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# Korea Environmental Policy Bulletin

## Water Quality Monitoring Using IT

CONTENTS




### Summary

The water quality monitoring systems based on Water Quality Tele-Monitoring System (Water TMS) and Internet Protocol-Ubiquitous Sensor Network (IP-USN) are the representative IT based water management systems in Korea. Water TMS was introduced to improve the conventional method of assessing effluent charges for facilities discharging wastewater, and can perform real time monitoring and management of discharging facilities, enabling prevention of water pollution incidents. Water TMS also effectively establishes integrated watershed management systems by monitoring point-sources, and produces the raw data required to enforce Total Maximum Daily Load (TMDL) in the four major rivers. Water TMS can effectively establish a monitoring system in the four major rivers and is linked with automatic water quality monitoring networks. In addition, the monitoring system based on IP-USN that has been tested in the Four Major Rivers Restoration Project, can be useful in strengthening the water pollution monitoring system, and can contribute to the building of a base infrastructure for a future advanced intelligent society.

# I. Background and objectives of the Water Tele Monitoring System (TMS)

## 1. Background

Introduction of Water TMS was first performed in order to improve on conventional methods of assessing effluent charges for facilities emitting sewage and wastewater. The previous method was to impose effluent charges on facilities when concentration of pollutants discharged exceeded water quality standards. However, this method was not considered effective because it adjudged all days from the occurrence of a single violation until the date of completion of redress as a continuous violation of standards, and was not based on the actual period where standards were not met, nor on the quantity in excess of standards. In respect of this, the Supreme Court determined that the existing method was contrary to the spirit of the law in June 1995; and in October 2004 an administrative verdict ensued that required improvement of the system to assess effluent charges based on actual emissions.

In consideration of the international trends in water quality management, which is shifting towards automatic monitoring and management using IT networks, as well as Korea's well developed communications networks, agreement was reached on improvement of assessment of effluent charges at the Ministerial Meeting on Regulatory Reform to rationalize water quality protected areas on January 25, 2006. To this end, a decision was made to establish the Water TMS, which can scientifically monitor effluent discharges. Discharging facilities installing Water TMS would be exempt from field inspections, and would be charged according to data obtained via the system.

## 2. Objectives

Water TMS aims to supervise discharging facilities in real time with remote monitoring instead of on-site monitoring; and to efficiently and systematically manage the water quality of effluent from discharging facilities through improved methods of assessment. Water TMS is intended to effectively establish integrated watershed management systems via remote monitoring of point sources, and to obtain raw data required to enforce Total Maximum Daily Load (TMDL) in accordance with the Special Act on Water Management of the Three Major Rivers, including the Nakdong river, Geum river and Yeongsan river.

From the perspective of environmental management policies, Water TMS is intended to

induce discharging facilities to voluntarily improve the treatment processes through analysis and control of water quality according to various time frames, including seasonal and hourly time frames; and to prevent water contamination by monitoring discharge facilities in real time and reporting discharge status to related agencies and facilities.

# Ⅱ. Overview of Water TMS

## 1. Operating system

Water TMS is operated under the purview of the Ministry of Environment with the participation of watershed environmental offices, local governments, the Korea Environment Corporation (KECO), and discharging facilities, whose roles in Water TMS are depicted in Figure 1. The procedure for installation and operation of automatic water quality monitoring instruments is presented in Figure 2. In this procedure there are three responsible parties including discharging facilities, watershed environmental offices, and local governments, and KECO, as well as three steps including installation, confirmation and use.

In addition to the institutional base for operation of Water TMS, significant effort has been expended on technical support and provision of information. The operation of the "Water TMS Control Center," which performs automatic data processing and remote control, will be explained in the next section.

