



Technological Examination of Tenryu River Dam Reorganization Project

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ABSTRACT:

The Tenryu River Dam Reorganization Project aims to effectively use Sakuma Dam, which is an existing dam designed specifically for water utilization, for flood control in order to prevent floods in the middle and lower reaches of the Tenryu River. This paper describes the Tenryu River Dam Reorganization Project.

Keywords: dam system reorganization, flood control project, sedimentation control

1. OVERVIEW OF THE TENRYU RIVER

The Tenryu River, which originates in Mt. Akadake (elevation 2,899 m) among the Yatsugatake Mountains in Chino City, Nagano Prefecture, and flows into the Sea of Enshu, is a 213-km-long Class A river (specified waterways of special importance protected by the government) with a drainage area of 5,090 km². The bed slope is steep with about 1/200 in the upper reaches, 1/300 to 1/700 in the middle reaches and about 1/500 to 1/1,000 in the lower reaches.

The basin of the Tenryu River spreads over three prefectures of Nagano, Shizuoka and Aichi. There are big cities in the lower reaches, such as Shizuoka, Hamamatsu and Iwata.

The Tenryu River has been flooded repeatedly and

caused serious damages. Today, the safety level of flood control is still low and needs to be improved. The sediment yield is large due to big faults in the basin, including the Median Tectonic Line, steep topography, brittle geology, and frequent large-scale slope failures. Of the five dams built for water utilization along the river, Yasuoka and Hiraoka Dams are nearly filled with sediment; and sediment has already filled one-third of the reservoir in Sakuma Dam.

The discontinuity of sediment transport has reduced the sediment supply to the river mouth and has caused the shoreline to retreat for at least 200 m from the line in 1955.

Ensuring the continuity of sediment transport is also a main issue of the Tenryu River as well as improving flood control capacity.



Figure 1. Tenryu River Basin

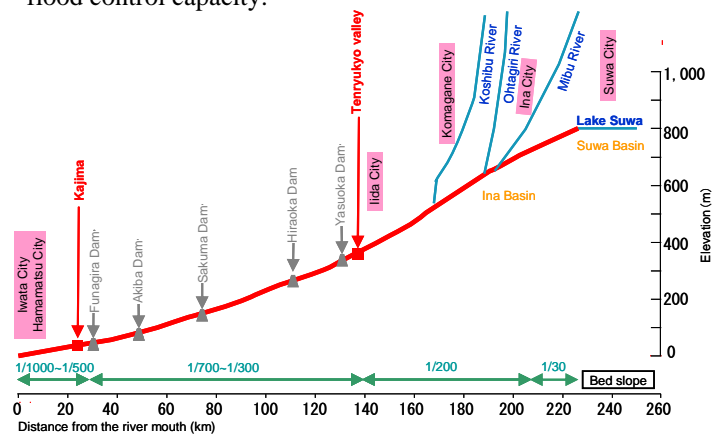


Figure 2. Bed slope of the Tenryu River

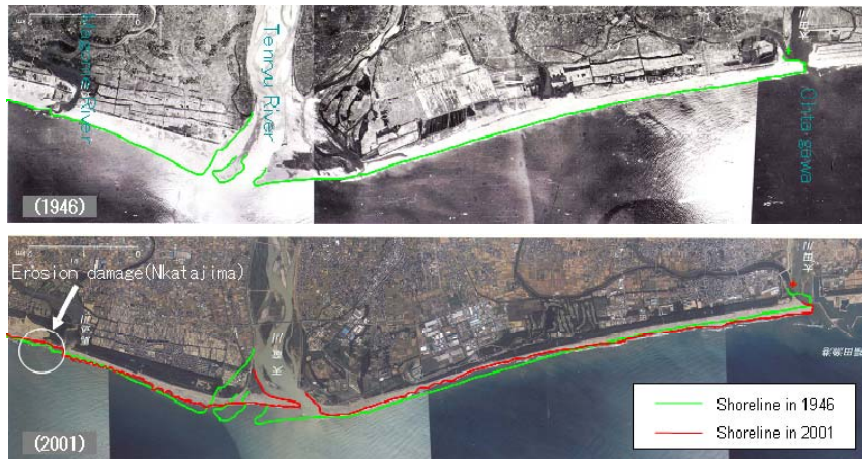


Figure 3. Great retreat of the shoreline along the Sea of Enshu (Enshunada)

2. OVERVIEW OF SAKUMA DAM

Sakuma Dam is located on the boundary between Shizuoka and Aichi Prefectures. It is a gravitational dam built in 1956 by Electric Power Development Company Ltd. to meet the tight power demand during postwar revitalization. The hydroelectric power generation of 1.37 billion kWh a year is the largest in Japan and supported the high economic growth.

