EXECUTIVE SUMMARY

Essential Guide for Engineers Involved in Dam Management
Approaches to Sediment Management for Sustainable Dam Operation
– Enhancing Dam Functions and Improving the Environment —
April 2026

Dam Sediment Management Study Group
Water Resources Environment Center (WEC)

1. Overview [Preface / Chapter 1]

1.1. Background and Objectives

Various sediment management measures have been implemented in reservoirs in Japan, and numerous technical guidelines and manuals have been published. However, most of these resources focus on specific measures—such as sediment replenishment or sediment bypass tunnels—and there has been a need for materials that enable a systematic and comprehensive understanding of reservoir sediment management.

To address this need, the Water Resources Environment Center (WEC), with technical guidance and advice from the Dam Sediment Management Study Group (for which WEC serves as the secretariat), has comprehensively revised its technical notes originally published in 2008. This technical material has been compiled by integrating the latest knowledge with practical expertise gained from field experience.

1.2. Target Audience and Concept

This technical material is primarily intended for engineers with relatively limited experience in sediment management.

In preparing this material, particular attention has been paid to the following points:

- The content is systematically organized to cover fundamental sedimentation processes, an overview of sediment management measures, and the environmental impacts of sediment replenishment.
- Practical knowledge from dam operation sites, along with key considerations for implementation, is extensively included.

1.3. Structure and Key Features of This Technical Material

This technical material consists of seven chapters and supplementary materials, which together provide a comprehensive overview of reservoir sediment management. [P.1]

Chapter 2 Reservoir Sedimentation in Japan
【Mechanisms and Regional Characteristics】

Chapter 3 Sediment Management Framework
【Classification of Measures and Selection Framework】

Chapter 4 Sediment Management Measures
【Cases (Sediment Removal and Beneficial Use) and Key Considerations】

Chapter 5 Sediment Replenishment
【Implementation Status in Japan, Cases, and Key Considerations】

Chapter 6 Impact Assessment and Monitoring
【Monitoring Methods for Downstream Rivers and Case Studies】

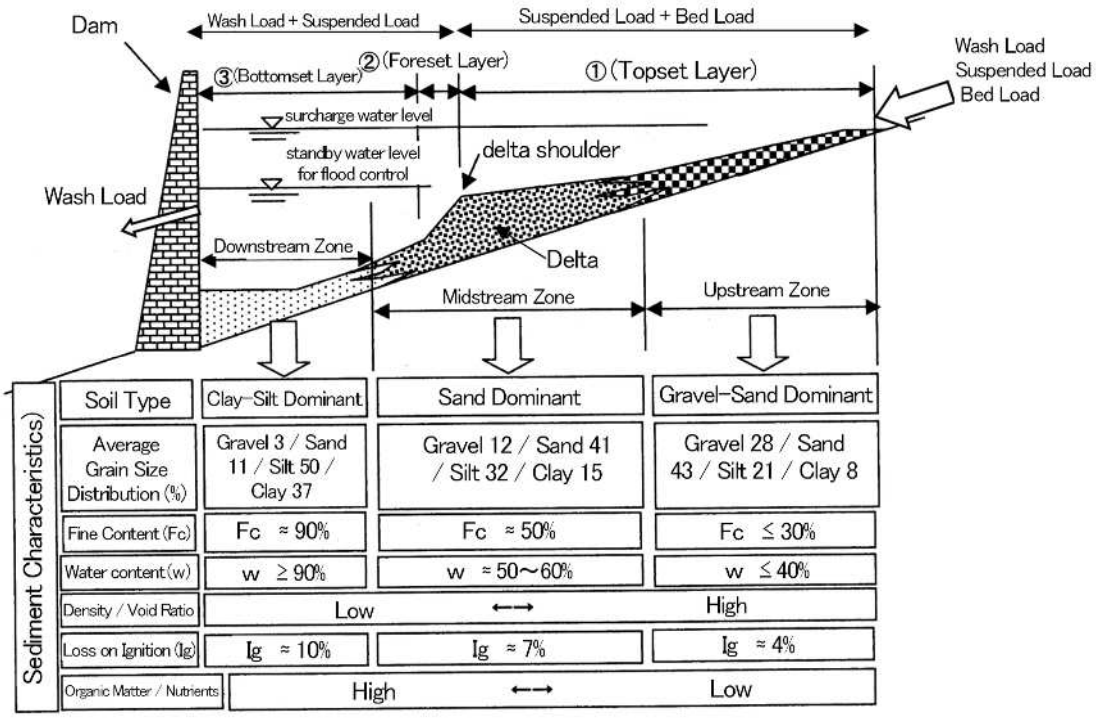
Chapter 7 Recent Developments

Appendix: Supplementary Materials (Timeline, etc.)

