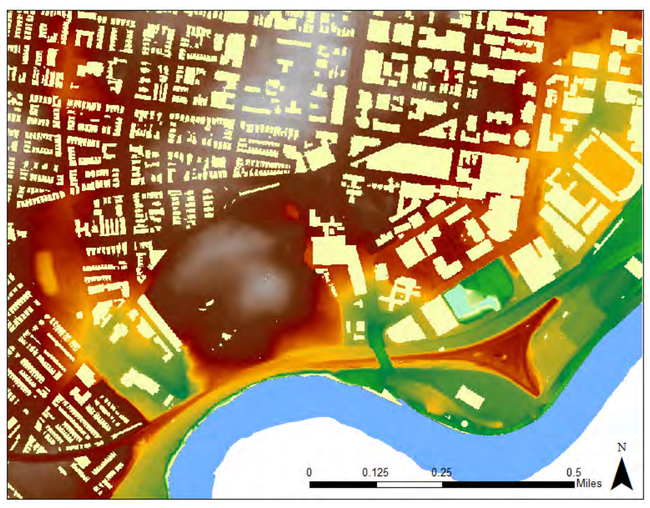
Urban Microwatersheds and Stormwater Modeling

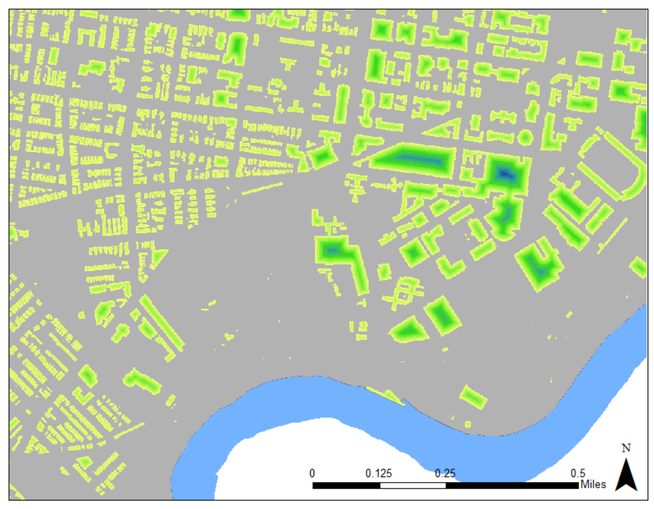
This study examines a subwatershed in West Philadelphia, Pennsylvania. It compiles LiDAR-derived digital elevation models to conduct hydrology analysis using geographic information systems (GIS). The initial purpose is to determine the capabilities of LiDAR-derived DEMs in understanding highly localized hydrologic functions. We then use available data to build an estimate of the study area's public stormwater infrastructure in order to evaluate the relationship between natural hydrology and these drainage systems, connecting water inlets to their respective outfalls. Finally, we discuss areas of future study and implementation of this data into practical watershed analysis and dissemination through a web-based GIS hydrology application called WikiWatershed.

