Historical Perspective on Erosion and Sediment Control

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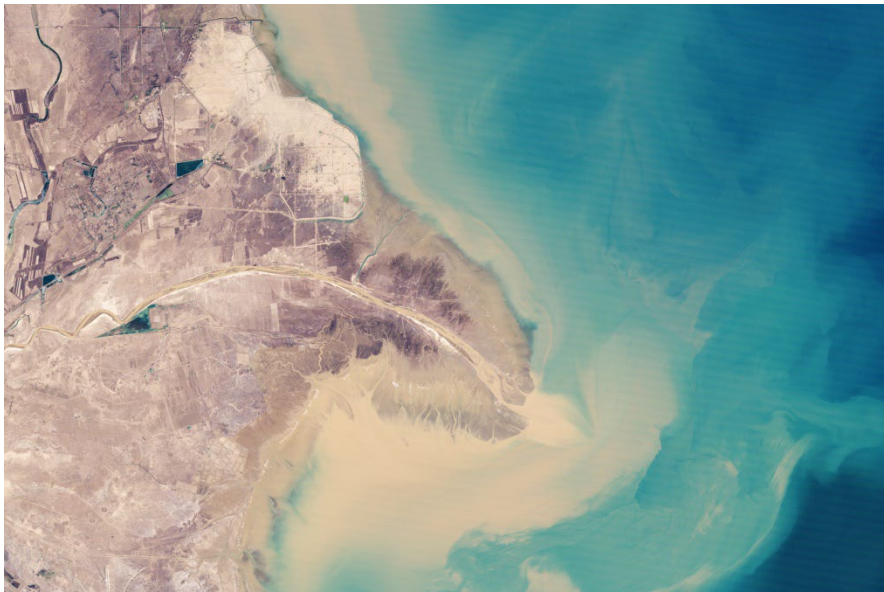


Central Europe Erosion Rates

Dotterweich, 2013. Geomorphology.

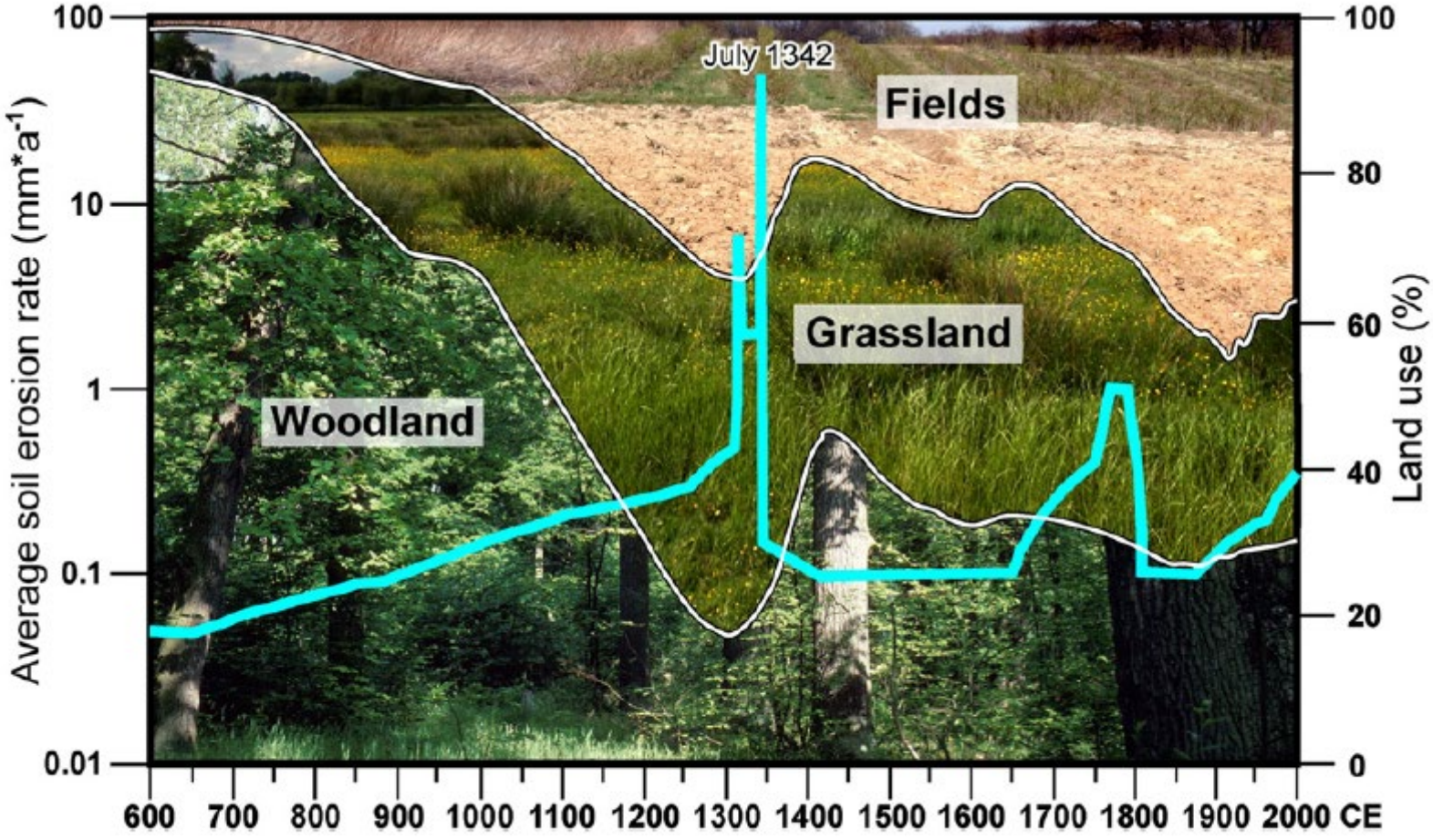


Fig. 2. Soil erosion and land use change in central Europe since 800 CE (adapted from Bork et al., 1998).

