Analyzing the Efficacy of Green Infrastructure by Using an Impervious Cover Analysis

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Purpose

- The purpose of this project was to assess the data analysis performed by Pennino et al. to:
  - Compare the proportion of impervious area to total watershed area to the proportion of impervious area to green infrastructure (GI) drainage area
  - Use the analyzed impervious area percentages to perform a distribution to the hydrologic metric of Mean/Median Peak Flow to verify the results of the original analysis

Introduction

- Stormwater GI is an "approach to stormwater management and flood mitigation that provides areas for water to soak into the ground, or evaporate back into the air, rather than forming runoff and leading to flooding" (EPA, 2018)
- No major scientific papers about the mitigative effects of GI on hydrologic and water quality parameters had been published prior to Pennino et al.'s 2016 report
- Pennino's results concluded that the presence of GI within Baltimore and Montgomery Counties, Maryland, and Washington, D.C., resulted in less stream flashiness (a smaller peak flow)

Methods

- Baseline data from Pennino's analysis provided for:
  - GI locations and drainage areas
  - Mean/Median peak flow
  - United States Geological Survey (USGS) gage selection
- 2011 Impervious Cover data obtained from the Multi-Resolution Land Characteristics Consortium National Land Cover Database
- Extracted impervious cover percentages for Baltimore and Montgomery Counties, Maryland
- Delineated USGS gage watersheds using the USGS StreamStats software
- Intersected and clipped GI drainage areas with gage watersheds
- Ran Zonal Statistics on both clipped and non-clipped GI drainage areas using the extracted impervious cover percentages
- Ran a linear regression/residual analysis on the results, comparing all the GI and gage drainage areas

