Generalized Sediment Budget of the Lower Missouri River

MRBIR Executive Meeting, February 22, 2017

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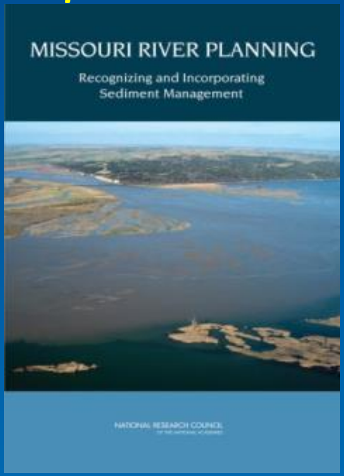
In cooperation with the U.S. Army Corps of Engineers

U.S. Department of the Interior
U.S. Geological Survey

Impetus for Study

"Corps of Engineers and the U.S. Geological Survey scientists have been conducting valuable collaborative investigations of Missouri River sedimentary processes that should be used as the foundations for a more detailed and extensive sediment budget. Over time, continued collaboration may lead to a more formal program for data collection and evaluation. The Corps and the USGS should extend their collaborative efforts and develop a detailed Missouri River sediment budget for the headwaters to the river's mouth, with provisions for continuing revisions and updates as new data become available."

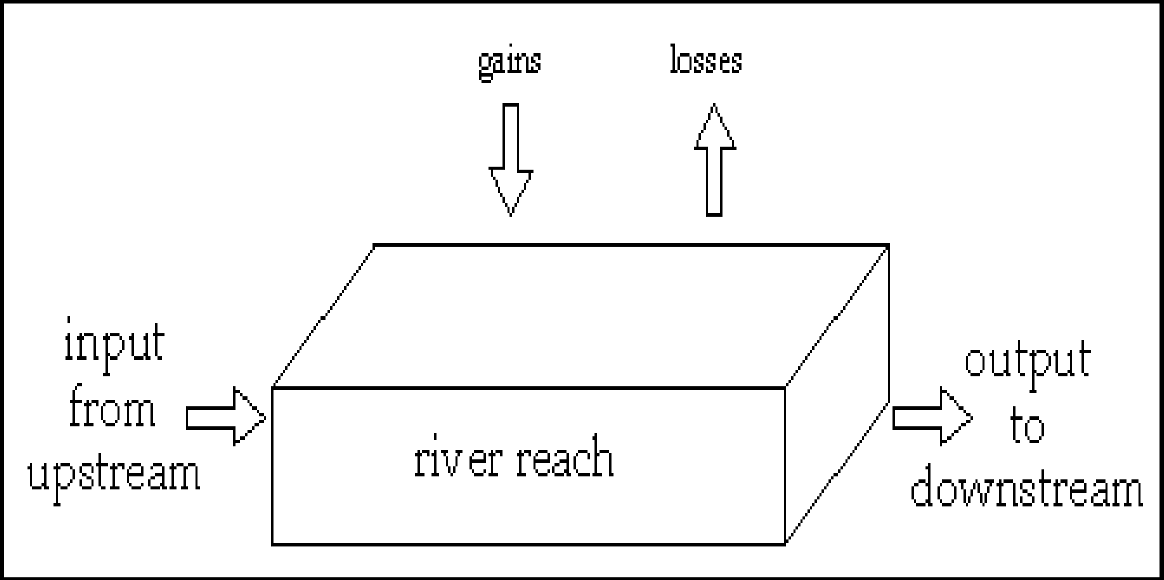
-National Research Council, 2011



National Research Council, 2011. Missouri River planning: Recognizing and incorporating sediment management. National Academies Press, Washington D.C., 152 pp.

Why is a Sediment Budget Important?

- **The sediment budget of a reach determines physical channel form**



(Inputs + Gains) – (Outputs + Losses) = $\boxed{\text{Residual}}$

Residual = 0, Equilibrium

Residual < 0, Degrading

Residual > 0 Aggrading

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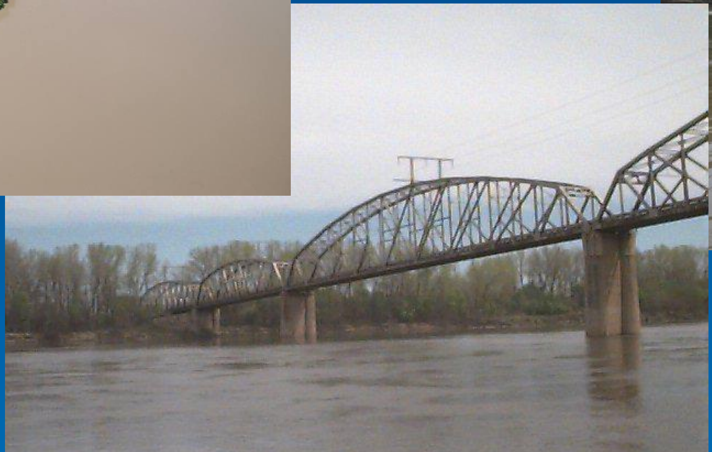
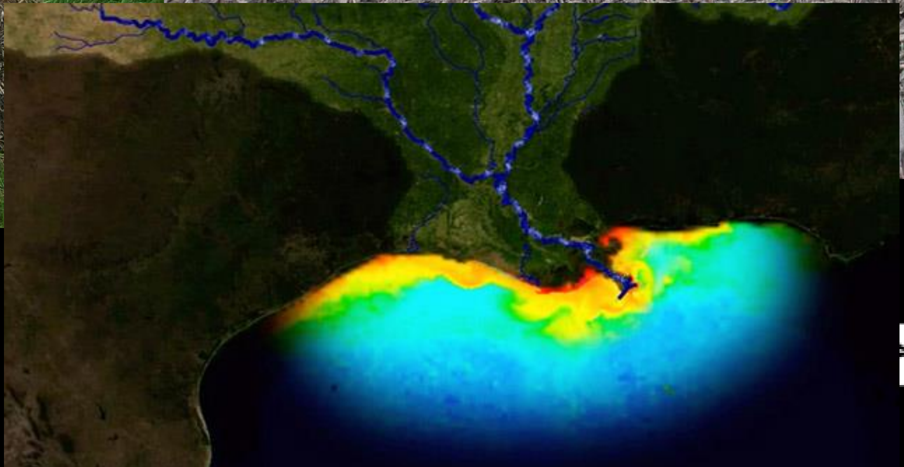
Why is a Sediment Budget Important?



Why is a Sediment Budget Important?

