Chemical Fingerprints of Rainfall Runoff

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Introduction

Urbanization increases the prevalence of impervious surfaces altering the way precipitation is routed to surface and groundwater. When rain events occur we wanted to see how surfaces directly influence the chemistry of runoff as it moves through systems and ends up in urban streams. Recent findings have suggested that ground water is a major contributor to increased flow in streams and a possible contributor of contaminants in addition to runoff directly from storm drains. To understand both of these inputs and how contaminants get into a system, we need to first understand what the chemical fingerprints are of the initial surfaces coming in contact with rain and then we can determine how those contaminants move through a system. To address this issue I asked two related questions:

How do impervious surfaces affect water quality?

Are there unique chemical fingerprints that we are able to trace from different impervious surfaces?

Experimental Design

To adequately collect diverse samples and increase sample size we performed simulated rain experiments in addition to collecting natural storm samples and urban irrigation run off.

1. Storm Sampling

Figure A: Collecting runoff during rain events.

2. Urban Irrigation

Figure B: Sampling irrigation runoff of maintained grass site.

3. Experimental Rain

Figure C : Creating an artificial rain event on a solar panel roof in a residential neighborhood.

Figure 1: Water moving through the Red Butte Creek system. Runoff from impervious surfaces can reach the stream through storm drains or though groundwater inflow. Our sampling attempted to account for a diverse range of samples within the system.

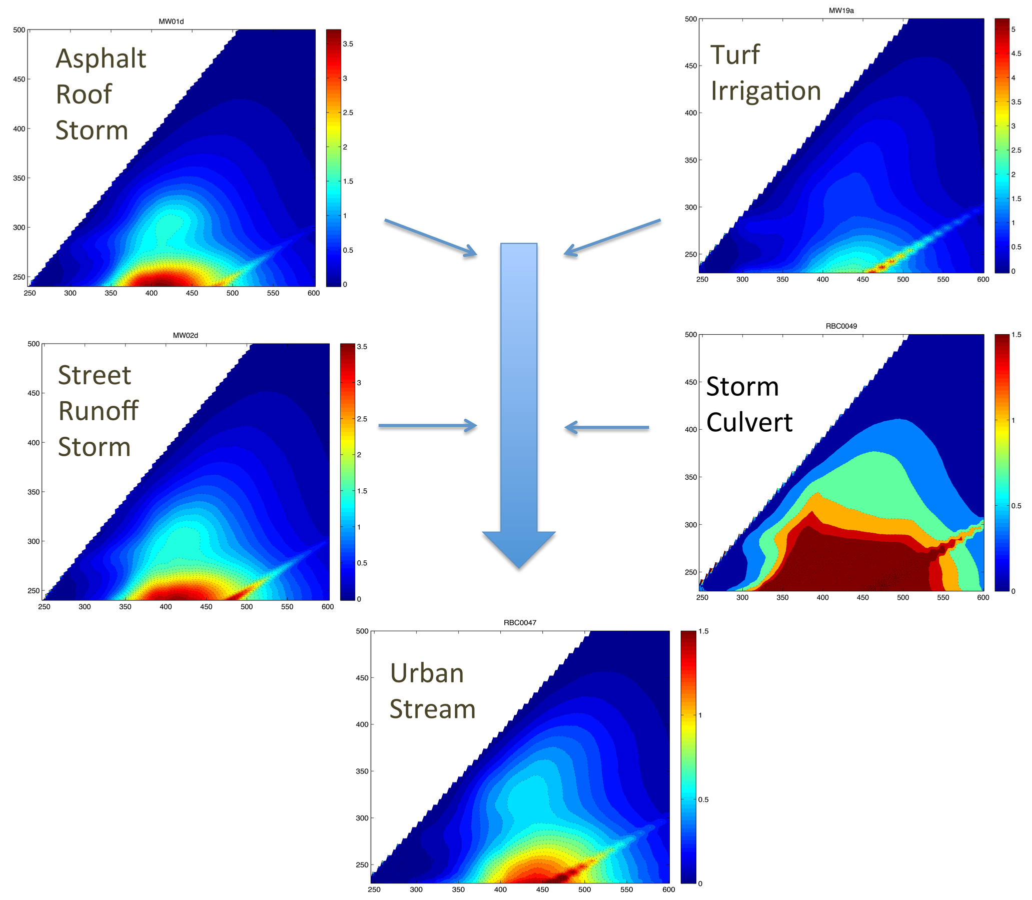

Figure 2 (above) : Excitation Emission Matrices (EEM's) measure the chemistry of the fluorescently active organic matter within a sample, providing a qualitative, visual representation as well as thousands of quantitative metrics to fingerprint water sources, routing, and reactions. The organic matter in Red Butte Creek is ultimately a sum of all of these (and other possible) inputs where direct storm drain runoff mixes with potential very large groundwater sources

Conclusions

As rainwater moves through an Urban System we can conclude that:

- Nitrate inputs seem to be much higher in storm samples compared to fertilized turf or experimental samples, suggesting that nitrate begins its entrance into this system from rain events.
- All four of the sources shown in Figure 2 are different from the stream itself indicating that not one source is dominating the overall chemistry and that there are changes occurring somewhere before entering the stream, possibly from ground water inputs that were not sampled.

