Topographic Metrics to Improve Mapping of Restorable Wetlands

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Restorable Wetlands

- Restorable wetlands are historic wetlands but not all historic wetlands are restorable
- Many factors control feasibility of wetland restoration, including factors that are difficult to quantify remotely (e.g., land owner cooperation).
- Factors which can be determined remotely with good reliability are land cover and historic wetland status.

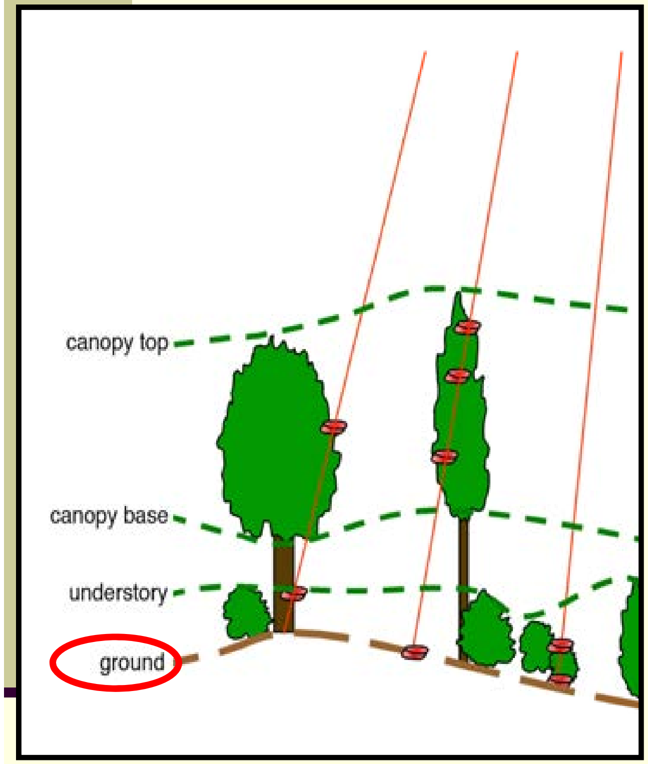
Restorable Wetlands

- Methods for mapping land cover are well established.
  - Semi-natural and agricultural lands are easier to restore than built environments (e.g., parking lot)
- However, wetlands are often difficult to map yet alone historic wetlands

Restorable Wetlands

- Wetlands are especially difficult to map in forested areas using traditional remote sensing data sources – e.g., aerial photography
- Newly available remotely sensed datasets can improve our ability to not only map wetlands but to map the location of historic wetlands and infer their hydroperiods!
  - LiDAR

Light Detection and Ranging (LiDAR)



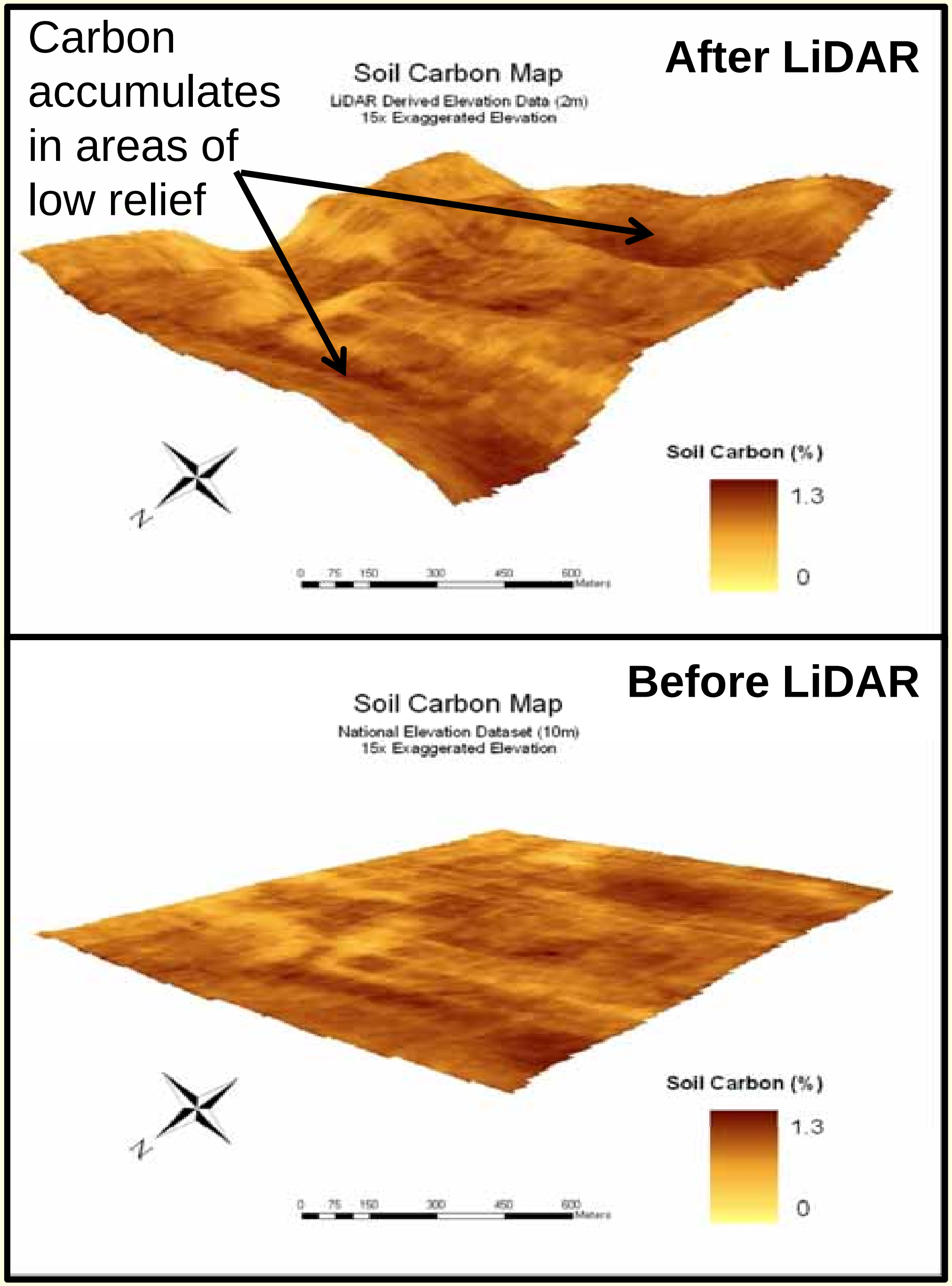
•Rapidly evolving technology, quickly becoming available for large areas