Gully from Erosion 1500-1600 CE in Poland

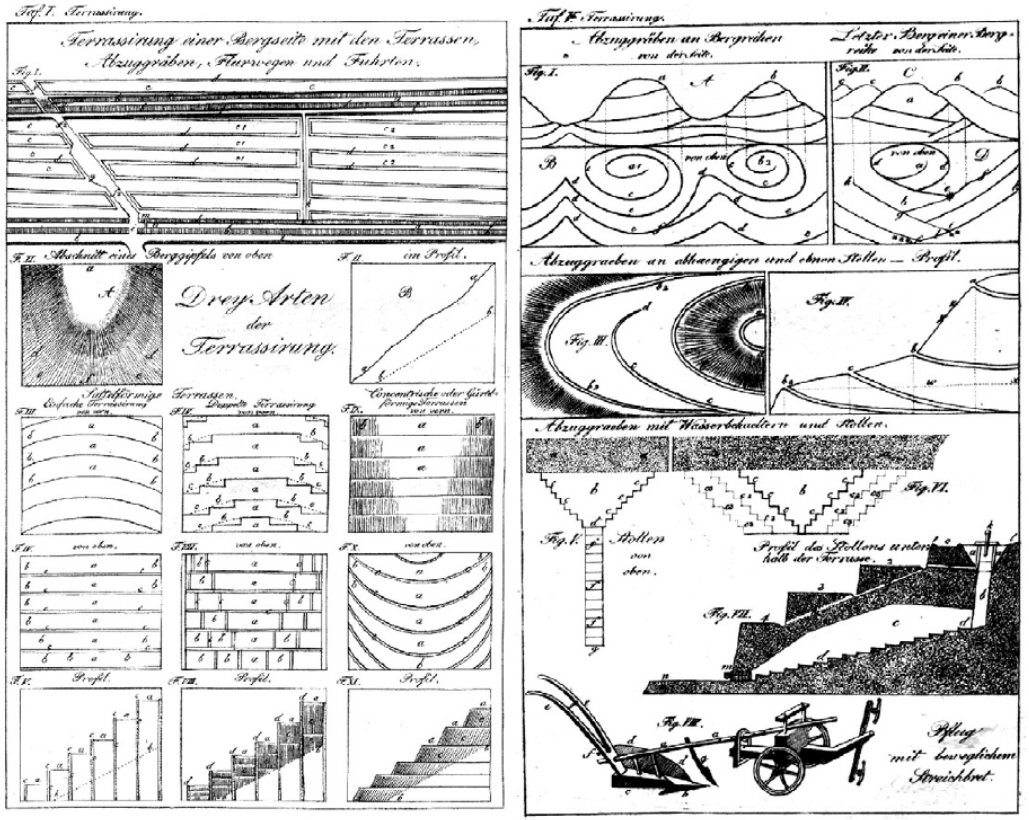
Early Observations

- Da Vinci (1500): "Here are the rivers which carry the eroded ground earth from the hills"
- Late 1600s: "They do not recognize that the hills used to be covered in
- woodland and that the trees' roots bind the soil and soak up water, thereby
- preventing flooding as well as gullying"

First Textbook

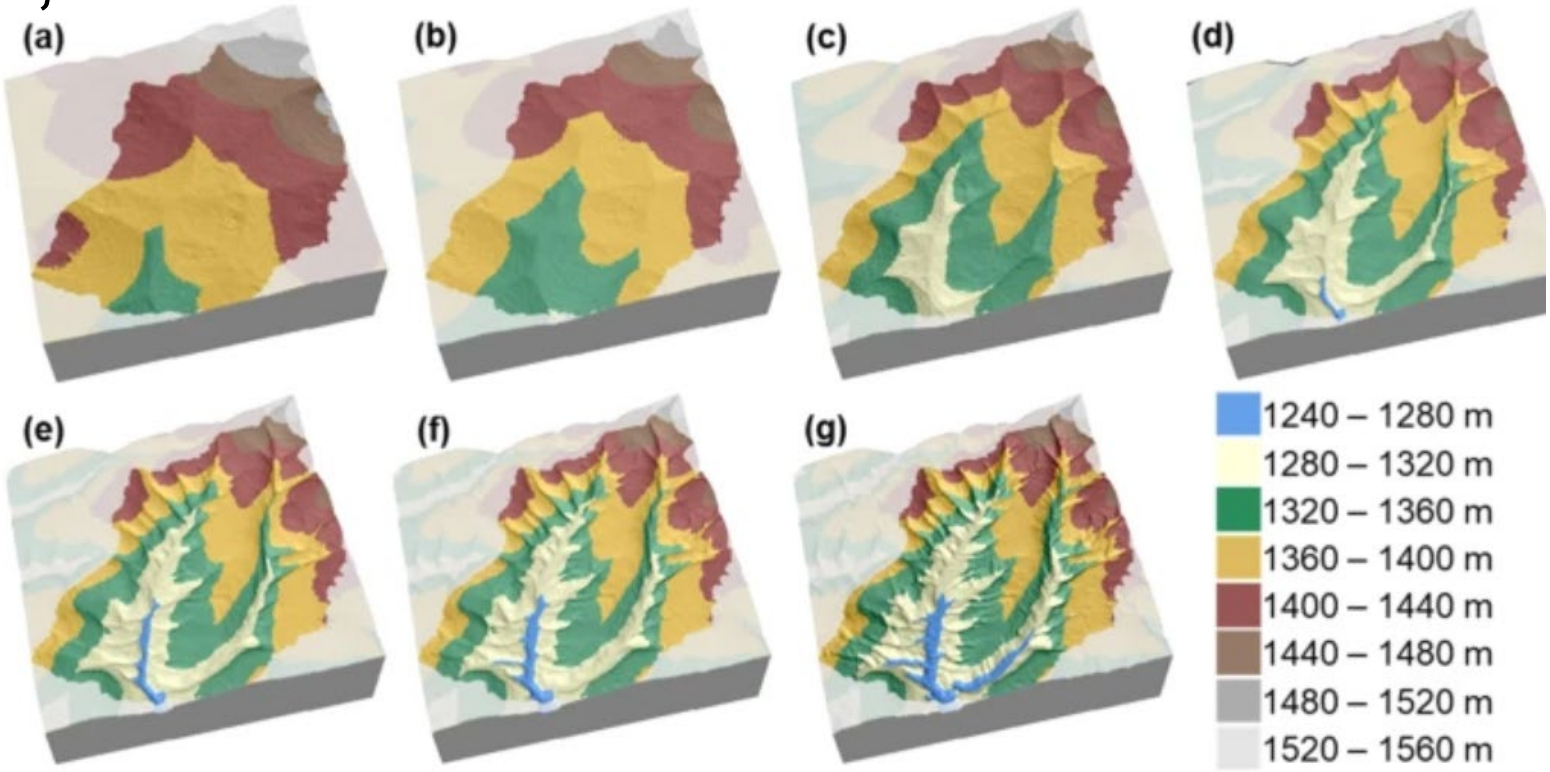
- 1815: Competition to come up with erosion prevention in Germany
- Heusinger won
  - Vegetation important
  - Soil loss = low fertility
  - Diagramed terraces and contour plowing

- Example diagram



China Experience: Loess Plateau Gully Erosion

8,000 BCE



1300 CE

Xioung et al, 2023. Comm. Earth Env.

China Experience

PHOTOGRAPH BY JIM RICHARDSON, NAT GEO IMAGE COLLECTION

- Population increases led to deforestation, cropping
- Relationship to erosion known ~400 BCE
- Great River turned to Yellow River ~500 CE
- Terracing known but not widespread

Soil Erosion in the United States

History Revisited

- 1600s-1700s: European settlers move in from coast, clear forests for crops.
  - Erosion rates increase compared to forests.
  - Numerous records of recommended conservation practies, mainly contour plowing and manuring. Not widely adopted.
- 1700s-early 1800s: Up to 65,000 mill dams constructed in US Piedmont.
  - Sediment from eroding farm fields settles behind dams.

