

Achievements of advanced flood control of JWA dams during a recent large-scale typhoon

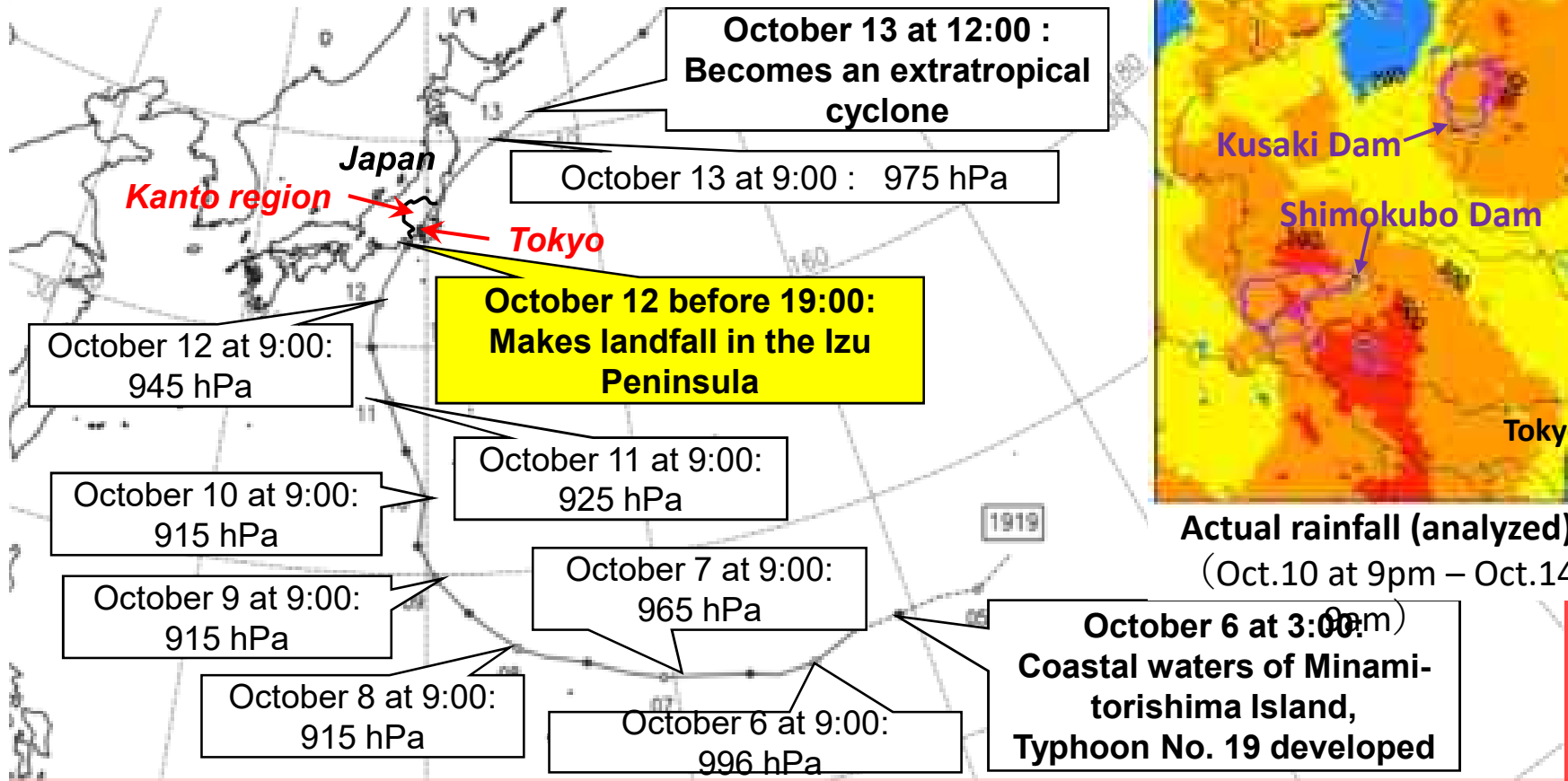
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Typhoon Hagibis (2019)

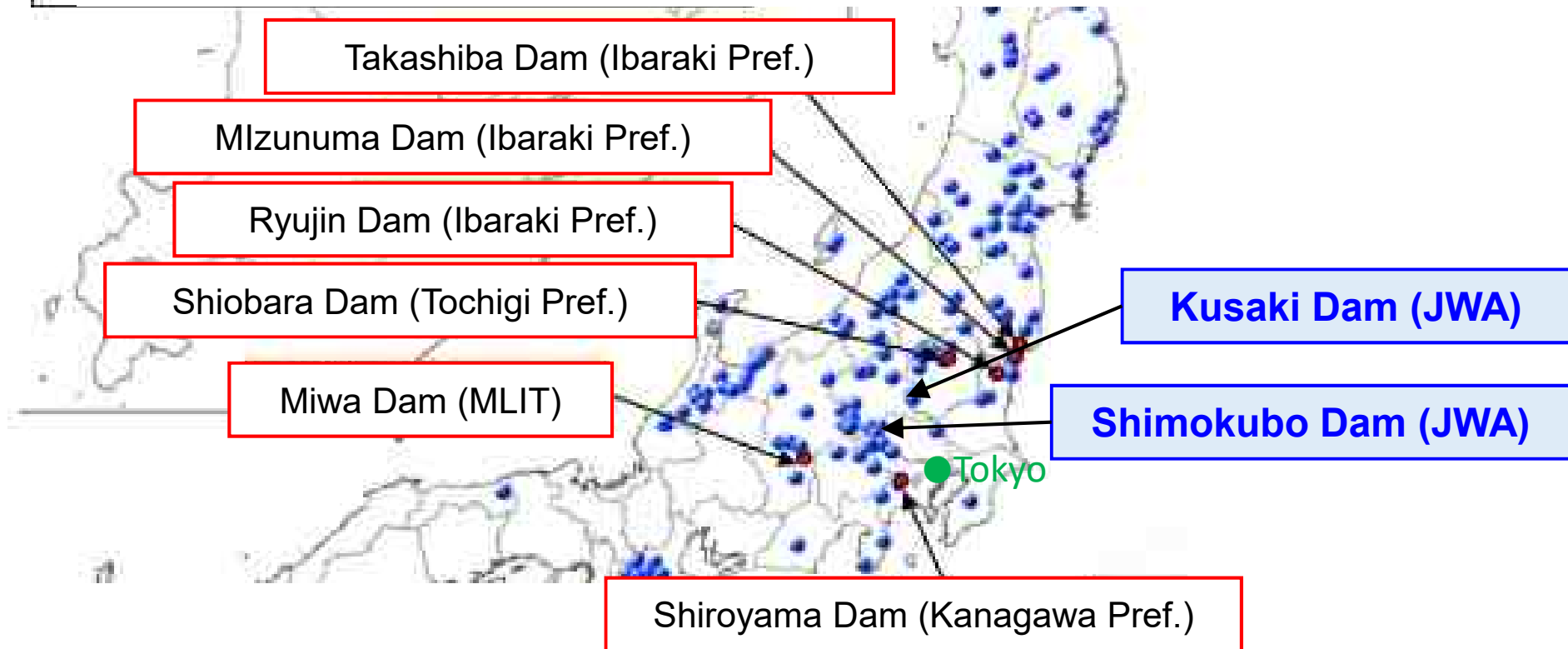


	Cumulative rainfall	Maximum inflow
Shimokubo Dam (1969-)	513mm (Maximum since dam management began)	1,840m ³ /s (Maximum since dam management began)
Kusaki Dam (1976-)	356mm (7th largest since dam management began)	1,637m ³ /s (2nd largest since dam management began)

