Modeling and measuring erosion in a sediment-impaired stream

Charlie **Shobe,** Aras **Mann,** Corey **Crowder,** Isaac **Miller,** and Nick **Colaianne**
Earth Surface Dynamics Group, Department of Geology and Geography

Streams have been straightened and dredged for flood control since the 1800s

WATER RESOURCES BULLETIN
VOL. 16, NO. 4 AMERICAN WATER RESOURCES ASSOCIATION AUGUST 1980

ENVIRONMENTAL IMPACT OF CHANNEL MODIFICATION[1]

Russell Schoof[2]

ABSTRACT: The purpose of this literature review is to identify and quantify the effects of channelization and to examine the feasibility and acceptability of alternative methods of flood control. In the past 150 years, over 200,000 miles of stream channels have been modified. Channelization can affect the environment by draining wetland, cutting off oxbows and meanders, clearing floodplain hardwoods, lowering ground water levels, reducing ground water recharge from stream flow, and increasing erosion sedimentation, channel maintenance, and downstream flooding. Channelization reduces the size, number, and species diversity of fish in streams. In a wet climate, the fishery requires less than 10 years to fully recover. However, in the drier climates, the fishery may never fully recover. In general, channel modifications have performed as designed for flood abatement. The Arthur D. Little Study (1973) reported that direct benefits estimated during channelization planning have been conservative and that damage reduction has been impressive. Diking seems to be a viable alternative to channel dredging. Dikes minimize destruction of wetland and eliminate the need for removing vegetation from the existing stream banks.
(KEY TERMS: channel modification; channelization; dikes; dredging; environmental impact.)

about 80 percent of them were in as few as 15 states. Channel-alteration work was most heavily concentrated in eight Southern states, and along with the five Midwestern states (Illinois, Indiana, North Dakota, Ohio, and Kansas) these were among the first 15 states with channel-alteration activities. Improvements of levees along stream channels was concentrated in California, Illinois, and Florida.

Most of the channels modified in recent years have been done by the SCS under Public Law 566 passed in 1954 and by USACE under Section 205 of the 1948 Flood Control Act. These agencies refer to channelization as "channel improvement" or "watershed management." However, others like Bauer and East (1970) described channelization as an "insidious cancer" that contradicts many of the basic principles of water management advocated by land and wildlife experts for many years.

The primary objections to channelization are the reduction

Streams have been straightened and dredged for flood control since the 1800s

WATER RESOURCES BULLETIN
VOL. 16, NO. 4 — AMERICAN WATER RESOURCES ASSOCIATION — AUGUST 1980

“…200,000 miles of waterways have been modified…”

ENVIRONMENTAL IMPACT OF CHANNEL MODIFICATION[1]

Russell Schoof[2]

ABSTRACT: The purpose of this literature review is to identify and quantify the effects of channelization and to examine the feasibility and acceptability of alternative methods of flood control. In the past 150 years, over 200,000 miles of stream channels have been modified. Channelization can affect the environment by draining wetland, cutting off oxbows and meanders, clearing floodplain hardwoods, lowering ground water levels, reducing ground water recharge from stream flow, and increasing erosion sedimentation, channel maintenance, and downstream flooding. Channelization reduces the size, number, and species diversity of fish in streams. In a wet climate, the fishery requires less than 10 years to fully recover. However, in the drier climates, the fishery may never fully recover. In general, channel modifications have performed as designed for flood abatement. The Arthur D. Little Study (1973) reported that direct benefits estimated during channelization planning have been conservative and that damage reduction has been impressive. Diking seems to be a viable alternative to channel dredging. Dikes minimize destruction of wetland and eliminate the need for removing vegetation from the existing stream banks.
(KEY TERMS: channel modification; channelization; dikes; dredging; environmental impact.)

about 80 percent of them were in as few as 15 states. Channel-alteration work was most heavily concentrated in eight Southern states, and along with the five Midwestern states (Illinois, Indiana, North Dakota, Ohio, and Kansas) these were among the first 15 states with channel-alteration activities. Improvements of levees along stream channels was concentrated in California, Illinois, and Florida.

Most of the channels modified in recent years have been done by the SCS under Public Law 566 passed in 1954 and by USACE under Section 205 of the 1948 Flood Control Act. These agencies refer to channelization as “channel improvement” or “watershed management.” However, others like Bauer and East (1970) described channelization as an “insidious cancer” that contradicts many of the basic principles of water management advocated by land and wildlife experts for many years.

The primary objections to channelization are the reduction

Streams have been straightened and dredged for flood control since the 1800s

WATER RESOURCES BULLETIN
VOL. 16, NO. 4 AMERICAN WATER RESOURCES ASSOCIATION AUGUST 1980

"…200,000 miles of waterways have been modified…"

ENVIRONMENTAL IMPACT OF CHANNEL MODIFICATION[1]

Russell Schoof[2]

"…drains wetlands, lowers groundwater levels, reduces groundwater recharge…"

ABSTRACT: The purpose of this literature review is to identify and quantify the … and acceptabil… 150 years, ove… Channelizatio… off oxbows and meanders, clearing floodplain hardwoods, lowering ground water levels, reducing ground water recharge from stream flow, and increasing erosion sedimentation, channel maintenance, and downstream flooding. Channelization reduces the size, number, and species diversity of fish in streams. In a wet climate, the fishery requires less than 10 years to fully recover. However, in the drier climates, the fishery may never fully recover. In general, channel modifications have performed as designed for flood abatement. The Arthur D. Little Study (1973) reported that direct benefits estimated during channelization planning have been conservative and that damage reduction has been impressive. Diking seems to be a viable alternative to channel dredging. Dikes minimize destruction of wetland and eliminate the need for removing vegetation from the existing stream banks.
(KEY TERMS: channel modification; channelization; dikes; dredging; environmental impact.)

about 80 percent of them were in as few as 15 states. Channel-

among the first 15 states with channel-alteration activities. Improvements of levees along stream channels was concentrated in California, Illinois, and Florida.

Most of the channels modified in recent years have been done by the SCS under Public Law 566 passed in 1954 and by USACE under Section 205 of the 1948 Flood Control Act. These agencies refer to channelization as "channel improvement" or "watershed management." However, others like Bauer and East (1970) described channelization as an "insidious cancer" that contradicts many of the basic principles of water management advocated by land and wildlife experts for many years.

The primary objections to channelization are the reduction

Streams have been straightened and dredged for flood control since the 1800s

VOL. 16, NO. 4 WATER RESOURCES BULLETIN AMERICAN WATER RESOURCES ASSOCIATION AUGUST 1980

"…200,000 miles of waterways have been modified…"

ENVIRONMENTAL IMPACT OF CHANNEL MODIFICATION[1]

Russell Schoof[2]

ABSTRACT: The purpose of this literature review is to identify and quantify the effects of channelization and to examine the feasibility and acceptabil

150 years, ove

Channelization

off oxbows and meanders, clearing floodplain hardwoods, lowering ground water levels, reducing ground water recharge from stream flow, and increasing erosion sedimentation, channel maintenance, and downstream flooding. Channelization reduces the size, number, and species diversity of fish in streams. In a wet climate, the fishery requires less than 10 years to fully recover. However, in the drier climates, the fishery may never fully recover. In general, channel modifications have performed as designed for flood abatement. The Arthur D. Little Study (1973) reported that direct benefits estimated during channelization planning have been conservative and that damage reduction has been impressive. Diking seems to be a viable alternative to channel dredging. Dikes minimize destruction of wetland and eliminate the need for removing vegetation from the existing stream banks.
(KEY TERMS: channel modification; channelization; dikes; dredging; environmental impact.)

"…drains wetlands, lowers groundwater levels, reduces groundwater recharge…"

about 80 percent of them were in as few as 15 states. Channel-

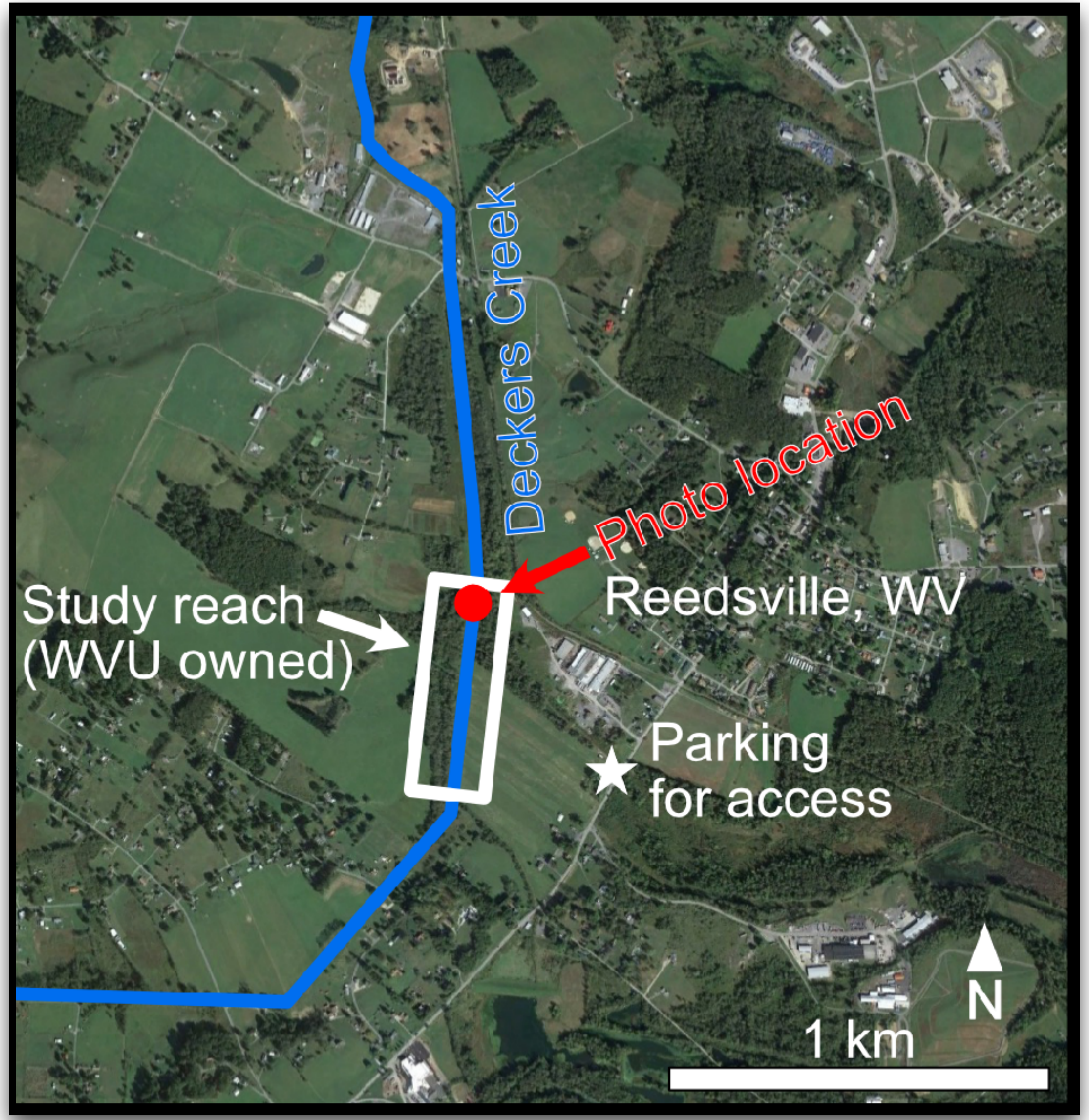
among the first 15 states with channel-alteration activities. Improvements of levees along stream channels was concentrated in California, Illinois, and Florida.

