

# *Challenges in flood control operation and dissemination of information*

*-Lessons from the record-breaking heavy rain in July 2018, Japan-*



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# *Flood Risk Management in Japan*

Recent flood  
disasters

Recent extreme floods in 2018

Dam  
upgrading

Special panel by MLIT to Increase flood mitigation function and Dam upgrading

New  
challenges

Long-term rainfall prediction and decision support system for the Integrated dam operation

# 2018/07 Heavy Rain in Western Japan

Human loss		Damaged houses		Inundated houses (above floor level)
dead	missing	totally collapsed	half collapsed	
237	8	6,767	11,243	7,173

Source: Fire Defense Agency (as of 9<sup>th</sup> January 2019)

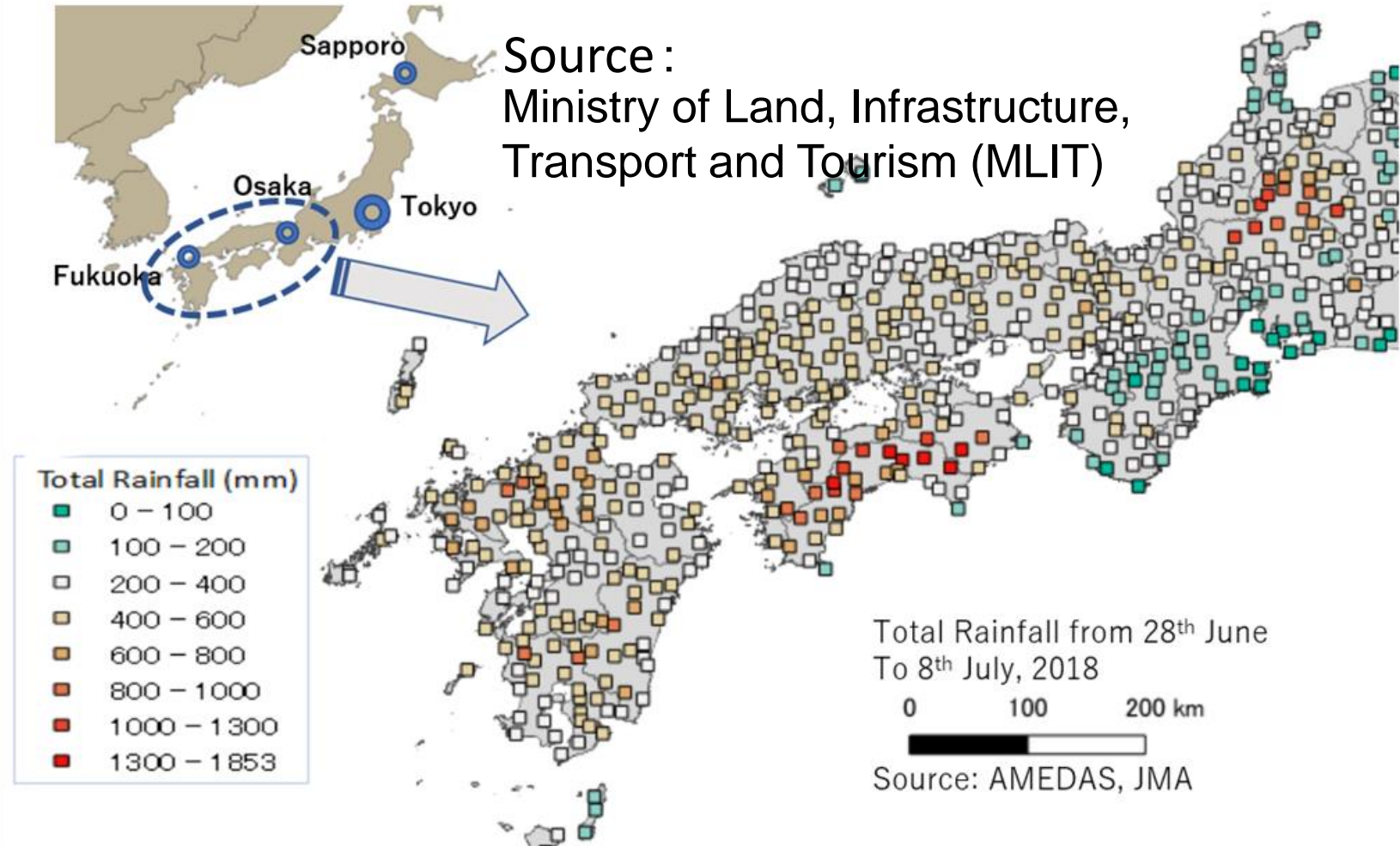
Stagnant rainy front  
and Typhoon No.7  
(Prapiroon)



Record-breaking heavy  
rain, mainly in the  
western part of Japan



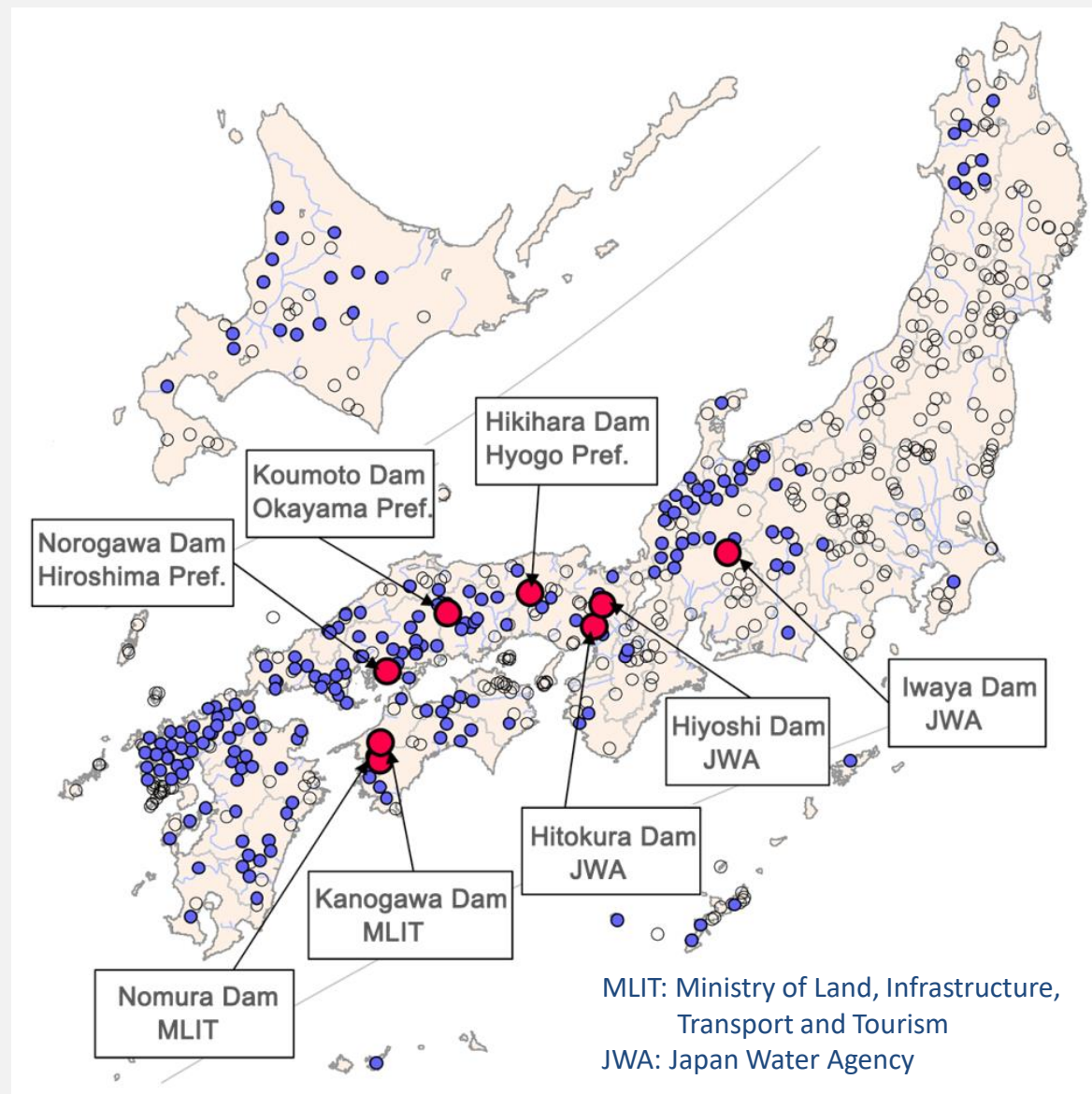
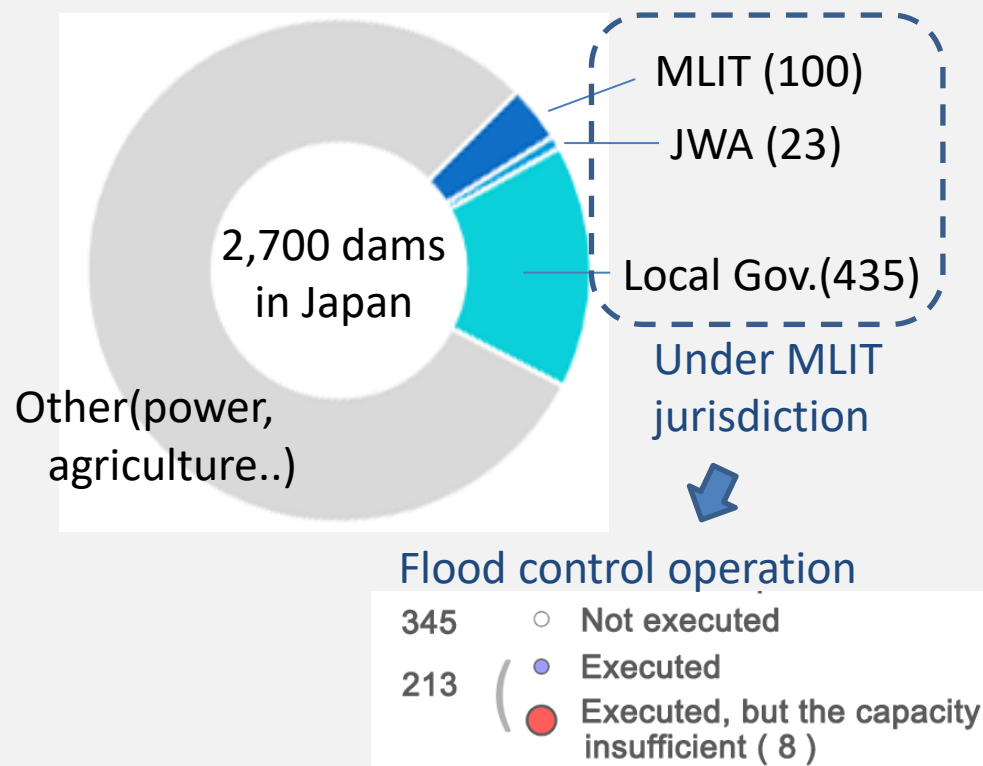
Worst flood damage  
in recent 30 years in  
Japan





