Stream & Wetland Mitigation Forecasting: Developing a Predictive Model for Faster Project Delivery and Cost-Savings

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Agency	
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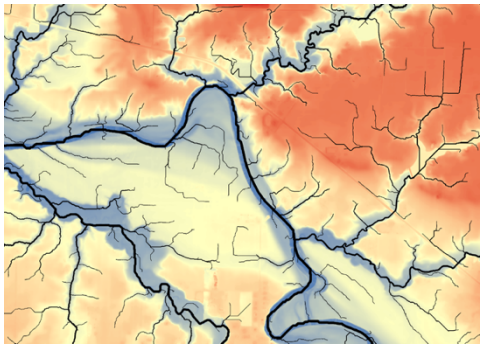
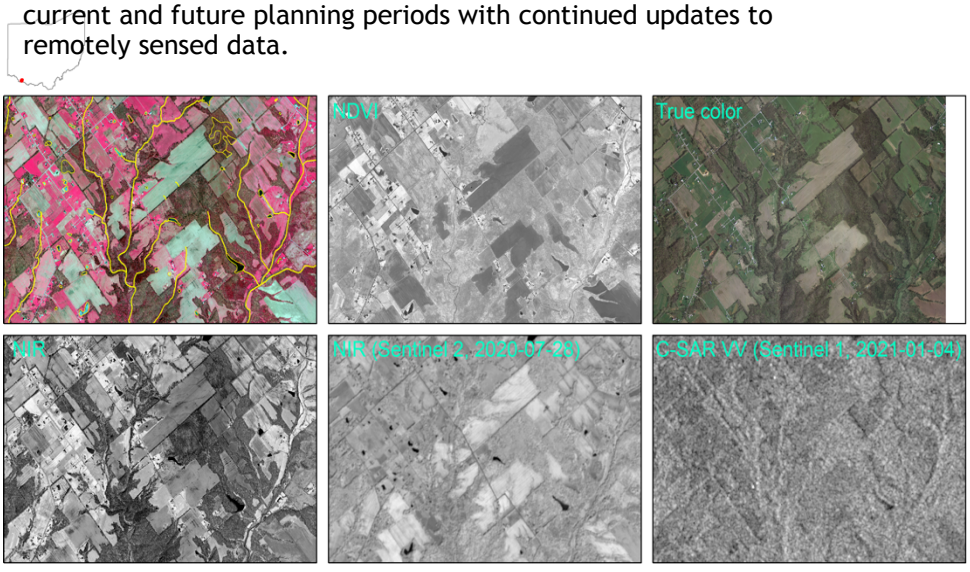
The Problem

Wetlands and streams provide numerous ecosystems services and are protected under federal and state laws. These regulations require permits when fill material is discharged into regulated streams and wetlands from roadway construction and maintenance activities, which also can require compensatory mitigation. Environmental review, permitting, and mitigation are time-consuming with the overall permitting process taking months to years to complete. ODOT cannot begin road construction or maintenance activities until impacted streams and wetlands are identified, permits have been obtained and mitigation is secured. ODOT seeks to streamline this process to reduce project delivery time and cost. In addition to planning timelines, ODOT plans for project costs within budget periods. For ODOT to develop accurate budgets, mitigation requirements and costs must be identified. Existing maps and information on streams and wetlands such as the National Wetlands Inventory (NWI) are outdated and often omit smaller wetlands and streams.

A method that could quickly and remotely forecast the location and boundaries of streams and wetlands would be of great benefit to ODOT by aiding in the planning of the budget and timeline of projects as well as identifying watersheds that will require large mitigation efforts for advanced credit purchasing. Such a tool would provide cost and time savings to ODOT for the current and future planning periods with continued updates to remotely sensed data.





Research Approach

We developed a method that incorporates remotely sensed information from aerial imagery and lidar (laser returns) to predict the locations of wetlands and stream channels.

We applied image classification and terrain analysis to identify potential wetlands and streams in five test watersheds across Ohio.

With an overlay of road project data, we identified potential ODOT projects over the next four fiscal years that could impact nearby streams or wetlands.

