate School of Environmental Science. For his research on thermal waste recovery system from industrial cooling water, he was conferred a master degree of environmental science from Hokkaido University in 1984. Then, he worked for a construction company; Obayashi Corporation, from 1984 to 1997 as a mechanical engineer on building service works. In the meantime, he was dispatched to Thailand from 1990 to 1995. He was dedicated to many construction and renovation projects (mainly hi-tech factories). His responsibilities covered air-conditioning, plumbing, water and wastewater treatment, utility supply, and pollution control. From 1997, he enrolled to Japan Overseas Cooperation Volunteers (JOCV), in the frameworks of Japan International Cooperation Agency (JICA). He spent two years in Morocco as an urbanist of the municipality of Fes. He was assigned to "Service Nettoiement et Parc Municipal" with responsibility for research and planning of a solid waste management system. In 1999, he returned to Japan and resumed his study in Hokkaido University as a PhD student at Environmental Risk Engineering Laboratory, School of Engineering. He obtained a PhD in 2003 for his dissertation entitled "Appropriate technology of domestic wastewater management for low-income urban communities."

Sombo T. Yamamura is visiting fellow of the Institute of Advanced Studies at The United Nations University, where he has been on faculty since 2001. He was admitted to Kyoto University and received the degree of Bachelor of Engineering in Sanitary Engineering in 1974. Then, he continued his study at the Department of Urban Engineering, The University of Tokyo and was conferred Master of Engineering in 1976. Immediately after graduation, he commenced his professional career at Department of Water Supply, Ministry of Health and Welfare, Japan. After working for the Ministry for ten years, he was dispatched to the Department of Public Works in Indonesia as an advisor of JICA (Japan International Cooperation Agency) in 1986. In 1988, he moved back to Japan and served as an Engineer at Office of Environmental Impact Assessment, Environment Agency. Since 1992, he developed his carrier at several national and international organizations. He served as a chief at Office of Drinking Water Quality Management, Ministry of Health and Welfare, Japan from 1992 to 1994, as a special advisor for Environmental Health Department at Environment Agency, Japan from 1994 to 1996, a JICA chief advisor for Environment Management Center in Indonesia from 1996 to 1998, then as a sanitary engineer of Water Sanitation and Health Unit, Department of Protection of the Human Environment, Cluster of Sustainable Development and Healthy Environments at WHO (World Health Organization). In the meantime, he also obtained a Diploma at Imperial College, University of London in 1983.

Katsuyoshi Tomono is Senior Engineering Adviser of Environmental Planning Institute, Tokyo Engineering Consultants, Co., Ltd., where he has worked since 1999. He graduated from Hokkaido University and received the degree of Bachelor of Engineering in Sanitary Engineering in 1961. After graduation, he worked for Nihon Suido Consultants, Co., Ltd. from 1961 to 1980. He served as Manager of Design Division with responsibilities for planning, design and construction supervision of water supply and sewer system projects in Japan and abroad, and studies on water treatment engineering and economic evaluation on projects. He then spent seven years as Project Engineer at Infrastructure Department, Asian Development Bank until 1987. He was responsible for appraisal and evaluation of bank-financed loan projects in the water supply, sewerage and sanitation sectors. From 1987 to 1999, he worked for Japan

Water Works Association as Senior Researcher for several fields, which include development studies on advanced water treatment, high-pressure water service, risk management, etc.
He has authored or co-authored many research articles at the Japan Water Works Association and American Water Works Association for more than 20 years. The subject of study includes the art of water treatment in Japan, the costs and benefits of risk management in water supply, economies of scale in water supply, etc.