Further research:

- We have a small sampling of what rain first hits before entering a steam and we have the end points of storm drains and the stream itself. Further research could include having a broader sample set for initial surfaces that rain hits as well as a way to understand how that runoff enters into the creek and what happens to the chemistry of that runoff as it moves though groundwater.

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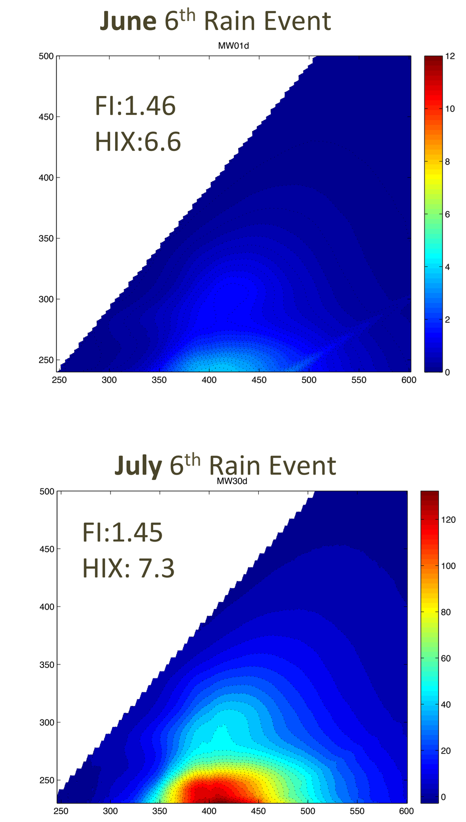
Results

Figure 3 (right): Asphalt roof storm samples taken two different dates on the same roof. (Upper) shows a rain event after a period of heavy rains during the month of May. (Lower) shows a storm sample following a drier month.

The FI values indicate that the organic matter on the roof is coming from the same source in both storms.

The HIX value indicates that after a month of accumulation, the organic matter has a higher proportion of bigger more complex molecules.

Note: July event shows 10X increase in intensity of fluorescent material present.



