

# Theme 8

## Dam Management

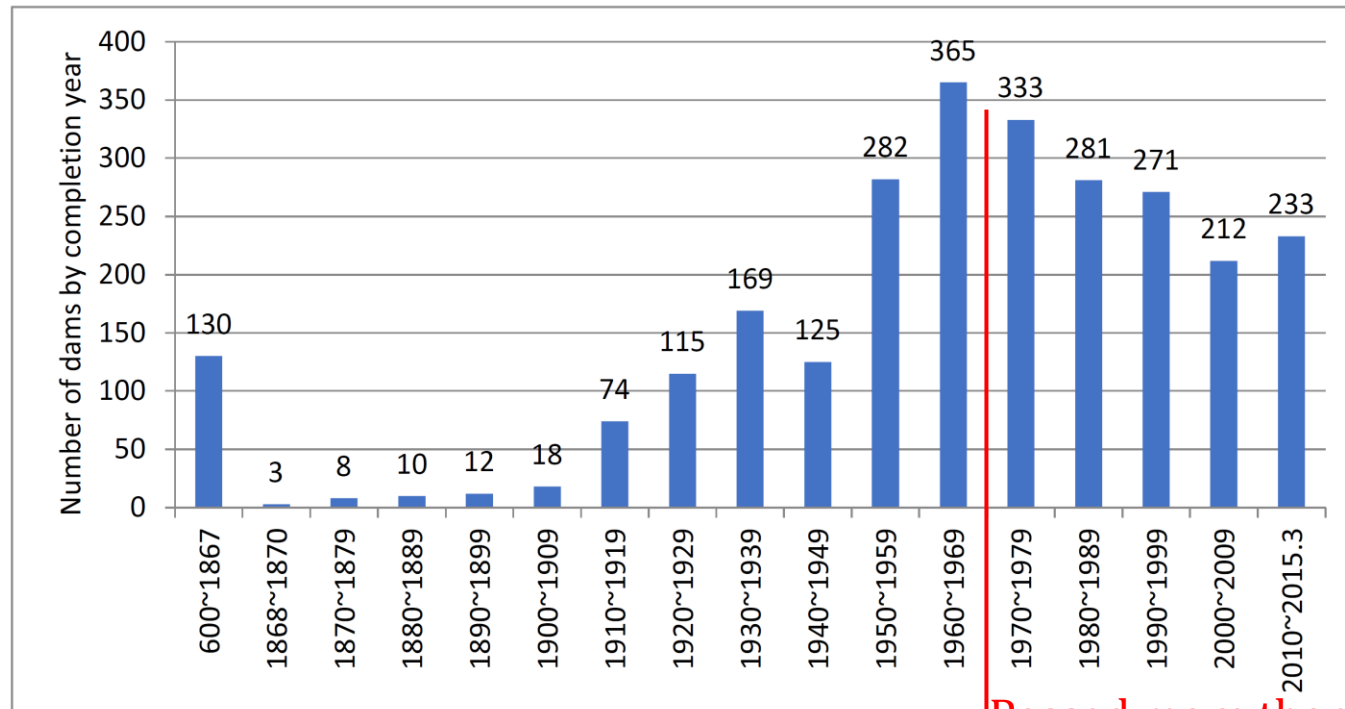
Managing & Operating Dams Safely, and  
Enhancing their Functions



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# 1. Introduction



Passed more than 50 years

Source: Edited data from Year Book of Dams (Japan Dam Foundation)

## History of Dam Construction in Japan

- Many dams were constructed in the 1960s to 1970s, and more than 50 years have already passed.
- It is necessary to manage aging dams efficiently and to maintain or improve their functions as necessary.

## 2. Dam Safety Management

### (1) Standards and Systems for Safety of Dams

Name of Dam	Comple-tion	Acci-dent	Type of Dam	Purpose	Damages
<b>Iruka-ike</b>	1633	1868	Earthfill dam	Irrigation	941 dead
<b>No.1 Regulating Pond, Komoro Hydropower Station</b>	1927	1928	Buttress type concrete dam	Hydro-power	5 dead
<b>Horonai Dam</b>	1939	1941	Gravity type concrete dam	Hydro-power	60 dead
<b>Heiwa-ike</b>	1949	1951	Earthfill dam	Irrigation	75 dead
<b>Yoake Dam</b>	1952	1953	Gravity type concrete dam	Hydro-power	-
<b>Taisyō-ike</b>	1949	1953	Earthfill dam	Irrigation	105 dead
<b>Wachi Dam</b>	1968	1967	Gravity type concrete dam	Hydro-power	1 dead
<b>Fujinuma Dam</b>	1949	2011	Earthfill dam	Irrigation	8 dead/missing

Source: Edited data from the documents of No.21 Expert meeting on future policy and concept of flood management

## 2. Dam Safety Management

### (1) Standards and Systems for Safety of Dams



Source: Prepared based on "Construction of Multipurpose for Dams" published by Japan Dams

## 2. Dam Safety Management

### Review of Technical Standards Based on Experience of Great Disasters

#### 1. Great Hanshin-Awaji Earthquake (1995)

Static Rigid Body  
Stability Analysis  
Method  
Design seismic  
coefficient



Probable  
Maximum  
Earthquakes  
Level 2  
earthquakes

#### 2. Damages due to Excessive Flood

##### Review and Improvement of:

- Information dissemination
- Public awareness
- Forecasting technology

## 2. Dam Safety Management

### Safety Management of Ponds & Small Reservoirs for Irrigation



Source: Brief session by Tohoku University one month after Earthquake dated on 13 April 2011

- 8 dead, 124 house damaged
- Dam was constructed with insufficient compaction & embankment with rich sand
- Magnitude of earthquake beyond past experiences

July 2018 collapse of 32 ponds

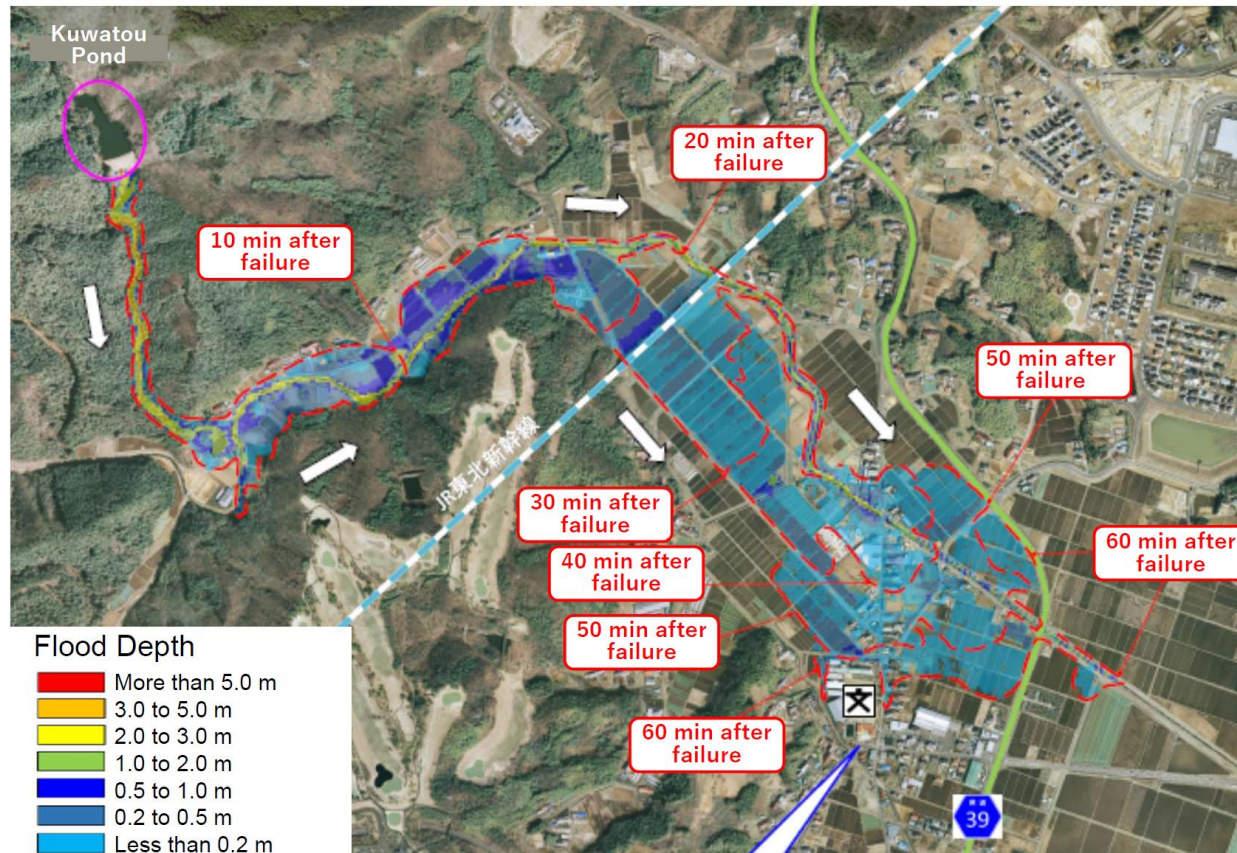
**Fujinuma Dam Failure  
(2011 Earthquake)**

