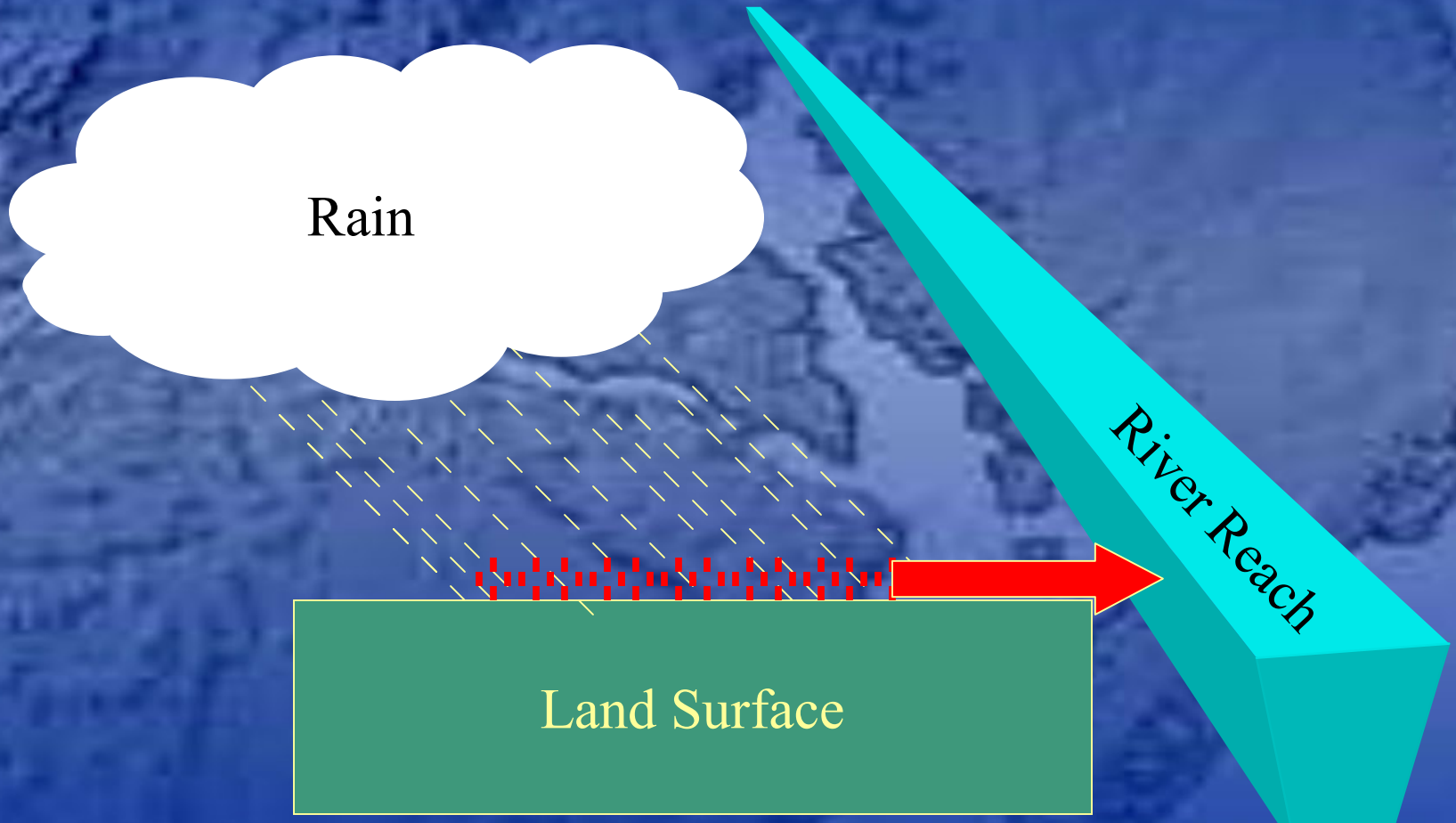
Sediment Calibration Strategies of Phase 5 Watershed Model

