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An Internet-based Real-time Heavy Rainfall Display System

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ABSTRACT

A new storm warning system, which can be accessed through the Internet and by cellular phones is described. At the time of a heavy rainfall for disaster prevention, it is important that every resident understand how heavy is that rainfall. A real-time heavy rainfall display system designed for all of Japan provides such information (http://www.disaster-i.net/rain/). In that system values for 1-hour precipitation, 24-hour accumulated precipitation, etc. are displayed at every observatory. Advantages are that not only the latest observations but differences from the historical highest records can be seen. Almost all information is displayed by characters so that users have easy access to the system even when the communication network is crowded. Access date for the six months after the system opened shows that the average daily number of accesses of the top page was 306, and the largest number 3078. The maximum number for daily access to all the pages was about 21,500. This is about 2% of the number obtained on the same day for a similar system operated by the Ministry of Land, Infrastructure and Transport (http://www.river.go.jp/).

1. INTRODUCTION

Various kinds of weather information now can be seen on the Internet. For example, the homepages of weather information companies and the press provide so-called "on-the-spot information" such as current precipitation observations and data from weather radar. Moreover, a traditional weather report (ex. "Fine", "Rain"), a quantitative precipitation forecast, a rainfall probability forecast, etc. also are seen on homepages. "On-the-spot information" and "forecast information" about precipitation are widely offered today not only to specialists but to the general public.

When coping with a heavy rainfall disaster (e.g.; flooding, sediment disaster), these "nowcast information" and "forecast information." are not sufficient. For example, the following information is required: "How much has it rained until now?", "What is the record high for the area?" Concretely, this would be the 24-hour accumulated precipitation, the highest precipitation at each observatory. Unfortunately this type of information is not found on the Internet today.

Ushiyama (1999, 2001) has reported that the general public dose not understand observation date (e.g., precipitation) and their meanings well, even when given as disaster information. Not only data supply but their explanations are required to overcome ignorance and avoid misunderstandings.

Access to the Internet by cellular phone (such as "i-mode" by NTT DoCoMo Inc.) has spread rapidly Japan since 1999. The percent of household use in Japan as of February 2001 was estimated as 46.5%, and the number of cellular phones in use at 28.4% (Internet Association, 2001). Internet browsing by cellular phone is a promising method for information exchange at the time of a heavy rainfall disaster. Weather information pages for cellular phones also are increasing, but so far do not contain information that is useful for disaster prevention.

We developed a "real-time heavy rainfall display system" which can be accessed with Internet browsers and cellular phones. This system aims to offer useful information for making judgment and decisions at the time of heavy rainfall. We here describe the concept and the construction technique of this system and examine the system's effectiveness by analysing the access log date for six months after it opened.

2. OUTLINE OF THE SYSTEM

2.1 Basic development policies

The system was developed based on the following policies:

a. Data should be displayed in distribution maps (pictures) and number tables.

b. Accumulated precipitation (e.g., 2- and 24-hour) should be displayed.

c. The highest historical precipitation at each observatory should be displayed to provide an easy comparison of the difference between the historical high and latest observation values.

d. Almost all information should be displayed by characters for quick response.

e. The homepage of this system should be accessible using standard Web browsers without additional software.

f. The information recorded can be accessed and downloaded.

g. Data can be easily seen with a cellular phone (especially "i-mode").

h. Explanatory descriptions about the observation data are included for easy understanding.

KEY WORDS: disaster information, Internet, cellular phone, historical rainfall records, AMeDAS.

2.2 System composition

(1) Outline

Data from the AMeDAS (Automated Meteorological Data Acquisition Syetm) observatories operated by the Japan Meteorological Agency (JMA) since 1979 are the basic data used in our system. The AMeDAS has about 1300 observatories through out Japan. It therefore is easy to receive real-time data, and the positions, historical information on observatories are available, and past observation data are readily obtainable.

The system, composed of two Windows 2000 personal computers, uses MICOS, a weather information supply system provided by the Japan Weather Association (JWA). One computer is used as the MICOS receiver, the other as an open server for processing real-time heavy rainfall.

The MICOS usually is used to scan and print weather information with the aid of JWA software. In addition, text data of weather information are saved in the MICOS receiver. Our Real-time Heavy Rainfall Display System makes use of the text data transmitted from the MICOS receiver to the open server (Fig. 1).

