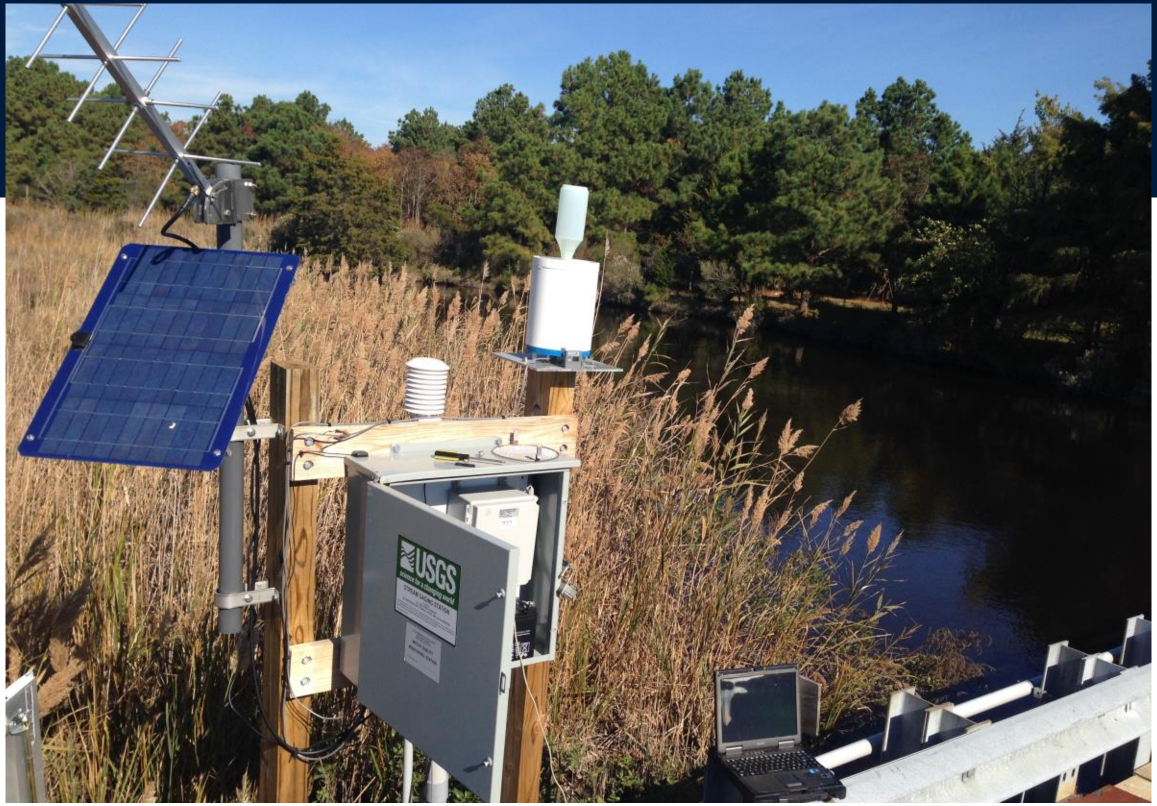
Potomac River at Chain Bridge, July 1930



Farm Creek near Toddville (01490200), 2015 (Todd Lester)

USGS
Next Generation Water Observing Systems

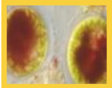
Who we are and What we do

Department of Interior Science Agency

Provide the Nation with reliable and impartial earth science


Land Resources


Ecosystems


Environmental Health


Water


Natural Hazards


Energy and Mineral Resources


Core Science Systems

Maryland-Delaware-DC Water Science Center

Cooperate with local, state and Federal partners

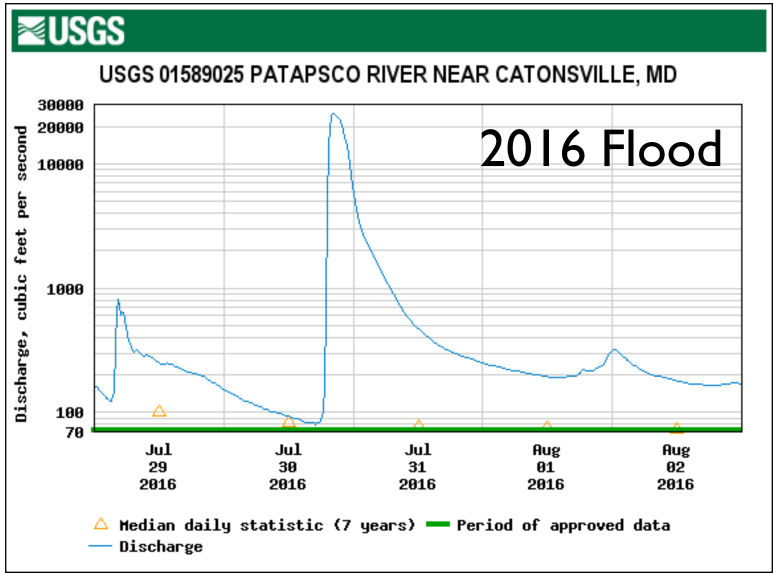
https://www.usgs.gov/centers/md-de-dc-water/

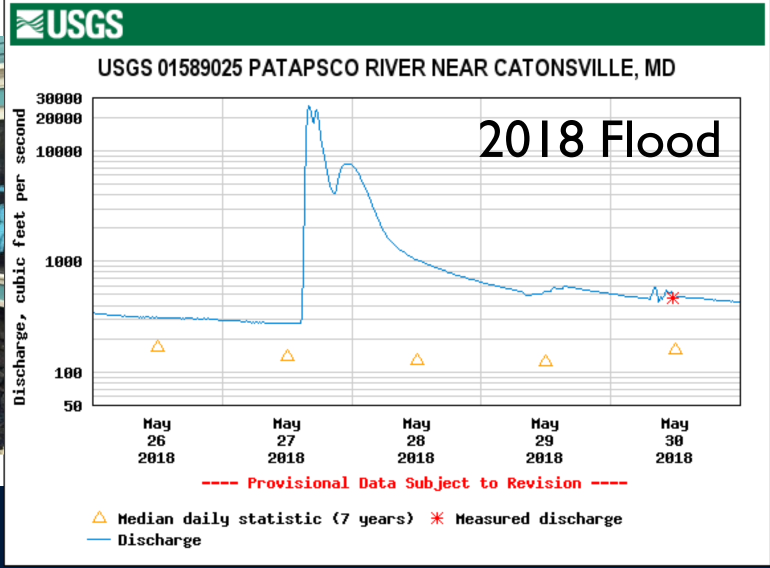
USGS

Case Study – 2018 Ellicott City Floods

- July 30, 2016 and May 27, 2018
- No streamflow gages exist in Ellicott City Watershed
  - Closest 3 gages are the Patapsco River –
  - Hollofield (Upstream), Catonsville (near EC), Elkridge (Downstream)