2. Sedimentation Conditions in Reservoirs in Japan [Chapter 2]

- The characteristics of Japan's national land—such as the predominance of mountainous and hilly terrain (over 70%), the presence of numerous faults, and high rainfall including intense storm events—are explained, highlighting the highly active sediment production. [P.2～]
- The mechanisms of reservoir sedimentation are organized, including sediment behavior by grain size and typical deposition patterns within reservoirs. [P.12～]
- Key indicators such as sedimentation rate and specific sediment yield are explained, and regional characteristics are presented. In particular, it is shown that both sedimentation rate and specific sediment yield tend to be higher in the Kanto region. [P.26～]

Figure 2-6: Example of Large-Scale Slope Failure (Mimikawa River, Miyazaki Prefecture)



Source:大矢ら．ダム堆砂の性状把握とその利用法．ダム工学，2002，12巻，3号，p.174-187.　　に一部加筆（translated）

Figure 2-15(simplified): Sediment Deposition Characteristics in Reservoirs

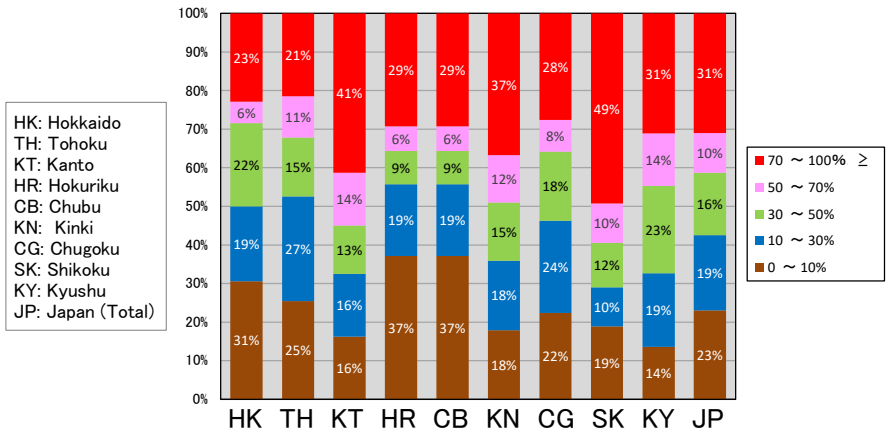


Figure 2-34: Distribution of Sedimentation Rate by Region
(Sedimentation rate = sediment volume / sediment storage capacity × 100)

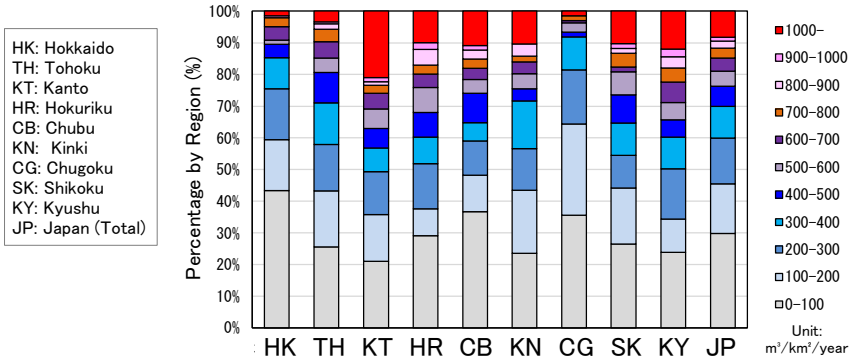
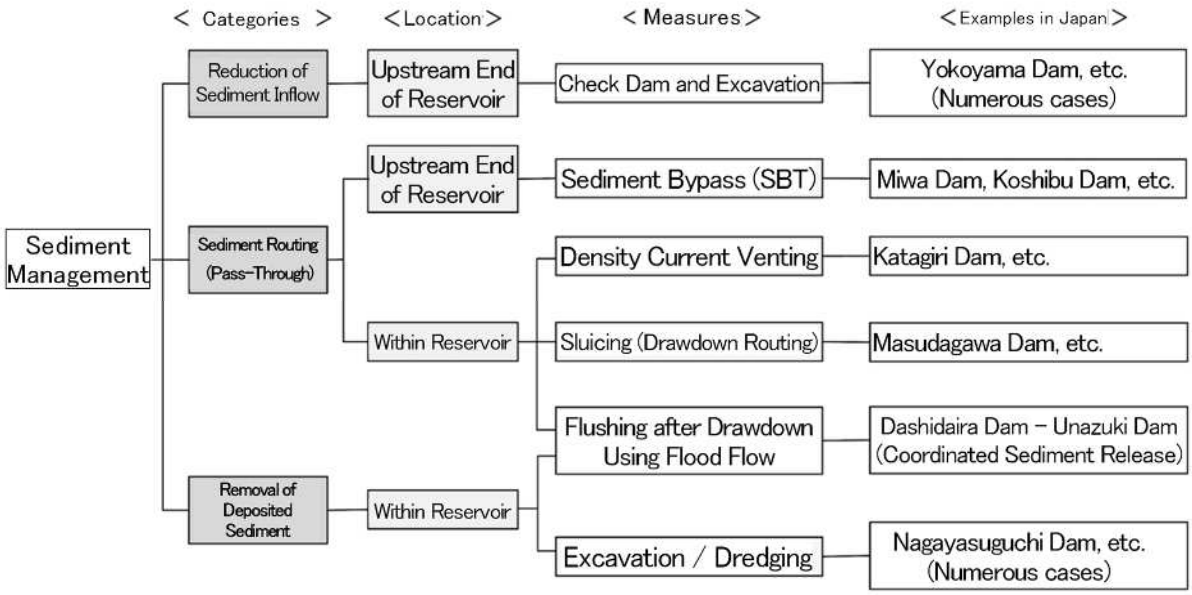