**The Law of Management and Conservation of Ponds and Small Reservoirs for Irrigation (2019)**



## 2. Dam Safety Management

### (1) Standards and Systems for Safety of Dams



Source: Data of Miyagi Prefecture

**Example of Information Disseminated for the Failure of Ponds and Small Reservoirs and Evacuation by Using Hazard Map**



## 2. Safety Management of Dams

### (1) Standards and Systems for Safety of Dams

- Examples of Maintenance and Management of Old Ponds and Small Reservoirs



Source: Agriculture and Rural Area Improvement Plan in Gunma Prefecture, 2020

**Sannako Dam Reinforcing against earthquake  
(Irrigation Water Supply Dam)**

## 2. Safety Management of Dams

### (2) Inspection for Dam Safety

**Patrol & daily inspection**

**Occasional Inspection**

Earthquakes, floods

**Periodic Inspection**

- Once in 3 years
- Inspection of implementation status of maintenance
- Inspection of dam structure and its reservoir

**Comprehensive Dam Inspection**

- Once in 30 years
- Detect deteriorations & damages from long-term viewpoint

## 2. Safety Management of Dams

### (2) Inspection for Dam Safety

Office Director

Deputy Manager (Administration)

Deputy Manager (Technical) (2persons)

General Management of Conservation Measures

Officer of Conservation Measures (2persons)

Construction Expert

Senior Expert Staff

Special Investigator

Yanba Dam Management  
Branch Office

Fujiwara Dam  
Management Branch Office

Aimata Dam Management  
Branch Office

Sonohara Dam  
Management Branch Office

Community Relations  
Division

Information of Disaster  
Prevention Division

Research and Development  
Division

Research Division

Regional Water  
Management Division

Management Division

Administration Division

Source: Website of Tone River Dams Integrated Management office

**Tone River Integrated Dam Group Operation Office of MLIT**

## 2. Safety Management of Dams

### (2) Inspection for Dam Safety



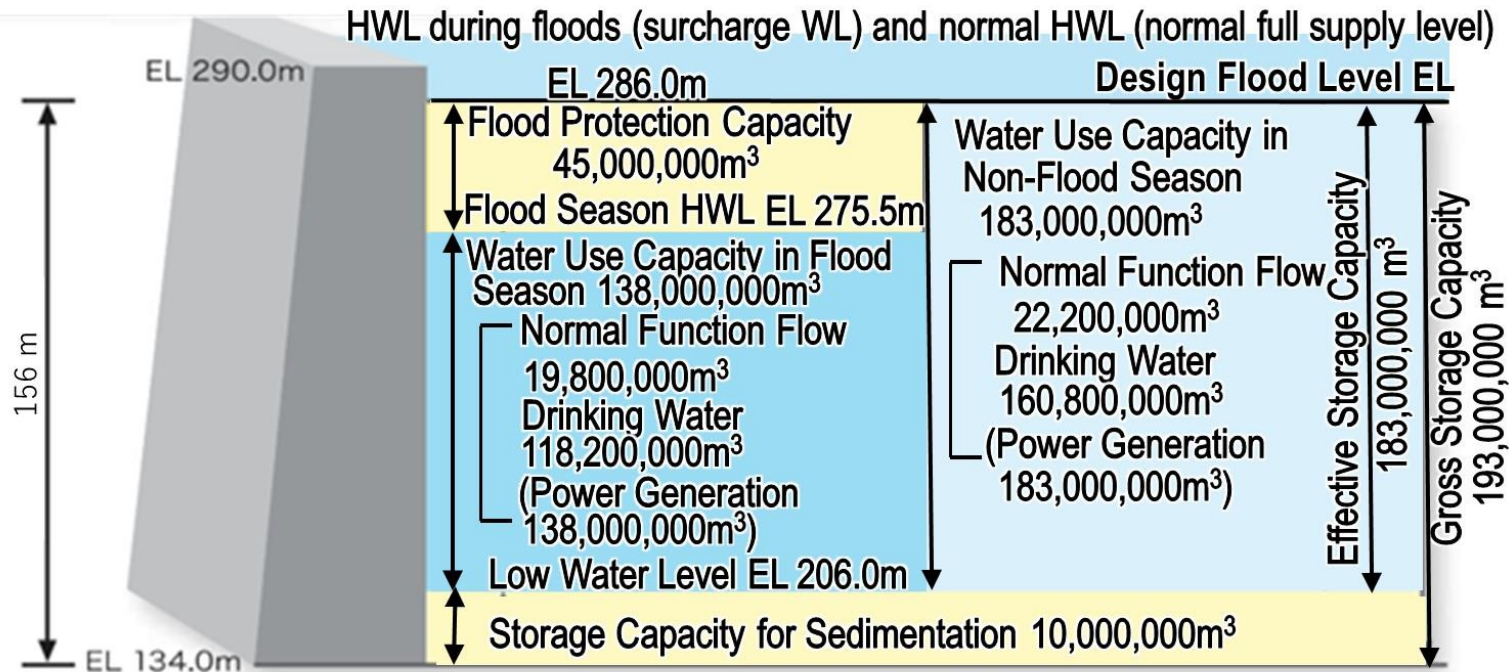
Source: Website of Tone River Dams Integrated Management Office

#### **Branch office of Fujiwara Dam**

- 3 Regular Staffs
- Part-time Staffs
- 3~4 Outsourced Staff

### 3. Dam Operation During Flood

#### (1) Storage Capacity Allocation and Flood Protection of Multipurpose Dam



Flood Season : 16<sup>th</sup> Jun. to 15<sup>th</sup> Oct. Non-Flood Season : 16<sup>th</sup> Oct. to 15<sup>th</sup> Jun.

Source: Pamphlet of Miyagase Dam, Sagami River System Dam Management Office, Kanto Regional Development Bureau, MLIT

**Non-flood season:** 183 million m<sup>3</sup> for water supply

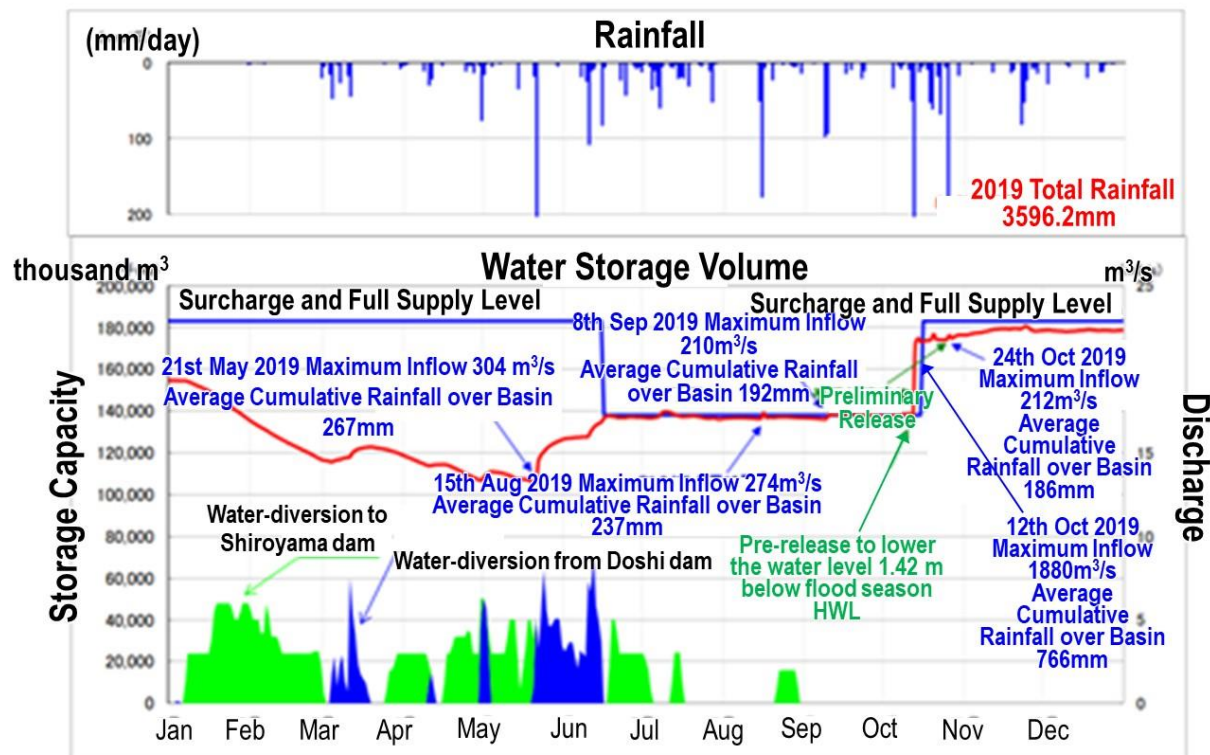
**Flood season:** flood control space of 45 million m<sup>3</sup>, rest for water supply

**Storage Capacity Allocation of Miyagase Dam**



# 3. Dam Operation During Flood

## (1) Storage Capacity Allocation and Flood Protection of Multipurpose Dam



Note: Doshi dam will divert its water, when it is expected to start spilling therefrom, to Miyagase dam for storage therein while Miyagase dam will divert its water to Shiroyama dam which is in shortage of stored water to meet the water supply to Tokyo.

