Evolution of Unstable Streams

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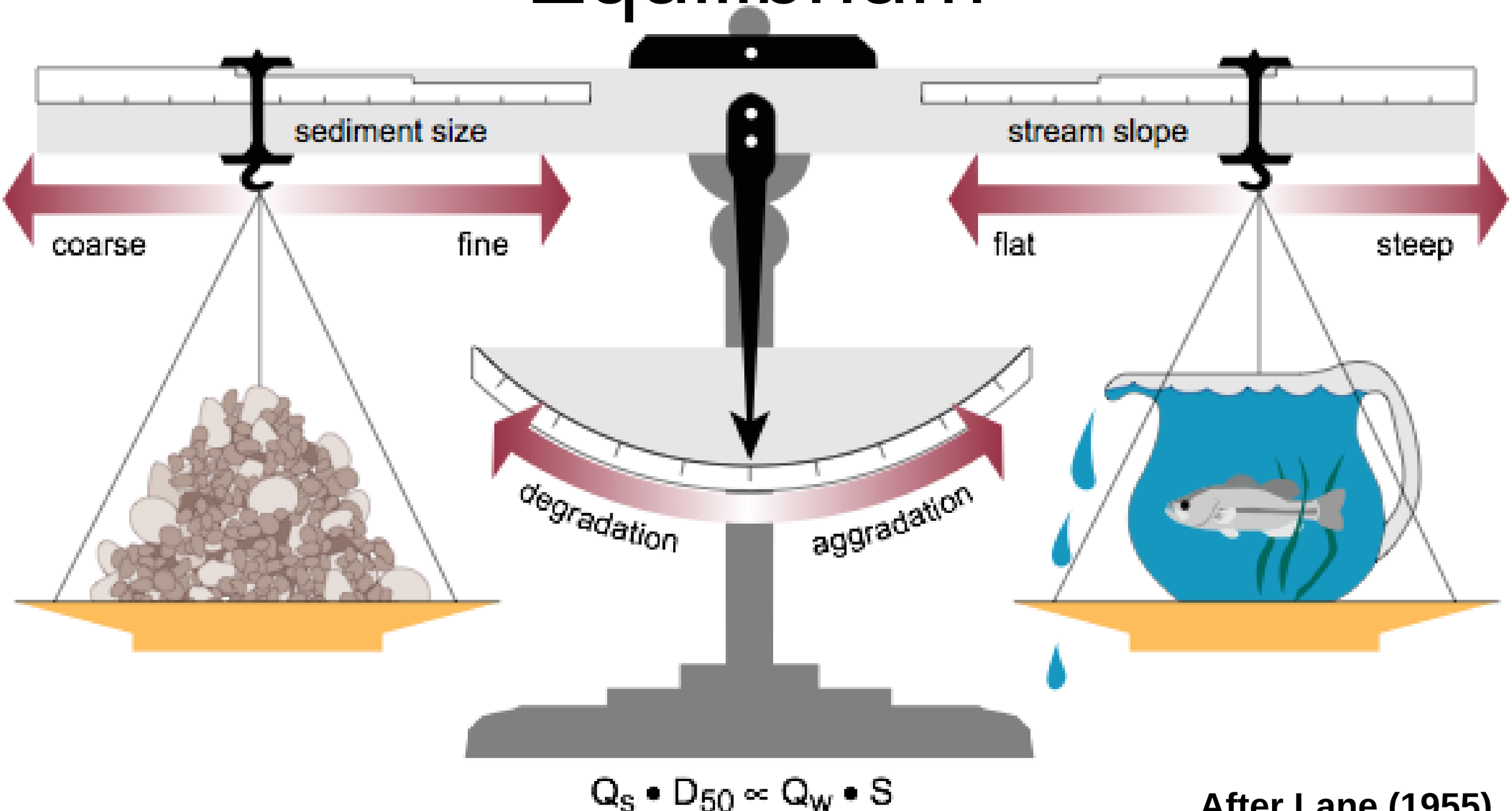
Unstable Stream Systems

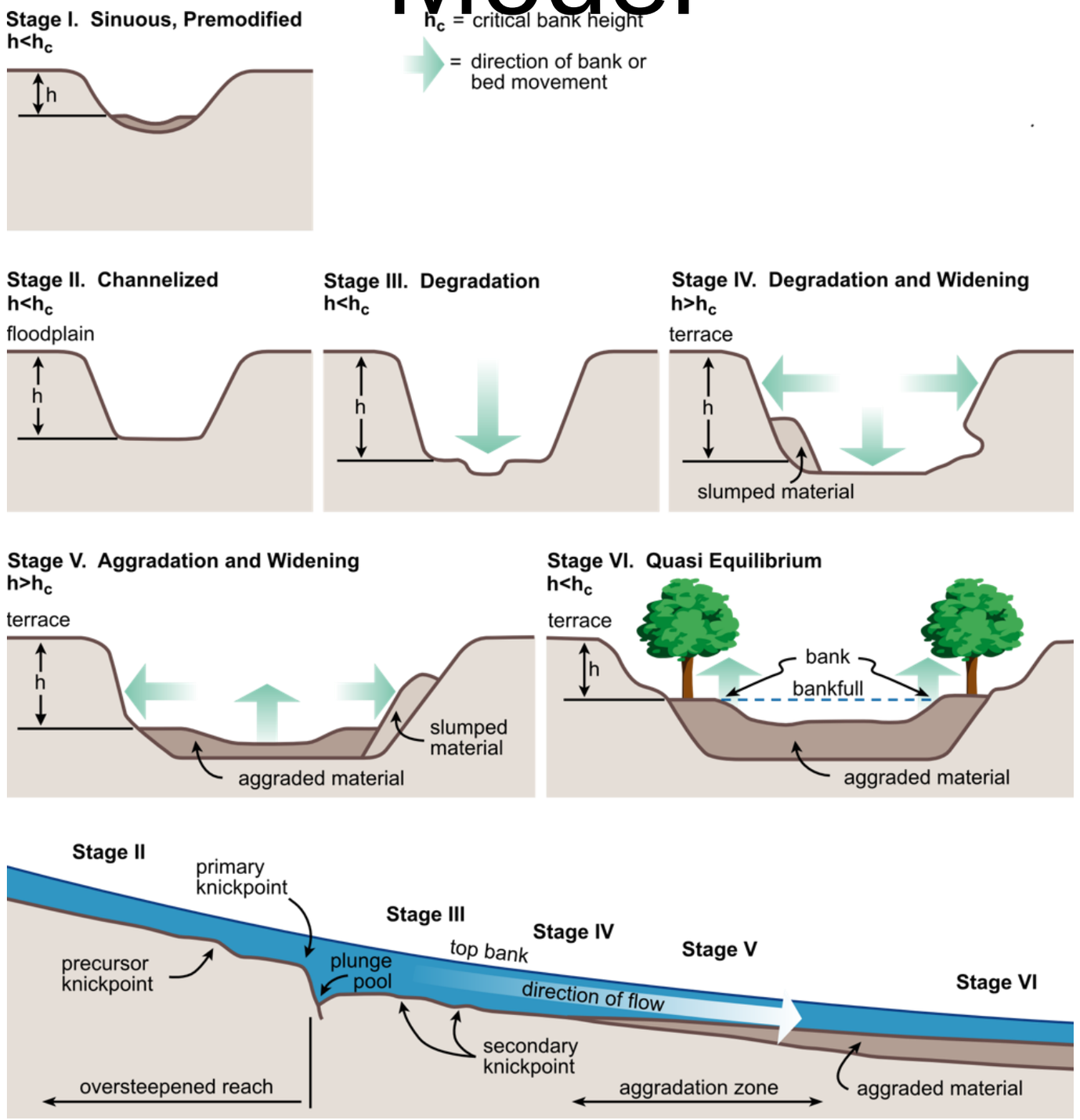
- Wide spread in Mississippi due to various channelization works
- Much studied since the 1940s with special emphasis in the 1970s-1990s
- Evolution described by Conceptual Channel Evolution Models

