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science for a changing world

Bank characteristics and erosion fluxes throughout the Chesapeake

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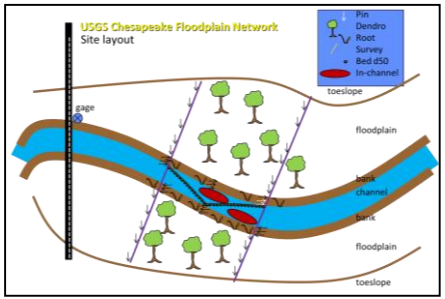
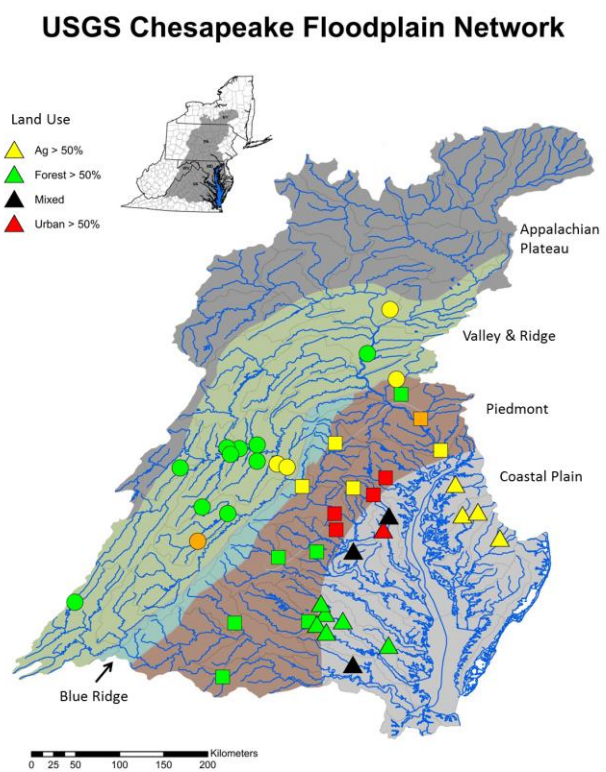
U.S. Department of the Interior
U.S. Geological Survey

Chesapeake Floodplain Network: bank sediment characteristics

Site selection:

- Chesapeake NTN load gages
- 'unmanaged' floodplain land use (with woody vegetation)
- Unchannelized
- Landowner permission
- Represents variability in watershed drainage area and land use





Bank coring (5 cm deep):

43 sites
X
2 x-sections per site
X
2 banks per x-section
X
Upper+lower elevation per bank
=
340 bank cores

Floodplain coring (5 cm deep):

43 sites
X
2 x-sections per site
X
2 to 3 locations per x-section
=
201 floodplain cores

Bank measurements:

Height (m)
Lateral erosion (cm/yr)
% eroding bank
Adjusted lateral erosion (cm/yr)

Bulk density (g/cm3)
Bulk density <2 mm (g/cm3)
Bulk density <1 mm (g/cm3)
% organic
% mineral
% carbonate
Total OC (%)
Total N (%)
Total P (%)
Total Ca (mg/g)
Total Na (mg/g)
Total Mg (mg/g)
Total K (mg/g)
Total Al (mg/g)
Total Fe (mg/g)
Total Ti (mg/g)
Particle size: mean (um)
Particle size: d50 (um)
Particle size: %<63 um

