Vegetative Impacts on Flooding in Wildcat Creek Watershed

Rory Reichelt[1], Derek Kvasnicka[1], Elena Watson[1], Jaimie Houser[1], Monica Disberger [1], Kaden Berry[1], Dr. Trisha Moore[1]

[1] Kansas State University, Manhattan, KS, USA

INTRODUCTION AND SIGNIFICANCE

Wildcat Creek covers 255 km^2 in the Manhattan, KS area. With its proximity to a large urban area, flooding is a concern. This research looks to find ways to decrease the impact of flooding with changes in surrounding vegetation. It takes into account some possible changes in the nearby urban area and its policies along with being environmentally friendly.

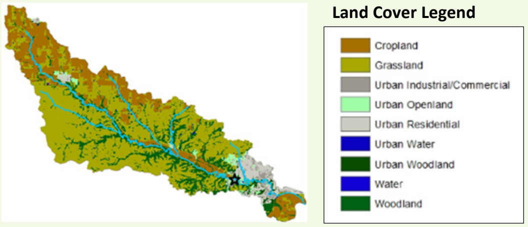

Figure 1. Wildcat Creek Watershed Land Cover Map

RESEARCH QUESTIONS

- How do varying land cover conditions affect flood potential in the Wildcat Creek Watershed?
- How does flood potential in Wildcat Creek vary seasonally?
- How does changes in vegetation impact flooding in the Wildcat Creek Watershed?

METHODOLOGY

The i-Tree Model was used to investigate the changes in total and impervious flow during a heavy rainfall event on June 13, 2010 between 2 a.m. and 11 a.m. by considering the following scenarios based on a calibrated base condition from 2012: an increasing urban scenario, a cover crop versus conventional till scenario and an increasing tree cover scenario. To calibrate the 2012 base condition, the existing land cover from the National Land Cover Database was inputted into the model. 8.4% of the land cover was tree cover, 63.8% was herbaceous cover, 0.5% was water cover, 3.1% was impervious cover and 24.2% was soil cover. In addition, the streamflow and weather data were were taken from the nearest stream and weather gauges to Manhattan. Once the i-Tree model was calibrated, the existing land cover percentages were changed to resemble each of the scenarios for 2010. The year 2010 was chosen because it was a wet year with multiple heavy rainfall events and recorded flooding. Finally, the depth of flow per hour based on the time of day was graphed for each scenario.

WILDCAT CREEK STREAM DATA RESULTS

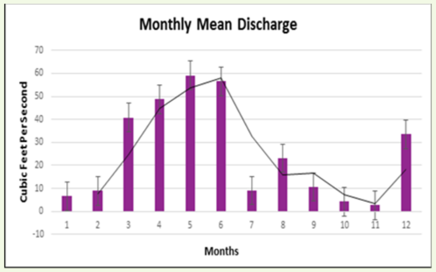

Figure 2. Wildcat Creek mean monthly stream discharge. Data collected from USGS website.

Figure 2 represents the average monthly discharge at Wildcat Creek. The data shows the highest flood rates are during the Spring into the early Summer. Referencing back to Figure 1 the star on the map shows the location where the gauge data was recorded.

PRECIP AND ET DATA RESULTS

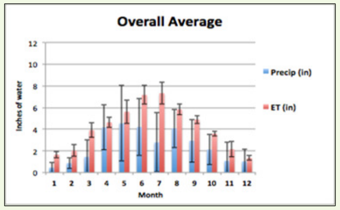

Figure 3. Overall Average precipitation and ET levels from Kansas Mesonet

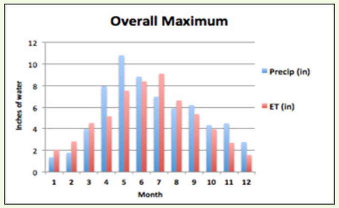

Figure 4. Overall Maximum precipitation and ET levels from Kansas Mesonet

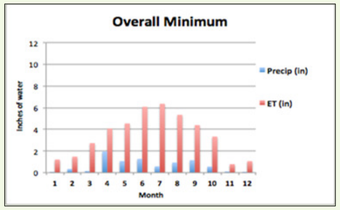

Figure 5. Overall Minimum precipitation and ET levels from Kansas Mesonet

Over a six-year period beginning January 2012, average monthly measurements were taken by Kansas Mesonet at Manhattan to determine the precipitation and reference evapotranspiration levels of inches of water from plants at Wildcat Creek watershed. When plants use the most water, there is not as much precipitation because it is less than what the plants need. The most rainfall is in the spring when evapotranspiration isn't as high. Overall, plants aren't getting enough water, but error bars show that there can be significant flooding mostly in the late spring of May and April. Error bars signify standard deviation of levels in the overall average.