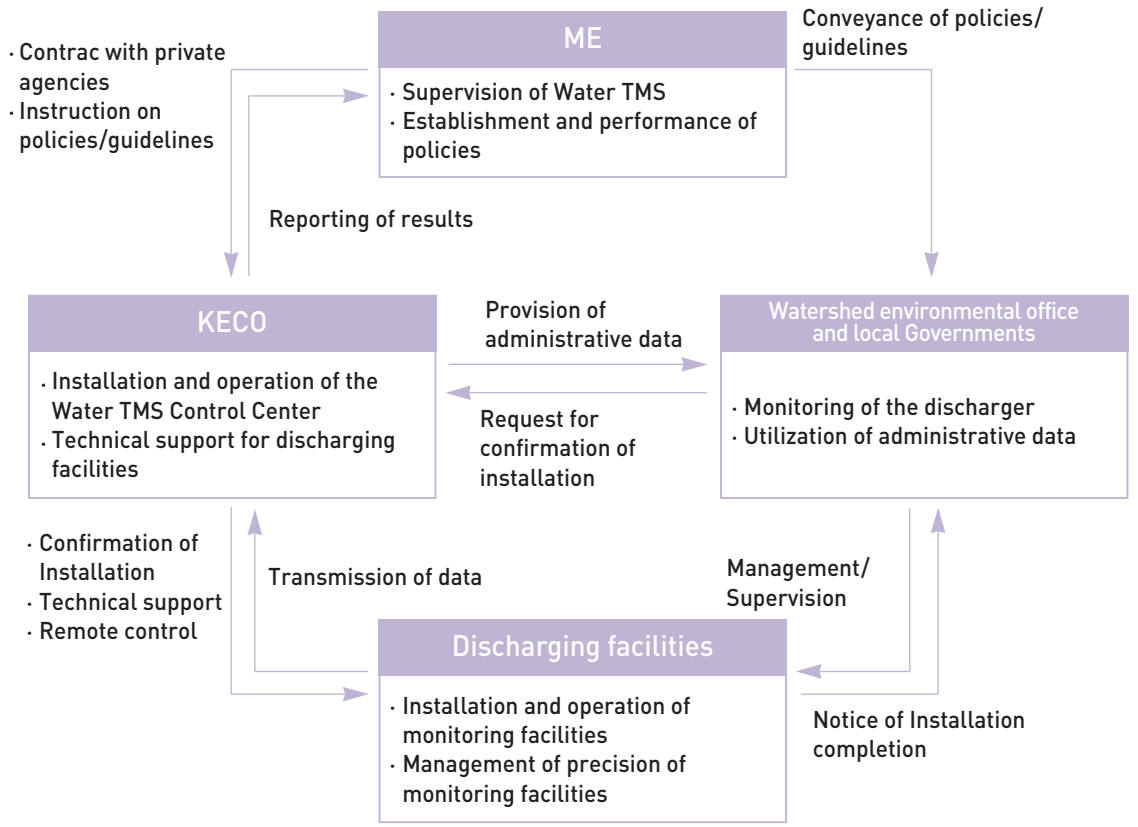
Technical support centers are operated on a regional basis, including the Seoul area, the Chungcheong area, the Youngnam area, and the Honam area for prompt and effective technical support and to assess accuracy of the monitoring facilities. Each manager from KECO has responsibilities for technical support for 10~15 discharging facilities.

In addition to technical support, substantial effort has been expended on education and promotion. Brochures on Water TMS were distributed to local governments and discharging facilities. Furthermore, various meetings, including informal gatherings, workshops, and exhibitions of monitoring facilities have been held to share information and experiences among the relevant parties with respect to selection and distribution of monitoring facilities as well as the establishment and operation of Water TMS.

## 2. Installation

Discharging facilities subject to installation of monitoring facilities are categorized into three main classes. These are public sewage treatment facilities with 2,000㎥/day of treatment capacity

