RESEARCH ON THE TECHNICAL STANDARD OF THE TREATED WASTEWATER REUSE SYSTEM

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Project period: 2001-2004

OBJECTIVES

In Japan, treated wastewater is reused for many uses in the cities as low quality water resources. But there happened some serious problems such as facilities troubles caused by treated wastewater. It is very important to adopt the appropriate materials or constructions and maintain the facilities adequately in order to make use of the treated wastewater as water resources. The objectives of this research is to show the measures to construct the safe, comfortable and sustainable re-use system of treated wastewater to the many uses of treated wastewater by studying the measures to maintain the beauty of the treated wastewater and protect the troubles of the function in the treated wastewater reuse system.

RESULTS

In 2003, we researched the below two things.

(1) The study on the technical standard to maintain the beauty of the treated wastewater and protect the troubles of the function in the treated wastewater reuse system.

(2) The fundamental study on the evaluation of the amount of the aerosols that may be produced in the reuse of treated wastewater.

We have studied about the technical standard of the treated wastewater reuse in the committee about the criteria of the treated wastewater in the treated wastewater reuse system(chairman; Prof. Kaneko, The Univ. of Setsunan).The main results of the discussion in the committee are the below things.

① The criteria will be applied to the water for toilet flushing, recreational impoundments, aesthetic impoundments, and sprinkling to trees, roads, fields and so on. Recreational impoundments and landscape impoundments may be ponds, rivers, fountains and water falls.

② The targets about the beauty of the treated wastewater and the troubles of the function were decided in consideration of the actual conditions of the troubles in treated wastewater reuse in Japan.

③ Chromaticity may be the important index in consideration of the results of questionnaire about the color, the clouds and the smell of the treated wastewater.

The committee will study about the technical standard of the treated wastewater reuse in 2004, too.

At the research of(2), we measured the coliform group and the heterotrophes in airs by the air filtration, using the experimental aeration tank as the source of aerosols. As a result of this research, we could find out the below thing.

① We should consider evaluating the amount of the aerosols by measuring the heterotrophes because the heterotrophes from the aeration tank were detected though the coliform group weren't detected.

② We may not have to consider the death of the heterotrophes under dry condition because the detected number of the heterotrophes is in proportion to the vacuuming time. But we should consider the way except the air filtration because the amount of the vacuuming air is little by air filtraion.

APPLICATION OF LCA TO WASTEWATER SYSTEM

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Project period: FY 2001 – 2004

OBJECTIVES

Recently, it has become necessary to evaluate the effect and influence of not only sewerage projects but also other public works from the viewpoint of global environmental protection. To evaluate the global environmental impact of projects, Life Cycle Assessment (LCA) is an effective technique. The life-cycle of social infrastructure includes the construction stage, operation and maintenance stage, and disposal stage; LCA studies the environmental aspects and impacts throughout this life-cycle. This research aims to establish and apply LCA to wastewater projects. We started this research in FY 2001, and in FY 2003 we calculated and analyzed the emissions of CO_2 and consumption of energy from a centralized wastewater treatment system and private (decentralized) wastewater treatment system.

METHOD

First, we selected an area for the case study and then calculated the present and future populations of the area. Next, we assumed that either a centralized wastewater system or private (decentralized) wastewater system would be installed in the area and defined four cases (Table 1). Finally, we calculated the emission of CO_2 and consumption of energy (environmental load) for each case.

Table 1 Classification in case study

Classification	Private (decentralized) wastewater treatment system (Case ①)		Centralized wastewater treatment system (Case ②)	
	General septic tank	Advanced septic tank	Building a new plant in the area	Treating wastewater at the existing plant outside the
Sludge treatment	Treating at the sludge treatment facility outside the area	Treating at the sludge treatment facility outside the area	Treating at the sludge treatment facility outside the area	Treating at the existing incineration facility outside the area
Case No.	Case ①-1	Case ①-2	Case ②-1	Case ②-2

RESULTS

The results were as follows (Fig. 1):

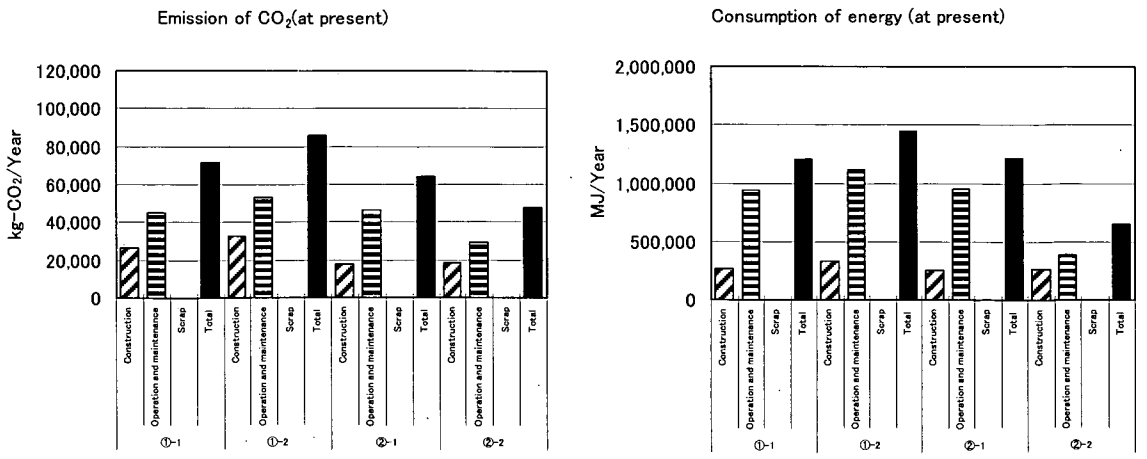

Fig. 1 Emission of CO_2 and consumption of energy (at present)

(1) The environmental load from the centralized wastewater treatment system was smaller than that from the private (decentralized) wastewater treatment system.

