A vulnerability assessment of wildland fire impacts to public drinking water in the western and southeastern United States

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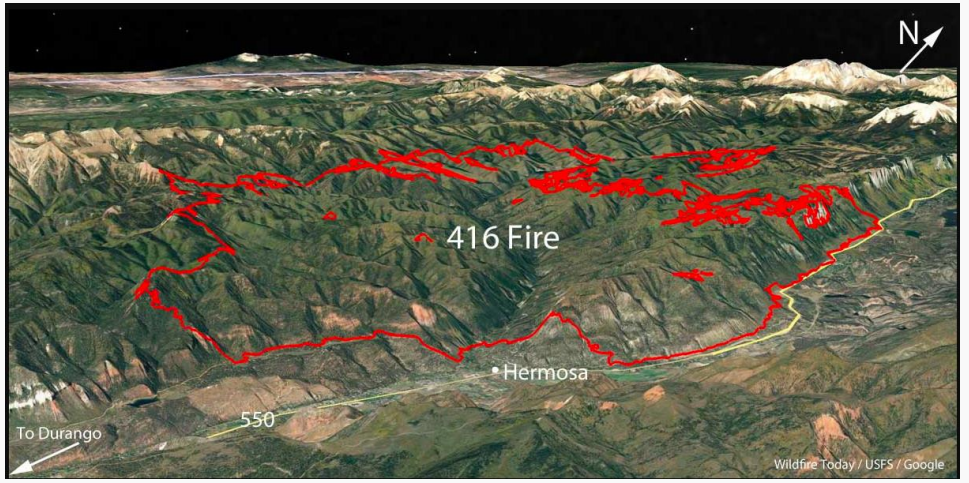
NC STATE UNIVERSITY

- **2015 Gold King Mine Spill**
- Animas River (Tributary to San Juan River)
- 3 million gallons of toxic waste released in one hour

- **2018 416 Fire, Hermosa, CO**
- Animas River (Tributary to San Juan River)
- 54,000 Acres burned



Mountain Studies Institute
SAN JUAN MOUNTAINS COLORADO

- **Al+ - 50X higher (416 Fire)**
- **Fe – 6X higher (416 Fire)**
- **Mn – 20X higher (416 Fire)**
- **Hg – 3X higher (416 Fire)**

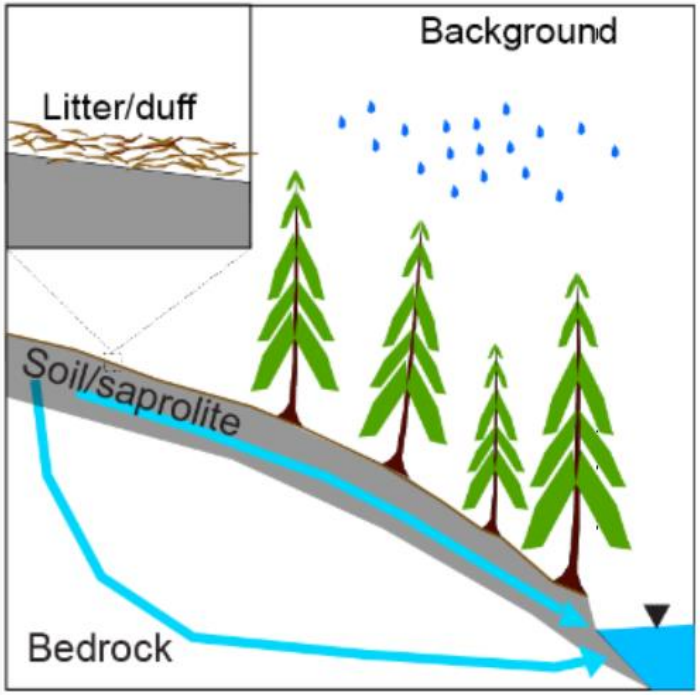
Which was worse for water quality: Gold King Mine spill or 416 Fire floods?

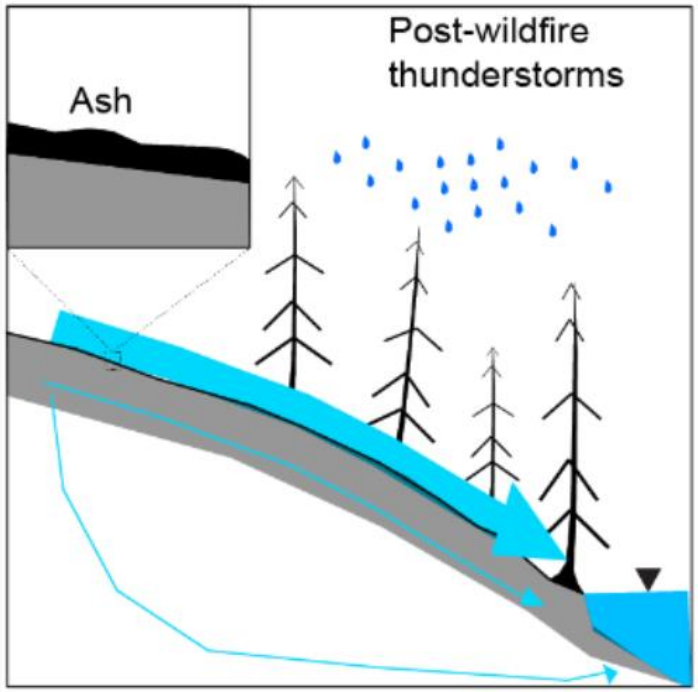
Study compared metal loading in both events; results surprised researchers

By Jonathan Romeo Staff reporter

Saturday, Nov 3, 2018 5:03

Wildfire impact to receiving water bodies





Murphy et al., 2018, *JGR-Biogeosciences*

This slide courtesy of Sheila Murphy, USGS

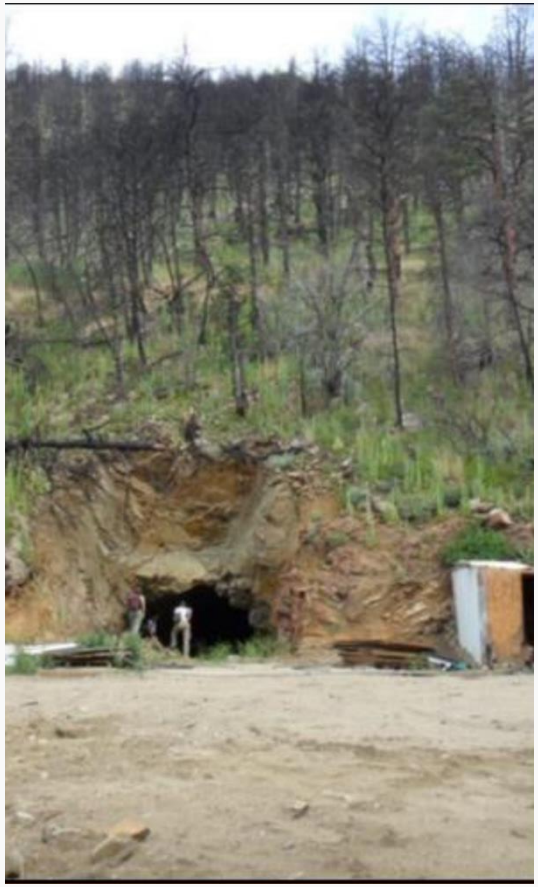
Background forested condition:

