Working with Uncertainty in Sparse and Unreliable Data

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Outline

○ Project Overview
○ Original goals
○ Data received
○ Sediment discharge
○ Gaussian Processes (GPs)
○ Data inconsistencies
○ Level of uncertainty
○ Future methods
Project Overview

- Study site: Ruth Reservoir, Mad River, CA
- Affected by a wildfire in 2015
- 8 tributaries, burned to various degrees
- Studying the effect of fire disturbances on river networks

- Expectation: increased sedimentation at burned sites\(^1\) due to hydrological and geomorphological changes\(^2\)
- Task: compare sediment yield between the eight tributaries


Six trips from January - May provided the following:

- Field notes
- Culvert Measurements
- Sampler Measurements
- Photos

We also used USGS stream gage data.
Culvert Measurements

Measurements needed to calculate discharge:

- Culvert diameter
- Water depth
- Culvert slope
- Manning’s roughness
Sampler Measurements

Sediment Mass: Phillip’s Sampler
Sampler Measurements

Sediment Concentration: ISCO & Grab Samples

Daily Sediment Discharge Records (the basics)

There is an empirical and temporal relation between sediment discharge and water discharge\(^1\)

Sediment Discharge

- \( Q_s = CQ_w K \)
  - \( Q_s = \) Sediment Discharge (tons/day)
  - \( C = \) Suspended-Sediment Concentration (g/ml)
  - \( Q_w = \) Water Discharge (ft^3/s)
  - \( K = \) Coefficient based on units of Water Discharge and specific weight of 2.65 for sediment

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Sediment Rating Curve (SRC)

SRC to Estimate Daily Discharge Records

○ Power Function:
  □ $Q_s = a(Q_w)^b$
    ○ $a =$ the intercept; and
    ○ $b =$ the slope\(^1\)
    ○ $a$ and $b$ both found by log-linear model

○ Log-Linear Model
  □ $\ln(Q_s) = \ln(a) + b\ln(\ln(Q_w)) + \epsilon$
  □ $Q_s = \exp(a + b\ln(Q_w) + \epsilon)$
    ○ $\epsilon =$ independent random variable $\sim N(0,\sigma^2)$

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FIGURE 3. Sediment rating curve by the turbidimeter indirect method.
Gaussian Processes

- A supervised learning technique often used for regression
- A distribution of functions defined by a mean function and covariance function
Inconsistencies

Water depth = 0
Level of uncertainty

- Culvert diameter
- Top of culvert to water +/- 1 inch
  - Water depth
  - Slope
  - Manning’s n

- Filter weight
- Gross Sample Weight
- Container weight
  - Volume of water

- Water discharge
  - Sediment discharge
  - Sediment mass
  - Sediment concentration
- **Level of uncertainty**

  - Culvert diameter +/- 3 inches
  - Top of culvert to water +/- 1 inch
  - Water depth
    - Slope
    - Manning’s n
  - Water discharge
    - Sediment discharge
    - Sediment mass
    - Sediment concentration
  - Filter weight
  - Gross Sample Weight
  - Container weight
  - Volume of water
Level of uncertainty

Culvert diameter +/- 3 inches

Top of culvert to water +/- 1 inch

Water depth

Slope

Manning’s n

Water discharge

Sediment discharge

Filter weight

Gross Sample Weight

Sediment mass

Volume of water

Sediment concentration

Container weight 51.6g or 56.29g
Marina Creek 1/9/16

Recorded diameter: 6.7ft
Culvert height: 83 in
Marina Creek

Point Estimate Range for Sediment Discharge per Site Visit (Marina)

- S. Discharge “L” (tonnes/day)
- S. Discharge “NC” (tonnes/day)
- S. Discharge “H” (tonnes/day)
Gaussian Process Results

USGS data: daily mean

![Graph showing discharge over days with peaks and valleys representing water flow.](image-url)
Gaussian Process Results

Every third day (37 of 111 data points)
Future collection methods

- Initial design planning
  - Parameters
  - How much data to collect

- Data collection
  - Accuracy of measurements
  - Consistent collection practices
  - Use intuition

- Quality Control
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