Day6, 2th DEC


# Experience of JAPAN on IWRM
# The case of Ara-kawa River

Keisuke HATANO
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Ara-kawa Dams, Japan Water Agency

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# Contents

1. Outline of Ara-kawa River
2. IWRM of Ara-kawa River
3. Management of Urayama dam
4. Problems and solutions of New challenge
5. Conclusions

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# First content

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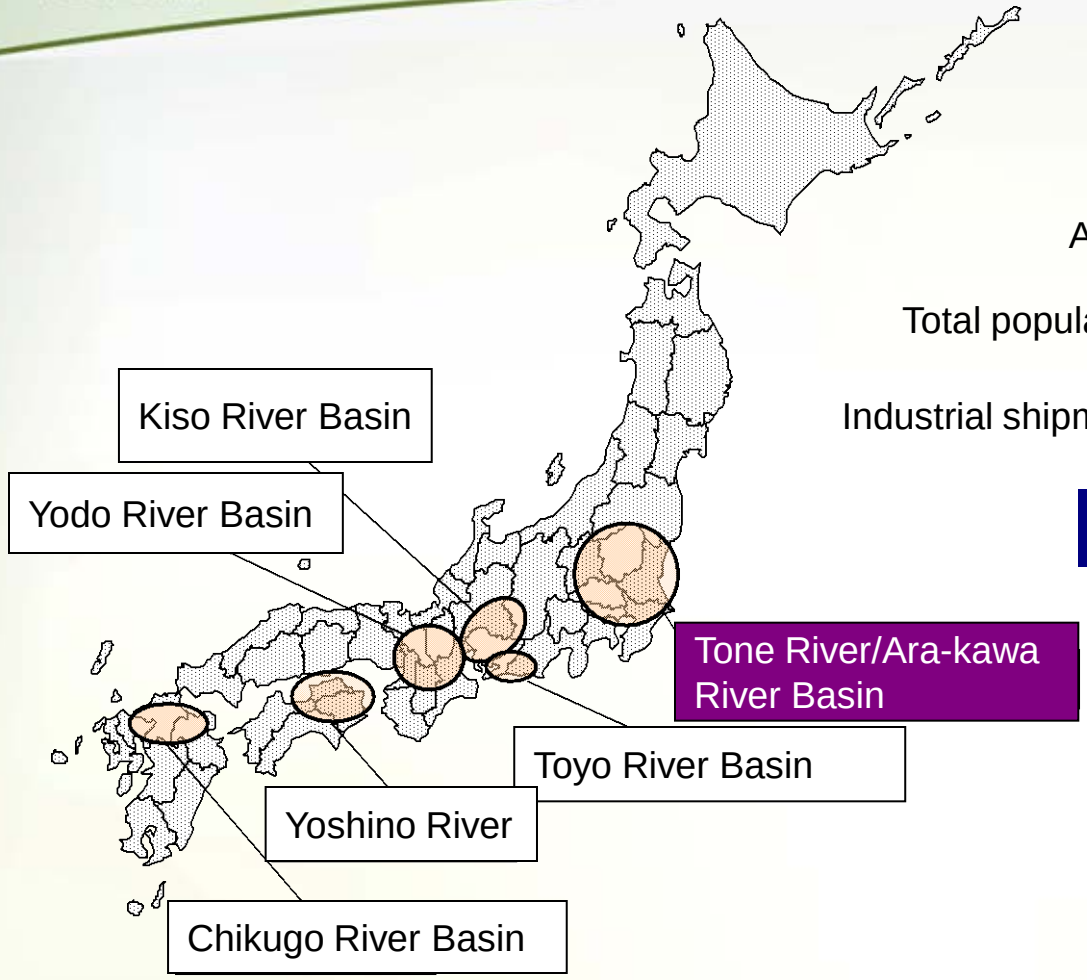
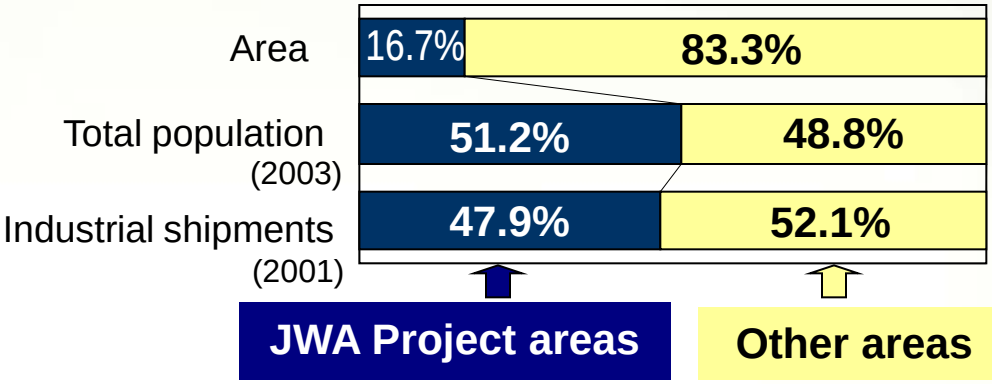
# Japan Water Agency

Since: 1962




The total area served water by JWA is only 17% of the national land.
However, about 50% of the population and industrial output are concentrated there

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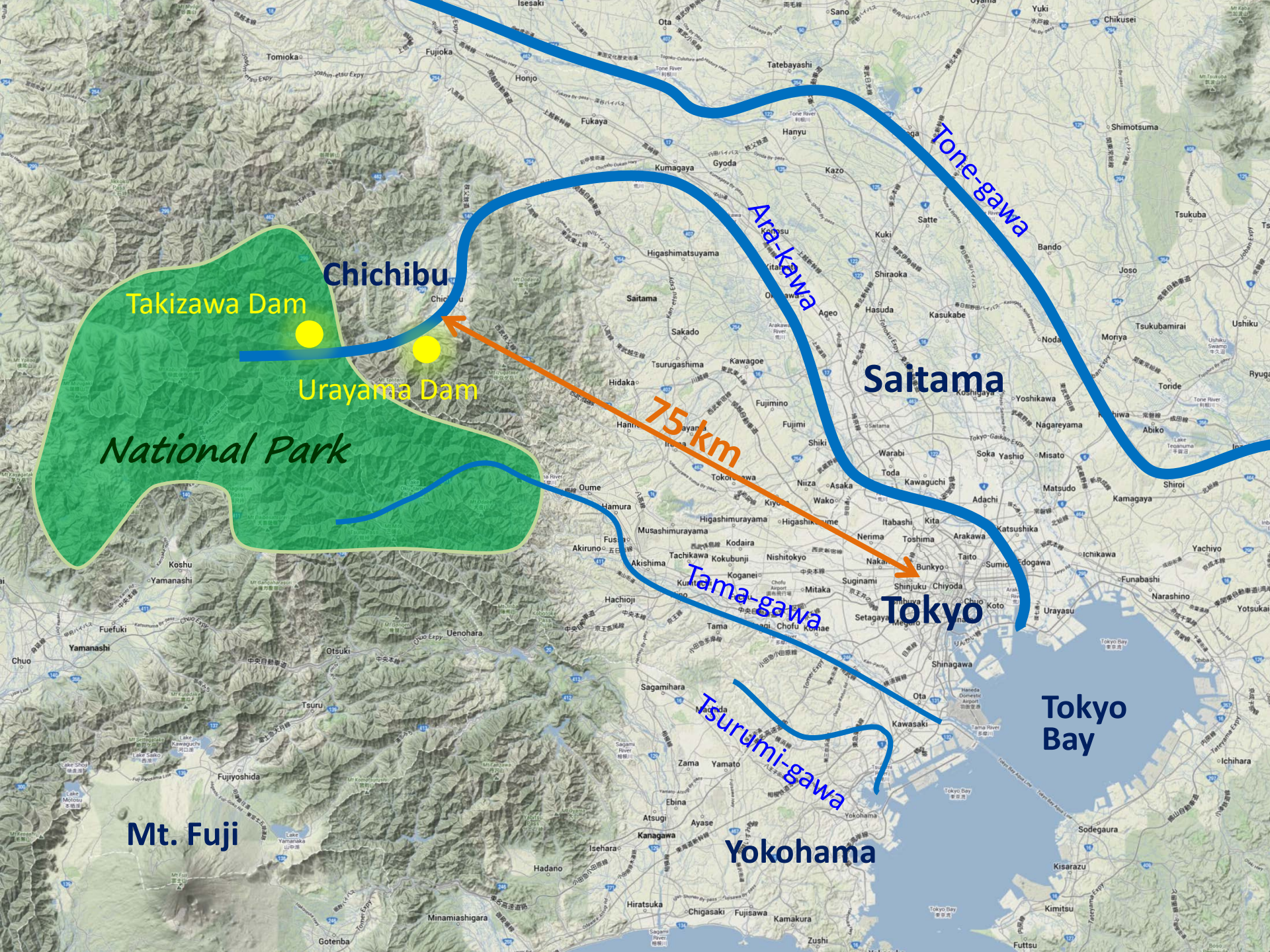
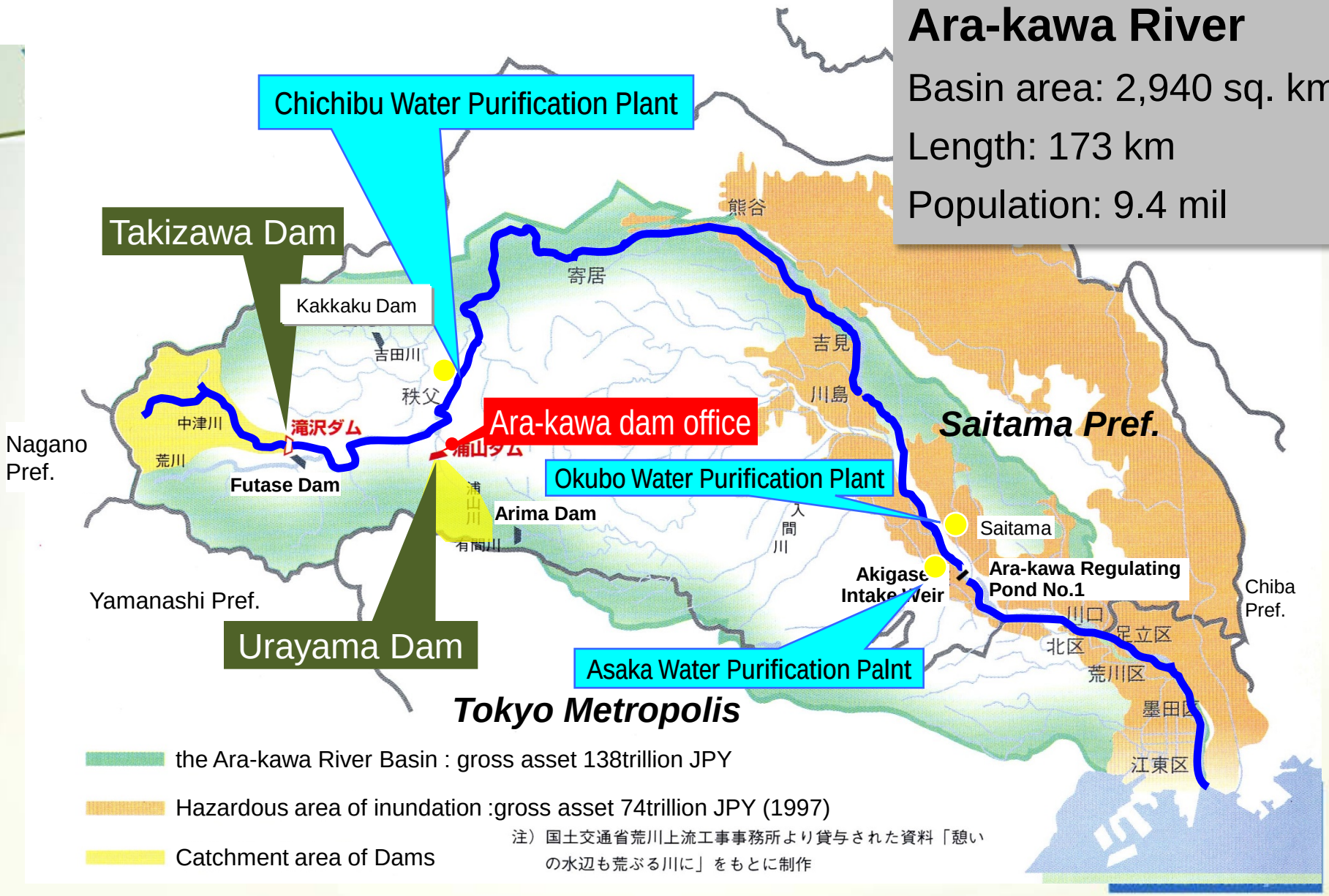
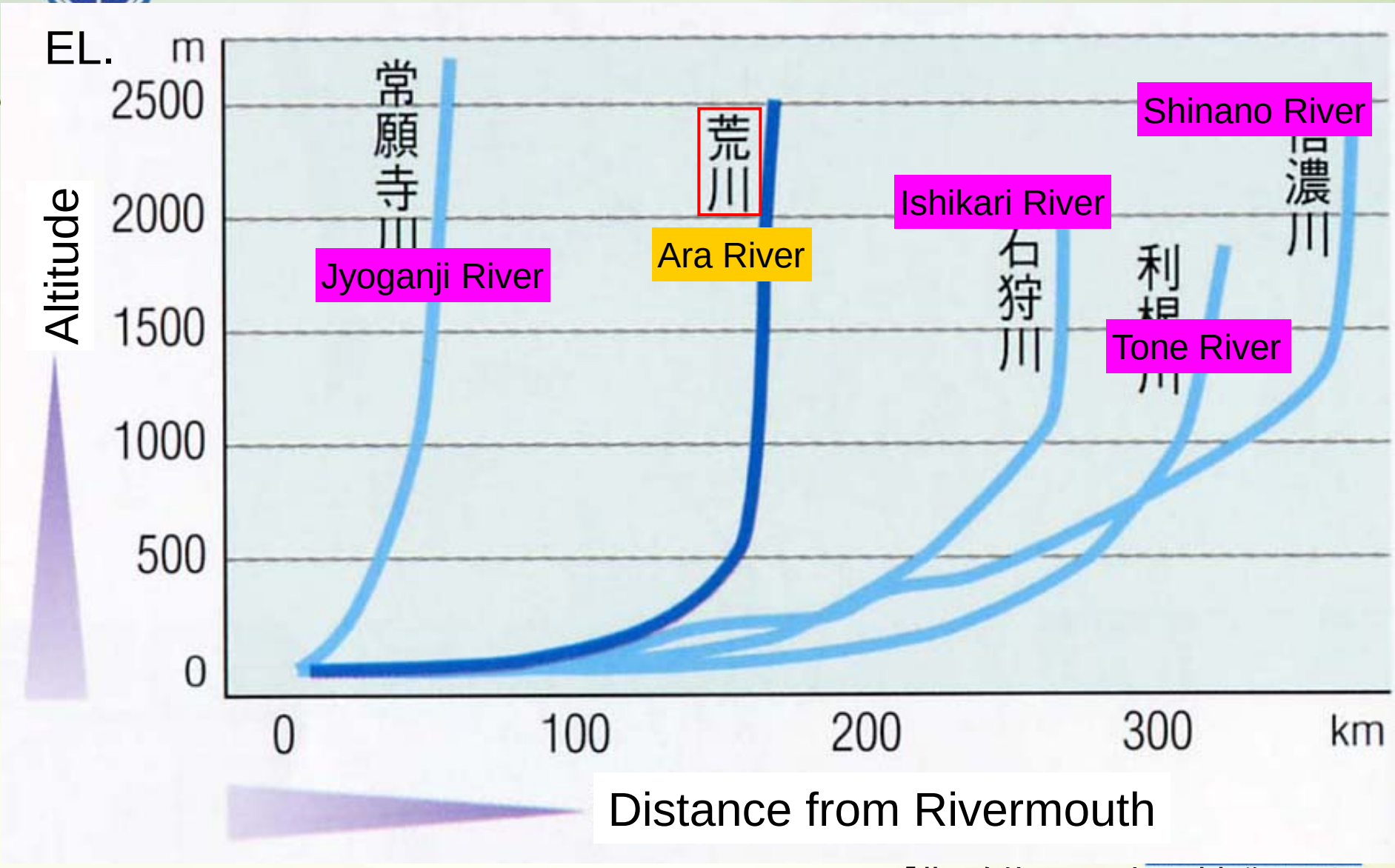

Chichibu
Takizawa Dam
Urayama Dam
National Park
75 km
Tone-gawa
Ara-kawa
Tama-gawa
Tsurumi-gawa
Saitama
Tokyo
Tokyo Bay
Yokohama
Mt. Fuji

# The Ara-kawa River Basin

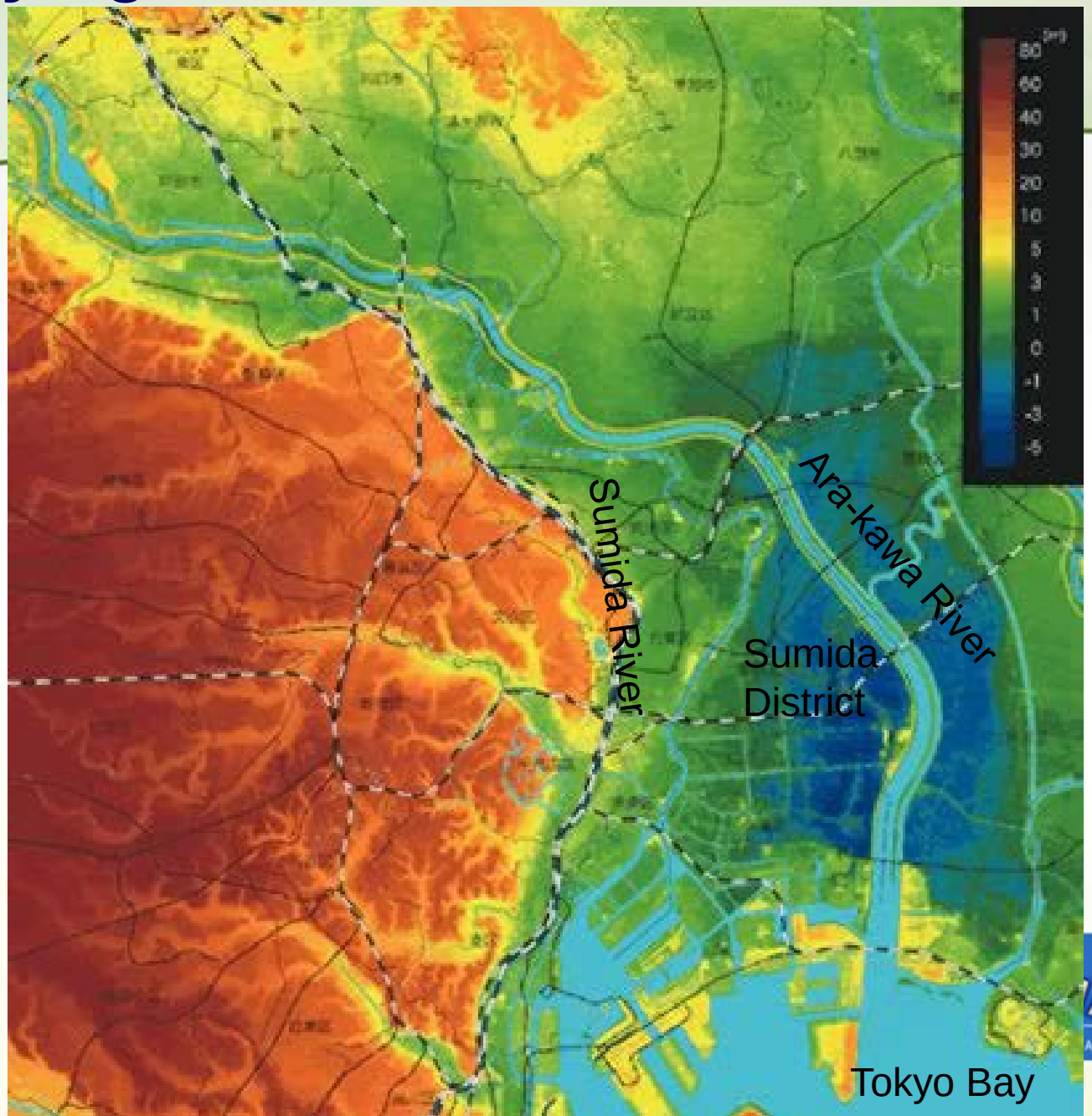


# Vertical Section of Major River in Japan




「荒川自然」P.329　坂井睦郎作図より

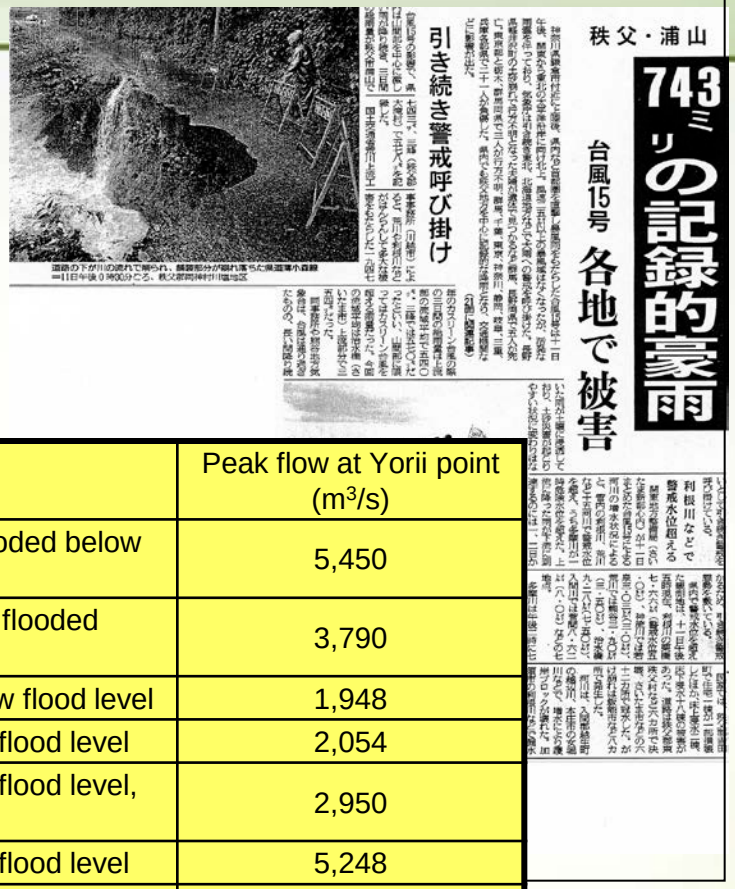
# Low lying area near Ara-kawa river mouth