- Subsurface flow dominant
- Overland flow very rare
- Forest acts as filter and sponge

Post-wildfire:

- Decreased interception, infiltration, and storage
- Overland flow
- Water (and entrained sediment, ash, etc) moves quickly to streams

Wildfire impact on formally vegetated and stable legacy mining sites

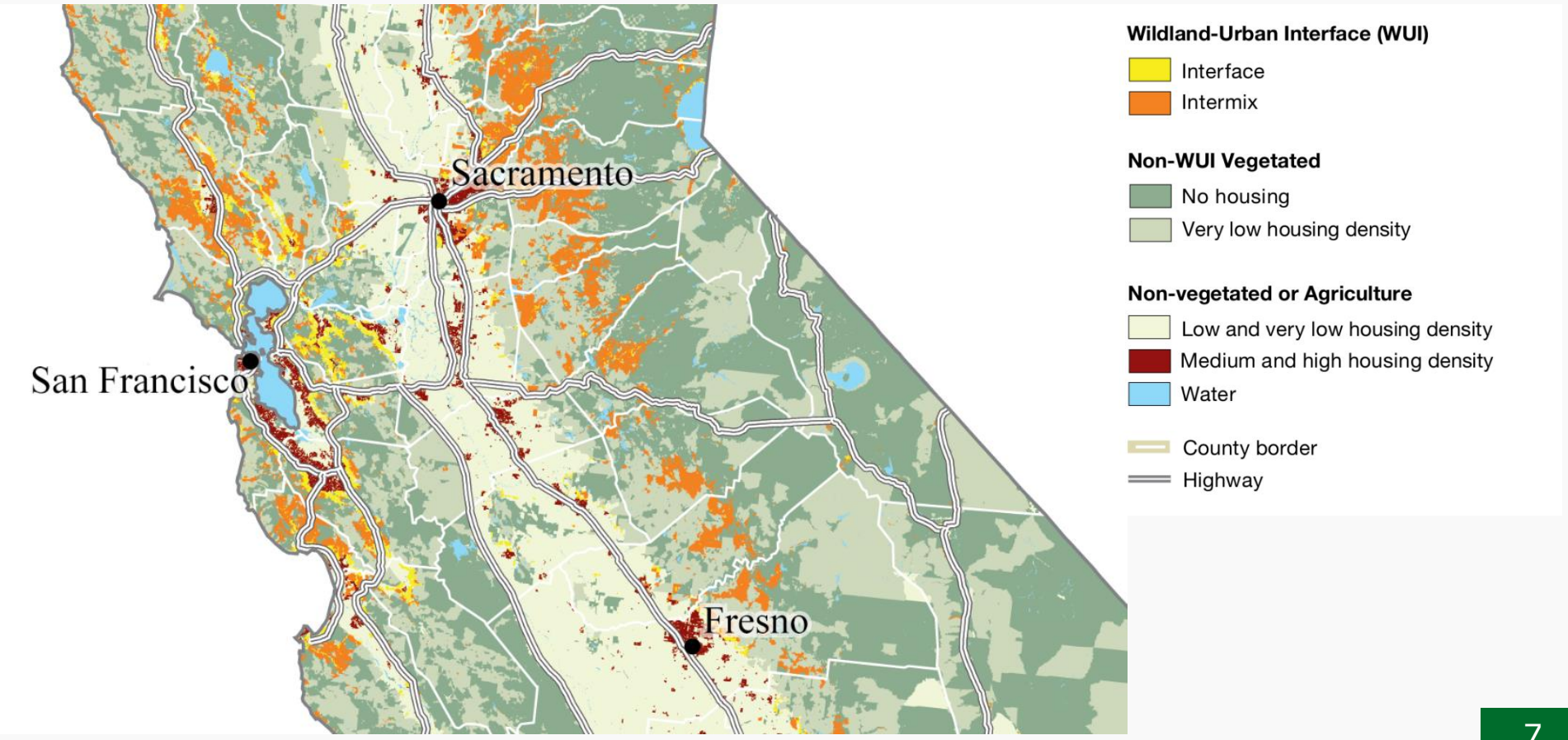


Mining legacy in the Fourmile Creek watershed (1860s-1940s)

Murphy et al., 2020

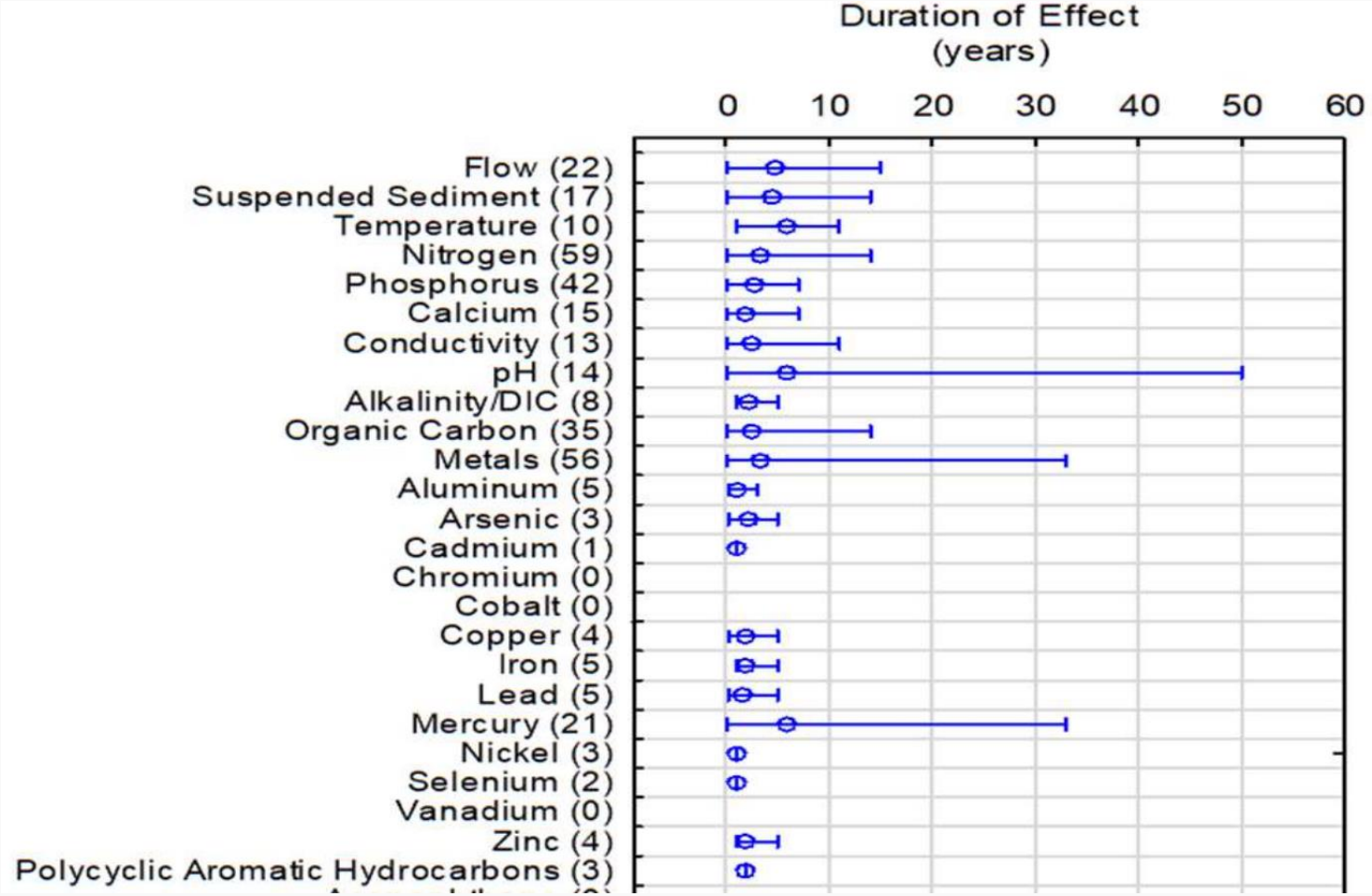
This slide courtesy of Sheila Murphy, USGS

