Geospatial and LiDAR-based analysis of 18th to early 20th century timber harvesting and charcoal production in southern New England

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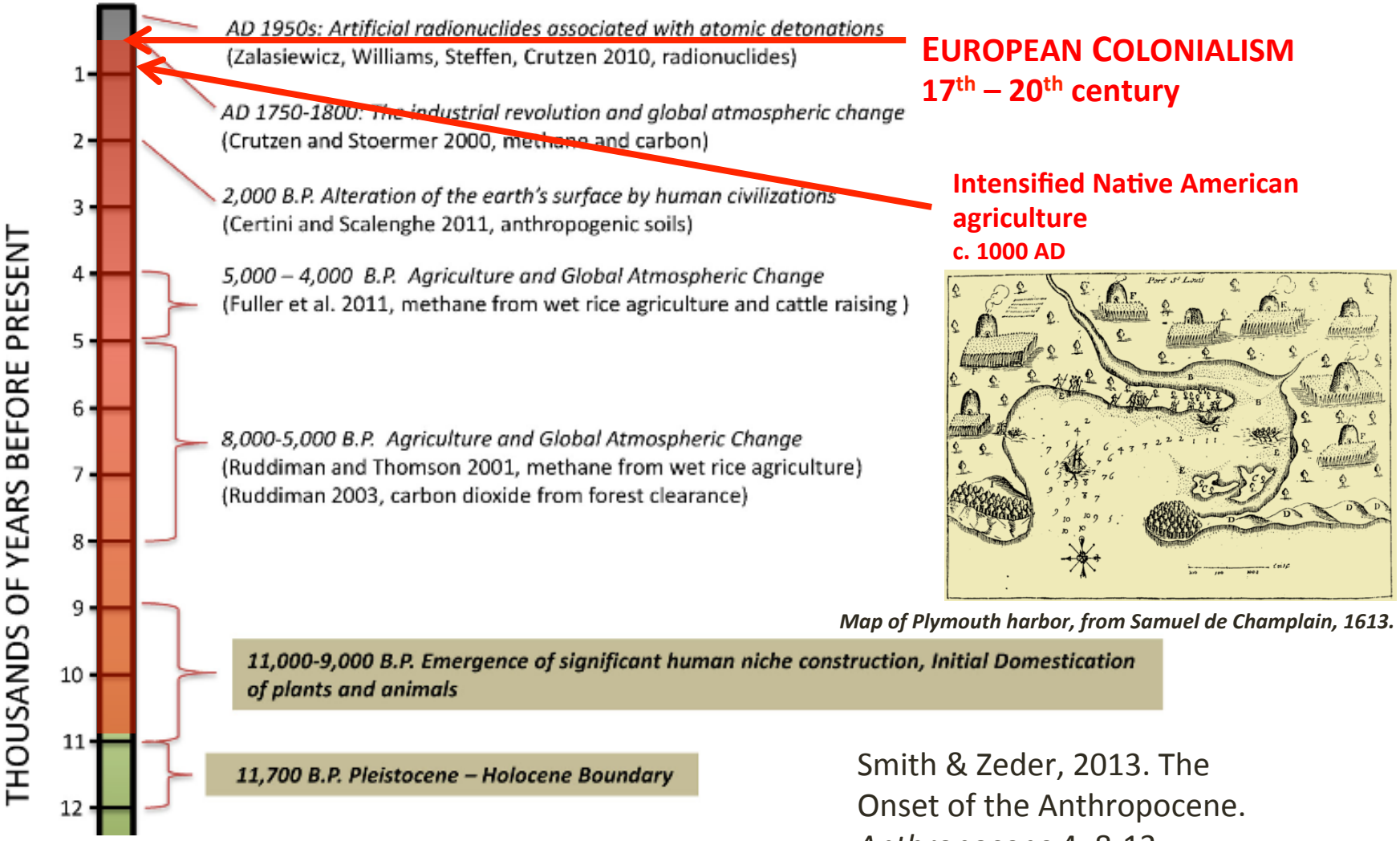
UNIVERSITY OF CONNECTICUT 1881

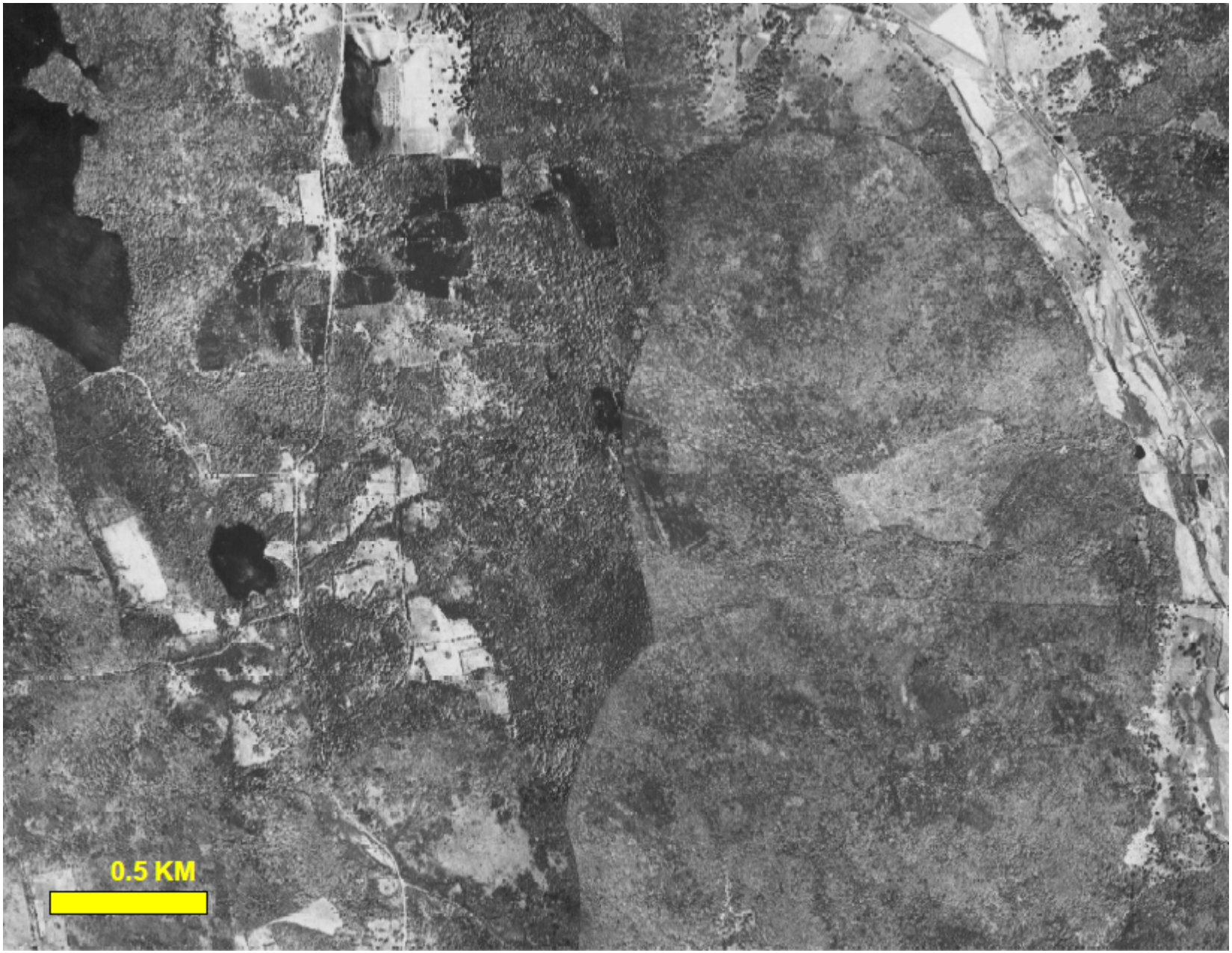
HUMAN IMPACTS ON THE LANDSCAPE

Humans are geomorphic agents, but have a dialectical relationship with the physical landscape.



Map of Plymouth harbor, from Samuel de Champlain, 1613.

Smith & Zeder, 2013. The Onset of the Anthropocene. *Anthropocene* 4: 8-13.