Most of the channels modified in recent years have been done by the SCS under Public Law 566 passed in 1954 and by USACE under Section 205 of the 1948 Flood Control Act. These agencies refer to channelization as "channel improvement" or "watershed management." However, others like Bauer and East (1970) described channelization as an "insi-

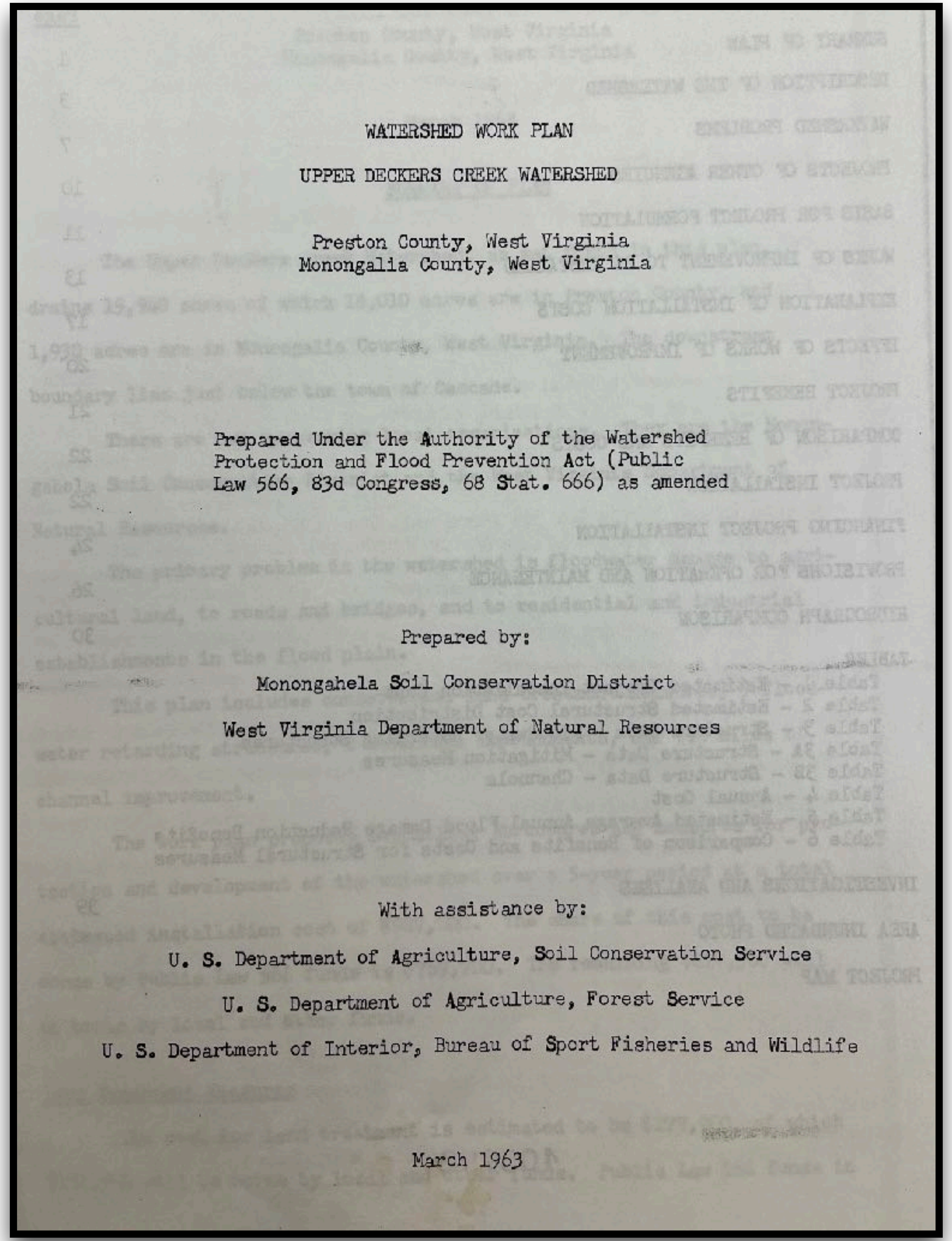
"…reduces the size, number, and species diversity of fish in streams…"

many years.

The primary objections to channelization are the reduction



Deckers Creek
Photo location
Reedsville, WV
Study reach
(WVU owned)
Parking
for access
N
1 km


WATERSHED WORK PLAN

UPPER DECKERS CREEK WATERSHED

Preston County, West Virginia
Monongalia County, West Virginia

Prepared Under the Authority of the Watershed
Protection and Flood Prevention Act (Public
Law 566, 83d Congress, 68 Stat. 666) as amended

Prepared by:

Monongahela Soil Conservation District

West Virginia Department of Natural Resources

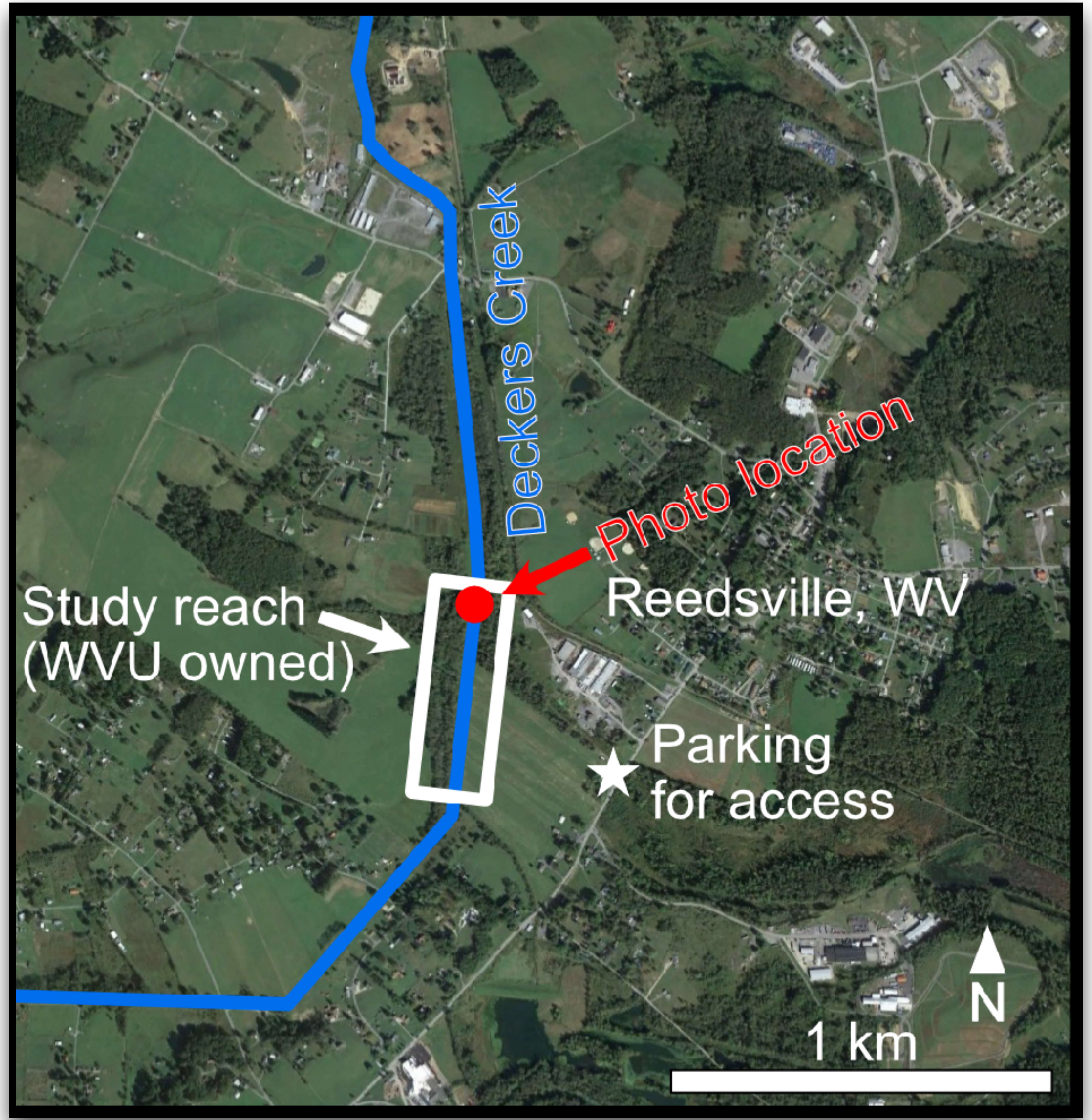
With assistance by:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife

March 1963



FRIENDS OF DECKERS CREEK

PO Box 877 * Dellslow, WV 26531 * www.deckerscreek.org

Updates to Watershed Based Plan

Submitted to:

United States Environmental Protection Agency

West Virginia Department of Environmental Protection

Original: September, 2014

Revised: May, 2015

Edited: August, 2015

Submitted by:

Timothy A. Denicola

Friends of Deckers Creek, Inc.

P.O. Box 877

Dellslow, WV 26531

304-292-3970

Contributors: Martin Christ, Meredith Pavlick, Doug Gilbert, Hannah Spencer and edited by Timothy Craddock

"Six miles of stream channels were dredged and straightened as part of the flood protection project…"

FRIENDS OF DECKERS CREEK

PO Box 877 * Dellslow, WV 26531 * www.deckerscreek.org

Updates to Watershed Based Plan

Submitted to:

United States Environmental Protection Agency

West Virginia Department of Environmental Protection

Original: September, 2014

Revised: May, 2015

Edited: August, 2015

Submitted by:

Timothy A. Denicola

Friends of Deckers Creek, Inc.

P.O. Box 877

Dellslow, WV 26531

304-292-3970

Contributors: Martin Christ, Meredith Pavlick, Doug Gilbert, Hannah Spencer and edited by Timothy Craddock

"Six miles of stream channels were dredged and straightened as part of the flood protection project…"

"These channels are prone to stream bank erosion…"

FRIENDS OF DECKERS CREEK

PO Box 877 * Dellslow, WV 26531 * www.deckerscreek.org

Updates to Watershed Based Plan

Submitted to:

United States Environmental Protection Agency

West Virginia Department of Environmental Protection

Original: September, 2014

Revised: May, 2015

Edited: August, 2015

Submitted by:

Timothy A. Denicola

Friends of Deckers Creek, Inc.

P.O. Box 877

Dellslow, WV 26531

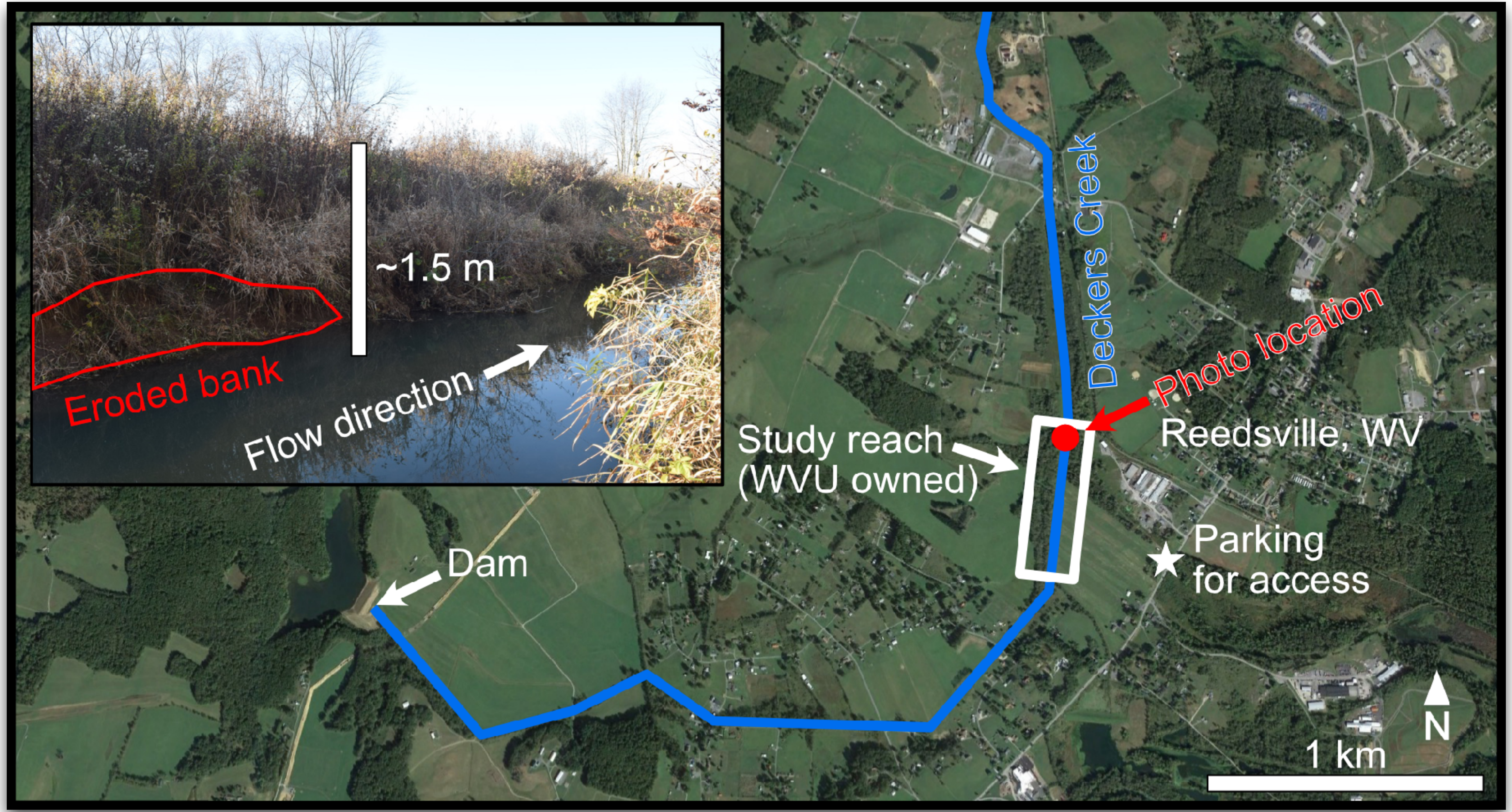
304-292-3970

Contributors: Martin Christ, Meredith Pavlick, Doug Gilbert, Hannah Spencer and edited by Timothy Craddock

