RESERVOIR SEDIMENT MANAGEMENT & ANALYSIS FOR ENGINEERS

Screening Level Analysis for Reservoir Sediment Management

University of Kansas
LEEP2 Building – Room G415
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ERDC
Engineer Research and Development Center

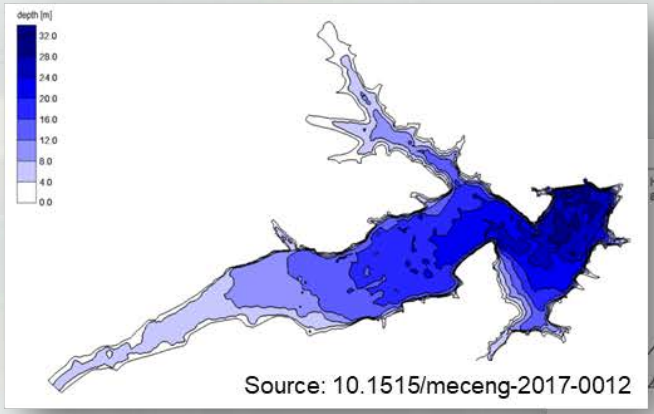
Classification of Sediment Management Alternatives

Three Strategies:

1) **Reduce Sediment Yield** from the watershed into the reservoir
2) **Route Sediment** to minimize deposition in the reservoir
3) **Remove Sediment** previously deposited in the reservoir to increase or recover volume

Choosing The Right Management Strategy

- Estimation of Success based on Parameterization (Empirical Methods)
- Estimating Trap Efficiency
- Using RESCON as a Screening Tool for Reservoir Flushing



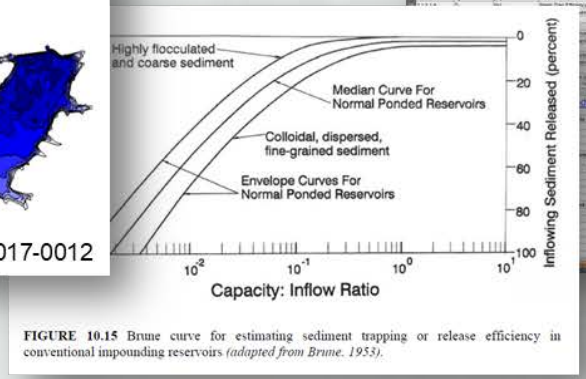
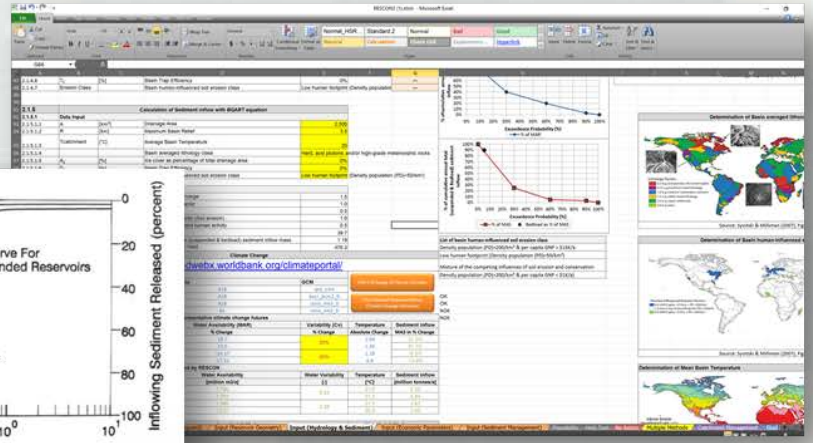
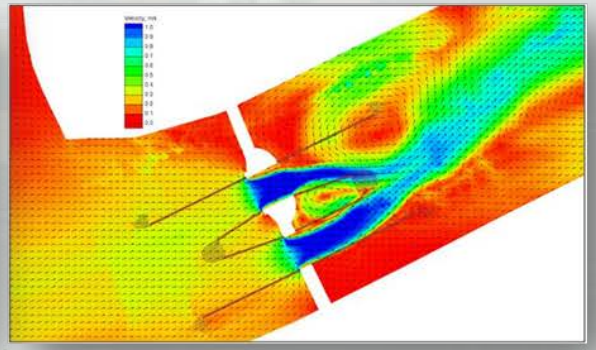


FIGURE 10.15 Brune curve for estimating sediment trapping or release efficiency in conventional impounding reservoirs *(adapted from Brune. 1953).*



Empirical Methods, Are You Sure?