(2) Data processing

Of the various kinds of weather information received by the

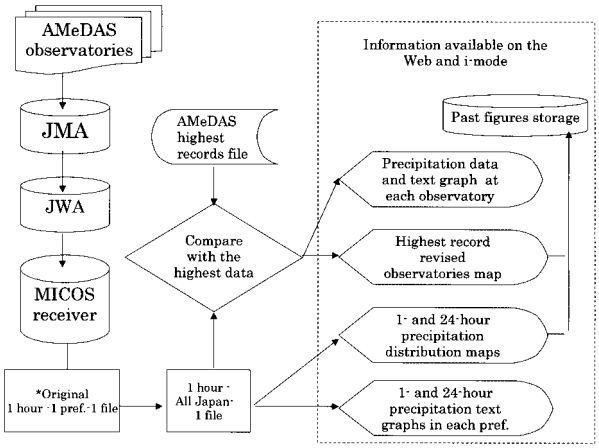

Fig. 1 Outline of the Real-time Heavy Rainfall Display System.

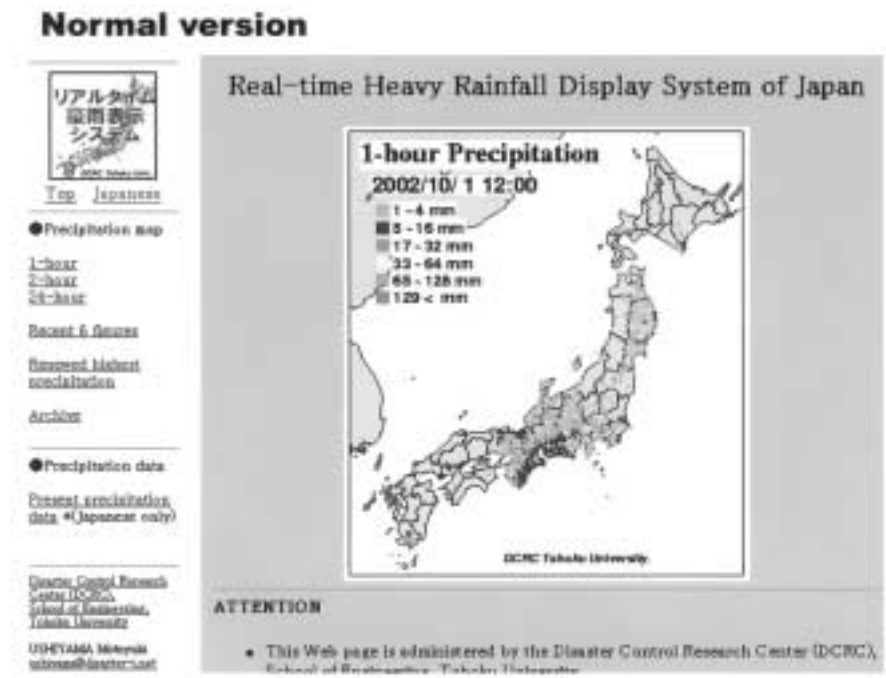

Fig. 2 The top pages of system.

MICOS system, AMeDAS data are processed in the open server. The locations and highest historical precipitations at all the AMeDAS observatories are based on Japan Meteorological Agency (2000) information. The highest historical precipitation records are consist of the highest data from 1979 to 1999. The system continuously compares the latest observation data with the highest historical data.

Data processing and HTML file composition respectively are executed by the "awk" and "perl" scripts. Distribution maps are created by "GMT", GIS software developed by the University of Hawaii (http://gmt.soest.hawaii.edu/). The GMT output file is a PS (Post Script) file which cannot be viewed on popular Web browsers. The PS file therefore is transformed into a PNG (Portable Network Graphics) picture file by "gswin32. exe" that is included in "Ghostscript", a popular PS file browser. For "i-mode" phones, the PS file is transformed into a small-size GIF picture file from PNG by the so-called retouch software "Dicre Image Touch" (http://www.dicre.com/).

AMeDAS observation data are distributed every hour 5 minutes after the hour but often are delayed. Our system therefore processes data every hour 15 minutes after the hour. The automatic running of this system is controlled by "Task", pre-installed in Windows 2000.