(Source; Japan Meteorological Agency (JMA) Website)

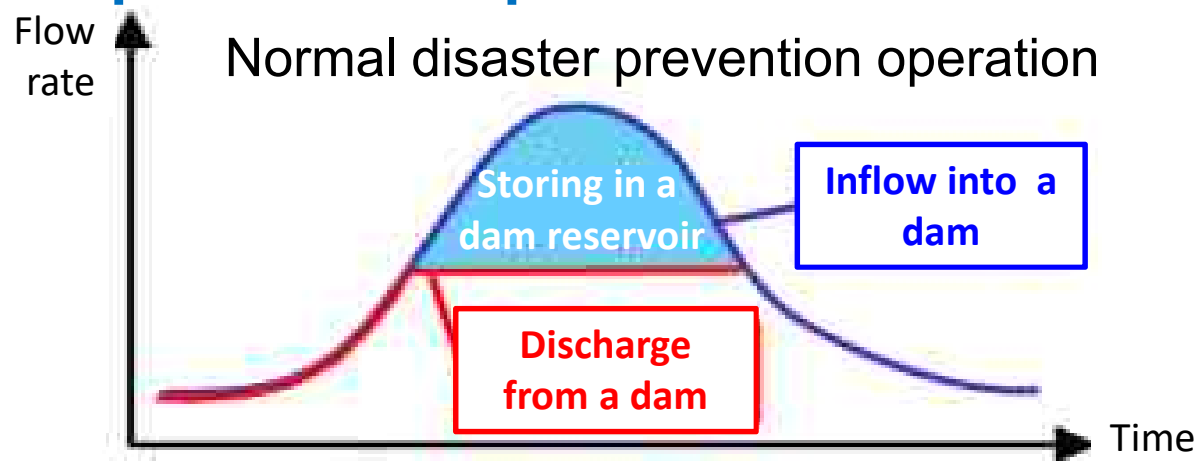
Flood control of dams in Japan during Typhoon Hagibis

- 146 dams carried out flood control
- 6 dams carried out “disaster prevention operation for extraordinary flood”

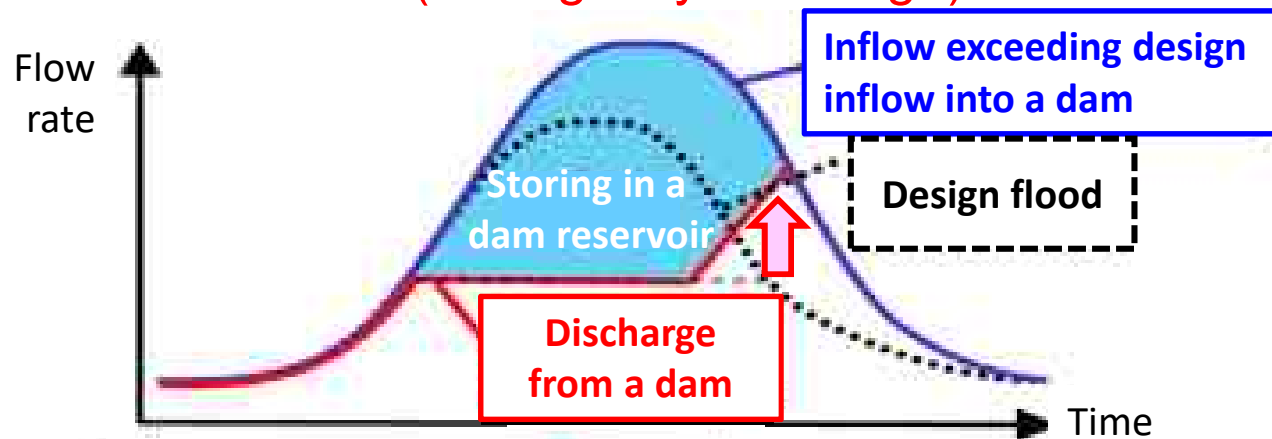


- ✓ 146 dams under the jurisdiction of MLIT implemented flood control.
- ✓ Pre-discharge was carried out at 33 dams.
- ✓ Disaster prevention operation for extraordinary flood was carried out at 6 dams.

Disaster prevention operation for extraordinary flood



Disaster prevention operation for extraordinary flood (Emergency discharge)



- ✓ In case of the situation where the storage level exceeds the allocated flood control capacity at a dam due to the over-design flood occurrence, **disaster prevention operation for extraordinary flood** is performed to gradually increase the discharge flow rate and balance it with the inflow rate.

(Source: MLIT)

The Kusaki Dam

Kusaki Bridge

Kusaki Lake

National Highway No. 122

Photo: taken after the flood control operation given by Watarase River Office of MELIT

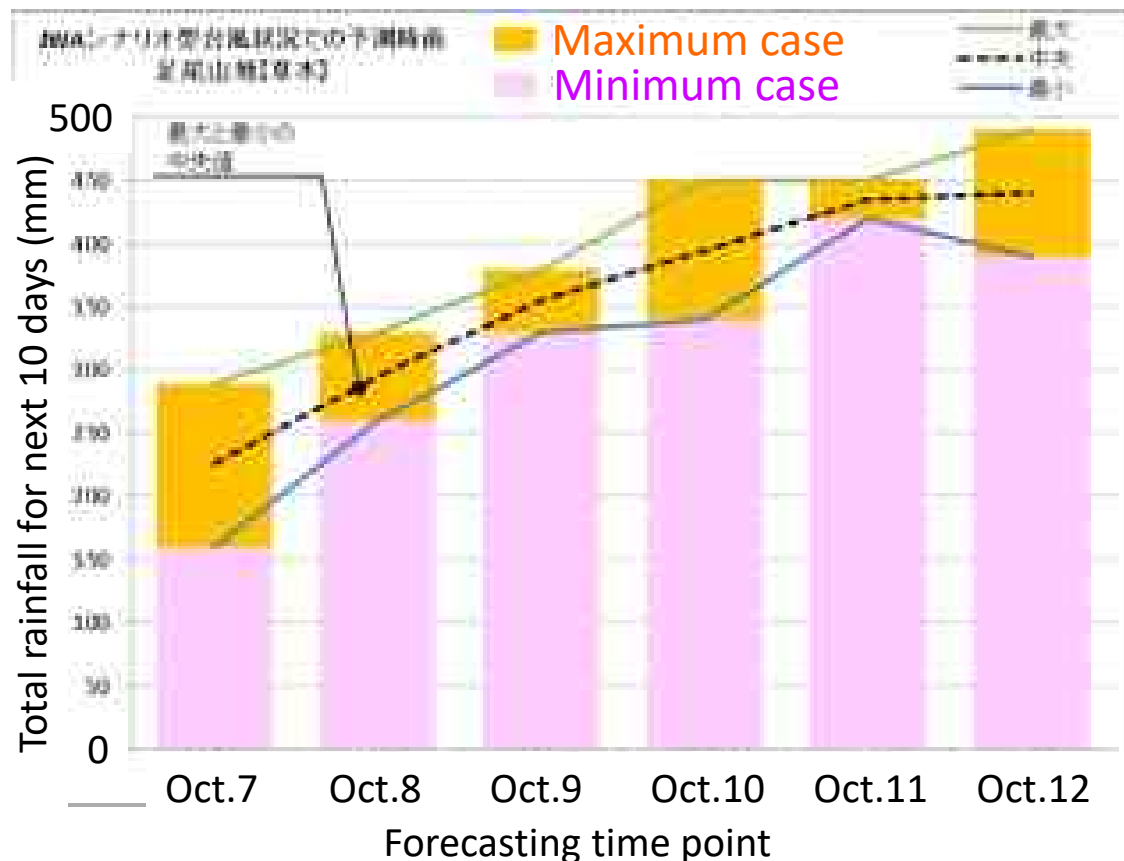
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Expected rainfall due to Typhoon Hagibis