TILLAGE RESULTS

Figure 6. Shows the difference between Strip Till and Conventional Till.

Figure 6 gives an example of a strip till which leaves residue on the soil surface, compared to a conventional till with no residue. Tillage systems expose organic materials and help improve oxidation of soil, which in turn reduces the soil's capacity to absorb rainwater and hold nutrients.

In a 3 year study done by K-State Extension, it shows that in a soybean/grain sorghum rotation in Franklin County, soil/water runoff is decreased by over half by converting to no till. 0.85 tons/acre/year lost with conventional-tillage and 0.275 tons/acre/year lost with no-tillage.

Daniel Devlin and Philip Barnes, Impacts of No-till on Water Quality, Kansas State University, September 2009.

MODEL RESULTS: Urban, Cover Crop vs. Conventional Till and Tree Cover Scenarios

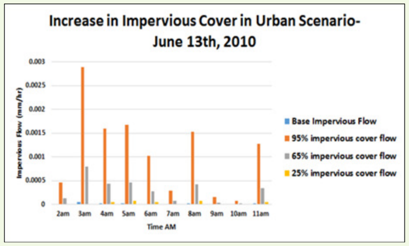

Figure 7. Changes in Impervious cover modeled in i-Tree

Urban Scenario : As the impervious cover area is increased the surface runoff is also increased. As the impervious area increases the pervious flow decreases.

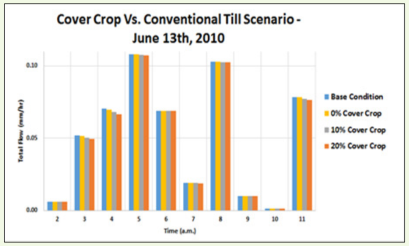

Figure 8. Cover Crops vs. Conventional till modeled in I-tree

Cover Crop vs. Conventional Till Scenario: The cover crops comprise 20% of the total watershed area. The base condition models 24% of the soil cover as conventional till. The model shows a decrease in streamflow meaning more water is being stored in the soil. When no till was modeled the ability for the soil to hold water increases.

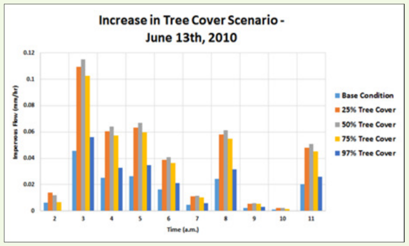

Figure 9. Changes in Tree cover modeled in i-Tree

Increase in Tree Cover Scenario: The tree cover originally comprised of 8% in the base condition and as the tree cover was increased, eventually the impervious flow peaked at the 50% tree cover scenario. As shown the 75% tree cover and 97% tree cover scenarios decrease in impervious flow. With increased tree cover, the canopy area is increased, which captures more rainfall which then evaporates before reaching the ground surface.

SUMMARY

- **Wildcat Creek Stream Data:** The results show Wildcat Creek has the most active flow throughout the Spring into early Summer.
- **Precipitation and Reference Evapotranspiration**: In comparing precipitation and ET, precipitation outpaces plant water use in late spring when flooding typically occurs.
- **Tillage Results:** Strip till methods allow for less runoff, resulting in a smaller amount of water that enters the stream system.
- **Model Results:** The urban model results showed a higher rate of impervious flow to pervious flow as the impervious area increased. For the cover crop versus conventional till scenario, more water could be retained by the soil as the cover crop was increased. Finally, the impervious flow increases with increased tree cover until approximately 50% tree cover. Once the tree cover increases to more than 50%, the impervious flow decreases.
- **Conclusion:** Vegetation affects flooding impacts in the Wildcat Creek Watershed.