Initiatives to improve soundness evaluation accuracy to prolong the lifespan of existing SABO facilities

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1. Introduction

Japan is highly prone to sediment-related disasters. In recent years, climate change has increased the frequency and intensity of large-scale sediment-related natural disasters. To protect people from such disasters, it is important to construct new sabo facilities and to maintain and prolong the function and performance* of existing sabo facilities.

In 2013, we began to develop the "Plan for Maintaining and Prolonging the Lifespan of SABO Facilities", to extend the life of existing sabo facilities in Japan and reduce the established budget for their maintenance. Information on the soundness of sabo facilities is indispensable for this project. Soundness is evaluated based on periodic inspections, which indicate the extent of deterioration at the time of inspection; thus, any changes in the soundness of sabo facilities that occur after an inspection are not reported until the subsequent inspection. The ability to predict such changes would contribute to the strategic development of the national sabo maintenance project through the incorporation of preventive measures.

*In this study, we define sabo facility function as soundness for sediment-related disaster prevention and performance as a safety structure.

2. Efforts to develop the "Plan for Maintaining and Prolonging the Lifespan of SABO Facilities" in Japan

2.1. Stage 1 (2013–2018)

Individual sabo managers began to develop the "Plan for Maintaining and Prolonging the Lifespan of SABO Facilities" from 2013, using the following three-step procedure to calculate the required costs for the next decade:

i) Evaluate the soundness of each target sabo facility.
ii) Determine the priority level of each sabo facility in terms of its importance and proximity to a conservation target.
iii) Determine appropriate countermeasure methods for each sabo facility and calculate their costs.

2.2. Stage 2 (2019–2022)

In 2019, we shifted the focus of the project to improving the accuracy of the analysis results obtained in the first stage, with the aim of reducing the total cost required for each sabo facility throughout its lifespan, including installation, maintenance, removal, and reinstallation. The cost required for countermeasures for a single sabo facility for the next 30–50 years is determined using the following procedure:

i) The soundness of the sabo facility during the next 30–50 years is calculated probabilistically based on the number of years since its installation and its current soundness.
ii) Countermeasures for the sabo facility during the next 30–50 years are designed and their costs calculated according the soundness of the facility.
iii) Based on these cost estimates, a countermeasure construction strategy and schedule are designed for each sabo facility to minimize the total cost of countermeasures among all sabo facilities during the next 30–50 years.

3. Development of a detailed soundness evaluation that incorporates predicted sabo facility deterioration.

The initial soundness evaluation assesses the soundness of the sabo facility at the time of inspection, and does not address future deterioration. In the second stage, soundness evaluations predict sabo facility soundness during the next 30–50 years according to probabilistic calculations based on past inspection data. However, although it is possible to predict deterioration over time due to normal wear, it is difficult to predict that caused by phenomena such as sudden heavy rainfall events.

In addition, we think that sabo facility deterioration occurs due to a combination of internal factors (structural type) such as the concrete dam or masonry dam, and external factors such as sediment movement around the dam. The simplest example is the correlation between crest wear and sedimentation conditions upstream of the dam. In other words, if we can predict future sediment movement, we can indirectly predict the progress of deformation.

The analyses performed in the first and second stages of the maintenance project barely consider the influence of external factors on sabo facility deterioration. For efficient long-term maintenance and prolongation of sabo facilities, it is necessary to develop a protocol for evaluating sabo facility soundness based on the correlation of their deterioration with external factors. Our organization has begun to develop such a strategy using the following procedure:

i) Develop a survey method and data format for recording external factors that influence sabo facility deterioration within classed regions surrounding the facility (**Fig. 1**).
ii) Analyze correlations between external factors and facility deterioration.
iii) Predict sabo facility deterioration according to predicted daily sediment movement (including both sedimentation and secondary movement) during and after heavy rainfall events (**Fig. 2**).

Using these methods, we are presently developing strategies for predicting the occurrence and progress of sabo facility deterioration.

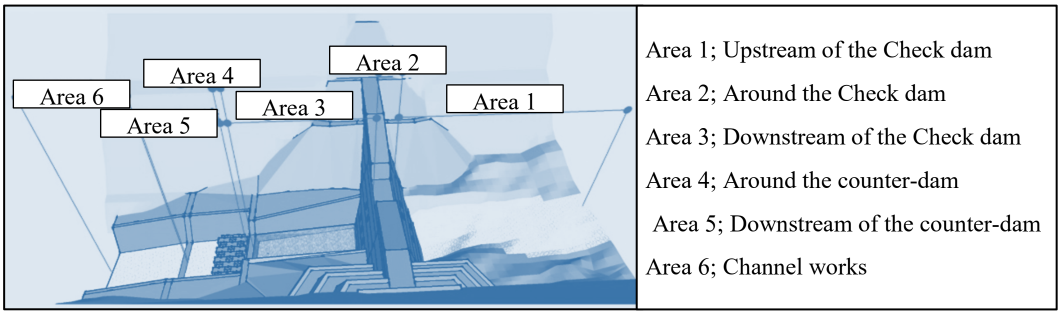

Figure 1. Classification of the region surrounding a target sabo facility.

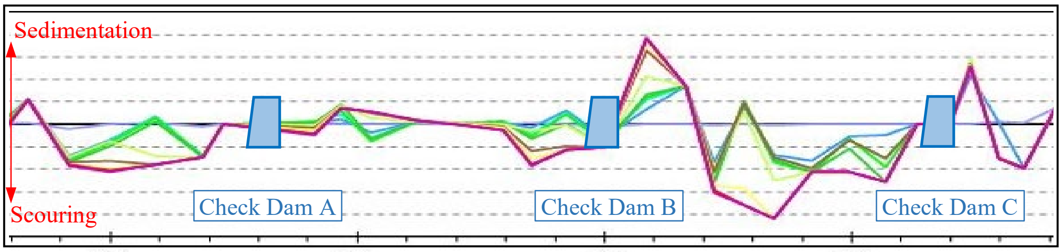

Figure 2. Future prediction simulator for sedimentation and scouring. (Developed by our organization: patent.)

4. Conclusion

In recent years, the environmental conditions of sabo facilities in Japan have changed remarkably. To maintain and improve the safety of the region under future climate change, it is important to predict deterioration and take effective measures in a timely manner to extend the lifespan of existing sabo facilities.

Our organization will continue to maintain and manage sabo facilities, including those that are culturally important, by integrating the knowledge and technology accumulated in previous efforts, as well as new research, as described in this study.

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