Using atmospherically-deposited radionuclides to identifying the source of excess fine-grained sediments in two New Jersey watersheds.

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MONTCLAIR STATE UNIVERSITY

Passaic River Institute

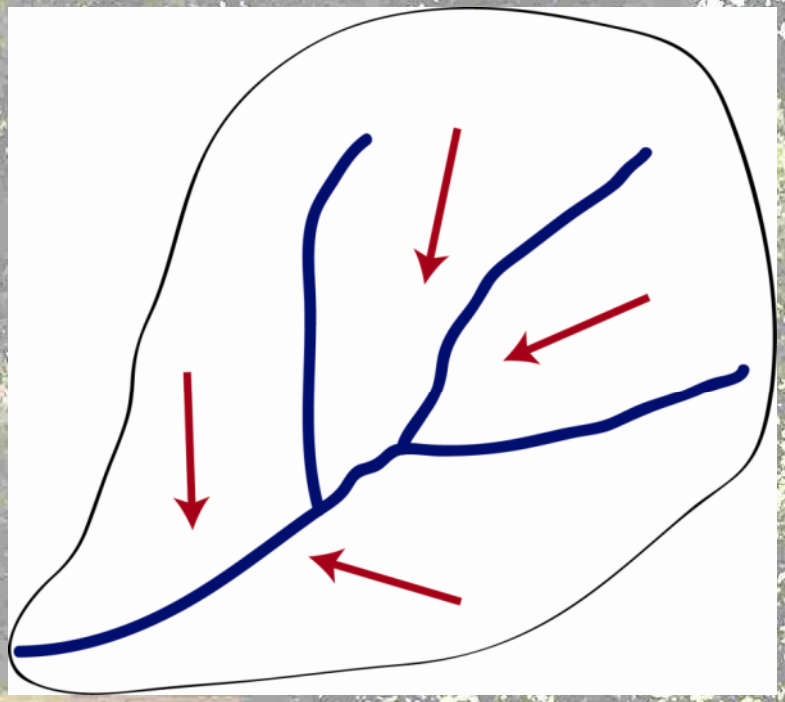
PRI

Excess sediment in streams

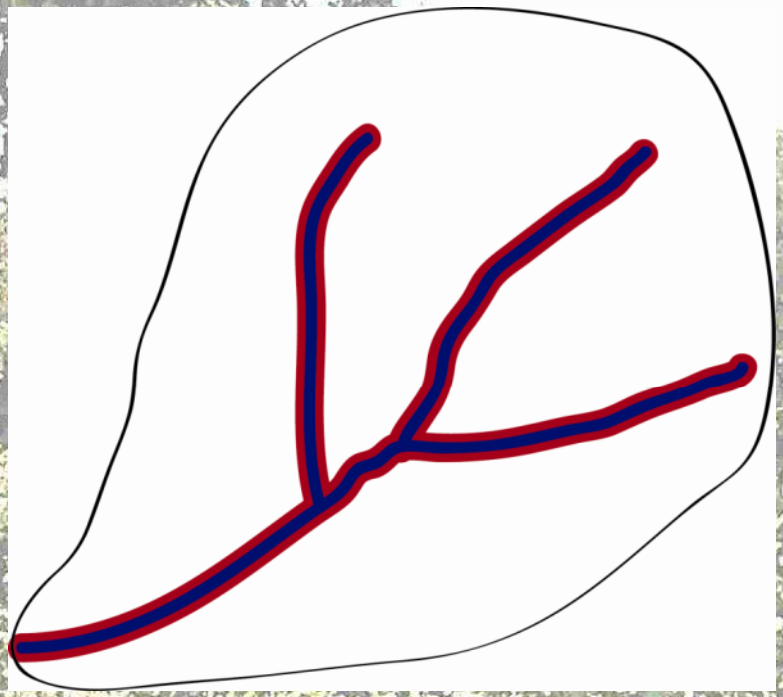
- In 2006 NJ DEP declared 370 miles^2 of watersheds and 700 miles of stream channel "impaired" by excess sedimentation
- 2007 EPA declared sedimentation the number one cause of stream impairment

http://www.glc.org/basin/images/projects/mi_BigSabRC_imag1.JPG

Sources of *sediment*

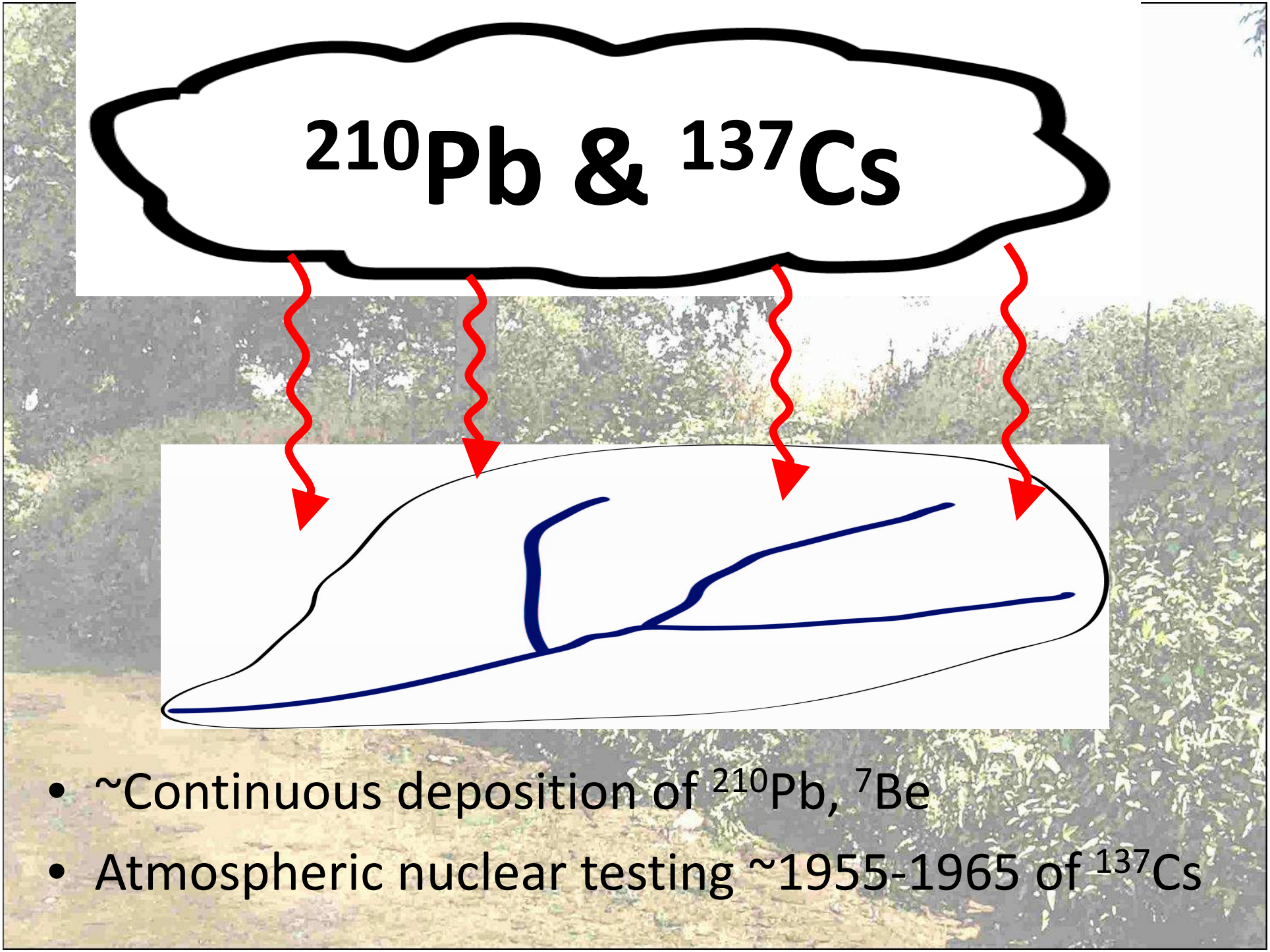


VS.