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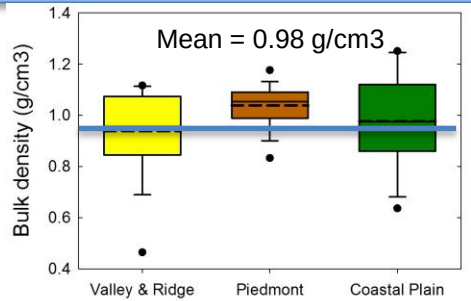
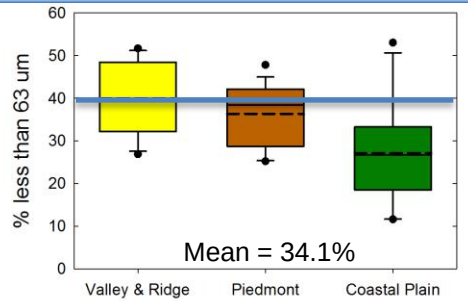
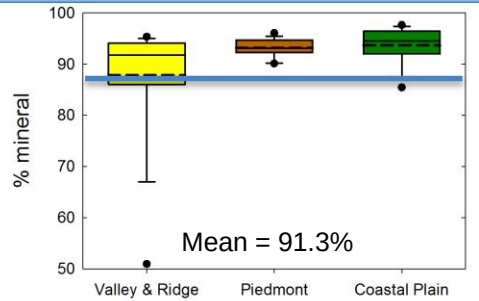
Chesapeake Floodplain Network: bank sediment characteristics

provisional results

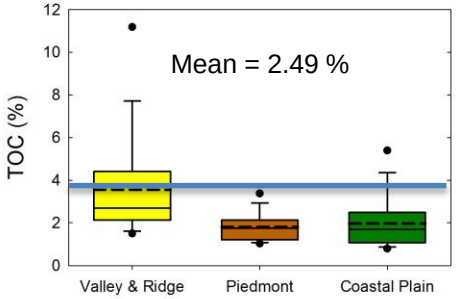


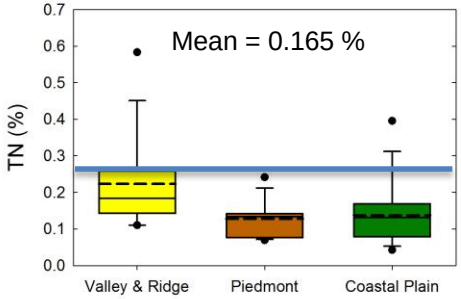


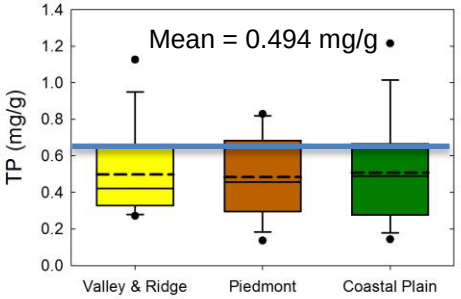


Mean floodplain

Physio. Province:	P=0.002	P<0.001	P<0.001
Bank high vs. low:	P=0.000	P=0.003	P=0.590
Interaction:	P=0.547	P=0.095	P=0.491







Mean floodplain

Physio. Province:	P<0.001	P<0.001	P=0.911
Bank high vs. low:	P=0.137	P=0.005	P=0.213
Interaction:	P=0.188	P=0.233	P=0.319

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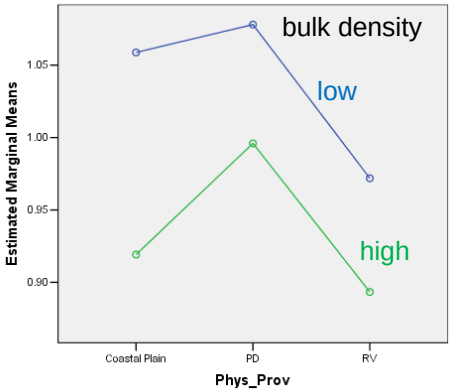
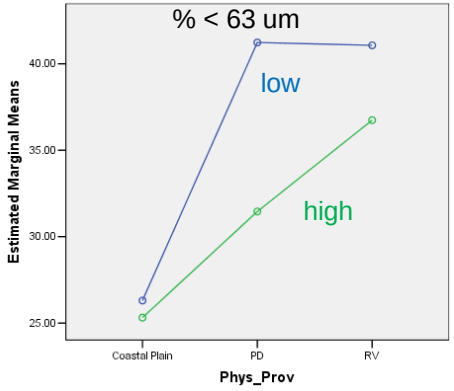
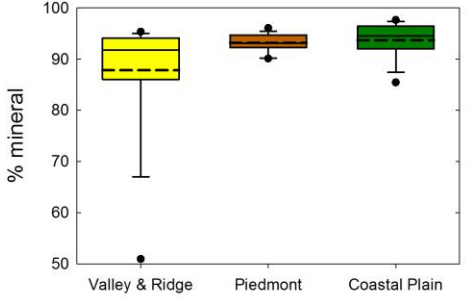
Chesapeake Floodplain Network: bank sediment characteristics