2.3 Contents

(1) Top page

The top page of this system is shown in Fig. 2 (http://www.disaster-i.net/rain/). There are two versions: the normal version (in English and in Japanese) and the "i-mode" version (in Japanese only). The "i-mode" version pages also can be seen with the Internet accessible cellular phone of J-Phone Inc. (so-called J-Sky).

(2) Precipitation distribution map

This system creates 1-, 2- and 24-hour precipitation distribution maps for the latest data, as well as providing certain explanations for better understanding. When a 1-hour precipitation of 50mm or more, or the 24-hour precipitation of 100mm or more occurs, it is shown in a table with the observatory name and the highest precipitation at that observatory (Fig.3).

(3) Renewal of the location map of the highest precipitation

When the latest 1- or 24-hour precipitation at an observatory surpasses the historical high from 1979 to 1999, a red-colored asterisk is placed on the map to show the location of the observatory (Fig. 4). It is difficult for a general user to understand the danger of such precipitation based on a simple precipitation distribu-

Observatories recording 100mm+/24-hour

- This table shows observatories that recorded 100mm over the present 24 hours
- "9999": Error data
- "No.":Observatory number
- "Long.":East longitude (degree), "Lat.":North latitude (degree)
- "Highest": The highest precipitation from 1979 to 1999

			Precipitation [mm]					
			1-hour		2-hour	3-hour	24-hour	
No.	Long.	Lat.	Present	Highest			Present	Highest
53378	136.1967	34.0667	11	104	16	21	164	487
64211	136.1133	34.1817	15	87	25	38	116	844
65311	135.8517	33.6717	7	96	18	25	125	513
97461	131.2533	31.6350	1	64	3	6	126	413

Fig. 3 The page for the 24-hour precipitation.

Observatories with revised highest 1- or 24-hour precipitation

- This table shows observatories that recorded the highest 1- or 24-hour precipitations since 1979
- The AMeDAS, a surface meteorological observation network usede in the system, was completed in 1979
- "No.":Observatory number
- "Long.":East longitude (degree), "Lat.":North latitude (degree)
- "9999": Error data
- "Highest": The highest precipitation from 1979 to 1999

			Precipitation [mm]					
			1-hour		2-hour	3-hour	24-hour	
No.	Long.	Lat.	Present	Highest			Present	Highest
53121	136.3100	34.7233	15	61	22	36	259	258
53378	136.1967	34.0667	18	104	61	95	549	487
53416	135.9833	33.8500	9	73	21	54	584	400
65306	135.7133	33.6350	1	75	2	5	597	488
65311	135.8517	33.6717	0	96	1	18	672	513
65321	135.4833	33.6033	2	68	3	4	353	334
71136	134.0350	33.9817	1	54	4	4	332	261
73152	133.5133	33.9100	4	63	19	35	332	324

Fig. 4 Page showing observatories with the highest historical amount of precipitation.

tion map, where as this figure readily indicates "the area in which the latest precipitation exceeded the highest rainfall recorded in the last 20 years." The figure is expected to help users understand how dangerous the rainfall is.

(4) Map archive

As all the precipitation distribution maps created by this system are stored, a user can obtain them freely from the archive through the Internet. FTP access however is not permitted for reasons of security. The map file name has ten digits indicating the year, month, day, and hour. Map files are saved in the "month" sub-directory in the "kind" directory. Users can reach the required maps by going through the directories.

(5) Precipitation distribution map for the "i-mode" phone

The "i-mode" cellular phone cannot see normal large-size maps such as those of 385x432 pixels, therefore small-size precipitation distribution maps (96x80 pixels) for portions of Japan are created. Moreover, to help users to understand them, explanation of the intensity of precipitation also is provided based on information from the Department of Forecast, Japan Meteorological Agency (2000).

(6) Observatory pages

Data display pages for each observatory also are made for these distribution maps. These pages are used in both the normal and "i-mode" versions. A user can search for a required observatory from the top page, as shown in Fig.5, or from the Prefecture name and observatory list pages. Each observatory page consists of characters without image data for the convenience of cellular phone access and consideration of the busy traffic on the network.

