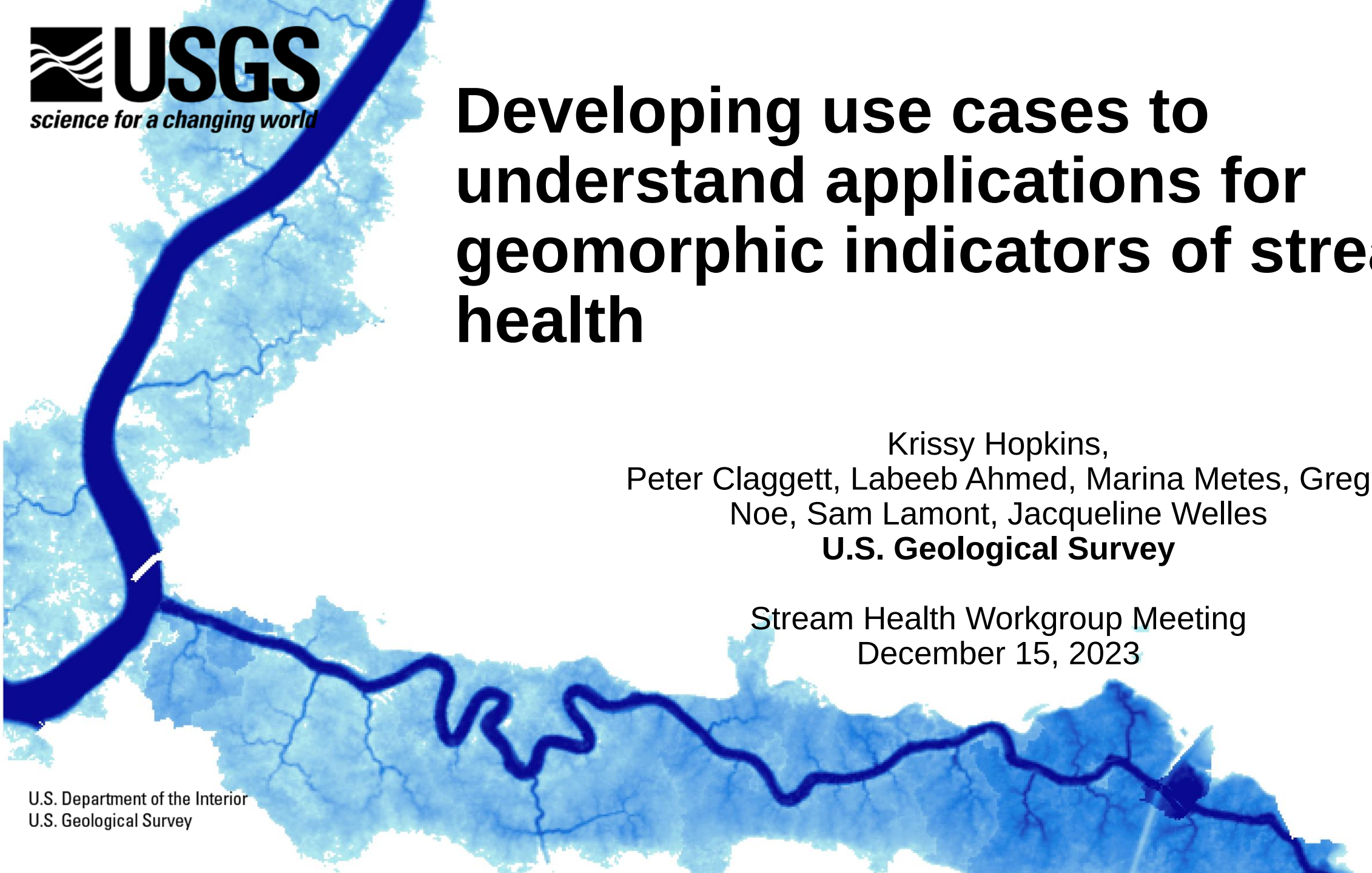


Developing use cases to understand applications for geomorphic indicators of stream health

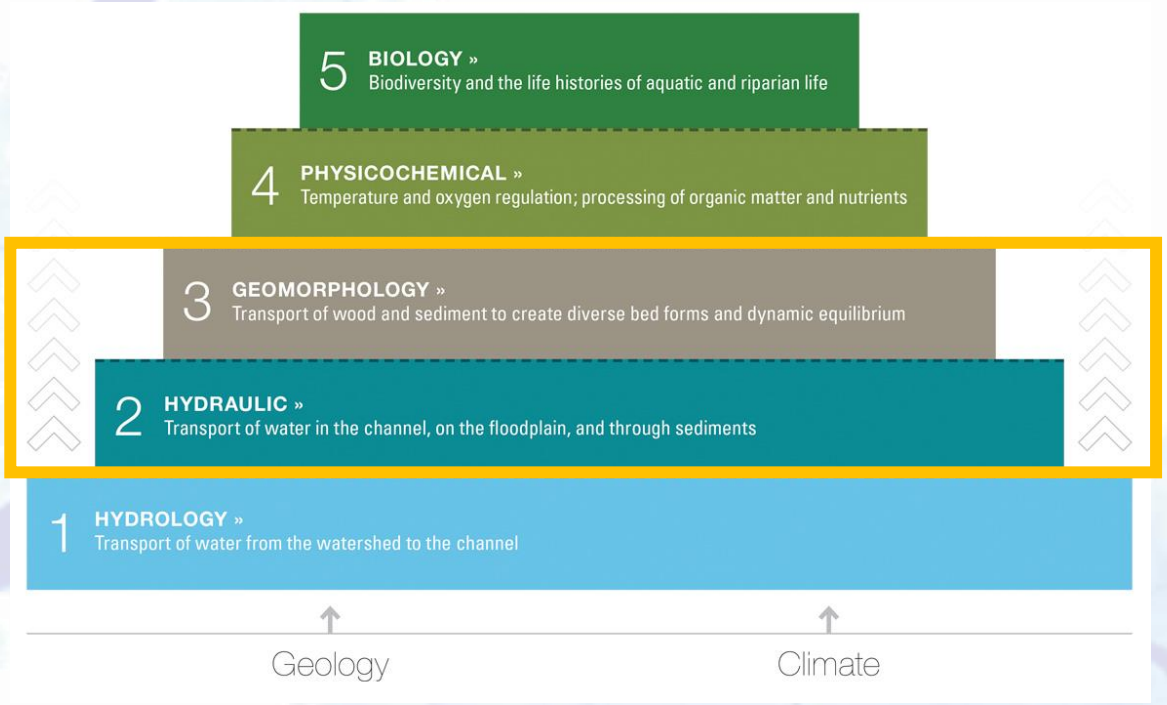
Krissy Hopkins,
Peter Claggett, Labeeb Ahmed, Marina Metes, Greg Noe, Sam Lamont, Jacqueline Welles
U.S. Geological Survey