- Quantifying sources of sediment in a budget also is a means of determining effectiveness of erosion and nutrient runoff reduction and targeting effective management activities

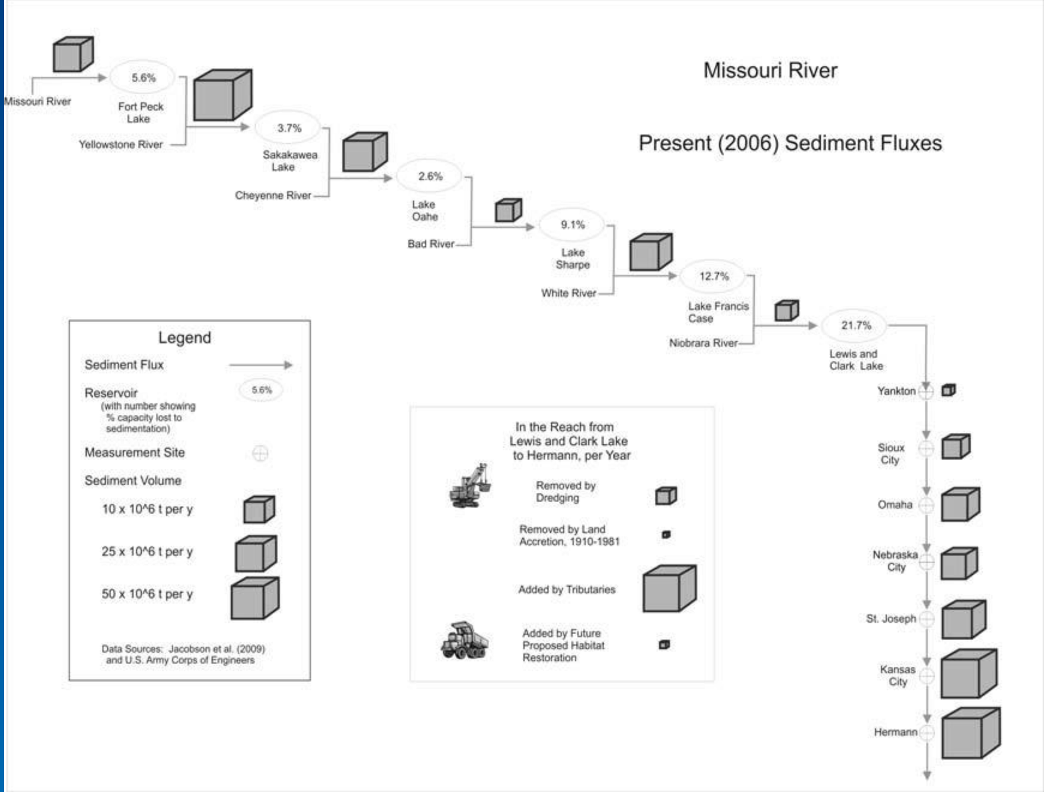




Objectives of Study—A Starting Point

- **Using existing information, establish the initial framework for a sediment budget with which to update the National Research Council (2011) conceptual sediment budget (Lower Missouri River, post-impoundment period).**

- **When and where possible, incorporate bedload transport into the generalized sediment budget.**