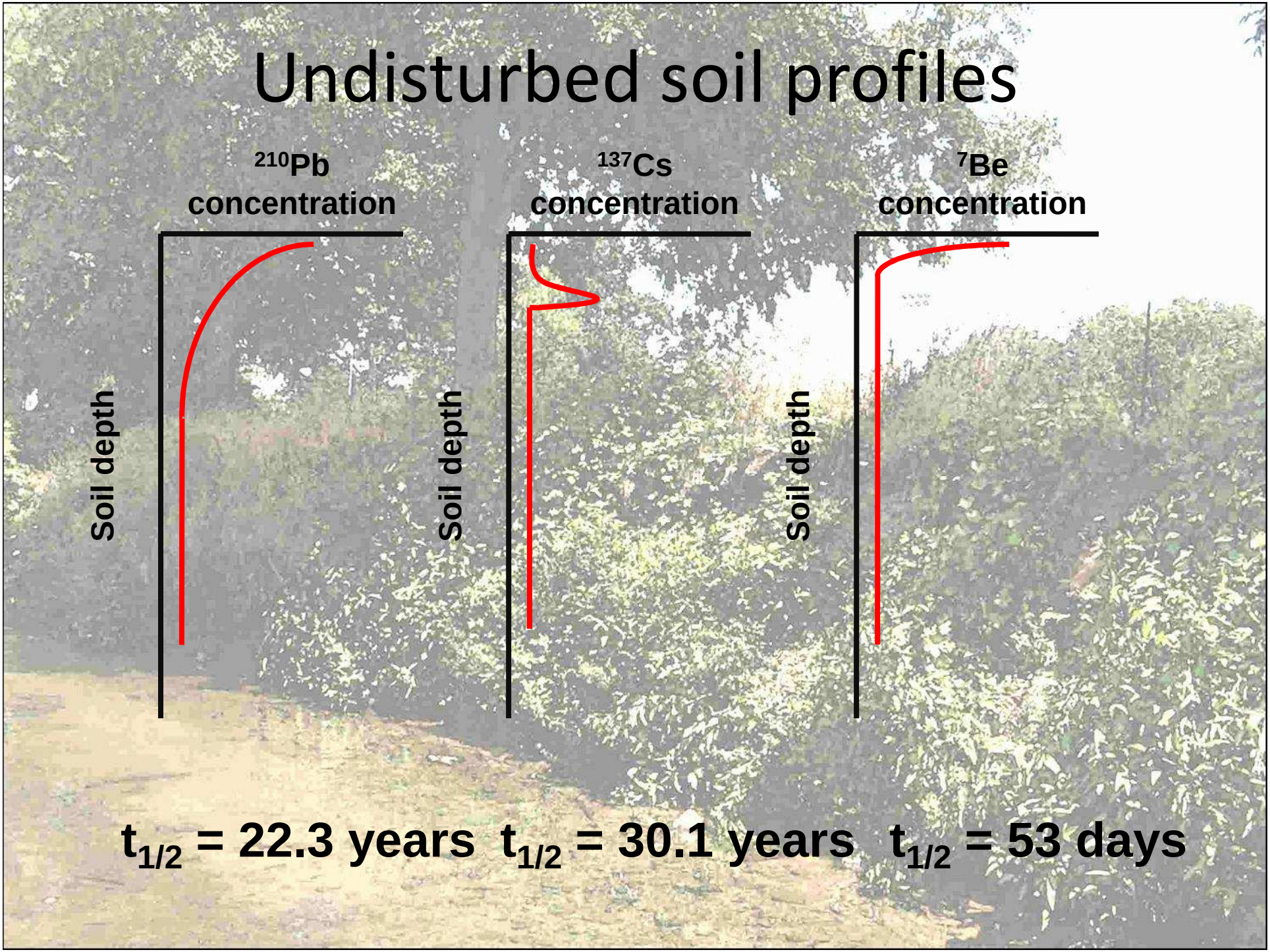
Generalized surficial erosion **Channel erosion**

Best management practices differ for each source…



- ~Continuous deposition of ^{210}Pb, ^{7}Be
- Atmospheric nuclear testing ~1955-1965 of ^{137}Cs

Undisturbed soil profiles



Similar work

- Tilled vs. non-till sediment sources (Matisoff et al., 2002)
- Erosion rates from developed land (Walling and He, 1999; Singh et al., 2007)
- Land-use change and sediment yield (Walling, 1999)

Local calibration is important

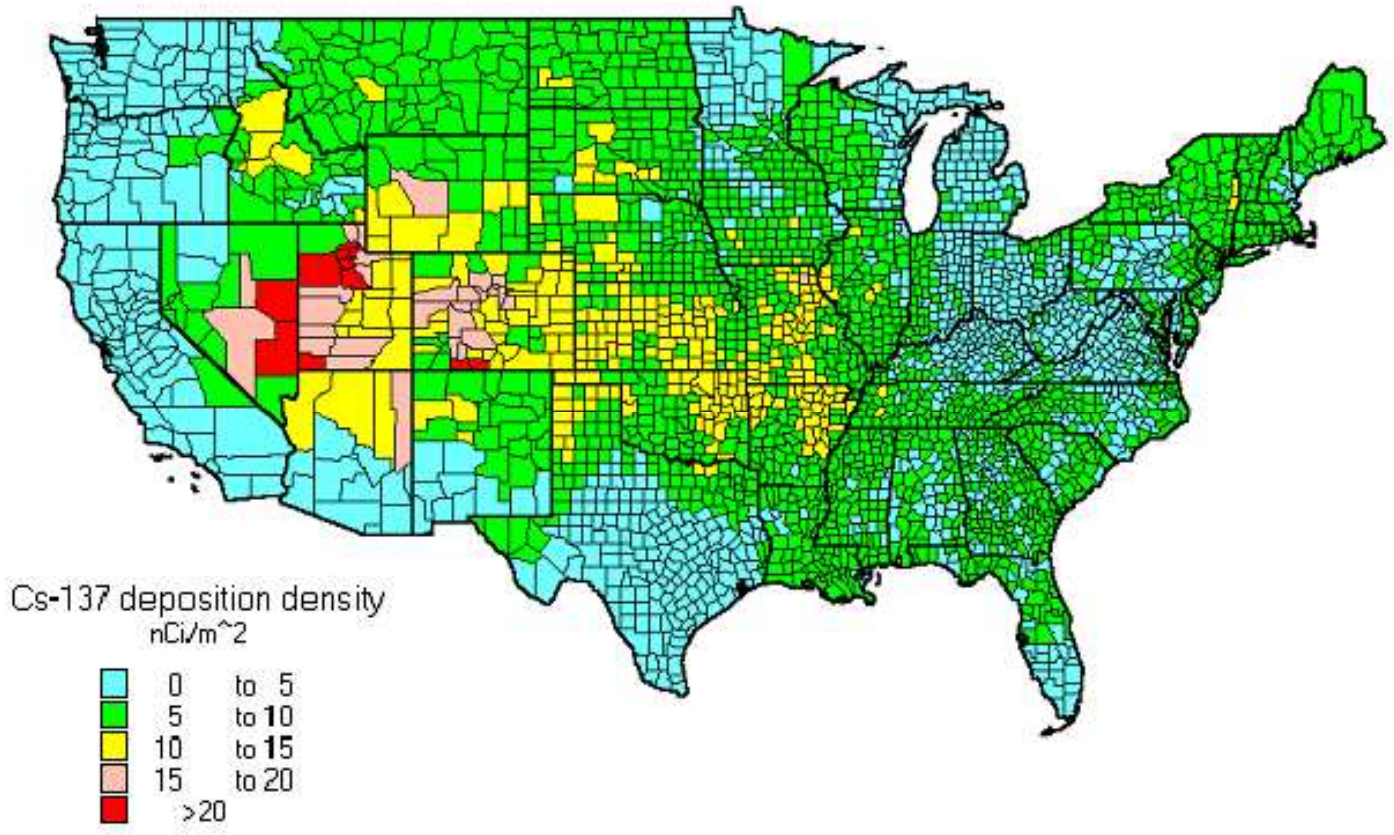
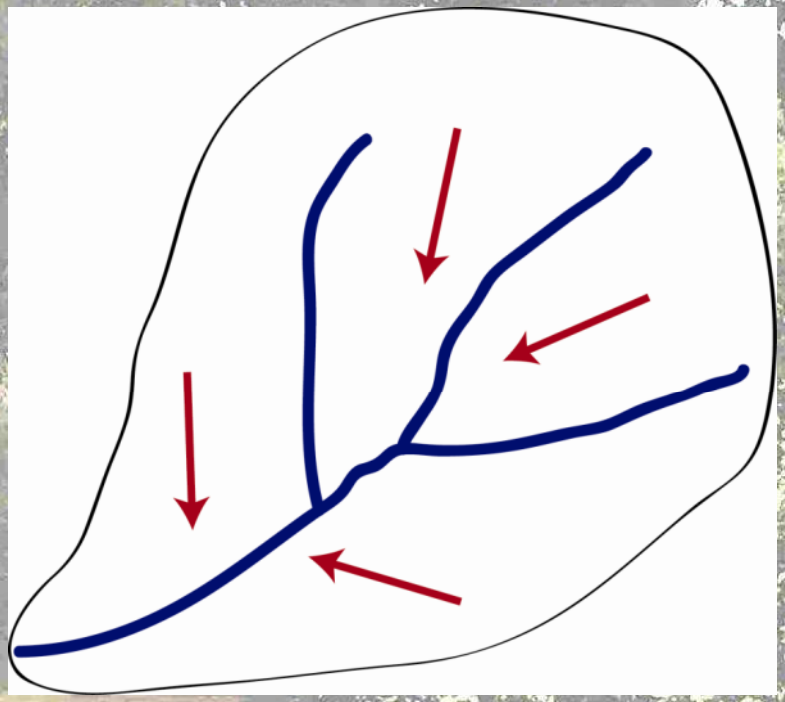


Figure 1. Cs-137 deposition density due to all NTS tests.