*USGS Recommends: Install three streamgages and re-activate several others



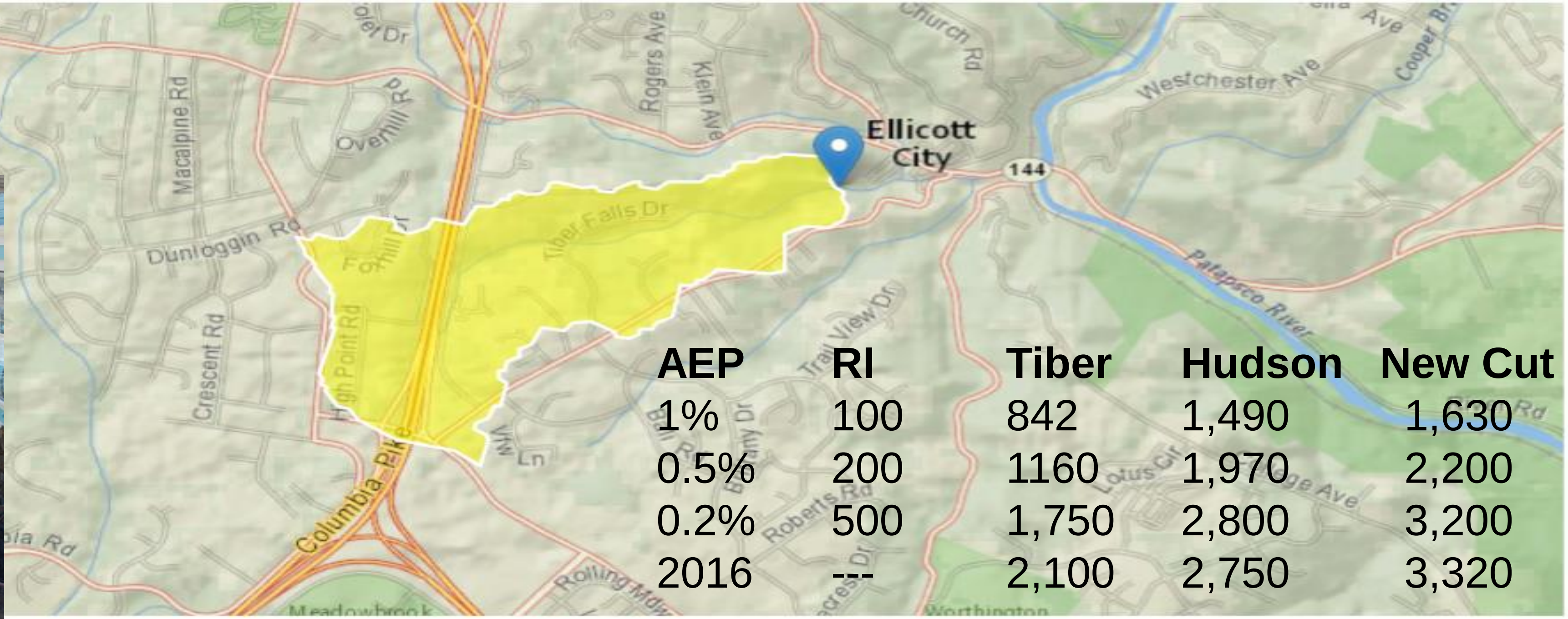


2016 “Observed” Peak Flows and StreamStats Flood Frequency Estimates

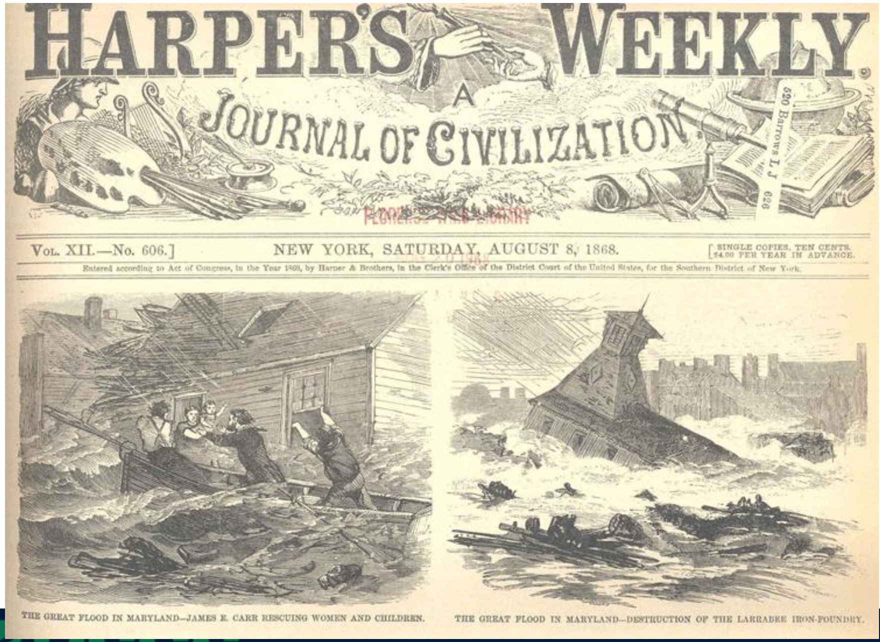
Tiber Branch indirect site

Region ID: MD
Workspace ID: MD20180615183156739000
Clicked Point (Latitude, Longitude): 39.26682, -76.80300
Time: 2018-06-15 12:32:11 -0600

*USGS Recommends: Update regional flood frequency equations (include paleoflood data)



AEP	RI	Tiber	Hudson	New Cut
1%	100	842	1,490	1,630
0.5%	200	1160	1,970	2,200
0.2%	500	1,750	2,800	3,200
2016	---	2,100	2,750	3,320



HARPER'S WEEKLY
A JOURNAL OF CIVILIZATION

Vol. XII.—No. 606.] NEW YORK, SATURDAY, AUGUST 8, 1868. [SINGLE COPIES, TEN CENTS. $4.00 PER YEAR IN ADVANCE.

Entered according to Act of Congress, in the Year 1868, by Harper & Brothers, in the Clerk's Office of the District Court of the United States, for the Southern District of New York.

THE GREAT FLOOD IN MARYLAND—JAMES E. CARR RESCUING WOMEN AND CHILDREN.

THE GREAT FLOOD IN MARYLAND—DESTRUCTION OF THE LARRABEE IRON-FOUNDRY.

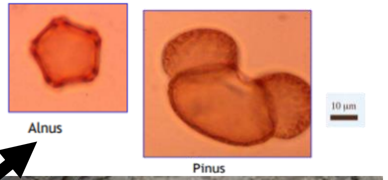
Paleofloods

Using the Past as a Guide to Future Decisions

Refining restoration design by investigating pre-colonial stream ecosystems in the Anne Arundel County Coastal Plain

1794 Griffith Map of Maryland
(shown: Anne Arundel County)

Peat buried beneath recent soils



Discovering a different riparian plant community

…and different channel form?

A new method to reconstruct the Ellicott City Flood Hydrographs?

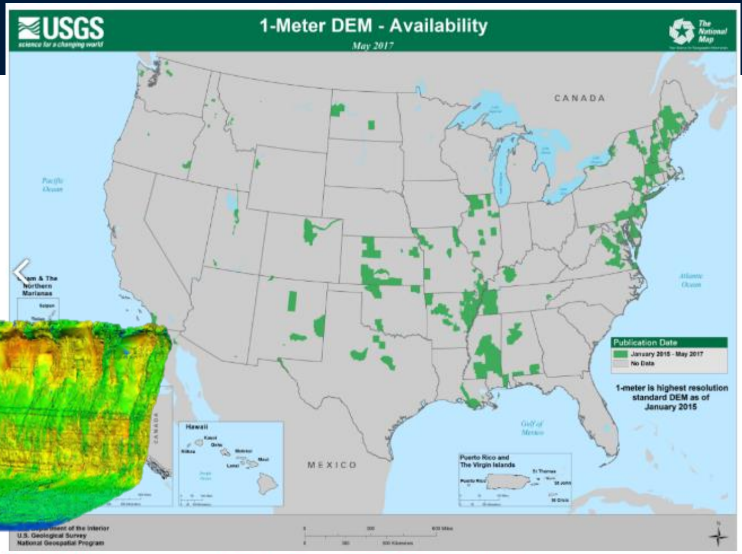
- Ron Peters's Ellicott City Camera network
  - 12 cameras around Historic Ellicott City
  - 1080p Full HD camera resolution, over 4 hours of footage each, over 200 GB of data

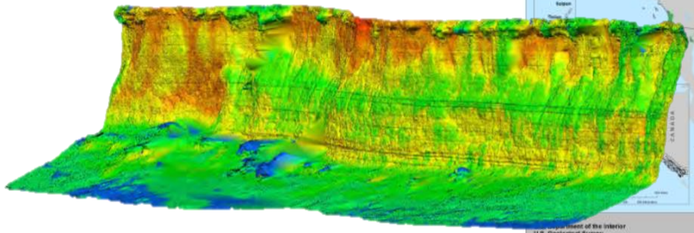
Portallis – Tiber Alley

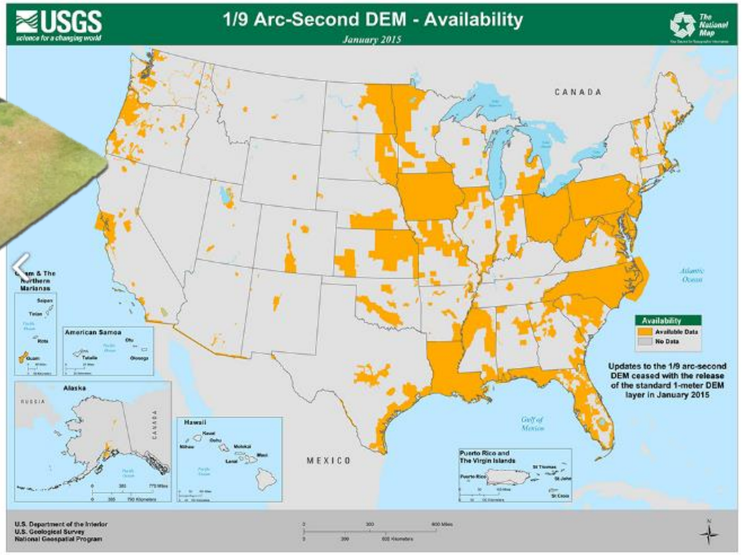
Court Avenue Culvert

What is Structure-from-Motion (SfM)

- Aerial lidar
  - High quality coverage is patchy nationwide, with limited repetition
  - Expensive, not project “timely”
- Terrestrial lidar
  - High resolution
  - Spatially limited, labor intensive
- **Structure from-Motion (SfM) Photogrammetry**
  - **Lidar quality data at fraction of cost**
  - **Rapid collection**
  - **Project-scale**



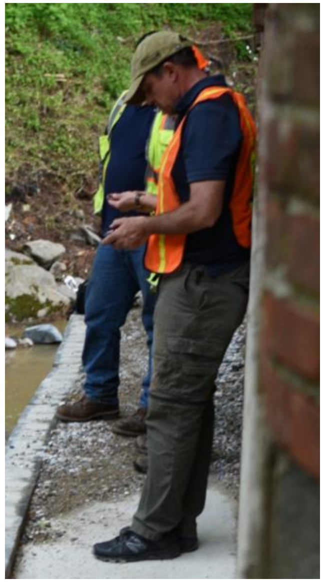




A new way to reconstruct the Ellicott City Flood Hydrographs?