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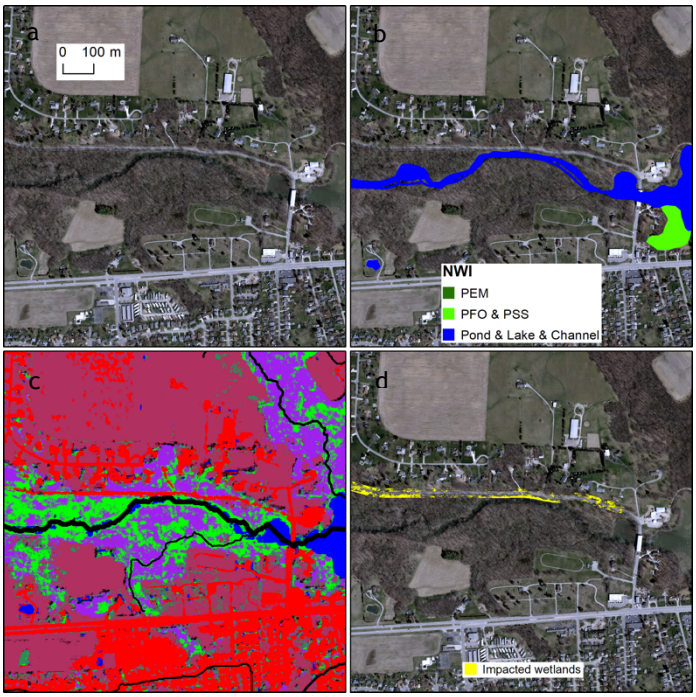
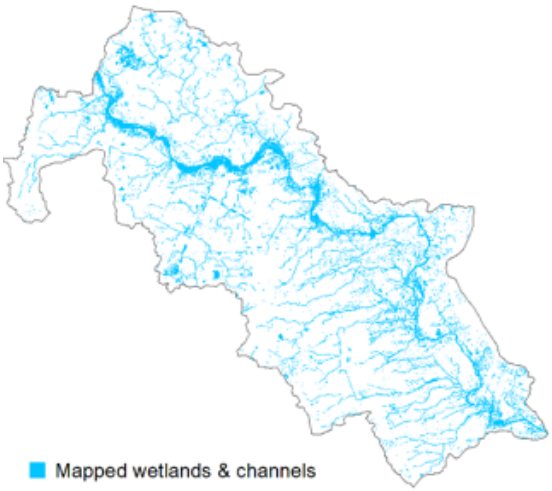
This research was sponsored by the Ohio Department of Transportation and the Federal Highway Administration.

Findings

Our method mapped significantly more vegetated wetlands and stream channels than identified by the NWI within our test watersheds. In addition, our method extracted drainage features alongside roads that could become captured streams if located within project easements. Ground truthing efforts verified the location of many predicted wetlands and streams. The overall accuracy of the method ranged from 64.5% to 85.6% when compared to known points. Accuracy decreased with increasing watershed size. Challenges with this method include: 1) Concurrent analysis of adjacent imagery that was taken at different seasons resulting in color/spectral discrepancies within the same land cover class; 2) Mis-classification of agricultural land due to differences in crop and soil moisture levels; 3) Mis-classification of land cover due to recent land cover change; 4) Color/spectral changes in open water due to turbidity or wind; and 5) Mis-classification of tree lines or tree canopy over roadways as wetland due to a shadow effect.





Recommendations

We recommend that ODOT apply our method and continue the analysis for additional areas throughout Ohio. The method is such that ODOT can continue to implement these procedures as new remotely sensed data becomes available. The resulting maps of wetlands and streams can continue to be overlaid with planned projects in the four-year window to prioritize and budget for mitigation efforts in perpetuity. Based on the challenges that we encountered in our five test watersheds, we recommend the following for implementation of the research methods by ODOT:

- Conduct the wetland analysis at a small scale (county level or smaller) to minimize differences in image quality. Using image rather than watershed boundaries may be more appropriate for wetland classification.
- Combine vegetation height (from lidar) with optical imagery to allow for the differentiation of wetland type (emergent vs scrub-shrub vs forested).
- Include up-to-date imagery to detect recent land cover changes due to land development or land conversion.
- Human interpretation of the results, especially to verify the locations where ODOT projects and wetlands or streams converge, is recommended. While we have worked to automate the prediction of wetlands and streams on the landscape as much as possible, remote sensing and artificial intelligence cannot yet replace the understanding and visual abilities of humans.

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