Use of Physical Habitat Data to Estimate Channel Vulnerability: Example from the Dry Creek Watershed

Lilly Allen, Walker Wieland, Barbara Washburn

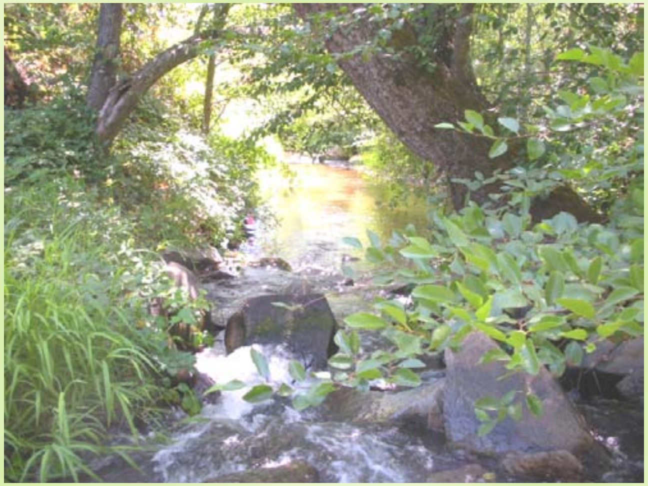
Ecotoxicology Program, Office of Environmental Health Hazard Assessment

Andy Collison, *Philip Williams and Associates*

Eric Berntsen, *State Water Board*

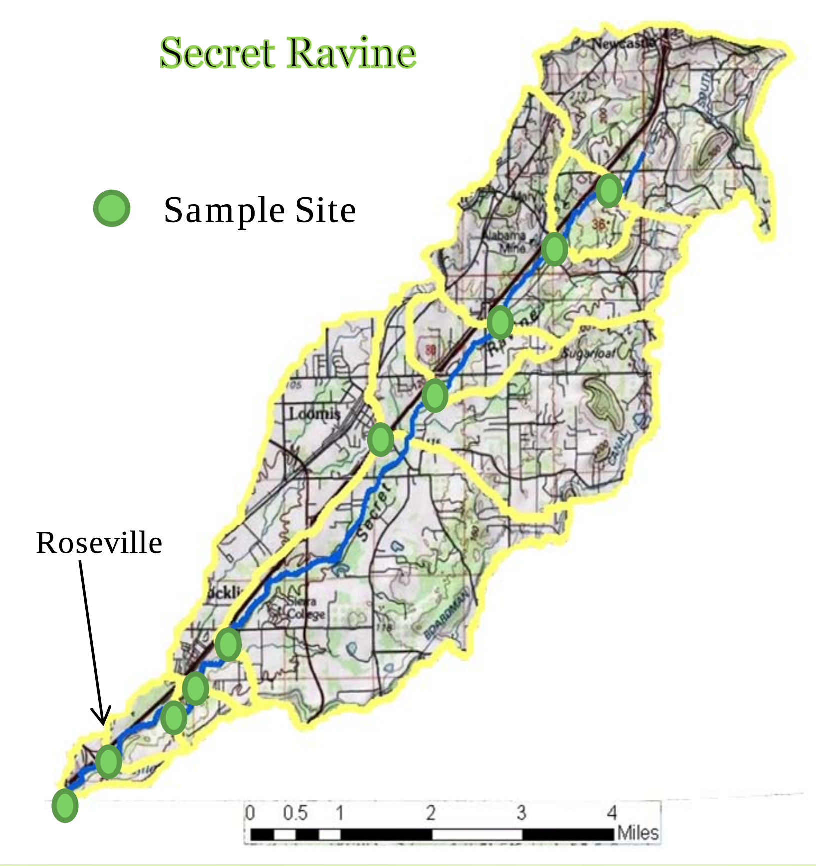
Background

- Assess the vulnerability of Secret Ravine (SR) to erosion
- Test and troubleshoot the Channel Vulnerability Calculator
  - Originally developed as a hydromodification management tool for Contra Costa county
  - Evaluate the Calculators usefulness as a tool for watershed assessment, utilizing data collected with the PHAB protocol