Data Results

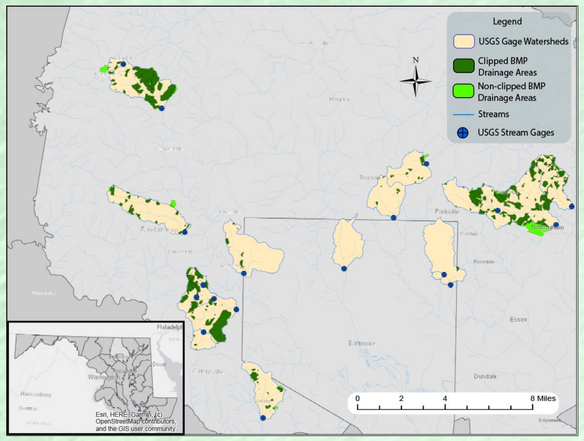

Figure 1: Baltimore County Gage Watersheds and GI Drainage Areas

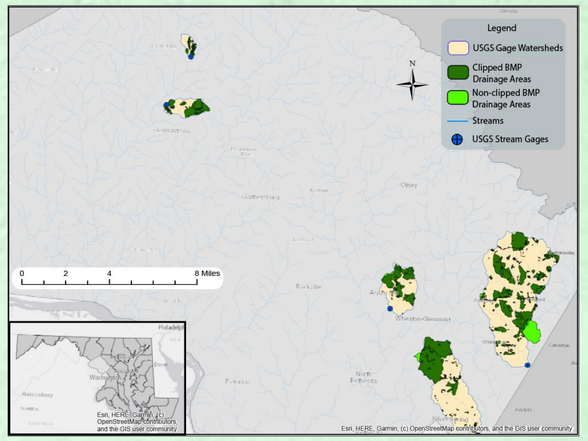

Figure 2: Montgomery County Gage Watersheds and GI Drainage Areas

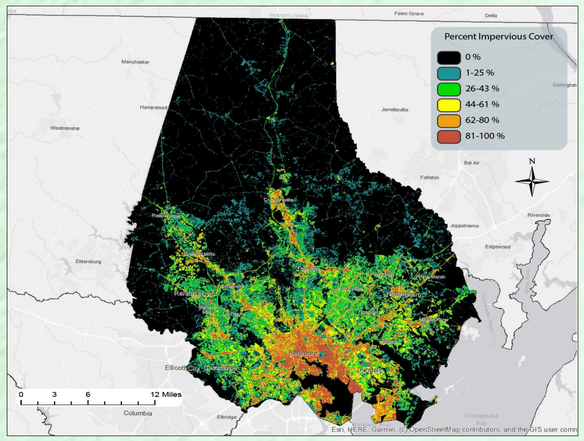

Figure 3: Baltimore County Impervious Cover 2011

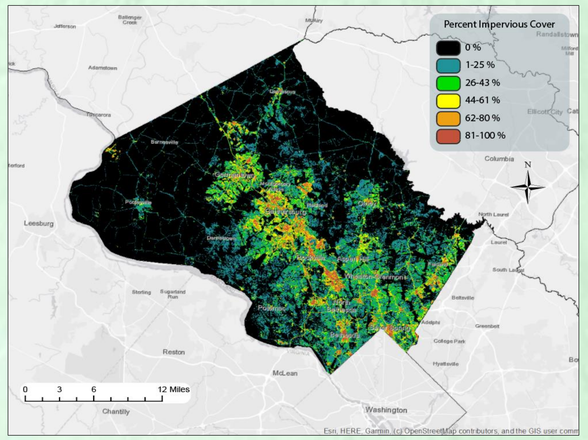

Figure 4: Montgomery County Impervious Cover 2011

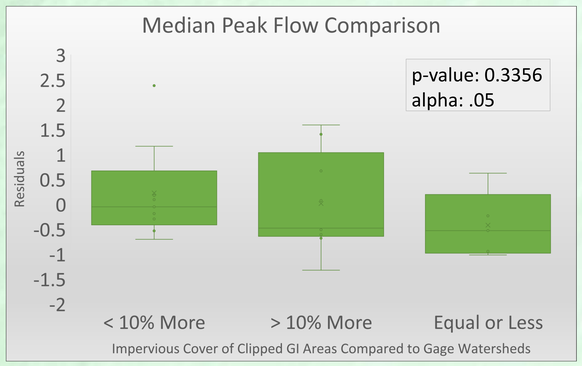

Figure 5: Median Peak Flow Comparison using Residual Analysis

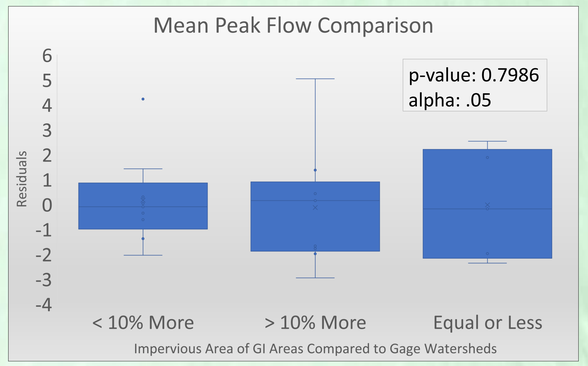

Figure 6: Mean Peak Flow Comparison using Residual Analysis

Discussion

- There was little-to-no statistical difference between the impervious cover of non-clipped and clipped GI drainage areas
- The slight differences between the non-clipped and clipped GI Drainage areas had no significant effects on the impervious cover analysis comparison with the USGS gage watersheds
- Zonal statistics had to be used on each individual watershed due to overlapping polygons
- Most of the GI drainage areas had higher proportions of impervious cover compared to the overall USGS gage watersheds

Conclusions

- The Median Peak Flow residual analysis shows the USGS gages with GI drainage areas treating more impervious cover had higher stream peak flows
- The Mean Peak Flow residual analysis shows similar results and that the USGS gages with GI drainage areas treating either equal to or less impervious cover had little to no effect on the stream peak flows
- The p-values shown on Figures 5 and 6 suggest statistical insignificance = inconclusive results
- Although the results are not conclusive, they suggest that the original analysis performed by Pennino et al. may be incorrect; there may be other confounding variables affecting stream peak flow

References

- Pennino, M.J., McDonald, R.I., Jaffe, P.R. (2016). "Watershed-scale impacts of stormwater green infrastructure on hydrology, nutrient fluxes, and combined sewer overflows in the Mid-Atlantic region." *Science of the Total Environment, 565*, 1044-1053.
- United States Environmental Protection Agency (EPA). (2018). "Storm smart cities: Integrating green infrastructure into local hazard mitigation plans." *EPA 903-K-18-001.*

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