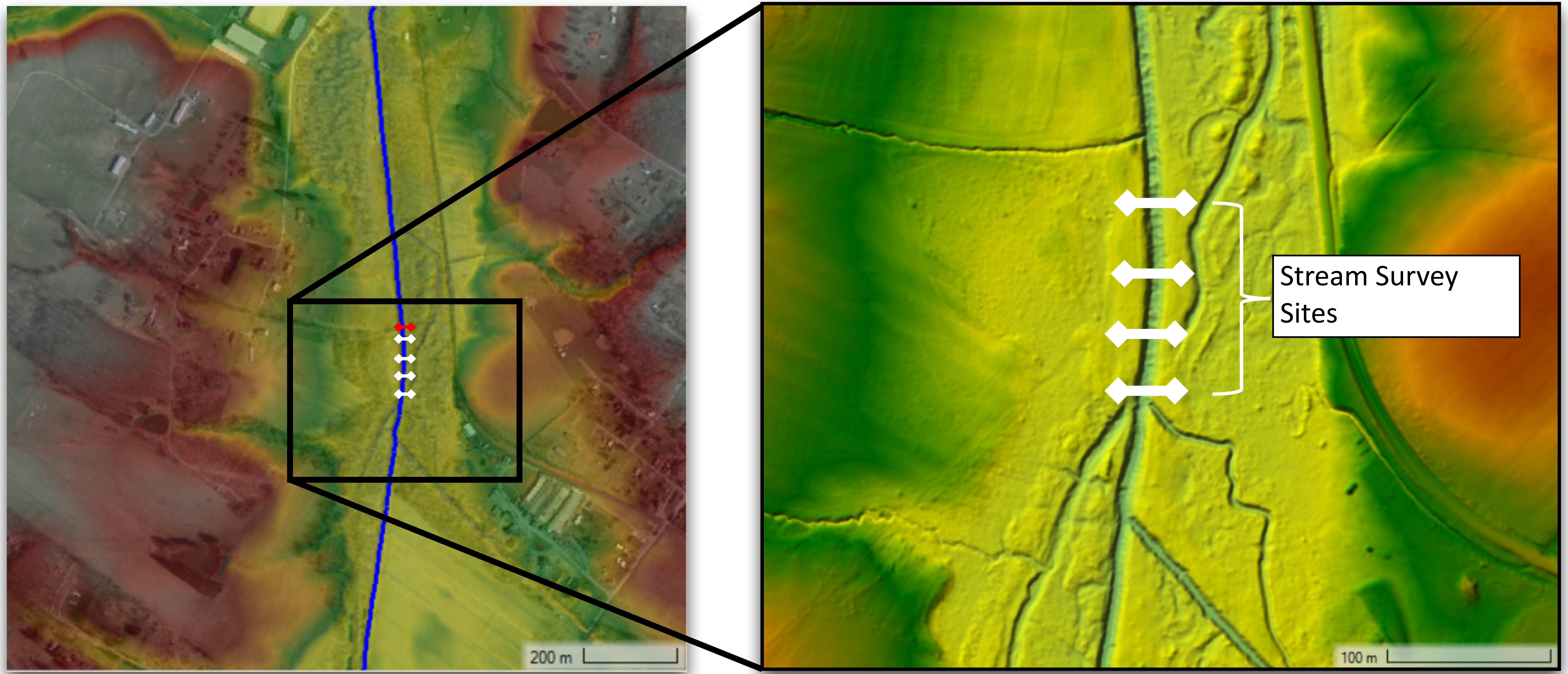
"Six miles of stream channels were dredged and straightened as part of the flood protection project…"

"These channels are prone to stream bank erosion…"

"Evidence of sediment contamination [includes] embedded substrate, channel incision, and destruction of aquatic habitat…"

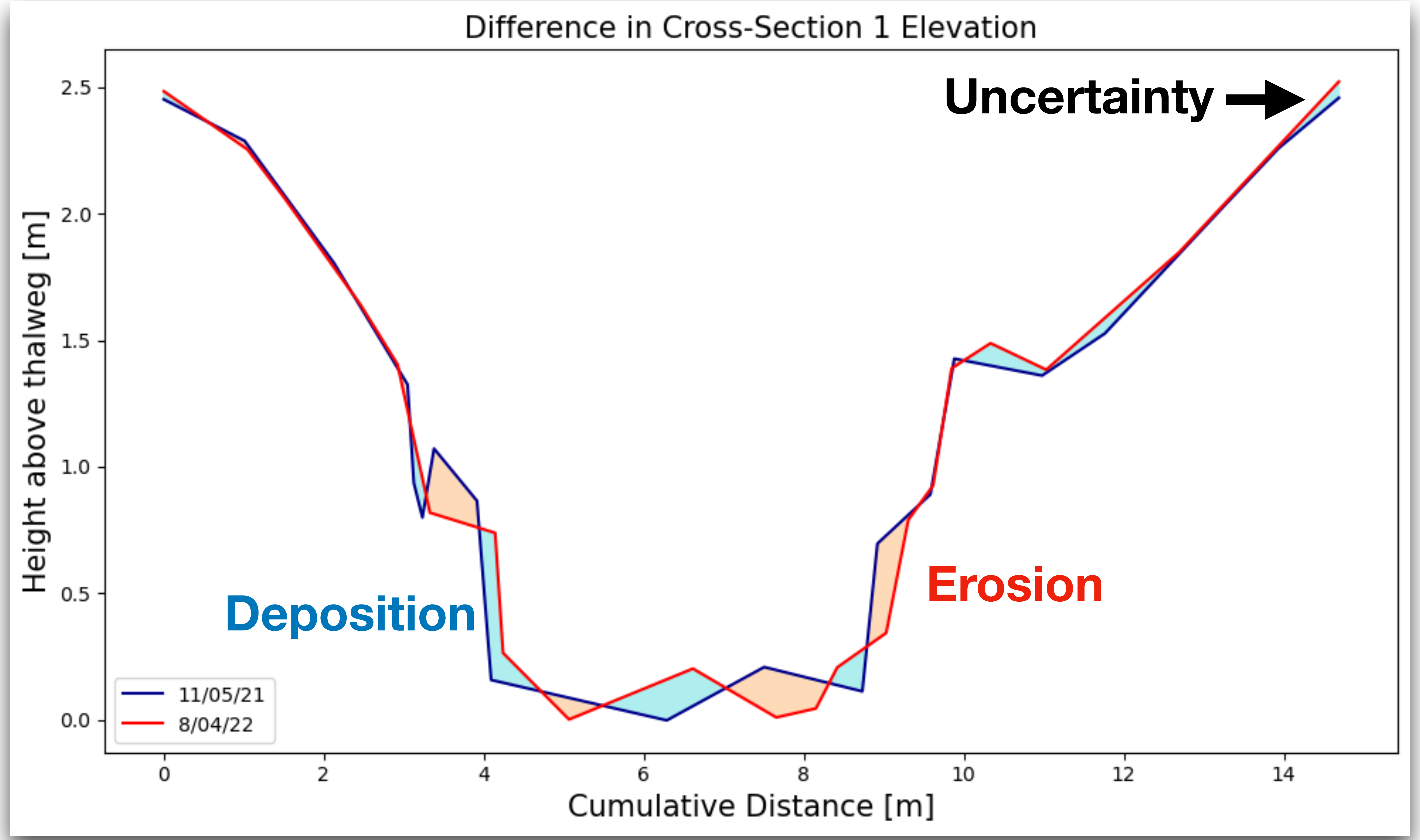

~1.5 m
Eroded bank
Flow direction
Deckers Creek
Photo location
Reedsville, WV
Study reach
(WVU owned)
Dam
Parking
for access
N
1 km