•~1-2 m horizontal resolution, 15 cm vertical accuracy or better

•Often used to create digital elevation models but LiDAR intensity data are also beneficial

•LiDAR intensity can directly map inundation while DEMs can map potential wetness

• A concerted effort is now being made to better understand LiDAR requirements, designate standards, and support the accelerated collection of data throughout the US (e.g., National Enhanced Elevation Requirements and Benefits Assessment).



Why LiDAR DEMs?

- LiDAR makes the analysis of relatively small but critical variations in topography possible

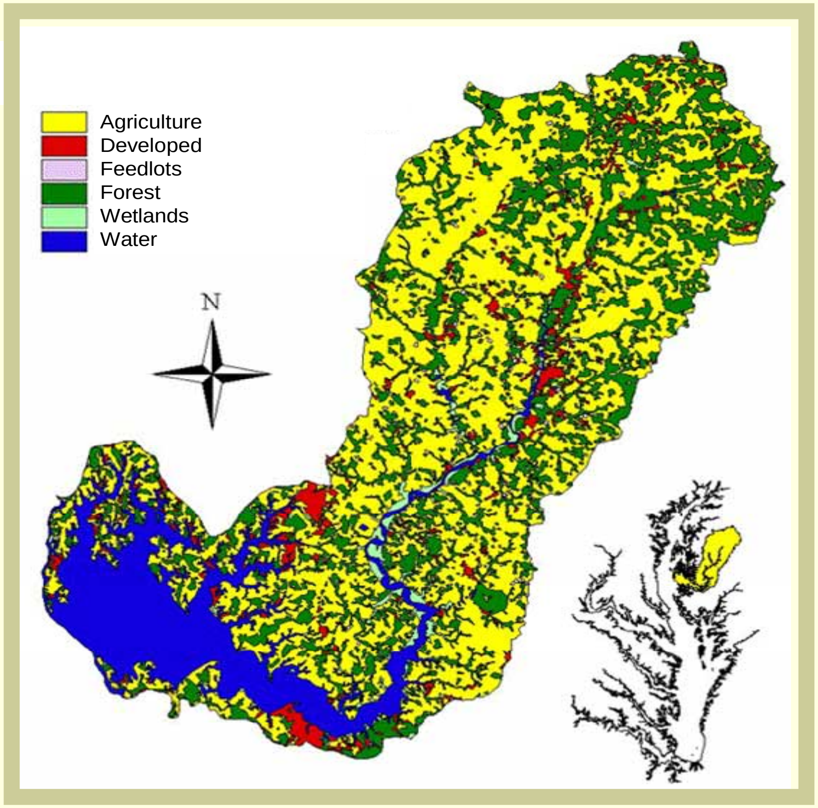
- Subtle variations in topography often lead to very significant variations in ecosystem structure and function