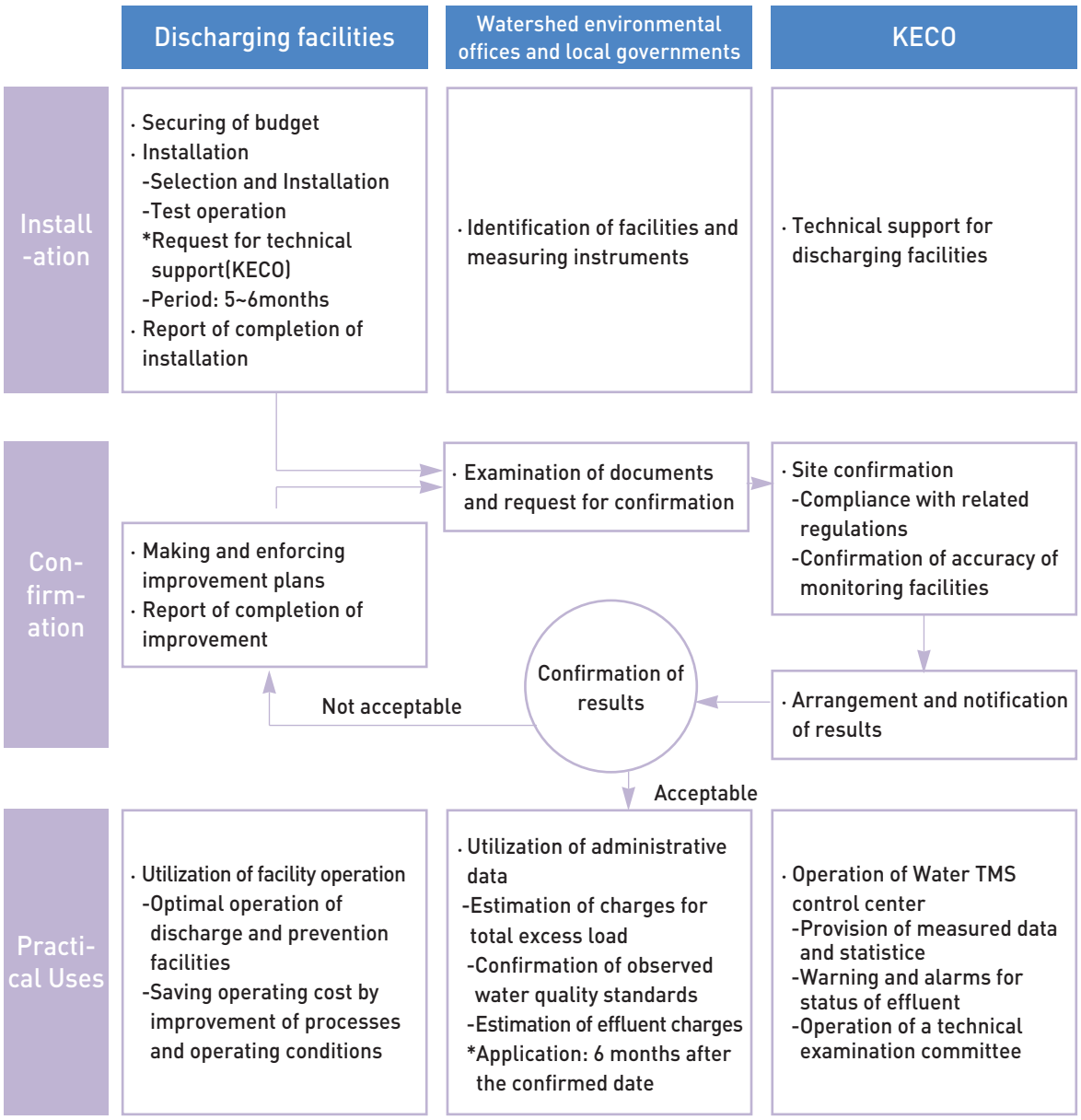
Figure 1: Operation of Water TMS




or more, wastewater treatment facilities with an annual average discharge of 700 ㎥/day or more (based on the effluent quantity in the previous year), and first to third class discharging facilities with 200 ㎥/day or more and public prevention facilities with 200 ㎥/day of discharge or more.

The following facilities are exempted from installation of Water TMS: discharging facilities or public prevention facilities with 200 ㎥/day or less of the maximum effluent quantity (including recycling and reuse of wastewater); facilities which discharge all wastewater to public prevention facilities; discharging facilities which discharge all wastewater to sewage treatment facilities or wastewater treatment facilities or public prevention facilities; discharging facilities or public prevention facilities which directly discharge only 200 ㎥/day or less of wastewater to public waters; facilities where installation of prevention facilities is not applicable (e.g., cases where the concentrations of the pollutants of discharged wastewater are always maintained under water

Figure 2: Procedure for installation and operation of automatic water quality monitoring facilities




quality standards or where all discharged wastewater is consigned to specialized treatment facilities); facilities where effluent facilities are planned to be closed or moved; facilities with less than 90 working days per year; facilities which install and operate water contamination prevention facilities that treat wastewater in a batch type system; and facilities where the

Minister of Environment has approved exemption of installation.