- As engineers we love to build models (physical and/or numerical)
- We can dream up dozens of ways to manage sediment, but we can't build a model for each one.
- How to narrow down the list to just a few sediment management techniques that have a reasonable chance of success?



Trap Efficiency Methods

- From measured survey data and water quality sampling
- **Churchill (1948)** developed a trap efficiency curve for settling basins, small reservoirs, flood retarding structures, semi-dry reservoirs, and reservoirs that are frequently sluiced.
- **Brune (1953)** developed an empirical relationship for estimating the long-term reservoir trap efficiency for large storage or normal pond reservoirs based on the correlation between the relative reservoir size and the trap efficiency.

Trap Efficiency Methods

- **Churchill** based on Tennessee Valley Authority reservoirs in the southeastern United States.
- **Brune** used 44 reservoirs across the U.S.
- General guideline:
  - Use the **Brune method** for large storage or normal ponded reservoirs
  - Use the **Churchill curve** for settling basins, small reservoirs, flood retarding structures, semi-dry reservoirs, or reservoirs that are continuously sluiced.

Brune Method of Sediment Trap Efficiency

From Morris and Fan (1998) Reservoir Sedimentation, McGraw-Hill

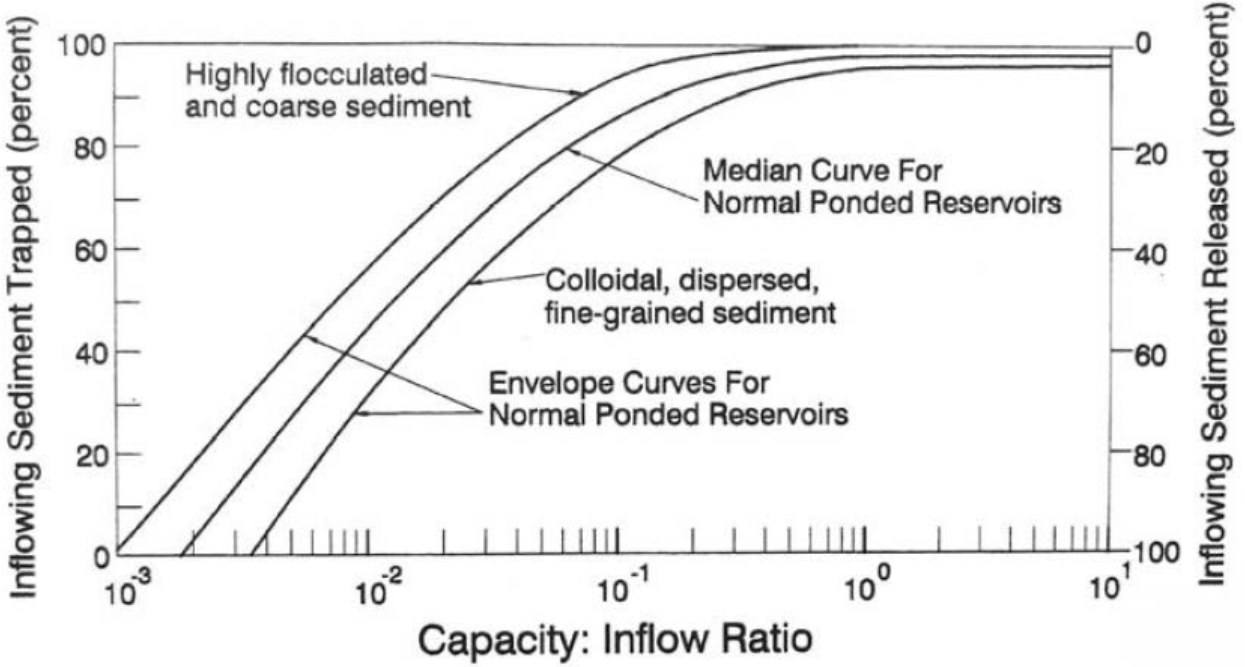
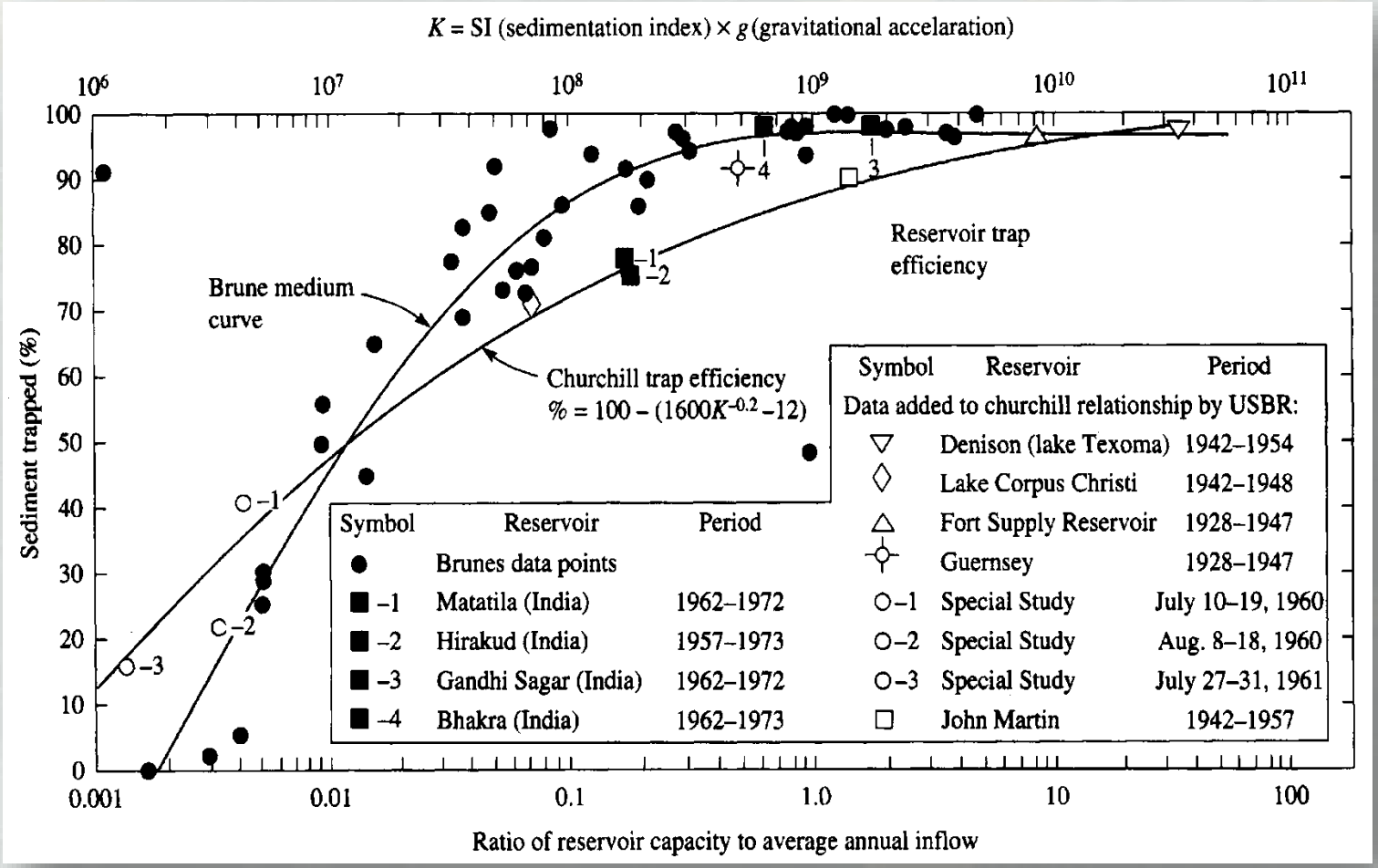


FIGURE 10.15 Brune curve for estimating sediment trapping or release efficiency in conventional impounding reservoirs *(adapted from Brune. 1953).*