Stream Health Workgroup Meeting
December 15, 2023

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

Topics

- Background on hydrogeomorphic indicators
- Discussion of use case applications for geomorphic indicators of stream health

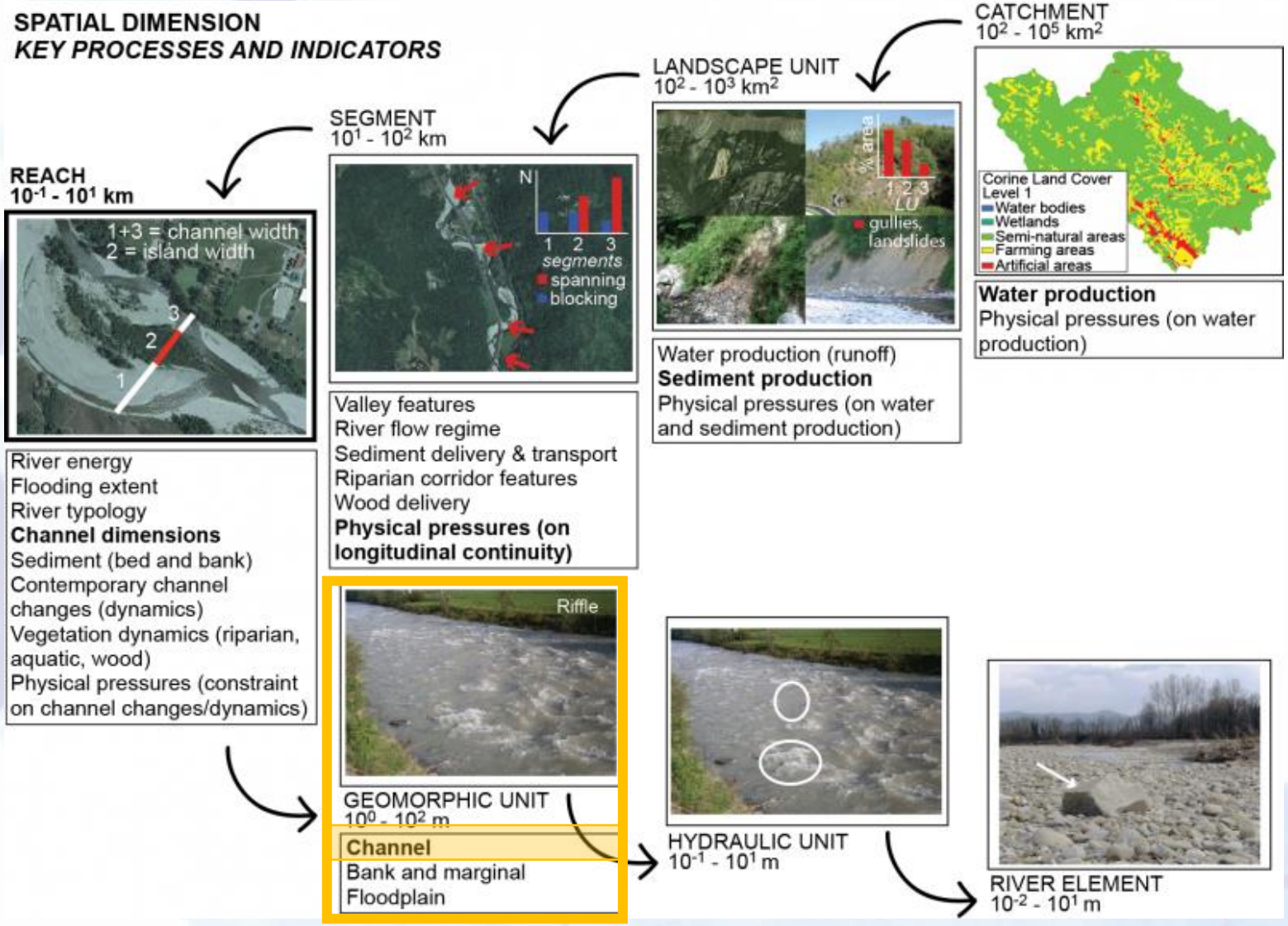


Functional Pyramid, StreamMechanics

Stressor category	Literature review: Frequency of measurement	Literature review: Frequency of importance	Jurisdictional analysis: Watershed-wide ranking
Geomorphology	High	High	High
Salinity & major ions	High	High	High
Nutrients	High	Moderate	High
Toxic contaminants	Low	High	Moderate
Flow	Low	Moderate	Moderate
Acidity	Moderate	Low	Moderate
Riparian	Low	Low	Moderate
Dissolved oxygen	Moderate	Moderate	Low
Temperature	Moderate	Low	Low

Fanelli et al. 2022, https://doi.org/10.1007/s00267-022-01723-7

How are rivers organized across space?



