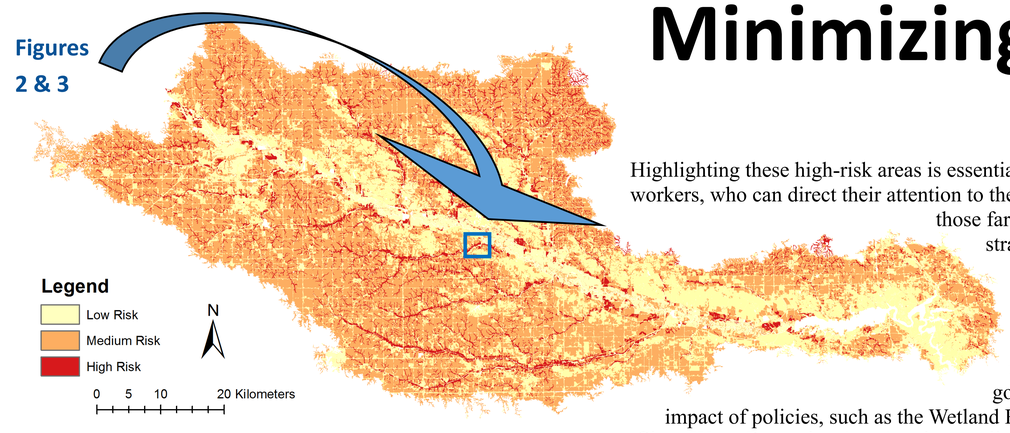
Minimizing Damage from Farmed Floodplains in Iowa

Figure 1. Middle Iowa Watershed Farm Pollution Risk



Introduction

Iowa boasts some the worst water quality of any state in the Union. In the Middle Iowa Water shed represented here, Marshall and Tama County both rank in the bottom quartile of water quality for the state. Wetland systems store surface water, a kind of built-in floodplain buffer to hold excess water, sequester nutrients and sediment, thus improving downstream water quality. However, 95% of Iowa's wetlands have been drained, lost or altered from their pre-settlement state. Draining Iowa's wetlands for agriculture has led to serious ecological consequences such as compromised water quality, natural habitat damage and increased flood incidence and consequences. Contaminants exceed legal health limits for drinking water in numerous water bodies and many lakes and streams cannot support swimming recreationg by midsummer due to pollution and algae blooms. During flood events, which have increased over the past 20 years, pollution from agricultural runoff is exacerbated. Agricultural lands on floodplains and altered wetlands are particularly vulnerable to increased runoff as the excess water flow during floods picks up sediment and agricultural pollutants. In attempt to maximize farmland, many owners plant dangerously close to riverbeds, adjacent to steep slopes and on frequently flooding lands.

Swimming unadvised Iowa's Rock Creek Lake due to algae blooms from agricultural runoff

While row-crop pollution is considered non-point source runoff, it is nonetheless essential to target high risk areas in order to most efficiently minimize runoff. This analysis identifies high-risk zones based on two key factors: agricultural crop practice on the land and flood risk.

Highlighting these high-risk areas is essential for agricultural extension workers, who can direct their attention to the worst actors and assist those farmers in agricultural practice strategies that help minimize flood risk and runoff, or, as necessary, help farmers set land aside as conservation land. This analysis is significant for local and federal government in evaluating the impact of policies, such as the Wetland Reserve Program and the Clean Water Protection Act: Are these policies improving the agricultural conservation practices of farmers? Are farmers maintaining Iowa's remaining wetlands or are they changing wetlands over to pasture and cropland? Are further economic motivators or policies needed to protect wetlands and water in Iowa?

Corn planted on the banks of the Iowa River, contributing to high flood and runoff risk

Methodology

This analysis evaluates overall pollutant risk level based on two factors:
1) Agricultural crop factor
2) Flood risk

In this model, agricultural crop is determined by National Agricultural Statistics Service 2016 Cropland Data Layer (published by USDA Cropscape). While Cropscape has varying degrees of accuracy for various crops, its identification accuracy for corn and soybeans, which dominate the Iowa landscape, are above 98%. Determining the crop does not identify the quality of agricultural practice. Corn, for example, can be farmed in a myriad of ways, from conventional till, to no-till, to agroforestry. Any farm practice that maximizes plant ground cover and roots in the soil dramatically increases soil water retention capacity, thus reducing pollution from runoff. However, data on agricultural practice is not publically available; therefore, the risk factors associated with unique agricultural land use were summarized by mere crop factor alone.