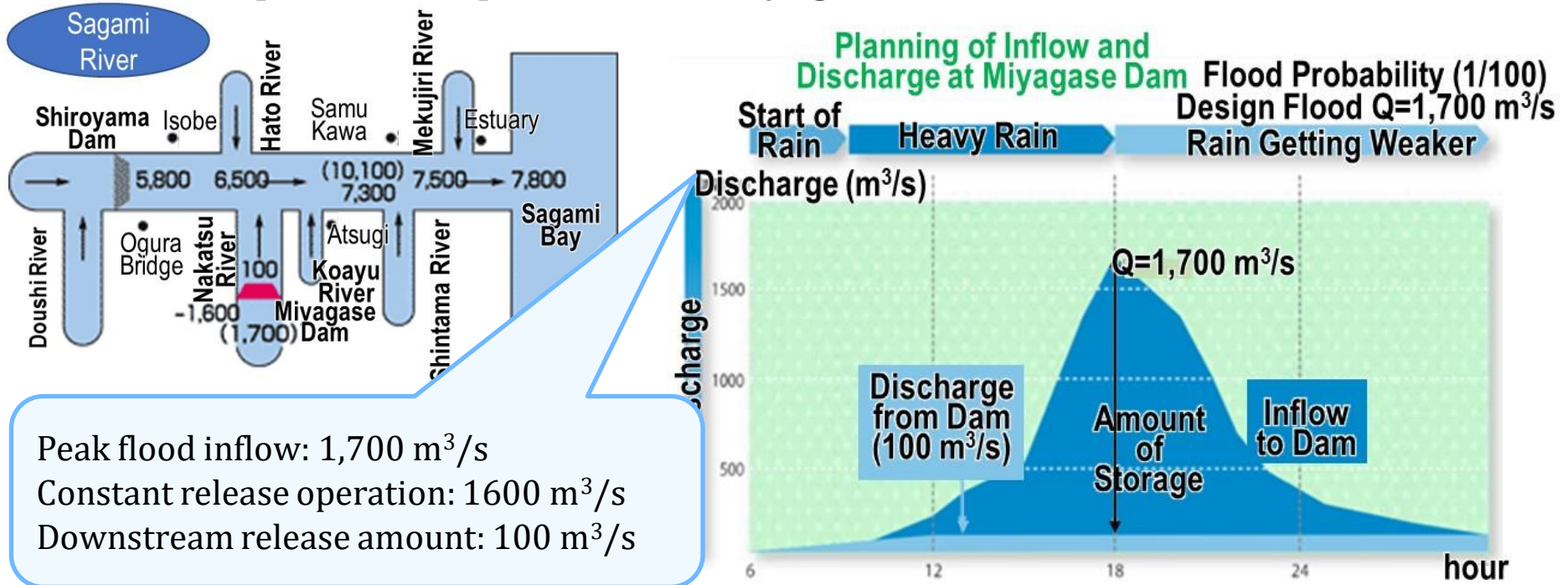
Source: Website of Sagami River System Dam Management Office

### Annual Reservoir Operation Record of Miyagase Dam

### 3. Dam Operation During Flood

#### (1) Storage Capacity Allocation and Flood Protection of Multipurpose Dam

- Example of flood protection – Miyagase Dam



Source: Website of Sagami River System Dam Management Office

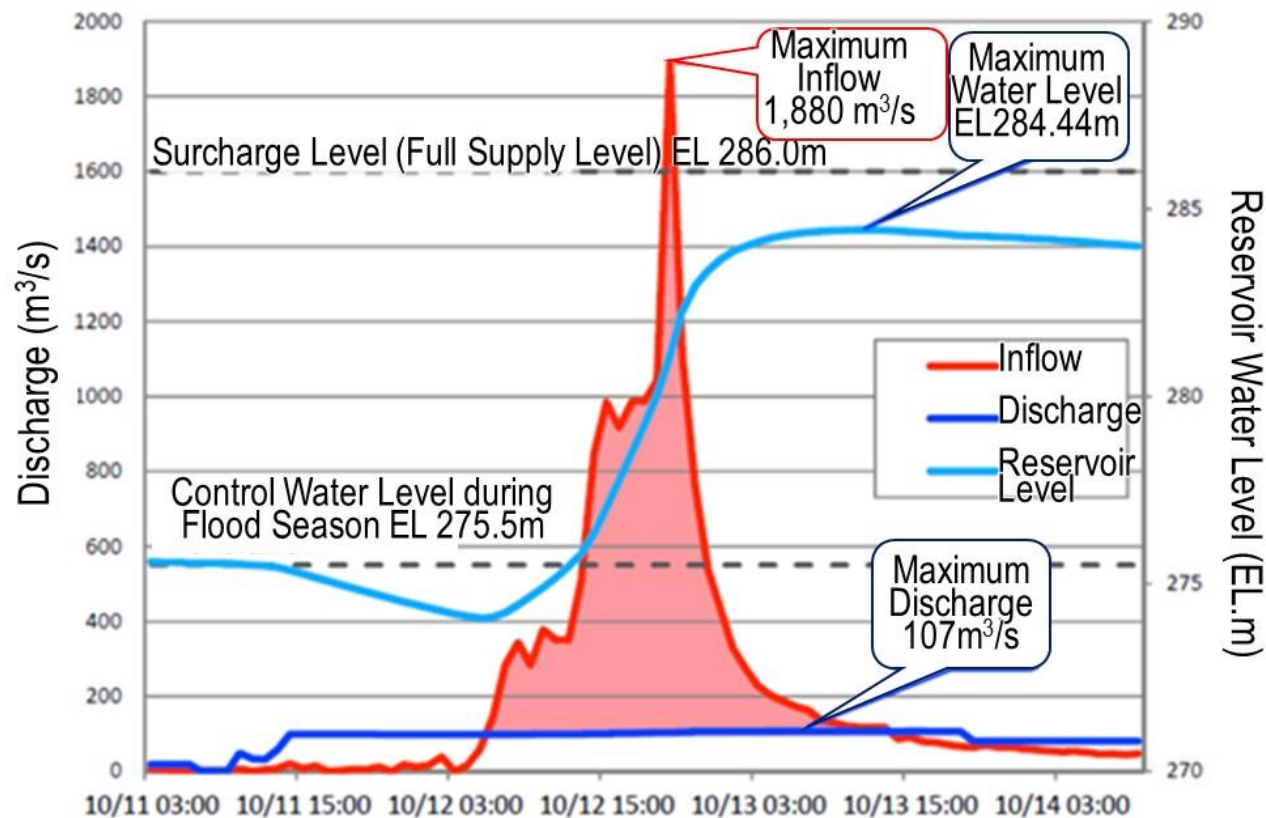
#### Flood Protection Plan of Sagami River and Flood Protection by the Miyagase Dam