Goshen, CT

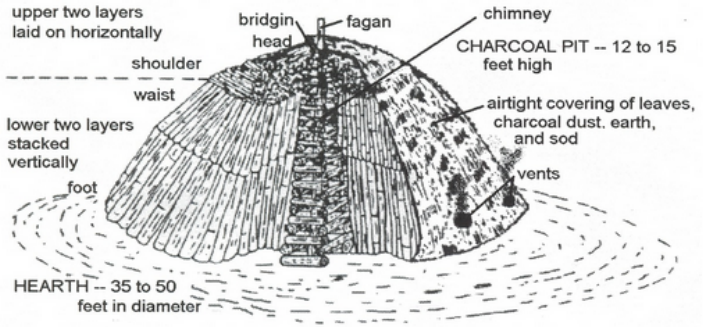
Charcoal platforms
Building foundations
Stone walls
Gullies

Background

- Charcoal burning platforms / hearths / pits/*meilers* (circular platforms referred to as “kilns” in Europe)
- Collier selected suitable site, graded it, stacked logs up to 20 feet high, fired near “lower side”, could be long or round. Might produce up to 6,000 bushels of charcoal. *
- Charcoal produced locally on smaller scales for subsistence and local economic trade/sale.
- Larger operations in areas where iron ore was discovered to fuel furnaces.
- Replaced slowly in second half of 19th century by metal kilns and increasing availability of anthracite coal. Put colliers out of business & decreased local demand for “backwoods” charcoal. *^

* *Journal of the United States Association of Charcoal Iron Workers 6(1). February 1885.*

^ Barger, Lucas C. 2013. *Life on a Rocky Farm: Rural Life Near NYC in the Late 19th Century*.

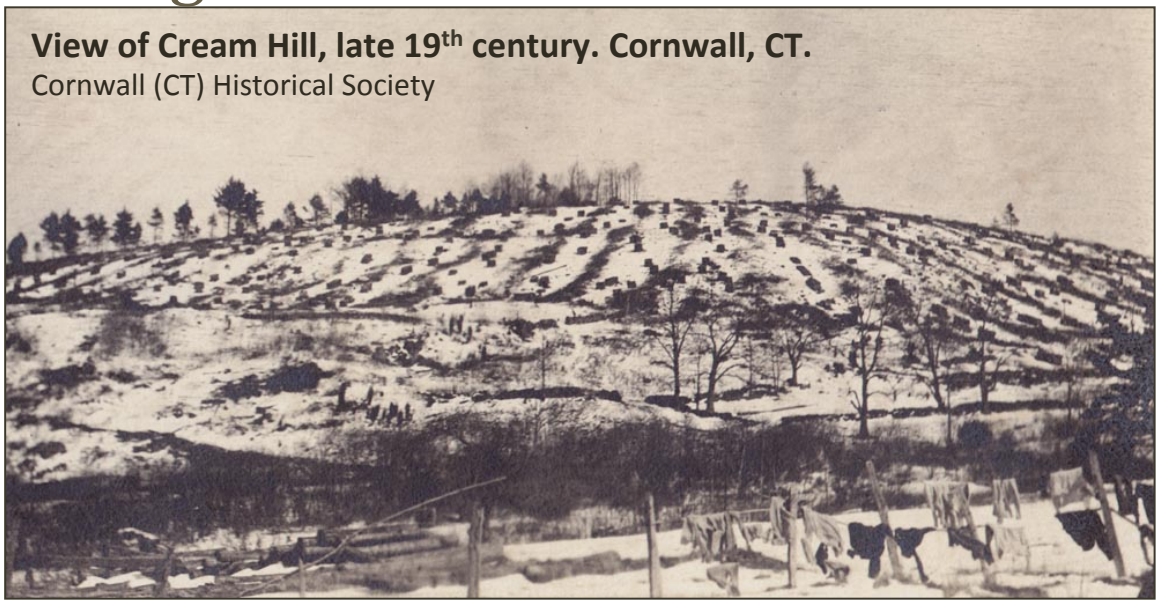


Chester County Parks & Recreation Iron Heritage

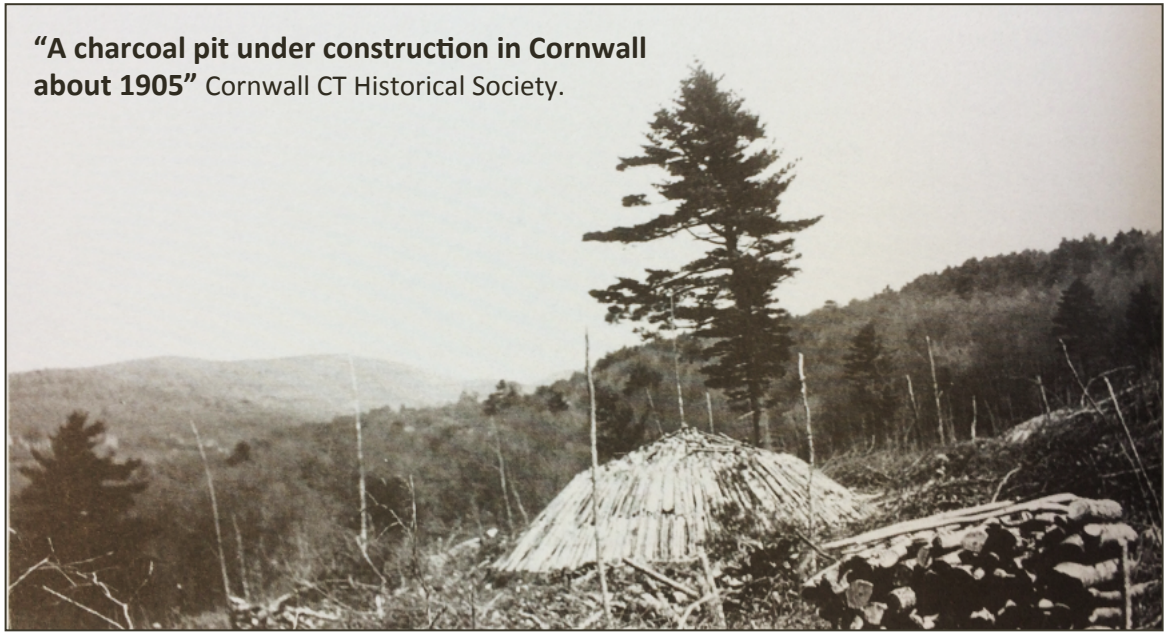
Connecticut Historical Society 1980.24.5

Connecticut Historical Society 1980.24.4

Background



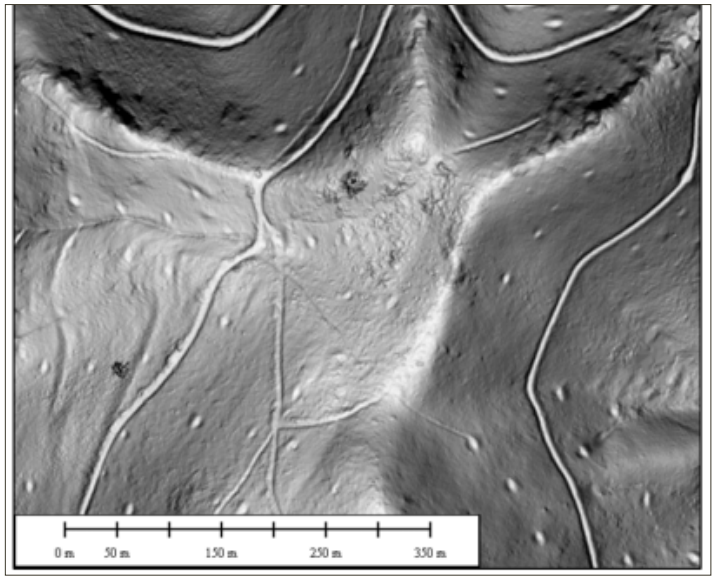
View of Cream Hill, late 19th century. Cornwall, CT.
Cornwall (CT) Historical Society



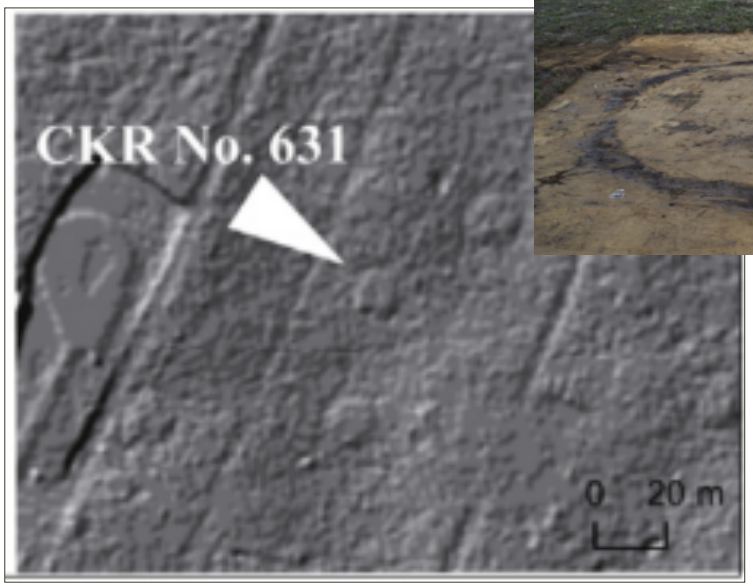
"A charcoal pit under construction in Cornwall about 1905" Cornwall CT Historical Society.

