Flood Management System Using Smart Floodwater Level Rulers

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Abstract

In Saga City, Saga Prefecture in Japan, we have begun to provide a flood management system service that quickly detects flood damage risks and notifies and spreads the information by remotely collecting data on measured floodwater levels. This is done by smart floodwater level rulers installed as a software-based measurement for the drainage of excess rainwater.

This service is a cloud-based solution that aims to be applied to non-structural measures for disaster prevention. It receives water level information on roads from smart floodwater level rulers. This ruler is equipped with a wireless transmission device and a water level gauge, and converts this precipitation data information to the Extended Radar Information Network (XRAIN) in real-time data. This is to provide "necessary information for disaster prevention" in real-time. The XRAIN is a real-time rainfall observation system using a multi-parameter radar installed and operated by the Ministry of Land, Infrastructure, Transport and Tourism of Japan.

Previously difficult to manage information, such as water levels on roads, is collected using the Internet of Things (IoT) and shared on the cloud to unify disaster prevention information and make a database accumulating information such as rainfall and water levels, This which can lead to support disaster prevention activities.

1 Preface

In recent years, flood damages have occurred in urban areas in Japan due to torrential rains, affecting the lives of residents and socioeconomic activities. In response to these floods, through the development of laws such as the Flood Prevention Act, the Japanese government has established various initiatives: for hardware measures, installing rainwater storage facilities, for software, making people aware of impending dangers of flood damage is included.

This paper introduces smart floodwater level ruler software installed in Saga City, Saga Prefecture, Japan.

2 Smart Floodwater Level Ruler

Since fiscal 2012, Saga City has been installing floodwater level rulers in areas prone to flooding to use them for future drainage measures. As of March 2019, in the event of flooding, Saga City officials and disaster volunteer groups were requested to help read the water level with floodwater level rulers.

To grasp flooding situations more accurately, 29 existing floodwater level rulers installed in Saga City were replaced with smart floodwater level rulers. It is categorized as smart by installing water level measurement equipment and a wireless transmission device, so that measured floodwater level data can be collected remotely. Measured floodwater level data is managed by a cloud server together with the Extended Radar Information Network (XRAIN) realtime precipitation data information. It enables real-time understanding of flood situation as well as collecting data and re-working how to effectively use such accumulated data. The XRAIN is a real-time rainfall observation system using a multi-parameter radar installed and operated by the Ministry of Land, Infrastructure, Transport and Tourism of Japan. Fig. 1 shows an outline of the smart floodwater level rulers. By enclosing a com-

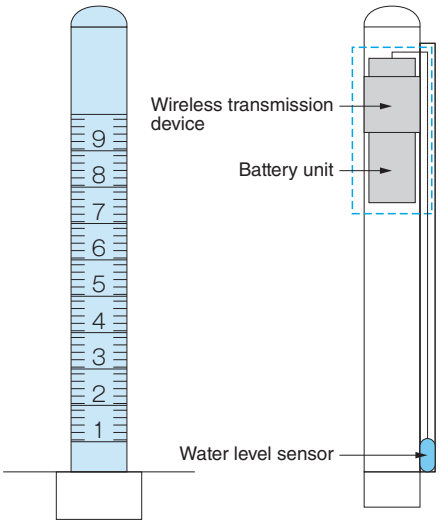

Fig. 1 Outline of Smart Floodwater Level Rulers

A case equipped with a wireless transmission device and a battery unit is enclosed inside the existing floodwater level rulers, and a water level gauge is installed on the side of the ruler.

Fig. 2 Smart Floodwater Level Rulers

Except for the fact that a water level gauge is installed on the side, it does not differ in appearance from the existing floodwater level rulers.

munication device and battery in the upper part of the existing floodwater level ruler and by putting a water level gauge on the side, it is possible to easily grasp the flooding situation in real time by using the internal battery. Fig. 2 shows the external appearance of the smart floodwater level rulers.

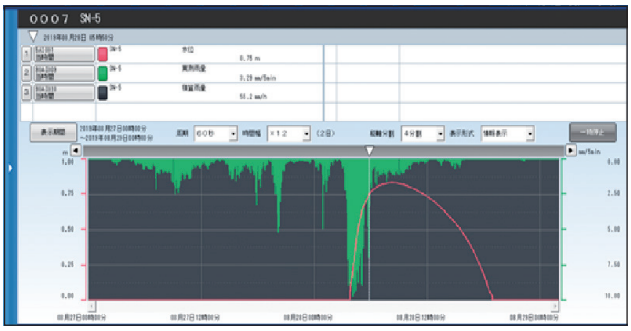

Fig. 3 Water Level and Rainfall Information Obtained from Smart Floodwater Level Rulers

Water level and rainfall information when a heavy rain emergency warning was issued in Saga Prefecture on August 28, 2019. The indicated time range is August 27 and 28, 2019. In the figure, red indicates water level and green indicates 5-minutes of rainfall. The water level at the point rose to 82 cm.

3 Utilization of Smart Floodwater Level Rulers

It was confirmed that real-time water level and rainfall information could be stably collected from smart floodwater level rulers. In addition, on August 28, 2019, a heavy rain emergency warning was issued for Saga Prefecture, and the largest rainfall event in history was observed in Saga City. We were able to stably collect water level and rainfall information in real time when it rained, and we were able to confirm that the water level was rising. Fig. 3 shows the water level and rainfall information obtained from the smart floodwater level rulers when a heavy rain emergency warning was issued. The introduction of smart floodwater level rulers has made it possible to easily check water level information from a PC or smartphone even during heavy rain, helping Saga City speed up its flood control activities. When a water level rise event occurs, e-mail notifications are sent to the preset email addresses. Fig. 4 shows the external appearance of the smart floodwater level rulers after heavy rain. An external and internal inspection was conducted, and no problems were found. In addition, a sticker was attached to indicate the depth of the water at the time of flooding. This made it clear that the system is useful for alerting residents.

4 Advancing Smart Floodwater Level Rulers

The water level information obtained from the water level gauge installed on the smart floodwater

Fig. 4 Smart Floodwater Level Rulers after Heavy Rain

No problems have been found in the exterior and the inside of the ruler. A sticker is also attached to the flood depth (82 cm here) in memory of the heavy rain on August 28, 2019.

Fig. 5 Water Level Information during LPWA Method Verification Test Period

Water level information from February 21, 2020, to March 18, 2020 is shown. Verification tests were was carried out at three locations, and red, green, and blue marks in the figure indicate the respective water levels and information.

level rulers can be monitored in real time by the mobile network via a wireless transmission device We verified the performance of three smart floodwater level rulers installed in Saga City using the LPWA (Low Power Wide Area) method (cellular LPWA: Cat-M1 (category M1)). This communication method is more cost effective and energy efficient than the current communication network. Fig. 5 shows an example of water level information during the LPWA method verification test period. It was confirmed that the water level could be measured without any communication errors, and that the communication performance of the LPWA (Cat-M1) communication device as a wireless transmission device for a smart floodwater level rulers could be satisfied. In addition, since the power consumption is about half that of current communication equipment, it is possible to extend battery life by saving power.

5 Postscript

As a measure to reduce the risk of flood damage increasing in recent years in Japan, we introduced a flood management system using smart floodwater level rulers.

Going forward, we intend to contribute to the development of safe and secure communities through the construction of sustainable infrastructure that harmonizes society and nature. We would like to contribute to mitigating the impact of the increasingly serious problem of climate change like flooding through our products and services.