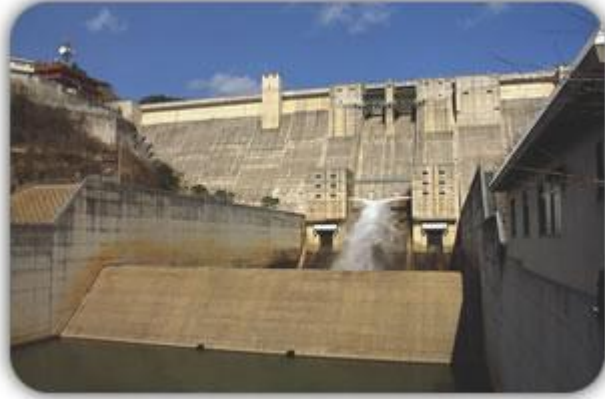
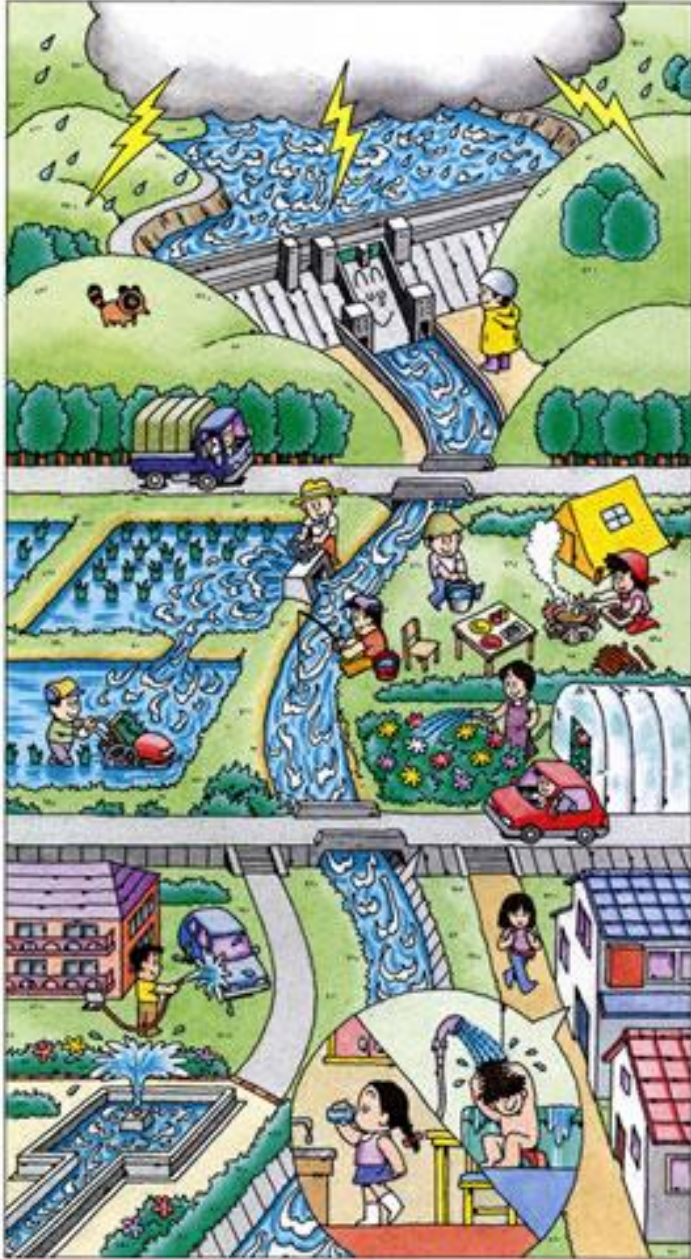


# 一庫ダム Hitokura Dam



- ◆ The cities of Amagasaki, Itami, Toyonaka, Kawanishi, Takarazuka, Ikeda and Mino are all located in the surrounds of the Ina River. Thanks to its economic growth from 1960 onward, this region rapidly developed as the center of Kansai, resulting in ballooning of the population of the region involving associated areas, reaching about 1.6 million, and giving rise to a serious water shortage problem.
- ◆ Moreover, frequent major flooding from the Ina River in the past inflicted serious damage on residents living on its shores. Even now, residents on the shores of the river still have vivid memories of the horrors of events such as the major floods centered on Kobe in 1938 and serious flooding throughout the entire Kinki region caused by the typhoon No. 13 in 1953.
- ◆ To address these issues, a plan was formed to construct a multi-purpose dam with floodwater regulating functions and channel improvement of the Ina River implemented to mitigate damage from flooding, so that water could be supplied from the dam during periods of drought for agricultural and waterworks use and sufficient additional municipal water produced for between 500 and 600 thousand more people.
- ◆ Subsequently, at the massive cost of 63.8 billion yen, the Hitokura Dam was completed over a period of 16 years from August 1, 1968, when the survey center was inaugurated, to March 1984.

# Roles of the Dam



## ■ Floodwater Regulation

To mitigate damage caused by flooding, the dam provides regulating functions that prevent too much water from flowing into the river when massive amounts of water are produced by events such as typhoons or torrential rainfall, thus reducing the amount of floodwater downstream.

