Sediment Impact Analysis Method (SIAM):

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Sediment Impact Analysis Method (SIAM)

- Initial development through ERDC/Colorado State University research effort on channel stability as part of Demonstration Erosion Control project. Originally conceived to assist with locating grade control structures.
- Original computer programming done by David Mooney (CSU PhD candidate, USBR).
- Incorporation into HEC-RAS through ERDC/HEC cooperative effort.
Question: What is SIAM?

Answer: A reach average sediment continuity assessment tool.
SIAM is incorporated in HEC-RAS
Hydraulic Design Module

- Popular, widely-used hydraulic modeling system.
- Stream network framework of HEC-RAS provides basis of SIAM application.
- HEC-RAS interface expedites data entry.
- HEC-RAS provides reach averaged hydraulic parameters.
- Many existing HEC-RAS models permit subsequent application of SIAM.
- Existing technical support.
SIAM is reach-based

A reach-based sediment continuity model. Uses reach averaged hydraulic parameters for sediment transport computations by grain size class.

Reach averaged hydraulics from HEC-RAS results

Transport capacity of bed material computed by grain size class
Local Sediment Balance
(Continuity)

Local sediment balance by comparing computed annual transport capacity with bed material supply on a reach-by-reach basis.
SIAM bed/wash material accounting

Total Sediment

Bed Material
- Found in significant quantities in the bed
- Function of hydraulic regime
- Interacts with bed - more geomorphic effect (work) on channel development
- Long-term impacts, may take years/decades to see effects.

Wash Load
- Not found in significant quantities in the bed
- Function of supply
- Minimal interaction with bed - more aesthetic or water quality effects
- Generally moves through system quickly

US Army Corps of Engineers
Engineer Research & Development Center
Question: What SIAM is not?

Answer: A sediment routing model or a sediment source/erosion predictor
SIAM is not a routing model....

- Cross section geometry is not adjusted, and sediment transport is not recomputed accordingly.
- Input geometry represents a “snapshot” that is assumed representative of average conditions for determination of sediment transport capacity.
- There is no temporal aspect (i.e., no time stepping through a hydrograph). Results are computed as average annual values.
SIAM is not a sediment source/erosion predictor....

- Sediment source input is user specified, both in quantity and grain size distribution.
- Sediment source loads are assumed uniform over the reach.
Question: What is applicability of SIAM?

Answer: A screening tool for rapid assessment of the impacts of channel modification or stream rehabilitation measures on sediment continuity.
SIAM Example Application

Kankakee River, IL
SIAM Modeling for the Kankakee River

- Hydrologic Engineering Center – River Analysis System (HEC-RAS)
- HEC-RAS model simulates average hydraulic properties of each reach defined in the river.
- SIAM = Sediment Impact Analysis Methods
  - Sediment load data: grain size and bed material gradations determine wash load/bed load division.
  - Sediment transport capacity: Hydraulics and wash load/bed load criteria determine sediment transport capacity.
- Taken together, Hydraulic Model, Sediment Input, and Sediment Model determine wash material / bed material supply and capacity for each reach and local balance.
Kankakee River Basin
Sources of Fine and Coarse Sediment

Average Annual Load (tons)
Kankakee River at mouth

Sand belt

Sources of silt & clay
- contributing area below Iroquois River
- Iroquois River
- Upper Kankakee (excluding Yellow River)
- Yellow River

Sources of Sand
- contributing area below Iroquois River
- Iroquois River

Average Annual Load (tons)
- Kankakee River at mouth: 77,000 tons, 91%
- Sand belt: 770,000 tons, 91%

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Average Annual Load (tons)
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- Sand belt: 770,000 tons, 91%
Estimated % Contribution
Silt and Clay (fines)
Kankakee River Basin
Estimated % Sand Contribution
Kankakee River Basin
(70% from “sand belt”)
3 Alternative Options Modeled with SIAM

1. Reduction in total sediment source load by 20 percent from existing condition levels for specified reaches
2. Channel re-meandering and flood plain reconnection in sediment reaches MK5 and MK6
3. Dredging in Six Mile Pool

Combinations of these 3 options created 35 different alternatives.

Following 6 slides illustrate the kinds of outputs and indicate types of findings.
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Alternative 3B

% Reduction in Total Sediment Load (downstream from Alternative 3B)

% Reduction Total Sed. Load (t/yr)
- 10% - 10.6%
- 10.7% - 11.5%
- 11.6% - 12.2%
- 12.3% - 13.9%
- 14% - 16.2%
- 16.3% - 20%
- 20.1% - 20.2%

---|---|---|---|---|---|---
Reach | LK1 | LK2 | LK3 | LK4 | LK5 | LK6 | LK7 | MK1 | MK2 | MK3 | MK4 | MK5 | MK6 | UK1 | UK2 | LI1 | LI2 | Y1 | Y2 | Reach
3B | | | | | | | | 20 | 20 | 20, S | 20 | re. | re. | 20 | 20 | 20 | 20 | 20 | 20 | 3B
Alternative 3B
% Reduction in SIAM Total Bed Material Supply Load

% Reduction Bed Mat. Load (t/yr)
- 0%
- 0.1% - 1.1%
- 1.2% - 7.8%
- 7.9% - 8.5%
- 8.6% - 19.6%
- 19.7% - 20%
- 20% - 36.7%
- 36.8% - 41.8%

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SIAM Results
General Observations

- Reduction in watershed suspended loads (silt and clay) persisted downstream to the Illinois River
- Reduction in incoming sand loads shifted the local balance towards degradation, but the shift did not persist significantly downstream
- Reducing bank erosion shifted river to eroding the sand bed locally and no net change downstream
- Re-meandering river caused increased deposition locally and reduced deposition just downstream
- The outcomes above reflect short-term effects of modified conditions
Kankakee River Basin Projects
Potential Next Steps

- Develop and assess additional alternatives
- Examine longer time periods of change
- Evaluate management actions that best achieve alternatives
- Develop a recommended plan that most effectively accomplishes the goal of Kankakee River sediment reduction and habitat restoration
- Implement the management actions in the recommended plan