The Tenryu River has large sediment yields, and sediment has accumulated in the reservoir of Sakuma Dam. Of the total reservoir capacity of 330 million m³, sediments occupy about 120 million m³ or 36% (as of 2006).



Figure 4. Sakuma Dam

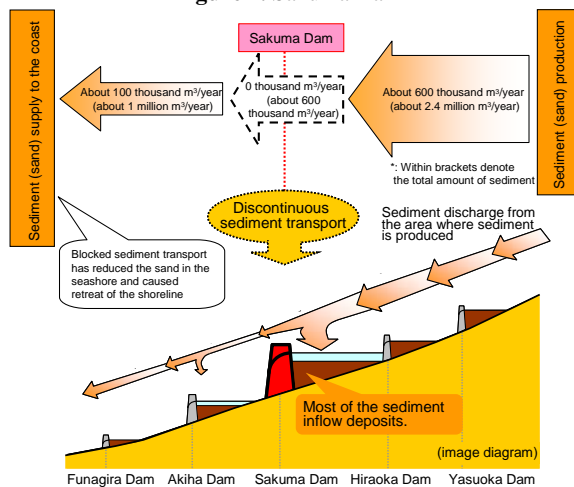


Figure 5. Schematic diagram of sand transport in the Tenryu River

3. OVERVIEW OF THE TENRYU RIVER DAM REORGANIZATION PROJECT

The Tenryu River Dam Reorganization Project aims to improve the flood control capacity, which is a key issue of the Tenryu River system, and ensure the continuity of sediment transport. In the basic policy for river improvement, the flood control plan of the Tenryu River involves using the dams to control 4,000 m³/s out of the design flood peak discharge of 19,000 m³/s at Kajima Reference Point and reduce the discharge through the river course to 15,000 m³/s. Today, there is only one flood control facility completed in the middle to lower reaches of the river, which is Shin Toyone Dam. The project will increase the flood control capacity of Sakuma Dam to 54 million m³ so that a discharge of 2,000 m³/s can be controlled at the dam.

Permanent sedimentation control for maintaining the flood control capacity will also be implemented to restore the continuity of sediment transport.

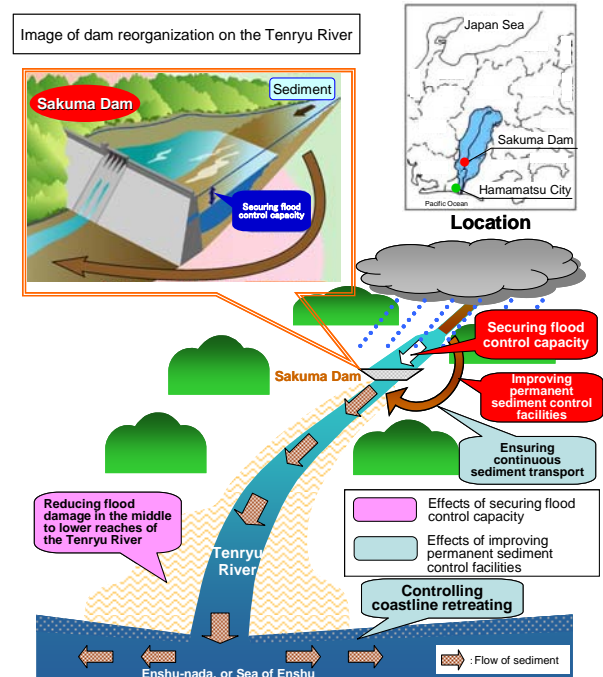


Figure 6. Image of dam reorganization on the Tenryu River

3.1. Project plan

3.1.1. Flood control

A flood control capacity of 54 million m³ will be ensured at Sakuma Dam by increasing the reservoir capacity and dredging the sediment above the limited water level (EL. 255.0 m) and below the surcharge water level (EL. 262.2 m).