Massive erosion rates, abandoned fields 1800-1940

History Cont.

- Late 1800s – 1930s: mills no longer used, dams breach, high erosion rates on farms.
- 1930s – 1950s: Farming becomes mechanized, large tracts can be farmed.

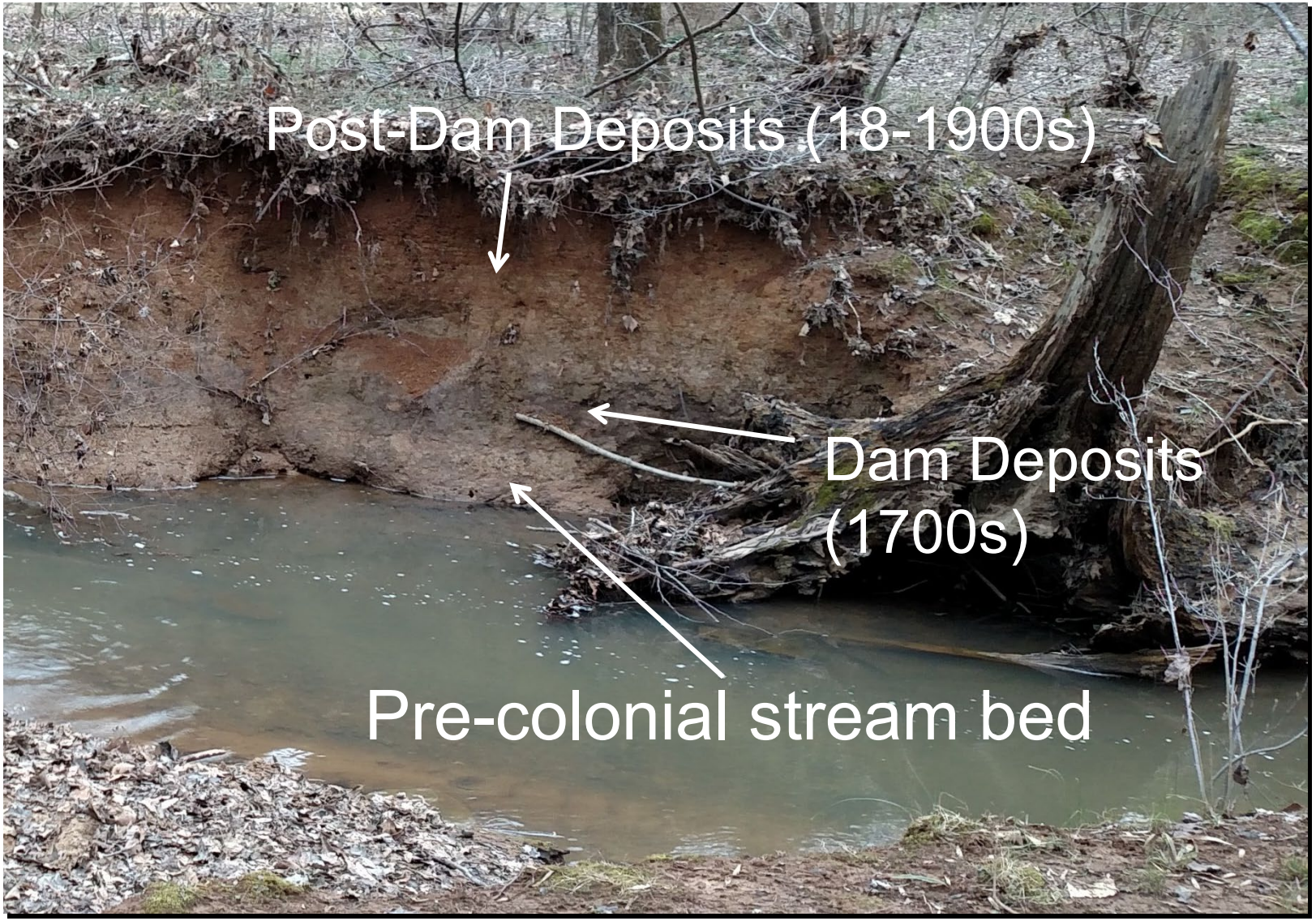
Subsistence farming disappears, many farms return to forest.

- 1950s – now: Farms begin to be developed, urbanized areas expanding.

Increased runoff in urbanizing areas, more water in streams.

Typical Piedmont Stream Bank

Stream Aggradation:



Baltimore Harbor Sedimentation

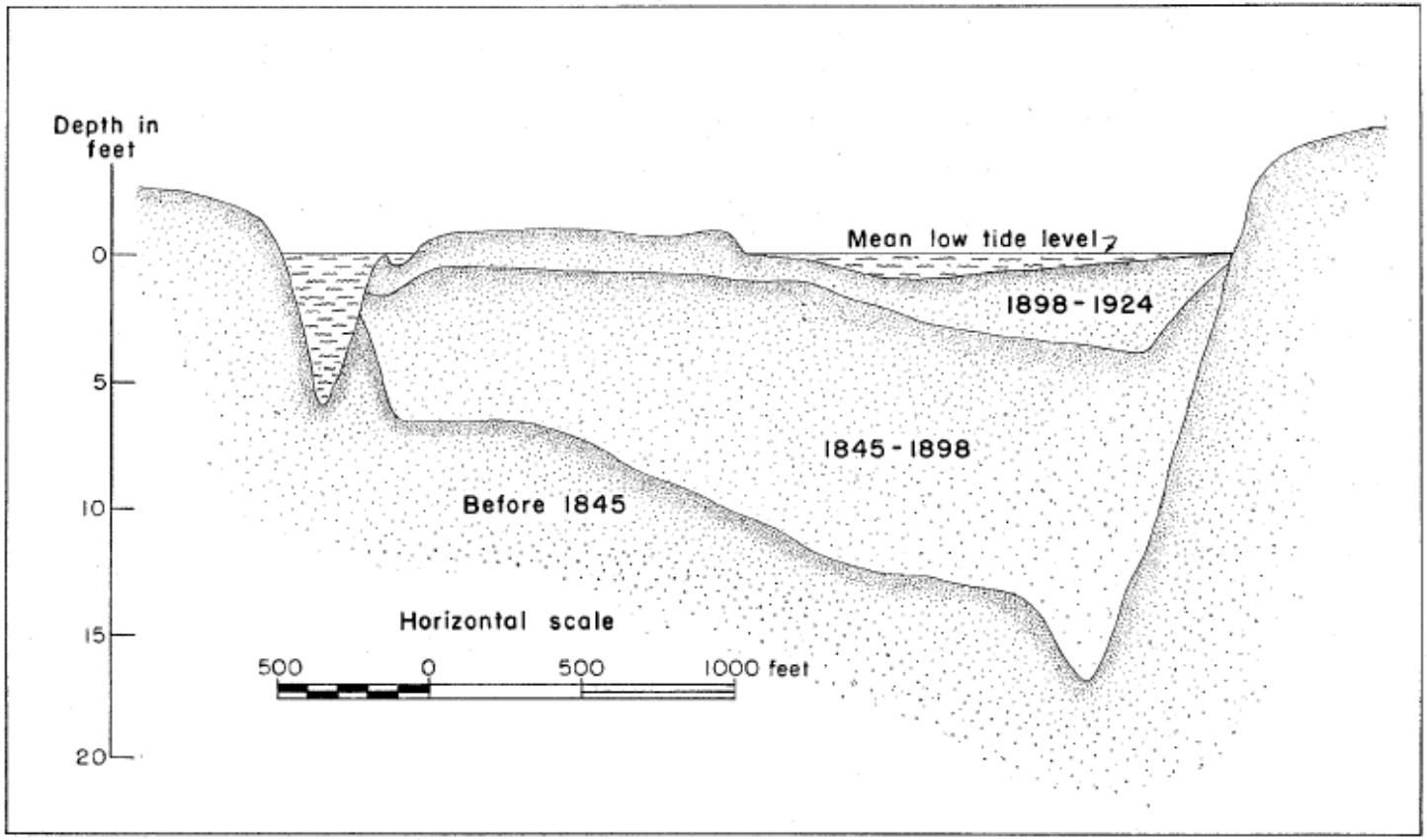
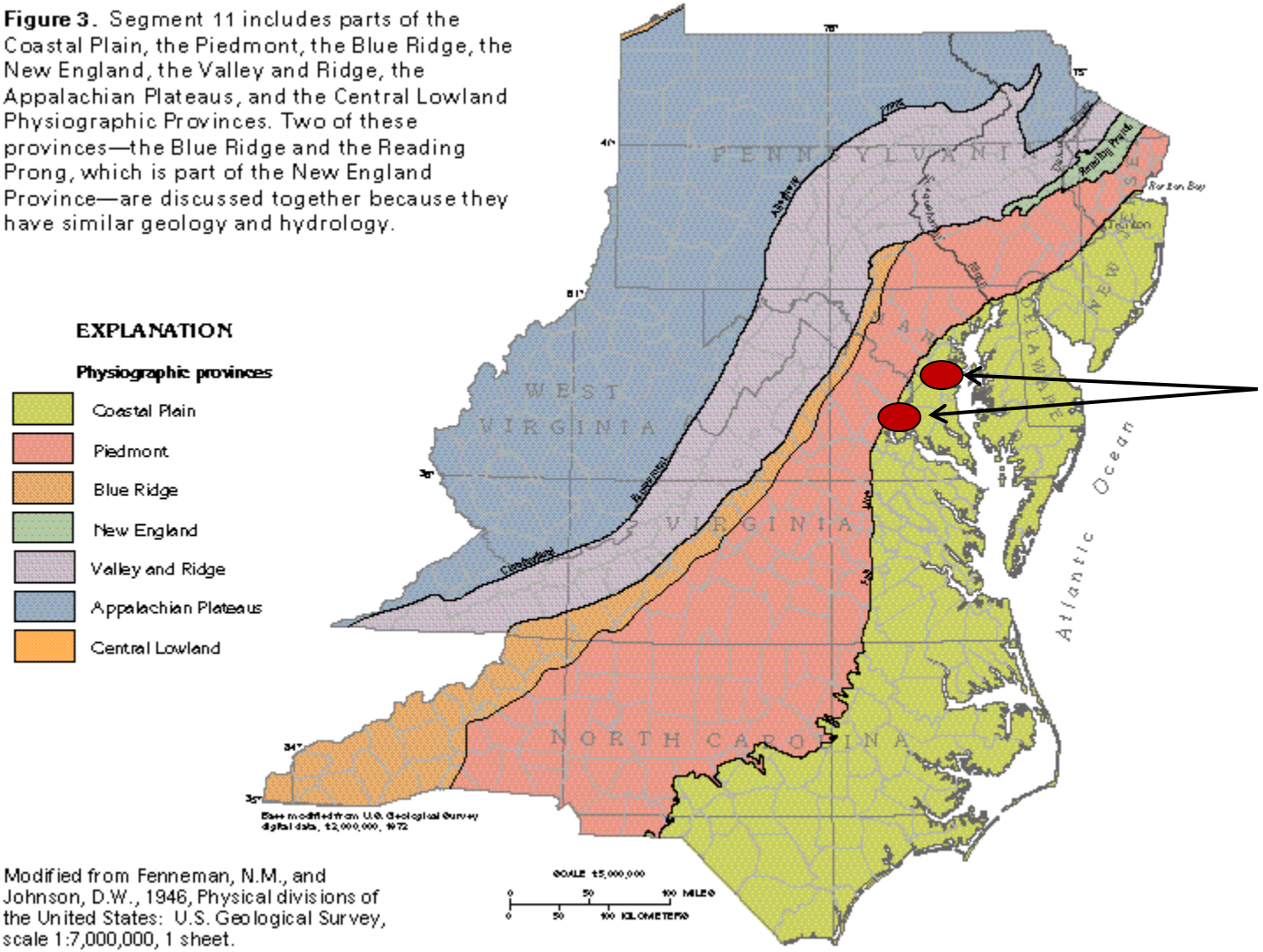


FIG. 5—Sedimentation of the Patapsco River arm of Baltimore harbor near the Hanover Street bridge.

Joppatowne: Port?