A simple graph display method with characters is used for easy understanding. This a creates a simple bar graph using the "=" character, called a "Text graph" or "Character graph"; e.g. for 24-hour precipitation, one "=" corresponds to 25 mm. This graph is displayed in the observatories list for each prefecture, therefore

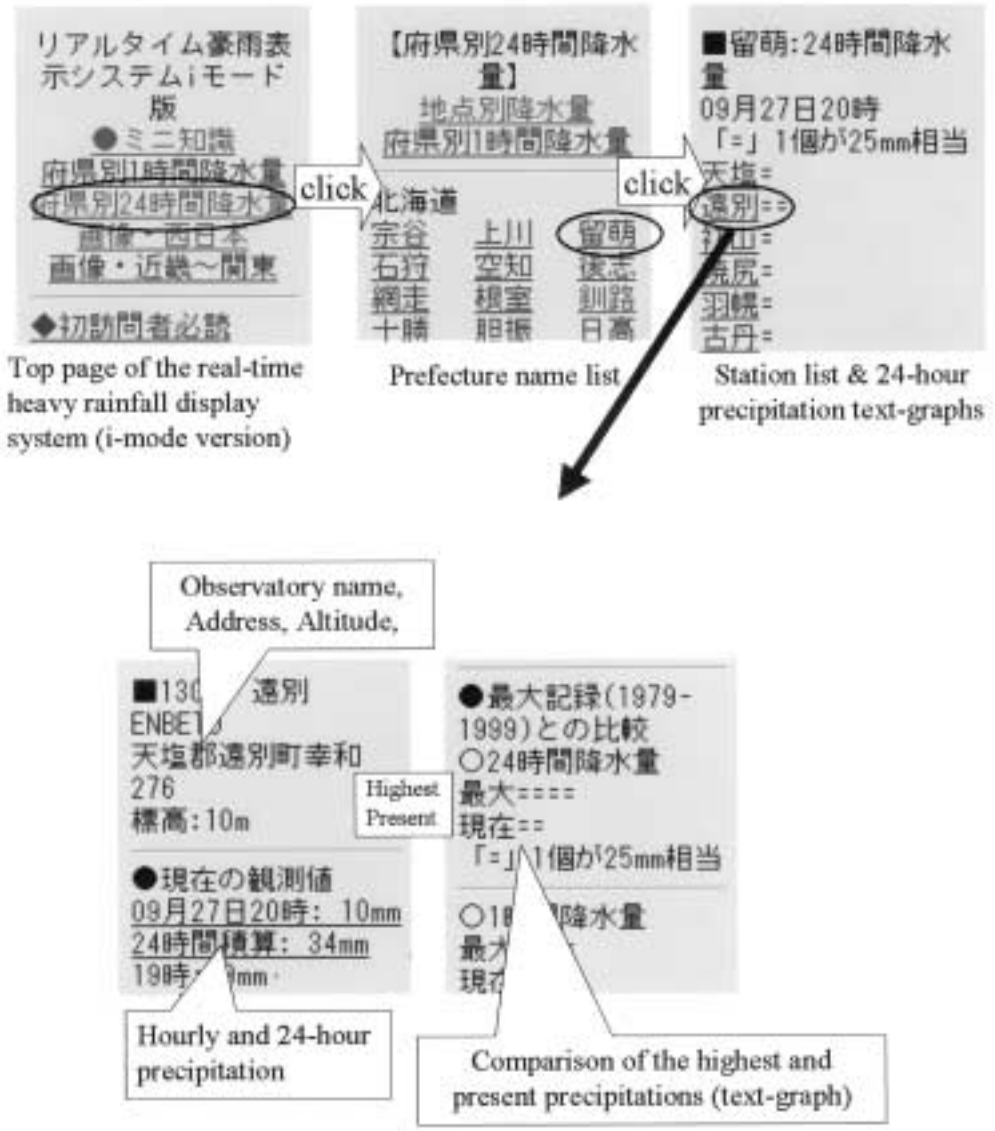

Fig. 5 Outline of observatory pages (i-mode version).

it is easy to find the rain areas in a prefecture. Each observatory page includes the observatory code, name, address and elevation, as well as the latest hourly and 24-hour precipitations followed by the series of previous 12 hourly precipitations. It also gives the highest historical hourly and 24-hour precipitations in a text graph and the 3 highest past records.

Even when the name of the AMeDAS observatory is the same as a city or town name, it may be located several kilometers from the central part of that city or town (Ushiyama, 1999). Often the difference in hourly precipitation between places several kilometers apart is 20 to 30mm or more, therefore location information is important. Few homepages show the addresses of AMeDAS observatories, where as this system does.

