Industrial Hemp Expansion in Kentucky: A land suitability analysis

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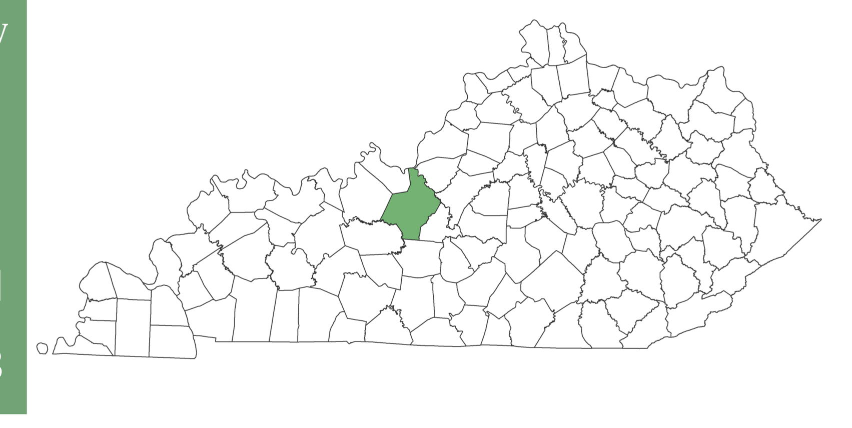
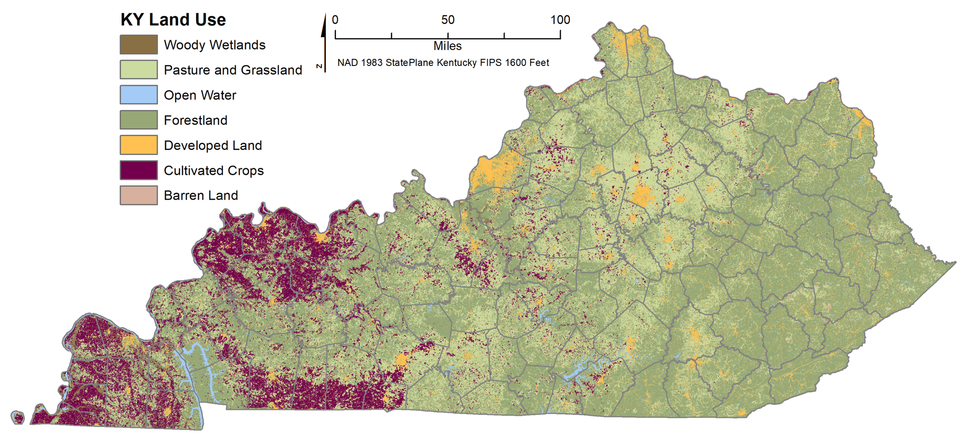


Introduction

Industrial hemp (*Cannabis sativa L.*) was legalized to be grown in the United States upon the passage of the 2018 Farm Bill.[1] Hemp is a crop that can grow in a variety of climates and conditions suitable for agriculture, and can be cultivated for its fiber, seed or as a dual-purpose crop (i.e. cover crop, biofuel).[2]



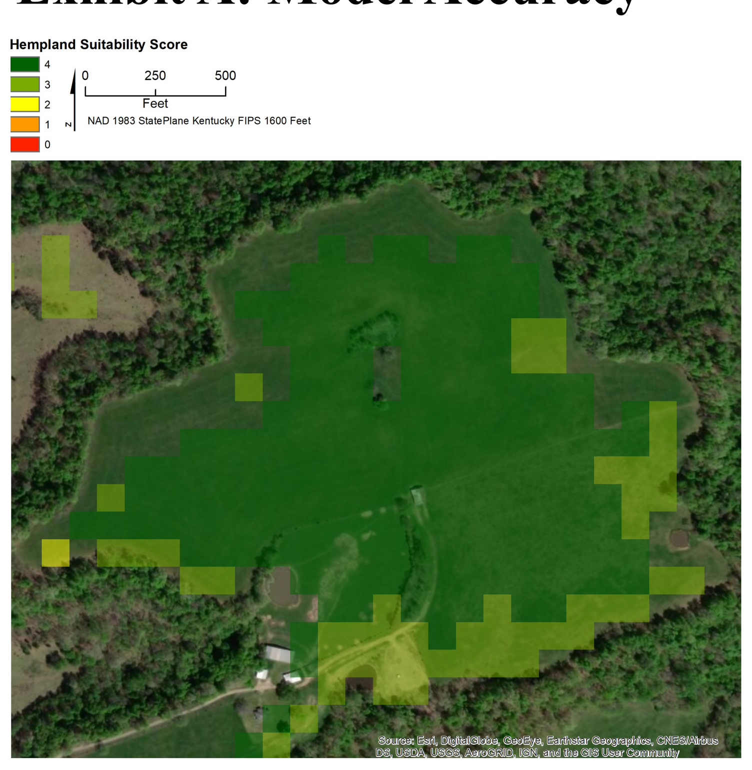
Since Kentucky was one of the states that paved the way for industrial hemp's legalization, I was interested in exploring the state's open, arable land to support industrial hemp expansion. I ran a preliminary state-wide suitability analysis using land use and land capability class data. I then used this analysis to assess which county appears to have the greatest potential for industrial hemp expansion according to my model. I zoomed into Harden County to examine the feasibility of my model against more granular parcel data.