## ■ Maintenance of Normal Waterflow Function

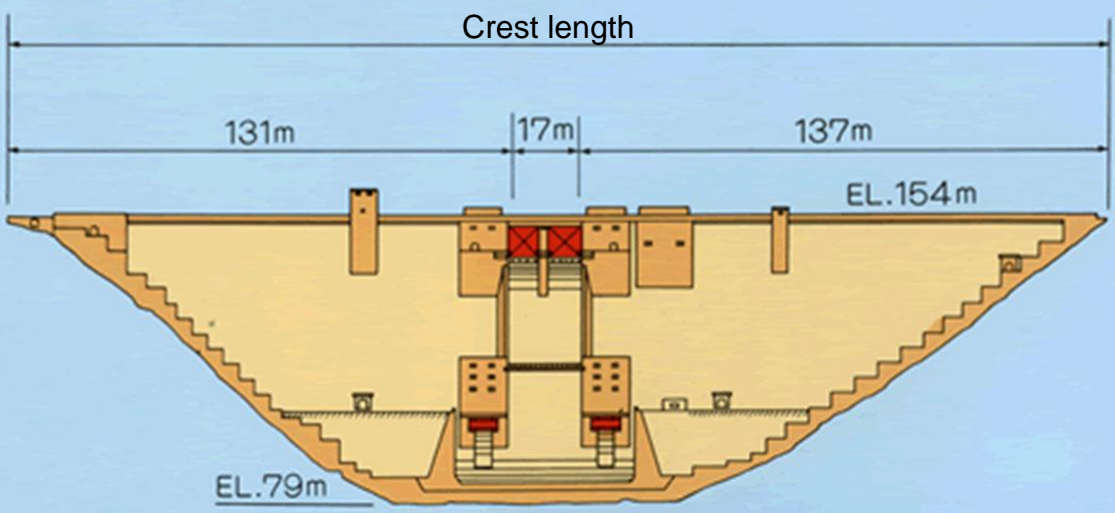
Water is supplied from the dam when there is a shortage of water in the Ina River to stabilize the river flow and ensure sufficient supply of water for irrigation of existing agricultural land on the shores of the river and waterworks intake.

## ■ Supply of Water for Waterworks

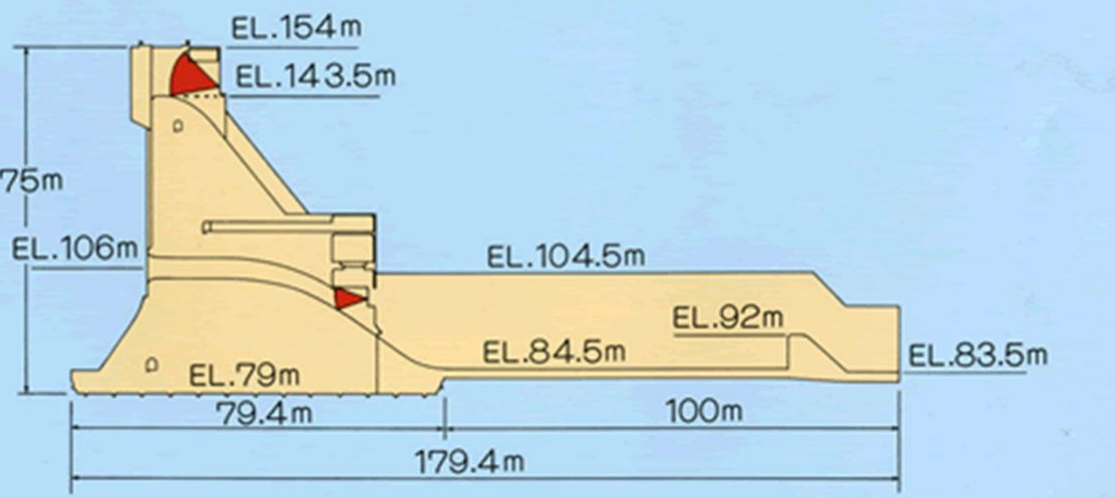
Water supply from the dam ensures sufficient city water for between about 500 and 600 thousand more people.

# Dam Structure and Specifications

■ Frontal View of the Dam (Downstream part)



■ Standard Cross Section Drawing (Overflow part)



■ Dam Specifications

|                                   |  |
|-----------------------------------|--|
| Location                          | Karamatsu, Hitokura-aza, Kawanishi-shi, Hyogo Prefecture     |
| River name                        | Yodo River system, Ina River tributary, Hitokura Oroji River |
| Type                              | Concrete gravity dam   |
| Total water storage capacity      | 33.300.000m <sup>3</sup>                                     |
| Floodwater regulation capacity    | 17.500.000m <sup>3</sup>                                     |
| Surcharge capacity                | 4.000.000m <sup>3</sup>                                      |
| Effective water storage capacity  | 30.800.000m <sup>3</sup>                                     |
| Irrigation capacity               | 13.300.000m <sup>3</sup>                                     |
| Sedimentation capacity            | 2.500.000m <sup>3</sup>                                      |
| Embankment height                 | 75m  |
| Crest length                      | 285m   |
| Dam volume                        | 441.000m <sup>3</sup>  |
| Height of crest above sea level   | EL. 154.0m   |
| Basin area                        | 115.1km <sup>2</sup>   |
| Reservoir area                    | 1.4km <sup>2</sup>   |
| Irrigation water depth            | 44.0m  |
| Surcharge level                   | EL. 152.0m   |
| Constant reservoir level          | EL. 149.0m   |
| Water level limit during flooding | EL. 135.3m   |
| Minimum level                     | EL. 108.0m   |
| Planned high water discharge      | 900m <sup>3</sup> /s   |
| Regulated flow rate               | 700m <sup>3</sup> /s   |
| Planned maximum discharge         | 200m <sup>3</sup> /s   |
| Design floodwater flow rate       | 1.730m <sup>3</sup> /s                                       |