# Situation of flood control of dams in Japan in the July 2018 flood event

## Flood control operation of dams in the July 2018 Flood Event



# Hiyoshi Dam and Katsura River

JWA

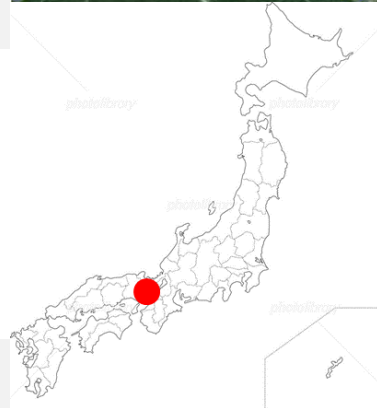
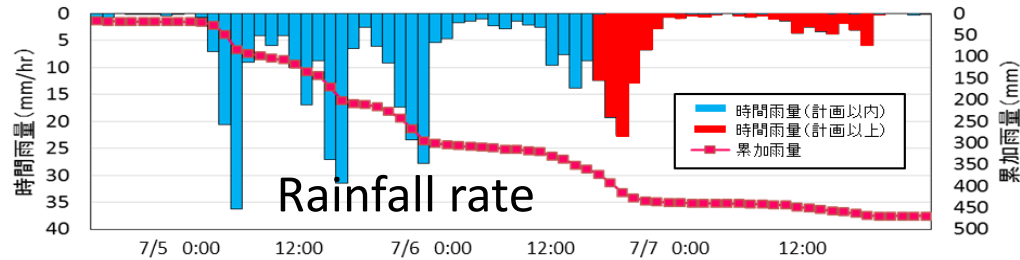
Source:  
MLIT



1997, Japan Water Agency  
H=67.4m, V=66 MCM  
A=290km<sup>2</sup>



Arashiyama



桂川

請田

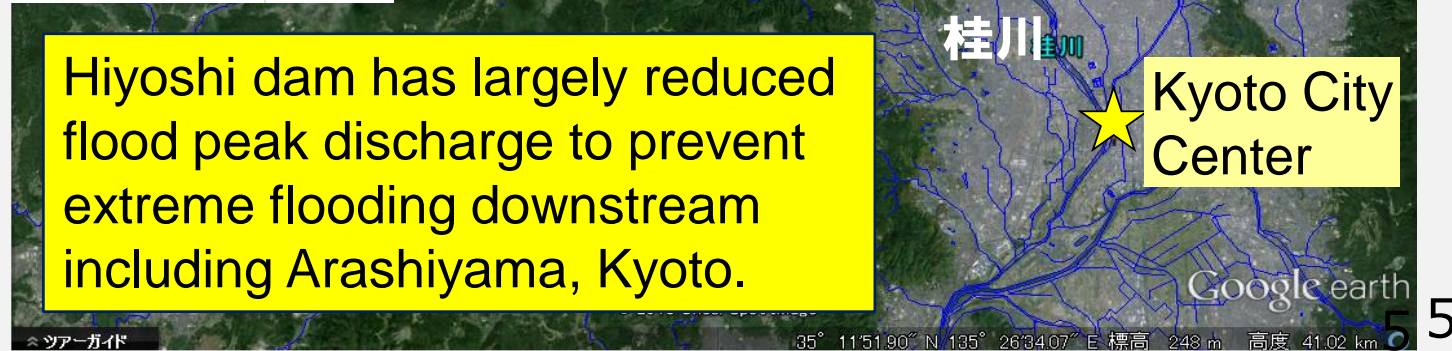
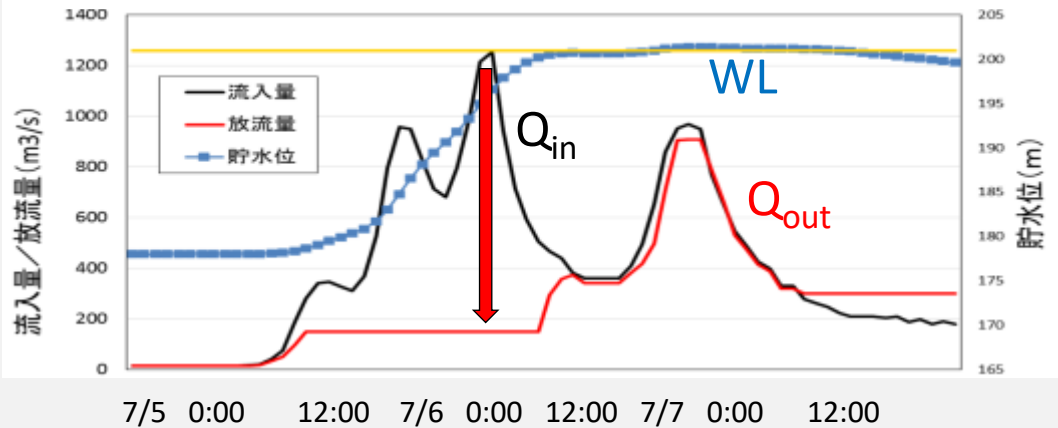
渡月橋

鴨川

桂川

Kyoto City Center

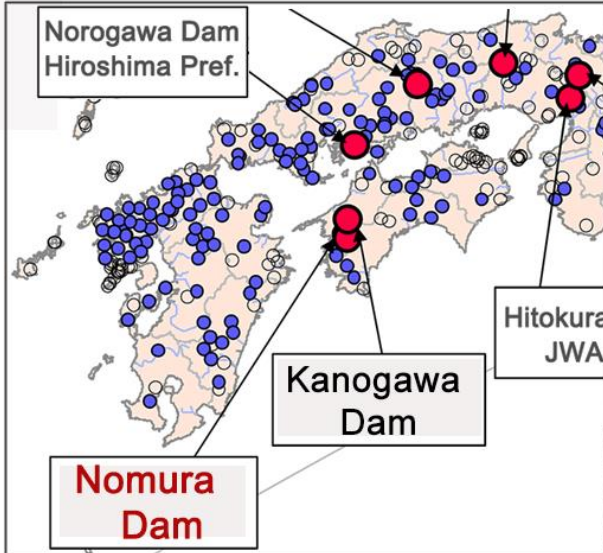
Hiyoshi dam has largely reduced flood peak discharge to prevent extreme flooding downstream including Arashiyama, Kyoto.