(2) Case ②-2 had the least environmental load of the four cases; case ①-2 had the highest load.

(3) In every case, the environmental load from the operation and maintenance cycle was more than that from the construction cycle, typically accounting for 60% to 79% of the total environmental load. The trend of the total load in the four cases can thus be inferred by analyzing the load of the operation and maintenance cycle.

Evaluation method for advanced wastewater treatment systems

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Project period: 2002-2004

OBJECTIVES

Advanced wastewater treatment is essential for improving the water quality in closed water bodies and the safety of treated wastewater, which are now strongly demanded. This study makes suggestions for policy-making concerning advanced wastewater treatment by developing a method for evaluating such treatment, presents clear alternative scenarios based on scientific principles, and proposes a consensus-based decision-making method. The feasibility of the suggestions was examined thorough a case study of the Lake Biwa watershed.

RESULTS

In FY2003, we studied a consensus-based method for evaluating advanced wastewater treatment: the study was conducted in cooperation with a non-profit organization (NPO), 'Biwako Mizu Net', which focuses on the sewage and water quality conservation of Lake Biwa as well as Shiga Prefecture. Various stakeholders such as local residents, NPOs, specialists, and so on are involved in this social experiment. The framework of the study and the role of participants are shown in Fig. 1.

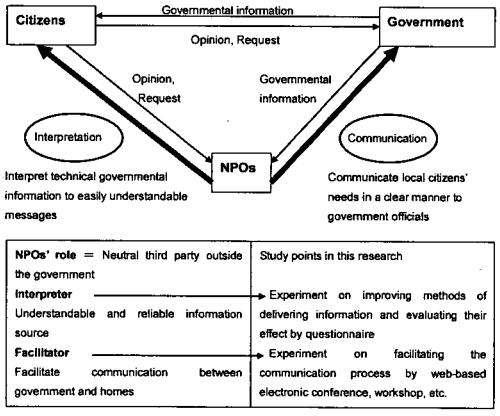

Fig. 1 Study framework and the role of the participants

The research results were as follows.

1. Questionnaire of NPOs' opinions regarding public works for conserving the water quality of Lake Biwa

A questionnaire study revealed that NPOs consider society should concentrate its efforts on the following: environmental education, measures against pollution from household wastewater and agricultural run-off, and implementation of sewage. Measures against familiar problems and reducing the large amount of pollutants were considered important. On the other hand, each NPO was interested in participating in the following measures: environmental education, measures against pollution from household wastewater, preservation of water-resource forests, and measures against agricultural run-off. Measures against familiar problems, as mentioned above, were considered important. Activities that are familiar and easy to participate in, such as planting trees and preserving mountain villages, attracted great interest, while less familiar or more difficult activities for NPOs, such as sewage, attracted little attentions, even though the necessity of the measures was recognized.

2. Methods for evaluating the effects of public involvement in the process by questionnaire of local citizens

According to the results of a questionnaire of local citizens, the citizens' group with a high level of knowledge about the water environment of Lake Biwa tended to state a higher willingness-to-pay (WTP) compared to the middle- and low-level knowledge groups (the average WTP was 789, 564 and 593 yen per house monthly, respectively). The higher the knowledge about the water environment of Lake Biwa, the more interested the respondent was about environmental issues including sewage. Therefore, a correct knowledge about these issues is essential to stimulate interest and awareness. It is also important to continuously supply information.

Technology-based risk standard for wastewater treatment

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Project period: 2002-2004

OBJECTIVES

In Japan, as elsewhere, the water related health risk posed by pathogenic microorganisms such as outbreaks of *Cryptosporidium* and food poisonings caused by noroviruses has become an increasing problem. This study presents a technology-based standard for ensuring the safety and reliability of treated wastewater.

RESULTS

In FY 2003, we studied the occurrence and evaluated the risk of several bacteria and viruses in raw sewage, treated wastewater and reclaimed wastewater of eight wastewater treatment plants. We also continued the detection of Protozoan (*Cryptosporidium* and *Giardia*) in these samples as in FY2002. In addition, we conducted a risk communication study by analyzing the results of FY 2002's questionnaire for pathogen risk with reuse of reclaimed wastewater.

The main results of research in fiscal 2003 were as follows.

1. Study for bacteria

   Total and fecal coliform groups, *Escherichia Coli*, fecal streptococcus group, enterococcus group, and *Clostridium perfingens* were examined as indicator organisms; and *Salmonella* spp., *Legionella* spp., *Campylobacter jejuni* and *E. Coli.* O-157 were tested as pathogens. All measurements were conducted by culture methods. Rare detection of these pathogens suggested that the annual risk of infection by them was far below 10^{-2}, yet it was difficult to estimate the statistical probabilities of their occurrence. *Salmonella*, *C. jejuni* and *E. Coli* O-157 are thought to be inactivated by proper disinfection (chlorination etc.) at the point of effluent discharge, so no special treatment is required. *Legionella*, on the other hand, is thought to re-grow in bio-film (slime) in pipes and so further research on this risk should be conducted.