UAS flight on June 6, 2018 – 11-days after the storm

122 million points with georeferenced XYZ coordinates
Provide cm-level scale elevation and position

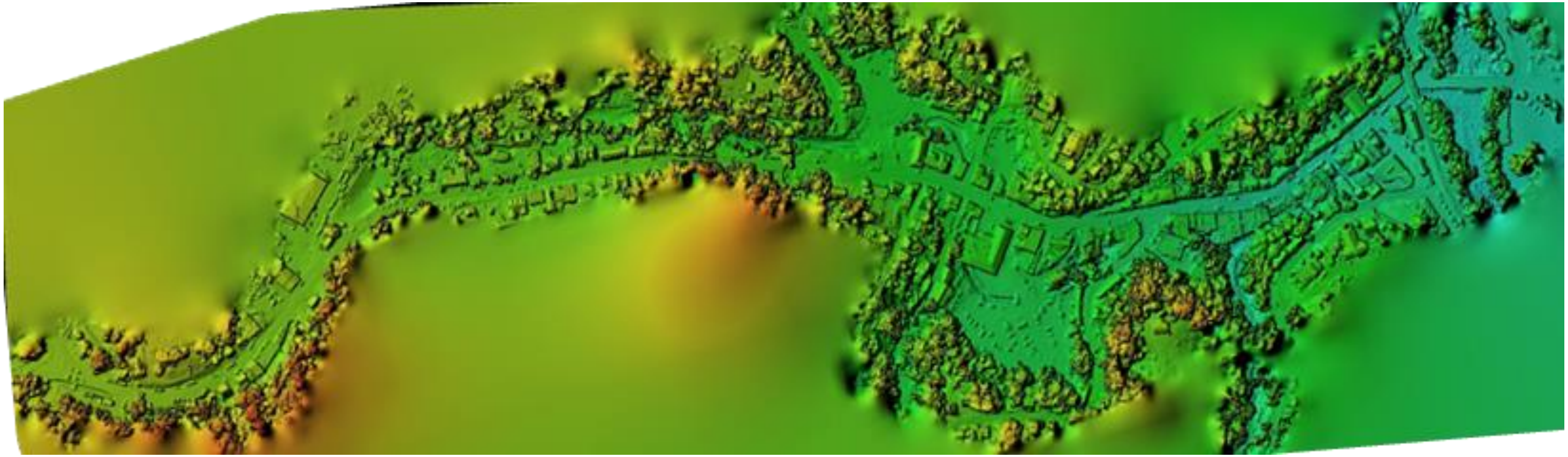


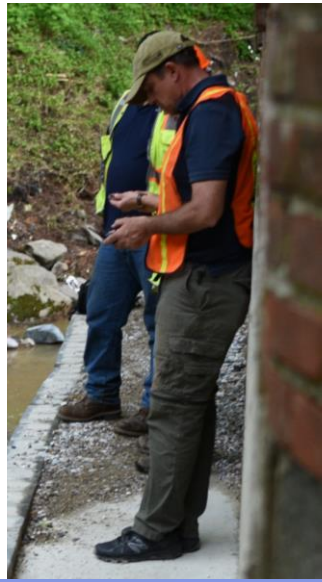
Elevated Media Concepts

A new way to reconstruct the Ellicott City Flood Hydrographs?

UAS flight on June 6, 2018 – 11-days after the storm

DEM derivation of town to assess damage and erosion
Planned comparison to 2011 and 2018 lidar





--- Provisional Data Subject to Revision ---

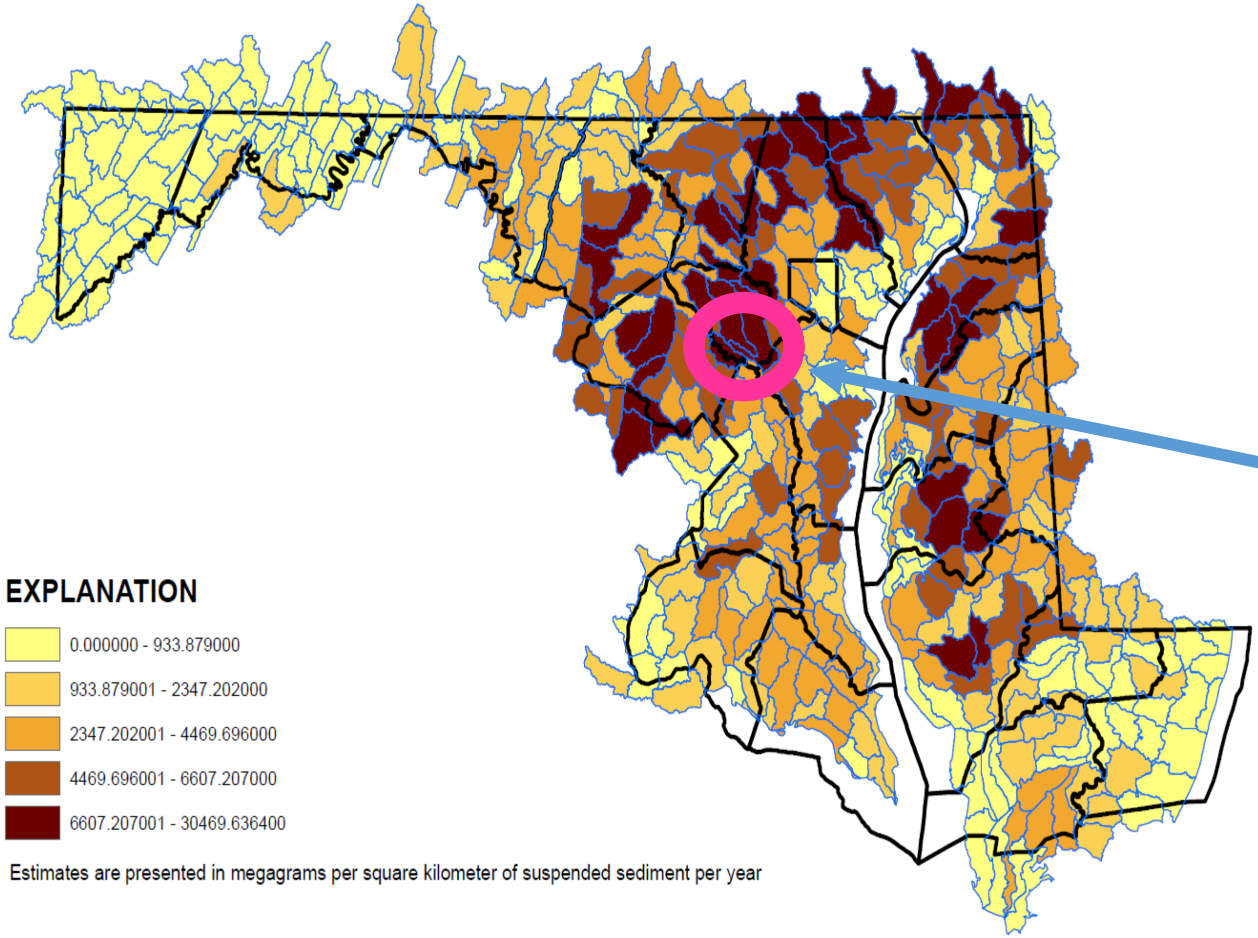
Particle Imagery Velocimetry

Using video to estimate velocity and discharge

Case Study: Monitoring a floodplain reconnection restoration

~1km

(SPARROW) Spatially Referenced Regressions On Watershed Attributes

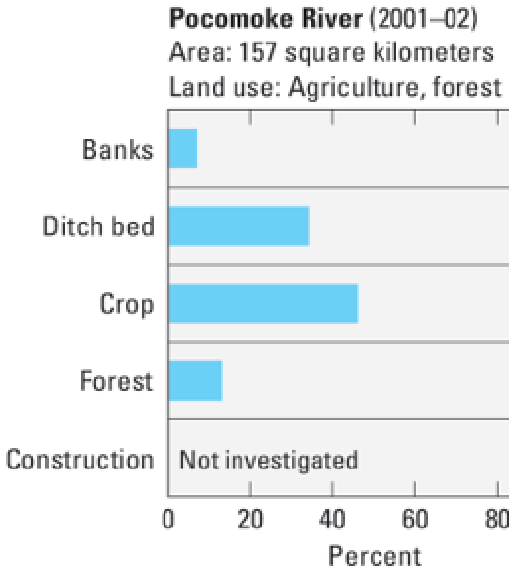


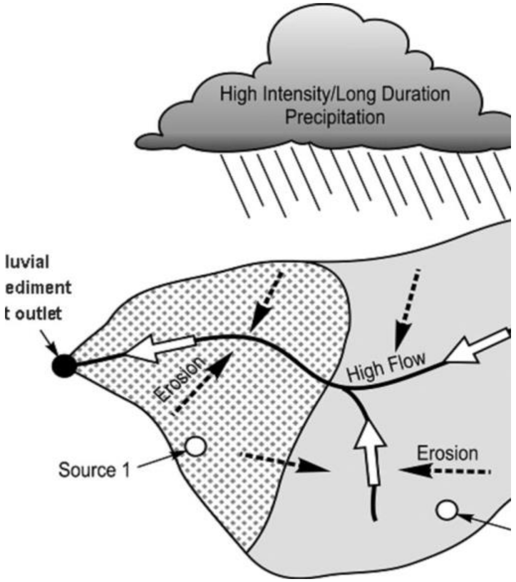
Site Identification / Site Selection

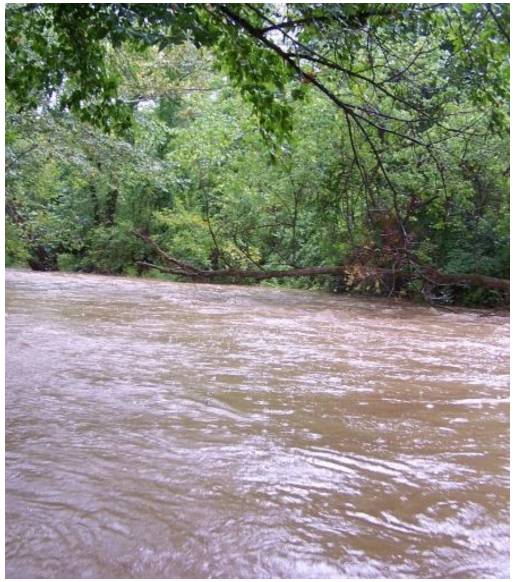
- Modeling Results
- Source Identification
  - Forest, Agriculture, Banks
- Reconnaissance

