
USGS Ad Hoc Committee on Sediment
Missouri River Basin Interagency Roundtable Meeting
Denver, CO
January 10, 2011
Who Cares and Why?

- Sediment Damages in North America (mostly in US) total $20-$50 BILLION annually (ARS-USGS)
- As much as 25 mi² Louisiana Coast lost annually
- Northern Gulf of Mexico Hypoxia
- COE dredging programs in MRB alone total ~$1Billion annually
- Impacts on infrastructure in Missouri River Basin
- EPA, NOAA, USDA, others have major investments in MRB
Who Cares and Why?

- The Preliminary Sedimentation Assessment for the Upper Missouri River Basin (NRCS)
  - Identified continued and excessive sediment loading in the mainstem reservoirs as a primary concern. Sediment accumulates in these reservoirs at the approximate rate of 92,500 acre feet per year. Negative impacts associated with high rates of sediment loading are:
  - Loss of flood storage.
  - Sediment may impact hydropower production.
  - Lost recreational opportunities.
Who Cares and Why?

- Increased water treatment costs for municipal, rural, and industrial (MR&I) water systems and loss of capacity, which in some cases leaves people with no suitable water source.
- Navigation relies on a water flow. Lost reservoir capacities may make river system operation difficult to provide adequate water supply.
Who Cares and Why?

- Personal property is being adversely affected by rising ground water in the upper reaches of the reservoirs.
- Irrigation and MRI water intakes will be impacted and may need to be relocated.
Who Cares and Why?

- “Missouri River Planning: Recognizing and Incorporating Sediment Management” - NAS 2010
- “Sedimentary processes and sediment management issues are important along the entire length of the Missouri River. For example, large volumes of sediment are trapped in the Missouri River’s upstream reservoirs and represent a substantial portion of sediment no longer available for transport to the Gulf of Mexico. Other sections of the report thus consider sediment processes, and data collection and evaluation systems, for the entire length of the river.
Who Cares and Why?

“Missouri River Planning: Recognizing and Incorporating Sediment Management”-NAS 2010

“The Missouri River basin once was a site of major sediment research. Over time, however, priorities shifted, expertise on Missouri River sediment has dwindled, and there has been a decline in the attention paid to overall data collection, management, analysis, archiving, and access. Historical Missouri River sediment data are extensive, and there are important studies of...
Who Cares and Why?

- “Missouri River Planning: Recognizing and Incorporating Sediment Management” - NAS 2010
- “sediment dynamics being conducted today in the basin, including ongoing collaborative efforts between Corps of Engineers and USGS scientists. In general, however, sediment-related data and studies are diffuse and scattered across the basin in a variety of locations and a variety of formats. A more systematic platform of sediment measurements, data archiving,
Who Cares and Why?

- “Missouri River Planning: Recognizing and Incorporating Sediment Management” - NAS 2010
- “and system-wide modeling knowledge will be necessary to support efficient decision making for ecosystem management initiatives.”
- “data generally provide an agreeable starting point for debate, which is lacking along the Missouri River.”
Figure 6--Suspended-Sediment Discharge

A

ca. 1700

Missouri River

Arkansas River

Red River

Ozarka

Missouri

St Louis

Ohio River

Burlington

Tarbert Landing

1980-1990

Out of Mexico

0

200

400

Out of Mexico

Suspended-sediment discharge, in millions of metric tons per year

B

Burlington, Iowa

Suspended-sediment discharge in millions of metric tons per year

1950-1960

1960-1970

1970-1980

30-yr MEAN

St. Louis, Missouri

Suspended-sediment discharge in millions of metric tons per year

1950-1962

1980-1992

Tarbert Landing, Miss.

Suspended-sediment discharge in millions of metric tons per year

1950-1961

1980-1991

C

Burlington

Percent of annual suspended-sediment load discharged in each month

JFMAMJ JASOND

St. Louis

Tarbert Landing
USGS Daily Sediment Stations by Year
1940-2000

Number of Stations

Water Year

Estimated from Glysson, 1989
Estimated from graphic, origin unknown


2 Lew, Melvin, 1998, Operation of Hydrologic Data-Collection Stations by the U.S. Geological Survey in 1997: U.S. Geological Survey Open-File Report 97-832, p.14. These data have been multiplied by a coefficient of 0.657 based on the relation between the red and tan bars for the period 1985-1993 in an attempt to render Lew’s data comparable to the blue and red bars. Data depicted by the blue bars were derived from the National Water Information System or its predecessor. Data depicted by the red bars, of unknown origin, also appear to be approximately derived from the National Water Information System. Almost half of the sediment stations operated in 2000 are in Puerto Rico.

