Assessing the Accuracy of the Michigan EnviroImpact Tool

2020 FINAL REPORT

By:

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Introduction

The objective of this project was to evaluate the accuracy of Michigan EnviroImpact tool at three on-farm sites in southeastern Michigan that are within the Western Lake Erie basin. To achieve this objective, we monitored how many correct forecasts, missed forecasts, and “false-alarm” forecasts are provided to users over the time-period of the project.

Project Background

Harmful algae blooms (HABs) in the Western Lake Erie basin have become a major problem in the last decade. HABs release microcystin toxin that is harmful to humans and wildlife (USEPA, 2015). In 2014, the city of Toledo, Ohio had to issue a “Do Not Drink” advisory to its citizens because of the detection of this chemical in its drinking water supply, causing consternation and a major risk to the public at large (Henry, 2014)

One of the causes of HABs is agricultural surface runoff, which can contain high concentrations of phosphorus and nitrate that end up in Lake Erie. Those phosphorus and nitrate nutrients are essential for living organisms, but also exacerbate HABs as well (USEPA, 2013). In light of this, the Michigan Department of Agriculture and Rural Development and Michigan State University (MSU) jointly funded the development of an online tool called Michigan EnviroImpact (https://enviroimpact.iwr.msu.edu/). The tool provides daily forecasts of surface runoff across Michigan, with the goal of providing agricultural producers with information on how to mitigate the amount of nutrients leaving their fields from surface runoff. If farms apply and incorporate fertilizer/manure to fields on days without surface runoff forecasted, it is believed that the amount of phosphorus and nitrate entering Lake Erie can be reduced.

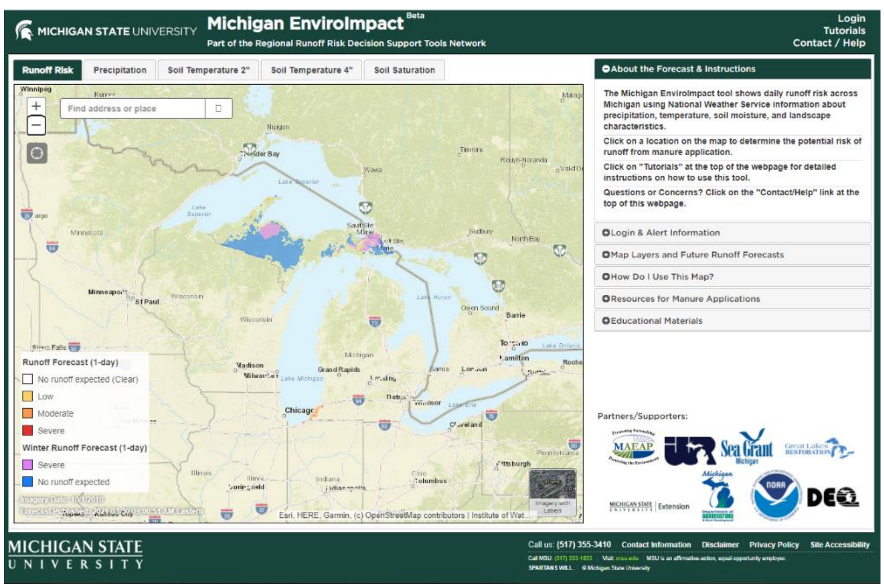

Figure 1 *- Screenshot of the Michigan EnviroImpact website interface.*

Michigan EnviroImpact is a tool that is based upon a runoff risk model created, provided, and maintained by the National Weather Service (NWS), which was validated across four states in the Midwest, but was only validated against a single edge-of-field site in Michigan. Because of only having a single site to evaluate in Michigan, there is a need to further validate the tool at other locations to gain more confidence in its state-wide predictions and to inform NWS as to whether the current model needs modification in the future.

Methods

For this project, ten cameras were setup at three locations to take photos of runoff events. The camera that was selected for observing runoff is the Browning Trail Camera Strike Force Pro XD Dual Lens 24MP Game Camera. This camera can take 24MP photos, which adequately allows for the observation of runoff during daytime, even at some distance from the camera. The time-lapse photography setting on the device prevents taking time-lapse photos at night, so therefore observing runoff events at night is not available. At the start of the project, the cameras were setup to take photos on an hourly basis, with the goal of capturing surface runoff as it occurs in fields. After a short period, this frequency was increased to every 30 minutes to better capture any events. Photos were then compared to the 24-hour forecast that has been provided for that day. Cameras were located on site starting on March 12, 2020 at three separate farms that we currently have permission to setup equipment. The farms were visited on a minimum of a weekly basis by personnel to conduct on-going research and download photos from the cameras.

