

# Flood Forecasting and Utilization of Radar-Raingauge in Japan

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**ABSTRACT:** There are 109 A class rivers in Japan. One purpose of river management is to reduce the flooding. For this purpose, government provides the information to public, as flood forecasting, rainfall forecasting and estimate the runoff magnitude to avoid the flood and inundation. In this paper, we introduce current situation of flood forecasting and rainfall forecasting in Japan, and we describe how to use the information of flood forecasting and rainfall forecasting in conjunction with current strategy for river management.

## 1 INTRODUCTION

In Japan we had 109 A class rivers, and each river basin had management office for flood and drought control and environmental management.

And there are more than four or five times of A class rivers which is small basing area and locate one prefecture, we named B class river.

A class river is managed by national government and B class river is by local government.

One purpose of river management is to reduce the flooding. For this purpose, government provides the information for public, as flood forecasting, rainfall forecasting and estimate the runoff magnitude to avoid the flood and inundation.

To provide these information, Ministry of Land Infrastructure and Transport office (MLIT) and Japan Meteorological Agency (JMA) jointly set up more than 6,000 rain gauge stations all over Japan, and provide observed data from certain stations every 10 minutes in case of flooding. And also, these two organizations are constructed 26 radar rain gauge system by MLIT and 20 by JMA, and provide observed data every 5 minutes. These data can be browsed by mobile phone. Added to these data, in Tokyo area, Tokyo Metropolitan Government provides their own radar rain gauge systems, and observed every minute and every 250m grid.

Another example, two radar rain gauge system are set up in Sakura-jima and Unzen-Fugendake mountain, both of these area is located in Kyusyu island, to observed rainfall data every minute and every 250m grid.

This paper shows the outline of flood forecast and rainfall forecast technology that is used in Japan, and also shows how to use it in river management.

## 2 EXAMPLES FOR PROVISION OF FORECASTING INFORMATION

It is important to provide information of river and basin rapidly to relevant authorities and people in order to protect human life and property from disaster. In Japan, government provides observed and predicted information of radar rain and water level in rivers.

Following figures shows the examples for provision of forecasting information.