- Preferences for size, quality, and type of wood to make better quality charcoal.
- Forest stands cut every 20-40 years when trees were smaller.
- Estimated 600 acres harvested annually to fuel **one** typical furnace. Over 20 year time period, 20 lots of 600 acres each; **12,000 acres** in rotation (Straka 2014)
- On steeper slopes that might not have been used or preferred for tillage but instead for wood lots or pasture.

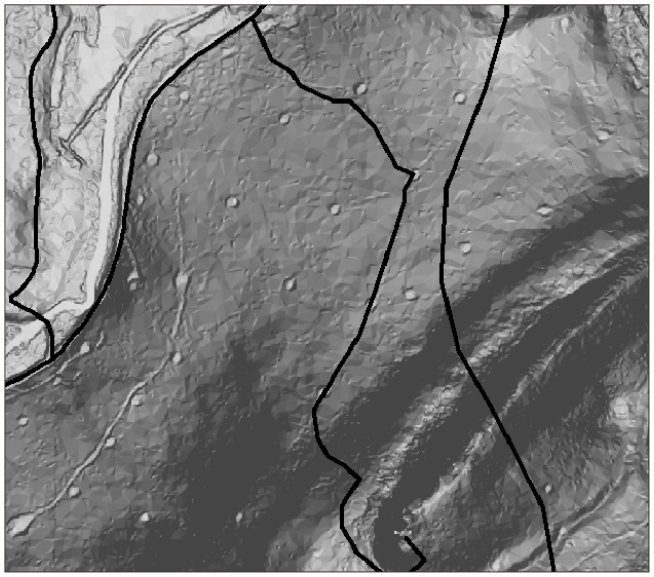
Found internationally



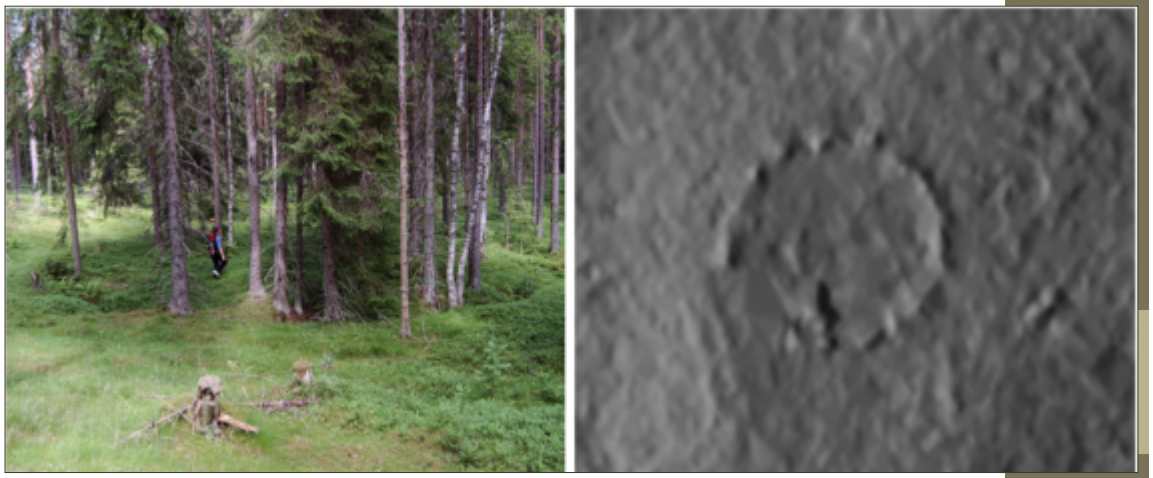
Hesse 2013, Germany



Raab et al. 2014, Germany

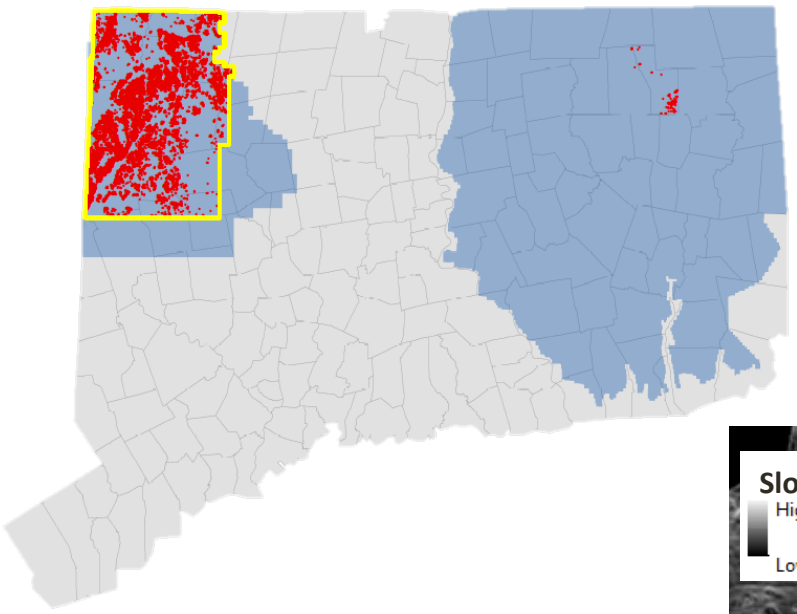


Potter et al. 2013, Pennsylvania



Risbol et al. 2013, Norway

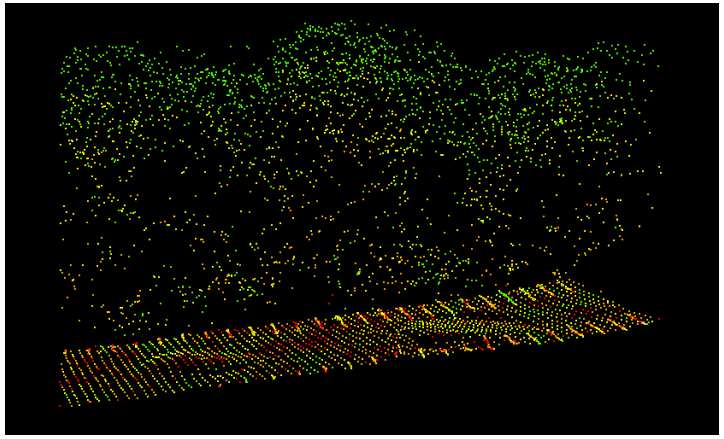
Dataset & Study Area

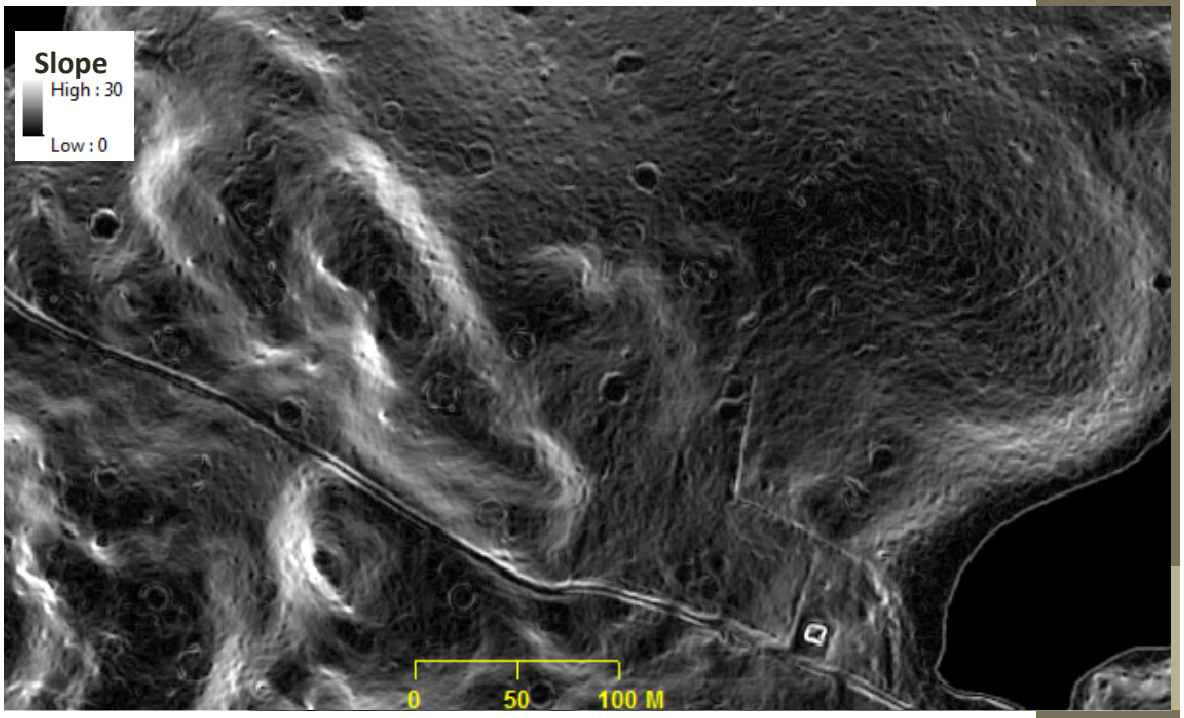


Study area: 1,170 km ^{2}

Charcoal burning platforms (n = 20,432)

LiDAR extents (NE & NW USDA datasets, 2010 & 2011 – avg. point spacing 2/m ^{2})



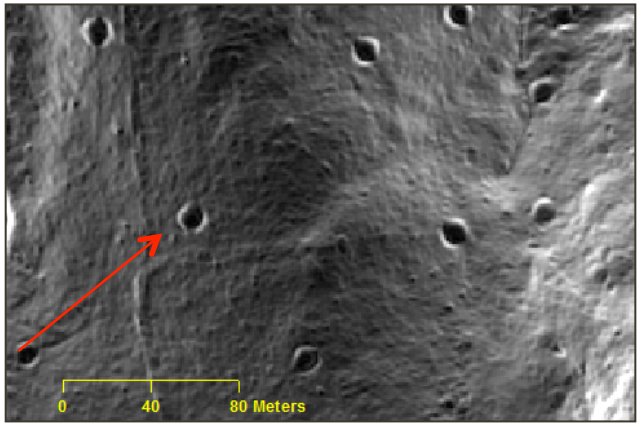


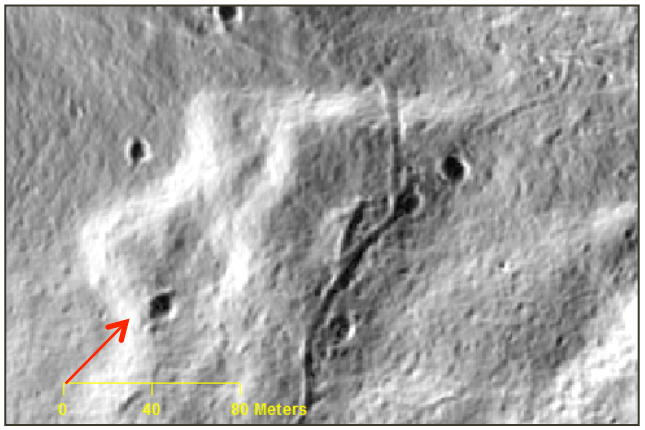
Variation in size and construction technique

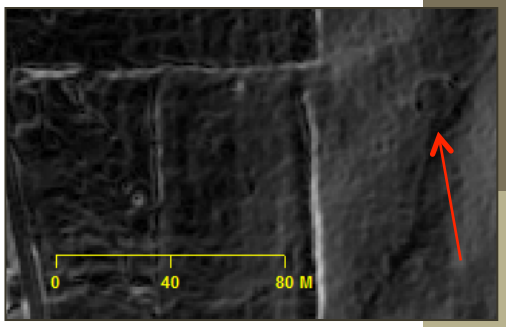
- Some built into slopes, and/or re-enforced by stones
- Others subtle topographic relief, rings with raised centers
- Variation based on collier preference, time period?