Using LiDAR to Map Current and Historic Forested Wetlands

An Example from the Choptank River Watershed, Maryland

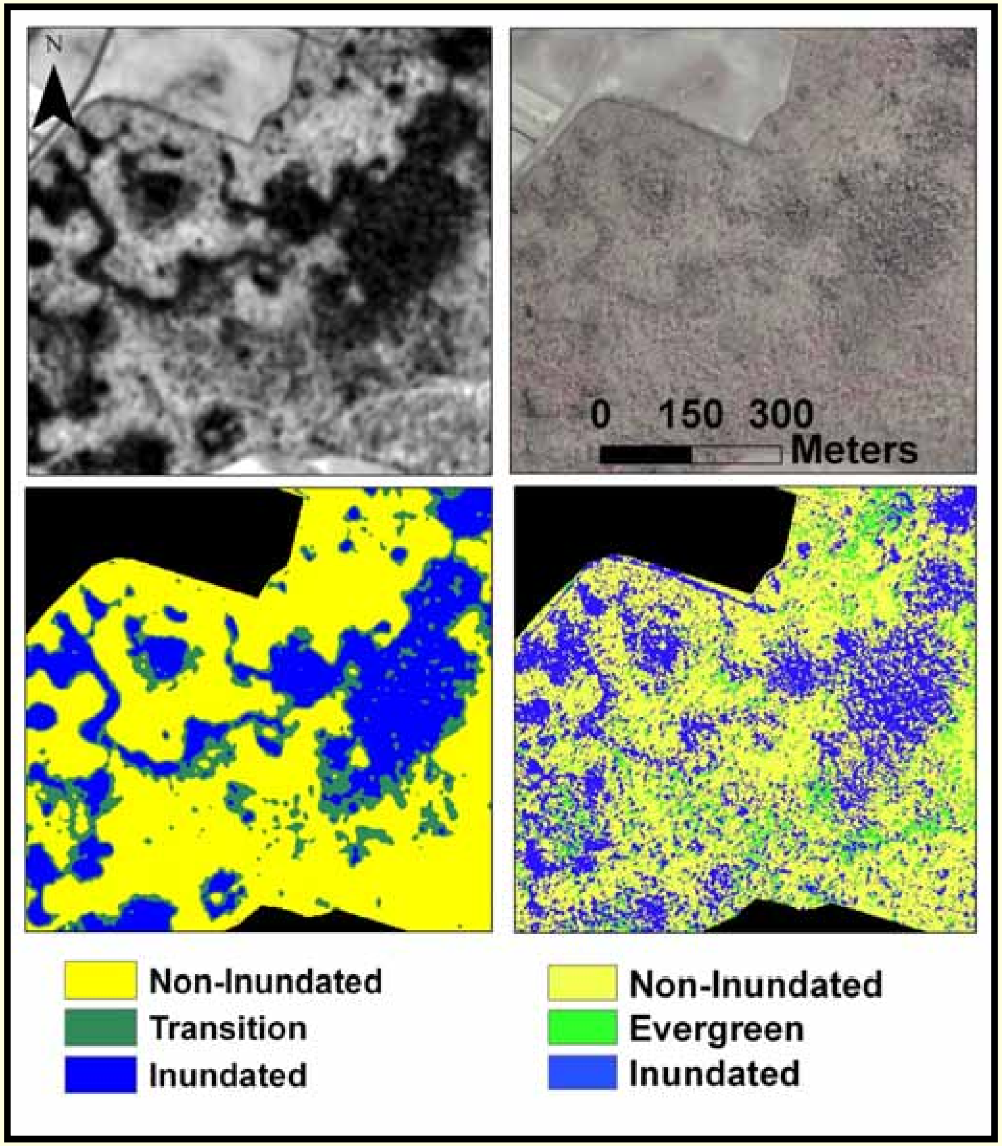
Choptank River and Watershed

- Chesapeake Bay tributary
- High levels of nutrients and sediments
- Low topographic variability
- Agriculture is the primary land cover (60%)
- Extensively drained and ditched



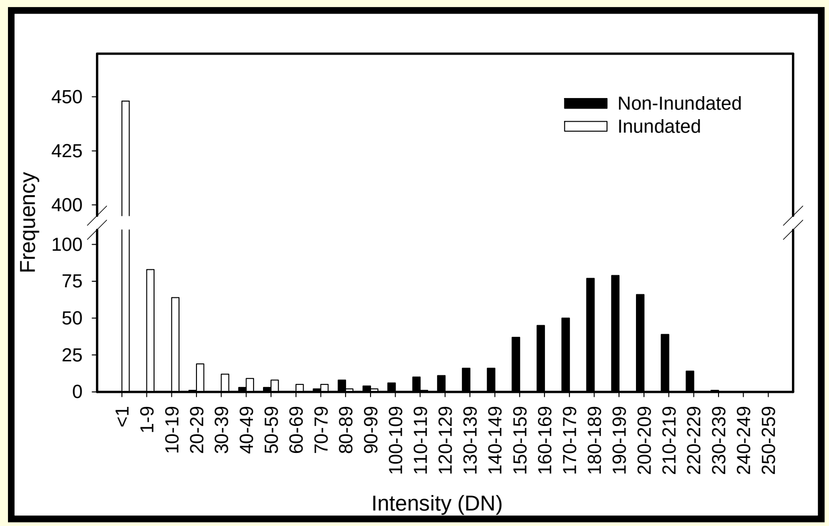
- Majority of wetlands drained for agriculture