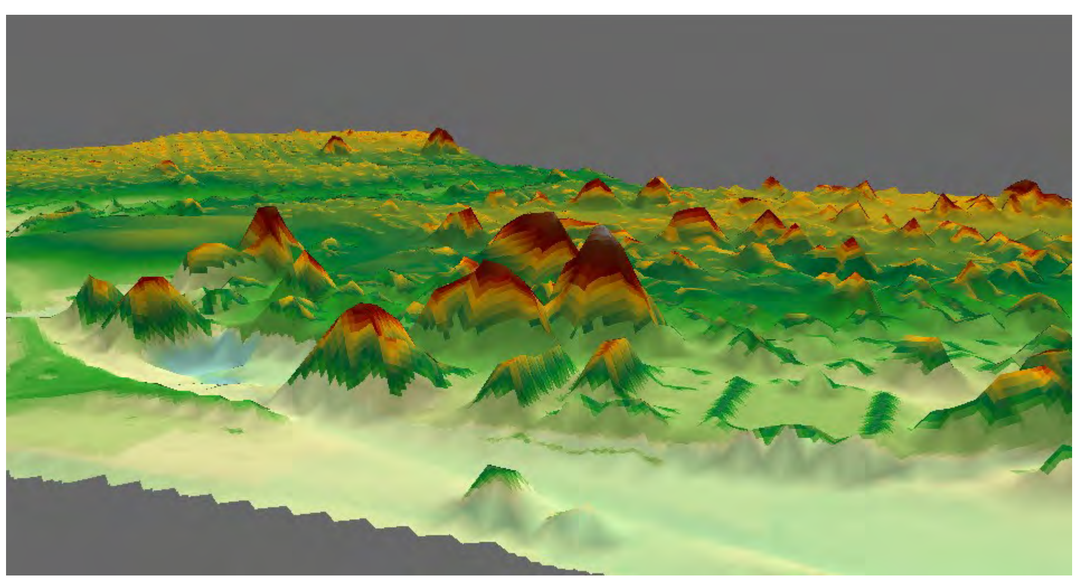
We alter the DEM to include the building foundations to estimate what effect the built environment has on urban hydrology. Knowing how water runs off of the roof of every building, however, is impossible. We will therefore treat each building in the study area as if it were a pyramid, with water that lands on the roof flowing to its nearest edge. This was done by setting entire building footprints to its maximum elevation to "flatten" them, measuring internal distances of each footprint, and adding it to the final DEM