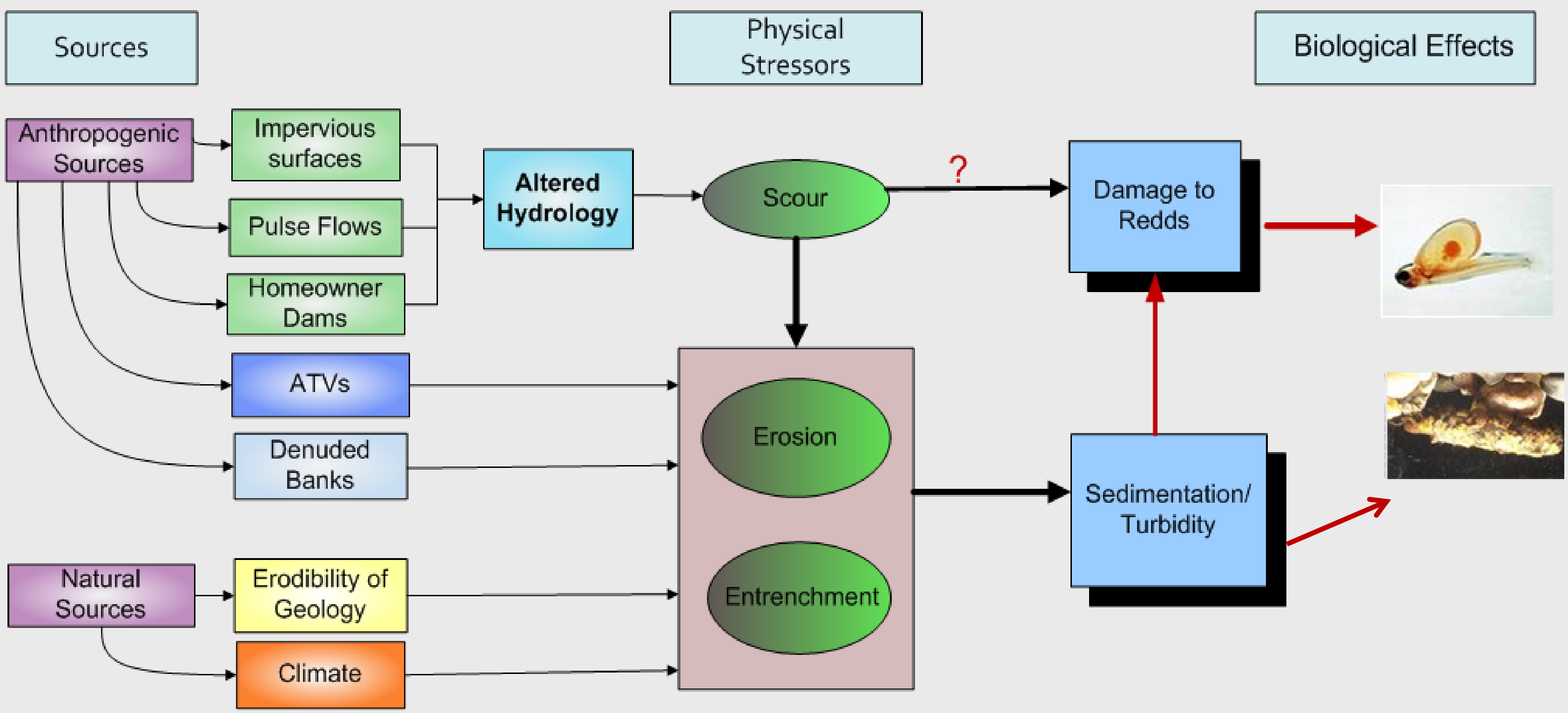


Background on Secret Ravine Creek

- Remnant populations of fall-run chinook salmon
- Rapid urbanization
- Documented sedimentation and turbidity problems