LiDAR Intensity: Improved Detection of Inundation Below the Forest Canopy



LiDAR Intensity
97% Accurate

Aerial Photography
70% Accurate



Topographic Wetness Index

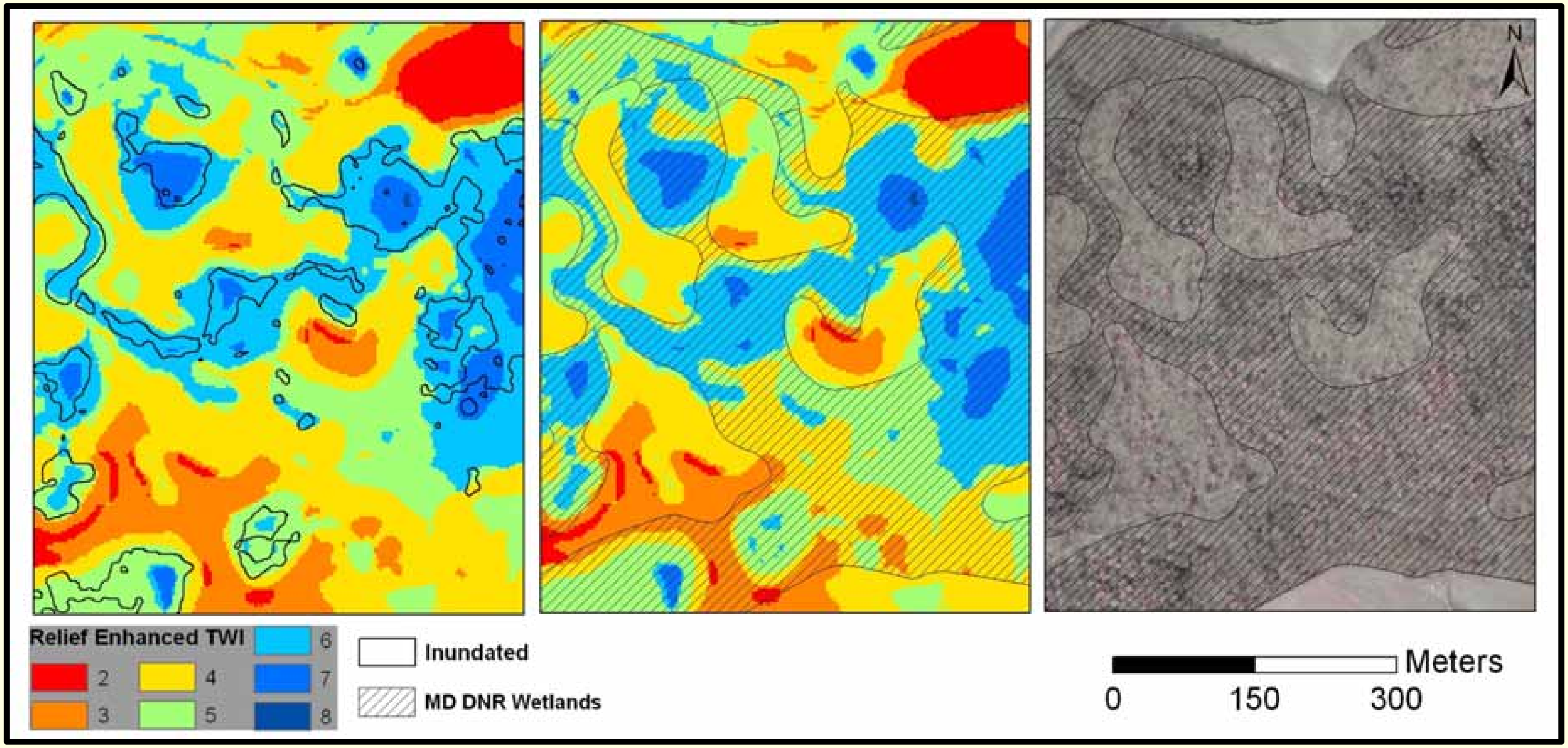
- TWI = $\ln(A_s / \tan\beta)$

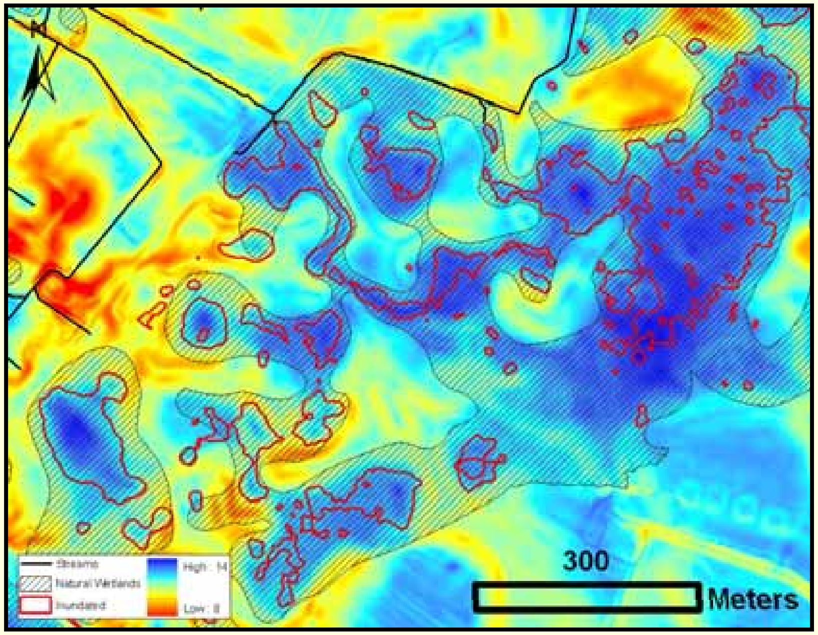
  A_s = upslope contributing area

  β = local topographic gradient

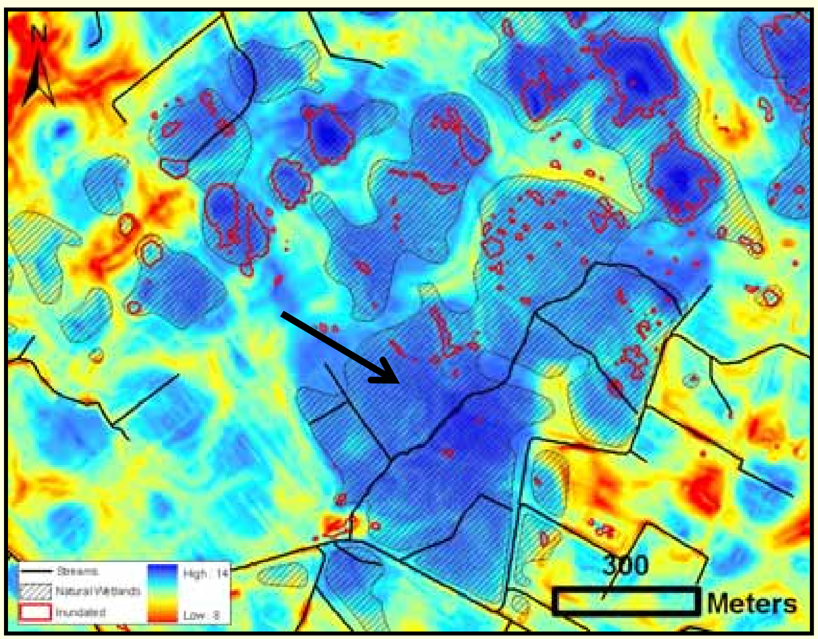
- Multiple algorithms developed
  - Calculation of β relatively consistent but calculation of A_s varies greatly depending applied flow routing algorithm.
- LiDAR makes calculation of TWI possible in areas of low topographic variability.