# Hitokura Dam Discharge Equipment

○ The dam is furnished with crest spillway gate, emergency spillway gate and low-water management discharge equipment, each of which is operated to discharge water matched to discharge requirements at the time. These gates can all be opened and closed remotely from the management office.

| Discharge Equipment                      |   |   |
|--|---|---|
| Crest spillway gate                      | Type  | I-type discharge pipe   |
|  | Discharge pipe  | Two 4.4 m (W) x 4.4 m (H) pipes   |
|  | Gate  | Two high-pressure radial gates<br>Two coaster gates                           |
|  | Discharge capacity  | Q=650 m <sup>3</sup> /s at water level limit level during flooding of 135.3 m |
| Emergency spillway gate                  | Type  | Crest overflow  |
|  | Gate  | Two 8.5 m (W) x 9.3 m (H) radial gates  |
|  | Discharge capacity  | Q=890 m <sup>3</sup> /s at design floodwater level of EL.152.5 m              |
| Low-water management discharge equipment | Type  | Intake tower  |
|  | Selective water intake  | Discharge pipe  |
|  | 7-stage round gate  | 950 m/m branching at less than φ1,400 m/m                                     |
|  | Gate  | Jet flow gate, etc.   |
| Discharge capacity                       | Q=9.0 m <sup>3</sup> /s at minimum irrigation water level of EL.108.0 m |   |

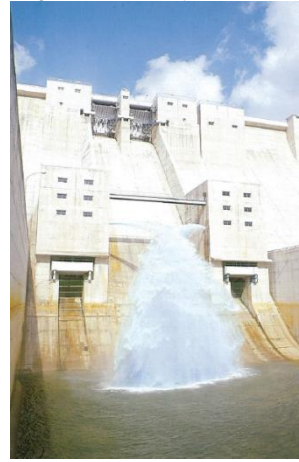
## Crest spillway gate

This is a floodwater regulating gate and water is discharged from all sluice gates until a flood on a scale that occurs only roughly once every hundred years occurs.



## Low-water management discharge equipment

### Discharge from the irrigation auxiliary valve



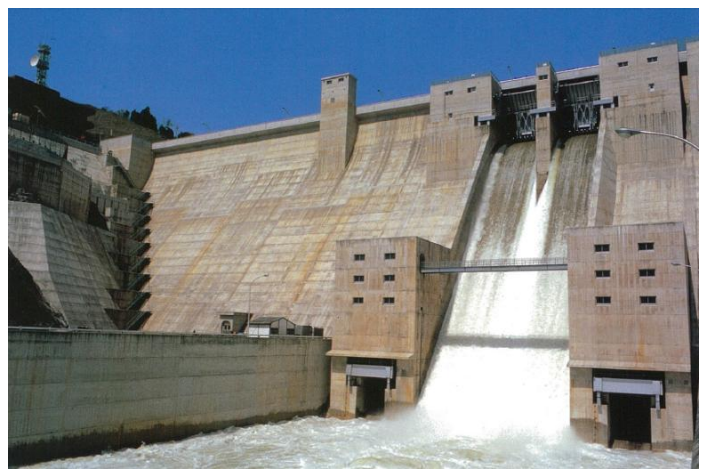
When water is discharged downstream from the dam to maintain normal city water and waterflow functions, water taken from selective water intake gates is discharged from facilities such as discharge valves or hydroelectric power generation equipment for management use.



Selective water intake gate opening and closing equipment

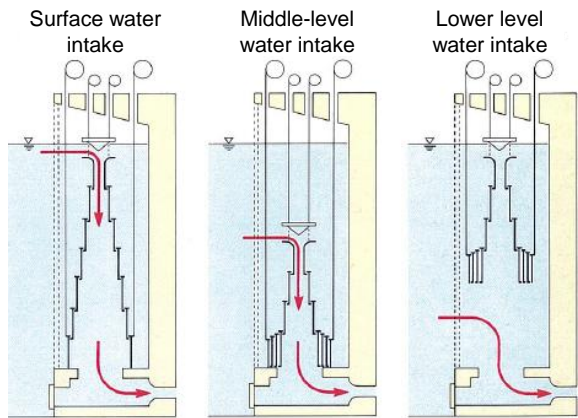
## Emergency spillway gate

This is an emergency gate that prevents overflow at the dam crest when massive amounts of floodwater that cannot be handled by the crest spillway gate alone are caused by a flood on a scale that occurs only roughly every hundred years.