### 3. Dam Operation During Flood

#### (1) Storage Capacity Allocation and Flood Protection of Multipurpose Dam

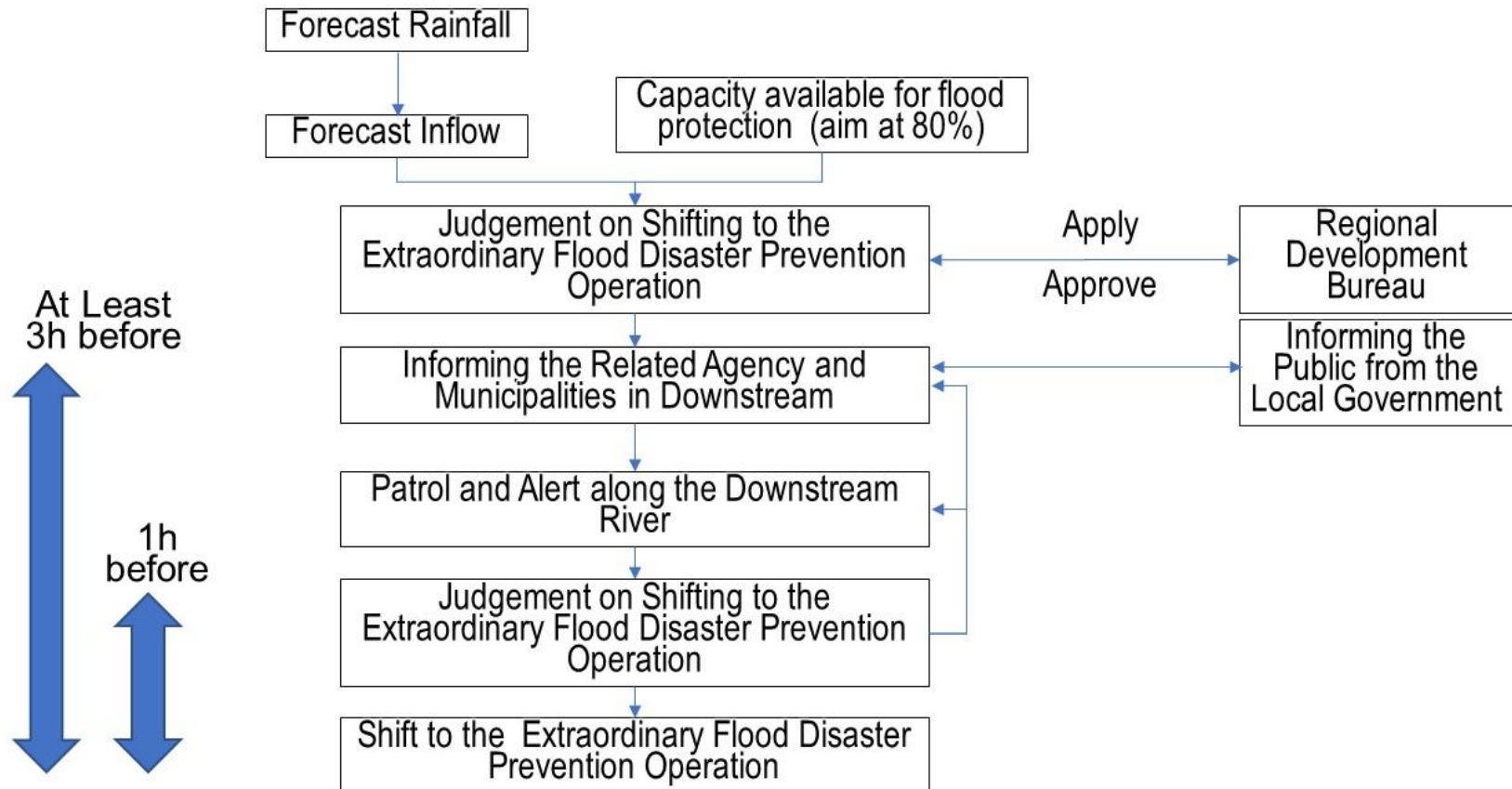
- Example of flood protection – Miyagase Dam



Source: States of Dams at Typhoon No.19 in 2019, MLIT

### 3. Dam Operation During Flood

#### (2) Dam Operation during Extraordinary Flood Exceeding the Design Discharge



Source: Hearing from Tone River Dams Integrated Management Office and Notes on Procedure for Operation of Nomura Dam

### 3. Dam Operation During Flood

#### (2) Dam Operation during Extraordinary Flood Exceeding the Design Discharge

July 2018 major flood damage along Hijikawa River (100 year flood)

People in flooded area  
**may not have received  
dissemination** information  
from Nomura Dam &  
Kanogawa Dam



**Proposed Measures** to  
reduce flood damages  
caused by dam operation



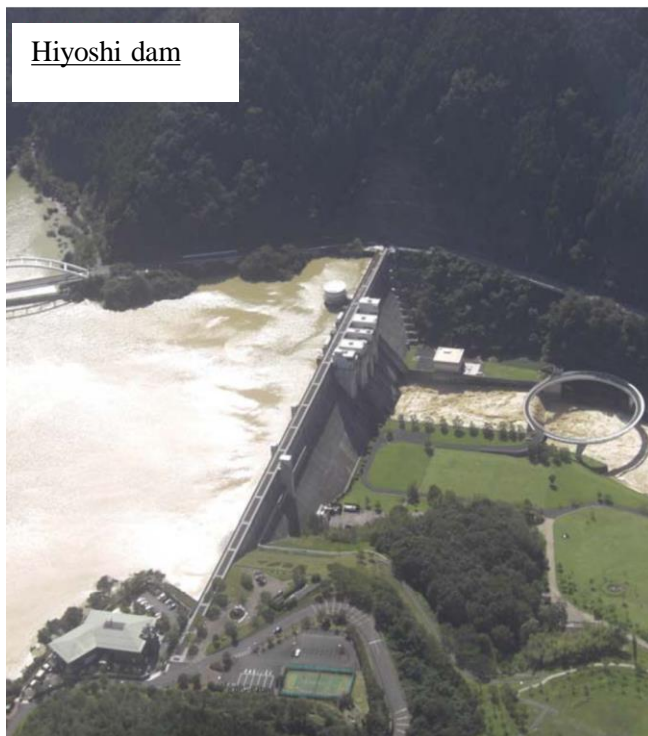
Source: MLIT

**Hijikawa River Inundation**

### 3. Dam Operation During Flood

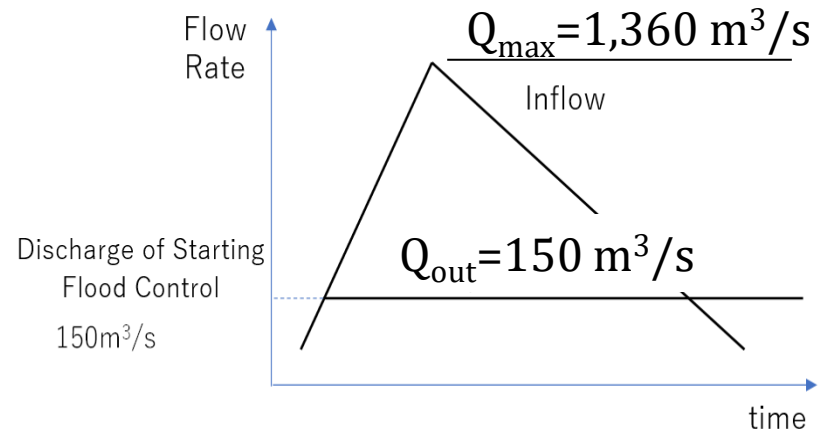
#### (2) Dam Operation during Extraordinary Flood Exceeding the Design Discharge

##### Advanced Dam Operation during Heavy Flood (Typhoon No.18)



Source: Kinki Regional Development Bureau (MLIT)

**Hiyoshi Dam**



##### Flood Protection Plan

Typhoon No.18:

$$Q_{\max} = 1,690 \text{ m}^3/\text{s} > Q_{\max} (\text{Plan}) = 1,360 \text{ m}^3/\text{s}$$

### 3. Dam Operation During Flood

#### (3) Operation and Role of Water Supply Dam during Flood

Classification of Water Supply Dam and Necessary Actions to Release Flood Water

##### Type 1

Flood discharge increase significantly

- Increase in flood flow velocity



Reservoir needs to store part of flood inflow

##### Type 2

Rising water levels upstream

- Riverbed upstream has risen due to sedimentation, or
- Dam area not large enough



Preliminary discharge

##### Type 3

Sudden rise in water level during flood

- Flood discharge > reservoir capacity, or
- Operation of flood discharge gates complicated