Figure 2-37: Distribution of Specific Sediment Yield by Region

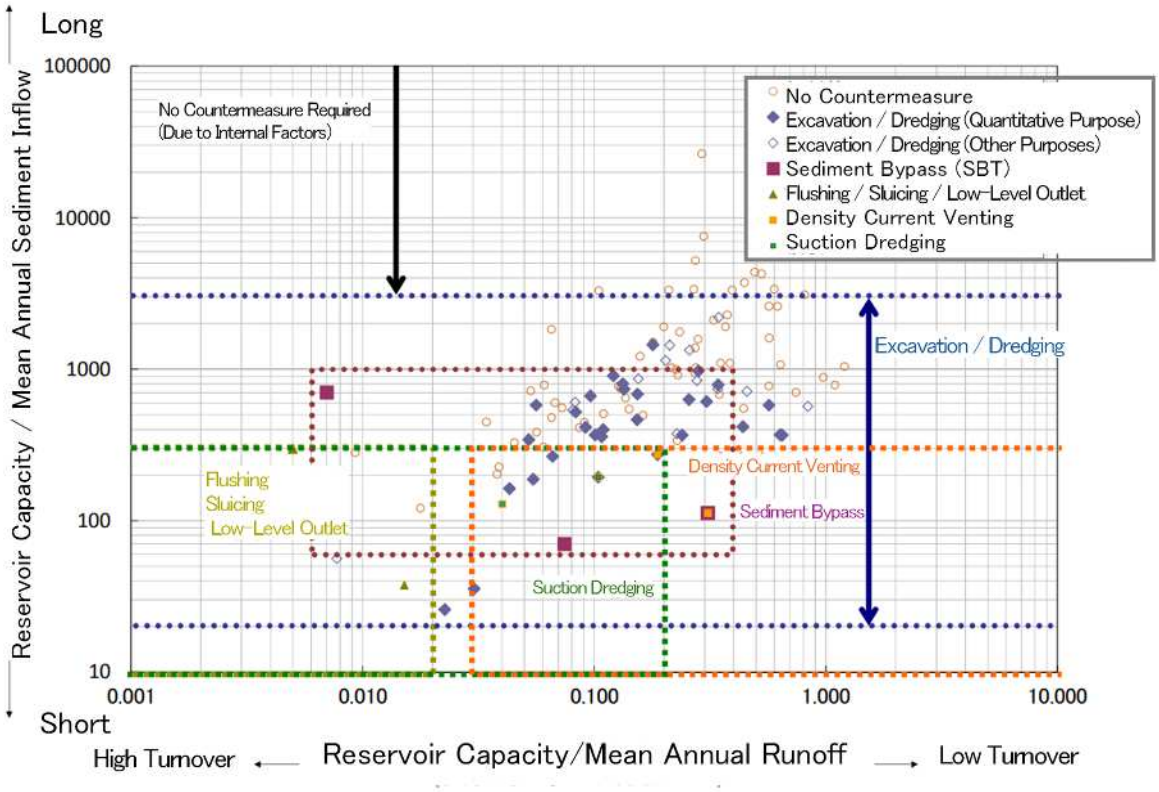
3. Overview of Sediment Management and Approach to Selecting Appropriate Measures [Chapter 3]

- Representative classifications of sediment management measures and approaches to selecting appropriate measures, as presented in existing technical materials in Japan, are introduced. [P.40～]



Source:主な堆砂対策，国土交通省. https://www.mlit.go.jp/river/dam/taisa/taisa3.pdf, (参照2025-03-13). (translated and modified)

Figure 3-1(simplified): Classification of Sediment Management Measures for Reservoirs (Source: MLIT)