# Nomura Dam and Hiji River

6



**Hiji River**  
 Location: Ehime Prefecture  
 River class: A  
 Catchment area: 1,210 km<sup>2</sup>  
 Length: 103 km  
 Major city: Ohzu



## Nomura Dam

Owner: MLIT (Shikoku Regional Development Bureau)

Purpose: Flood control, Irrigation, City water

Total Reservoir capacity: 16 million m<sup>3</sup>

Flood control capacity: 3.5 million m<sup>3</sup>

Catchment area: 168 km<sup>2</sup>

Dam type: Concrete gravity

Height: 60 m

Length: 300 m

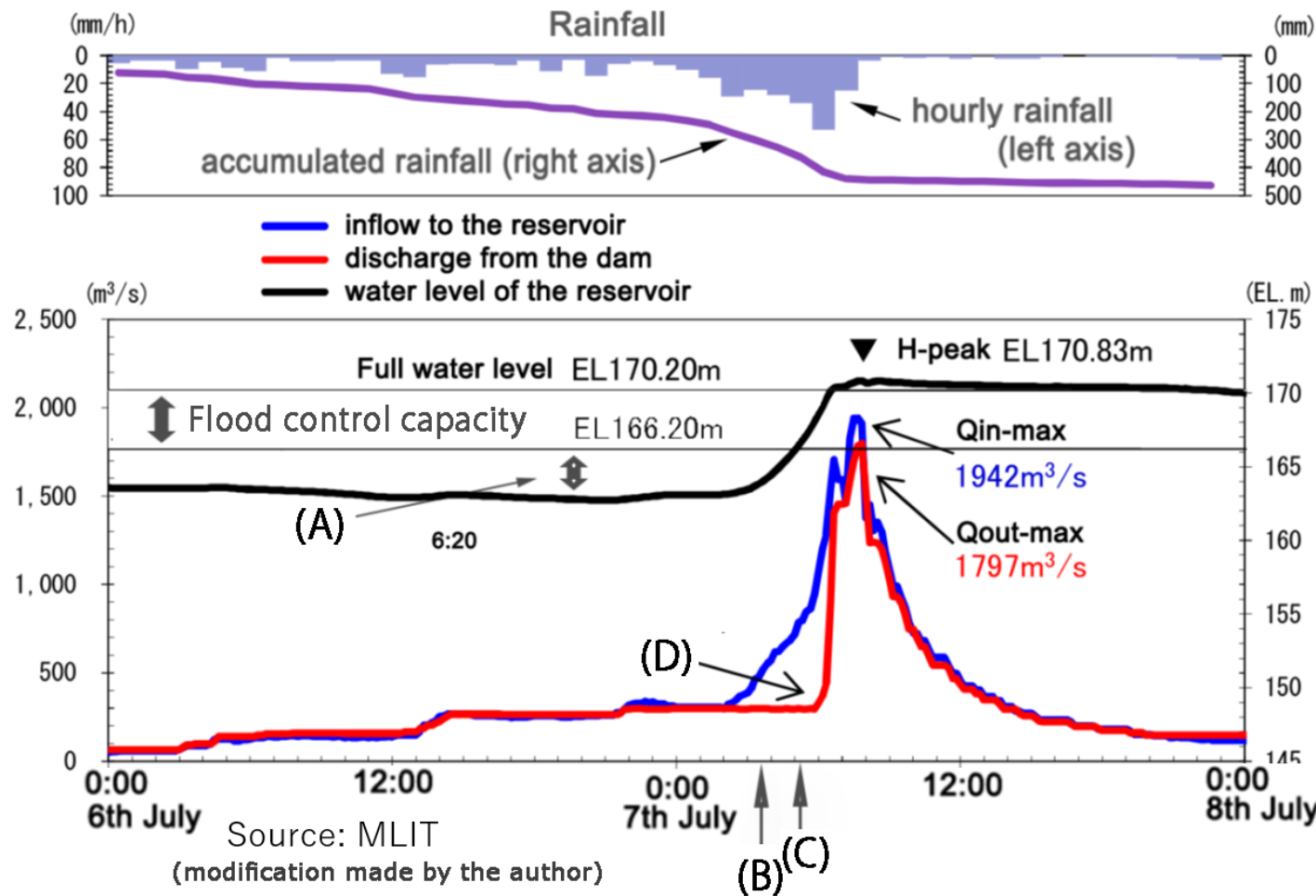
Completion: 1981

Photo: JSCE Digital Archives ( taken by Takashi Yasukouchi)



# Flood Control Operation of Nomura Dam

7



- (A) preliminary draw down of the reservoir water level executed
- (B) 3:37 necessity of DRO/EF identified (notice from the dam operator to the municipalities)
- (C) 5:15 warning of DRO/EF along the downstream executed  
5:18 evacuation directive from the Mayor issued (firefighting team urges residents to evacuate)
- (D) 6:20 start of DRO/EF

cf. DRO/EF: Disaster Reducing Operation for an Extraordinary Flood <Emergency spillway gate operation>

The maximum flood discharge into the dam was 1,942 m<sup>3</sup>/s, the largest inflow on its record. Unfortunately, there were 650 inundated houses and five casualties in the downstream of the Dam.



# *Flood Risk Management in Japan*

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Recent extreme floods in 2018

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Special panel by MLIT to Increase flood mitigation  
function and Dam upgrading

New  
challenges

Long-term rainfall prediction and decision support  
system for the Integrated dam operation





## *Set up of a special panel by MLIT (2018)*

In this flood disaster:

- Some dams have used up their flood control capacity and failed to fully control the flood peak, due to extraordinary large and lengthy rainfall
- Information concerning the operation of dam, including emergency flood gate operation has not effectively lead to the evacuation activities of the residents

In view of the growing concern that the climate change would increase the possibility of extreme floods exceeding the flood control capability of existing dams, MLIT set up a special panel of experts in September 2018.

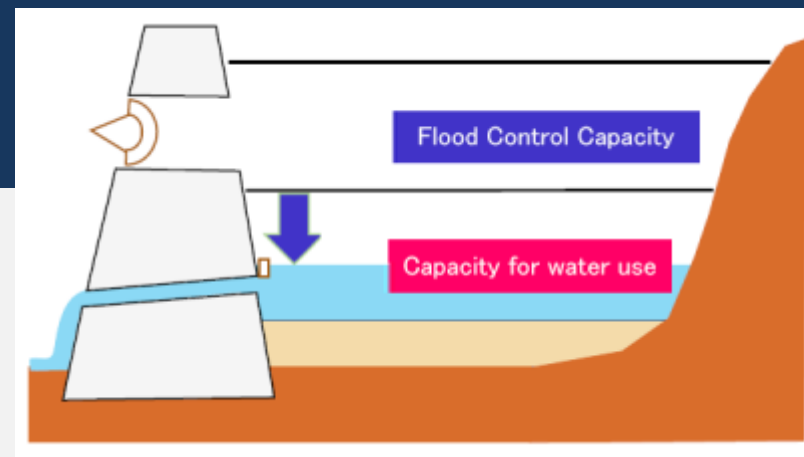
Ministry of Land Infrastructure, Transport and Tourism (MLIT)

# Proposal by the Special Panel by MLIT

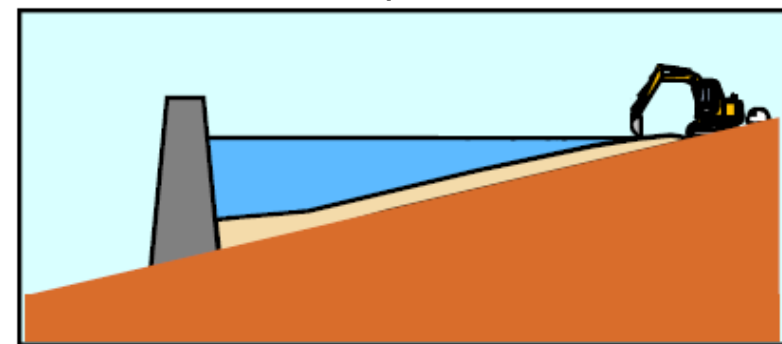
## - Three principles -

Source: MLIT

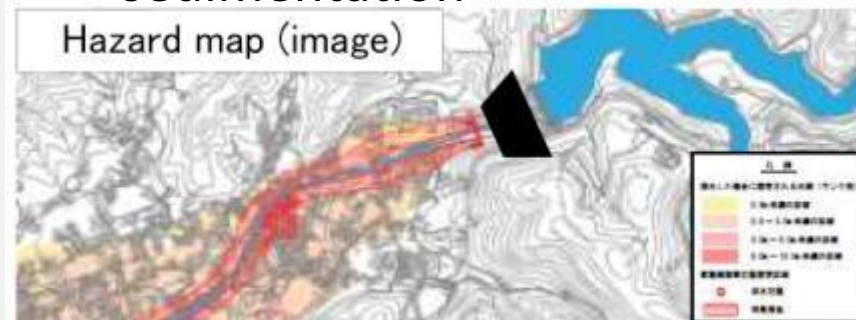
- ◆ Promote both **structural measures** such as upgrading of existing dams, and **non-structural measures** such as **pre-release operation** to utilize water use capacity for flood control
- ◆ Promote basin-wide and comprehensive measures including river improvement work in the downstream of dams, **management of reservoir sedimentation**
- ◆ Encourage self-motivated evacuation activities based on the **risk information** provided by dam operating offices, municipalities and meteorological agencies.