Pre-releasing water to lower water level

##### Type 4

Flood water release cause no adverse effect on flood management downstream



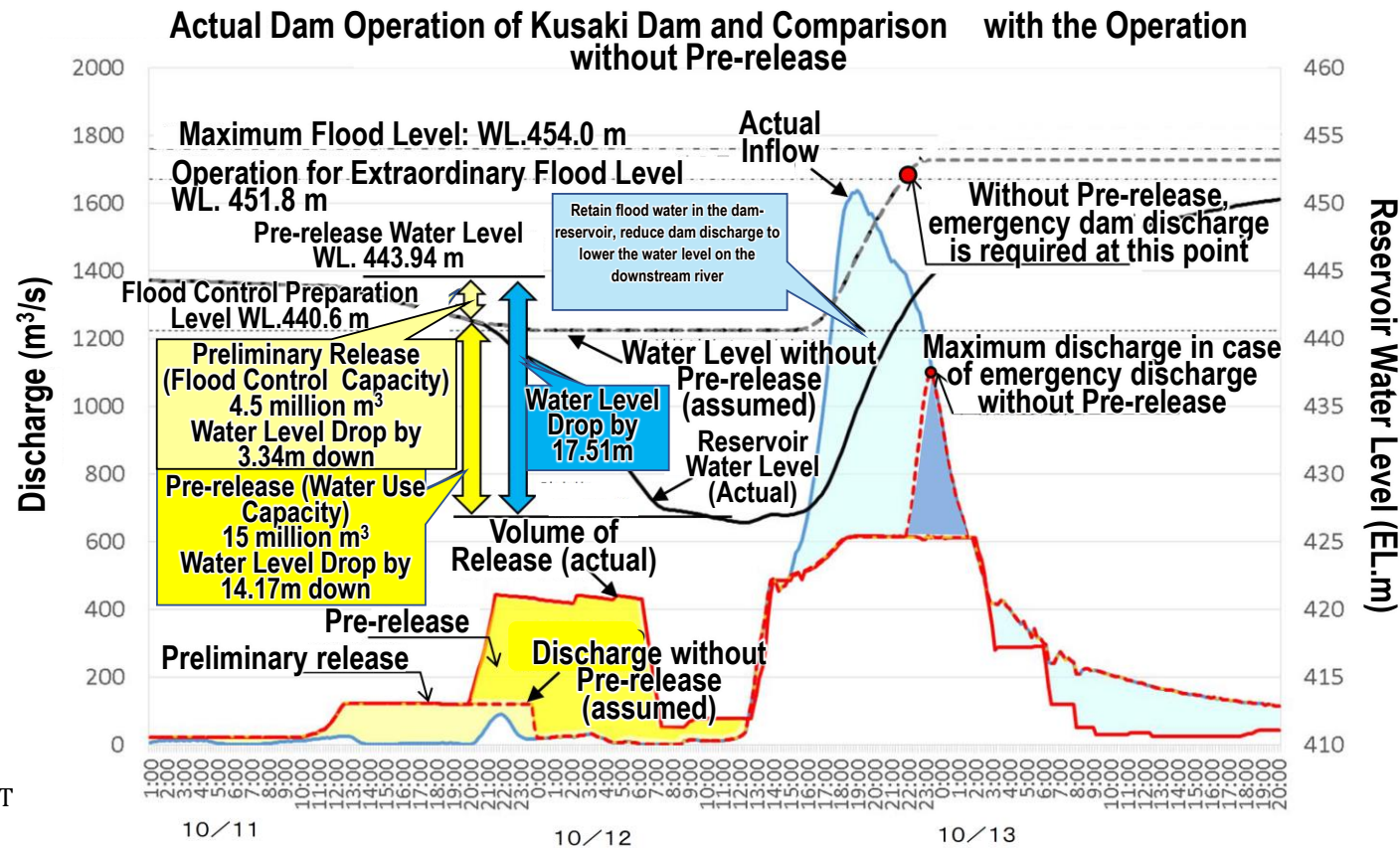
None

Article 52 of River Law: River administrator has authority to instruct temporary storage of flood water to the owner of the water supply dam

# 3. Dam Operation During Flood

## (3) Operation and Role of Water Supply Dam during Flood

Recent efforts to use reservoir water in water supply dams for flood protection



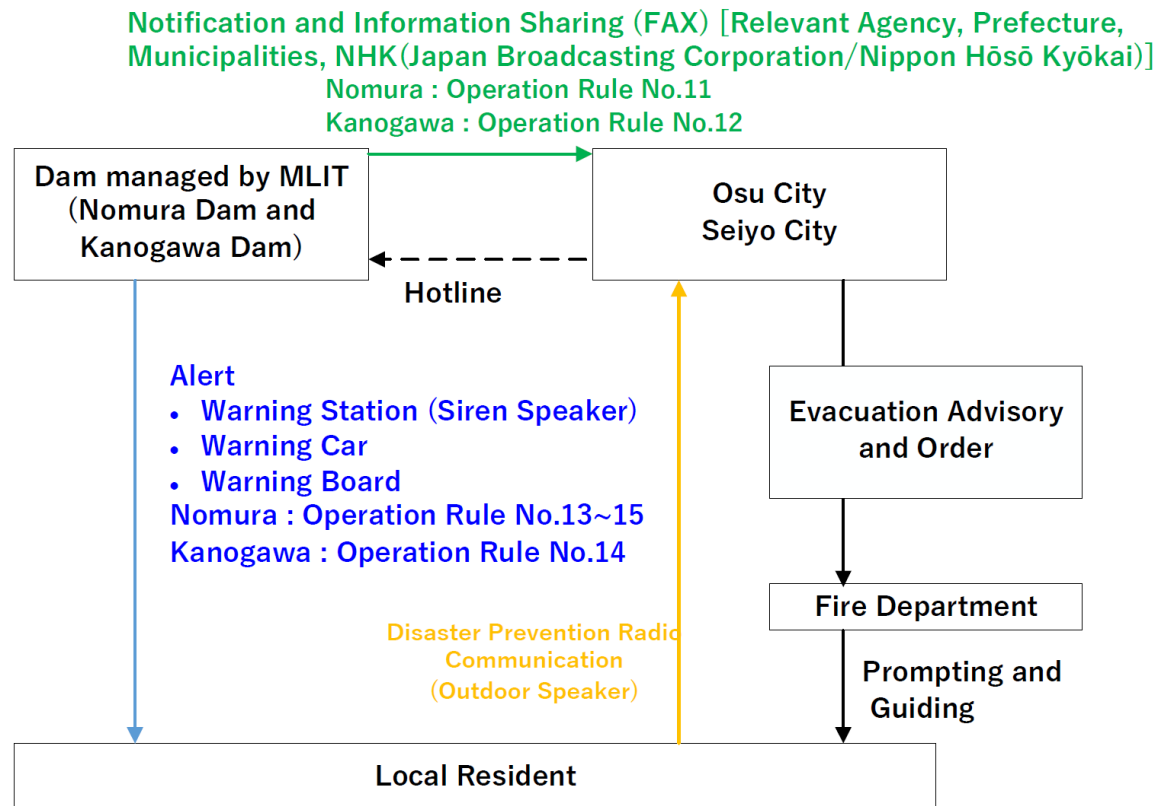
Source: MLIT

### Advance Release Operation of Kusaki Dam at Typhoon No. 18 in 2019 and its Effect



# 3. Dam Operation During Flood

## (4) Securing Safety for Residents and River Users in Downstream Area



Source: Summary of Discussions for Verification of Information Sharing on the Operation of Nomura Dam and Kanogawa Dam, November 2018

### Example of Notification and Information Sharing (Nomura Dam and Kanogawa Dam)



# 3. Dam Operation During Flood

## (4) Securing Safety for Residents and River Users in Downstream Area



Source: MLIT

Real-time dam data of MLIT

MLIT Fujiwara Dam Management Office

Follow

580 件のツイート  
MLIT Fujiwara Dam Management Office

@mlit\_fujiwara\_D · 2017年5月13日

Due to the increased inflow into the dam caused by rainfall and snow, the Fujiwara Dam is currently releasing water through three crest gates. The water level on the downstream rivers will remain high. Be careful of the further rise in the downstream water level, as the dam discharge may be increased if necessary. The second photo was taken from the Dam crest, looking down the discharge channel