Wildfire-Urban Interface areas are increasing…



https://www.fs.fed.us/nrs/pubs/rmap/rmap8/rmap_nrs8-hi.pdf
Martinuzzi et al., 2015

Water quality: literature assessment - Duration



LeDuc et al., 2021 (in prep)

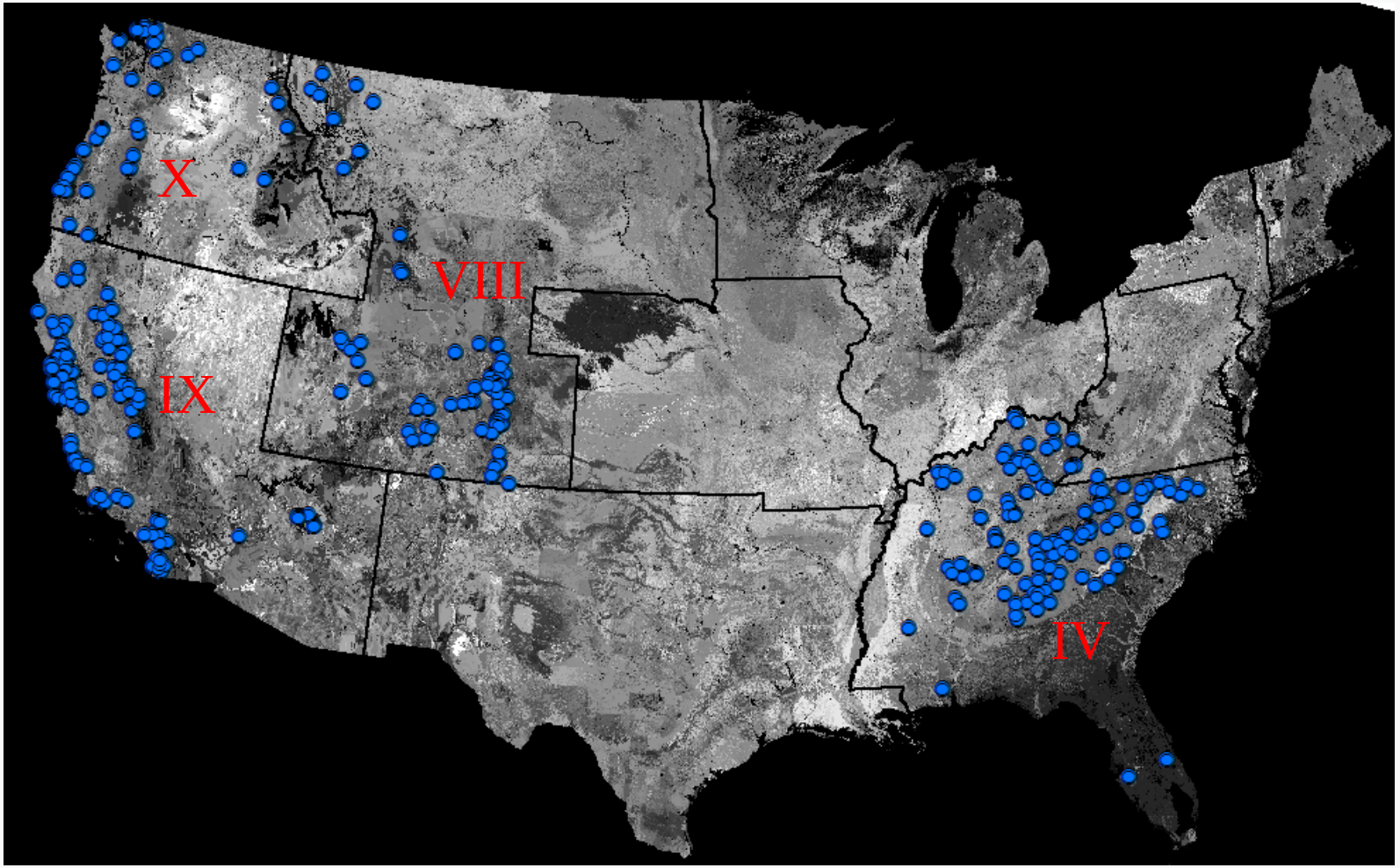
Outline

- Introduction – A brief narrative…
- Forest ecosystem alterations from fire
- Beyond the Smoke: Effect of wildfire events on drinking water
- Lit Review- Duration, Frequency, Magnitude
- **Research Design and Results**

Overview:

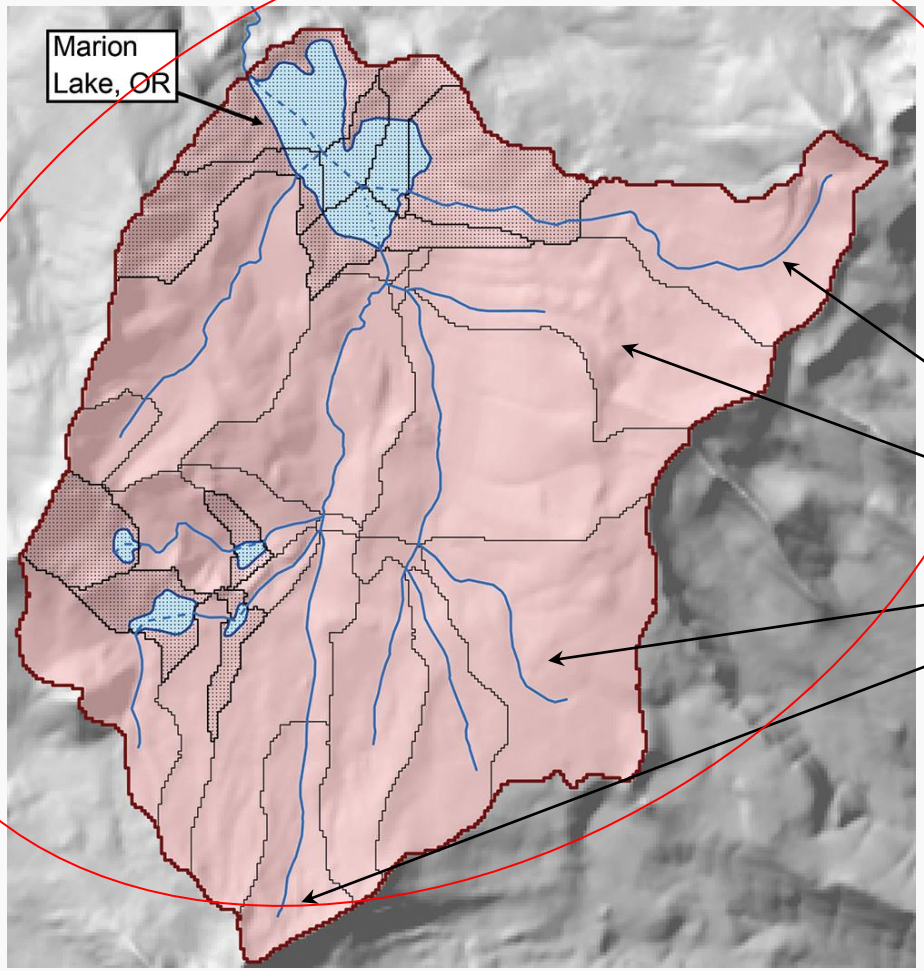
- The US EPA is evaluating **361** 'lakesheds' in the western and southeastern US
- Lakes chosen for the following criteria:
  (1) Non-overlapping watersheds (i.e., not nested)
  (2) Water intakes at minimum 100 m from shoreline
- Lakesheds developed for each water intake (LakeCat)
- Assimilation of lakeshed attributes (e.g., fire- history, probability, intensity; physiographic – aspect, elevation, slope, erosion; climate – precipitation and temperature; fuel loadings – landcover; anthropogenic influences – mining, insect infestation, human use index)
- Hierarchical Sums Modeling – Ranking of vulnerable water bodies