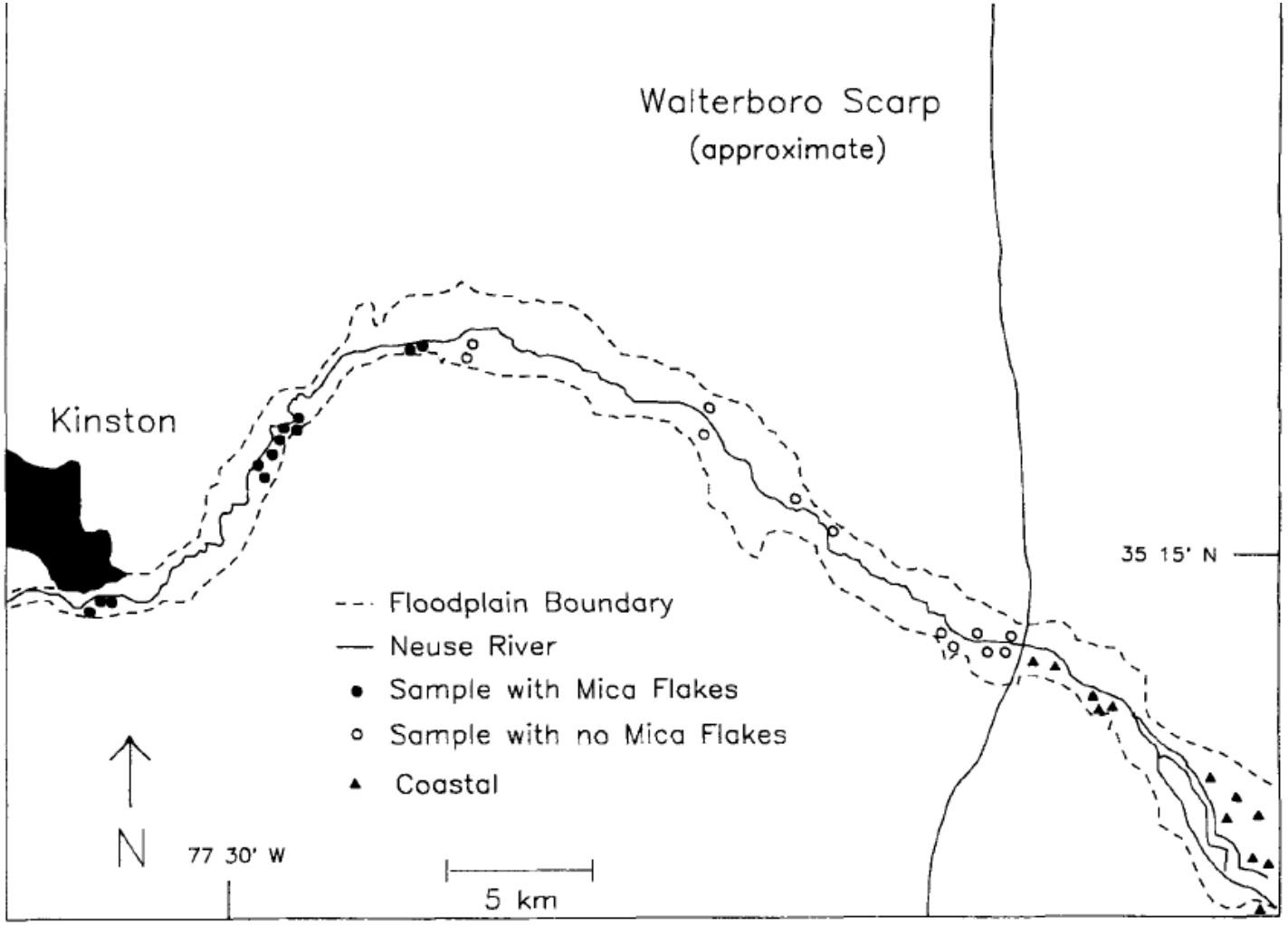
What About North Carolina?

Figure 3. Segment 11 includes parts of the Coastal Plain, the Piedmont, the Blue Ridge, the New England, the Valley and Ridge, the Appalachian Plateaus, and the Central Lowland Physiographic Provinces. Two of these provinces—the Blue Ridge and the Reading Prong, which is part of the New England Province—are discussed together because they have similar geology and hydrology.

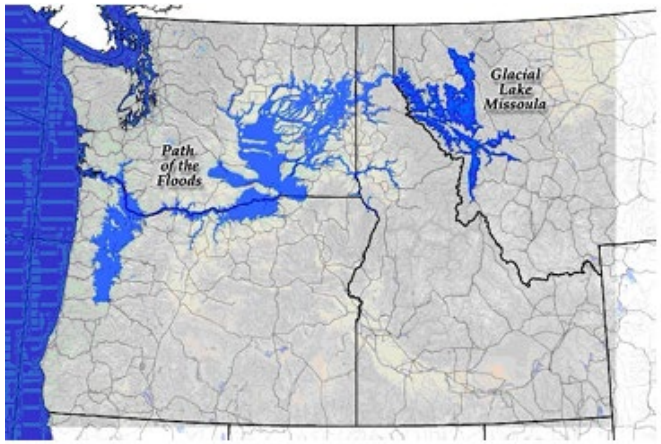


Modified from Fenneman, N.M., and Johnson, D.W., 1946, Physical divisions of the United States: U.S. Geological Survey, scale 1:7,000,000, 1 sheet.

Lower Neuse River Sediment Sources



Natural Erosion: Missoula Floods



- Catastrophic ice dam failure 14,000 years ago
- Wall of water up to 2,000’ deep at 100 mph going west to Pacific
- Notch 800’ deep and a mile wide could only handle ½ of the flow

Government Programs

- 1897: Division of Soil of USDA
- 1899: Soil Survey Division
- 1908: Division of Soil Erosion
- Erosion problems documented, but little else

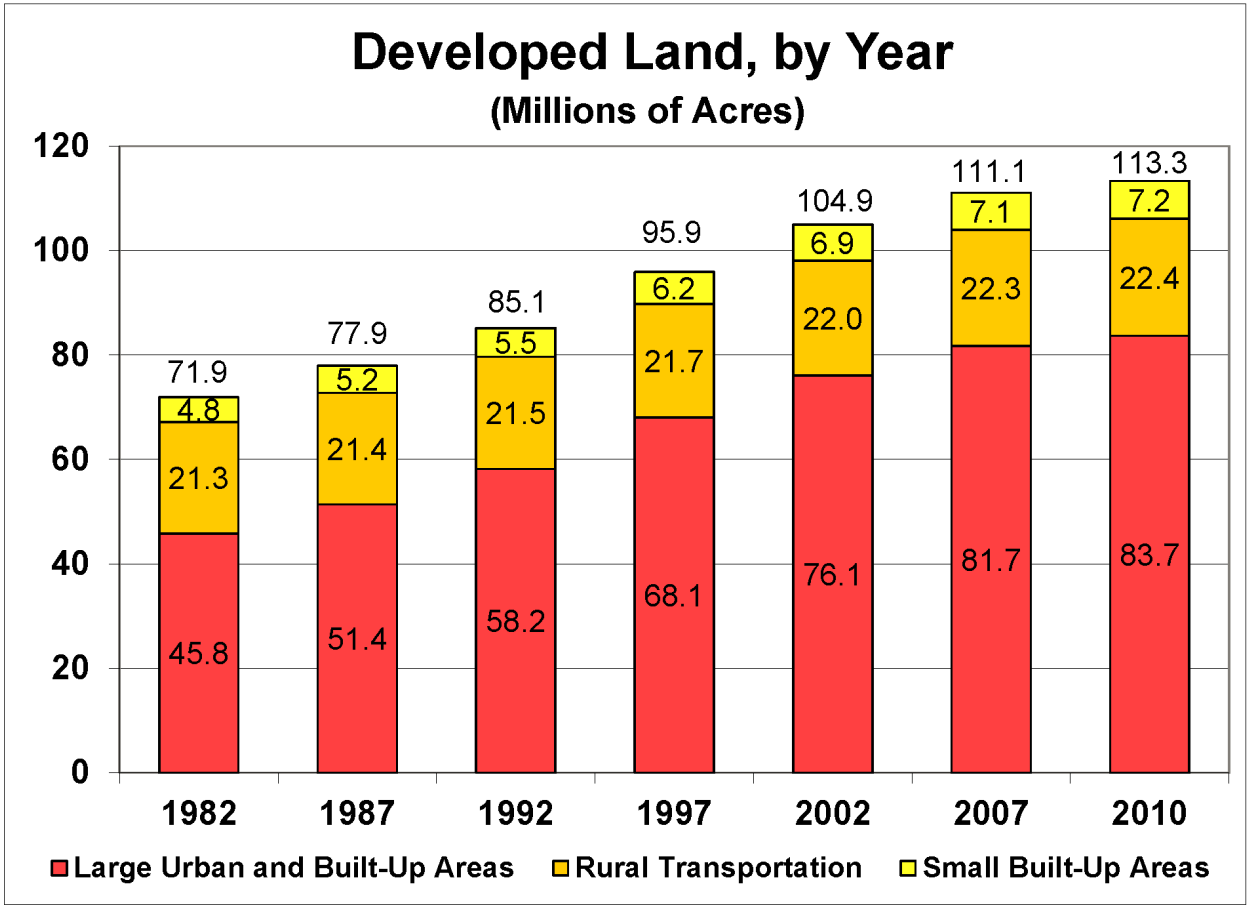
Soil Conservation Service
(Natural Resources Conservation Service)