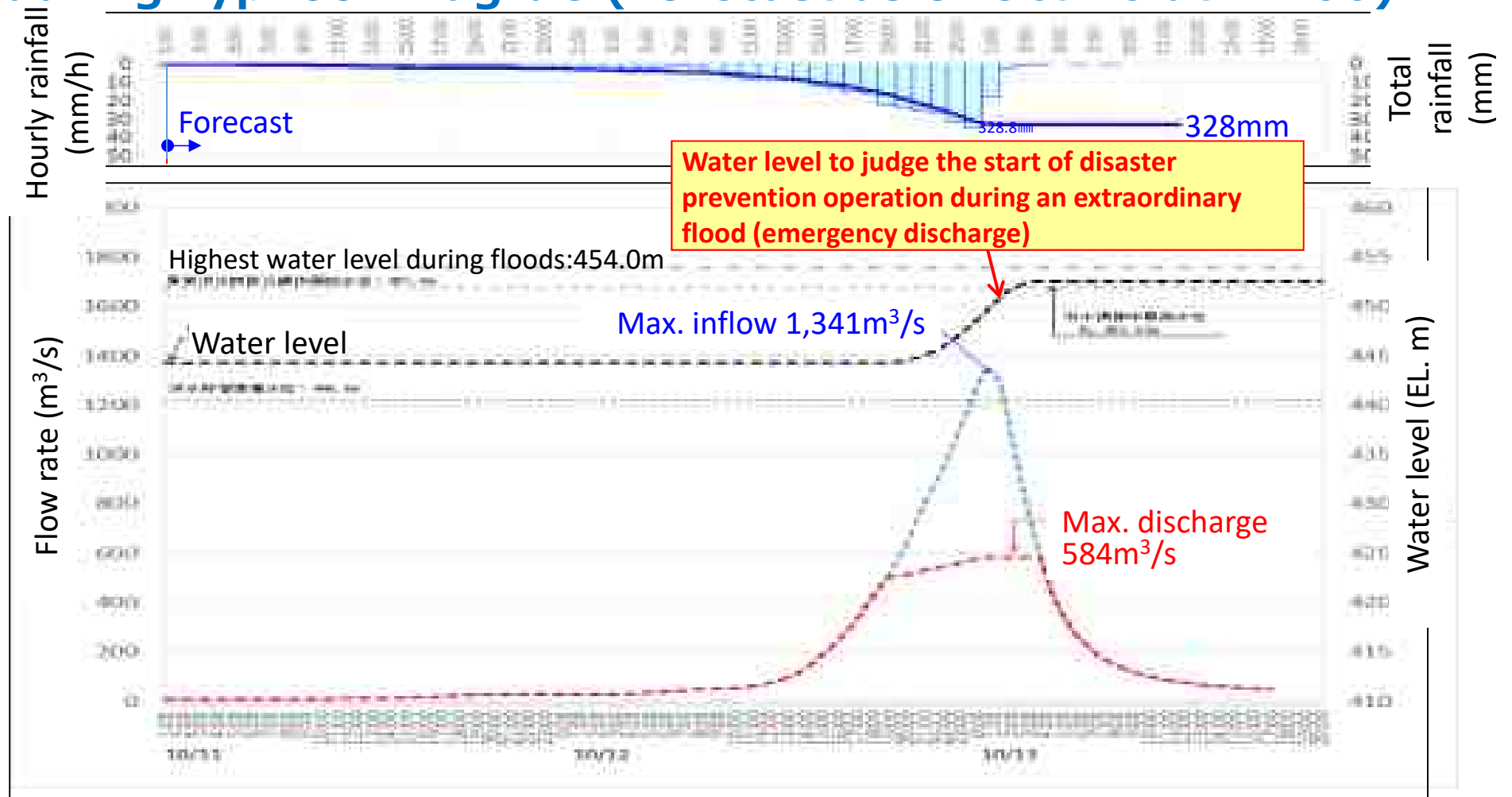
- ✓ In the basin of Kusaki Dam, rainfall was expected to increase as the typhoon approached.
- ✓ Total rainfall was forecasted to exceed 400 mm.



Rainfall forecast Scenario

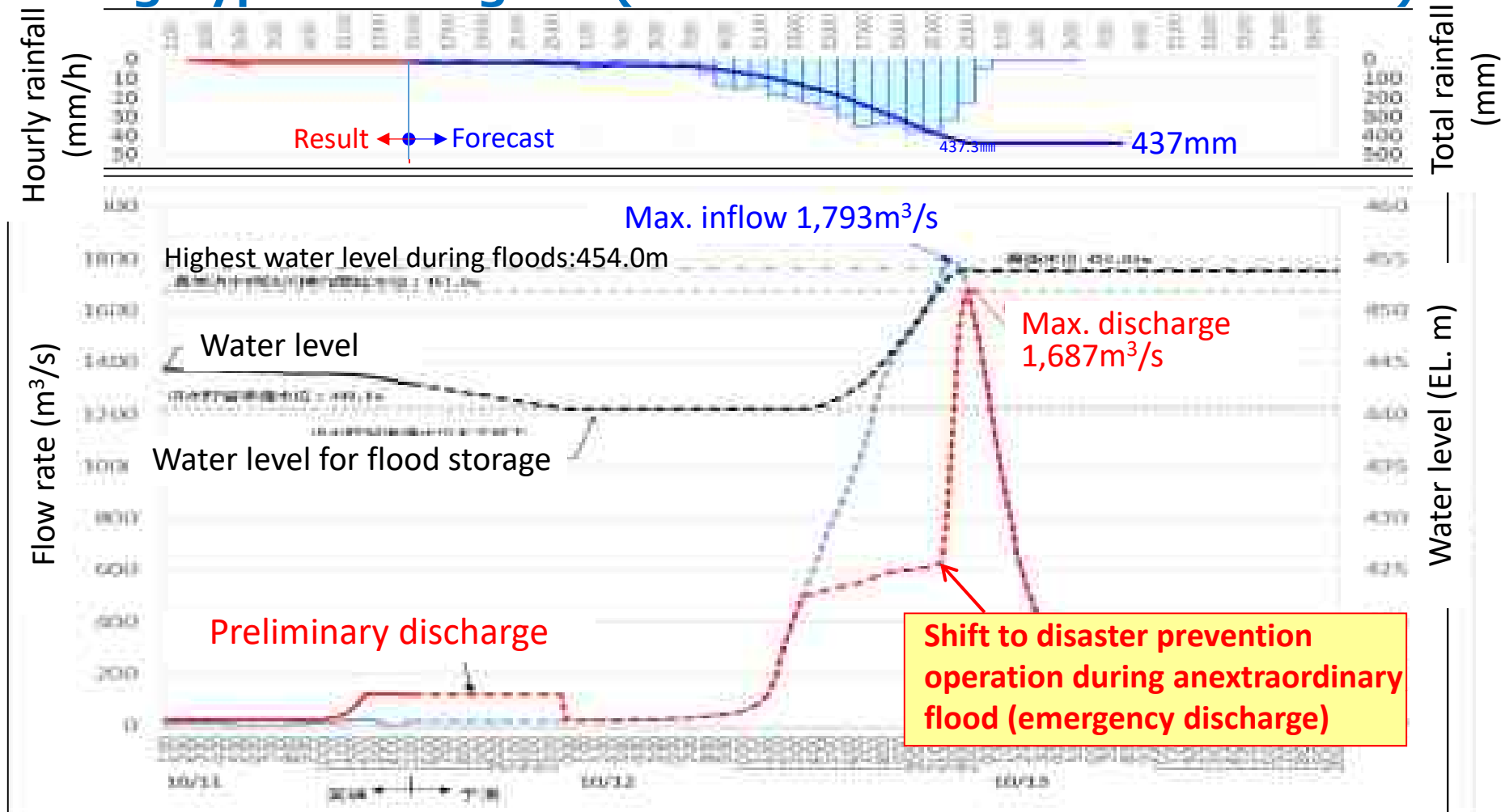


Disaster prevention operation at Kusaki Dam during Typhoon Hagibis (Forecast as of Oct.10 at 17:00)



