THE CORRELATION BETWEEN SOIL PERMEABILITY AND FLOODING IN THE NORTHEAST SECTOR OF THE DOG RIVER WATERSHED

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Soil permeability plays a much larger role in flooding than most people estimate. Soil permeability can be defined as “the ease in which water, air or gases can move through a layer of soil” (Biology Online). Therefore, the higher the permeability of a soil layer, the faster water can infiltrate through and avoid flooding. To prove the correlation between soil permeability and flooding, a comparative analysis was created on the northeast quadrant of the Dog River Watershed. The analysis was done using soil data downloaded from the City of Mobile’s website along with FEMA flood data also obtained from the City of Mobile. Once downloaded and “clipped” for the study area, the two sets of data were compared and analyzed to find a correlation. Flooding has had a large negative impact on the Dog River Watershed, and has a great potential to become worse if the public does not gain more insight on the causes. This research educates people on how much soil permeability can be connected with flooding, and why it is an important factor to consider.

Keywords: soil, permeability, flooding.

**Introduction**

Soil permeability plays a very large role in flood management. Typically when someone thinks of why an area is prone to flooding, they think of the area’s elevation or terrain, or if it is in a natural floodplain. Many people do not take into consideration if the soil’s permeability plays a factor or not in flooding and flood recovery. The *Journal of Environmental Management* included in their article on mapping flood hazards the three types of factors to strongly analyze to help flood management and prediction: “topography, soil type, and land use” and that “soil properties” was definitely a main driver in flood recovery (Kalantari et al., 2014). Soil permeability affects not only how quickly and how much an area can flood, but also the recovery time of an area after a flood event. For instance, a soil with a high permeability will be much less
likely to flood versus a soil with a low permeability, because of its ability to infiltrate water more quickly, thus not flooding at all or possessing a fast recovery rate.

The concern here is not so much how to prevent flooding itself, but to grasp a better understanding of which soils in what areas will permit a faster recovery post-flood. The *Journal of Hydrology* explicitly states, “An important criteria in Natural Flood Management (NFM) is understanding and improving the surface soil permeability (or field, saturated hydraulic conductivity, Kfs)(Bouwer, 1966, Reynolds et al., 1985 and Talsma, 1987) of natural ground surfaces with the view of increasing rainfall infiltration and storage capacity (Bens et al., 2007 and Marshall et. al., 2009)” (Archer et al., 2013). This research will help to educate a vast array of people such as famers (flood risks for crops and fields) or potential home buyers (if the surrounding area is prone to flooding, how fast can it recover?). By using FEMA flood zone data along with soil series data both provided by the City of Mobile, it is possible to predetermine which areas may recover more from a flood event based on their soil permeability characteristics.

The area of interest for this research is the extreme northeast quadrant of the Dog River Watershed (Figure 1). The western boundary is Interstate 65, and the southeastern boundary is Interstate 10. The headwaters of E. Bolton Branch and E. Eslava Creek are included in this subject area, as well as Woodcock Branch. This particular area in the watershed is also considered to be the midtown area of Mobile, Alabama.
Hypothesis

Most land classified by FEMA as having a high risk of flooding (presumably on the basis of elevation, slopes, and proximity to water) tends to have soils with poor internal drainage. Using the provided data, it is possible to see which select parts of the flood zone in my area will recover at a faster rate based on their soil permeability and drainage.

Methods

All data acquired for this research was downloaded from the City of Mobile. The city provided me with many useful shapefiles such as soil series data, and also a flood zone map provided by FEMA which outlined areas highly prone to flooding based on elevation, slopes, and proximity to water. Additional data used included the city’s watersheds, and water body’s shapefiles, which were mainly used as background purposes. After downloading the necessary files from the city’s website, I was able to “clip” the soil data and FEMA data using ArcGIS by using the space parameters of my study area as the boundary. After that, using the “Statistics” tool provided by ArcGIS within the attribute table, I was then able to calculate how much of my study area was covered by flood zones (9.62%) (Figure 2). I was also able to find out which soil series types were within the flood zone by clipping out the soil data, using the flood zone as my boundary parameter.

