River dynamics, bank erosion and the fine sediment load in pearl mussel rivers

Dynamique des rivières, érosion des berges et transport des sédiments fins dans les rivières à mulettes perlières

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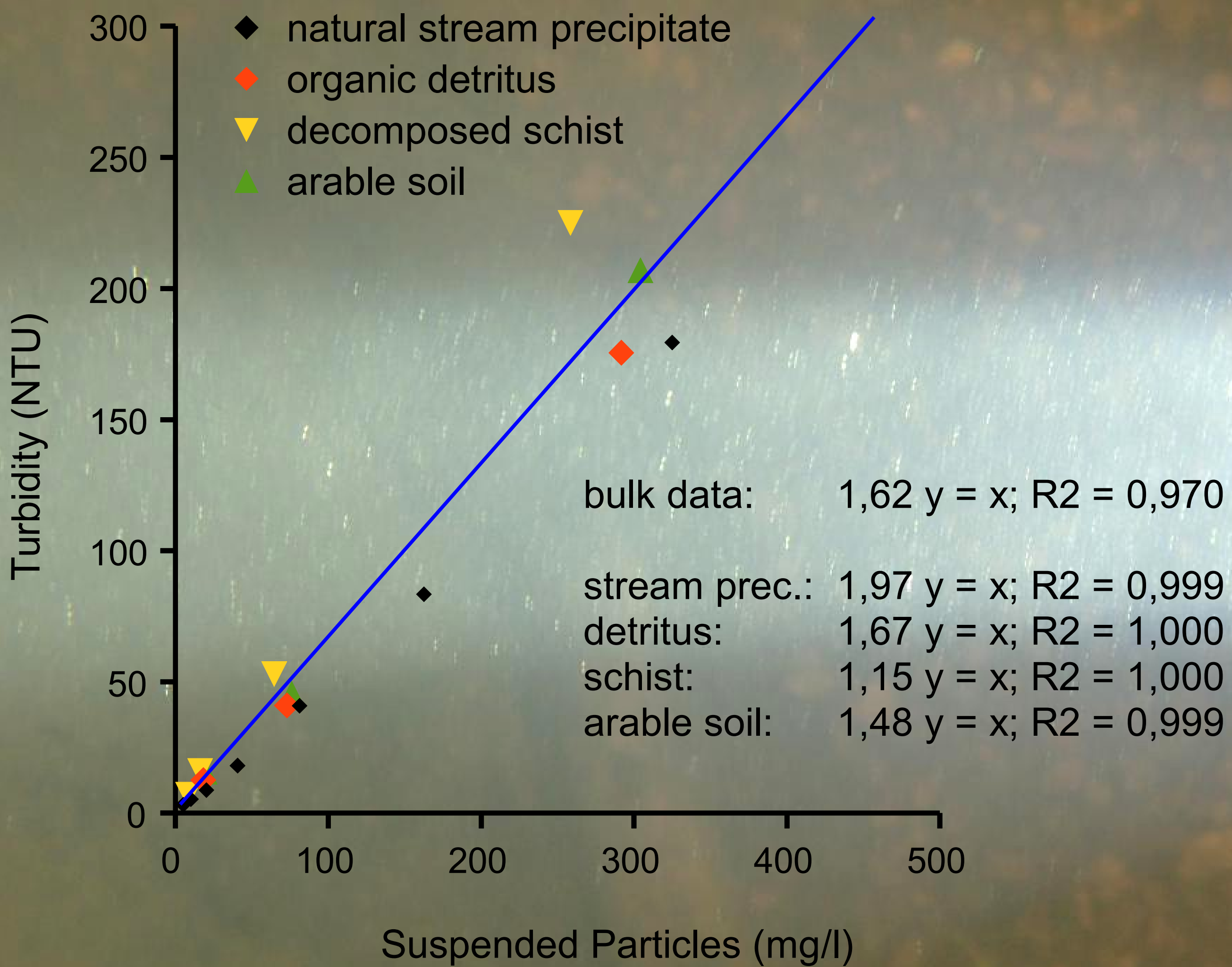
Schmidt & Partner


Siltation of the river bottom
silt content
water exchange
oxygen supply

Turbidity:
Transport of Silt and Clay

Turbidity

1 NTU ≈ 1,2 - 2.0 mg / l of suspended particles



Österling et al. 2010:

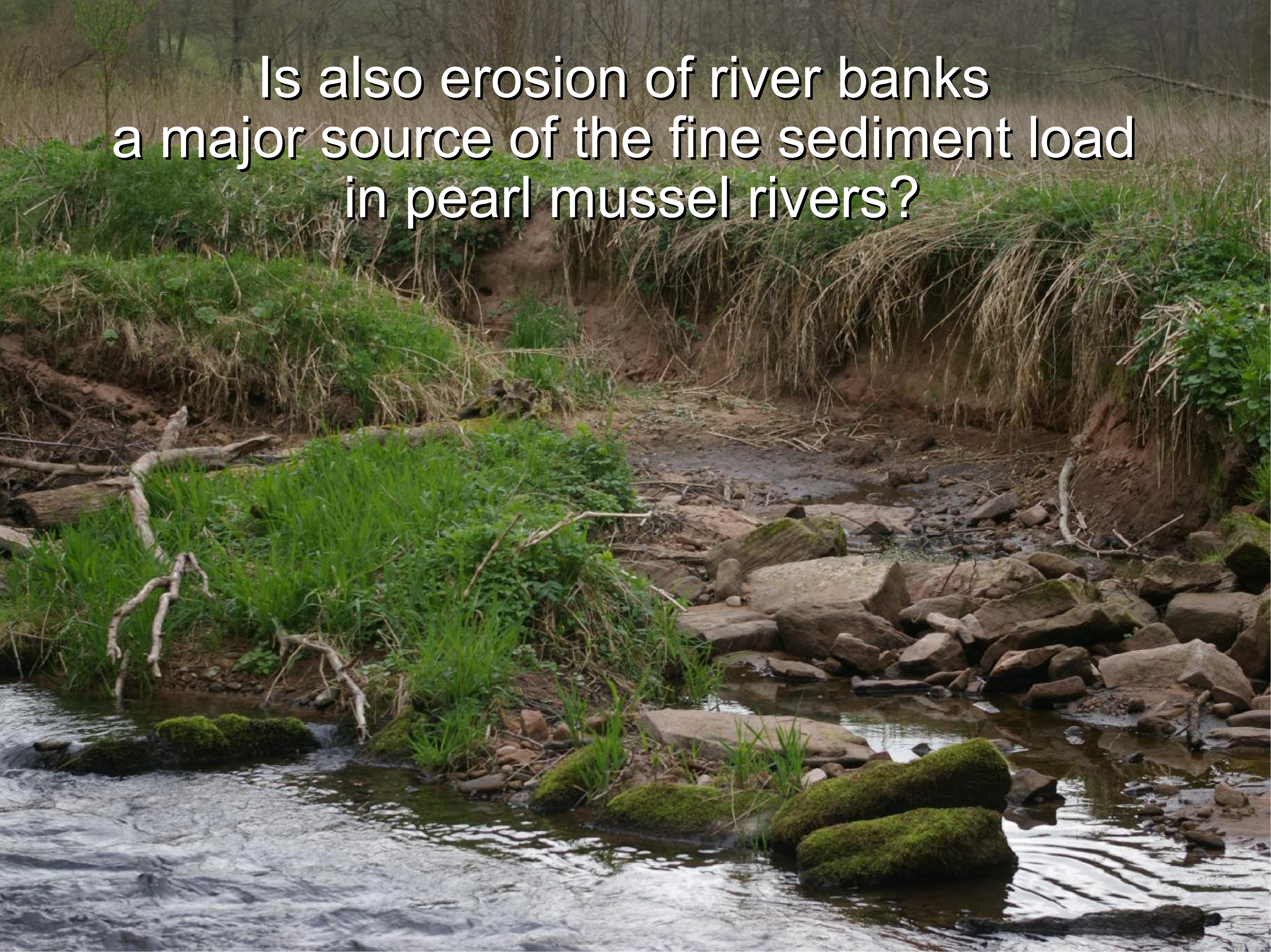
0.96 ± 0.14 NTU in streams with juvenile pearl mussels