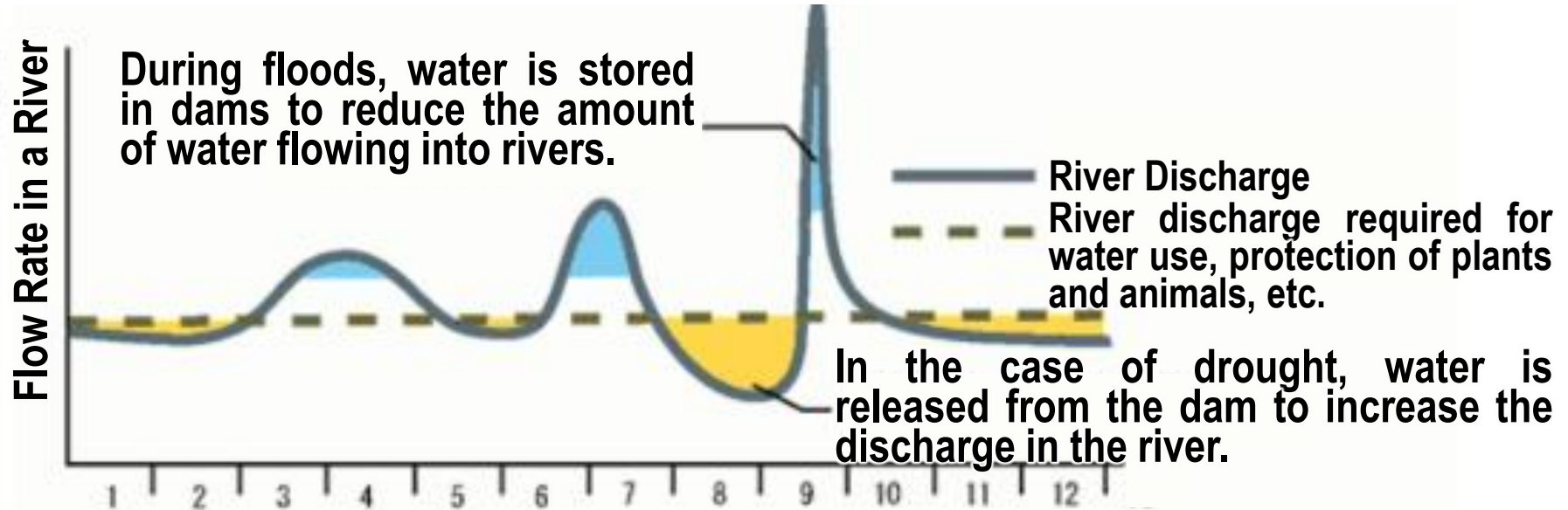


Source: Fujiwara Dam

Warning of discharge release (Twitter)

## 4. Dam Operation For Water Supply

### (1) Water Supply by Dam

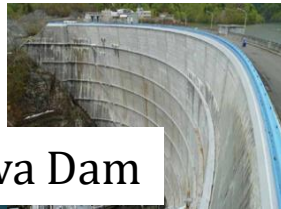


Source: MLIT

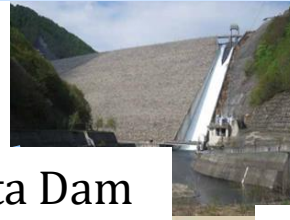
**Illustration of Water Supply Enhanced by Dam**

# 4. Dam Operation For Water Supply

## (2) Integrated Operation of Dams



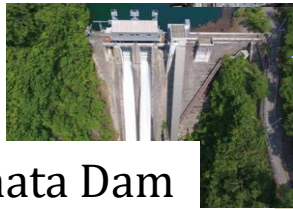
Yagisawa Dam



Naramata Dam



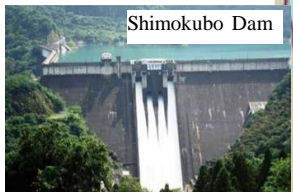
Fujiwara Dam



Aimata Dam



Yanba Dam



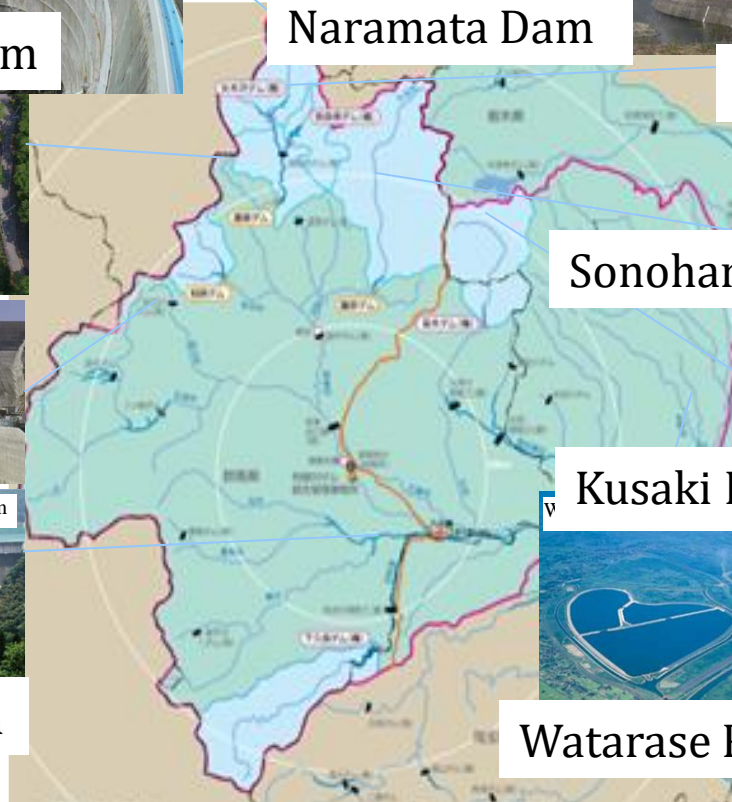
Shimokubo Dam

Shimokubo Dam

Kusaki Dam



Watarase Retarding Basin



### Integrated Operation of Multiple Dam

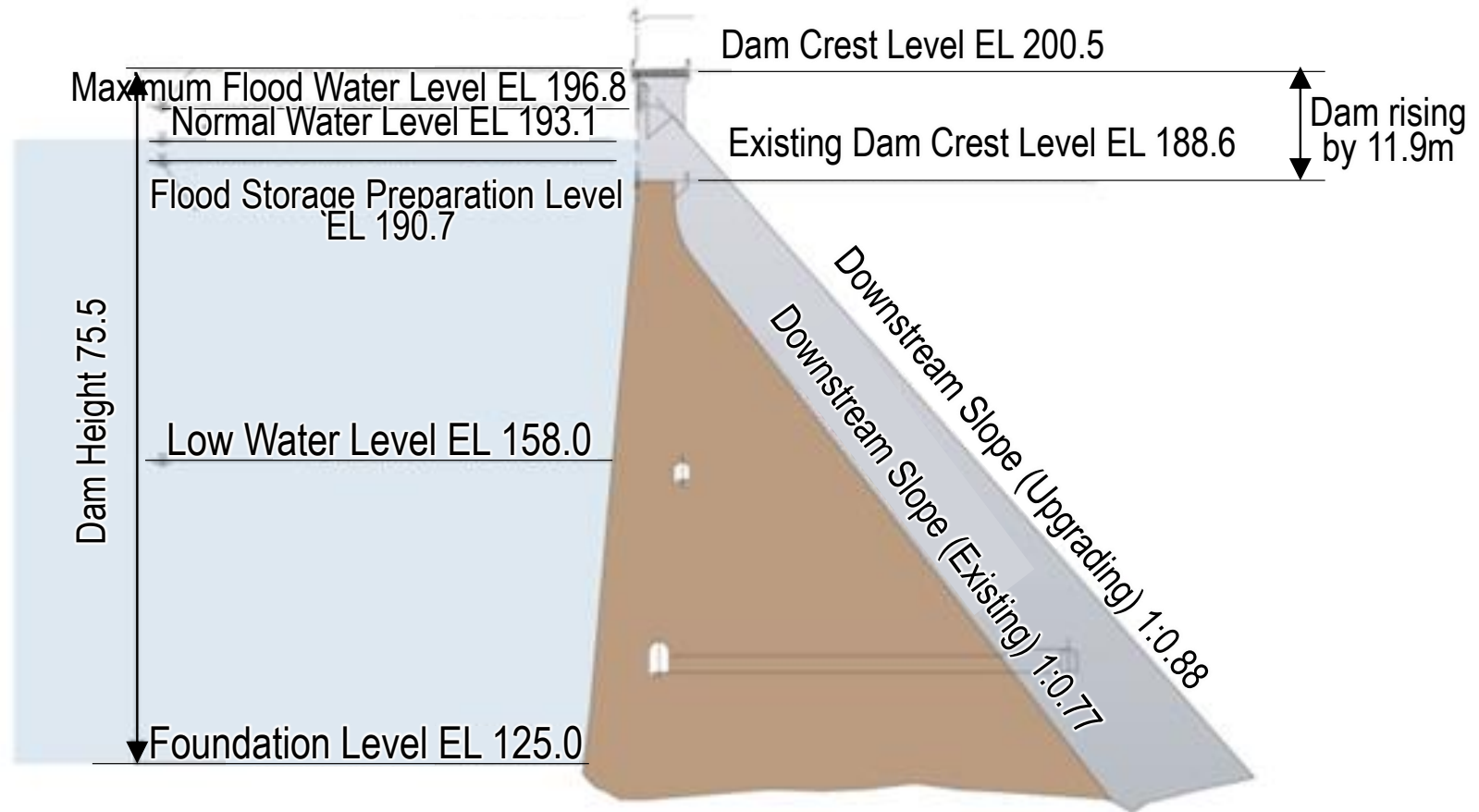
- Integrated operation by considering the dam's location, reservoir volumes, and characteristics of the river basin
- Example: nine dams managed by national government & Japan Water Agency Tone River basin