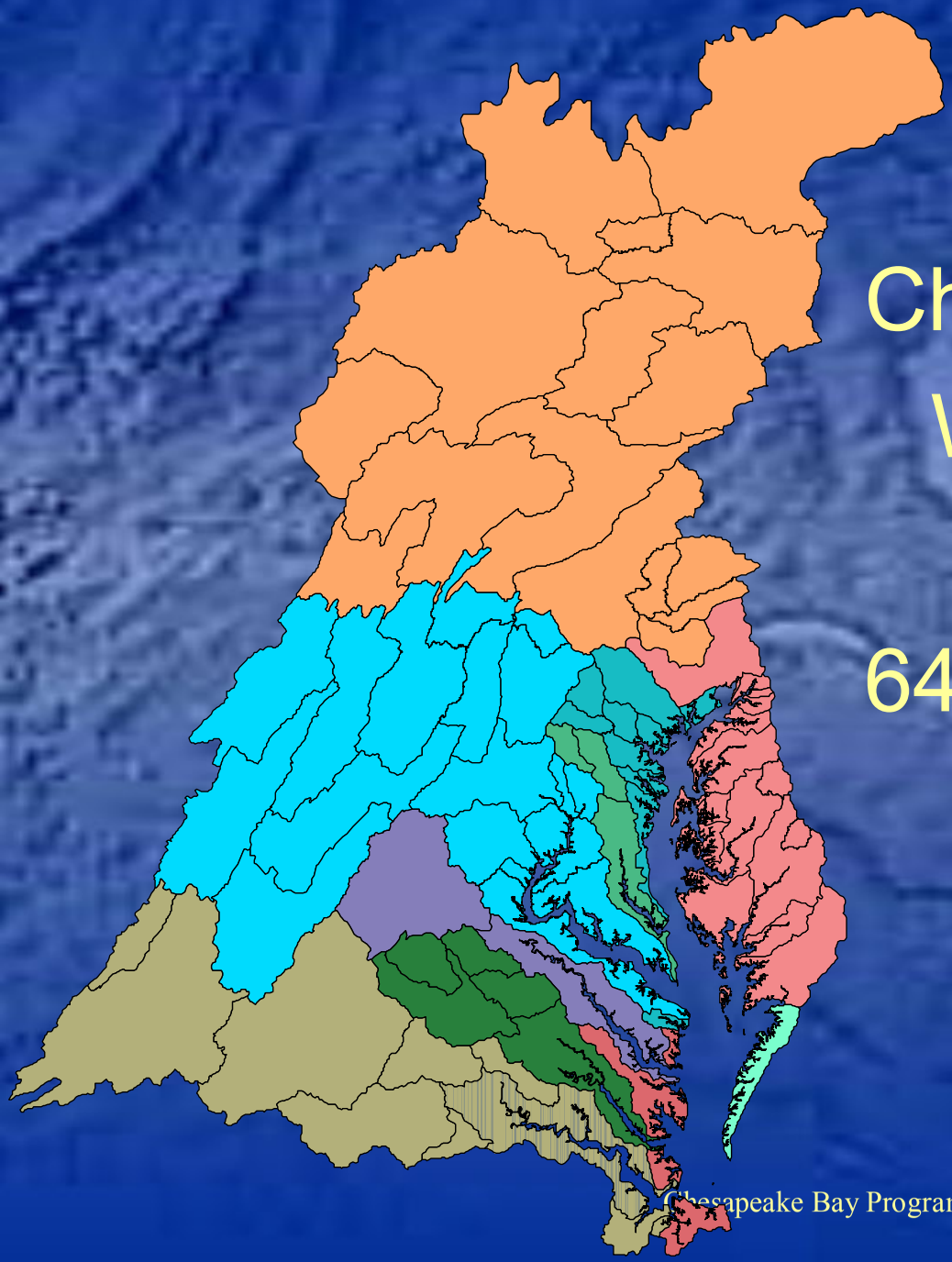
Chesapeake Bay Program Modeling

HSPF Sediment Simulation



Corresponding to model structure, calibration strategies break into…

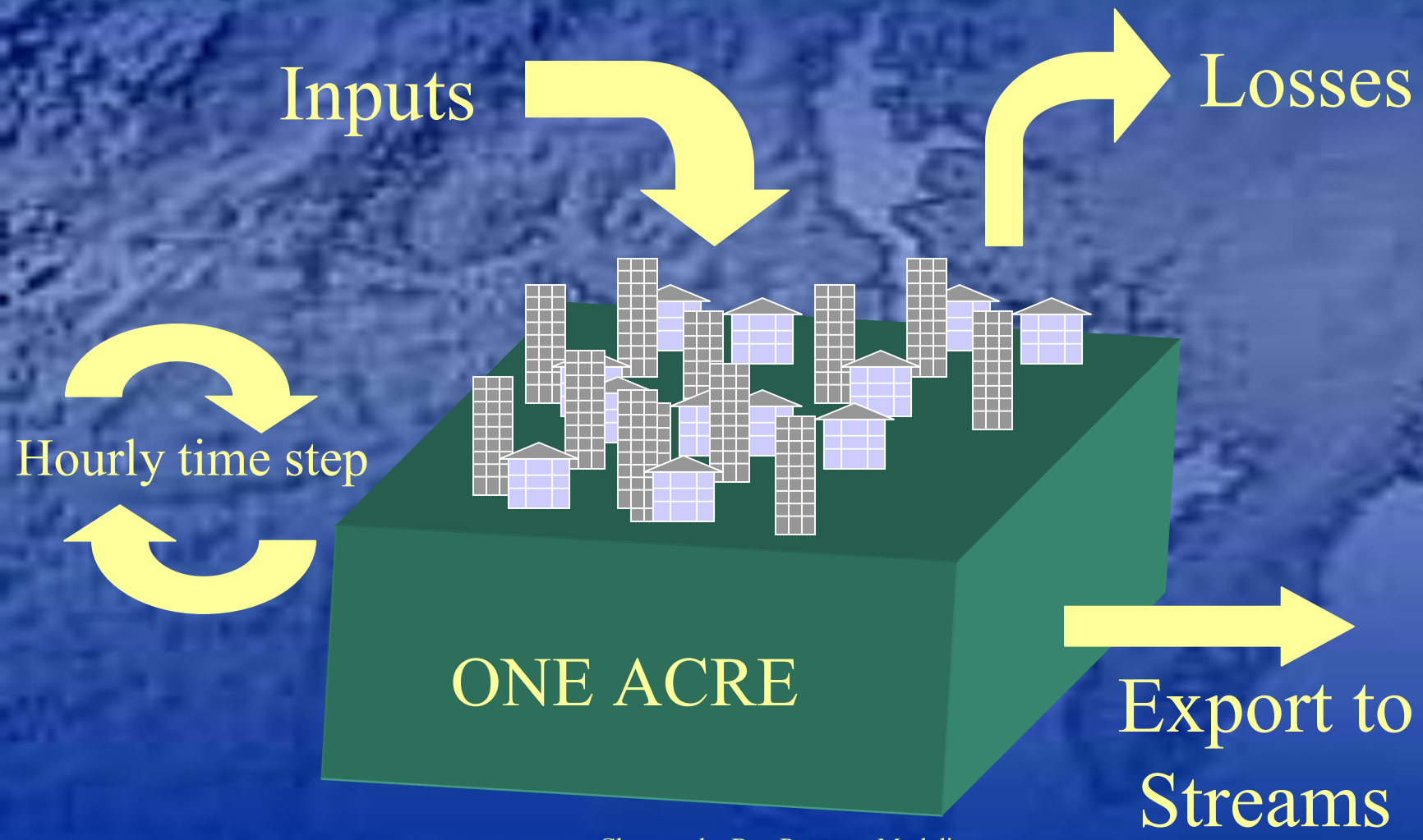
- Land calibration
- River Calibration



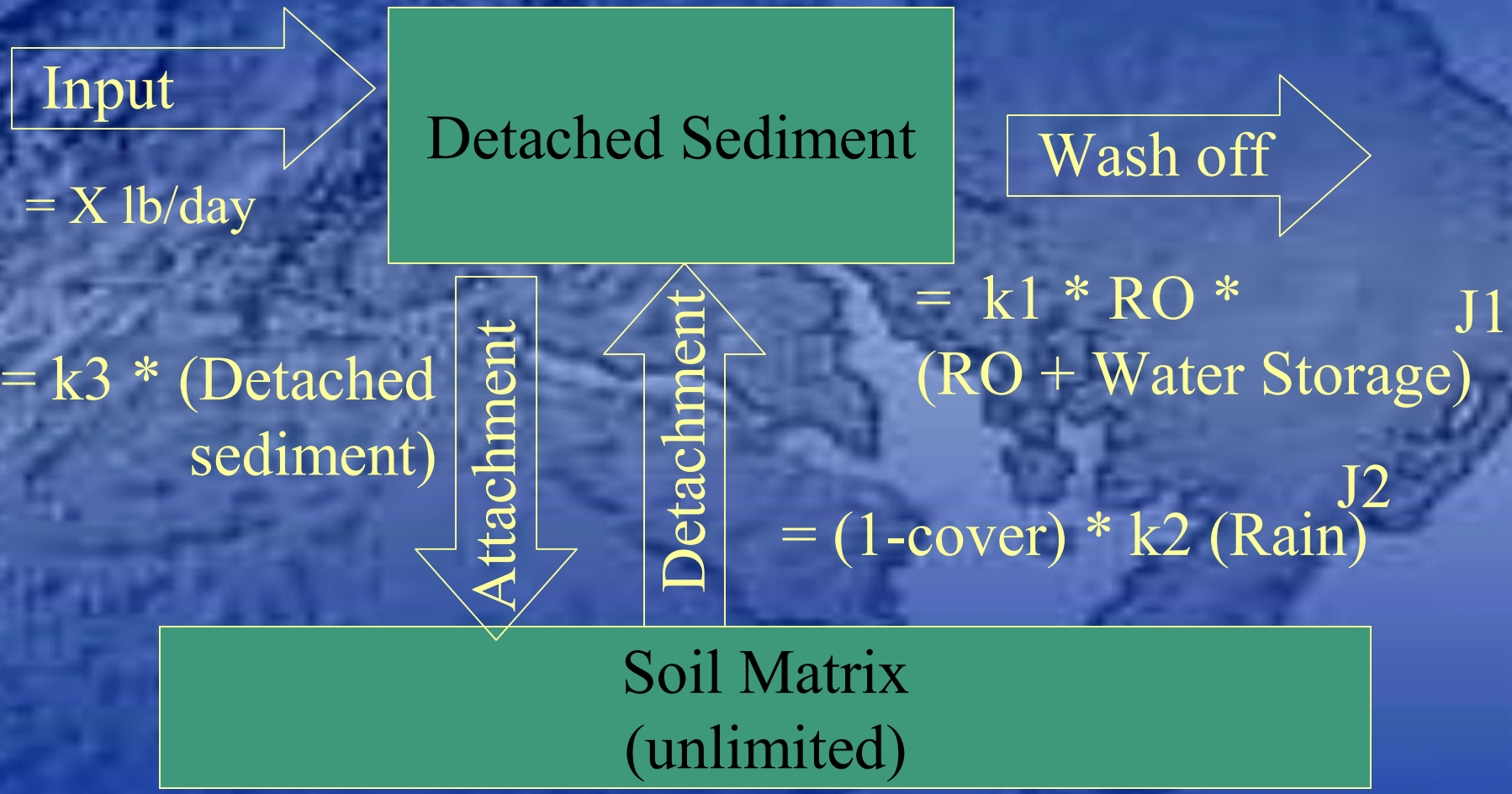
Chesapeake Bay Watershed

64,000 square miles

Watershed Model Land Simulation



Land Sediment Simulation



Land Calibration

- Calibrate Edge of Field to RUSLE supplied by NRI
- split into major land uses

13 Land use categories for sediment:

Group 1 -

- Forest
- Harvested Forest
- Natural grass
- Extractive
- Barren
- Pervious Urban
- Impervious Urban
- water

Group 2 -

- Pasture
- Hay
- High till with manure
- High till without manure
- Low till with manure

For Each Land Use in group 1:

- Mean EOF for entire watershed reach to target
  - Keep land parameters same everywhere
  - Use different energy in hydrological processes to drive the difference

- Reasons:
  - Only ONE EOF value available
  - Avoid over-parameterization

For Each Land Use in group 2:

- EOF targets available at county level
- Reach EOF county by county
- Different land parameters

Decision Rules for Four Key land Parameters:

- Rule1 – Set re-attachment rate so that sediment storage reaches 90% of asymptotic value in 30 days.

$$\frac{dS}{dt} = NVSI - AFFIX * S$$

$$S = \frac{NVSI}{AFFIX}(1 - e^{-AFFIX*t})$$

Detached Sediment

Attachment

= AFFIX * (Detached sediment)

AFFIX = 0.07673

- Rule2 – Vertical Input high enough for hysteresis

NVSI (lb/acre/day)= a * target load (lb/acre/yr)

