





#### Shoshone River Water Resources

Assessing Sediment Inputs into the Shoshone River in Wyoming to Determine Areas for Protections and Restoration Practices

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Pop-Up Project | Fall 2022

# **Project Location**

#### Study Area

- Shoshone River
  - Buffalo Bill Dam to Willwood Dam
  - Tributaries & irrigation canals feed into the river
- Surrounded by mountains
- Annual precipitation: 10.5in

#### Study Period

- Jan. 2019 Oct. 2021
  - While USGS operated a water monitoring station



Basemap Citation: NRGC, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, Esri, Here, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS. USDA, Esri, NASA, NGA, USGS



# **Historical Background**

- Sediments become trapped behind the Willwood Diversion Dam (WDD)
- Heavily concentrated when released, impairs downstream water quality
- 2016 release prompted the creation of three working groups to address sedimentation in WDD



Image: Carmen McIntyre

# **Project Partners**

#### WY Department of Environmental Quality

#### Shoshone River Partners

#### **USGS MT-WY Water Science Center**



#### David Waterstreet

Watershed Protection Program Manager



Carmen McIntyre

Watershed Coordinator



Jason Alexander
Supervisory Hydrologist



# **Community Concerns**



#### Ecological

- Fish spawning habitat
- Aquatic insects



#### Economic

- Rafting, angling, recreation
- Irrigated agriculture

#### **Quality of Life**

 Community member recreation



# Why remote sensing?

- Look at turbidity spatially
- Identify sources of sediment to prioritize watersheds for BMPs
- Estimate sediment input from inaccessible areas



# **Project Objectives**



Image: Carmen McIntyre

- Create categorical sediment contribution maps indicating priority tributaries
- Conduct precipitation analysis to better understand runoff events
- Analyze which land cover types are correlated with high turbidity



#### **Earth Observations**





#### **PlanetScope**

- 4 band (RGBn) imagery
- > 3m resolution
- Daily

#### **GPM IMERG**

- Precipitation estimations
- 10km resolution
- Daily



# **Sensing Turbidity**



- Light bounces off suspended sediment particles, increasing reflection
- Change in reflection differs across the light spectrum



#### **Methods**





# **Results: Empirical Study**



 Sulphur Creek (Upper Watershed)



Dry/Homesteader
Creek (Middle
Watershed)



PlanetScope Imagery

 Penney Gulch (Lower Watershed)



#### Sulphur Creek Example







#### **Results: Sediment Contribution Map**



 Turbidity change along part of the Shoshone River: Low, Moderate, High, based on a high storm day



# **Results: Turbidity Calibration**

- Calibrated reflectance to in-situ turbidity
- T = green / (a + b \* red)
  - ▶ a = 0.0473
  - ▶ b = 0.165
  - ▶ (r2 = 0.70)

NDTI = (Red – Green) / (Red + Green)

Measured Turbidity vs. Remotely Sensed Turbidity



## **Results: Precipitation Analysis**

GPM IMERG Averaging Time	R <sup>2</sup> , without snowmelt influence (Apr to Oct)	R <sup>2</sup> , entire study period
None	0.37	0.34
Two-Day	0.61	0.57
Three-Day	0.59	0.56



## **Results: Precipitation Analysis**

			5000 -		
GPM IMERG Lag Time	R <sup>2</sup> , without snowmelt influence (Apr to Oct)	R <sup>2</sup> , entire study period	- 4000 - (NNJ)		
One-Day	0.59	0.55	/ Turbidity	•	r = 0.59
Two-Day	0.23	0.22	Mean Daily	•	
Three-Day	0.10	0.09	1000 -		•
	•	•	0 -		

0.0 0.2 0.4 0.6 0.8 1.0 1.2 One-Day Lag GPM IMERG (in/day)

## **Results: Land Cover Analysis**



Dominant land cover types are:

- Shrub/scrub
- Cultivated crops

Basemap Citation: Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, Esri, NASA, NGA, USGS



## **Limitations and Uncertainties**

 Often missed storm runoff events because of clouds



Spectral data quality



Spatial resolution
of precipitation data (10km)



# Conclusions



- Remote sensing allows watershed managers to investigate sources of turbidity spatially
- Sediment plumes from small tributaries were clearly visible on multiple days
- PlanetScope data provided a spatial resolution suitable for looking at a small river, but the spectral resolution may have caused challenges with data analysis

Image: Carmen McIntyre

## **Future Work**

- Project will be continued during a 2nd term:
  - Investigate turbidity during snowmelt season
  - Soil Water Assessment Tool (SWAT) Hydrologic Model
  - Quantitative turbidity



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#### **Backup Slides**

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# **Sensing Turbidity**

#### NDTI = (Red – Green) / (Red + Green)



#### **Earth Observations**







#### **PlanetScope**

- 4 band (RGBn) imagery
- > 3m resolution
- Daily

#### **GMP IMERG**

Precipitation

#### Sentinel-2 MSI

- 8-band imagery
- 10m resolution



#### **Results: Dry/Homesteader Creek**







#### **Results: Penney Gulch**







PlanetScope Imagery

### **Results: Precipitation Analysis**