The cameras were placed at locations within fields that are predicted to have surface runoff, as mapped in the Michigan Sensitive Areas Identification System's concentrated flow layer (http://sais.iwr.msu.edu/). After collecting the photos on a regular basis, a student intern reviewed each of the photos and evaluated whether surface runoff was occurring or likely to occur, based upon her judgement. Conditions that were looked for in the photos were surface ponding, movement of crop residue, and changes in the depth of water.

Figure 2 *- Browning Trail Camera that was used for observing surface runoff. This camera is located at the BL site.*

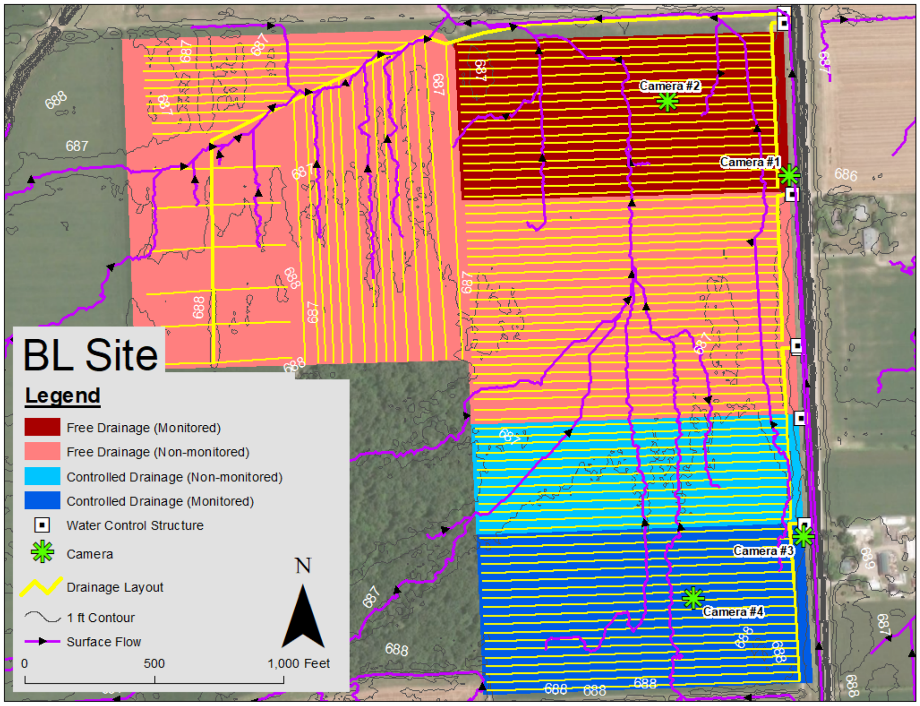

Figure 3 - *Site layout at the BL monitoring site. Four cameras have been setup at this site. Areas shaded in blue are managed for controlled drainage, while areas shaded in red are managed for conventional (free) drainage.*

