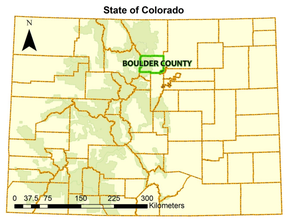
‘ROUND-UP READY’ FLOOD RISK

Agrichemical Exposure Risk Assessment along the Front Range, CO

INTRODUCTION & METHODS

This study was undertaken in order to determine whether communities in and around Boulder County are susceptible to downstream agrichemical runoff from crop lands cultivated on public open space. At the heart of Boulder County is the City of Boulder, a city that prides itself on fitness and health, and a strong credo of environmental stewardship. The county owns over 100,000 acres of public land dedicated as open space to preserve the natural beauty and ecosystem services of the area.



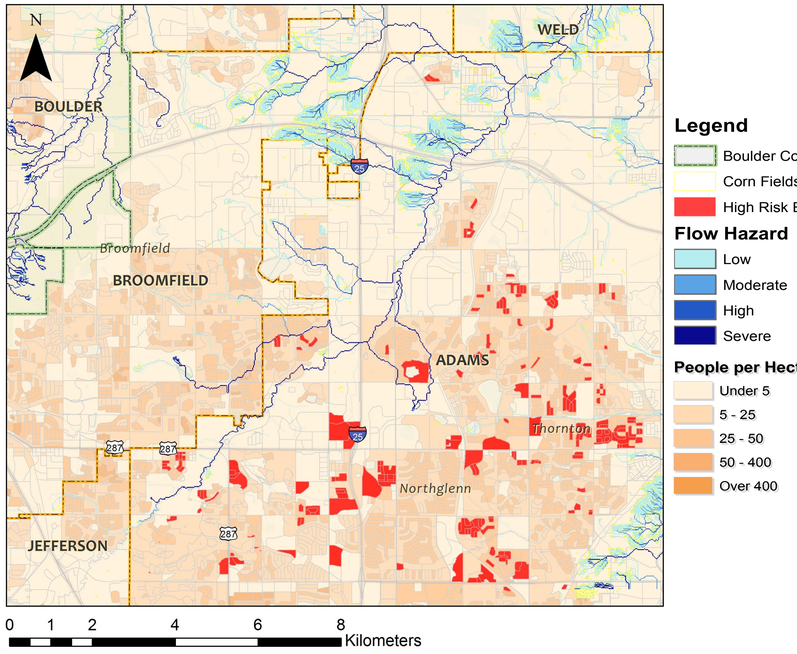
According to the county’s Department of Agriculture, over a quarter of open space land is dedicated to crop production, primarily crop inputs for livestock feed and sweetener production[1]. Despite ongoing debates among community members, the County currently allows for genetically-modified crops to be grown on public land. Two of the top three crops grown in the area are now genetically engineered to be resistant to the pesticide glyphosate, recently identified by the World Health Organization as a probable carcinogen[2]. The crops are then dubbed ‘Round-up Ready’ (RR). Environmental concerns over ‘superweed’ development, now compounded with public health risk from glyphosate application warrant investigations of hazard areas downstream of crop fields with high population density. As resistance continues, farmers may return to older, more hazardous pesticides such as atrazine and 2,4-D.


City of Longmont in Boulder County during the 2013 Colorado Front Range Flood

An elevation-based, hydrological model is relevant for this study area given the hilly terrain along the front range. This initial investigation may provide some understanding of the risks and opportunities for social responsible and economically viable use of public land. Research in this area is particularly important in light of the record-breaking and devastating flood of September 2013, which destroyed over 15000 homes. As extreme weather events become more common, the model may be increasingly useful for identifying susceptible populations downstream of toxic pesticide applications, such as children, the elderly and low-income communities.

