Integrating historical land cover and land management in Michigan's Kalamazoo Watershed: a story of carbon flux impact

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Project background and study area

Landowners make thousands of uncoordinated land use decisions that collectively and critically impact the landscape. This activity has a significantly higher influence over carbon flux and storage than that of climate change. Various ecosystems within a landscape, each with their own unique carbon production levels, are heavily influenced by these land management strategies. How does this activity, in combination with physical processes, collectively impact carbon flux—a major driver of climate change?

Research goal and objective

The goal of this research is to quantify historical carbon flux in southwest Michigan's Kalamazoo Watershed in units of CO_2^{eq}. We will isolate landowner properties, collect in-depth biophysical and socioeconomic data, and combine results in a production life cycle assessment.

Study population: our storytellers

Within the study area, we assume that farmers can be storytellers. Any land use, management practices, and historical recollections of change in policy, landscape or other perspectives are useful resources in telling the history of the study area. Michigan Centennial Farmers, landowners with >=10 acres of operating farmland, offer 100+ yrs of this local knowledge.

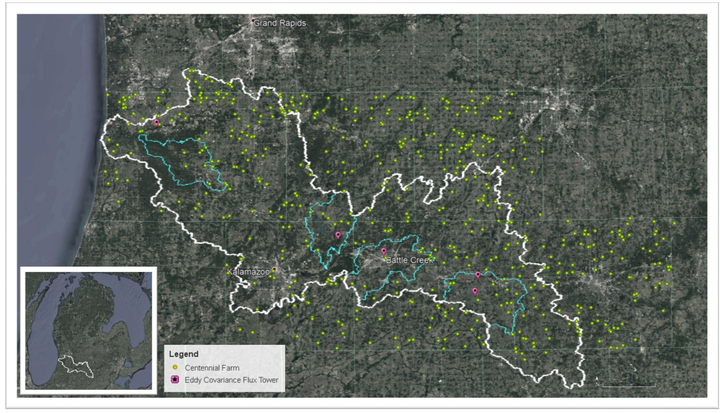
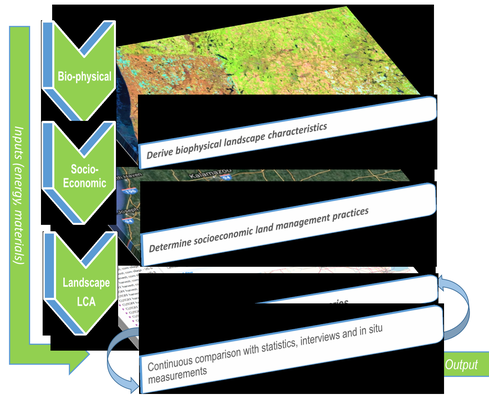


Figure 1. Study area: Kalamazoo Watershed is a 5,261 km^2 HUC8 –level watershed located in southwest Michigan.

How to tell the story: research framework



Data collection and integration

Biophysical
- eCognition™, DigitalGlobe (Quickbird-2, GeoEye-1 and IKONOS-2)
- 12 Eddy covariance flux towers, *in situ* biometric measurements

Socioeconomic
- Mail survey and interview Centennial Farmers
- MAEAP, NASS, MDARD, Michigan Forest Stewardship Plan Boundaries

LCA integration
- OpenLCA Software
- GIS base maps (e.g., Figs. 3-7)

Landscape scale CO_2^{eq} of the Kalamazoo Watershed

Figure 2. Research conceptual framework. A combination of both biophysical and socioeconomic variables will be combined into a GIS-compatible Life Cycle Assessment software to determine landscape scale CO_2^{eq} of the Kalamazoo Watershed

Preliminary work: exploring the study area

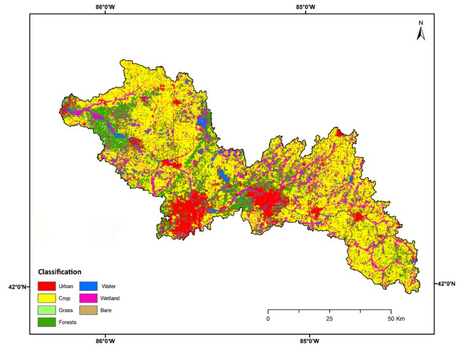


Figure 3. Land cover classification of seven land types: urban, crop, grass, forest, water, wetland, and bare land. Data source: NLCD 2011.

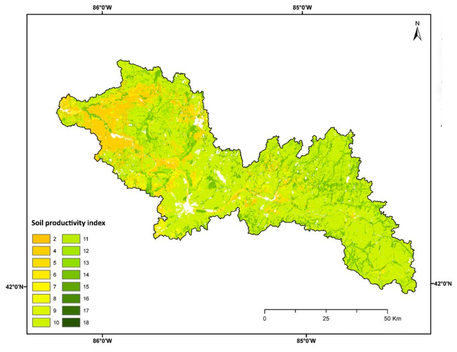


Figure 4. Soil productivity index ranks all soils on natural, inherent productivity, from 1-16 (higher numbers = more fertile) (Schaetzel 2012).