2. Study for viruses

   Enteroviruses and noroviruses (genotype G1 and G2), RNA virus, and adenoviruses, DNA virus, were detected by a real-time PCR (polymerase chain reaction) method and enumerated by the MPN method. Frequent occurrence of viruses was observed in raw sewage and secondary treated wastewater; noroviruses were detected in advanced treated wastewater sporadically. There were several difficulties in assessing the risk of noroviruses and so a tentative risk assessment had to be adopted: PCR positive results (gene detection) did not directly mean the occurrence of infectious viruses and cell-culture methods for noroviruses have not yet been developed. A dose-response model of noroviruses is not available, so the risk should be calculated by a model of the surrogate viruses. The use of advanced disinfection techniques such as ozonation and ultraviolet radiation (UV) should be considered if the risk of infection is considered to be high, such as reused recreational water

3. Study for protozoa

   Cryptosporidium parvum oocyst and *Giardia lamblia* cyst were examined by microscopy as in FY 2002. The occurrence of *Cryptosporidium* decreased significantly compared to FY 2002; modification of collection step (changed to collect both oocyst and cyst simultaneously) might have affected the recovery rate of oocyst. The occurrence of *Giardia* was high in raw sewage, but the internal structure was difficult to confirm in treated/advanced treated wastewater; thus, their infectivity should be considered for risk assessment because they were not so robust to chlorination as *Cryptosporidium*,

DECOMPOSITION OF ENDOCRINE DISRUPTERS UTILIZING MICROORGANISM GROUPS

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Project period: FY2001-2003

OBJECTIVES

It is necessary to efficiently reduce endocrine disrupters (EDs) through sewage treatment processes because EDs generated by urban activities are discharged to sewerage systems. Although the majority of EDs are removed, some cannot be removed. On the other hand, microorganisms which effectively decompose EDs have been found (Ogoshi, et al. 2001), and have the potential to be used in existing wastewater treatment facilities.

This research examined how such microorganisms act, and how wastewater treatment processes could be controlled to utilize such microorganisms. Finally, wastewater treatment technologies which reduce the risk of EDs were developed.

RESULTS

The performance of EDs which decompose microorganisms was investigated by using a wastewater treatment pilot plant. In FY 2003, a batch investigation and a pilot plant investigation were conducted. The results of the investigations in FY2003 are summarized as follows.

1) In the batch investigation, E2 was added to the activated sludge to the amount of 100 μ g/L, and the state of decomposed EDs was observed. In one case, the carriers, that immobilized the EDs that decompose microorganisms , were mixed with activated sludge, and in another case, the carriers were not mixed. As a result, most of the E2 were decomposed quickly in both cases. The amount of decomposed E2 was higher in the case where the carriers were mixed. The difference was observed especially just after E2 was added to activated sludge. (Fig. 1)
2) In the pilot plant investigation, two pilot plants were prepared. The carriers were mixed in one pilot plant, and not in the other. 10mg of E2 were added to each pilot plant at time 0, and the state of decomposed EDs was observed. As a result, E2 concentration in treated water was always lower in cases where the carriers were mixed. The decomposition rate was thought to be larger in the cases where the carriers were mixed because not only E2 was lower, but also E1.(Fig. 2) that was investigated using the same pilot plant.

REFERENCE

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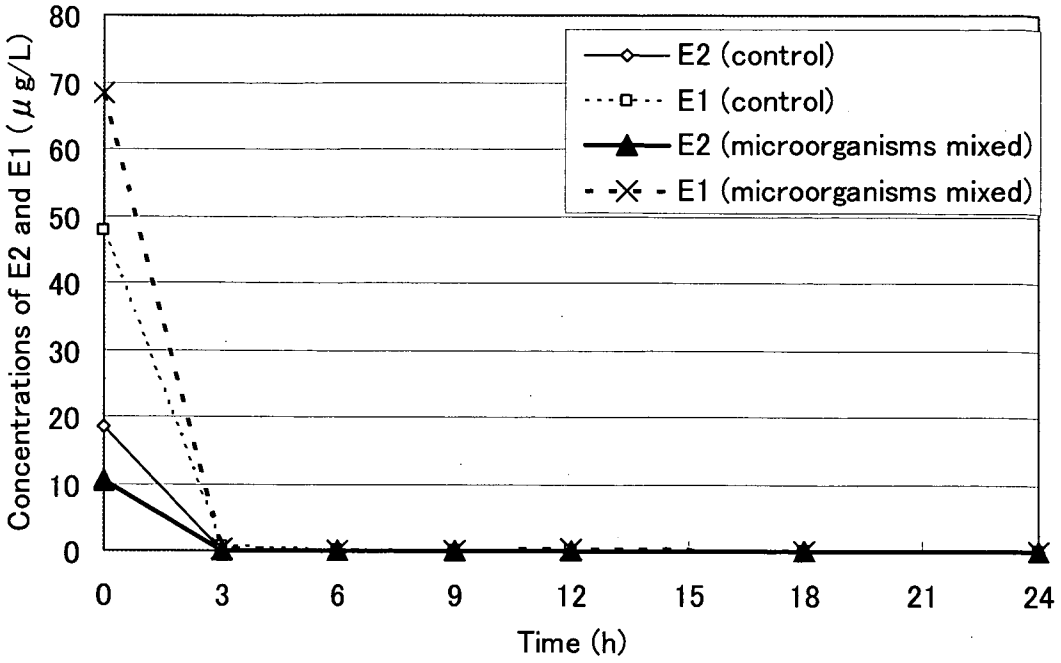