SEDIMENT FINGERPRINTING

- In order to reduce sediment loads it is imperative to determine the sources of sediment
- Underlying principle – potential sediment sources can be characterized using a number of diagnostic physical and chemical properties







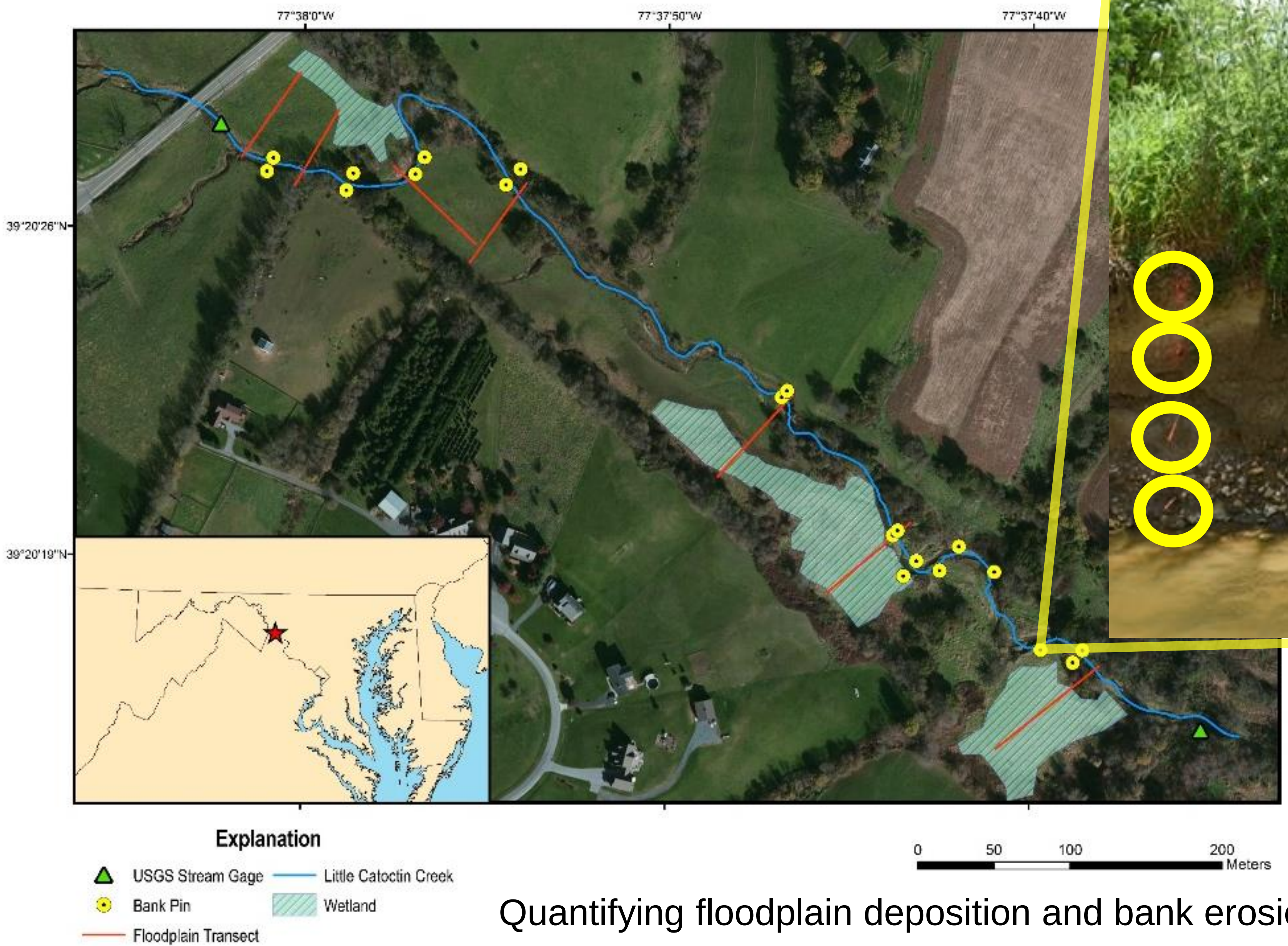
Monitoring Restoration Effectiveness:

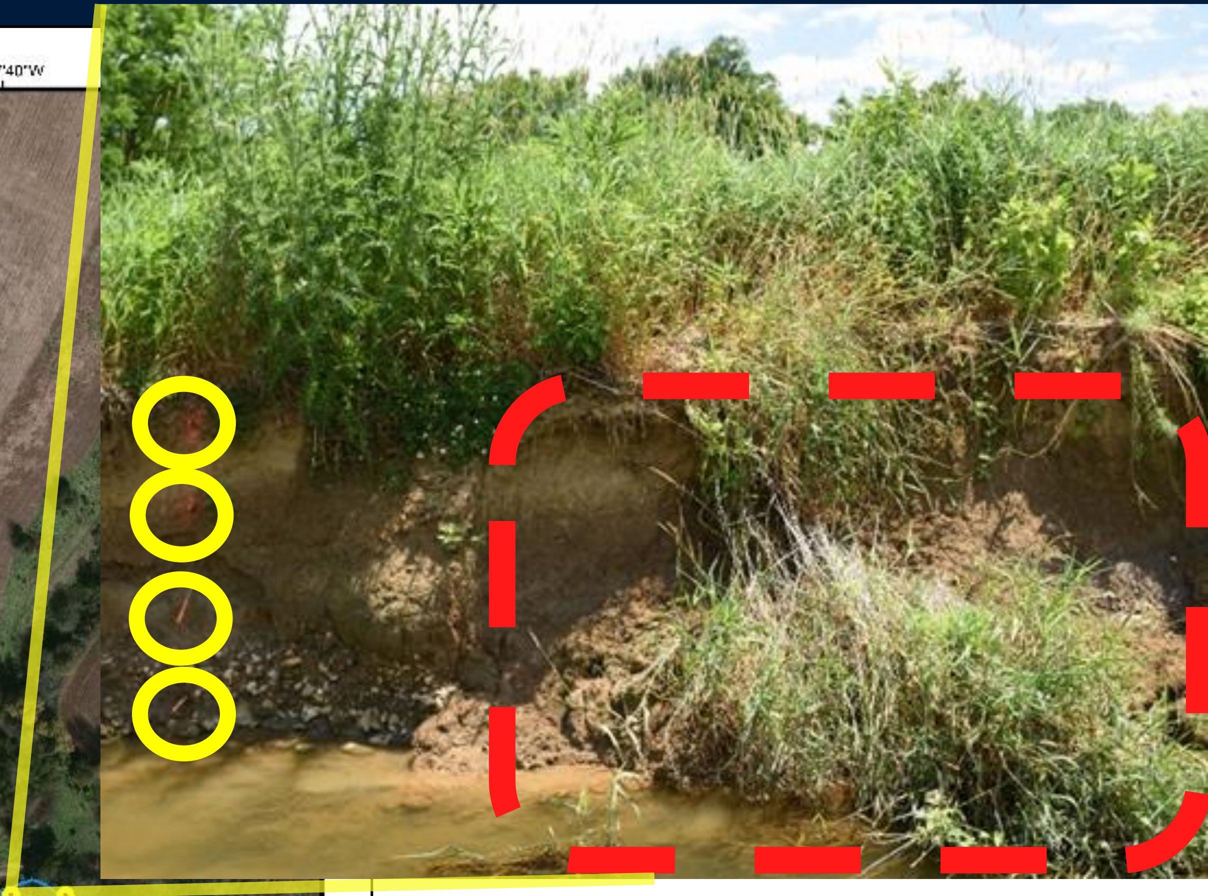
A floodplain-reconnection restoration

How does an incised stream respond when reconnected to its floodplain as a stream/wetland complex?