Churchill Method of Sediment Trap Efficiency

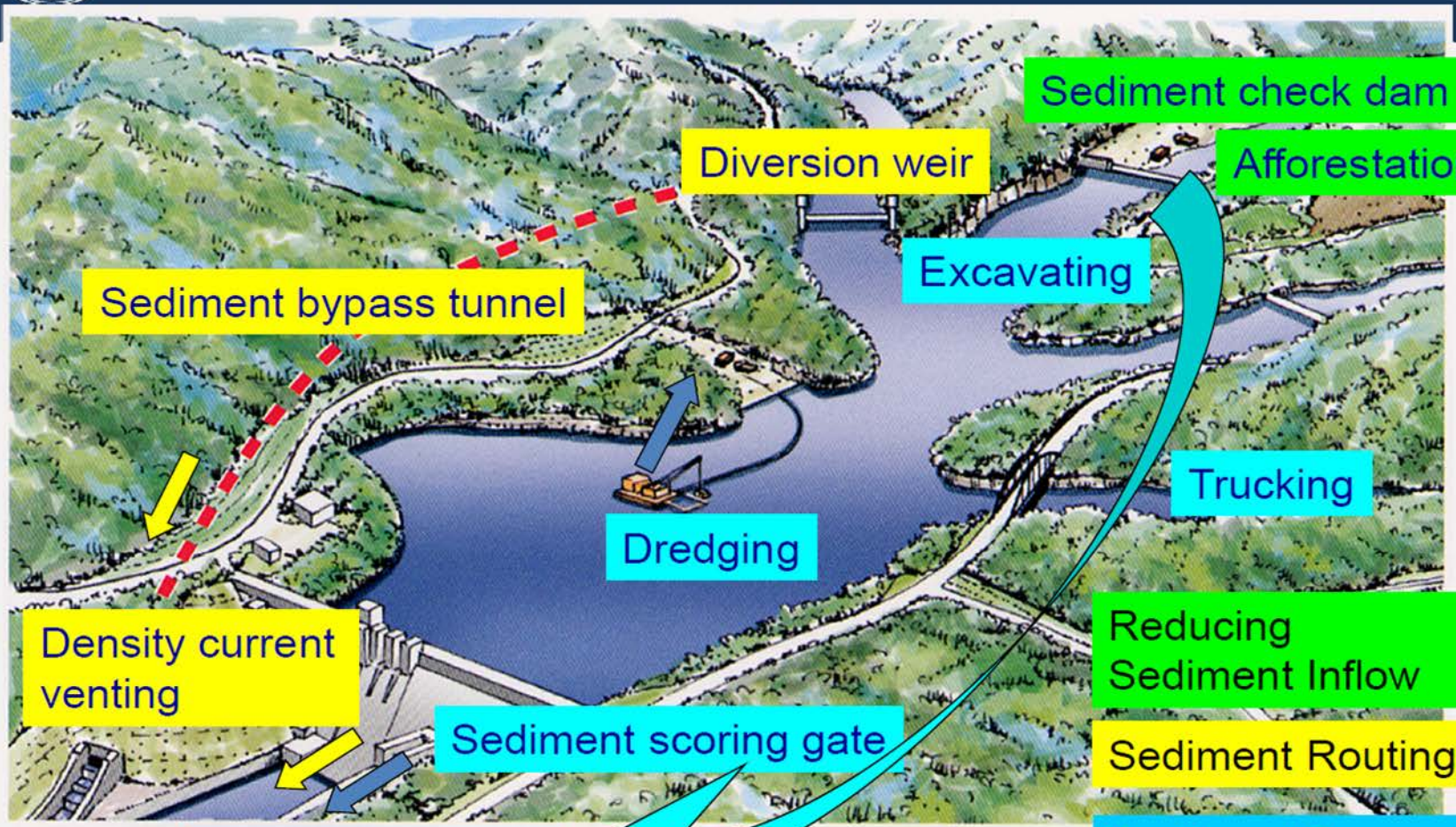
- Uses a relationship between the percent of incoming sediment passing through a reservoir and the sedimentation index of the reservoir
- The Churchill curve has been converted to a dimensionless expression by multiplying the sedimentation index by g, acceleration due to gravity.
- Can be used for small reservoirs and those that are dry or semi-dry.