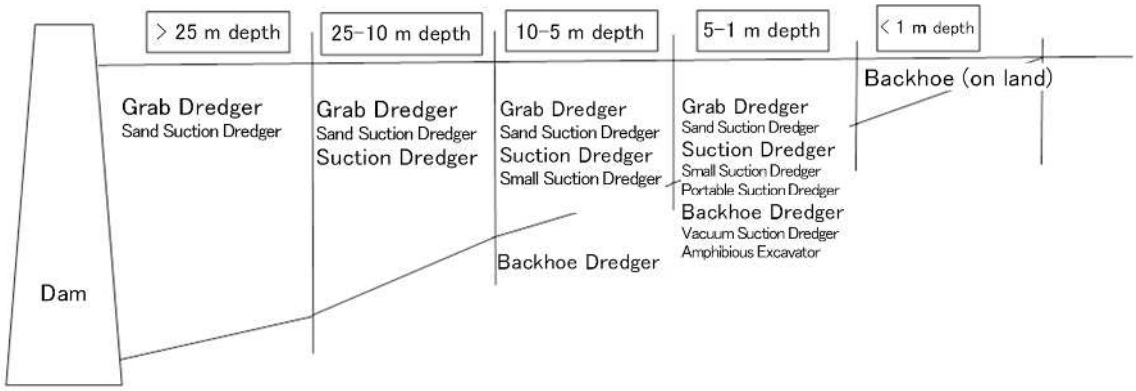


Source:ダム貯水池土砂管理の手引き（案），平成 30 年 3 月，国土交通省 水管理・国土保全局 河川環境課.
https://www.mlit.go.jp/river/shishin_guideline/dam7/pdf/damtyosuichidosyakanritebikiH30.pdf, (参照 2025-03-13). に一部加筆 (translated)

Figure 3-3: Conceptual Diagram for the Selection of Sediment Management Measures

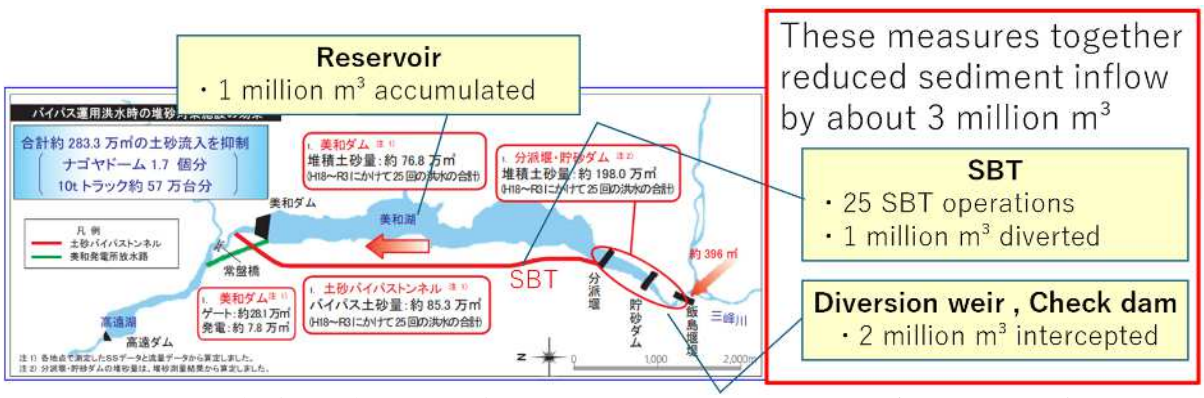
4. Implementation of Sediment Management Measures [Chapter 4]

- This chapter provides a detailed description of excavation and dredging, which have been widely implemented in Japan; sediment bypass tunnels (SBTs), for which the number of applications has been increasing in recent years; and Instream flood mitigation dams (FMDs), a type of sediment sluicing measure that has also seen increasing application in Japan. [P.51～]
- **Excavation and dredging:** The applicable conditions for each method and key considerations for their implementation are presented. [P.51～]
- **SBTs:** In addition to an overview of facilities in Japan and abroad, the effectiveness of installation and abrasion countermeasures within tunnels are explained, with a focus on the Miwa Dam case.
- **FMDs:** Along with an overview of facilities in Japan, sediment behavior within the reservoir and key considerations such as driftwood management are described, with a focus on the Masudagawa Dam case. [P.70～]
- **Other measures:** Examples and technical characteristics are presented for sediment check dams, sluicing and flushing, density current venting, and hydrosuction sediment removal systems. [P.80～]
- In addition, topics related to the selection of sediment management measures are addressed, including asset management perspectives, economic evaluation of sediment management, and examples and challenges in the beneficial use of sediment. [P.98～]



Source:本多将人．“ダム堆砂対策工法の概要”．（一社）ダム水源地土砂対策技術研究会　平成25年度技術講演会．
https://doshaken.com/event/images/pdf/H26_presen2.pdf，（参照2025-03-20）（translated）