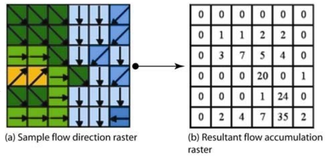
This study combines USGS National Elevation Data along with the U.S. Census and Cropland Data Layer to determine whether these data are precise enough to explore the exposure issue fully. Data will be used to estimate census blocks with high population density downstream of agricultural land within the study area, in attempt to identify neighborhoods at higher risk of exposure to glyphosate.

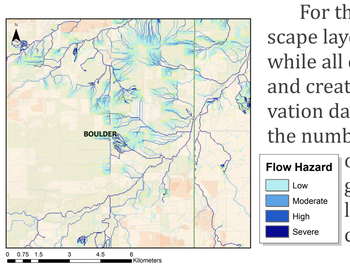
1. http://www.bouldercounty.org/os/openspace/pages/agstats.aspx
2. Fritschi, L., et al. "Carcinogenicity of tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate." *Red 114 (2015)*
3. Jenson, S. K., and J. O. Domingue. 1988. "Extracting Topographic Structure from Digital Elevation Data for Geographic Information System Analysis." Photogrammetric Engineering and Remote Sensing54 (11): 1593–1600.



GEOPROECESSING RESULTS

The geospatial mechanism of interest for this study is the aggregate surface runoff, or downstream flow, from fields identified as corn into residential areas. The primary tool employed was Flow Accumulation tool, a hydrological tool that calculates the accumulated weight of all cells flowing into each downslope cell. Each grid cell in the flow direction grid (a) is evaluated to count the total number of upstream cells flowing into it, and then transcribed into the corresponding cell of the output raster (b).

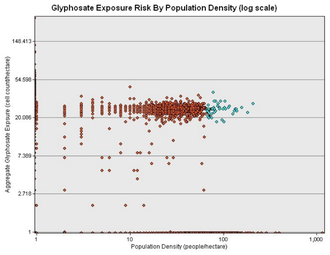


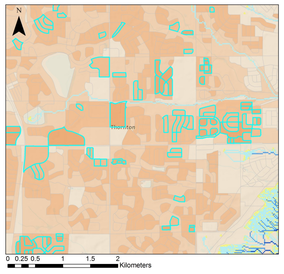


For this model, all cells identified as corn in the Cropscape layer were first reclassified and given a weight of 1, while all other crops and land uses as 0. After filling sinks and creating a flow direction raster using USGS raster elevation data, the Flow Accumulation tool was used identify the number of cells of corn that are upstream of each cell on the map. This raster was reclassified into four graded levels of risk as shown on the map to the left, and normalized per hectare in order to then compare risk levels with population counts.

DISCUSSION & NEXT STEPS

As illustrated in the primary map to the left, most of the census blocks identified as high-risk, that is census blocks with both high aggregate glyphosate cell count density and high population density, are located outside of Boulder County, in the neighborhoods of Thornton and Northglenn. After completing the model, a scatter plot was generated comparing people per hectare with accumulated cell counts per hectare, shown on a logarithmic scale to the right. The census blocks with high levels of both variable were selected and then identified on the map (high-lighted in turquoise to the right). Most blocks are small, which makes sense since the denominator is area. Most are quite far from agricultural areas, and many are not even directly adjacent to streams, but reside in flood plains downstream from fields. Using summary statistics, it is estimated that over 44,000 people, mostly in families, live in these high risk blocks.





The model seems to have been effective in identifying high risk blocks. However, the interest area was focused on Boulder County, and thus may underestimate accumulated flow by not fully accounting for all upstream corn fields that my lie outside the study frame. If the model were replicated with a larger frame that includes the entire Denver basin, it seems that the Census and elevation data would enable planners to begin identifying particular census blocks at high risk of agrichemical exposure during a flooding event.