(John R. Gray and Roger K. Chang, USGS, OSW, October 2000)
Past and Present Sediment Monitoring Locations on the Lower Missouri River

Sediment Monitoring Stations
- Yankton, SD
- Sioux City, IA
- Omaha, NE
- Nebraska City, NE
- St. Joseph, MO
- Kansas City, MO
- Waverly, MO
- Boonville, MO
- Hermann, MO
- St. Charles, MO
Periods of Sediment Sample Collection on the Lower Missouri River

- **Yankton**: 75-125 samples/yr
- **Sioux City**: 25-100 samples/yr
- **Omaha**: 75-125 samples/yr
- **Nebraska City/Plattsmouth**: ~210 sample days/yr
- **St. Joseph/Leavenworth**: ~61 samples/yr
- **Kansas City**: ~216 sample days/yr
- **Waverly**: ~308 sample days/yr
- **Boonville**: 5 pt samp/yr
- **Hermann**: ~91 sample-days/yr
- **St. Charles/Howard Bend**: Surface samples only

- Samples collected by USACE:
  - **Yankton**: 75-125 samples/yr
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- Samples collected by others:
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Isokinetic samplers used at all sites after Oct. 1, 1947 except as noted.
A Proposal to Establish a Long-Term, Base-Funded, Network-Design National Monitoring Network to Generate Sediment, Nutrient, and Sediment-Associated Chemical Concentrations, Loads, Budgets and Temporal Trends Integrated with existing and proposed networks such as HBN, NAWQA, and NASQAN
MRB Pilot Program -- OBJECTIVES

1. Establish a sediment, nutrient, and solid-phase QW monitoring program on the Mississippi, Missouri, and Ohio Rivers, and selected tributaries to compute fluxes at key spatial and time scales.

2. Ascertain trends in sediment and constituent transport on selected economic, ecologic, and restoration activities in the MRB.
VISION: A NATIONAL Sediment & QW Monitoring Program Cost/Benefits

- $75-$90M annually, 400-450 stations
- Based on National Monitoring Network Design (ACWI)
- National Program cost <1% of estimated costs/sediment damages annually
- Ergo, 1% reduction in damages/costs will pay for the National Program
Pilot: Mississippi River Basin Pilot Program

- $17.6M in FY2012; ~$14M annually thereafter
- Based in part on National Monitoring Network Design (~50% of available NMN sites)
- The means for quantifying sediment and QW fluxes to address large-scale problems
- A framework for supporting “nested” sediment- & QW-flux research on smaller scales
Why Now?

- Because it wasn’t done before…!
- Because it is necessary for making informed decisions on resources management.
- Because even modest returns on investment will pay for the program – likely many times over.
- Because reliable, network-design-based information will greatly increase the accuracy of our models.
MRB Pilot Program -- Scope

- 68 stations
  - 20 priority 1
  - 48 priority 2
  - Max use of USGS gages & programs

Priority 1:
Large-scale processes

Priority 2:
Watershed proc./issues

US Army Corps of Engineers
MRB Pilot Program -- Constituents

- **Suspended Sediment (routine)**
  - Fluxes by size category (silt/clay vs sand)
  - Full gradation from samples
  - Nutrients, other QW

- **Filtered Water (routine)**
  - Nutrients, common ions, trace elem., pesticides, other

- **Bed Material (2/year)**
  - Gradation
  - Selected QW

- **Bedload (non-routine)**
Water Sample Collection on Rivers

- Objective – Collect samples representative of sediment concentration over entire cross section
- Suspended sediment concentrations vary 500 to 1000 percent from top to bottom and bank to bank
  - Equal-Discharge Increment samples
  - Equal-Width Increment samples
  - Depth-Integrated samples
  - Point samples
  - Surface sample – need additional EDI samples
    - B - not representative
Historical equipment and data

- Are data collected using historical equipment accurate and useful in predicting changes in suspended sediment concentrations and loads over time?
Historical Suspended Sediment Samplers