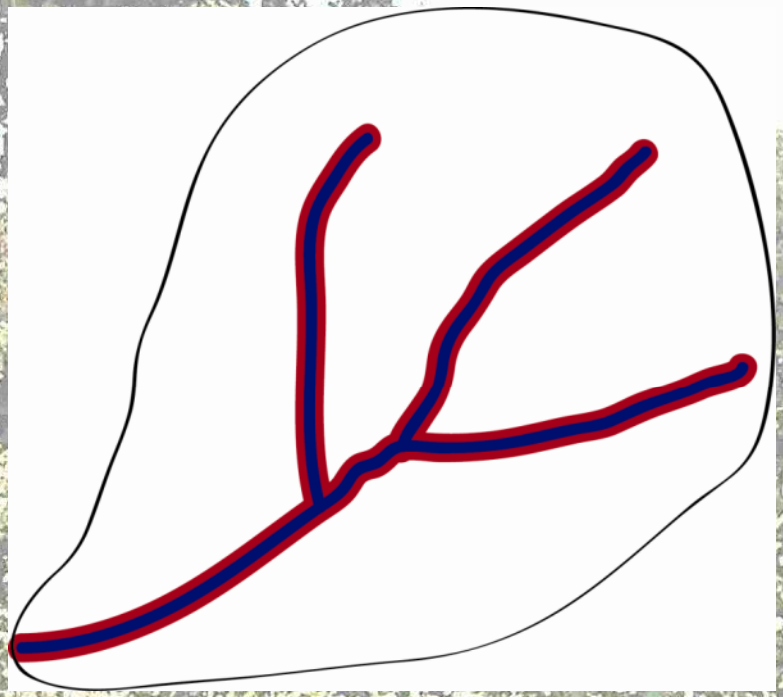
http://www.idealist.ws/cesium137.bmp

Sources of *sediment*



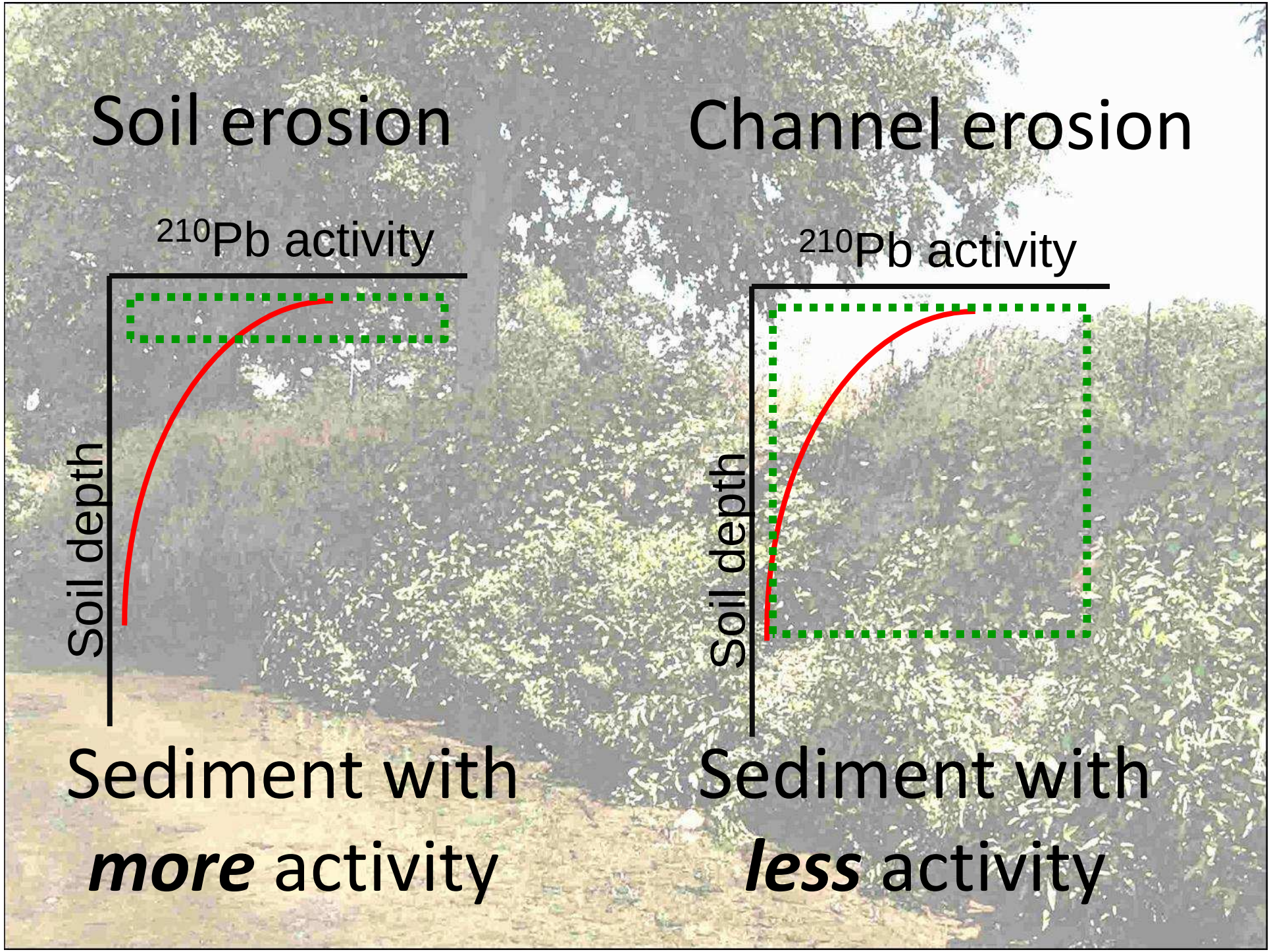
Generalized surficial erosion

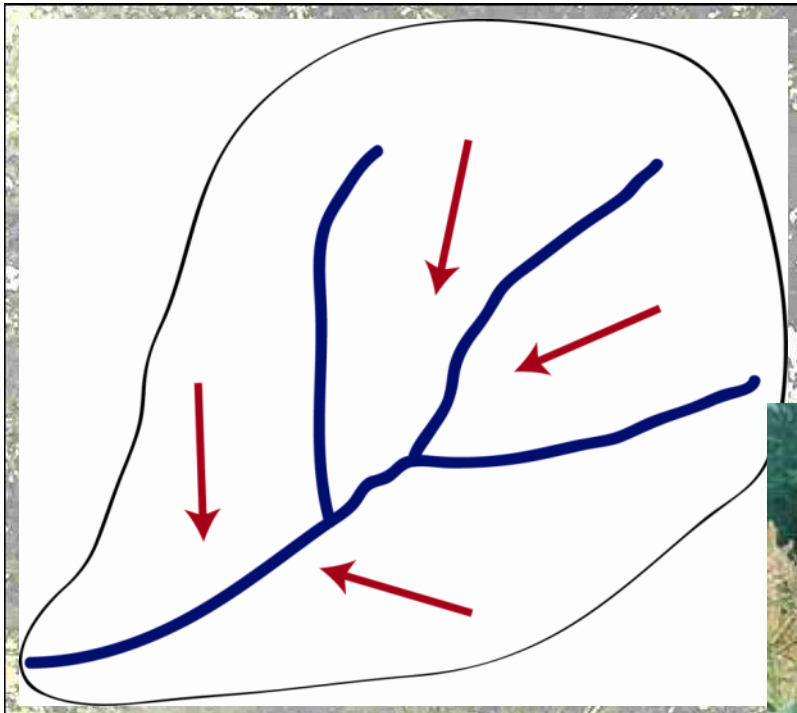
vs.