Sampling Design – EPA Regions



Lakes

“Lakesheds” and Catchments:



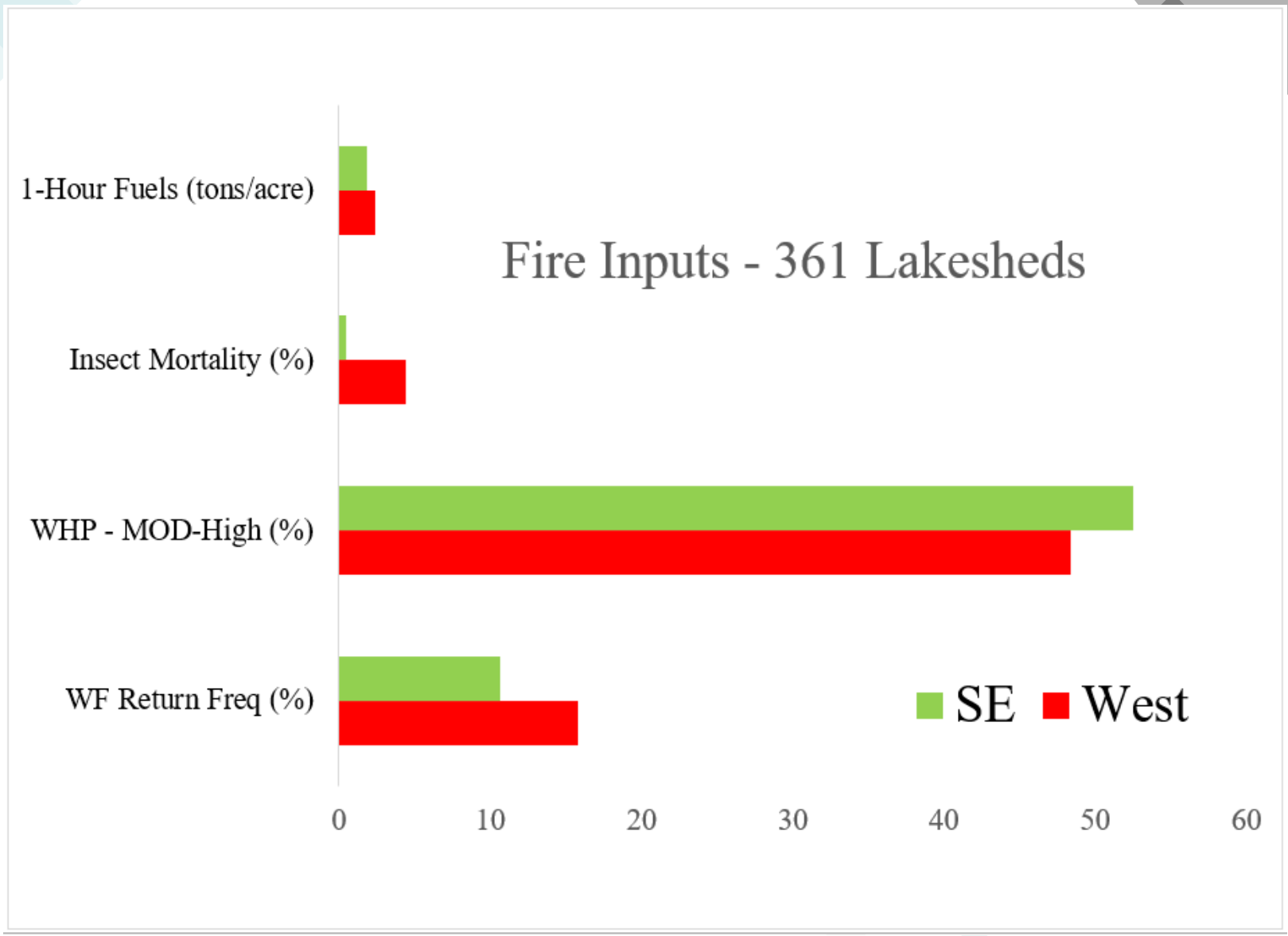
Lakeshed

Catchments

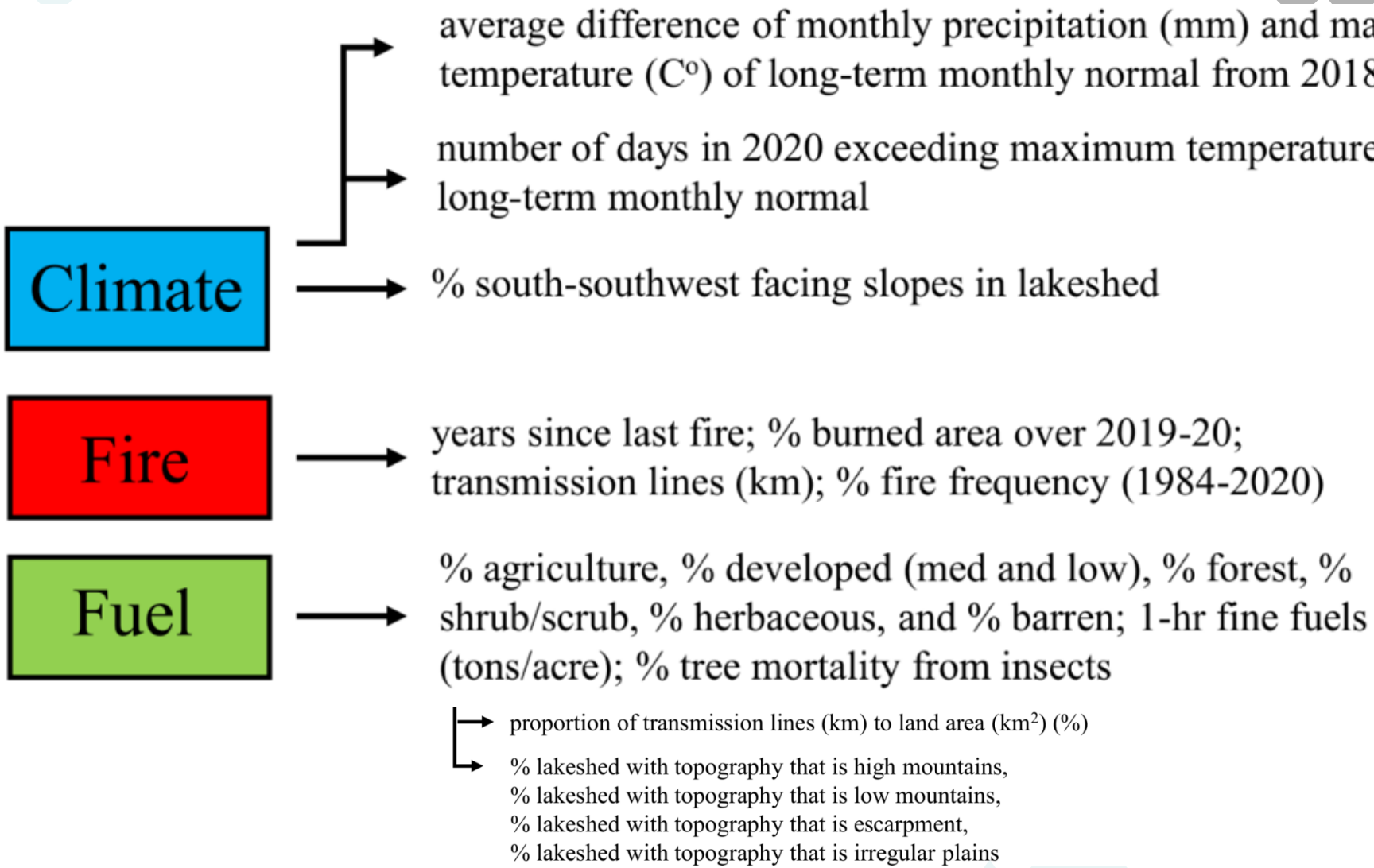
Ryan A. Hill, et al., 2018

Data Sources:

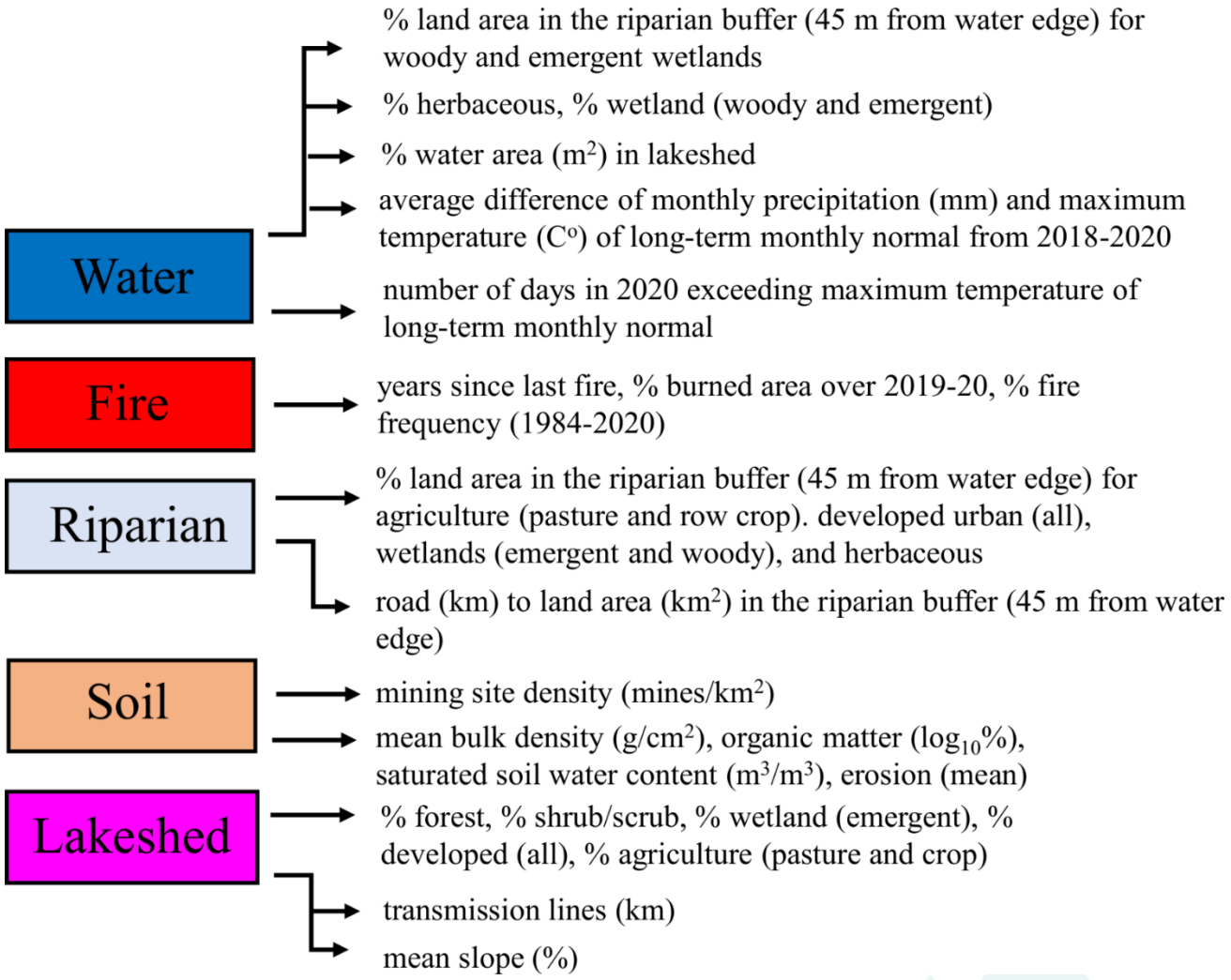
Physiography:
Landfire Slope, Aspect, Elevation
Climate:
PRISM – Daily/Monthly Temperature and Precipitation
Soils:
gSSURGO (Gridded Soil Survey Geographic) – (e.g., Kffact – soil erodibility factor)
Forest-to-Faucets
Wildfire:
Wildfire Hazard Potential (2018)
Monitoring Trends in Burn Severity (MTBS) – 1984-2020
Landsat Burned Area Essential Climate Variable (BAECV) – 1984-2015
Insect Infestation Data, Forest Fuel (Landfire, NLCD 2016)
Human Use:
Mining Site Density, Fire Retardant Avoidance Areas
National Wall-to-Wall Anthropogenic Land Use Trends (NWALT 2012), National Land Cover Database (NLCD 2016)

