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Heavy Rainfall Disaster in Eastern Japan Caused by Typhoon 0206 from July 9 to 12, 2002

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ABSTRACT

Typhoon 0206 (CHATAAN) struck the Pacific coast of Japan from July 9 to 12, 2002 and caused heavy rainfall in eastern Japan. In Gifu Prefecture, hourly precipitation of 93mm was recorded on July 10 and the total precipitation was more than 500 mm. The highest accumulated precipitation for approximately the last 20 years was recorded at several observatories in Iwate Prefecture. This rainfall caused 7 deaths, destroyed 39 houses, and inundated some 9,800 houses. The worst damage was in Higashiyama Town, Iwate Prefecture in which twenty-five percent of all the houses were inundated. Residents of that town had had several previous flood experiences, but in spite of those experiences, extensive damage occurred because the water level rose faster than in past flooding. In Ogaki City, Gifu Prefecture, the flooding of the Otani River inundated of 550 houses. The existence of a fuse plug levee of the Otani River in the vicinity of a residential area was blamed. The real time rainfall information and hazard maps developed recently were not sufficiently made use of as indicated by the results of a questionnaire that surveyed the damaged municipalities.

1. INTRODUCTION

A heavy rainfall disaster occurred in the Japanese archipelago from July 9 to 12, 2002. Seven people died or were missing, 39 houses collapsed, and 9,785 houses were inundated (Fire and Disaster Management Agency, 2002). The causes of this heavy rainfall were typhoon No.0206 (CHATAAN) and a Bai-u front (rainy season stationary front). The characteristics of this event are compared with those of other recent heavy rainfall disasters in Japan.

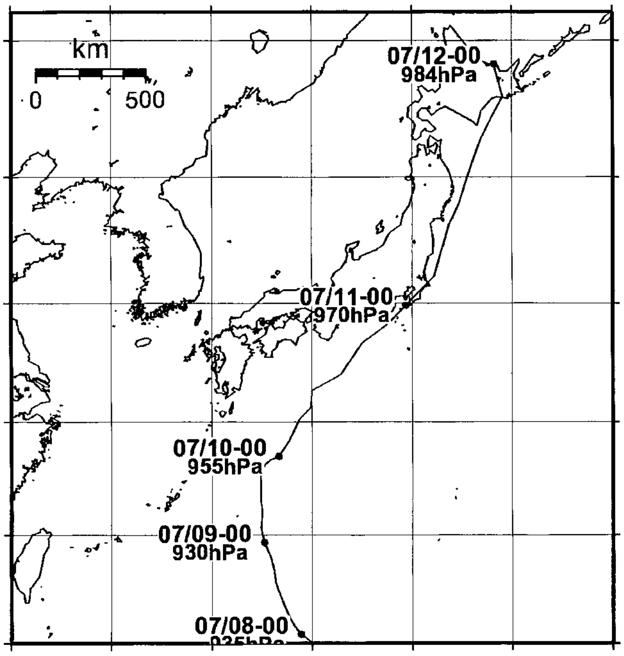

Fig. 1 Route of typhoon 0206.

2. PRECIPITATION CHARACTERISTICS

2.1 Outline of weather conditions

The Japanese archipelago has two rainy seasons. The first from June to July, is caused by the bai-u front. In 2002, this front appeared around in mid-June. The Japan Meteorological Agency (JMA) announced that the bai-u season had begun in Kyushu on

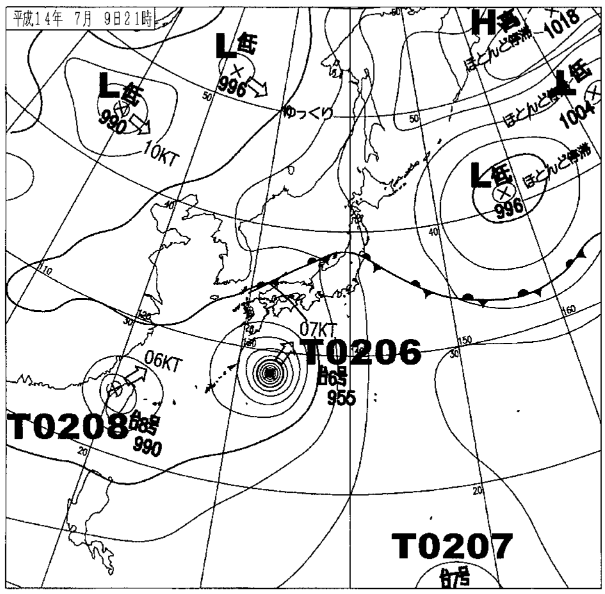

Fig. 2 Surface weather map (21JST, July 9, 2002).

