B－12. 3 **Impact of Global Warming on Urban Water-supply and Sewerage System**

Contact Person Hiroshi Tsuno
Dept. of Environmental & Sanitary Engineering
Faculty of Engineering, Kyoto University
Yoshida, Sakyo-ku, Kyoto, 606-01 Japan

Total Budget for FY1990-1992 9,256,000 Yen

Abstract Factors which are affected by global warming and impact the urban water-supply and sewerage systems are listed, and correlation among them are identified. Water temperature in euphotic zone of lakes are found to increase by about 1 degree of centigrade with each 1 degree of centigrade increase of atmospheric temperature from the correlation analysis with the data of Lake Biwa, 26 lakes in Japan 116 lakes in 50 countries and areas. Stimulation of algal growth and depletion of dissolved oxygen in hypolimnion are shown by surveyed data and simulation model. By using the developed model, the extent of effect can be assessed at a given site. Effects by increase in biochemical reaction on water quality in rivers and on sewage treatment efficiency are discussed. Increase extent of flowrate of water usage in water supply in Japan is also discussed and shown to be about 6 L per person per day with increase of 1 degree of centigrade. And corrosion of sewage facilities caused by infiltration of sea water is also taken into consideration.

Key Words Global Warming, Water Supply, Sewer, Lake

Introduction

The mean temperature is predicted to increase by 3.5-5.0 degrees of centigrade in FY 2100 as a result of increase in atmospheric concentration of global-warming effect gases. Sea water level is also estimated to increase by about 60 cm according to the global warming effects.

A great number of people live in urban area, and they rely on water supply and sewerage systems in Japan. In order to sustain safe and stable life in urban area in the future, it is important to assess and response appropriately to the effects of global warming and sea-level increment on these urban systems and their operation performance. It is also important to assess the possible effects and response to them gradually and safely from now at their construction and renewal time.

The purpose of this study is to identified and correlate factors associated with the global warming and sea-level increment, and to develop simple models available to assess the extent of several effects caused by the global warming on water-supply and sewerage systems.

Results

Factors which are affected by the global warming and impact the water-supply and sewerage systems are listed, and correlation

among them are identified. The deterioration of quality of lake water used for water supply source include stimulation of algal growth and prolonged stratification which are caused by increase in water temperature of euphotic zone. As a result, increase in DOC, taste and odor problem, and depletion of DO in hypolimnion occur. Increase extent of water temperature caused by increase in atmospheric temperature are shown as Table 1. Examples are shown in Figure 1.

Table 1 Relationship between atmospheric(X) and water(Y) temperatures in lakes

Lakes		equation	correlation coeff.	
Lake Biwa	Southern basin	Y=0.956X+1.12	0.965	Data[1)]
	Northern basin	Y=0.867X+2.04	0.956	Data[1)]
26 lakes in Japan		Y=0.892X+3.48	0.926	Data[2)]
117 lakes in the world		Y=0.906X+3.03	0.936	Data[2)]

From these, water temperature in euphotic zone is shown to be increased by 1 degree of centigrade with each 1 degree of centigrade increase in atmospheric temperature. A ecological model, which incorporates nutrients, algae, zoo plankton, detritus and DOC as state variables, is developed to predict the effects caused by the increase in water temperature. Water column is separated to euphotic zone and hypolimnion to predict the effects by prolonged stratification in this model. A example predicted by this model is shown in Figure 2. The effect is shown to be significant.

Deterioration of water quality in rivers used as water supply sources is caused by decrease in saturation concentration of DO and increase of biochemical reaction activity with increase in water temperature. Water temperature increases about 0.7-0.9 degree of centigrade with each 1 degree of centigrade increase of atmospheric temperature as shown in Figure 3 (36 rivers in Japan: Data[3,4)]). A example of the effects caused by the water temperature increase is predicted by Streeter-Phelps equation is shown in Figure 4. Depletion of DO becomes more severe.

Water volume used by a person per day increases with atmospheric temperature. The increase extent is analyzed and shown to be 6-7 L increase per 1 degree of centigrade increase[5,6,7)]. Capacity of water supply and sewerage systems should be checked. Increase of consumption rate of chloride by about 1.3 times per 5 degrees of centigrade increase is also important.