The existing discharge facilities will also be improved to secure the required discharge capacity.

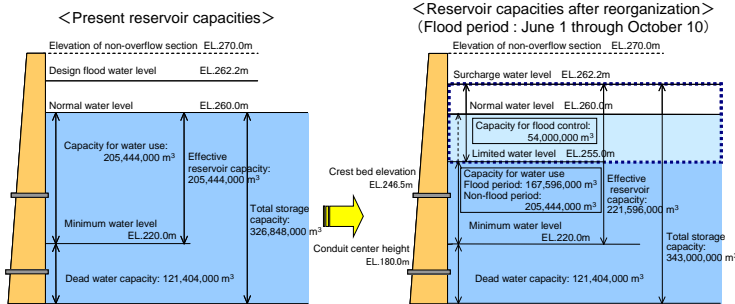


Figure 7. Reservoir capacities

3.1.2. Permanent sedimentation control

Permanent sedimentation control will be implemented to discharge the sediment that flows into the dam, secure permanent flood control capacity, and ensure the continuity of sediment transport. Construction of a bypass tunnel for flushing the sediment is being investigated for permanent sedimentation control.

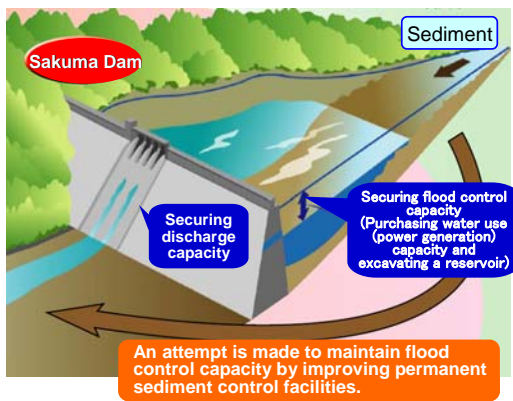


Figure 8. Image of project plan

3.2. Effects of the project

3.2.1. Flood control effects

Sakuma Dam will control 2,900 m³/s (at peak inflow) out of the design inflow of 9,200 m³/s at the dam site, which will reduce the inflow at Kajima Reference Point by 2,000 m³/s and lower the water level there by about 1 m.

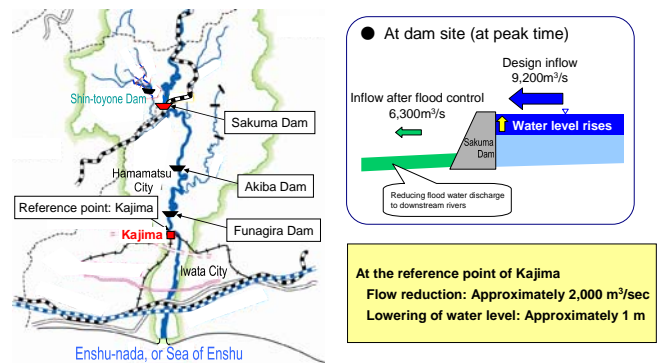


Figure 9. Downstream area of Tenryu River

3.2.2. Effects of permanent sedimentation control

The permanent sedimentation control will ensure the continuity of sediment transport and mitigate coast erosion. The latter will be achieved by considering the transport of sediment throughout the entire river as a “sand flow system” that continues from the source to the coast and comprehensively controlling the sediment transport.

According to a trial calculation at this stage, the permanent sedimentation control together with the sediment discharge facilities of the branches, such as the bypass tunnel of Koshibu Dam, will increase the amount of sand that forms beach at the river mouth by about 200 thousand m³/year.



Figure 10. Comparison of estimated sediment discharges at present and after project implementation

4. PROGRESSES UP TO PRESENT

The permanent sedimentation control to be implemented in this project involves large-scale works of high technologies.

Therefore, the technological aspects of the sedimentation control measures that are likely needed at Sakuma and Akiba Dams have been assessed, and possible technological problems have been investigated. Advice has also been provided from experts of river engineering, dam engineering and coastal engineering.