- ✓ Water level was expected to exceed the level to judge the start of disaster prevention operation (emergency discharge), but not to reach the highest water level.
- ✓ Preliminary discharge was decided considering the possibility of increased rainfall in the future.

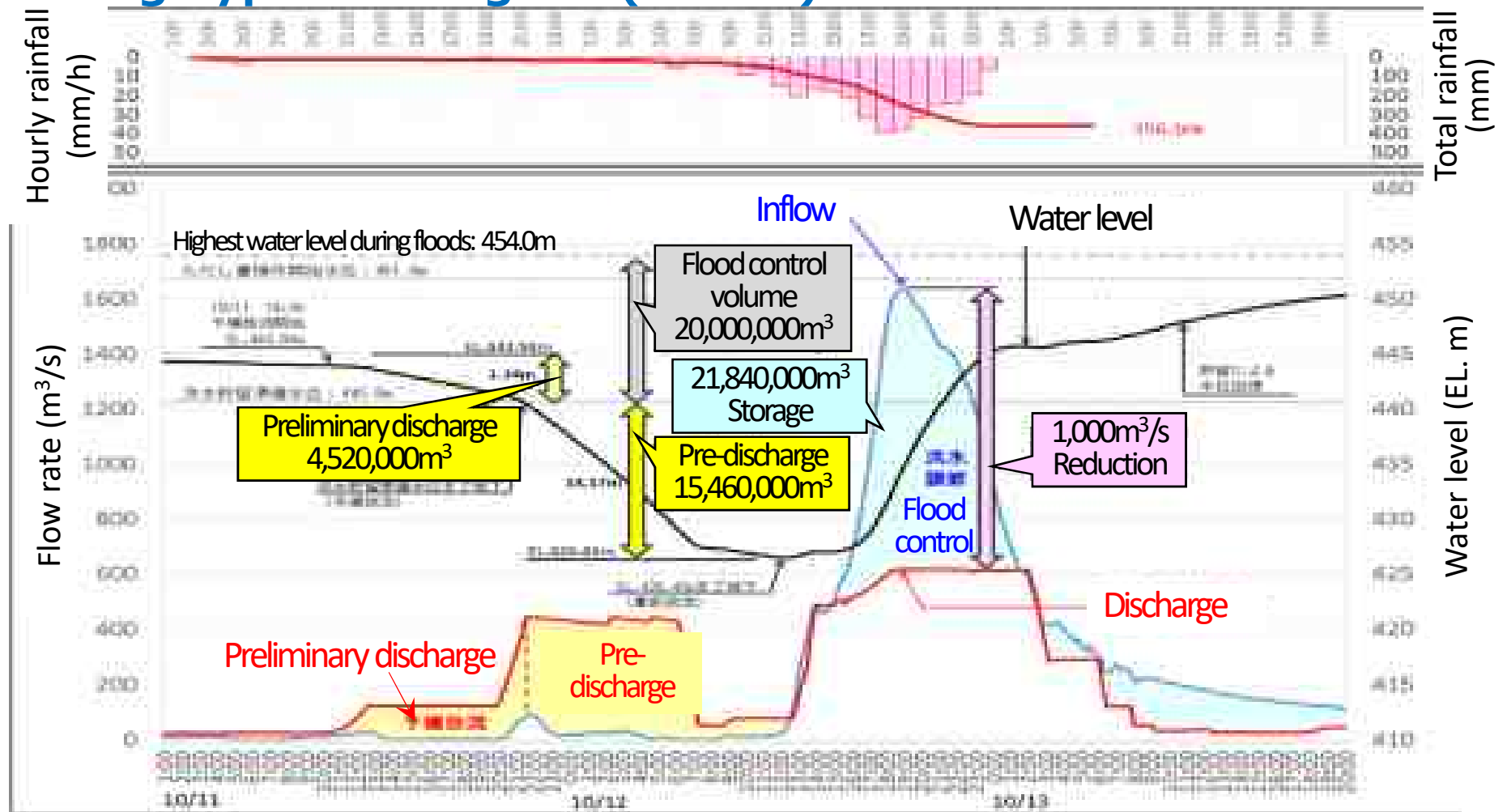
Disaster prevention operation at Kusaki Dam during Typhoon Hagibis (Forecast as of Oct.11 at 15:00)



- ✓ Large amount of emergency discharge was required due to the increase in predicted rainfall, and it was forecasted that the damage downstream would be unavoidable.

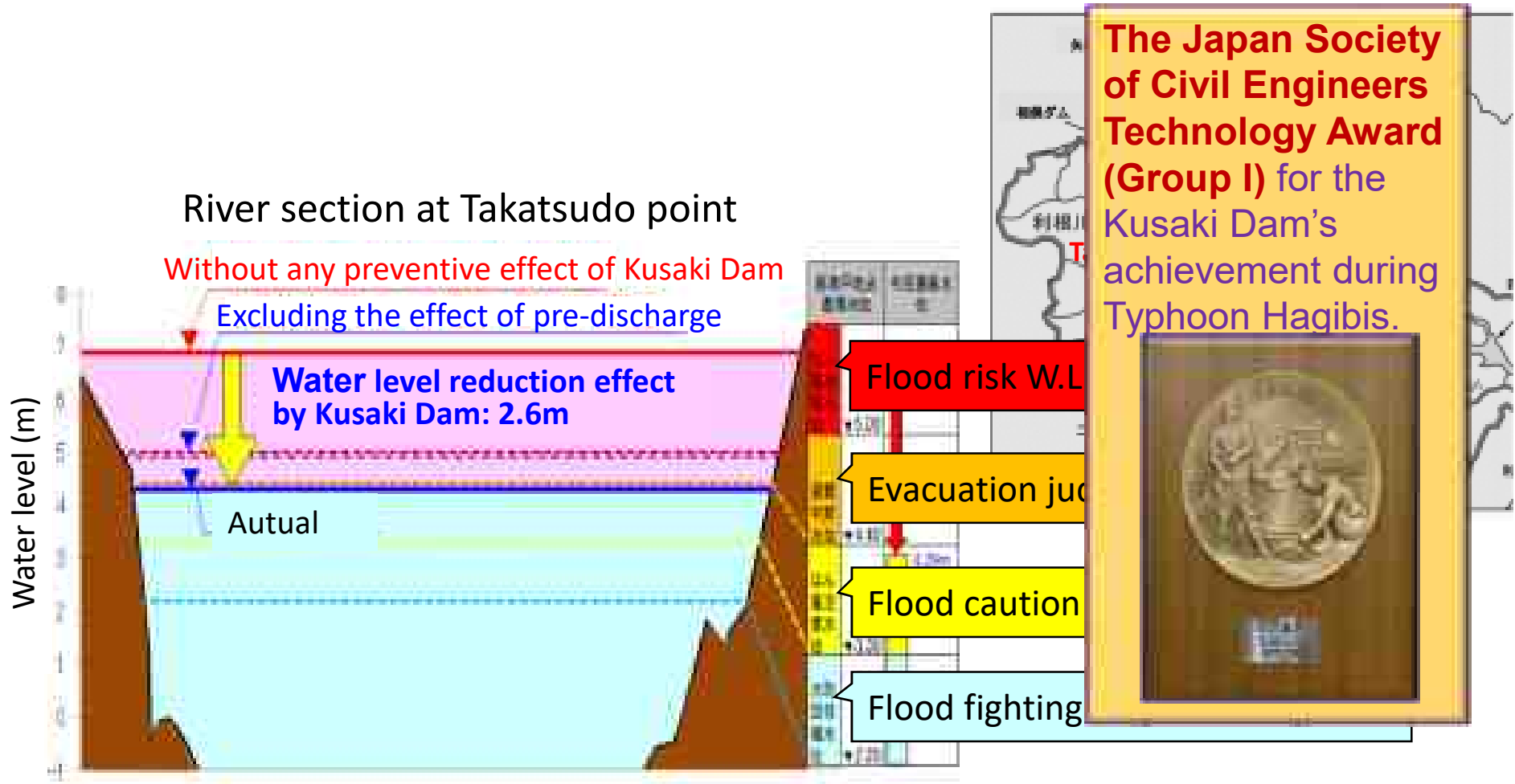
➡ Pre-discharge was required to secure further flood control capacity