- USGS monitoring water quality, flooding, erosion, deposition
  - Before / During / After restoration
  - Gages both upstream and downstream of restoration (Control/Impact)

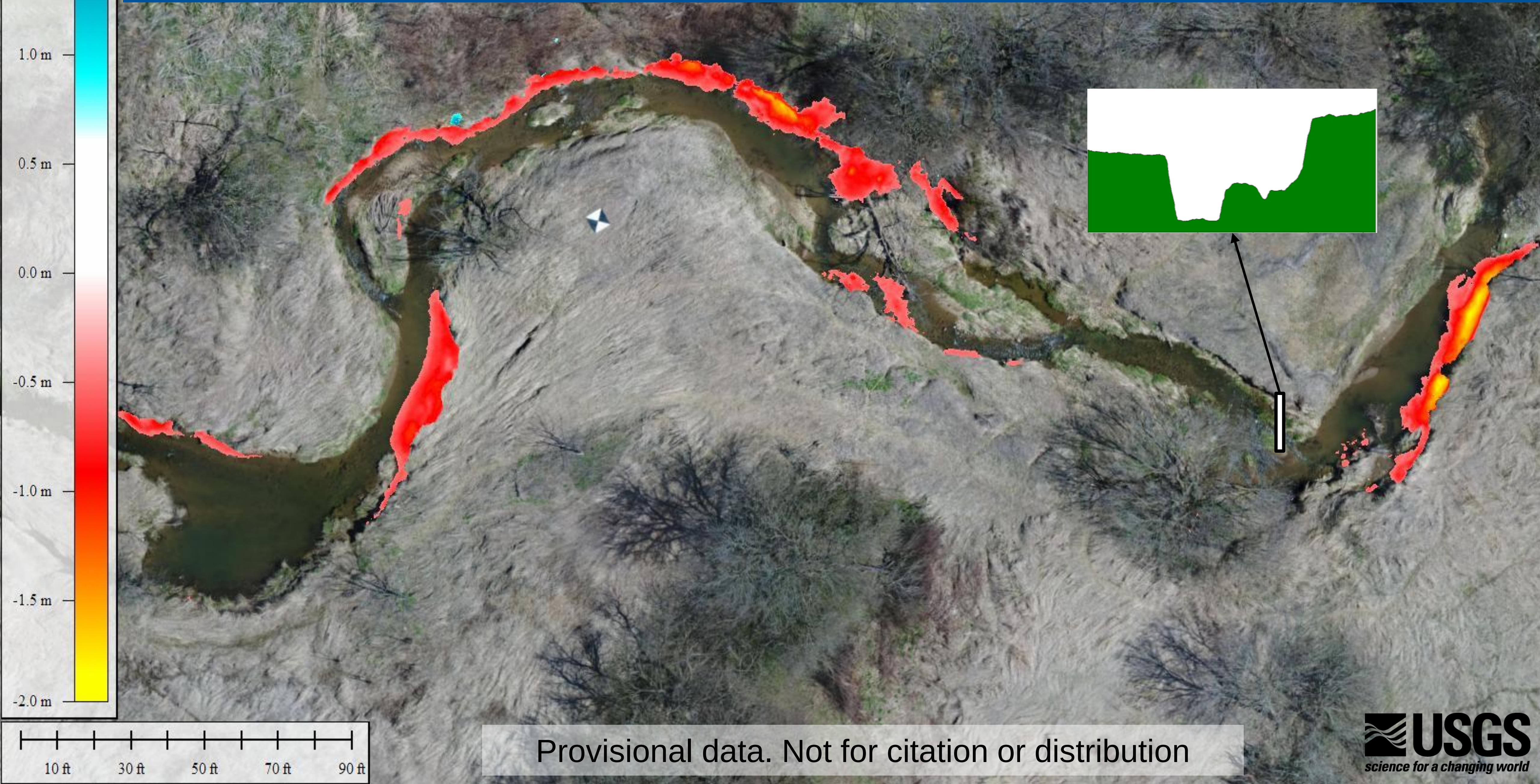
Traditional field measurements are at points and lines