Channel Morphological Equilibrium



After Lane (1955)

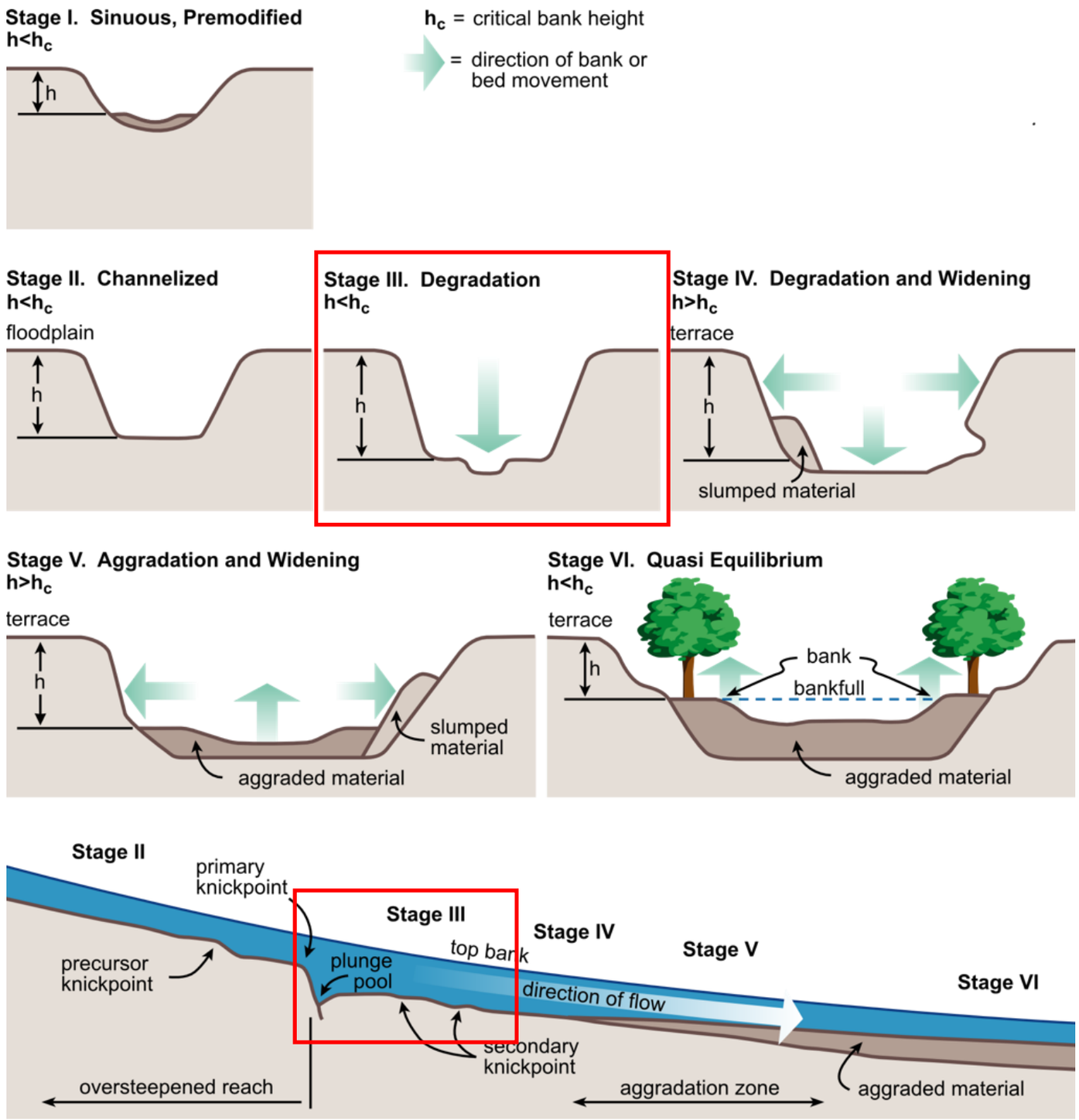
Conceptual Channel Evolution Model



After Simon & Hupp (1986)

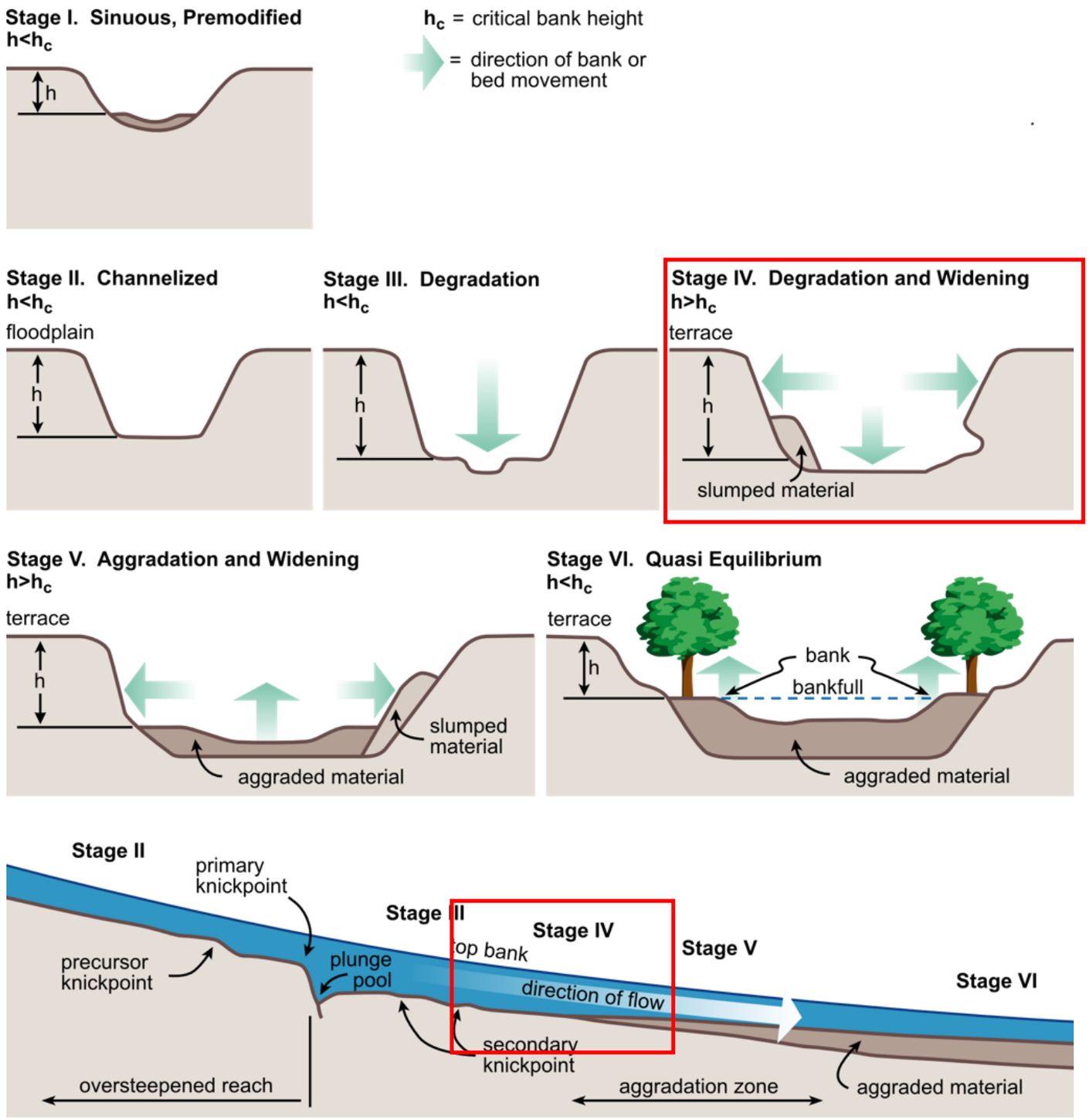
Channel Adjustment Processes

- Stage III
  - Rapid incision caused by migrating knickpoints
  - Bed material main source of sediment