Disaster prevention operation at Kusaki Dam during Typhoon Hagibis (Result)



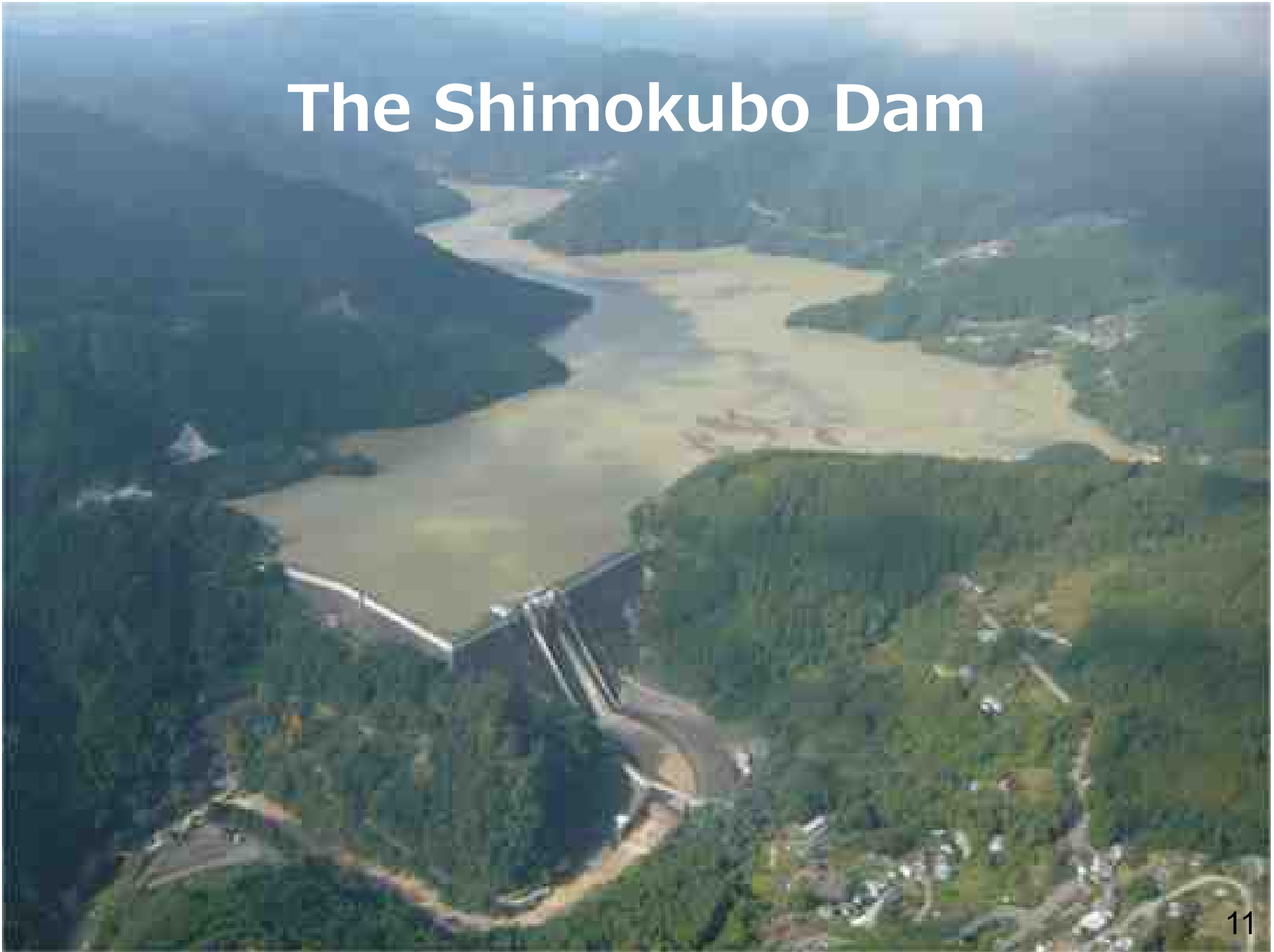
- ✓ Preliminary discharge and pre-discharge secured 15,460,000m³ of reservoir storage in addition to the flood control capacity of 20,000,000 m³.
- ✓ This operation avoided emergency discharge and contributed to the reduction of the flood damage downstream.