# Flood in Ara-kawa River Basin

東京新聞（H13.9.12台風15号）

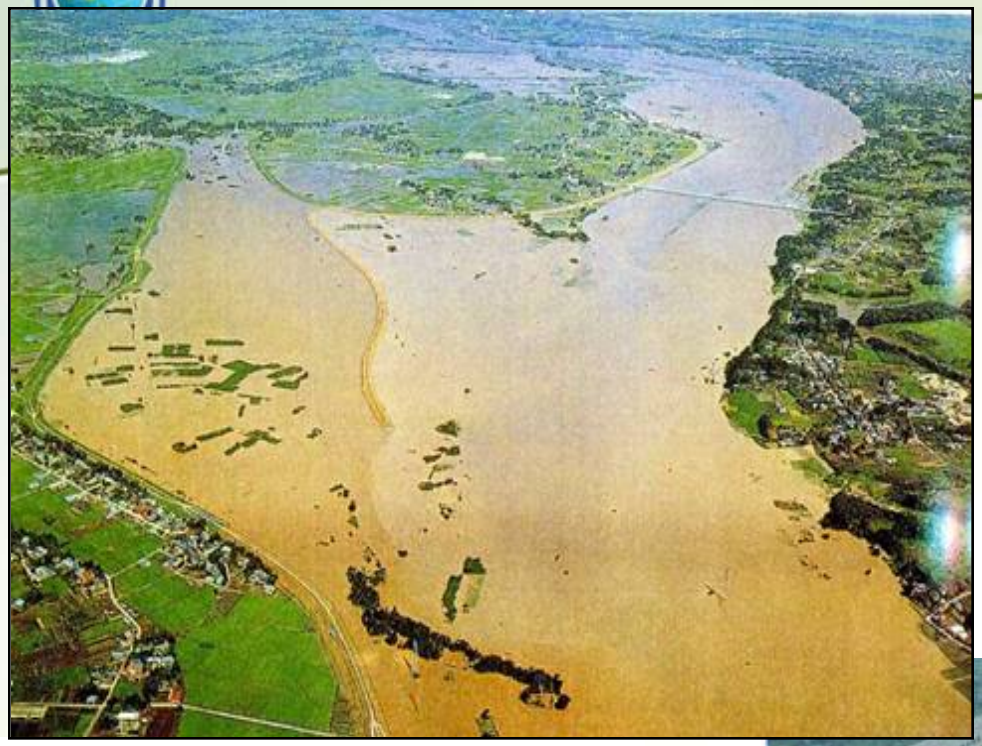

埼玉新聞（H13.9.12　台風15号）




| Flood occurrence | Description of damage | Peak flow at Yorii point ($m^3/s$) |
|---|---|---|
| Aug. 1982 | Two deaths, 97 houses flooded above the floor level, 2,229 houses flooded below flood level | 5,450 |
| Sept. 1982 | One death, 4,163 houses flooded above the floor level, 13,005 houses flooded below flood level | 3,790 |
| Sept. 1991 | 2,750 houses flooded above the floor level, 9,335 houses flooded below flood level | 1,948 |
| Aug. 1993 | 410 houses flooded above the floor level, 2,902 houses flooded below flood level | 2,054 |
| Sept. 1998 | 674 houses flooded above the floor level, 3,925 houses flooded below flood level, 10 damaged river sites | 2,950 |
| Aug. 1999 | 605 houses flooded above the floor level, 1,747 houses flooded below flood level | 5,248 |
| July 2000 | 517 houses flooded above the floor level, 997 houses flooded below flood level | 1,712 |
| Sept. 2001 | 3 houses flooded above the floor level, 23 houses flooded below flood level | 3,888 |

The catchment area of the Ara-kawa River flowing through the Tokyo Metropolitan area, in which about one third the Japanese population and industries are concentrated, covers an area of 2,940 $km^2$ in the Tokyo and Saitama Prefectures, containing 19 wards, 39 cities, 24 towns and 7 villages, 9.2 million people with a population density of 3,100 people per $km^2$, and total assets of about 138 trillion yen. The assets in the area in the catchment area expected to be flooded total about 73 trillion yen. (Source: River Status Survey, March 1997)

# Flood in Ara-kawa River Basin



Typhoon No.18, 1982

Tropical storm, 1999

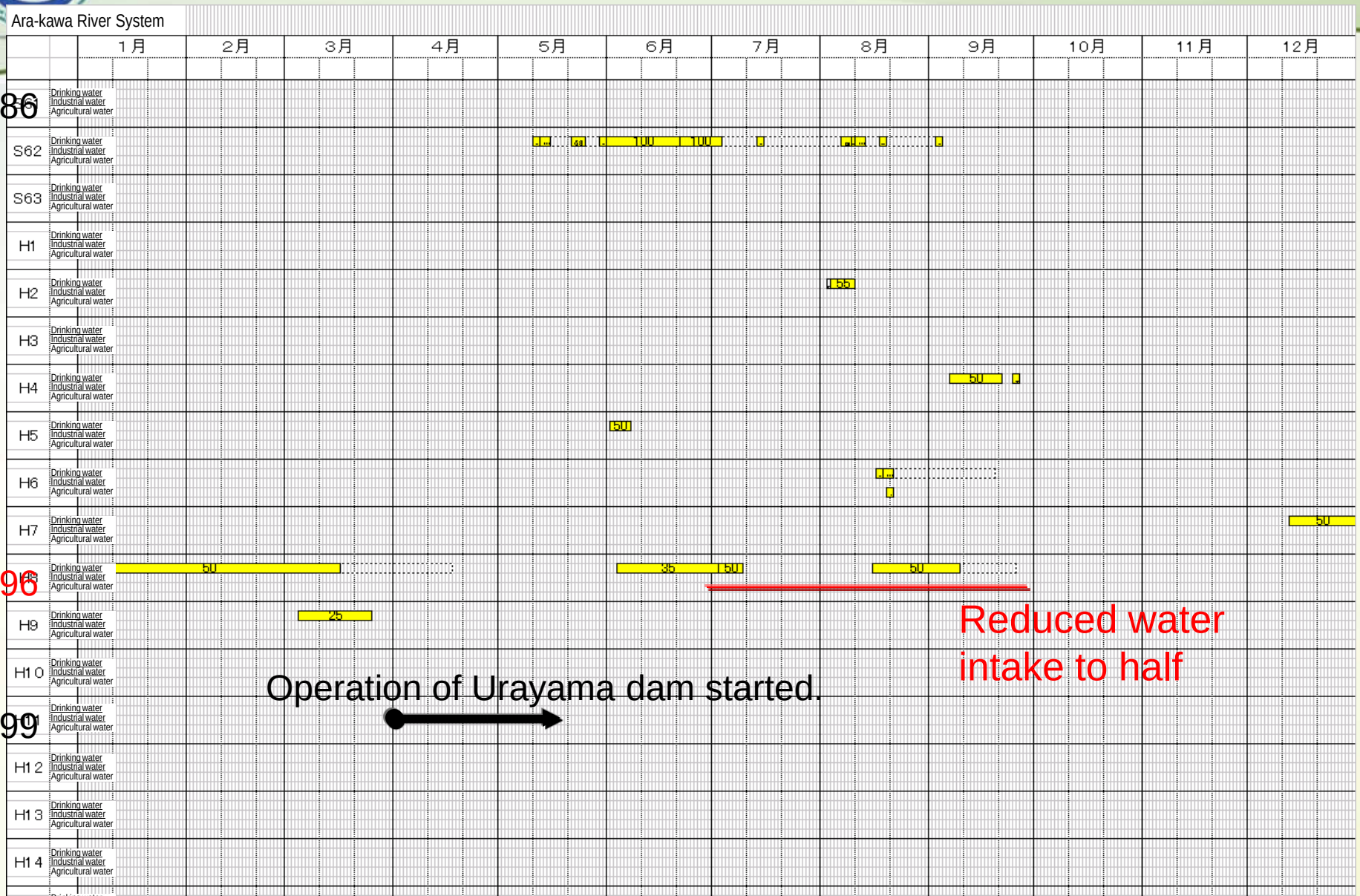
# Ara-kawa River Drought

River flow interruptions caused by draught, which not only disrupt the supply of traditional agricultural irrigation water but also have significant impact on the environment, including deaths of fish.

Ara-kawa River water disappears.

(Aug. 20, 1996)

# Ara-kawa River Drought



# Challenges of Ara-kawa River Basin

- Flood control
- Supply water

  for drinking and river environment

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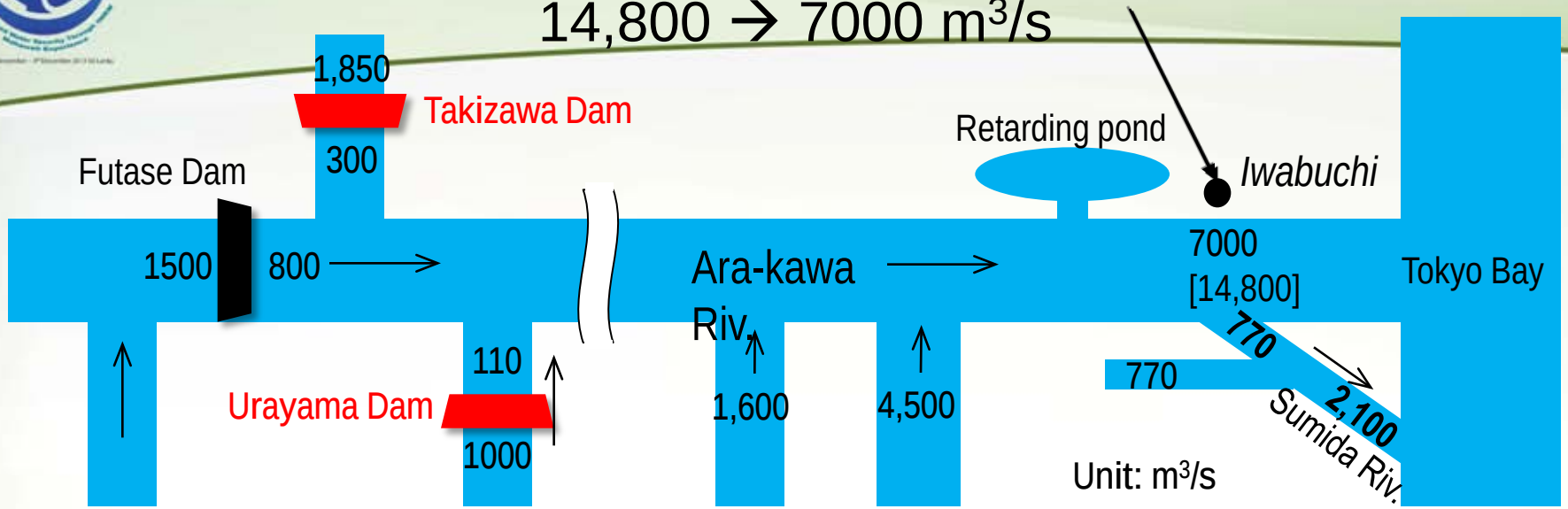
# Flood Management Plan

Flood occurring once every 200 years

14,800 → 7000 m³/s

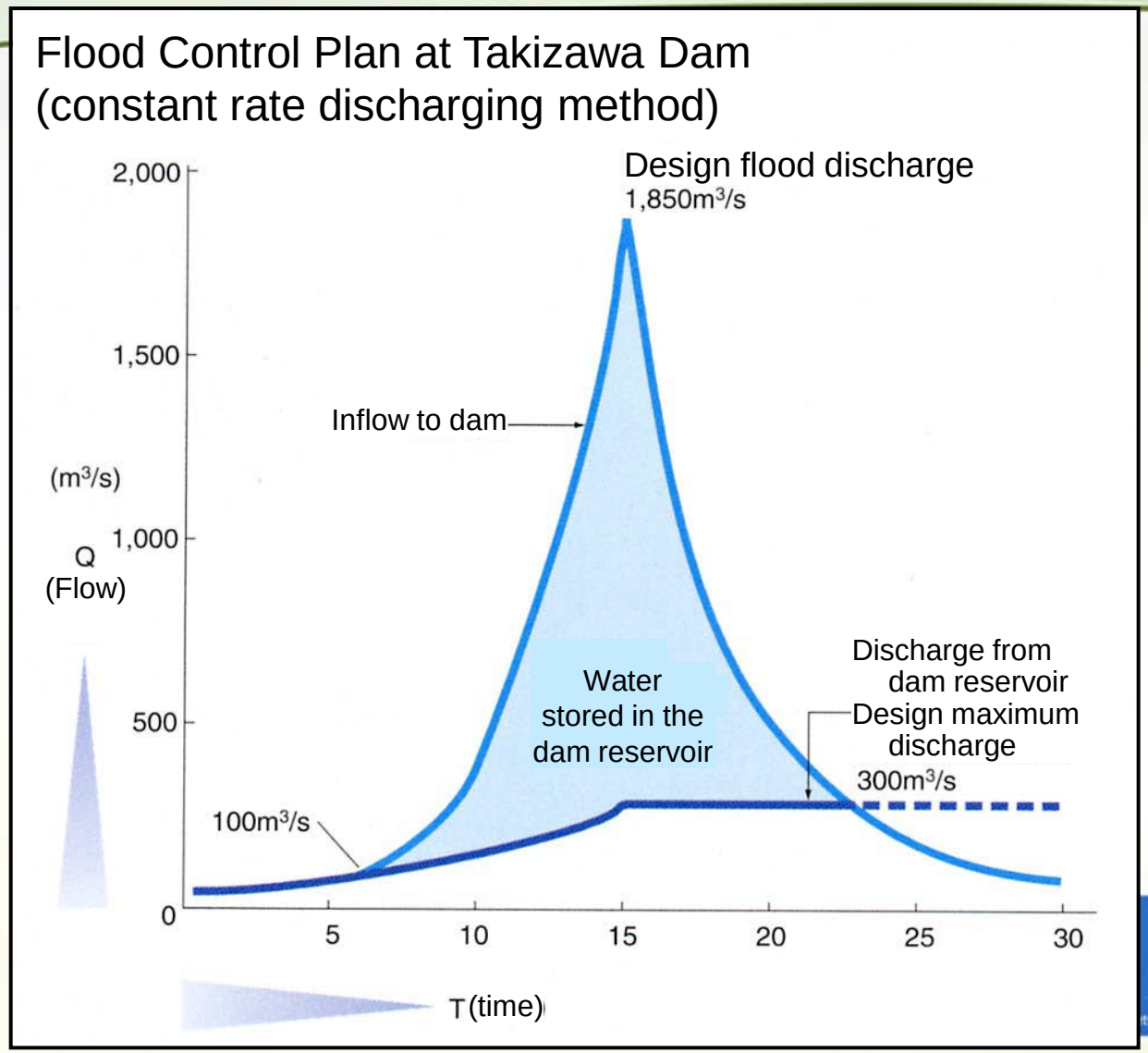



Figures are design high water discharge.
Figures in [ ] show basic high water discharge.