Fig. 1 E2 and E1 in batch investigations

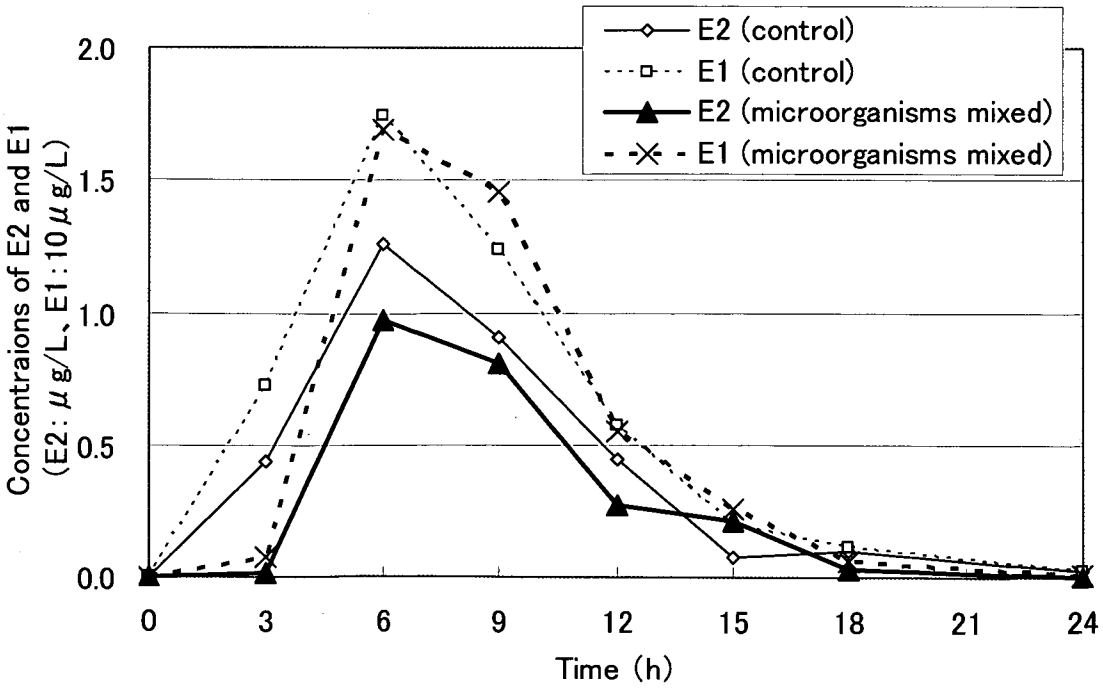

Fig. 2 E2 and E1 in pilot plant investigations

Study on Wastewater Reclamation System for River Ecosystems

(FY2001–2005)

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Introduction

As the sewerage system diffuses, the amount of treated wastewater increases proportionally. When treated wastewater is discharged to public water bodies, it has a serious impact on the ecosystem of the receiving water body that cannot be ignored. The amount of treated wastewater reused as landscaping water in urban areas is being increased to restore the waterside environment that had been lost by urbanization. Such places provide oases in cities for aquatic life.

However, aquatic biota, including algae, aquatic insects, and fish that live in these artificially restored waterside areas are mainly species known to survive in somewhat polluted waters. This is because the objectives of the wastewater reclamation system are limited with primary emphasis on BOD, hygienic safety, and appearance (coliform count, SS, chromaticity, etc.). In fact, wastewater treated with sand filtration or other similar processes after biological treatment is often reused for landscaping water, but there have been few cases in which more advanced treatment for removal of nitrogen or phosphorus or disinfection by ozone or ultraviolet irradiation has been applied. Also, it is not yet fully understood what impact or effect such highly advanced treatment processes have on aquatic life.

Therefore, further research is needed on wastewater treatment methods and treatment levels necessary to create good habitats for aquatic life at artificial watersides to which treated wastewater is discharged.

Aiming to restore and create better habitats for aquatic life at receiving waters, we are studying the relationship between aquatic biota, including algae, benthos and fish, and environmental factors, including the quality of treated wastewater and hydraulic conditions at wastewater receiving waters. We will propose an ideal form of wastewater reclamation system which is acceptable for the ecosystem in terms of effectiveness and economy.

Method

1) Fieldwork in Yokohama city

The purpose of this fieldwork was to identify the differences of aquatic biota caused by different types of wastewater treatment method and treatment level, especially concentration of nutrients. The Kohoku wastewater treatment plant in Yokohama city uses two different treatment processes: the conventional activated sludge process and the anaerobic-Wuhrmann process. Each process has its own effluent point. We observed aquatic biota at each effluent point and analyzed the features of the biota which had formed there. We observed attached algae, benthic animals and phytoplankton; analyzed the biomass, dominant species, occupancy rate and biological diversity for the organisms; and examined the transformation of species composition.