Conceptual Model for Aquatic Life in Secret Ravine

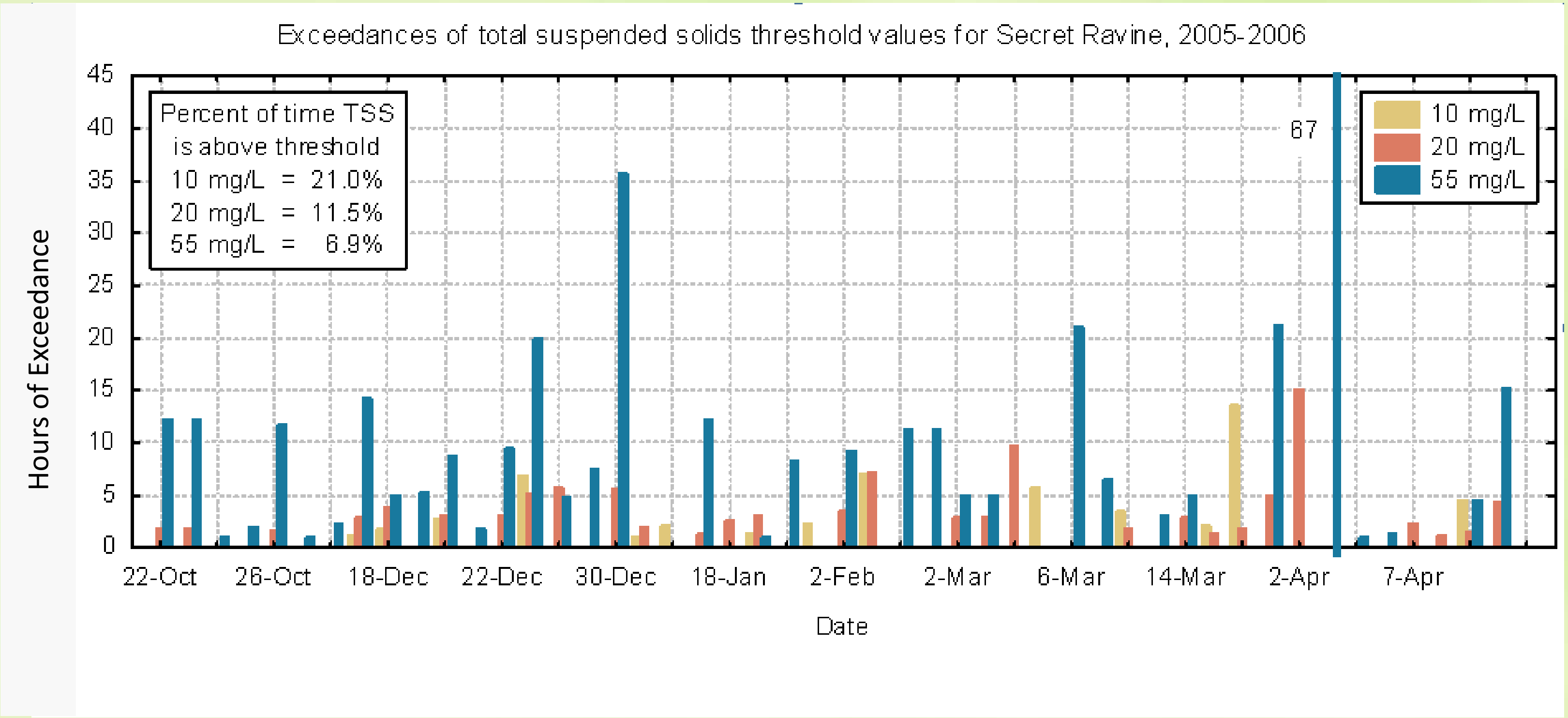


Irrigation Canal

Denuded Bank

Decomposed granite streambed

Exceedances of turbidity criteria 2005-2006 water year



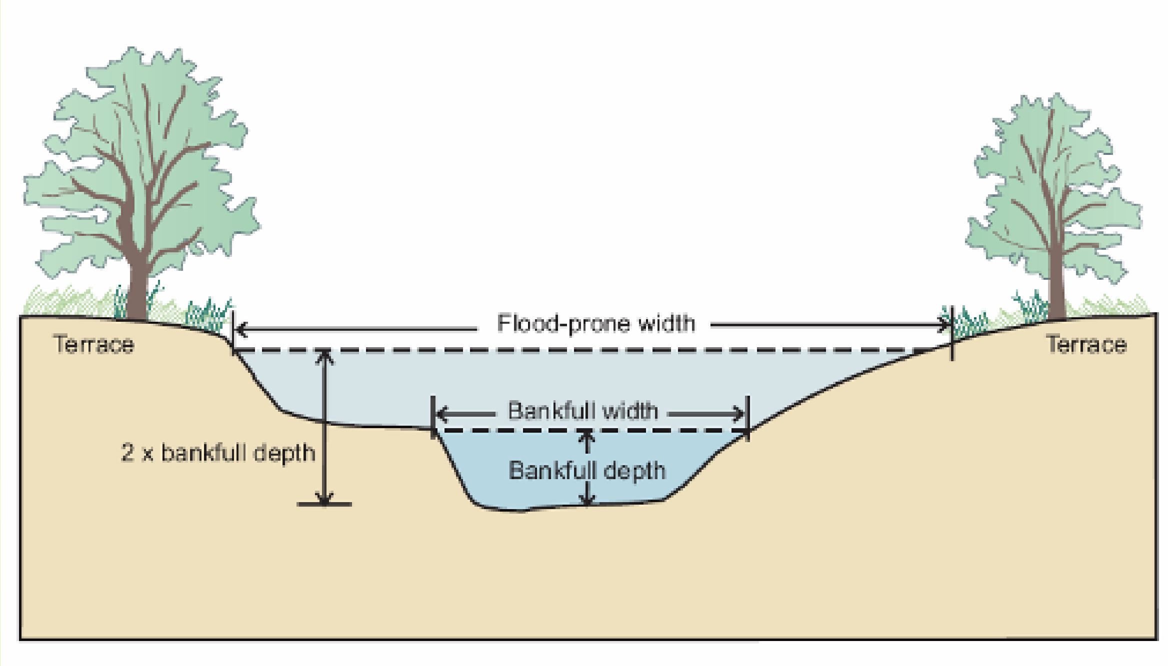
Each bar represents an exceedance in turbidity for a 1 hour (blue), 7 hour (red), or 24 hour (yellow) period.

Gaining a better understanding of this type of data – one important reason for this project