> 1.9 NTU in streams without recent pearl mussel recruitment

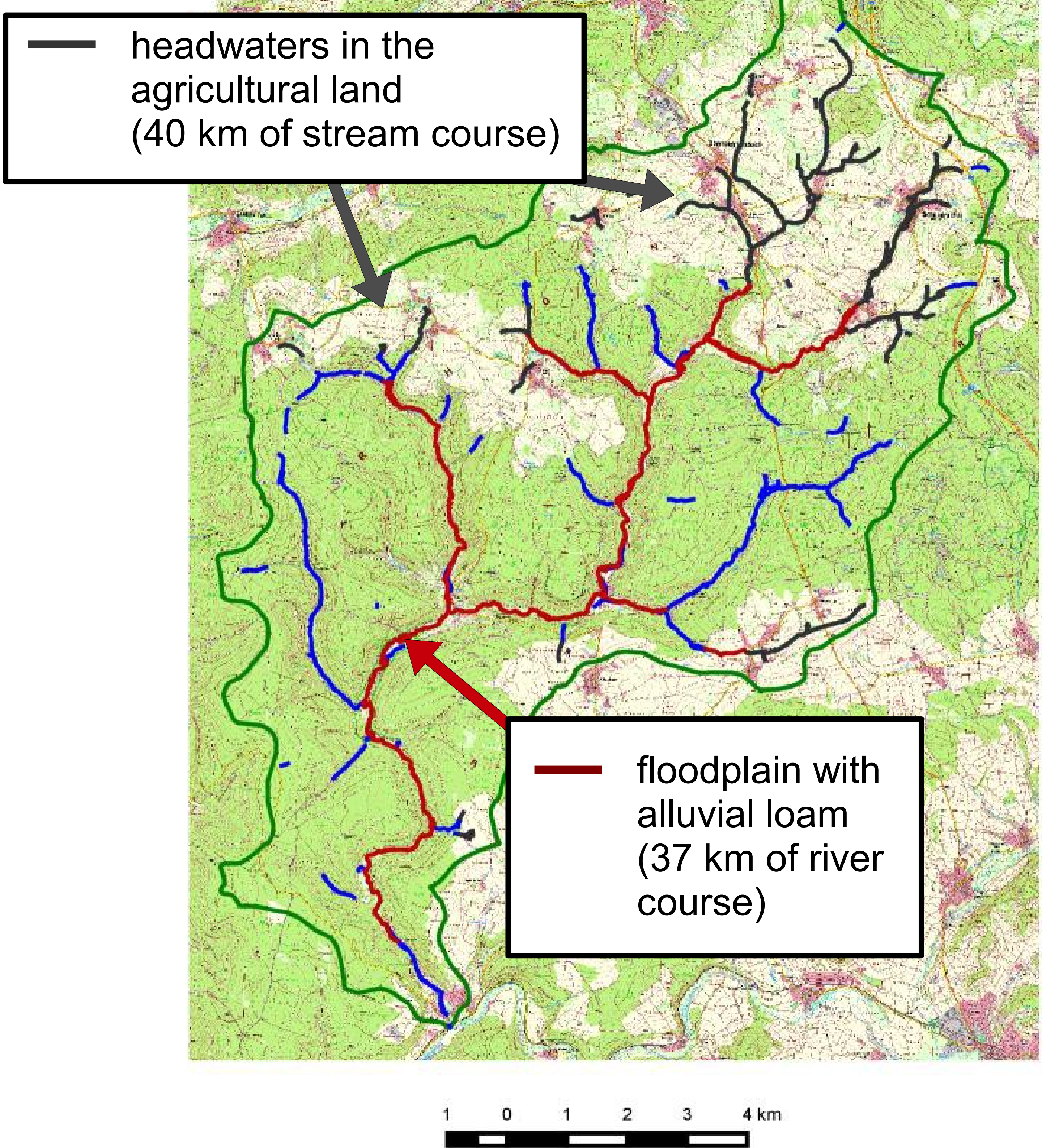

sources of silt and clay:
destroyed river banks

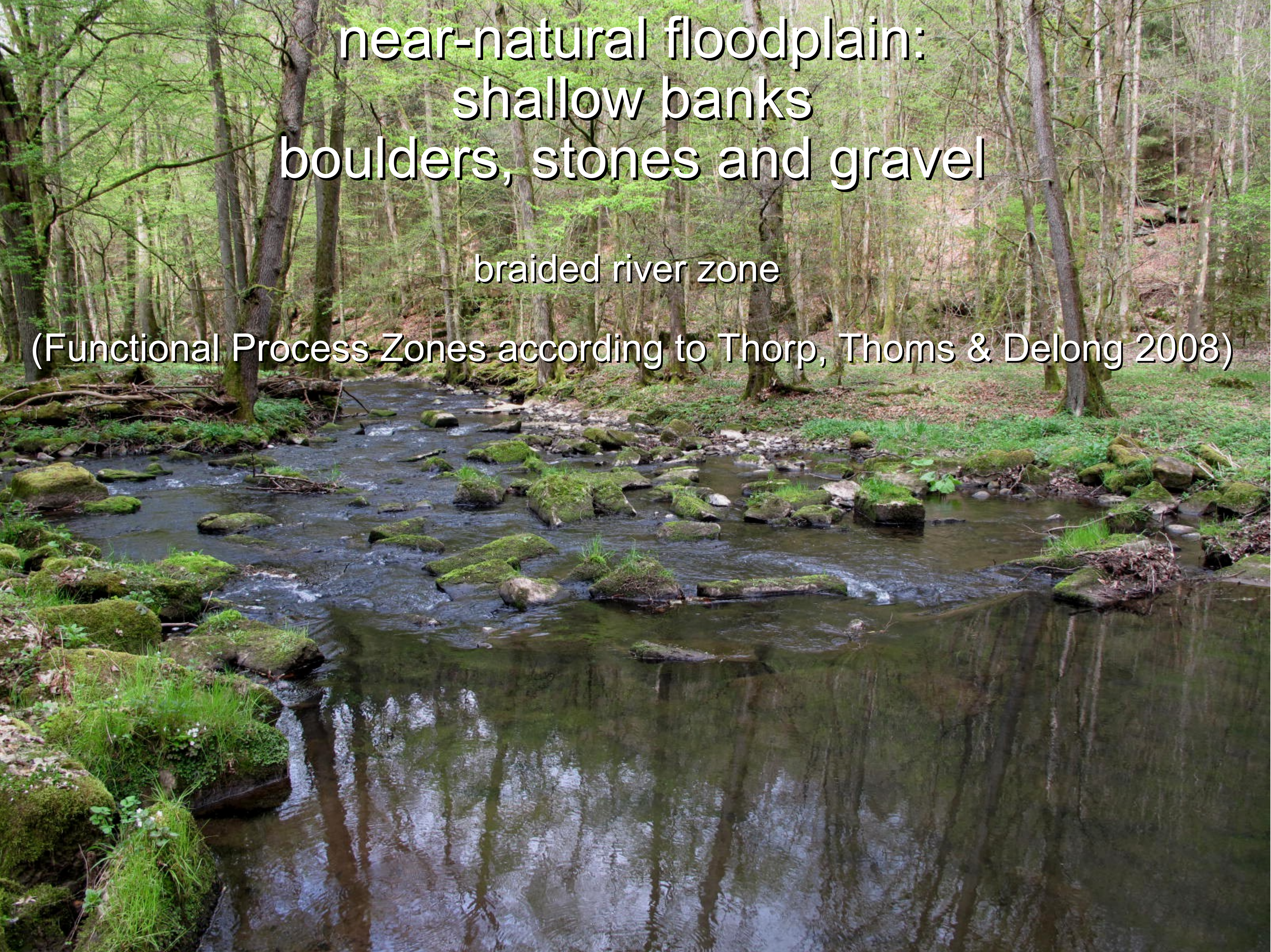
sources of silt and clay:
soil erosion from arable fields