I found that there are four types of soils series that lie within the flood zone of my study area: Benndale, Escambia, Harleston, and Smithton. Using the Soil Survey of Mobile County,
In Alabama, I researched each soil on its permeability and general qualities. Benndale was described as “well-drained, moderately permeable soils”; Escambia was described as having “somewhat poorly drained soils”; Harleston was defined as consisting of “moderately well drained, moderately permeable soils”; and Smithon was depicted as “poorly drained, moderately slowly permeable soils” (Hickman & Owens, 1980). Since Benndale and Harleston soils possessed similar “good” permeability characteristics, they were categorized as being “permeable”. Similarly, since Escambia and Smithton soils shared “bad” permeability characteristics, they were categorized as being “non-permeable”.

Once I researched each of my soil types, using ArcGIS, I divided up the soils within the attribute table and clipped my permeable soils (Benndale and Harleston) and my non-permeable soils (Escambia and Smithton) separately from each other. This would allow me to see how much area each group of soils took up of the flood zone, both visually and statistically.

**Results**

The results showed that the non-permeable soils took up the most area of the flood zone. The flood zone covers ~10% of the Midtown Mobile area. I found that the Benndale soil series took up 26.7% of the flood zone; Escambia covered 4.5% of the flood zone; Harleston covered 0.4% of the flood zone; and Smithton took up 68.4% of the flood zone. Since I had

![Figure 3: Extent of permeable and non-permeable soils within the flood zone of the Midtown Mobile area](image-url)
planned on grouping the soils with their similar counterpart, I was able to come to the conclusion that the non-permeable soils (Smithton and Escambia) took up 72.9% of my subject area, while my permeable soils (Harleston and Benndale) took up only 27.1% of the flood zone. As you can see in Figure 3, it’s visually obvious that the non-permeable soils covers a much larger expanse than the permeable soils.

**Discussion/Conclusion**

It is clear that soil permeability does in fact play a very large role in flooding and flood recovery. The original purpose of the research was to show a direct correlation between soil permeability and just flooding alone. But, since the algorithm used for the FEMA flood zone parameters did not include soil type as a variable, it was impossible to create such a comparison. With the available data, it was, however, possible to create a risk analysis between soil drainage, and flood recovery. Using these methods and data, it is possible to see which areas within a flood zone may have a better time recovering from a flood event, than not. As stated earlier, this is especially useful for farmers, potential home buyers, and even urban and real estate planning. For example, if you are planning to build a deck or patio in the backyard of your home, you can utilize this information to determine how high off the ground you should build it, based on how fast your backyard has the ability to soak up water after a heavy rainstorm. Or, if you are a farmer you can use this information to best determine which crops to grow, based on how long the ground below them will be flooded. There are many different types of situations where this research could potentially be beneficial.

To get a better visual understanding of the relationship between soil drainage and flood risk, a matrix was created to better compare the two variables to each other. As you can see in Figure 4, “flood risk” was defined as being either “low” or “high”, and soil drainage as either
being “good” or “poor”. In this matrix, block “A” represents the best case scenario, while block “D” represents the worst case scenario, while “B” and “C” were grayed out as being medians. Block A is based on the guidelines that if you have a potentially low flood risk, with good soil drainage, you are in the clear. However, if you have a high flood risk associated with poor soil drainage, you could find yourself in a potentially very dangerous situation.

Flooding has had a very large and negative impact on the Dog River Watershed, and especially within the flood zones located in the Midtown area of Mobile, Alabama. This impact is not based on the force of Mother Nature alone, but also the public’s lack of knowledge and information on flooding and the potential causes and effects of it. Hopefully, this research will help people realize the associated factors that come along with flood recovery and in the end will be used to the public’s benefit.
References Cited