Channel erosion

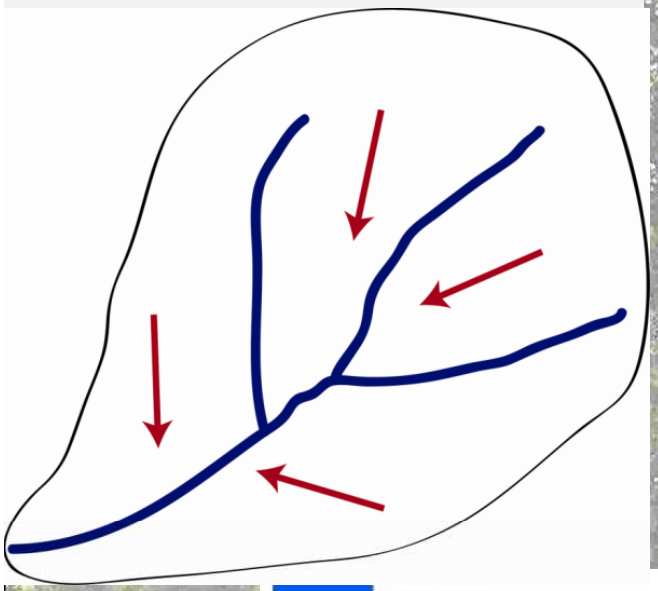
Finding the right watershed…

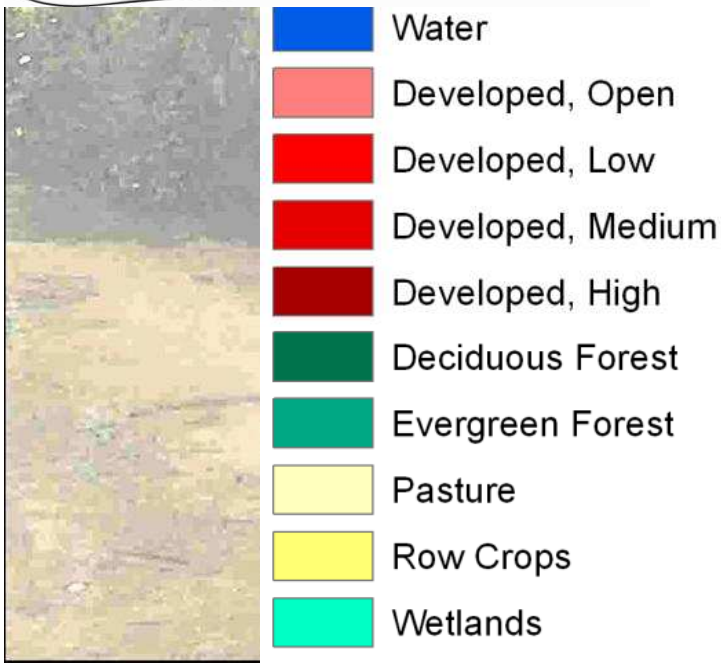

Soil erosion
^{210}Pb activity
Soil depth
Sediment with *more* activity
Channel erosion
^{210}Pb activity
Soil depth
Sediment with *less* activity

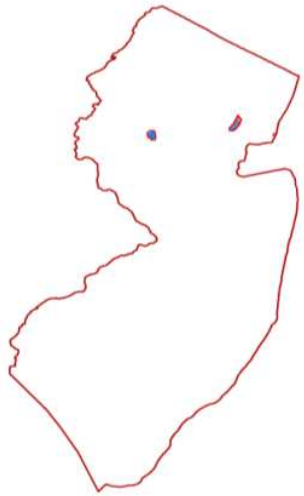


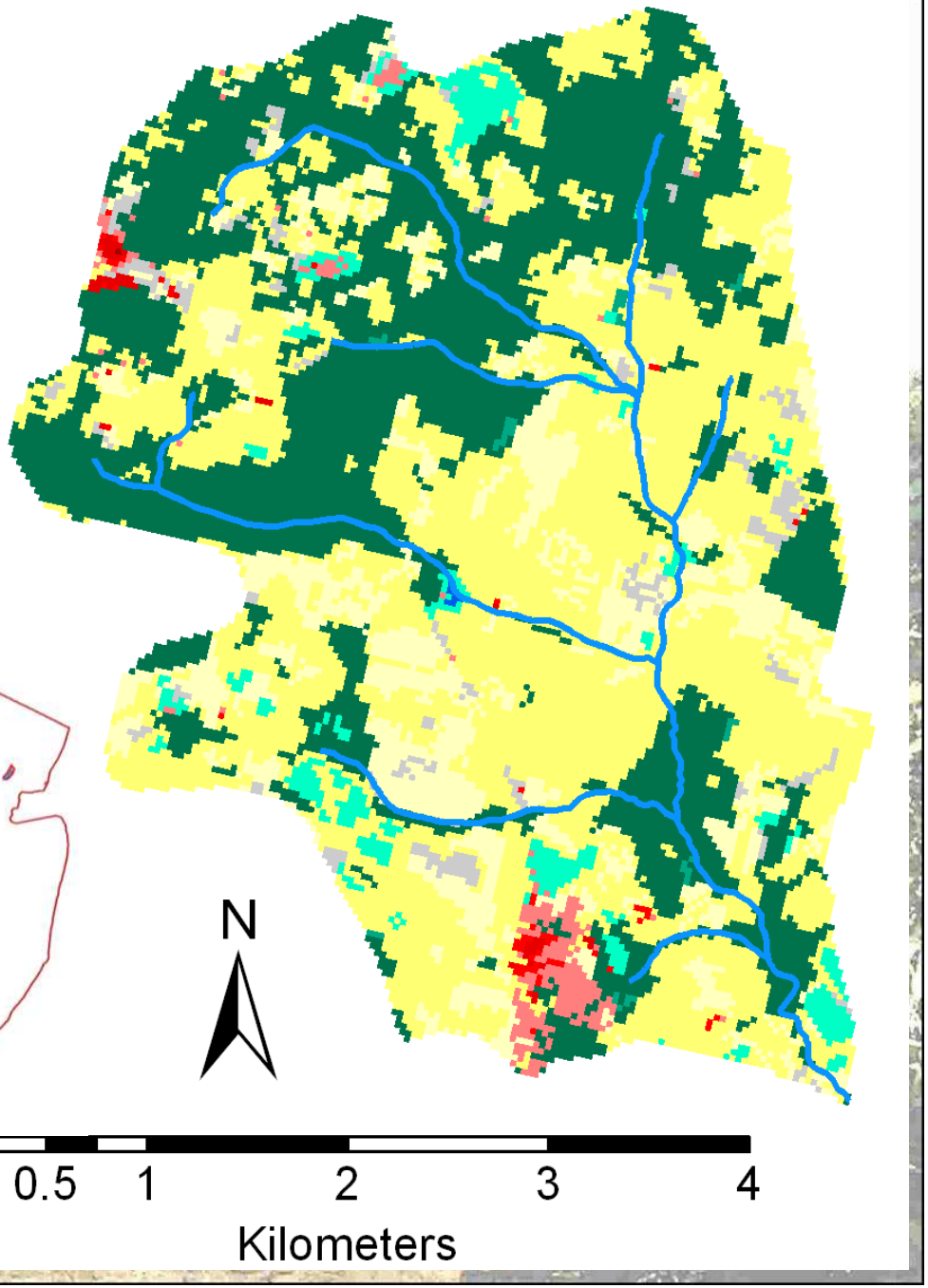
What's the ideal land use?