Churchill Method of Sediment Trap Efficiency



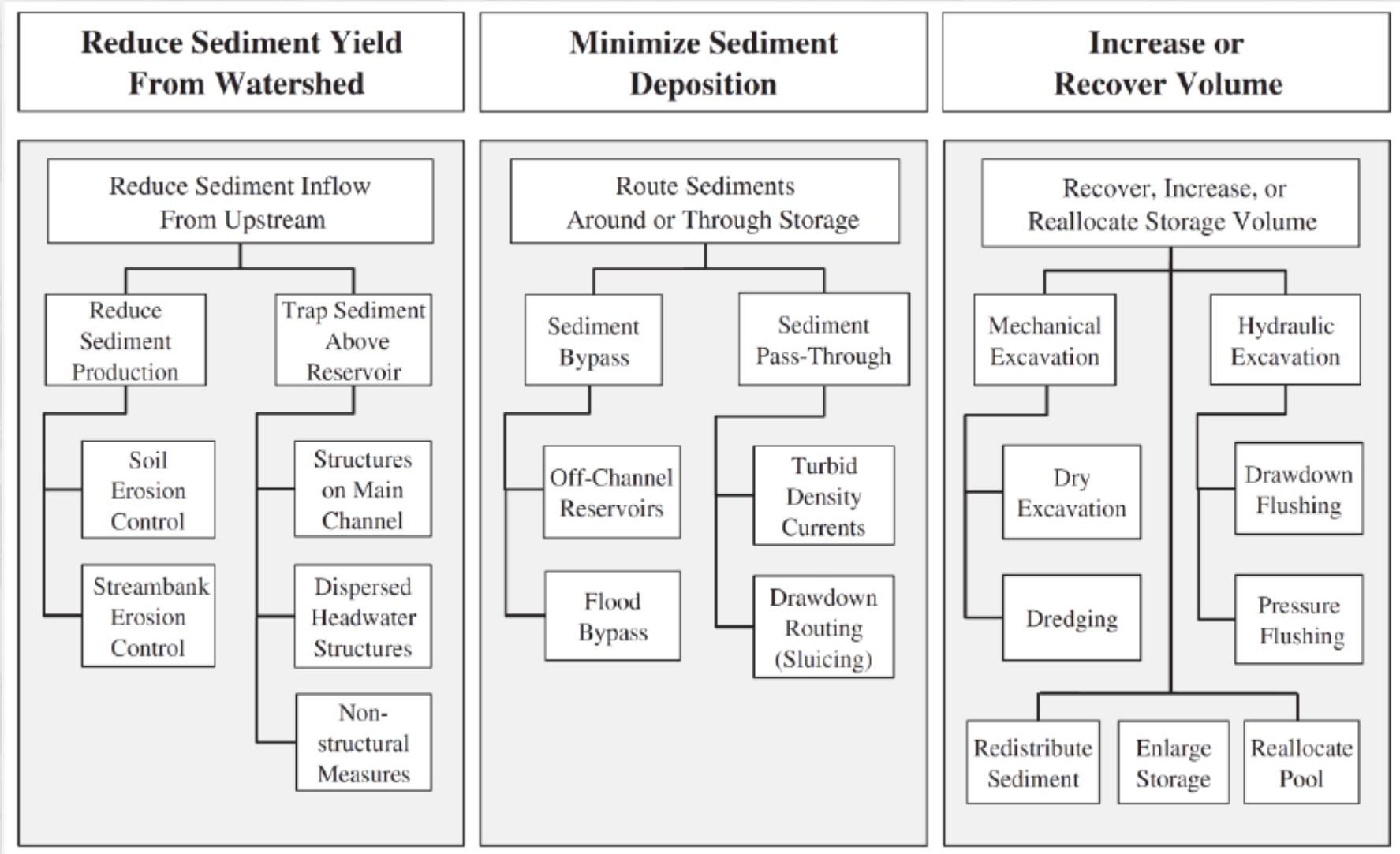
Review of Sediment Management Methods

How should we select suitable measures for reservoir sediment management?