## 3. Monitored parameters and auxiliary facilities

The parameters (i.e. the items monitored) for the monitoring facilities include cumulative flow quantity as well as five water quality related parameters: pH, organic substances (Chemical Oxygen Demand (COD) or Biochemical Oxygen Demand (BOD)), Suspended Solids (SS), Total Nitrogen (TN), and Total Phosphorus (TP). Water TMS also requires installation of auxiliary facilities, including auto samplers and data loggers (D/L). If the concentration of pollutants discharged from wastewater treatment facilities is maintained under water quality standards, however, devices

Table 1: Monitored parameters and auxiliary facilities by type of discharging facility

| Discharging facility | Auto-monitoring facilities | | | | | Auxiliary facilities | | Cumulative watt-hour meter | Cumulative flow quantity | |
|---|---|---|---|---|---|---|---|---|---|---|
| | pH | BOD/ COD | SS | TN | TP | Sampler | Data logger | | Water | Wastewater and sewage |
| 1st-3rd class discharging facility | O | O | O | O | O | O | O | O | O | O |
| 4th class discharging facility | | | | | | | | O | O | O |
| 5th class discharging facility | | | | | | | | O | O | |
| 5th class discharging facility (wastewater 30 ㎥/day or more) | | | | | | | | O | O | O |
| Public prevention facility (200 ㎥/day or more) | O | O | O | O | O | O | O | O | O | O |
| Public prevention facility (200 ㎥/day or less) | | | | | | | | O | O | O |
| Wastewater treatment facility (700 ㎥/day or more than the previous year's average) | O | O | O | O | O | O | O | | | O |
| Wastewater treatment facility (700 ㎥/day or less) | | | | | | | | | | O |
| Public sewage treatment facility (2000 ㎥/day or more) | O | O | O | O | O | O | O | | | O |
| Registered wastewater treatment discharging facility | | | | | | | | | | O |

for the corresponding parameters can be exempted from installation. Moreover, at least one device must be installed which measures BOD or COD, whichever is higher. Table 1 presents the monitored parameters and auxiliary facilities by type.

## 4. Assessment standard for automatically monitored values

The arithmetic average of the time series data obtained from automatic monitoring facilities every three hours is used to determine whether the effluent water quality standard has been complied with. If the three hour average exceeds the effluent water quality standard over three times a day or over ten times a week, an enforcement order is sent, and the number of violations is increased up by one. The quantity exceeded is assessed by subtracting the permissible standard effluent density from the three hour average value and multiplying this against the cumulative flow quantity over three hours.

## 5. Current status of monitoring of discharging facilities

Automatic monitoring facilities are installed differently at facilities with installed monitoring devices and new ones, respectively. Established facilities are defined as ones that have attained permission for or reported installation of discharging facilities up to November 30, 1997; as well as ones that have already installed or are installing wastewater treatment facilities or public sewage treatment facilities. New facilities are defined as ones that have attained permission for or reported installation of discharging facilities after November 30, 1997; and ones that have started to install wastewater treatment facilities or public sewage treatment facilities after November 30, 1997. Table 2 presents the current status of installation of Water TMS by year and by facility up to the end of December 2009.

## 6. Functions and operation of the Water TMS Control Center

The Water TMS Control Center is located at KECO. As shown in Figure 3, data collected from the data logger at individual discharging facilities is transmitted to the Water TMS Control Center. Data is compiled at the server in the Control Center and analyzed and managed via the systems in the Control Center.

The Control Center plays a variety of roles in choosing and adopting effluent water quality standards, including determination of compliance with effluent standards, and provision of data regarding assessment of effluent charges to administrative agencies. In addition, the Control Center is responsible for Quality Assurance (QA)