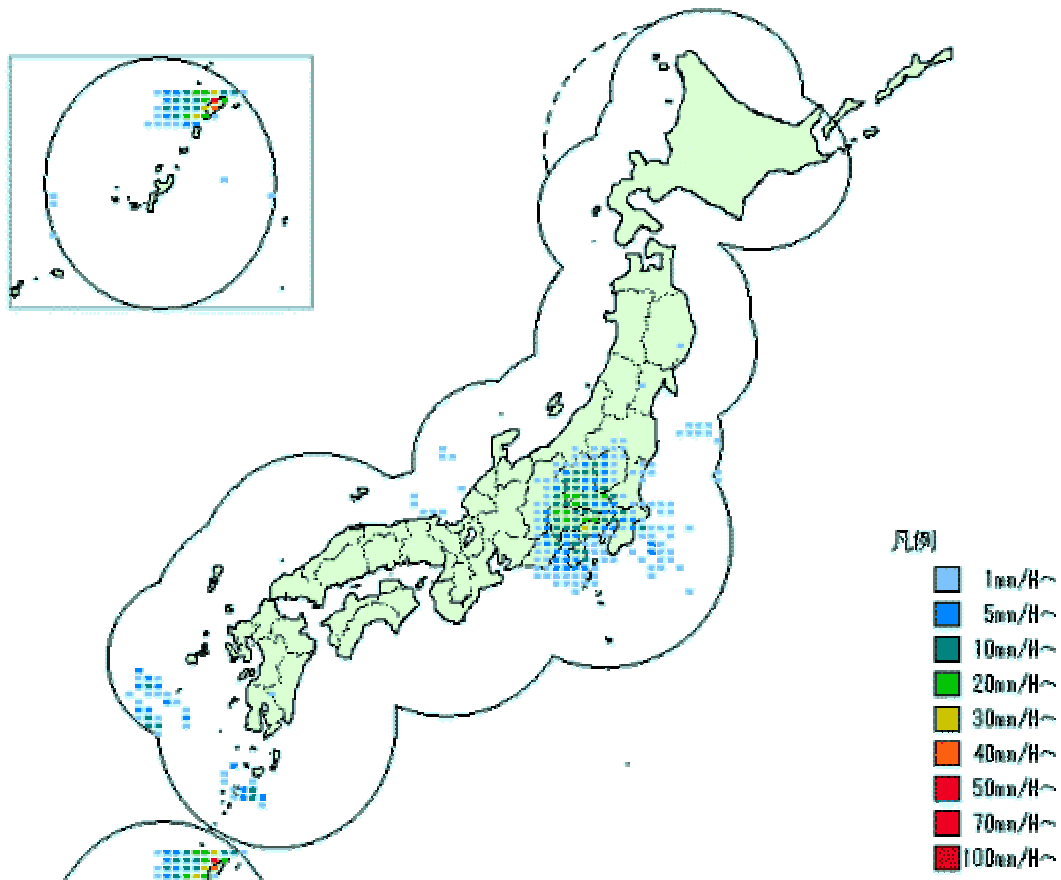


Fig. 1. The example for observed information of radar rain gauge

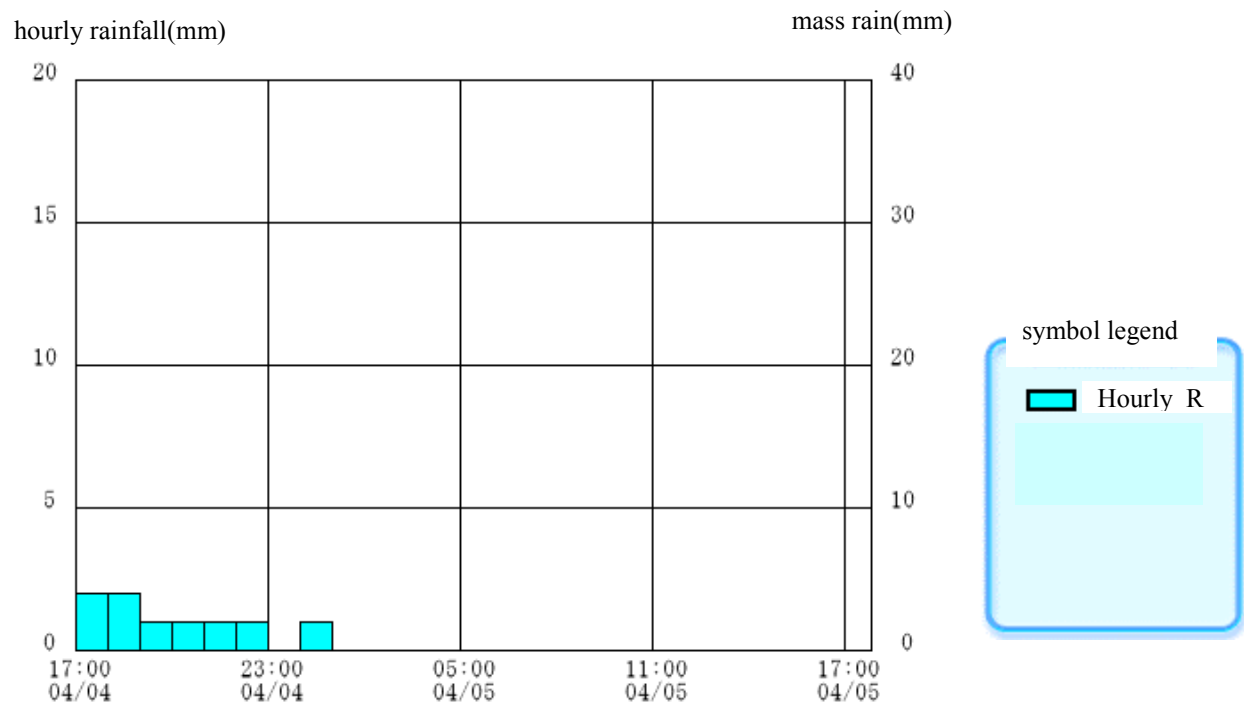