Methodology

To create the hemp suitability score, I utilized the most recent land use data for Kentucky (2005) as well as the Land Capability Class data layer from the Natural Resources Conservation Service's National Cooperative Soil Survey from 2012. Both layers were reclassified to produce a score from 0-3, with 3 being the "best" condition and "0" being "out of the question." For land use, I ranked "grassland/herbaceous" as 3, "pasture/hay" and "shrub/scrub" as 2, "barren land" as 1 and everything else as 0.

The Land Capability Class (LCC) dataset distinguishes 8 classes of land suitability, I-IV considered for cultivation and V-VIII not deemed suitable for cultivation. A total of 20 soil attributes are considered to determine land class (see LCC I detailed below).[3] I reclassified this dataset by marking classes I-IV as 3, 2, 1, 0, respectively and "NoData" for classes V-VIII. While the LCC is useful to suggest the general suitability of land for agricultural use, it doesn't necessarily take into consideration the specific soil attributes required for hemp production.

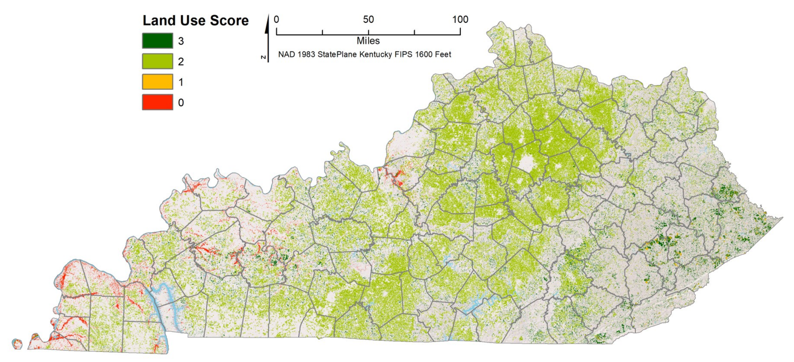
Exhibit A: Model Accuracy

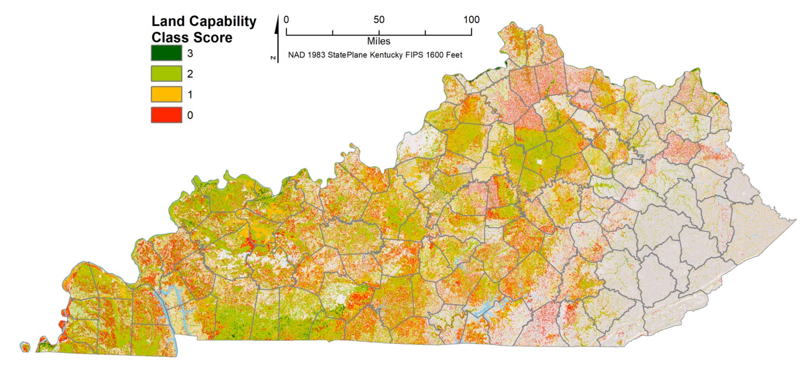


This image shows an example of the model's relative accuracy to suggest a plot of land for hemp production. Most of the plot was given a score of 4, "most suitable" and the edges along the forested area were reduced to a score of 3, "good."