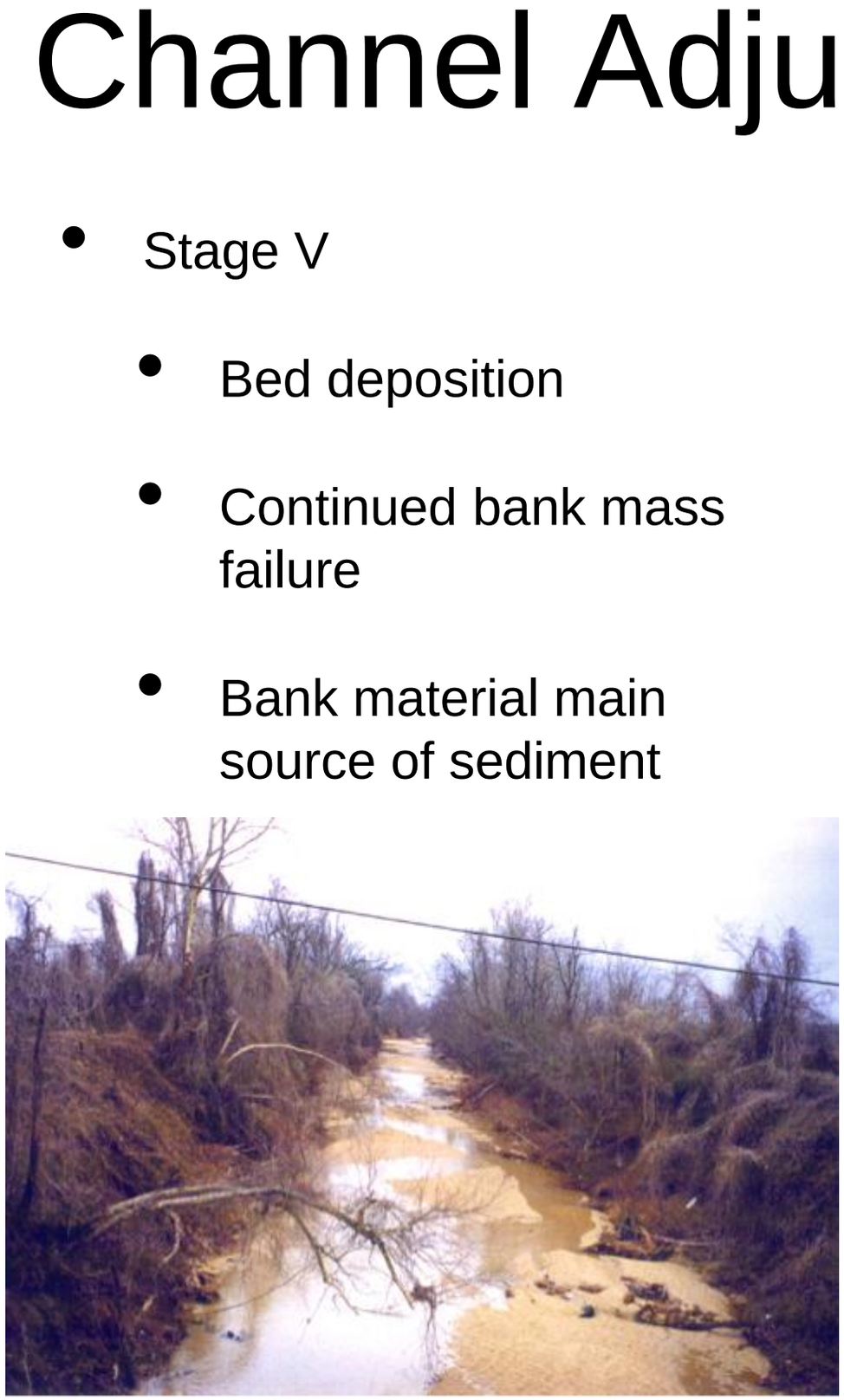
Channel Adjustment Processes

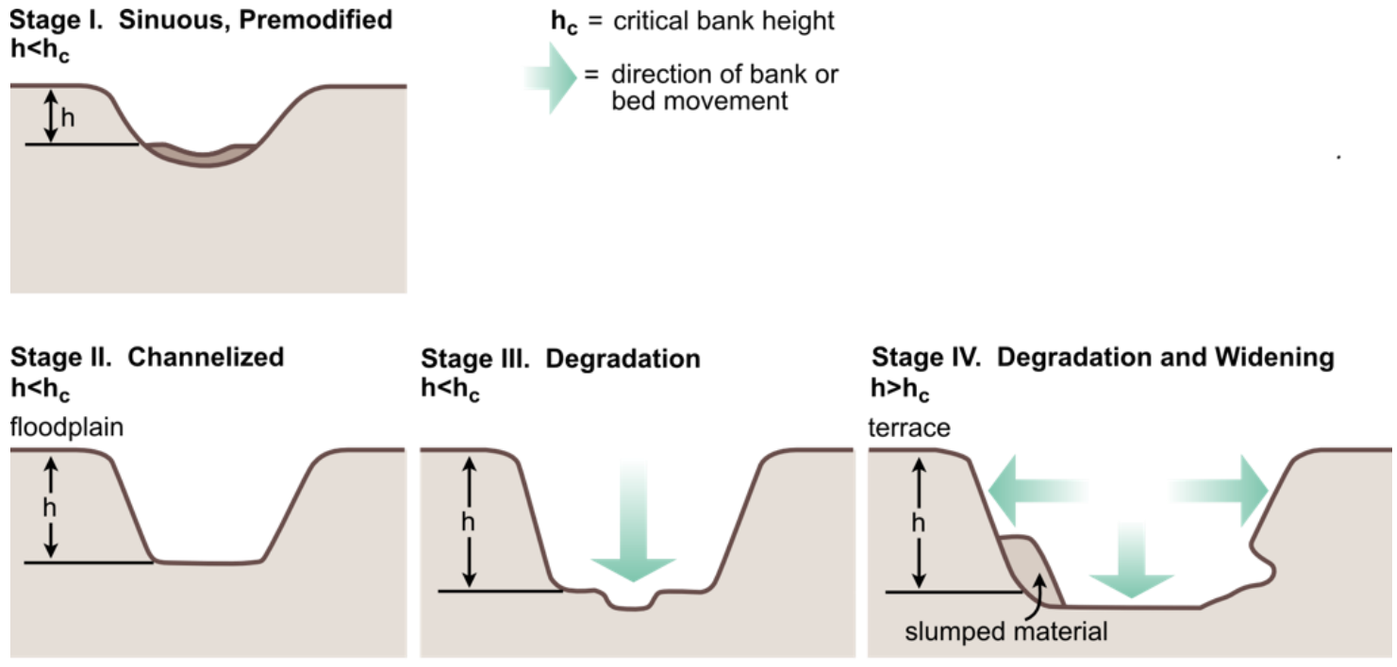
- Stage IV
  - Reduced bed erosion
  - Bank mass failure
  - Bank material main source of sediment