Pre-release operation



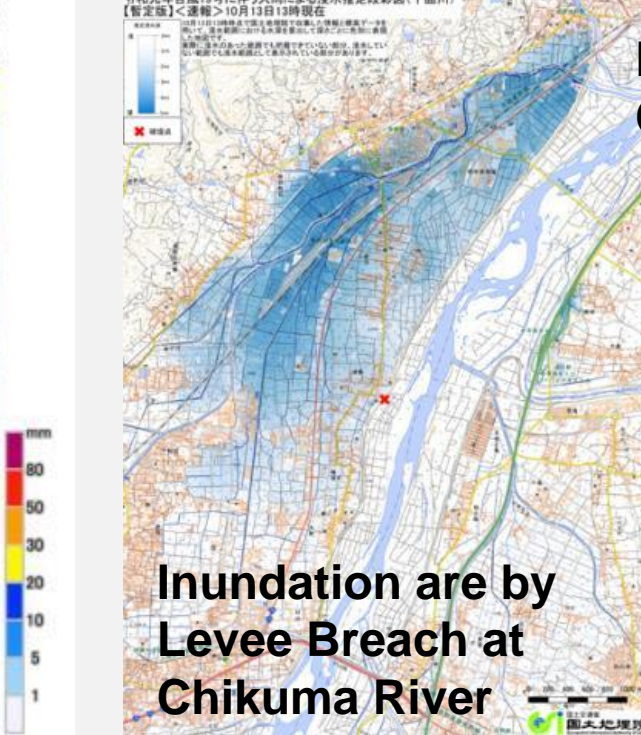
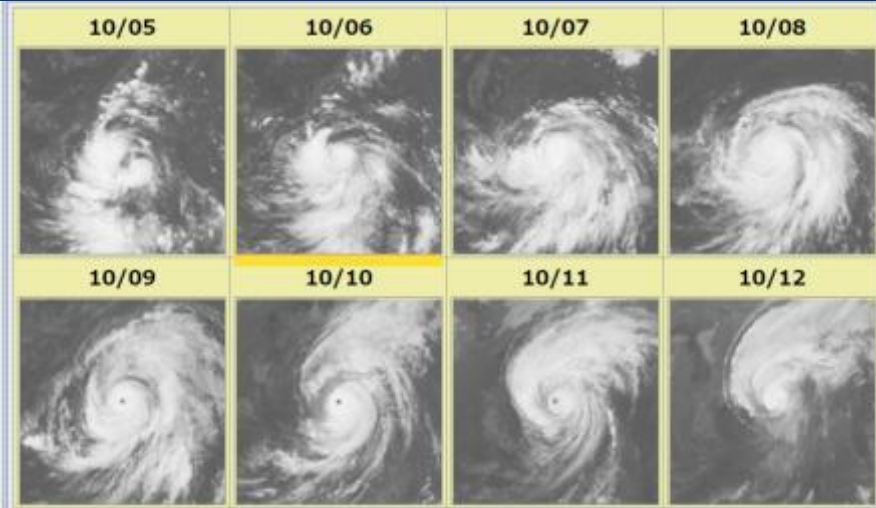
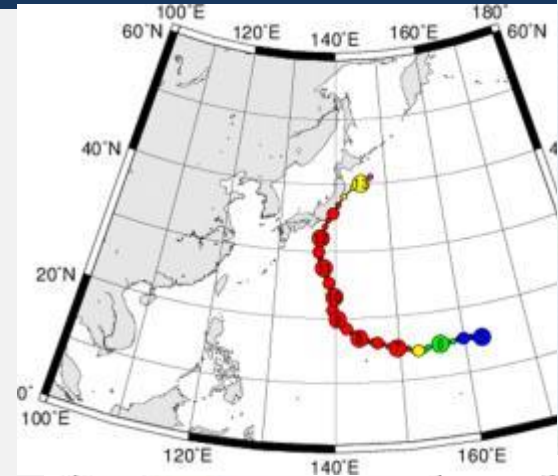
Management of reservoir sedimentation