Land in Capability Class I contains:

100 cm minimum depth to lithic or paralithic, favorable/easy to modify soil pH, loam soil texture, >22.5 cm available water capacity, moderately slow to moderately rapid water/air permeability, well or moderately well drainage class, 120 cm minimum depth of water table during growing season, no flooding, <2 mmhos/cmin upper 100 cm salinity, <2 sodicity, <0.1% stones/boulders on surface, <15% rock fragments on surface, <0.1% rock outcrop, >140 frost free days, >= 1,100 mm precipitation effectiveness, <135 cumulative dry days, maximum slope K factor of 2, none-slight erosion hazard.





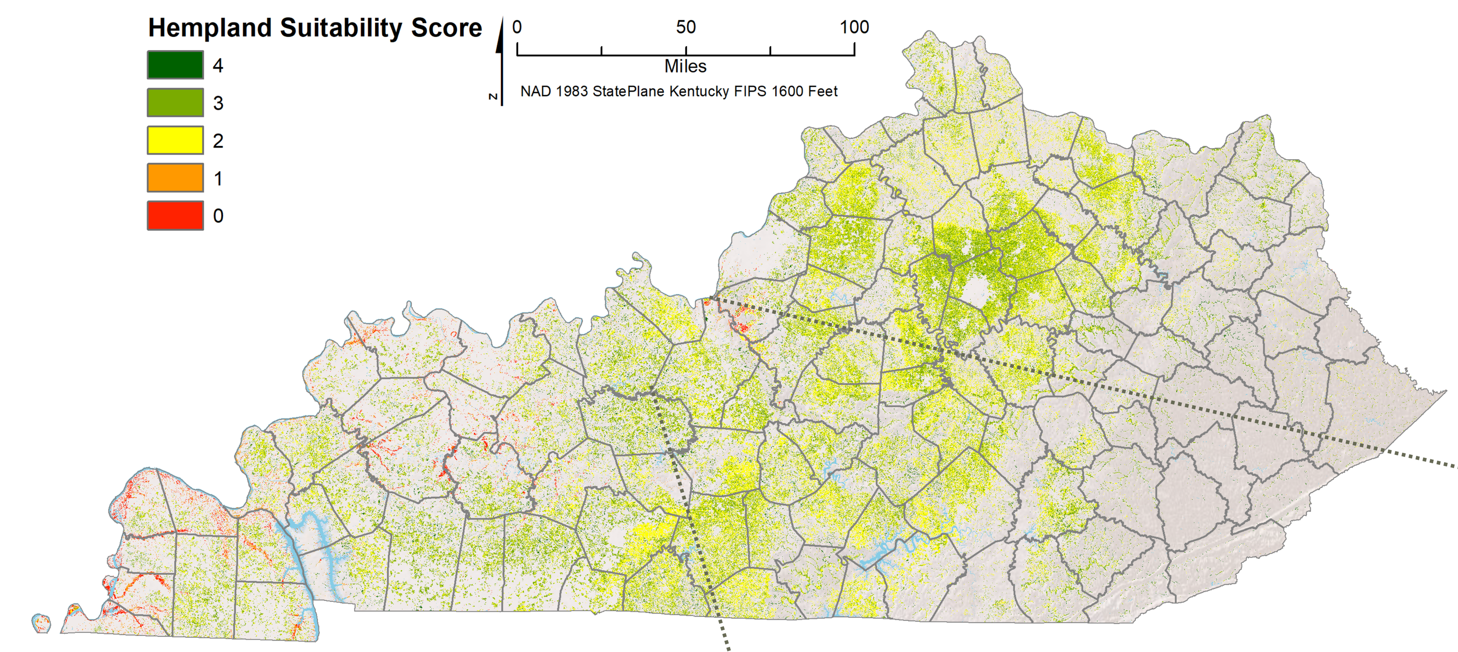


Exhibit B: Model Inaccuracy

This image shows an example where the model inaccurately scored land suitability. A score of 3, "good" was given to a section of a developed subdivision.