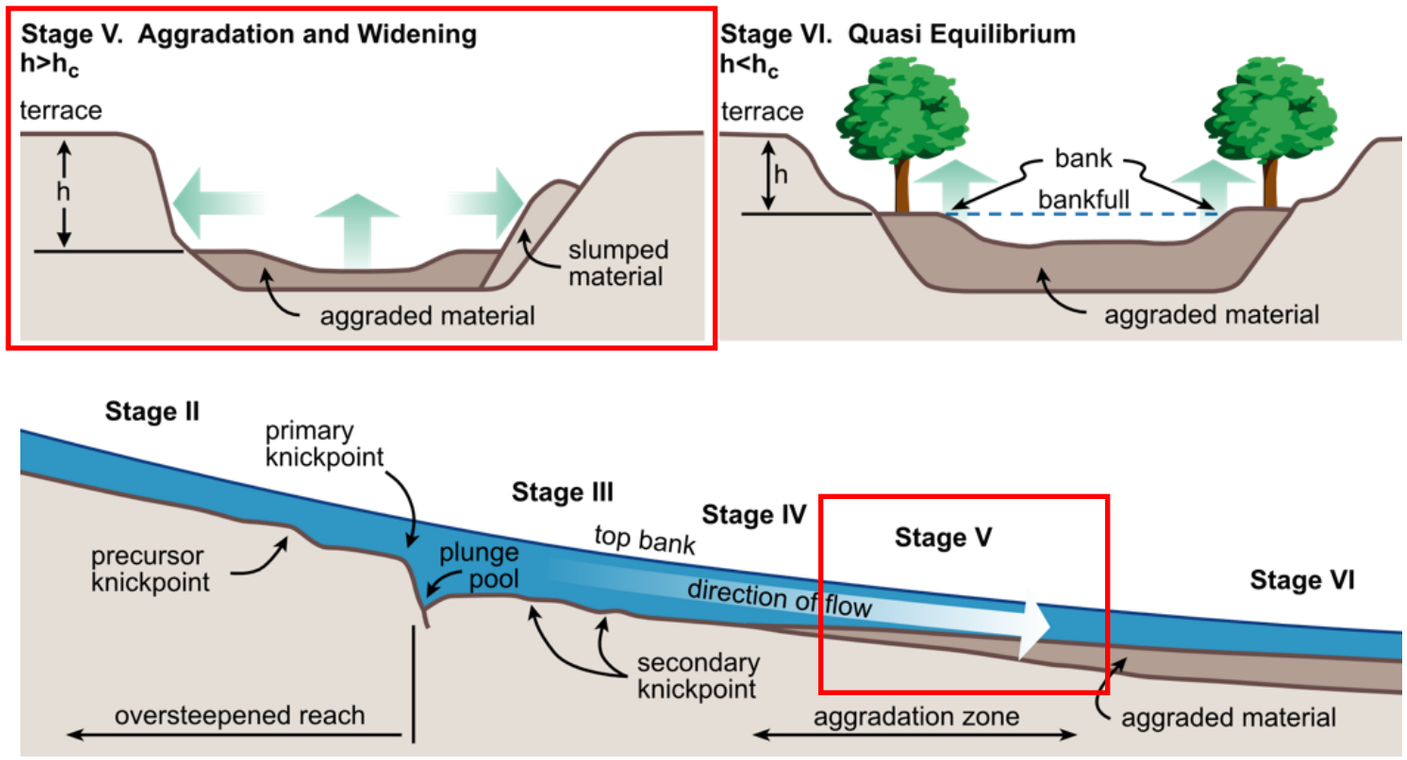


Channel Adjustment Processes

- Stage V
  - Bed deposition
  - Continued bank mass failure
  - Bank material main source of sediment