1. Is bank erosion the key driver of sediment impairment over annual timescales?

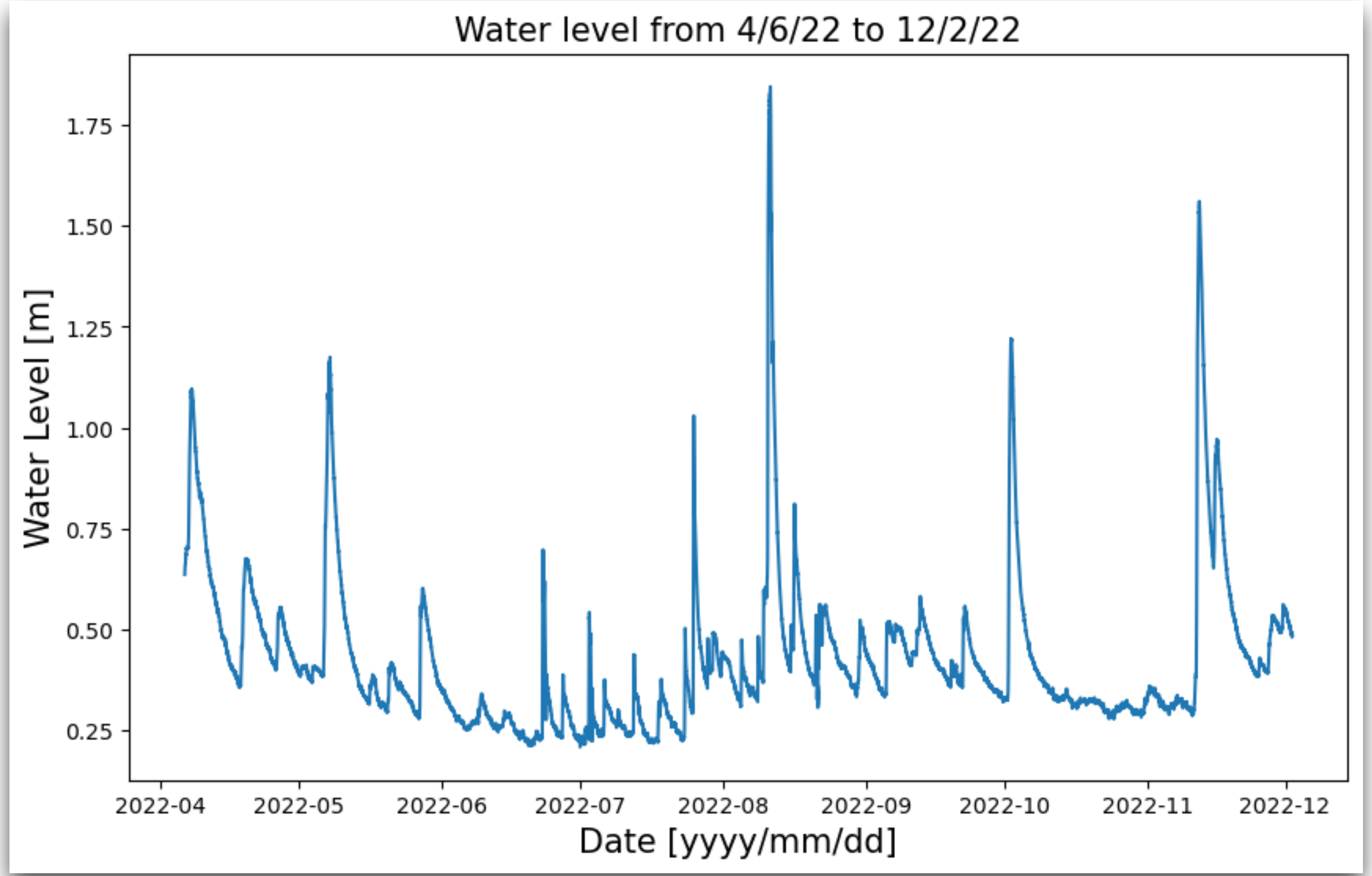


200 m
Stream Survey Sites
100 m

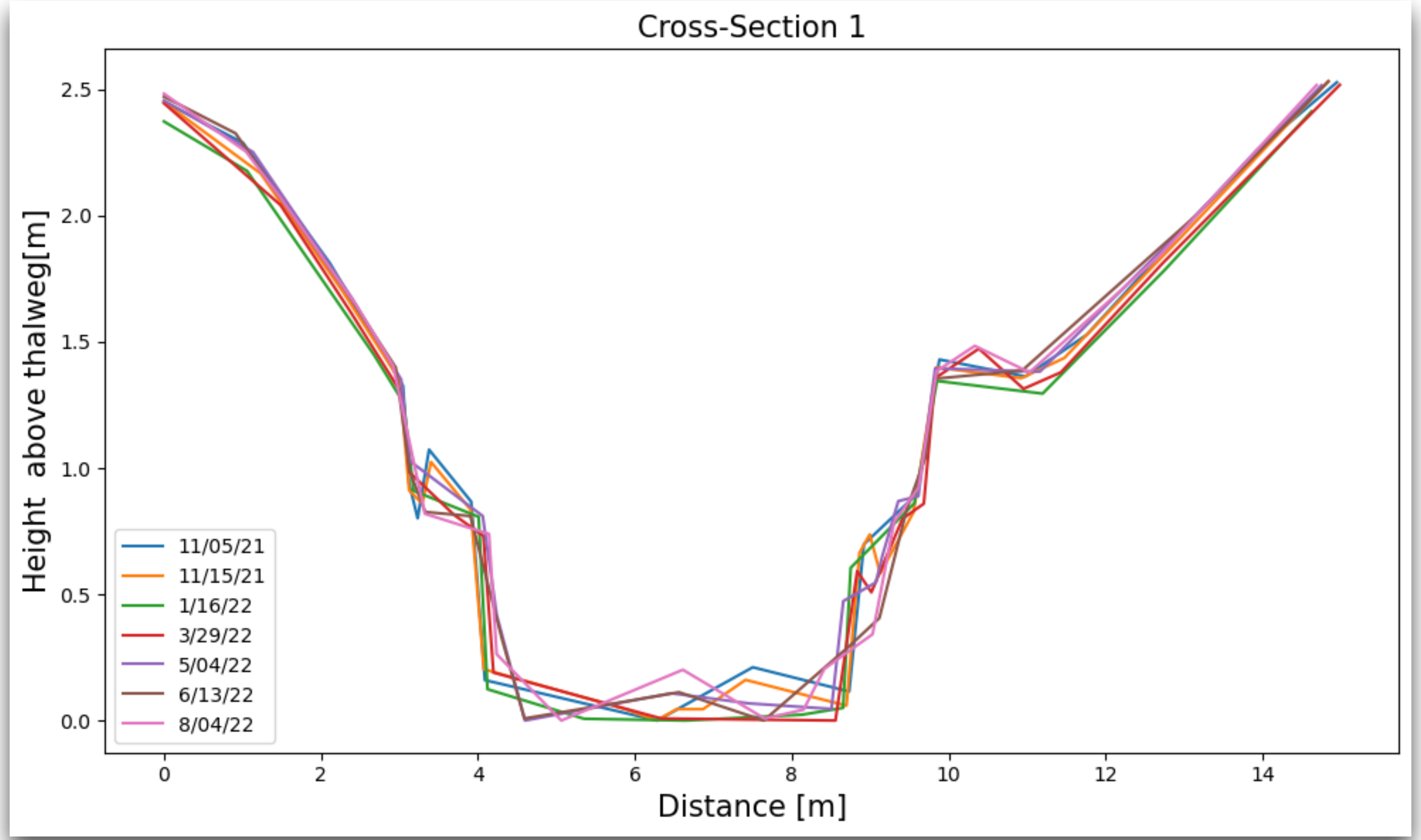
Successive surveys allow change detection



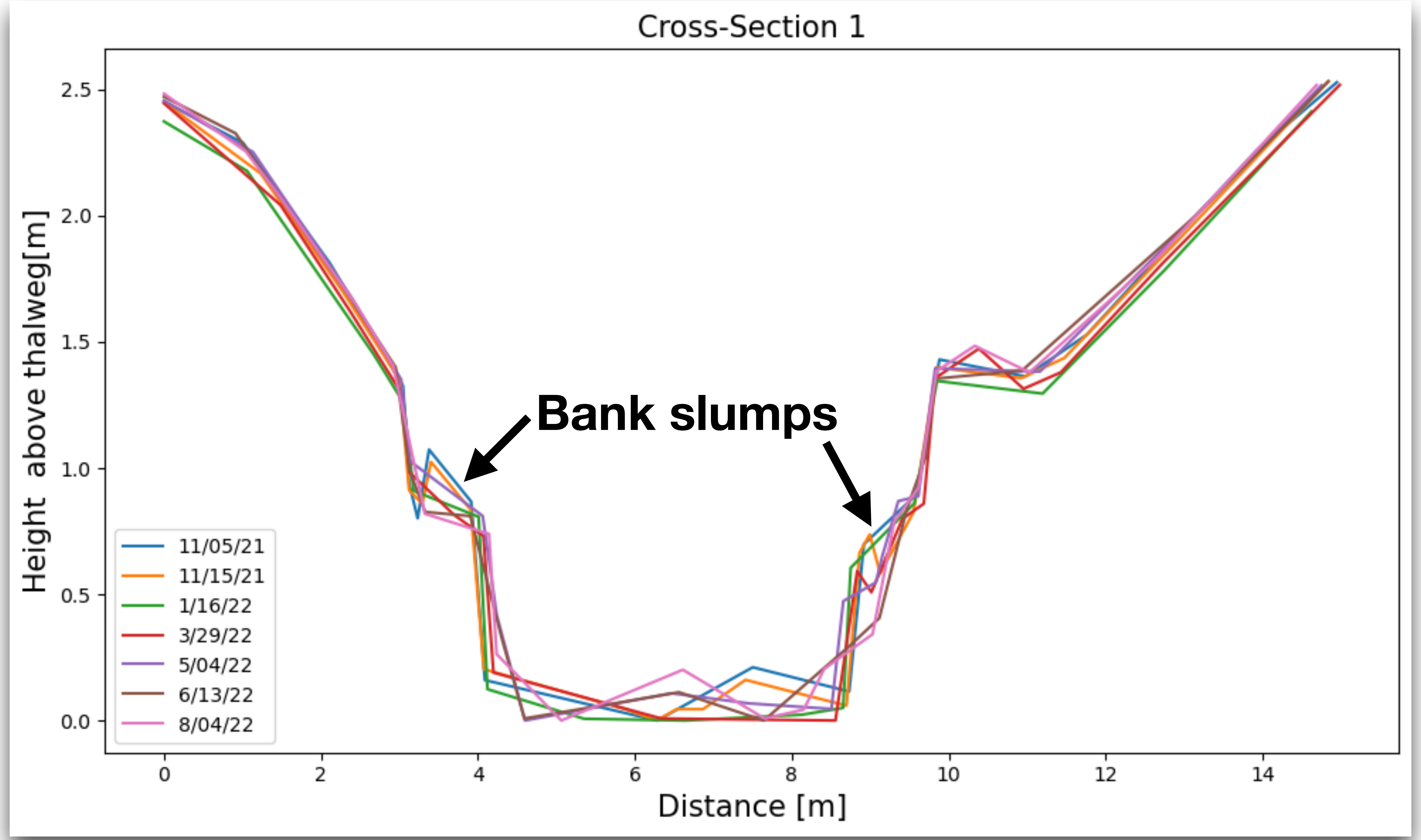
Six floods over 1m, one nearly to 2m…



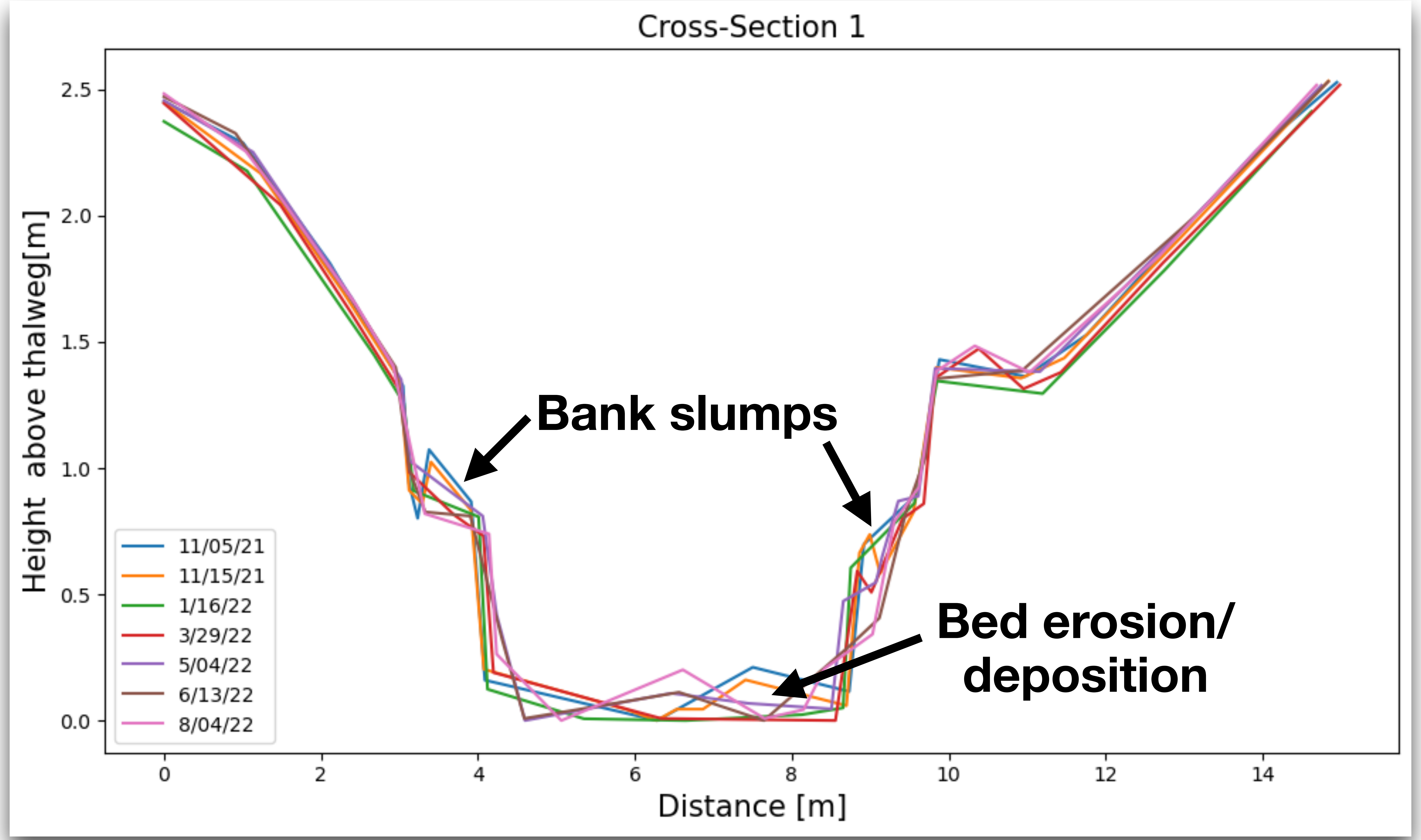
…yet little consistent morphologic change (1)



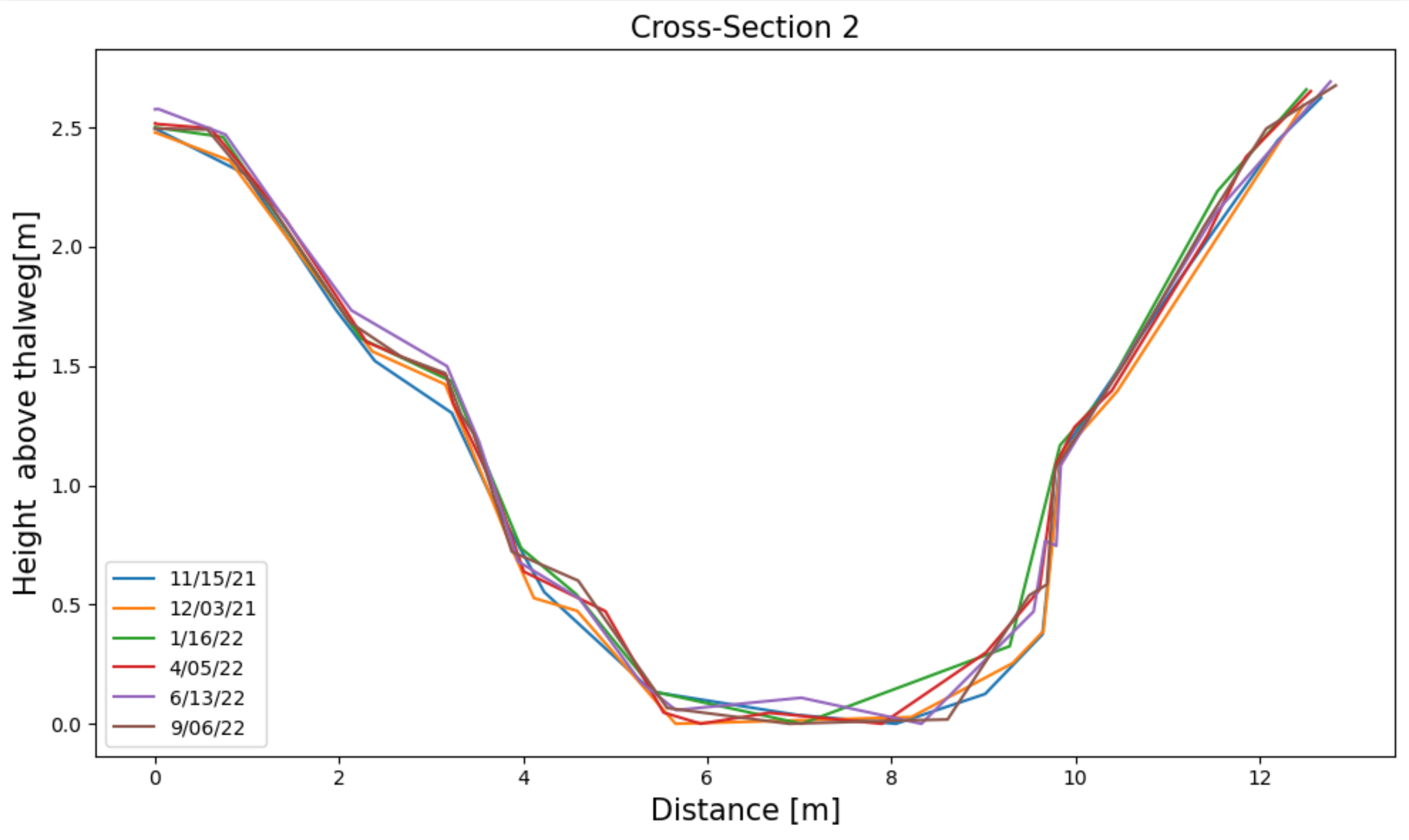
…yet little consistent morphologic change (1)