KEY WORDS: heavy rainfall disaster, flood damage, disaster information, Iwate Prefecture, Gifu Prefecture

June 10, and in Honshu and Shikoku on June 11. The bai-u front of that was not active from the middle to the end of June, but the situation changed at the beginning of July. Passage of typhoon No.0205 near Kyushu from July 3 to 4 activated the front.

Typhoon No.0206 passed Minami-Daito Island on July 8, moving in a northerly direction. The bai-u front was activated by the its movement and caused rainfall in west Japan after July 8. The course of the typhoon changed on the afternoon of July 9, and it passed along the Pacific coast from July 9 to 11 (Figs. 1, 2).

2.2 Precipitation distribution

The center of typhoon 0206 did not pass over the landmass of the Japanese archipelago, but a wide area was hit by the heavy rainfall caused by the bai-u front and typhoon. The major heavy rainfall areas were (1) western Gifu Prefecture, (2) eastern Shizuoka and western Yamanashi Prefecture, and (3) northern Tochigi and northern Gunma prefecture. Cumulative precipitation of more than 300 mm was recorded from July 10 to 11 (48-hour) in these areas (Fig. 3). In western Gifu Prefecture, a high of 500 mm of precipitation was recorded.

Figure 4 shows hyetographs of Tarumi (Neo Village, Gifu Prefecture) and Ichinoseki (Ichinoseki City, Iwate Prefecture). The highest 48-hour precipitation was recorded at the Tarumi observatory. Ichinoseki is in the neighborhood of the district most heavily inundated.

Fig. 3 Map: 48-hour precipitation distribution (July 10 to 11).

Rain began at Tarumi before dawn on July 10. The highest 1-hour precipitation (93mm) was recorded at 1 a.m. on July 10. There after, a precipitation of more than 20mm was recorded every hour from between 1 a.m. and noon on July 10. The 48-hour precipitation totaled 506mm. At Ichinoseki, rain began on the morning of July 10. Approximately a rainfall of 10mm per hour was recorded from 11 p.m. on July 10 through 08 a.m. on July 11. The highest 1-hour precipitation (31mm) was recorded at 06 a.m. on July 11. The 48-hour precipitation totaled 223mm.

2.3 Comparison with historical rainfall records

Precipitation caused by this event was compared with historical rainfall records through the use of AMeDAS observatory (1150 stations) data compiled by the JMA for the years 1979 to 2000. The highest historical 1-, 24-, and 48-hour precipitations respectively were exceeded at 9, 32, and 33 observatories, respectively, indicative that the number of observatories with revised highest 1-hour precipitations was smaller than those with longer observation times. One of the characteristics of this event was the heavy cumulative precipitation, as seen from various indexes. The "effective rainfall" and the "soil water index" (SOI. Okada et al. 2001) are cumulative precipitations which are determined by multiplying past precipitation by a degressive coefficient. These indexes are used as warning indicators of sediment and other disasters. The historical highests recorded effective rainfall and SOI respectively at 30 and 27 observatories in this event.