Fig. 2. The example for observed information of ground rain gauge

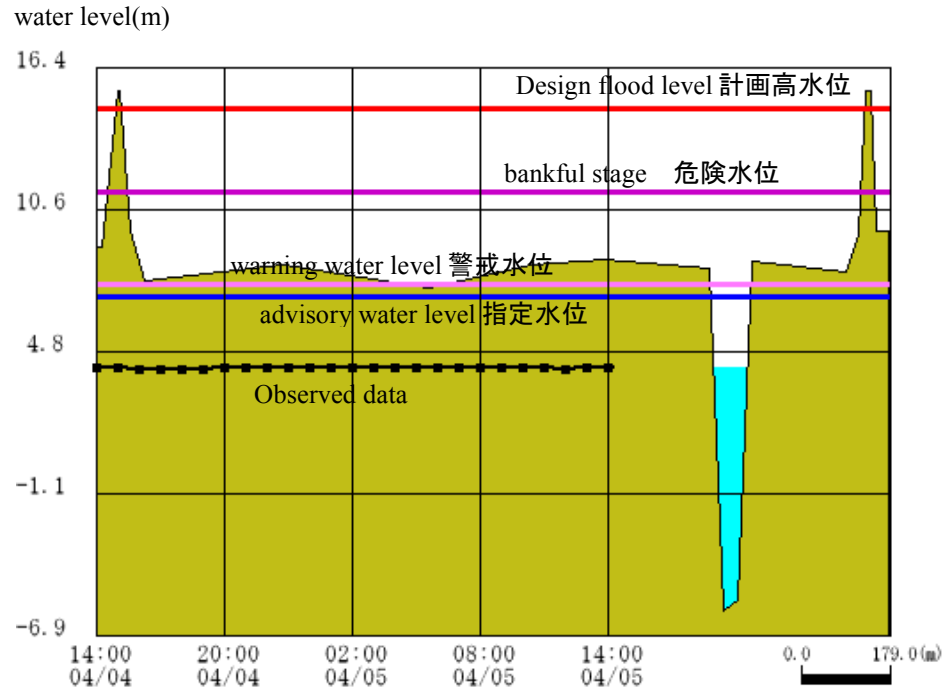
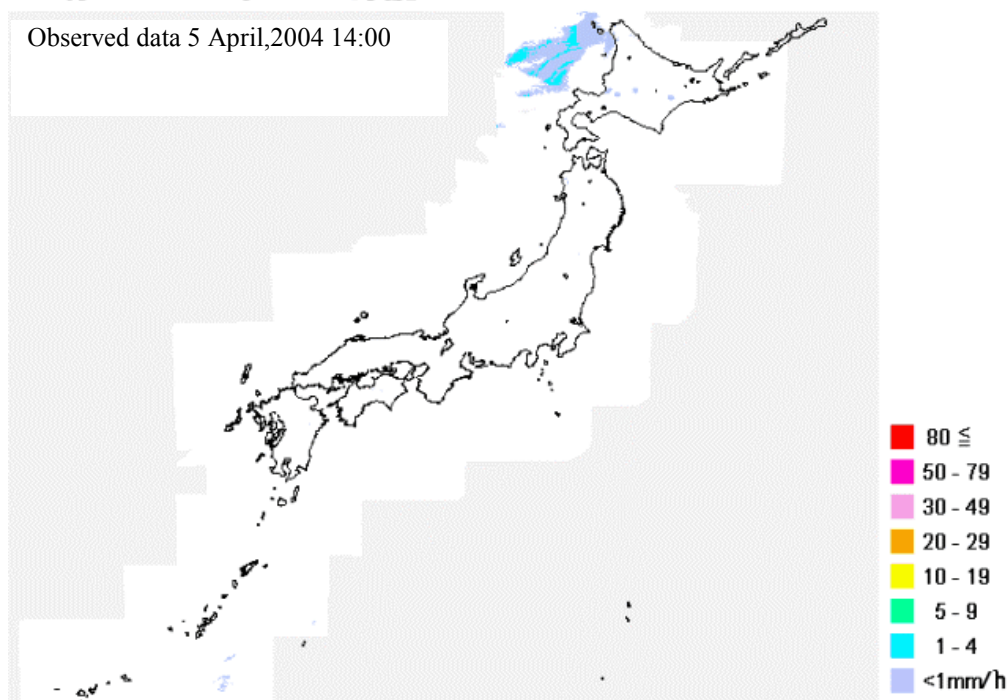