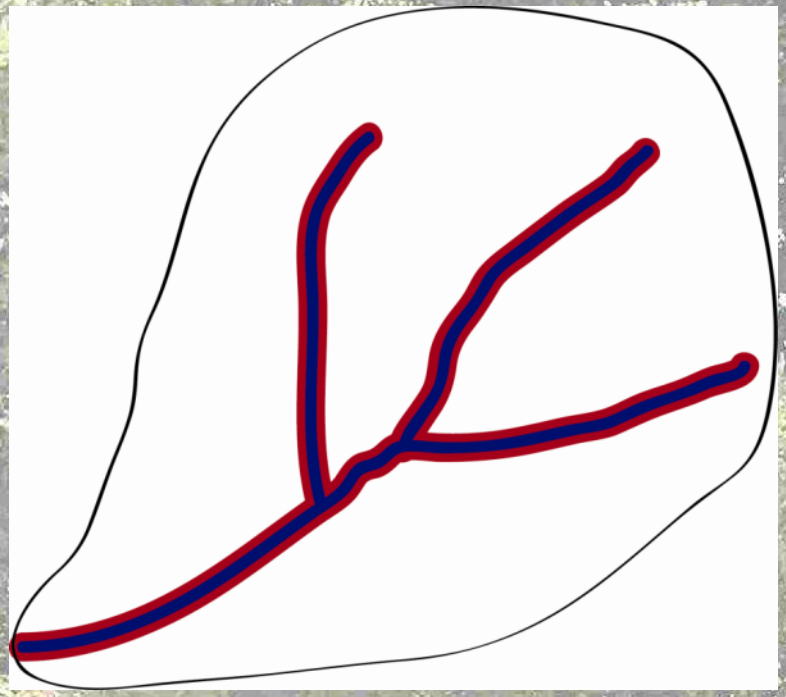
Cold Brook



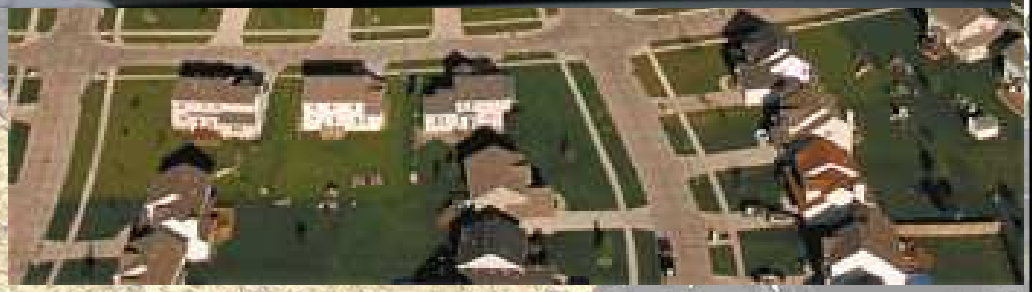

Water
Developed, Open
Developed, Low
Developed, Medium
Developed, High
Deciduous Forest
Evergreen Forest
Pasture
Row Crops
Wetlands




N
0 0.5 1 2 3 4
Kilometers

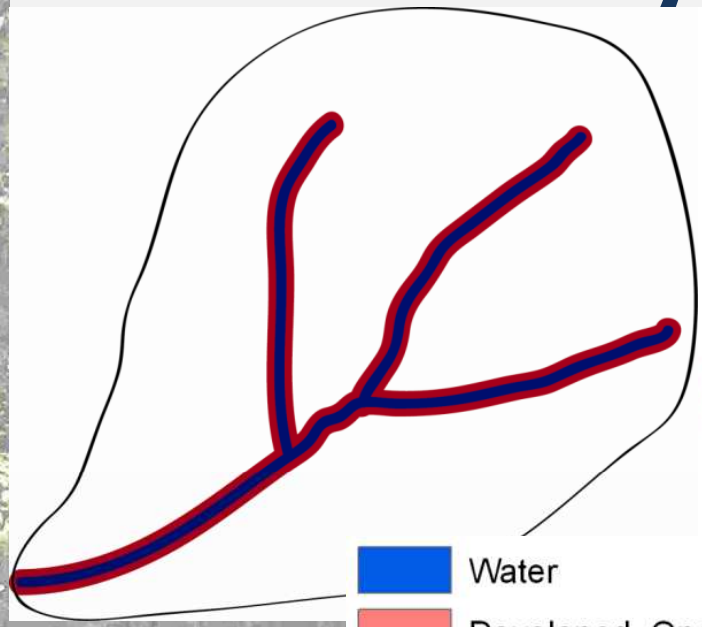


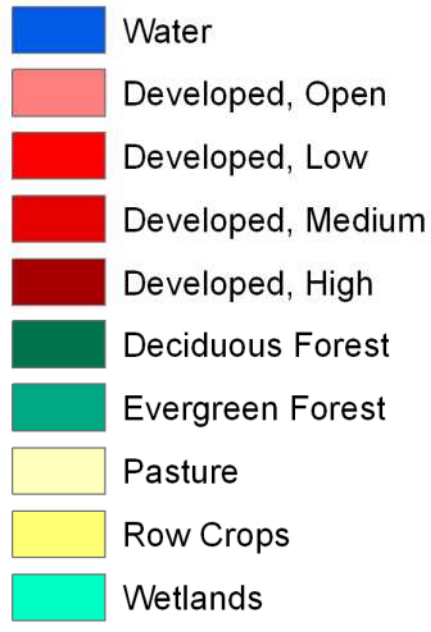
Channel erosion



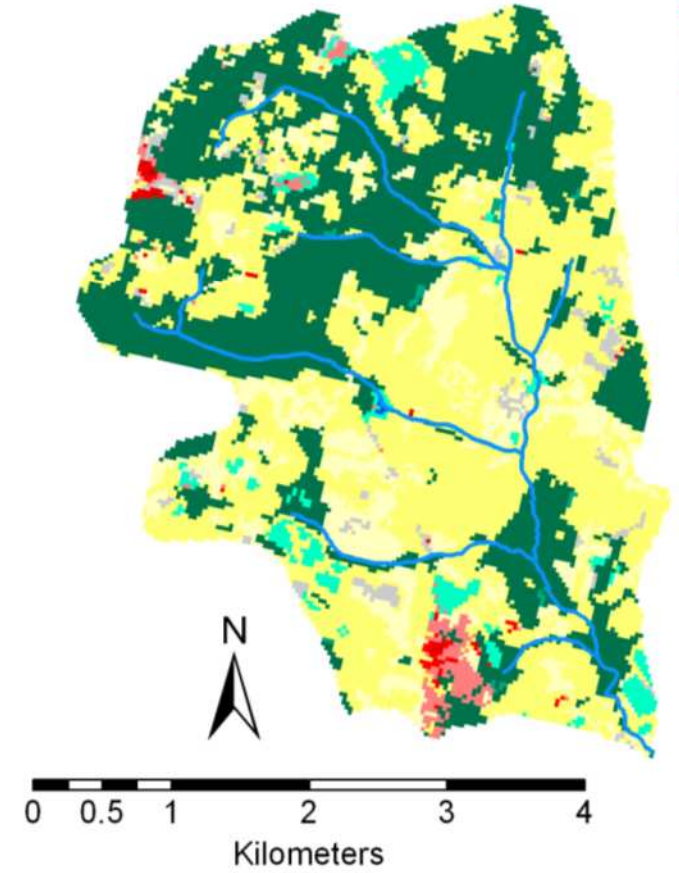
What's the ideal land use?