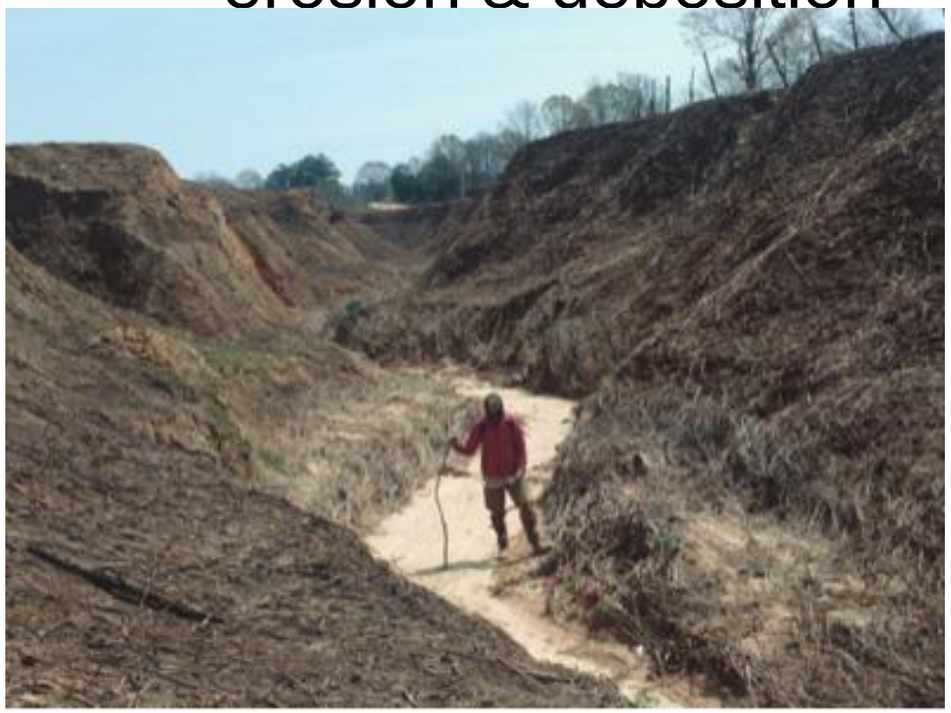


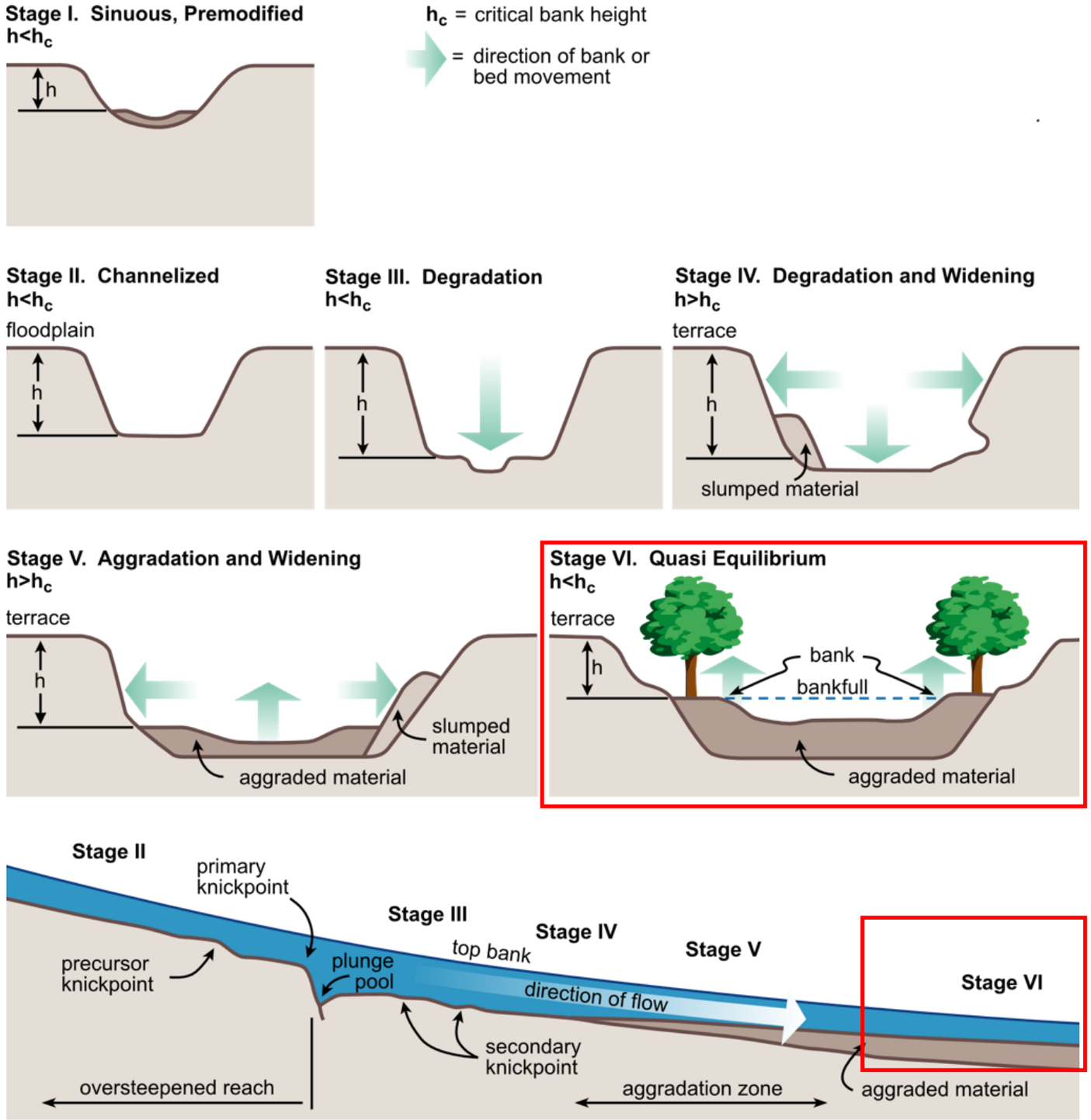




Channel Adjustment Processes

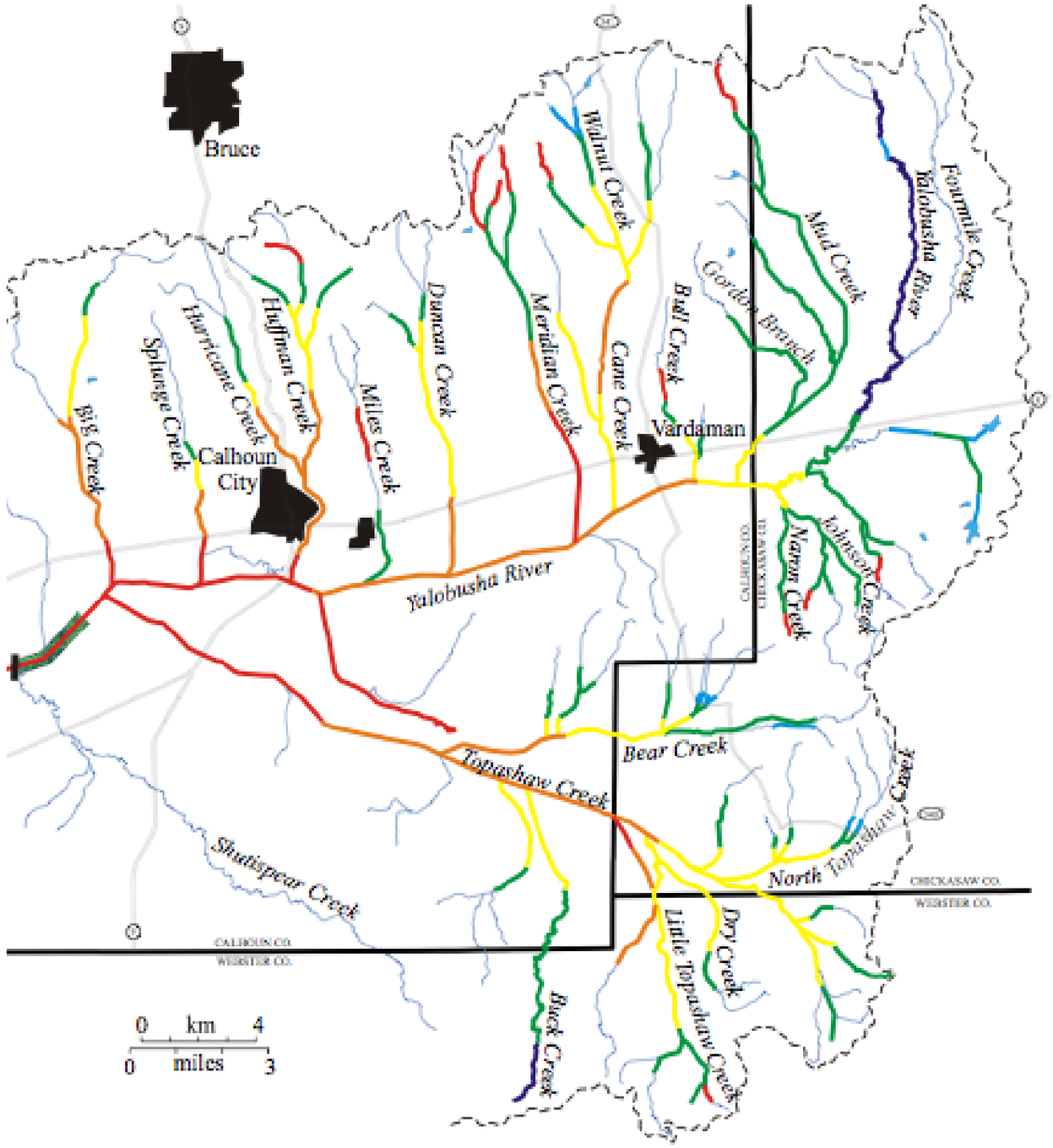
- Stage VI
  - Long-term morphologic equilibrium
  - Small amounts of erosion & deposition