This is 3rd master plan established in 1973
(1st master plan in 1911
2nd master plan in 1965)

# Flood Control Plan at Takizawa Dam

inflow 1,850 $m^3$/sec → outflow 300 $m^3$/sec



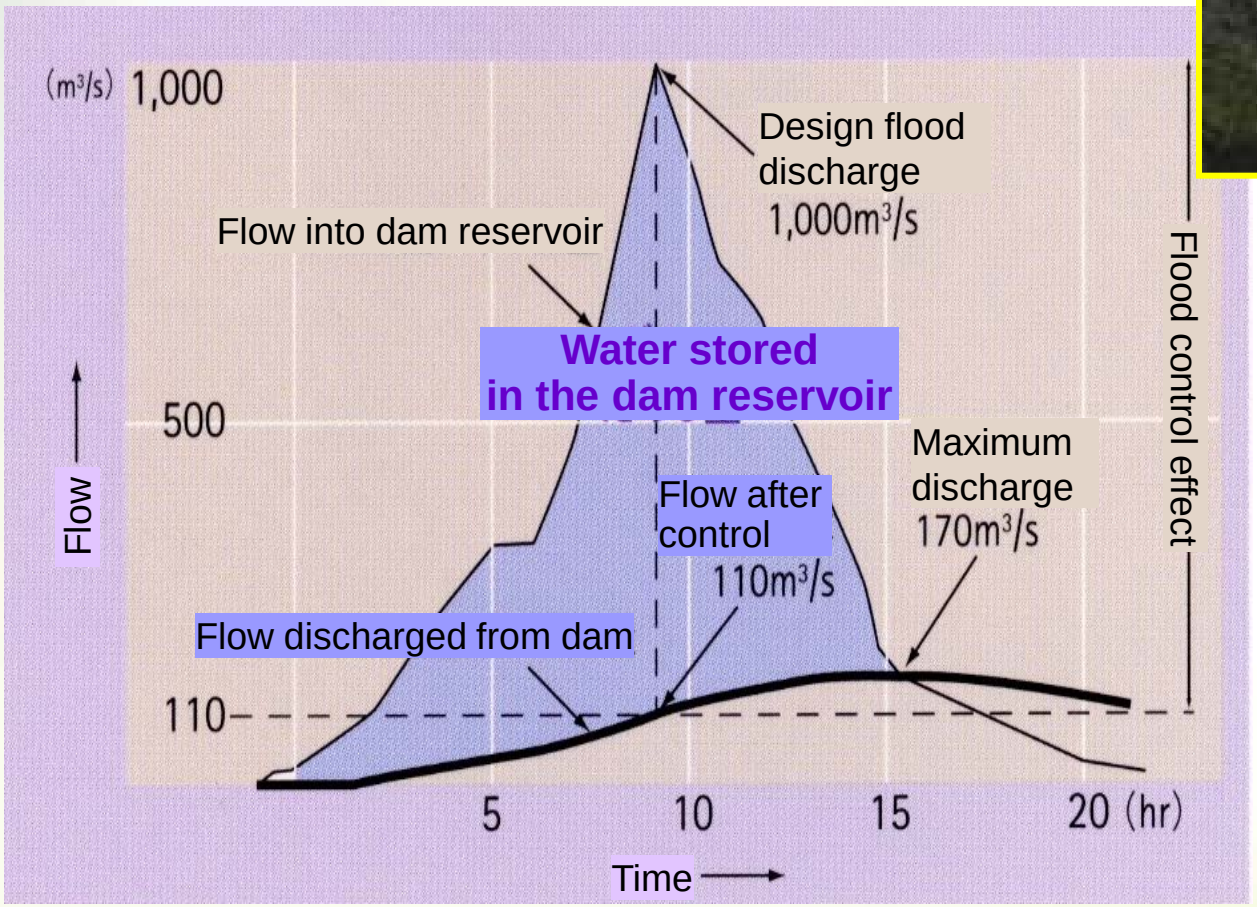
# Flood Control Plan at Urayama Dam

inflow 1,000 $m^3$/sec → outflow 110 $m^3$/sec

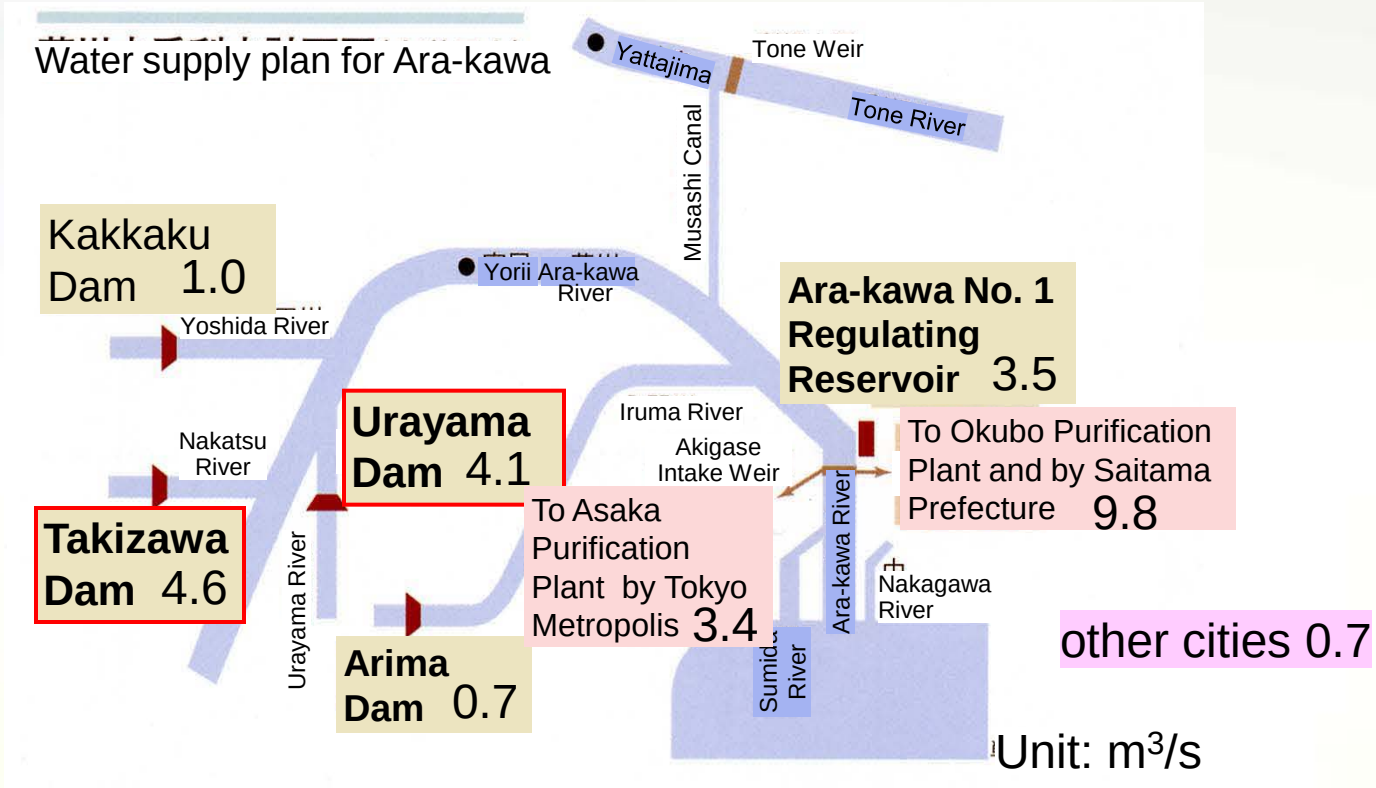
Photo showing flood control operation

Qout = 100 $m^3$/sec

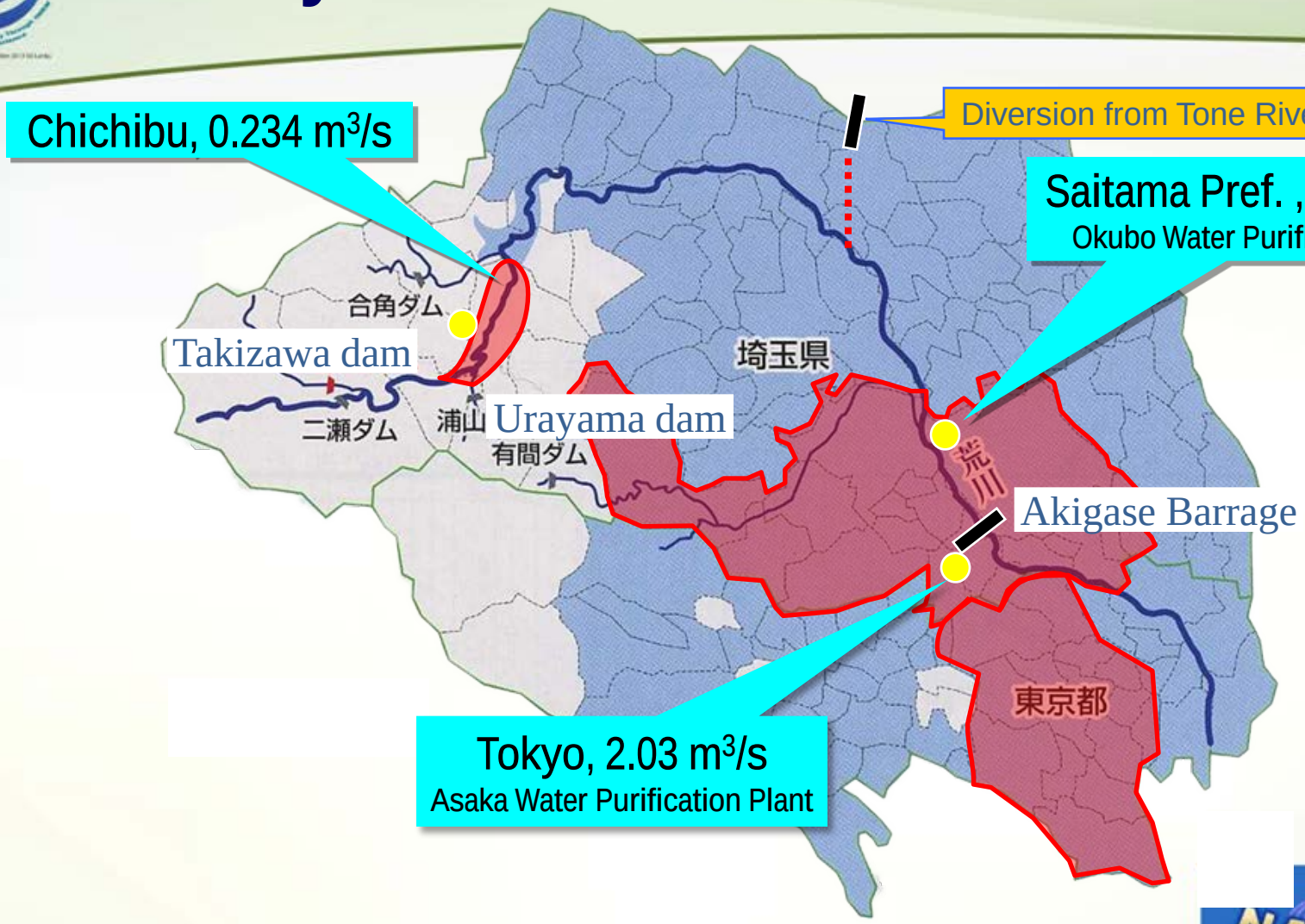
## Flood Control Plan at Urayama Dam (natural regulation method)



# Municipal Water Utilization Plan for Ara-kawa River basin



# Water supply area of Urayama and Takizawa dams




Water supply area served by Urayama & Takizawa Dams

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Urayam Dam

1967 pilot survey

1990 start dam construction

1996 start first impounding

1999 completion

Futase Dam (MLIT)

1961 completion

Takizawa Dam

1965 pilot survey

1999 start dam construction

2005 start first impounding

2008 completion

# Urayama Dam & Takizawa Dam

## Profile

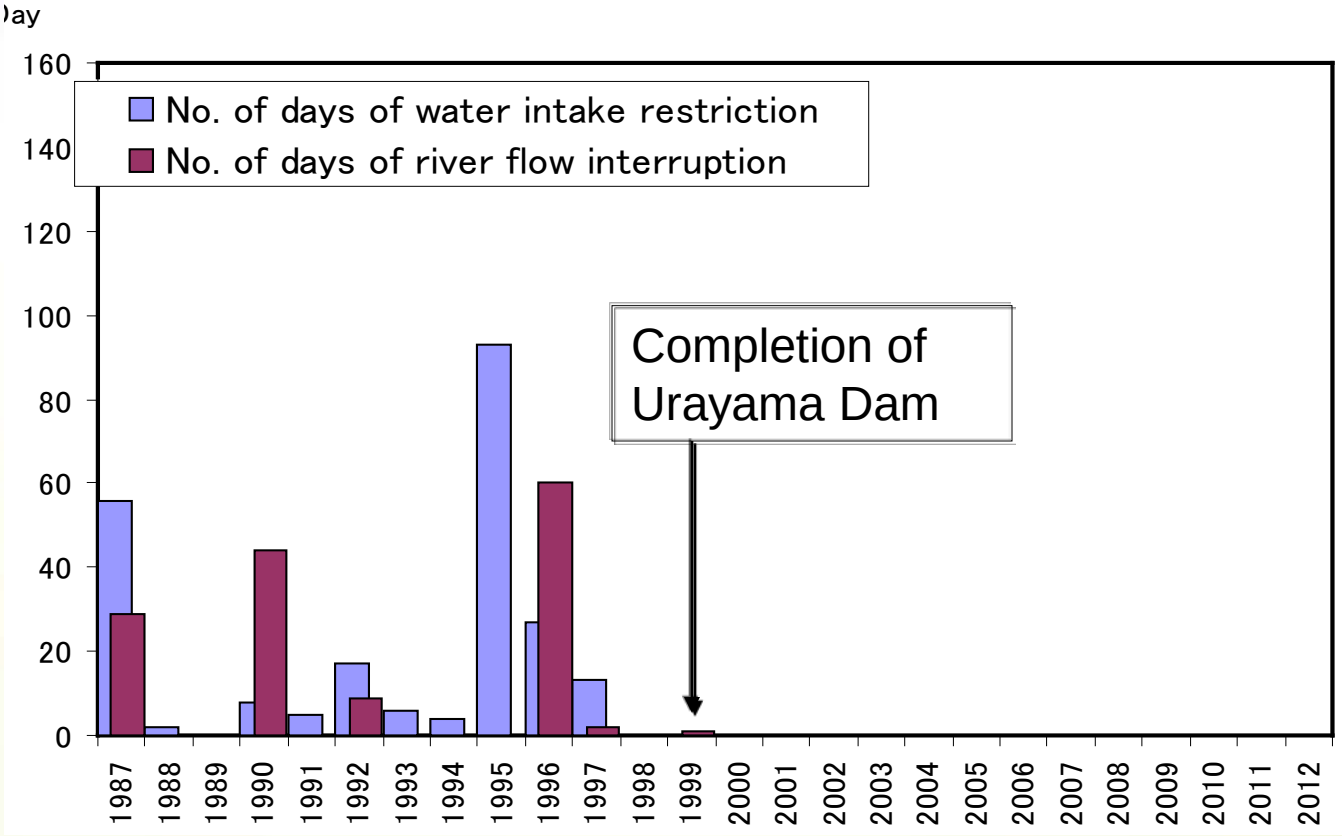
| | Urayama Dam | Takizawa Dam |
|---|---|---|
| Completion | 1999 | 2008 |
| Total Storage | 58 mil $m^3$ | 63 mil $m^3$ |
| Height | 156 m | 132 m |
| Catchment | 51.6 $km^2$ | 108.6 $km^2$ |

## Project Purpose

| | Urayama Dam | Takizawa Dam |
|---|---|---|
| Flood Control | 1,000 → 110 $m^3/s$ | 1,850 → 300 $m^3/s$ |
| Water Supply | 4.1 $m^3/s$ | 4.6 $m^3/s$ |
| Securing Normal flow | 0.7 $m^3/s$ | 0.49 $m^3/s$ |
| Hydro Power | 5 MW | 3.4 MW |

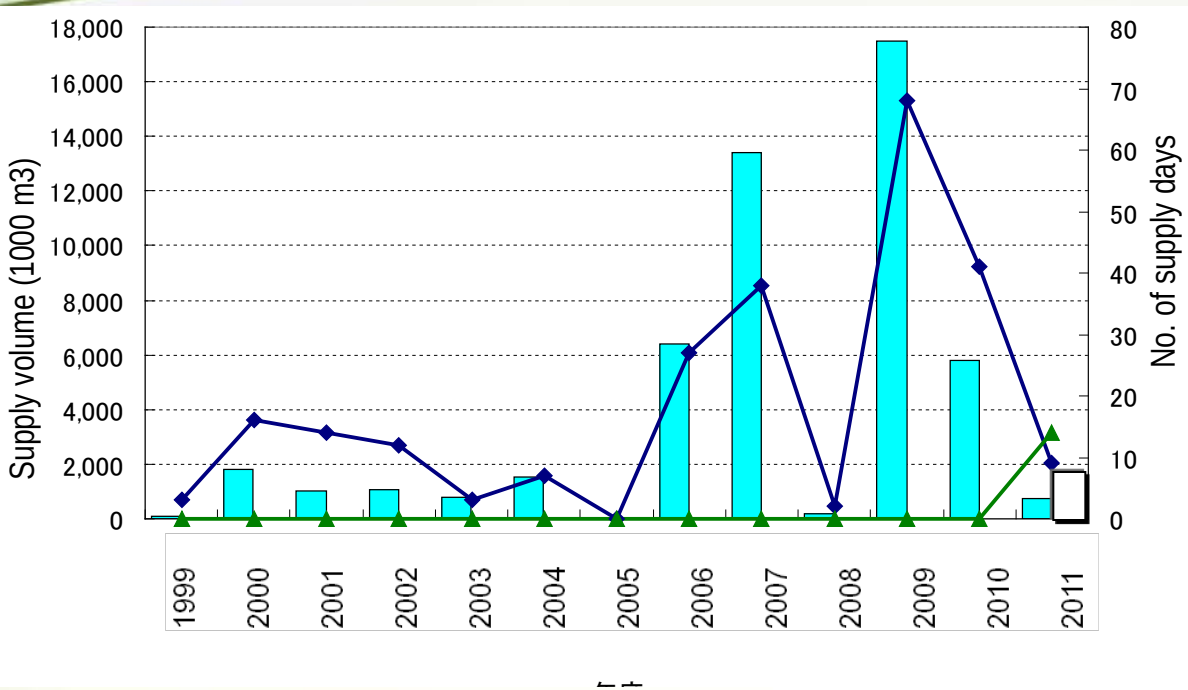
# Conservation of River Environment

River flow interruptions became less frequent after the construction of Urayama Dam.

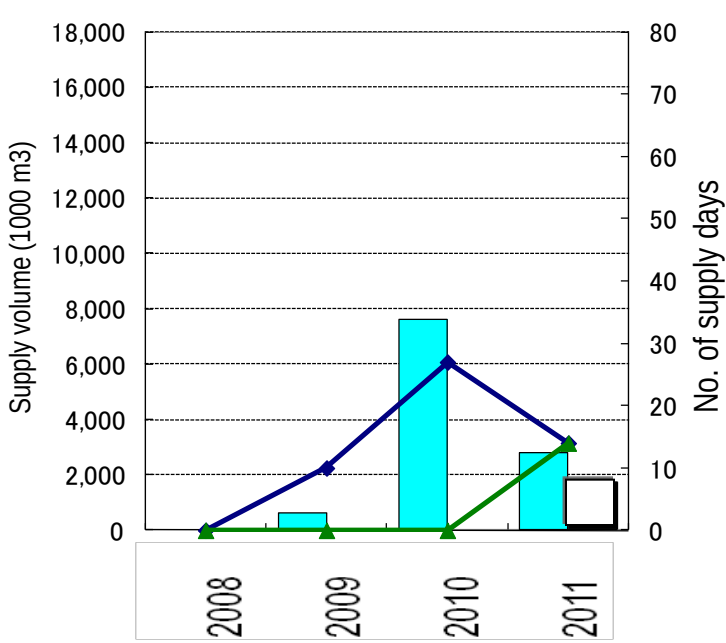


# Water Supply from Dams

No draught after completion of Dams




Urayama Dam




Takizawa Dam

Supply volume N (1000 m3)

Supply volume W (1000 m3)

No. of supply days N

No. of supply days W

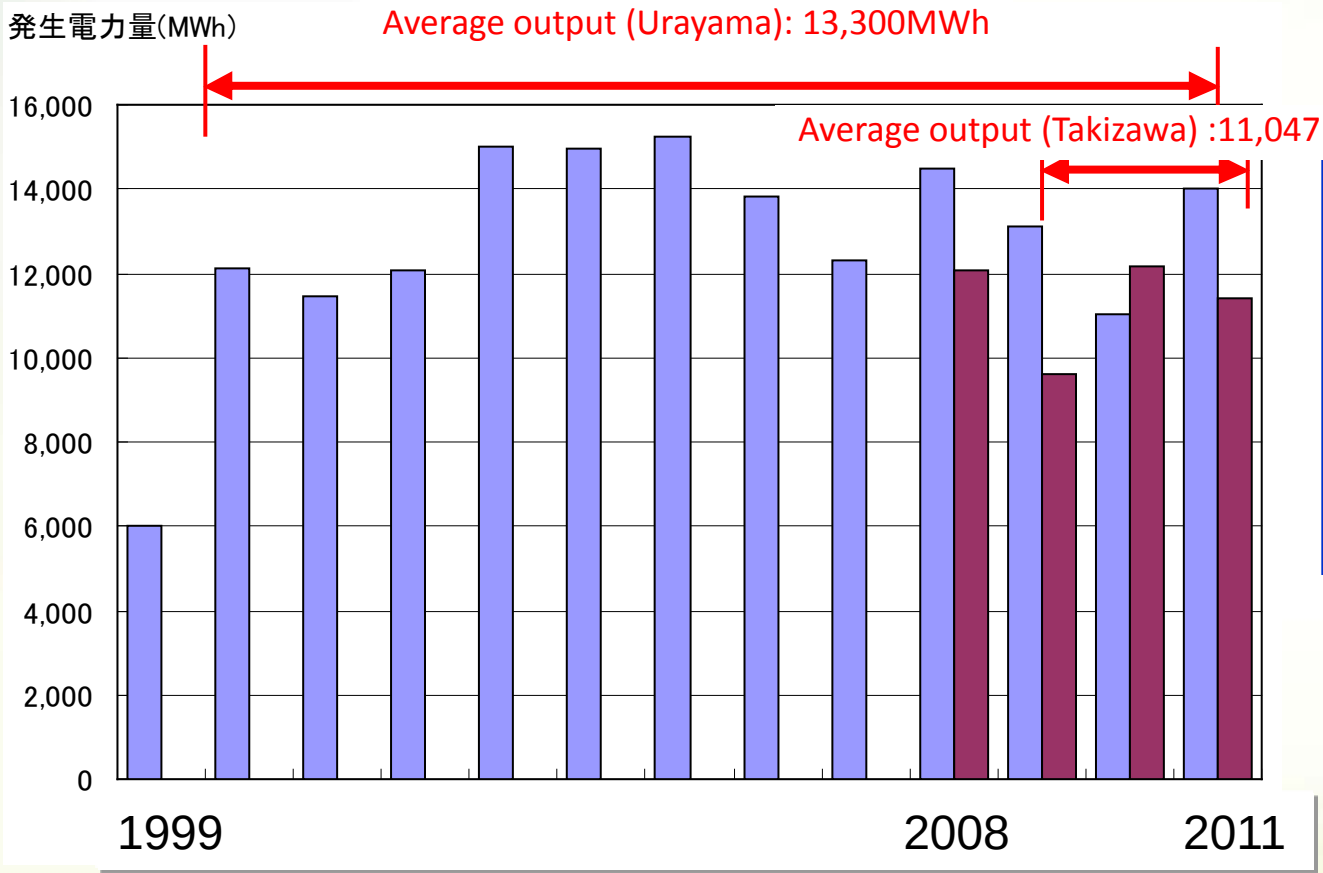
# Hydropower Generation

Urayama and Takizawa Dams can generate max. output of 5,000kW and 3,400kW, respectively.