Assumed a =0.5

	for	hvf	grs	pur	…
NVSI	0.93	9.32	4.11	3.01	…

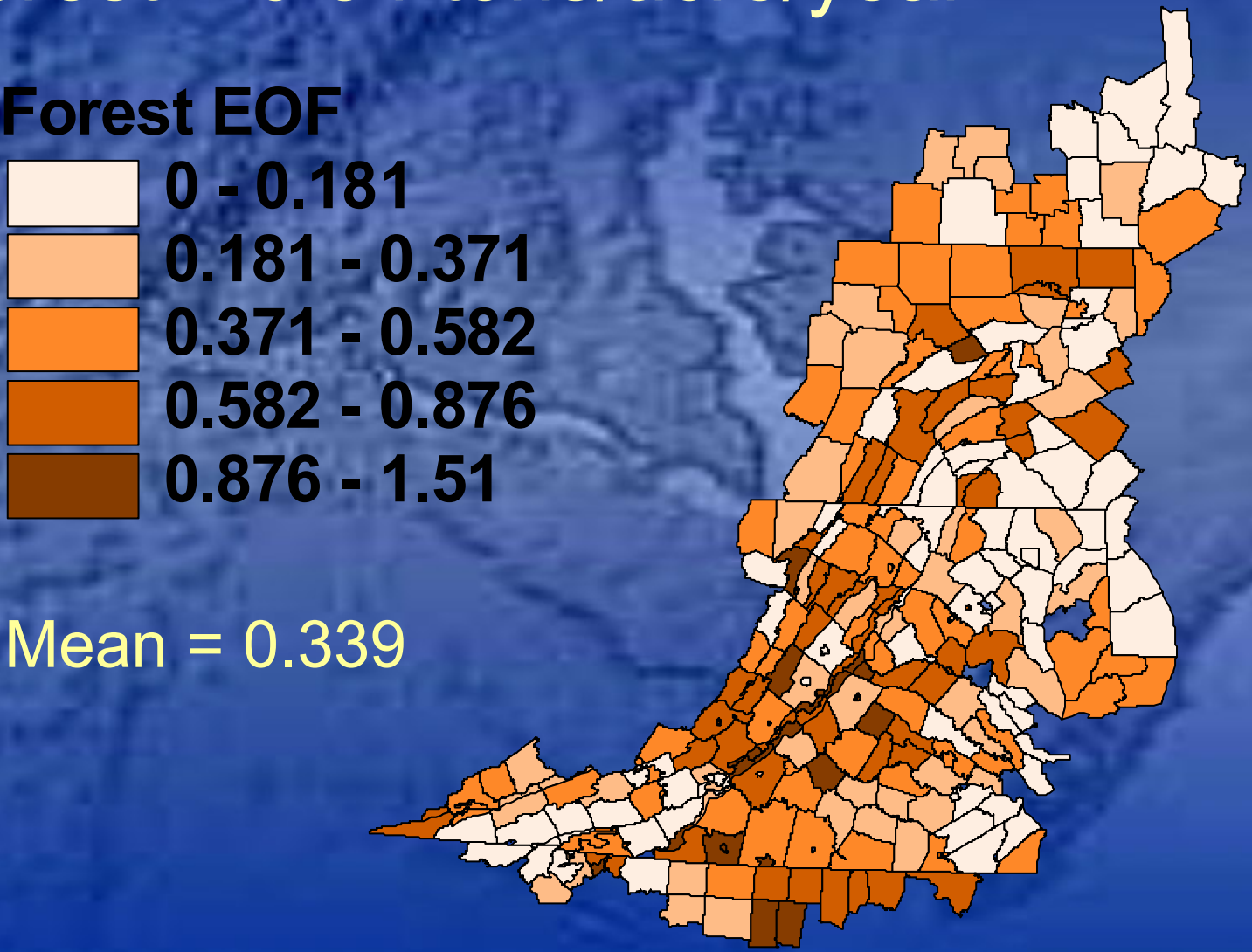
- Rule 3 - Zero Detached Sed after Large Storms