Photo by Megan Hill

Photo by Will Ouimet

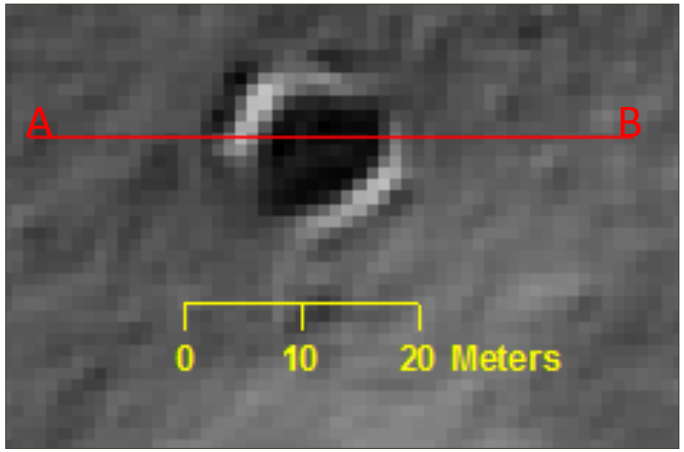






Slope
High : 30
Low : 0

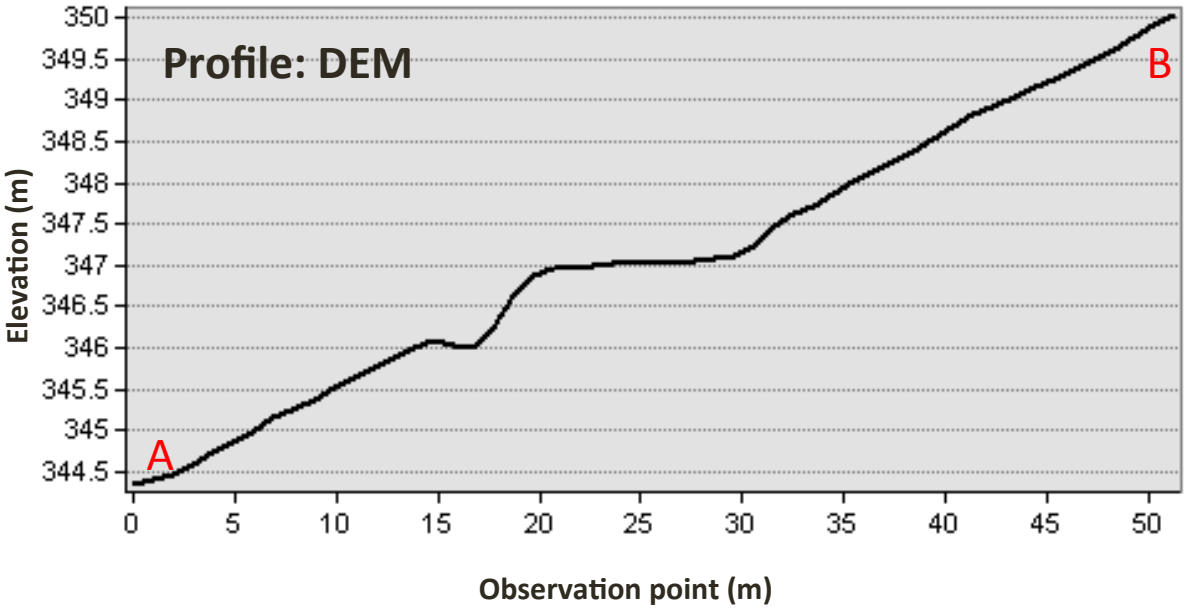
Morphology

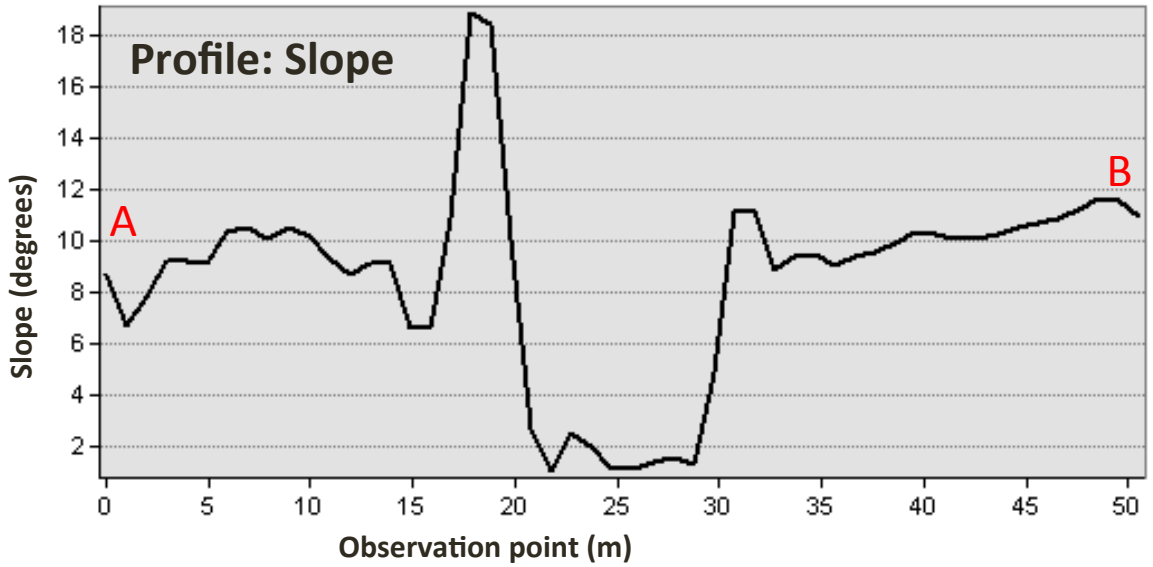


Slope

High : 30

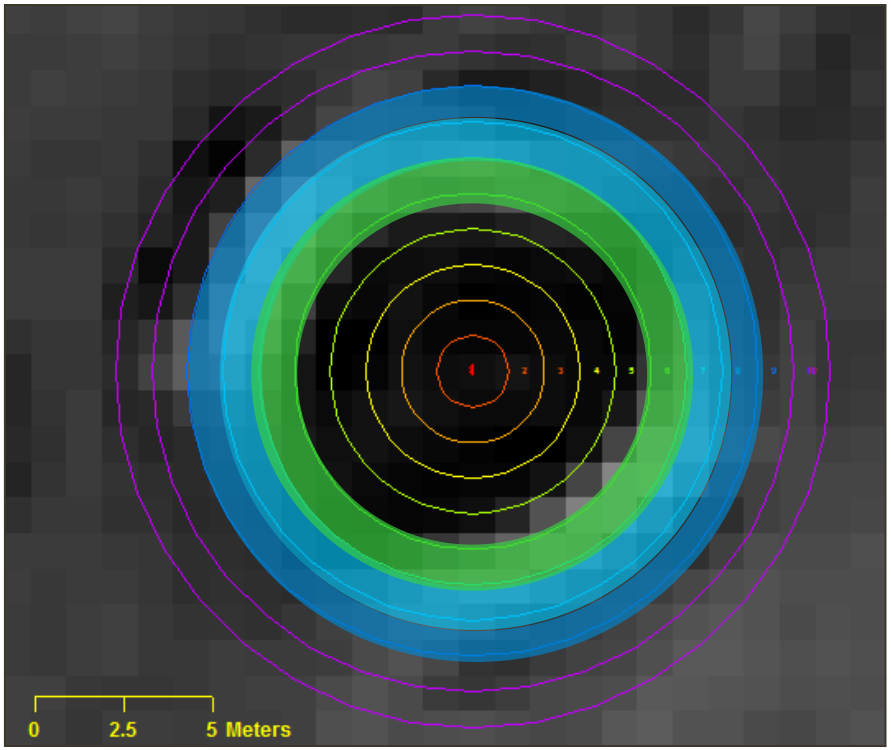
Low : 0





Morphology

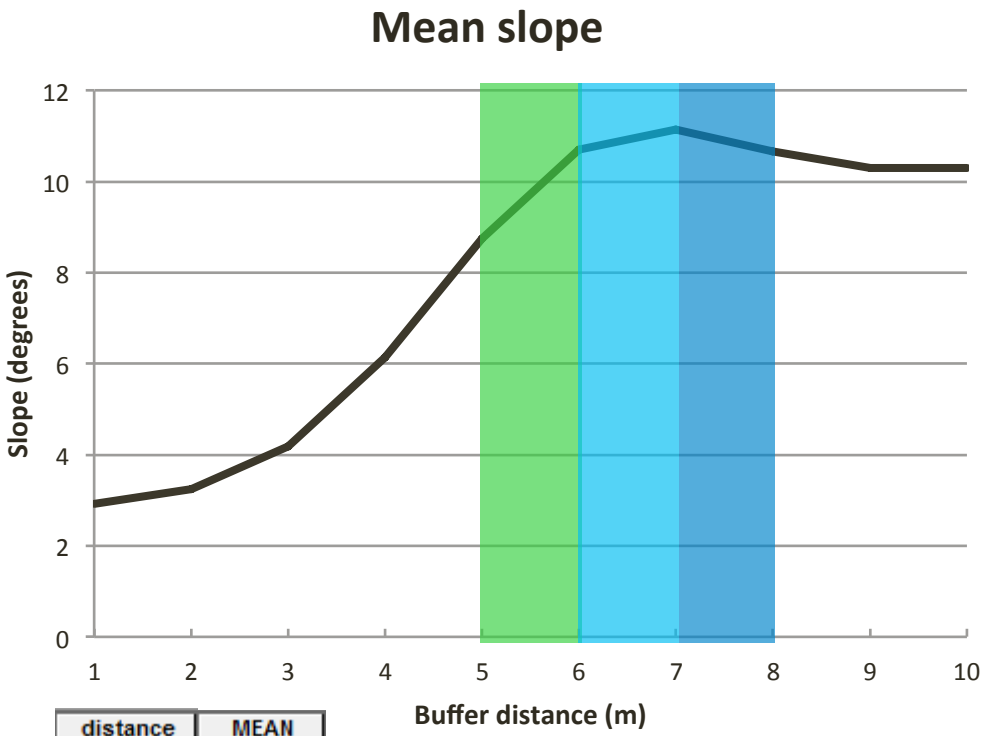
- Zonal statistical mean slope on sample of 6,017 CBPs in a highly clustered region of NW CT.
