Watershed-wide Stormwater Management in an Underserved Community of Tennessee through Community-University Partnership

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ABSTRACT

Effective stormwater management of a community requires a comprehensive understanding of the its watershed. Many studies have implemented the watershed approach to stormwater management. However, when reviewing the literature, a glaring disparity can be observed. Most work on watershed planning is focused on large urban areas, while very little effort has been put forth to understand and address stormwater issues in smaller underserved watersheds. Considering this disparity, our study initiated the development of a watershed-wide stormwater management plan for the town of Gainesboro, a small, underserved community in Jackson County, Tennessee. Through a Community-University Partnership Program (CUPP), relevant hydrological, socio-demographic, meteorological, land-use, soil and topographical data were collected. Historic flow data of the Doe Creek and its tributaries, flood maps, and sewer maps were also obtained. Preliminary assessment indicated the town's poor stormwater management infrastructure as a plausible reason for flooding. To address this stormwater pipes were surveyed. All geospatial data were organized in a geodatabase. Its analysis in the future will allow for an informed understanding of the stormwater issues in Gainesboro, with the aim of developing effective mitigation measures.

BACKGROUND

The Town of Gainesboro experienced significant flooding and stormwater management issues in June 2018 from water logging as well as the overflowing of Doe Creek, a nearby stream (Figure 1). The flood impacted the town's Emergency Management Services building, Jackson County Public Library, and surrounding residential and commercial areas. However, prior to this study, limited data were available to determine factors contributing to the flooding. This hindered with stormwater management planning and developing any flood mitigation measures.

Figure 1. June 27, 2018 Flooding in Jackson County (Source: Town of Gainesboro)

STUDY OBJECTIVES

- Characterize the Doe Creek watershed
- Address data gaps by collecting information that will enable the development of an effective watershed-wide stormwater management plan
- Perform a preliminary analysis of the data to understand stormwater management issues

METHODOLOGY

- Characterized the Doe Creek watershed through existing data gathering

Data Type	Source
Historic weather data	NOAA
Historic land-use data	MRLC
Topographical information	TNGIS
Soil data	USGS WSS
Flood maps	FEMA

- Identified data gaps to be local precipitation data; flow data of Doe Creek and its tributaries; and details of the state of existing stormwater infrastructure
- Addressed the data gaps through relevant equipment installation and surveying
- Created a geodatabase to store and organize all geospatial data
- Performed preliminary analysis of existing stormwater infrastructure using EPA's Storm Water Management Model (SWMM)

RESULTS

I. Characterizing the Doe Creek Watershed

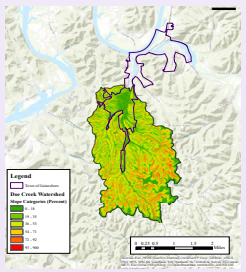


Figure 2. Watershed Slope Map

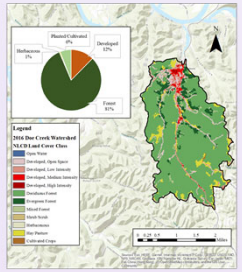


Figure 3. 2016 Land Cover Dataset

NLCD Land Cover Classes	2001	2006	2011	2016
	Land Cover (%)			
Water	0	0	0	0
Developed	12	12	12	12
Forest	81	80	81	81
Herbaceous	0	1	1	1
Planted/Cultivated	6	6	6	6

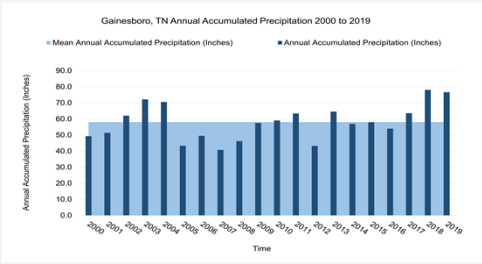
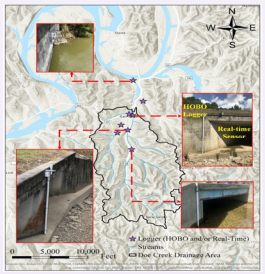


Figure 4. Gainesboro, TN Accumulated Precipitation 2000 to 2019 (Source: NWS NOAA NOWData)

II. Addressing Data Gaps



Installed 7 HOBO Water Level Loggers, a Campbell Scientific Weather Station, and 3 Ultrasonic Real-Time Water Level Sensors

Figure 5. Equipment Installed in the Doe Creek Watershed

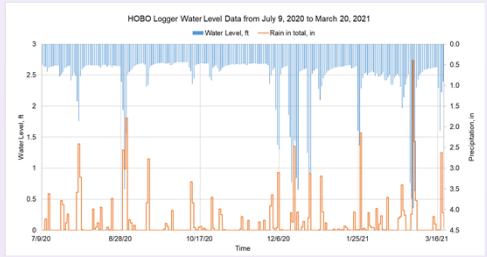


Figure 6. Doe Creek Water Level with respect to Precipitation

III. Doe Creek Geodatabase

Figure 7. Online Doe Creek GIS Layers
https://gisportal.tntech.edu/arcgis/apps/webappviewer/index.html?id=ec2fb0d9c1b24d789ae18608bf726f8a

IV. Preliminary Analysis on Stormwater Infrastructure using EPA SWMM

Assumptions:

- Rainfall from roofs is diverted to nearest downstream catch basin
- Catchment areas are 100% impervious
- Stormwater pipes have no offset with the inverts of connected catch basins
- Pipes are in perfect condition

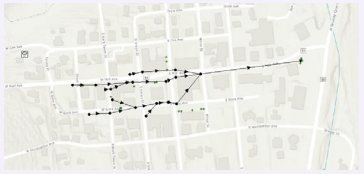


Figure 8. Preliminary SWMM Model Schematic

Preliminary Findings:

- Stormwater pipes have an average slope of 5 percent and higher
- At a 10-year 24-hour design storm, catch basins reach capcity
- A thorough survey of the existing infrastructure should be completed to allow for conclusions to be drawn in the future

CONCLUSIONS

Through initial data collection and analysis, it is being hypothesized that the age and overall inadequacy of the Town's stormwater infrastructure, combined with overgrowth and debris accumulation in Doe Creek may be causing the floods; however, additional work is necessary to test this hypothesis.

FUTURE WORK

As relevant data continue to be collected, the SWMM model will be improved to understand the existing stormwater infrastructure and propose mitigation measures where needed. Additionally, a HEC-RAS model will be developed for the watershed, which can be used for future flood risk assessments.

REFERENCES

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- United States Department of Commerce, and NOAA. "National Weather Service." National Weather Service, NOAA's National Weather Service, www.weather.gov/.

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