The power generation business of both dams are operated by Tokyo Power Generation Co.

Urayama power plant generates 3,300 households electricity per year.

Takizawa Power Plant generates 2,700 households electricity.

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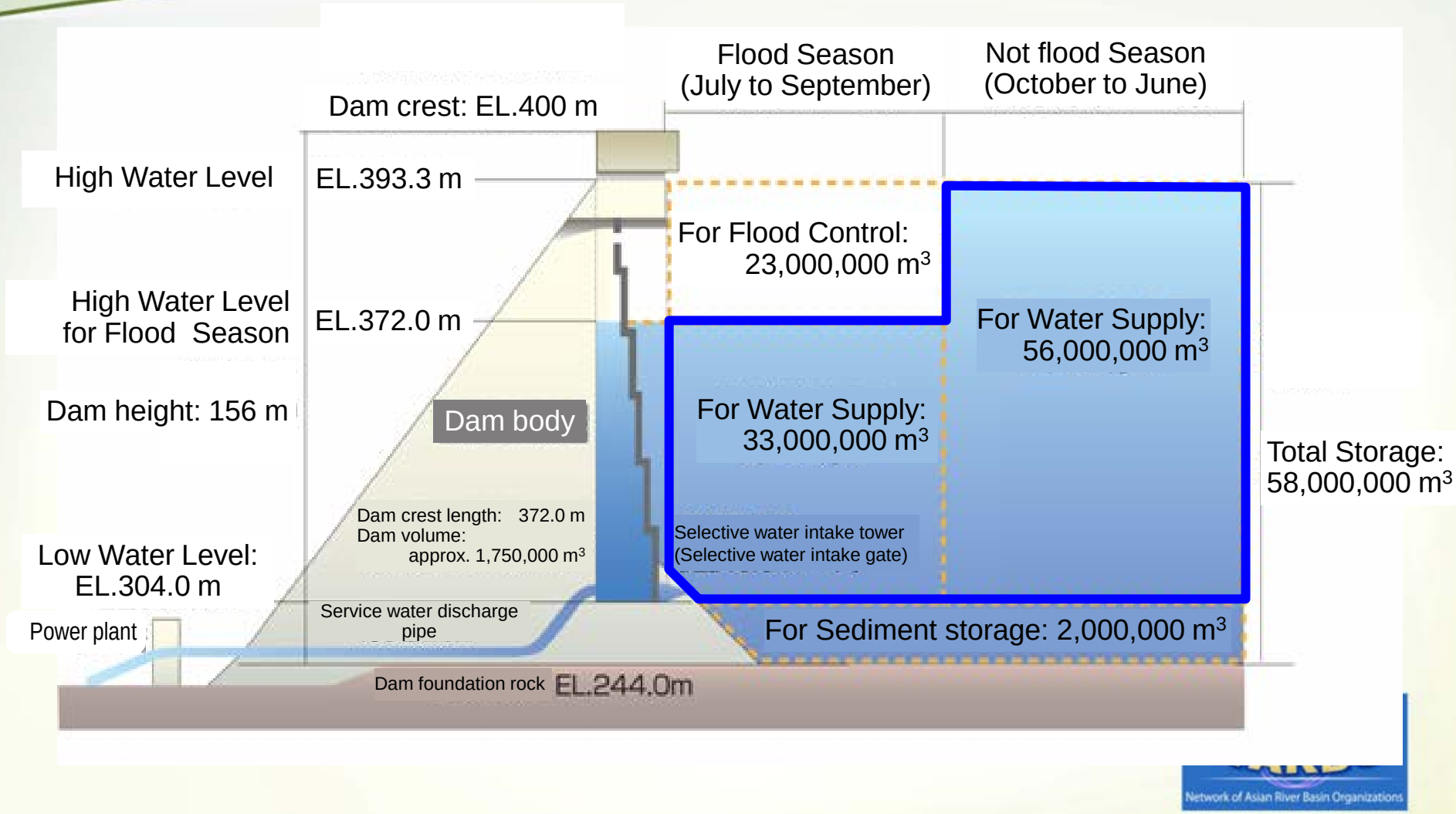
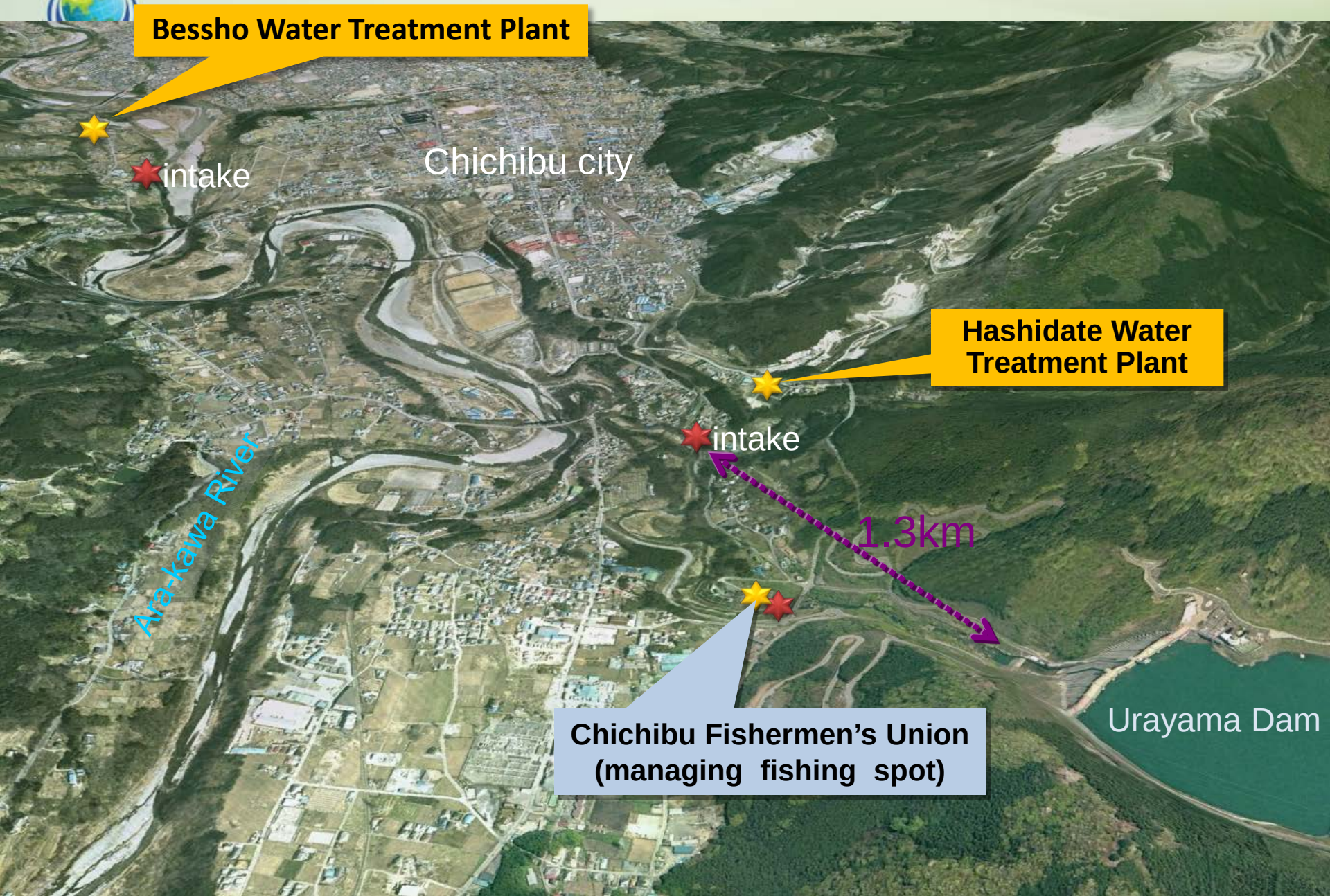
# Storage allocation of Urayama Dam



# Strong demand for quality water



# Observation of the hydrological and water quality data


Management center


Hanamido Water Level and Quality Observatory

Water Quality Observatory



Okubo Rain Gauge Station

Hosokubo Rain Gauge Station

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# Observation of the hydrological and water quality data

Each observatory is equipped with a telemeter. The data automatically measured every hour is transmitted wirelessly to the management center and stored in the server.

Each piece of data may be checked by using a PC in the management center or a cellular phone.


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# Sharing daily information of dam operation and water quality with stakeholders

## ＦＡＸ送信表

昭和電工株式会社
秩父漁業協同組合
秩父市役所水道部浄水課　各担当者　様
アイウエオ順

送信日：平成25年11月6日

### 浦山ダム情報

平成25年　11月　6日　AM 8:00 現在　（速報値）

**1．ダム状況**

| | | |
|---|---|---|
| 貯水位 | EL.366.57 m | |
| 流入量 | 3.12 | $m^3/s$ |
| 全放流量 | 4.05 | $m^3/s$ |
| 発電放流量 | 4.05 | $m^3/s$ |
| 利水管放流量等 | 0.00 | $m^3/s$ |
| 合計 | 4.05 | $m^3/s$ |

**2．気象状況〔流域平均〕**

| | | |
|---|---|---|
| 気温（ダム地点） | 7.5 | ℃ |
| 雨量（時間） | 0.0 mm | （7:00 -8:00） |
| 日雨量 | 0.0 mm | （11/5） |

・秩父地方の現在の降水確率

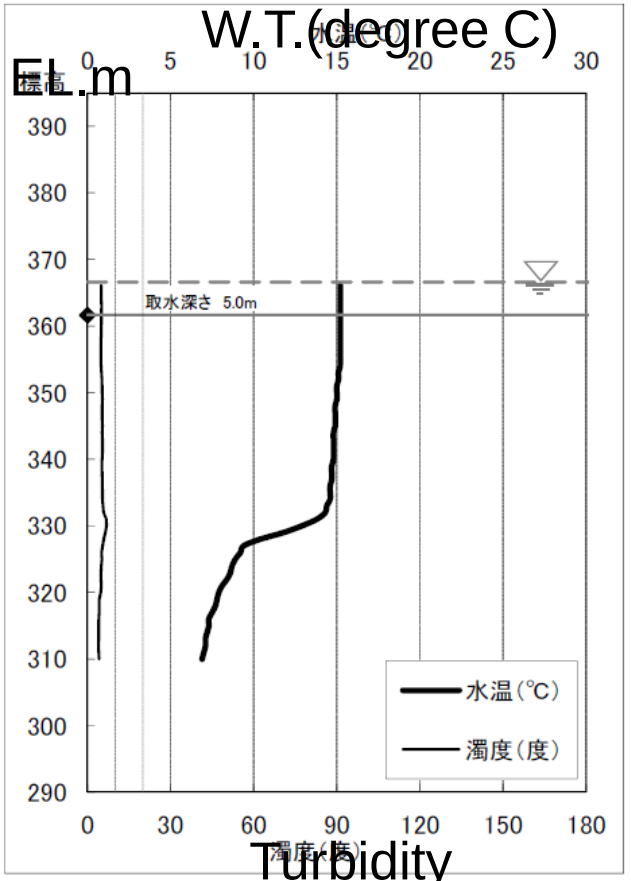
| | |
|---|---|
| 06－12 | 0 % |
| 12－18 | 0 % |
| 18－24 | 10 % |

**3．水質状況**

| 計測地点 | | 計測水深 | 水温〔℃〕 | 濁度〔度〕 | 備考 |
|---|---|---|---|---|---|
| 流入河川 | 上流端 | | 11.4 | 1.7 | |
| 貯水池（基準地点）（AM1:00） | 表層 | 0.5m | 15.2 | 4.9 | |
| | 取水深 | 5.0 m | 15.2 | 5.1 | |
| ダム下流 | 放流口 | | 14.8 | 4.7 | |
| | 花御堂 | | 14.2 | 欠測 | |

## 基準地点水質自動観測結果（速報）

2013/11/6　1:00観測　　観測開始時貯水位366.60 m
濁度Max　6.9 度
◆ 選択取水上段扉　　EL.361.63m




Turbidity

Inflow and outflow volume, Water temperature, Water turbidity, Water selected level, and so on.

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# Urayama Dam Accessible for the Local Community

Dam Right Bank Plaza and Resource center

# Urayama Dam Accessible for the Local Community

**Development of the area around the reservoir**

Building of recreation trails

Construction of lakeside parks

Use of canoes

# Urayama Dam Accessible for the Local Community

Chichibu Cherry Blossom Lake Festival


Prince Chichibu Memorial Road Race

Upstream and Downstream Exchange Meeting

# Water quality problems of Urayama Dam

| Blue-green algae (Mold odor) | Freshwater red tides | Long-term turbidity of the water reservoir | Cold and hot water discharge |
|---|---|---|---|
| Phytoplankton is seriously proliferated in the water reservoir and mold odor is generated.<br>(Generated in July to October) | Phytoplankton is seriously proliferated in the water reservoir and freshwater red tides are generated.<br>(Generated in March to December) | Turbid water which flowed in at the time of flooding, etc. stay in the water reservoir for a long time. It stays especially long during the stirring period.<br>(Generated in August to January) | The temperature of the natural river water which is flowing in is different from that of the discharged water.<br>(Occasionally) |




# Water quality problem and solution of Urayama Dam

## Blue-green algae (Mold odor)

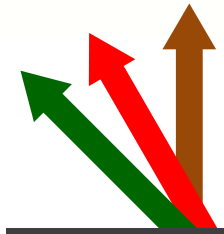
Phytoplankton is seriously proliferated in the water reservoir and mold odor is generated.
(Generated in July to October)

## Freshwater red tides

Phytoplankton is seriously proliferated in the water reservoir and freshwater red tides are generated.
(Generated in March to December)

## Turbidity of the water reservoir

Turbid water which flowed in at the time of flooding, etc. stay in the water reservoir for a long time. It stays especially long during the stirring period.
(Generated in August to January)

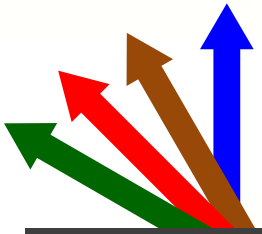


**Partition fences In center of reservoir**

## Cold and hot water discharge

The temperature of the natural river water which is flowing in is different from that of the discharged water.

(Occasionally)



**Selective water intake facilities**

To take reservoir water at the chosen depth.

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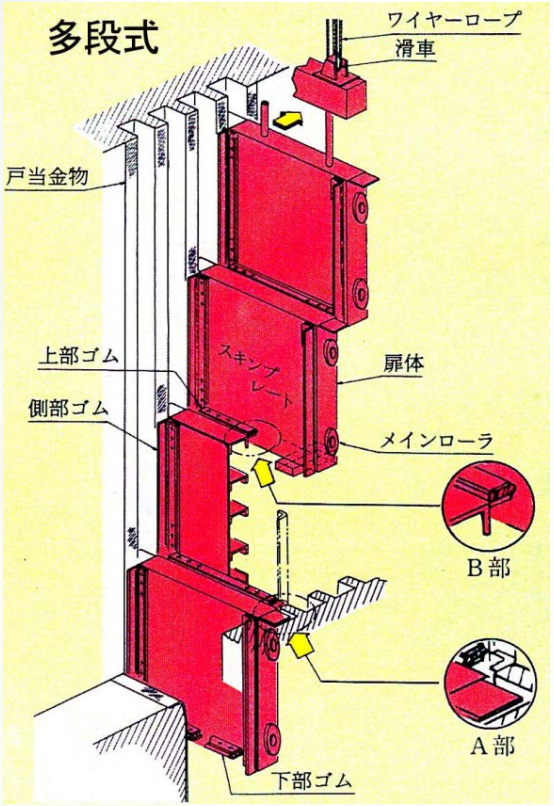
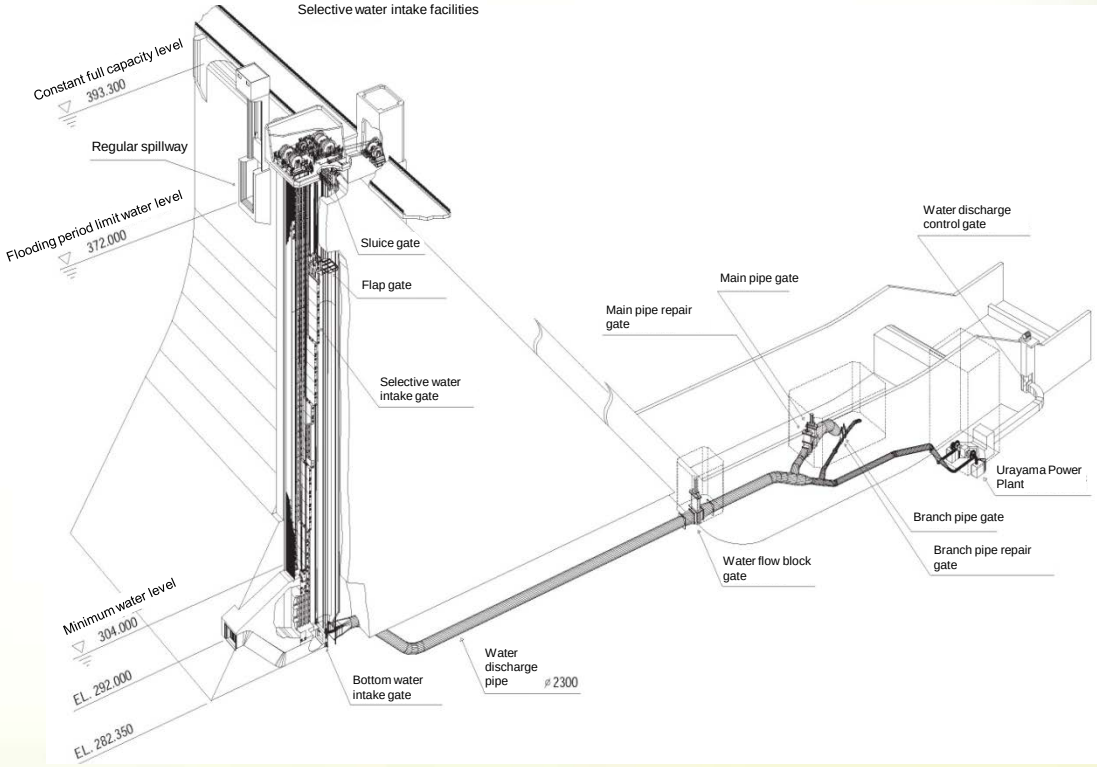
# Selective water intake facility