Hazard map below dams in case of extreme flood operations 10



# 2019/10 Typhoon Hagibis (No.19)

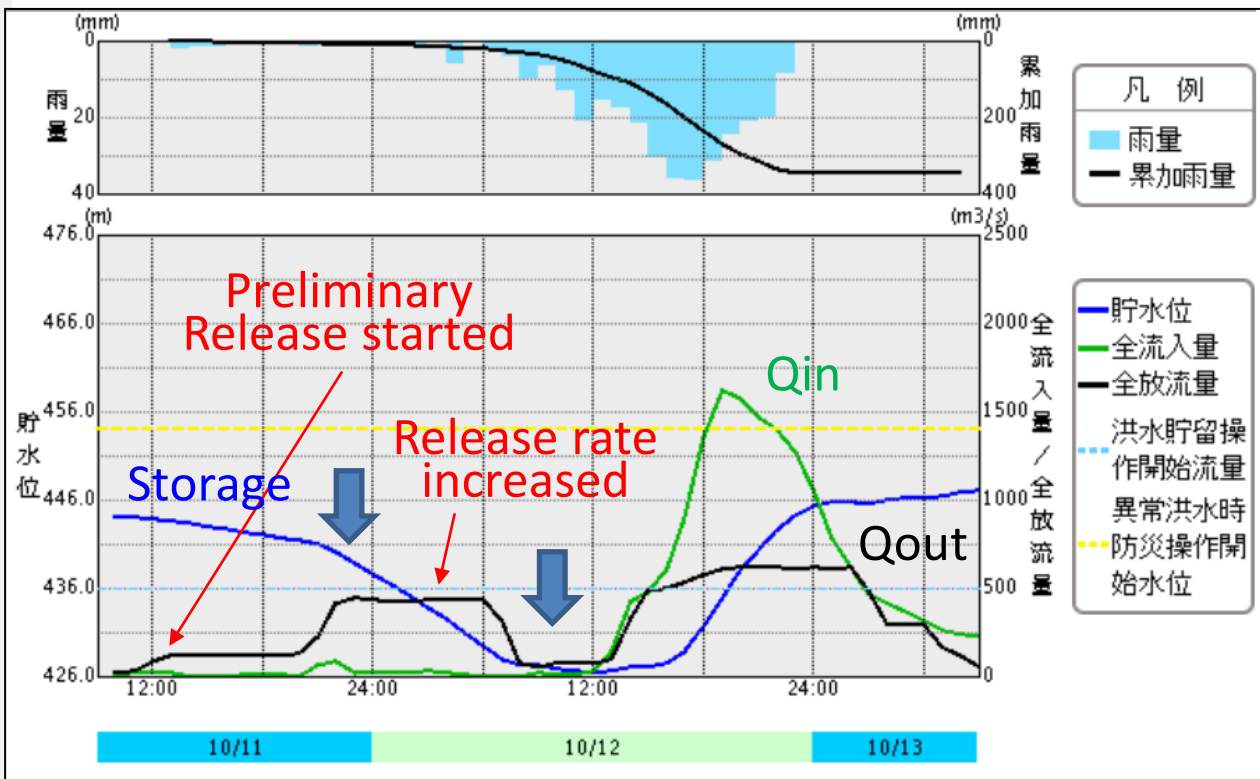


Inundation are by  
Levee Breach at  
Chikuma River

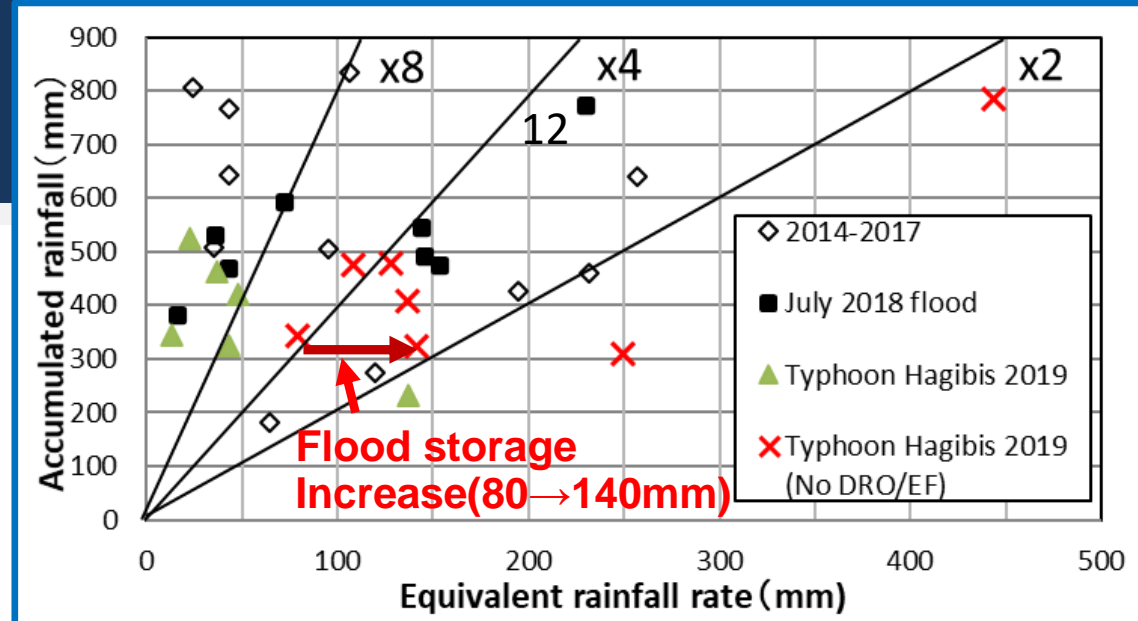
Source: MLIT



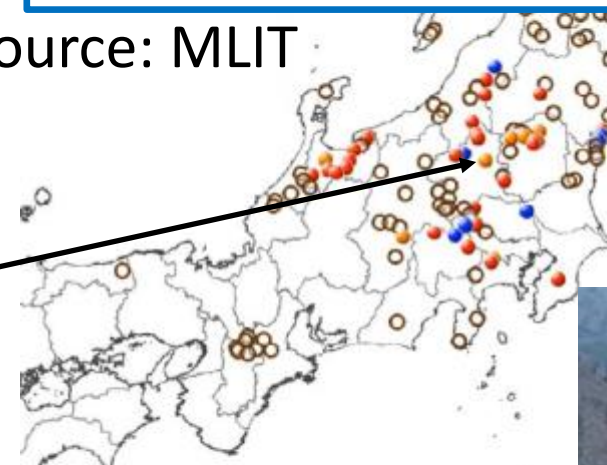
# Pre - Release Operation Practices (Kusaki dam)



20 MCM was released by preliminary release to increase flood control capacity up to 35MCM. ERR was increased from 80 to 140mm (ERR>100mm). Without this operation, it is highly possible that DRO/EF started.



Source: MLIT



**Equivalent Rainfall Rate = (Flood storage)/A(mm)**

Kusaki dam, JWA  
H=140m, A=254km<sup>2</sup>  
V=60.5MCM, 1976



33 reservoirs conducted preliminary release out of 146 reservoirs carried out flood control.

The diagram illustrates the operation of a flood control system in three stages:

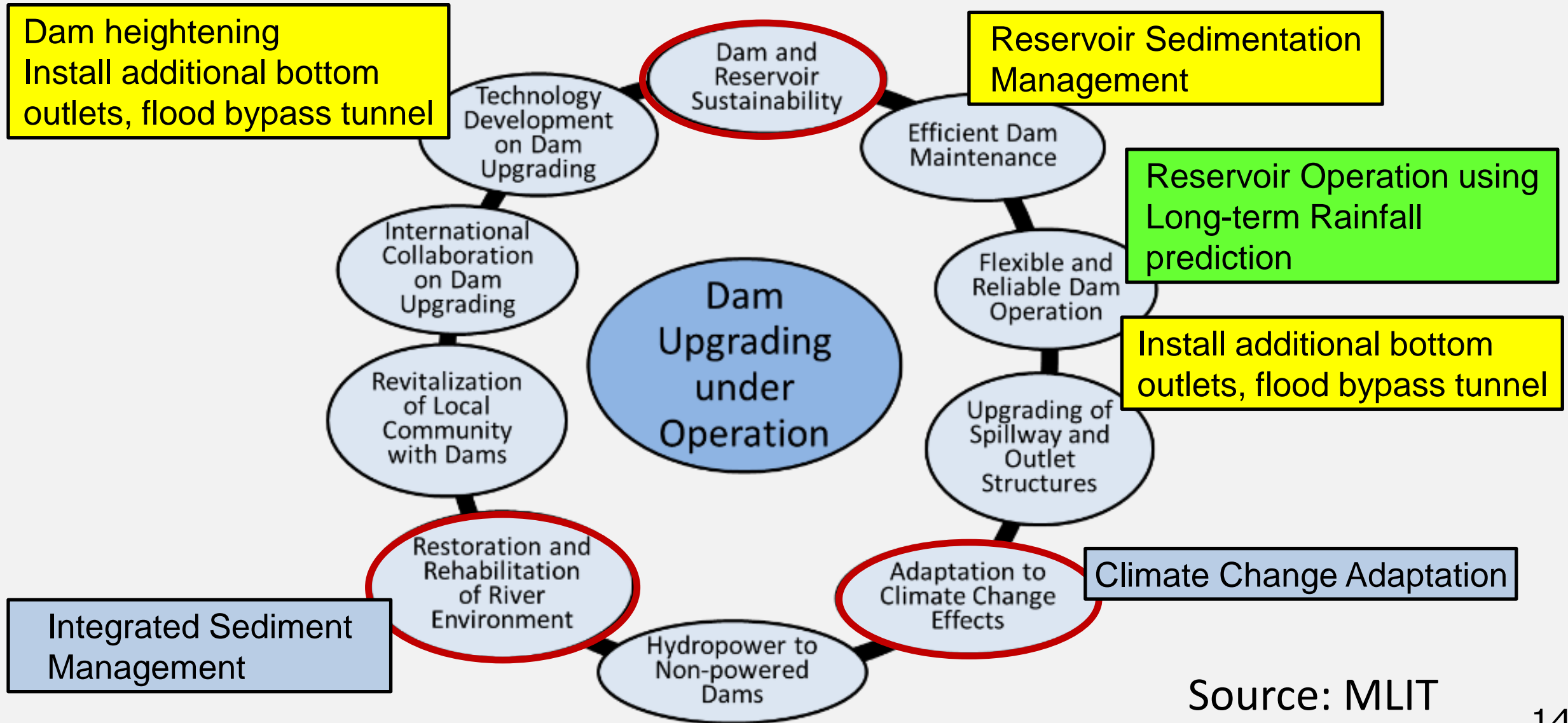
- Normal period:** A dam is shown with water level below the crest.
- Before a flood event:** A green box labeled "Prediction of flood occurrence" points to the dam. A yellow arrow points down into the reservoir, indicating incoming flood water.
- After the flood event:** A green box labeled "Storing flood water" points to the dam. A yellow arrow points up from the reservoir, indicating water being released or stored.



New guideline has been established in 2020.