Biochemical activity is also affected by increase in sewage temperature. Sewage temperature increases with atmospheric temperature as shown in Figure 5 (Data[5)]). The effects on hydraulic retention time in treatment reactors are shown in Figure 6 for organic removal, nitrification and denitrification. Though expectation of decrease of reactor volume is shown, we should consider it as safety volume.

Corrosion of sewage facilities is also important, which is caused by infiltration of sea water. This is acceleration by increase of sea water level caused by the global warming. Concentration of sulfate in sewage which receives infiltration of sea water is measured and shown to be 50 to 150 mg/L, while the

concentration is around 20 mg/L without the infiltration.

References
1)Quality of environment in Shiga--Data Book-- (1989,1990)
2)ILEC Suevey of the State of world Lakes (1989)
3)Water Works Association--Data Book--(1989)
4)National Astronomical Obsevatory, Maruzen Chronological Scientific Tables
5)Sewage works data in Kyoto
6)Yoshiko Hosoi, Climatic Sensitivity of Water Demand in Shikoku Island Pro. of the 13th Syposium of AESER, Kyoto University (1991)
7)Kiyoshi Yamada, Water Supply Engineering, Sanitary Engineering, Kshima (1987)

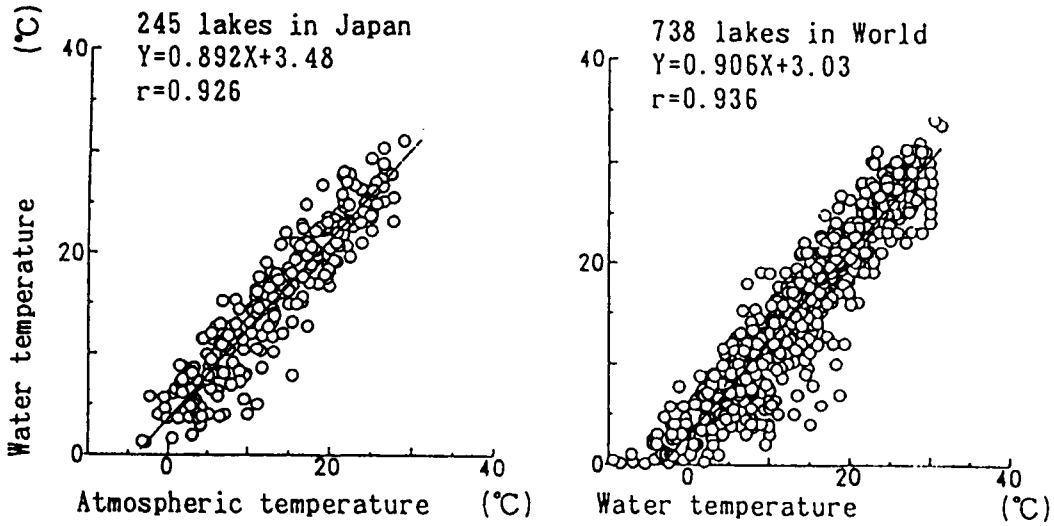

Fig.1 Relationship between atmospheric and water temperature in lakes.

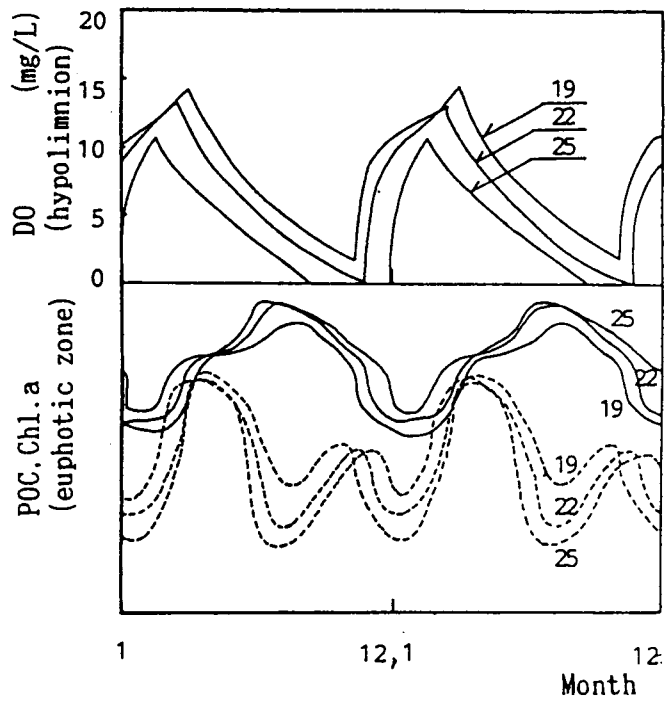

Fig.2 Simulated results by ecological model.

