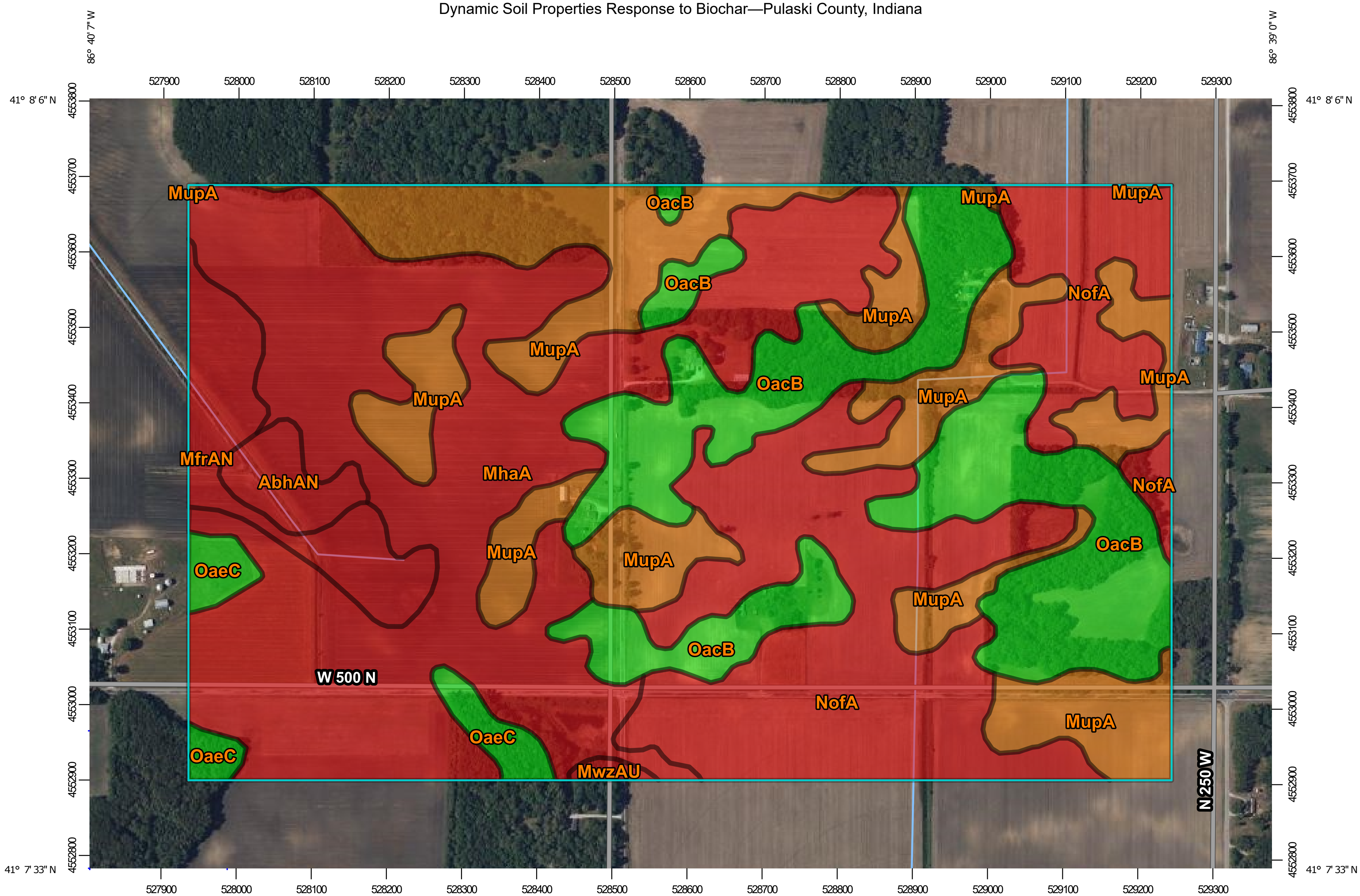
Dynamic Soil Properties Response to Biochar—Pulaski County, Indiana



Map Scale: 1:7,190 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 100 200 400 600

Feet: 0 300 600 1200 1800

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Unsuited
- Low response
- Fair response
- Good response
- Excellent response
- Not rated or not available

Soil Rating Lines

- Unsuited
- Low response
- Fair response
- Good response
- Excellent response
- Not rated or not available