ditches facilitate the transport of eroded soil
to the river

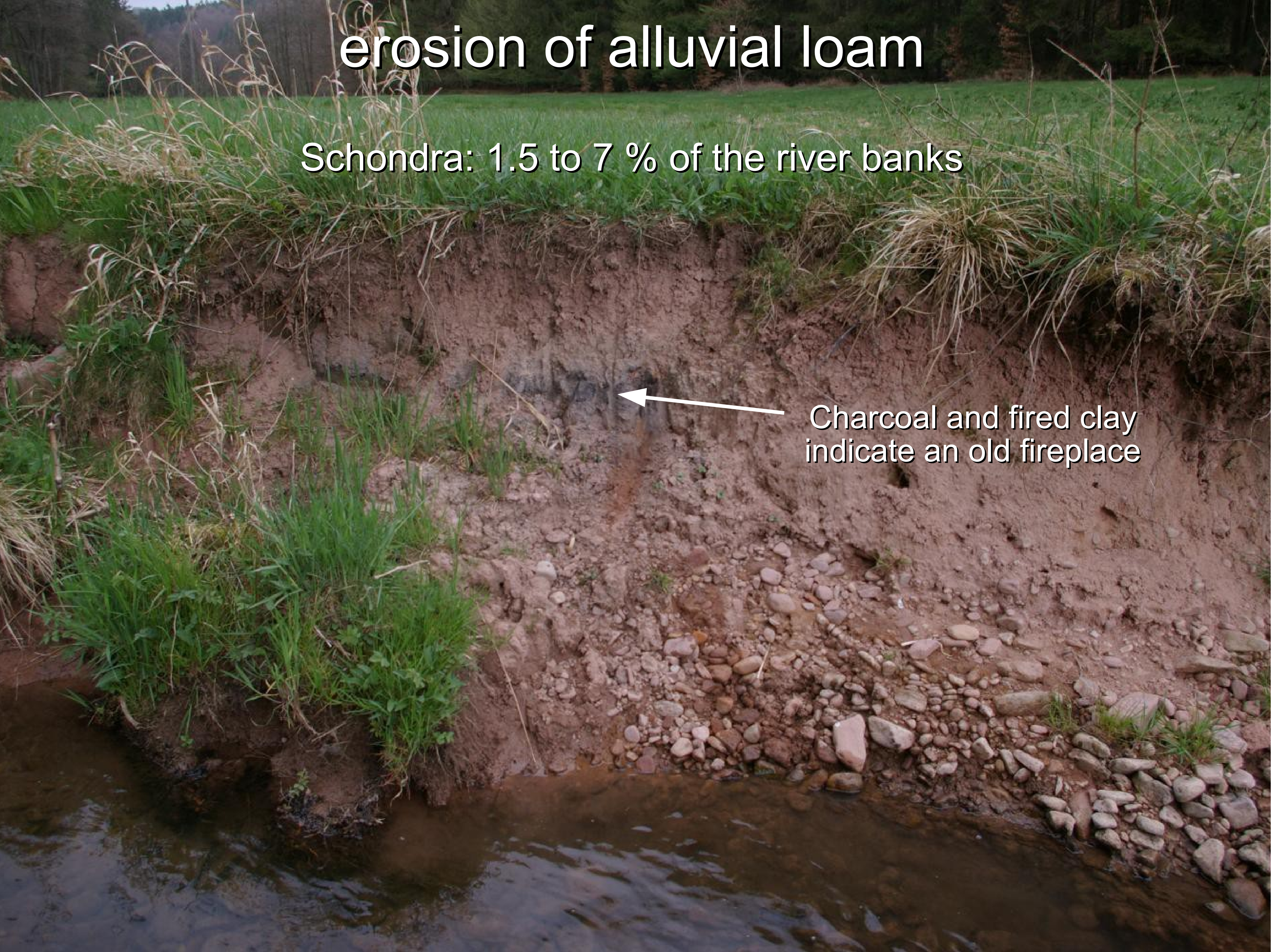

Is also erosion of river banks
a major source of the fine sediment load
in pearl mussel rivers?

Survey of bank erosion: Pearl mussel river Schondra, Rhine catchment


headwaters in the agricultural land (40 km of stream course)
floodplain with alluvial loam (37 km of river course)
1 0 1 2 3 4 km


near-natural floodplain:
shallow banks
boulders, stones and gravel
braided river zone
(Functional Process Zones according to Thorp, Thoms & Delong 2008)

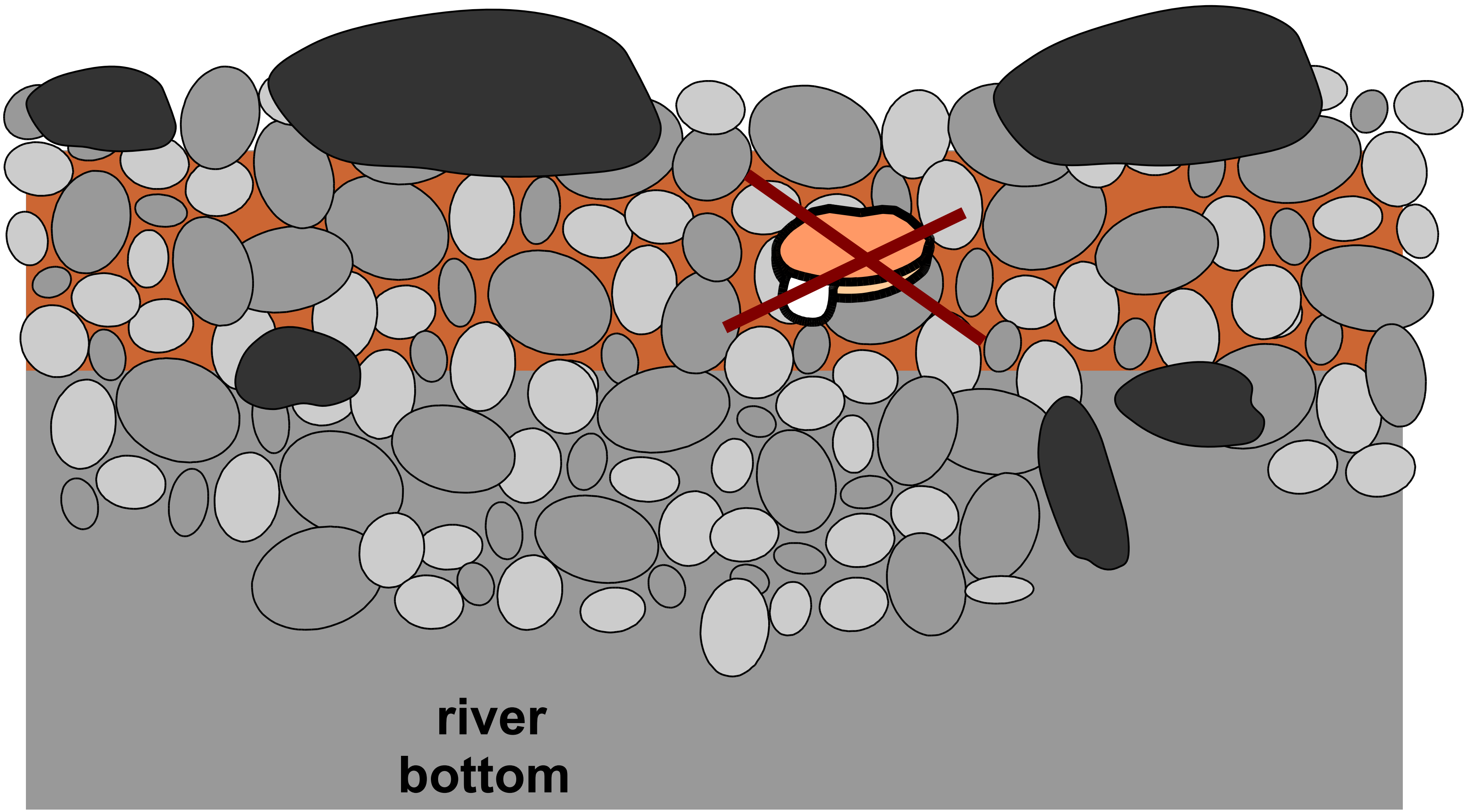
floodplain in the cultural landscape: gravel covered by alluvial loam