(7) Heavy rainfall warning e-mail system

This function automatically informs users of the occurrence of heavy rainfall by e-mail system, when a value exceeding the specified precipitation (e.g. 50 mm for 2-hours of precipitation) is recorded. Information transmission is kept to a minimum for cellular phone users. This e-mailed information gives the prefecture and observatory names in 2 Japanese characters, the 1-, 2- and 24-hour precipitations, and the time. Users can access detailed information by clicking the URL, given below. About 180 persons have now registered as users of this e-mail system.

3. CURRENT USE OF THIS SYSTEM

3.1 Access situation

The system was implemented between October 2000 and March 2001 (Table 1). Figure 6 shows the day-to-day access its top pages since April 1, 2001. Note that access to the "i-mode" version pages from personal computers is not included.

Access appears to be increasing for both versions top pages. The average number of accesses from Apr. 12, 2001 to Sep. 24 was 306 per day for the normal version and 75 per day for the "i-mode" one.

When heavy rainfall occurred, access increased rapidly. The maximum access to the normal version top page on Aug. 21, 2001,

Table 1. Timetale of system development.

Period	Operation
Oct. 2000	MICOS data reception and preparation of Web server began.
Dec. 2000	First version of this system was completed. Test run started.
Mar. 2001	System opened for some monitors.
Apr. 2001	System was announced to some mailing lists and linked to the USHIYAMA homepage, to which the average number of accesses is about 300 per day (http://www.disaster-i.net/).
July 2001	Heavy rainfall warning e-mail system started.

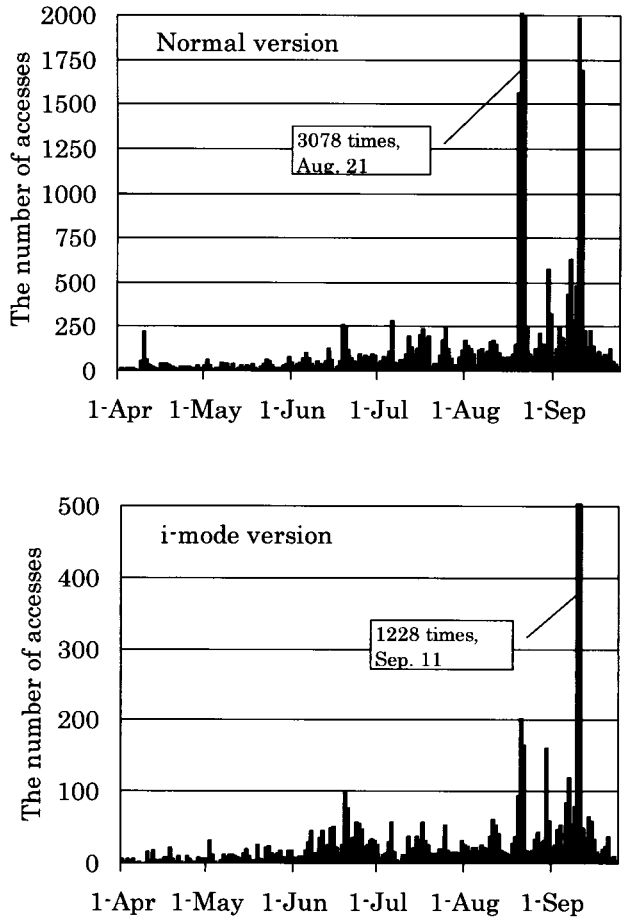

Fig. 6 Top page accesses from April 1 to September 24, 2001.

was 3078 hits, followed by 2001 hits the next day. On those days Typhoon No.0111 passed through the Japanese archipelago. When Typhoon No.0115 passed through east Japan on Sep.11 and 12, the respective of accesses to the normal version top page were 1986 and 1690.

There tend to fewer accesses to the "i-mode" version than to the normal version. On Sep. 11, 2001 the maximum number of accesses to the "i-mode" version was 1228.