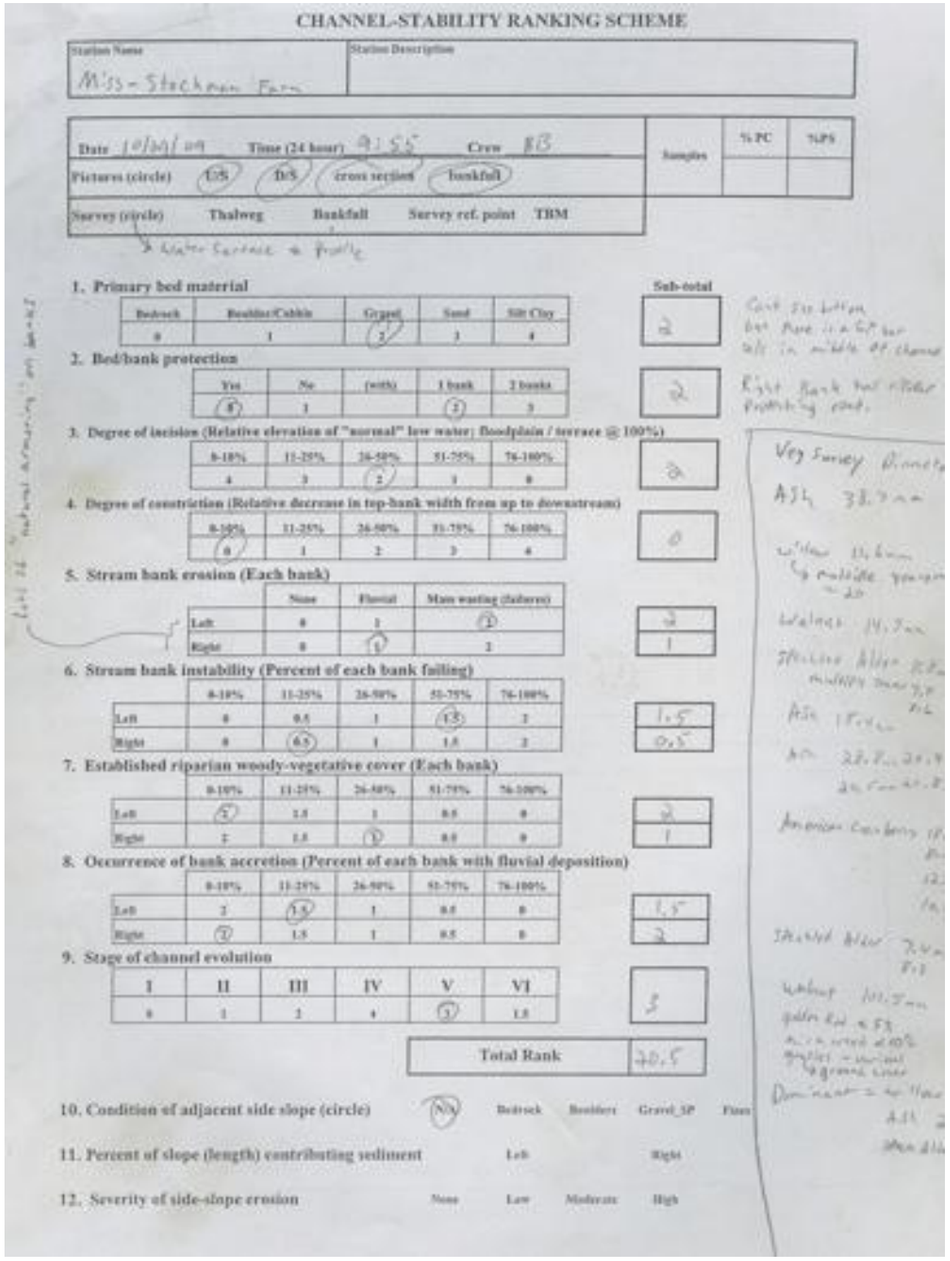
Use of CCEMs

- Assess the geomorphic state of the channel network
- Target stream stabilization
- **CANNOT** provide a quantitative analysis:
  - How much, where & when



NSL Tools (I)

- Rapid Geomorphic Assessments (RGA)s:
  - Uses diagnostic criteria of channel form to infer dominant channel processes
  - Enables assignment of stages of channel evolution



CHANNEL-STABILITY RANKING SCHEME

Station Name: M'ss - Stockman Farm | Station Description:

Date 10/20/09 | Time (24 hour) 9:55 | Crew BB | Samples | %PC | %PS

Pictures (circle): US DS cross section bankfull

Survey (circle): Thalweg Bankfull Survey ref. point TBM

1. Primary bed material — Sub-total: 2

Bedrock	Boulder/Cobble	Gravel	Sand	Silt/Clay
0	1	(2)	3	4

2. Bed/bank protection — 2

Yes	No	(with)	1 bank	2 banks
(0)	1		(2)	3

3. Degree of incision (Relative elevation of "normal" low water floodplain / terrace @ 100%) — 2

0-10%	11-25%	26-50%	51-75%	76-100%
4	3	(2)	1	0

4. Degree of constriction (Relative decrease in top-bank width from up to downstream) — 0

0-10%	11-25%	26-50%	51-75%	76-100%
(0)	1	2	3	4

5. Stream bank erosion (Each bank)

	None	Fluvial	Mass wasting (failures)	
Left	0	1	(2)	2
Right	0	(1)	2	1

6. Stream bank instability (Percent of each bank failing)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	0	0.5	1	(1.5)	2	1.5
Right	0	(0.5)	1	1.5	2	0.5

7. Established riparian woody-vegetative cover (Each bank)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	(2)	1.5	1	0.5	0	2
Right	2	1.5	(1)	0.5	0	1

8. Occurrence of bank accretion (Percent of each bank with fluvial deposition)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	2	(1.5)	1	0.5	0	1.5
Right	(2)	1.5	1	0.5	0	2

9. Stage of channel evolution — 3

I	II	III	IV	V	VI
0	1	2	3	(4)	5

Total Rank: 20.5

10. Condition of adjacent side slope (circle) (NA) Bedrock Boulders Gravel_SP Fines

11. Percent of slope (length) contributing sediment Left Right

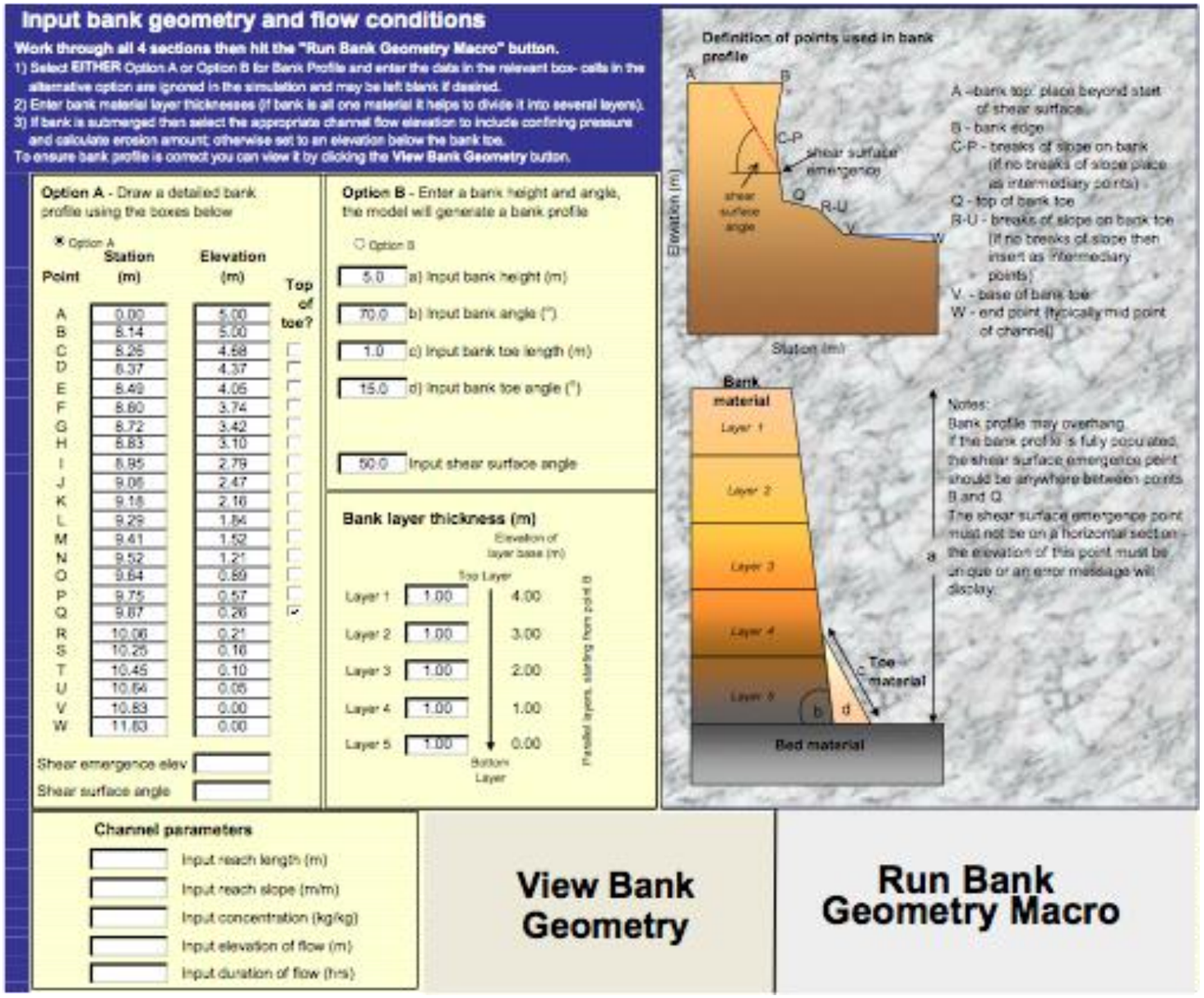
12. Severity of side-slope erosion None Low Moderate High