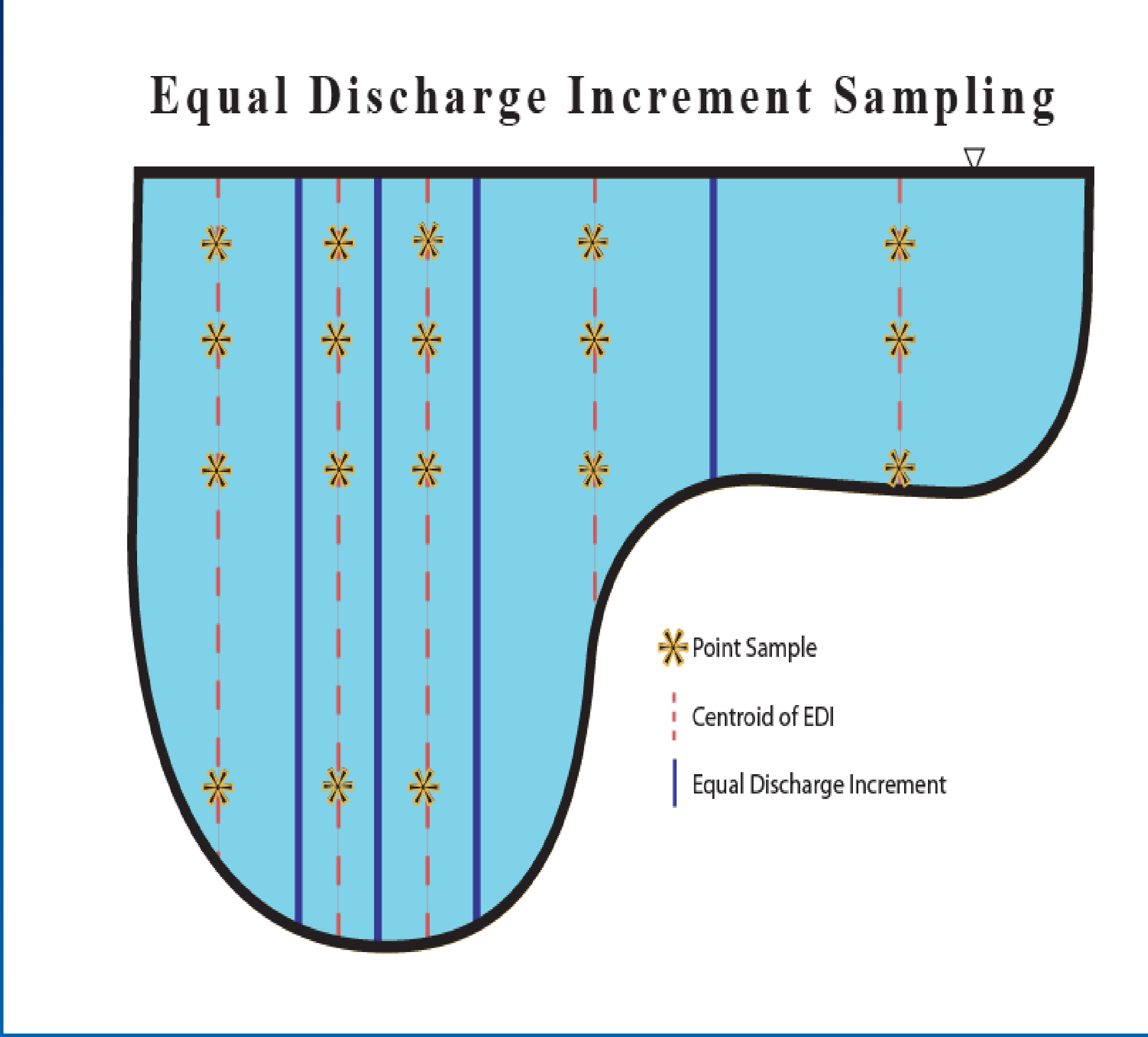


Sediment Sample Collection

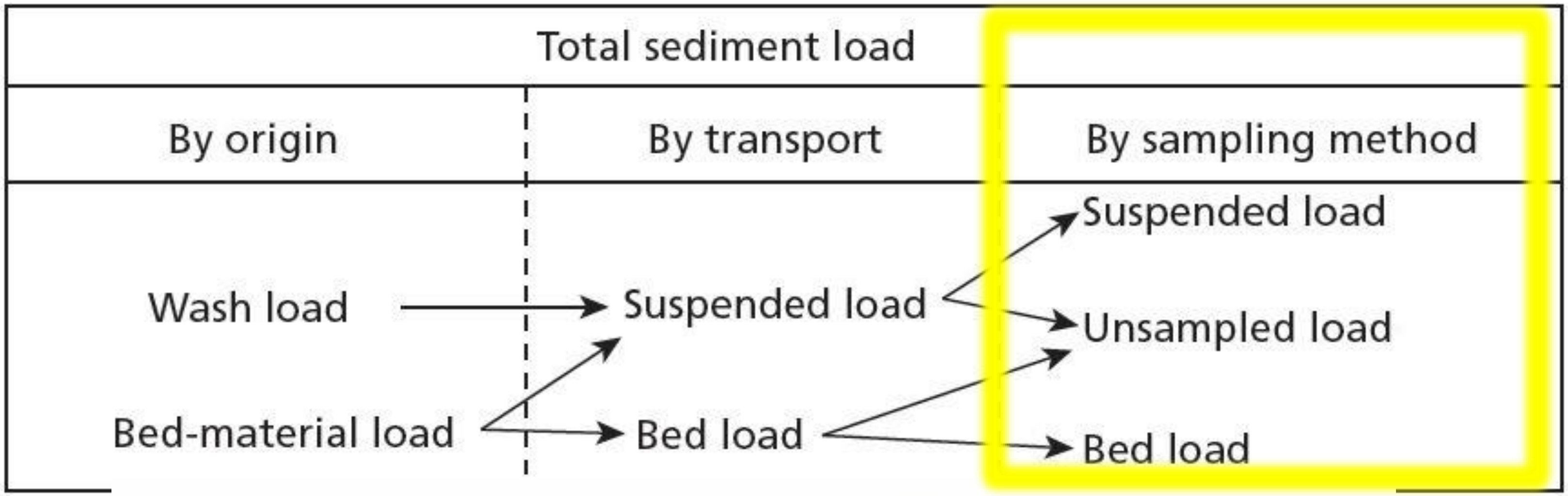
- Objective – Collect samples representative of sediment concentration over entire cross section
- Suspended sediment concentrations can vary 500 to 1000 percent from top to bottom and bank to bank
  - Equal-Discharge Increment samples
  - Depth-Integrated samples

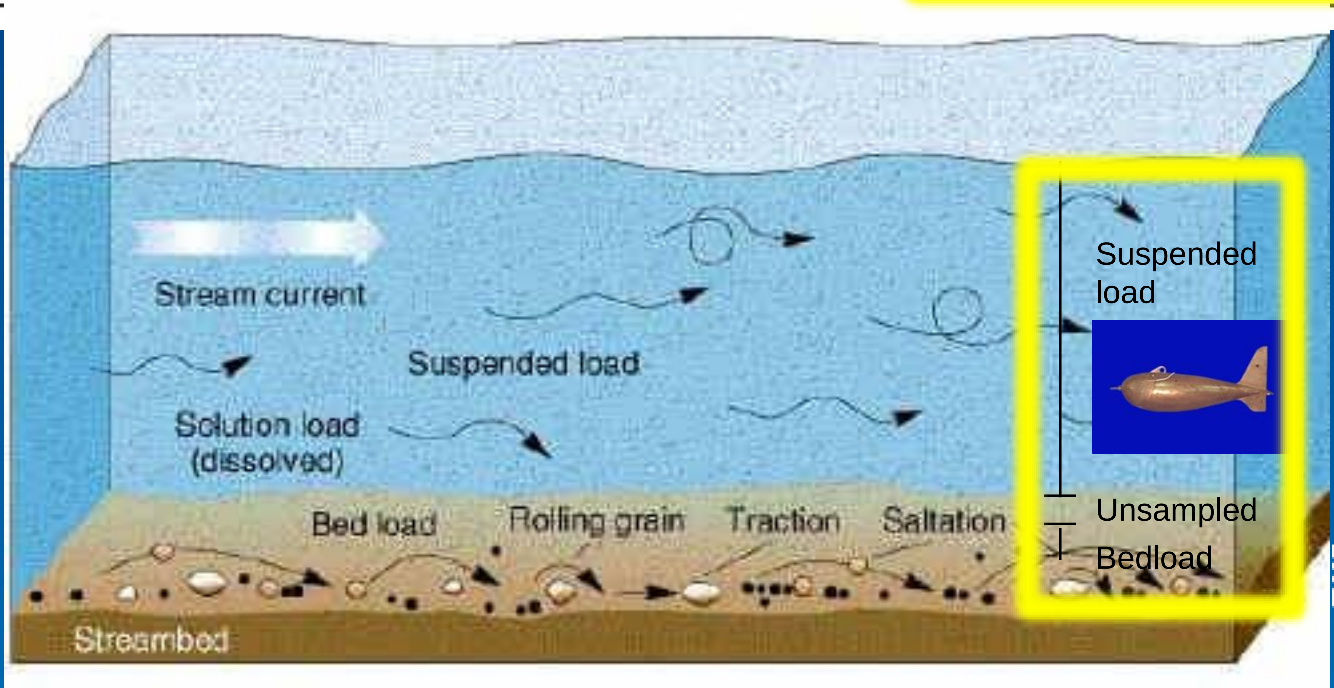
Equal-Discharge Increment Sample Collection

- Discharge measurement needed
- Break up discharge into 4-7 equal increments
- Find horizontal center of each increment
- Collect depth-integrated sample at each increment center



Sediment-Load Categories

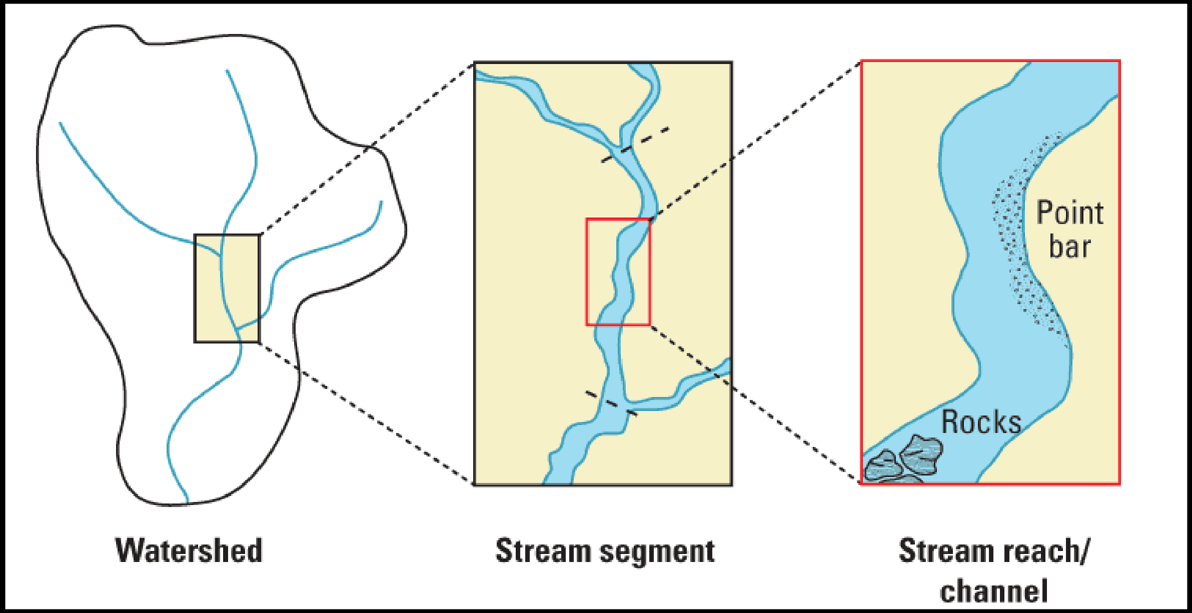




>90%
(70-90+%)