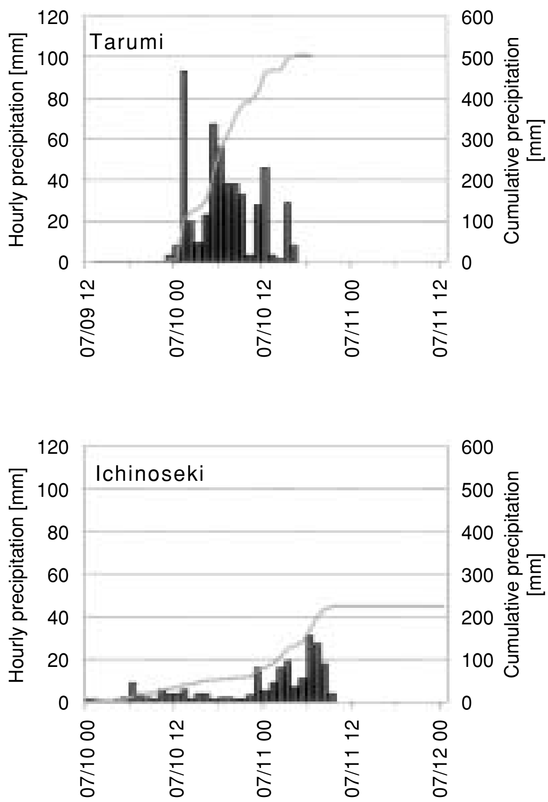

Fig. 4 Hourly and cumulative precipitation at Tarumi (Gifu Prefecture) and Ichinoseki (Iwate Prefecture).

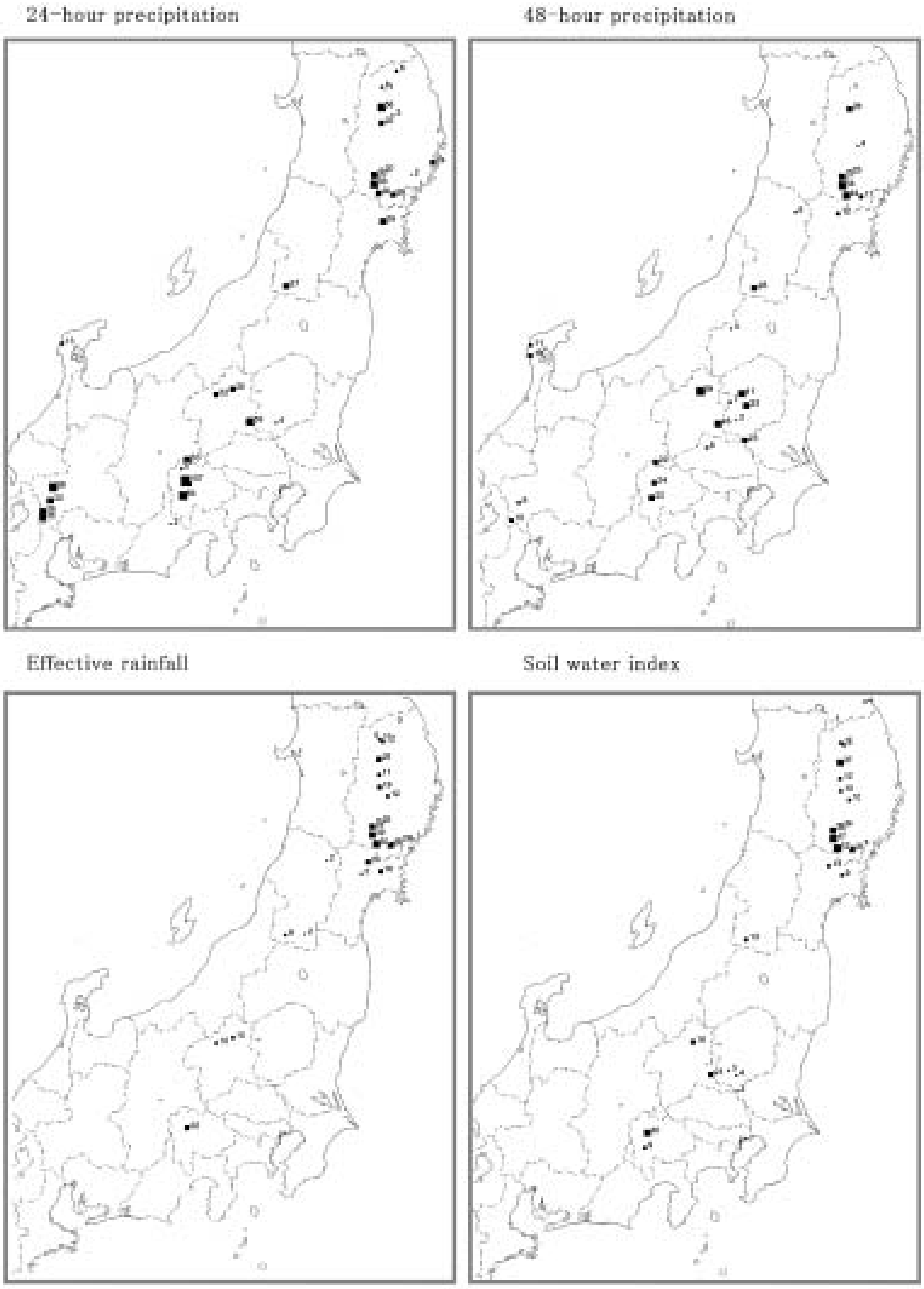

Fig. 5 Observatories with revised highest (1979 to 2000) precipitations.
Box size indicates the difference between the highest and present records.