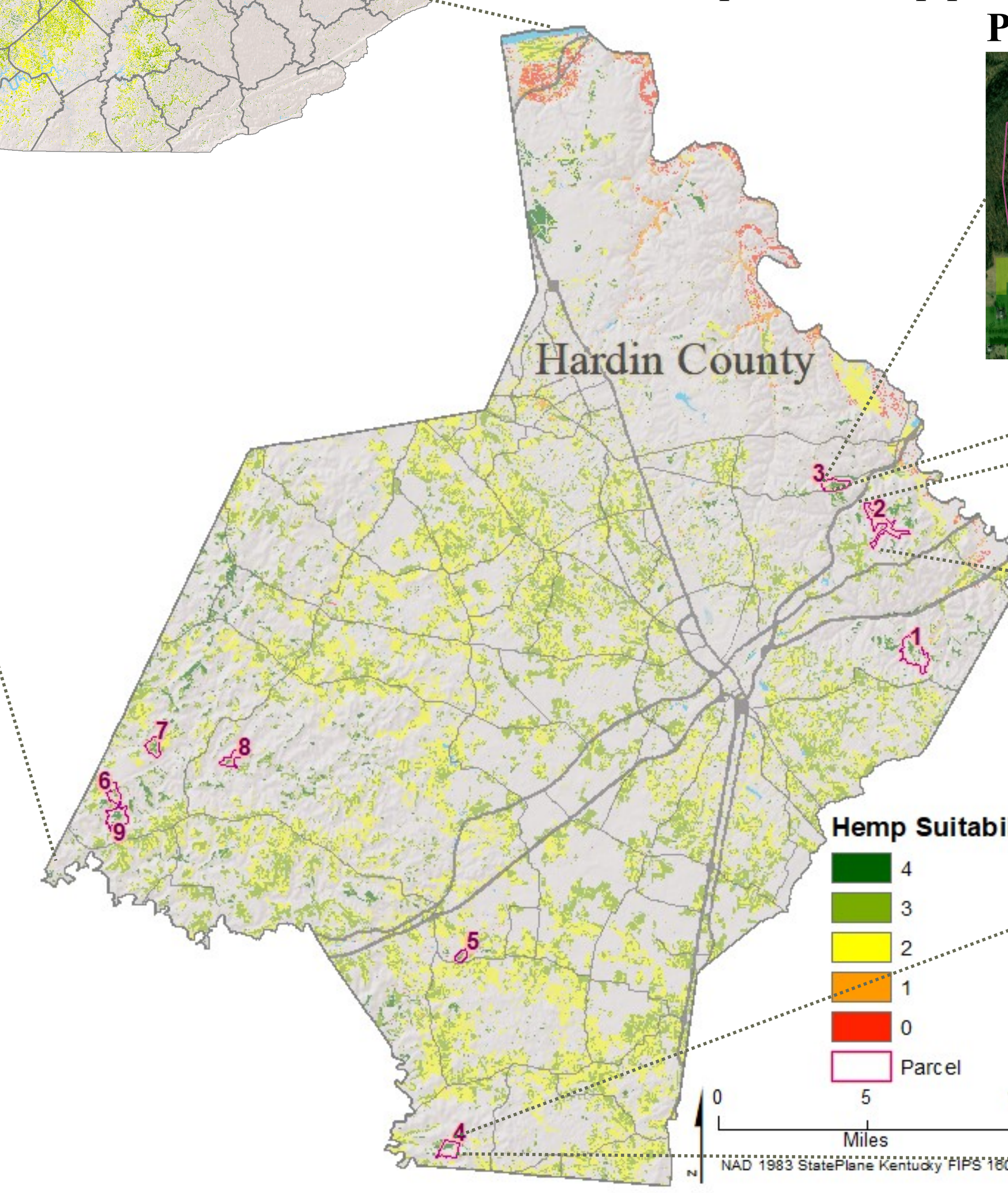
Statewide Results and Limitations

The output of the hemp suitability score model was a raster with 98x98 ft cells. From a broad level, it appeared to narrow the potential arable land in Kentucky: few areas were reported as "most suitable" and "out of the question," with more designated as "okay" and "good." However, upon closer analysis of particular land parcels, it appears that the model, in general, overpredicted the extent of suitable land. There appeared to be two key causes for this: one, since the model did not control for contiguous land parcels, high-scoring parcels were sometimes scattered or nested amongst a mass of low-scoring parcels. In reality, these would not be conducive to industrial-scale production and therefore not receive a high suitability score. Secondly, examining potential suitable areas atop satellite imagery revealed inconsistencies between the hemp suitability score and actual land use (see exhibit B). This could be due to the outdated land use data and/or a product of the large cell size. Additionally, the large cell size is likely contributing to other limitations in accurately portraying soil/land conditions. For instance, aspects such as clusters of rock fragments on land surface, small holes/mounds and detailed slope attributes.