- Suggests full outer diameter of **16m** and inner diameter of **10m** for sample size in NW CT, but variation is likely.



Slope

High : 30

Low : 0



distance	MEAN
1	2.922605
2	3.236634
3	4.177025
4	6.131228
5	8.740123
6	10.709216
7	11.139383
8	10.663235
9	10.291844
10	10.297072

Morphology

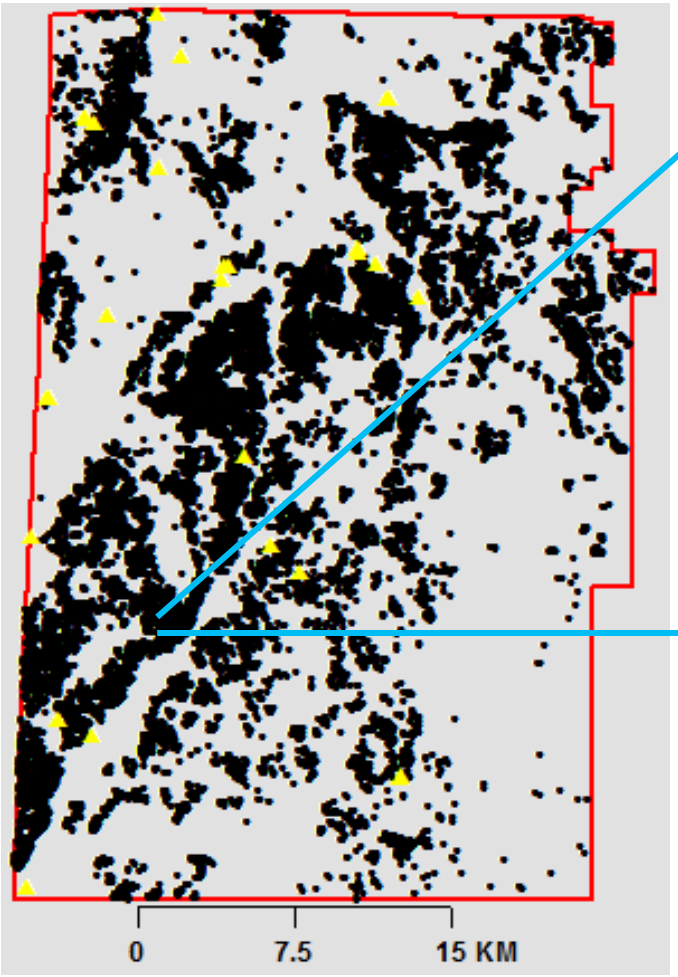
- Size varies across time and location
- Ranges seen in CT are similar to those for same time period in Europe