Fig. 3. The example for observed information of water level in river

#### 4 月 5 日 14 時 00 分の実況

Observed data 5 April, 2004 14:00



#### 4 月 5 日 15 時 00 分の予想

Forecasted data 5 April, 2004 15:00

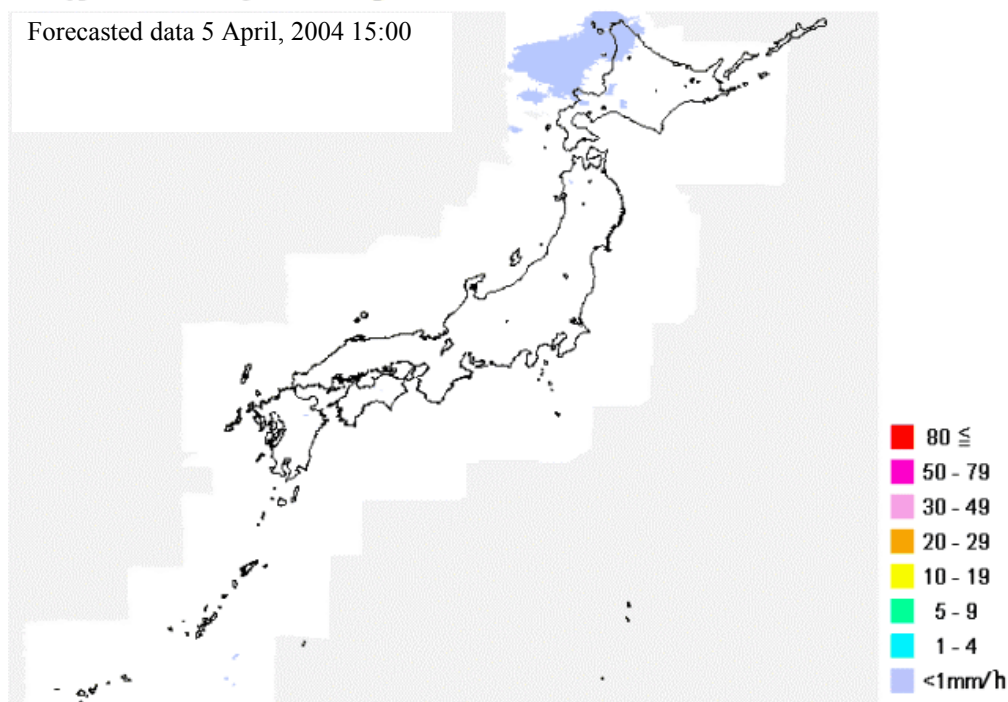
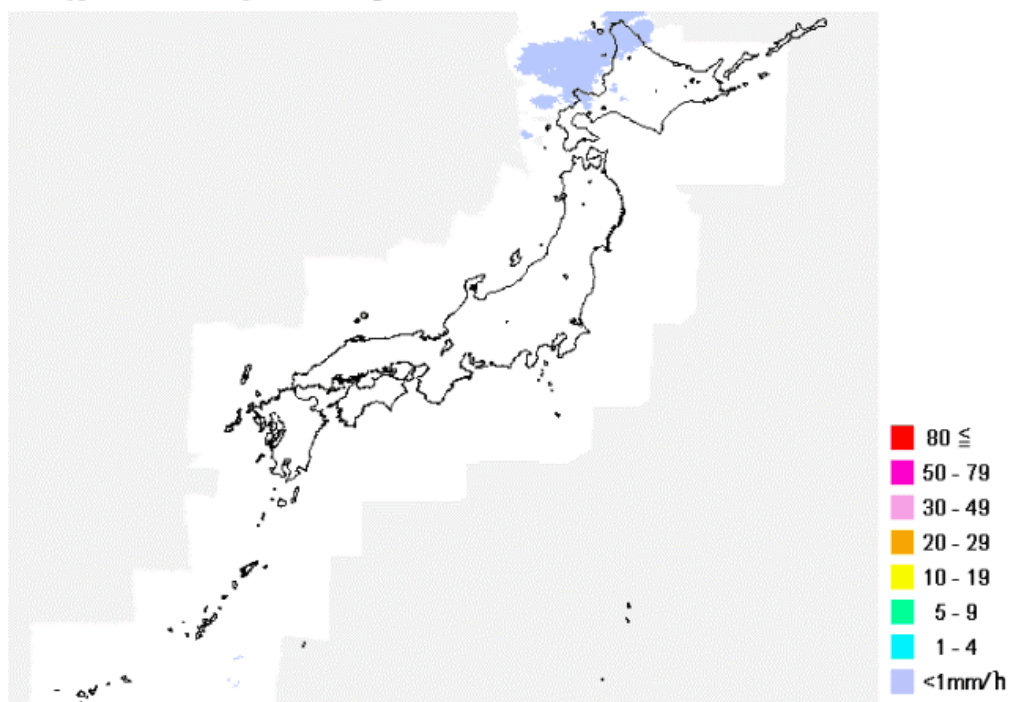