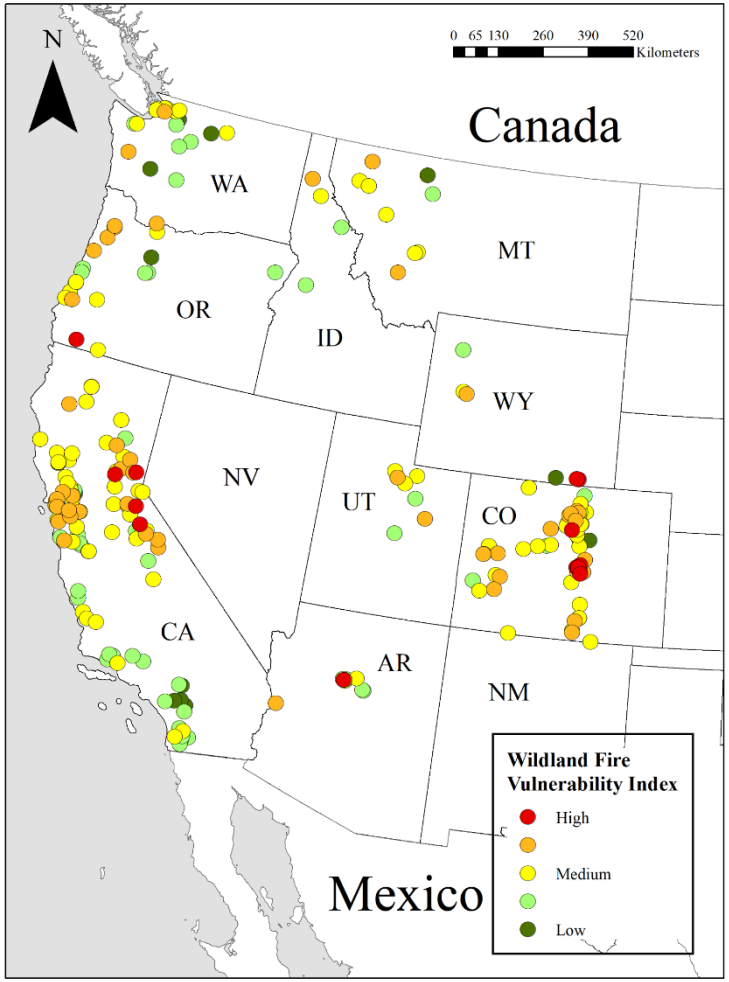

Fire Inputs - 361 Lakesheds
1-Hour Fuels (tons/acre)
Insect Mortality (%)
WHP - MOD-High (%)
WF Return Freq (%)
SE
West
0
10
20
30
40
50
60

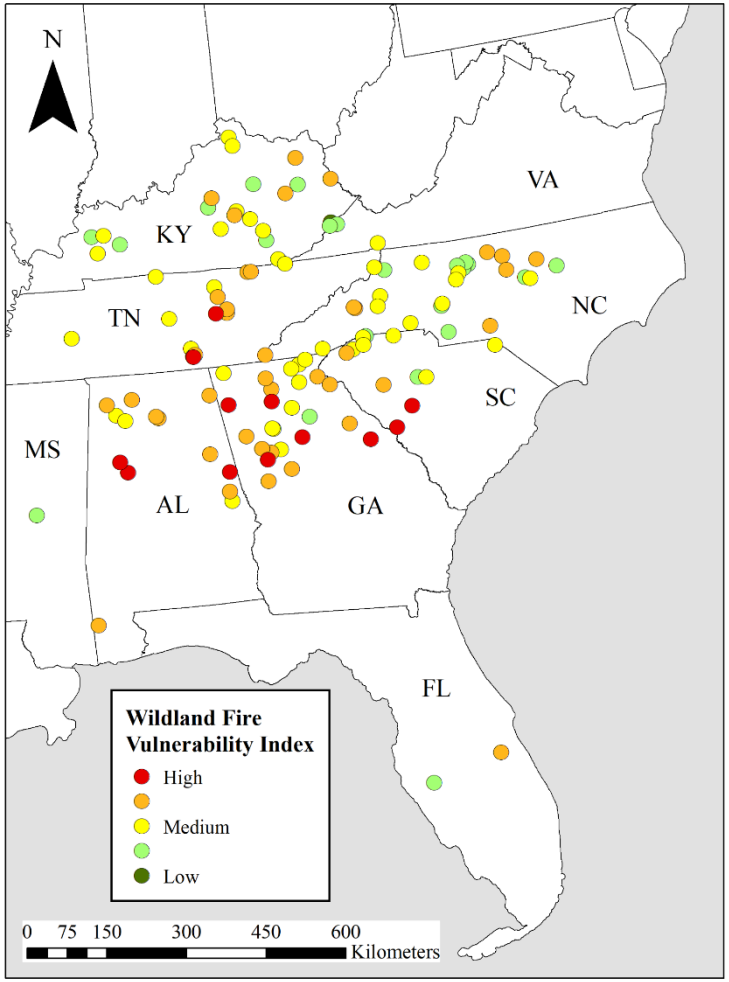
Wildland Fire Vulnerability Index Hierarchy



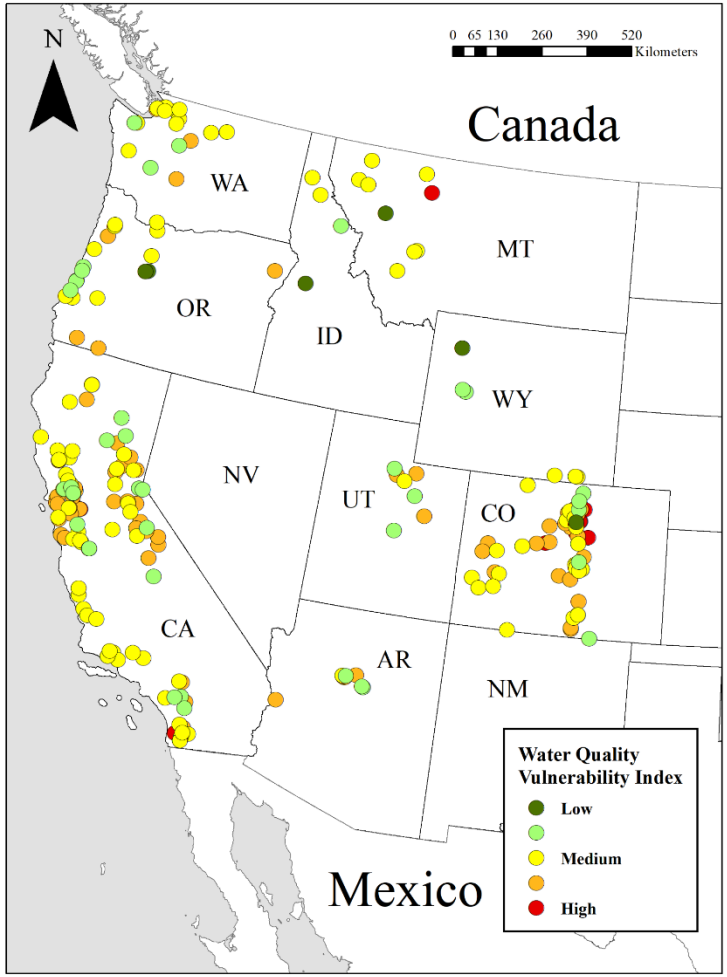
Water Quality Vulnerability Index Hierarchy