Source	Location	CBP Size	Time Period
Johnson, Ouimet & Raslan 2015	**NW CT**	**~ 10 - 16 m diameter**	**18th-20th century**
Hesse 2013 Nelle 2002	Southern Black Forest Germany	7-11 m diameter 4-12 m diameter (smaller on steeper slopes)	17th-20th century
Crutchley & Crow 2009	England	"up to 10m in diameter"	??
Risbol 2013	Norway	~ 20 m diameter	17th-19th century
Potter et al 2013	Pennsylvania	~ 15 m in diameter	18th-20th century
Raab et al 2014	Germany	2.6-28.5 m (9.9 avg)	17th-19th century (dendrochronology)

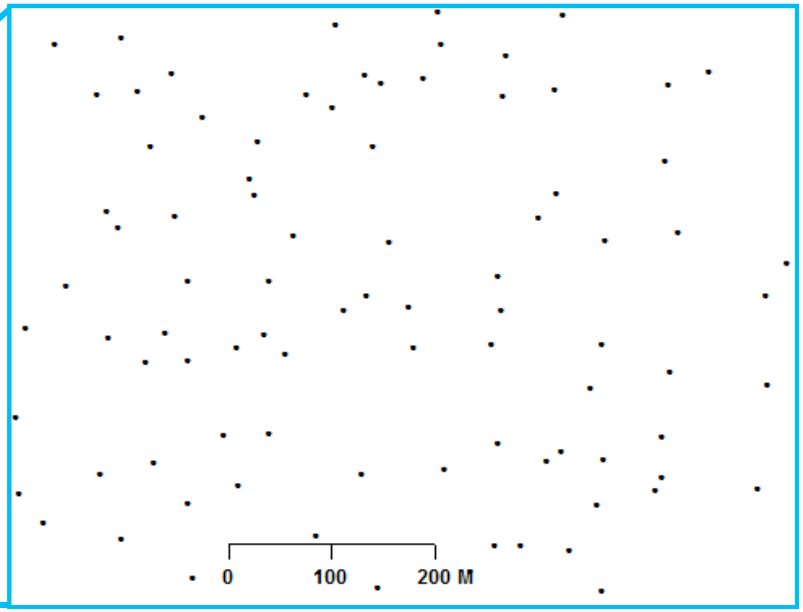
Spatial Distribution / Clustering

- At study-area scale, there are clear first-order trends
- Spatial distribution varies dependent on certain scale thresholds
- Dispersed/regular spacing over larger area, and clustering over smaller area could be result of human land use decisions.

NNR: 0.5283 (clustered)



NNR: 1.25 (dispersed)



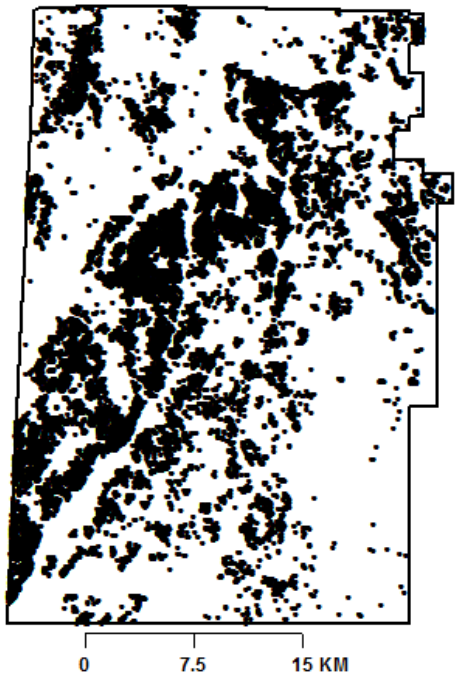
Future: Thiessen polygons to measure area for each platform.

Furnace/Ironworks c.1858 (n=36)

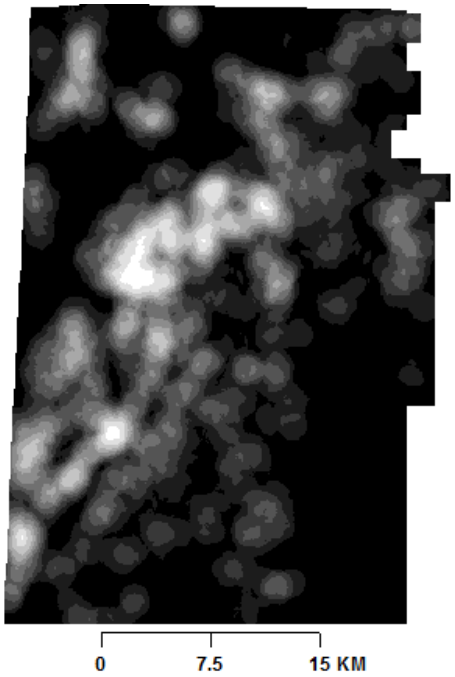
Charcoal burning platform (n=20,432)

Importance of elevation and slope on density

Distribution



Density (30m)

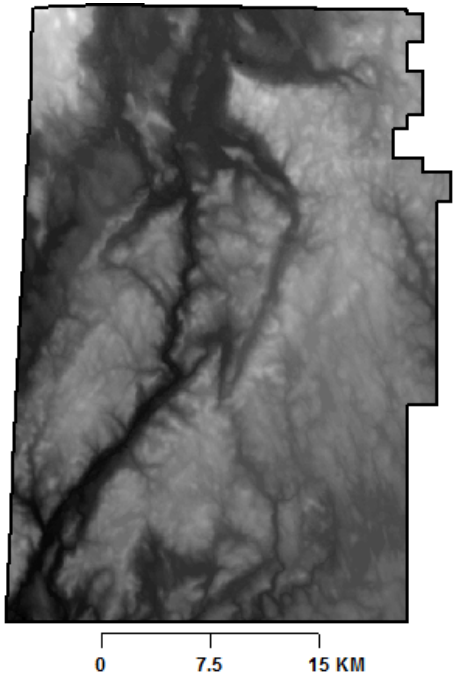


Per sq km

0 - 5.13
5.13 - 13.69
13.69 - 23.96
23.96 - 34.80
34.80 - 46.20
46.20 - 58.75
58.75 - 73.02
73.02 - 90.70
90.70 - 111.81
111.81 - 145.46

Mean: 16.90

Elevation – 30m SRTM

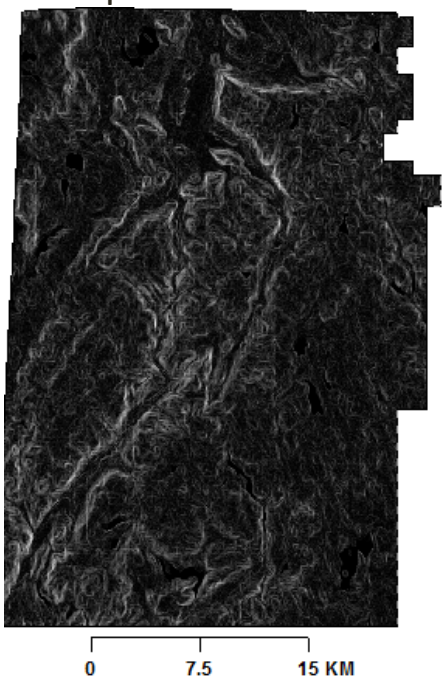


High : 720

Low : 87

Mean: 328.75 m

Slope – 30m SRTM



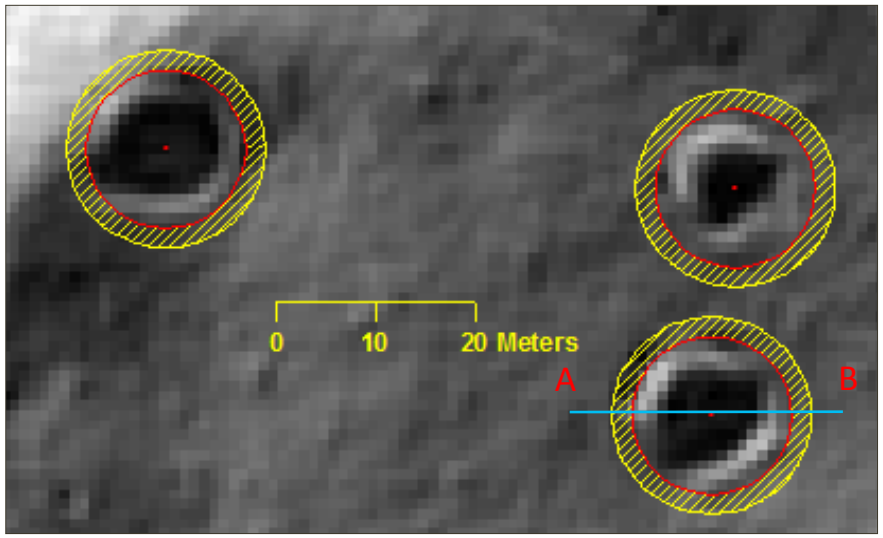
High : 53.5432

Low : 0

Mean: 7.67 deg

- Reveals intensity of charcoal production, deforestation, and land use preference/ decision making in specific areas.