2) Fieldwork in Tadotsu town

Tadotsu town in Kagawa prefecture plans to reuse treated wastewater effectively in the town and has some facilities for this purpose. These facilities began to be operated at the beginning of FY 2004. This fieldwork is analyzing the transformation of species composition before and after the facilities began to be operated.

This year, we observed the species composition before the facilities began to be operated. We examined aquatic biota at three effluent points: Sakaemachi artificial channel, Higashisakura River and Sakura River.

3) Laboratory test

This test included implementing a control experiment of discharging wastewater treated by an actual treatment plant using the anaerobic-anoxic-oxic process and sand filtration without chlorination in order to identify differences in aquatic biota growing at the test channel under different conditions of disinfection. We discussed the relationship between the quality of treated wastewater and aquatic biota. Experiments conducted this year were based on the following two stages: the first stage focusing on the relationship between chlorine dosage and attached algae, and the second stage focusing on the relationship between different types of disinfection method (chlorination, ozonation and ultraviolet irradiation) and attached algae. As the second stage was continuously conducted after the first stage, we could observe the transformation of aquatic biota caused by changing the disinfection method from chlorination to ozonation or ultraviolet irradiation (see Table 1).

Table 1 Disinfection Method and Concentration

channel No.	the 1st stage			the 2nd stage		
	disinfection method	concentration	unit	disinfection method	concentration	unit
A	chlorination	0.01	mg/L	chlorination	0.01	mg/L
B	chlorination	0.1	mg/L	chlorination	0.1	mg/L
C	chlorination	1.0	mg/L	chlorination	1.0	mg/L
D	chlorination	1.0	mg/L	ozonation	5.0	mg/L
E	chlorination	1.0	mg/L	ultraviolet	200	J/m^2
F	not disinfection	-		not disinfection	-	

Results

1) Fieldwork in Yokohama city

In this fieldwork, we obtained the following results:

- There was no difference of biomass caused by different types of wastewater treatment method or treatment level, especially the concentration of nutrients at each effluent point.
- The higher the concentration of nutrients is, the higher the occupancy rate of green algae is.

2) Fieldwork in Tadotsu town

This year, we observed the species composition before the reclamation facility began to be operated at three different effluent points. Next year, we will observe the species composition after the facilities began to be operated at the same points; analyze the biomass, dominant species, occupancy rate and biological diversity for the organisms; and examine the transformation of species composition.

3) Laboratory test

We are continuing to carry out this experiment in the test channel and analyze the results. In the first stage, we observed visible differences between the biomass growing at channels A, B and F and that growing at channels C, D and E. The amount of biomass growing at channels A, B and F is more than that growing at channels C, D and E, and we consider that this phenomenon was caused by differences of chlorine dosage.

FATE OF SANITARY INDICATORS IN TREATED WASTEWATER

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Project period: 2002-2004

OBJECTIVES

With the ongoing development and expansion of sewage systems, treatment plants are discharging treated sewerage water in considerable volumes into rivers and waterways, steadily increasing the proportion of treated water in natural water resources. Meanwhile, recycling of sewerage water is being introduced in urban areas to help conserve finite water resources. Treated sewerage water from treatment plants is used for a range of applications such as flushing toilet, using landscape, watering of vegetation and industrial processes. In this way, members of the general public are increasingly likely to come into contact with treated sewerage water in the course of normal everyday life.

Sewerage contains a variety of pathogenic microbes generated by human activity. Total coliforms, the microbe indicator traditionally used to identify pathogenic microbes, are not considered a sufficiently reliable indicator. In order to maintain proper hygienic standards in treated sewerage water and environmental water, we need to assess to all indicator microbes, not just total coliforms, and select the most suitable indicator for the task at hand. In this study, we compared the behavior of total coliforms with that of E.Coli, Faecal streptococcus and C.perfringens spores in discharged sewerage and analyzed the characteristics of indicator microbes in water resources such as rivers, coastal areas and discharge streams.

METHODS

The study involved a combination of a model watercourse experiment and a field survey. The model watercourse shown in Fig.1 was constructed for the purpose of the experiment. Disinfected treated sewerage water was circulated along the watercourse with a pump and indicator microbes were measured periodically over time. For the field survey, river water was sampled in five to six locations prior to treated sewerage discharge, then directly following discharge, then further downstream. Indicator microbes and water quality indicators were analyzed on the day of sampling.

RESULTS

(1)Watercourse experiment

The watercourse experiment was designed to provide information about chronological changes in indicator microbes in discharge areas. The results are shown in Fig.2.

· The test measurements indicated a change in the total coliforms count, as measured using desoxycholate base agar medium, over the period following chlorine disinfection. These results suggest that microbe populations in sewerage discharge can vary depending on the time of measurement. Note that the E.coli count from the medium used in this experiment did not increase after chlorine disinfection.

· Faecal streptococcus had lower survival rates than total coliforms, both with and without chlorine disinfection. As with E.coli, the number of Faecal streptococcus colonies did not increase after disinfection.

· Chlorine disinfection did not have any affect on C.perfringens spores. With no disinfection, the concentration fell directly after discharge. In this way, the behavior of C.perfringens spores clearly differs from that of the other indicator microbes (total coliforms, E. Coli and faecal streptococcus).

(2)Field survey

The field survey was conducted in order to corroborate the results from the watercourse experiment.