European Commission REFORM hierarchical framework, 2015

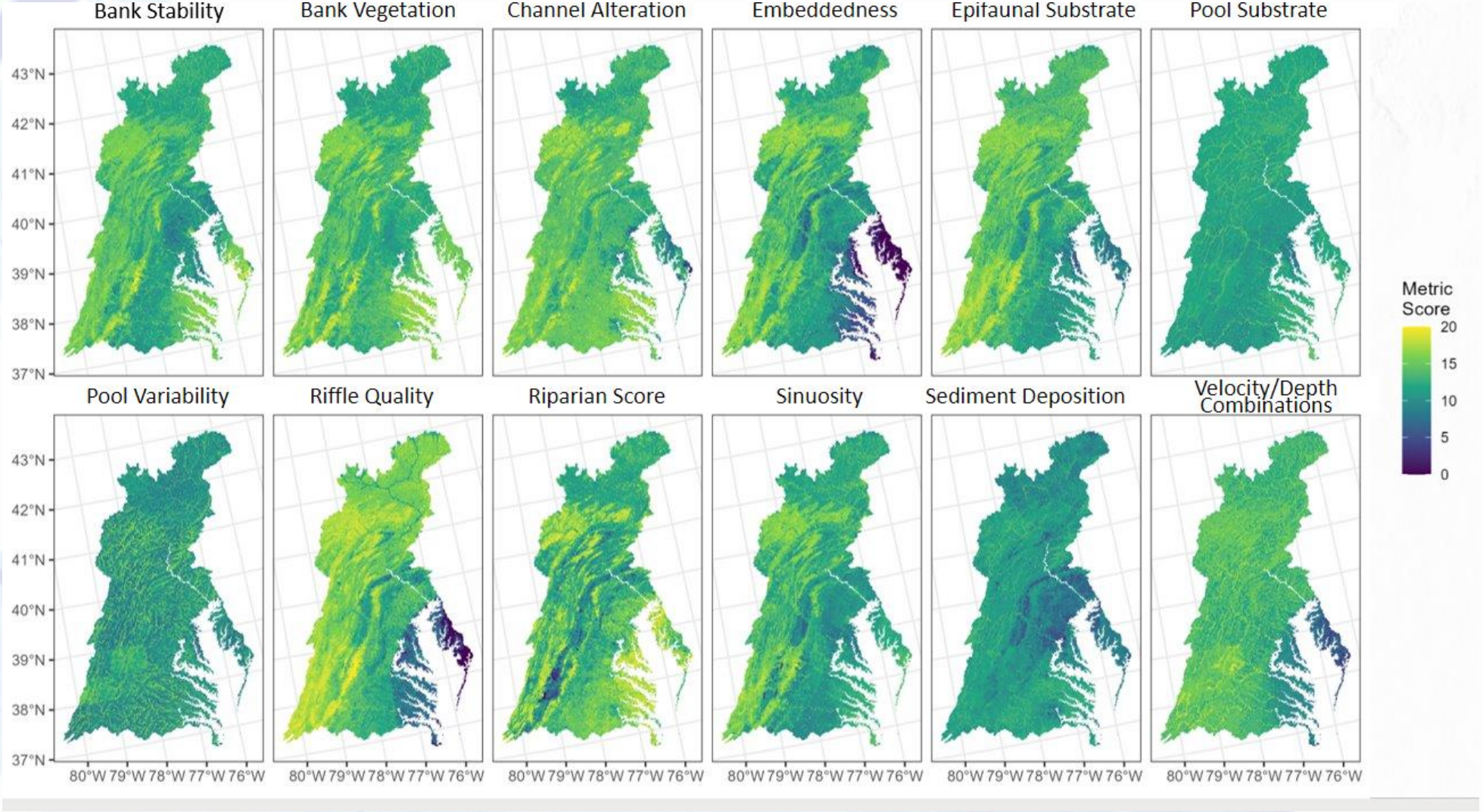
Which indicators to track for stream health?

Hydrogeomorphic indicators

- Valley type/confinement
- **Floodplain connectivity**
- Riparian vegetation
- Bedform diversity/stability
- **Lateral stability**