# *New policy initiative on comprehensive upgrading of existing dams for sustainable development (MLIT, 2017)*

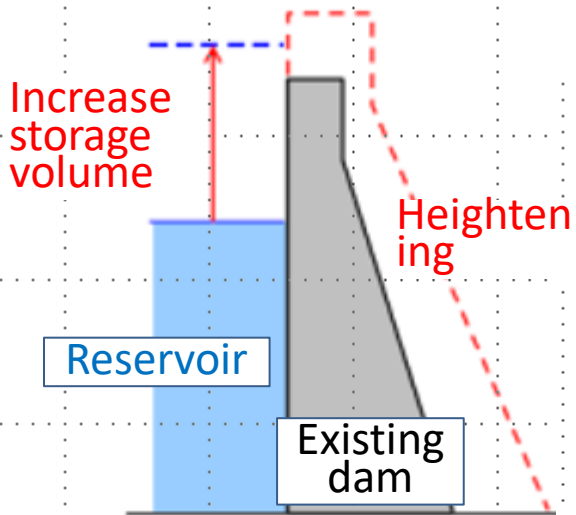


Source: MLIT

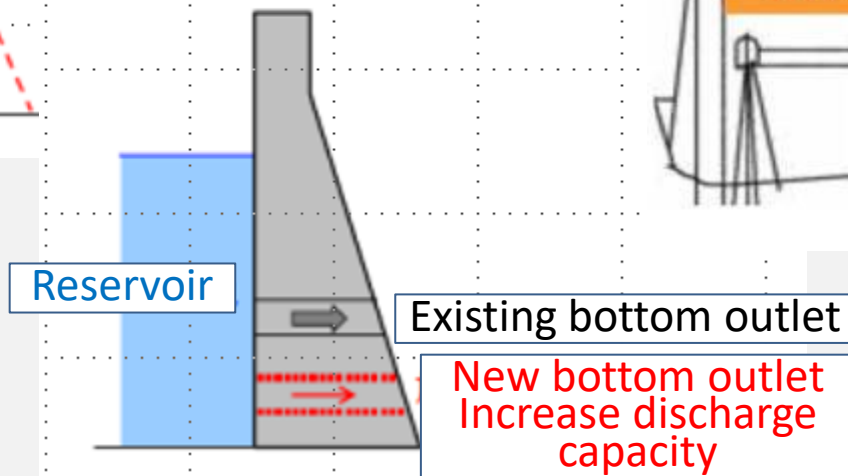


# Types of dam upgrading projects

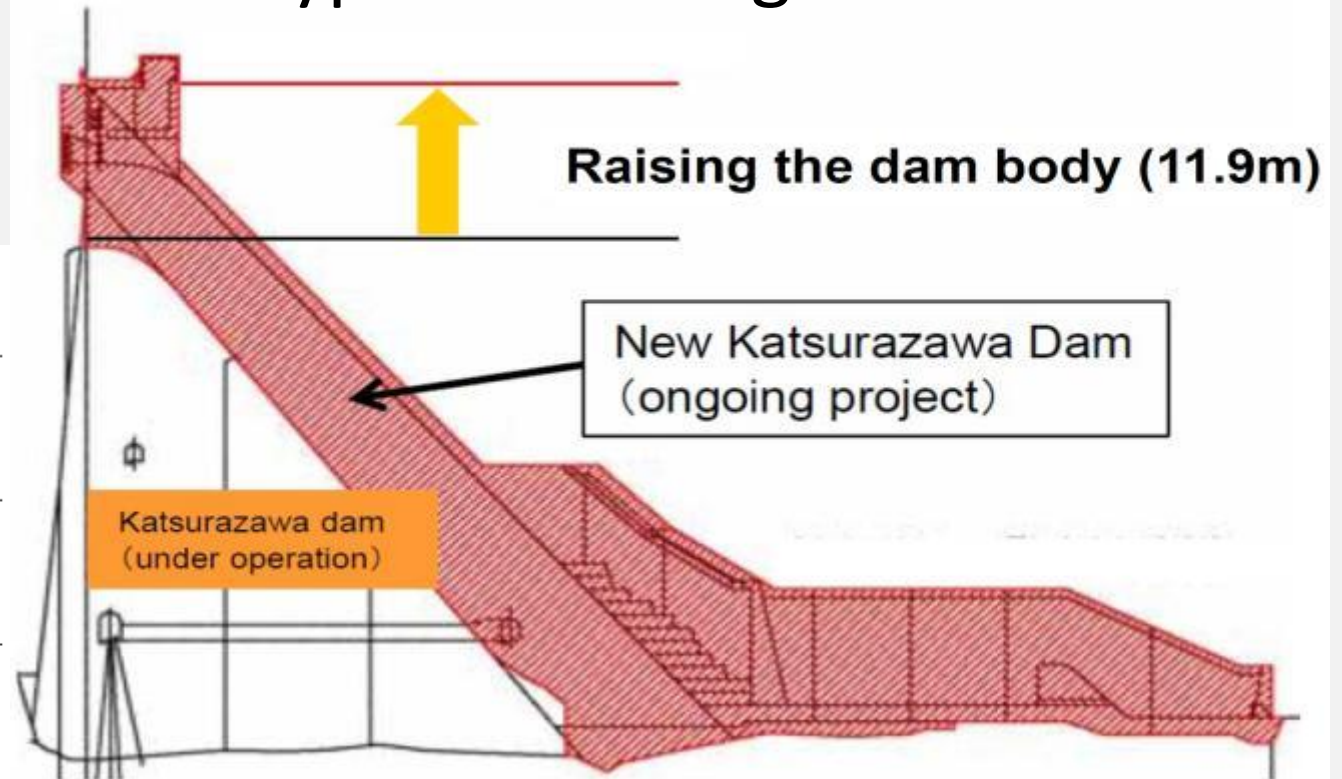
Heightening to increase storage volume



Install additional bottom outlets to increase discharge capacity



Type A2 Raising dam bodies



In order to effectively drawdown and keep stored volume for flood peak, enough discharge capacity needed under lower water level.

Source: MLIT



# *Flood Risk Management in Japan*

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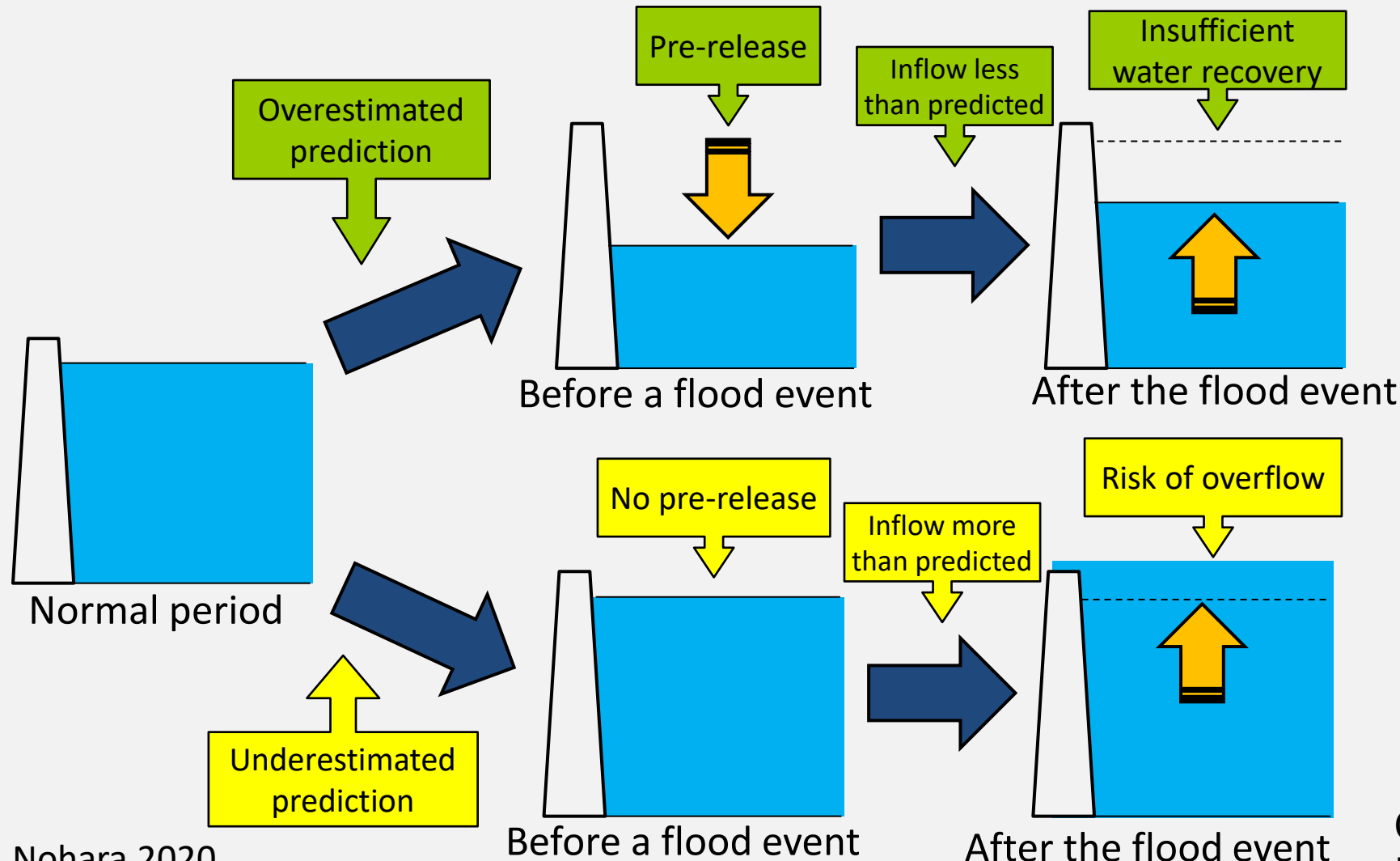
Special panel by MLIT to Increase flood mitigation function and Dam upgrading

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Long-term rainfall prediction and decision support system for the Integrated dam operation

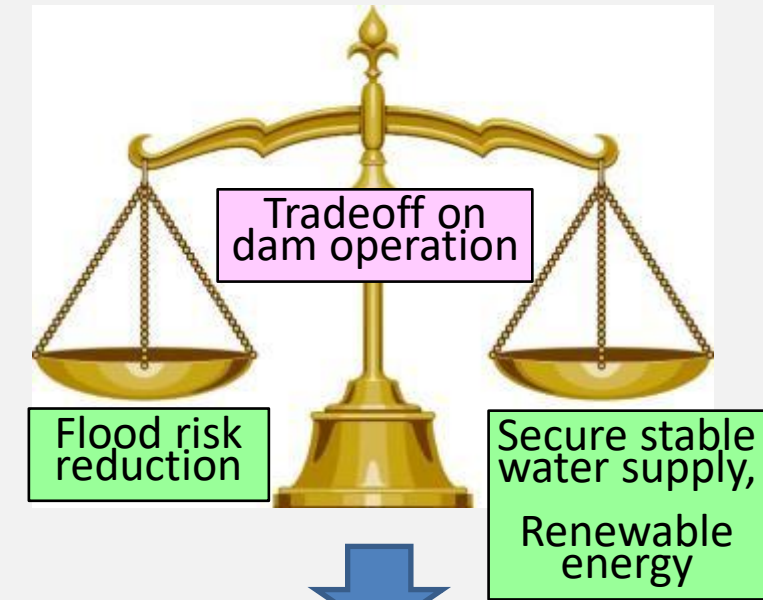
# Effect of prediction uncertainty on pre-release operation

Handling uncertainty contained in the predictions has been issues.



Nohara 2020

It is difficult to know suitable amount of preliminary release volume because of rainfall prediction uncertainty.