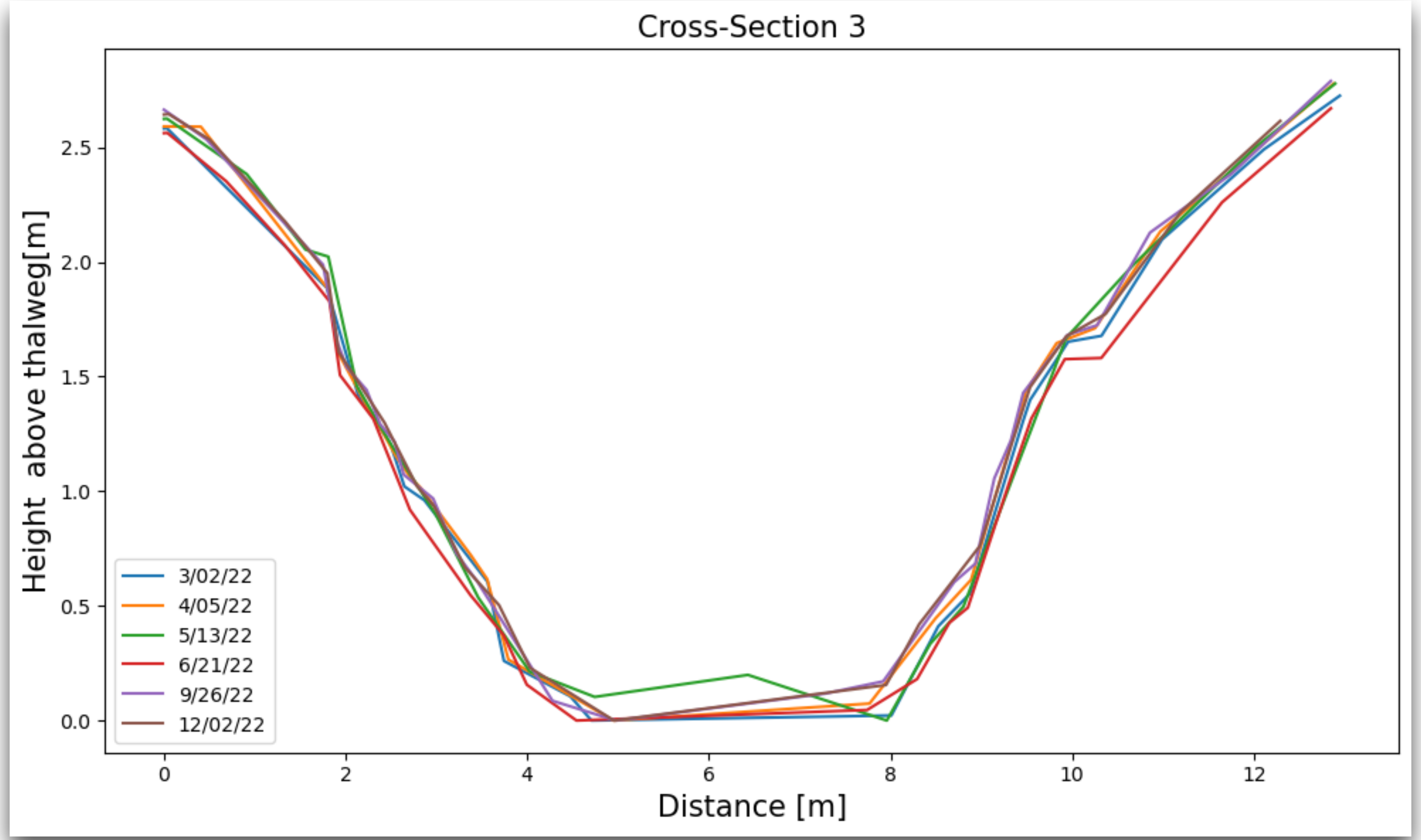
…yet little consistent morphologic change (1)



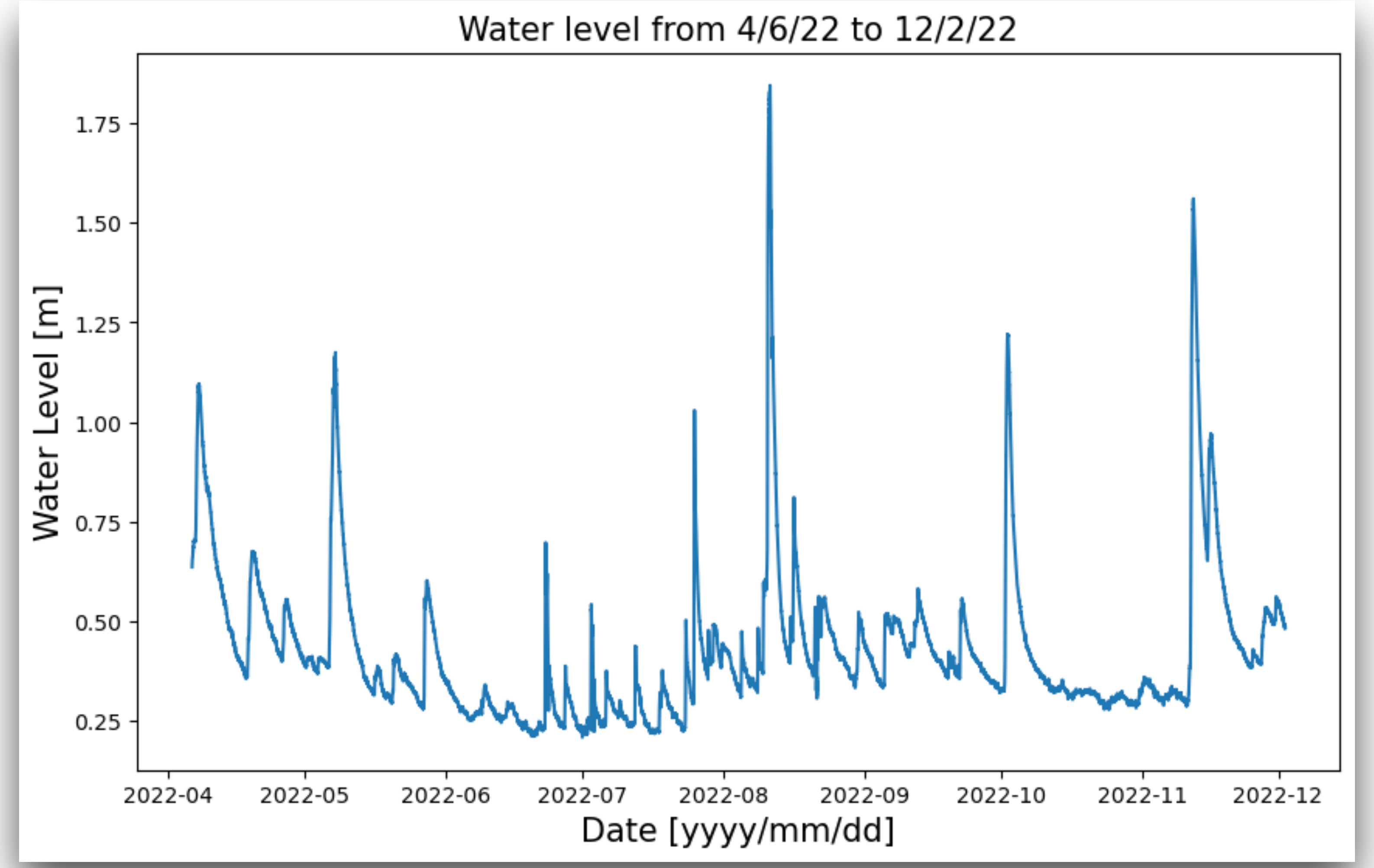
…yet little consistent morphologic change (2)



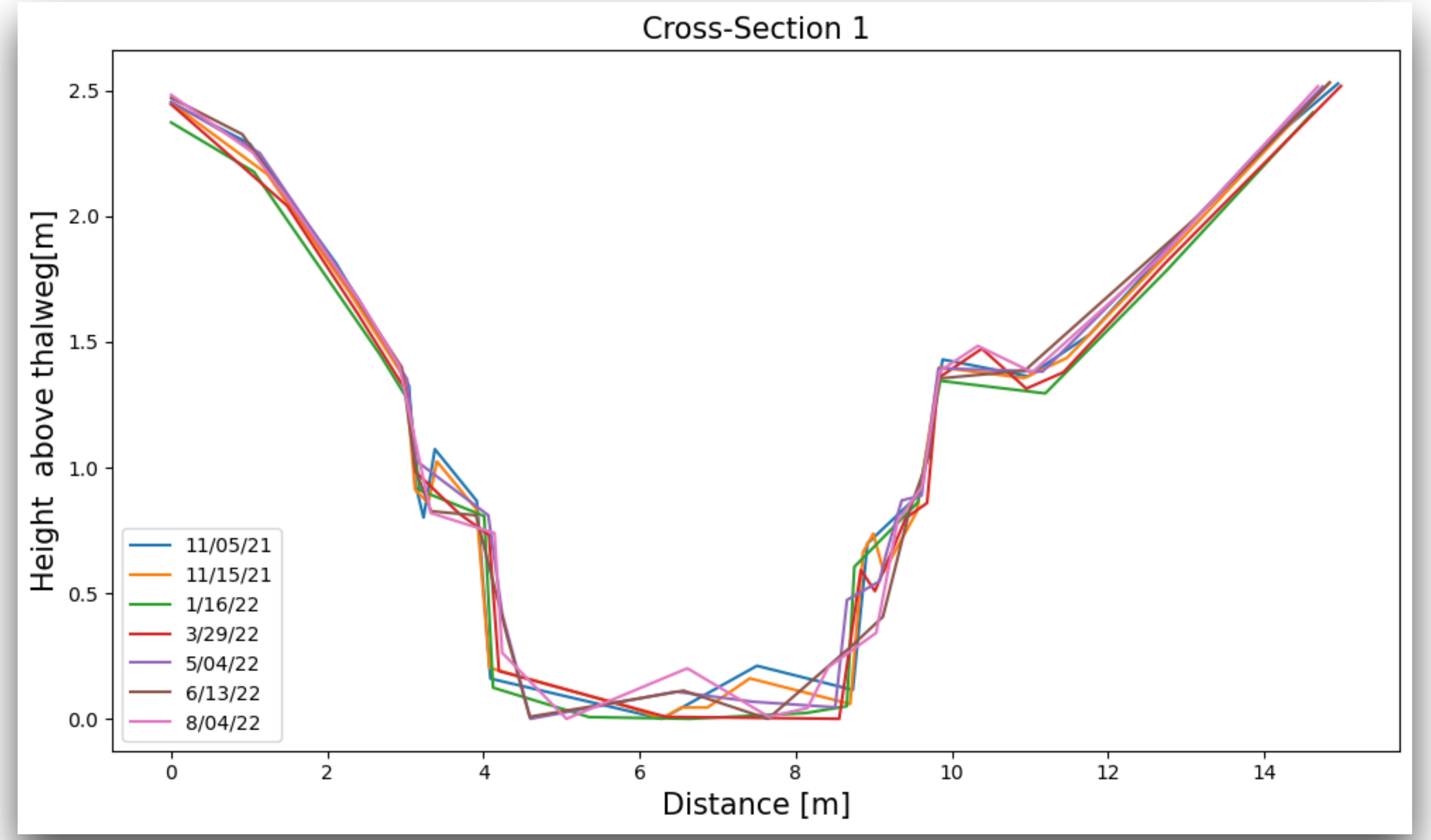
…yet little consistent morphologic change (3)



Bank erosion as a source of sediment: much ado about [almost] nothing?