Sediment Budget—Temporal and Spatial Scales

- Geographic (reach, segment, basin)
- Temporal (daily, monthly, annual, long-term period of record)



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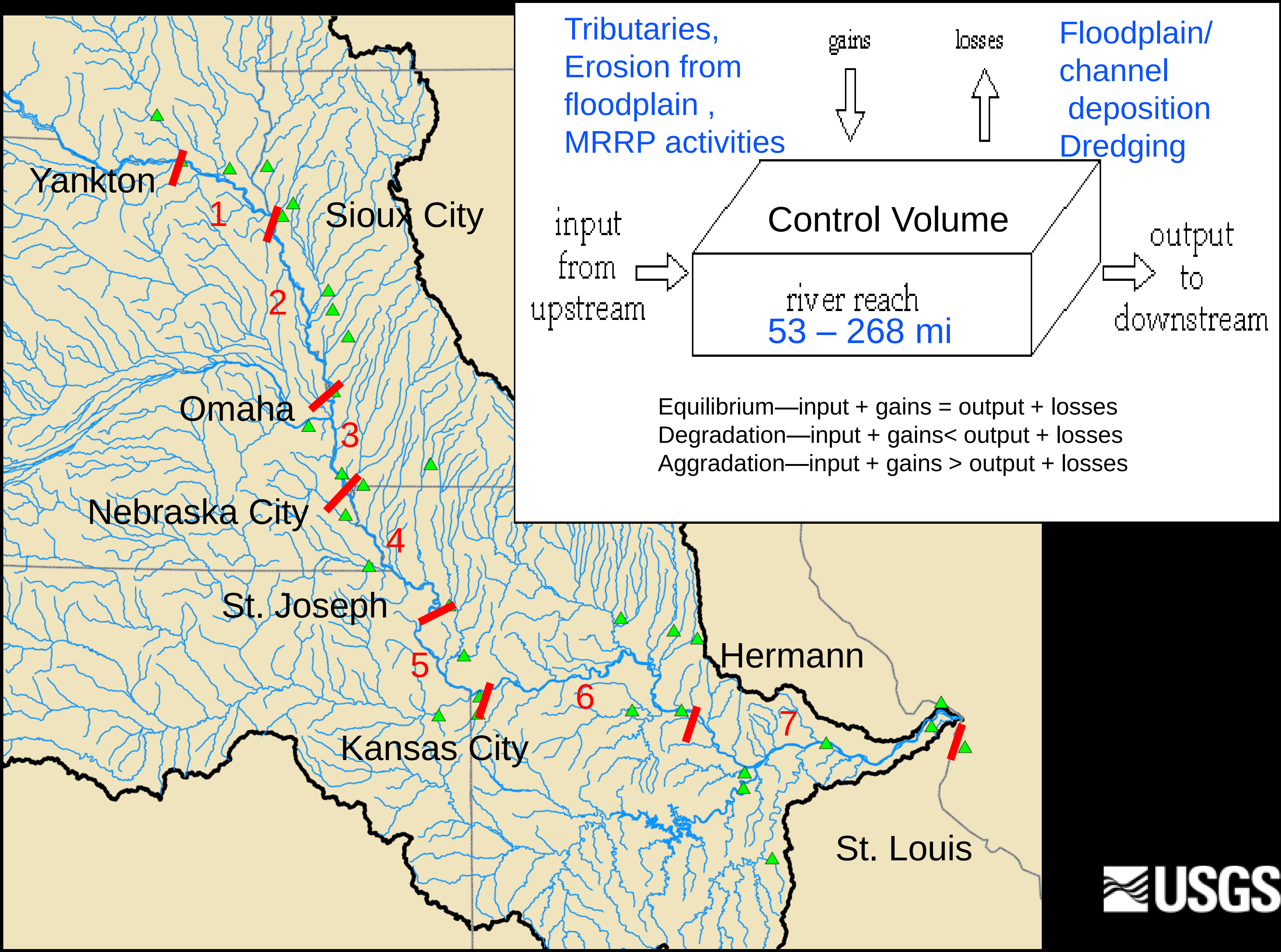
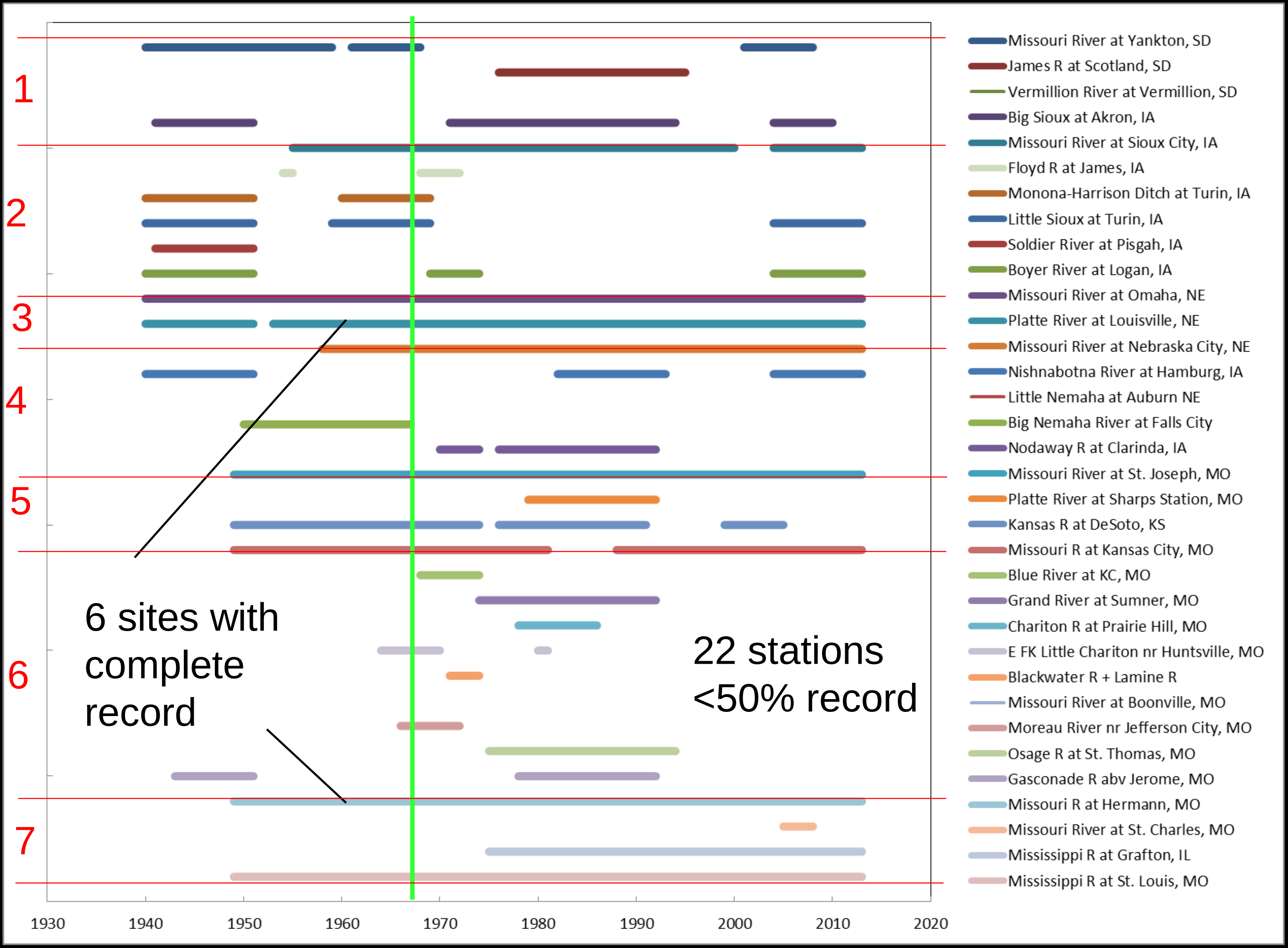
Components of Sediment Budget