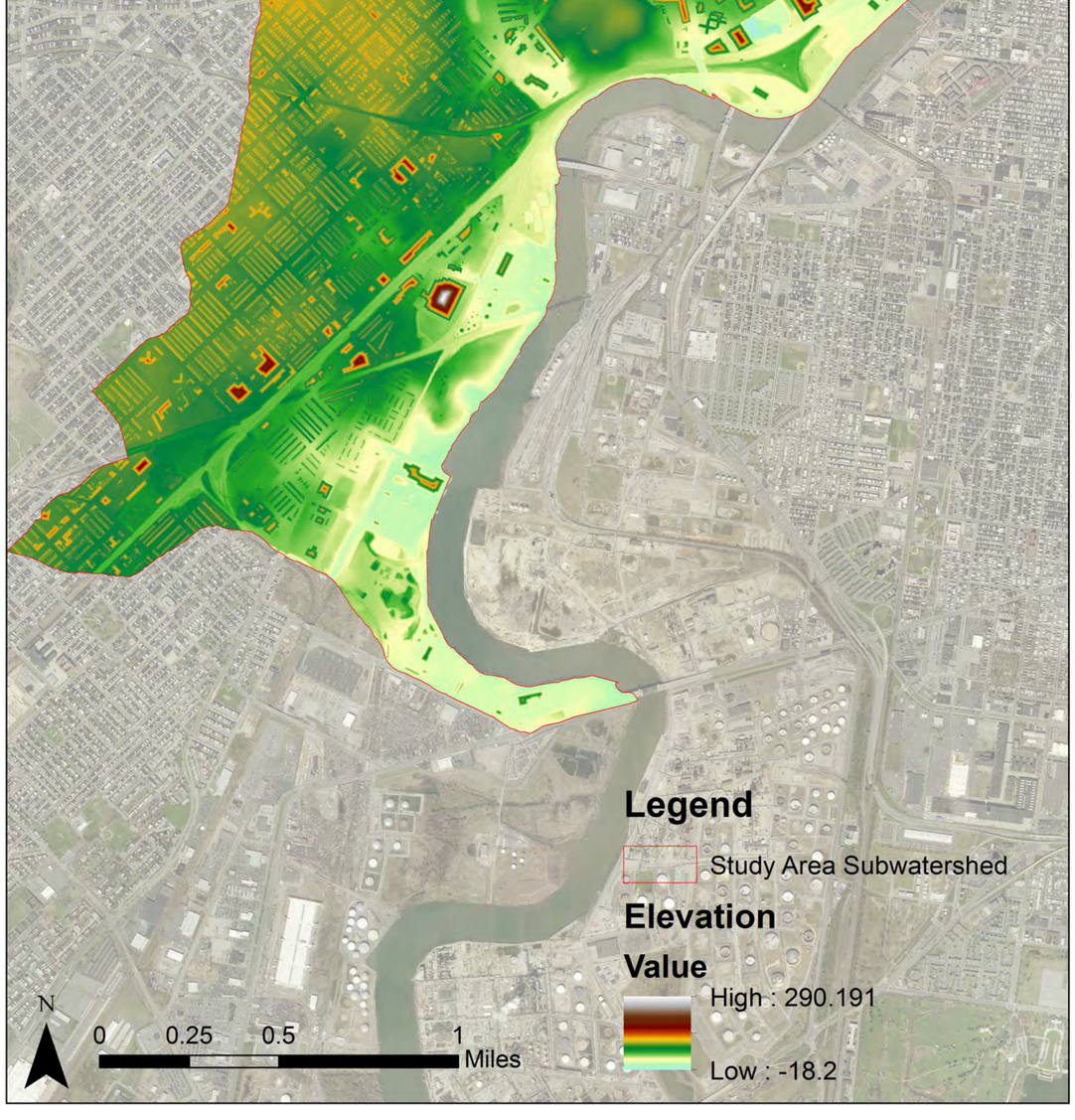
"Flattened" Building Footprints

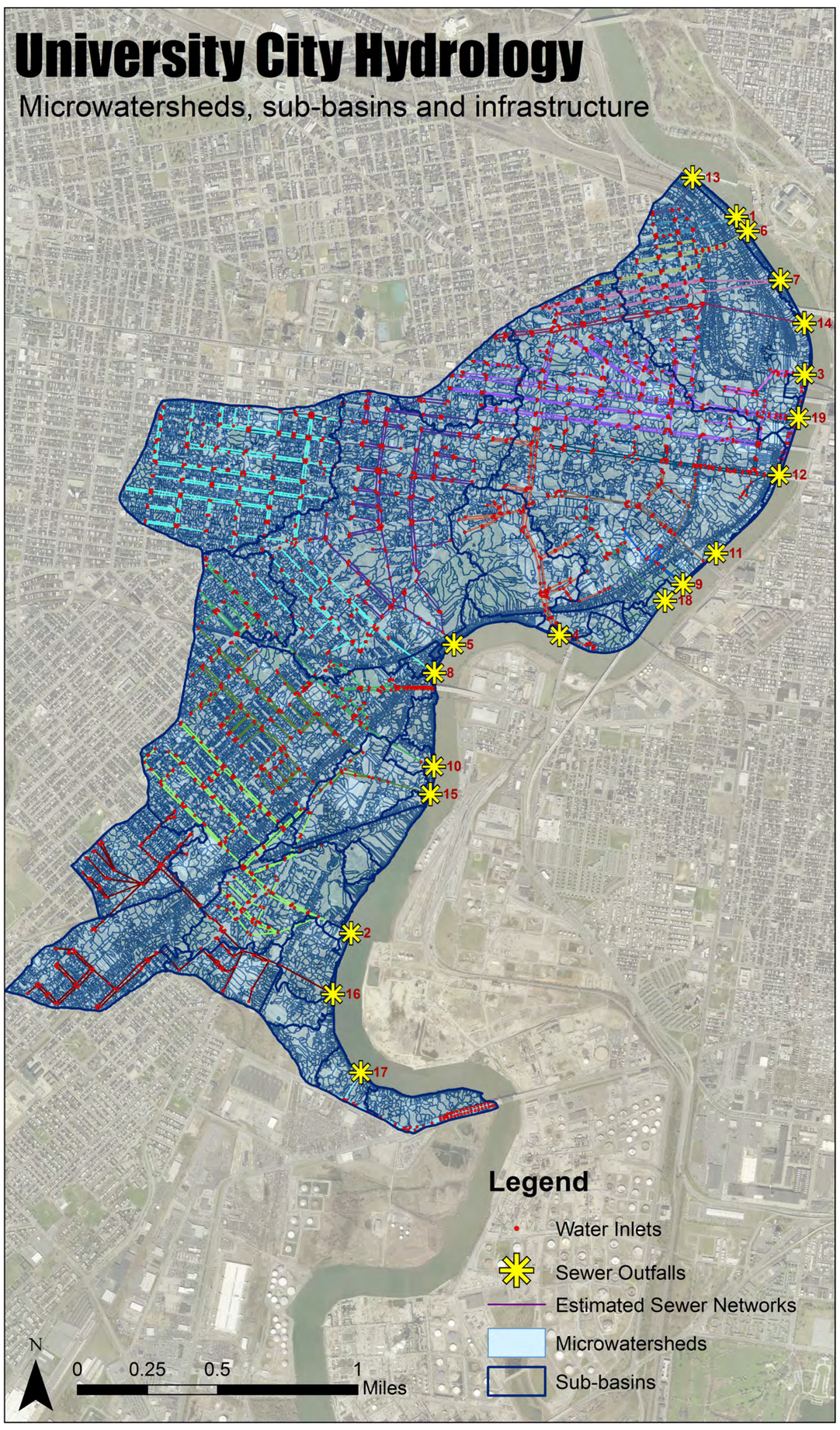


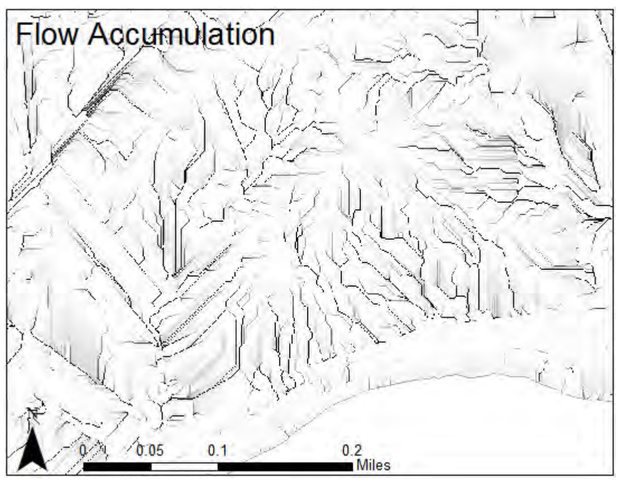
"Pyramid" Building Footprints

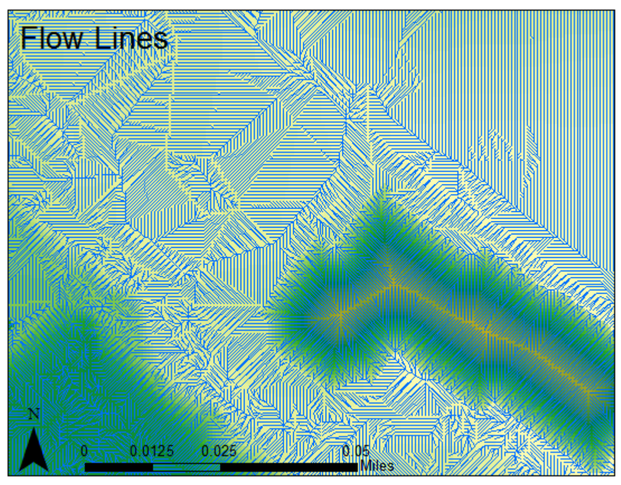


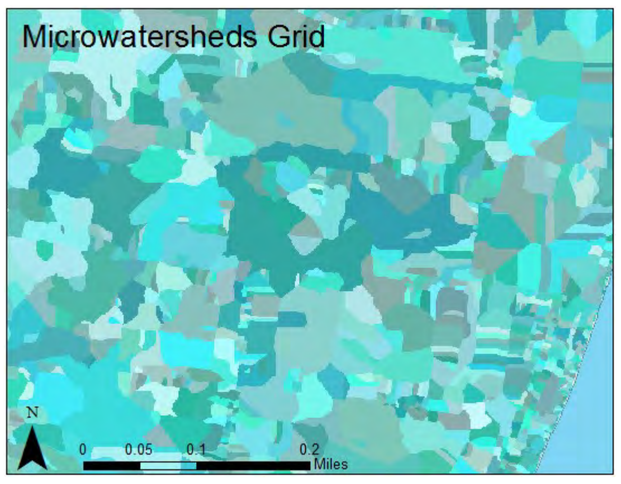


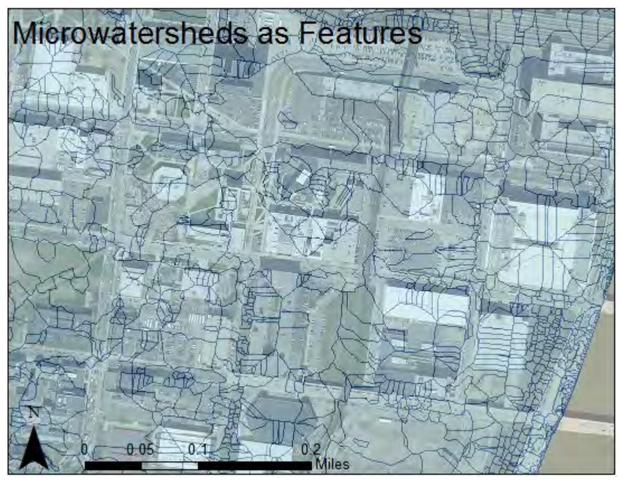












In this study, we found that using an unfilled LiDAR-derived terrain DEM to model hydrological functions resulted in extremely localized delineation of watersheds and associated sinks. In the study area, a subwatershed of the lower Schuylkill River located in West Philadelphia, Pennsylvania, there were over thirty thousand microwatersheds. We also performed a flow accumulation procedure on the DEM to determine flow patterns. We then created another DEM by filling sinks and generated another map of delineated watersheds. These were much larger and there were far fewer. It should also be noted that creating "pyramid" structures in place of building footprints was effective at dispersing water around buildings.