Influence of local slope on platform construction

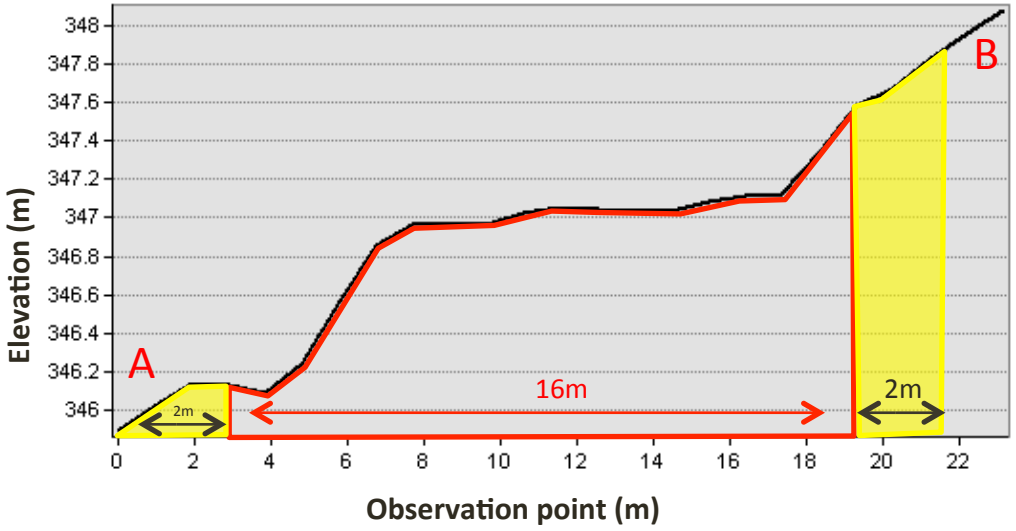


- Flat platform, can't extract slope to points.
- 2m buffer, 8m away from point center.
- Zonal statistics for buffer (113 1m pixels, avg.)
- **To get significant results, created 20,432 random points (same as original dataset)**
- **Ran 30 simulations (>95% CI)**

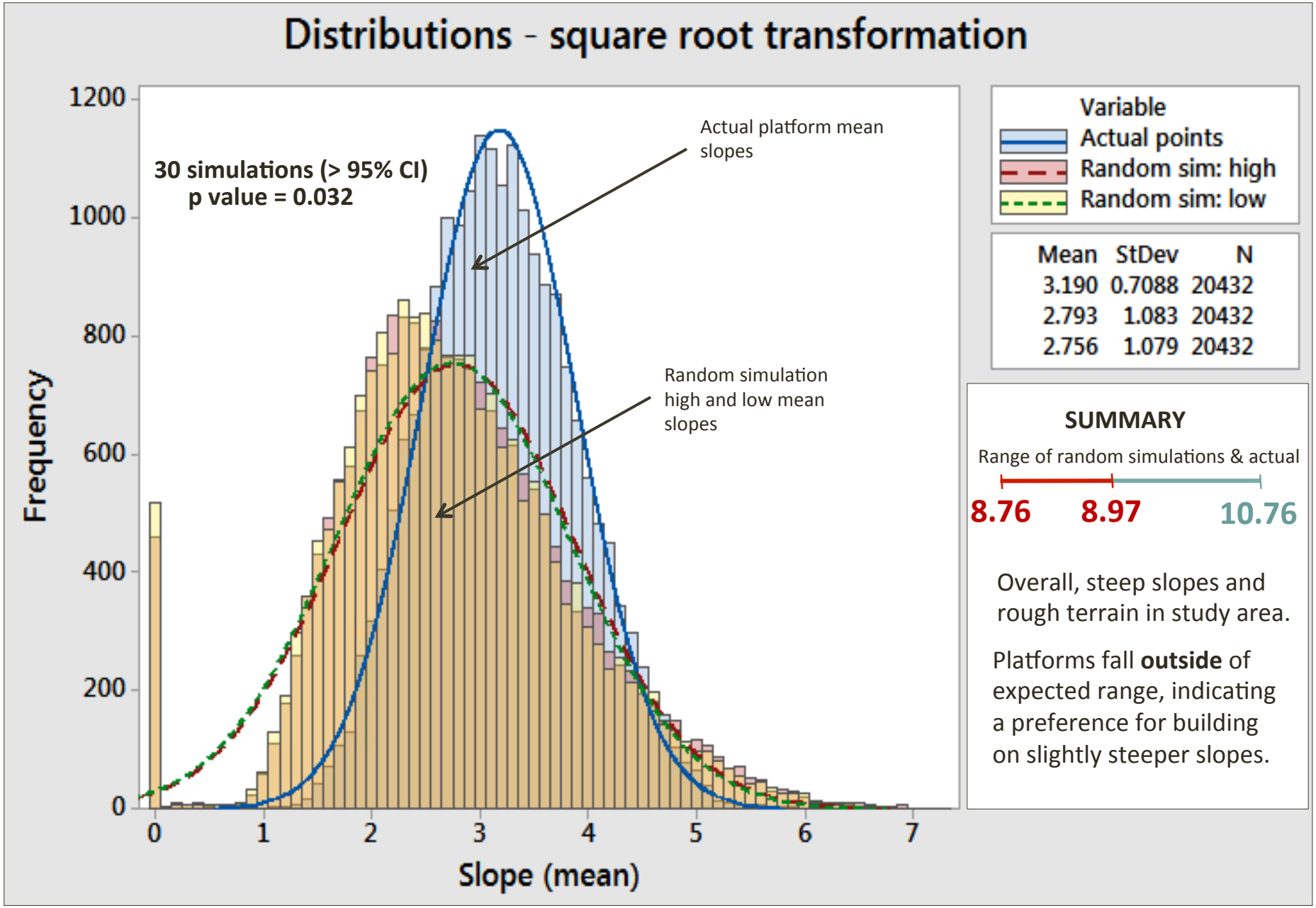
Slope (degrees)