Equilibrium—input + gains = output + losses
Degradation—input + gains< output + losses
Aggradation—input + gains > output + losses

Suspended-Sediment Data Availability, 1968-2014

- Annual loads



Upstream

33 stations

8 Missouri River main stem

23 tributaries

2 MS River stations

Downstream

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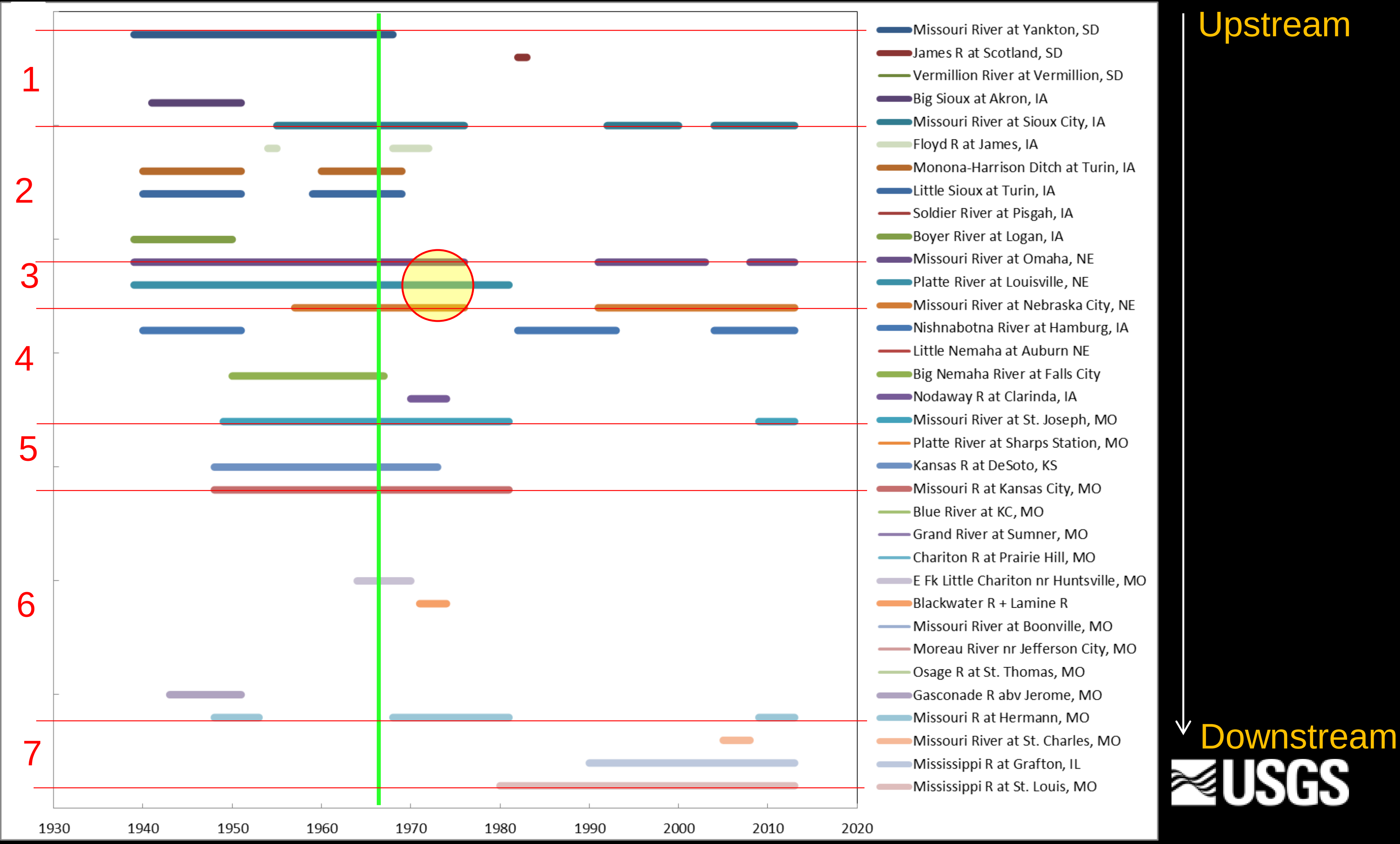
Suspended-Sediment Data Availability