GIT#12, Tetra Tech, 2023

Geomorphic unit: Physical habitat metrics developed by Matt Cashman



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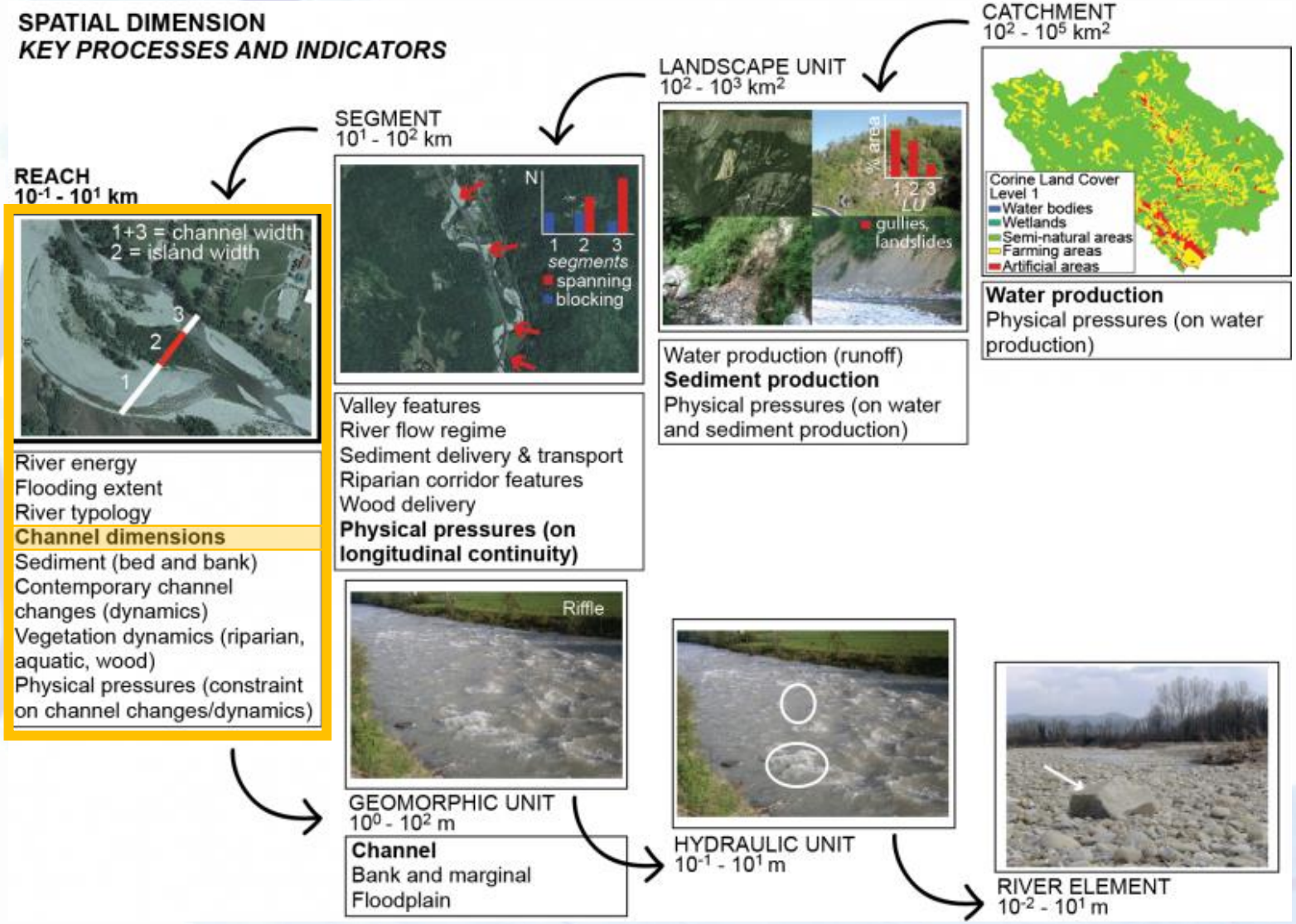

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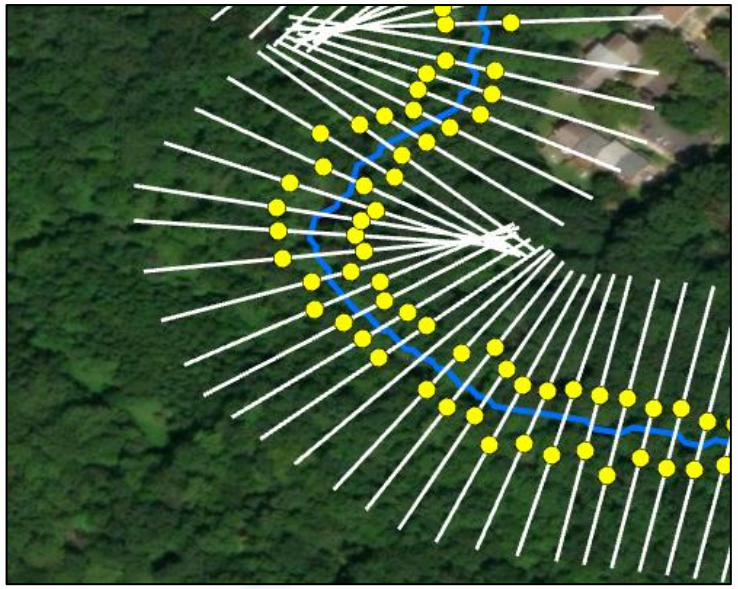
GIT#12, Tetra Tech, 2023

Reach scale: The Floodplain and Channel Evaluation Tool: FACET

Channel and Floodplain Dimensions

- **Bank height**
- Bank angle, avg
- Bank angle, max
- **Channel width**
- Channel length
- Bank-full area
- **Floodplain width**
- Floodplain elevation range
- Floodplain elevation, sd
- Sinuosity
- Stream slope

