Demonstration Experiment using the Multi-Parameter Phased-Array Weather Radar

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1.Introduction

Toshiba installed the Dual-pol. Phased-Array Weather Radar (hereinafter referred to as MP-PAWR: Multi-Parameter Phased-Array Weather Radar) at Saitama University in November 2017 and started observing precipitation. In addition, we have begun to consider ways to utilize observation data. Conventional parabolic weather radar, required more than 5 minutes for 3D observation, MP-PAWR realizes 30 seconds observation by electronic scanning using an array antenna, and increases space density of observation area by 2.5 times. Moreover, 3D observation of MP-PAWR achieves up to 90 degrees in 30 seconds, while 3D observation of the conventional radar achieves up to 20 degrees in 5 minutes. This is equivalent to observations of about 25 times as high-speed. Furthermore, by dual polarization possible to observe rainfall quantitatively, and it is expected to improve prediction of extreme weather phenomena such as heavy rain and gusts.

In this paper, we report on the demonstration experiment of "Providing heavy rain information based on prediction information" and the fundamental study of "Inundation / flood prediction due to sudden heavy rain".

2. Demonstration experiment

2.1 Overview

The demonstration experiment was conducted to distribute heavy-rain alarm based on MP-PAWR data with a railway company who is an envisioned user of that data. The alarm distributed system used a heavy-rain detection system developed by Toshiba (Yoshimi, et al. [2018]). MP-PAWR has the feature that 3D observation of meteorological phenomena can be realized at high speed and there is a possibility that it can be used effectively by the local government or private enterprise who is concerned about heavy-rain damage. The targets who can effectively use the alarm information may have trouble in operation due to heavy rainfall, and it is a business operator having social infrastructure facilities such as a railway. Therefore, in this demonstration experiment, it was assumed that the railway operators were the target of distribution of alarm information, and it was verified whether the alarm information would be useful for their flood control activities. The distribution information is a heavy-rain alarm based on MP-PAWR 3D observed rainfall. The alarm information is classified into two types of "potential hazard" and "serious hazard". The "potential hazard " is an alarm delivered before strong rain falls near the ground, using some index such as echo top, rainfall intensity, analyzed from MP-PAWR data, as a determination threshold. In addition, it was distributed "serious hazard" that represents the state where strong rain was already observed near the ground.

2.2 Result

In consequence, the potential hazard delivered by the heavy-rain detection system was reported earlier than the warnings by JMA (Japan Meteorological Agency). The railway operators will prepare a flood control system and take on-site measures, triggered by the warnings by JMA (refer to Figure-1). Therefore, prior information is useful for localized heavy rainfall. Thus, it turned out that the alarm information based on 3D observation can be used effectively when the flood prevention against local heavy rain is needed.

3. Urban flood forecasting

3.1 Overview

The runoff analysis was carried out in the urban basin using the rainfall forecast results using VIL (Vertically Integrated Liquid Water content) obtained from MP-PAWR as input data. And we examined the predictability of water level. The analysis procedure from the observation of MP-PAWR to the runoff analysis is as follow. First, VIL is calculated from the observation result of MP-PAWR. Next, rainfall forecasting is performed using the calculated VIL and MP-PAWR rainfall intensity as input to calculate forecasted rainfall (Hirano and Maki [2018]). After that, runoff analysis (Watanabe, et al. [2012]) is performed using the forecasted rainfall as an input, and the water level of the target point is determined.

3.2 Result

As a result, it was found that when the water level predicted from the MP-PAWR data is compared with the measured water level, the rough shape of the hydrograph can be roughly predicted. In addition, it was revealed that the rising limb and time to peak of the hydrograph can be generally predicted with respect to the actual measurement, and the peak value can also be reproduced well. It is considered that the flash flood like the urban runoff was also successfully reproduced because of the high temporal resolution of the hyetograph.

4. Conclusions

In the demonstration experiments, it was proved that possible to deliver alarms in advance that could prevent heavy-rain damage to end users such as railway operators using the system using MP-PAWR data. From now on, in order to make it a system that contributes to user needs, we plan to do hearings and repair the system as necessary. Moreover, it was found that the runoff analysis using 3D observation data of MP-PAWR almost reproduces the observed water level at the target point. In the future, we plan to analyze quantitatively the impact of 3D rainfall on runoff analysis results.

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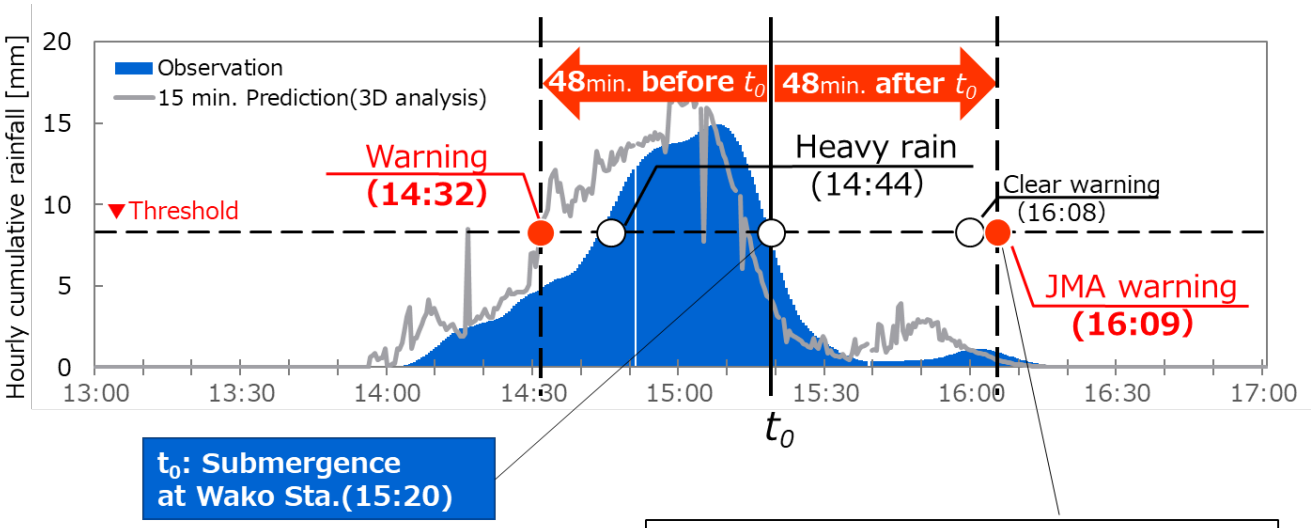

t_0: Submergence at Wako Sta.(15:20)

Activity of railway operator

At the same time to JMA alert, they implemented usual flood control measures.