- Daily loads



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Sediment Data Availability

- **Bedload**

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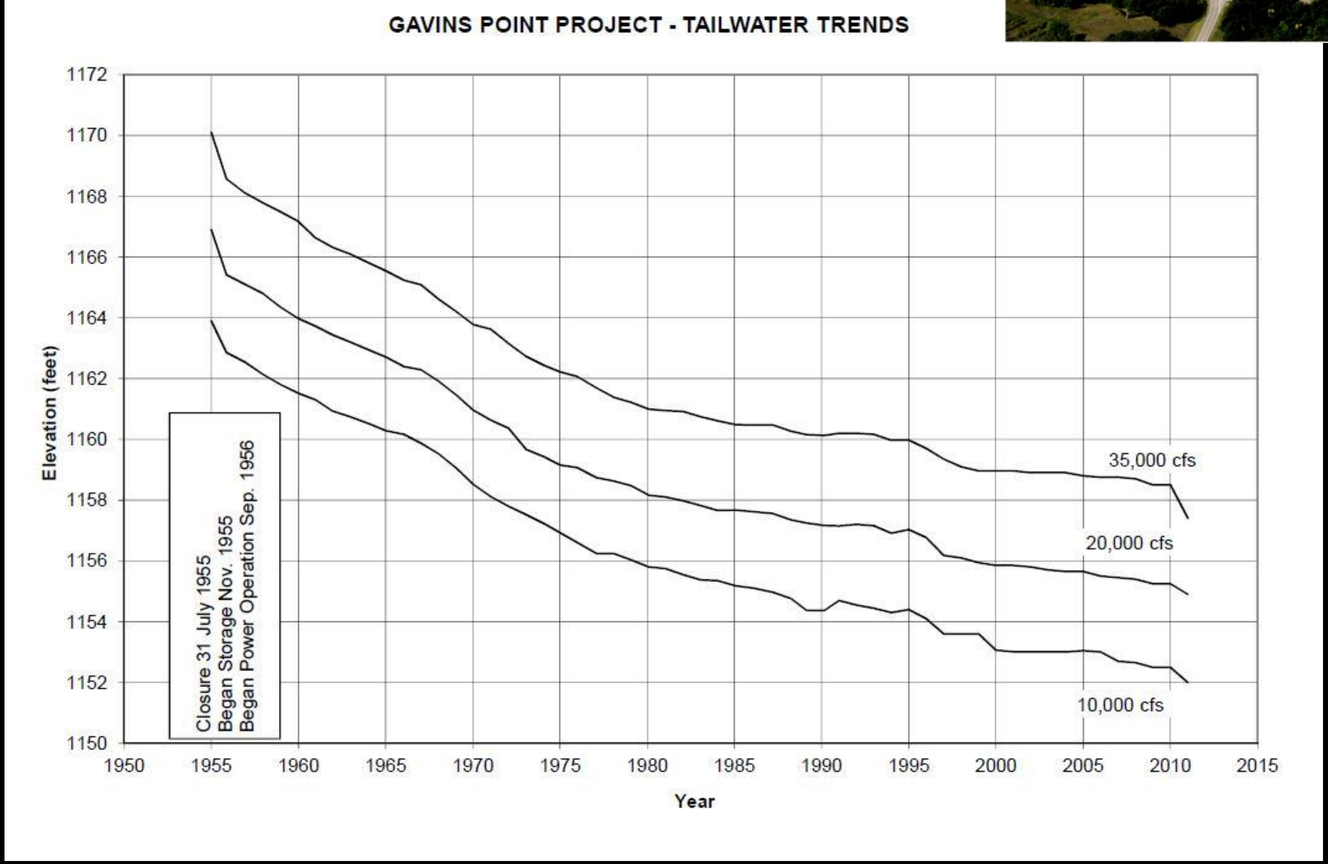
Sedient Budget, 1968-2014, Yankton to Sioux City

Stage Trends-Gavins Point Dam Tailwaters



-7 feet downstream of Gavins Point Dam between 1968-2012

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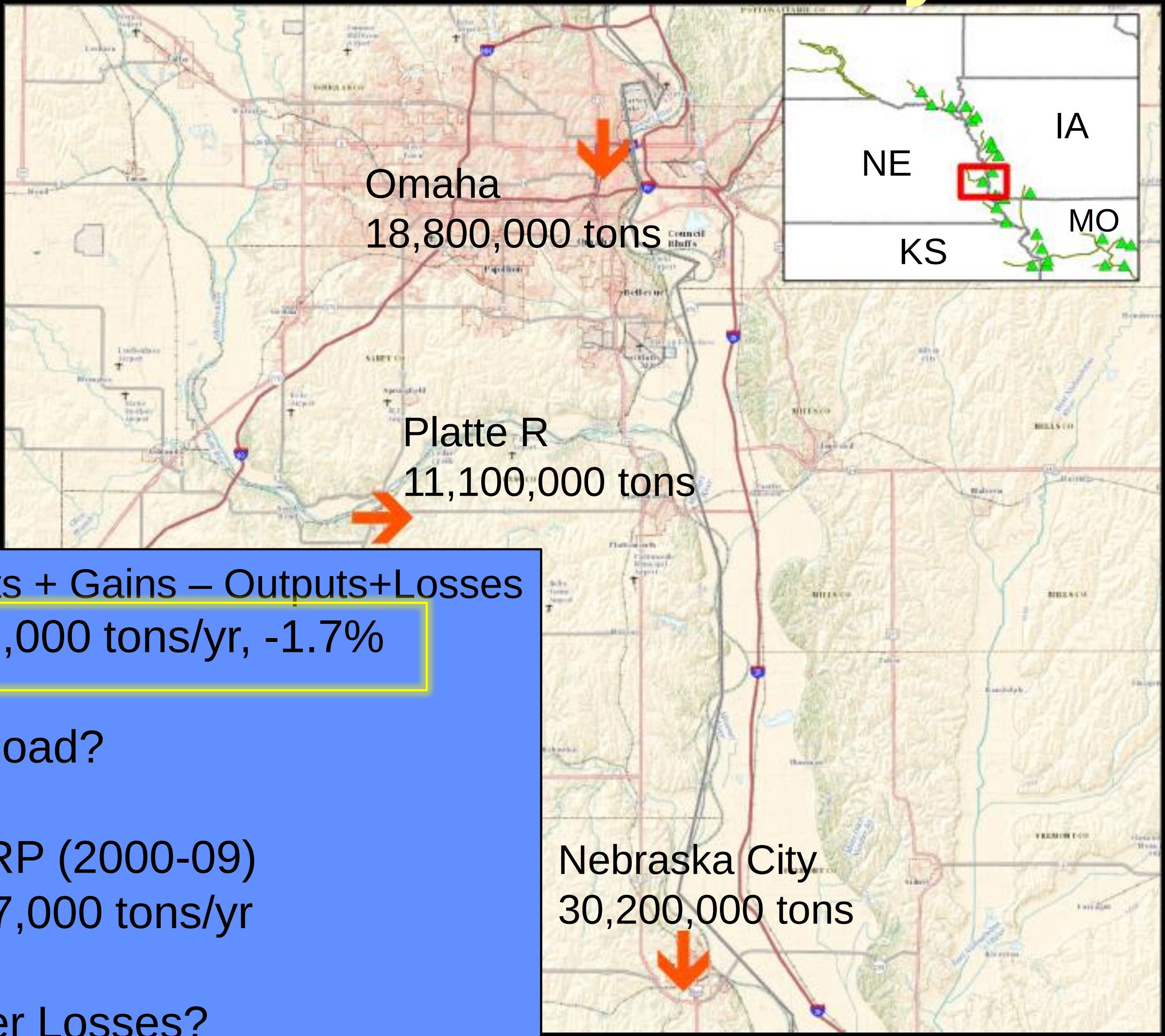
Sedimeht Budget, 1968-2014, Omaha to Nebraska City



Inputs + Gains – Outputs+Losses

-513,000 tons/yr, -1.7%

Bedload?

MRRP (2000-09)
+137,000 tons/yr

Other Losses?