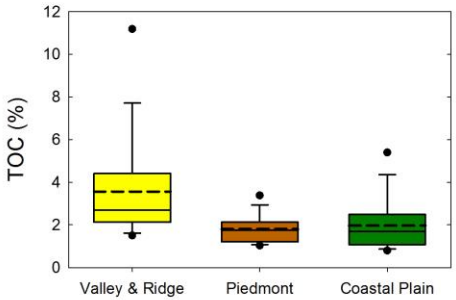
provisional results

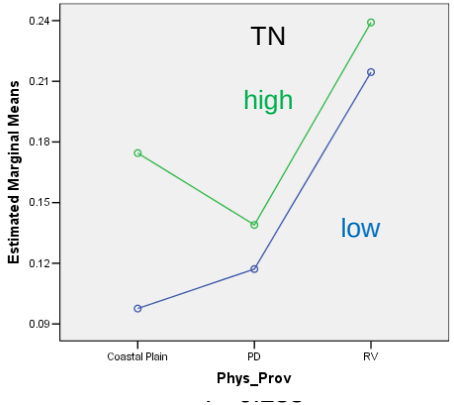


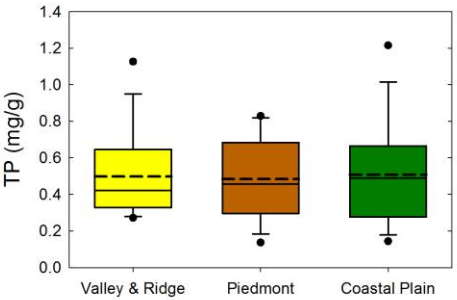




Physio. Provi P<0.001
Bank high vs. P=0.590
Interac P=0.491







Physio. Province: P<0.001 P=0.911
Bank high vs. low: P=0.137 P=0.213
Interaction: P=0.188 P=0.319

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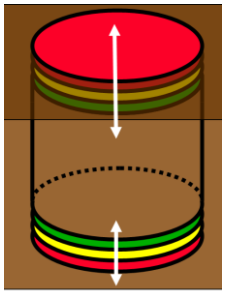
What is the bioavailability of N and P in legacy sediments?