Purpose: To take water at an arbitrary depth

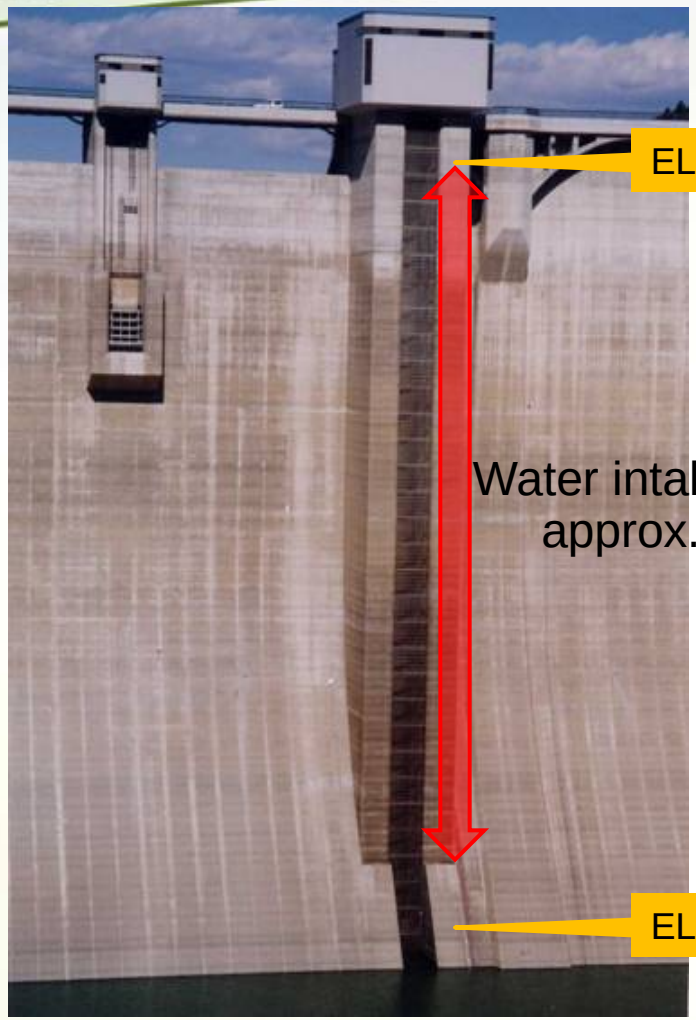
Effect: To prevent the turbid or cold water, or the water with abnormal growth of phytoplankton from discharging to downstream by selecting water from an arbitrary water layer. Also, the water reservoir may be maintained in the normal condition by preventing the turbid water layer, etc. from accumulating in the dam and intentionally discharging it to downstream at an early stage.



# Selective water intake facility

To intake a proper quality water at any water depth




Winch
(The gate is moved by controlling the wire rope.)

Control panel
(The button used for moving the gate is located on the panel.)

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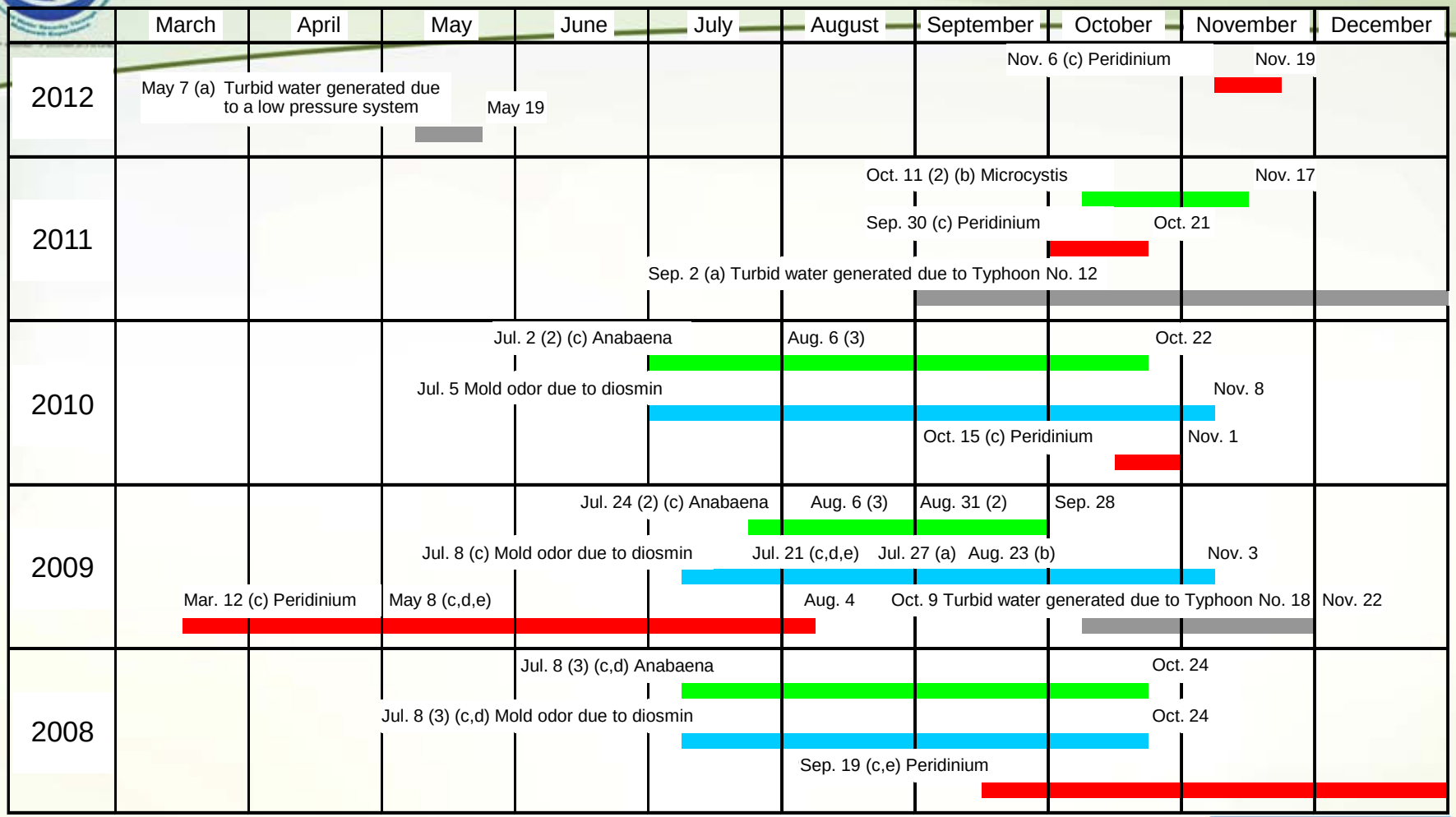
# Water quality of Urayama Dam




- Blue-grean argee
- Mold odor
- Red tide
- Turbid water

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# New Challenge of Urayama Dam

First challenges

- Flood control
- Water supply

for drinking and river environment

New chellenge

- Improvement Water quality

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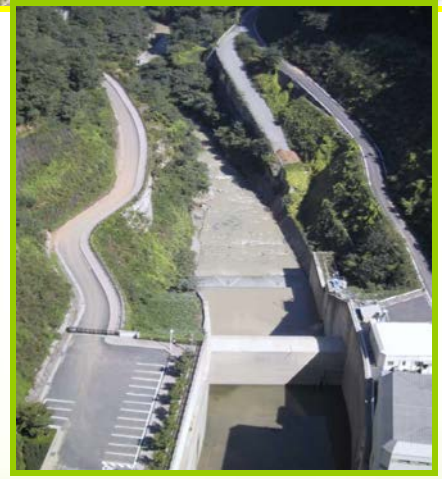
# Water Turbidity for Long Period

The water of the reservoir tends to stay turbid for a long time over 3 months after a large flood. As the water turbidity period lengthens, various problems occur, such as the difficulty of downstream water users to intake water and the worsening quality of the river environment.

Before flood

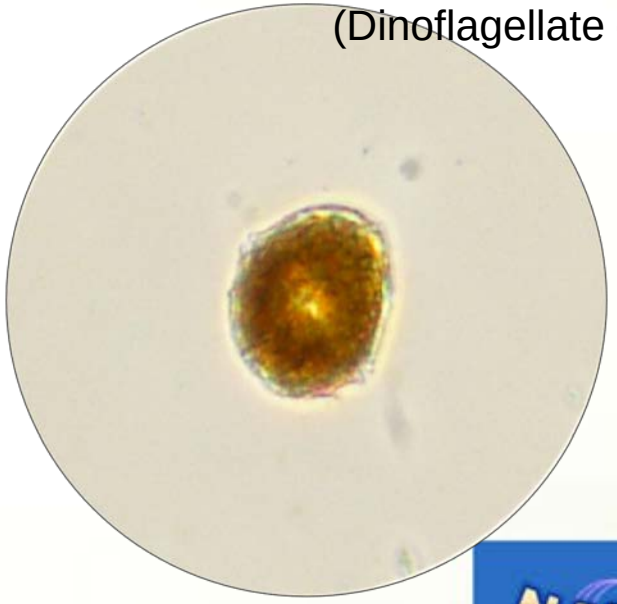
After flood



# Freshwater red tides

Peridinium influence river environment and purification for drinking water

↓ Peridinium
(Dinoflagellate genus)



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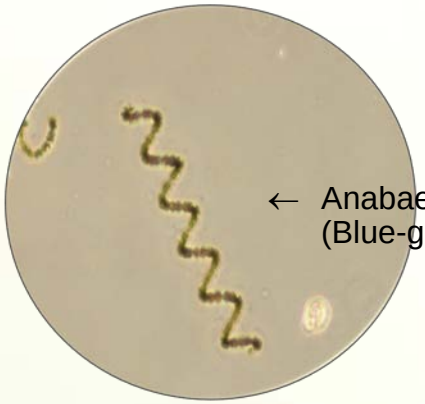
# Blue-green algae (mold odor)


Diosmin generated by blue-green algae is accompanied by mold odor, which caused a lot of complaint to purification plant, one of our stakeholders.



← Anabaena
(Blue-green seaweed)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# Water quality problems and solutions of Urayama Dam

| Blue-green algae (Mold odor) | Freshwater red tides | Long-term turbidity of the water reservoir | Cold and hot water discharge |
|---|---|---|---|
| Phytoplankton is seriously proliferated in the water reservoir and mold odor is generated. (Generated in July to October) | Phytoplankton is seriously proliferated in the water reservoir and freshwater red tides are generated. (Generated in March to December) | Turbid water which flowed in at the time of flooding, etc. stay in the water reservoir for a long time. It stays especially long during the stirring period. (Generated in August to January) | The temperature of the natural river water which is flowing in is different from that of the discharged water. (Occasionally) |

| Aeration stirring facilities | Partition fences | Clear Water Bypass | Selective water intake facilities |
|---|---|---|---|
| The facilities used for stirring the surface layer of the water reservoir (Water depth: approx. 20 m) | The facilities used for preventing phytoplankton from moving by partitioning the water reservoir. | The facilities used for discharging the water located at the inflow section directly to downstream, not through the water reservoir. | The facilities used for taking in the discharged water at an arbitrary depth. |

New facilities

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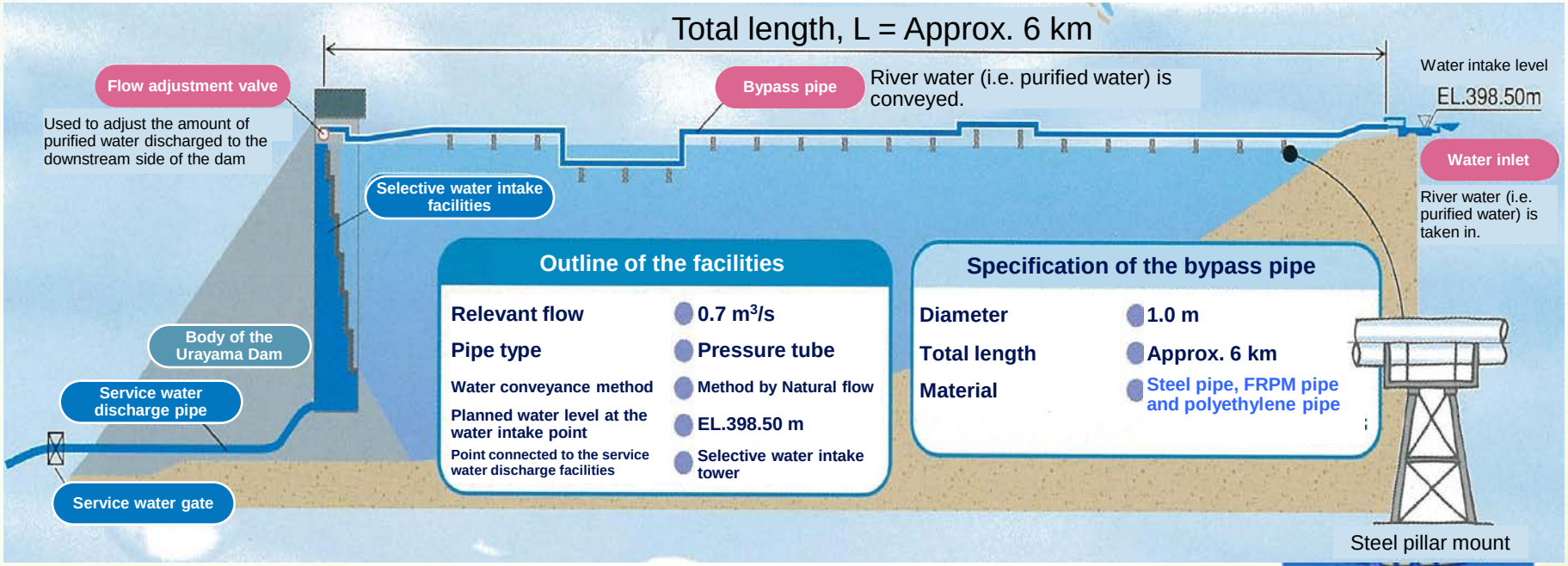
# Bypass system for Clear Water since 2007

Purpose: To reduce the discharge of turbid water to downstream

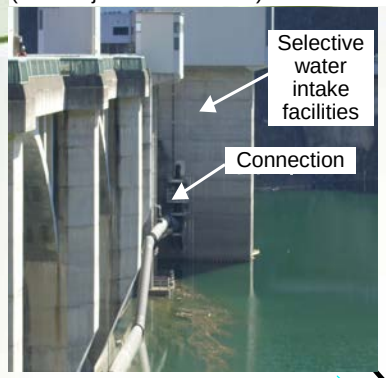
Effect: It is directly taken into the selective water intake facility and discharged to downstream.

Outline

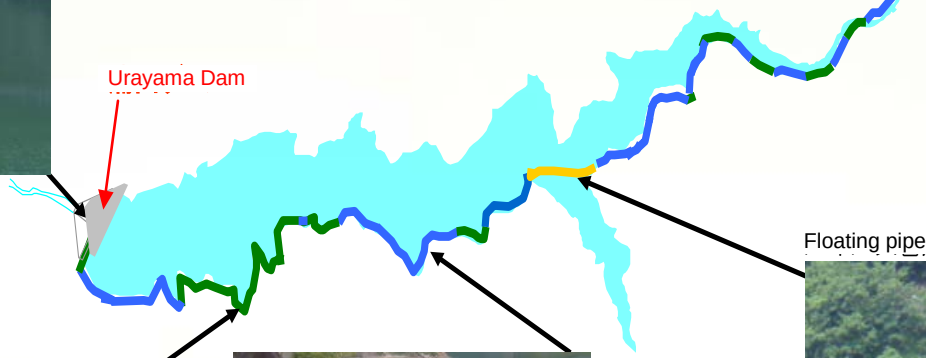


# Bypass system for Clear Water

Connection of the selective water intake facilities
(Flow adjustment facilities)



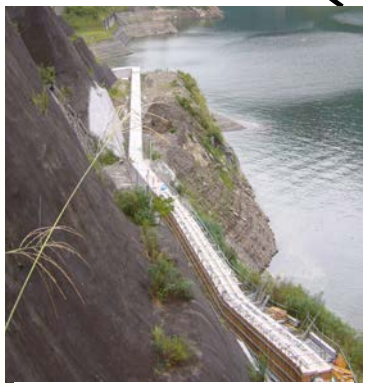

- Steel water pipe channel section (Approx. 2.7 km)
- Prelining concrete section (Approx. 2.6 km)
- Floating pipe section (Approx. 0.4 km)




Water intake facilities


Floating pipe section of the bypass pipe

Steel water pipe channel section of the bypass pipe



Prelining concrete section of the bypass pipe

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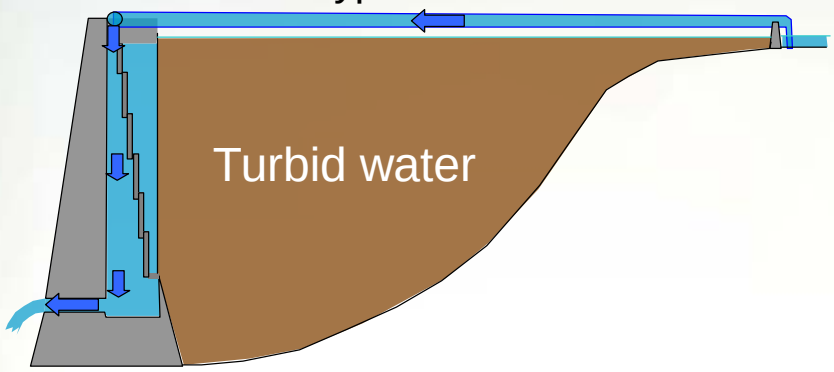
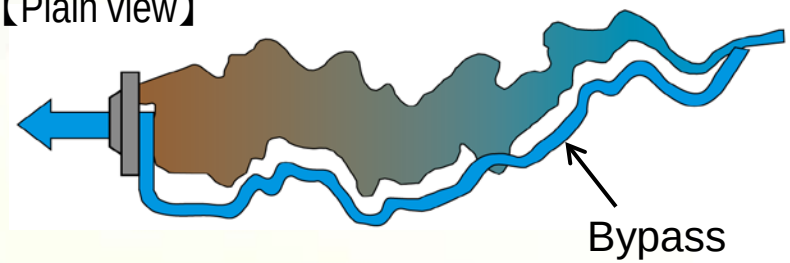
# Bypass system for Clear Water