erosion of alluvial loam
Schondra: 1.5 to 7 % of the river banks
Charcoal and fired clay
indicate an old fireplace


Normal state in former days:
River banks are stabilized with stones.
confined river zone
straight stream current with little structures
no river bank erosion
old river bottom

old river bottom

- covered with large stones (armoring)
- pore space filled with silt (clogging, colmation)
- Fe- and Mn-oxides (hardening, crust formation)



Bank stabilization was abandoned in many places

(Nature reserve since 1983)

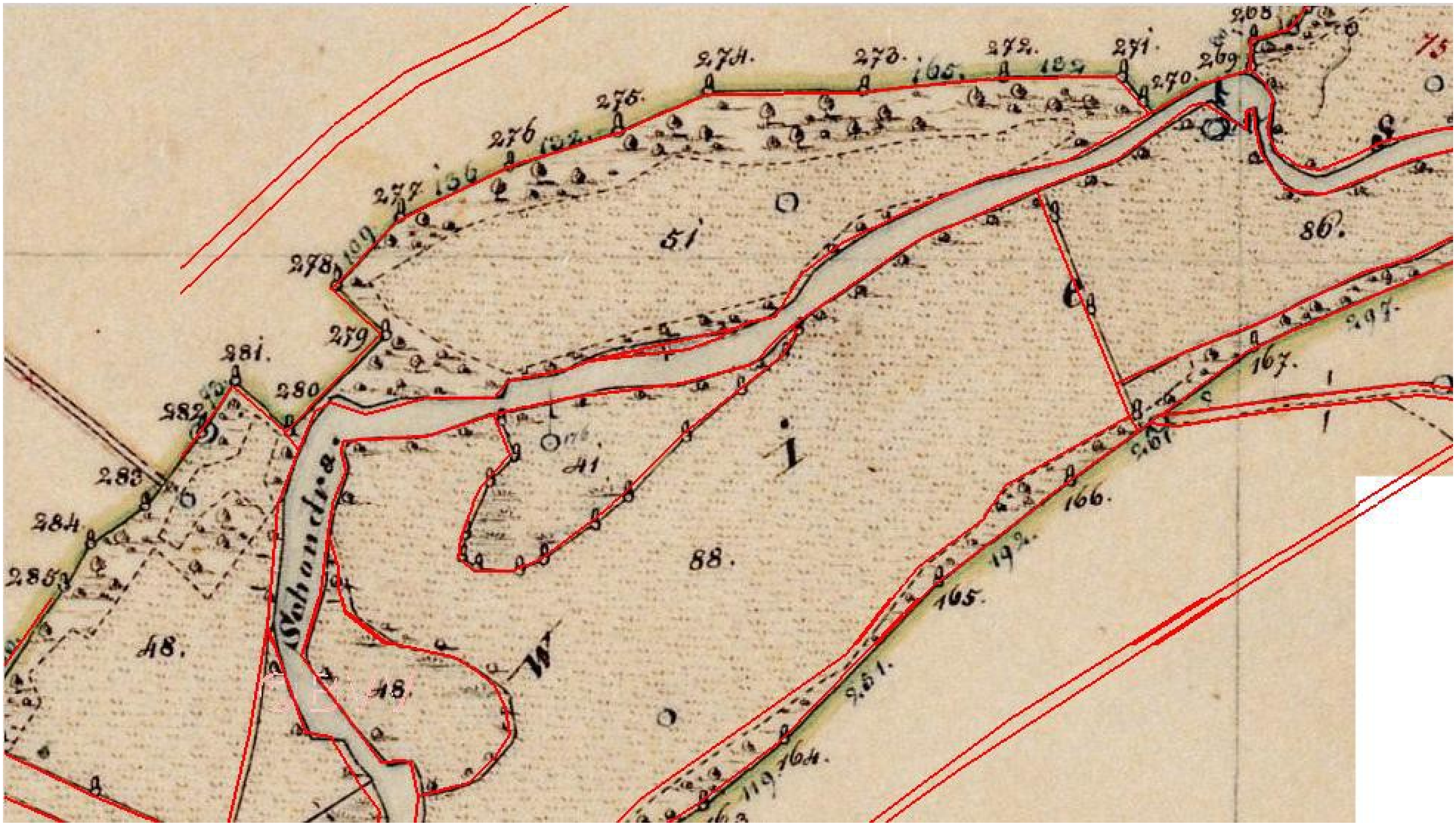
river bank erosion

remobilization of eroded soil

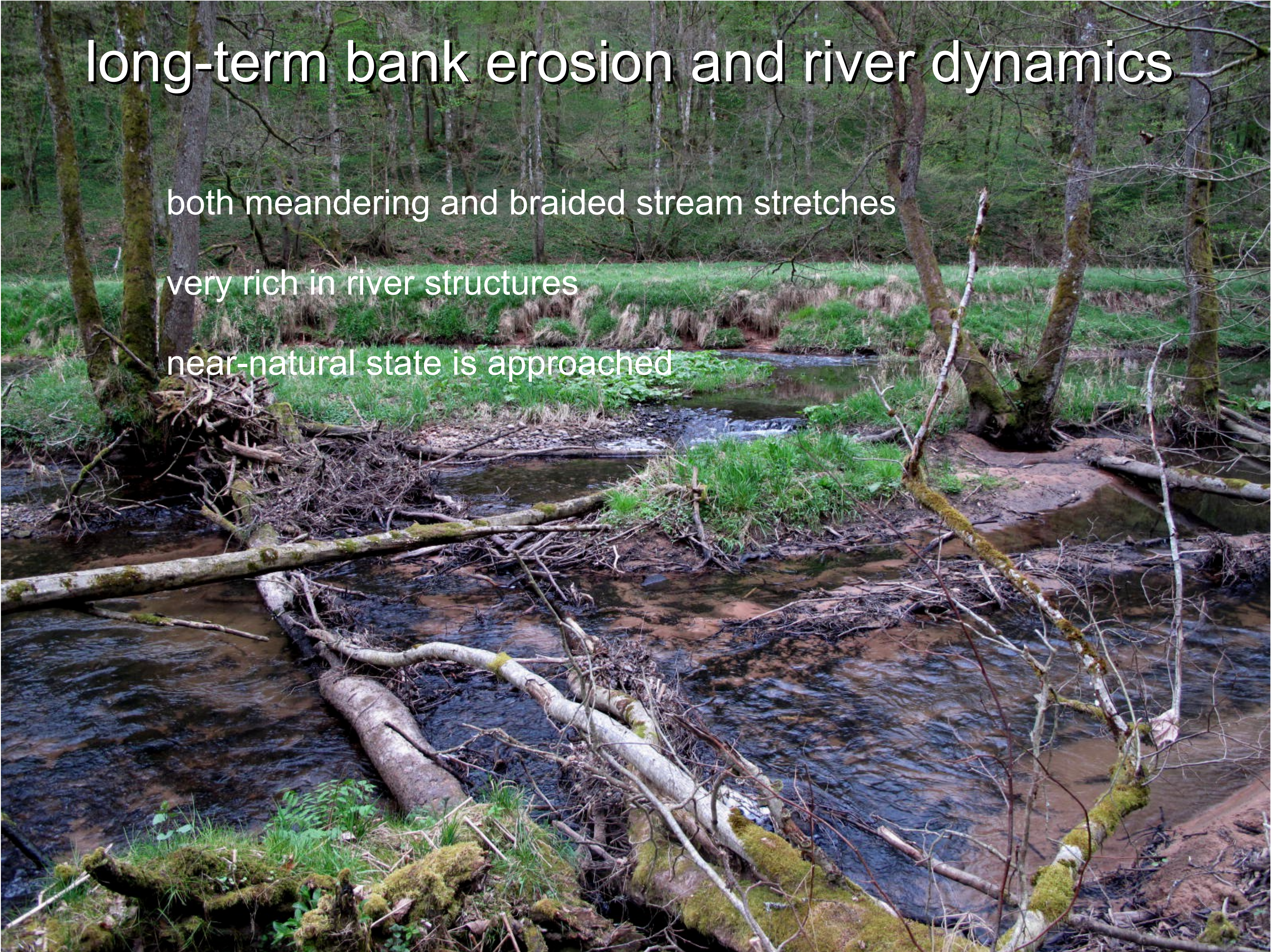
both new and old river bottom

new river structures

Schondra-floodplain ca. 1860



Schondra-floodplain today


long-term bank erosion and river dynamics
both meandering and braided stream stretches
very rich in river structures
near-natural state is approached

Floodplain: Conclusions

The primary source of siltation is soil erosion from arable soils in the headwaters.

