The Impacts of Water Runoff at Waste Facilities on the Wetlands in Florida: A Conservative Estimate

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Introduction

Water runoff can carry and deposit harmful chemicals, sediment, bacteria, or other pollutants into rivers, streams, lakes, and the ocean. It is the greatest threats to clean waters in the U.S. However, not only clean waters but also wetlands are vulnerable to water runoff. Even though wetlands can provide pollutant removal functions to the ecosystem, they can only absorb so much as pollutants can accumulate in wetland sediments (Ronca, n.d.). Pollutants in wetlands can be dangerous for plants and animals and can degrade wetlands' natural functions. Once a wetland is polluted, it is difficult to restore as wetlands restoration requires a wide range of expertise and takes up decades to make the degraded wetlands fully recovered (EPA, 2022). This project aims to identify the wetlands that are at the most risk from water runoff in Florida and need conservation attention. This project pays a particular attention to water runoff from waste facilities because waste facilities, such as landfills, can bring a broad spectrum of harmful chemicals or organic compounds to their surroundings.

Methods

The goal of this project is to build a vulnerability index for the wetlands in Florida to see the potentially impacts of human activities, especially waste facilities, to wetlands. Thus, in order to explore the relationship between waste infrastructures and wetlands, this project uses the following equation:

$$Vulneability = Distance\ to\ Waste\ Facilities \times Water\ Runoff\ Value$$

Distance to Waste Facilities is measured by using Distance Accumulation and Fuzzy Classification (Small Type). Water Runoff Value is Reclassified from a hydrologic soil group map created with soil data provided by USDA. The final vulnerability map is created with Fuzzy Overlay (Gamma 0.9).

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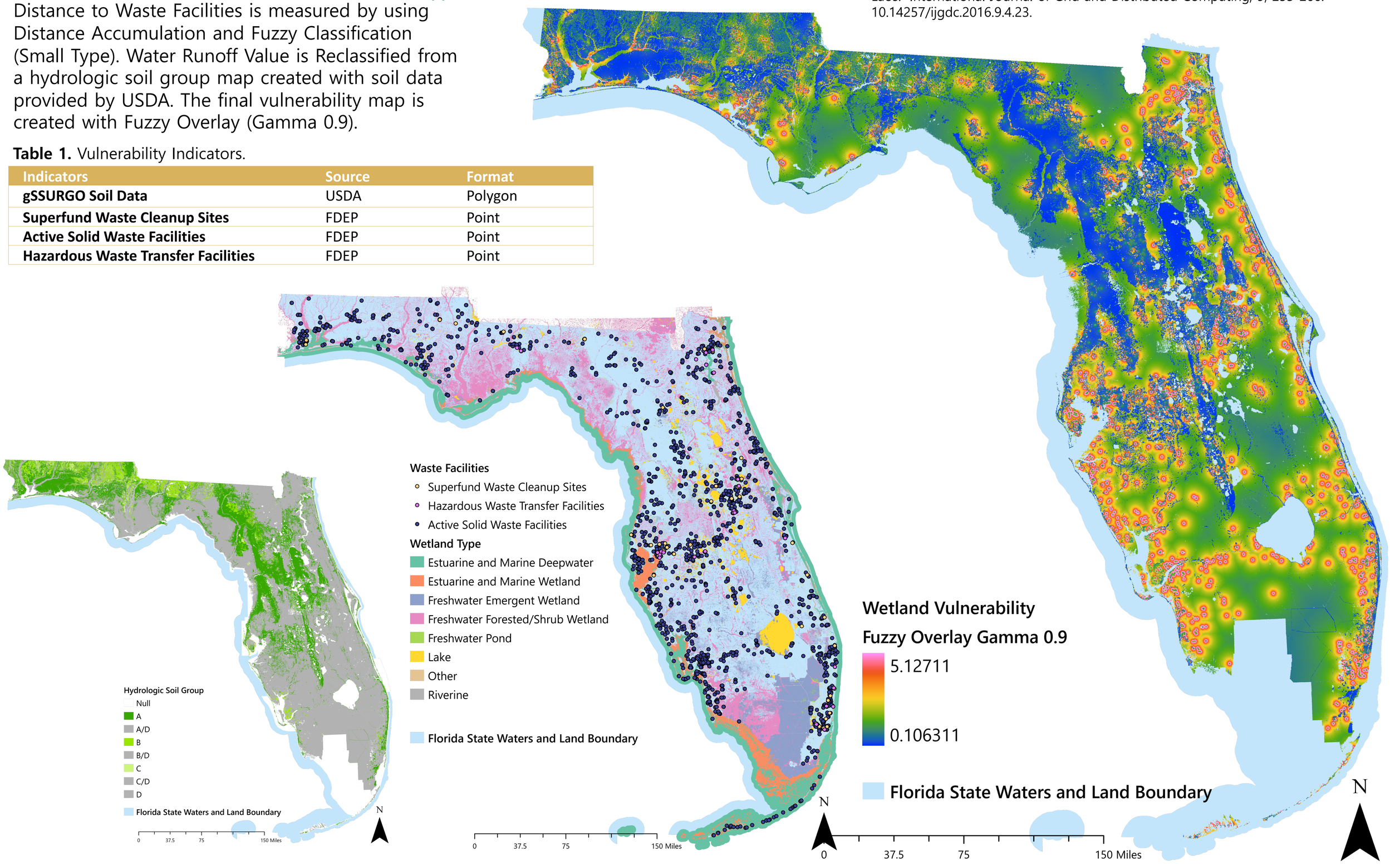
Data Source:
FWC. 2021. Florida State Waters and Land Boundary.
FWS. 2022. National Wetlands Inventory (NWI).
USDA. 2022. Soil Geographic Databases.
FDEP. 2022. Florida Superfund Waste Cleanup Sites
FDEP. 2017. Solid Waste Facilities.
FDEP. 2017. Hazardous Waste Transfer Facilities.

