Questioning the Sustainability of Concentrated Animal Feeding Operations:

Researching the impact CAFOs have on local economies, social equity, and the environment using GIS

Purpose

The purpose of this project was to question the the current structure of one of this country's primary food systems. I believe that using the pillar model of sustainability was an appropriate approach because of the impact, both potential and documented, that industrial agriculture has on the pillars of sustainable development: local economies, social equity, and the environment. The Brundtland Report defined sustainable development as development that **"...meets the needs of the present without compromising the ability of future generations to meet their own needs."** If our food systems do not meet this description, not only are they actively preventing future generations from thriving, but they are missing an opportunity to use their role as a major industrial force to be a leader in sustainable development, rather than an aggressive detractor.

I chose to focus this project on a specific sector of industrial agriculture, Concentrated Animal Feeding Operations (CAFOs) because, although many of the detrimental effects they cause have been documented, I wanted to use GIS to research the different sectors in which those effects occur, as well as examine how they may overlap and create increasingly compound issues. I was also interested in approaching CAFOs from not only an environmental standpoint, the most commonly discussed and researched angle, but one that considers industrial animal agriculture to be a perpetuator of environmental injustice. I believe changes can be made to make our food systems sustainable and equitable, but it is very hard to question socially accepted institutions that most of us have been familiar with our entire lives. Using GIS to spatially visualize inequity, environmental destruction, and unsustainable economies has the potential to help people look at this industry in a new light, one that reveals the everyday victims of large-scale industrial animal operations.

Objective

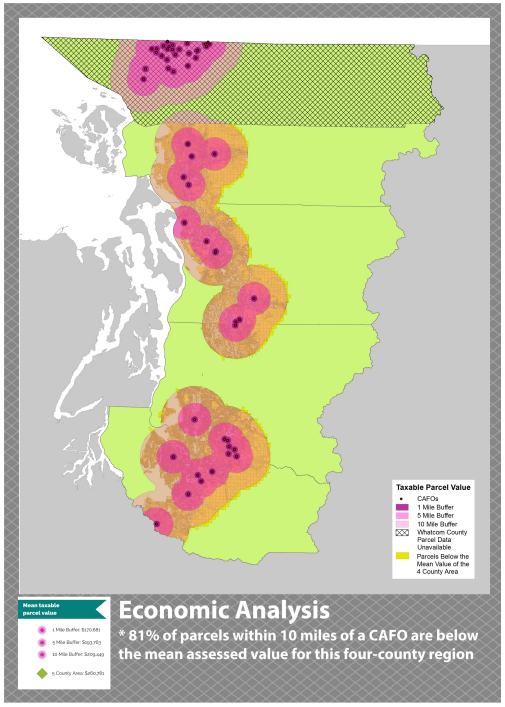
My goal in this project was to utilize GIS to create three separate analyses,based on the pillars of sustainable development model, that would identify any spatial patterns that occured based of off the proximity a person lived to the location of a CAFO, with the extent being five counties in Western Washington.

For my economic analysis, I chose to look at taxable parcel value because high or low property value can be indicative of a strong or weak local economy, and also because it is a consistant form of measurable data across county lines. The introduction of a CAFO to a community has been known to reduce property values, with a study in Missouri finding that **"...houses located within one tenth of a mile of an industrial farm lost as much as 88 percent of their value."**

My social equity analysis focuses on Census-derived demograpic data because **environmental justice is defined as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."** I chose to examine density of Hispanic populations, because of the history of exploitation of undocumented laborers by the agricultural industry, and income levels, because it is often individuals who do not have the financial means to move away from an environmental hazard that must disproportionately endure its effects.

For my environmental analysis, I chose to examine the presence of wetlands in the vicinity of CAFOs compared to the larger five-county area as a whole. According to the EPA, **"...wetlands provide values that no other ecosystem can, including natural water quality improvement, flood protection, shoreline erosion control, [and] opportunities for recreation and aesthetic appreciation."** Although there are laws in place to prevent dumping, the vast amounts of waste that CAFOs constantly produce means there is a continuous threat of spillage. **When "...an eight-acre hog-waste lagoon in North Carolina burst [...], the spill killed about 10 million fish and closed 364, 000 acres of coastal wetlands to shellfishing."** Uncontrolled waste can pollute groundwater, cause diseases, and contribute to algal blooms and dead zones in water bodies.

