For the Establishment of Estuarine Environmant Monitoring Network

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For the Establishment of Estuarine Environment Monitoring Network

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Abstract - A maintenance-free observation unit and a cost-effective data transmission system, which are necessary for water quality monitoring in estuarine areas on a long-term basis, are introduced. Through a number of such monitoring systems, an Estuarine Environmental Monitoring Network (EEM-Net) is proposed for the management of estuarine environments and ecological and fishery conservation.

I. Introduction

Estuaries are dynamic environments constantly undergoing complex water-mass movements and changes in water quality due to the intermixing of seawater from one side and the river discharge from the other, complicated by variable meteorological conditions such as atmospheric pressure, precipitation, solar radiation, etc[1,2]. The changes, especially in the salinity and anoxic bottom waters basically control the estuarine ecosystem[3,4]. In addition, pollution of estuarine waters has become a major problem because most estuaries are adjacent to the zones of strong human impact. Therefore, it is essential to continuously monitor the ever-changing water quality in the estuaries for a proper management of these fragile wetland environments.

Of late, the multi-water quality sensors are frequently employed for monitoring the estuarine environments[5,6]. In the cases of long-term monitoring, however, the functioning of such sensors and the associated data transfer systems are seriously affected by various organisms that adhere themselves to these devices. We present here our experiments with a modified maintenance-free observation system in Lake Nakaumi, the largest coastal lagoon along the Japan Sea (Fig. 1), and propose establishment of a permanent monitoring network system of estuarine environment.

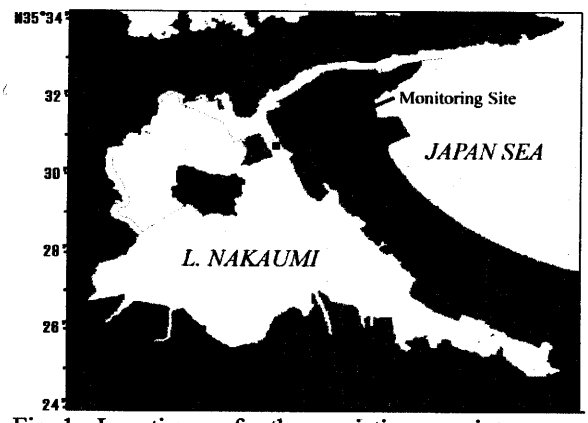

Fig. 1 Location of the existing maintenance-free water-quality monitoring system in the Lake Nakaumi

II. Maintenance-free water quality unit

The water quality monitoring units are usually covered by such adhering organisms like algae, mollusks, barnacles, etc., within about ten days after their deployment near the water

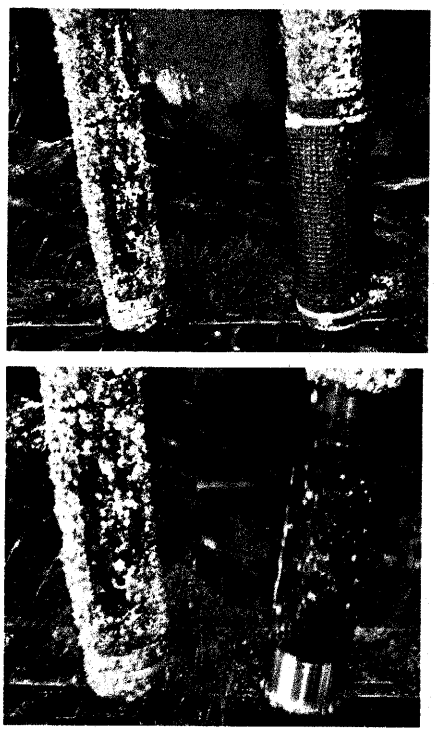

Fig.2 Adherence of organisms to the sensor without Aquacute cover (left), and the sensor with cover free from organisms (right) after about one month of deployment.

surface, especially in summer, thereby rendering the sensors ineffective. In such cases, it is necessary to periodically attend these units for maintenance for obtaining reliable data. In order to overcome such a necessity, a sensor cover, namely, "Aquacute", which is developed by Kuraray Inc., was tested in our experiments. The Aquacute is a bag-shaped woven fabric fit to cover the entire surface area of the sensor. An organic nitrogen sulfur compound ($C_{11}H_{17}C_{12}NOS$), which acts as an antifouling agent, is contained in the sheath of the fiber. This chemical compound is completely free from organic tin, heavy metals, boron and fluorine. It is quickly decomposed when leached into seawater from the woven fabric. Either the ingredient or the decomposed chemicals do not accumulate in the natural environment.

