Wildfire-derived Polycyclic Aromatic Hydrocarbons in a Southern California Coastal Watershed

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Study Site: Malibu Creek Watershed

- 2018 Woolsey Fire burned ~2/3 of Malibu Creek Watershed
- Ecologically sensitive: ~50 endangered and threatened species
- Varying land use, terrain, vegetation, burn intensity
Study Site: Malibu Creek Watershed

- Question: How did Woolsey Fire impact water quality in watershed?
  - Larger study includes metals, mercury, nutrients
  - This talk focuses on organic polycyclic aromatic hydrocarbons (PAHs)
PAHs – Polycyclic Aromatic Hydrocarbons

- Made of multiple fused benzene rings
- Formed during incomplete combustion of organic matter and present in petroleum
- Mutagenic, \textit{carcinogenic}, reproductive defects
- \textbf{Toxic to aquatic organisms}
- Bioaccumulate in lower organisms
Sampling Plan

- Water sampling in Woolsey burn area
  - Malibu Creek and all major tributaries
  - Unburned Cold Ck.
  - Bell Ck (LA River watershed)
Methods

• Samples collected during 13 significant rain events Dec. 2018-Jan. 2021
• ~Monthly during dry season
• Soil samples collected shortly after fire and periodically after @ 2 sampling locations
• Sampling paused March – November 2020 due to COVID
Results Highlights

- Soil PAH concentrations decline relatively rapidly after fire
Results Highlights

- Water concentrations consistently below drinking water MCLs
- Numerous exceedances of US EPA “Human Health Criteria for Ambient Waters”
- Up to 1000x criteria!
Are PAHs from the fire?

- PAHs may come from fire vs road runoff (oil) vs fossil fuel combustion
- Simple molecular ratio approach → imperfect, but gives some indication
- Other molecular ratio approaches and potentially isotopic methods in progress
Water – Late Spring-Fall 2019: 4/18/19 - 9/26/19

[ANT]/([ANT]+[PHE]) vs. [FLU]/([FLU]+[PYR])

- Petroleum Combustion
- Vegetation/coal combustion

- 4/18/19
- 9/6/19

- 2/14/19 - 3/7/19
- 1/13/19 - 2/2/19
Conclusions

- PAHs do not exceed drinking water MCLs, but do exceed EPA ambient water quality criteria during/after rain events
- Soil PAH concentrations decreasing (source degrading), but preferentially low MW (less toxic) compounds
- PAH concentrations in water linked to SPM → Discharge → Precipitation
  - Interrelationships appear to be changing over time
- Continued contributions into second rainy season after fire. Losing fire “signal” at some locations, then essentially lost by third year.
Ongoing and Future Work

- Other source differentiation approaches being applied (other PAH ratios, ADPI, alkanes-based approaches, isotopes)
- Continue analyzing samples for metals, Hg, DOC
- Continued sampling – at least during rain events → what is “baseline”?
- Further assessment of spatial variation + impact of fire intensity, land use, other factors

- Applying similar methods for investigating fire history in paleosols with Dr. Jen Cotton and Adit Ghosh
Thanks!

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