- TWIs can significantly reduce the amount of time and resources spent mapping wetlands and improve accuracy.
  - At least 2/3s of study area was mapped automatically with 95% or higher accuracy.
  - TWIs can guide mapping in remaining 1/3 of landscape

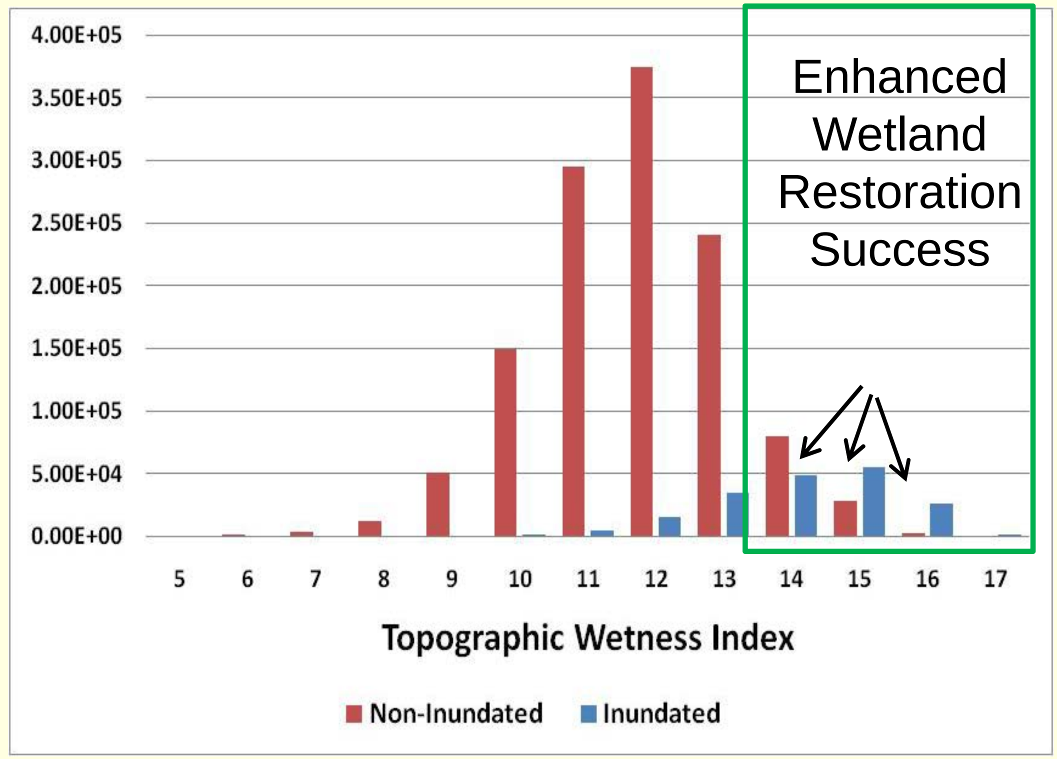




Minimally Drained Forested Wetland



Potentially Drained Forested Wetland

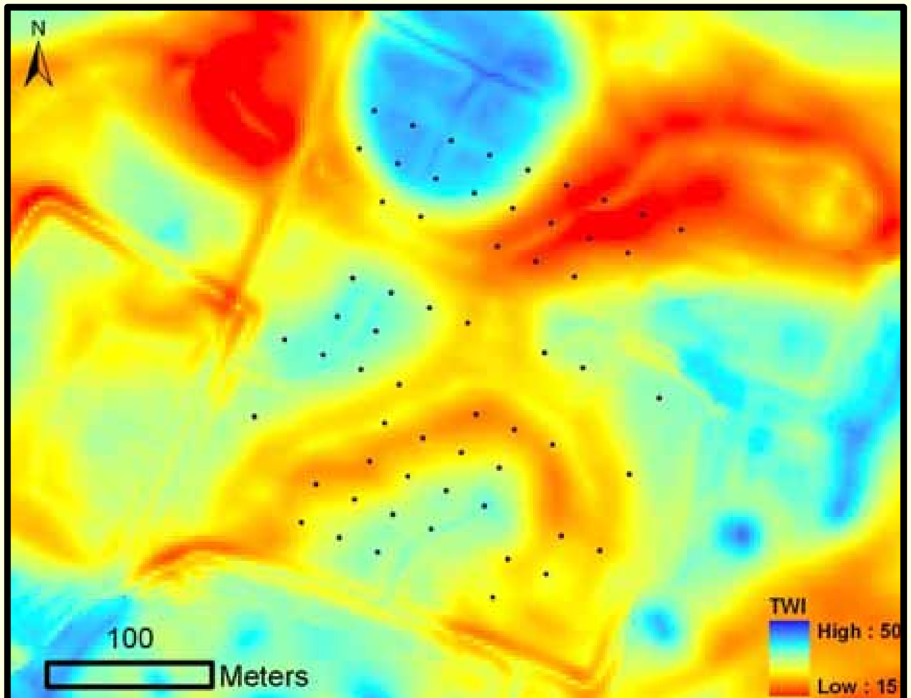


- Areas with high TWI values that are not flooded are likely to be historic or impaired wetlands, especially if drainage is evident.