NSL Tools (II)

- **Models**
  - *BSTEM* - Bank stability & toe erosion model
  - *RVR-Meander* - Toolbox for river meander assessment and design
  - *CONCEPTS* - Stream-riparian corridor evolution model

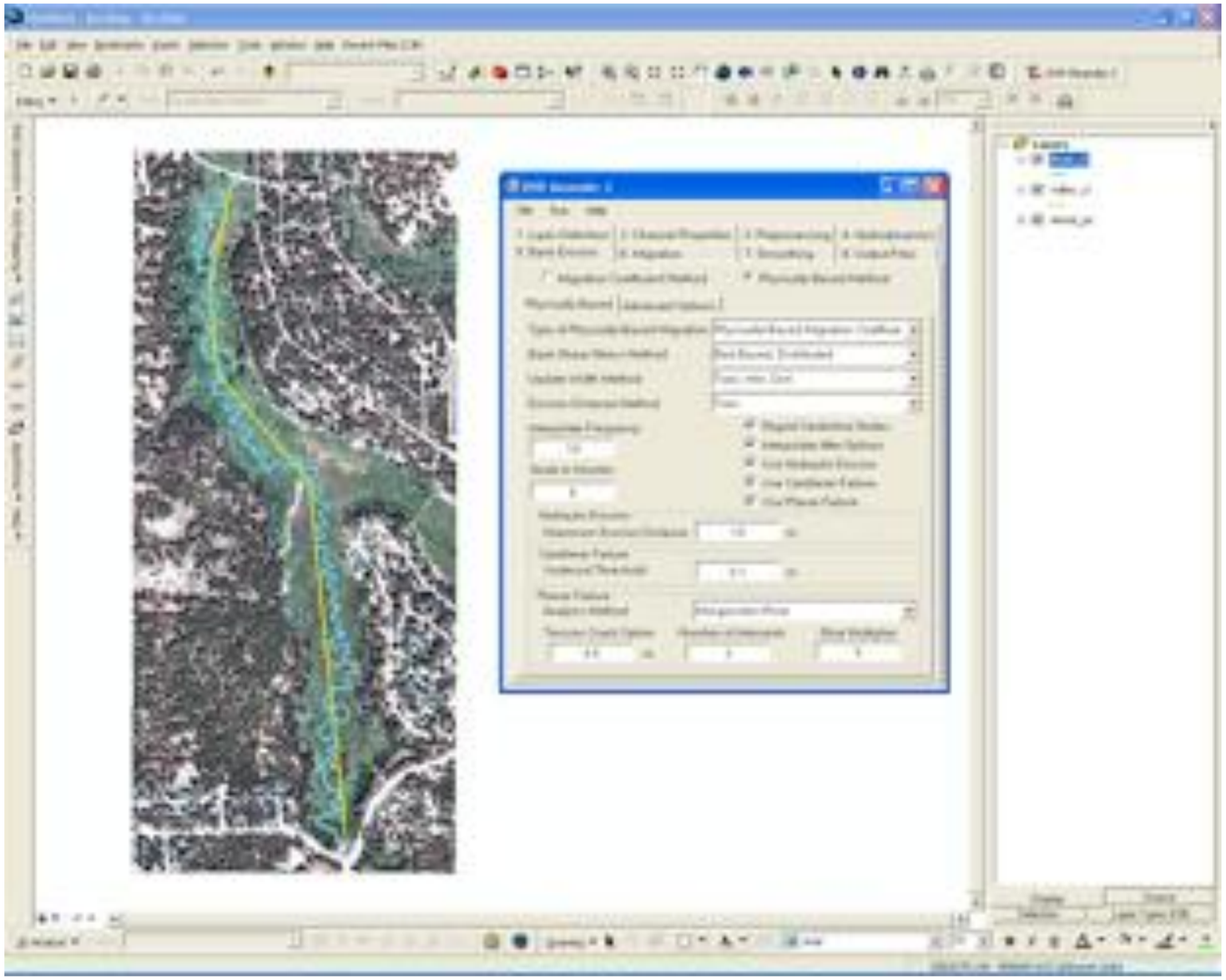
BSTEM - Bank Stability & Toe Erosion Model

- 2D wedge & cantilever failures
- Hydraulic toe erosion
- Bank protection
- Vegetation effects through RipRoot
- Bank material properties and vegetation assemblage



