Combining Remotely Sensed Data and Machine Learning for Rapid and Repeatable Wetland Mapping and Assessment

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WETLAND REGULATION

Wetlands provide several environmental and social benefits. Some of the key environmental benefits include:

- Water Quality
- Flood Resiliency
- Carbon Sequestration
- Erosion Prevention
- Biodiversity/Habitat Diversity

Federal and often state regulations protect wetlands from development. Definitions for classifying these areas and determining which areas fall under regulatory jurisdiction are constantly changing. Regulations typically require wetland boundaries to be mapped in the field as part of the permitting projects. Unavoidable wetland impacts require permitting and often mitigation. Regulation of wetlands is considered throughout the project life cycle, from planning, design, permitting, mitigation, and through construction to ensure compliance.

FIELD DATA COLLECTION

Identifying and mapping wetlands in the field is a labor-intensive process requiring staff to navigate difficult terrain and dangerous environments. Field staff are required to document soil profiles, vegetative communities, local hydrology, and GPS wetland boundaries. Regulatory rules are ever-changing and are difficult to adequately characterize in the field. Challenging terrain also increases the chances that wetlands may be omitted because they are not accessible.

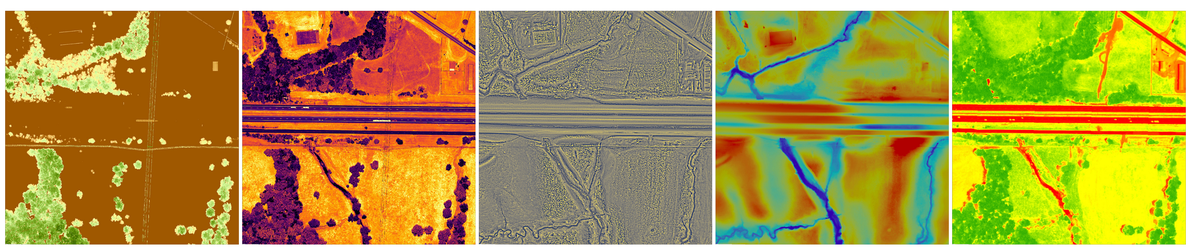
REMOTE SENSING MODEL FEATURES

Light Detection and Ranging (LIDAR) data drives the bulk of data used for a deep learning model to predict wetlands.

- Canopy Height Model (CHM) is used to quantify vegetation height.
- Intensity varies between surface types and vegetative species.
- Local deviation of ground at multiple thresholds is used for hydrology.

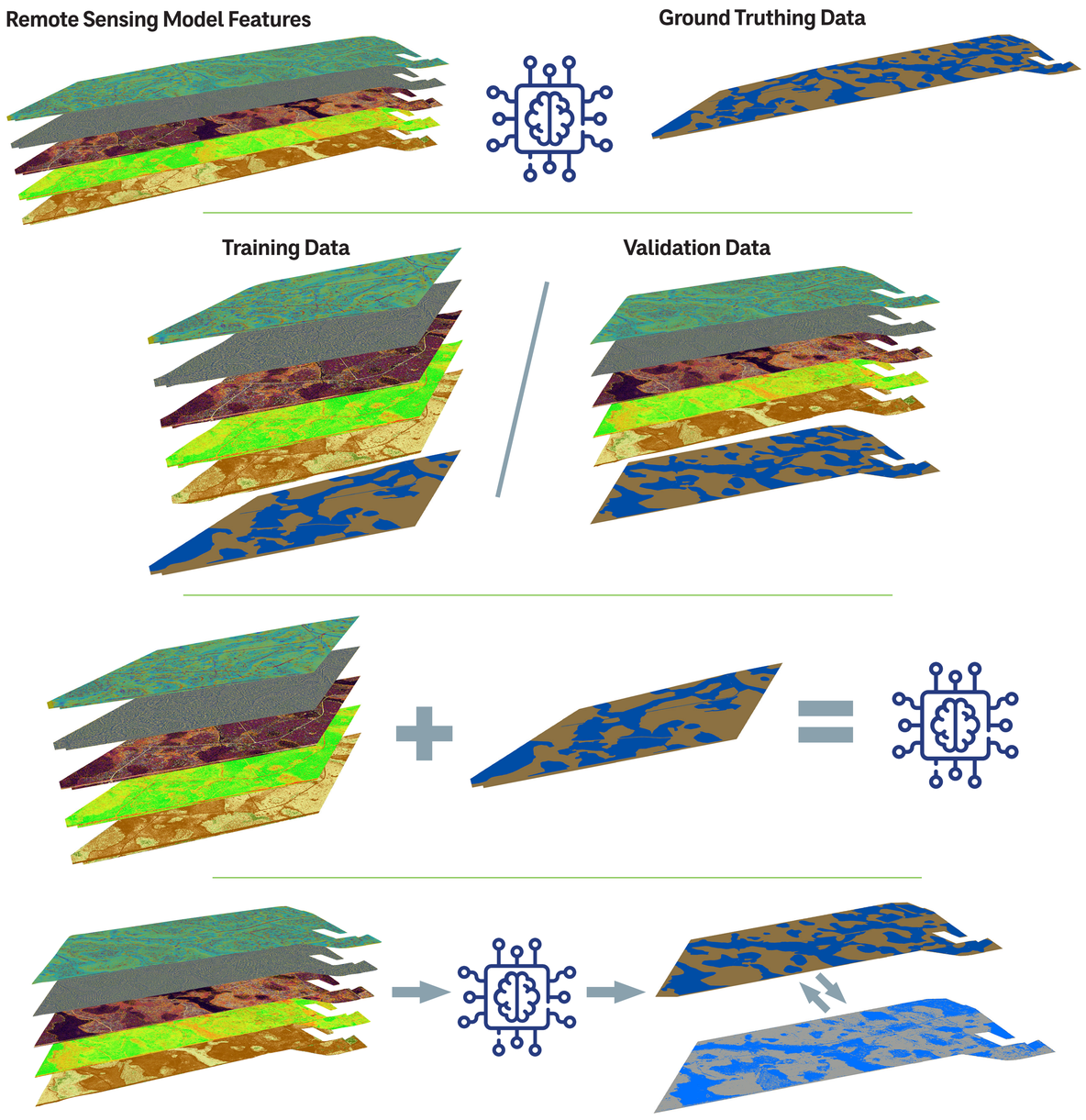
Publicly available National Agricultural Imagery Program (NAIP) Imagery is also used as a model input.