Flood control effect of Kusaki Dam in the rivers downstream

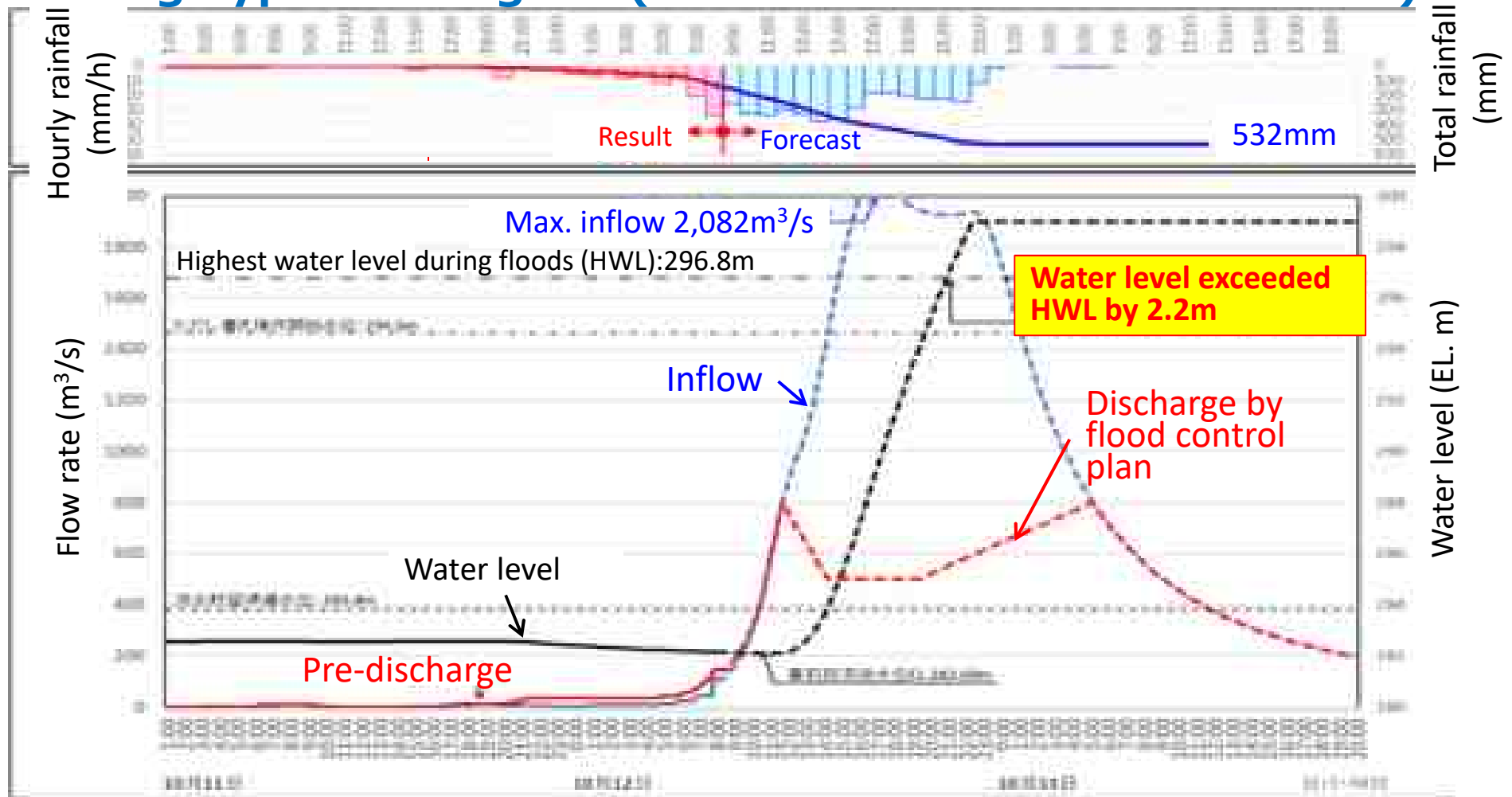


- ✓ Without Kusaki Dam, the flood risk level would have been exceeded.
- ✓ It was estimated that the water level would reach the flood risk W.L. if pre-discharge was not performed.

The Shimokubo Dam



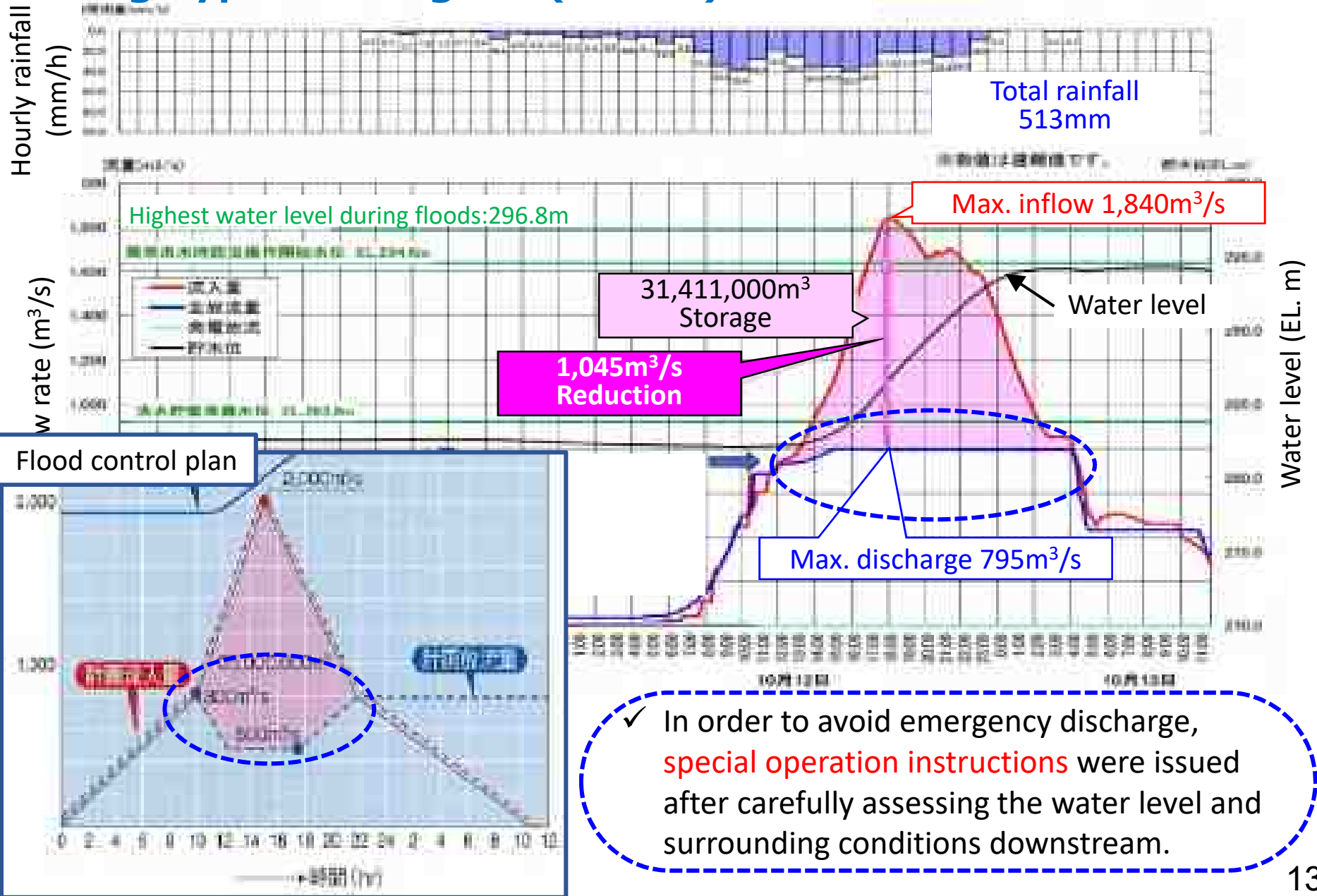
Disaster prevention operation at Shimokubo Dam during Typhoon Hagibis (Forecast as of Oct.12 at 08:00)