The primary issue encountered during the modeling process is that the Cropscape data layer may contain significant inaccuracies. Given increased resources, improving the spatial accuracy of the crop level data would be the priority. Access to more demographic information about the populations within targeted areas may also improve the utility of the results: policy-makers may be encouraged to revisit regulation surrounding the use of the herbicide in the county’s Open-Space if the affected households are particularly disadvantaged (for instance, low income or non-English speaking). Given more time, it may also be useful to incorporate wind and weather patterns to assess the movement of glyphosate by other means. Overall, this study represents an initial foray into the downstream accumulation of agrichemicals into residential populations around Boulder County, with a relatively high degree of confidence. Further work will refine and expand upon this effort to best ensure the continued well-being of all Colorado residents.

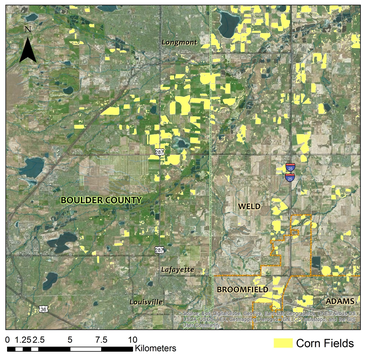
Colorado State Plane Projection
Cartographer: Anaya Hall | Dec. 2015
NUTR231 Fundamentals of GIS

SOURCES:
CropScape- Cropland Data Layer, September 1, 2015, United States Department of Agriculture; published by National Agricultural Statistics Survey On-Line Link, accessed November 03 2015.
USGS National Elevation Datasets (NED), February 2013, United States Geological Survey; published by National Map Viewer, accessed November 25, 2015.
Population and Housing Counts, January 1 2010, United States Census Bureau; published by Census Tiger On-Line Link, accessed November 03 2015.

CROPSCAPE- Cropland Data Layer

The Cropland Data Layer, available on the National Agricultural Statistics Survey (NASS) Web Based platform CropScape, uses remote sensing to identify crops and specific land cover classifications. USDA’s NASS uses satellite imagery of the coterminous United States during the growing season to estimate acreage for major agricultural commodities and specialty crops, and examine changes over time. The collected data have wide ranging applications, from land use research, agricultural sustainability evaluations, and agricultural production decision-making.

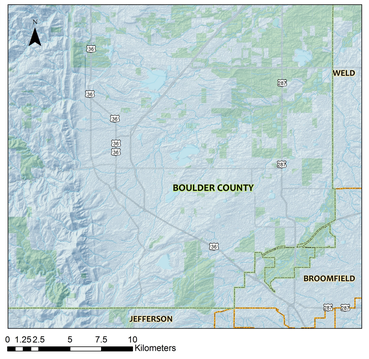
The geo-referenced raster data display agricultural land using a mapping unit of 30 meters, and illustrate the major crops grown in Boulder County. Crop attribute data are available for the years 2008 through 2014, and can be used to estimate the location of corn fields in and around the county.



USGS National Elevation Dataset

The National Elevation Dataset (NED) is collaborative effort by the U.S. Geological Survey, State and local partners to collect accurate topographic information for the U.S. Data are used for a variety of purposes, including recreation, analysis and emergency response. NED is a continuous raster dataset generated from USGS Digital Elevation Models (DEMs).

The National Map Viewer was used to download 1/3 arc-seconds data for 4 adjoining parts of the US, then mosaicked together into a seamless raster model representing the terrain of the study area around Boulder County. Each cell in the raster layer has a value corresponding to its elevation, allowing researchers to understand associations between cells, such as upstream & downstream, using ArcGIS tools such as the Flow Accumulation tool used in this model.



2010 U.S. CENSUS– Population Counts

The U.S. Census is collected by the United States Census Bureau in order to understand a variety of demographic variables used in disbursing government resources. The census contains information on age, gender and ethnicity within census blocks, block groups and larger tracts. Data is collected by surveying households every ten years (years ending in zero) on a specific date. The data can be easily mapped against geographical data to represent population density, commuting time and other community-based economic factors. For this model, 2010 population counts are normalized by hectare to estimate population density within each census block. The data may underestimate particular populations counts, such as the transient college student body.