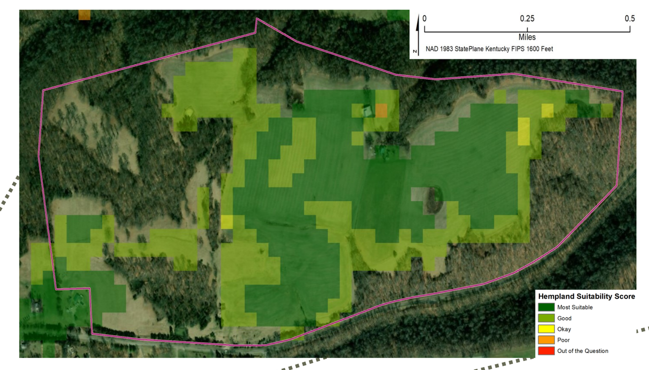
County-Level Application by Parcel

	0	1	2	3	4	Total Acres
Parcel 1			1	28	39	68
Parcel 2		1	0	3	**51**	55
Parcel 3		0	1	44	**50**	95
Parcel 4			0	15	**51**	65
Parcel 5			19	16	32	67
Parcel 6			18	21	22	62
Parcel 7	3	1	3	39	39	84
Parcel 8			0	21	34	56
Parcel 9			1	14	49	64

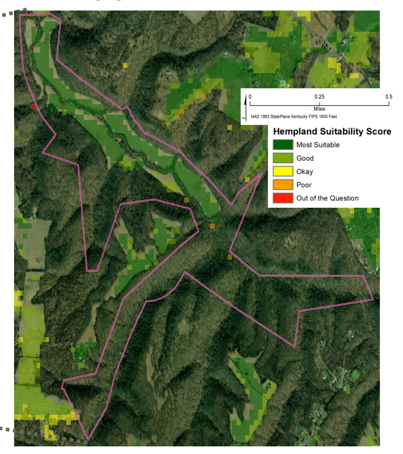
Parcel data from the county of Hardin was plotted to provide a specific and realistic application for the original model. Based on the 2006 data, only 43% of parcels contained land suitable for industrial hemp (36,860 acres). I decided to narrow this further by selecting parcels that were 50 acres or larger, to better distinguish land viable for industrial-scale production. 2% of the scored acres were 50 acres or larger and, of this selection, 9 parcels contained a majority score of 4 (calculated via the zonal statistics tool). The top 3 parcels were determined by those containing 50 or more acres given a score of 4, "most suitable." A future model could improve the top parcel selection by controlling for contiguous parcels with a score of 4.



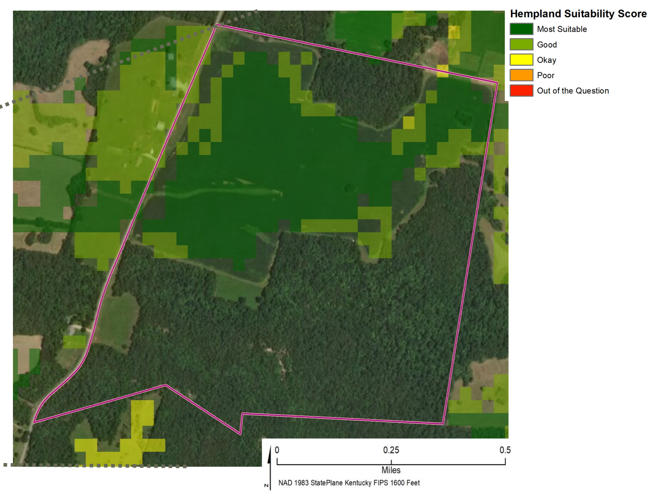
Parcel 3



Parcel 2



Parcel 4



Conclusions/Next Steps

This model showed moderately good ability to suggest potential areas to explore for industrial hemp expansion. It was useful in analyzing and narrowing down a vast amount of land to be considered, but more precise methods could be employed to better classify land quality and fitness to support industrial-scale production. Improvements would be made with updated land use data as well as a customized land/soil classification model based on the specific needs of hemp (for example, considering ideal precipitation, temperature, soil type and slope factors).

The model showed usefulness at the county-level when supported by parcel data, and could be utilized in the future to help suggest potential parcels to evaluate for a new industrial hemp operation.

References

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[2]Lin, T. (2005). Sustainable Development: Building a Case for Hemp. *Journal of Textile and Apparel, Technology and Management, 2005*(3), 4th ser.

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