· In the field survey, the treated water is diluted by the river water and reduced levels of indicator microbes were recorded. However, the increase in total coliforms observed in the watercourse experiment was not detected in the field survey.

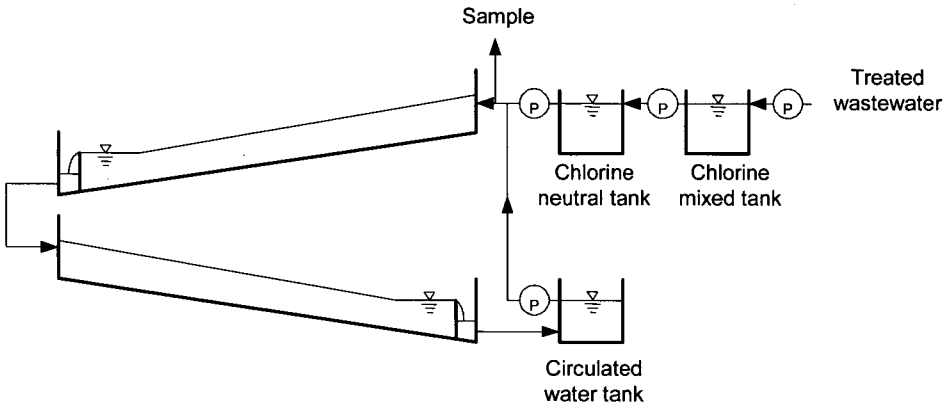

Fig.1 Schematic of model watercourse

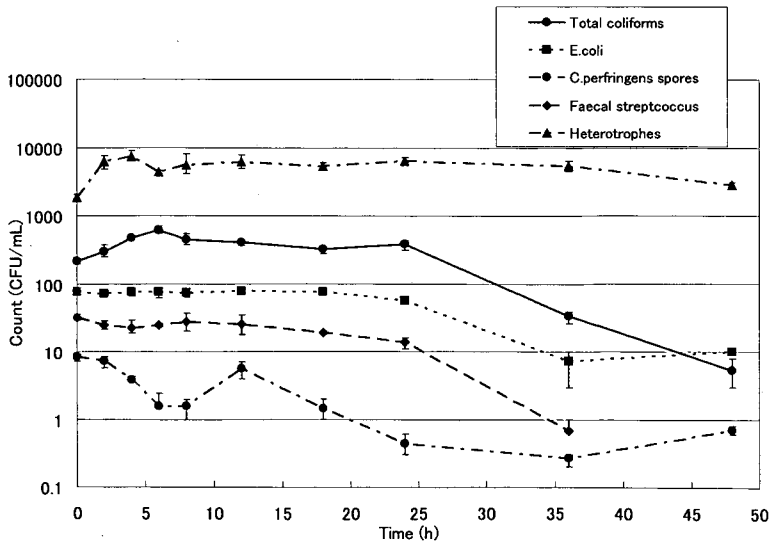

Fig.2 Microbe behavior when chlorine added at 0.5mg/L

EFFICIENT REMOVAL OF SLIGHT HAZARDOUS MATERIALS BY OZONATION

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Project period: 2002-2004

OBJECTIVES

The problems of the slight hazardous materials represented by the endocrine disruptors are getting more serious year by year. These materials may have a bad influence on natural environment, ecosystem and human health even if these are slightly contained. Endocrine disruptor is said to decrease sharply in process of wastewater treatment by some researches, but the influence which endocrine disruptor have on ecosystem is unknown and it may be needed to decrease more on the basis of the influence. The objectives of this research is to establish the way of efficient removal of slight hazardous materials by ozonation.

RESULTS

We considered the details of the experiments as below on a basis of the last-year results and set up the systems for the experiment.

(1) decision of the target materials

We will choose NP and BPA which may be the endocrine disruptors to the fishes and E1 and E2 which may be the endocrine disruptors included in the urine of human and animals as the target materials.

(2) decision of the property of the treated wastewater used in the experiments

We will choose the treated wastewater by the conventional activated sludge process and the A2O process in the pilot plant and by the sand filtration in the real treatment plant in order to grasp the influence of the property of the treated wastewater on the removal efficiency of the endocrine disruptors.

(3) decision of the concentration of the target materials in the treated wastewater before ozonizing

We will add the standard liquid of the target materials into the storage tank and adjusted the concectration in the tank to the maximum concentration in the effluent from the sewerage treatment plant in 2000. (NP=1.0 μ g/L, BPA=0.5 μ g/L, E1=0.06 μ g/L, E2=0.003 μ g/L)

(4) decision of the ratio of the amount of ozone to the flow of the treated wastewater, the reaction time, and height of the reactor

We found that it is important to reduce the amount of ozone and reaction time as much as possible in order to reduce the maintenance cost and the construction cost of the ozone treatment facilities from the last-year experiment. And also, we found that E2, NP, and BPA were reduced down to the level of N.D. under the condition that the ration of ozone is more than 5mg/L and the reaction time is more than 7min from the last-year experiment.

So, we will consider the removal efficiency of the target materials under the condition that the ration of ozone is less than 5mg/L and the reaction time is less than 7min. And also we will consider the influence of the reactor height on the removal efficiency of the target materials and ozone dissolution efficiency by setting the reactor height in the four stages of 1.6m, 2.4m, 3.1m and 4.1m.