My hypothesis for my economic analysis was that property values would decrease the closer properties were to CAFOs within the 1, 5, and 10 mile buffer zones. In my social equity analysis, I speculated that Hispanic density would increase and income would decrease the the closer census block groups are to CAFO locations. For my environmental analysis, I did not have a specific hypothesis, I just hoped that there were not a significant amount of wetlands in the vicinity of CAFOs.



Economic Analysis

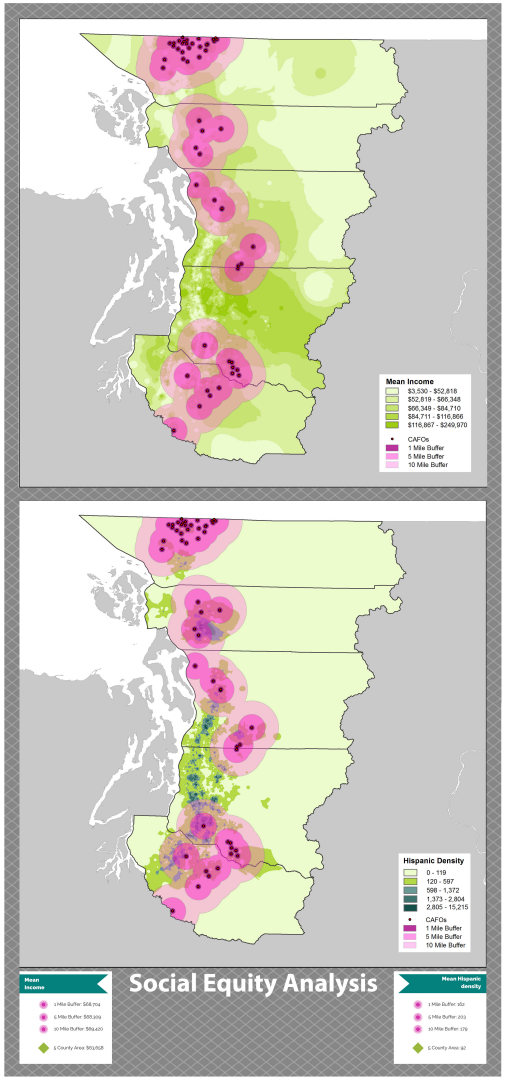
*** 81% of parcels within 10 miles of a CAFO are below the mean assessed value for this four-county region**

Flooding can cause waste to escape from CAFO facilities, polluting nearby wells, waterbodies, and groundwater

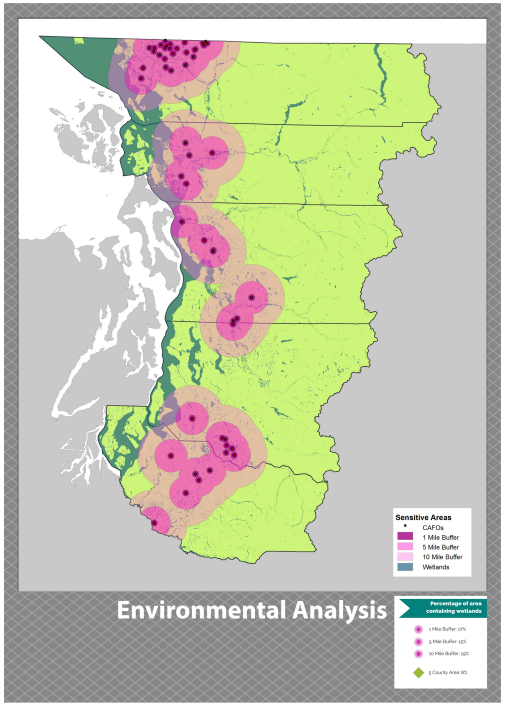
The constant dust from a nearby CAFO causes this North Carolina man to wear a mask when he is in his front yard

"But that's the challenge- to change the system more than it changes you."