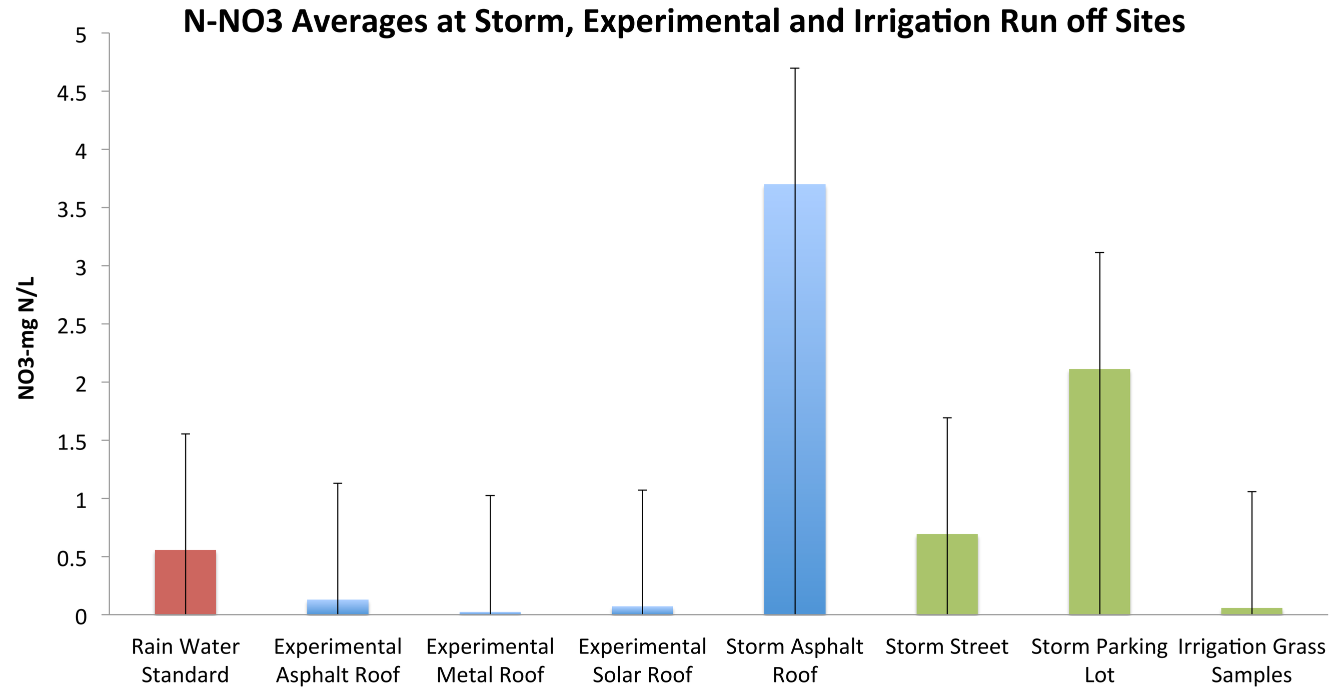


Figure 4 : Average value of NO3-N. Samples were taken from different surface types from storm, experimental, and irrigation run off, all within the Red Butte Creek surrounding area.

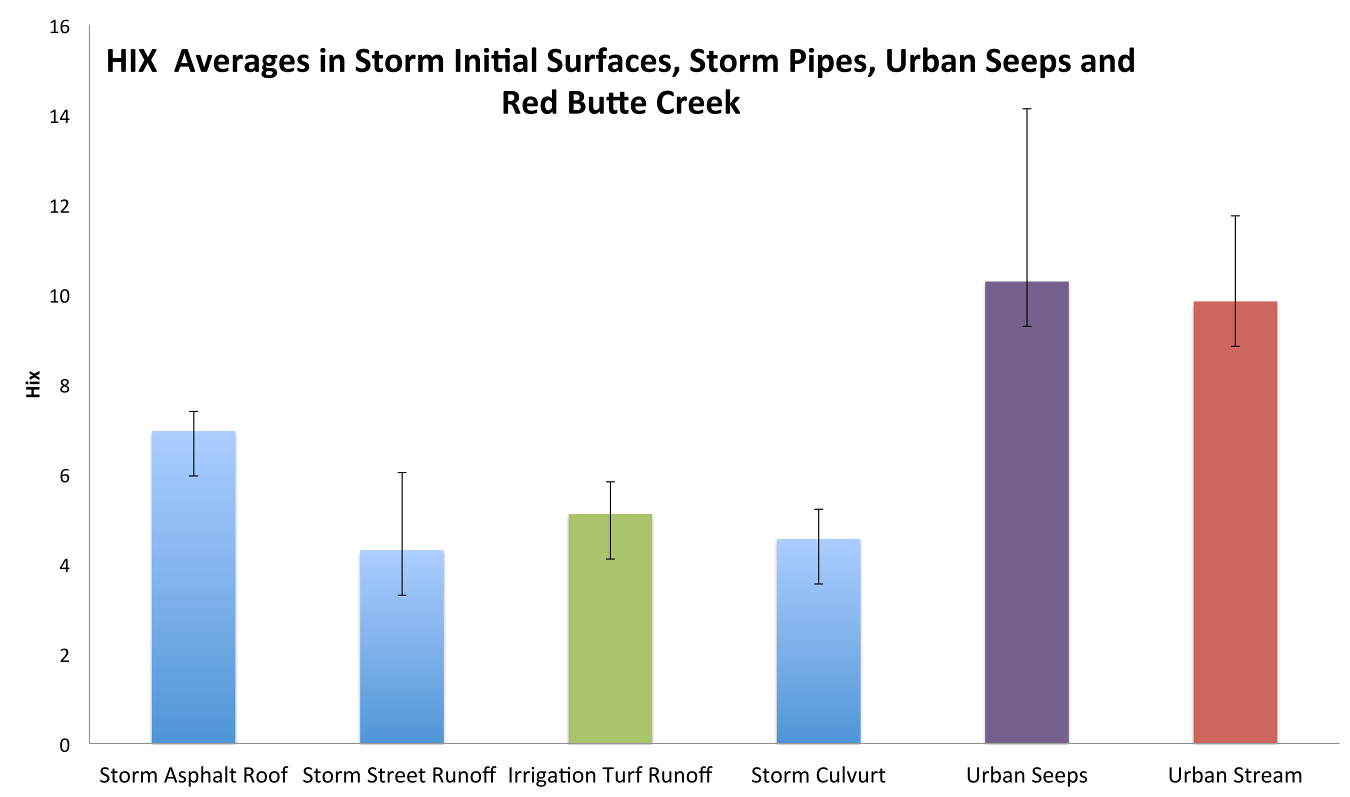


Figure 5 : HIX is a quantitative index of change in fluorescence signal. Higher values have lower H:C, greater aromaticity, and higher molecular weight