RESEARCH ON THE RISK ASSESSMENT OF CHEMICAL SUBSTANCES IN A WATER ENVIRONMENT

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Project period: 2003-2005

OBJECTIVES

Recently, there has been growing concern about the effects of chemical substances like dioxin or endocrine disrupters on human health and the ecosystem. For example, companies have been required to register the release or transfer of 354 chemical substances under the PRTR law (Pollutant Release and Transfer Register) since 1999. The environmental standards were examined in view of aquatic life protection, and total zinc was added to the environmental standards list on Nov. 5 2003.

The Ministry of Land, Infrastructure and Transport, that manages rivers, sewerage systems, roads, and so on, is obligated to perform risk management of chemical substances in the environment cooperatively with stakeholders. But, the actual state of chemical substances in the environment is not clear. So this research was case studies of water environment like rivers, and the collection and classification of information necessary for risk management such as the amount of chemical substances or chemical change of these substances in the environment.

METHODS

The actual state of chemical substances in the environment of rivers for example is not clear, so in FY2003, appropriate rivers were chosen, and the actual states of the main chemical substances were studied.

As appropriate rivers, Kurokawa river (in Tochigi Pref.) and Yatagawa river (in Gunma Pref.) were chosen because many chemical substances referred to in the PRTR flowed into them in 2001. We surveyed chemical substances such as those often detected in environmental standards and PRTR in 2001, and endocrine disrupters such as Nonylphenol and estrogen which is discharged from wastewater treatment plants.

RESULTS

The results of the studies in FY2002 were as follows.

(1) On the Kurokawa river, which was not affected very much by industrial wastewater, the effects on wastewater treatment plant of organic substances and heavy metals were severe, and these substances were reduced as the river flowed. On the other hand, organic substances produced by the chemical industry were detected but completely unaffected by wastewater treatment plant. (Fig. 1)

(2) On the Yatagawa river that was affected severely by industrial wastewater, the effects of the wastewater treatment plant were not observed. On the other hand, discharged chemical substances were thought to differ between industries, because the concentrations of chemical substances produced by the chemical industry were very different at each sampling point. (Fig. 2)