SIP Model

 戦略的イノベーション創造プログラム  
Cross-ministerial Strategic Innovation Promotion Program

Cross-ministerial Strategic Innovation Promotion Program 17



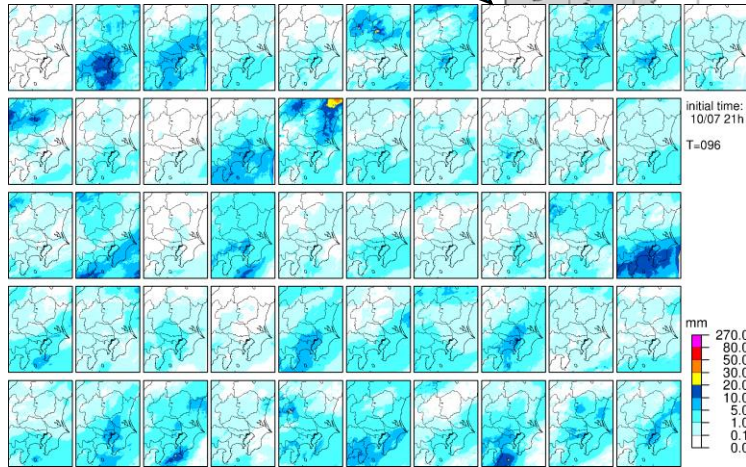


# Long-term rainfall prediction and decision support system for the Integrated dam operation

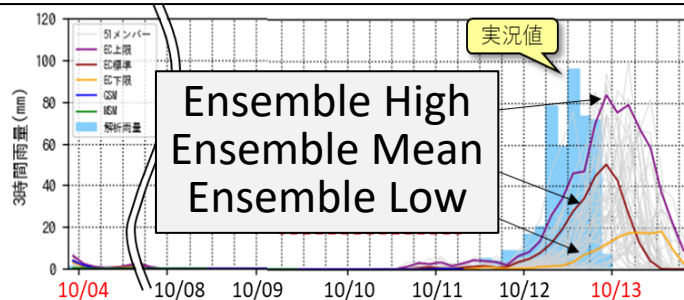


## ② Ensemble rainfall prediction

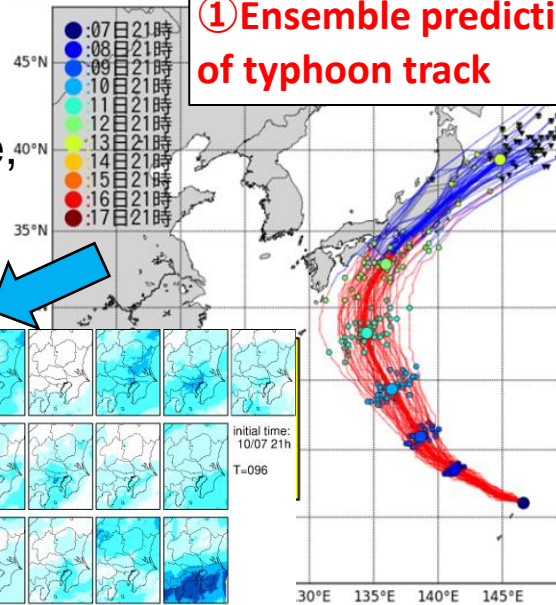
ECMWF, 51 Ensemble, 15 days advance, Downscaling 1km, 1hr



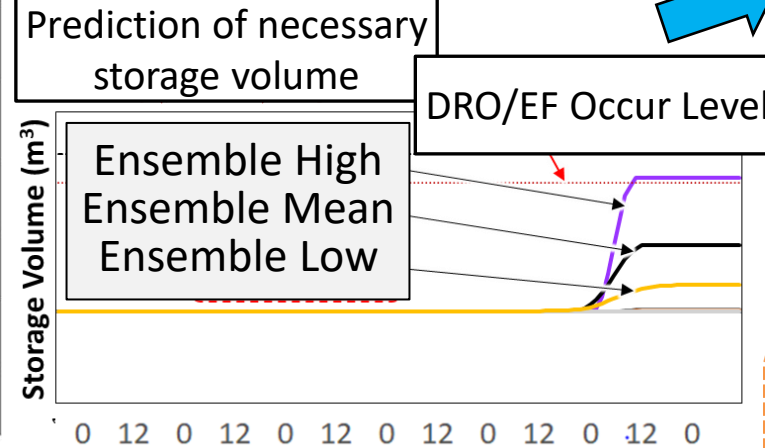
## ③ Ensemble rainfall prediction (51 ensemble)



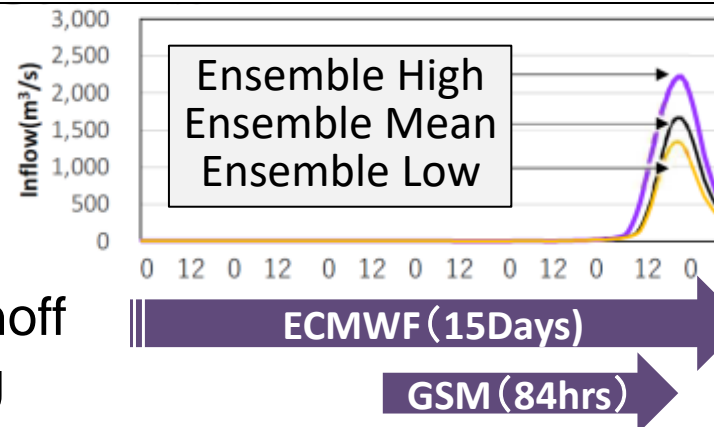
## ① Ensemble prediction of typhoon track



## ⑤ Ensemble accumulated storage volume (3 representatives)



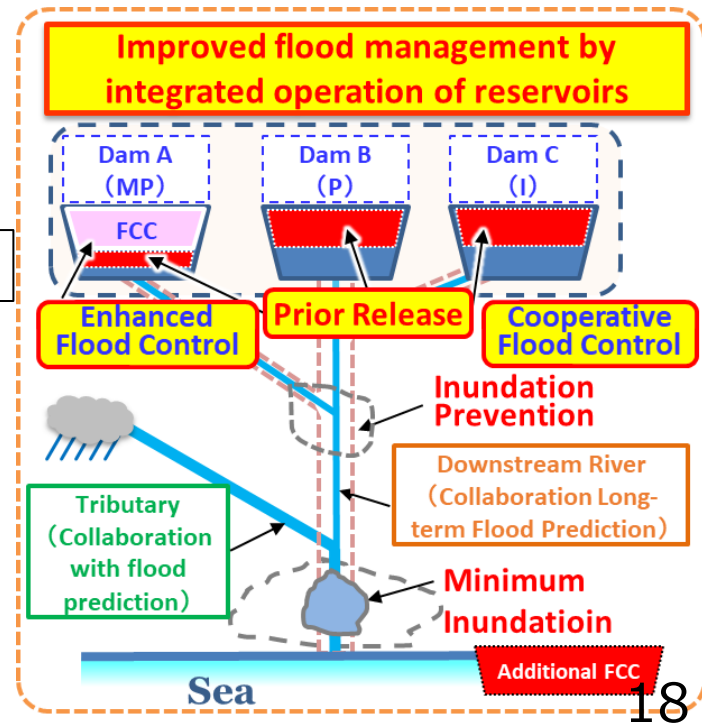
## ④ Ensemble inflow discharge (3 representatives)



## ⑥ Optimization of dam flood mitigation operation

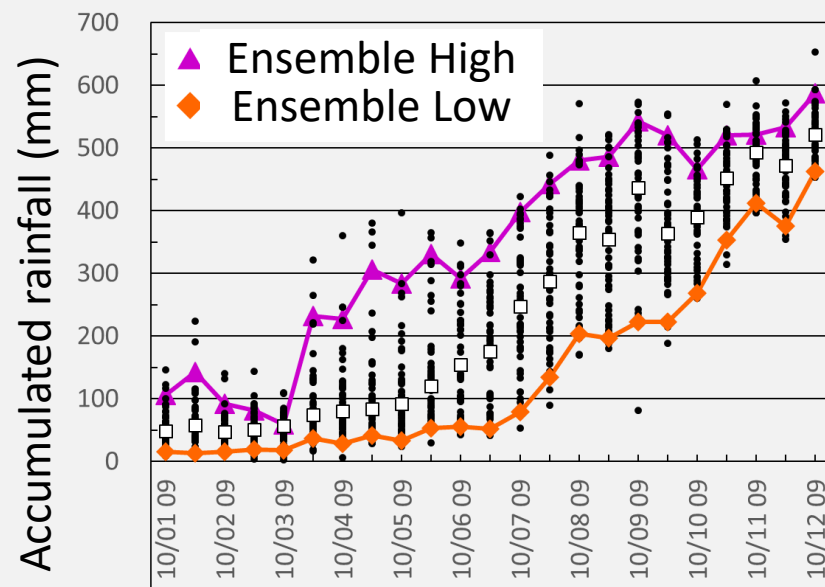
Triggered by Ensemble High but storage volume is defined by Ensemble Low for secure storage recovery.