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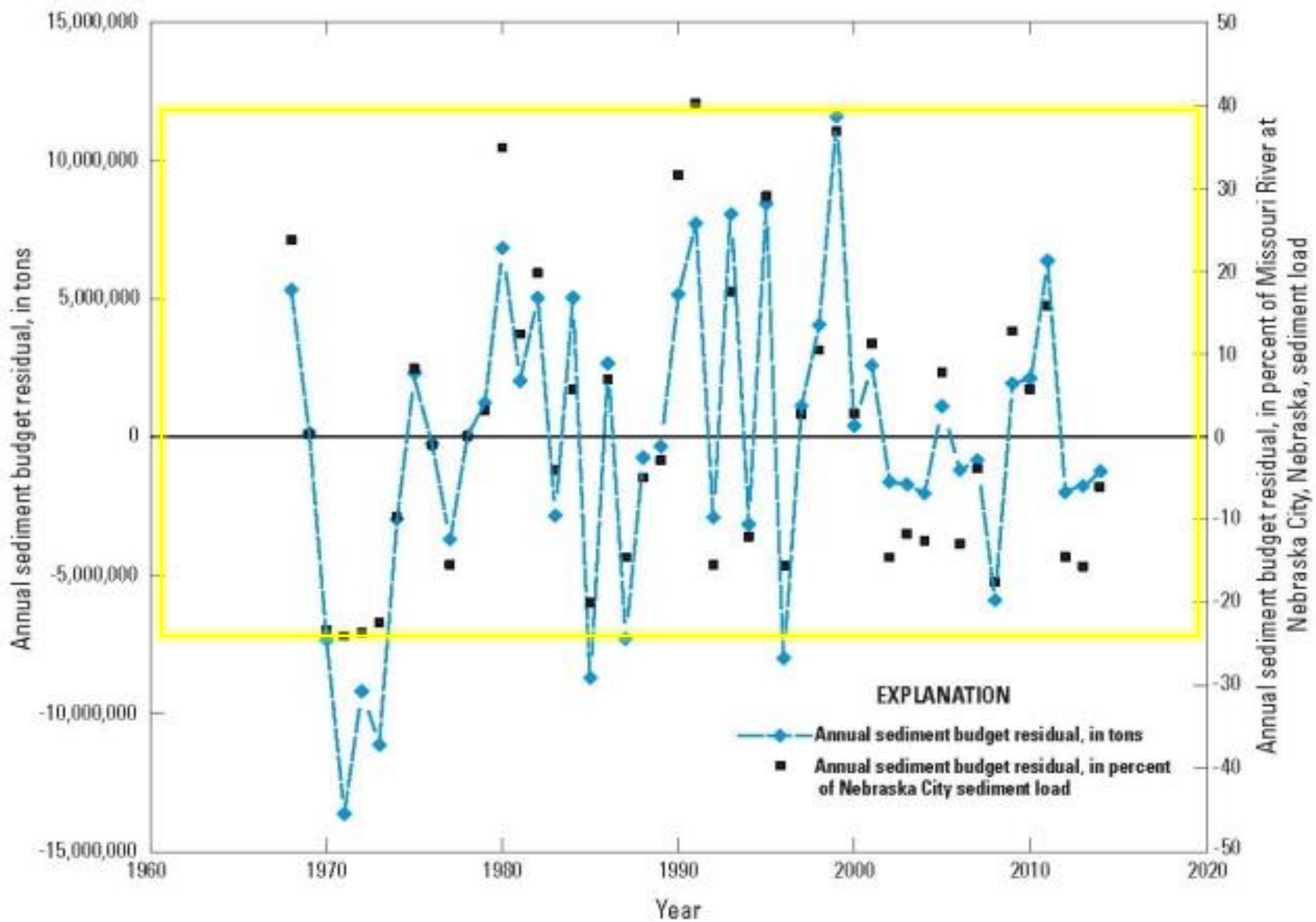
Long-term (1968-2014) Budget Residuals

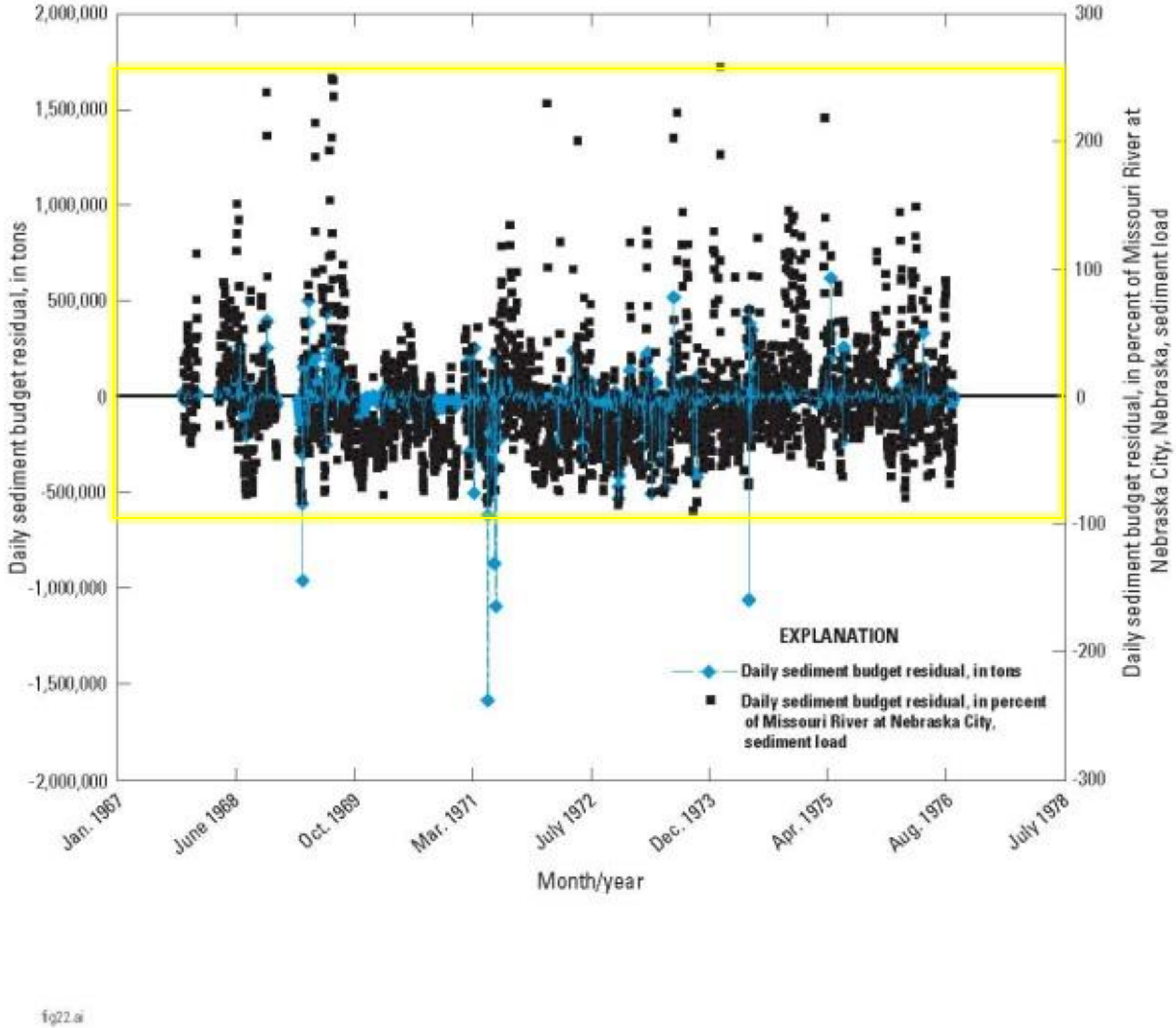
Reach		Residual
1	Gavins Point to Sioux City	-87.8%
2	Sioux City to Omaha	-9.2%
3	Omaha to Nebraska City	-1.7%
4	Nebraska City to St. Joseph	4.0%*
5	St. Joseph to Kansas City	-4.9%*
6	Kansas City to Hermann	0.1%*
7	Hermann to St. Louis	-6.9%

*Includes bedload estimate

Annual Variability in Sediment Budget Residuals, Omaha to Nebraska City, 1968-2014



Daily Variability in Sediment Budget Residuals, Omaha to Nebraska City, 1968-1976



Sediment Budget Data Gaps

- **Bedload?**
- **Tributary sediment loads**
- **Bank erosion/channel storage?**
- **Flood-plain erosion/storage?**

Tributary data

Flood-plain/Channel storage losses?