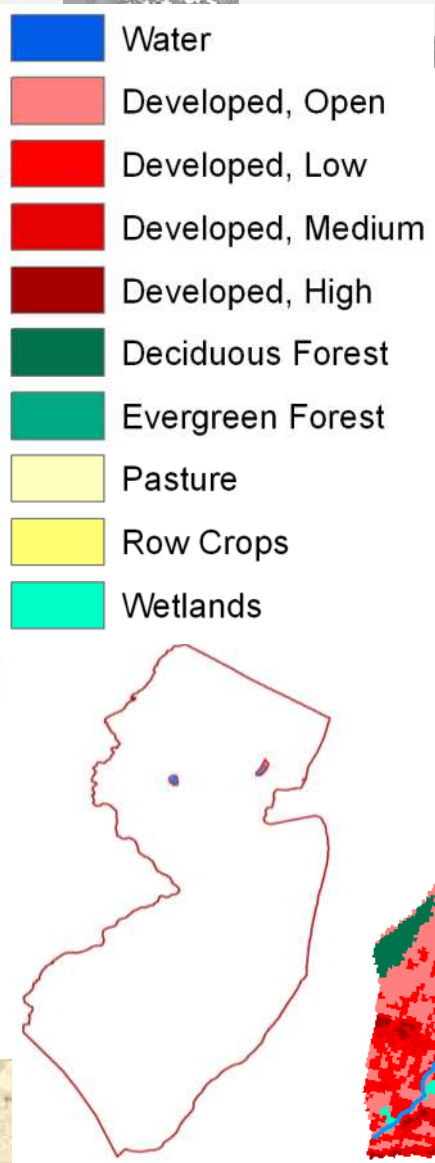
East Branch of the Rahway



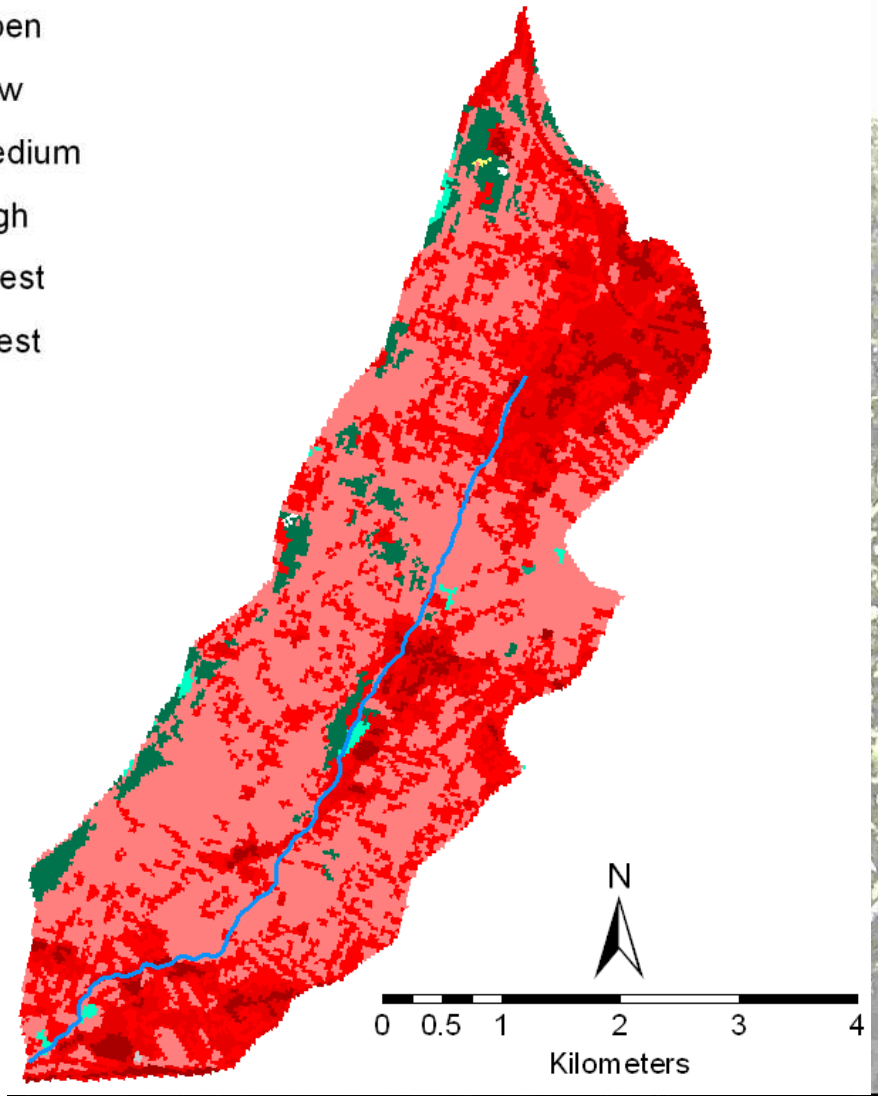


Cold Brook

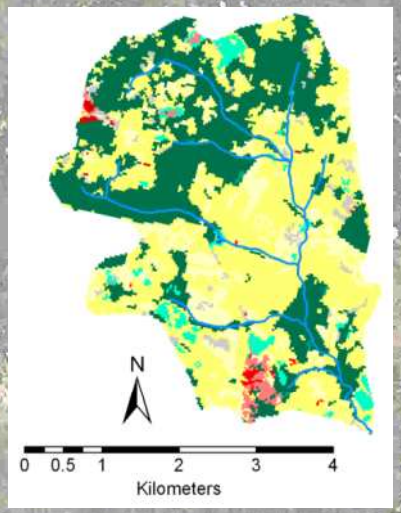


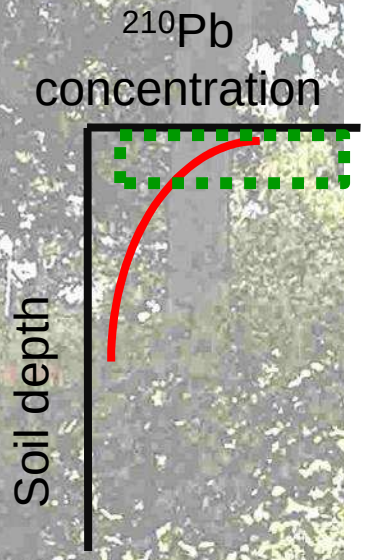


East Branch of the Rahway

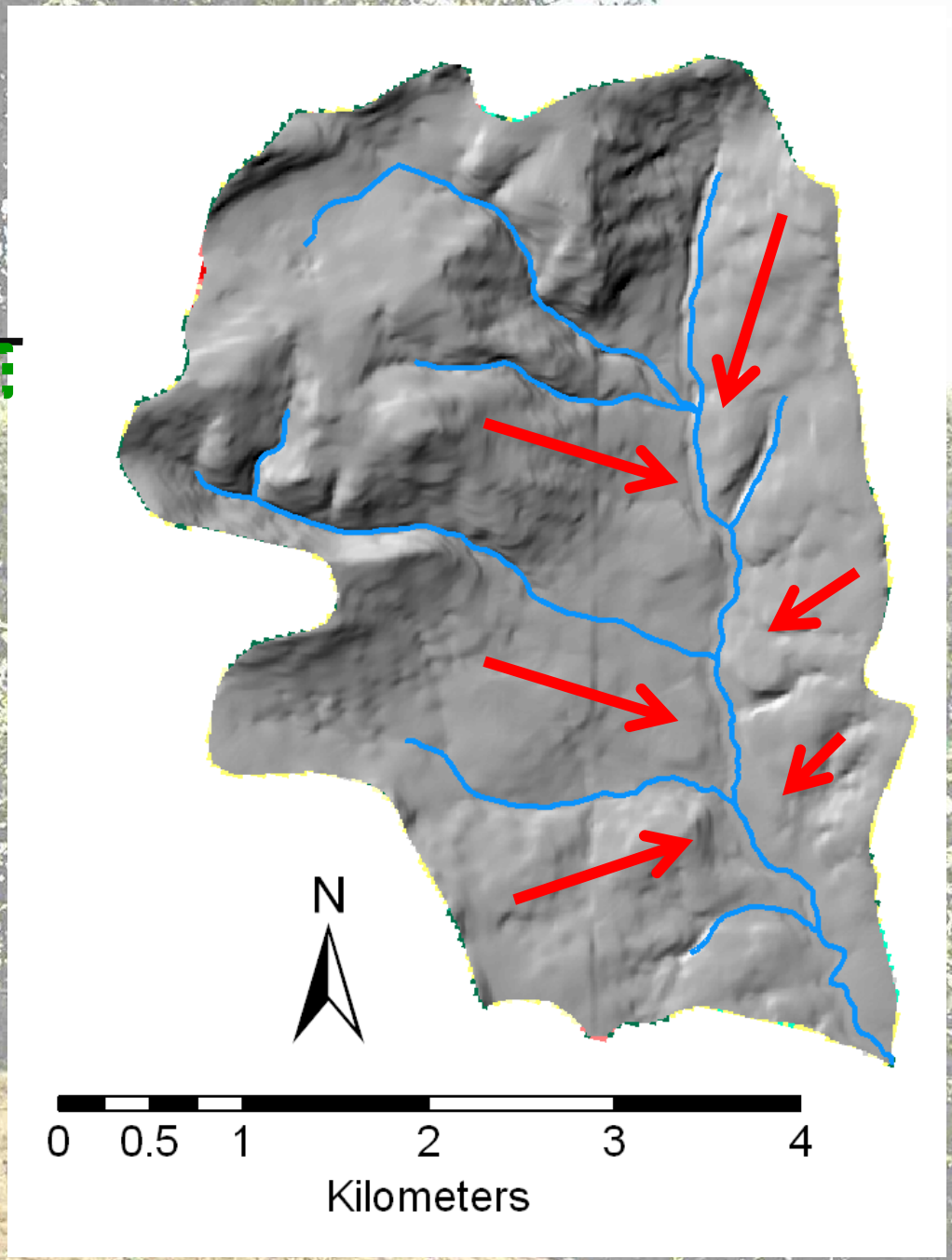


Expected result 1

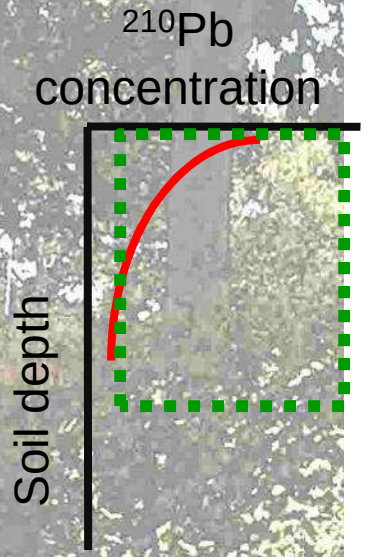


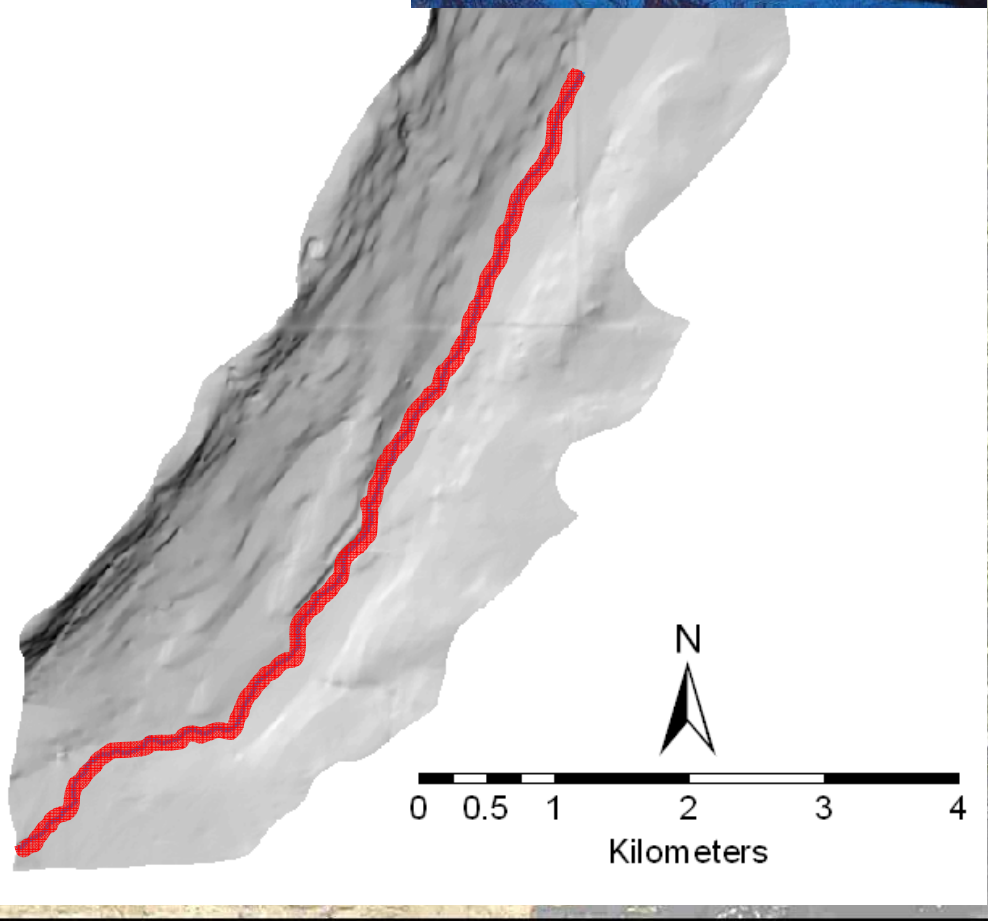


- Surficial (rill & sheetwash) erosion
- High radionuclide activity



Expected result 2

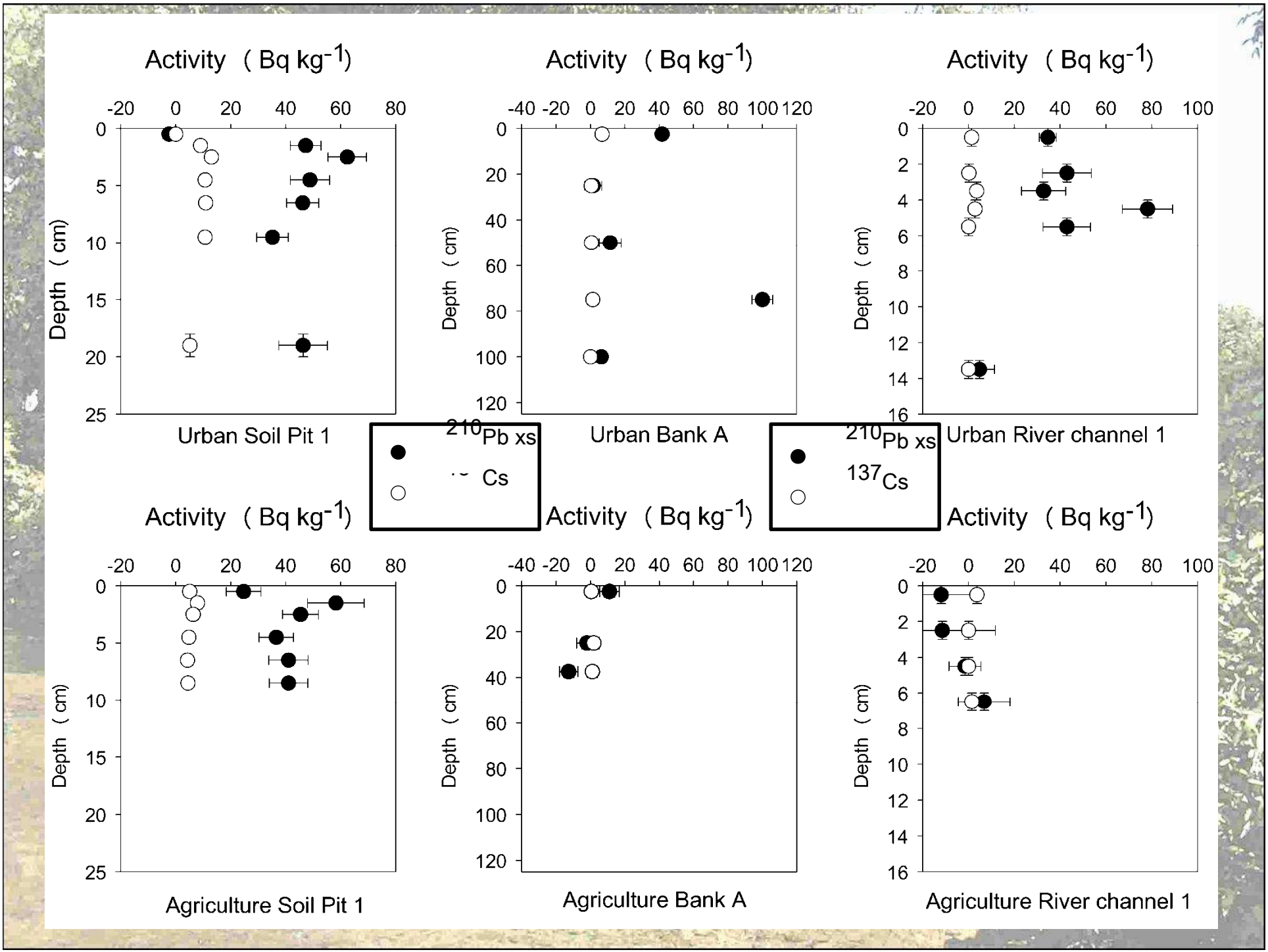