Adjust KRER and KSER

- No build-up after most big storms

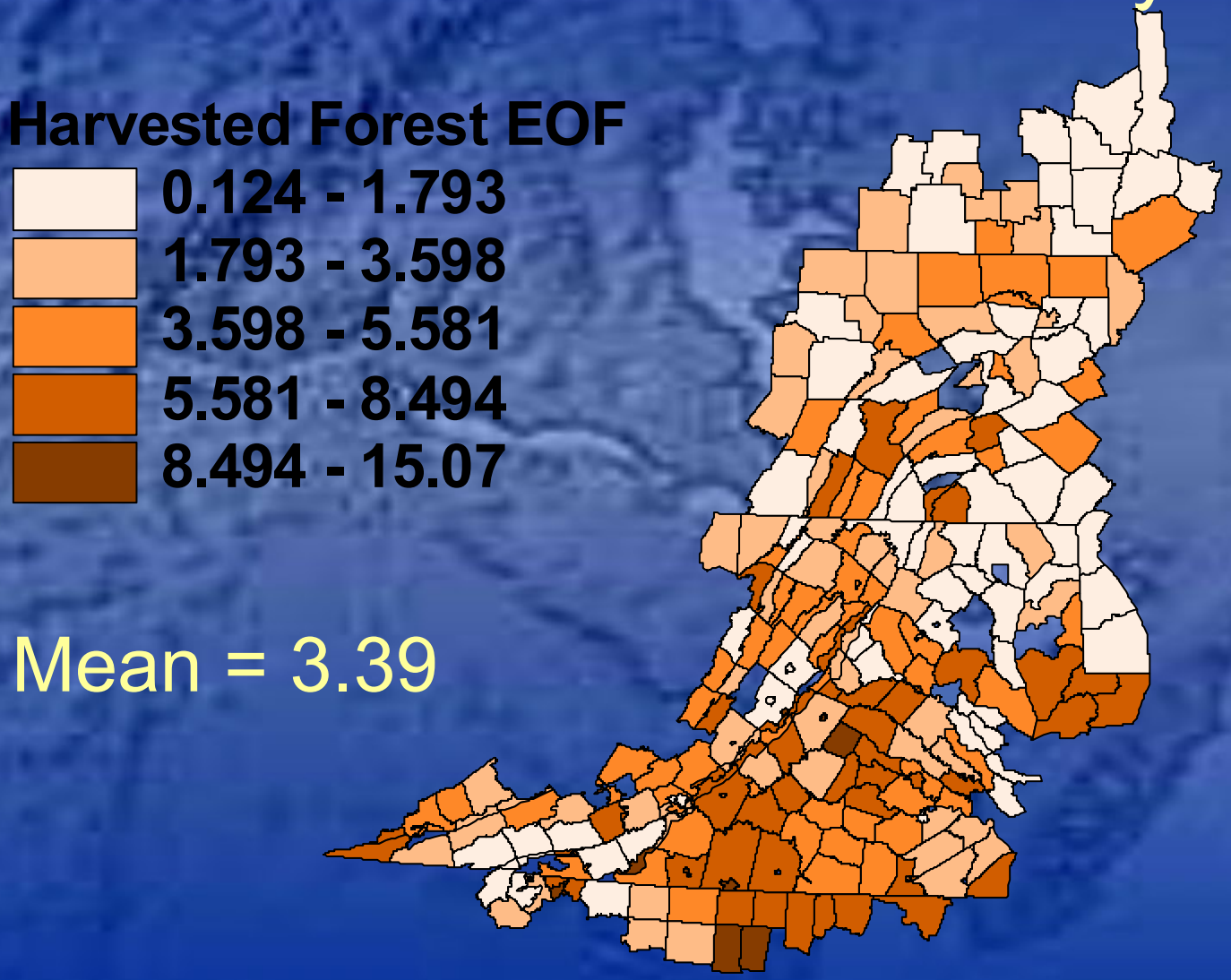
- Reach to NRI targets

Forest – 0.34 tons/acre/year



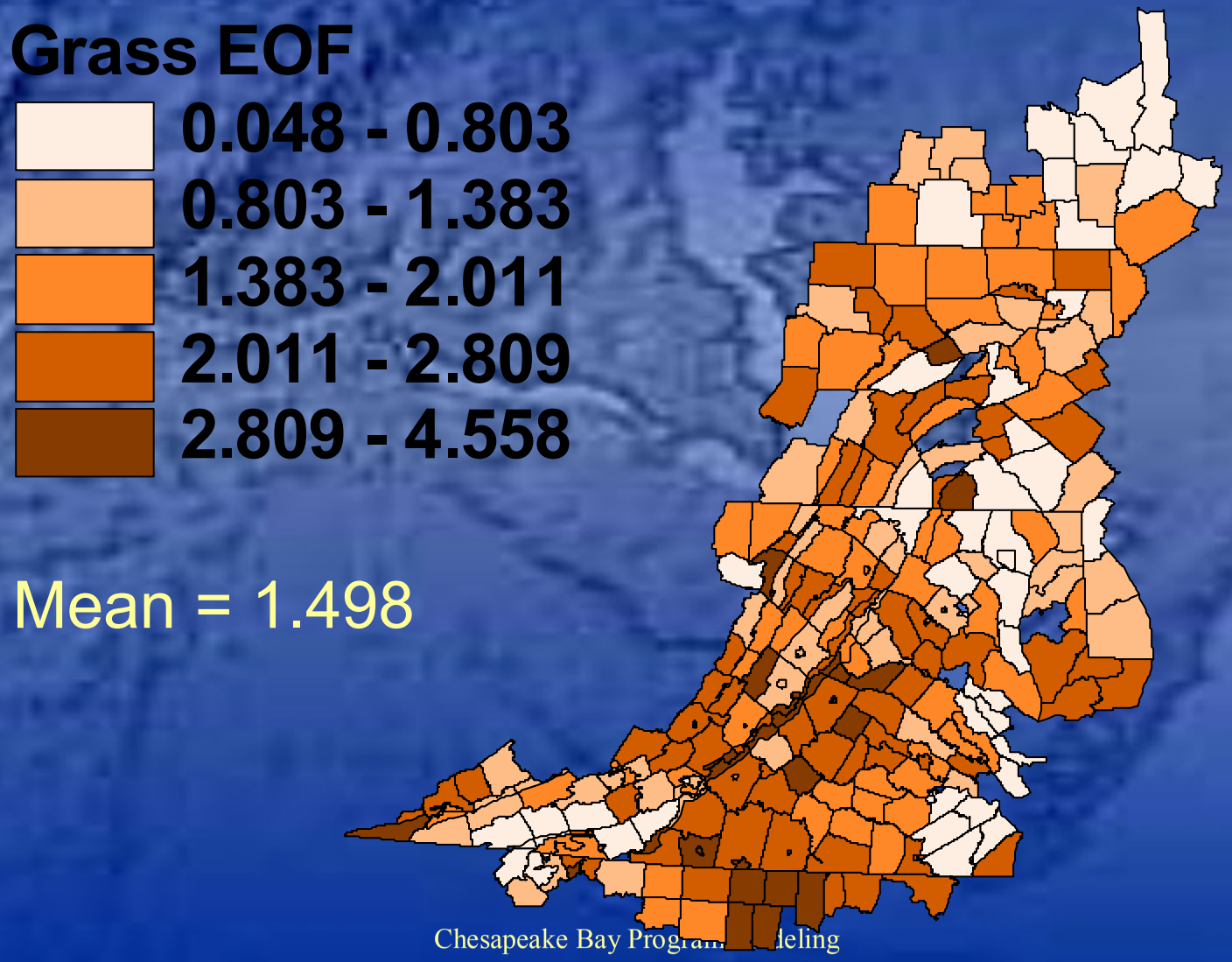
Mean = 0.339

Harvested Forest – 3.4 tons/acre/year



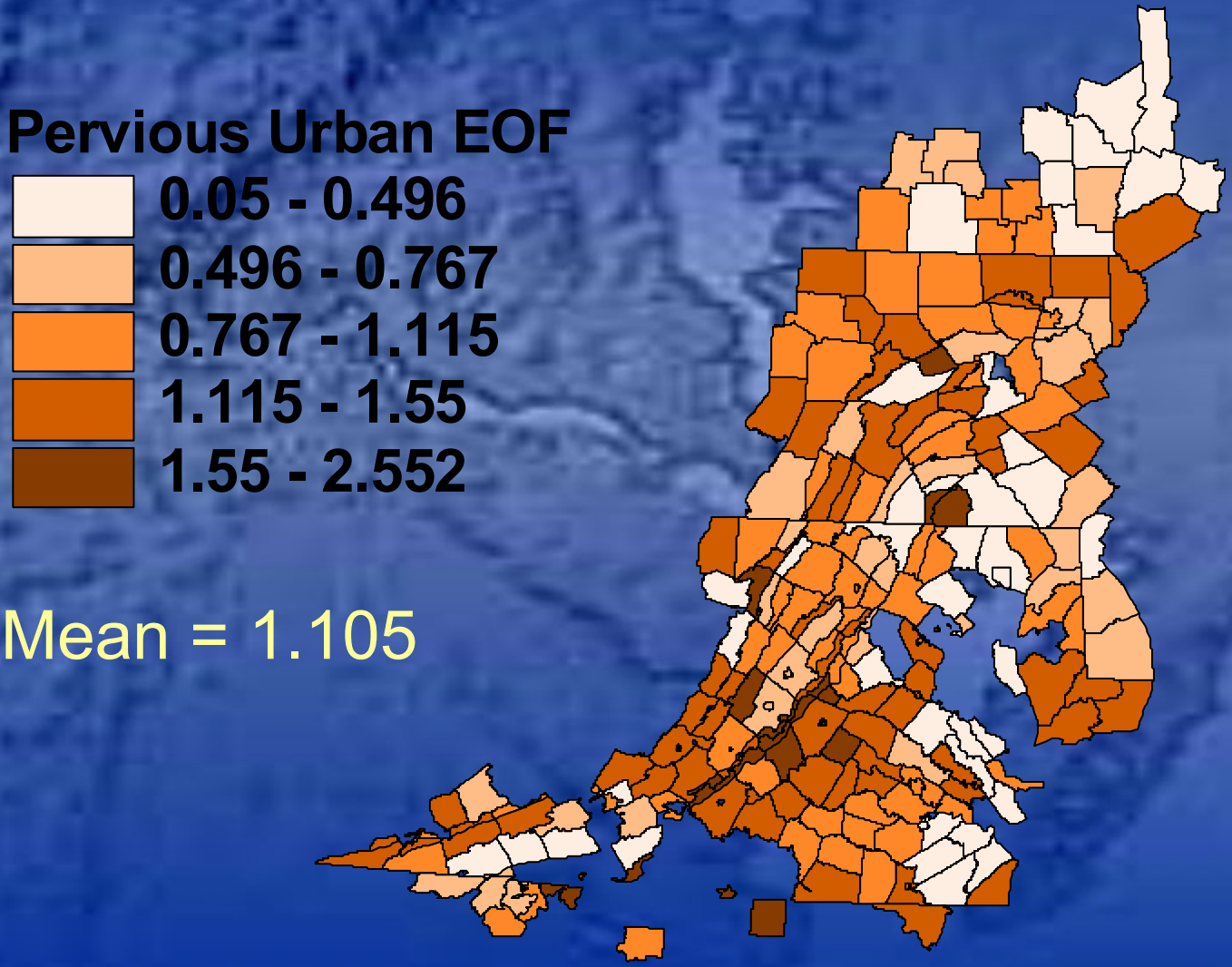
Mean = 3.39

Natural Grass – 1.5 tons/acre/year



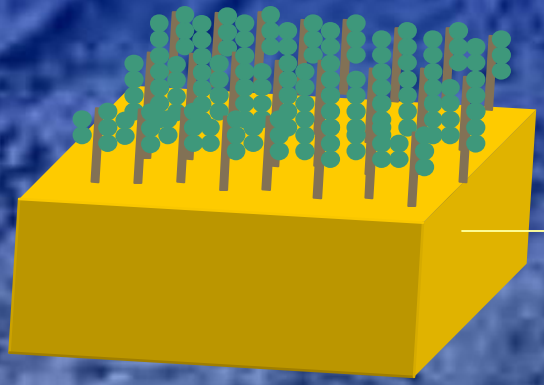
Mean = 1.498

Pervious Urban –1.1 tons/acre/year



Mean = 1.105

Land-River Connection



Edge of Field

BMP factor

Land Acre Factor

Delivery Factor

Edge of Stream

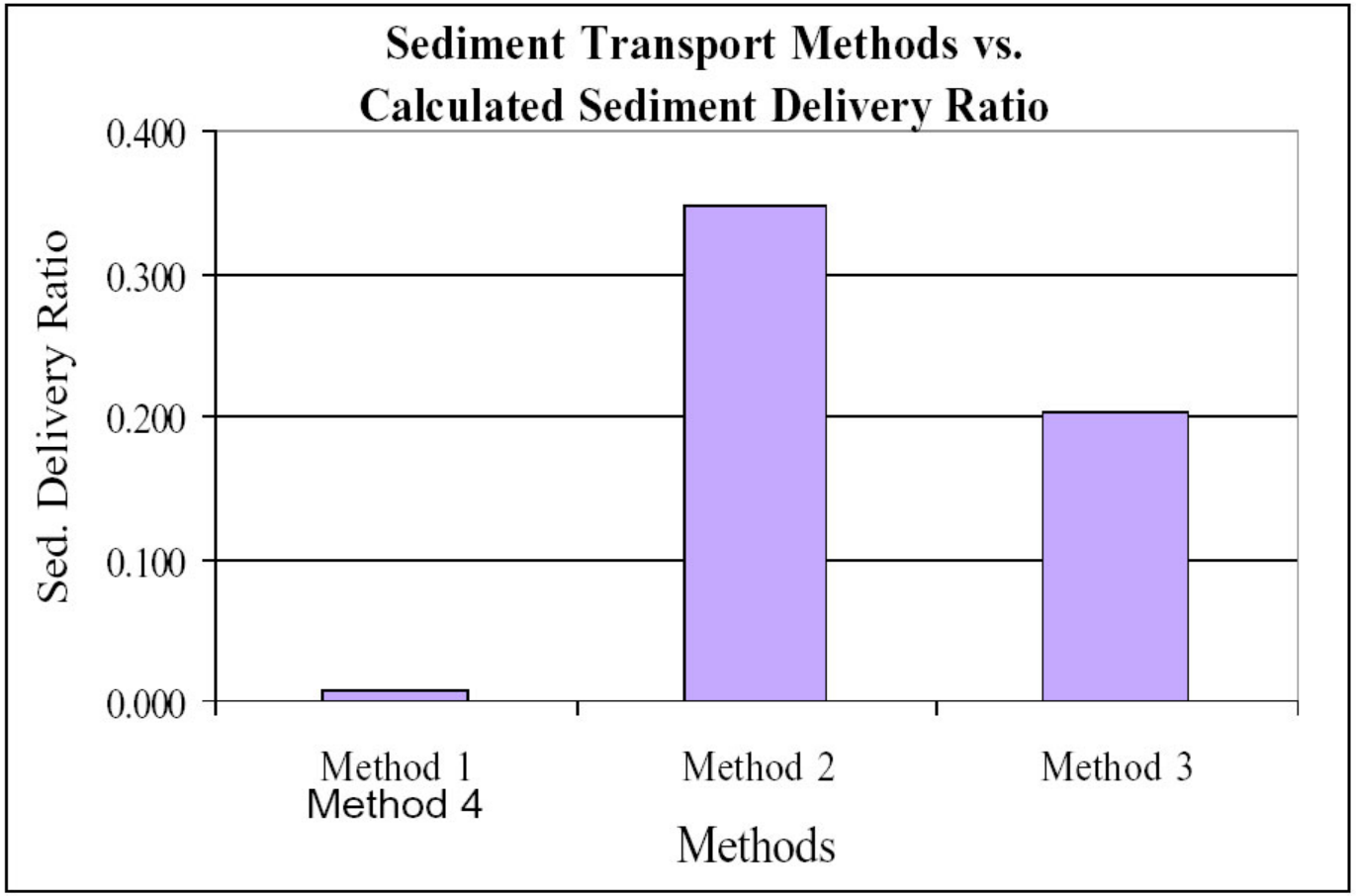
Ideal delivery factor

- Vary by segment
- Vary by land use type
- Vary by flow condition

- Last two are like a finer segmentation scheme

Delivery factor methods
EPA region 4 sediment tool

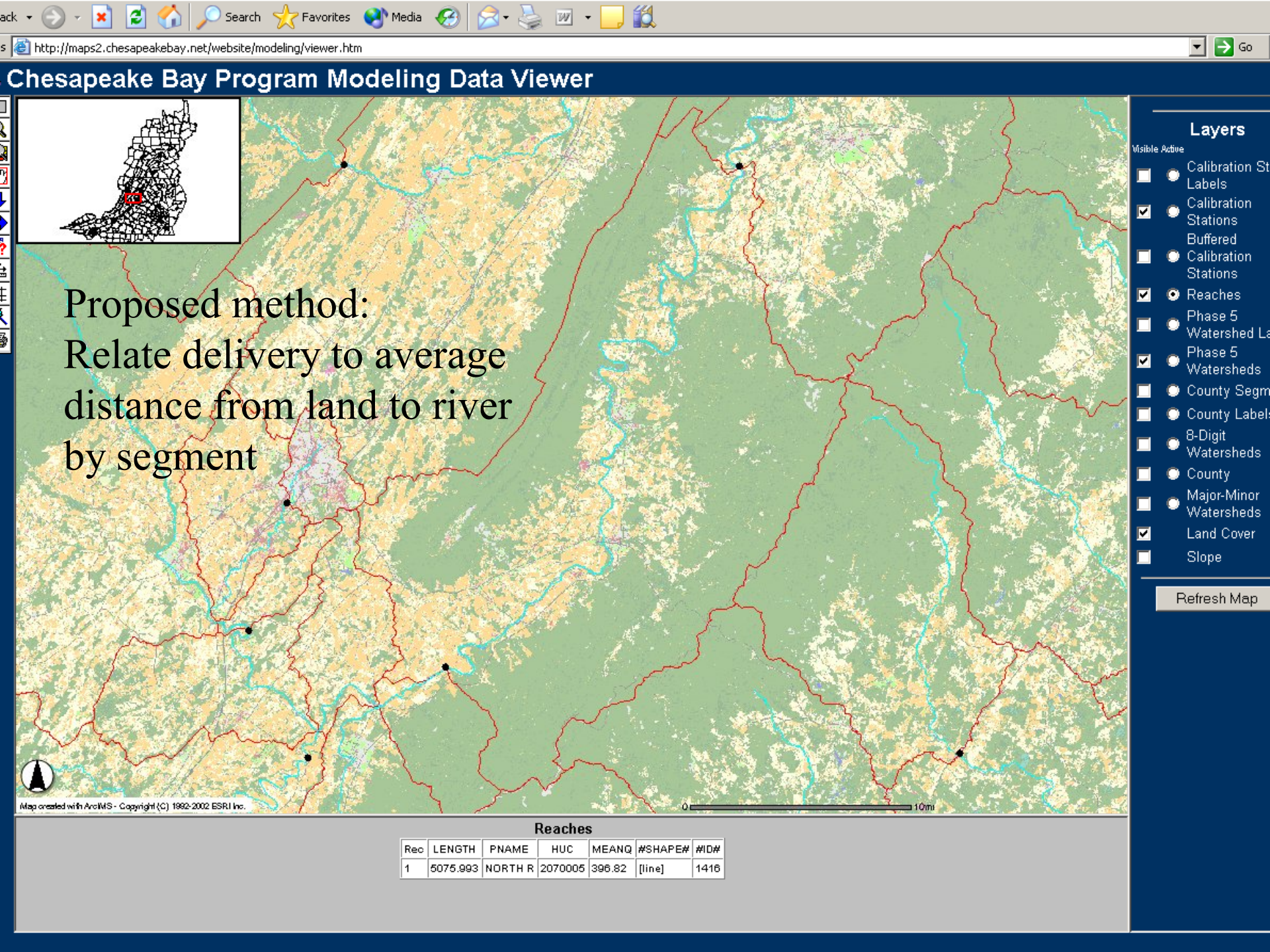
- DF = (1 - 0.97 * L / C) (sun and Mcnulty 1998)
- DF = exp(-0.4233*L*exp (-16.1* (Y/L + 0.057)) - 0.6) (Yagow 1988)
- DF = 0.417762 * A $^{-0.134958}$ - 0.127097 (SCS 1983)
- DF = .9004 - .1341 (lnL) - .0465 (lnL)2 +.00749 (lnL)3 - .0399 (lnY) +.0144 (lnY)2 +.00308(lnY)3 (Swift 2000)