Source: Tone River Dams Integrated Management Office

**Dams Operated by the Tone River Dams Integrated Management Office**

# 5. Measures for Rehabilitation and Improvement of Dam Function

## (2) Dam Rehabilitation Technologies in Japan



Source: Sapporo Development and Construction Office, Hokkaido Regional Development Bureau

**Cross Section of Dam Body**

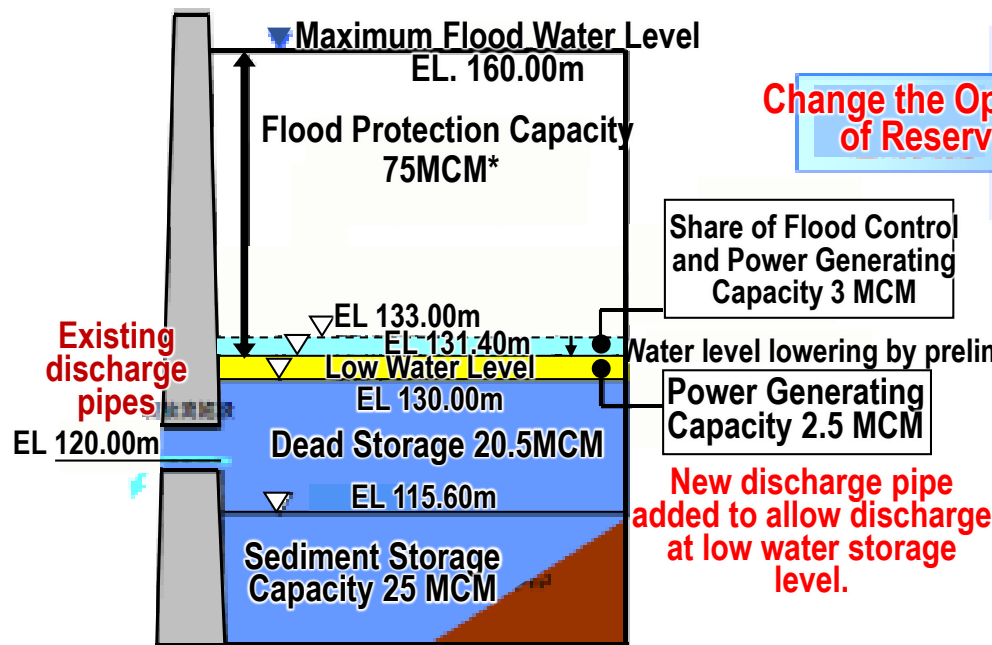


# 5. Measures for Rehabilitation and Improvement of Dam Function

## (2) Dam Rehabilitation Technologies in Japan

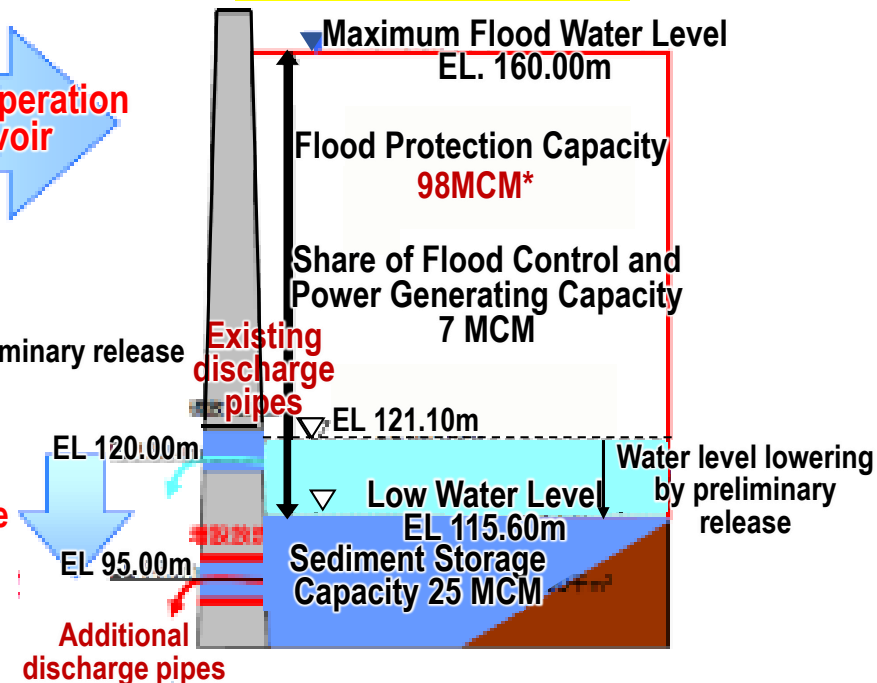
### Installation of Additional River Outlet Facility by Drilling (Tsuruda Dam)

Current (Flood Season)



\*Maximum Flood Protection Capacity During flood Season

After Rehabilitation (Flood Season)



Source: Sendai-gawa River Office, MLIT

### Reformulation of Reservoir Operation for Tsuruda Dam

# 5. Measures for Rehabilitation and Improvement of Dam Function

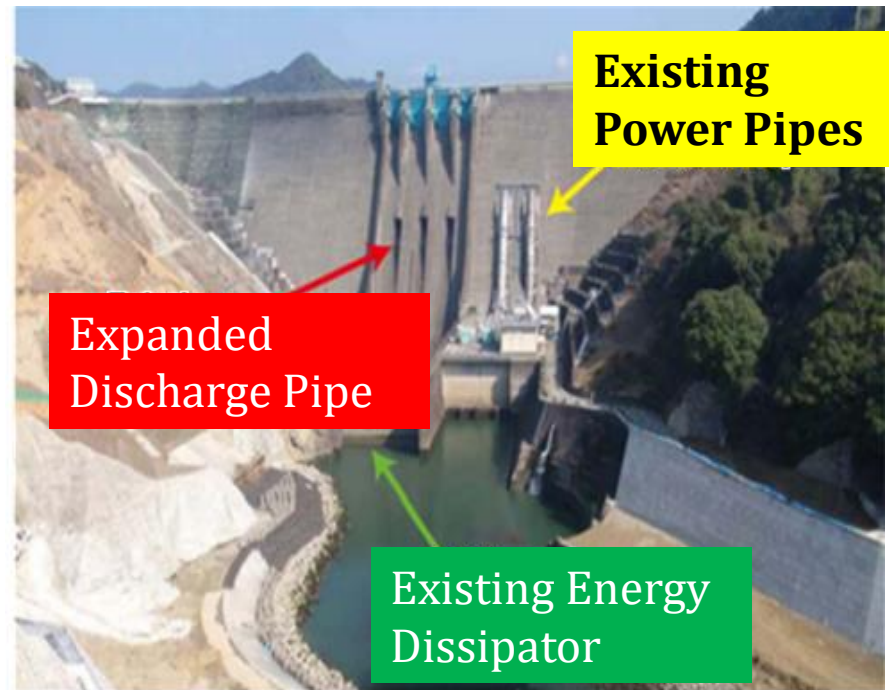
## (2) Dam Rehabilitation Technologies in Japan