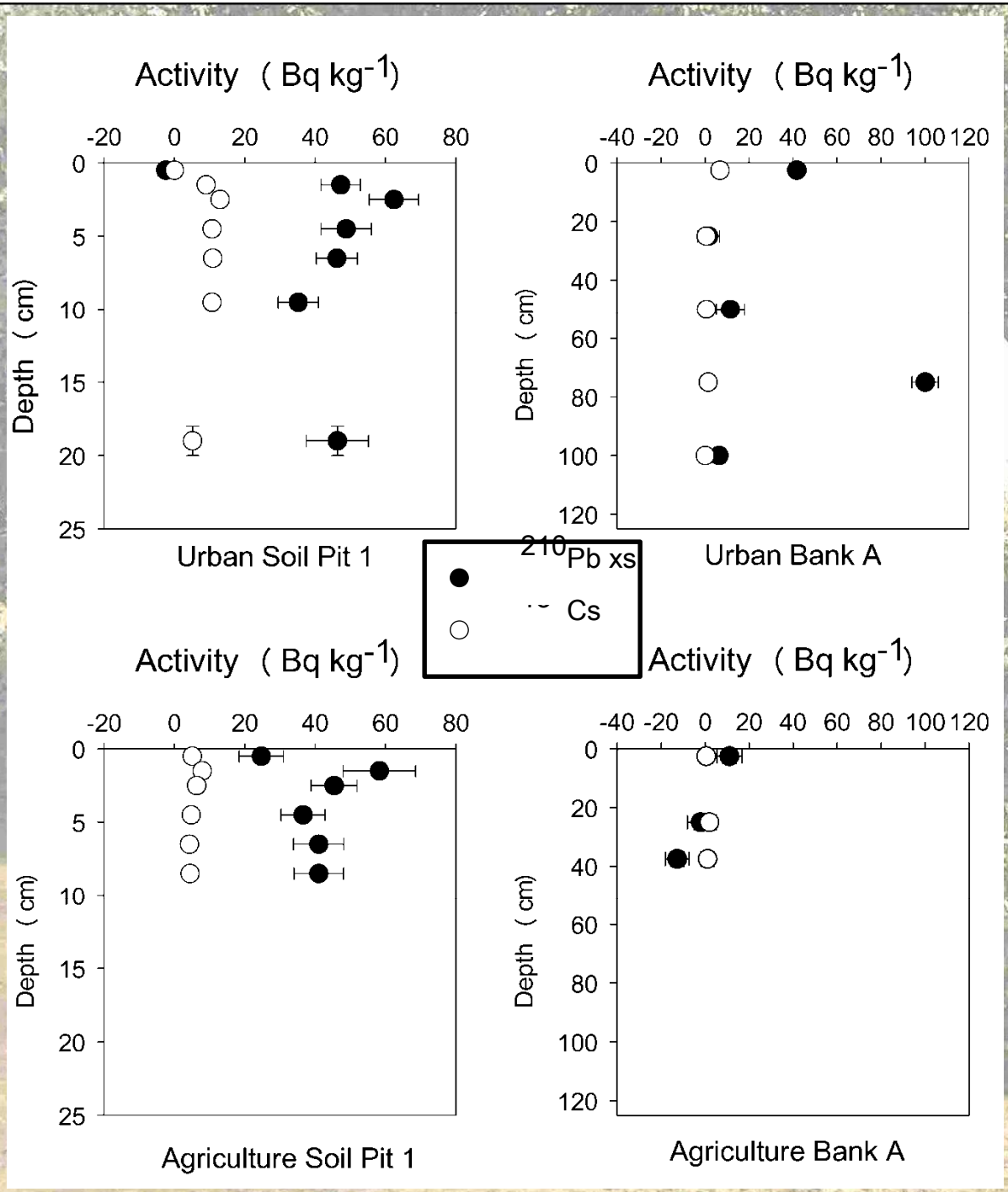


- More stream bank erosion
- Lower activity

Sampling methodology

- Soil pits
  - ~20 cm depths
- Stream bank
  - 5 evenly-spaced
- Channel sediment
  - Cores taken from the strea


Activity (Bq kg-1)
Depth (cm)
Urban Soil Pit 1
Urban Bank A
Urban River channel 1
Agriculture Soil Pit 1
Agriculture Bank A
Agriculture River channel 1
210Pb xs
137Cs

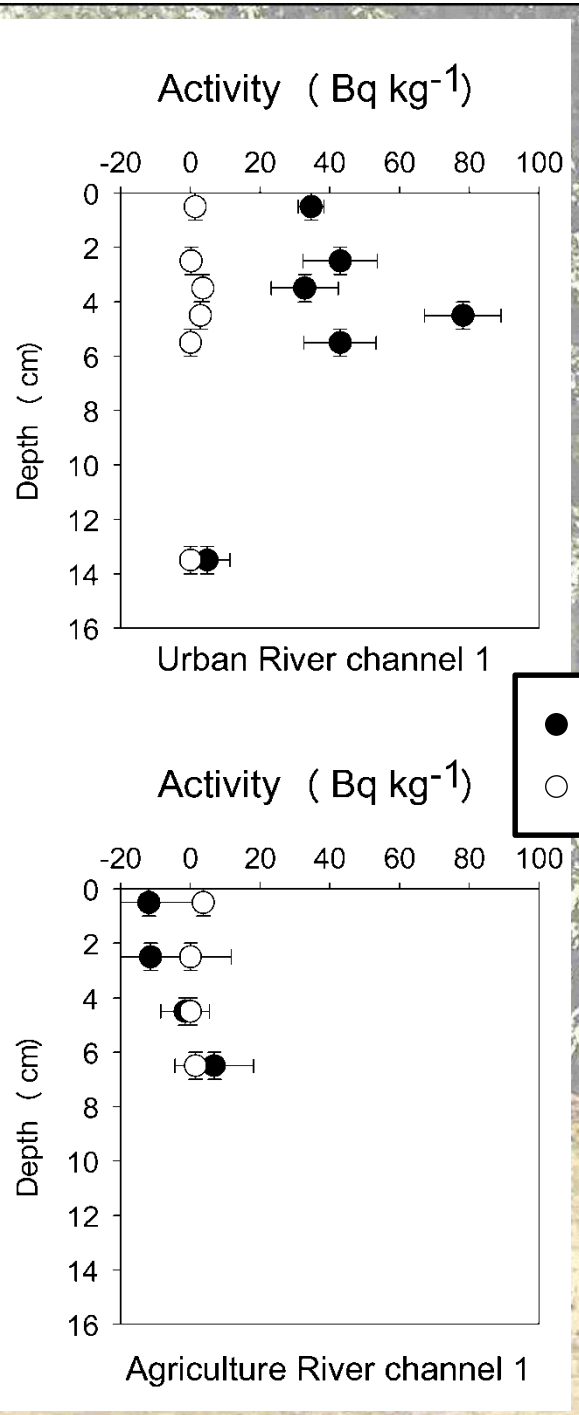


Results

- Soil surface is eroding: More erosion at urban site