Evaluate the use of the Calculator for assessing watershed conditions

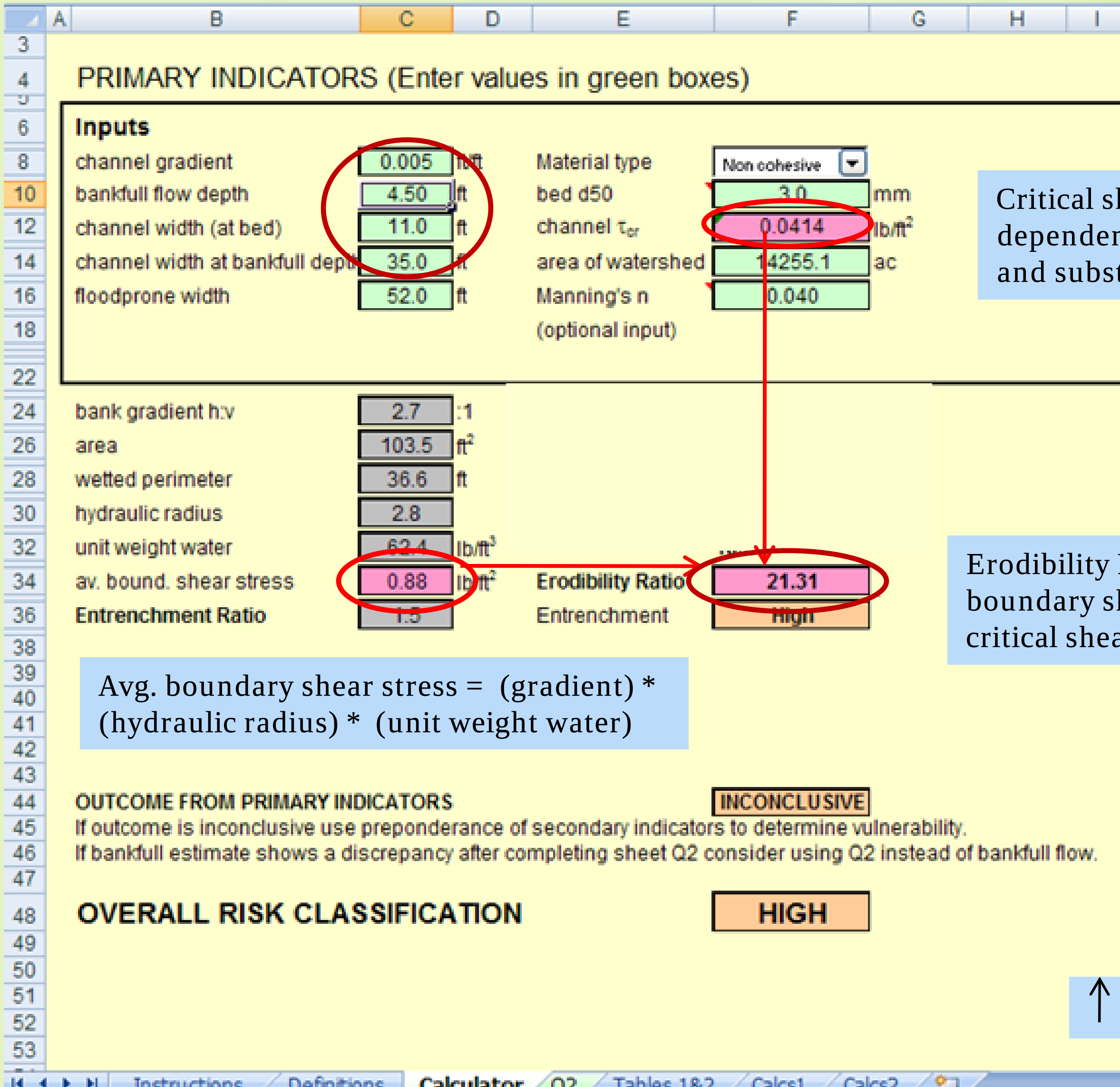
- Gives a quantitative measure of bank stability
- Key metric: erodibility ratio (**ER**) estimates water's erosive force against resistance of bed & bank materials
- Most data needed already collected under the March 09 revised protocol:
    - Particle size/pebble count
    - Gradient