Spatial scale

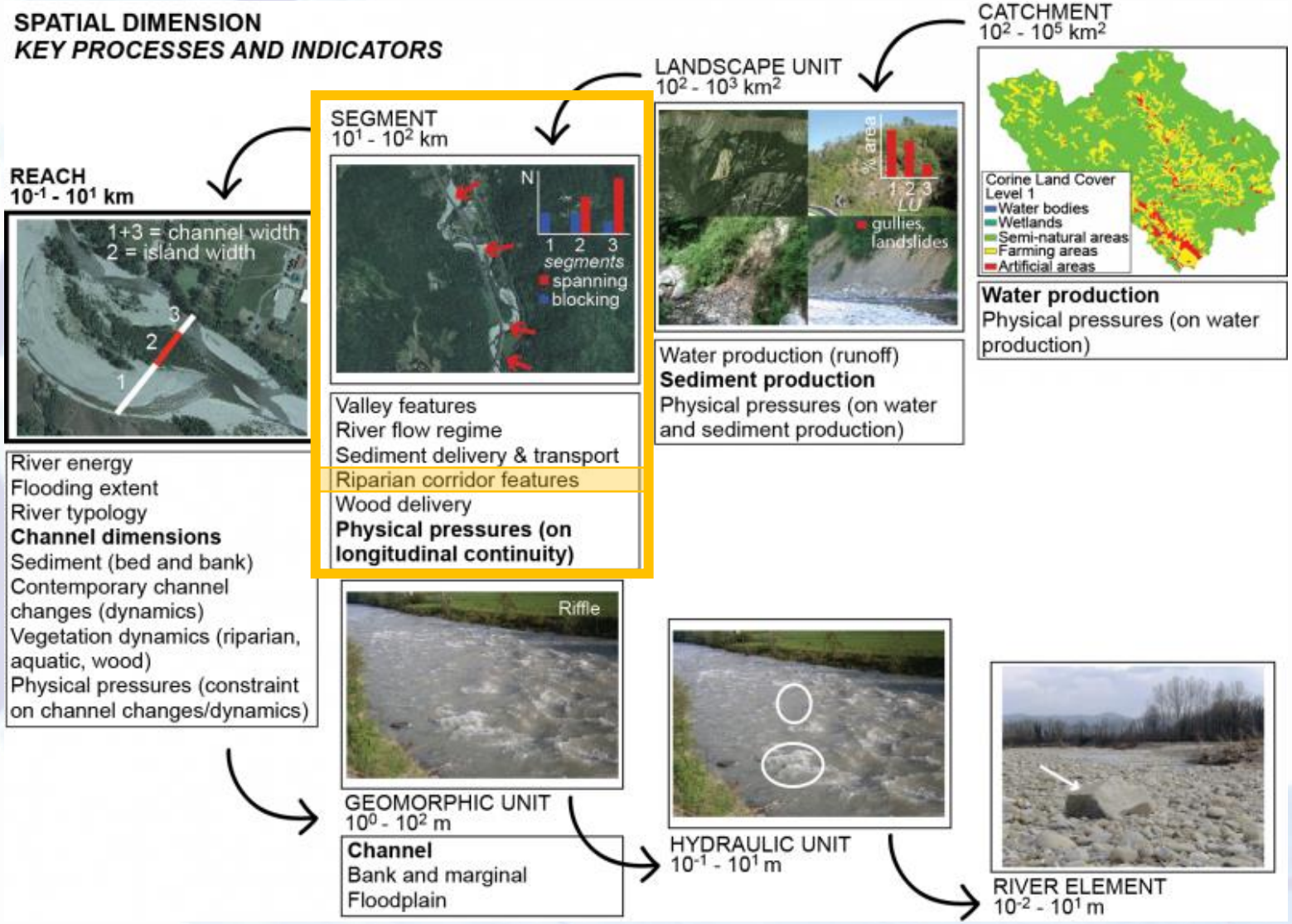


Reach
Individual
cross sections

Segment
Stream segment
Future release will be at 24K scale

Data Release: Hopkins et al. 2020, https://doi.org/10.5066/P9RQJPT1

How are rivers organized across space?



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GIT#12, Tetra Tech, 2023

Segment scale: The Floodplain and Channel Evaluation Tool: FACET

Reach mean

Channel and Floodplain Dimensions

- Bank height
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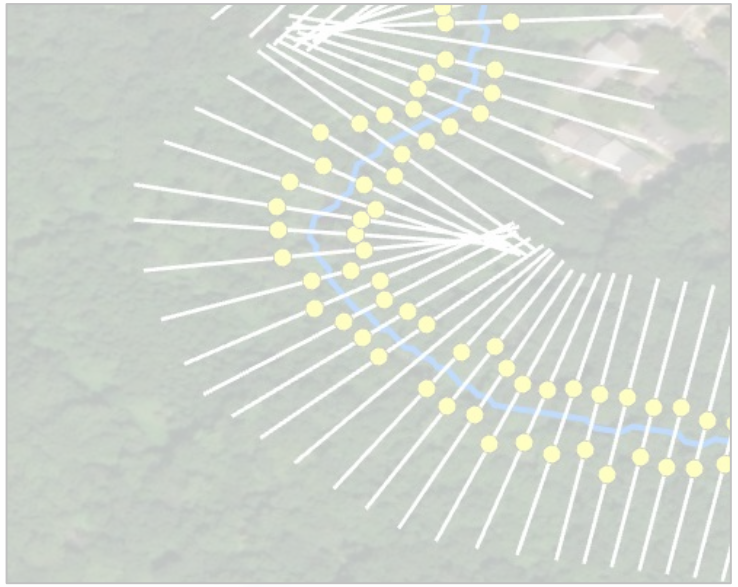
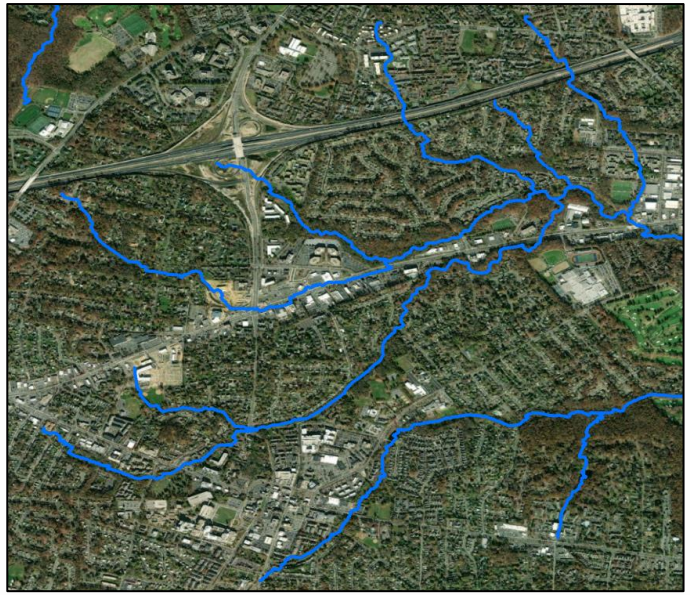
Spatial scale