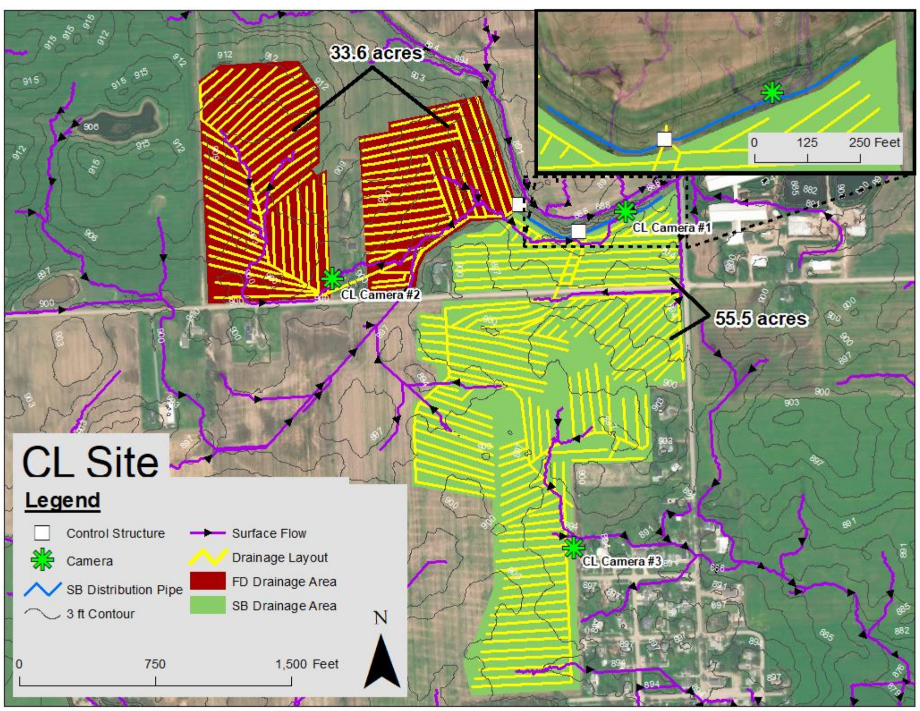

Figure 4 - *Site layout at the CL monitoring site. Three time-lapse cameras have been setup at this site. The area shaded in red is managed as conventional drainage, while the green shaded area has a saturated buffer conservation practice installed.*

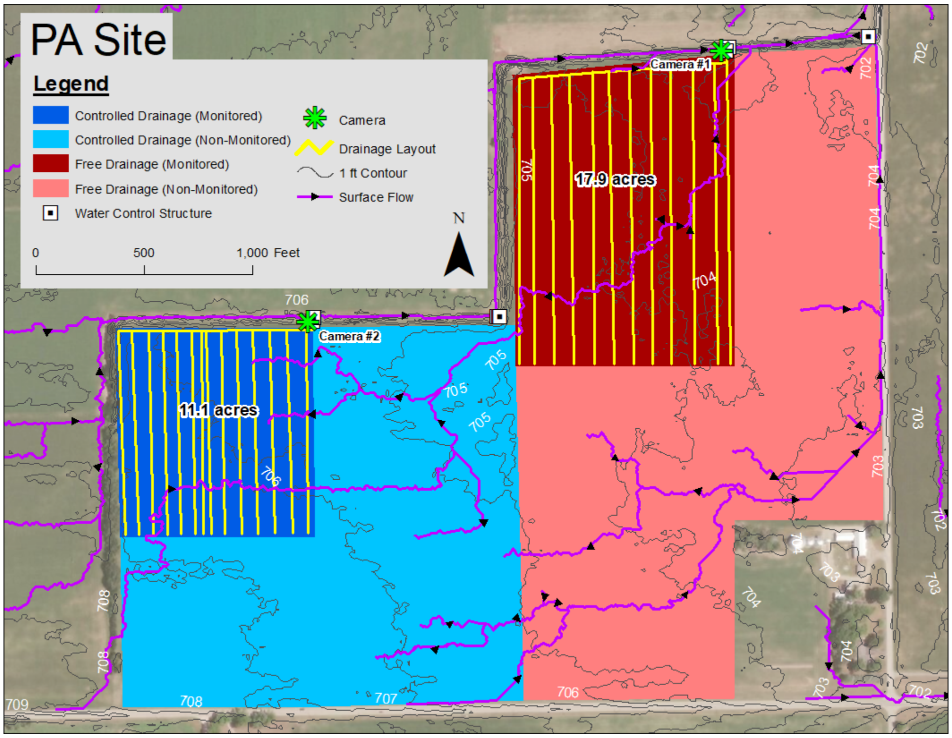

Figure 5 - Site layout at the PL monitoring site. Two cameras were setup at this site. Areas shaded in blue are managed for controlled drainage, while areas shaded in red are managed for conventional (free) drainage.

Each of the sites where the cameras were setup had subsurface drainage systems installed, as is typical in much of Michigan. In addition, at the BL and PA sites, cameras were installed to observe runoff at locations to observe runoff from conventionally drained and controlled drained fields. Controlled drainage at these sites started on May 1, 2020.

