BASIC CONCEPTS AND DEFINITIONS IN WATER QUALITY AND STANDARDS

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Summary

Water is used for various kinds of purposes: for agriculture, industry, fishery, as well as domestic purposes. As water flows over the ground surface and becomes available as water resource in rivers, lakes/marshes, undergroundwater, and coastal water, it accumulates inorganic substances from the soil, and organic substances and microorganisms generated by human activities and natural ecosystems. The production of food for maintaining living creatures also relies heavily on water. At the beginning of the new millennium, it is doubtful whether water can be secured for everyone at the

minimum acceptable level. Impurities which exist in water include not only the substances necessary for supporting living creatures but also hazardous substances, which are not just unnecessary for living creatures, but cause health problems. Water quality standards for a variety of those contaminants should be established by relating their properties to water use, their behavior in the aquatic environment and their effects on ecological system, including human beings.

A water quality standard sets the level that does not cause any hazard to human bodies and/or limitations on use of water usage. A reasonable standard is that which corresponds to the latest scientific information. Therefore, the standard should be scientifically evaluated periodically, and should be revised if necessary. If a survey shows that intake of a particular chemical from food is rather small, drinking water can share a larger portion of the tolerable daily intake (TDI) of that chemical. Eventually, the standard value will become higher than the default value of 10%.

Monitoring is conducted to examine the compliance with the standards. If the compliance is not satisfactory, measures must be taken to reduce input from the source. Practical implementation of drinking water quality standards or guidelines values requires collection and analysis of samples. The sampling program should be designed to cover both random and systematic variations in water quality and to ensure that the collected samples are representative of water quality throughout the whole distribution system.

Central and local governments are involved in river water quality management. In the usual situation, wherein a public-oriented approach to environmental protection and promotion is emphasized, the government, both national and local, plays the most decisive role in water quality management. However, industries as well as the local populace also have an important role to play.

1. Introduction

Water is used for various kinds of purposes: for agriculture, industry, fishery, and domestic purposes. It is supplied from the ocean to the atmosphere by evaporation and comes back to the ground surface as rainfall. It supports various kinds of human activities and, of course, the natural ecosystem. As water flows over the ground surface and becomes available as water resources in rivers, lakes/marshes, underground water, and coastal water, it accumulates inorganic substances from the soil, and organic substances and microorganisms generated by human activities and the natural ecosystem.

The world population reached to six billion in 1999, and is expected to increase to eight billion by 2015. Considering that it took about 30 years for the population to grow from four billion to six billion, it is clear that the rate of population growth is accelerating. People generally try to improve their living conditions, but for how long will the Earth be able to adequately support humanity, with such rapid population growth in so many countries? WHO defines “Health” in its charter as follows: “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Physical existence in terms of biological aspects is not sufficient in considering the lives and dignity of human beings. In addition, energy and metabolism, which are essential factors for existence, are also dependent on water in many aspects.

Production of food for maintaining living creatures also relies heavily on water. At the beginning of the new millennium, it is doubtful whether water can be secured for everyone at the minimum necessary level. Water is used not only for food production, but also for secondary industry, tertiary industry and the information/communication industry. Using water means the use of its attributes, i.e. its dissolving power, transportation power, or heat characteristic. Therefore, it should be recognized that during water consumption, its amount does not change; instead, it becomes wastewater, with different attributes.

Contaminants in water include not only substances necessary for supporting the life of living creatures, such as nitrogen, phosphorus and iron, but also hazardous substances, such as arsenic and mercury, which are not just unnecessary for living creatures, but also cause health problems. Furthermore, parasites and infectious microorganisms, and chemical substances such as agricultural chemicals, which may cause health problems to humans or living creatures, are also carried by water. In addition, other substances, which do not cause any direct hazard to humans or living creatures, are nuisances in the proper use of water, e.g. silt and sand, which make water turbid. Contaminants in water can be classified according to their effects and sources, as shown in Figure 1. Water quality standards for these contaminants must be established by relating their properties to water use, their behavior in the aquatic environment and their effects on the ecological system, including human beings.