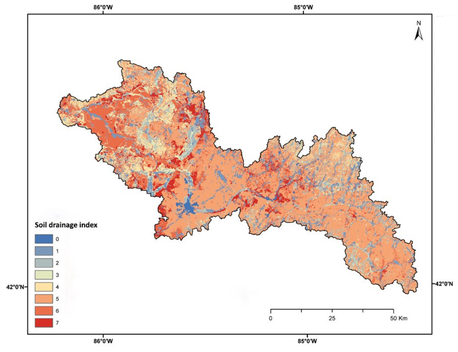


Figure 5. Soil drainage re-classed with poorly drained soils represented by lower numbers, while higher numbers represent well drained soils (Schaetzel 2009).

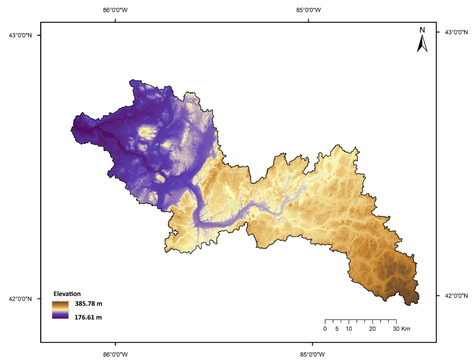


Figure 6. Elevation index ranks from USGS National Elevation Dataset 1/3 arcsec [10 m].

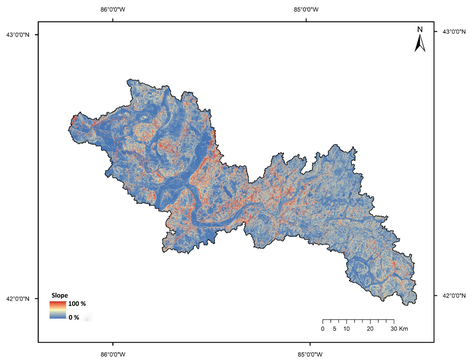


Figure 7. Slope metrics in percentage USGS National Elevation Dataset 1/3 arcsec [10 m].

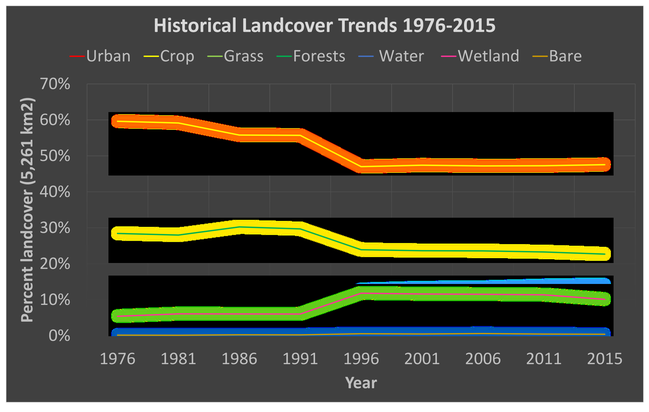


Figure 8. Land cover change 1976-2015 in the Kalamazoo watershed: urban, crop, grass, forest, water, wetland, and bare land (Landsat8).

Land cover 1976	
Urban	3.54%
Crop	59.61%
Grass	0.38%
Forests	28.41%
Water	2.50%
Wetland	5.41%
Bare	0.15%

Land cover 2015	
Urban	14.18%
Crop	47.55%
Grass	1.24%
Forests	22.67%
Water	3.87%
Wetland	10.09%
Bare	0.41%

Expected Results

(1) Michigan Centennial Farmers will own land that is representative of the Kalamazoo watershed's composition of various landscapes.

We assume the surrounding 10 acres of Michigan Centennial Farmers have multiple landscapes (e.g., wetlands, forest, agriculture) that represent the percentages of land cover in the watershed.

(2) Landowners collectively have a large impact on ecosystem carbon production.

We hypothesize that survey results with Michigan Centennial Farmers will indicate their belief that they individually impact the landscape scale carbon production in the watershed. However, our collection of land management records and remote sensing imagery will indicate otherwise.

(3) Michigan Centennial Farmers collectively own significant amounts of marginal land that impact carbon flux.

Remote sensing of marginal lands (e.g., land that is not capable of agricultural production) and self-reported acreage by Michigan Centennial Farmers will amount to significant land cover in the Kalamazoo watershed.

Acknowledgements

- Center for Global Change and Earth Observations
- Kellogg Experimental Forest
- Blight Farms
- Allegan Conservation District
- Michigan Centennial Farmer Association
- Battle Creek Math + Science Center

Literature

1. Schaetzl, R. J., Krist, F. J., Stanley, K., & Hupy, C. M. (2009). The natural soil drainage index: an ordinal estimate of long-term soil wetness. *Physical Geography, 30*(5), 383-409.
2. Schaetzl, R. J., Krist Jr, F. J., & Miller, B. A. (2012). A taxonomically based ordinal estimate of soil productivity for landscape-scale analyses. *Soil Science*, *177*(4), 288-299.