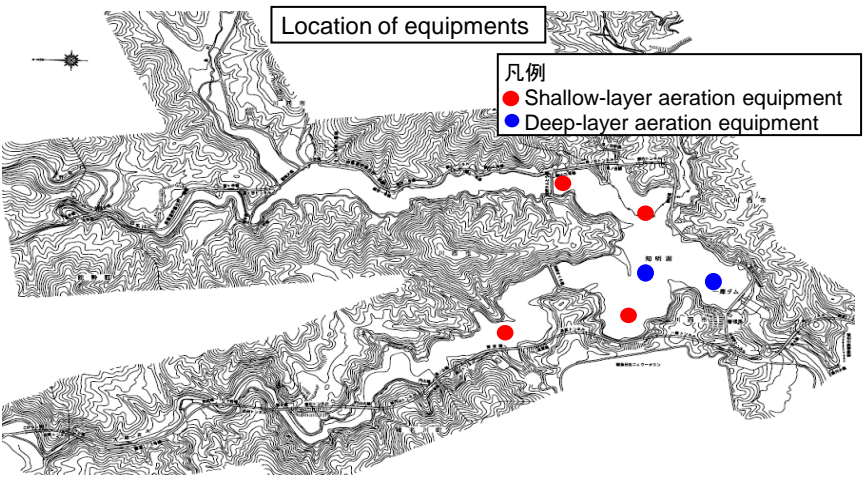
## About selective water intake

During the period from spring to autumn, the upper level of water in the reservoir is warm, and the lower level cold. Normally, only water from the upper level is taken in and discharged downstream from the dam. However, when, for example, abnormal growth of phytoplankton on the upper level degrades the water quality, relatively clean water is taken from the middle level and discharged.



# Aeration equipments and hydroelectric power plant

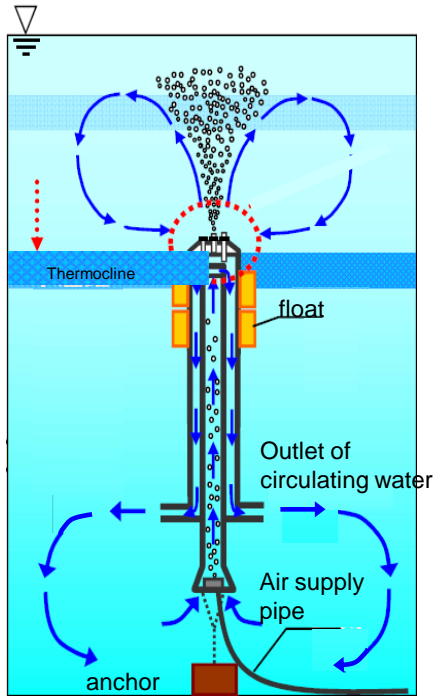
## Aeration equipments for water quality improvement



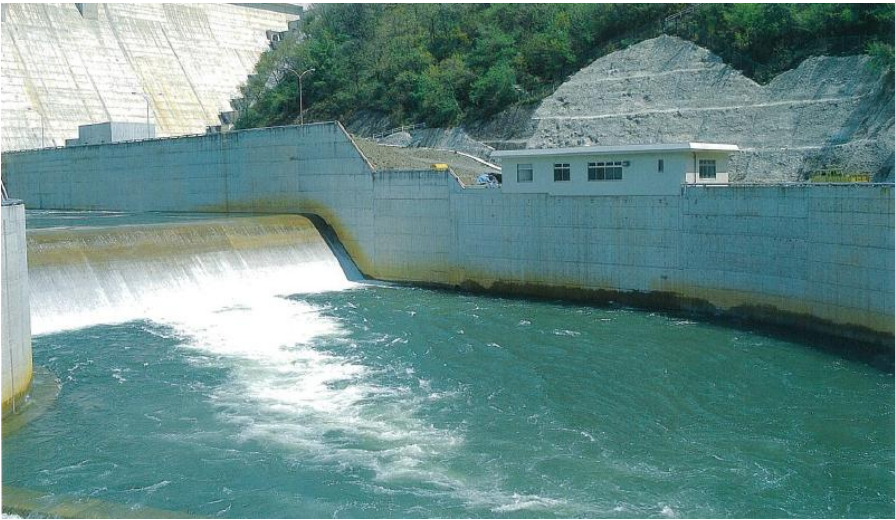
There are six aeration equipments in the reservoir to improve water quality. Two of them is deep-layer aeration equipments, which also works as shallow aeration equipment and the rest is shallow-layer aerations.

A deep-layer aeration equipment sends oxygen to the bottom of the reservoir to control the creation of hydrogen sulfide, inorganic phosphorus and also hydrogen sulfide odor caused by discharge from the gates.

A shallow-layer aeration equipment circulates the water in the reservoir using bubbles generated in the depth of about 15 to 20 m in the reservoir to control the unusual huge scale of emergences of algae such as water bloom.