-Michael Pollan



Social Equity Analysis



Environmental Analysis

Proposed Future Analysis

There are a few areas in which I believe this project could be improved, given the time and resources. I would have liked to source urban and rural data designations from the Census so I could do a comparative analysis determining the impact that that designation may have had on some of my outcomes.

With my environmental analysis, I think it would be interesting to map out an index of a variety of sensitive areas, not simply wetlands. It could also be enlightening to analyze where the most litigation is taking place concerning CAFO pollution and adherence to waste management laws.

I would like to revisit my income analysis because I believe it would have been more accurate if i had excluded some of the outlier data. I think it is possible that a few extremely high incomes skewed the outcome, making the outputs so similar and suprisingly high. Since data for undocumented workers is not available, I do not know how accurate my Hispanic density analysis is. I believe this portion would benefit from adding ethnographic research to it.

The area I am most interested in elaborating on is the social equity aspect. Multiple studies show that communities in the close vicinity of a CAFO experience an increase in respiratory diseases, crime, and, contaminated water. Those who can afford to leave these situations do, and those who cannot are left to suffer. In addition to the effects CAFOs have on communities, they also are know for mistreatment and exploitation of their workers. I believe that research such as this necessitates the addition of qualitative data. When health and social equity are involved, personal experiences are just as important, if not more so, than the data I had available to me.

"When we try to pick out anything by itself, we find it hitched to eveything else in the universe."

-John Muir

Methods

All three of my analyses use three dissolved buffer rings I created around CAFO point locations I sourced from the Department of Ecology. I used the Clip tool on the buffers so that they would remain within the extent of county boundaries.

For my economic analysis, I located parcel data off of each individual county's website; Whatcom County was left out of this analysis because its parcel data was unavailable. I used Clip to create 1, 5, and 10 mile parcel data polygons for each county. After that, I was able to use the Merge tool to create singular 1, 5, and 10 mile polygons that contained the data for every county. Once this was accomplished, I was able to calculate the mean assessed parcel value for parcels that were 1, 5, and 10 miles away from a CAFO point. Since I needed a reference to compare these numbers to, I used Merge to combine the parcel data for all 4 counties and determine what the mean parcel value was over the total area of all of the counties combined. Then I used Select by Attribute to locate all of the parcels within 10 miles of a CAFO that were valued at less than the county mean. This is what I used to determine the percentage of parcels within my buffer zones that were lower than the 4-county mean.

For my equity analysis, I began by joining demographic data to block group data, both of which were downloaded from the Census. Then I used the Feature to Point tool so I could interpolate the points using the IDW tool, thus creating rasters for both median income and Hispanic density. Next, I used Zonal Stats as Table to find mean income and mean Hispanic density for each buffer zone. I repeated this proces for the full county extent to find reference statistics to compare the buffer statistics to.

For my environmental analysis, I started by converting the wetlands raster to a polygon. Then I dissolved the polygon before clipping it to 1, 5, and 10 mile buffer zones. After doing this, I could compare the area of wetlands to the total buffer area to determine what percentage of the buffer zone was comprised of wetlands. I used the same calculation process to find the percentage of wetlands that the greater county area is for comparative analysis.

Results

Upon completing my economic analysis, I found that assessed parcel values increased the further they got from CAFO points. There was a steady increase in value as the buffers grew and the mean value of the total county area was also significantly higher.

I did not get the results that I expected in my social equity analysis. There was no distinct pattern in the income analysis, if anything, it was the opposite of what I expected. The mean income was of comparable value between all three buffer zones, and the 5-county area mean income was actually lower than all of the buffer zones. The Hispanic density simultaneously met my expectations and surprised me. While the county mean was significantly lower than all three buffer zones, the lowest buffer zone was 1 mile, the 10 mile zone fell in the middle, and the 5-mile zone was the largest.

The environmental analysis completely surprised me. While the buffer zones offered relatively similar percentages, the total county area was decidedly smaller. The prevalence of wetlands in the defined buffer zones is over double that of the proportion in the rest of the counties.

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Data Sources

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King County
Pierce County