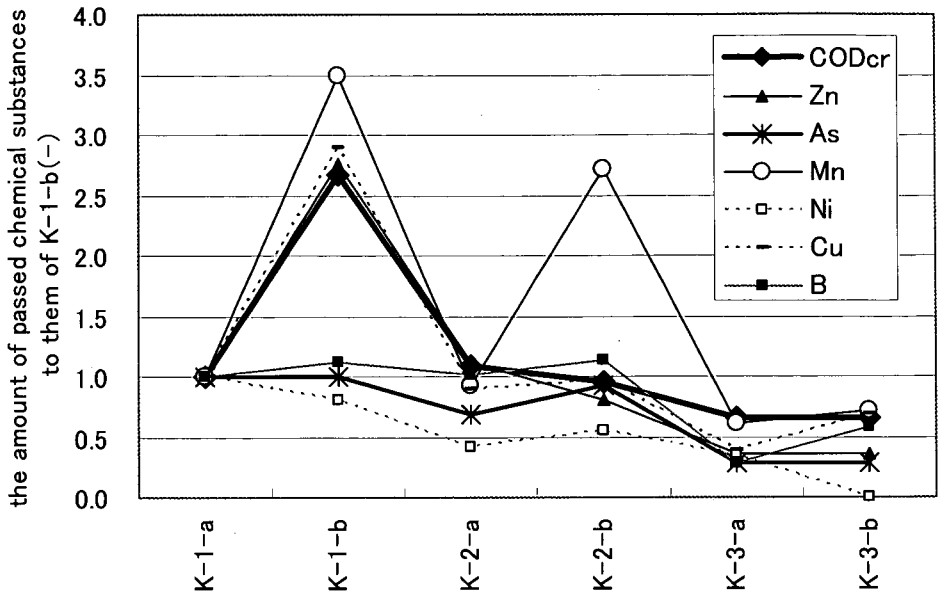

Fig. 1 The amount of heavy metals in Kurokawa river

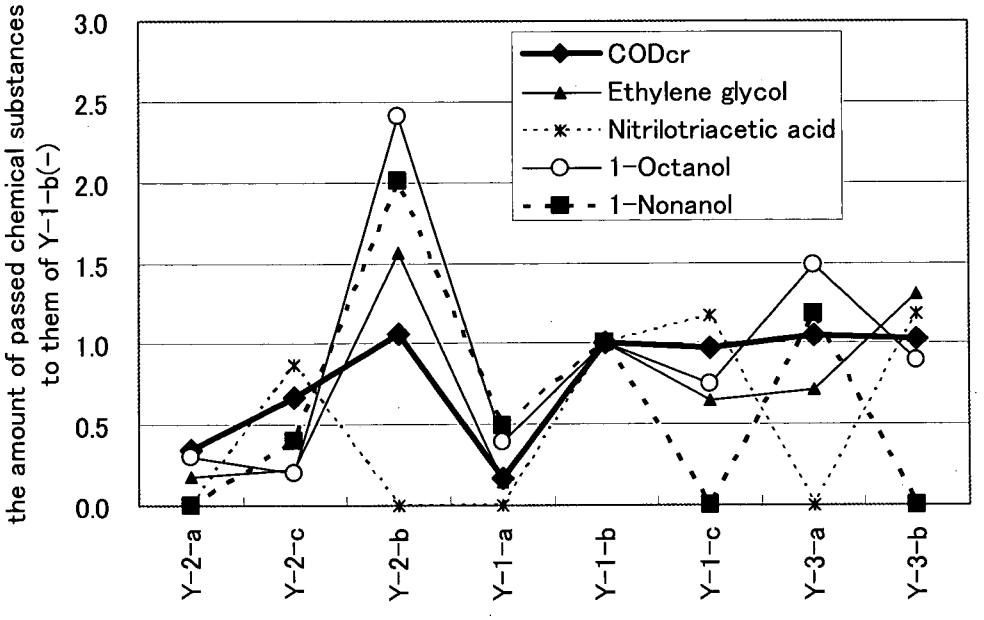

Fig. 2 The amount of organic substances in Yatagawa river

EVALUATION OF WATER QUALITY SECURITY MEASURES IN THE GANGES RIVER BASIN

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Project period: FY2003-2008

OBJECTIVES

In Asia and other regions, rapid population growth, urban development, and industrialization have exacerbated water problems, and human activities have caused fluctuation of water cycles and other problems. The goal of this research is to help resolve these problems by presenting policy scenarios for nine typical Asian river systems. This research is done as team research (CREST type) led by research representative Professor Sunada of the University of Yamanashi, because the area studied is vast and faces many challenges. The Wastewater and Sludge Management Division of the NILIM is in charge of the presentation of policy scenarios with priority on water problems in the Ganges river basin.

OBJECT AREA

The Ganges river is the most heavily populated river basin in Asia, and here, population growth and urbanization have been accompanied by water quality pollution and the consequent shortage of sanitary water, flooding, and other serious problems. Asian rivers typified by the Ganges River are irreplaceable for the daily life of the people, many of whom use them for bathing and washing clothes, and who discharge their human waste in their waters. This results in rampant infectious diseases originating in the river water, and in regions where urbanization is particularly advanced, water pollution accompanied by health problems caused by pathogenic microorganisms are serious public issues. Therefore, water quality preservation measures have been proposed as ways to prevent health problems caused by pathogenic microorganisms, taking the Ganges River Basin as the major example.

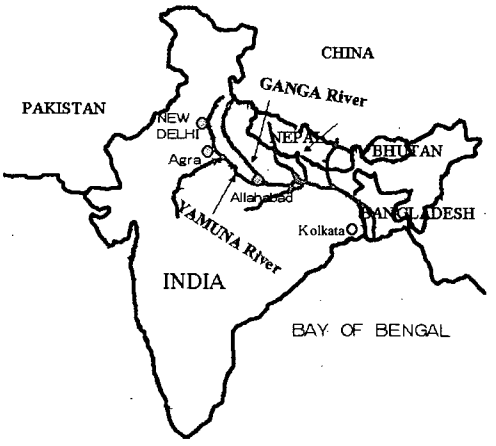

Figure 1 Ganges river area

METHOD

This research is carried out by first conducting a field survey to collect adequate basic documents concerning the life style of the local people, state of pollution of the river, pollution sources and basic units, then based on these findings, organizing step-by-step sewerage system provision methods that hypothesize future developments to present scenarios with the priority on water quality problems. The field survey is a

survey centered on the Indian capitol city of New Delhi where water pollution is particularly severe. In New Delhi, the Yamuna river that is a tributary of the Ganges river is used as a source of water for daily use by the local people.

In 2003 that was the first year of the surveys, a field survey was performed in India to complete basic documents. The survey included observations of the region and measurements of water quality in New Delhi and its surroundings.

RESULT

The results have shown that the water quality is high in the upstream section, but its water quality is severely harmed as it passes through cities (Table 1). The causes are insufficient sewerage treatment plants and the excessively dense population, but in New Delhi in particular, the quantity of water flowing into the city is too low, because upstream, water is used for irrigation and is taken for treatment by water treatment plants.

Table 1 Water quality of Yamuna river

		Up Stream	Down Stream	Down Stream
		Palla	Okhla	Mahatpur
pH		7.2	7.5	7.1
DO	(mg/L)	5.7	2	0
T-BOD	(mg/L)	<1	30	35
T-CODcr	(mg/L)	3	96	122
T-N	(mg/L)	1.6	32.4	45.53
K-N	(mg/L)	1.4	20	37
NH4-N	(mg/L)	1	17	32
NO2-N	(mg/L)	0.2	0.7	0.03
NO3-N	(mg/L)	<1	11.7	8.5
PO4-P	(mg/L)	1.3	3.1	9.1
SS	(mg/L)	5	61	27
Coliform Group	MPN (MPN/100mL)	2.4E+05	1.5E+07	9.4E+08
	Plate Culture (CFU/mL	4.0E+02	1.1E+05	8.0E+05
Fecal Coliform Group	MPN (MPN/100mL)	2.4E+05	1.5E+07	9.4E+08
	Plate Culture (CFU/mL	2.1E+03	8.5E+04	7.1E+06
E . coli	MPN (MPN/100mL)	2.4E+05	1.1E+07	9.4E+08
	Plate Culture (CFU/mL	2.7E+03	7.8E+04	6.1E+05
Enterococcus	MPN (MPN/100mL)	2.3E+03	9.4E+05	9.4E+06
Salmonella		detect	detect	detect

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