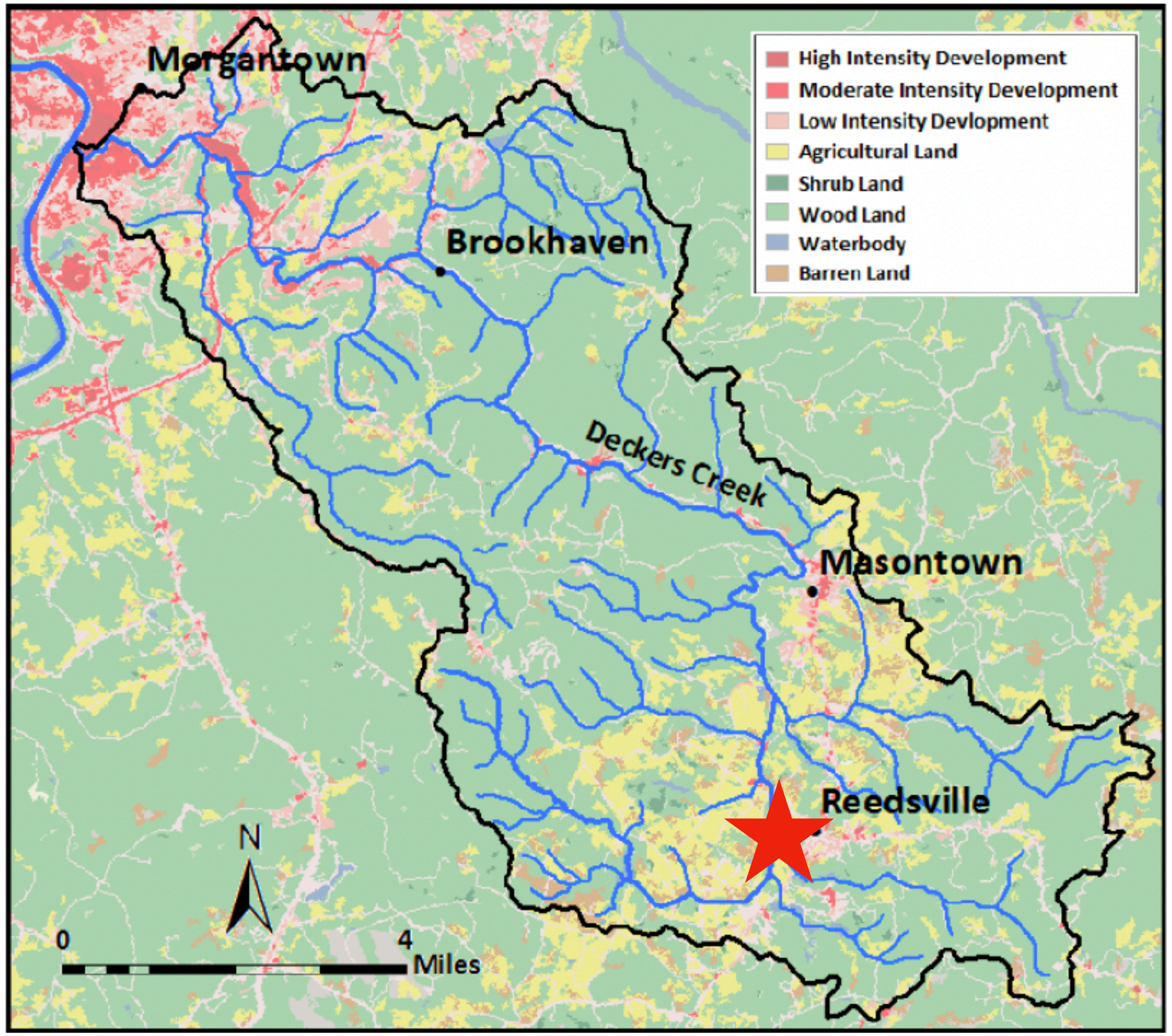


Despite flows of up to 2m depth exerting ~20 Pa of bed shear stress…



…we observe geomorphic change that is lower in magnitude than routine erosion/deposition events

Is [sub]urbanization of watersheds the real driver of sediment impairment?



2011 land use (FODC)

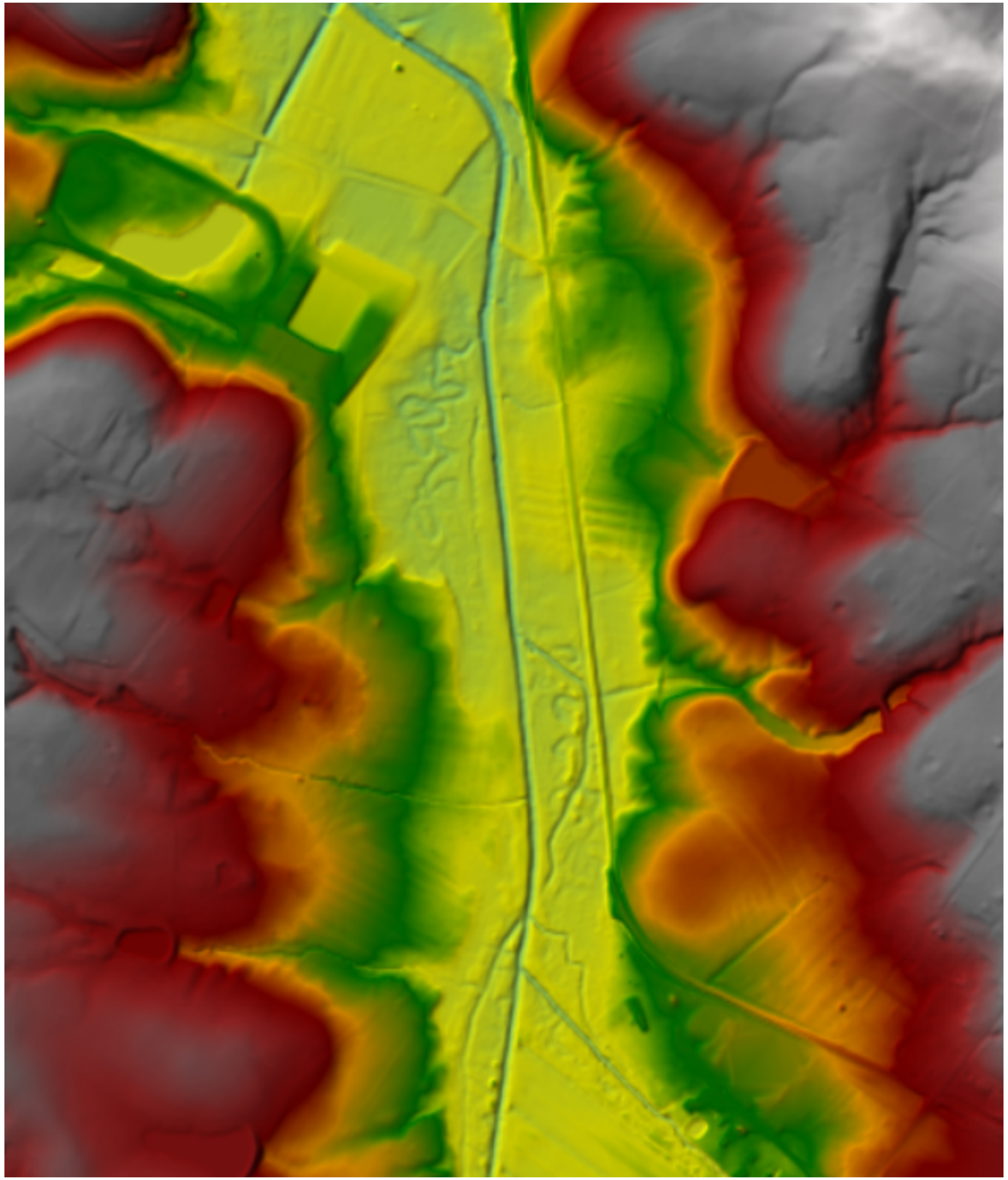
2. How can we mitigate longer-term bed/bank erosion?

2. How can we mitigate longer-term bed/bank erosion (intelligently)?

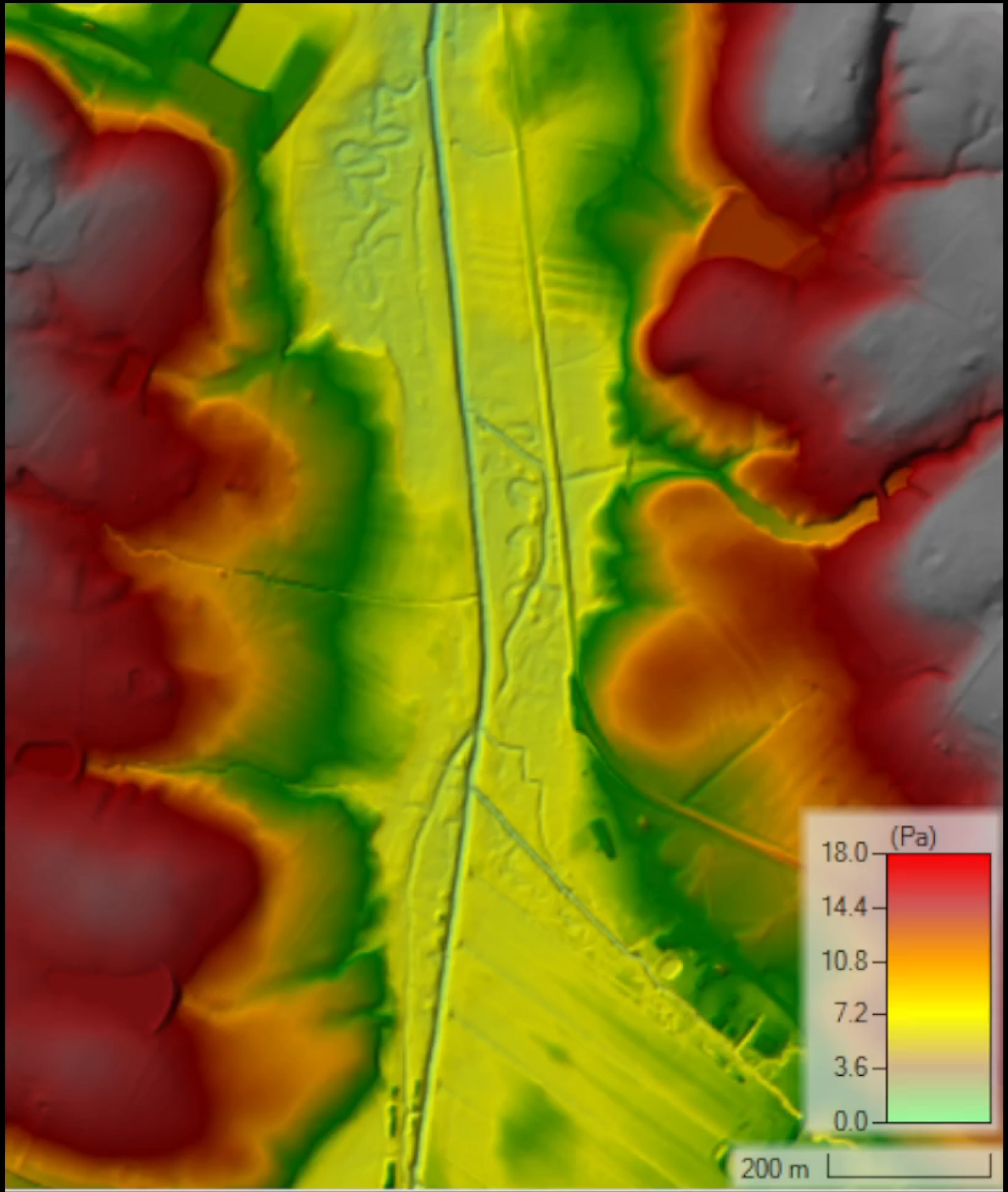
Objectives:

1. **Determine erosive stresses** in the study reach through hydrodynamic modeling.