Reach
Individual cross sections



Segment
Stream segment
Future release will be at 24K scale

Data Release: Hopkins et al. 2020, https://doi.org/10.5066/P9RQJPT1

FACET 1-m data release coming Spring 2024

Will be aggregated to the NHD HiRes (24K) catchments

Geomorphic metrics relevant to stream health

- Width to depth (incision)
- Entrenchment ratio (channel width/floodplain width)
- Deviation from Bieger regional curve for width (Observed/Expected)
- Deviation from Bieger regional curve for depth (Observed/Expected)
- Valley confinement (degree of confinement or Y/N)

Planning for these 1-m metrics to be incorporated into the regional assessment models

FACET provides many of the recommended metrics for a Desktop Stream Hydromorphology Assessment Tool

Spatial Dimension	Metric	Measurement Method	Metric Thresholds			Data Source	Comments
			Stable	Partially Unstable	Unstable		
Large Catchment and Landscape Unit (Pyramid Level 1)	Impervious Cover (IC)	Percent IC				Existing GIS IC data layer	
	Runoff	Flashiness				Existing GIS land use / land cover (LULC) and IC data layers; Flow Alteration Metrics (Maloney et al. 2021)	
	Sediment Production	Sediment Load				Existing GIS LULC, IC, soils, and riparian vegetation data layers and flow regime analysis results; Gridded Soil Survey Geographic Database (gSSURGO) and Parameter-elevation Regressions on Independent Slopes Model (USGS under development)	
River Segment (Pyramid Level 2)	Valley Type/ Confinement*	Anthropogenic Confinement				Floodplain and Channel Evaluation Tool (FACET) and valley type based on landscape position; Hyper-Resolution Terrain-based Hydrography Mapping (CIC and UMBC under development)	
	Sediment Transport	Degrading or Aggrading				FACET and floodplain connectivity and channel dimension analysis results; Multi-jurisdictional Rapid Habitat Assessment Database (USGS under development); Gridded Soil Survey Geographic Database (gSSURGO) and Parameter-elevation Regressions on Independent Slopes Model (USGS under development)	
Reach (Pyramid Levels 2 & 3)	Floodplain Connectivity*	Bank Height Ratio (BHR)				FACET and bankfull channel dimensions regional curves	
		Entrenchment Ration (ER)				Hyper-Resolution Terrain-based Hydrography Mapping (CIC and UMBC under development); Stream and Floodplain Geometry Mapping (USGS in revision)	
	Stream Energy	Stream Power				FACET and stream power equation; Stream and Floodplain Geometry Mapping (USGS in revision)	
	Channel Dimension	Width/Depth (W/D) Ratio				FACET and bankfull channel dimensions regional curves	
	Riparian Vegetation*	Width and Type				Existing GIS data layer(s)	

Which indicators to track for stream health?

FACET is the data source

GIT#12, Tetra Tech, 2023

Co-developing use cases that use hydrogeomorphic indicators

Objective: Develop use cases using hydrogeomorphic indicators to address a management challenge.

Timeline: January – September, 2024
Coincides with release of 1-m geomorphic metrics in the Spring 2024.

Time Commitment: Attend 2-4 meetings to provide direction and feedback on the use case.

Product: A 2-pg summary of the use case.