    - Bankfull metrics
        - Bankfull = height water reaches along the bank associated with a 1-2 year storm event

Materials and Methods



- Supplemental Field measurements
  - floodprone width
  - channel width at bed
- GIS data
  - Watershed area calculation

Channel Vulnerability Calculator



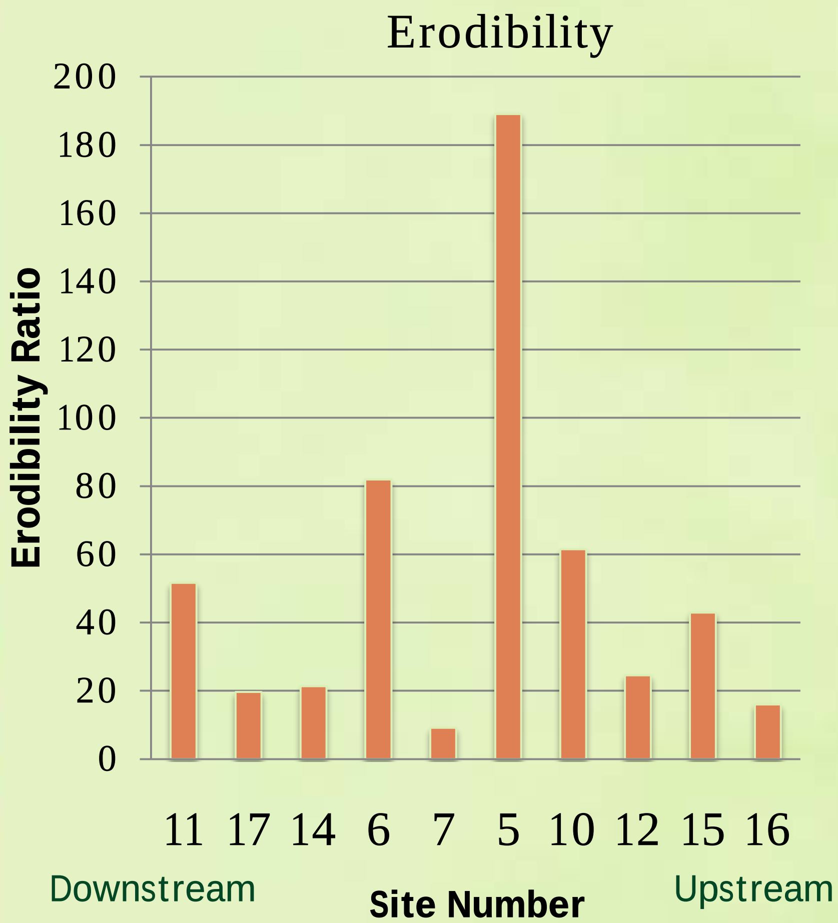
Critical shear stress dependent on d50 and substrate type