3.2 Characteristics of access information

The access situation for pages of this system is shown in Fig.7. Except for top pages the 1-hour precipitation page was the most often accessed. For the 24-hour precipitation page the value was about half that for the 1-hour precipitation page for both the normal and "i-mode" versions. This means that many people have a greater interest in "the latest 1-hour precipitation" than in "accumulated precipitation". Access to the "observatory which surpassed the highest record" page was 29% of that to the 1-hour precipitation page. This function, a special feature of the system, provides users with information on the record-breaking rainfall event that occurred and its location.

4. CONCLUSIONS

An Internet-based, real-time heavy rainfall display system which can be viewed with Internet browsers and cellular phones was developed. It is composed of certain existent tools (programs) and original script files available on Windows 2000. One important feature is that the highest historical precipitation and the present precipitation are shown on the same page. This is useful in that users can easily compare the present precipitation intensity with past heavy rainfall and knew the seriousness of the present one. Another important feature is that the system is very simple. Because almost all the pieces of information are displayed as characters, users can readily gain access from cellular phones.

The "Real-time Heavy Rainfall Display System", opened in April 2001, has attracted attention from society. The number of accesses to it shows a favorable increase. The system is accessible from various computers and cellular phones, as shown in 3.1.

The maximum number of accesses to all the pages of this system was about 21,500 on Sep. 11, 2001, and about 21,000 on Aug. 21. The number of accesses to a similar governmental system, which opened after ours on Sep. 11, the "Disaster Prevention Information on Rivers" (http://www.river.go.jp/) operated by the Ministry of Land, Infrastructure and Transport was about 1,000,000 (Turuta et al., 2001). Because this governmental system has greater content, these numbers cannot be compared directly, but our system has drawn the attention of many people even, though it was developed by very few people.

The system now is linked to at least 50 homepages. It was announced as "king of this week" in the Oct. 26, 2001 issue of "Giga Choice"(http://www.gigahz.net/choice/) which evaluates "i-mode" version homepages throughout Japan. The system also was introduced in other evaluation sites; magazines for "i-mode" users and newspapers. As evaluated by society, it has already proved practical. Our "Real-time Heavy Rainfall Display System" is a pioneering work and several similar systems follow the ideas of that system.

Access log analysis showed that the number of accesses on a peak day is several dozens of times that on a normal day. This proves that a simple design is needed for this type of information

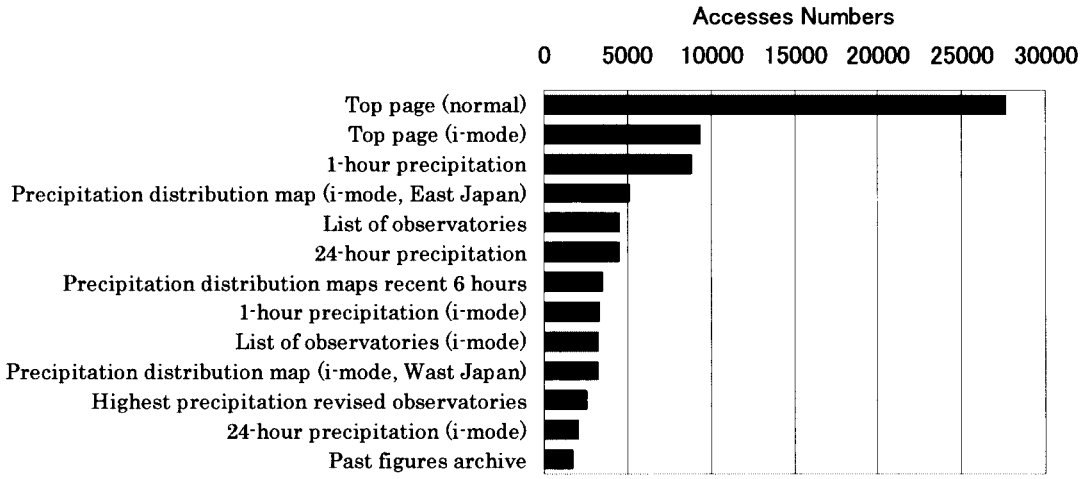

Fig.7 Number of accesses to the main iformation pages from April 1 to September 24, 2001.

system. In contrast, it can show more kinds of information. Development of a simple, intelligent system in the near future is expected to make the system more tractable and practical.

Not only accumulated precipitation but the effective precipitation (e.g., Antecedent Precipitation Index) is important in terms of sediment disasters. This type of rainfall information system also is expected to useful for sediment disaster prevention and mitigation.

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