## After flood or Winter season

【Lateral view】



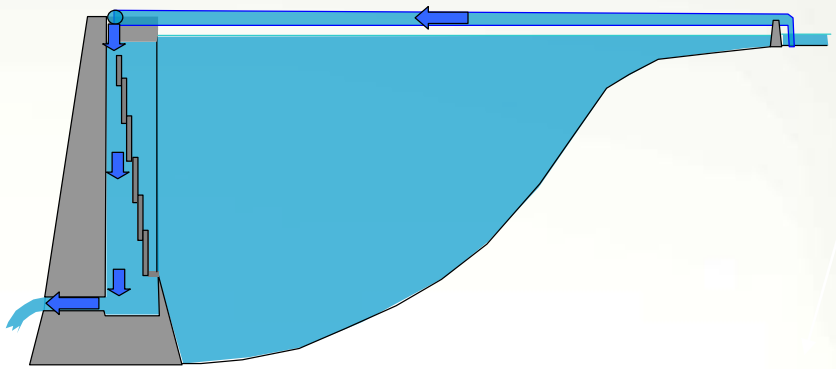

【Plain view】



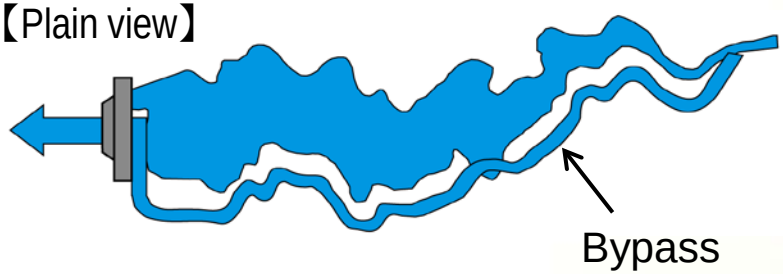

- The system can divert clearer water for downstream

## Normal condition

【Lateral view】




【Plain view】

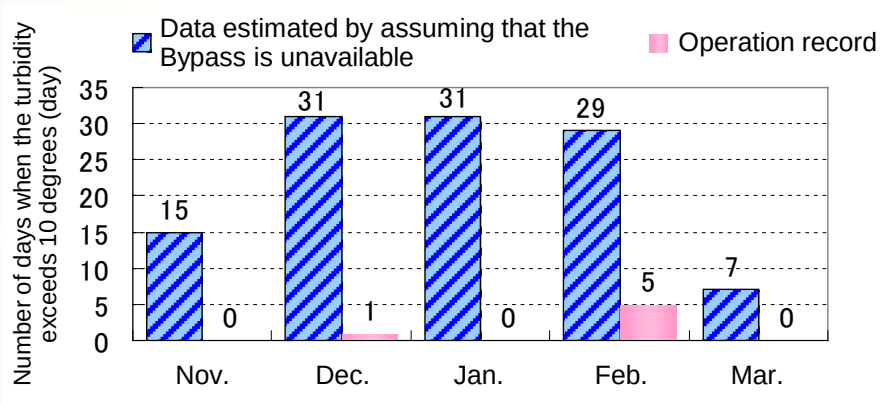


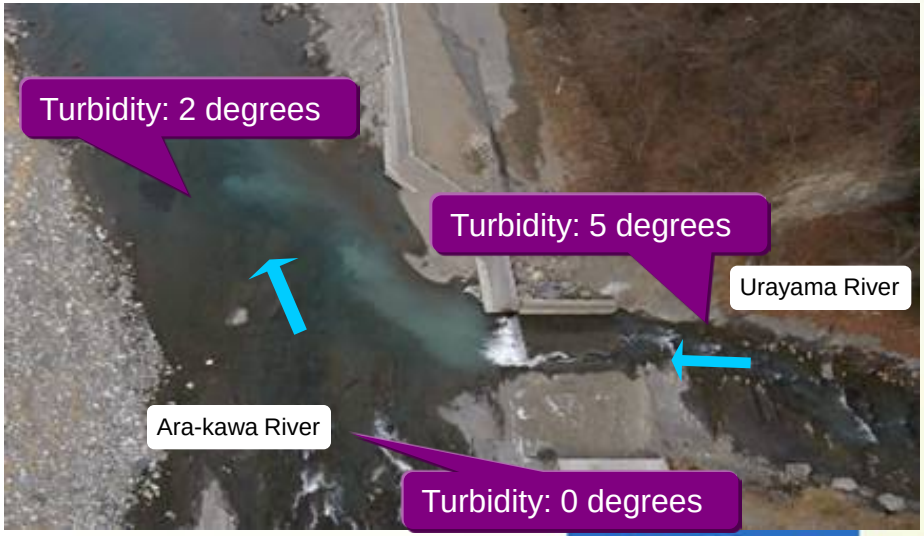

- The system can reduce inflowing nutrient which will cause eutrophication, and
- can fill the gap between inflow and outflow water temperature.

# Bypass system for Clear Water


September 28, 2007 (Before starting the operation)

When the Bypass was not available, the number of days for water discharge with the water turbidity higher than 10 degrees during the period from November 16 to March 31 was estimated to be 113. However, the number of those days was reduce to only 6 by starting to use the bypass.




January 22, 2008 (After starting the operation)

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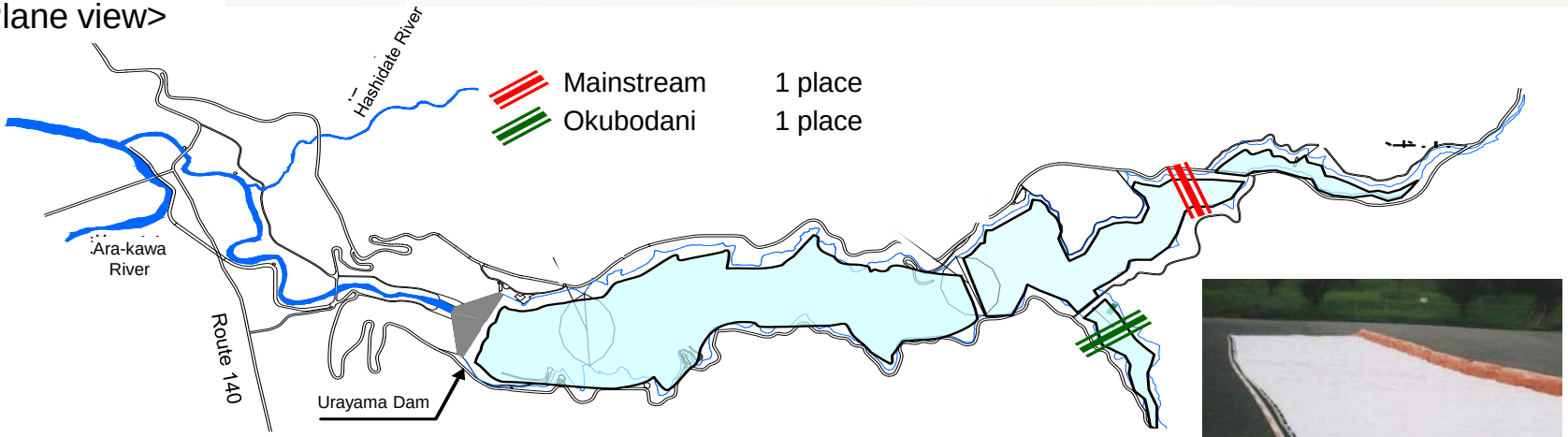
# Partition fences

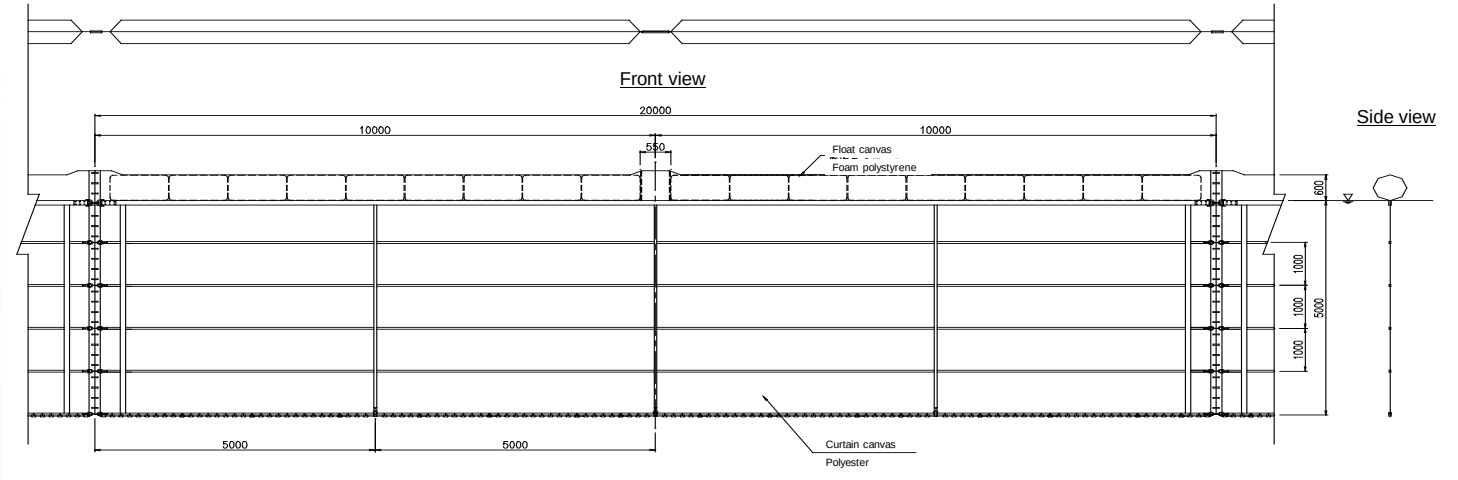
Purpose: To Peridinium is prevented from accumulating upstream.

<Plane view>

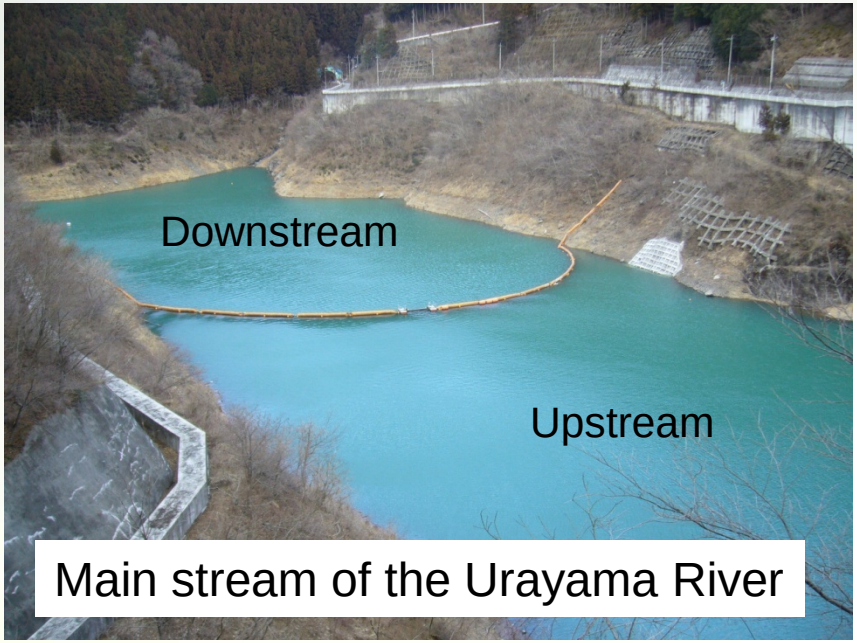




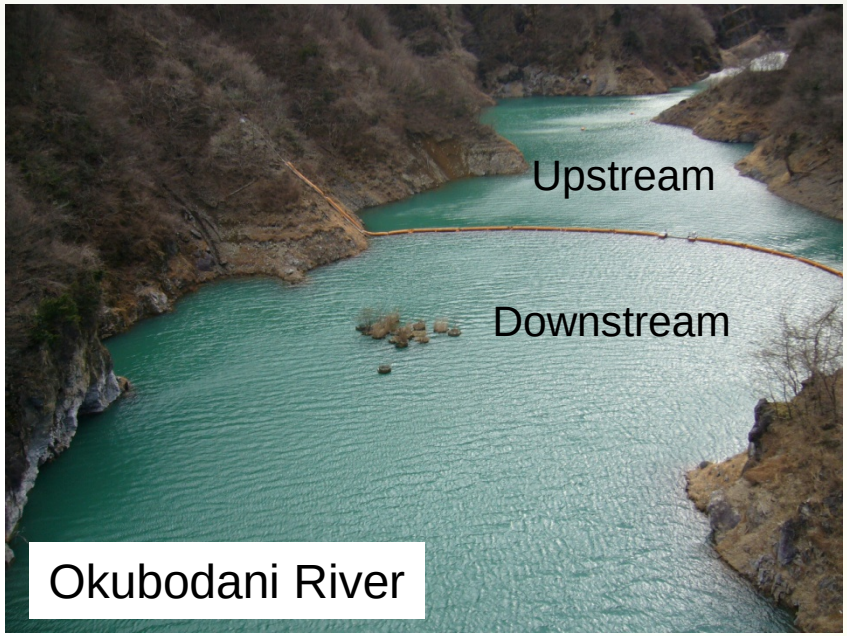

<Structural drawing>



# Partition fences since 2010



Main stream of the Urayama River



Okubodani River

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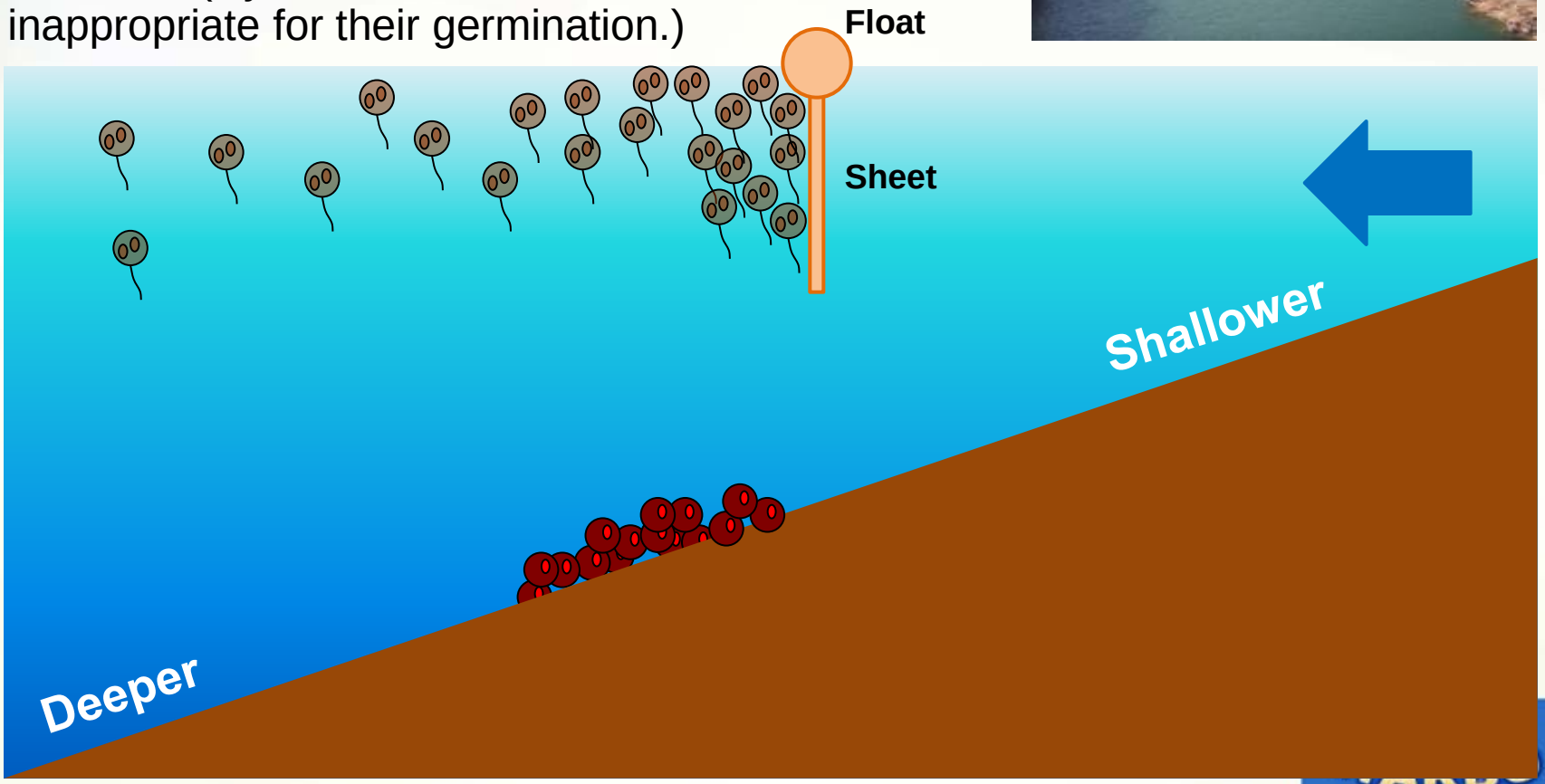
# Partition fences

Mechanism:
Cysts are confined in a deeper place of the water reservoir. (Cysts are fed into an environment inappropriate for their germination.)

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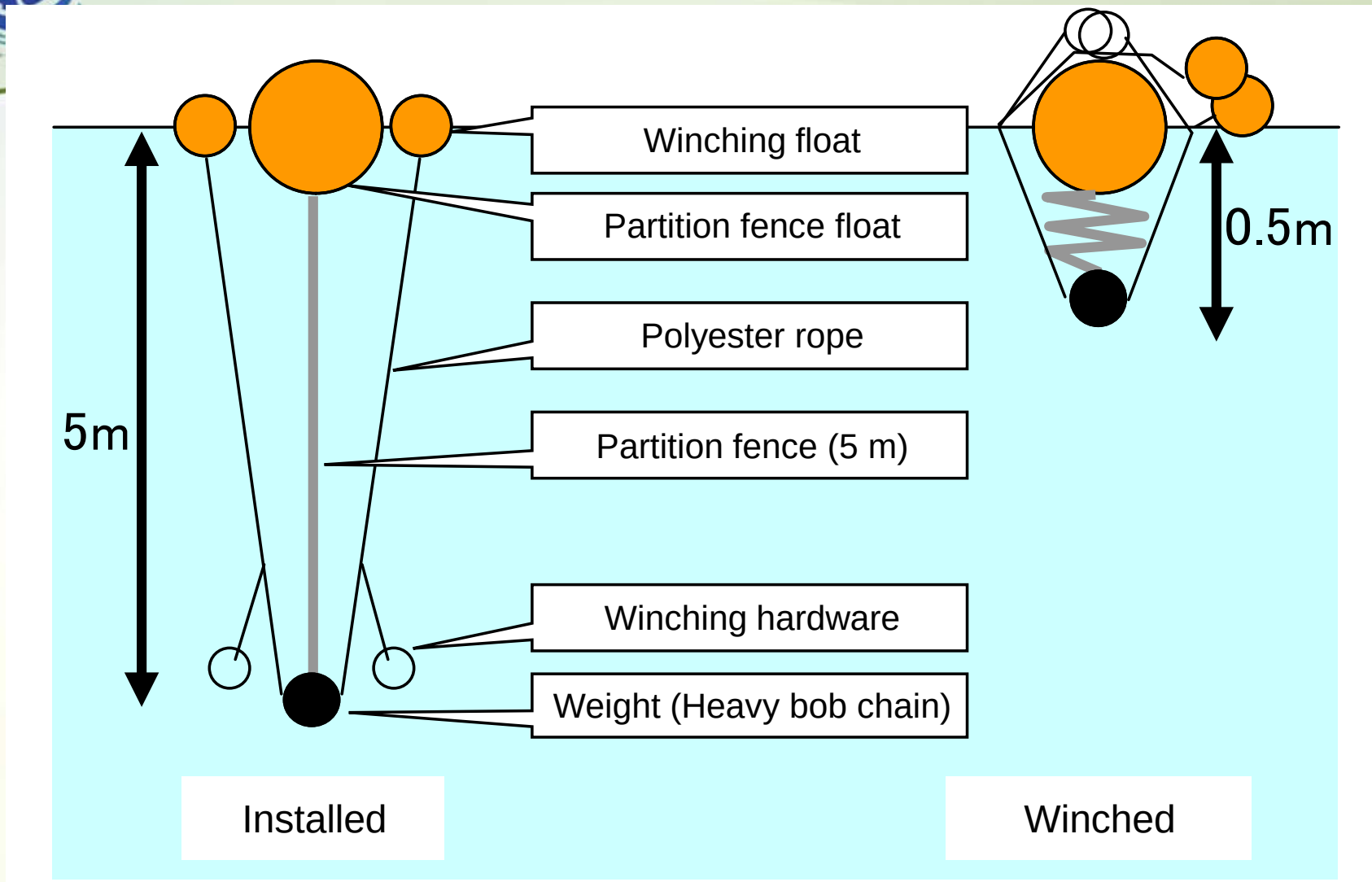
# Partition fences

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# Aeration stirring facilities since 2011