## Hydroelectric power plant for daily dam management and maintenance works



The hydroelectric power plant can generate 1,900 kW electricity at maximum using discharged water from the dam. The generated electricity is used for daily dam management and maintenance works. The surplus electricity is sold to Kansai Electric Power Company, so the management and maintenance costs can be saved.

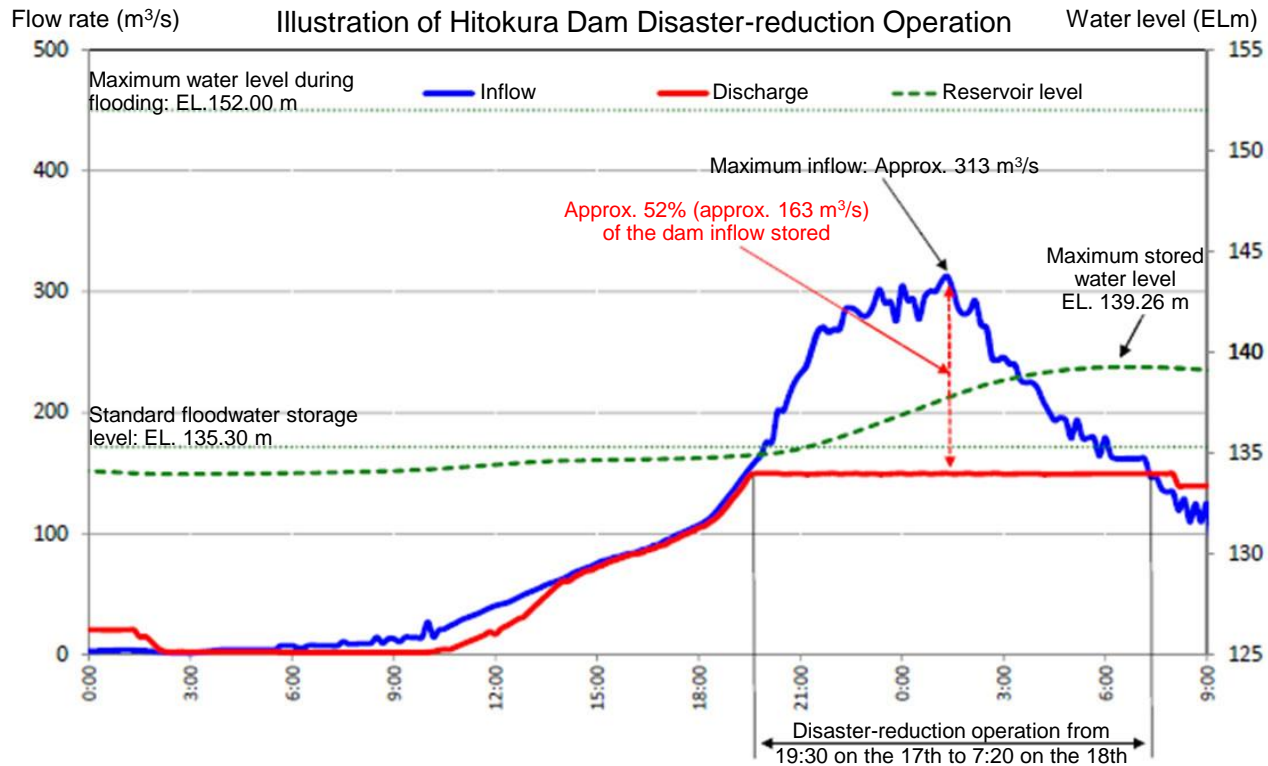
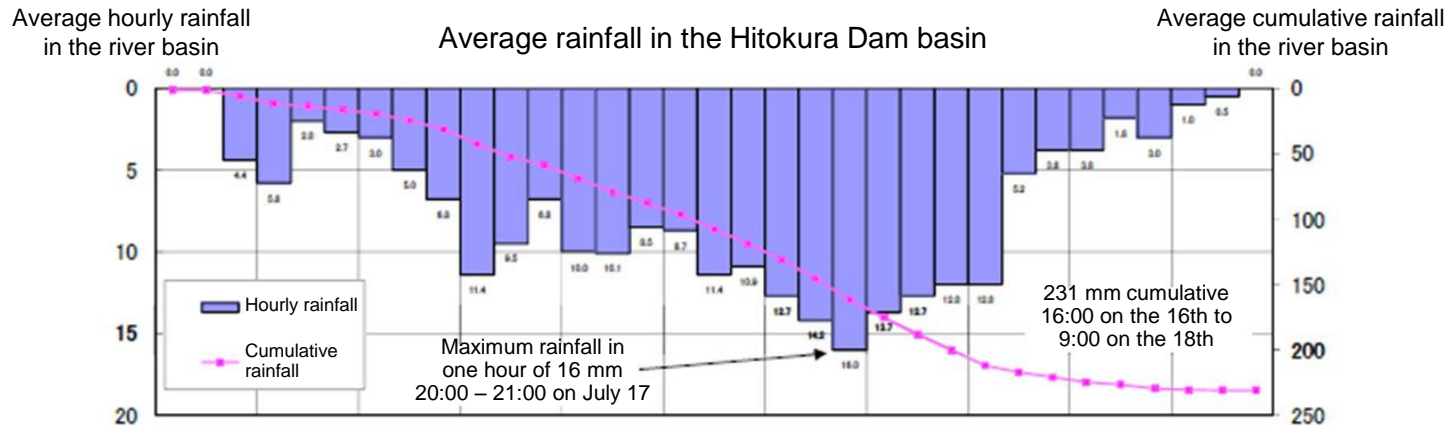