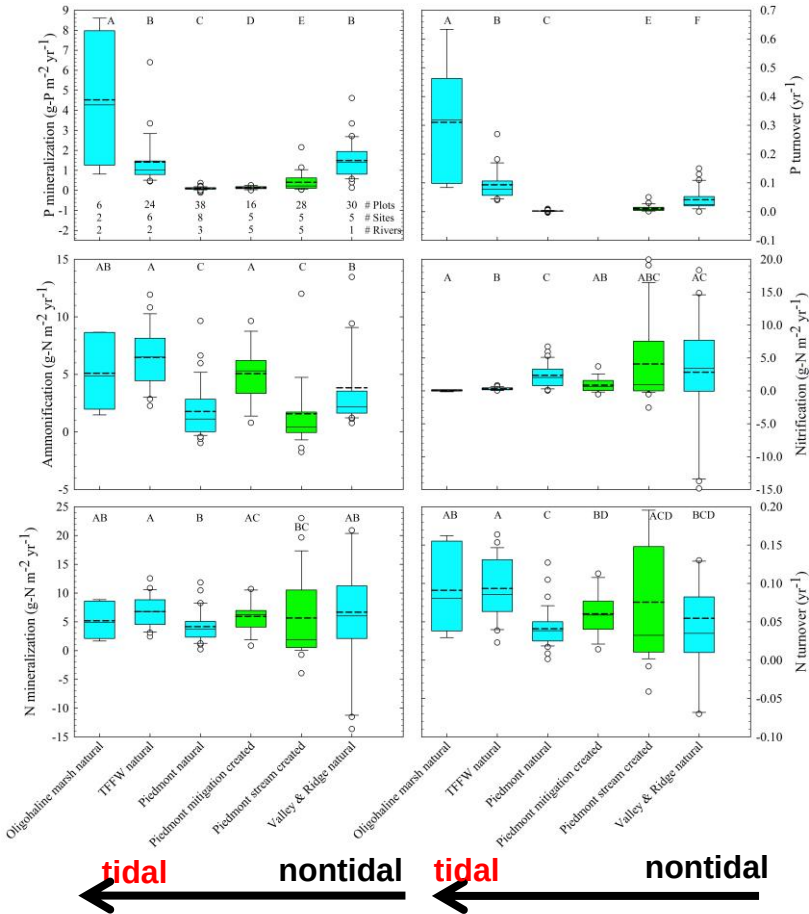
Noe 2011, *SSSAJ.*

Measurement of net NH_4, NO_3, and SRP production
in surficial (0-5 cm) floodplain soils
Using modified resin cores

Non-tidal Chesapeake floodplains:

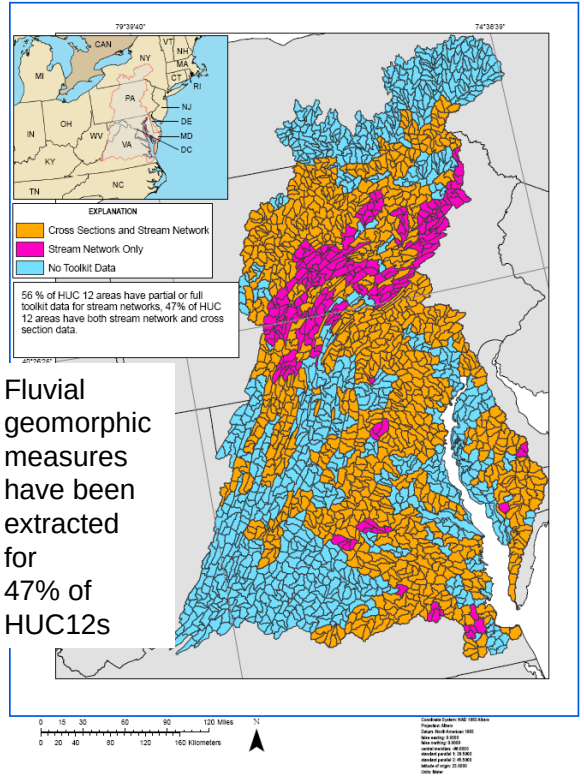
Mean
N turnover = 0.050 yr^{-1} = 20 yr
P turnover = 0.021 yr^{-1} = 48 yr

Difficult Run: suburban Piedmont (Noe et al. 2013)
Created and natural floodplains: rural Piedmont (Wolf et al. 2013)
Smith Creek: agricultural Valley & Ridge (Gillespie et al. In revision)