Figure 4-2: Applicable Water Depth for Excavation and Dredging Methods in Reservoirs



Source: 2023 年度（令和 5 年度）事業概要，令和 5 年 4 月，国土交通省　中部地方整備局　三峰川総合開発工事事務所.
https://www.cbr.mlit.go.jp/mibuso/jigyo/images/09gaiyou/2023gaiyou.pdf，（translated and modified）

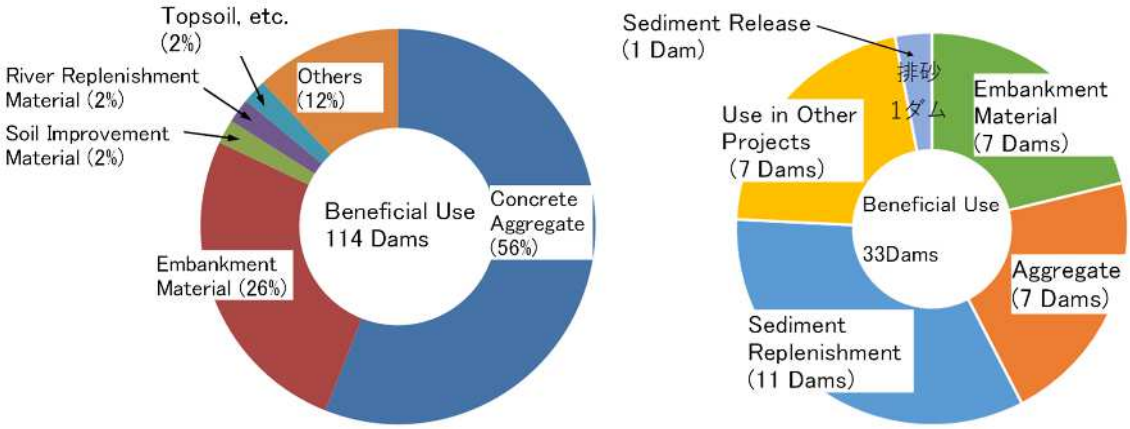
Figure 4-10: Effectiveness of Sediment Management Facilities Including the SBT at Miwa Dam

Source：中村壽浩．益田川ダムの設計と施工．島根県提供資料．（translated）

Figure 4-25: Driftwood Capture Facility at Masudagawa Dam

Source：中村ら．西之谷ダムの貯水池地形の変遷と土砂管理手法に関する考察．河川技術論文集．2024，第 30 巻，p. 125-130．（translated）

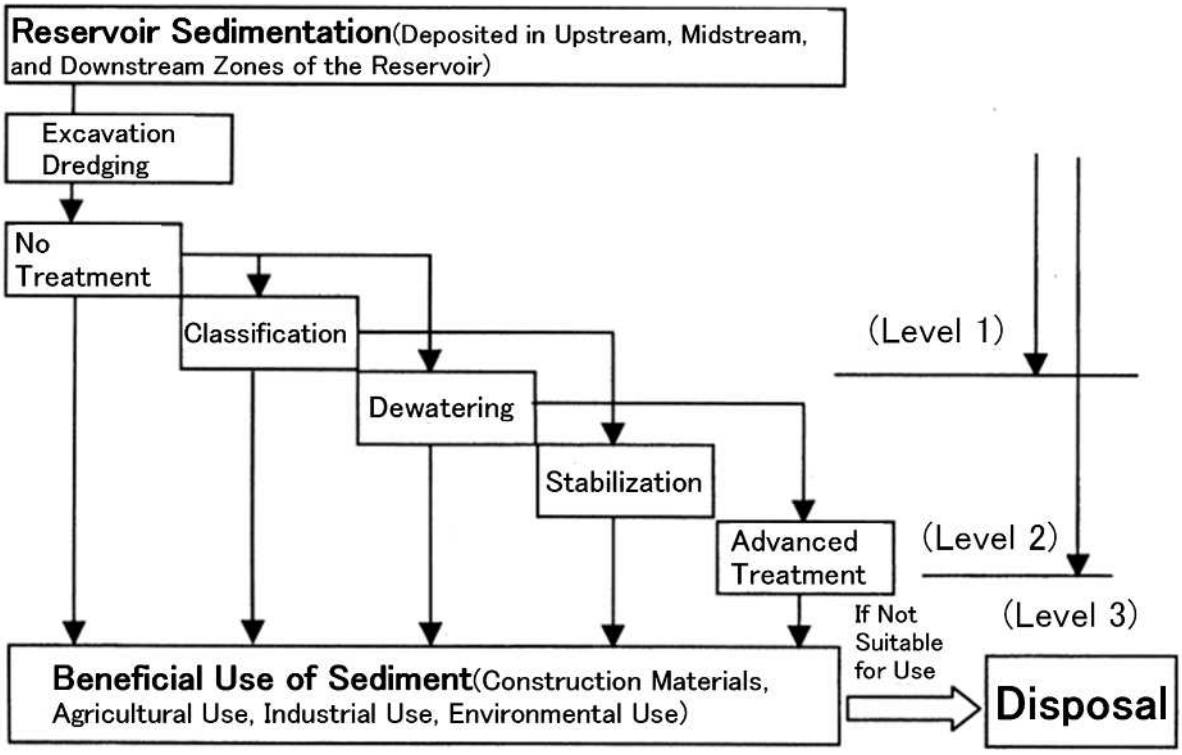
Figure 4-37: Sediment Sluicing Operation at Saigo Dam (2017)