- Mixing AND/OR simultaneous deposition of deeper soil material
- Bank sediment is old (>200)

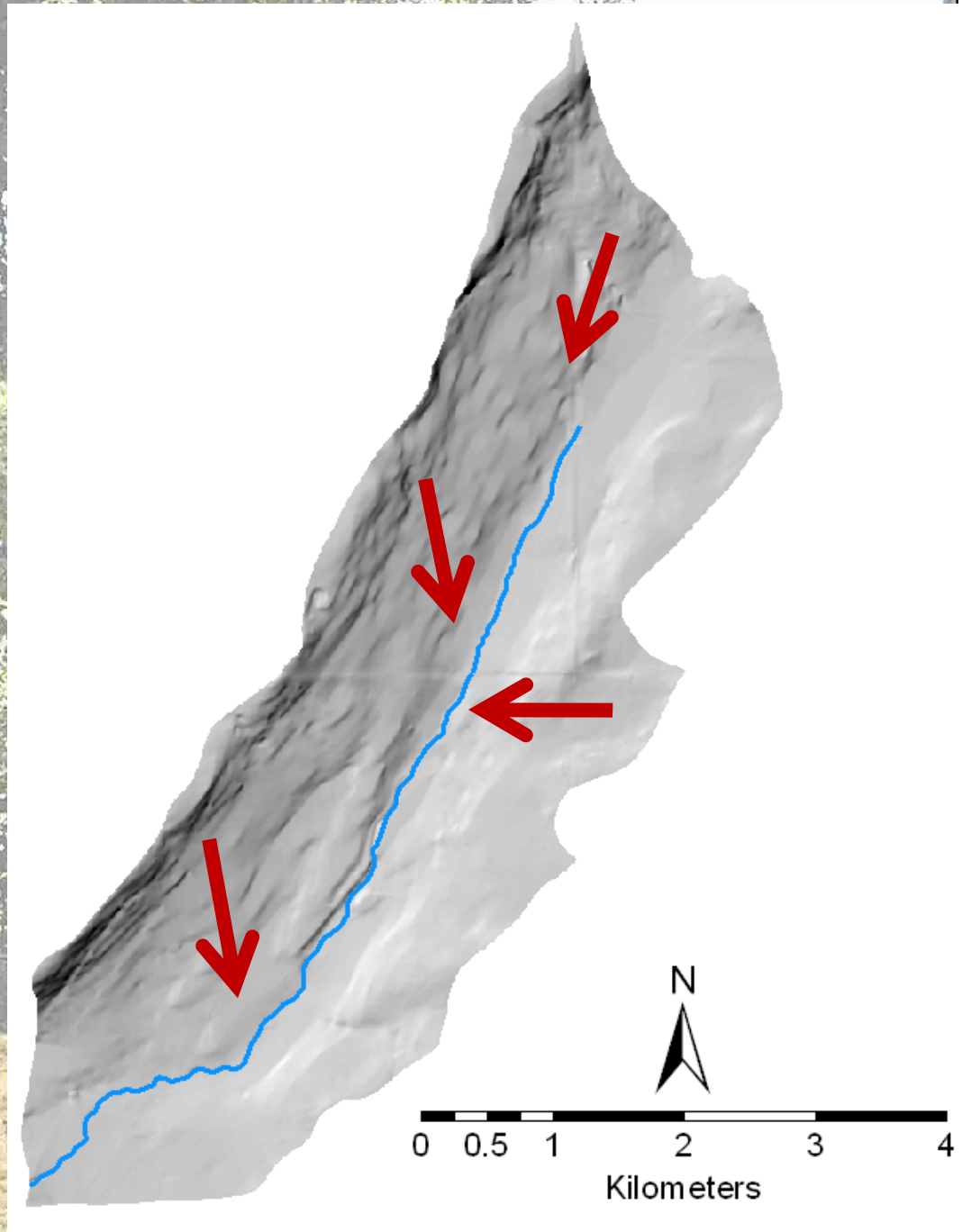
Results

- Both channel sediments are well-mixed
- Urban channel sediment has ***more*** activity



Urban watershed

- Opposite of expected results
- Urban channel has ***more*** surficial material



Next steps

1. Run duplicate sampling sites (soil pit 2, soil pit 3…)
2. Run samples from other locations in same watersheds
3. Expand to streams impaired by sediment