USGS Stream Channel and Floodplain Metric Toolbox v1.3

provisional results

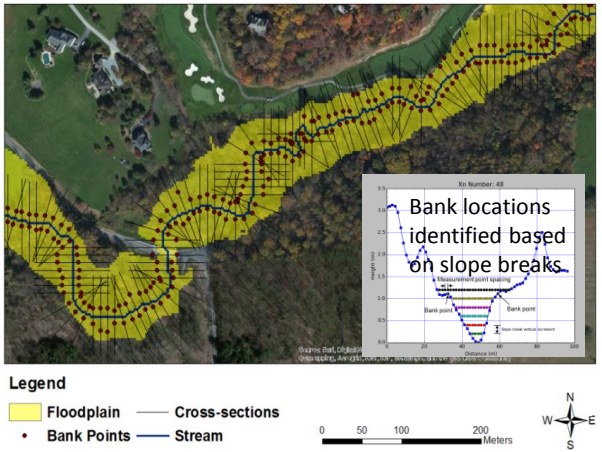


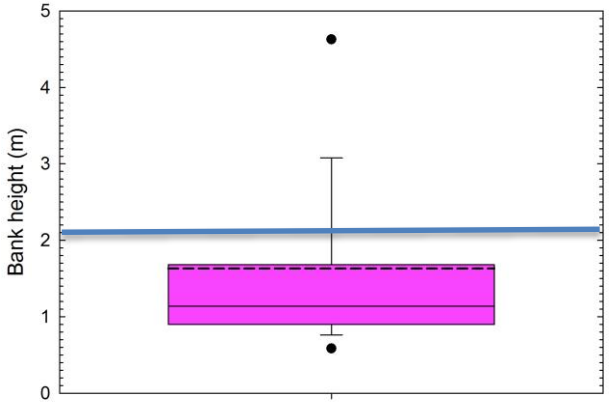
Fluvial geomorphic measures have been extracted for 47% of HUC12s

Channel Cross-section Metrics

- Bank height
- Bank angle
- Channel width
- Bankfull area
- Over-ratio
- Area-ratio
- Floodplain width
- Floodplain elevation range
- Ratios of bank, floodplain, and channel

Output of Layers from USGS Tool





n= 29,955 reaches
Mean = 1.63 m
Median = 1.14 m

CFN sites mean = 2.1 m

Claggett, Lamont, Noe, and others

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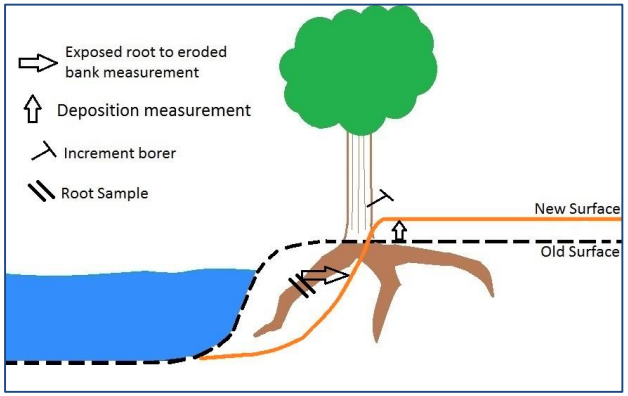
Chesapeake Floodplain Network: bank and floodplain flux