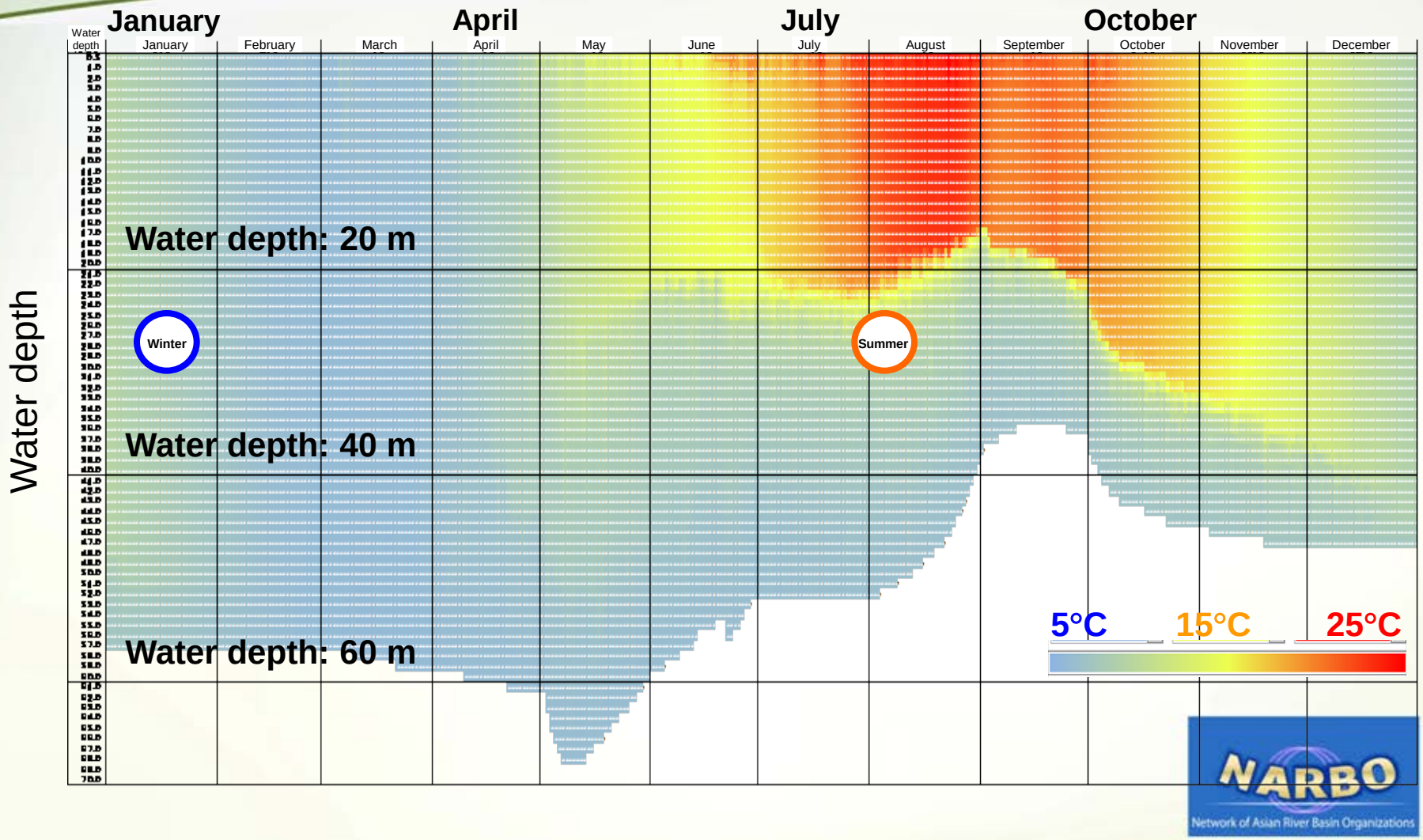
Purpose: To arrest the proliferation of the factors causing **mold odor**

Effect: The surface water layer is forcibly stirred by using aeration stirring devices to bring phytoplankton including *anabaena* to the deep layer and prevent it from proliferation.

Outline

# Effect of stirring water

Chart of water temperature according to the water depth of the water reservoir for 2012

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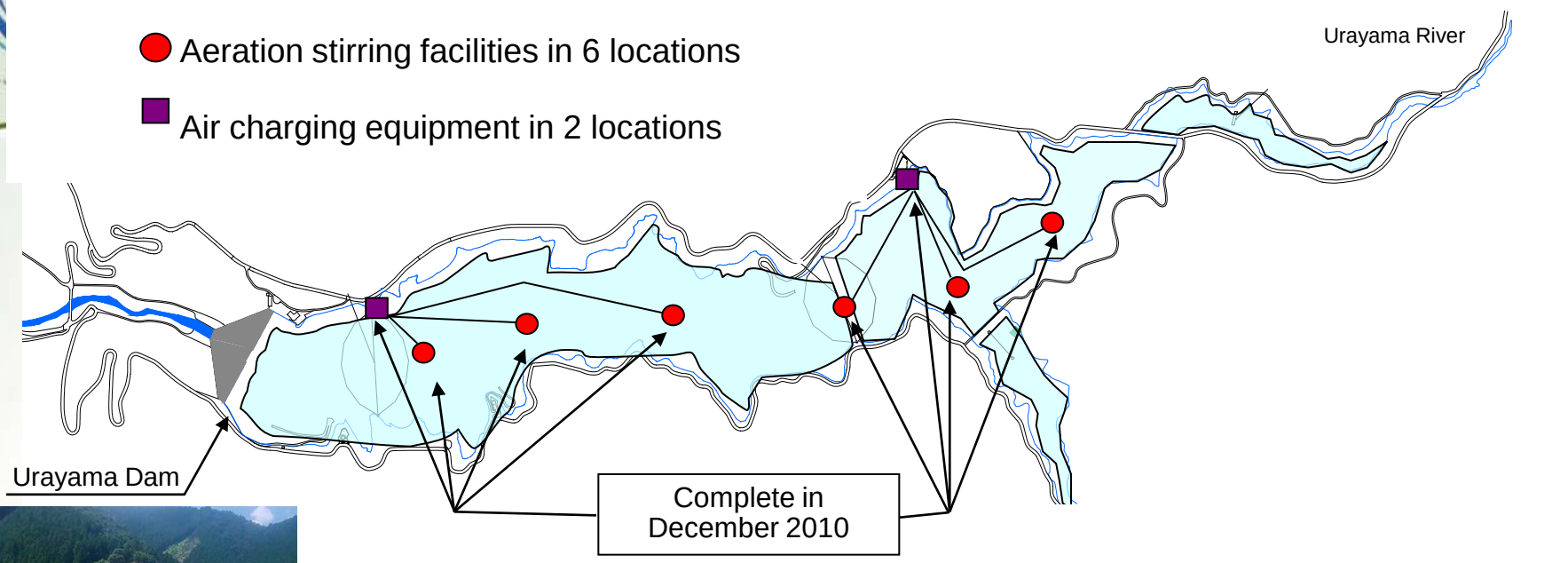
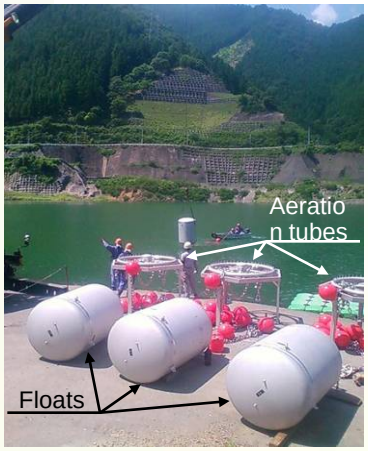
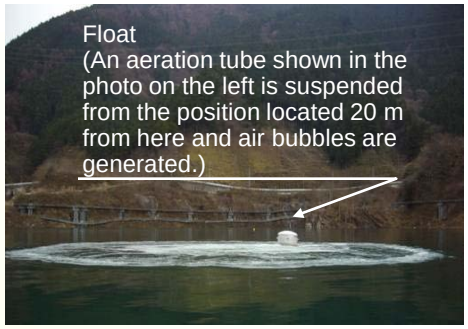
# Aeration stirring facilities




Construction of aeration stirring facilities (Aeration tubes and floats)




Trial run of the aeration stirring facilities

Air charging equipment (Compressor) and building

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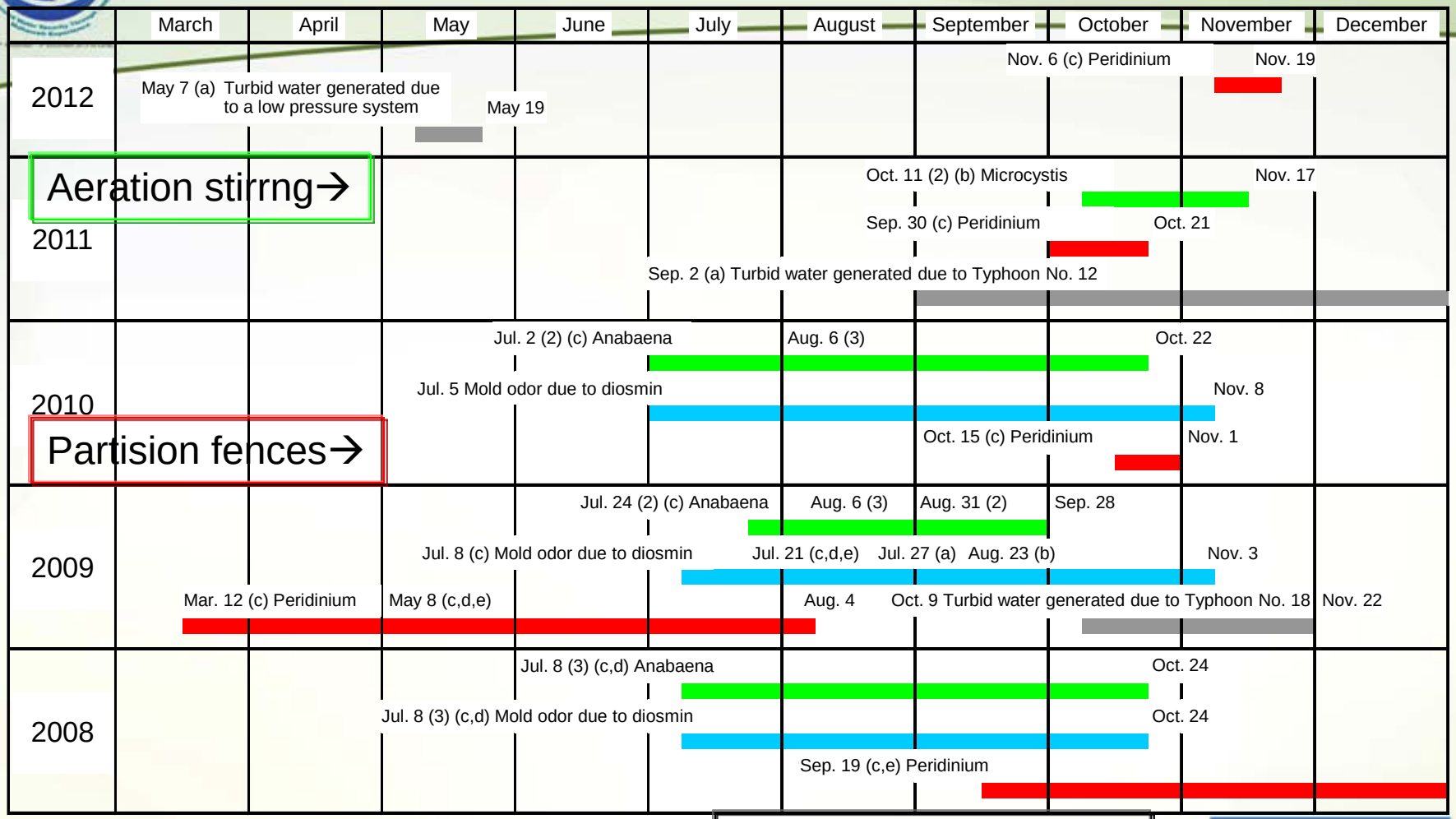
# Water quality improvement of Urayama Dam




Blue-grean argee
Mold odor
Red tide
Turbid water

2007 Bypass system→

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# 5. Conclusions

When you start to manage facilities, some new problems will occur.
Then you should correct your plan or find new way with your stakeholders and other organizations.

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# Thank you for your attention.

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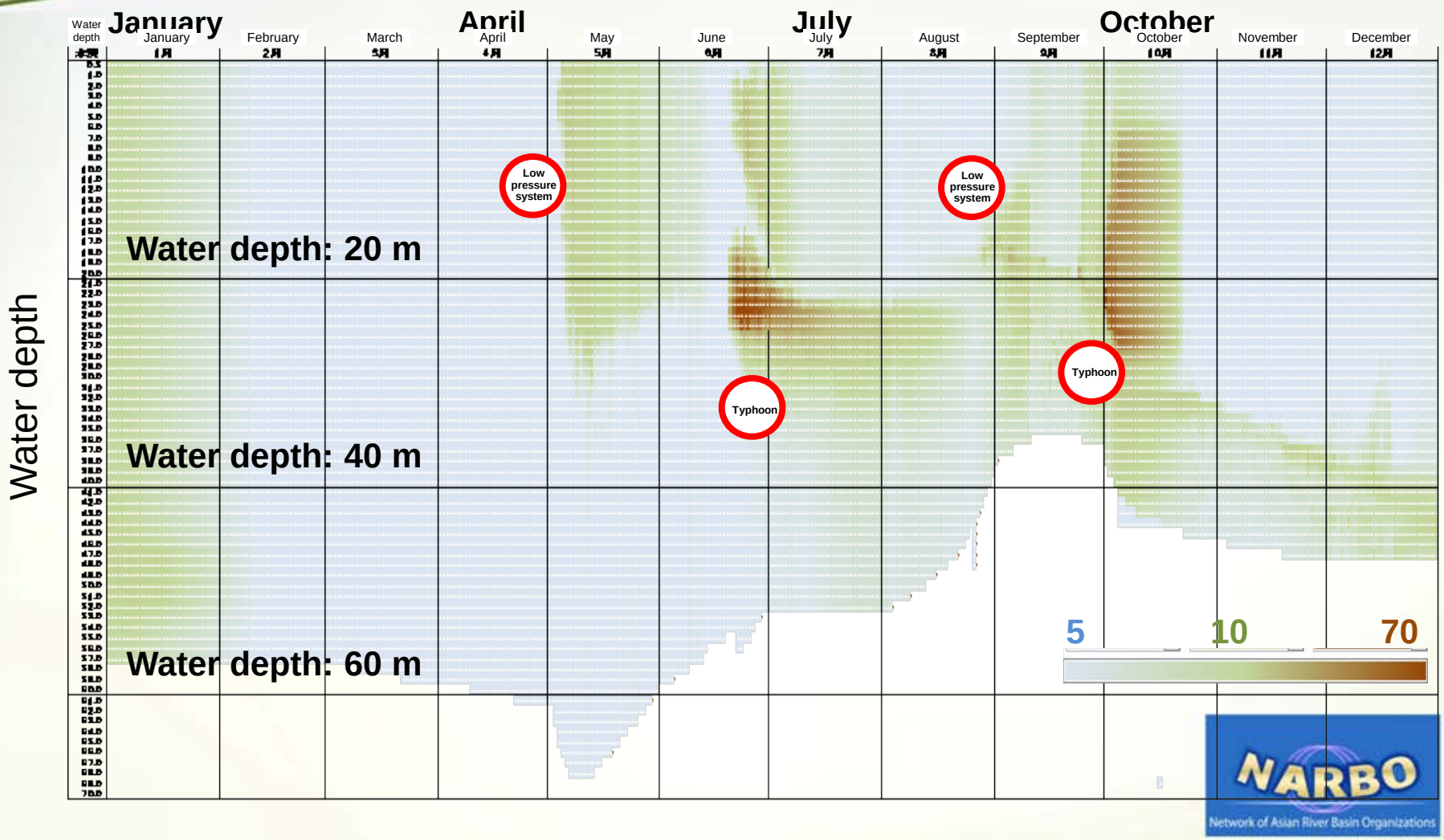
# References hereinafter

# Selective water intake

Chart of turbidity according to the water depth of the water reservoir for 2012



# Conflict between Public Use and Protection of Birds

Public camp site on the former quarry site (Natureland Urayama) and protection of the Hodgson's hawk eagle which lives in th

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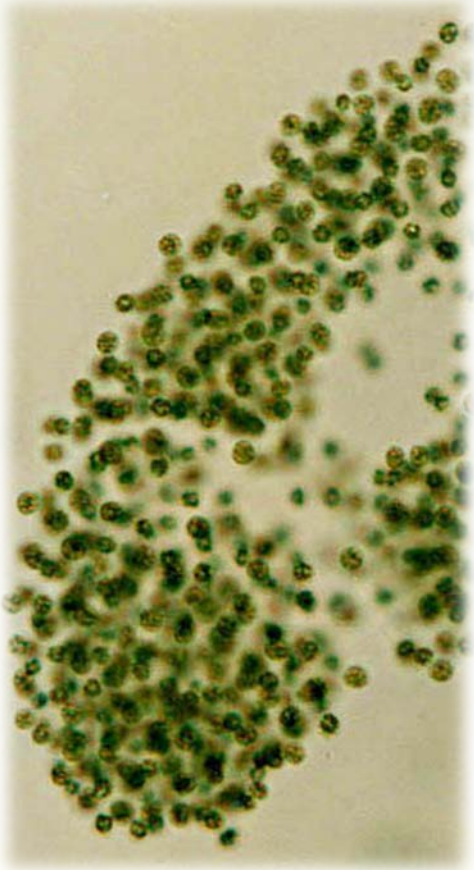
# Blue-green algae toxicosis

## Microcystis (Blue-green seaweed)



50 μm

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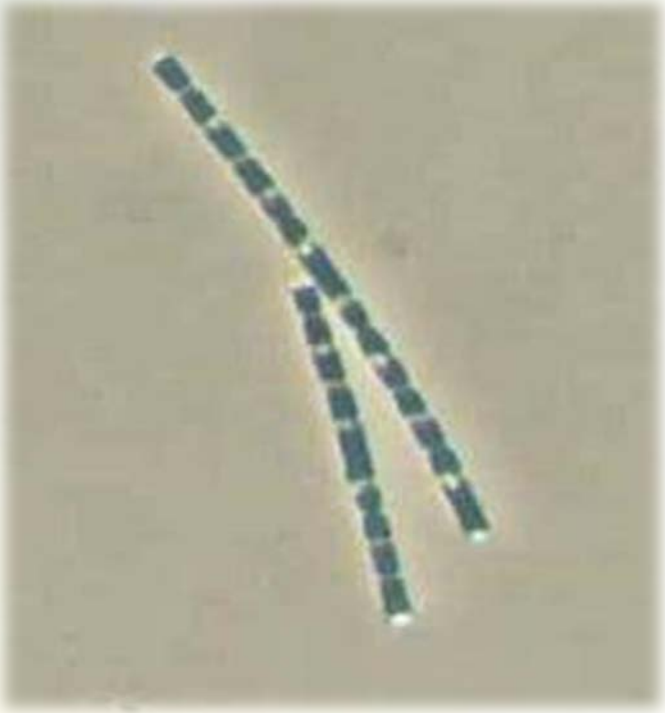
# Mold odor

100 µm

**Some species generate mold odor and others not. Their biology is unknown.**

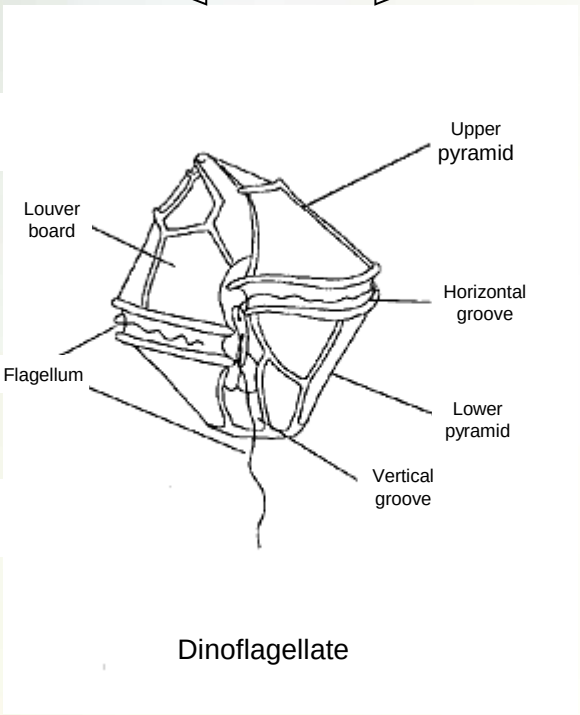


Phormidium (blue-green seaweed) generating 2-MIB.