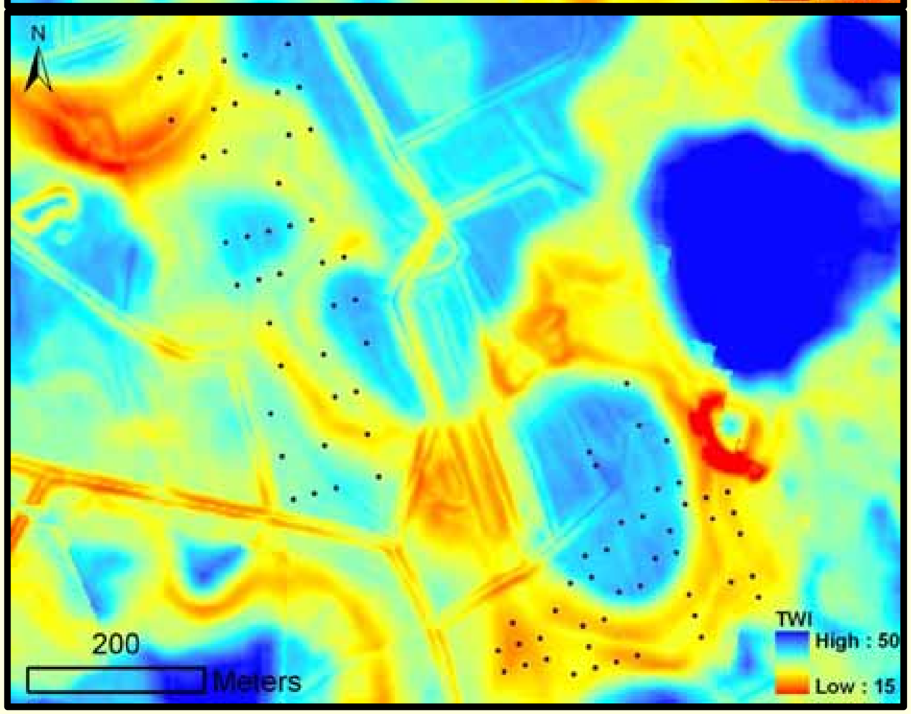
Using LiDAR to Map Historic Wetlands on Croplands

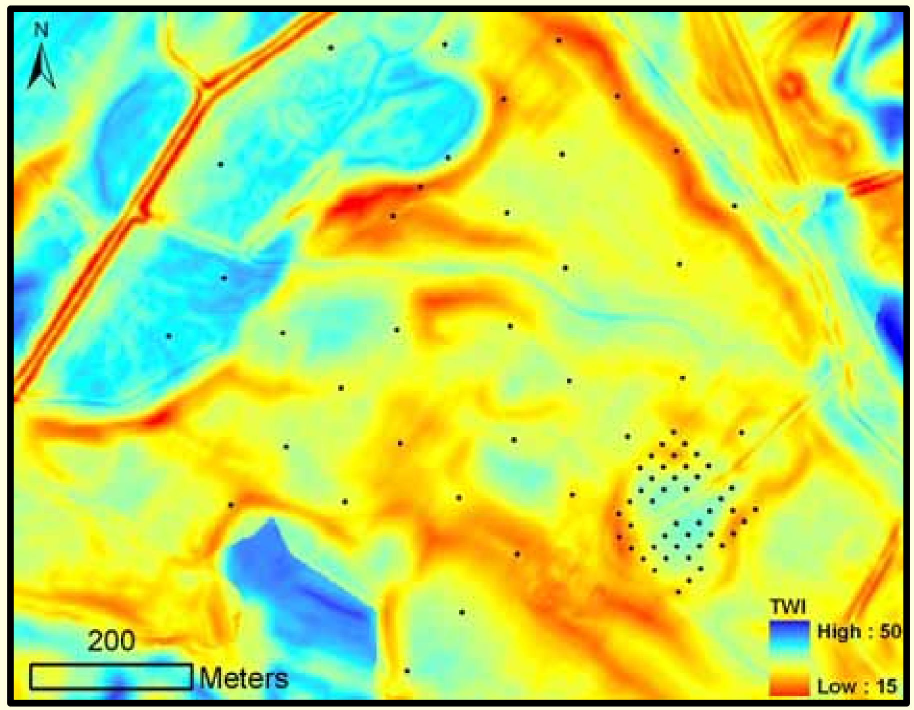
An Example from the Choptank River Watershed, Maryland