Reference:
Vannasy, Moukmany & Nakagoshi, Nobukazu. 2016. "Estimating Direct Runoff from Storm Rainfall Using NRCS Runoff Method and GIS Mapping in Vientiane City, Laos." International Journal of Grid and Distributed Computing, 9, 253-266. 10.14257/ijgdc.2016.9.4.23.

Table 1. Vulnerability Indicators.

Indicators	Source	Format
gSSURGO Soil Data	USDA	Polygon
Superfund Waste Cleanup Sites	FDEP	Point
Active Solid Waste Facilities	FDEP	Point
Hazardous Waste Transfer Facilities	FDEP	Point



Results

In this project, I conducted a vulnerability analysis. The major tools I utilized were Distance Accumulation, Reclassify, Fuzzy Membership, and Fuzzy Overlay. I would say that the overall process ran smoothly. I was able to process all the steps with only one or two errors, saying that were not able to access the layer or that the results were currently being shown to another person. I was not sure why I had these errors, but one reason I could think of is that I ran the same geoprocessing step for too many times for ArcGIS Pro to react. The only thing I did to fix these errors was restarting ArcGIS Pro. Meanwhile, Fuzzy Membership and Fuzzy Overlay used in this project are meant to reduce uncertainties. However, there should still be some uncertainties when I used Fuzzy Overlay with the waste facilities and the water runoff values because we still do not know how water or pollution travel. Or in other words, we are uncertain about the relationship between waste facilities and water runoff.
All in all, from these maps, we can see that there are a lot of places in Florida that are covered by the 500m pollution buffer and have low-runoff-potential soil type, most of which are at the coastal areas or the estuaries. The estuarine and marine wetlands and the freshwater forested wetlands located at the middle-west part of Florida are observed to be, potentially, the most vulnerable wetlands to water runoff from waste facilities.

Table 2. Assigned Runoff Values.
Source: Vannasy, Moukmany & Nakagoshi, Nobukazu, 2016

Soil Class	Example Description	Average Infiltration Rate (mm/hour)*	Runoff Potential*	New Runoff Value**
A	Sand & Gravel	7.62	Lowest	1
B	Sandy Loam	3.81	Moderate low	3
C	Loamy Sand	2.54	Moderate high	5
D	Silt/Till	0.65	Highest	7

Conclusion

Overall, I would recommend future work to include more indicators for a more comprehensive picture. Including precipitation data can also help see how much water or rain the areas have in average, so that the results can be more precise in telling how vulnerable the wetlands are. I would also encourage future study to find a polygon file of Florida's administrative boundaries and use Zonal Statistics to compare how much wetlands are in an area with the pollution level or the vulnerability of an area. In this way, we can generate more insight on how each city or neighborhood can better protect wetlands.