(Left: Survey from FY1997–1999, 580 dams; Right: Survey in FY2018, 119 dams)

Source: (一社) ダム工学会維持管理研究部会. ダム堆砂の有効活用に関する事例研究. ダム工学. 2022, Vol.32, No.1, p.1-7. (translated)

Figure 4-49: Utilization of Excavated Sediment

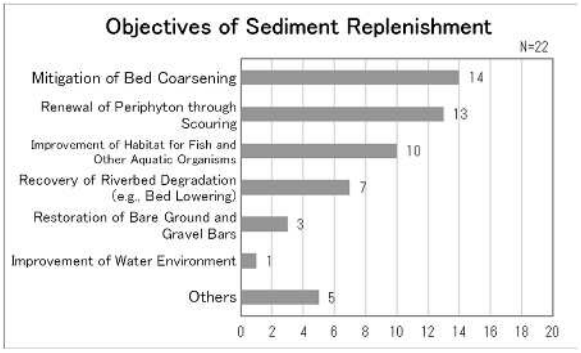


Source: 大矢ら. ダム堆砂の性状把握とその利用法. ダム工学, 2002, 12 巻, 3 号, p.174-187. (translated)

Figure 4-48: Flow Diagram for the Utilization of Reservoir Sediment

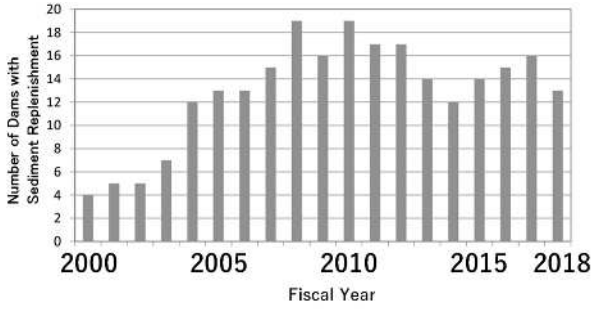
5. Sediment Replenishment in Downstream Rivers [Chapter 5]

- An overview of sediment replenishment (sediment placement) practices in Japan is presented based on information compiled in March 2019.
- Approximately 30 dams in Japan have implemented sediment placement. The primary objectives include improving bed coarsening conditions and promoting the renewal of attached algae through scouring. The volume of sediment placement is generally limited to about 10% of the annual average sedimentation, and the sediment used is predominantly sand and gravel. [P.110～]
- Case studies demonstrating environmental improvements are presented, including mitigation of bed coarsening (e.g., Nibutani Dam), recovery of riverbed conditions (e.g., Nagayasuguchi Dam), changes in benthic fauna (e.g., Agigawa Dam), changes in fish communities (e.g., Futase Dam), changes in periphyton communities (e.g., Managawa Dam), and landscape improvement (e.g., Shimokubo Dam). [P.115～]
- The basic approaches to sediment placement methods and volume setting are described, and it is shown that early implementation is effective for achieving environmental improvements. [P.121～]