- Established in 1934, led by Hugh Hammond Bennett from NC
- Many practices tested and recommended
- Planting of pine, black locust, and kudzu on eroded/gullied land

"Out of the long list of nature's gifts to man, none is perhaps so utterly essential to human life as soil." Hugh Hammond Bennett

Gully Fix

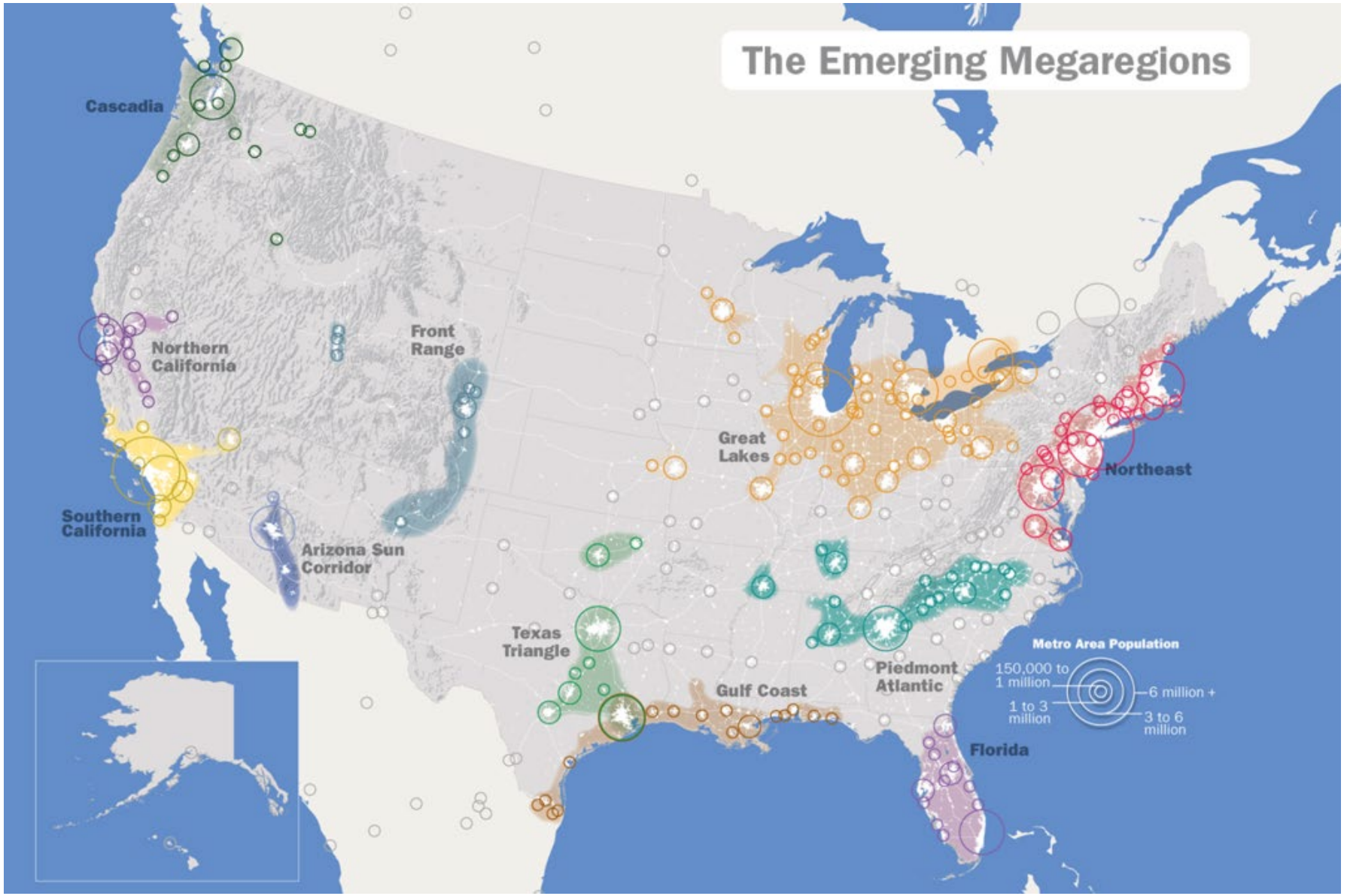
Land Development



Cropland: 420 down to 350 million acres

Farms: 987 down to 914 million acres

Source: USDA



By IrvingPINYC - Own work, CC BY-SA 3.0,
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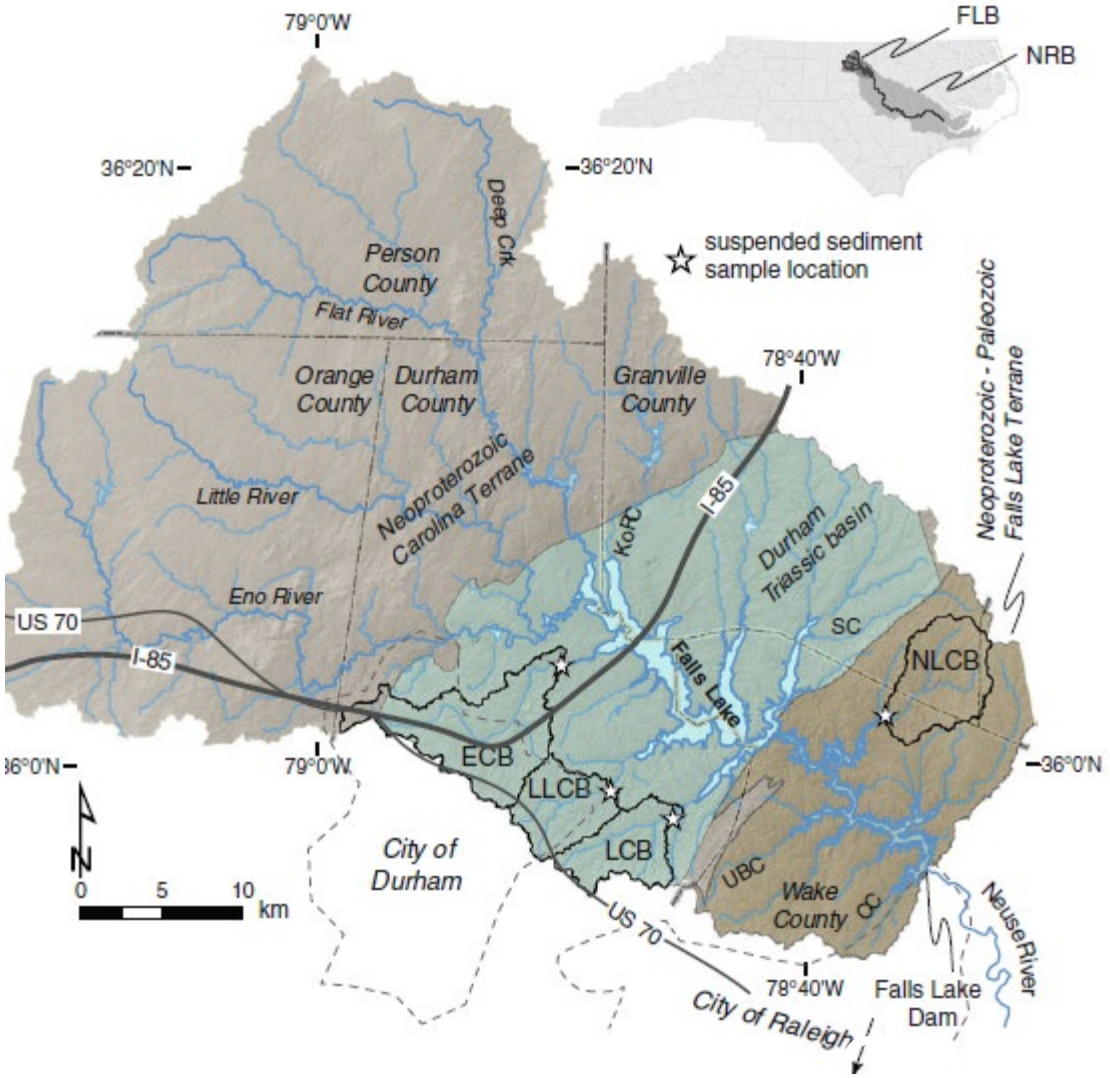
Sources of Sediment



Sediment Sources: Four Durham Creeks

	Ellerbe	New Lick	Lick	New Light
	% of suspended sediment			
Bank	58	33	27	62
Construction	19	18	43	6

- Ellerbe very urban, deeply incised, lots of sediment exported
- New Lick and Lick have poor soils (White Store)
- New Light is undeveloped (pasture/forest)

Erosion and Sediment Control History

- 1970: Maryland enacted Sediment Control Law to protect Chesapeake Bay. First design manual?
- 1973: NC SL-1973-392 AN ACT TO ESTABLISH A PROGRAM FOR THE CONTROL OF POLLUTION FROM SEDIMENTATION