Sediment Transport Methods vs.
Calculated Sediment Delivery Ratio
Sed. Delivery Ratio
0.400
0.300
0.200
0.100
0.000
Method 1
Method 4
Method 2
Method 3
Methods

SCS method Adopted

- Similar to successful phase 4 method
- Less data intensive and more stable that other methods
- Not particular to a land use type

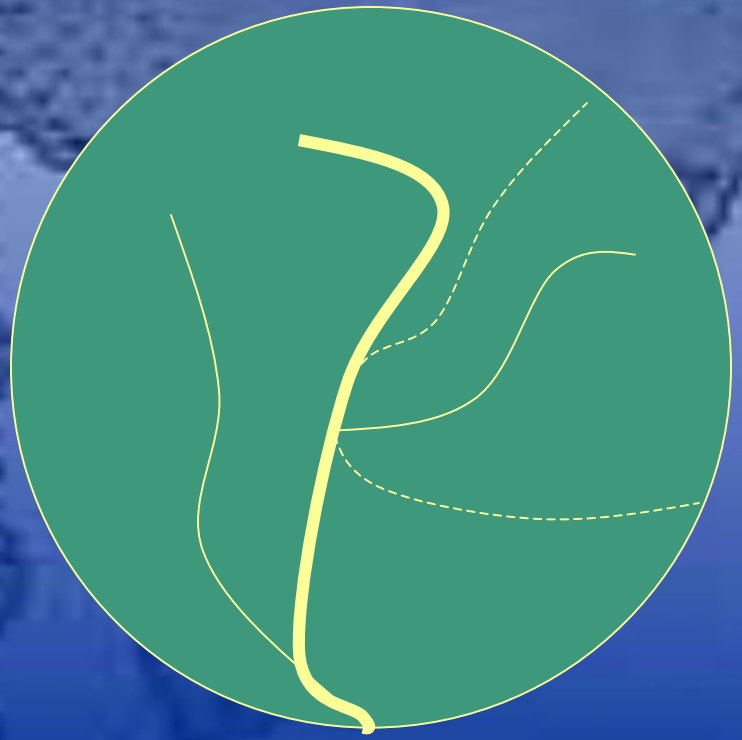
- $DF = 0.417762 * A^{-0.134958} - 0.127097$


Search
Favorites
Media
http://maps2.chesapeakebay.net/website/modeling/viewer.htm
Go
Chesapeake Bay Program Modeling Data Viewer
Proposed method:
Relate delivery to average distance from land to river by segment
Layers
Visible Active
Calibration St Labels
Calibration Stations
Buffered Calibration Stations
Reaches
Phase 5 Watershed La
Phase 5 Watersheds
County Segm
County Label
8-Digit Watersheds
County
Major-Minor Watersheds
Land Cover
Slope
Refresh Map
Map created with ArcIMS - Copyright (C) 1982-2002 ESRI Inc.
0
10mi
Reaches
Rec | LENGTH | PNAME | HUC | MEANQ | #SHAPE# | #ID#
1 | 5075.993 | NORTH R | 2070005 | 396.82 | [line] | 1416