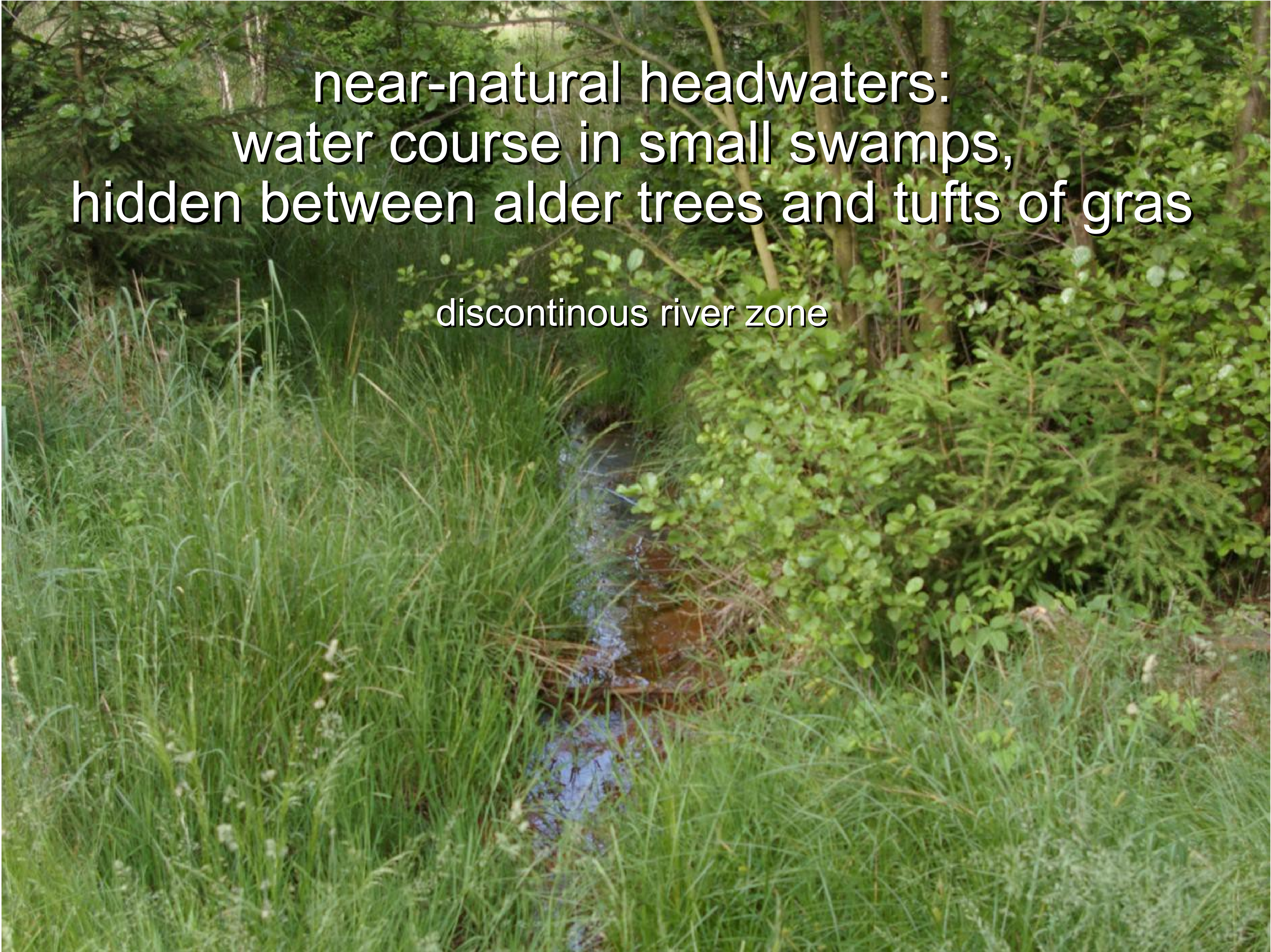
Alluvial loam is a deposit of eroded soils from former times.

The erosion of alluvial loam (bank erosion) might significantly contribute to the fine sediment load in the stream.

Bank erosion is a process of river dynamics that creates new river structures and new habitats.

The mussel habitat needs both stable and dynamic zones and sediments.


Headwaters


near-natural headwaters:
water course in small swamps,
hidden between alder trees and tufts of gras
discontinous river zone


headwaters in meadows
- stream course often artificial, dug into loam

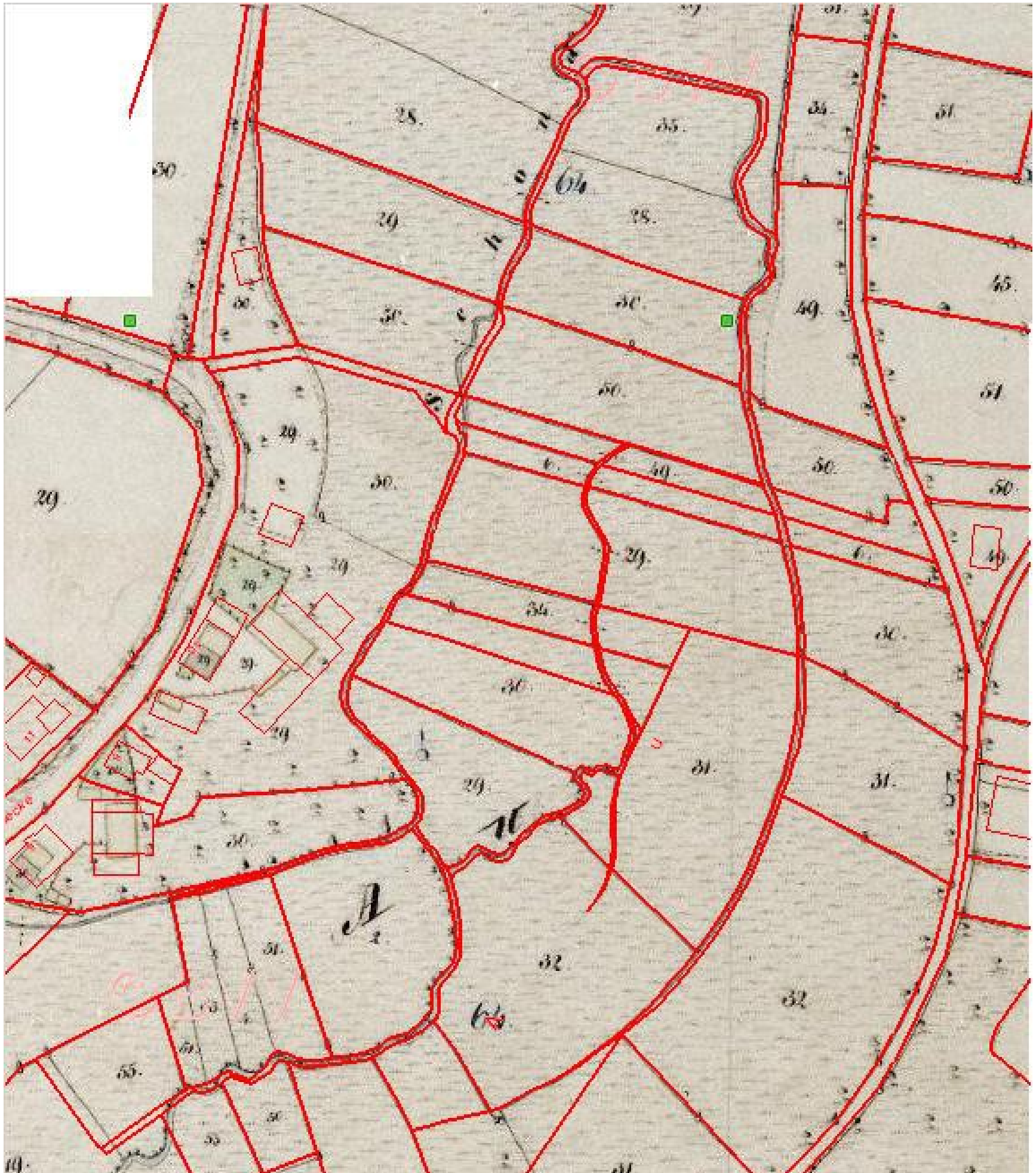

- Extensive contact with fine sediments and
recent bank erosion.
Schondra: ca. 25 - 50 % of stream banks
- Agriculture right to the edge at most places


Temporary accumulations show that large
amounts of fine sediments are transported.

