Urban stormwater quality during the COVID-19 pandemic and stay-at-home orders

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Introduction

Urban landscapes and activities are more conducive to higher pollutant loadings than are natural environments. Urbanization introduces infrastructure and impervious surfaces that alter the way water moves through the water cycle. Impervious surfaces include parking lots, roads, and buildings, and do not allow for infiltration of precipitation. Instead of water soaking into the ground at or near where it falls, it concentrates as runoff, accumulating pollutants from where they have built up and posing a threat to water quality (Iarrapino and Attorney, 2014).

Vehicles and traffic are known contributors to pollution of stormwater runoff. The list of these contaminants as well as their origins is long and diverse. Some of these include BTEX (benzene, toluene, ethylbenzene, and xylene), polycyclic aromatic hydrocarbons (PAH), and metals, although there are many other pollutants as well (Müller, 2020). These originate from different physical and chemical processes and vehicle parts, including, but not limited to, exhaust, vehicle wear, breaks, and road abrasion (Müller, 2020). It is important, however, to note that pollutants in urban stormwater do not solely originate from these sources, as additional anthropogenic activities contribute.

Beginning in the United States in March and April of 2020, the COVID-19 pandemic forced schools, restaurants, and other non-essential businesses to close, as states were placed under various stay-at-home or safer-at-home orders. With these closings and orders mandating that people only go out for essential tasks, every metropolitan area in the United States observed at least a 53% reduction in traffic since early March (Tomer & Fishbane, 2020). Because of this decline in traffic, we hypothesize that urban stormwater runoff was cleaner during the stay-at-home orders, due to a decreased presence of vehicles and associated pollutants. Our goal was to understand whether urban water quality has changed as a result of the stay-at-home orders.

Methods

The team at Colorado School of Mines has been collecting dry and wet weather samples at a variety of urban flow sites in Denver, Fort Collins, and Golden to test for BTEX, PAHs, and metals that originate from vehicles and traffic, as well as traditional water quality parameters. At sites without a nearby flow gauge, their sampling included flow data. Due to the same orders driving our research question, I contributed to this project remotely to supplement the work of the Mines lab team.

I began by reviewing important background sources to understand the pollutants and where they come from. I then moved on to search for data that had been collected on the same pollutants before, during, and after the stay-at-home orders in several western states. This proved to be a challenge for several reasons. Primarily, BTEX and PAHs are not typically tested for in routine water quality testing. Metals are somewhat more common, but still not universal. After utilizing the U.S. Geological Survey (USGS) National Water Information System (NWIS) and contacting people in state and local government, private agencies, and universities, I acquired minimal data. While this was somewhat discouraging, it helped to establish the novelty of the work being done at Mines. When all avenues of contacting researchers for data were exhausted, we moved on to assist with data analysis of flow and precipitation.

To graph each of the storm events during which samples were collected, we collected flow and precipitation data. I once again utilized the USGS NWIS and some of the team's manual data to compile flow data for each of the sampling sites and events, while my fellow REU and colleague used CoAgMET to collect the corresponding precipitation data.

Results and Discussion

Combining the precipitation and flow data, we plot both on the same graph (Figure 1). Figure 1 shows a lag in the stream flow behind the precipitation, a common trend in storm hydrographs. We repeated this process for several of the Mines sampling sites. The output will allow us to better understand the characteristics of the storm events during which samples were taken. Moving forward, these graphs can be used to compare the loadings of pollutants in relation to the storm event.

If the data show a strong correlation between urban water quality and traffic characteristics, implications could be potentially significant. If we know that increased traffic also increases the levels of pollution in urban waterways, we will have a strong motivation to keep cars off the roads. In this case, public transportation could be pushed as well as other traffic-reducing activities, such as online shopping and increased telecommuting for jobs and meetings.

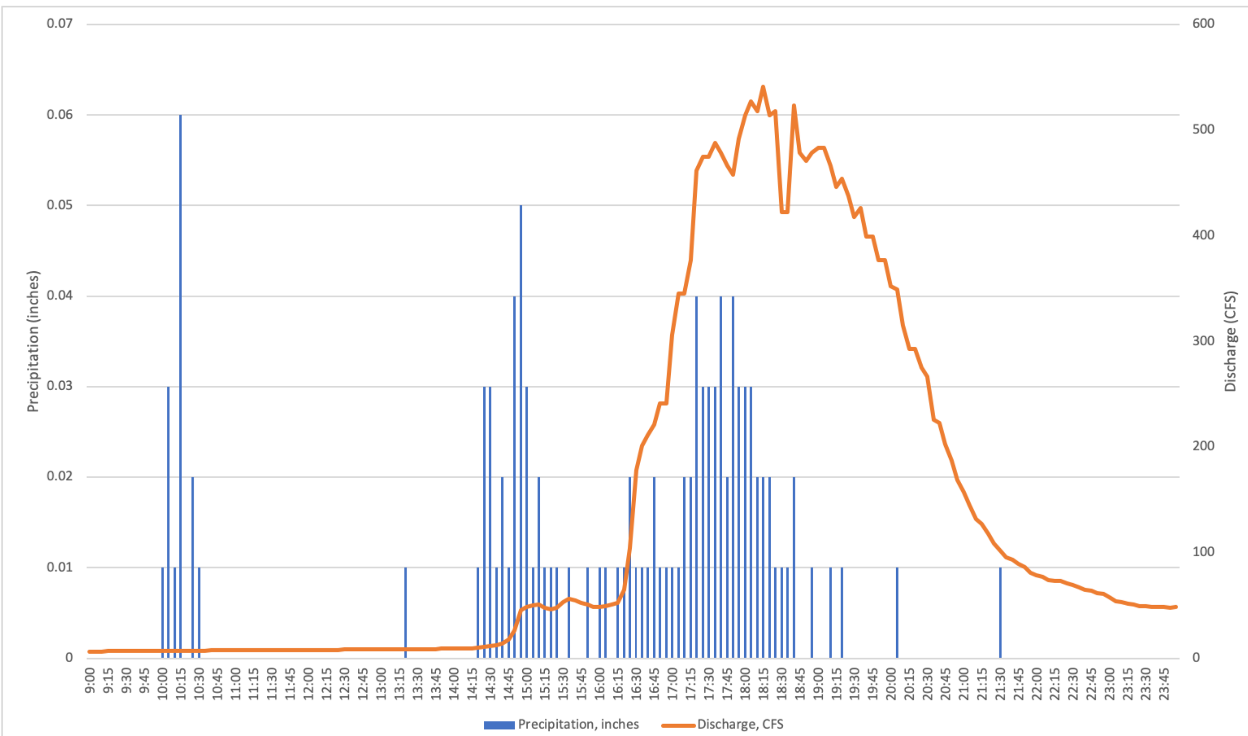

Figure 1. Storm hydrograph for Lakewood Gulch downstream from the city (LGDN) in Denver on May 24, 2020.

References

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