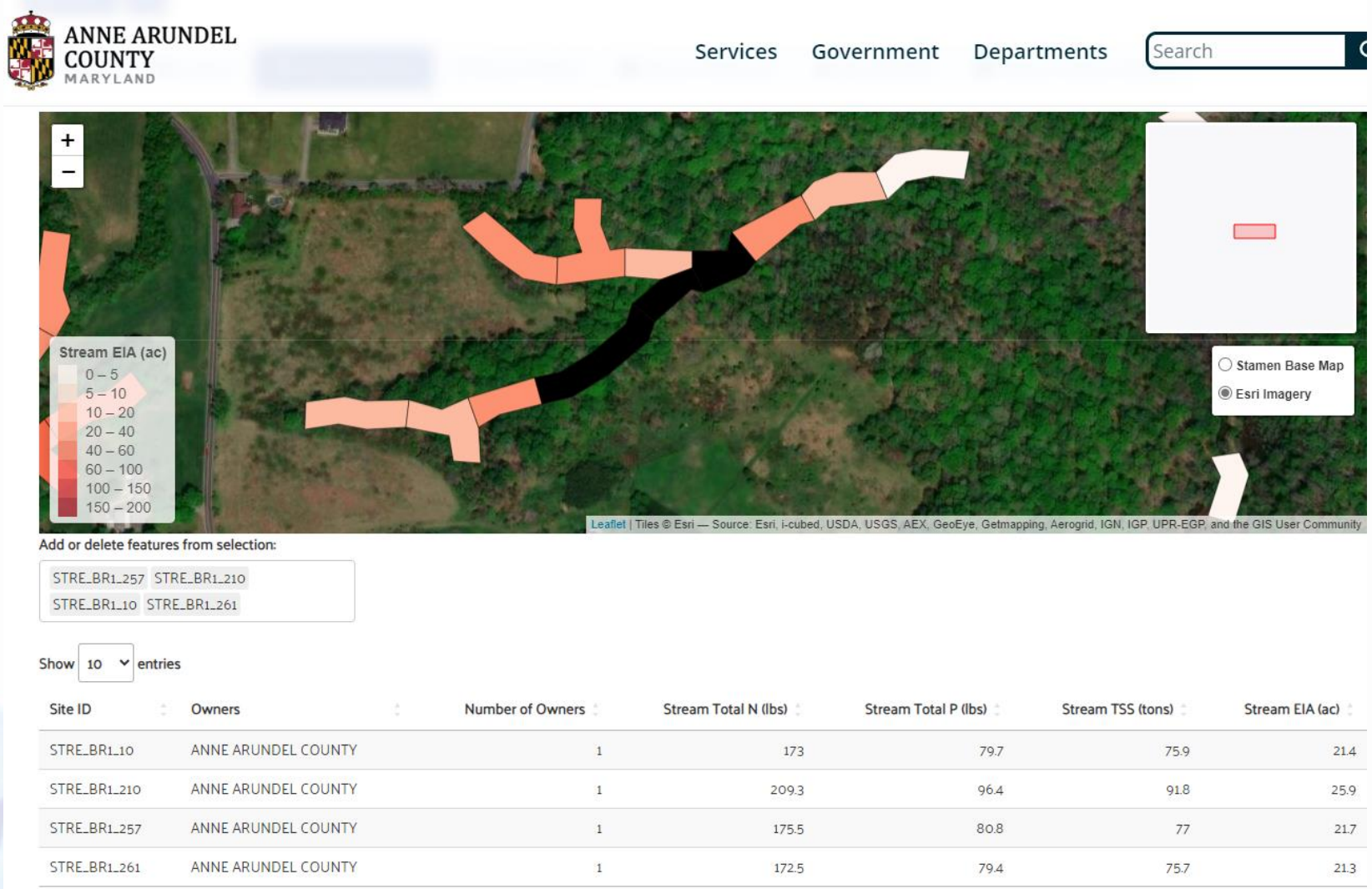
USGS

Example from Anne Arundel County, MD

Anne Arundel County, MD

Estimates stream restoration credits based lidar elevation changes between 2017 and 2020.

200ft stream segment credits
- Total nitrogen
- Total phosphorus
- Total suspended sediment



Site ID	Owners	Number of Owners	Stream Total N (lbs)	Stream Total P (lbs)	Stream TSS (tons)	Stream EIA (ac)
STRE_BR1_10	ANNE ARUNDEL COUNTY	1	173	79.7	75.9	21.4
STRE_BR1_210	ANNE ARUNDEL COUNTY	1	209.3	96.4	91.8	25.9
STRE_BR1_257	ANNE ARUNDEL COUNTY	1	175.5	80.8	77	21.7
STRE_BR1_261	ANNE ARUNDEL COUNTY	1	172.5	79.4	75.7	21.3

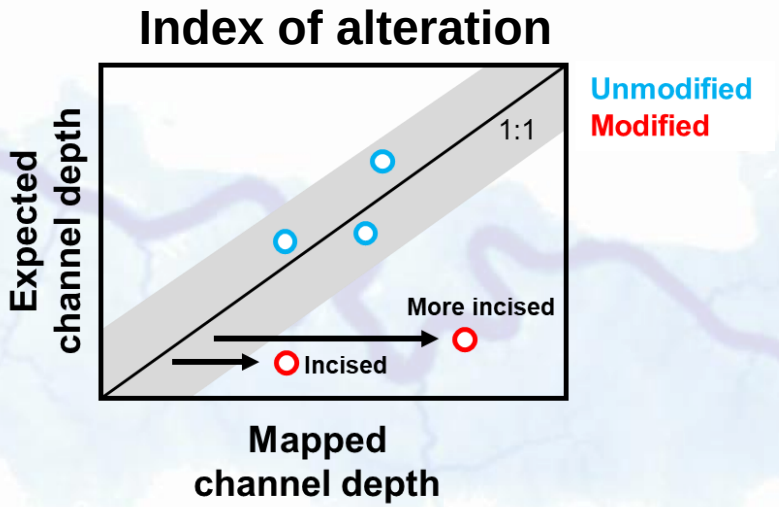
USGS

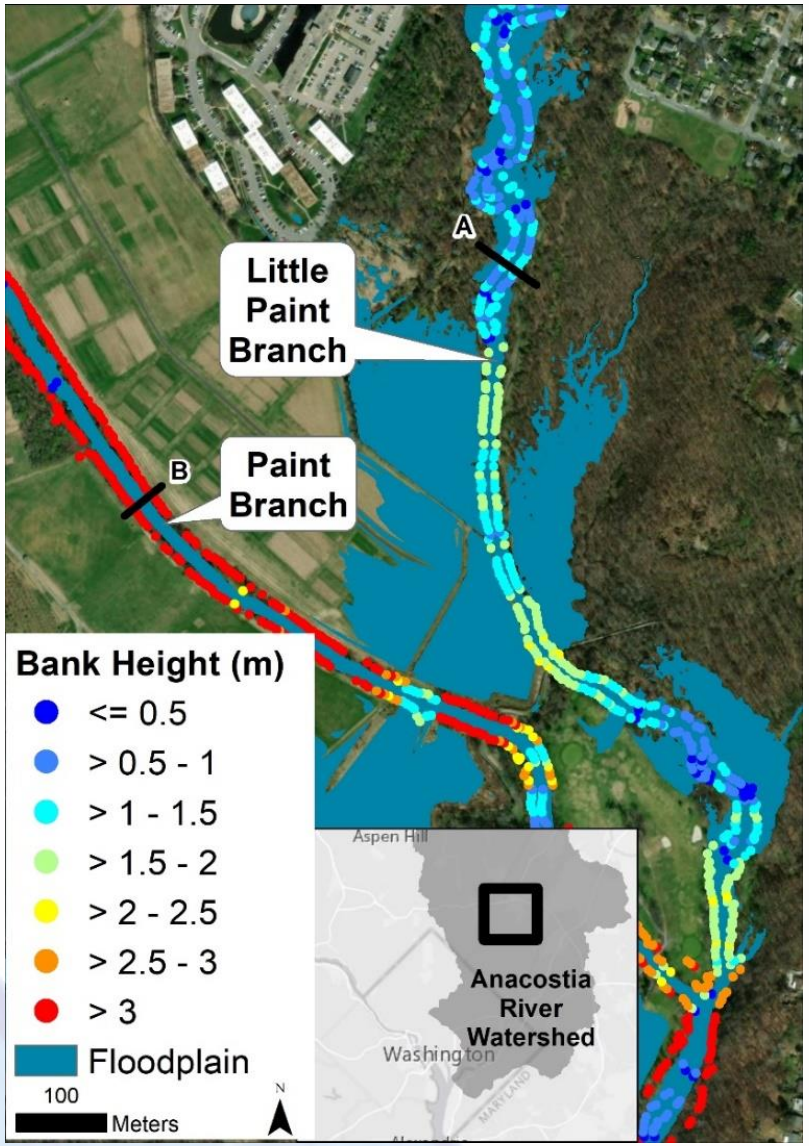
Anne Arundel County, Maryland - Restoration Estimator Tool

Use Case 1: Channel depth and width

How is this variable useful in a management context?