A distribution map of those observatories that had the highest revised precipitation is shown in Fig. 5. The 24-hour precipitation record was exceeded in (1) western Gifu Prefecture, (2) eastern Shizuoka Prefecture and western Yamanashi Prefecture, (3) northern Tochigi and northern Gunma prefectures, (4) southern Iwate Prefecture. Areas (1), (2), and (3) which had very heavy rainfall (cumulative precipitation of more than 300mm) were those in 2.2. In contrast, the 48-hour precipitation, effective precipitation, and SOI highs mainly were exceeded in area (4). That area did not have heavy rainfall, but the highest historical records were exceeded at many observatories. Area (4) may have been at high risk of a heavy rainfall disaster during this event.

3. DAMAGE CHARACTERISTICS

3.1 Damage outline

The Fire Defense Agency of the Ministry of Home Affairs summarized the effects of this disaster as of July 19, 2002 on the entire country (Table 1). The death toll was low and building damage (ruined and half ruined) slight as compared to other important heavy rainfall disasters in Japan during the past several years, whereas the number of houses inundated was similar to the numbers in those past events. The greatest inundation damage (3,500 houses) occurred in Iwate Prefecture and is the highest amount recorded in Iwate Prefecture in the last 30 years. Miyagi, Fukushima, and Gifu prefectures also experienced much damage.

3.2 Human damage

Drowning in a river was the cause of the deaths of 5 persons (Aomori, Akita, Miyagi and Oita prefectures).

Two deaths in Kamaishi City, Iwate prefecture were caused by a sediment disaster. This deaths case had two important problems. First, they were single and aged individuals living in an old housing complex. It is difficult to disseminate disaster information to this type of person, and this is a recent cause for concern because of Japan's aging society. The second problem is that of an "unexpected disaster". A newspaper (Iwate Newspaper, July 12) reported that the Kamaishi City office and the city's residents were alerted only to river flooding, not to the risk of a sediment disaster. This type disaster here is called an "unexpected type disaster". Such disasters have occurred several times. A recent example was the July 1997 Harihara debris flow disaster in Kagoshima Prefecture (Moriwaki et al. 1998).

3.3 The flood disaster in Ogaki City, Gifu Prefecture

The Ibi River basin in western of Gifu Prefecture sustained heavy rainfall (24-hour precipitation of more than 500mm) on July 10, (see 2.2). The water level in the downstream section of the Ibi River rose during the daytime on July 10 because of heavy rainfall. At the Mangoku water level observatory, the designed high-water level (about the height of the embankment) was exceeded on July 10 from 11 am to 2 pm. The highest level, recorded at 12 pm, exceeded the designed high-water level value by 0.26m (National Institute for Land and Infrastructure Management, 2002).

No breach of the levees of major rivers occurred during this flood, but many houses were flooded due to inundation inside a levee and overflow. In Ogaki City, in particular, 551 houses were inundated (over floor, 327; under floor, 224), the deepest inunda-

Table 1 Damage by prefecture.

Prefecture	Death toll	Building damage (houses): Ruined	Half-ruined	Inundated: Over floor	Inundated: Under floor	Headquarters for disaster countermeasures (number / all)*1
Hokkaido						13 /212
Aomori	1			72	163	1 / 67
Iwate	2	4	10	983	2,509	36 / 59
Miyagi	1	1	1	515	2,649	43 / 71
Akita	1					
Yamagata				2	59	
Fukushima		1		404	716	23 / 90
Ibaragi				12	39	9 / 85
Tochigi				48	139	
Gunma		9	11	8	36	5 / 70
Saitama				6	85	1 / 92
Chiba						
Tokyo			1	1	1	2 / 41
Kanagawa			1		3	
Niigata					5	
Ishikawa				3	126	3 / 41
Fukui						1 / 35
Yamanashi				1	50	8 / 64
Nagano					1	
Gifu	1			391	515	36 / 99
Shizuoka				26	124	1 / 74
Aichi						10 / 88
Mie					1	69 / 69
Shiga					16	1 / 50
Kyoto					7	
Hyogo					1	
Nara				1		
Shimane						1 / 59
Okayama					3	
Tokushima				2	60	
Ooita	1				2	1 / 58
Total	7	15	24	2,475	7,310	264 / 3,230

*1 Number of established municipal headquarters for disaster countermeasures / Number of all municipalities per prefecture.