Single factor for each land use in each segment

- Related to watershed size
- Unique for each Land use
- Assume mean distance is the radius of a circle

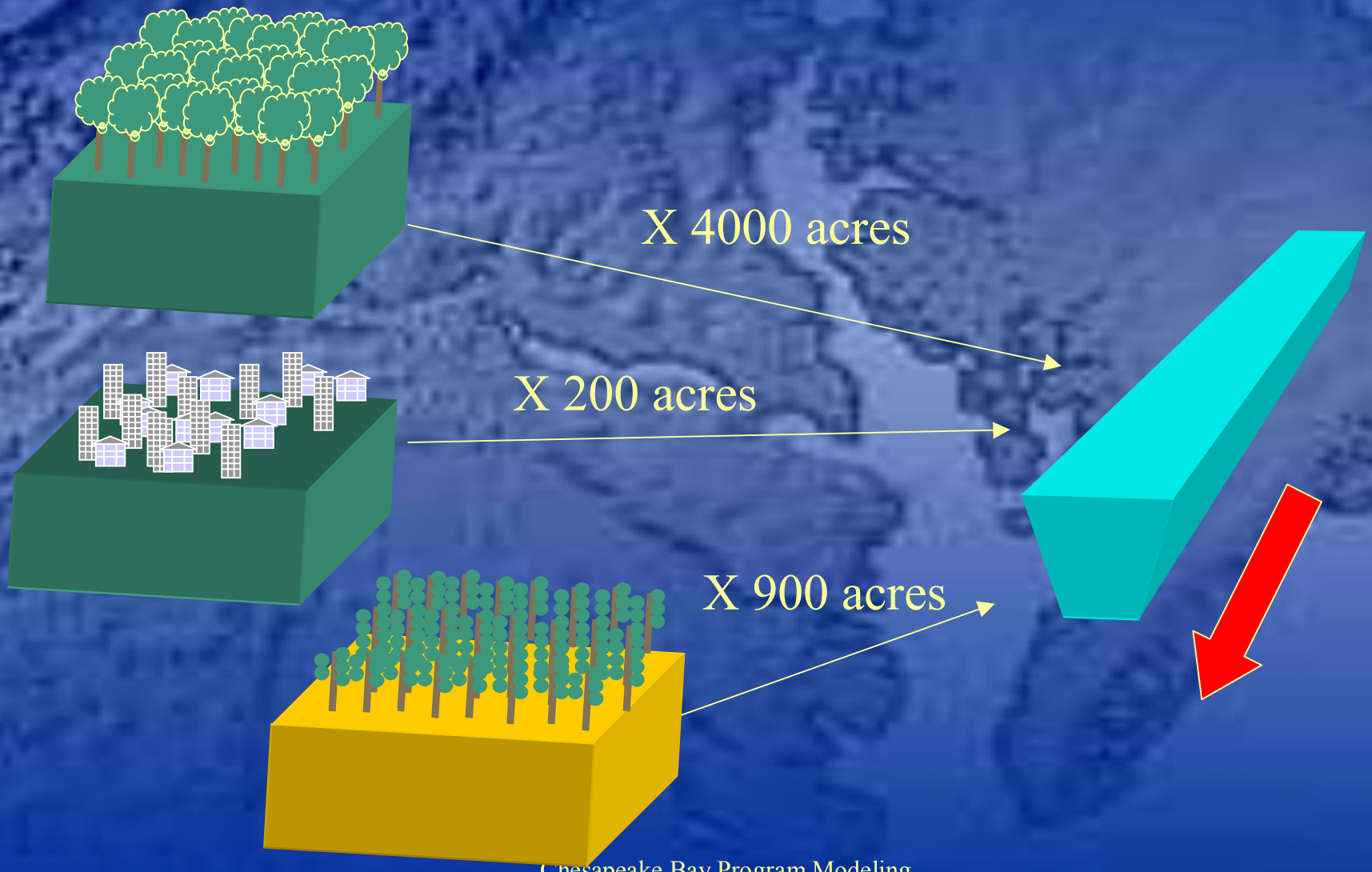
$A = \pi * (\text{mean distance})^2$



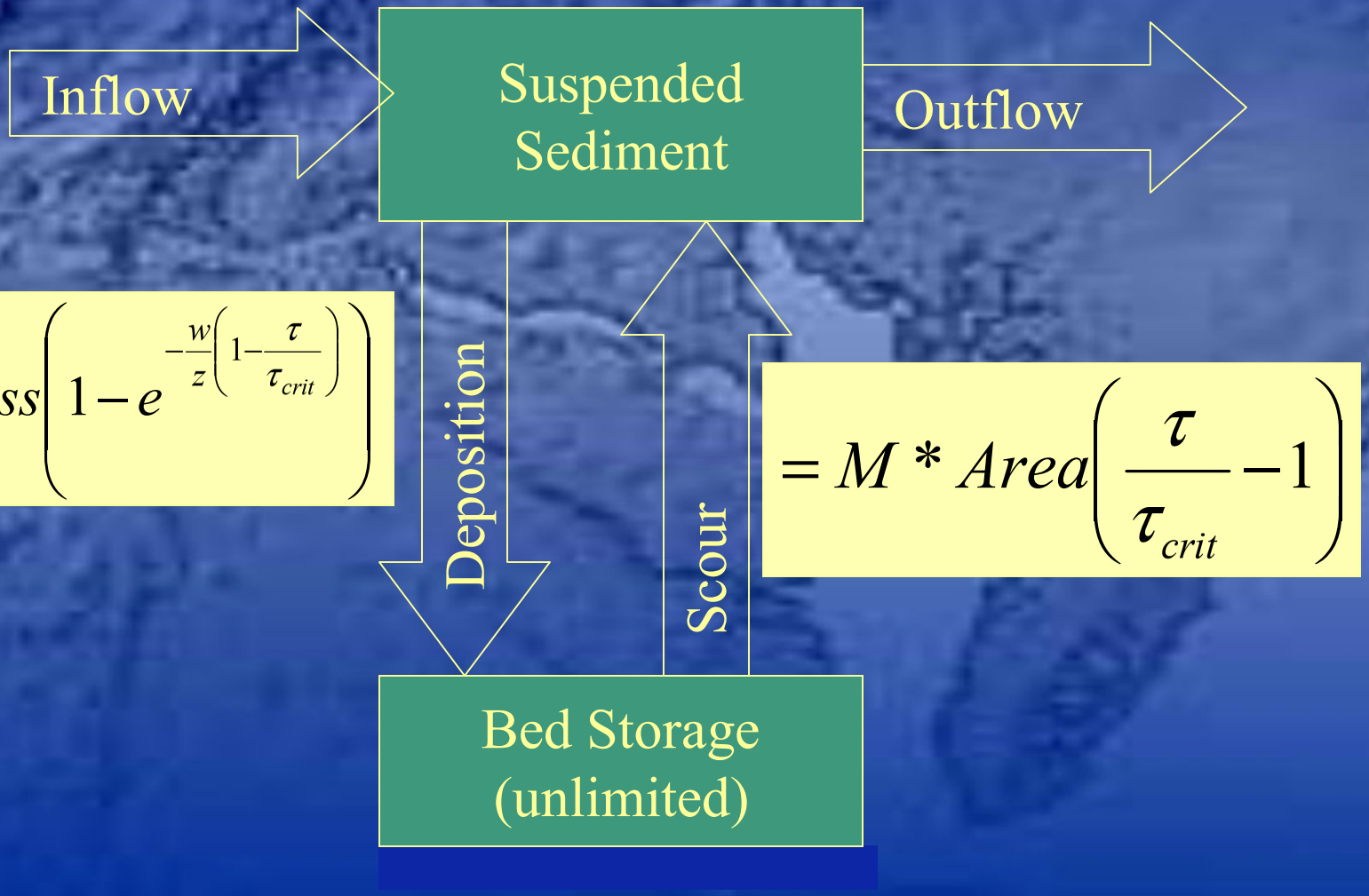
Some Preliminary Results -

river	land	forest	Ag	bare	extract	grass	urban
DE0_2590_0000	A10003	0.1750	0.1509	0.1885	0.2114	0.1672	0.1866
DE0_2600_0000	A10003	0.2572	0.2352	0.2568	0.2515	0.2884	0.2522
EL0_5151_0000	A24019	0.1622	0.1407	0.1463	0.1124	0.1412	0.1300
EL0_5271_0000	A24047	0.1698	0.1937	0.1447	0.1737	0.2996	0.2280
MN3_8190_8260	A51111	0.1053	0.0996	0.1205	0.0564	0.1300	0.0935
MN3_8190_8260	A51117	0.1571	0.1481	0.1362	0.0981	0.1021	0.1244
NR3_8420_8430	A51063	0.1342	0.1386	0.2352	0.1541	0.1243	0.1364
NR3_8420_8430	A51121	0.1704	0.1633	0.1069	0.3977	0.4393	0.1785
PS2_6730_6660	A51015	0.1805	0.2390	0.1876	0.1995	0.1963	0.2249
PS2_6730_6660	A51820	0.3544	0.4745	0.2961	0.3358	0.3029	0.3763
PS3_5100_5080	A51171	0.1752	0.1555	0.2149	0.1932	0.0940	0.1906
SL2_1670_1880	A42037	0.1937	0.1929	0.2564	0.1927	0.1941	0.1969
SL2_1670_1880	A42097	0.2146	0.1893	0.3024	0.1828	0.1772	0.1882
SU2_0780_0710	A42115	0.2153	0.2106	0.2049	0.3429	0.1613	0.2449