## Table 2: Water TMS by year and by facility (based on data as of December 31, 2009)

| Classification | | | Established | | New, suspension, etc. | No. of total installations | Test operations | Regular operations (Legal application) |
|---|---|---|---|---|---|---|---|---|
| | | | Period | Installation | Installation | | | |
| Total | | | | 553 | 35 | 588 | 248 | 340 |
| Public sewage and wastewater | Large | Sewage | May 19, 2008 | 49 | 2 | 51 | | 51 |
| | | Wastewater | | 26 | - | 26 | - | 26 |
| | Subtotal | | | 75 | 2 | 77 | 0 | 77 |
| | Medium | Sewage | Nov. 19, 2008 | 127 | 7 | 134 | 9 | 125 |
| | | Wastewater | | 24 | 7 | 31 | 8 | 23 |
| | Subtotal | | | 151 | 14 | 165 | 17 | 148 |
| | Small | Sewage | Nov. 19, 2008 | 134 | 7 | 141 | 141 | - |
| Wastewater discharging facility | 1st class discharging facility | | Sep. 30, 2008 | 116 | 8 | 124 | 9 | 115 |
| | 2nd class discharging facility | | Sep. 30, 2009 | 77 | 3 | 80 | 80 | - |
| | 3rd class discharging facility | | Since Oct 1, 2010 when effluents exceed | | 1 | 1 | 1 | - |

※ **Size of facilities for installation**

○**Public sewage waste water treatment facilities**

(Large) Treatment capacity for sewage of 100Kton/day or more, of wastewater of 10Kton/day or more

(Medium) Treatment capacity of sewage of 10Kton/day or more, and 100Kton/day or less

Treatment capacity for wastewater of 1Kton/day or less (discharge of 700ton/day or more)

(Small) Treatment capacity of sewage of 2,000ton/day or more, and wastewater of 10Kton/day or less