Texture Modified Topographic Wetness Index

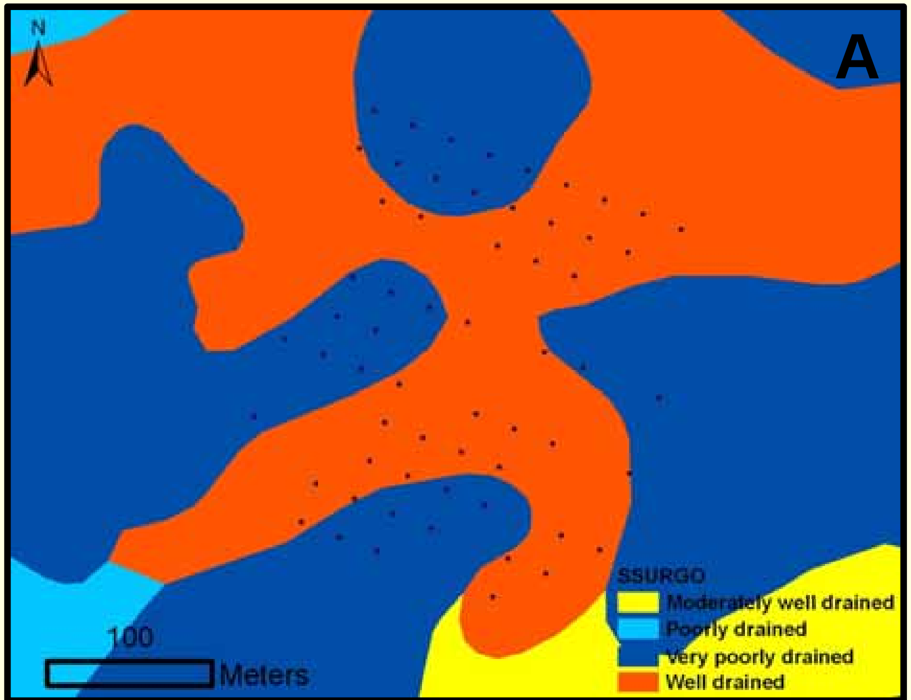


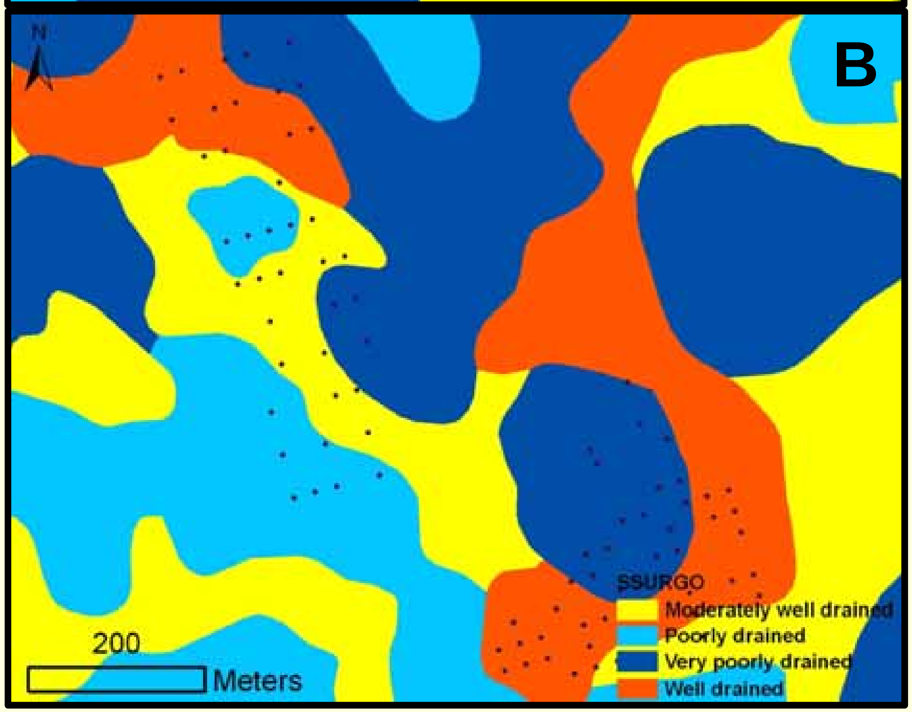
Gridded and randomly selected sampling points are indicated as dots.