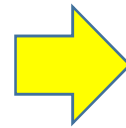
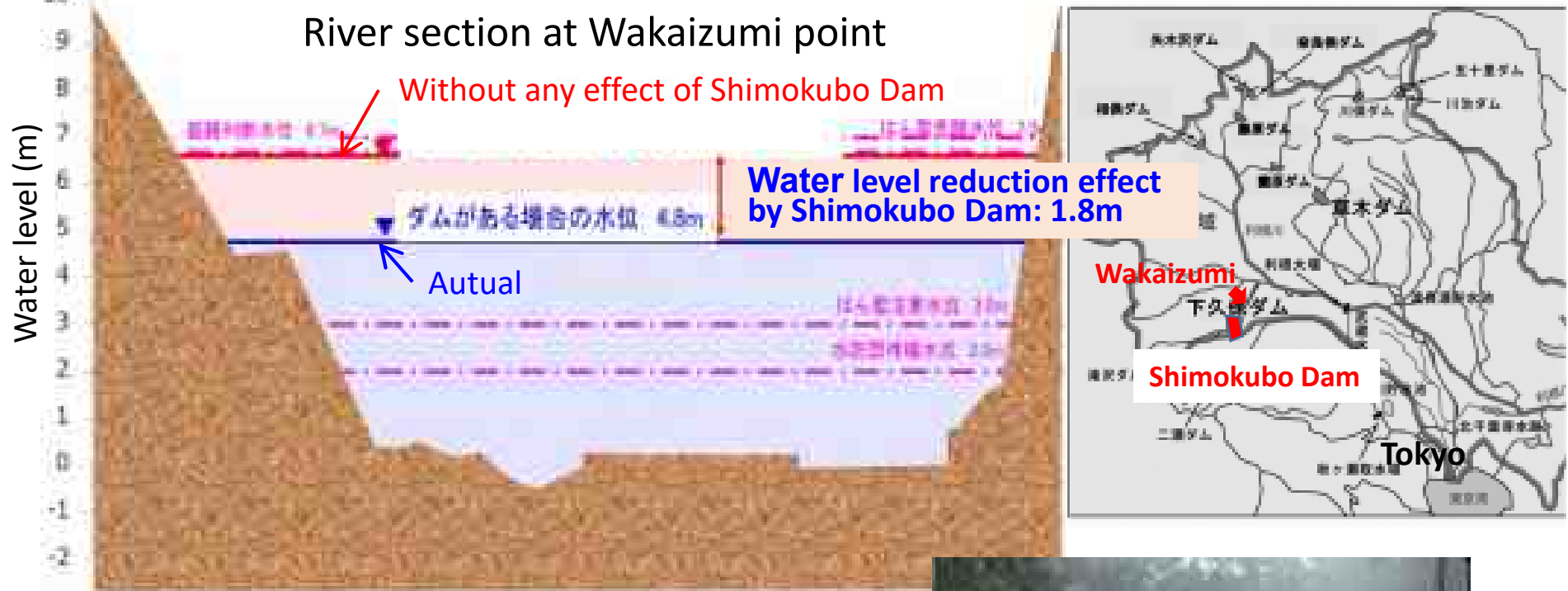
- ✓ Difficult to pre-discharge a large amount due to restrictions on slope stability
- ✓ Under the regulated flood control plan, the water level was expected to significantly increase.

➡ Special discharge operation was required to avoid emergency discharge

Disaster prevention operation at Shimokubo Dam during Typhoon Hagibis (Result)



Flood control effect of Shimokubo Dam in rivers downstream



- ✓ Without Shimokubo Dam, the water level would have been close to 0.3m to the flood risk water level.

Sediment Suppression effect and driftwood outflow at Shimokubo Dam

Sedimentation at the end of a river upstream of the reservoir



Driftwood and debris in the reservoir



Further improvement of flood control capacity of dams

- The Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT) established the "**Pre-discharge Guidelines**" in April 2020, and accordingly efforts for more effective pre-discharge operation are being made at dams nationwide.
- In parallel with these movements, Kyoto University Disaster Prevention Research Institute, Japan Water Agency and Japan Weather Association have been developing the "Integrated dam disaster prevention support system for super typhoons" at SIP (the Cross-ministerial Strategic Innovation Promotion Program) since 2018.
- One of the key concepts in the development of SIP is to make the best use of the reservoir from both flood control and water utilization views by utilizing the **long-term ensemble rainfall forecast**.

SIP: The Cross-ministerial Strategic Innovation Promotion Program

- SIP is a national program led by the Council for Science, Technology and Innovation (CSTI) of the Japanese Government with interdisciplinary management to realize scientific and technological innovation in Japan.
- SIP promotes interdisciplinary research and development ranging from fundamental study to industrial application with industry-academia-government cooperation.

SIP 2nd period (2018-2022)

Theme-9 : Enhancement of national resilience against natural disasters

Sub-theme VI : Development of super typhoon damage prediction system

Development of Integrated dam disaster prevention support system

Members; Disaster Prevention Research Institute of Kyoto Univ.

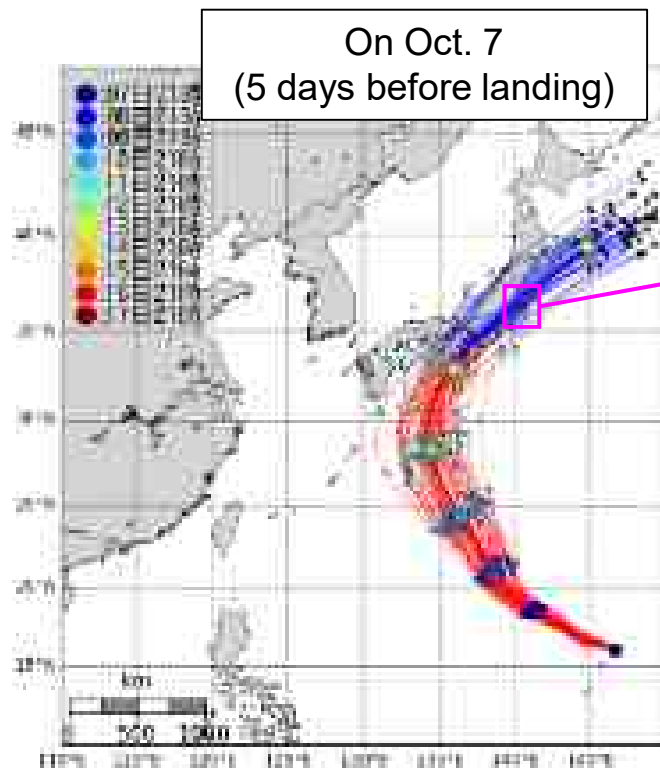
[Japan Water Agency](#)

Japan Weather Association

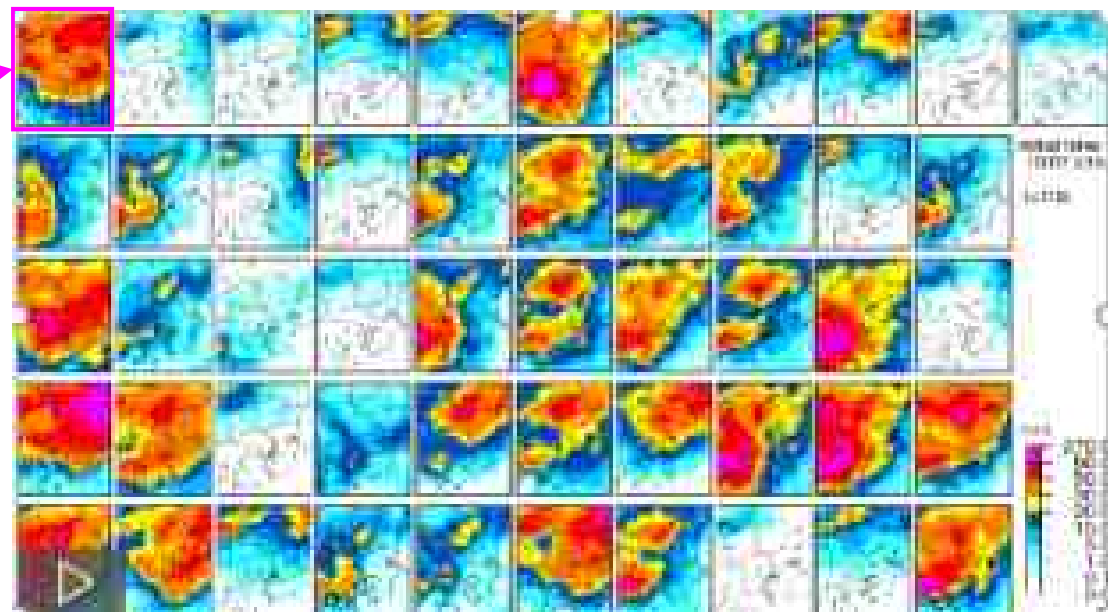
(2021-) Electric power companies (Kansai, Chubu, Kyushu)

Long-term ensemble rainfall forecasts

- ✓ Ensemble forecasts: Numerical weather forecast using multiple initial values with slight variations and statistical processing enables probabilistic forecasting considering uncertainty.