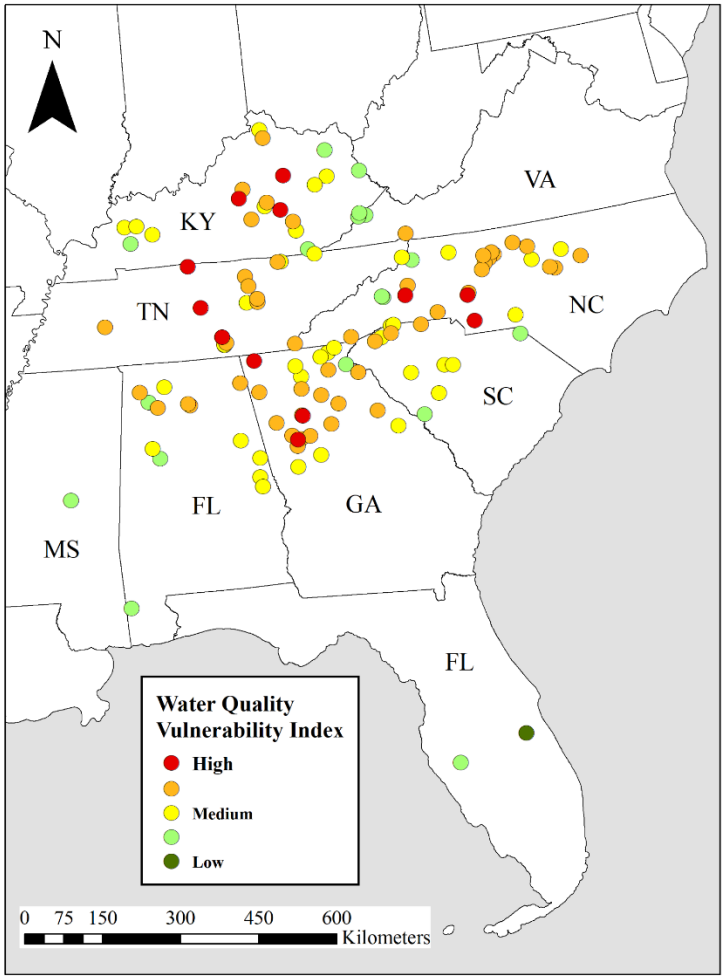






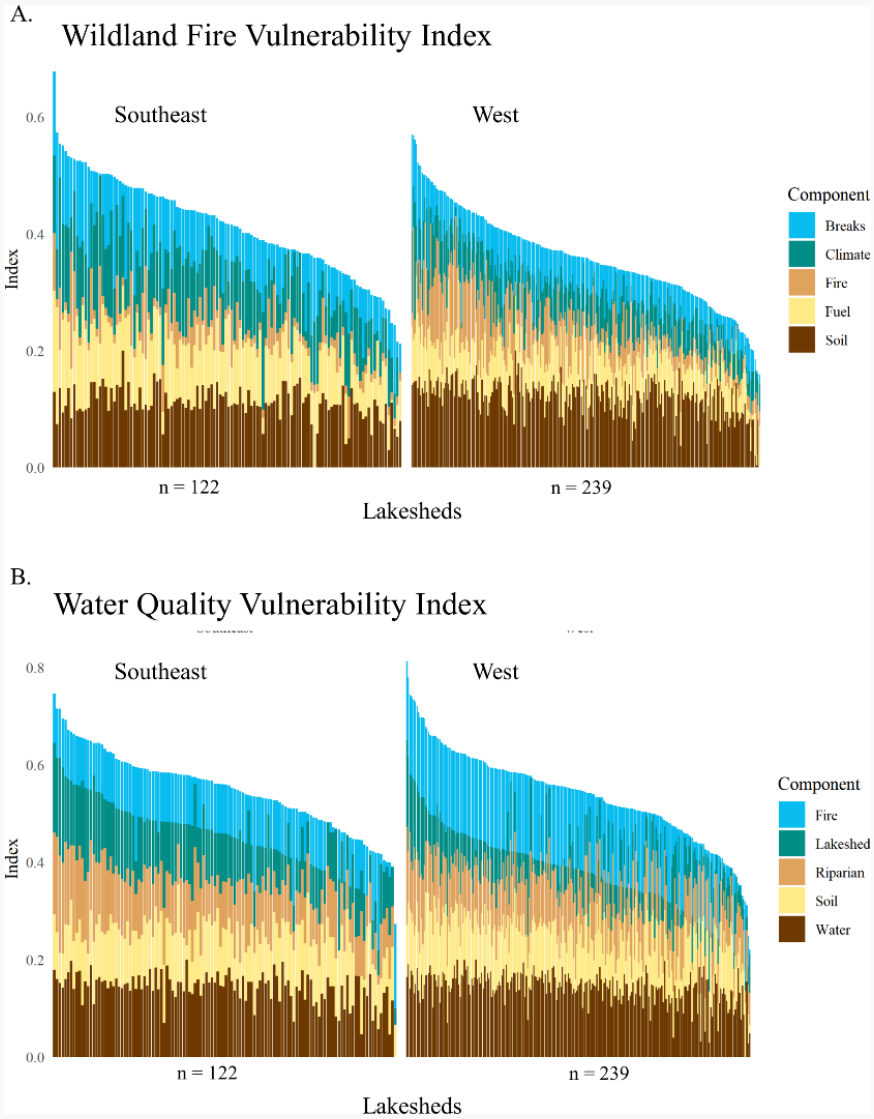
Wildland Fire Vulnerability Index

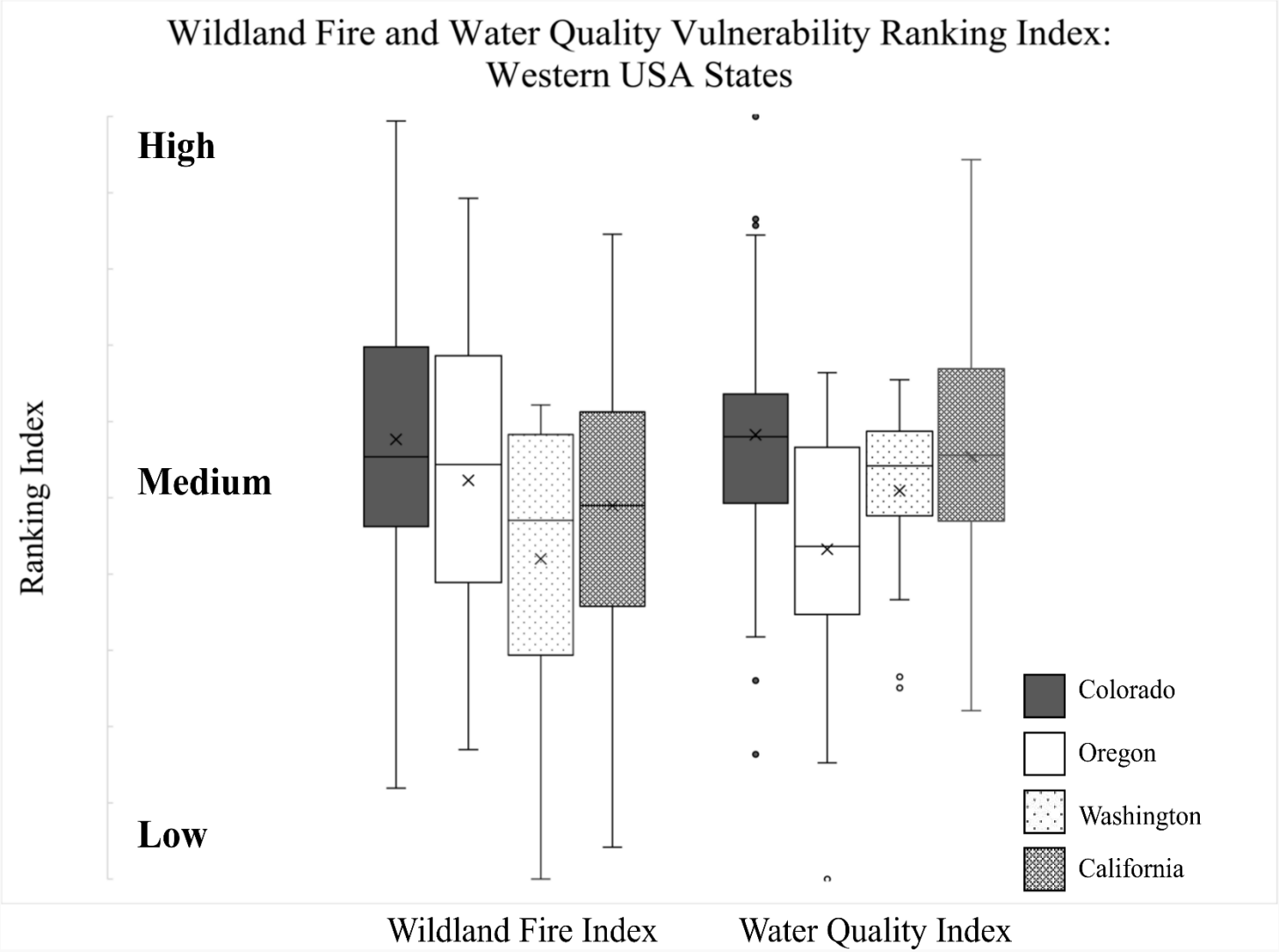


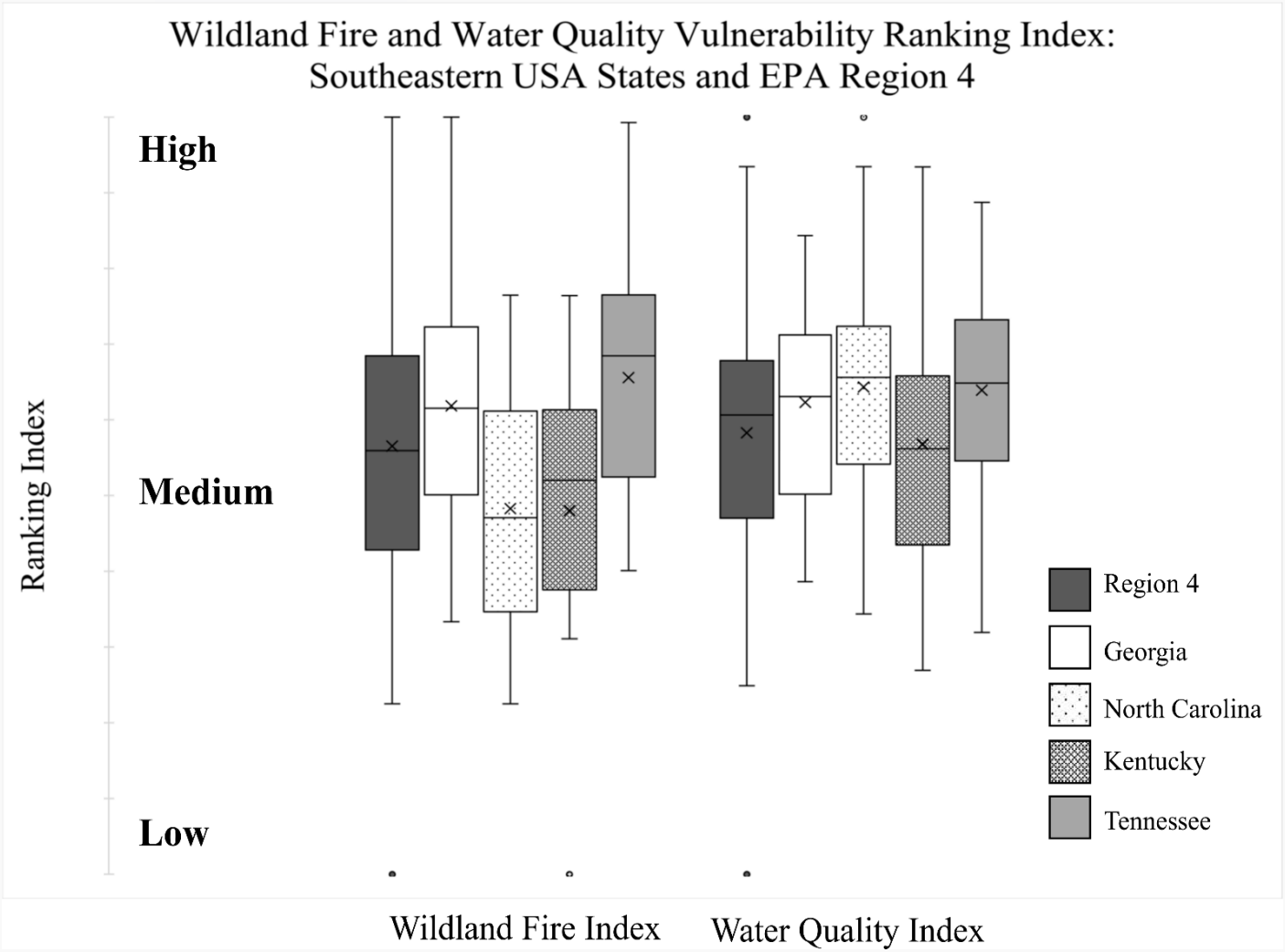


Water Quality Vulnerability Index

WF/WQ Vulnerability Index – Ranking factor distributions across all lakesheds – SE and Western United States




Wildland Fire and Water Quality Vulnerability Ranking Index:
Western USA States
Ranking Index
High
Medium
Low
Colorado
Oregon
Washington
California
Wildland Fire Index
Water Quality Index


Wildland Fire and Water Quality Vulnerability Ranking Index:
Southeastern USA States and EPA Region 4
Ranking Index
High
Medium
Low
Region 4
Georgia
North Carolina
Kentucky
Tennessee
Wildland Fire Index
Water Quality Index

Next Steps:

Bringing in response variables for retro looks and predictive modeling

- Safe Drinking Water Information System (SDWIS)
- Cyanobacteria Assessment Network (CyAN)

Remote Sensing Integration (Bulgaria):

- Fuel model creation - Bulgaria (IceSat-2, Global Forest Canopy Height (GEDI), Landsat-derived Tree Canopy Cover) - *Space Research and Technology Institute, the Bulgarian Academy of Sciences (SRTI-BAS)*

Questions/Comments?

Thank You!

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