Soil Rating Points

- Unsuited
- Low response
- Fair response
- Good response
- Excellent response
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Pulaski County, Indiana
Survey Area Data: Version 23, Sep 9, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 6, 2020—Jun 8, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Dynamic Soil Properties Response to Biochar

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
AbhAN	Adrian muck, drained, 0 to 1 percent slopes	Unsuited	Adrian, drained (75%)	AWC response low (0.00)	4.1	1.6%
				Bulk density response low (0.00)		
				Ksat response low (0.00)		
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
			Antung, drained (10%)	Bulk density response low (0.00)		
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
			Edwards, drained (6%)	AWC response low (0.00)		
				Bulk density response low (0.00)		
				Ksat response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
			Muskego, drained (3%)	AWC response low (0.00)		
				Bulk density response low (0.00)		

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
MfrAN	Madaus muck, drained, 0 to 1 percent slopes	Unsuited	Madaus, drained (80%)	Bulk density response low (0.00)	10.7	4.2%
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
				pH response low (0.00)		
				Ponding (0.00)		
			Edselton, drained (10%)	AWC response low (0.00)		
				Bulk density response low (0.00)		
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
			Moston, drained (10%)	AWC response low (0.00)		
				Bulk density response low (0.00)		
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
MhaA	Maumee loamy fine sand, 0 to 1 percent slopes	Unsuited	Maumee (90%)	Bulk density response low (0.00)	80.5	31.4%
				Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
				AWC response (0.50)		
				Organic carbon response (0.56)		
			Gilford (3%)	Bulk density response low (0.00)		
				Ksat response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
			Gumz (2%)	Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
				AWC response (0.06)		
				Organic carbon response (0.06)		
				pH response (0.50)		
			Newton (2%)	Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
				Organic carbon response (0.01)		
				Bulk density response (0.13)		
				AWC response (0.55)		

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
MupA	Morocco loamy fine sand, 0 to 2 percent slopes	Low response	Morocco (88%)	Bulk density response low (0.00)	51.9	20.3%
				Depth to high water (0.13)		
				AWC response (0.53)		
				Organic carbon response (0.90)		
MwzAU	Muskego muck, undrained, 0 to 1 percent slopes	Unsuited	Muskego, undrained (70%)	AWC response low (0.00)	0.6	0.2%
				Bulk density response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
			Moston, undrained (10%)	AWC response low (0.00)		
				Bulk density response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
			Palms, undrained (5%)	AWC response low (0.00)		
				Bulk density response low (0.00)		
				Adsorptive capacity response low (0.00)		
				Organic carbon response low (0.00)		
				Ponding (0.00)		
NofA	Newton-Morocco loamy fine	Unsuited	Newton (45%)	Ponding (0.00)	55.5	21.7%

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
	sands, 0 to 1 percent slopes			Depth to high water poorly suited (0.00)		
				Organic carbon response (0.02)		
				Bulk density response (0.13)		
				AWC response (0.55)		
			Morocco (35%)	Bulk density response low (0.00)		
				Depth to high water poorly suited (0.00)		
				AWC response (0.58)		
				Organic carbon response (0.84)		
				pH response (0.98)		
			Maumee (10%)	Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
				Organic carbon response (0.06)		
				pH response (0.32)		
				AWC response (0.50)		
			Gilford (5%)	Organic carbon response low (0.00)		
				Ponding (0.00)		
				Depth to high water poorly suited (0.00)		
				AWC response (0.06)		
				Bulk density response (0.44)		

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
OacB	Oakville-Denham fine sands, 1 to 5 percent slopes	Excellent response	Oakville (45%)	Bulk density response low (0.00)	47.6	18.6%
				AWC response (0.83)		
				pH response (0.92)		
				Organic carbon response (0.99)		
			Denham (40%)	Bulk density response low (0.00)		
				AWC response (0.80)		
				pH response (0.92)		
				Organic carbon response (0.98)		
			Brems (5%)	pH response (0.32)		
				AWC response (0.50)		
				Bulk density response (0.90)		
				Adsorptive capacity response (1.00)		
OaeC	Oakville fine sand, 5 to 12 percent slopes	Excellent response	Oakville (80%)	Bulk density response low (0.00)	5.3	2.1%
				Slope somewhat suited (0.78)		
				AWC response (0.83)		
				pH response (0.92)		
				Organic carbon response (0.99)		
			Denham (10%)	Bulk density response low (0.00)		
				AWC response (0.80)		