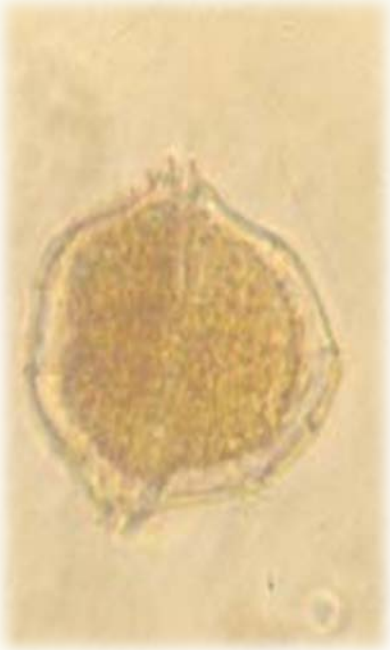
Anabaena (blue-green seaweed) generating geosmin.

# Freshwater red tides

50 µm

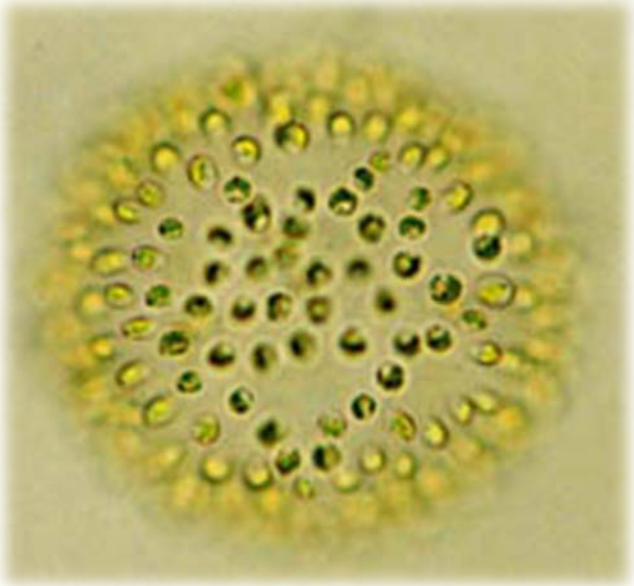



Dinoflagellate



Peridinium (Dinoflagellate genus)

50 µm



Uroglena (Dinoflagellate genus)

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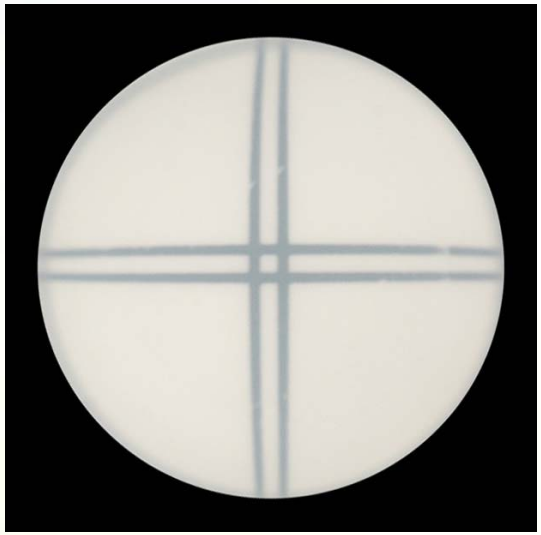
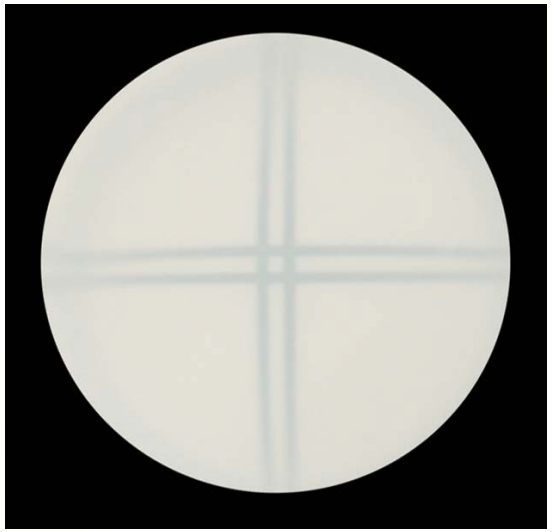
# Turbid water

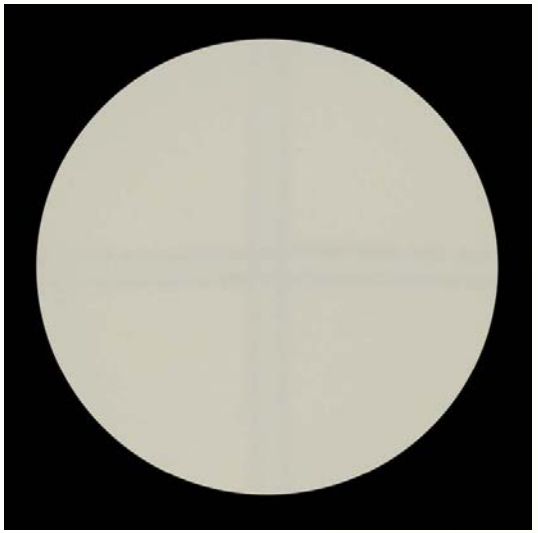
Turbidity: 1-degree turbidity corresponds to 1-liter water containing 1mg purified kaolin (Drinking water test).



**10 degrees, 10 cm**



**10 degrees, 25 cm**



**10 degrees, 50 cm**

**Turbidity: 10 degrees**

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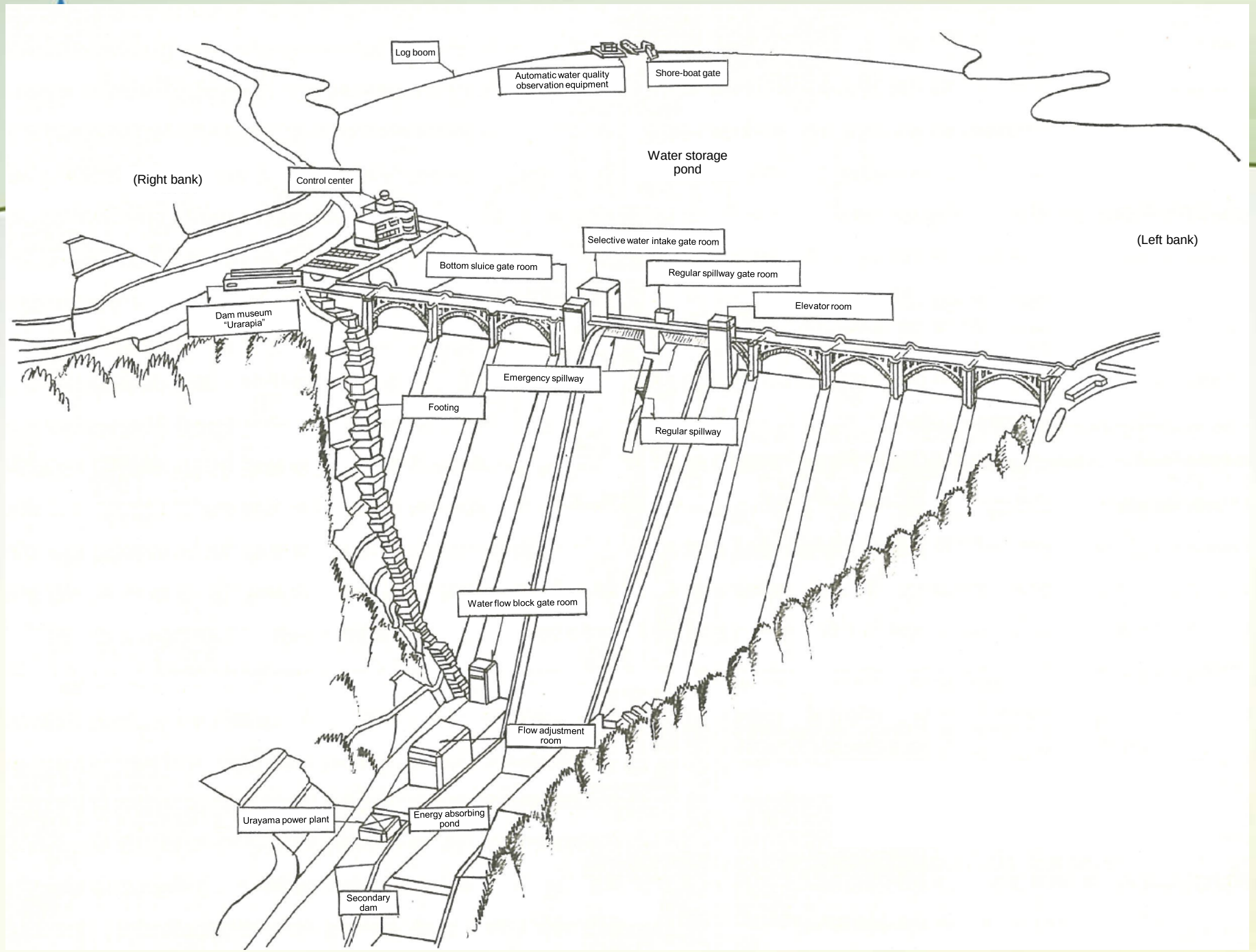
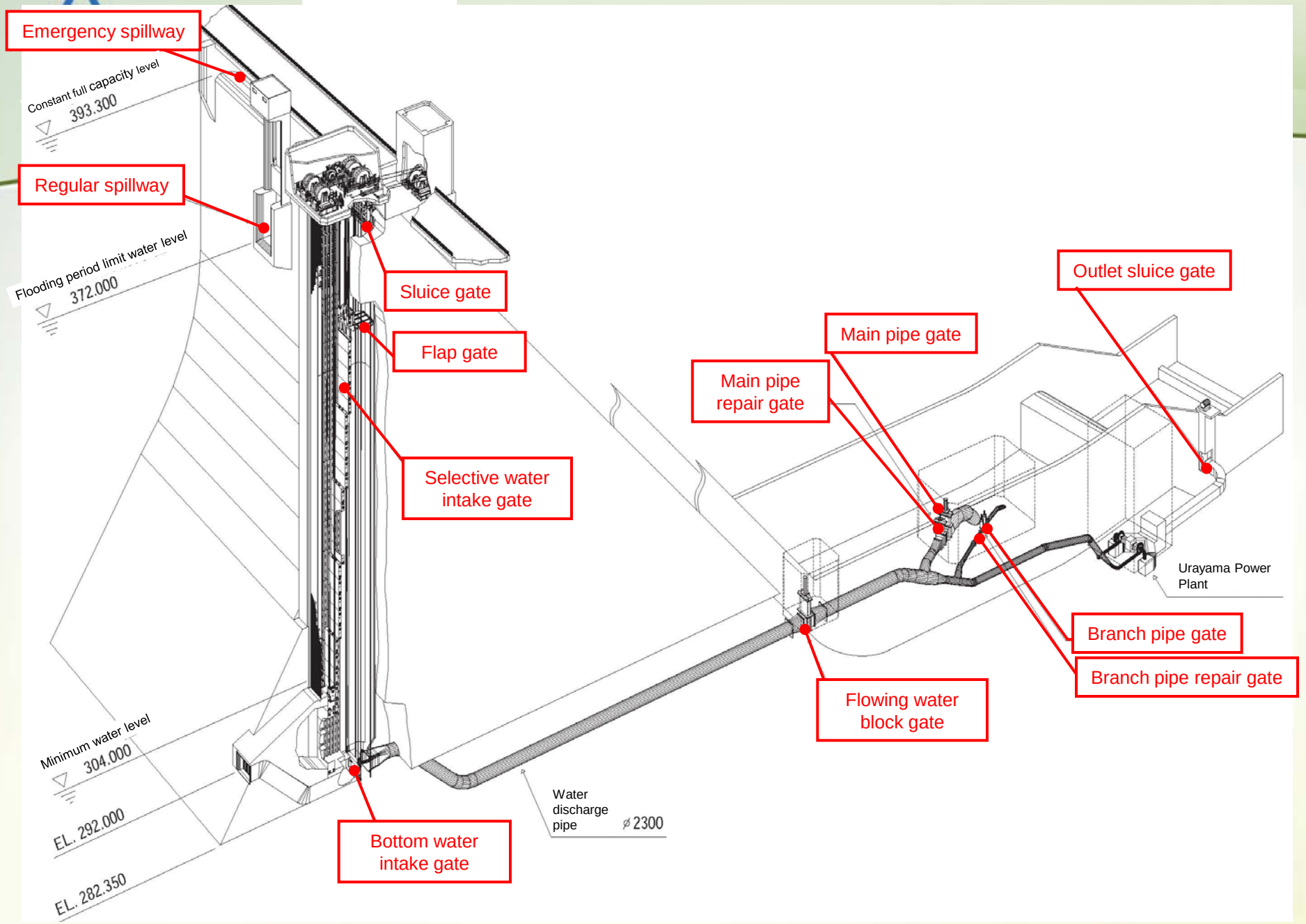
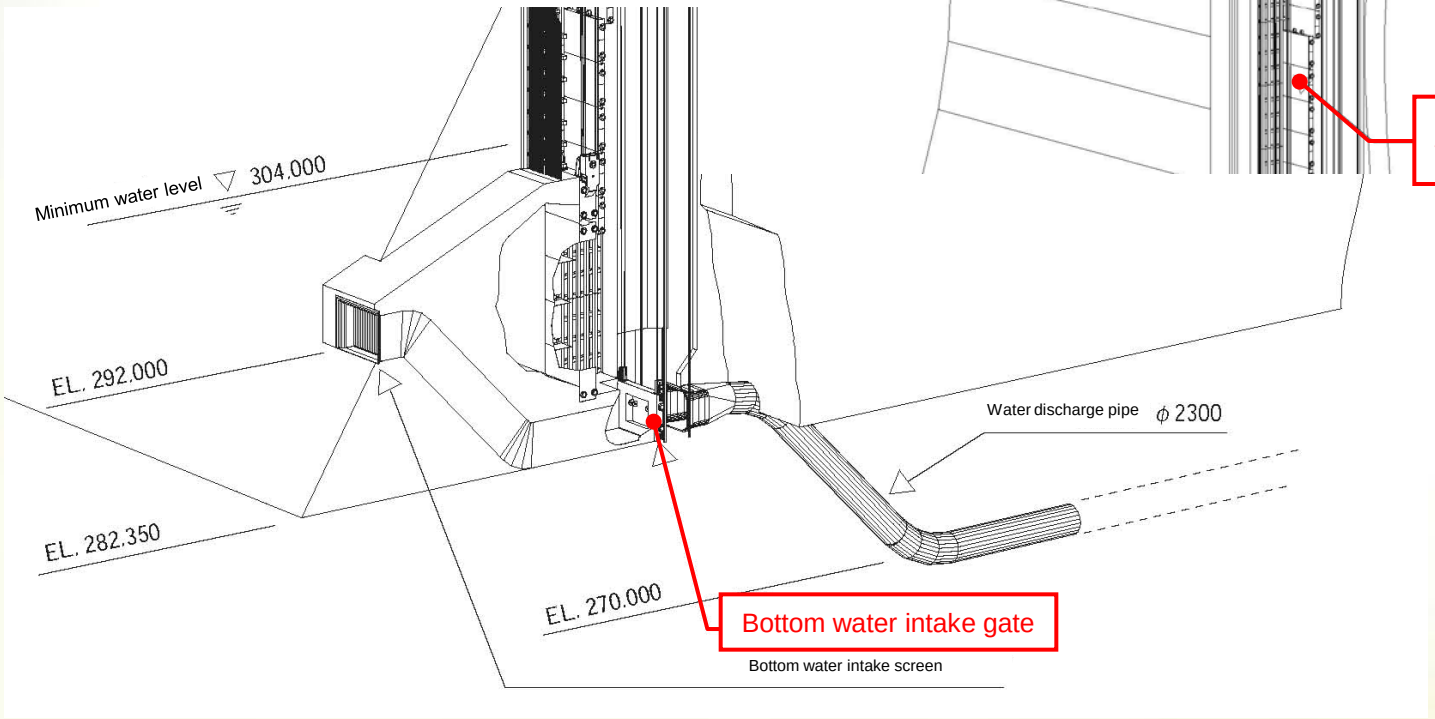

Log boom
Automatic water quality observation equipment
Shore-boat gate
Water storage pond
(Right bank)
Control center
(Left bank)
Selective water intake gate room
Bottom sluice gate room
Regular spillway gate room
Elevator room
Dam museum "Urarapia"
Emergency spillway
Footing
Regular spillway
Water flow block gate room
Flow adjustment room
Urayama power plant
Energy absorbing pond
Secondary dam


Emergency spillway
Constant full capacity level
393.300
Regular spillway
Flooding period limit water level
372.000
Sluice gate
Flap gate
Selective water intake gate
Outlet sluice gate
Main pipe gate
Main pipe repair gate
Urayama Power Plant
Branch pipe gate
Branch pipe repair gate
Flowing water block gate
Minimum water level
304.000
EL. 292.000
EL. 282.350
Bottom water intake gate
Water discharge pipe
ø2300


Selective water intake gate
opening/closing facility room
Bottom water intake and control gate
opening/closing facility room
Regular spillway gate
opening/closing facility room
EL. 400.000 (Dam crest)
Flooding
period limit
water level
393.300
Emergency spillway
Screen
(Entire surface
fixing type)
Sluice gate
Regular spillway
Constant full
capacity level
372.000
Flap gate
Selective water intake gate
Minimum water level
304.000
EL. 292.000
Water discharge pipe
ϕ 2300
EL. 282.350
EL. 270.000
Bottom water intake gate
Bottom water intake screen

# Takizawa Dam

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# Countermeasures against Landslide

# Countermeasures against Landslide

# Total environmental design and Creation of tourist attractions

## Raidentodoroki Bridge is

- A loop bridge planned and designed by JWA,
- Constructed not only for compensation to the water source area, but also for creation of new tourism resource, and
- Awarded many prizes;
  - ✓ Good Design Award by METI, 1998
  - ✓ JSCE Outstanding Civil Engineering Achievement Award, 2011

GOOD DESIGN AWARD 1998

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# Raiden-Todoroki Loop Bridge

# Raiden-Todoroki Loop Bridge

# Minimizing environmental impacts and Restoring productive environment

- Restoring quarry by transplanting indigenous vegetation.

Storing surface soil

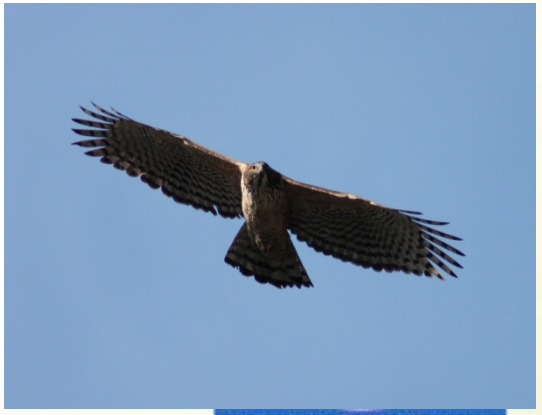
Excavating aggregate and replacing stored soil (during construction)

Recovering after construction

- Protective measures of rare raptors (hawk eagle etc.)

Soundproofing wall against blast

Propagative research of raptors




Flying hawk eagle