Quantifying floodplain deposition and bank erosion

UAS – UAS 11-month change



Provisional data. Not for citation or distribution

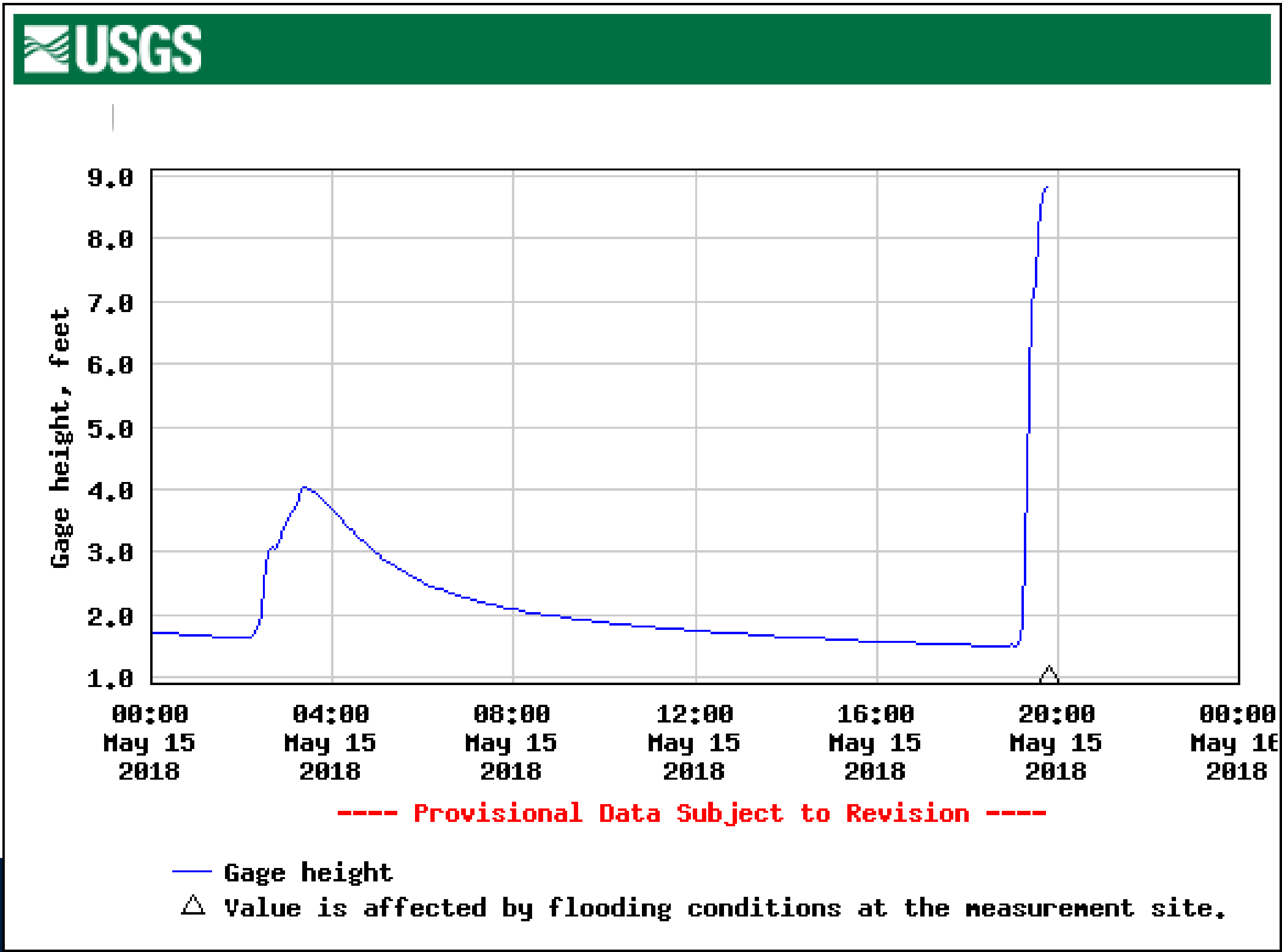
USGS
science for a changing world

A “1,000 year” storm during restoration – May 16, 2018

6.5 inches of rain in under three hours

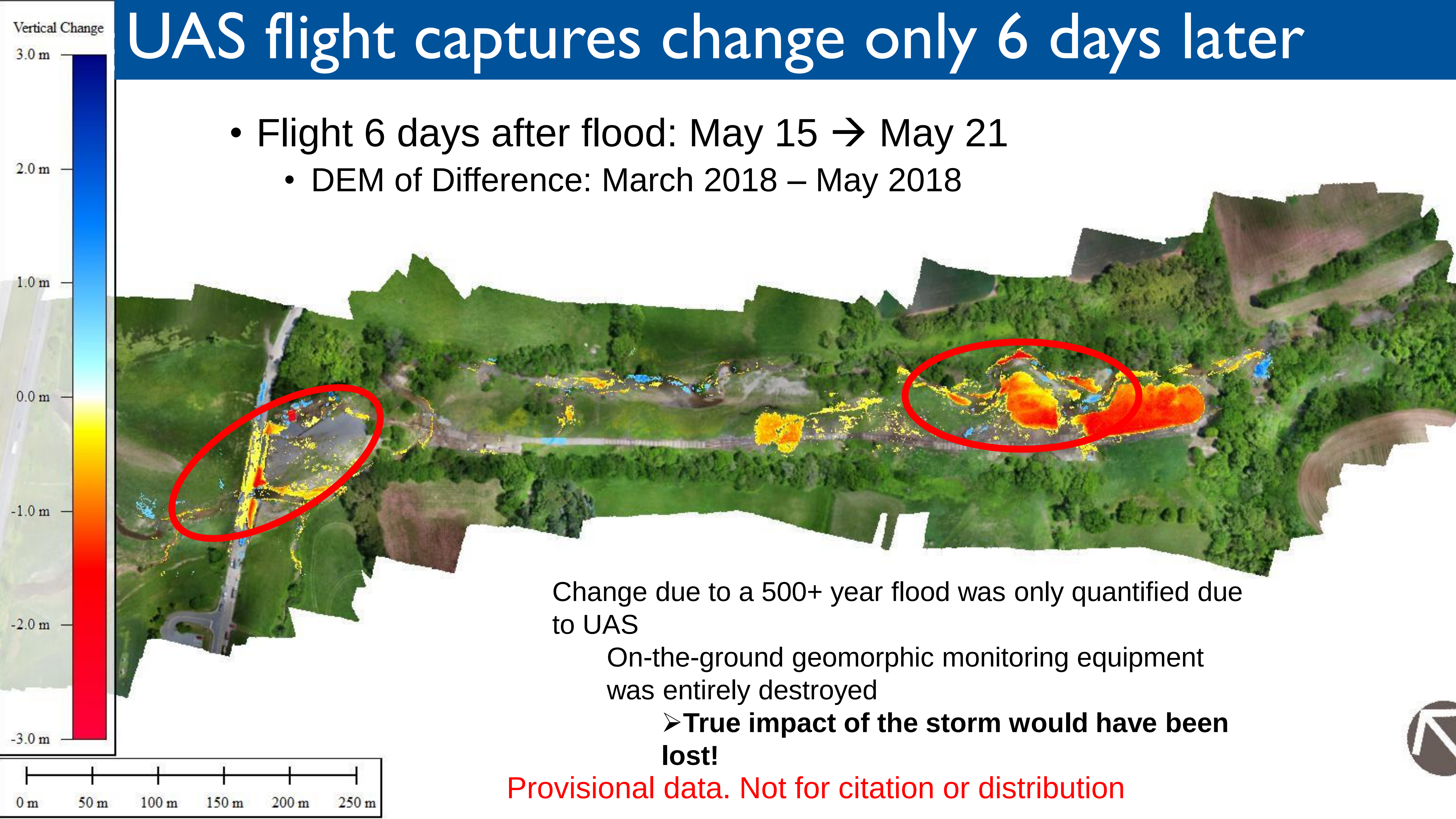
- Peak of 9,630 cfs → 500+ year flood

Destroyed gage and all ground-based erosion measurements



UAS flight captures change only 6 days later

- Flight 6 days after flood: May 15 → May 21
  - DEM of Difference: March 2018 – May 2018



Change due to a 500+ year flood was only quantified due to UAS

On-the-ground geomorphic monitoring equipment was entirely destroyed

➢**True impact of the storm would have been lost!**

Provisional data. Not for citation or distribution

Using watershed management to mitigate multiple stressors from land

Goals of watershed management

- Improve water quality (SS, N, P)
- Reduce flooding (peak flows)
- Improve biodiversity of aquatic organisms

Watershed management approaches

- In-channel stormwater management or stream restoration
- Outfall retrofits
- Green infrastructure

Regenerative stormwater conveyance

Floodplain reconnection

Bioretention basins

Biochar Soil Amendment for BMPs

- Provide data on potential use of biochar amendment to soils as a BMP measure for NPDES (MS4) and TMDL programs.
- Similar to the accepted use of compost as a BMP measure.
- ***Conduct a controlled field study*** of *t*he effect of biochar-amended soils to improve stormwater retention and nutrient removal.
  - select swale and establish unamended area, tilled control area, and tilled biochar-amended area
  - monitor stormwater retention and nutrient removal

high internal porosity; low particle density

increases soil hydraulic conductivity

enhances sorption of nitrogen compounds

provides electron donors and acceptors

enhances microbial nitrogen reduction

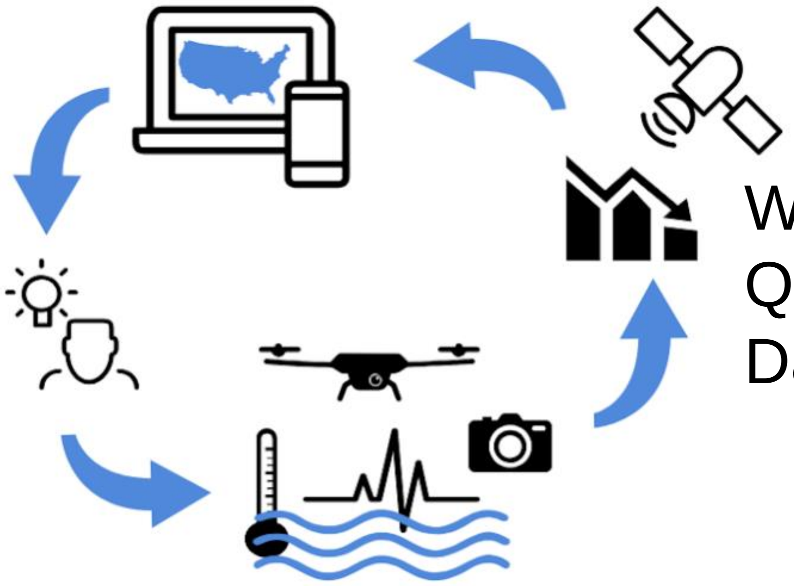
Biochar: charcoal-like material formed by combusting waste organic matter in oxygen-limited conditions.

POTOMAC RIVER

Next Generation of Water Observing Systems?

Next Generation Water Observing System (NGWOS)

Support modern water prediction and decision support systems



Water Quantity, Quality, and Use Data

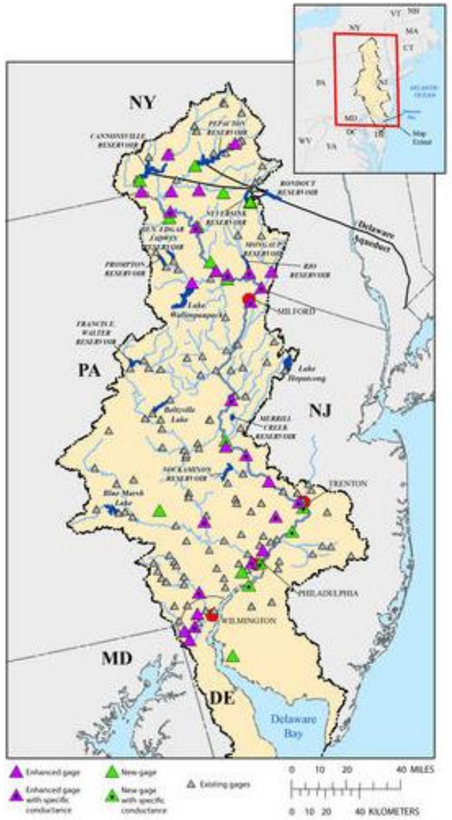
Integrated set of fixed and mobile monitoring assets in the water, ground, and air

Pilot NGWOS – Delaware River Basin

An opportunity to demonstrate an integrated water observing system to support innovative modern water prediction and decision support systems in a nationally important, complex interstate river system.

The Delaware River Basin:

- Ecologically diverse and critical to the regional and national economy;
- Provides drinking water to over 15 million people;
- Long history of innovative, regional solutions to insure the long-term sustainability of this treasured resource.

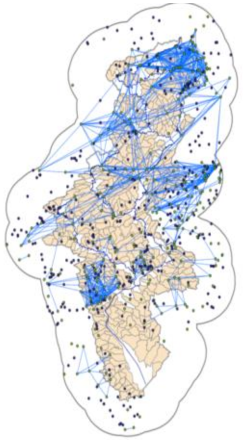


www.usgs.gov/NextGenWOS-DRB

NGWOS Delaware River Basin Pilot

- **Enhanced Mainstem Monitoring**

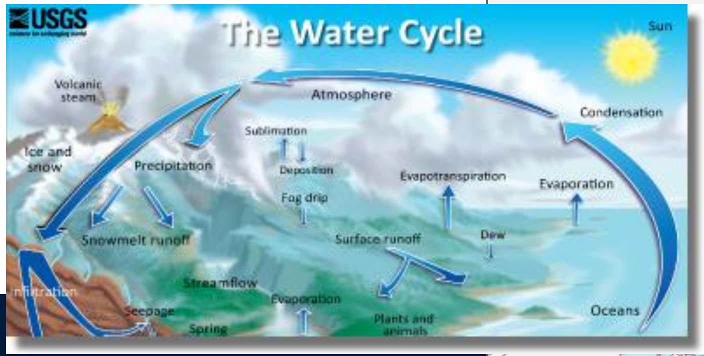
- 17 new streamgages
- Enhancements to 28 streamgages
- Addition of ~ 36 temperature & 10 salinity monitoring

