Contribution of Dairy Cattle in Pennsylvania to Non-Point Source Pollution to the Chesapeake Bay

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GIS in Water Resources Term Project Proposal

Project Description:

The health of the Chesapeake Bay has been of great concern over the past 50 years. Nutrients such as nitrogen and phosphorus have depleted dissolved oxygen in the bay that has hindered the aquatic ecosystem. An extensive effort has been made to reduce non-point source pollution running off into the bay, but since the bay's watershed stretches over portions of six states and many stakeholders this is quite a challenge. One large stakeholder group is dairy farmers in eastern Pennsylvania.

Individual farms can potential contribute very large amounts of non-point source pollution due to their large land areas and heavy use of fertilizers. I am interested in mapping the location of the farms within the Susquehanna River Watershed and estimating nutrient loadings to the river's tributaries by land type and production scale. With this information I would like to identify streams of interest with high pollution loadings that could be further studied to determine treatment solutions.

Progress:

The main base information of the project is complete. I have collected and imputed data for Pennsylvania counties and the overall Susquehanna River Basin and flowlines. This data is shown in Figure 1 below. In addition, I have begun collecting data for farms and dairy cattle within Pennsylvania.
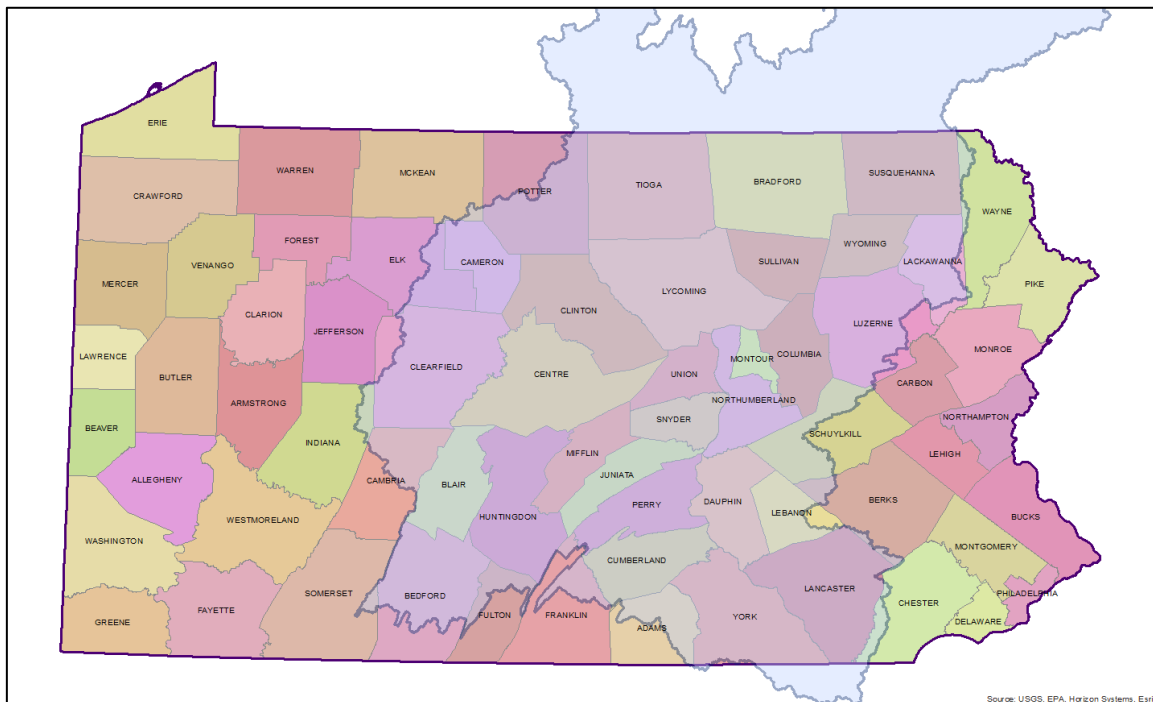

FIGURE 1: Map of PA Counties and Susquehanna River Watershed

Problems Encountered:
Since the government shutdown is now over, I could finally access the USDA farm census data. I have found that although this data source is very large in volume, it does not provide the level of detail as I expected. The most defined inventory of dairy cattle is on a per county basis, which is not quite defined spatially enough to understand the impact to specific streams. After searching I could not find any more detailed information, however I could find data on number of farms that have dairy cattle on a per zip code basis. This leads me to think that there might be some estimation technique that can be used to spatially distribute the number of dairy cattle in each county, but I am still unsure on how this will work.

The Susquehanna River Basin is very large, draining close to half of Pennsylvania. In total approximately 36 counties have some area draining to the river. Already I am experiencing problems while managing so much data with such a large river system. I think it might be easier to focus on one of the major subwatersheds of the overall basin, which would focus my study area to 6-7 counties instead of the entire watershed. A major factor in this decision is how the spatial farm analysis will be handled. If a eloquent solution to the problem described above cannot be found, I might be forced to use all the counties and the whole network, and take a much more broader view of non-point pollution.

Future Work:
A major component of this project, which I have yet to begin, is to incorporate runoff. Stormwater runoff connects the pollution on a farm to the stream segments. I believe the first step is to determine how the water will flow from each farm point. That is, which stream will receive the farm runoff. I can do this by using a DEM from elevation data available through ArcGIS services. Second, I have to come up with some method of determining how much pollution comes off of each farm. This hopefully can be understood from some literature sources, although I have yet to research it. Lastly, it may be possible to incorporate land cover data into the analysis, from the ArcGIS services. Depending on the type of land cover, determines how much pollution runoff and how quickly.