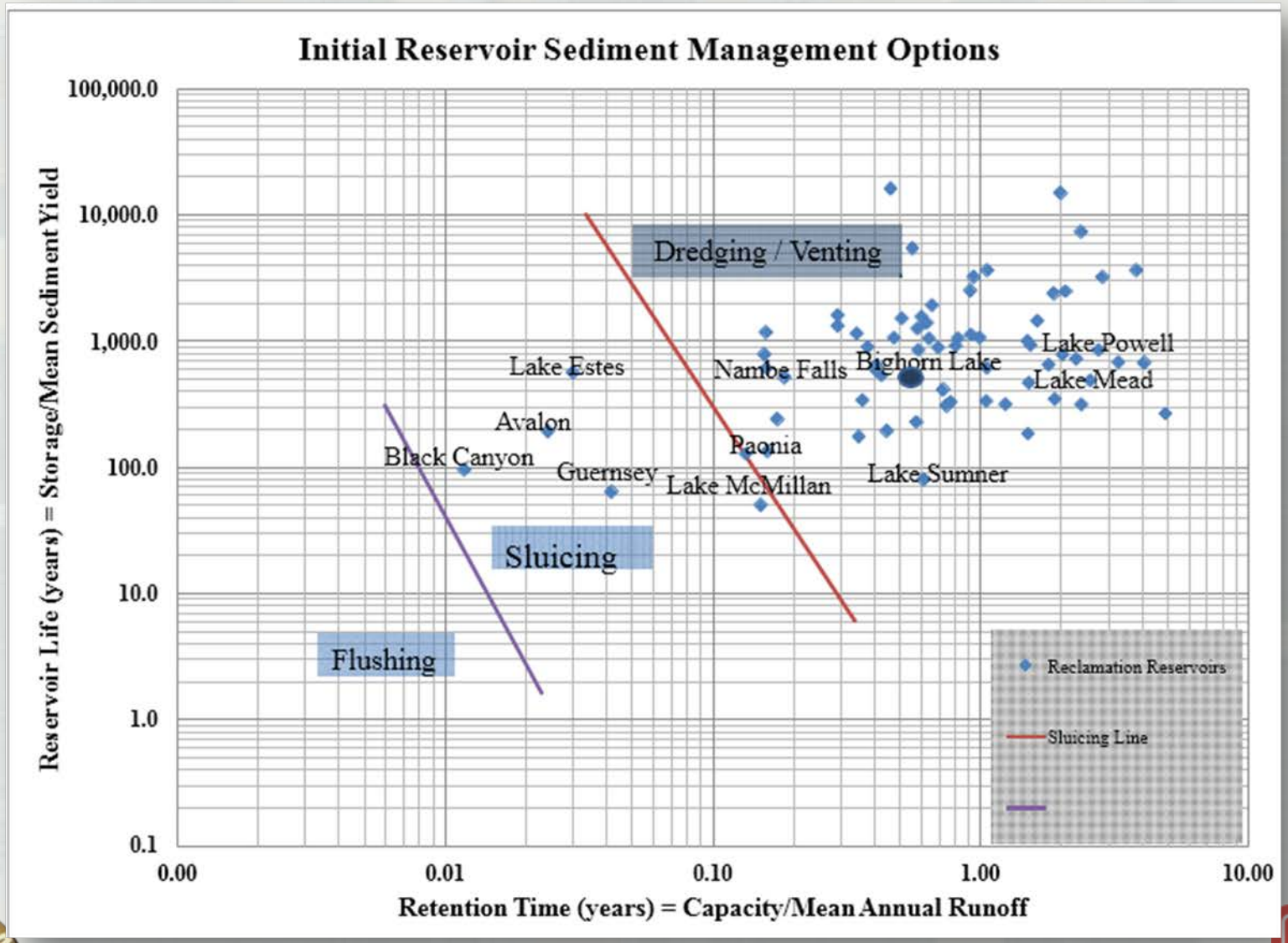
Sumi, 2015

Management Strategies



Kondolf, 2014

Basson and Roseboom Type Plot