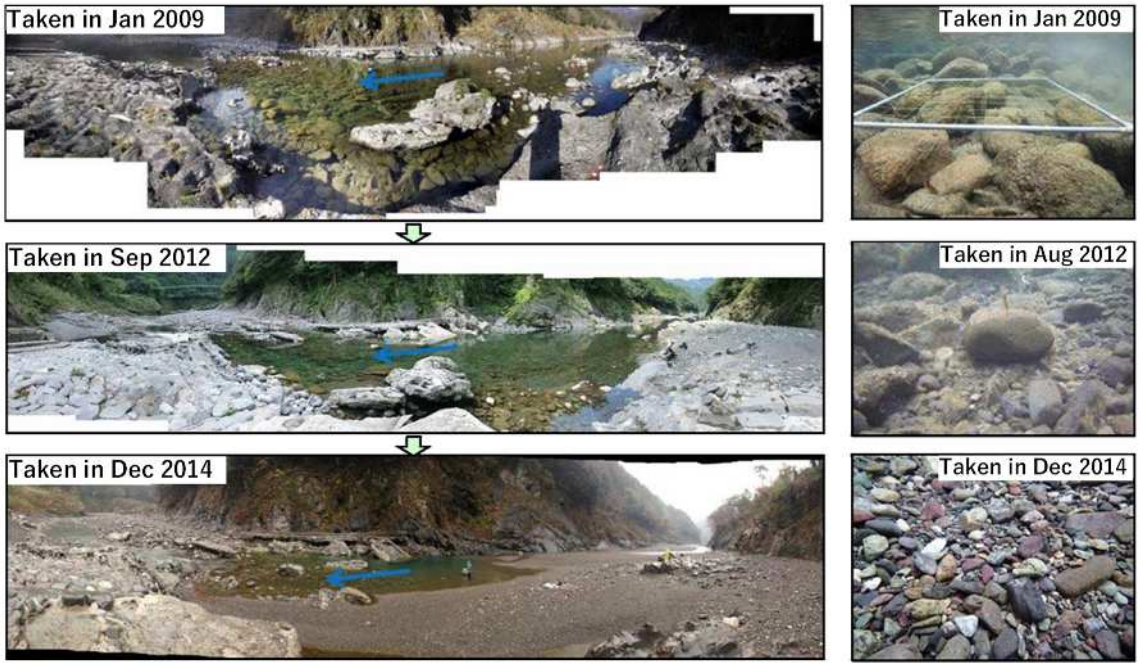
Source:国土交通省及び水資源機構管理ダムにおける土砂還元（置き土）の取り組みについて，令和６年３月，国土交通省 水管理・国土保全局 河川環境課．（translated）

Figure 5-1: Objectives of Sediment Replenishment



Source:国土交通省及び水資源機構管理ダムにおける土砂還元（置き土）の取り組みについて，令和６年３月，国土交通省 水管理・国土保全局 河川環境課．（translated）

Figure 5-2: Trends in the Number of Dams Implementing Sediment Replenishment



Source:国土交通省及び水資源機構管理ダムにおける土砂還元（置き土）の取り組みについて，令和６年３月，国土交通省 水管理・国土保全局 河川環境課．（translated）

Figure 5-9: Changes in River Landscape and Bed Material Downstream of Nagayasuguchi Dam

6. Assessment and Prediction of Impacts of Sediment Release [Chapter 6]

- Sediment release through measures such as sediment bypassing and sediment replenishment is expected to alter the physical and biological conditions of downstream rivers. Therefore, monitoring surveys are required when implementing sediment release, and it is shown that monitoring is conducted at many sites where sediment management measures are applied. [P.123～]
- Monitoring parameters currently used in Japan are summarized. In addition, case studies of monitoring associated with major sediment management measures involving sediment replenishment are presented, including sediment placement (Naka River system), sediment sluicing (Mimikawa River system), and SBTs (Koshibu Dam and Matsukawa Dam). For each case, the monitoring parameters and key findings obtained from the monitoring are described. [P.124～]

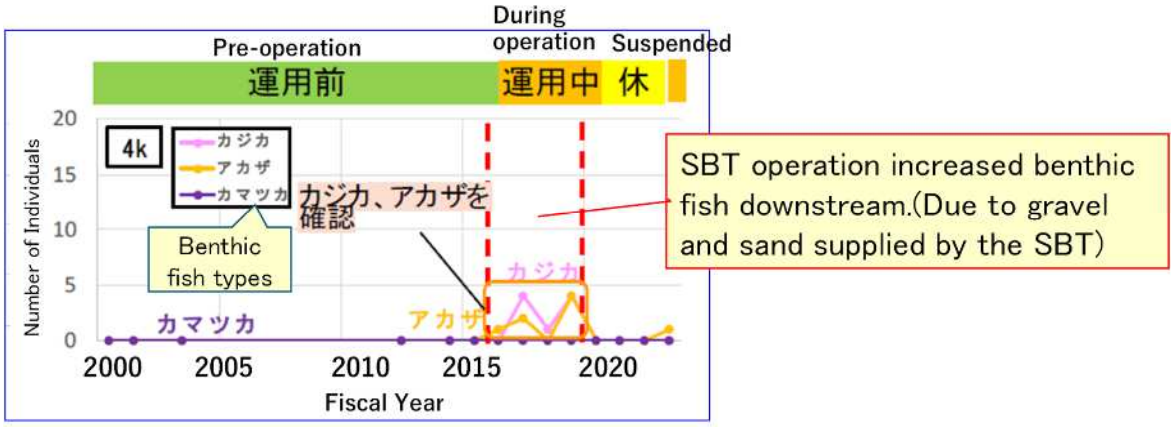
Table 6-1: Monitoring Parameters for Assessing the Impacts of Sediment Release