- Normalized Difference Vegetation Index (NDVI) is an indicator of plant health and density.

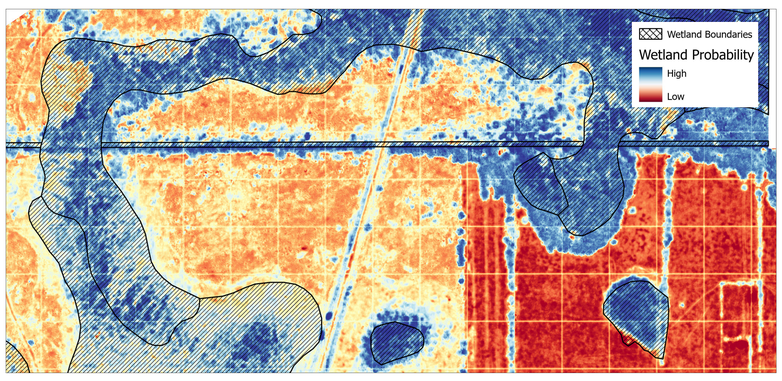


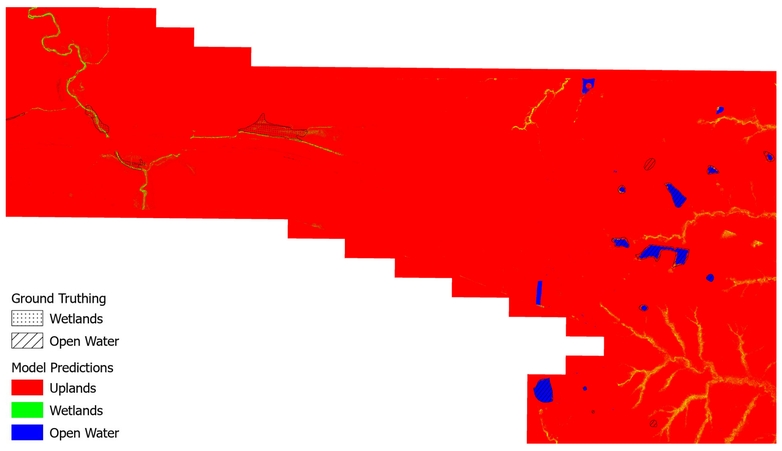
MODEL TRAINING

Machine learning models are trained on site-specific examples of ground-truthing data. The design of training and validation is important for understanding the accuracy of these models and the ability to scale them to new areas. New geographies may require new models, but it may be possible to use similar model features and model architectures. CDM Smith is currently working on model designs for data in the southeast and Midwest. These two datasets encompass very different environments. Just like not all geographies are the same, not all wetlands are the same. These models are only able to predict what they have seen. Thus, it is important to have representative samples of all different types of wetlands in the training and validation process.



DEEP LEARNING MODEL





A deep learning U-Net segmentation model is able to locate and predict the likelihood of wetland features. This can be used not only for current but future planning. Identifying areas that may be transitioning between wetlands and uplands. This deep learning model can run on thousands of acres in less than an hour.