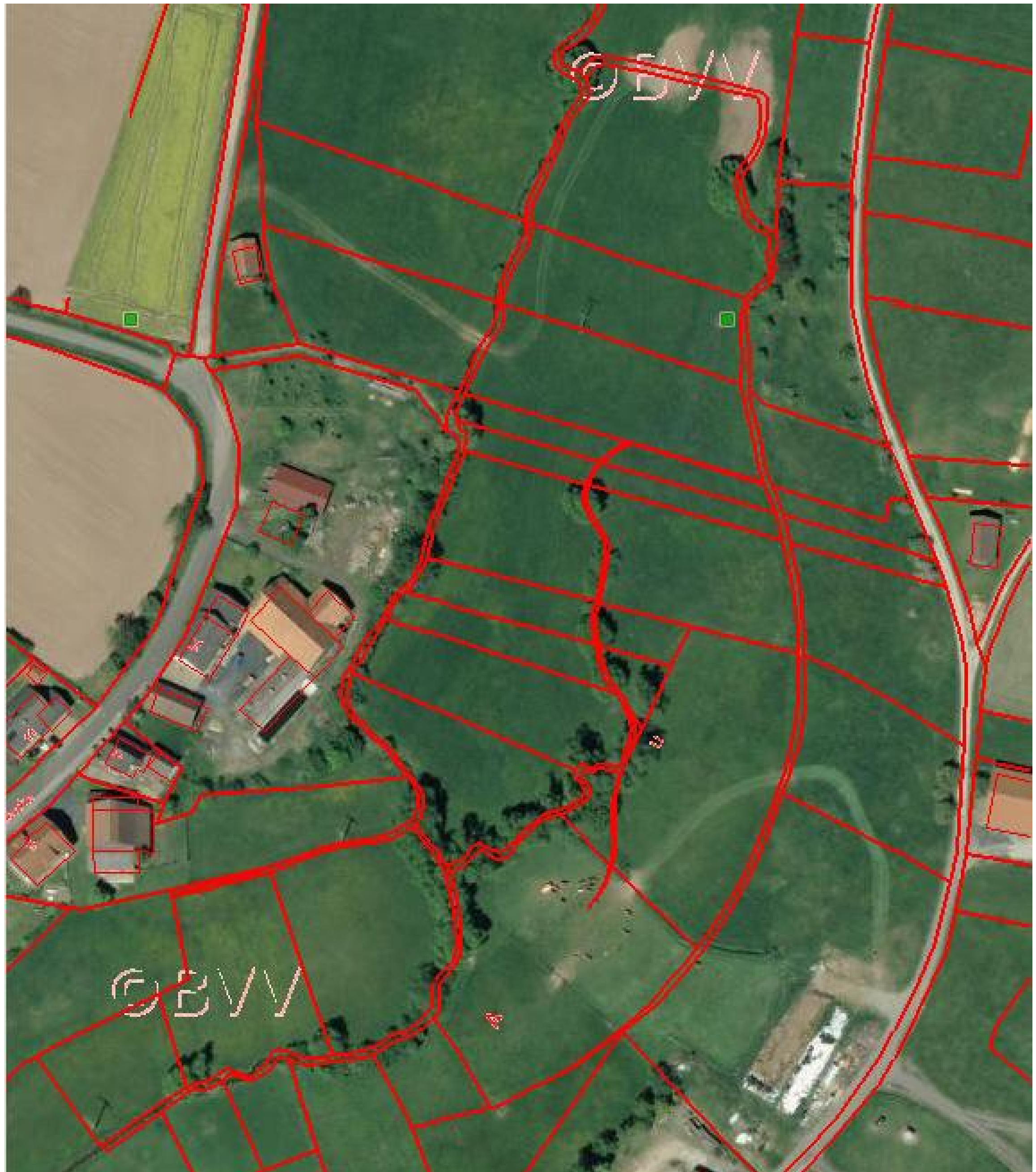

severe channel erosion

Presumed cause: connected road drainage

Schondra-headwaters ca. 1860



Schondra-headwaters today



Headwaters: Conclusions

Small channels in the headwaters can transport large amounts of fine sediments.

In artificial channels the water has extensive contact with unprotected fine sediments. Often the water is turbid also at low discharge.

Channels show extensive bank erosion.

If surface runoff from sieled areas (e.g., roads) is connected, the channels tend to show severe channel erosion.

Despite bank and channel erosion, the course of the channels has been stable since 160 years - presumably due to regular maintenance.

bank erosion - soil erosion

assumptions / extrapolations

floodplain
5 cm/a
x 1990 m^2

= 99,5 m^3/a

headwaters
2.5 cm/a
x 3970 m^2

= 99,3 m^3/a

arable soil
5 $m^3/ha/a$
x 2040 ha
x 12 % SDR[1)]

= 1224 m^3/a

1) Sediment Dislocation Ratio, 160 km^2, Auerswald 1997

4. Measures: How to reduce the fine sediment load

1) Abate soil erosion on the arable fields (catch crops etc.)

2) Disconnect arable fields and streams
(buffer strips along roadside ditches etc.)

3) Make headwater channels shallow and wet

Grill & Lacas 2005

floodplain:
tolerate river dynamics