### Water-wheel and generator specifications

| Water wheel specifications |                                  | Generator specifications |                               |
|----------------------------|----------------------------------|--------------------------|-------------------------------|
| Type                       | Horizontal-shaft Francis Turbine | Type                     | 3-phase synchronous generator |
| Maximum output             | 2,100 KW                         | Maximum output           | 1,900 KW                      |
| Maximum head               | 59.0 m                           | Voltage                  | 6,600 V                       |
| Maximum flow rate          | 4.2 m <sup>3</sup> /s            | Frequency                | 60 Hz                         |
| Rotation speed             | 720 rpm                          |                          |                               |

# Floodwater Regulation when Typhoon Number 11 struck in 2015 – 1/2

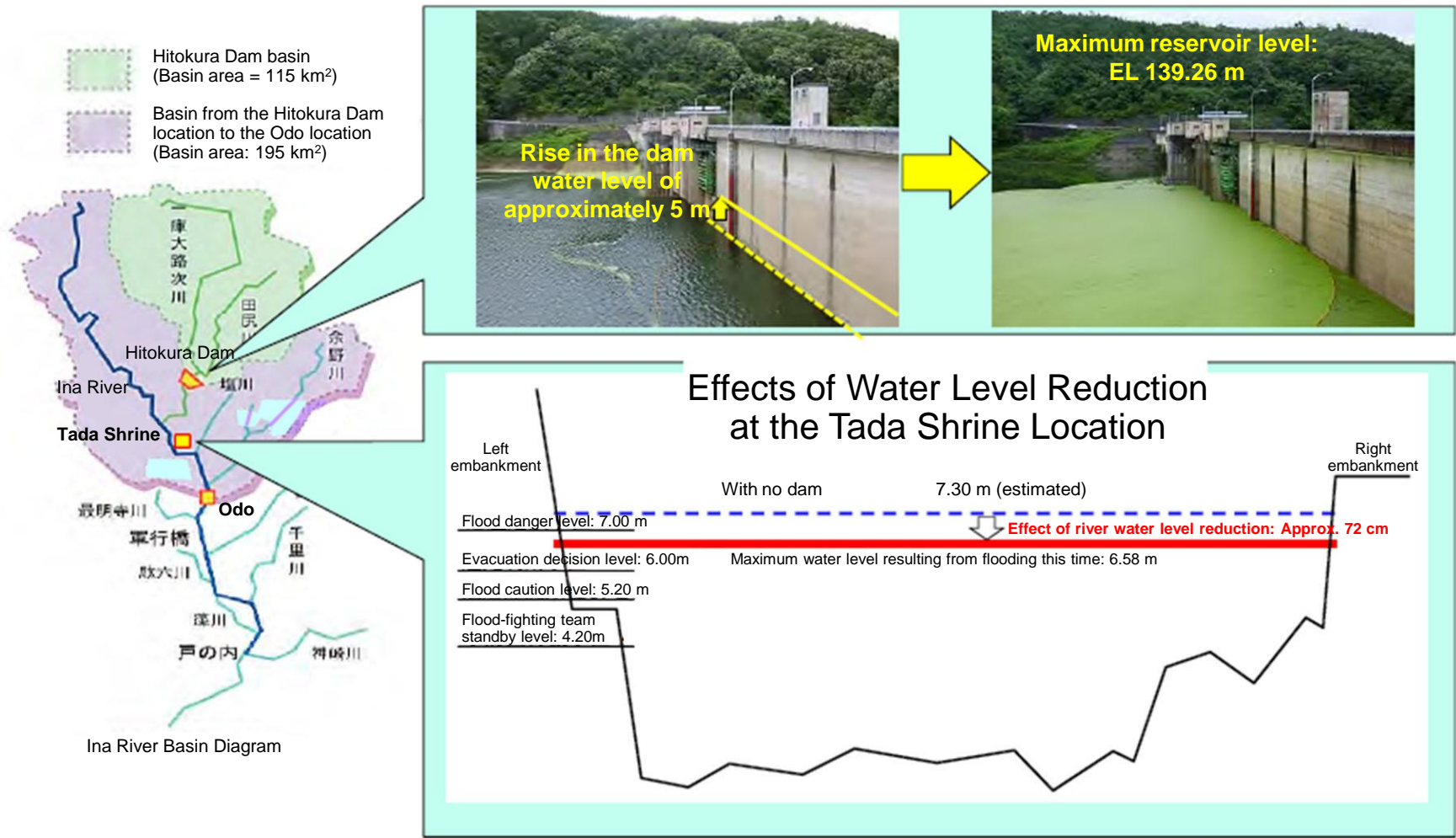
## Regarding Hitokura Dam Disaster-reduction Operation during rainfall produced by Typhoon Number 11