Erodibility Ratio= avg. boundary shear stress / critical shear stress

Avg. boundary shear stress = (gradient) * (hydraulic radius) * (unit weight water)

↑ ER = ↑ Erosion Potential

Results



ER = Boundary Shear Stress / Critical Shear Stress (threshold)

- Mean ER = 52
  - Suggests a highly erodible system
- Site 5
  - ER = 185
  - Likely caused by sediment starved pulse flows from local irrigation canal
- Site 7 and 16
  - Two lowest erodibility ratios
  - Two highest d50
  - Site 7 most favored salmon spawning site

Checking the Accuracy of Bankfull Measurements

- Calculation of ER requires accurate measurements of:
  - Bankfull width and depth
  - Gradient
- Method to validate bankfull measurements:
  1. Calculate bankfull discharge based on bankfull measurements
  2. Obtain Q2 data from an independent source ie local flood control agency
  - If greater than 30% difference, potential error in measurements

Inputs					
channel gradient	0.006	ft/ft	Material type	Non cohesive	
bankfull flow depth	5.5	ft	bed d50	2.0	mm
channel width (at bed)	20.0	ft	channel τ_{cr}	0.0104	lb/ft^2
channel width at bankfull depth	40.0	ft	area of watershed	64000.0	ac
floodprone width	50.0	ft	Manning's n	0.025	
			(optional input)		
bank gradient h:v	1.8	:1	bankfull velocity	11.3	ft/sec
area	165.0	ft^2	bankfull discharge	1800.0	cfs
wetted perimeter	42.8	ft	Q2 (see "Q2")	1160.0	cfs
hydraulic radius	3.9		bankfull estimate	**Discrepancy**	
unit weight water	62.4	lb/ft^3		**Risk**	
av. bound. shear stress	1.44	lb/ft^2	**Erodibility Ratio**	**138.42**	
entrenchment ratio	1.3		**Entrenchment**	**High**	

Ongoing work on the Calculator

- Add instructions
- Add Q2 and d50 worksheets
- Develop ranking system for ER

Conclusions

- PHAB data can be used in the Calculator to produce new information on habitat conditions.
- The Calculator suggests Secret Ravine is a highly erodible system
  - Further analysis is ongoing

Key reference

Fischenich, C. Stability Thresholds for Stream Restoration Materials. EMRRP Technical Notes Collection, U.S. Army Engineer Research and Development Center, Vicksburg MS. 2001

Further Information

Lilly Allen, lallen@oehha.ca.gov

Walker Wieland, wwieland@oehha.ca.gov

Barbara Washburn, washburn@oehha.ca.gov

Questions/Comments?

Further steps in SR assessment

- Collect additional field data on bankfull measurements where we found discrepancy in internal validations
- Examine relation between sources of stress and erodibilty ratio
  - Impervious Cover
  - Geology
  - Pulse flows
  - Denuded banks