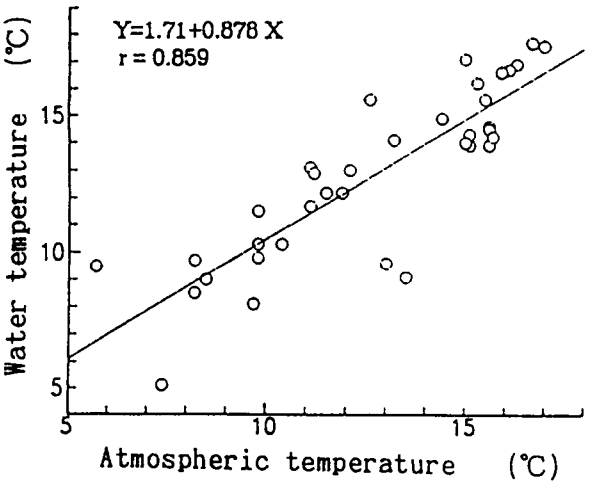

Fig.3 Relationship between atmospheric and water temperature in rivers.

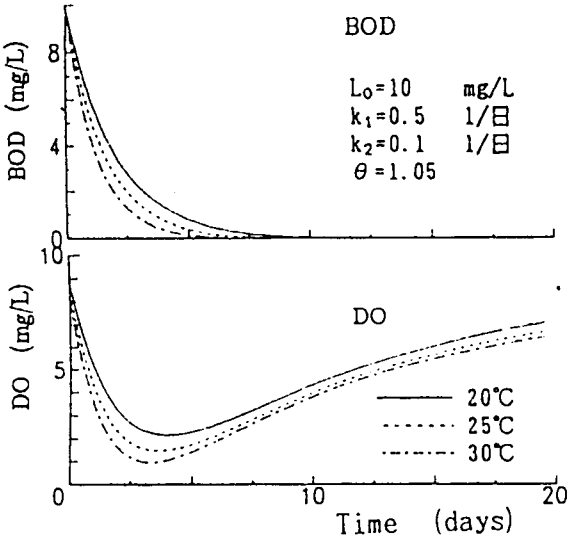

Fig.4 Simulated results by Streeter-Phelps equation.

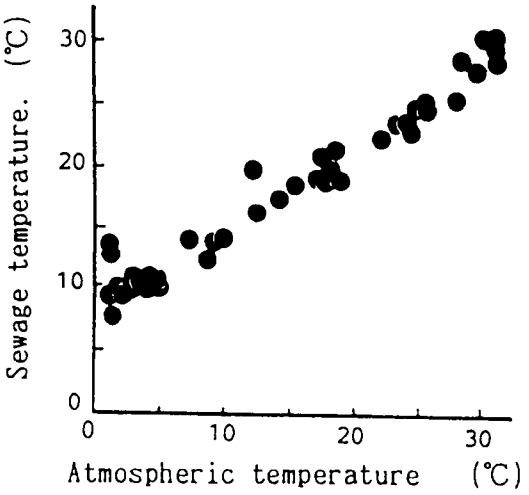

Fig.5 Relationship between atmospheric and sewage temperature.

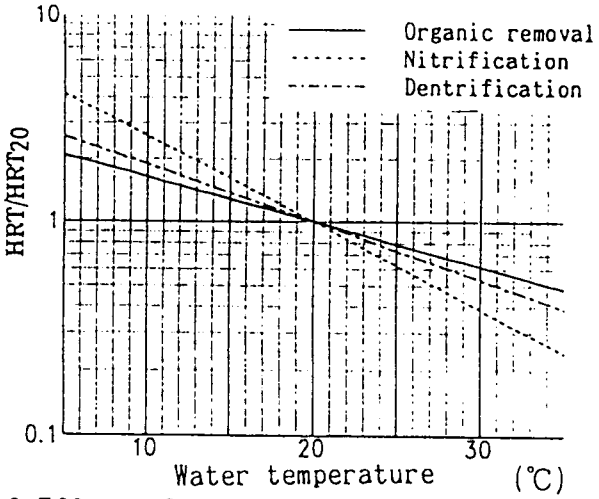

Fig.6 Effect of sewage temperature on hydraulic retention time of reactor.