Land-River Connection



River Cohesive Sediment Simulation

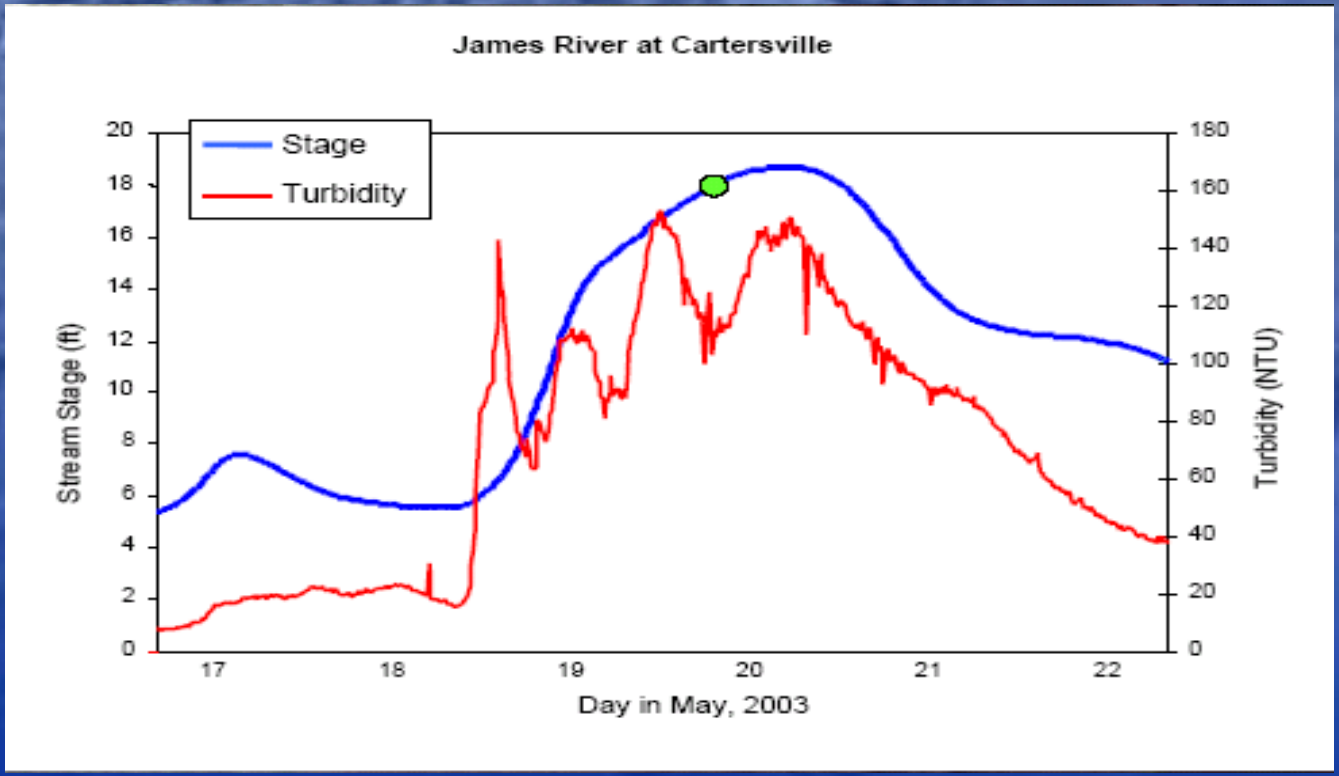


River Calibration

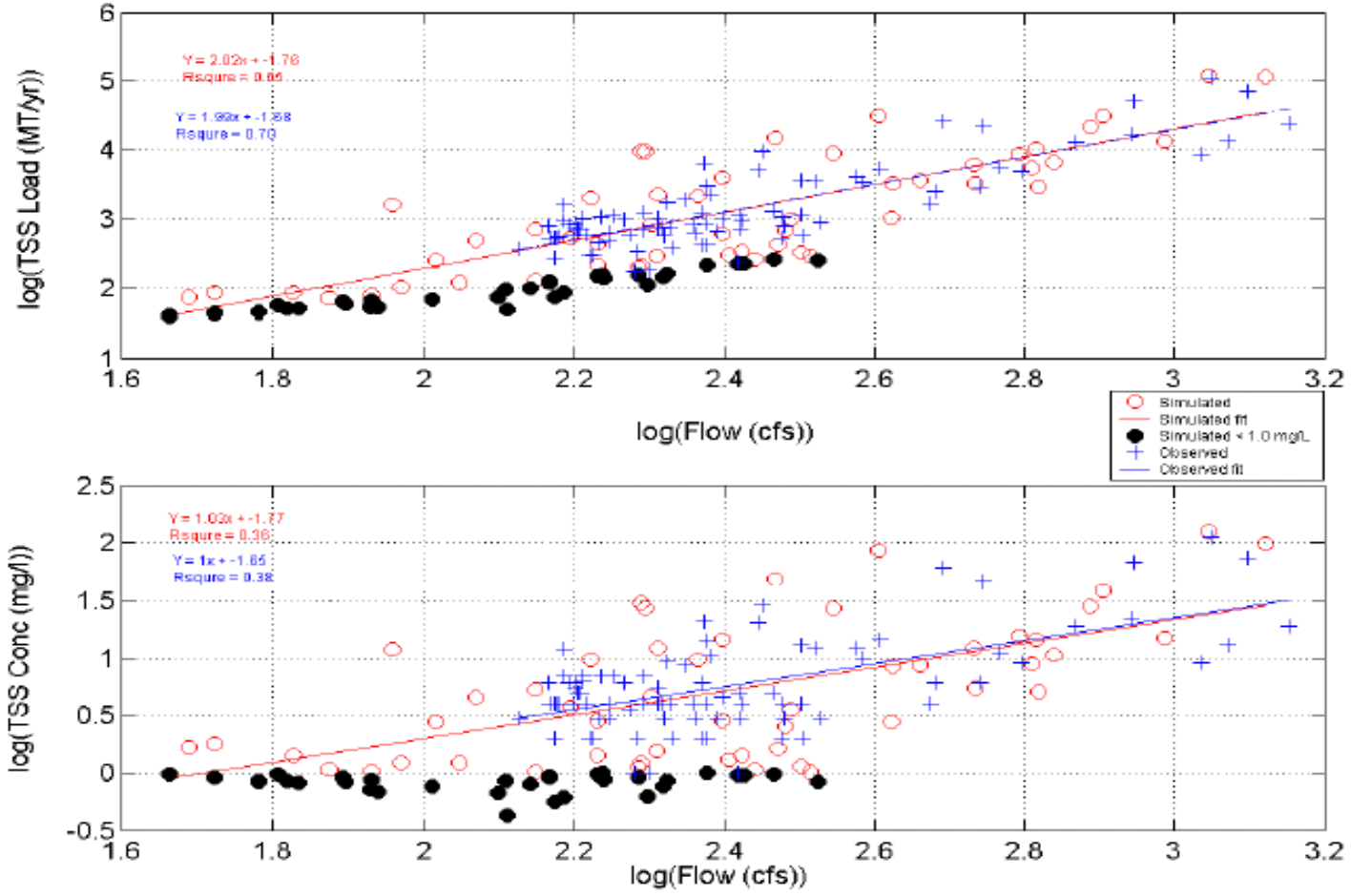
- 70 USGS Gauging Stations
- Four Strategies:
  - Rating curve
  - Change of bed depth
  - Deposition/scour
  - Cal5 statistics