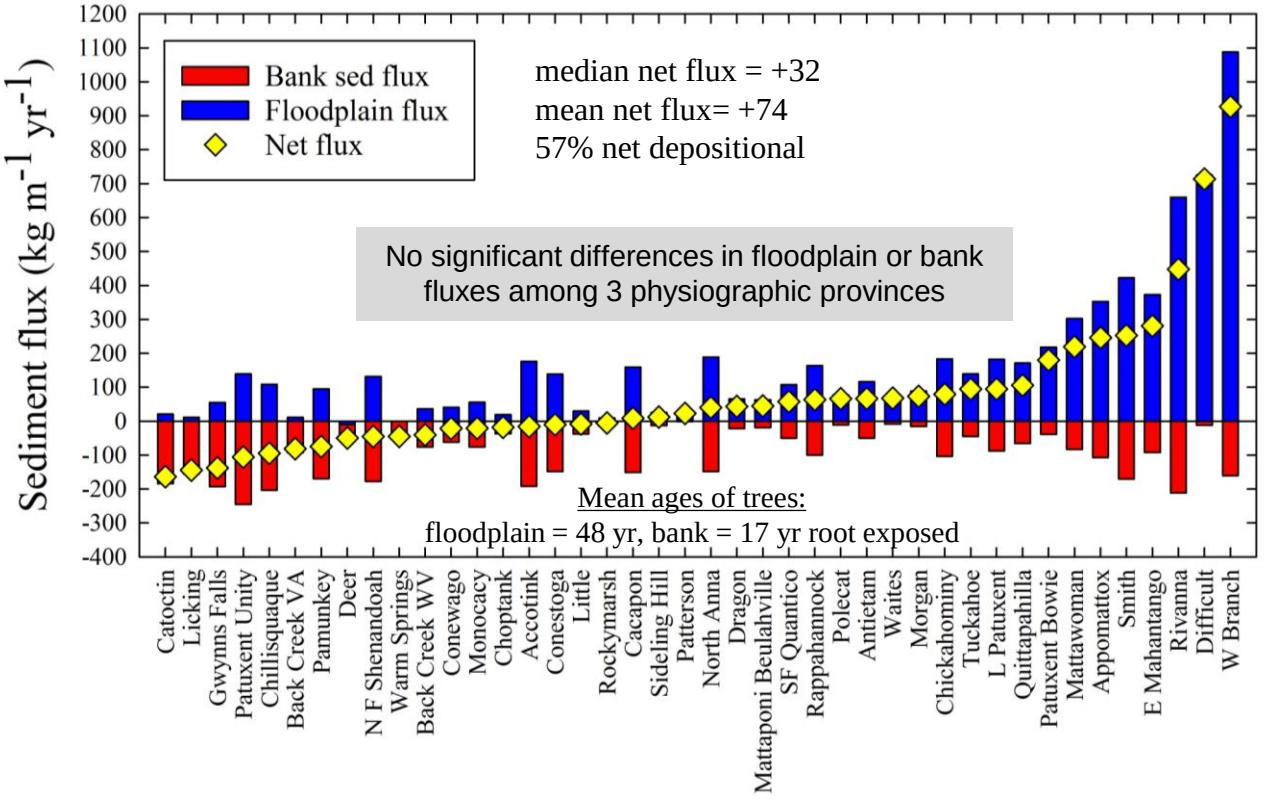
provisional results

Dendrogeomorphic fluxes



Bank flux =
lateral change rate * bulk density * bank height * 2 * Correction

Floodplain flux =
vertical change rate * bulk density * total floodplain width



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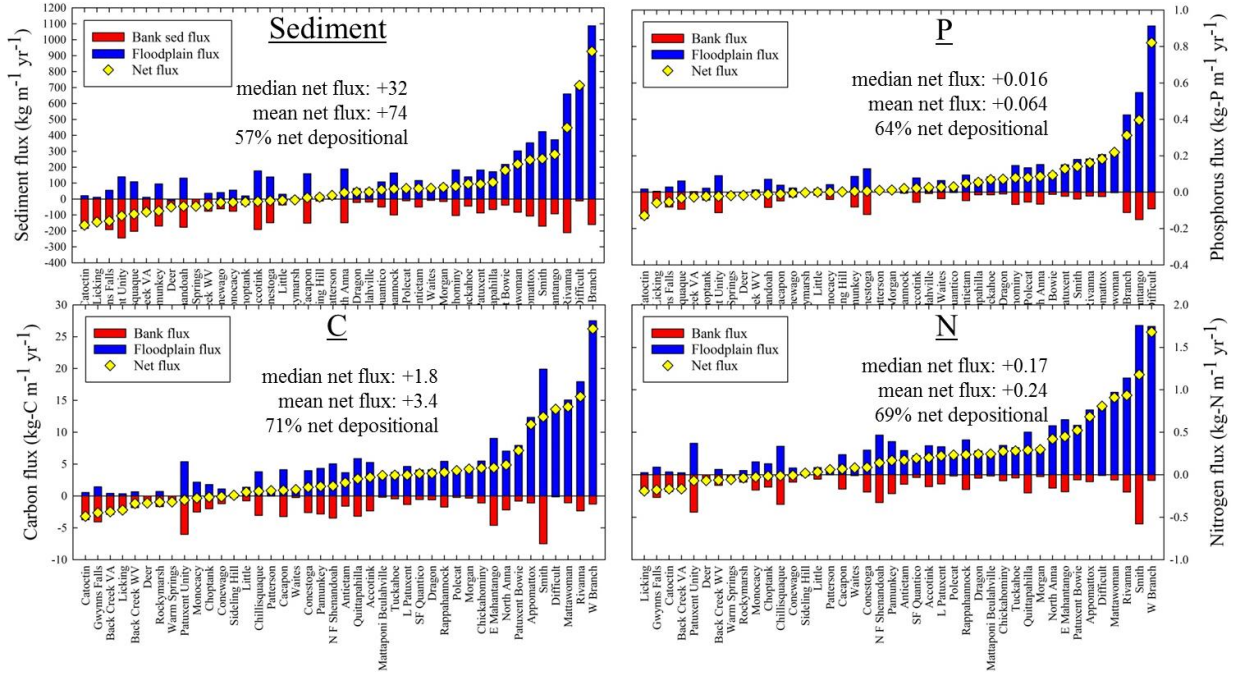
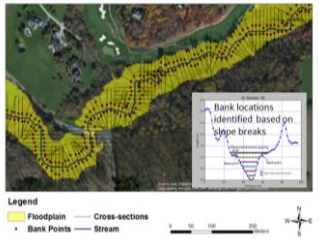
Chesapeake Floodplain Network: modeling of fluxes