## ⑦ Integrated Operation of Reservoir Systems



Rainfall-Runoff Modelling

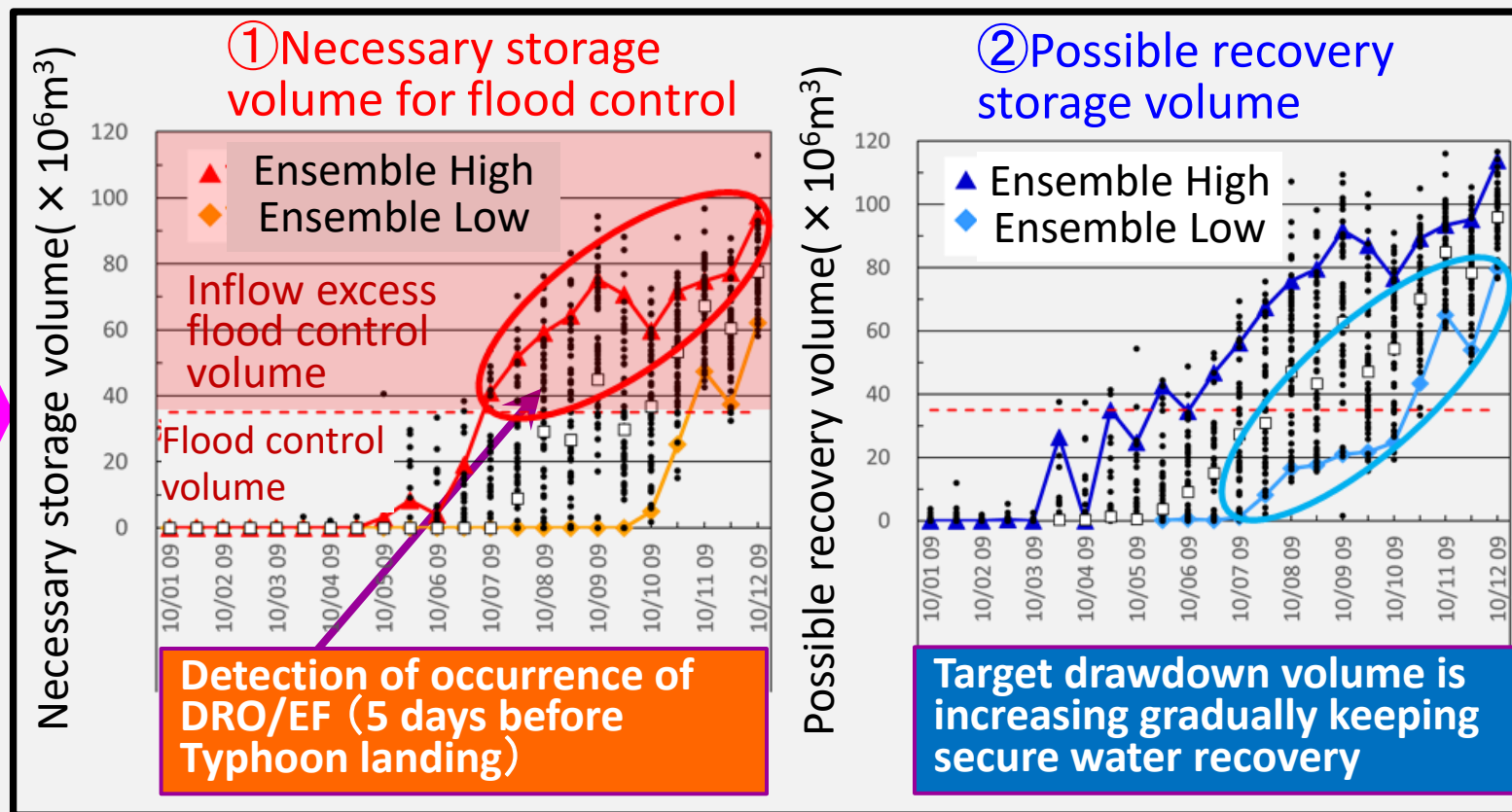
## Rainfall Prediction in Reservoir Catchment Area



Ensemble High: Mean value of No.1-5  
Ensemble Low: Mean value of No.47-51

(Kido et. al. 2020)

## Dam Inflow Prediction



## SIP Ensemble pre-release operation (SIP-EPRO)

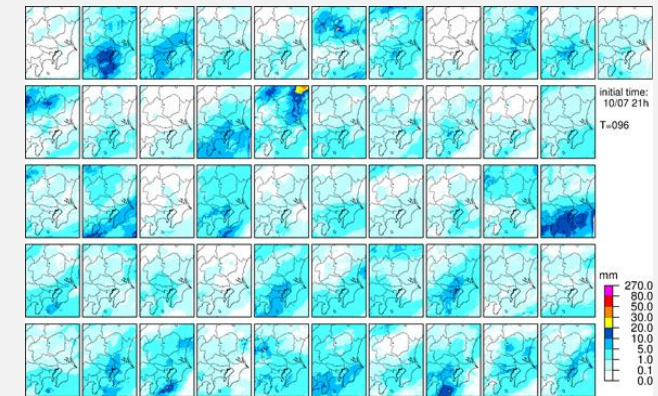
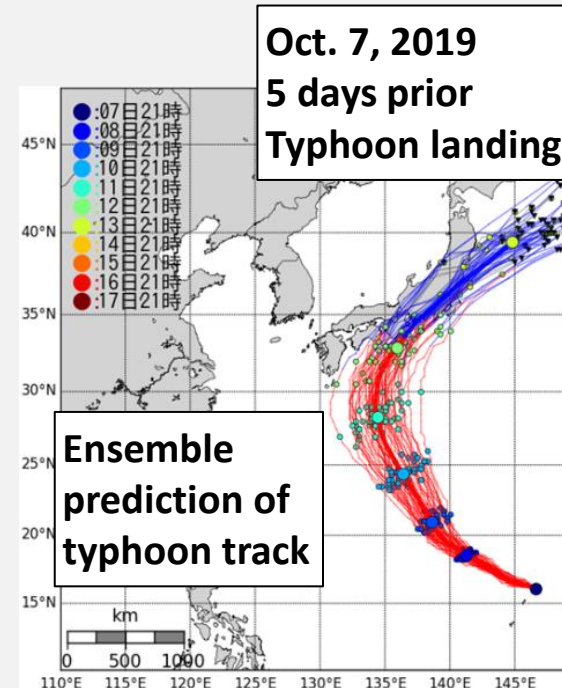
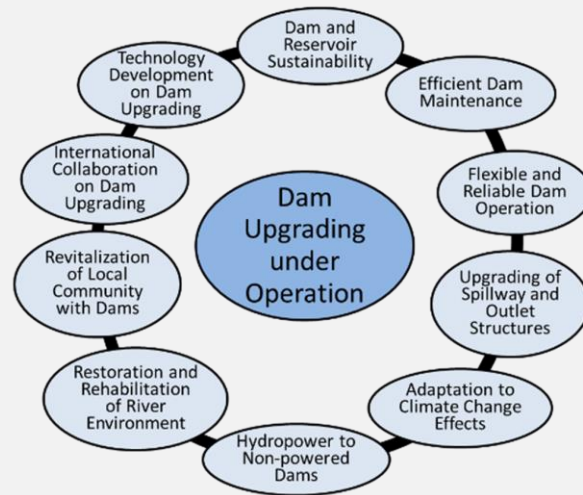
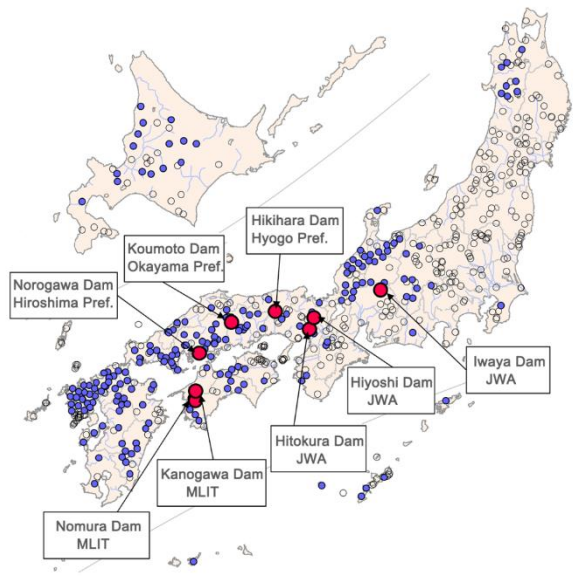
*Using Long-term Ensemble rainfall prediction, optimum drawdown storage volume is obtained by adaptive pre-release under prediction uncertainty.*

Balancing both flood and water security risks.



# Conclusion

- Recently, record breaking rainfall impacts by **extreme rainy front with linear precipitation zone** and **super typhoon** caused severe flood damages in Japan.
- Regarding flood mitigation by dams, **pre-release operation** and **dam upgrading** are proposed by the MLIT Special Panel to **increase flood mitigation function**.
- **Integrated dam operation** using **long-term ensemble rainfall prediction** is the new challenge.



***Thank you for your kind attention.***



- <https://search.jcold.or.jp/dammap.html>

Pre-release operation dams



<https://search.jcold.or.jp/dammap.html?category=1&en>

***Thank you for your kind attention.***