- Sediment rating curve

- Three different rating curves:
  ascending, descending, and base flow



- Compare observed and simulated



- Change of bed depth

- Time series of bed depth for each river
- The probabilities of bed depth within limits

segment	Ave.(feet)	frac>0.	frac>3.	frac>5.	frac>6.	frac>6.5	frac>7.	frac>10
RU2_5220_5640	5.964	1.0	1.0	1.0	0.0088	0	0	0
RU2_5500_5610	5.241	1.0	1.0	0.7192	0.0068	0	0	0
RU2_5810_5610	5.692	1.0	1.0	1.0	0.0088	0	0	0
RU2_6090_6220	3.115	1.0	0.1562	0.0231	0.0002	0	0	0
RU2_6200_6170	9.317	1.0	1.0	1.0	1.0	0.9814	0.8684	0.3363
RU2_6220_6170	6.969	1.0	1.0	1.0	1.0	0.9537	0.8414	0
RU4_6040_6030	6.231	1.0	1.0	1.0	1.0	0	0	0
RU5_6030_0001	6.126	1.0	1.0	1.0	1.0	0	0	0

- Deposition/Scour

- Related to total annual loads
- Help identifying source areas

segment	Annual (ton)	perc	frac>0.	frac>3.	frac>5.	frac>6.	frac>6.5	frac>7.	frac>10
RU2_5220_5640	-6738.681	-0.312	1.0	0.1124	0.097	0.0921	0.0901	0.0884	0.0782
RU2_5500_5610	-71439.17	-0.897	1.0	0.124	0.1124	0.1083	0.1074	0.1062	0.1003
RU2_5810_5610	-27653.86	-0.811	1.0	0.0966	0.0858	0.0813	0.0796	0.0782	0.071
RU2_6090_6220	-83947.27	-0.92	1.0	0.1574	0.1498	0.1474	0.1469	0.1461	0.1418
RU2_6200_6170	19611.254	0.1545	1.0	0.1578	0.1469	0.141	0.1382	0.1363	0.131
RU2_6220_6170	42971.332	0.7128	1.0	0.2607	0.2393	0.2317	0.2282	0.2243	0.2108
RU4_6040_6030	31663.875	0.2134	1.0	0.3653	0.3399	0.3299	0.3264	0.3224	0.3078
RU5_6030_0001	10227.578	0.0384	1.0	0.3201	0.2826	0.2734	0.2671	0.2624	0.2458

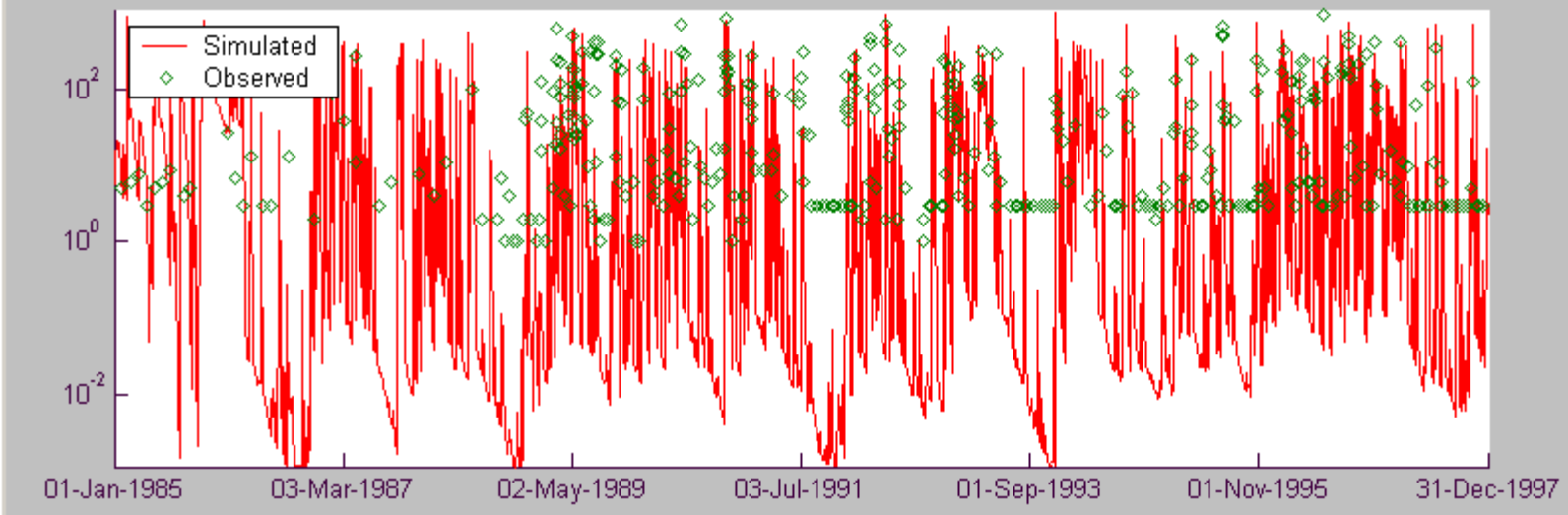
- Cal5 Statistics

- Mean, Correlation, Variance and Model Efficiency
- Calculated for both load and concentration
- Base and log scale

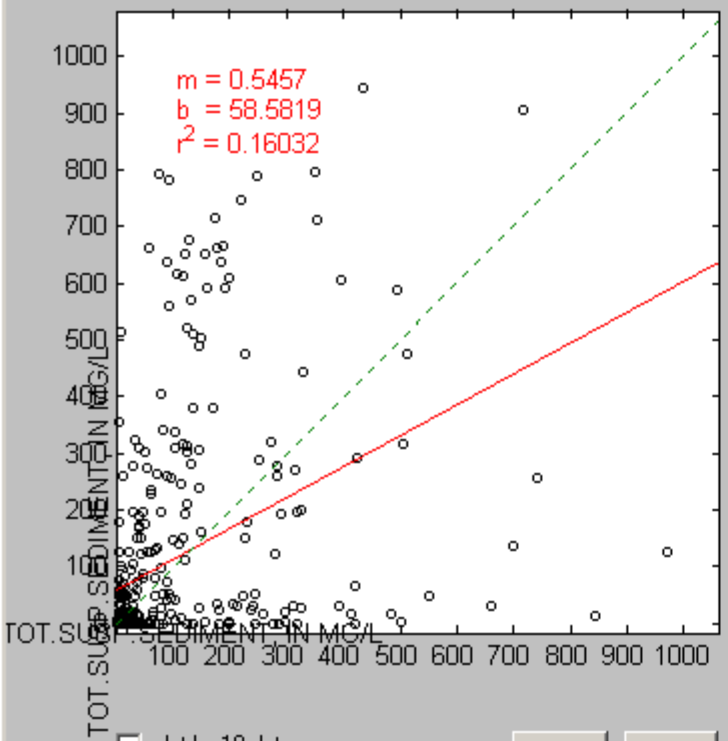
cal5

load precipitatio | hide precipitatio | hide observed value | y-axis log-scale | Examine | Print

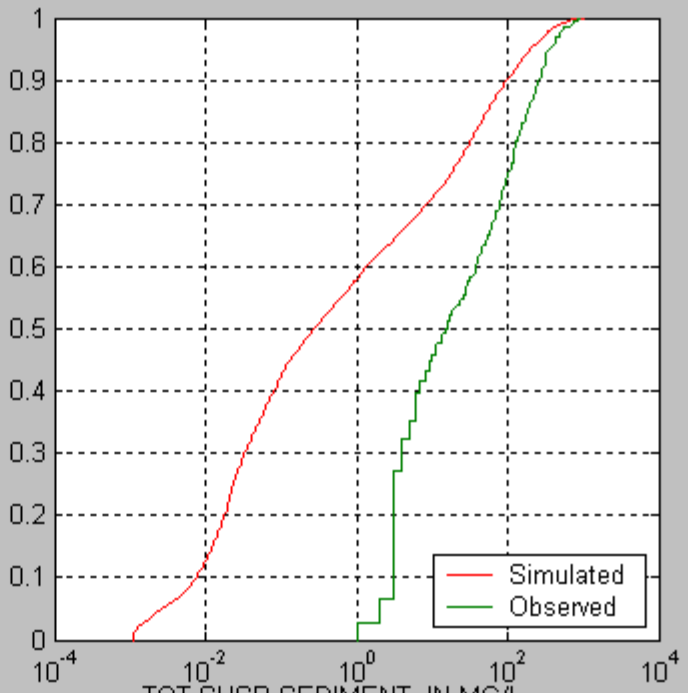
RAPPAHANNOCK R: TSSX TIME-SERIES



RU5-6030-0001: SIMULATED VS. OBSERVED



RU5-6030-0001: EMPIRICAL CUMULATIVE DISTRIBUTION



DATA SELECTION

scenario: qbsed | RU5_6

plot data: TSSX - total suspended se

min: 1/1/1985 | ma: 12/31

Update Plots and Stat

STATISTICS

	observed	sim
n	388	
min	1	0
	0	
mean	82.9175	
	1.29933	
median	15.5	
	1.19011	0
max	972	
	2.98767	
variance	19788.7	
	0.625286	
JB	0	
	.76354e-00	.147
	raw	
% rel.bias	25.2212	
err.var.	35386.3	
rel.std.err	1.7882	
mod.eff	-0.788202	

Residual P

Percentile F

Daily Accumu

Individual Month

Accumulated Mon

Print All

Save as PD

Comments & Suggestions