Land Use	Risk Level
Wetland, Forest	No Risk
Pasture	Low Risk
Hay, Alfalfa	Medium Risk
Cereal Crops	Med-High Risk
Corn, Soy, row crops & barren	High Risk

Flood risk was evaluated based USDA's National Resource Conservation Service (NRCS) SSURGO 2014 data (Soil Survey Geographic Database), which rates flood risks as: none, very rare, rare, occasional, frequent, very frequent--based on increasing percent chances of flooding in a 500 or 100-year period, and percent chance of annual flooding.

All risk factor inputs data was in 30m cell size raster cells. Thus, objects or land use smaller than 90-100m may be ignored. This compromises the data's accuracy more seriously along river banks where a small land area can have a significant impact on pollutant risk, based on its proximity to the river bed. Thin buffer strips (which powerfully protect against runoff) would not necessarily be recognized in Cropscape data. Combining these rasters, a final Pollution Risk rating scale was created, ranging from No Risk

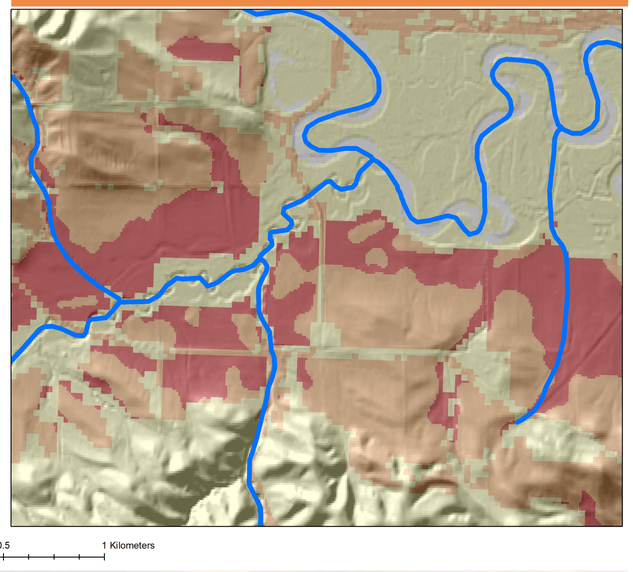
Results & Discussion

Of the total 43,738,035 hectares in the Middle Iowa Watershed analyzed in this study, 40,905 hectares are high risk flood areas under row cropping (Figure 1). This high-risk land represents 9.4% of the watershed's total area, but contributes a disproportionate amount of runoff pollution. Future research would benefit from an analysis of the impact of these farmed high risk areas. However, since non-point source pollution is so difficult to assess, measurement would likely prove most effective in an intervention—measuring pounds of toxic releases in the downstream surface water both before and after intervention efforts. Figures 2 and 3 offer a zoomed-in look at an Iowa farm that poses high pollutant risk due to its location on a floodplain, and its row crops' proximity to the river, without sufficient buffer. It provides an example of the kind of farm that could be targeted in an intervention strategy.

While error may exist, this model nonetheless offers guidance for targeting high risk pollution zones. Intervention strategies targeting these high risk zones could improve pollution and runoff throughout the watershed, and ultimately throughout the state. Though it could not be measured in this model, agriculture practice can significantly mitigate runoff and thus pollution. The model identifies target areas for conservation practices that could mitigate the nearly 7 million pounds of toxic releases present in Iowa waterways today.

Figure 2. Aerial Photo of High Risk Zone in Middle IA

Figure 3. Same Middle IA Zone, Rated by Pollution Risk



Cartographer: Julie Kurtz
Nutr231: Introduction to GIS

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Projection NAD83 UTM zone15N
Sources SSURGO 2014, ESRI Landscape, Iowa DNR, USDA Ag Census, USDA Cropscape