Kimbrel et al., 2015

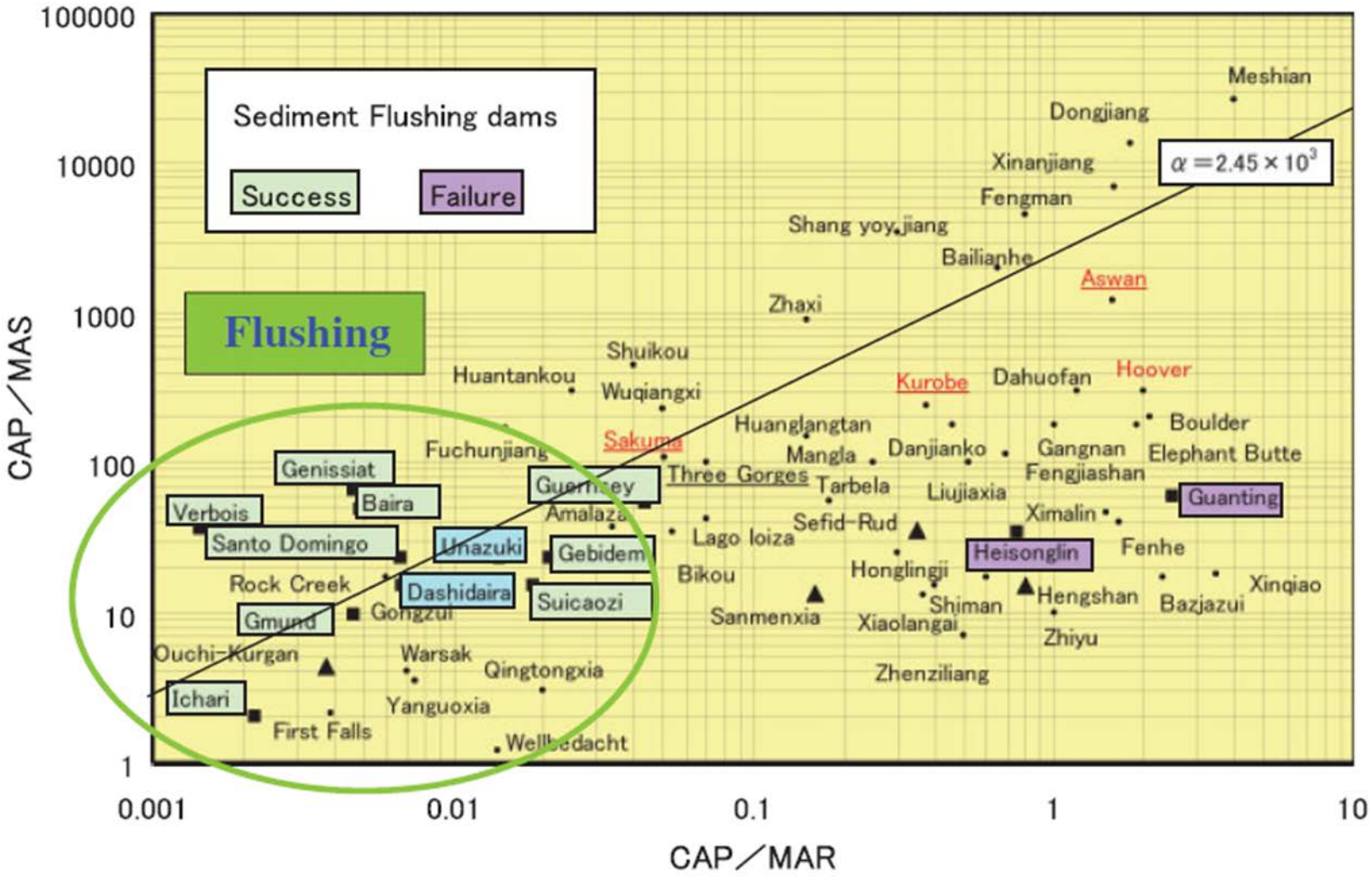
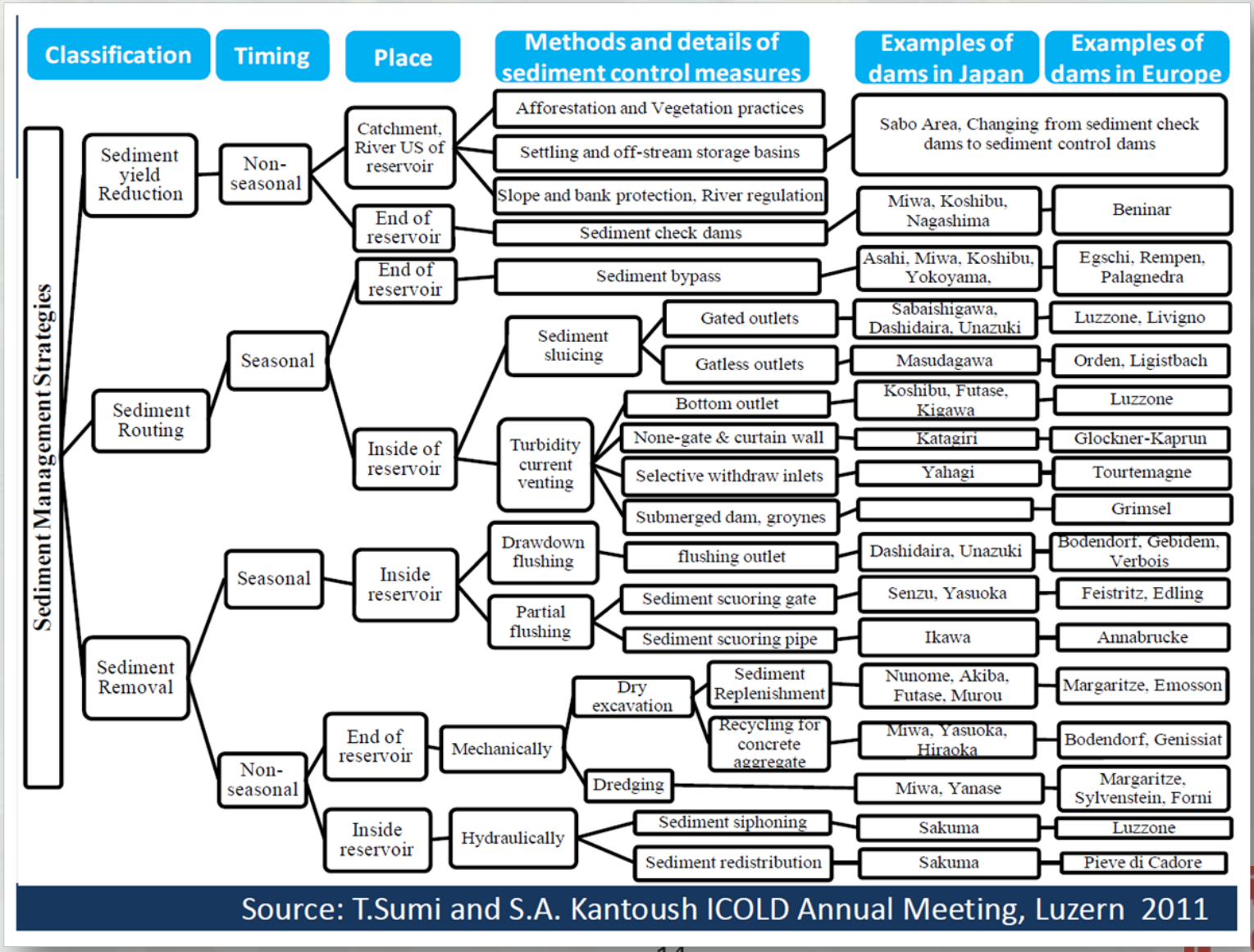