*2 Blanks in columns mean "0".

Photo 1 Flood damage in Ogaki City, Gifu Prefecture.
Photograph: July 10, 16:00. The fuse plug levee is on the right. Copyright (C) 2002 Asia Air Survey Co., Ltd.

Photo 2 Close-up of the fuse plug levee (Otani River Arai zeki).

Photo 3 Flood damage in Higashiyama Town, Iwate Prefecture.
Photograph: the morning of July 11. Provided by the Higashiyama Town office.

Photo 4 Inundated house in Higashiyama Town.
Inundation by over flow in spite of being built on filled ground (about 1m). The wall was destroyed the river water. Photos 4, 5, and 6 were taken on July 13 by the author.

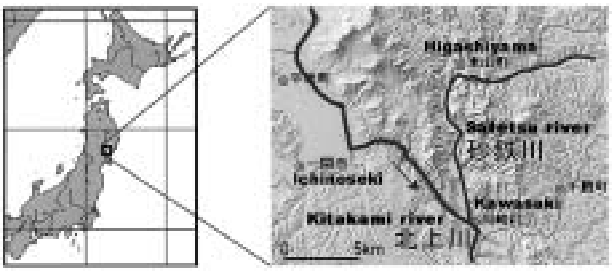

Fig. 6 Location of Higashiyama Town, Iwate Prefecture.

tion in the residential zone being about 1 m (National Institute for Land and Infrastructure Management, 2002). Most of the damage occurred in the Arasaki area (Photo 1) due to overflow at the fuse plug levee of the Otani River (Photo 2). Residential land development of a lowland paddy zone resulted in this damage. Local residents were not fully aware of the existence and objective of the fuse plug levee. Local people therefore need to be more thoroughly informed about that type structure.

Upstream of the Ibi River basin where 500 mm of precipitation was recorded in 48 hours, there were some sediment disasters and channel erosions. Most of the damage done was small scale, no human or building damage occurring in that area.

3.4 Flood damage in Higashiyama Town, Iwate Prefecture

In southern Iwate Prefecture, a 48-hour precipitation of 200 to 300 mm was recorded. This was the highest heavy rainfall in this area in the past 20 years (see 2.4). The level of the Kitakami River, the principal river in southern Iwate Prefecture, rose on the evening of July 10 because of the heavy rainfall. At no observatory did it exceed the designed-high-water-level, whereas the critical-water-level was exceeded at several water level observatories. At the Kozenji observatory (Ichinoseki City), the highest water level was the 3rd highest recorded since 1945 (Iwate Office, MLIT, 2002). No levee was breached along the Kitakami River, and inundation damage was negligible, whereas much inundation damage occurred along its branch rivers.

Higashiyama Town suffered the greatest damage in the Kitakami River basin area. This town is located in the basin of the Satetsu River, a branch of the Kitakami River (Fig. 6). There were

Photo 5 The Satetsu River in the central area of Higashiyama Town, Iwate Prefecture.

Photo 6 Central Higashiyama Town.
Inundation in this area was more than 1m deep. The ground is covered with mud from the river. Piles of refuses from the flooding can be seen along the road.

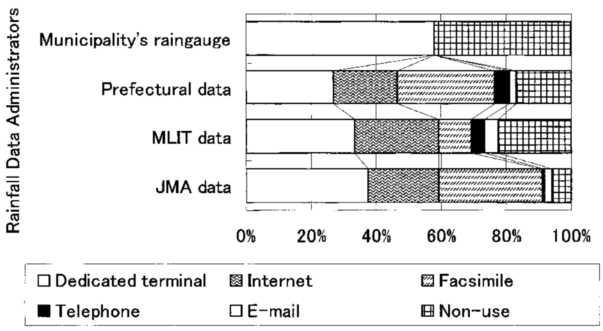

Fig. 7 Methods of real-time rainfall data access by municipal public officials.