Fig. 4. The example for predicted information of radar rain gauge (1/2)

4 月 5 日 16 時 00 分の予想



4 月 5 日 17 時 00 分の予想

Forecasted data 5 April, 2004 17:00

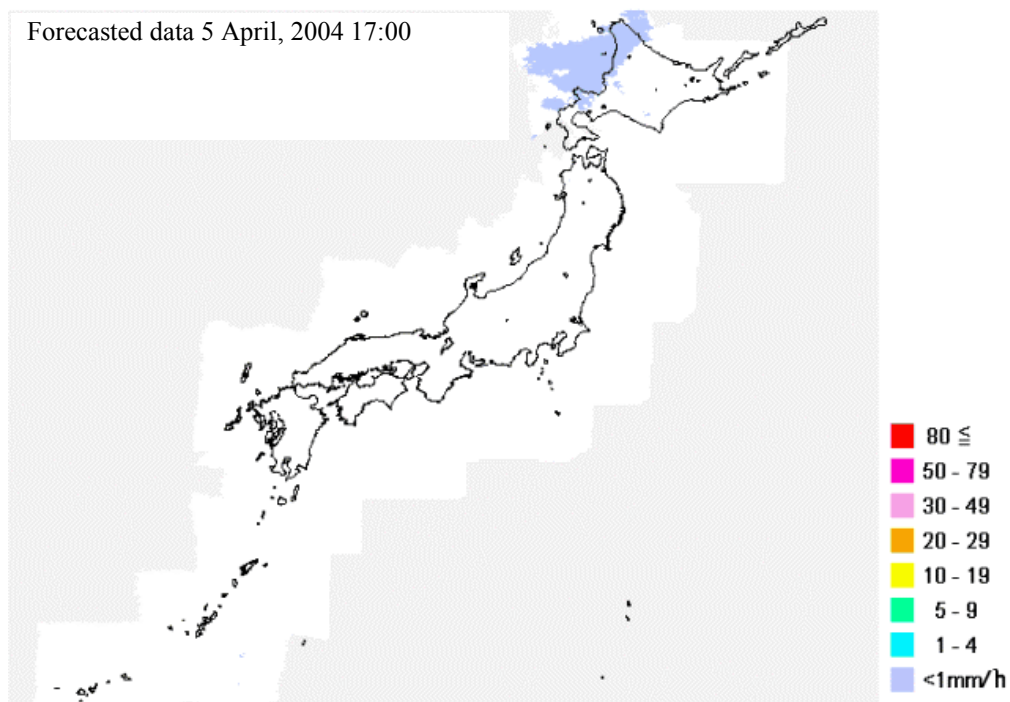


Fig. 5. The example for predicted information of radar rain gauge (2/2)

<b>A River System B River Flood Forecasting No. X</b>
Year, Month, Day, Hour, Minute
Joint announcement by C prefecture D management office and E meteorological observatory
Contents
Announcement of flood warning for B River
It needs strict alert because it is afraid to exceed the bankful stage at E water level observatory (A River System B River)

Fig. 6. The example for predicted information of water level in river

### 3 OUTLINE OF OBSERVATION AND PREDICTION BY RADAR RAIN GAUGE

#### 3.1 Observation by Radar Rain Gauge

Weather radar observes water particle in the atmosphere. Rainfall value for 5-minute is calculated from the receiving electric power in the rectangle area in all directions about 1 km in Japan. There are 46 radar rain gauges in Japan. (26 radar rain gauge system by MLIT and 20 by JMA)

In order to make effective use of radar rainfall data for flood management, it is necessary to calculate radar rainfall values consistent with surface rainfall values. Dynamic window method and so on are being used as calibration technique.