○**Wastewater discharging facility**

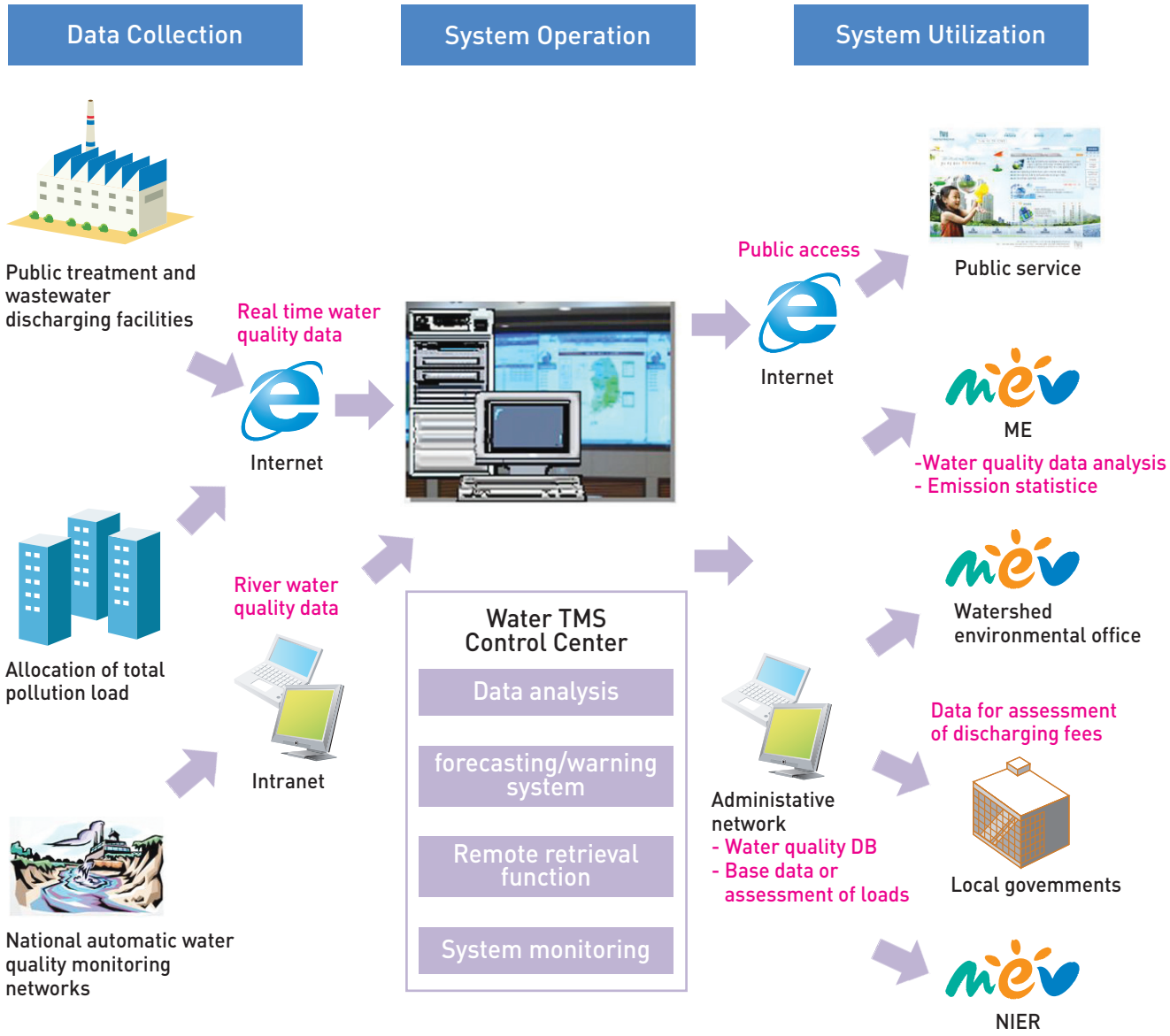
(1st class) 2,000tons/day or more

(2nd class) 700tons/day or more, and 2,000tons/day or less

(3rd class) 200ton/day or more, and 700ton/day or less

and Quality Control (QC) inspection to verify the reliability of the monitored data, and for technical support for stable operation of the system of Water TMS and for operating sites (i.e., discharging facilities).

Figure 3: Schematic diagram of Water TMS



## Ⅲ. Expected effects of Water TMS

Various positive effects are expected from establishing and operating the Water TMS. From an administrative point of view, the establishment and operation of Water TMS allows environmental agencies and local governments to transparently and effectively perform administrative proceedings because effluent charges can be fairly imposed as a result of assessment of water quality data automatically in real time. This allows agencies to impartially guide and manage discharging facilities with the raw data from point sources obtained at operating sites.

On the other hand, discharging facilities can prevent accidents related to effluents or excessive discharge of pollutants through the advance warning system. Moreover, Water TMS can motivate discharging facilities to improve the processes of wastewater treatment plants and prevention facilities by analyzing and controlling water quality of effluents depending on various temporal conditions (e.g., seasonal or hourly).

Finally, Water TMS can increase economic benefits and reduce the amount of pollutants, and can prevent the occurrence of accidents in public waters.

## Ⅳ. Future Implementation plans

Water TMS effectively establishes monitoring systems in rivers connected with national automatic water quality measuring networks as shown in Figure 3. The monitoring system can ensure the safety of the water environment, while the data obtained from the monitoring system can be valuable in environmental policies and research.

On the other hand, there is a water quality forecasting system based on IP-USN that is being built as part of the "Green IT 9 core project" in order to monitor water quality in real time and to construct a disaster response system. This forecasting system has been tested to monitor turbidity occurring at the construction sites for the Four Major Rivers Restoration Project in 2010; eventually to build an automatic water quality monitoring system. IP-USN has been installed at eight stations in the four major rivers as of May 30, 2010 which are excluded from the existing

Table 3: Location of IP-USN installation at the four major rivers

| Total no. of stations | Han river (no. of stations) | Nakdong River (no. of stations) | Geum River (no. of stations) | Yeongsan River (no. of stations) |
|---|---|---|---|---|
| 8 | Gangcheon, Yeoju (2) | Sangju, Nakdan, Gangjung, Dalsung (4) | Geum River (1) | Juksan (1) |

Figure 4: IP-USN installed at the Sangjubo station (downstream from the Jeongdong Bridge)

monitoring network. Plans are underway to install more IP-USN annually (See Table 3 and Figure 4).

IP-USN has five measuring parameters including water temperature, DO, pH, electro conductivity and turbidity. As shown in Figure 4, the monitoring facilities are powered by solar cells or batteries depending on weather conditions, and have a self cleaning function in the multi probe method.

Data is transmitted to the server through wireless internet using High Speed Downlink Packet Access (HSDPA) and a wireless router. The data is compiled and managed in the Water Pollution Control Center and sent to the relevant agencies when contamination incidents have occurred. Accordingly, this monitoring system can be expected to function as a piece of fundamental infrastructure required to establish an advanced intelligent society in which anyone can use services for sensing, storing, processing, and integrating information on water quality, anytime and anywhere.

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