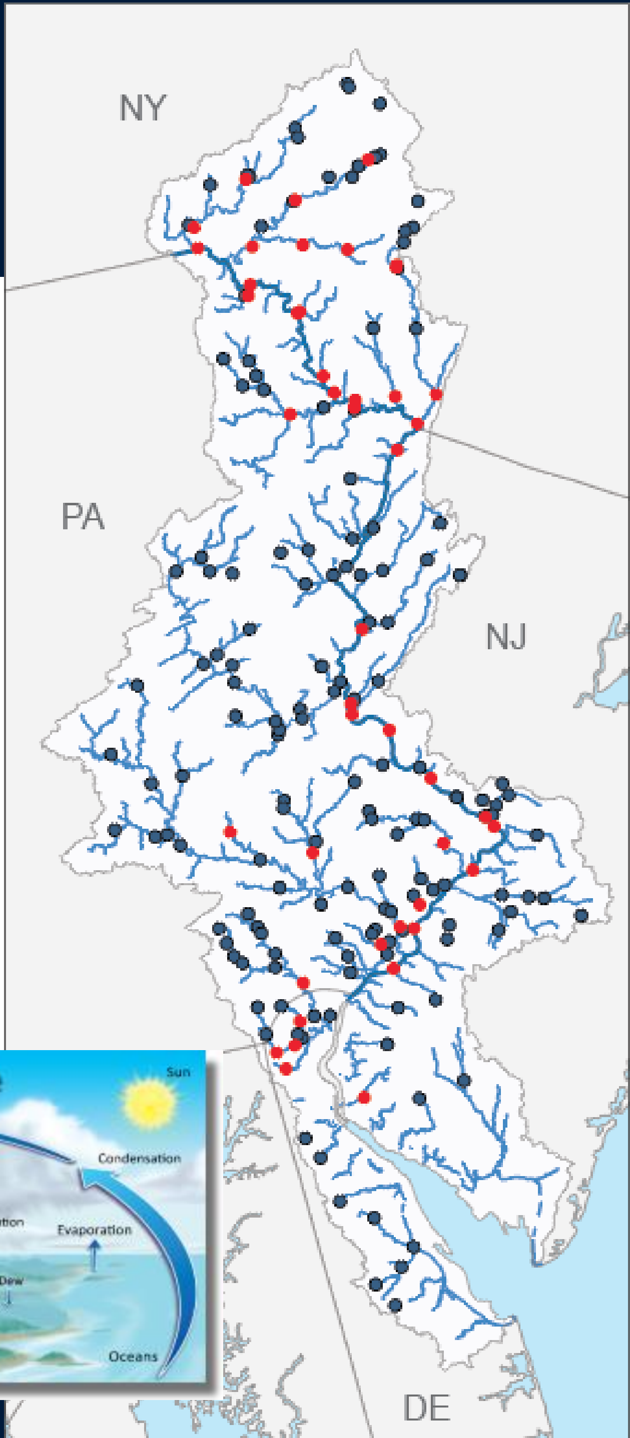


- **Intensive Sub-Basin Monitoring**

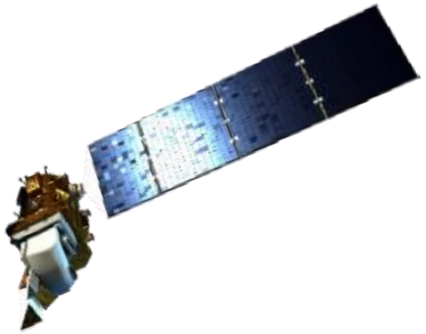
- **Innovation Test Beds (R2O)**

- Innovation test bed Philadelphia
- Operational test beds for new technology
- Limited monitoring of entire water budget





Hydrologic Variables that can be Observed with Remote Sensing



Water Quality
- Temperature
- Turbidity
- Chlorophyll
- Others

Water Quantity
- Bathymetry
- Water Levels
- Surface Water Extent
- Water Velocity
- Discharge (calculated from above parameters)

Water Cycle
- Precipitation
- Evapotranspiration
- Recharge
- Snow cover / SWE
- Soil Moisture
- Inundation

USGS Hydrologic Remote Sensing – Surface Water Extent (Inundation)

New Product: **Dynamic Surface Water Extent (DSWE)**

- DSWE detects surface water in each pixel
- Landsat 5-8 cloud-free and snow-free pixels
- Includes mixed pixels (e.g., wetlands with vegetation).
- 5 inundation categories