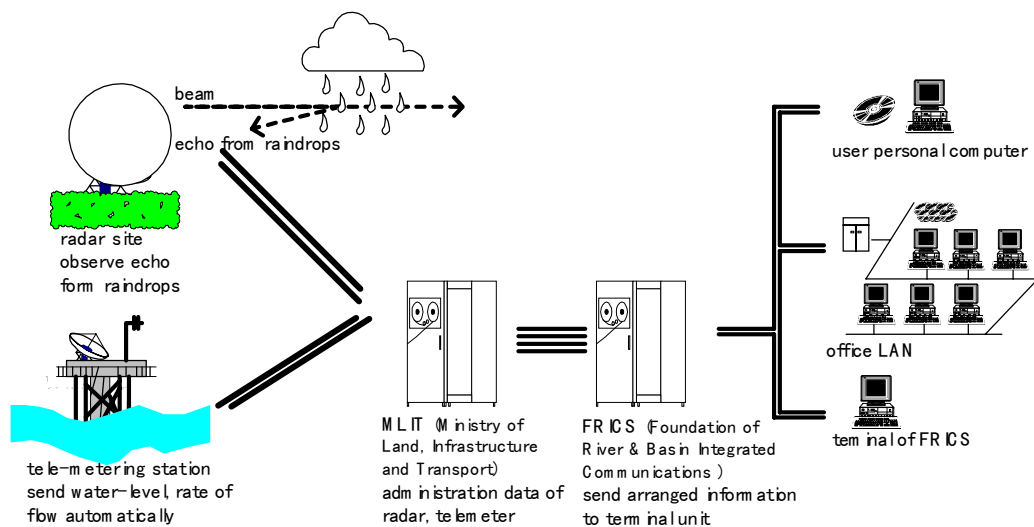
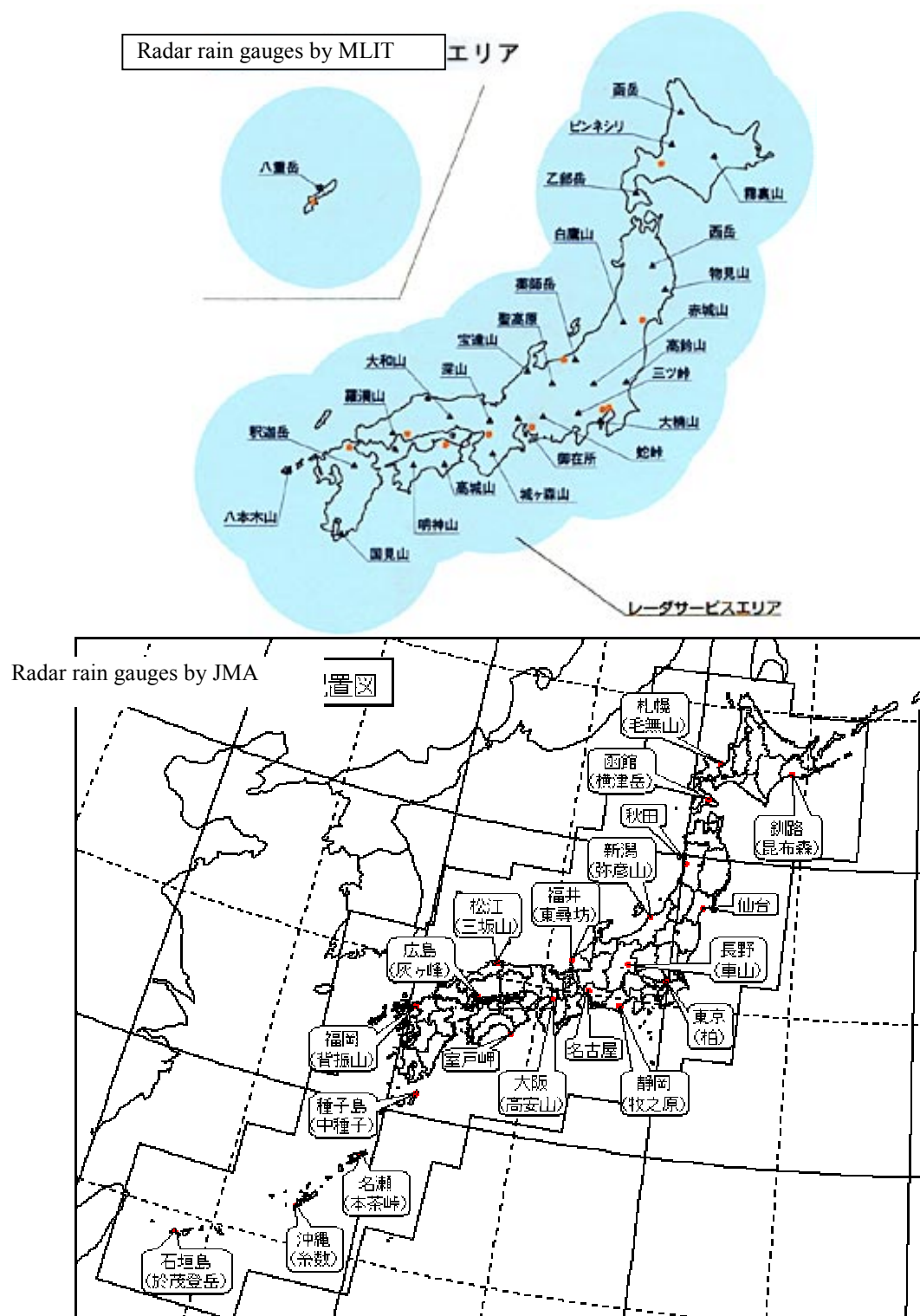