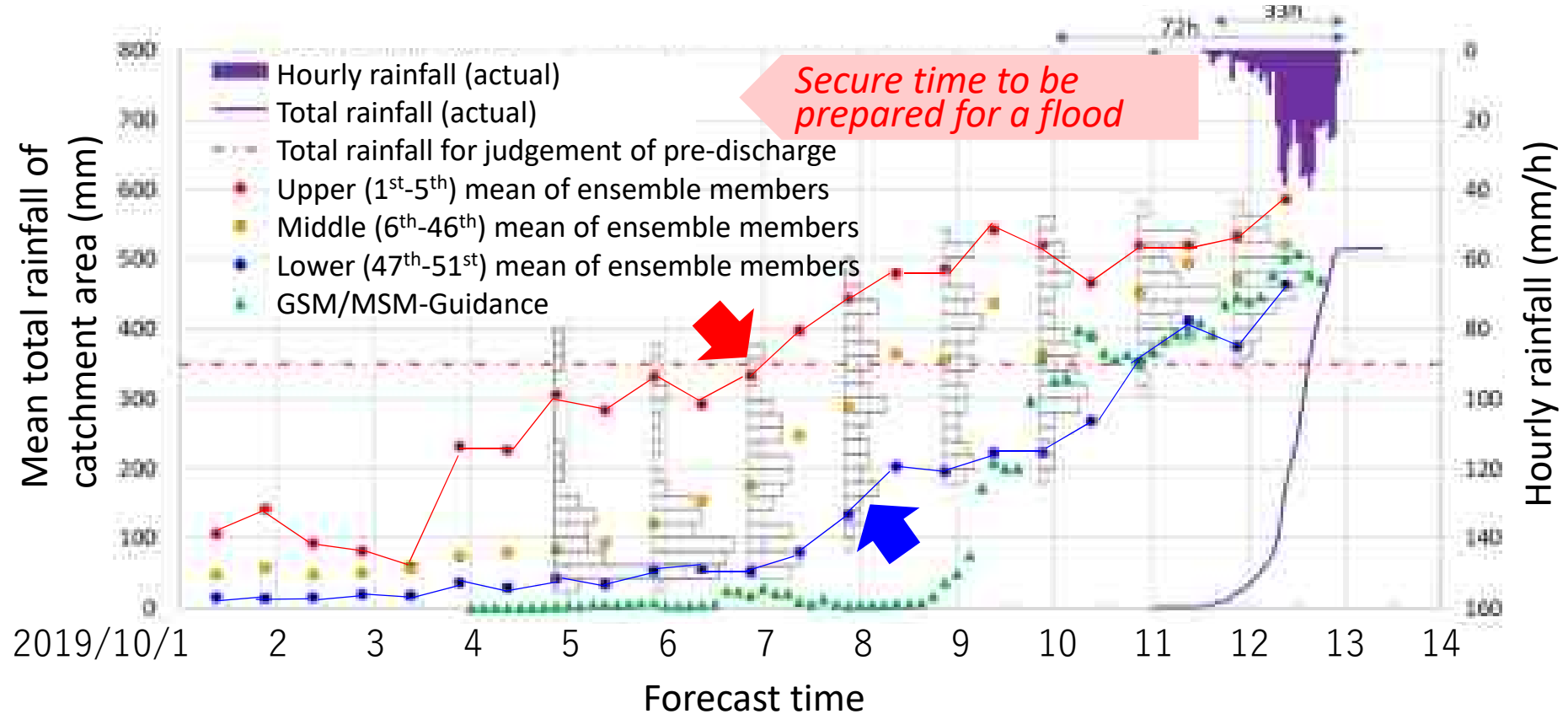
Predicted courses of
Typhoon Hagibis
(51 members)



Distribution of total rainfall
(51 members)

Application of ensemble forecast (in the case of typhoon Hagibis)

Changes in mean total rainfall of Shimokubo Dam catchment area



- ➡ Pre-discharge can be started early by using **Upper ensemble** forecast
- ➡ Target amount to lower the water level can be adjusted step by step using **Lower ensemble** forecast

These can be updated sequentially according to the changes in forecast information

International expansion of SIP achievements

~Magat Dam (The Philippines)

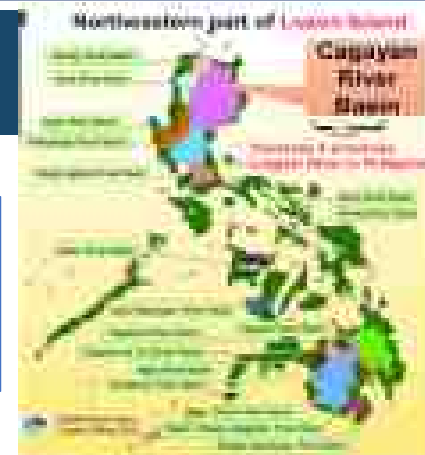
Led by Prof. T. Sumi, Kyoto Univ.



JASTIP : Japan-ASEAN Science, Technology and Innovation Platform
WP4 – Disaster Prevention

Typhoon Ulysses disaster emergency investigation

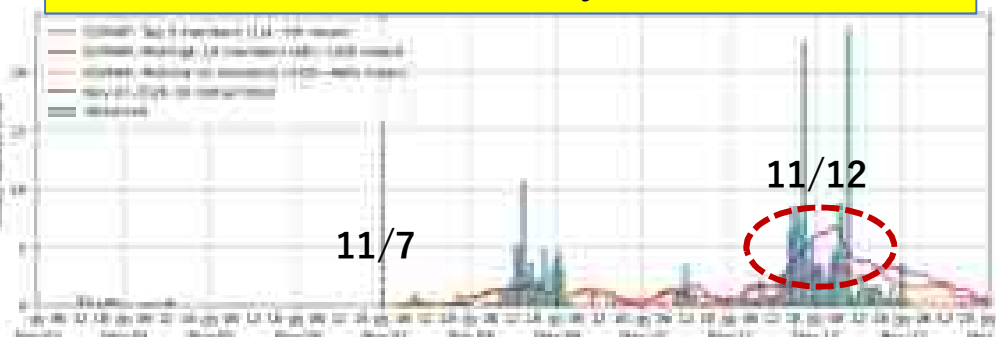
During Typhoon Ulysses (2020), an emergency discharge was carried out at the Magat Dam on the Cagayan River due to insufficient pre-discharge.



Flood and sediment Ulysses in Cagayan River Basin Due to Typhoon Ulysses (2020) (https://www.earth.mcgill.ca/2020/11/23/typhoon-ulysses/)



Using SIP's long-term ensemble forecast, rainfall could have been predicted on November 7, about 5 days earlier.



Research subjects

- Hydrometeorology data collection
- Analysis of rainfall forecast issues and improvement
- Verification of rainfall-runoff models
- Sediment inflow and countermeasures

Achieve pre-discharge from a few days to a week in advance and expand the flood storage function

< For your reference >

Pre-discharge operation is briefly explained as part of the disaster prevention operation by dams in the English website of the Japan Water Agency, as follows:

https://www.water.go.jp/honsya/honsya/english/topics/2021/210720_new%20era.html