Killer Crops: A Vulnerability Analysis of Nutrient Pollution in the Chesapeake Bay

Introduction
This project will serve to display the level of nutrient pollution across the Chesapeake Bay. Nutrient pollution, mainly from nitrogen and phosphorus in agricultural runoff, is a major problem in the Chesapeake Bay because excess plant nutrients causes eutrophication and a depletion of dissolved oxygen in the water. Hypoxic water cannot sustain marine life, which is vital for natural water filtration and maintaining a healthy ecosystem. The Chesapeake Bay Watershed encompasses parts of New York, Pennsylvania, West Virginia, Virginia, Delaware and Maryland. This project focuses on the state of Maryland because it is the closest state to the bay and therefore the runoff is the least diluted in river water and groundwater. Since the area is well studied, it is clear that the agricultural fertilizer runoff is the main source of pollution for the bay, but this project will serve to identify exactly where the prevention and remediation efforts such as artificial oyster reefs and aquatic vegetation planting, which filter out the nutrients in the water and keep the ecosystem healthy.

Methodology
In order to determine the most vulnerable areas in Maryland in terms of causing nutrient pollution and eventual eutrophication in the Chesapeake Bay, the following ArcGIS methods were performed:

- Proximity near tool on farmland polygons to major rivers in Maryland and to the Chesapeake Bay shoreline
- Raster creations for distance from nearest river, distance from the bay shoreline, and underlying geology
- Raster reclassification to assign scores (0-4) for each distance range and aquifer permeability
- Weighted raster overlay with all three rasters to obtain a final vulnerability score
- IDW interpolation of the dissolved oxygen sample points to obtain a raster masked on the whole bay

Results and Conclusions
The figure above demonstrates the weighted overlay for the three pollution vulnerability rasters. The distance to rivers raster shows that most of the farmland in Maryland is relatively nearby to a river, which is reasonable for irrigation purposes. The distance to the bay raster shows that the majority of the farmland close to the bay is on the Eastern Shore (the MD territory on the Delaware Peninsula). Finally, the aquifer permeability raster shows that the fastest flowing aquifers under farmland in the state are also on the Eastern Shore. The weighted overlay of these three rasters results in the final figure above, which confirms that the middle and northern sections of the Eastern Shore are the greatest sources of nutrient pollution in the state. Fertilizer regulations should begin with studies of this area and remediation efforts such as artificial oyster reefs and aquatic vegetation plantings should be focused along the coast of Maryland’s Eastern Shore. Oysters and vegetation can filter out these excess nutrients and make the Chesapeake Bay a healthy environment for all marine life once again.

Limitations
The main limitation of this project is the assumption that Maryland is the only state affecting nutrient pollution in the Chesapeake Bay. The watershed reaches up to New York, and the majority of the farmland in the watershed is in Pennsylvania and upstate New York. Another limitation is that there is no data on what type of farm is on each farmland polygon. This information could be used to determine how much fertilizer, and of what variety, each farm is actually using. Finally, the aquifer permeability scores only take the permeability of the geologic unit into account, but the elevation gradient and reactions in the runoff and groundwater could change the concentrations of nutrient pollution over distance and time.

Cartographer: Julian Finney
CEE 187 Geographic Information Systems | May 2019
Data Source: MD Imap 2013
CS: NAD_1983_StatePlane_Maryland_FIPS_1900
Projection: Lambert Conformal Conic