As our experiments revealed, the product was effective in keeping off the fouling organisms even after one month of its deployment during summer (Fig. 2 and Fig. 3). Initially, however, it was found that the values of dissolved oxygen (DO) were lower when compared to the control data. This was found to be the result of the release of hydrogen sulfide as a decomposition product of the Aquacute, which consumed DO in the surrounding water and produced free sulfur. This problem was overcome by activating a small stirrer that was set up near the detector, about five minutes each time before taking the measurements (Fig. 4). Thus it was possible to obtain the data over a longer-term free from any maintenance cost of the sensors.

III. Cost-effective communication method

Till recently, a large-scale and expensive data transmission system was required for real-time telemetry. But the latest innovations in communication technology have made the data transfer very easy at present. The experimental system that we set up in the Lake Nakaumi uses the NTT-DoPa (Docomo Packet) communication system, thereby a cost-effective and maintenance-free data transfer is ensured. The power source for the DoPa transmitter as well as the water-quality monitoring sensor is from a solar battery panel (Fig. 5). The data are sent

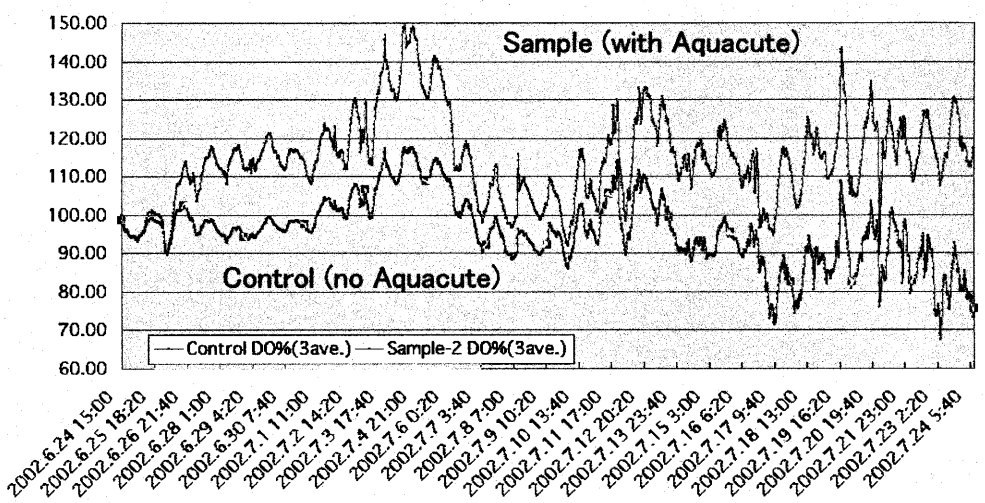

Fig.3 Test of the sensor cover for long-term monitoring

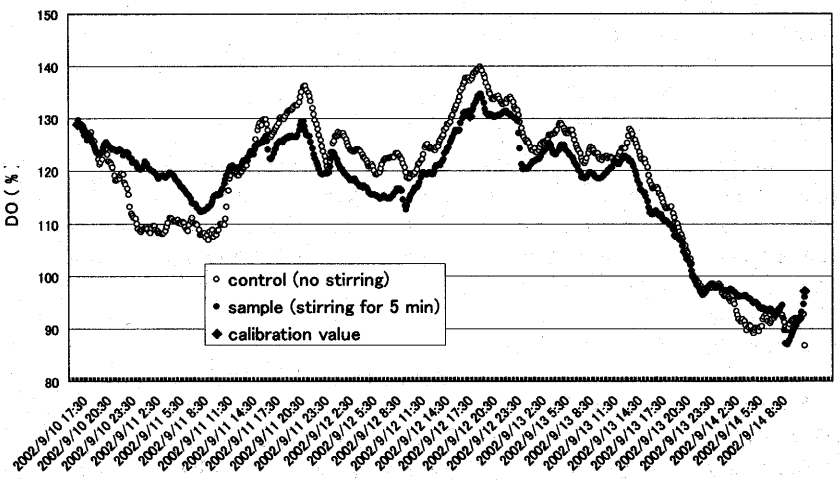

Fig.4 Effect of stirring before measurements.

The DO values of the control (no stirring) show the lower than those of the sample (stirring) during the first 20 hours, then become slightly higher by the effect of attached algae.

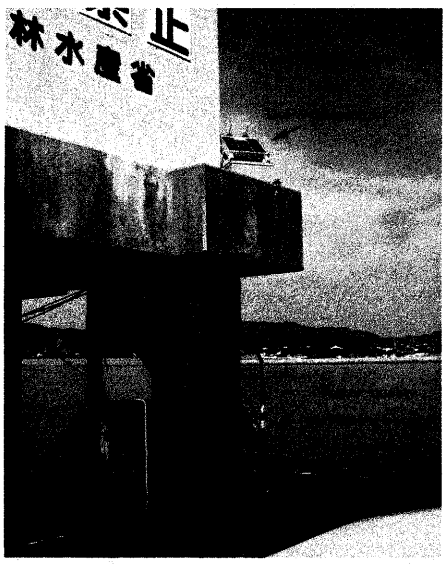

Fig.5 Monitoring site at the Nakaura Channel

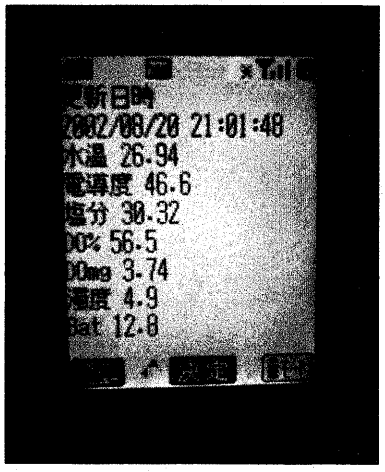

Fig.6 Data access through cellular phone

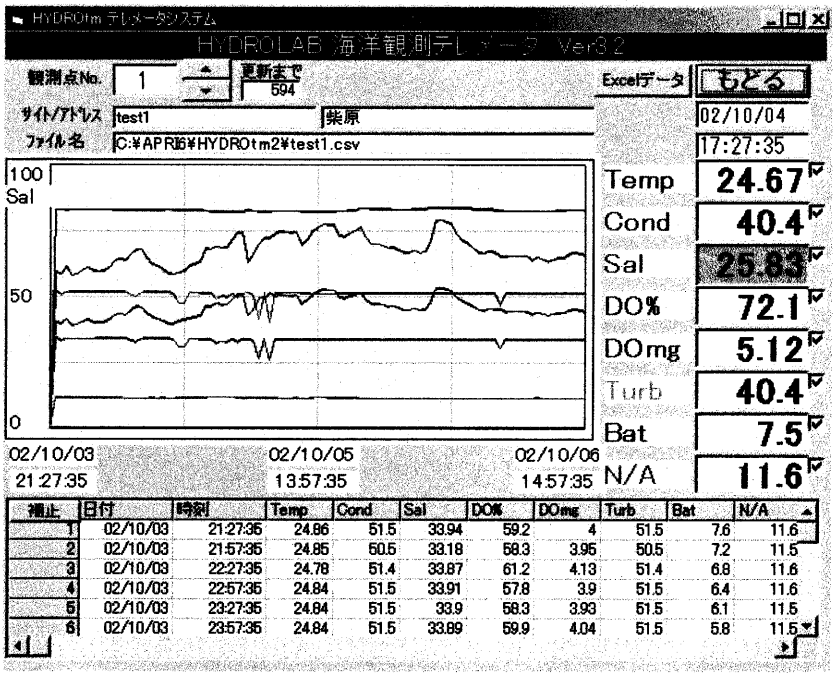

Fig. 7 Graphic out-put of the data

through the DoPa transmitter to the data server at the Research Center for Coastal Lagoon Environments, (ReCCLE), Shimane University and then delivered to the users via Internet. The users can access the required data either on their computer monitor or cellular phone (Fig. 6). In addition, a graphic out-put of the data is also made available to the users from the server through Internet (Fig.7).