Not water

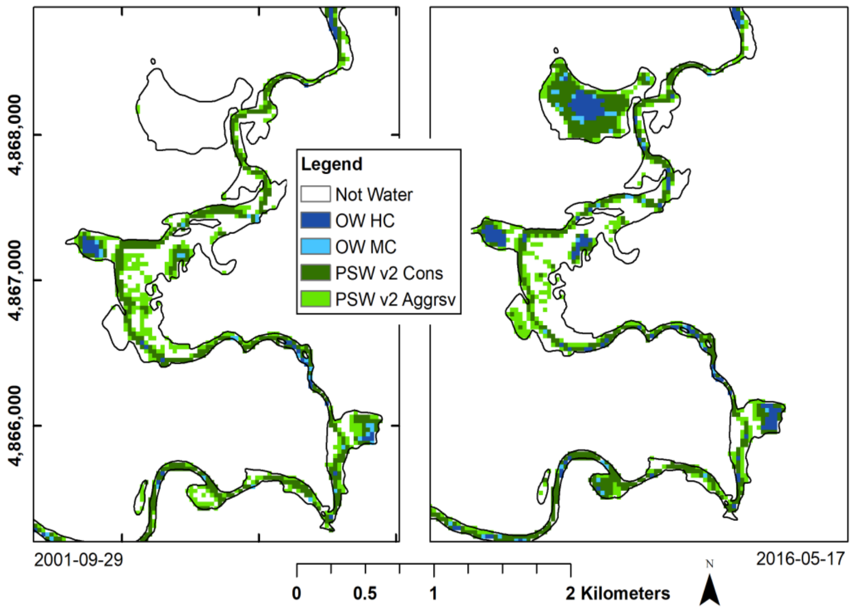
Open water, high confidence

Open water, moderate confidence

Partial surface water, conservative

Partial surface water, aggressive

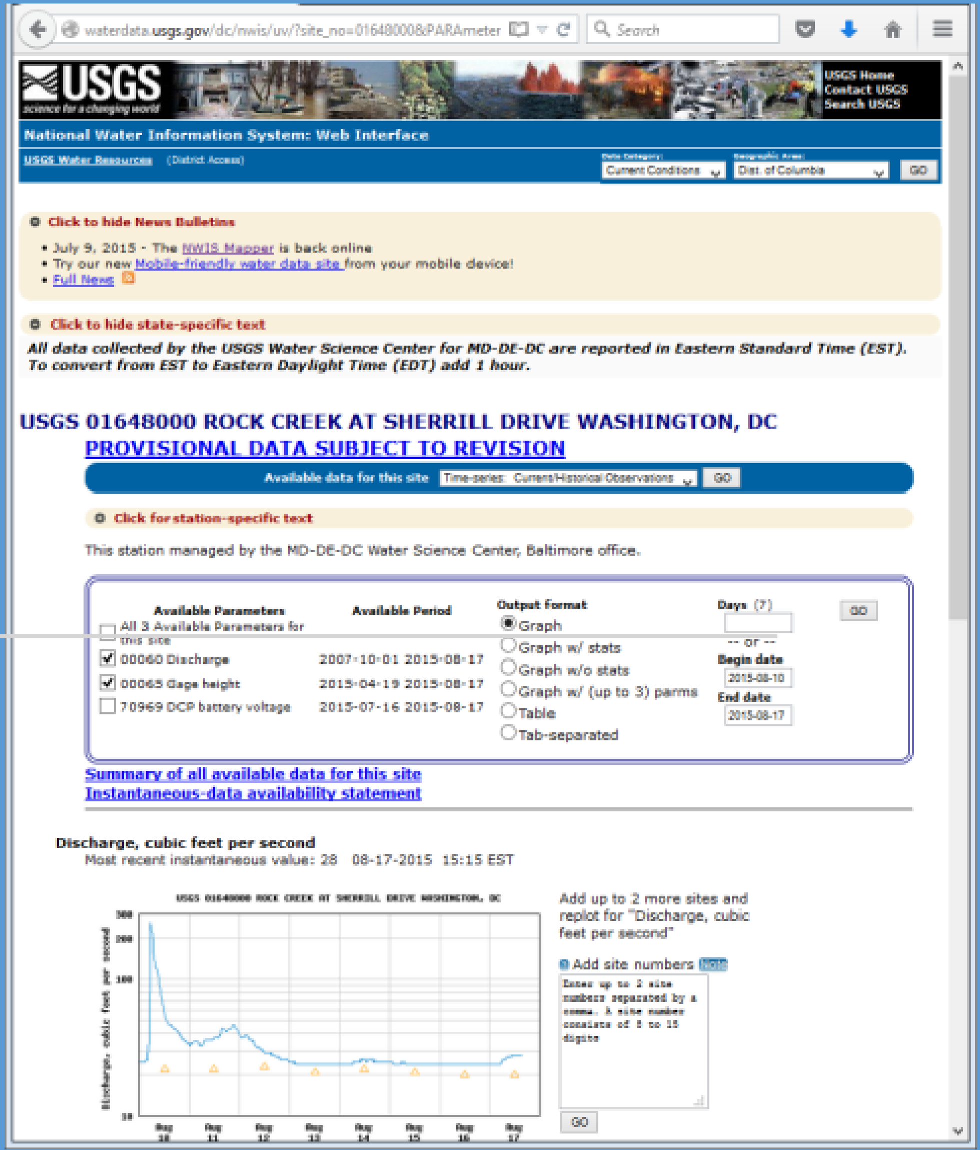
Deschutes River near Bend, OR

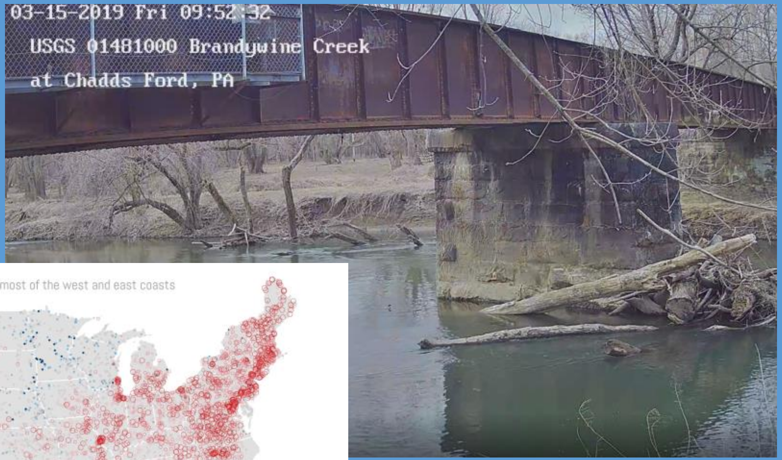


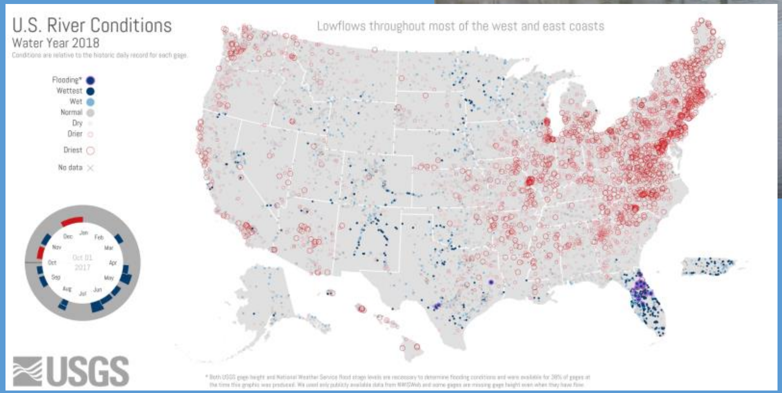
From Jones, 2019, Remote Sens., v11, 374.

USGS

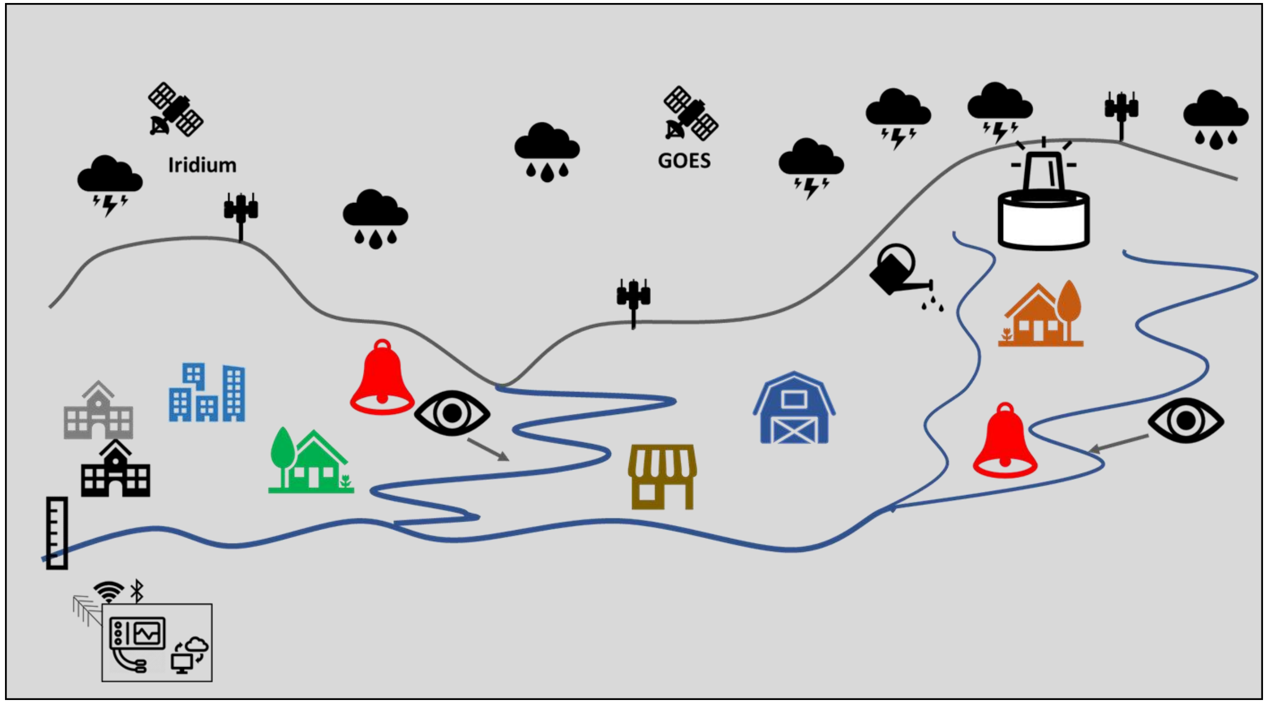
NWIS Upgrade







Fit-for-Purpose **LoRaWAN** monitoring networks



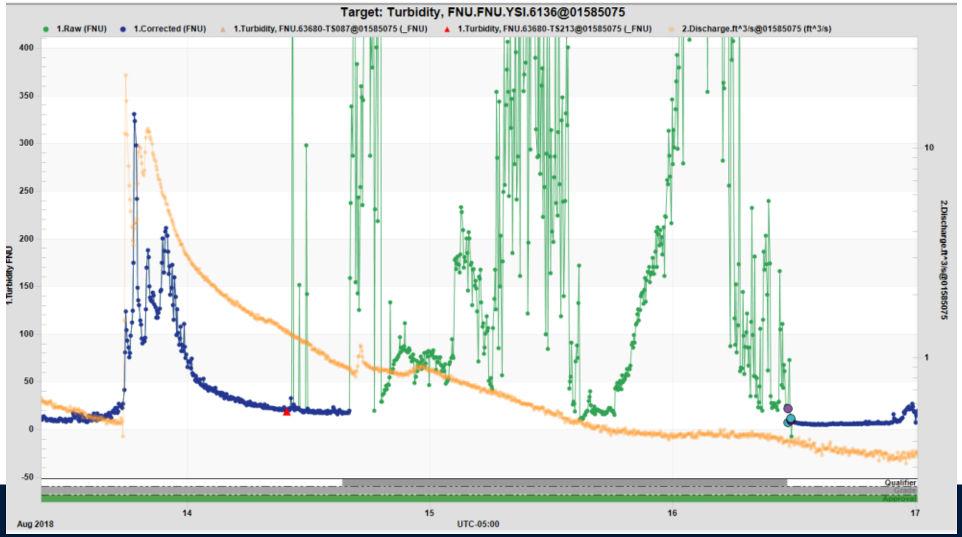
- USGS LoRAWAN fit-for-purpose monitoring as part of early detection/warning networks

- Cost-effective, high-fidelity ecosystem **Fit-for-Purpose** monitoring networks within Chesapeake Bay Watershed
- **Uses existing gages as a gateway**

Artificial Intelligence/Machine Learning

- Automated Records Processing
  - i.e. Temperature, water-level
  - Reduce costs of monitoring

- Maryland only: Pilot study at Rock Creek and Foster Branch (Station 01585075) to predict sensor malfunction



NGWOS Basin Selection

- Up to 10 basins will be selected
  - Depends on Budget
  - A USGS Basin Selection Team will select 40-50 candidate NGWOS basins selected by end of 2019
  - Water Science Centers have been asked to propose basins
  - Begin stakeholder engagement to make final selection of NGWOS basins #3-10 in FY20

Why pick Potomac?

- Encompasses four states and D.C. with varied hydrogeology
- Provides drinking water for approximately 6 million people, managers have serious concerns over the Region’s ability to withstand future growth without water shortages
- Groundwater withdrawals exceed recharge rates and overallocation of groundwater resources has reduced baseflow by 51%.
- Washington DC has unique concerns for water supply due to terrorism
- Model to simulate water supply and demand
- Long period of record with decadal trends networks WQ
- Good exposure to congress

Integrated Water Availability Assessment

Water Quality and Ecology

Drought

Water Use and Availability

Stakeholder engagement will be considered when making final selections

- Department of Interior
- Other Federal Agencies
- Other Stakeholders

Mary Kay Foley P.E., PMP
Director
U.S. Geological Survey
Maryland-Delaware-D.C.
Water Science Center

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