

Management of Dam Reservoirs with Consideration for Downstream Environments

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1. Introduction

The dam reservoirs of Japan play indispensable roles in our everyday lives by providing for both stability of water supplies and for flood control. At the reservoirs themselves, we are working to handle several challenges, including the decline of water quality as a result of eutrophication, cold effluent, prolonged periods of turbidity, etc, using methods of aeration, deep aeration facilities, selectable intake, selective intake works and other techniques. The use of such facilities to improve water quality has demonstrated clear benefits at many dam reservoirs, for example the suppression of plankton growth et al.

However, the conventional operation of such facilities has less focused on what should be preserved in the downstream environment or on what environmental purposes there might be, than on problems and issues raised by the managers of rivers and dams and by the people living in the basins. In these areas, we can expect to better and more effectively utilize our facilities. This study commenced in FY 2004 to set objectives for reservoirs and downstream environments, effectively manage reservoirs to reach those goals, and prepare proposals for the operation of facilities to improve water quality and to restore downstream environments, in what is essentially, a "Guide (to Paths to Environmental Improvement)."

2. Content and Framework of Study

(1) Current Status of Reservoirs and Downstream Areas

Factors core to implement the study include an understanding of past environmental conditions of the area and of current conditions of the reservoirs and downstream areas (to include downstream ecology, the course of the river, and physical environment factors such as riverbed composition). While each reservoir is routinely inspected at this time, more detailed studies for better understanding of the water movement (flow) and changes in water quality is required in some cases. For example, observation points should be positioned, and the range of vertical monitoring that is undertaken should be expanded. Also, monitoring and other activities are not systemically conducted for sections of the downstream areas, which is integral to defining the existing issues through research and observation.

(2) Reviews of Goal Setting Methods for Reservoir and Downstream River Environment

Consideration for downstream river environments is apparent in some of the measures already in place at several reservoirs, such as flushing discharge and draining water from thermal stratification layers, much as is done

with river water inflows. With these achievements, clearly defined purposes are integral to making these measures more effective. Therefore, based on the results of (1) above, we must give consideration to the necessary river water volumes (including fluctuations) and the water quality desired to preserve river ecology, as well as environmental goal setting technology required for reservoirs followed by downstream rivers.

(3) Proposed Operations Systems for Reservoirs, River Flows, Downstream Environments

① Studies of Water Quality Improvement Facilities for Reservoirs

We must consider how to best operate the water quality improvement facilities that have already been installed. For example, we should put forward specific improvements in operating the water quality improvement facilities installed at reservoirs, and consider new operating policies where the implementation of water quality measures for river flows is feasible.

Using the results from such applications and with a better understanding of what improvements can be obtained with the facilities now installed at our reservoirs, we can clearly define what improvements can be expected in our current facilities if we install new facilities. With these results, we can constantly monitor conditions to determine if utilizing the current facilities is sufficient or not, or whether there is a need to install new facilities to achieve the set purposes or not.

② Developing Reservoir Water Management Systems Using Rainfall Prediction

Current reservoir management systems use real time calculations. By including the use of forecasts for levels of precipitation, temperature, and sunlight hours to these figures, we can better estimate the effects of changes in water volume and water quality on reservoirs and downstream river flows. This would enable us to prepare countermeasures in advance and operate reservoirs more in accord with the changes. We are now studying the feasibility of "enhancing management sophistication" in this manner.

③ Studies Reviewing Monitoring and Inspection Items

Based on the results, we can then consider what aspects should be monitored in detail, what items or factors should be added to our inspections, and what cases call for further study (e.g. further research may be required where there are significant fluctuations in reservoir water level or during the algae bloom season).

3. Technical Issues in Implementing these Studies

In terms of specific methods to handle the issues,

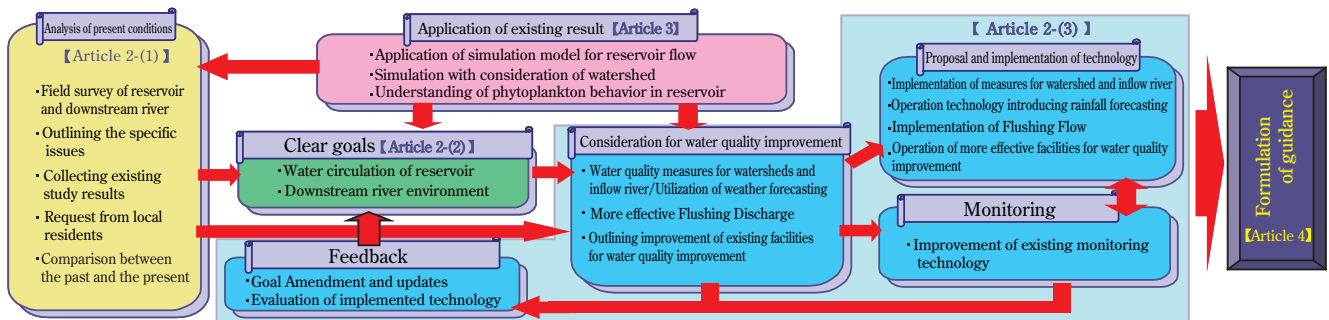


Figure 1 The Overall Research Flow (Numbers in table correspond to report section numbers)

we have developed simulation models accompanied by applicability evaluation techniques. These are focused on achieving environmental purposes and lead to more effective measures by allowing the integration of already known data into the overall study. Some primary issues in obtaining the information necessary from the study are outlined below.

(1) Point 1 - Reservoir Flows

This study includes plans to use simulation models to outline changes in water quality, flow behaviors and patterns, and turbidity. We are currently working on the development of simulations of reservoir water flows that allow expression of the effects provided by aeration facilities. By developing the simulation in accord with different uses, we expect to be able to forecast and quantitatively express the resultant effects (e.g., operation technology for new aeration facility).

(2) Point 2 - Relationships of Reservoirs and their Surroundings

In addition to water quality improvement measures for reservoirs, the study also focuses on the watershed and will consider in the basin water quality improvement measures. We are now working creating models to allow simulation of different qualities of influent water, and the impact on reservoir and downstream river environments based on the land use data from a GIS database on the upstream and downstream watersheds.

(3) Point 3 - Plankton Movements in Reservoirs

The effort to inhibit massive phytoplankton bloom is concentrated on experiments using aeration facilities in reservoirs. Current facility operations focus on the increase or decline of algae that appear with changes in water quality, primarily in the reservoir area. We know, however, from past study findings that zooplankton appears to have a significant influence on the increase and decrease of phytoplankton. Therefore, it may be possible to provide more effective facility operations by monitoring phytoplankton and zooplankton separately and better understanding their mechanisms of increase and decline.

4. The Implementation and Use of Study Findings

The study simulations will permit us to determine which operating technologies allow the most effective use of facilities, and to apply these results to reservoirs. The study

will continue by concentrating on on-site applications, and by monitoring the results, we will be able to constantly find points for improvement. We consider the results obtained through these processes to provide indicators valuable for the environmental management of the overall river system including basins.

5. Conclusion

Dams have made great contributions to flood mitigation and to secure water resources. However, at the same time, they have also fallen under critical scrutiny for their negative impacts on river environments. In future, we must not only find ways to alleviate the impact of dams on river environments but also ascertain what is the best usage of dams to establish desired river environments. The study, with its actual onsite results and achievements, will contribute toward better harmony between dams and their environments.

*1: Effects of Flushing Discharge

Using water flow speed controls to discharge larger volumes of water than usual over abbreviated time spans, is expected to refresh the river and improve the dam downstream river environment.