The Consistent Development in the Whole River System

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Consistent development of the whole river system

Integrated management of water resources in the Kiso River system
  • History of hydropower development
  • Improvement of the river flow
  • Redevelopment of existing power plants

Integrated management of sedimentation in the Kurobe River system
  • Sediment
  • Flushing Operation
Consistent development of the whole river system

The concept in Japan

Consistent river-system development involves setting up a reservoir at the most upper-reach of the river system for improved river flow, and making maximum use of the river's elevation head and water flow to achieve a large peak output across the whole river system.
The position of each river system

- Sho River
- Jinzu River
- Kurobe River
- Kiso River
- Osaka
- Tokyo

- Lake Biwa
- The Sea of Japan
- Pacific Ocean

- 150 hydropower stations
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The history of hydropower development in the Kiso River

Year
1900
10
20
30
40
50
60
70
80
90

Waterway-type Hydropower development 1910～1920

Dam-type Hydropower development 1920～1945

Consistent development in the whole river system 1945～1960

Redevelopment of existing plants 1960～1980

Elevation

Miura Dam

Maximum Discharge

Electricity demand in Japan

Nuclear Nuclear

Hydro

Thermal

1,000MWh

1900
10
20
30
40
50
60
70
80
90

Dam-type

Waterway-type

1,000MWh

Thermal

Hydro

Nuclear
Hydropower Development in Kiso River System

Hydropower
32 stations
Total: 1,040 MW

River channel length: 227 km
Catchment area: 9,100 km²
Following the startup of Miura Dam, the annual river flow of Kiso river was improved as illustrated below.

Miura Dam (Miura Power Plant)
Maximum output: 7,700kW
Maximum discharge: 17.5m³/s
Effective head: 54.7m
Following completion of the Miura Reservoir in 1942, the duration of Kiso River was improved. Kiso power plant makes use of surplus river flow which is generated by operation of Miura Dam.

**Kiso**
(116,000kW, startup in 1968)

- Nezame (35,000kW, startup in 1938)
- Agematsu (8,000kW, startup in 1947)
- Momoyama (24,600kW, startup in 1922)
- Suhara (10,000kW, startup in 1921)
- Okuwa (12,100kW, startup in 1920)

**Yomikaki No.2**
(70,000kW, startup in 1960)

- Nezame
- Agematsu
- Momoyama
- Suhara
- Okuwa
The position of Kiso power plant

New power system with higher efficiency
⇒ Prioritized operation

Kiso Dam

Nezame P/S

Kiso water intake weir

Miura Dam

Kiso P/S
Development image of Yomikaki No.2 power plant

\[
\text{Old system} \quad \text{New system}
\]

[Diagram of Yomikaki No.2 power plant with labels for Dam and Weir, and the connection between Yomikaki No.1 and No.2 power plants.]
Optimal use of existing facilities

- Newly constructed Yomikaki Dam
- No.1 plant headrace tunnel
- Decommissioned part of No.1 plant headrace tunnel

Cross-section of No.1 plant intake
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Kurobe Dam
Height: 186m (the highest in Japan)

Kurobe River No.4 Power Plant
Maximum output: 335,000kW
Seine River
Shinano River
Kiso River
Shou River

Elevation [m]

Kurobe River

Average river gradient: 1/40
River gradient around the source of the river: 1/20 ~ 1/35
The amount of inflowing sediment into dams is huge compared with reservoir capacities.

It is difficult to transport excavated or dredged materials to the downstream under the conditions of steep gorge.

Blocking the flow of sand and soil causes

- raising the riverbed at the upstream
- lowering the riverbed or coastline set back at the downstream

A more comprehensive soil management approach is needed.
Outline of Dashidaira dam

<table>
<thead>
<tr>
<th>Catchment area</th>
<th>461.18 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Plant</td>
<td>Name: Otozawa</td>
</tr>
<tr>
<td></td>
<td>Maximum Output: 124MW</td>
</tr>
<tr>
<td>Dam</td>
<td>Type: Concrete gravity</td>
</tr>
<tr>
<td></td>
<td>Height: 76.7m</td>
</tr>
<tr>
<td></td>
<td>Length: 136.0m</td>
</tr>
<tr>
<td>Reservoir</td>
<td>Total Capacity: 9.01 x 10⁶ m³</td>
</tr>
<tr>
<td></td>
<td>Effective Capacity: 1.66 x 10⁶ m³</td>
</tr>
<tr>
<td></td>
<td>Operation area: 18m</td>
</tr>
<tr>
<td>Flushing channel</td>
<td>Number: 2</td>
</tr>
<tr>
<td></td>
<td>Area: 5.0 x 5.0m</td>
</tr>
<tr>
<td>Flushing gate</td>
<td>Upstream: Slide gate</td>
</tr>
<tr>
<td></td>
<td>Center: Roller gate</td>
</tr>
<tr>
<td></td>
<td>Downstream: Radial gate</td>
</tr>
</tbody>
</table>
Outline of flushing facilities

Slide gate
For maintenance

Flushing channel

Radial gate
For prevention of seepage

Roller gate
For flushing control

Flow

Moving protection flame
Drawdown

Flushing through a low-level outlet

Refill
The end