### Installation of Additional River Outlet Facility by Drilling (Tsuruda Dam)



Source: Sendai-gawa River Office, MLIT

**Drilling of Dam Body**



Source: Sendai-gawa River Office, MLIT

**Rehabilitation Works**

# 5. Measures for Rehabilitation and Improvement of Dam Function

## (2) Dam Rehabilitation Technologies in Japan

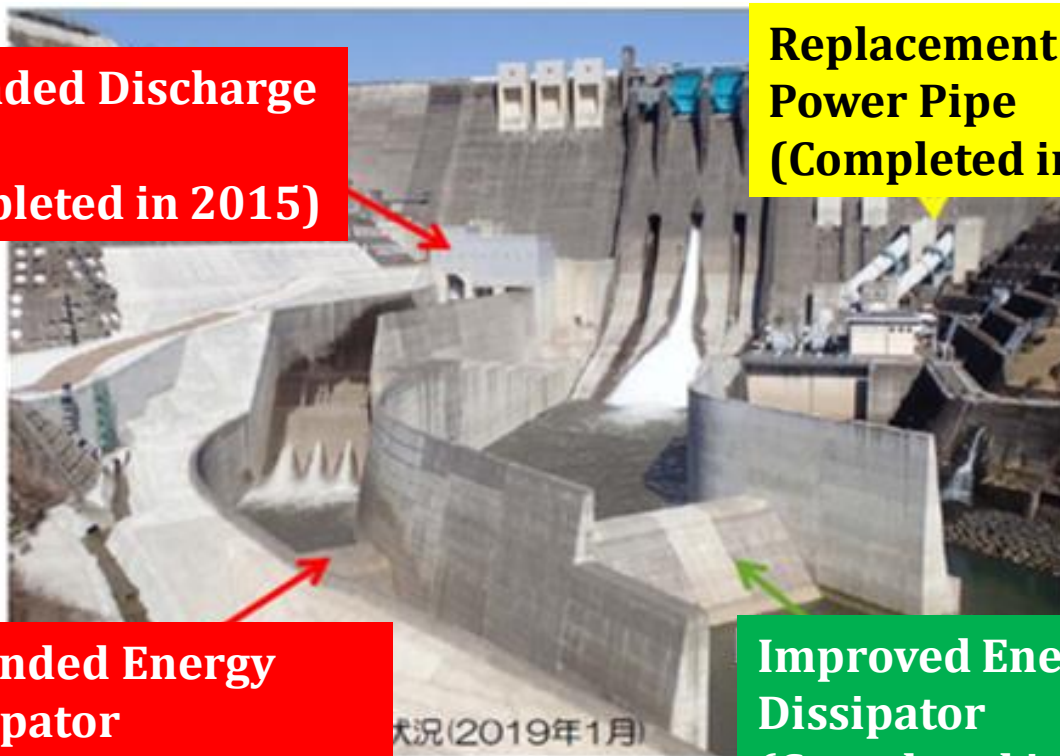
### Installation of Additional River Outlet Facility by Drilling (Tsuruda Dam)

**Expanded Discharge Pipe  
(Completed in 2015)**

**Replacement of  
Power Pipe  
(Completed in 2015)**

**Expanded Energy  
Dissipator  
(Completed in 2015)**

**Improved Energy  
Dissipator  
(Completed in 2017)**

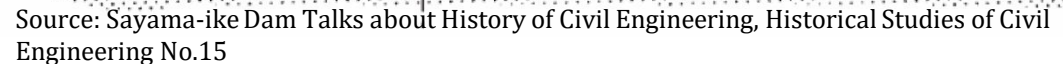


Source: Sendai-gawa River Office, MLIT

### Restoration Works



## Restoration of Japan's Oldest Dam (Improvement of Sayama-ike)



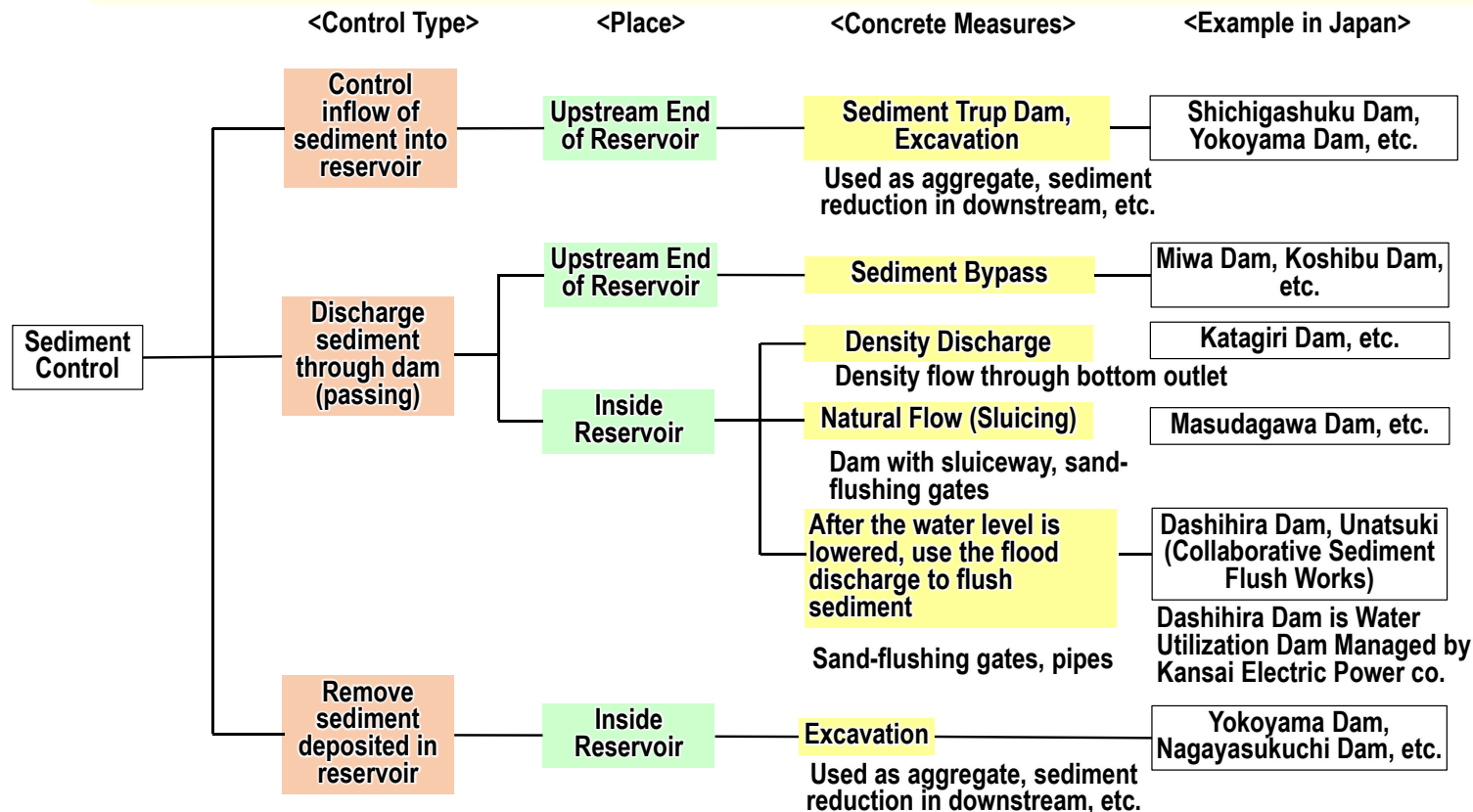
Source: Website of Osaka Prefecture

## Before and after Restoration

# 5. Measures for Rehabilitation and Improvement of Dam Function

## (3) Technologies for Dam Sediment Control

In Japan, the sediment capacity of reservoirs is determined by estimating the sedimentation volume that will be deposited over 100 years.



**Sediment Gates**



**Sediment discharge bypass facility**

Source: MLIT (left) , Guide for Dam Sediment Control (Draft), Tenryu River Dams Integrated Management Office, Hokuriku Regional Development Bureau, MLIT(right)

# 5. Measures for Rehabilitation and Improvement of Dam Function

## (3) Technologies for Dam Sediment Control



Source: Nakagawa River Office

2009



2017



**"To Restoring Sediment Downstream" (Nagayasuguchi Dam)**

## 6. Lessons Learned (1)

- (1) To secure dam safety, legislation, technical guidelines, and examination system should be established.

The mechanisms of dam safety should involve thorough examination at each stage, i.e., planning, design, construction, and maintenance. It is important to conduct daily inspections and patrols, as well as periodic inspections, and not to overlook any small changes or signs of risk. The periodic and comprehensive inspections and establishment of extension plans for the service life can improve the management and reduce the lifecycle costs. Because many ponds built in the old days have structural problems, accidents should be prevented through legislation and financial support for the inspection and reinforcement of dam structures.



## 6. Lessons Learned (2)

- (2) To secure a dam and its downstream areas during flooding, operation rules should be followed.

The operation rules prescribe gate operations and procedures for the patrol and warning methods for downstream areas. They also cover the gate operations for extraordinary floods that exceed the design flood. This is intended to prevent artificial flooding in downstream areas, even under extraordinary floods. The flood inflow should be discharged in the same amount as entering the reservoir. The inflow volume can be obtained from the flood-inflow forecast based on rain radar data. Flood forecasting is effective for introducing and deciding whether to pre-release reservoir water for increasing the flood-protection capacity before floods.

- (3) Integrated operation of multiple dams can ensure an adequate water supply.

The integrated operation of multiple reservoirs in the basin and reallocation of the reservoir capacity may enhance the reliability of the water supply and improve the river environment.

## 6. Lessons Learned (3)

### (4) Rehabilitation works can extend lifetime and functions of dams.

Existing dams can be rehabilitated at a relatively low cost, in a short time, and with minimal burdens on nature and society. Additionally, it is possible to improve the dam functions by using the latest software and hardware technologies, e.g., flood forecasting and countermeasures for reservoir sedimentation, dam raising, and the construction of dam-discharging facilities. Some rehabilitation works can be implemented without interfering with the dam operation.