Category	Monitoring Parameters	Monitoring Methods and Contents
Physical Environment	Channel morphology	Cross-sectional surveys, vegetation surveys, photographic records, aerial surveys (ALB, LP), riffle-pool structure, distribution of bars and tidal flats
	Bed material (grain size)	Grain size distribution curves, photographic records
	Bed material (surface distribution)	Grid sampling (area grid / line grid methods), photographic records
	Landscape	Photographic records, water surface width
	Sediment transport	Tracer surveys, photographic records, turbidity meters, sediment traps with load cells, hydrophones
Water Quality	Turbidity	Turbidity meters, suspended solids (SS) analysis, photographic records
	Water temperature	Continuous monitoring using data loggers
	Water quality	Water quality meters, laboratory analysis (pH, BOD, DO, etc.)
Biological Environment	Periphyton	Species composition, biomass, ignition loss, photographic records
	Benthic fauna	Species composition, biomass
	Fish	Species composition, biomass, behavior

Table 6-6: Assessment of the SBT Based on Environmental Monitoring Results from Downstream of Koshibu Dam

Category	Item	Assessment of SBT
Physical Environment	Channel morphology	Contributed to increased disturbance in the downstream river channel
	Bed material	Contributed to suppressing bed coarsening and promoting fining in the downstream river channel
	River landscape	Increased the extent of bare ground in the river corridor
	Water quality	Contributed to maintaining continuity of suspended sediment between upstream and downstream of the dam
Biological Environment	Periphyton	No clear impact attributable to SBT operation was observed
	Benthic fauna	Fining of bed material contributed to changes in species composition
	Fish	Changes in bed material contributed to an increase in species preferring gravel beds and interstitial spaces (See Figure 6-11)
	Terrestrial vegetation	Loss of target plant species was observed (however, this was attributed to vegetation succession and repeated large flood events rather than SBT operation)
	Terrestrial important species	Impacts on important riparian plant species remain unclear at present

Source:第 12 回 小渋ダム土砂バイパストンネルモニタリング委員会 説明資料, 令和 6 年 3 月 12 日, 国土交通省 中部地方整備局 天竜川ダム統合管理事務所. https://www.cbr.mlit.go.jp/tendamu/dam/pdf/monitoring/122_siryou_20240312.pdf, (参照 2025-3-13). の掲載情報を元に作成 (translated and modified)



Source:第 12 回 小渋ダム土砂バイパストンネルモニタリング委員会 説明資料, 令和 6 年 3 月 12 日, 国土交通省 中部地方整備局 天竜川ダム統合管理事務所. https://www.cbr.mlit.go.jp/tendamu/dam/pdf/monitoring/122_siryou_20240312.pdf, (参照 2025-3-13). の掲載情報を元に作成 (translated and modified)

Figure 6-11 (excerpt, modified): Monitoring Results for Benthic Fish Downstream of Koshibu Dam

7. Recent Developments in Sediment Management [Chapter 7]

- Recent developments in sediment classification technologies and sediment management–related technologies under the Cross-ministerial Strategic Innovation Promotion Program (SIP), a Cabinet Office initiative in Japan—such as remotely operated dredging systems—are introduced. [P.142～]
- Activities such as industry–academia collaborative research led by Kyoto University and recent trends in the International Commission on Large Dams (ICOLD) are also presented. [P.148～]

Figure 7-1: General View of the Sediment Classification Experimental Plant at Yahagi Dam (FY2023)

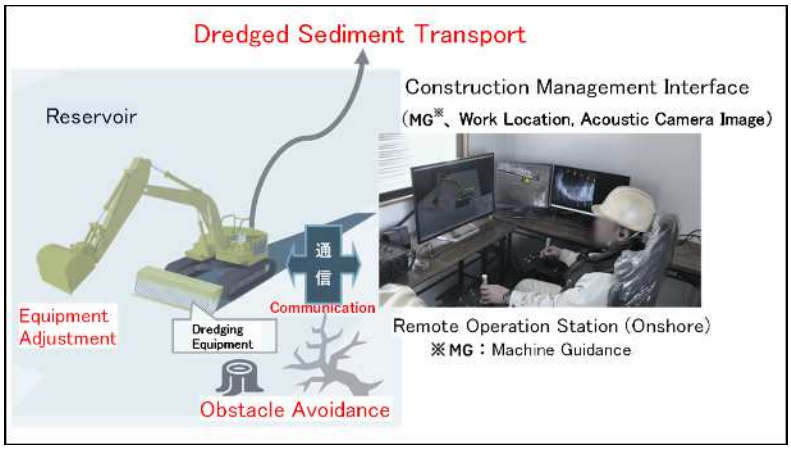


Figure 7-5: Conceptual Image of a Remotely Operated Dredging System

8. Future Directions

Through the dissemination of this technical material, we aim to support engineers involved in dam management in examining and implementing appropriate sediment management measures tailored to individual reservoirs.

This technical material will also be continuously updated in the future.