Figure 9. Plot of flushing projects from diverse environments showing that successful cases are characterized by impoundment ratios of 0.4 or less. That is, reservoir storage capacity divided by mean annual runoff (inflow to the reservoir) should be less than 0.4.

Kondolf, 2014

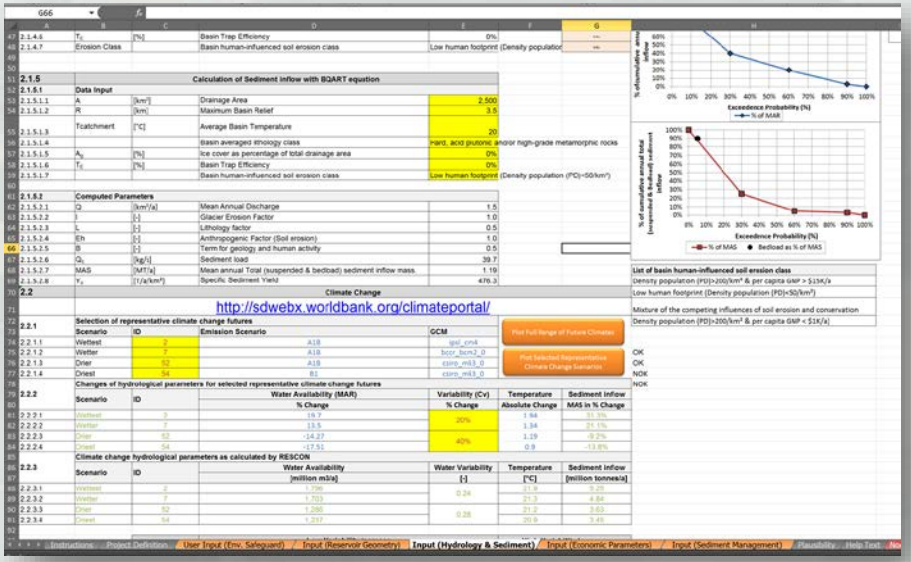
It can be done!



Source: T.Sumi and S.A. Kantoush ICOLD Annual Meeting, Luzern 2011

Reservoir Conservation Toolkit (RESCON)

- Spreadsheet-based tool for examining reservoir management
- It is a useful first review of possible management techniques
  - Examines the economics of Flushing, Dredging, Hydrosuction, and Trucking
  - **It is not a design tool, only a screening tool (primarily for reservoir flushing)**



RESCON Data & Limitations

- Source Data
  - RESCON determines the efficiency of flushing based on the sediment balance ratio (SBR) from Atkinson (1996). The dataset from this paper has few data points from reservoirs with flushing activities
- Limitations
  - RESCON is a screening tool, which can help determine if flushing is possible, it does not provide information about the hydrograph, timing, or efficiency of a flush. A positive result in RESCON **does not guarantee** that flushing will be effective.

Ongoing USACE Research

- Paul Boyd, John Shelley, Stanford Gibson, and others are monitoring and modeling reservoir flushes (RSM).
- Travis Dahl and Marielys Ramos-Villanueva are working on updating screening criteria for reservoir sediment management (Flood & Coastal Storm Damage Reduction R&D).

Thank You

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