Fig. 6. The flow of the observation by radar rain gauge.



### 3.2 Observation by Radar Rain Gauge

There are various forms of short time prediction technique of the rainfall in such cases as a statistics method and weather dynamics by the numerical value model method. The technique to use the movements of rain echo has been used for the prediction by radar for a short period of time. Using past radar echo composition figure, precipitation distribution is predicted for three hours ahead with the forecast model in JMA. Prediction is being done based on the extrapolation the rainfall strength distribution of the initial time that is made by radar echo composition treatment by the kinematical technique.

Operation is divided to the next four steps.

- 1) The detection of orographic precipitation.
- 2) The calculation of extrapolation speed.
- 3) The calculation of the amount of growth and weakness by the geographical features.
- 4) The estimation of rainfall intensity.

Extrapolation speed is calculated by the method of pattern matching. The prediction of the orographic precipitation is computed by the Seeder-Feeder model.

JMA introduced meso-scale numerical model for rainfall forecast three years ago. Prediction time has been six hours from three hours as this result.

Table 1. The outline of rainfall prediction technique.

Prediction Model			Use purpose
Meso-scale numerical model (MSM)	Horizontal resolution	10 km	Disaster prevention information etc.
	The number of vertical layers	40 layers	
	Initial time	00,06,12,18 UTC	
Short-time period rainfall prediction	Horizontal resolution	5 km	Disaster prevention information
	Prediction time	6 hours	
	Initial time	Every 30 minutes	

## 4 OUTLINE OF FLOOD PREDICTION

The information of flood is shown when a disaster will be estimated by a heavy rain and so on. MLIT and JMA announce a flood forecast information in the cooperation. There are 192 rivers those are already set up the flood prediction system and it is possible to provide forecasted information.

The flood prediction information is carried out by the flood prediction system which conforms to the drain character of the river, rainfall character of the basin, and so on.

### 4.1 Flood prediction system

A flood prediction system predicts water level or discharge based on the weather and hydrology condition. The outline of the general flood prediction system is as the following.