Sediment gains from bank erosion?

Surrogates and Technological Advancements in Sediment Monitoring

Continuous turbidity

Figure 1. Three self-cleaning nephelometric turbidity sensors—*A*, YSI Incorporated (Yellow Springs, Ohio) model 6136 turbidity sensor, *B*, Hydrolab (Loveland, Colorado) self-cleaning turbidity sensor, and *C*, Forest Technology Systems (Blaine, Washington) model DTS-12 turbidity sensor.

LISST-SL (real time particle size)

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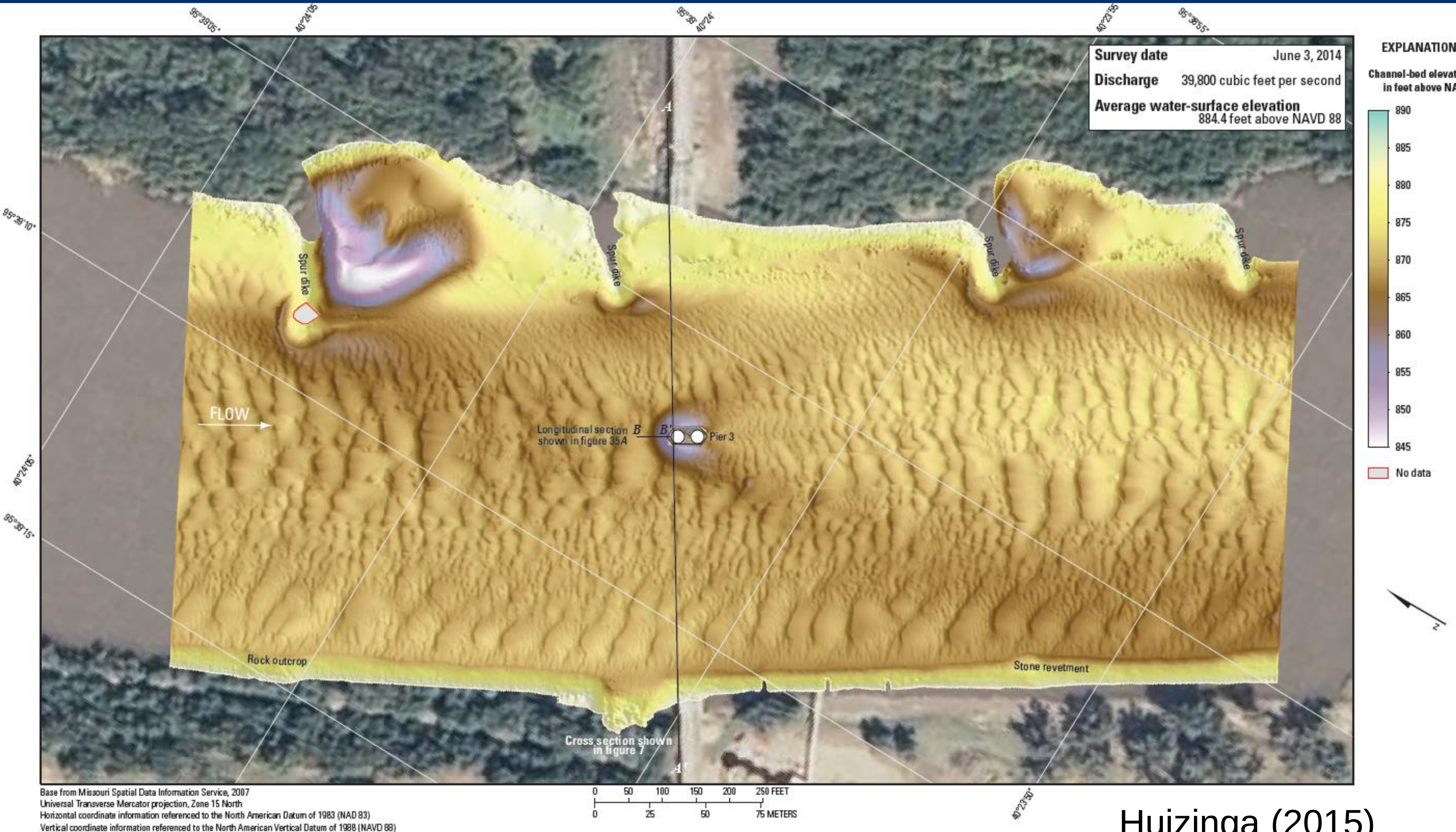
Time-lagged Multi-beam Surveys for Determining Bedload Transport



Huizinga (2015)

Questions?

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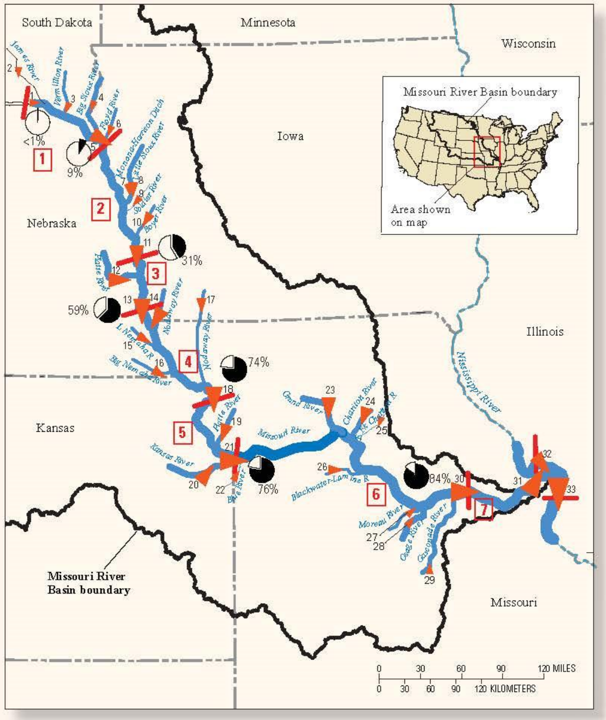
Prepared in cooperation with the U.S. Army Corps of Engineers

Generalized Sediment Budgets of the Lower Missouri River, 1968–2014



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