An investigatory committee was also established in July 2006 by experts for assessing the impacts of the Tenryu River Dam Reorganization Project on the physical environment and habitats in the lower reaches of the dam including the sea.

Based on the results of the investigations by the committee, etc., permanent sedimentation control works are being investigated, and monitoring surveys are being conducted on the impacts of the project on the physical environment and habitats.

4.1. Permanent sediment control measures

At the moment, the suction method plus a bypass tunnel are considered for Sakuma Dam.

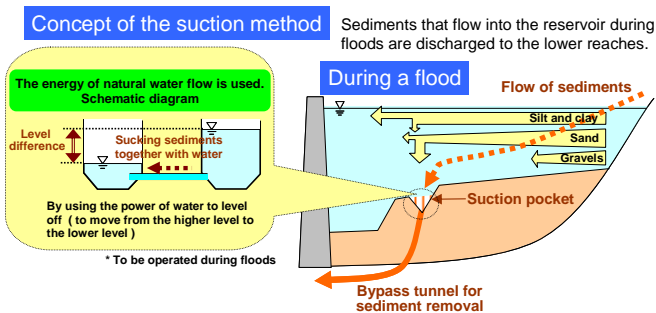


Figure 11. Suction method and bypass tunnel for sediment removal (Sakuma Dam)

The suction method that uses water head difference is still under development. Therefore, the performance of the method and the adaptability at the site need to be checked by conducting field experiments, and precise investigations must be done on the structure and operation method.

Aiming to check the sand discharge performance of the suction method, a committee consisting of experts was established in July 2008 for investigating the verification experiments of the sediment discharge method for the Tenryu River Dam Reorganization Project. Applicants were invited to design the suction method and conduct verification experiments. The committee has drawn up experimental plans, decided the competition requirements and methods for selecting applicants,

selected applicants, discussed methods for evaluating the results of verification experiments and evaluated and checked the performances.

4.2. Monitoring survey

The objectives of the monitoring surveys discussed by the environment impact assessment committee of the Tenryu River Dam Reorganization Project were:

- 1) Continue monitoring to understand changes caused by the project,
- 2) Verify predictions and theories formulated before the project, and
- 3) Understand and clarify the mechanisms involved in physical environments and habitats.

Based on these objectives, the data sets shown in Fig.12 are being collected.

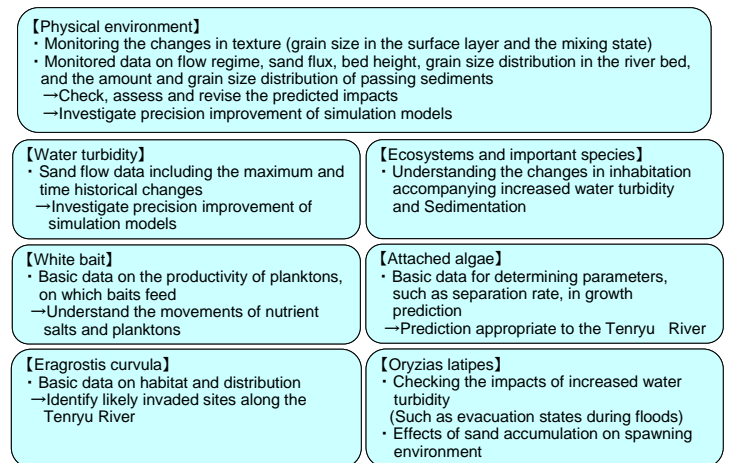


Figure 12. Data to be collected by monitoring surveys

5. CONCLUSIONS

The Tenryu River Dam Reorganization Project is in the stage of conducting surveys and investigations of various kinds for permanent sediment control based on the knowledge collected and advice given by the committees, etc. and performing monitoring surveys for understanding the impacts of the project.

Investigations are going to be made on the economy, reliability and impacts of sediment control methods on the river environment, which are needed for deciding the method to implement. Predicted effects of the project will also be verified by using data collected in monitoring surveys, and the impacts on the physical environments and habitats will be clarified to achieve early completion of the Tenryu River Dam Reorganization Project.