Figure 6 - Above you can see the CL site during a large runoff event on May 18, 2020. While visiting the site to collect the photos, the deposition of crop residue was seen throughout the area to the right of the photo. As a side note, this event was successfully predicted by the runoff risk model.

Results

The following tables are a summary of observations from the first nine months cameras have been setup on site (March 12 – December 31, 2020). Additionally, on the right, you can find a list of the various categories used for the classification of runoff events from the Michigan EnviroImpact tool. Note: cameras were not removed from the field sites on Dec. 31, 2020 and have continued to collect data since then.

Forecasts: Whether any runoff was forecasted that day by EnviroImpact.

Runoff Events: Whether any runoff was captured by onsite cameras.

Runoff Hits: Runoff was forecast for that day and occurred.

Runoff Miss: Runoff occurs, but none was forecasted.

Runoff False Alarm: Runoff was forecasted but did not actually happen.

Site Name	Total Runoff Forecasts	Total Runoff Events	Total Runoff Hits	Total Runoff Misses	Total Runoff False Alarms
CL	23	17	9	8	14
BL	16	23	7	16	9
PA	16	13	6	7	10

Table 1 *- Summary of the runoff risk model performance during the first three month of cameras being deployed to the monitoring sites.*

Site Name	Correct Forecasts	Forecast False Alarms	Runoff Events Missed
CL	39%	61%	47%
BL	44%	56%	70%
PA	38%	54%	63%
Average	40%	57%	60%

Table 2 *- Percentage breakdown of correct runoff forecasts, forecasts for runoff that did not occur, creating false alarms, and the percentage of runoff events that occurred, but were not forecasted.*

As it can be seen in Tables 1 and 2, performance of the runoff risk model varied by site. Each site recorded about the same percentage of accuracy for correct forecasts (40% average), with the same that could be said for forecast false alarms (57% average). When looking a breakdown of the category of forecast alert that turned out to be a false alarm, most of the false alarms turned out to be the prediction of minor runoff events.

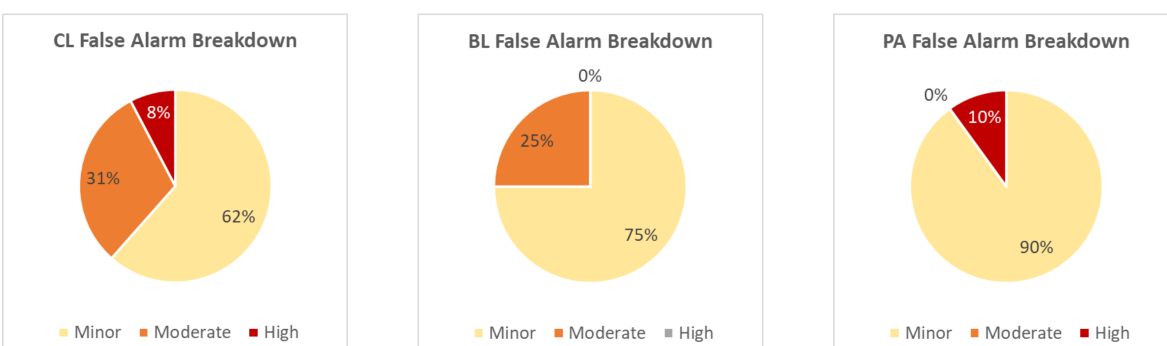

Figure 7 *- Breakdown of false alarms by category for each monitoring site. At the BL site, there were no false alarms with the "High" category and at the PA site, there were no false alarms with the "Moderate" category.*

Conclusion

During this initial phase of this project, the performance of the runoff risk model showed the need for improvement. It was only able to predict runoff events on 40% of the time on average and frequently predicted runoff events that did not actually occur, with 60% of alerts for runoff being false. Looking through the data, some of these runoff events that were not predicted involved spring thunderstorms, which perhaps are not considered thoroughly in model. Additionally, during the nine months that the cameras were deployed, this region of Michigan did not receive a lot of precipitation, which lowered the number of runoff events as compared to a normal year (a drought began during summer). This could have led to a skewing in the observation of runoff at the monitoring site. Considering this, it will be useful to see how well the model performs going forward under different seasonal conditions, which might reflect a more normal pattern of precipitation.

References

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Acknowledgement

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