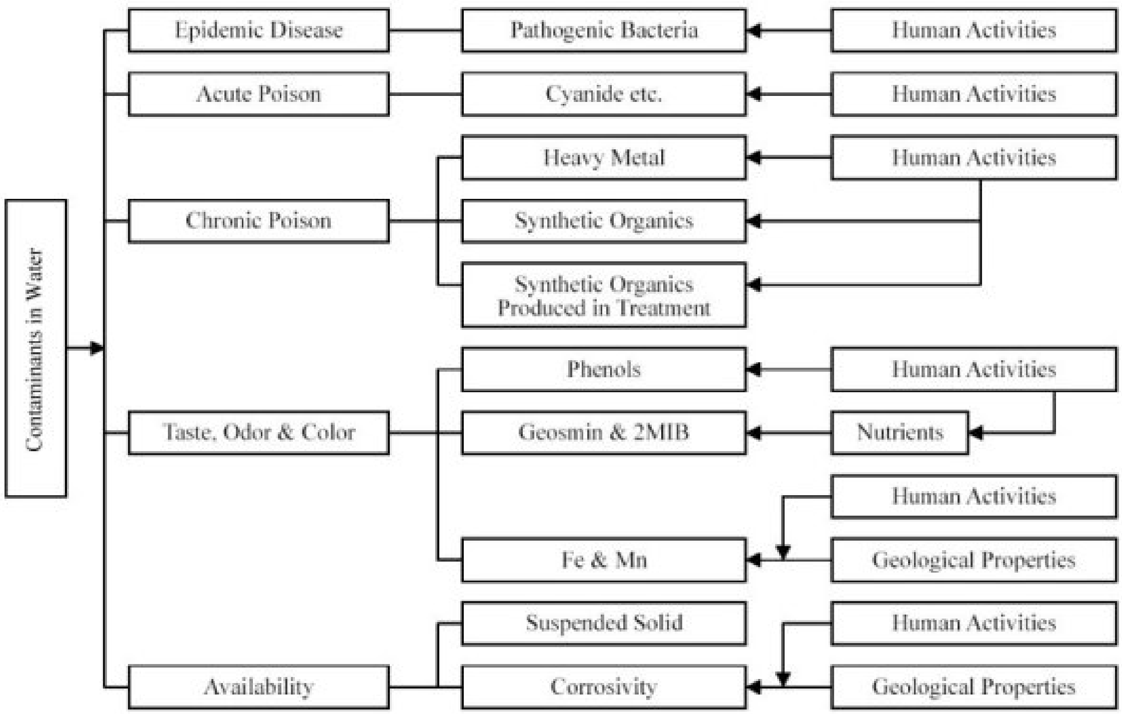

Figure 1. Contaminants and their effects, and their sources in water

	River water (km^3 $year^{-1}$)	**River water (1000 m^3 per capita per year)**
Europe	2,900	4.2
North America	7,770	17
Africa	4,040	5.7
Asia	13,508	4
South America	12,030	38
Australia and Oceania	2,400	84
Globe	42,650	7.6

Source: I. A. Shiklomanov (1997). Comprehensive assessment of the freshwater resources of the World - assessment of water resource and water availability in the world. WMO.556, p.88.

Table 1. Distribution of available fresh water resources

The water environment is one aspect of the hydrological cycle on Earth. The available freshwater resources, which is essential to human life, has a constant cycle volume: 150×10^{12} m^3. This volume circulates with a period of one week to ten days. Six billion people are now using 150×10^{12} m^3 of this fresh water, and eight billion people will use it before long and ten billion people will probably be using it by the middle of the twenty-first century. However, it is evident that fresh water is not equally distributed seasonally and spatially, as shown in Table 1.

2. Water quality standards and their development

2.1. Concepts

Water quality standard shows the levels which do not cause any hazard to human bodies and/or impose limitations on use of water, according to the purpose of water usage. Accordingly, there are various criteria of water quality standards, i.e. safety of drinking water, acceptability of water quality for industrial use such as cooling water for boilers, water used for agriculture, fish farming, fishery, and for sustaining natural aquatic ecosystems. Therefore, in order to establish a water quality standard, scientific examination is required into the safety and availability of water for each purpose. The water quality standard must have technical and economic considerations. It is not practicable to enact a standard that requires technology (for measuring concentrations or treatment), that is either not yet available or which is too expensive for practical implementation.

The enforcement of the standard must be ensured once the standard has been established. In order to ensure compliance with the standard, periodic or continuous monitoring will be needed. The results of such monitoring will be useful information in reviewing the standard itself. If some adverse effect is observed, even though the standard has been complied with, measures should be taken to resolve the problem. Or, if compliance with the standard is very low, law enforcement may need to be intensified.

A reasonable standard is one which corresponds to the latest scientific information. Therefore, the standard should be scientifically evaluated periodically, and should be revised if necessary.

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Biographical Sketch

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 National Institute of Public Health in 1970. He served as the Director of the Institute from 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 he has studied 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. Meanwhile he 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.