- Primitive Straub. Vertical bottle with messenger, knife, and paper cap (1929-1932)
  - Overestimated sediment
- Omaha (1939-1948)
  - Overestimated sediment
- P43 (1948-1961)
  - Isokinetic
- P61 (1962-present)
  - Isokinetic

Colorado sampler

Straub sampler with valve
Omaha Sampler

- Years of Use
  - 1939-1948
  - 1939-1954 at some sites
Traditional equipment and Methods Currently Used

- Isokinetic equipment in use today are considered the “gold standard” for use in the collection of suspended sediment samples.
Federal Interagency Sedimentation Project Samplers and Sampling Techniques Are the Standards for quality-assured data

USA, and International Standards Organization
Point Samples

- Isokinetic P-61 Point Sampler lowered to desired depth with nozzle closed
- Sampler opened electronically with solenoid
- Sampler left open long enough to partially fill bottle inside and then closed
- Sample returned to surface and sent to laboratory for analysis
- Provides information about changes in sediment concentration with depth and laterally
New Technology

- Can new instruments/technology provide us with real-time concentrations, grain-size distribution loads, and still get accurate suspended-sediment data?
- Will this data be comparable to traditionally-collected samples?
- New Capabilities that may Revolutionize Acquisition of Fluvial-Sediment and QW Data
Optical Backscatterance & Turbidity

Paul Buchanan (USGS), San Francisco/Delta Bay, April 1999
Turbidity provides the best estimate of suspended-sediment concentrations.

**Figure 8.** Relations between (A) turbidity and suspended-sediment concentration, (B) streamflow and suspended-sediment concentration in linear space, (C) turbidity and suspended-sediment concentration, and (D) streamflow and suspended-sediment concentration in log space for U.S. Geological Survey streamgage on Little Arkansas River near Sedgwick, Kansas, 1999–2005.
Example: Side-Looking ADV/ABS

Courtesy of Sontek/YSI, Inc.

Sontek Long-Range Argonaut-SL Systems
Single Frequency

1.5 – 120 meter penetration
Two 600 kHz RDI Sentinel ADCPs used in rotation.

Initial deployments were self contained, we’ve since moved to a 400’ land line.
Hudson River -- Calibrations

Acoustic data collected from bins at the same depth as the water sampler

Point-integrating water sampler (P-61)
Hudson River Cross-Section Adjustments

- Cross Sectional Adjustment:
  - “Box-coefficient” based on ADCP cross-sectional estimates of SSC
Isokinetic withdrawal LISST-SL

• Active control, pump-assisted isokinetic withdrawal
• Pitot tube velocity sensor
• 2-Wire communication
• H₂O Depth, Temp, Vel. meas. along with PSD, SSC
• Low drag permits low weight.

“Laser In-situ Scattering Transmissometer”

Cooperative Research and Development Project Between Sequoia, Sci., Inc., USGS, FISP
MRB Pilot Program – Synthesis

- ID Principal Sources/Sinks of sediment, nutrients, other QW constituents.
- Identify phase of transport of sediments as a function of location, flow, other variables.
- Calibrate model(s) to “allocate” sediment to source types based on digital coverages, thus enabling simulation of sediment transport by real or simulated land use.
- All data on-line/publically available.
EPA and NOAA have considerable interest in sources and transport mechanisms for nutrients.

USDA likewise has interest in sediment and nutrient transport from farmlands to receiving waters.

31 MRB States have vested interests.
Next Step?

- Full proposal and synopsis submitted by the COE and USGS development team.
- Both publically available.
- Shared with EPA, NOAA, USDA, and other potential partners.
- Build a synergistic relationship between existing and proposed programs such as HBN, NAWQA, and NASQAN with the USGS-COE sediment monitoring proposal such that sediment can be traced from headwaters to estuaries so informed management decisions can be made.
Samples to be collected are listed below:

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<th>Semi-Volatiles - PAH</th>
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<th>USGS NWQL (Denver CO)</th>
<th>GCMS - GS O-5506-06</th>
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<td>Oil &amp; Grease</td>
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<td>Toxicity</td>
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<thead>
<tr>
<th>In Situ Measurements</th>
<th>Medium</th>
<th>On Site</th>
<th>Method Reference</th>
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<td>Dissolved oxygen</td>
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