# Floodwater Regulation when Typhoon Number 11 struck in 2015 – 2/2

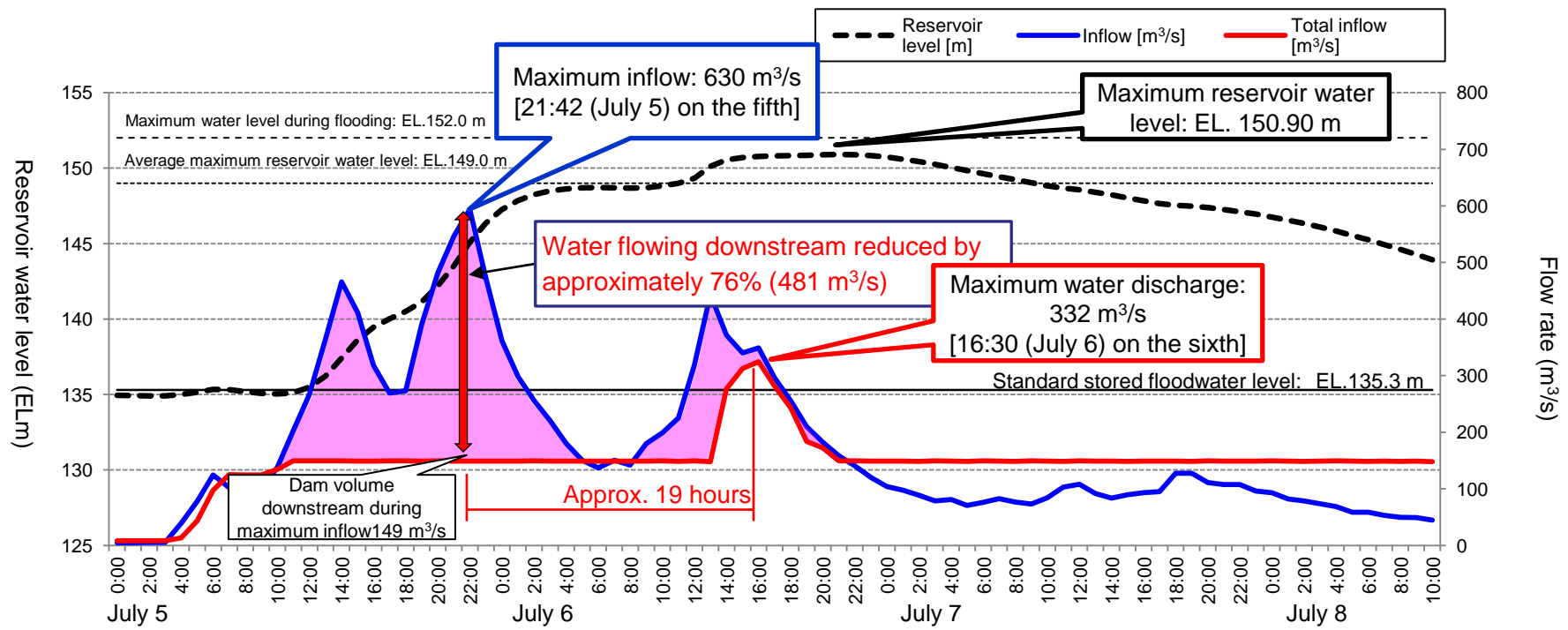
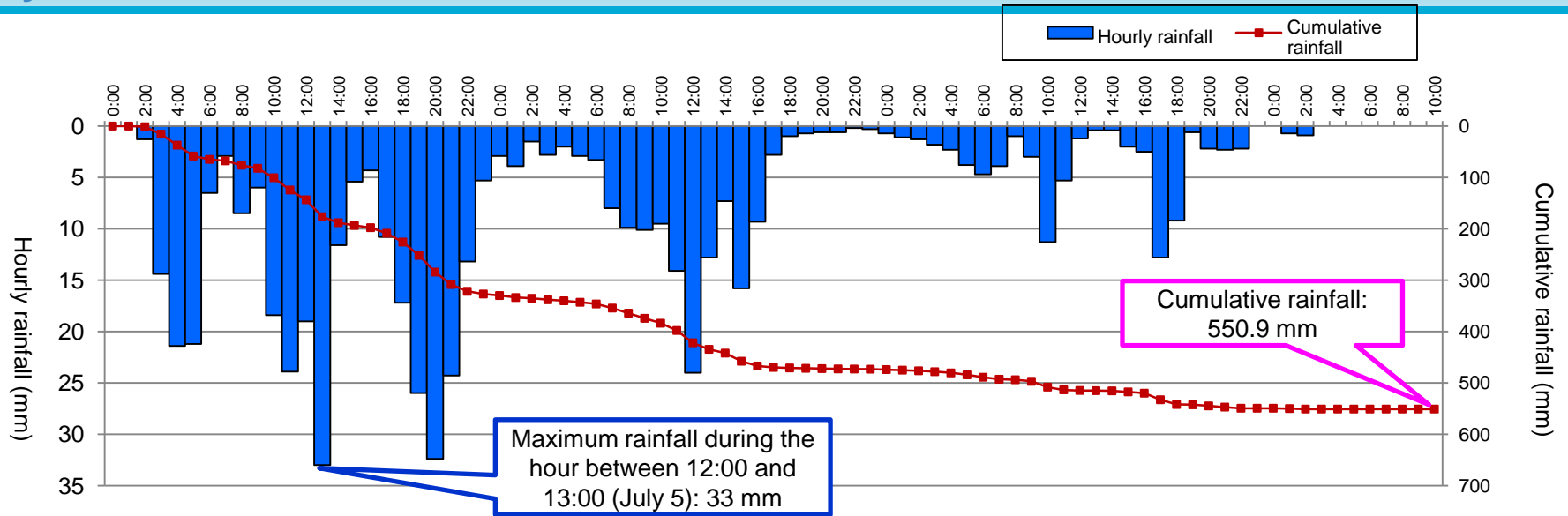
Floodwater equivalent to approximately three times the size of the Kyocera Dome Osaka was stored and the water level downstream from the dam reduced by a maximum of 72 cm.