High : 30

Low : 0

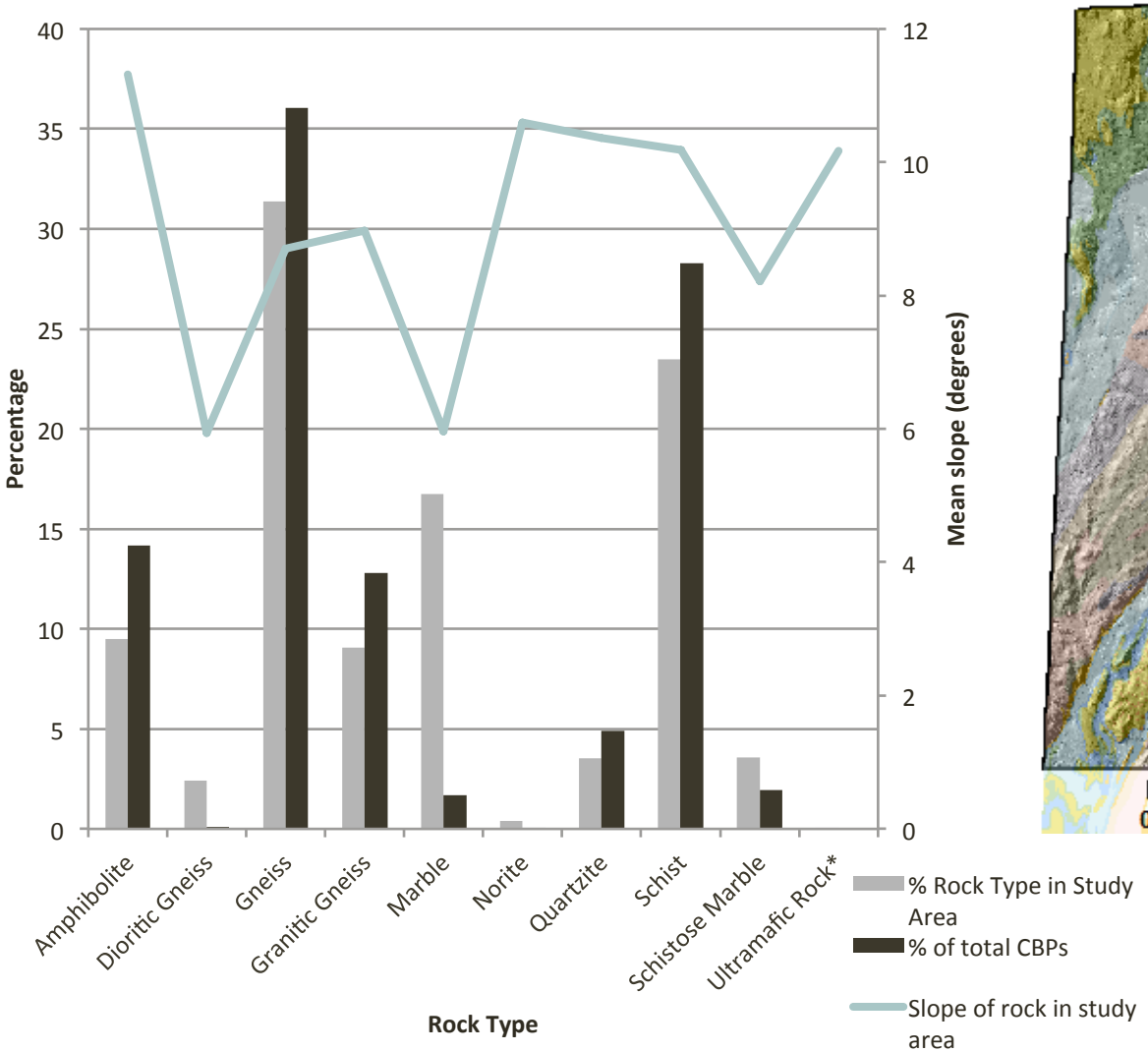


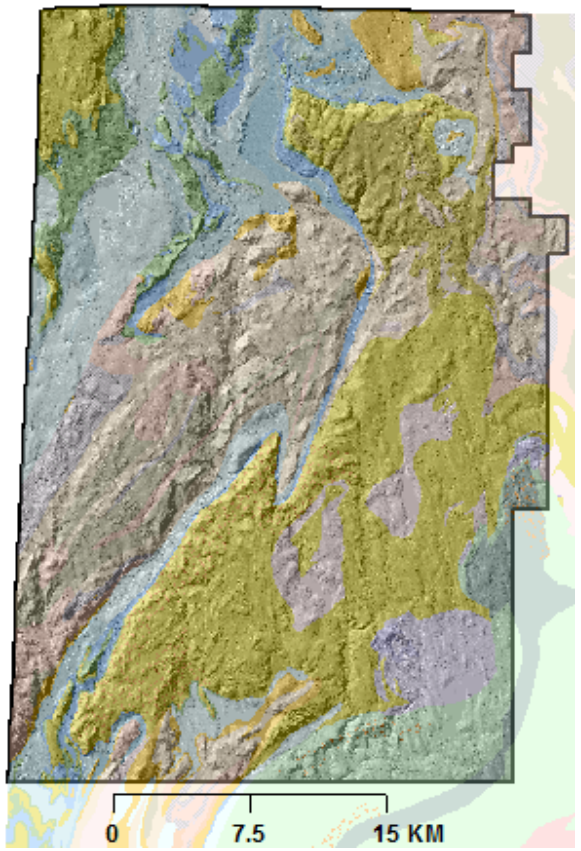
Influence of local slope on platform construction



Other variables – future research

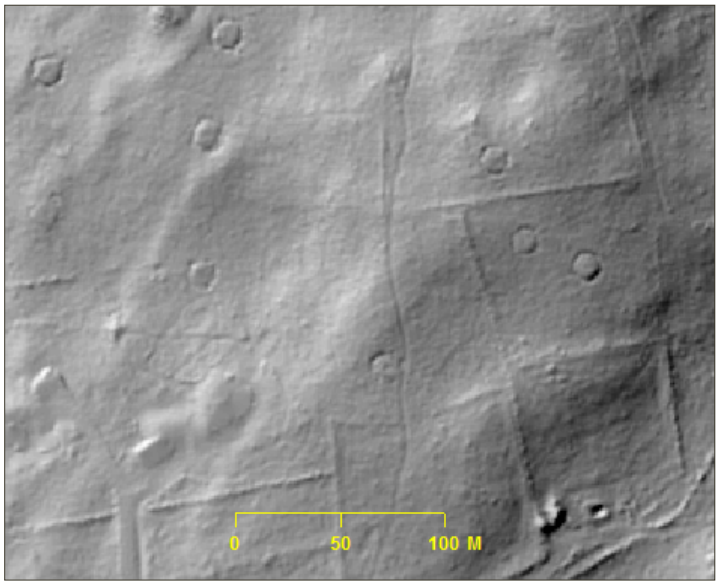
- Bedrock geology – preference for higher slope?

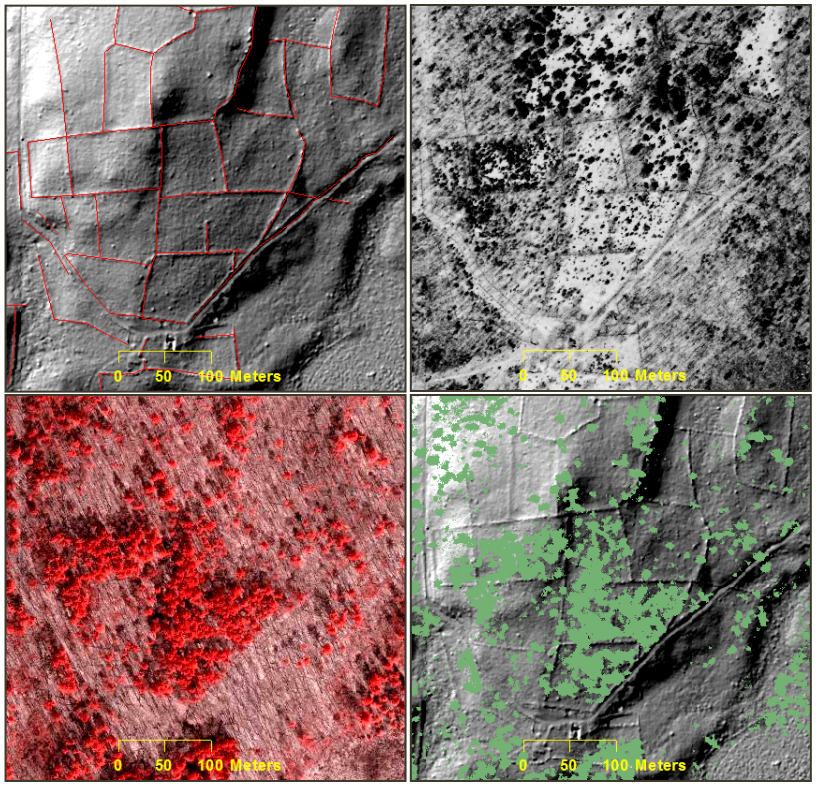




Other variables – future research

- Decision-making process of historic land use; relationship to stone walls and other types
- Extent of historic deforestation and land use patterns; relate to modern landscape
- Distance to iron works/furnaces
- Understand extent of land surface modifications in Anthropocene





Thank you! Questions?

Acknowledgements:

Zachary Raslan for digitizing the locations of charcoal platforms, **Amy Burnicki** at UConn Geography/ Engineering for assistance with statistical methods, **Noel Potter et al** for their work at 2013 NE GSA on PA charcoal industry/LiDAR, **USDA NRCS/CT ECO** for making the LiDAR datasets available

Funding:

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