  - Set up Sedimentation Control Commission, DEQ as lead agency

Erosion Control

- Borrowed heavily from agriculture
- New products developed – erosion control blankets, turf reinforced matting, hydromulch

From Kelsey, 2023. Geosynthetics.

Early Sediment Control

- Focus on temporary measures to drop out "heavy" sediment
- 50% sediment loss documented

Surface Outlet Improvement (Skimmer)

- Improved sediment capture significantly

Early Skimmer Testing

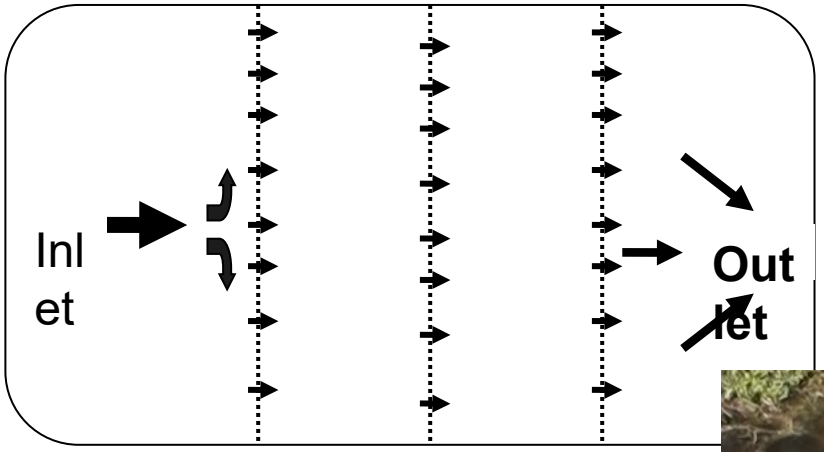
- Various basins around Carrboro/Chapel Hill
- Measured levels, took water samples

Skimmer Basin Functions

- Skimmer backs up inflow to create pool
- Pool acts to slow flow and drop sediment
- Basins dewater primarily over emergency spillway during high flow
- Skimmer dewaters basin once inflow ceases.
  - Allows sediment to dry between storms
  - Reduces standing water (liability, mosquitoes – not so much)

Porous Baffles Introduced

Flow in a Porous Baffle



Best Practices for Sediment Control In Place

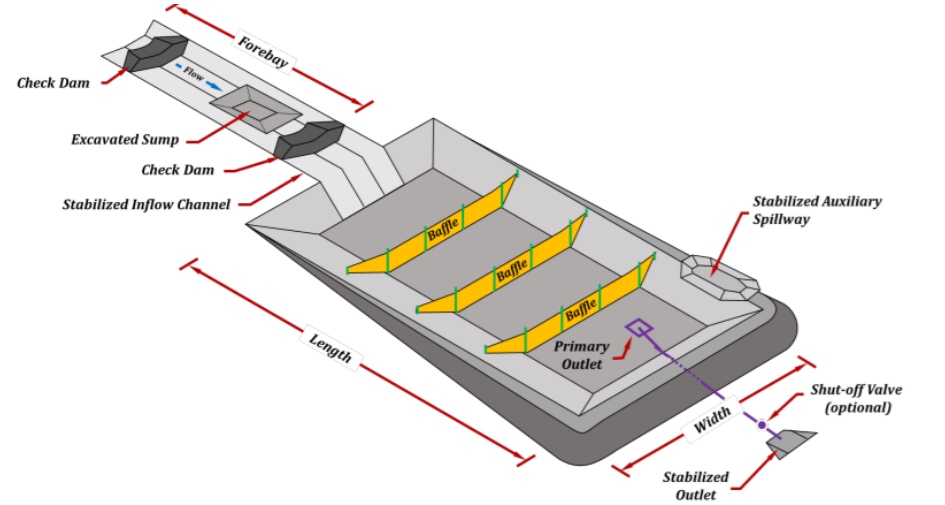


Figure 1. Typical sediment basin diagram with key elements.