Maximum inflow (313 m<sup>3</sup>/s) was recorded when rainfall caused by Typhoon Number 11 increased inflow to the dam. Floodwater equivalent to approximately three times the size of the Kyocera Dome Osaka (approx. 3.56 million cubic meters) was stored in the Hitokura Dam and it is estimated that the water level at the Tada Shrine location downstream from the dam was reduced by 72 cm. (The size of Kyocera Dome Osaka is calculated to be 1.20 million m<sup>3</sup>.)



\*This presentation shows preliminary figures which may change through future close investigation.

# Floodwater Regulation during the Torrential Rainfall of July 2018 – 1/2





# Floodwater Regulation during the Torrential Rainfall of July 2018 – 2/2

- Record rainfall totaling 550.9 mm from the onset of rain caused by a stationary active seasonal rain front was observed in the Ina River Hitokura Dam basin in the Yodo River system. Although a maximum inflow to the dam of 630 cubic meters per second was recorded during the rainfall, attempts to reduce the river water level downstream from the dam were made by implementing disaster-reduction operation, resulting in reduction of the inflow by approximately 76% (481 cubic meters per second).
- If there had been no dam, it is estimated that the water level at the Tada Shrine location would have risen 8.26 m above the height of the embankment, resulting in floodwater overflowing the embankment and causing flood damage.

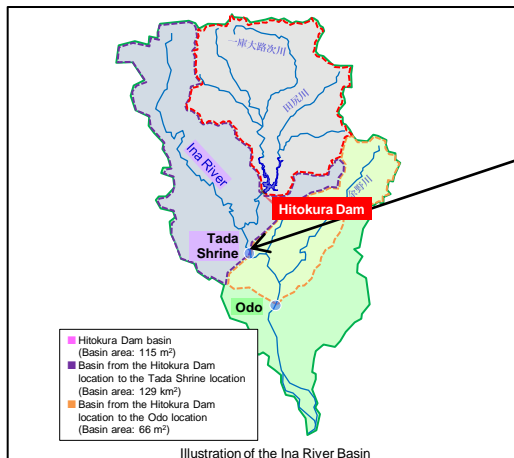
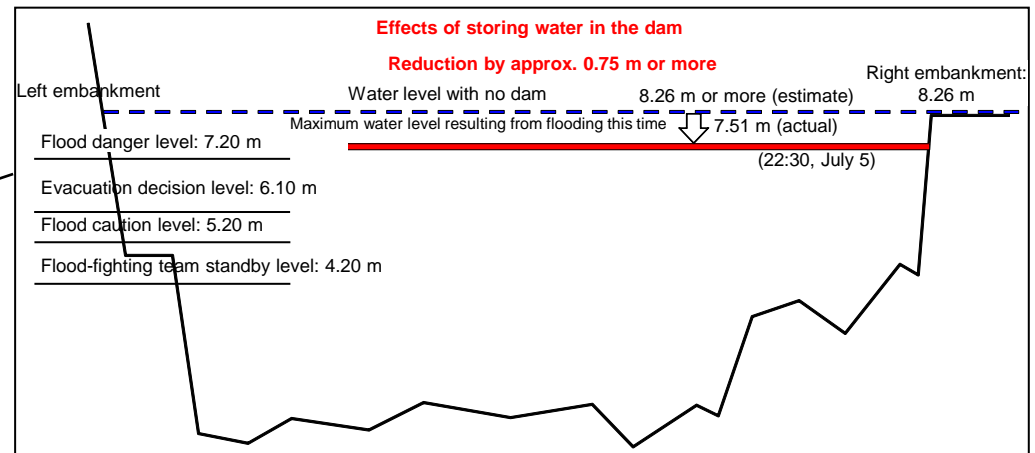


State of the reservoir before the start of floodwater storage  
(Approx. 10:00 on July 2; EL.135.84 m)



State of the reservoir with water approaching the maximum level during flooding  
(Approx. 17:00 on July 6; EL.150.81 m (water continuing to rise))

## Effects of Water Level Reduction at the Tada Shrine Location



\*This presentation shows preliminary figures which may change through future close investigation.