2. Examine the influence of **reconnecting abandoned** channel reaches



Flood Simulation
Discharge = 25 m^3/s

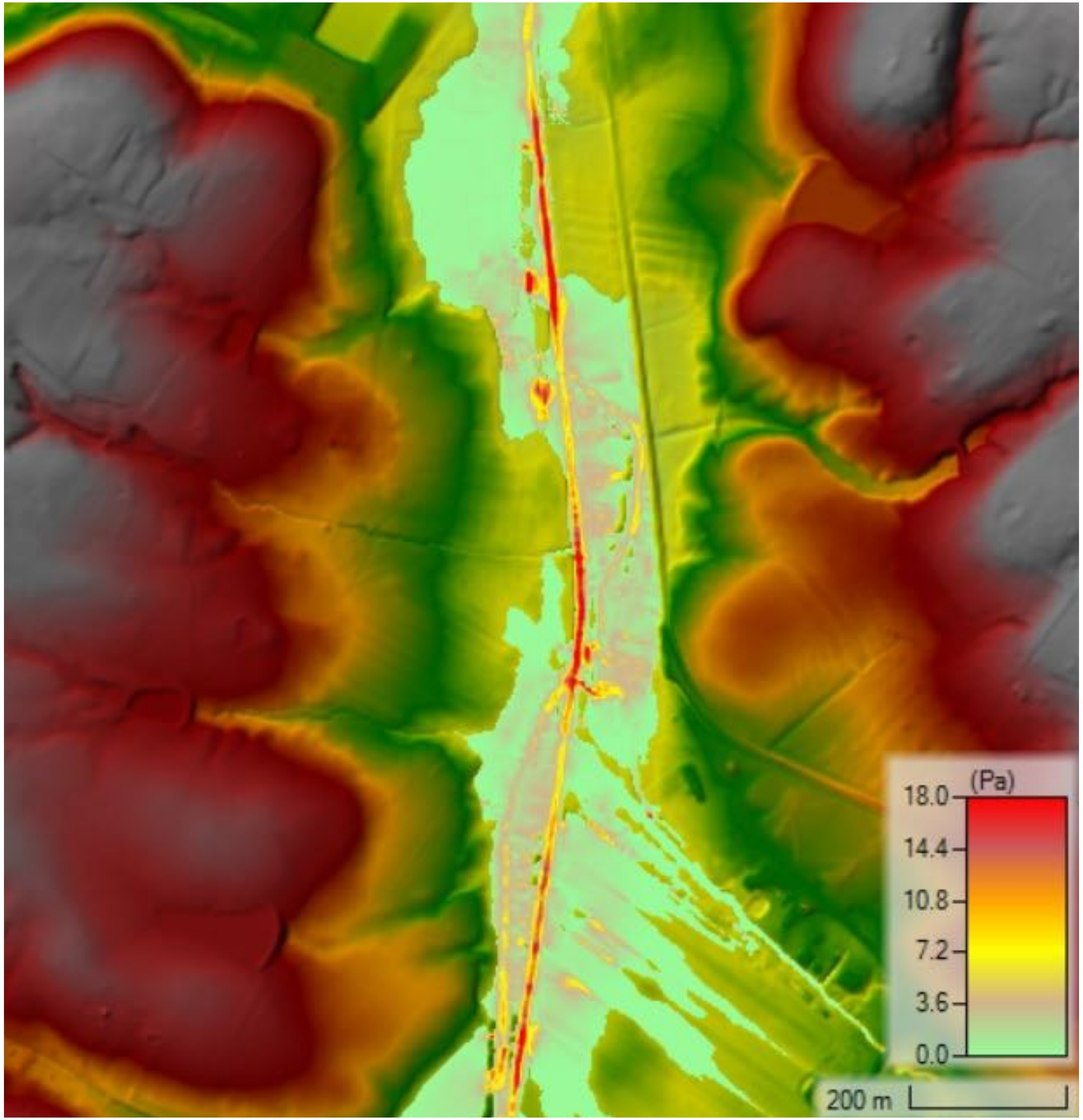


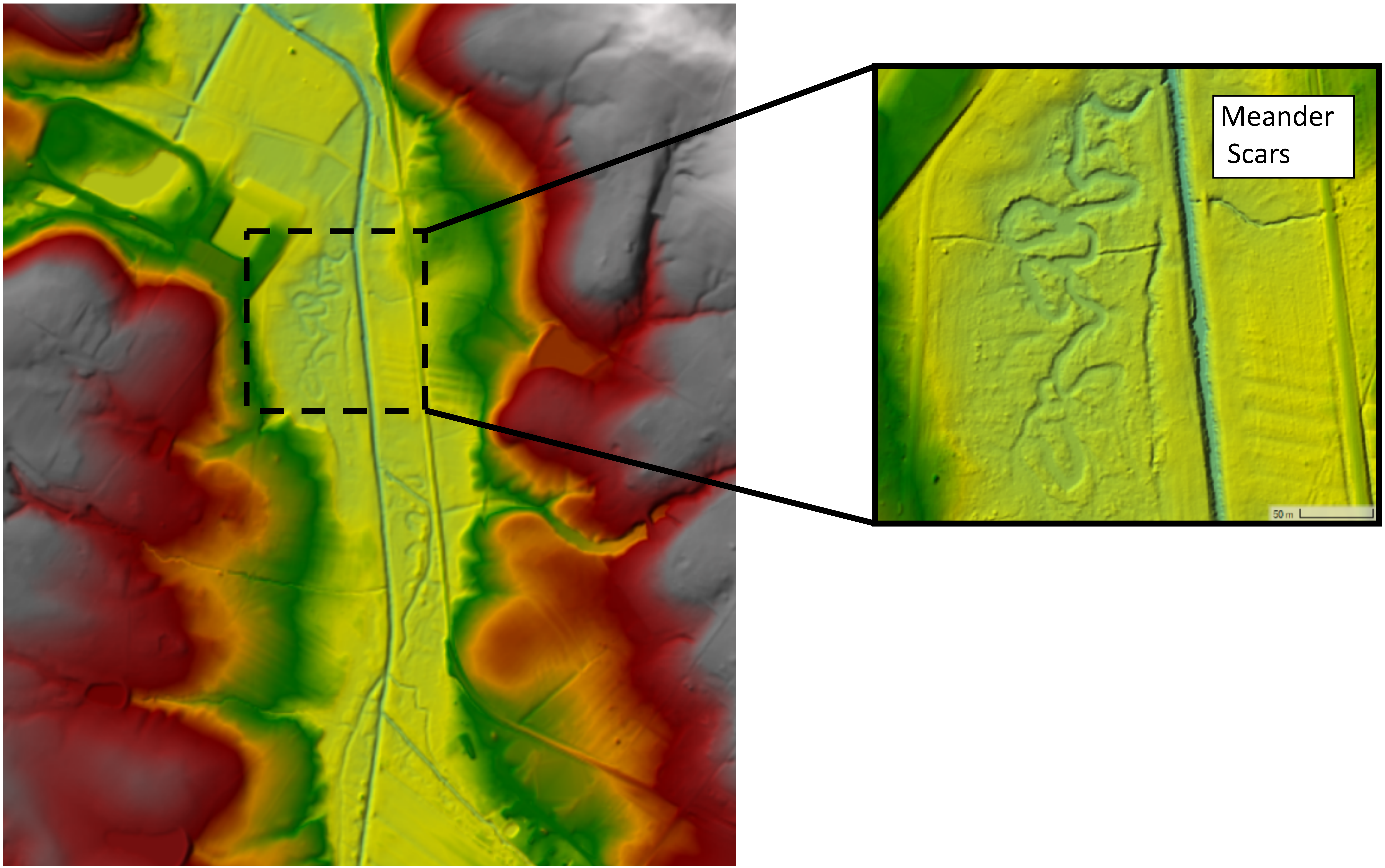
Observations:

1. High flow velocity and erosive stress due to **straightening and dredging**.

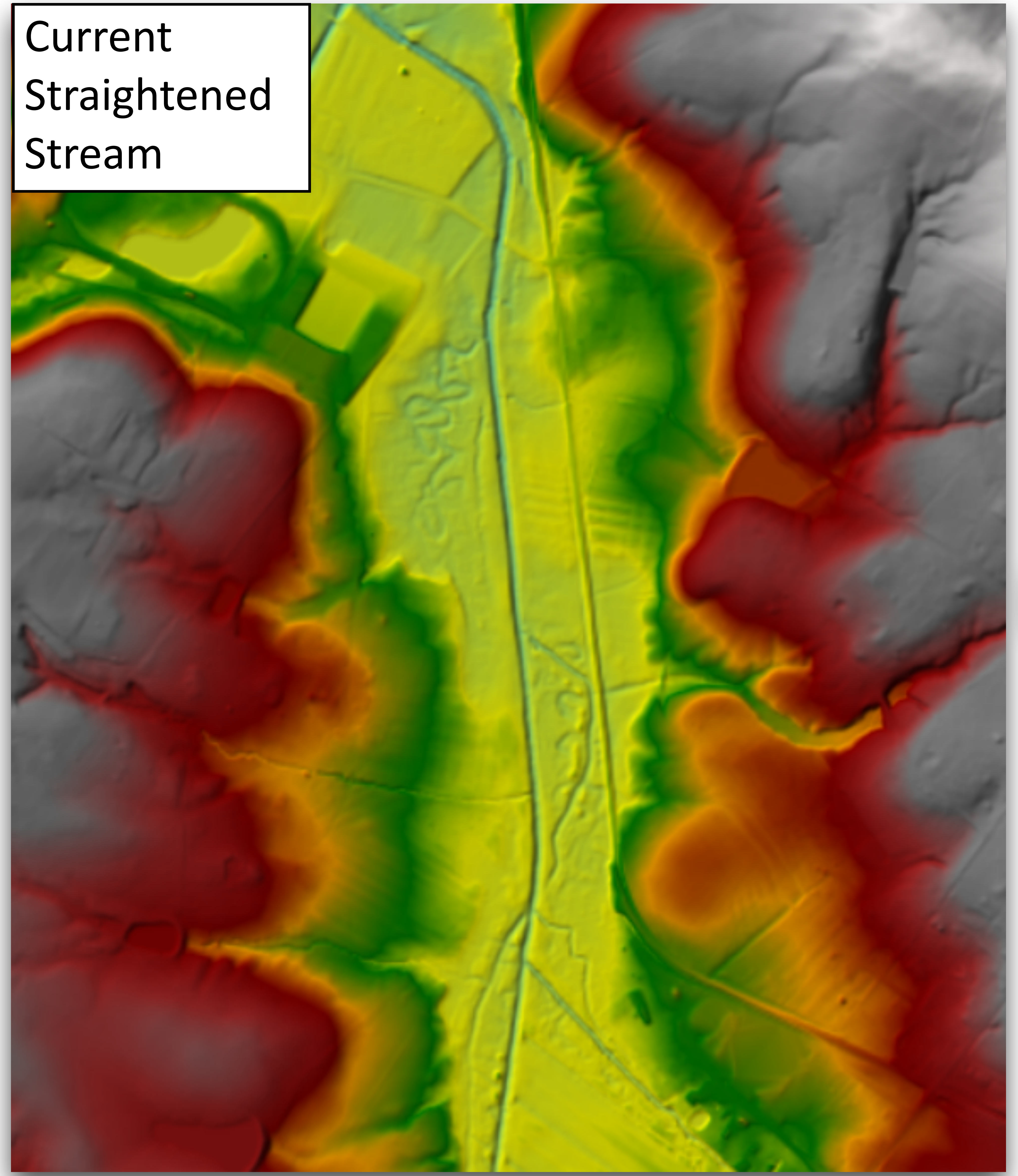
2. Up to **18 Pa** of shear stress.

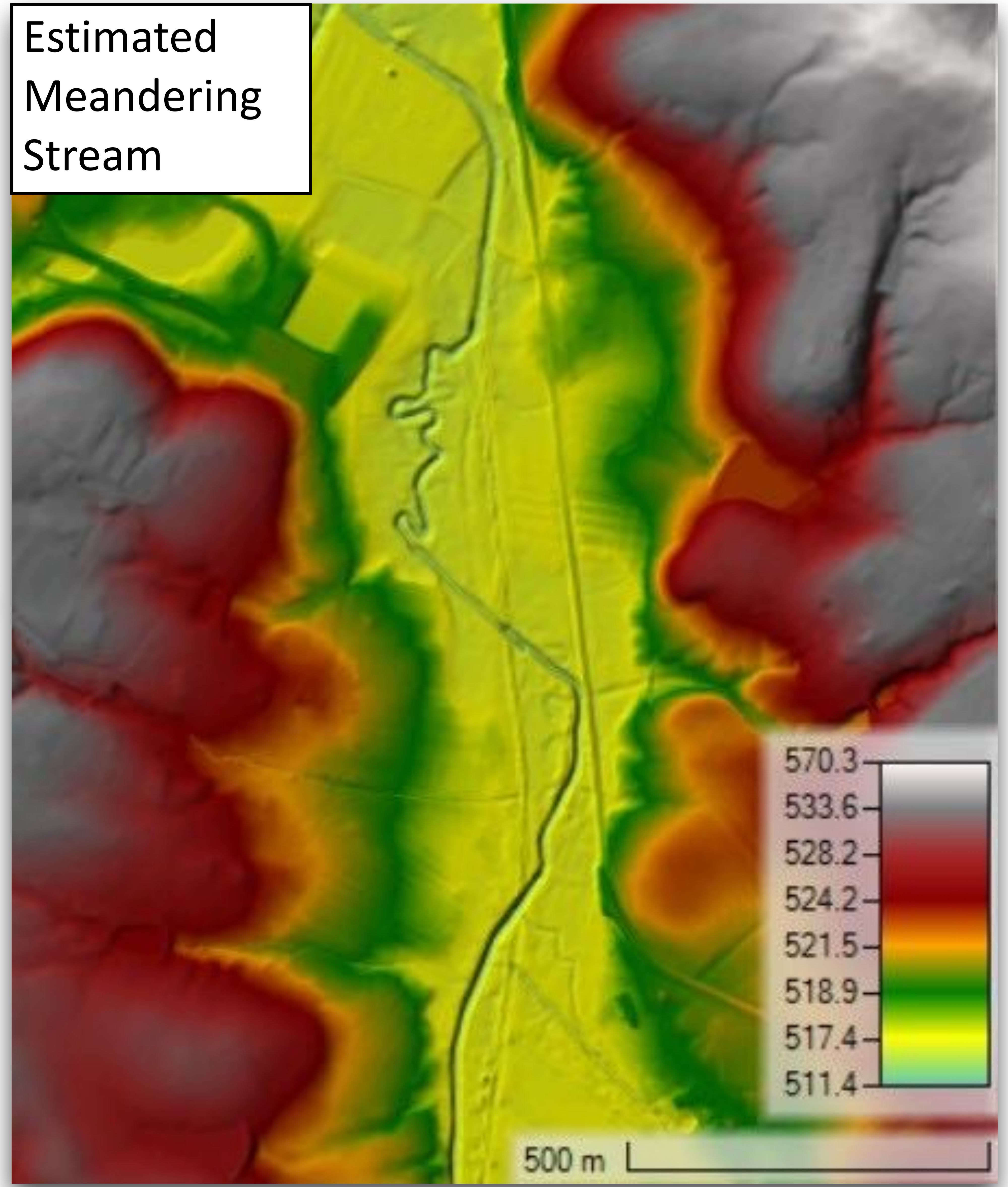
3. Overall potential for **degradation** of stream (over long timescales)