IECA Standards and Practices Committee Basin

NCDOT Skimmer Basin

Chemical Treatments: Erosion

- 1950s: Polyacrylamide and other chemicals for erosion control tested in ag settings
- 1990s: Testing on slopes also
- Excellent erosion reduction if applied correctly and at right rate
- Works best with a ground cover

Furrow irrigation, no PAM

Furrow irrigation, with PAM

Chemical Treatments: Turbidity

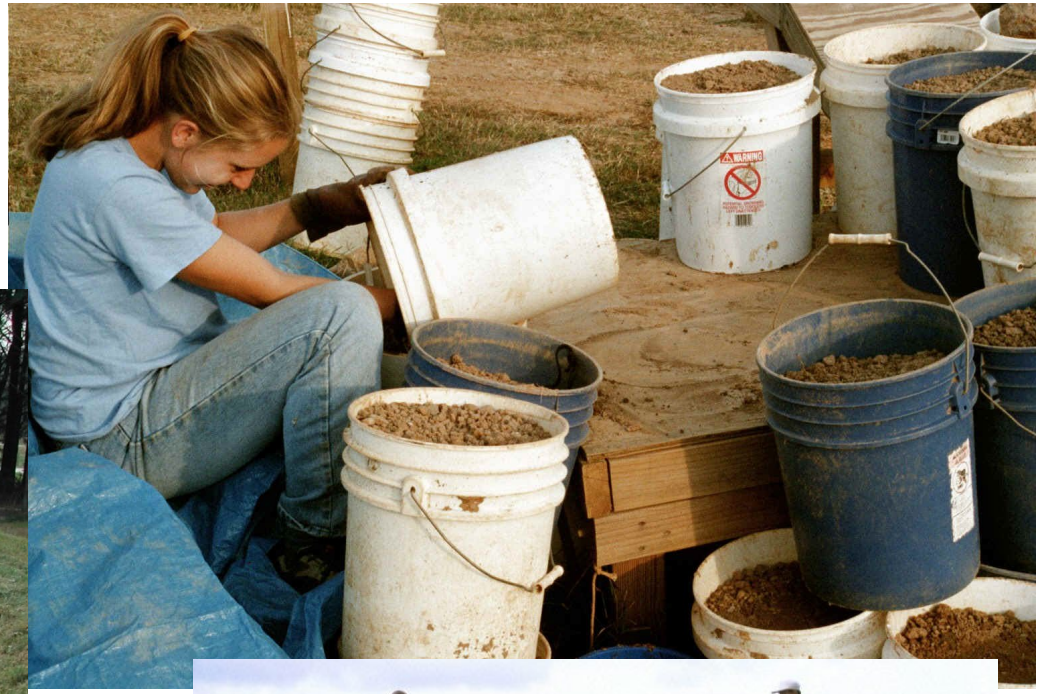
- Polyacrylamide used widely in water treatment, logical choice for construction site runoff
- Different forms on the market for different applications
- Passive vs active treatment

Need Research Facility: Penn State Example

Controlled Testing: Birth of SECREF 1999

Test devices using known flows and sediment amounts

Testing Begins



No Baffles

Silt Fence Baffles

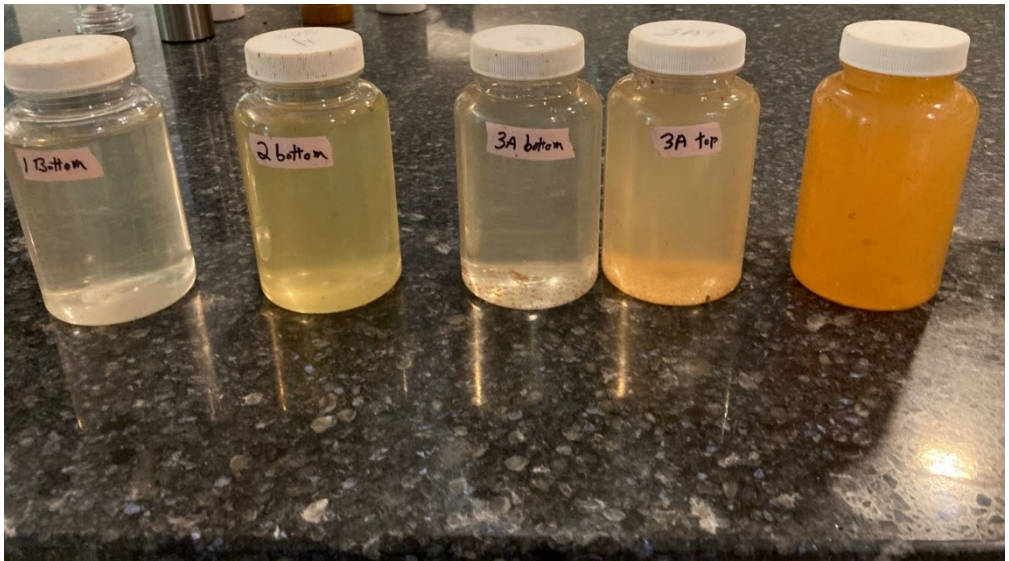
Porous Baffles: Spread flow, reduce turbulence

Research on Construction Sites As Well!

Recent Project Samples

PAM Treated Watersheds

Untreated



Testing Results
Information Transfer

- NCDOT Certification for Construction Site Stormwater Control
  - 27,000 through training since 2007
- NC DEQ Collaboration Workshops
  - 668 in person since 2016
  - 590 online in 2020
- NCSU Workshops
  - 543 in person since 2011
  - ~500 in person 2001-2010
- Hosted classes, conferences, etc.
- Countless presentations…

Acknowledgments

- Funding support from NC DOT, NC DEQ, WRRI
- Many staff and graduate students
- DOT Staff and Contractors

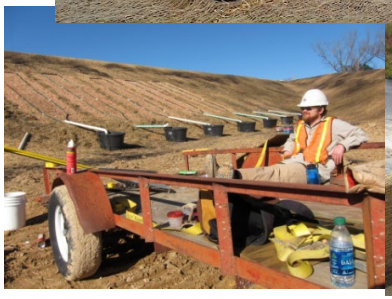












Parking at SECREF

Questions?

Please Remember to Complete the End of Workshop Evaluation

https://bit.ly/2023EscEval