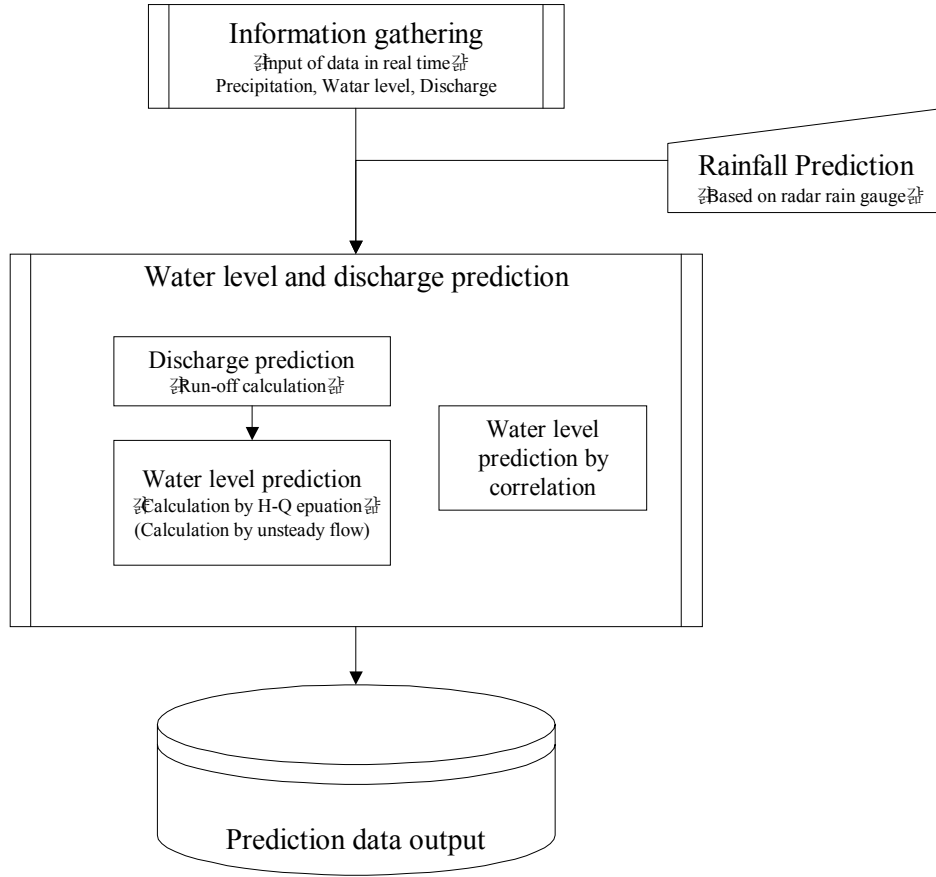


Fig. 9. The whole outline figure of the flood prediction system

#### 4.2 Rainfall prediction

We use short-term rainfall prediction data by JMA for the flood forecast. The drain and rainfall character of the river is fully examined before to use. Furthermore, it pays attention in the flood arrival time, and effective prediction time in the water level prediction is taken into consideration.

#### 4.3 Water level and discharge prediction

The discharge and water-level will be estimated by numerical model. The discharge is calculated by numerical model that based on observed and forecasted rainfall data, and discharge is changed to water level by stage discharge curve.

The numerical model is determined by the purpose of forecasting. The typical model is storage function method, hydrograph method with rational formula.

Furthermore, it is possible that the lower reaches water level is predicted by the stage relation curve.

## 5 CONCLUSION

The information of rainfall and runoff data that is estimated by forecasting system is applied for flood management and urban flood management.

### 5.1 Installation of flood forecasting system as revision of Flood Fighting Act

In 1997, the river law was revised. The new river law includes the river management concept as not only flood control and water use but also environment control (protection and improvement).

June 1999, flood damage happened at Fukuoka area in Kyushu Island (Fukuoka flood damage). Because of this event, the flooded houses were 1047 and one person was lost in the flooding accident of basement floor.

And next year, September 2000, flood damage was also happened at Aichi area in Tokai region (Tokai flood damage). Because of this event, the flooded houses were 71,291 and 10 persons were lost.

After these flood damages, the Flood Fighting Act was revised as prepare the flood forecasting system for most of major rivers and publicize the Hazard-Map.

At now more than the 200 rivers are developing the flood forecasting system.

### 5.2 Expectation for Urban River Inundation Prevention Act

In 2003, government established the "Expectation for Urban River Inundation Prevention Act", based on Tokai flood damage, as a measure for Urban river inundation and flood of underground city. In this act, the river administrator have to provide and install the rainwater storage, infiltration facilities, regulation of storm water retention, and publicize the probable flood area in Urban River.

From this, the publicize the probable flood area that based on rainfall forecasting, runoff forecasting is most important mission for river administrator.

After technological development of rainfall forecasting and flood forecasting technology, these forecasting technologies are installed to every river basin.

## 6 REFERENCES

### BOOK:

MLIT, JMA (2001). "The flood forecast guide line which is done by the JMA chief cooperates with the prefectural governors."

Yoshino, Fumio (2002). Radar Hydrology. Morikita Shuppan, Japan.

### WEB SITE:

<http://www.bosaijoho.go.jp/index.html>

[http://www.jma.go.jp/JMA\\_HP/jma/index.html](http://www.jma.go.jp/JMA_HP/jma/index.html)

<http://www.river.or.jp/>

<http://playground.jwa.or.jp/kansai/kousui/>