Meander
Scars
50 m

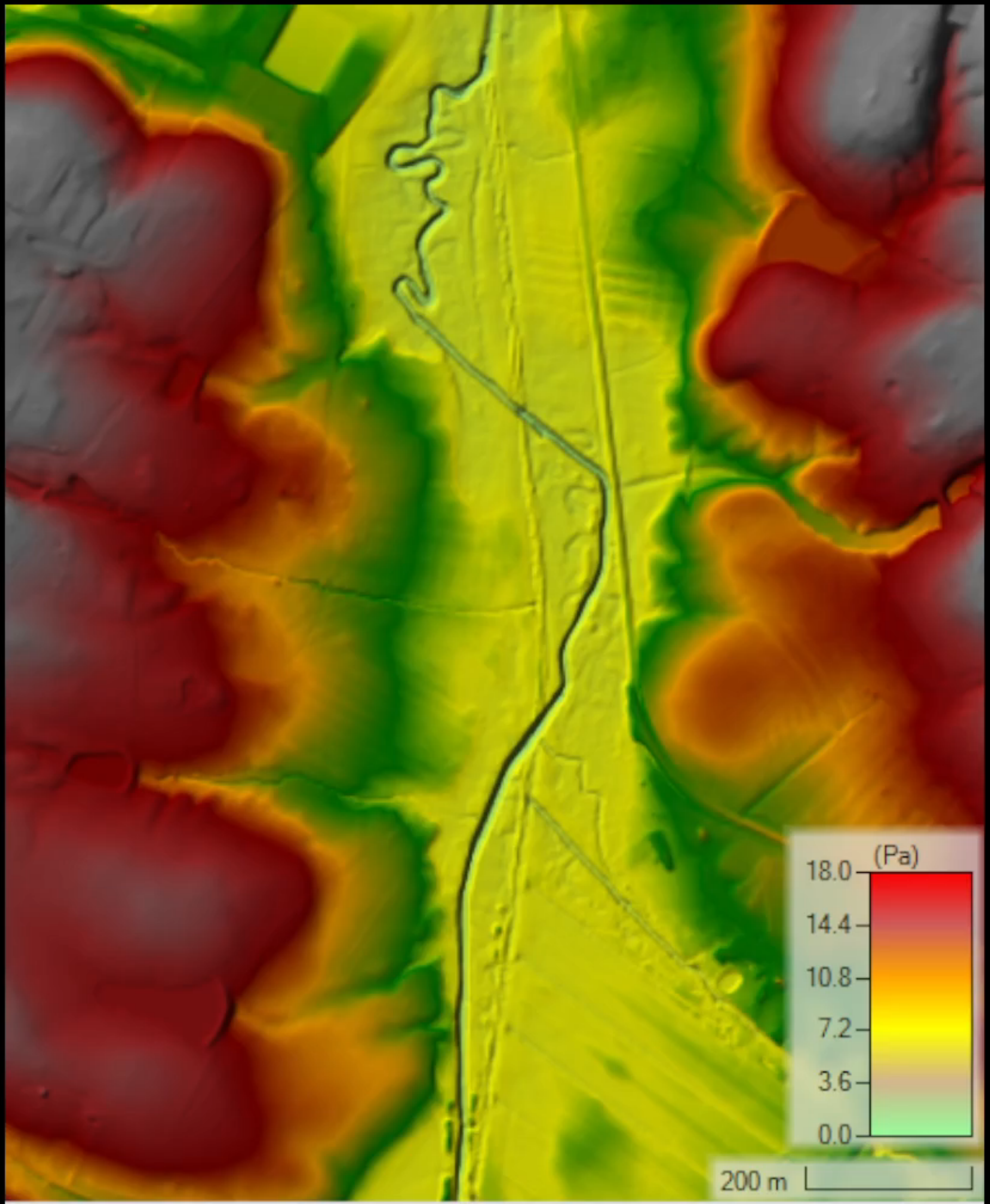
What if we reconnect abandoned meanders?



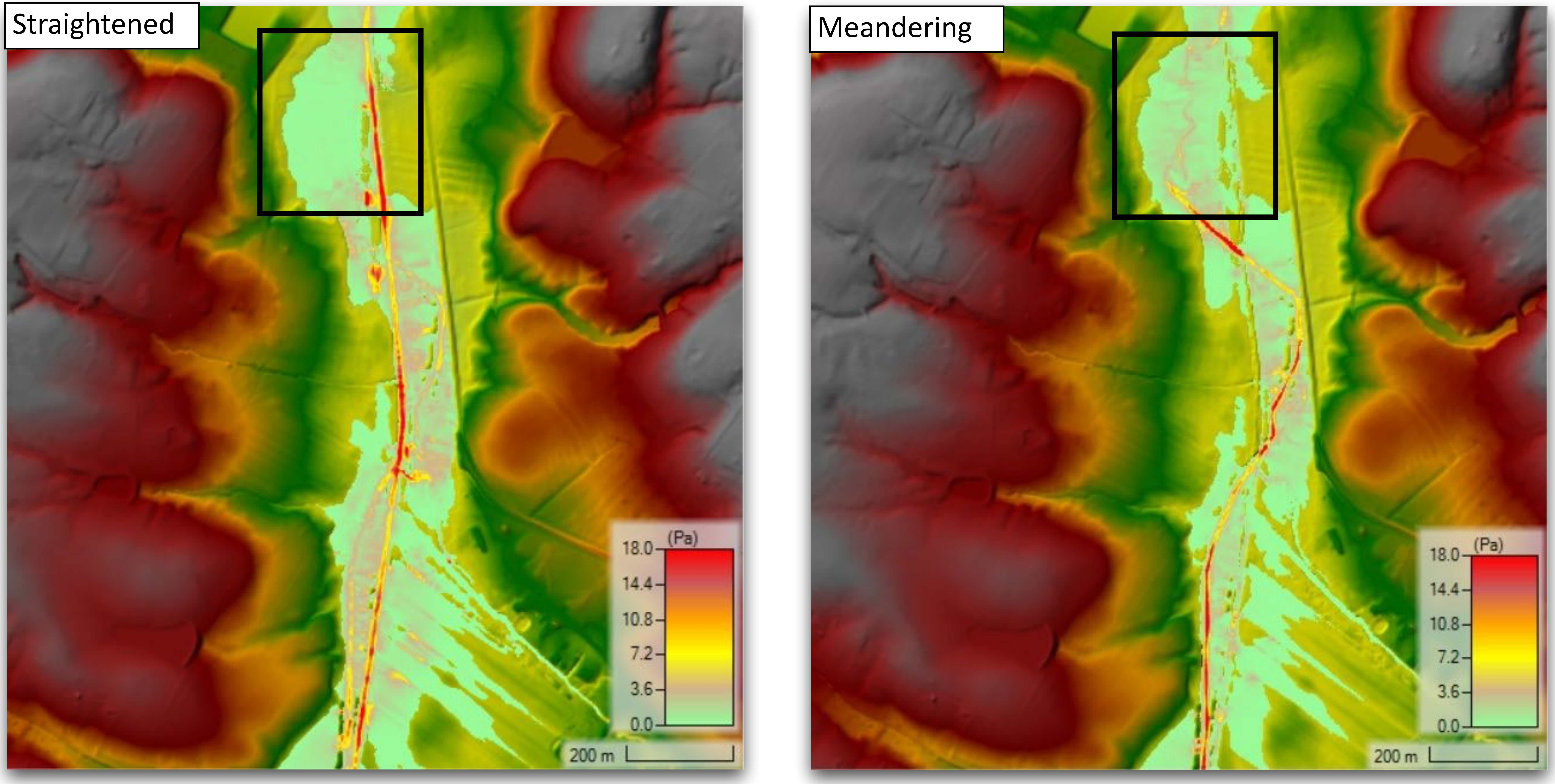


Flood Simulation
Discharge = 25 m³/s

Manipulated DEM:
meandering stream



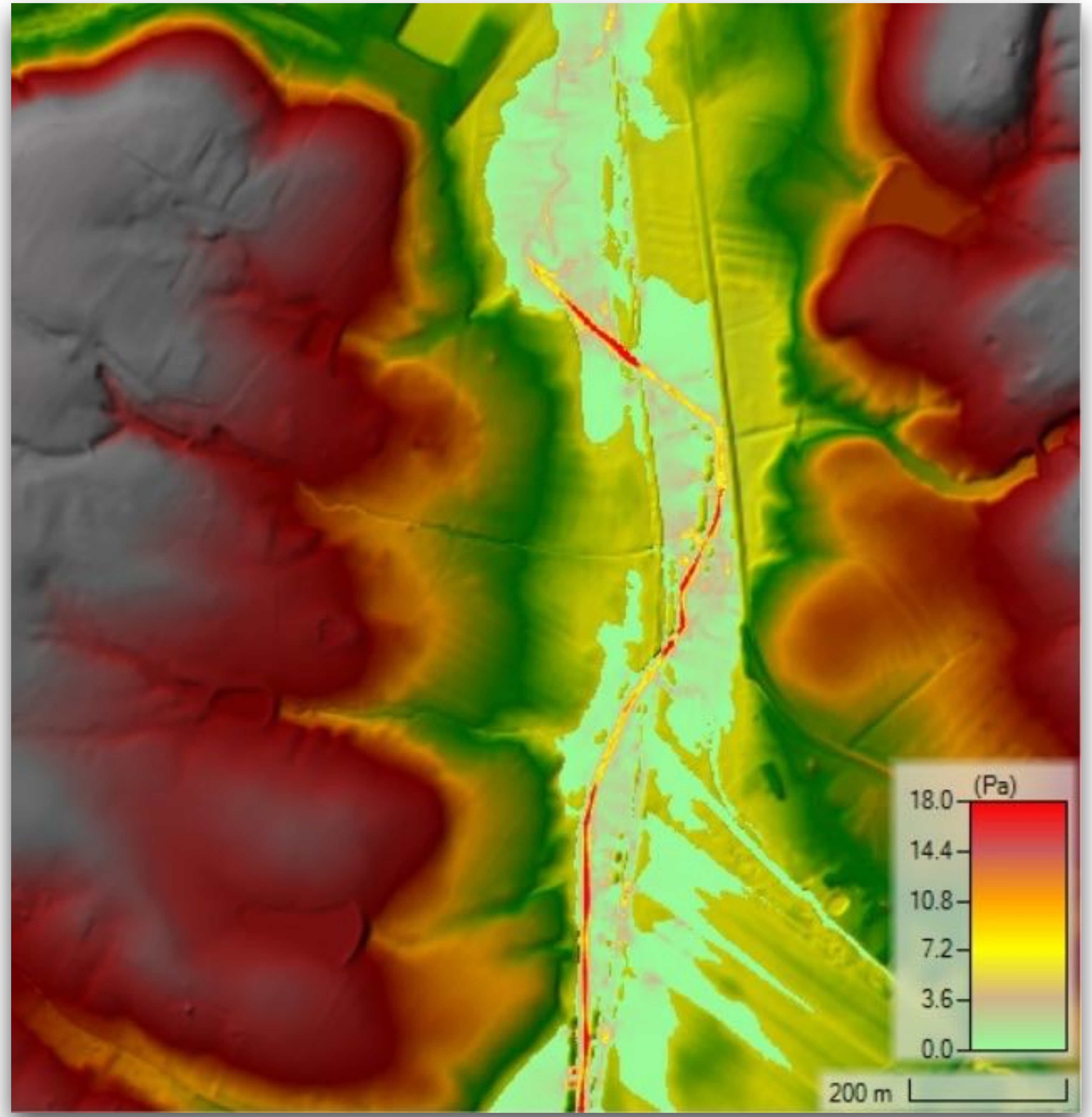
Reconnecting meanders reduces erosive stresses



In defence of channel curvature

1. Erosive stresses may be reduced by restoring sinuous reaches

2. Reconnecting "abandoned" channel reaches is one promising nature-based option



charles.shobe@mail.wvu.edu