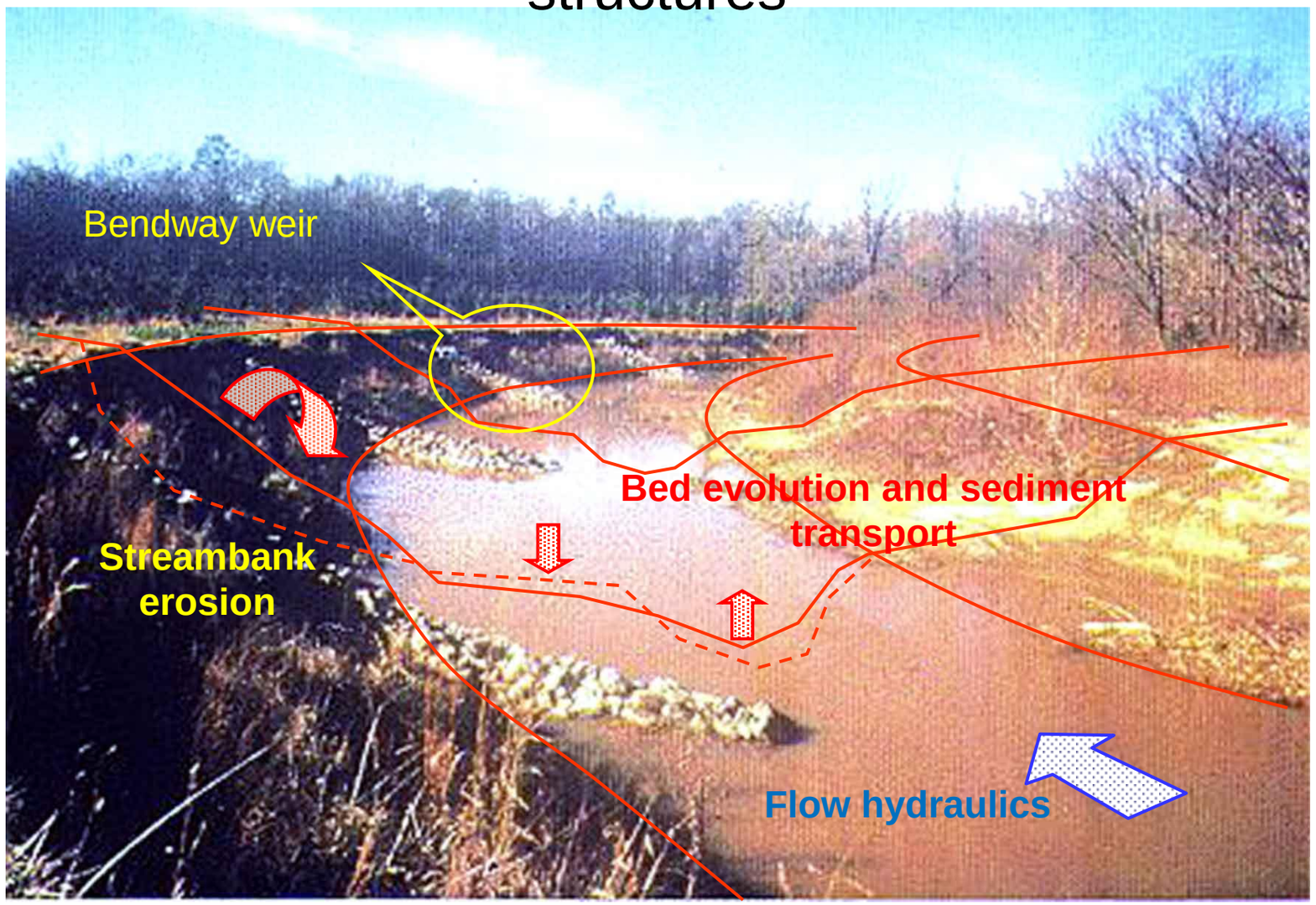
RVR Meander

- 2D model of meander hydrodynamics, bed evolution, and migration
- GIS based: ArcGIS 9.3 or 10
- Assess existing or design new meander planform
- Design discharge, valley slope, roughness, channel dimensions & bank material properties



CONCEPTS – CONservational Channel Evolution and Pollutant Transport System

CONCEPTS simulates long-term response of channels to loadings of water and sediments, and to instream structures



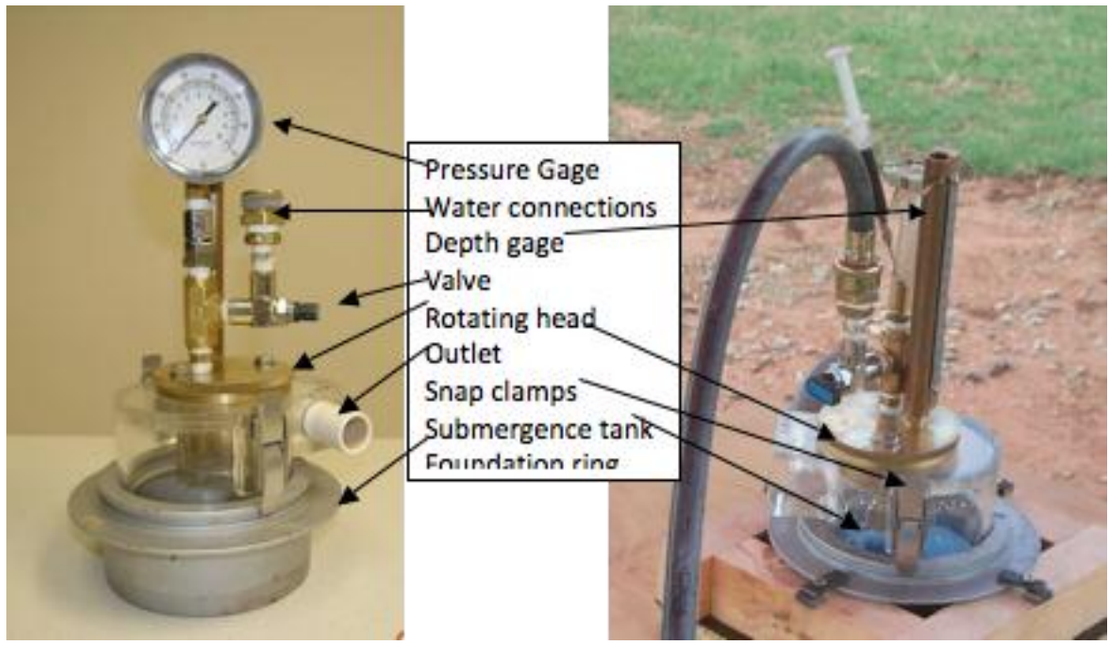
- *Input*
  - Channel geometry
  - Bed & bank material properties
  - Loadings of water and sediments
- *Output*
  - Changes in channel geometry
  - Time series of hydraulic variables and sediment yield

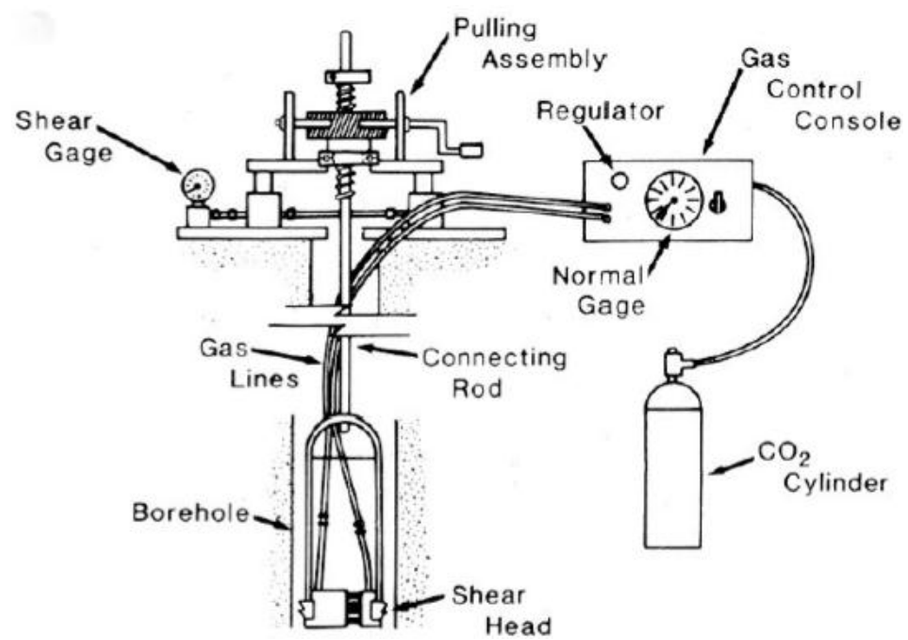
Stream Restoration/Stabilization Assessment

- *BSTEM*
  - Local impact of bank protection on bank erosion
- *RVR Meander*
  - Reach scale impact of bank protection on channel planform
- *CONCEPTS*
  - Reach scale impact of bed and bank protection on channel evolution and sediment transport

Quantifying Bank & Bed Material Resistance

- Grain size analysis
- Bulk density
- Soil erodibility
- Soil shear strength
- Soil water distribution





Thank You