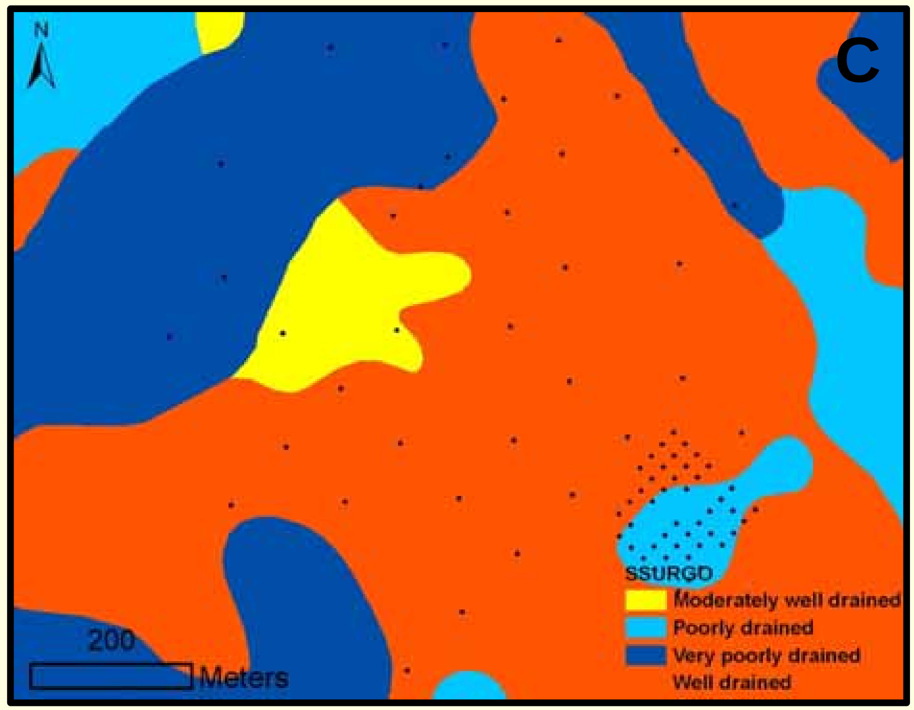


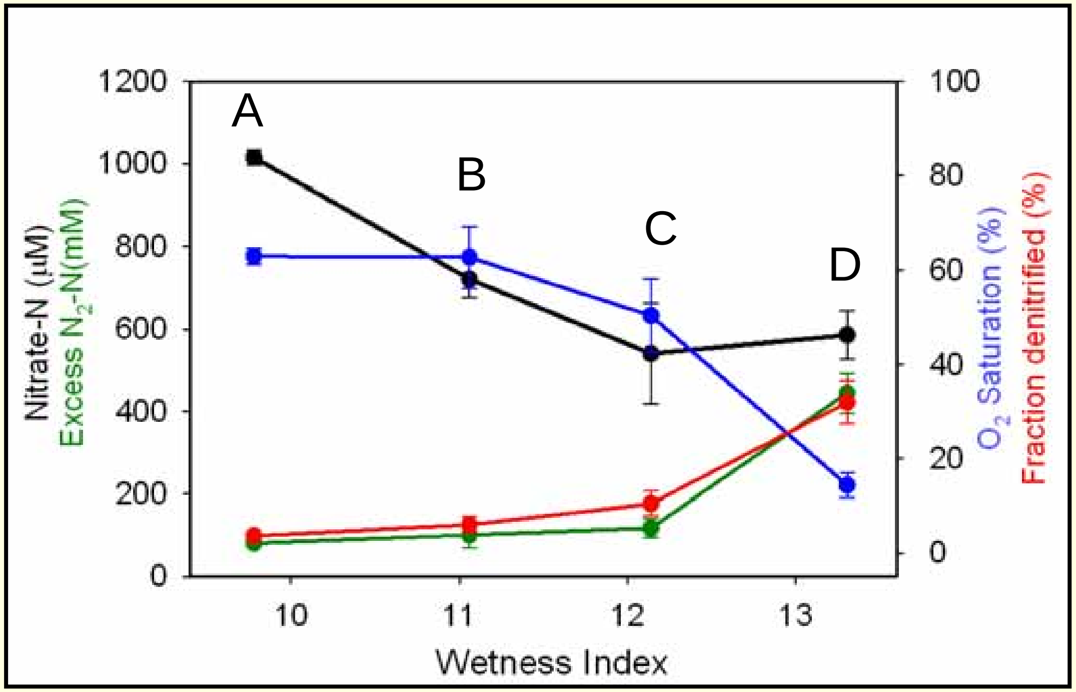


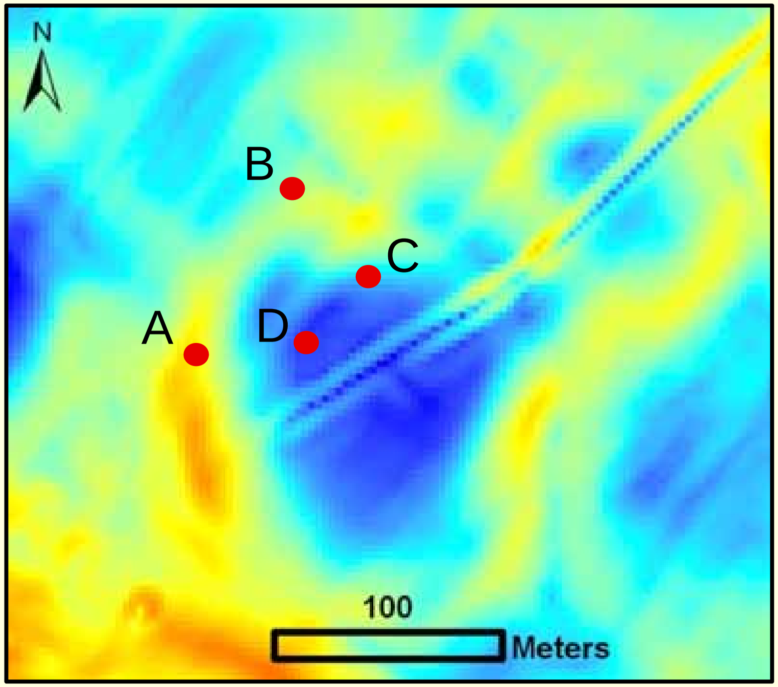
SSURGO Drainage Classes











- Water quality related to TWI
  - Lower TWI: higher nitrate, less denitrification, more static
  - Higher TWI: lower nitrate, greater denitrification, more dynamic
- Can TWIs summarize pollutant reduction services at the landscape scale?

Summary

- LiDAR based Topographic metrics map potential wetness based on topographic position.
- This information can be used to map current and historic wetlands.
  - Improve the current wetland mapping process through decreased production time and increased accuracy
  - Assess effects of human impacts
  - Improve targeting of wetland restoration
  - Map the provision of ecosystem services

Thank you!

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For further information about this project or USDA CEAP-Wetlands please contact Megan at mwlang@fs.fed.us.

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