2 half-collapsed houses, 382 over-floor inundations, and 195 under-floor inundations (Photo 3). As the number of households in Higashiyama Town is 2,277, 25 percent of all the households experienced inundation. This municipality suffered the worst inundation damage in this heavy rainfall event.

The water level of the Satetsu River had rose rapidly after 2 am on July 11, and overflows occurred everywhere in the central area of Higashiyama Town. Many were inundated, houses and at 6:45 am on July 11, an evacuation order was given. Thirty persons who failed to escape were rescued by helicopter or boat; fortunately there were no deaths. Results of my field survey showed that the inundation depth ranged from 1.5 to 2.0m in the town. Houses with raised basements for flood defense are situated along the Satetsu River, but even these sustained over-floor inundation (Photo 4).

Residents along the Satetsu River also had some flooding due to the backwater from the Kitakami River. In past event, flooding was slow because the water level of the Satetsu River rose slowly, after that of Kitakami River. In the 2002 event, the increase in the water level was very rapid due to the heavy rainfall in the Satetsu River basin. According to several residents, they didn't have time to remove their household effects before flooding took place. Thus, there was the possibility of an "unexpected type disaster".

4. DISASTER INFORMATION

In Japan, the development of rainfall observation and disaster information dissemination systems has progressed rapidly in recent years. The JMA and Ministry of Land, Infrastructure and Transportation (MLIT) oversee rainfall measurement at about 4,000 observatories. In addition, individual prefectures' recently have instituted rainfall observation systems. Information from these observatories has been disseminated by TV, dedicated terminals, facsimile transmission, telephone, etc. Moreover, real time disaster information dissemination has been growing; e.g., the Internet provides a new tool for transmitting disaster information. It has many weather information pages, and disaster-related governmental offices, as well as almost all prefectural offices, have published disaster information (disaster warnings, rainfall data, hazard maps, etc.) on their homepages. It is no exaggeration to say that today is the "Internet disaster information age". The effectiveness of these information systems, however, needs further examination.

The disaster discussed here is one of the first events to have occurred in this Internet age. Therefore, I investigated by questionnire how to collect and use the heavy rainfall disaster information compiled by local governments. Questionnaire information was gathered from 230 municipalities in Iwate, Miyagi, Fukushima, Gifu and Mie prefectures. Thirty-two of them had issued evacuation orders during the heavy rainfall disaster, half of them answered that the occurrence of damage was the decisive factor in issuing the evacuation order. Results of the questionnaire indicated that in spite of the availability of disaster information it was difficult to issue evacuation order before damage actually occurred. Percentages of rainfall information received in real time based on responses were rainfall JMA data 92%, Ministry of Land, Infrastructure and Transportation (MLIT) rainfall and water level data 72%, prefectural rainfall and water level data 78%. Rainfall information use at the time of the heavy rainfall event were JMA data was 74%, MLIT data 38%, and prefectural data 51%. These findings show that it is not always a real time rainfall information system that is used at the time of an actual disaster. Flood hazard maps were made in 23 municipalities, but only 13 municipalities used hazard maps during this event. It is important that the practicality of the use hazard maps be verified.

5. CONCLUSION

The characteristics of this disaster were as follows:

(1) In the heavy rainfall disaster in East Japan caused by typhoon No.0206 (CHATAAN) and the bai-u front, 7 people died or were missing, 39 houses collapsed, and 9,785 houses were inundated. It was the worst weather disaster in a 2-year period.

(2) The highest 48-hour precipitation (about 500mm) was recorded in western Gifu Prefecture. Historically the highest 24- and 48-hour precipitations, effective-rainfall, and soil-water-index after 1979 had been recorded mainly in southern Iwate Prefecture.

(3) The worst damage was in Higashiyama Town, Iwate prefecture where inundation damage was especially severe. Residents had had several previous flood experiences, this time they and their household effects could not evacuated because the water level rose much more rapidly than in past events.

(4) Dissemination of rainfall disaster information via the Internet has progressed in recent years. Almost all municipalities are able to use real time rainfall information, as indicated by the responses to the questionnaire submitted to damaged municipalities. The percentage of municipalities using such information, however, was 74% at the time of the rainfall disaster. Moreover, only some municipalities utilized hazard maps.

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