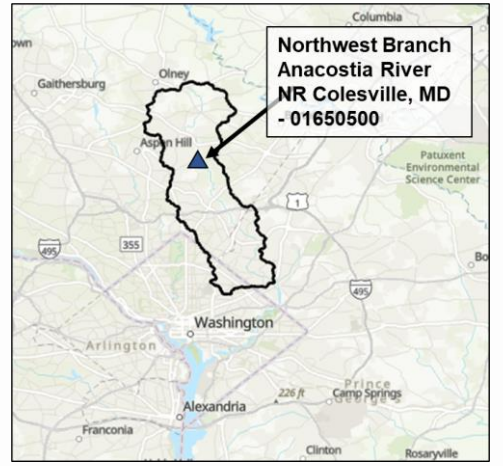
- Identify and triage areas for restoration
- Develop incision proxy (width/depth)
- Develop an index of alteration within a county or watershed





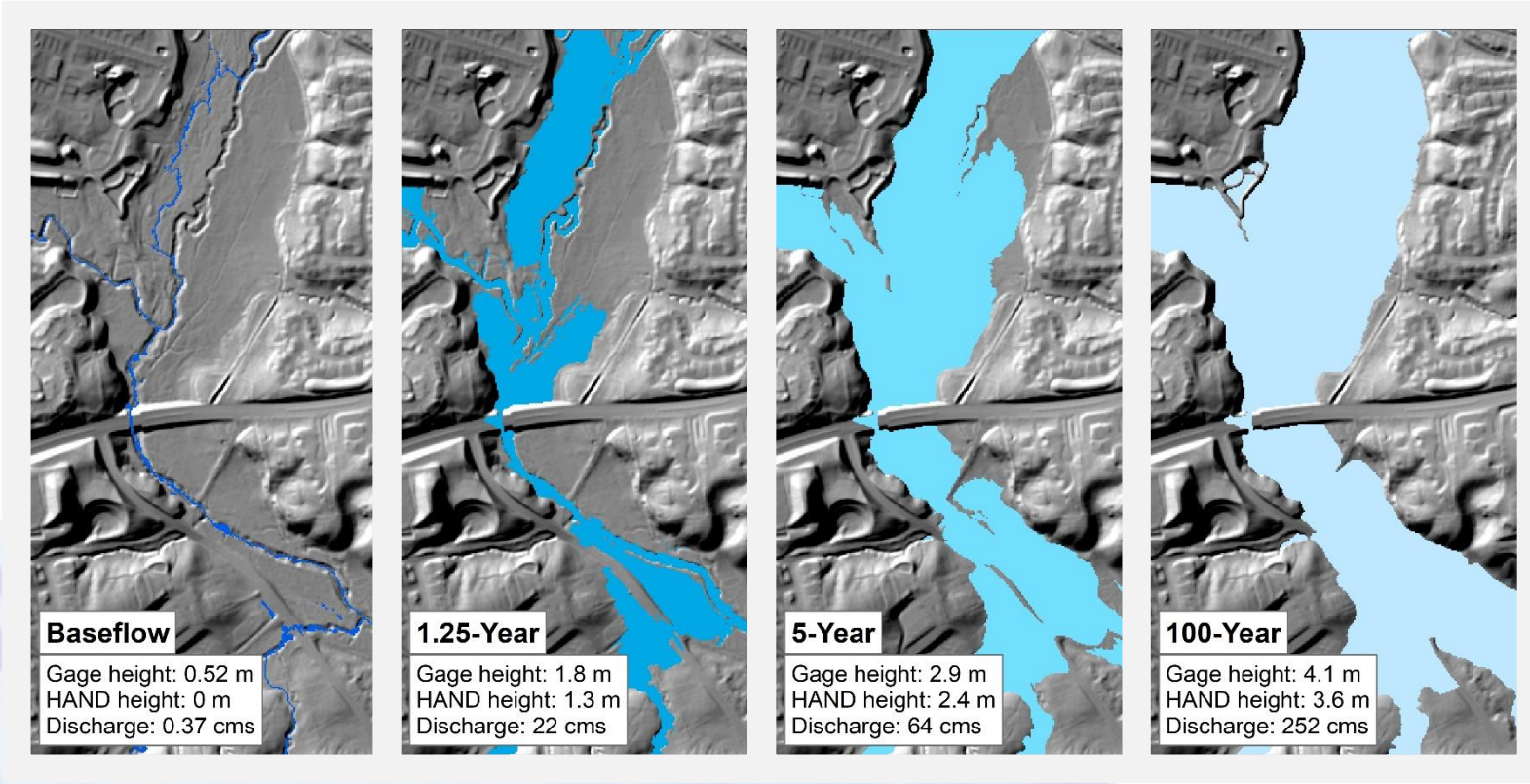
Data Release: Hopkins et al. 2020, https://doi.org/10.5066/P9RQJPT1

Use Case 2: Floodplain inundation



How is this variable useful in a management context?

- Maps the **active river area** that could be used to identify riparian areas
- Are any members managing floodplains using something other than FEMA's 100 yr floodplain?
- Implications for floodplain conservation



USGS

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Contact: Krissy Hopkins, khopkins@usgs.gov

USGS