provisional results



GIS Geomorphic Toolkit

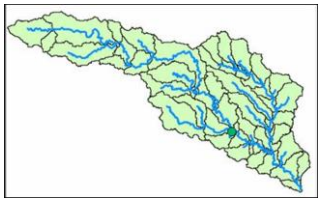
Floodplain width, bank height, channel width, …



best subsets regression using PRESS

GIS Watershed Attributes

Land use, hydrology, soils, topography, upland erosion



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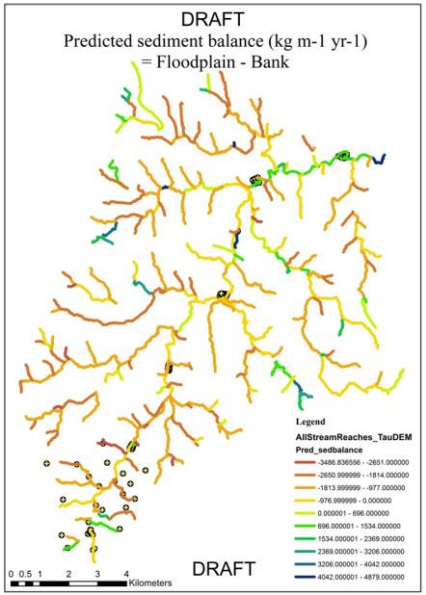
Chesapeake Floodplain Network: predicted loads

provisional results

Difficult Run watershed:
GIS mapping of reach-specific fluxes



RUSLE2 and SDR using new 1-m
Chesapeake Land Use data: ***Peter Claggett***

Fluxes extrapolated to 81,069 NHD+v1 Chesapeake digital stream reaches

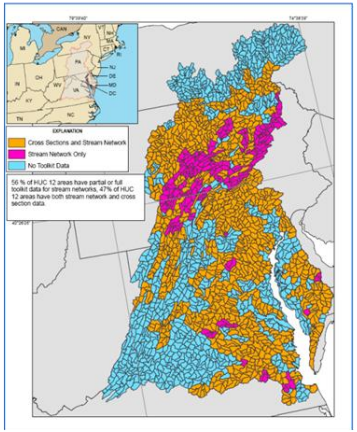
Sum of whole Chesapeake Bay watershed (kg/yr)

DRAFT! v1 to be updated to v2

Upland erosion
-3.8×10^9 sed

Sediment delivery to small streams
-8.0×10^8 sed

(Upland storage)
$+3.0 \times 10^9$ sed



(Net stream balance)
-6.7×10^8 sed
-3.9×10^5 N
$+3.2 \times 10^5$ P

Bank
-8.6×10^9 sed
-1.0×10^7 N
-3.1×10^6 P

Floodplain
$+7.9 \times 10^9$ sed
$+9.7 \times 10^6$ N
$+3.4 \times 10^6$ P

Load to Chesapeake Bay (1990-2015, 9 RIM)
-4.6×10^9 sed
-1.4×10^8 N
-6.3×10^6 P

http://www.chesapeakebay.net/indicators/indicator/sediment_loads_and_river_flow_to_the_bay

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