The monitoring system at present delivers such data as water temperature, salinity, pH, DO and water depth measured by the two sensors that are set up at the water surface and the bottom waters of the Nakaura Channel, the only entrance of seawater into the Lake Nakaumi. In the near future, the meteorological data such as air temperature, air pressure, wind direction, wind velocity, precipitation, solar radiation, etc., would also be delivered through the same system.

IV. Proposal of the EEM-Net

Water quality of estuarine areas is influenced in space and time by various phenomena such as global warming, daily tidal cycles, abrupt changes in the atmospheric conditions,

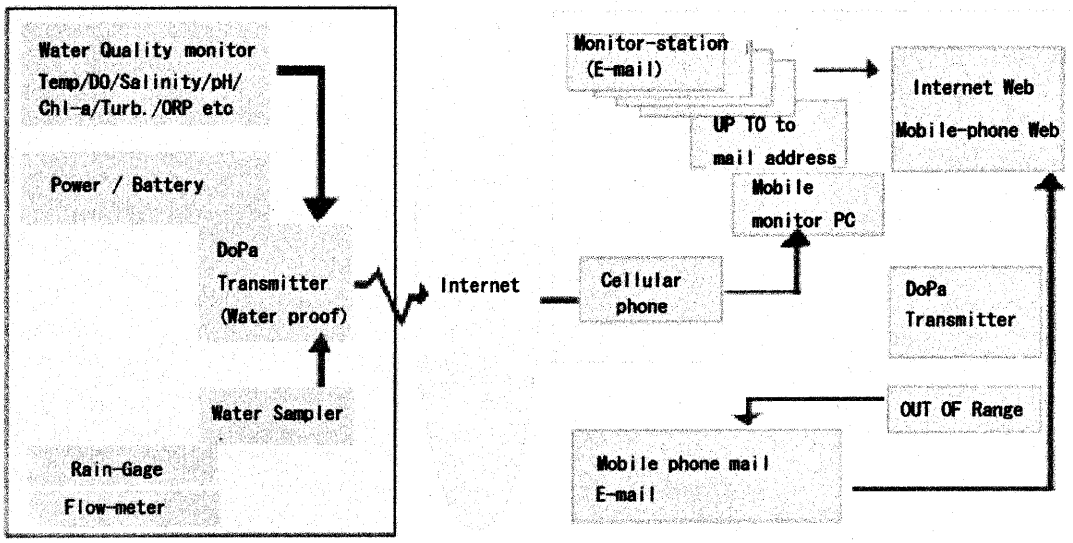

Fig. 8 Image of the monitoring system along with a schematic diagram of the proposed EEM-Net

bottom topography, size of the catchments, etc. For a proper understanding of the mechanism of such a dynamic system, we propose establishment of an Estuarine Environment Monitoring Network (EEM-Net) consisting of a number of water quality observation stations set up at representative estuaries along the coast of Japan Sea (Fig.8). The water quality monitoring systems similar to the one set up in the Lake Nakaumi, are proposed to be installed at each selected station and the data management would be standardized to achieve uniformity in data quality. After such necessary improvements of the entire system are achieved, the EEM-Net would be expanded through Internet to the other coastal regions of Asia.

Comparative analysis of the data simultaneously transmitted from each of these monitoring stations would help in discriminating the changes that are common to the whole of Japan Sea so that the inherent phenomena in the relevant estuary and its response characteristics against environmental change can be clearly assessed. Such information is useful for environmental management of each estuarine zone as well as the ecological and fisheries conservation.

Acknowledgements

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