For some water resource planning, obtaining such a large number of catchment areas would defeat the purpose of the analysis. Using a mostly raw LiDAR-derived DEM is likely not useful for examining typical watersheds. That said, this type of analysis could be extremely useful on a very small scale. When comparing the microwatersheds to the aerial photograph imagery, we could see that useful information could be derived from this data at a property-by-property basis. If we examined a property or a group of properties, we would likely be able to accurately predict the flow patterns and catchments associated with them. This could allow a property owner, resource planner, or water department to effectively site infrastructure to capture and contain runoff, reducing stream load. Specifically, this procedure could allow for proper siting of stormwater best management practice infrastructure, such as urban wetlands and bioretention ponds. It may also prove useful for identifying areas in most need of storrmwater runoff capture. Finally, the ability to map flow patterns at a microwatershed level allows analysts to view dispersion of illicit discharge point source pollution at a property level, as might be seen from a car wash, gas station, restaurant, or other facility that is out of compliance with drainage regulations.

At a slightly larger scale, the watersheds delineated from the filled DEM allows water researchers to take stock more generalized flow patterns, but still at a manageable scale. In combination with micro- and larger watersheds, resource planners, local government, and water departments could examine land uses and determine impact at a local scale. This would allow for small scale runoff mitigation. In concert with other local watersheds, this could be tremendously effective at reducing runoff and pollutant load altogether.

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