Map unit symbol	Map unit name	Rating	Component name (percent)	Rating reasons (numeric values)	Acres in AOI	Percent of AOI
				pH response (0.92)		
				Organic carbon response (0.98)		
Totals for Area of Interest					**256.2**	**100.0%**

Rating	Acres in AOI	Percent of AOI
Unsuited	151.4	59.1%
Excellent response	52.8	20.6%
Low response	51.9	20.3%
Totals for Area of Interest	**256.2**	**100.0%**

Description

Dynamic Soil Properties Response to Biochar Application

Biochar is the solid byproduct of the decomposition of organic materials in oxygen-limited environments at high temperatures, a process known as known as pyrolysis. The extremely carbon-rich material has an average half-life of 1,400 years, due to its recalcitrant benzene-ring structure, allowing it to sequester carbon in soils over long periods of time, with the potential to provide substantial increases to soil organic matter when applied to soils. Although it has only recently begun to receive attention as a soil health amendment, biochar has been used to increase the fertility, productivity, and health of soils around the world by indigenous communities for thousands of years, most notably in the Amazon rainforest.

The feedstock used to produce biochar has a significant impact on its properties. Many waste products can be pyrolized to produce biochar. These include forestry wastes, grass clippings, manure, food wastes, and many other waste products. This interpretation assumes a corn stover and manure waste feedstock, producing a mid-range particle size, ideally sourced locally. In recent years, the number of large-scale biochar producers has increased, lowering the cost of using the material. This interpretation assumes a minimal incorporation with tillage, rather spreading the biochar with a manure surface spreader. Application methods vary. The biochar can be mixed with manure and spread as a part of a slurry.

Soil and site properties can be dynamic (changeable on a human timescale) or more or less use invariant. Dynamic soil properties associated with soil health include pH, cation exchange capacity, water holding capacity, bulk density, hydraulic conductivity, and organic matter content. These properties affect aggregate stability, fungal growth, and microbial activity, which in turn affect plant growth. Conceptually, these properties may be improved by the application of biochar. The degree of improvement of a property is dependent upon how poor the current soil health condition is. Less healthy soils are more likely to be improved than healthy soils. Thus, soils that are already healthy will not be substantively improved with biochar application. Some conditions of the site, such as slope, ponding, flooding, karst, and rock fragment content, while affecting the application and use of biochar, cannot be changed by biochar application.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are suited by all of the soil features that affect these uses. Numerical ratings indicate the degree of suitability of each soil or site feature. The ratings are shown in decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest theoretical positive response of dynamic soil properties to biochar application (1.00) and the point at which the soil and site features indicate that biochar application will not improve dynamic soil properties (0.00).

Verbal ratings are defined as follows:

Excellent response (rating index equals 1.0) — One or more dynamic soil properties present are suboptimal for the growth of crops and may be substantially improved with biochar application.

Good response (rating index is greater than 0.75 but less than 1.0) — One or more dynamic soil properties present are suboptimal for the growth of crops and may be substantially improved with biochar application. One or more use invariant properties may limit the effectiveness of biochar.

Fair response (rating index is greater than 0.25 but less than 0.75) — One or more dynamic soil properties present may already be nearly optimal for the growth of crops and may not be substantially improved with biochar application. One or more use invariant properties may limit the effectiveness of biochar.

Low response (rating index is greater than 0 but less than 0.25). — One or more dynamic soil properties present may already be nearly optimal for the growth of crops and may not be substantially improved with biochar application. One or more use invariant properties may limit the effectiveness of biochar, but not preclude its use.

Unsuited (rating index equals 0). — The soil is rendered unsuitable for biochar application because the use invariant soil and site properties are limiting to crop production and cannot be overcome. The site may be too steeply sloping, too wet, flooded, or ponded.

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is provided to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

References and Resources

Arif, M., Ilyas, M., Riaz, M., Ali, K., Shah, K., Ul Haq, I., Fahad, S. 2017. Biochar improves phosphorus use efficiency of organic-inorganic fertilizers, maize-wheat productivity and soil quality in a low fertility alkaline soil. Field crops research. 214, 25-37.

Bruun, S. and El-Zehery, T. 2012. Biochar effect on the mineralization of soil organic matter. Pesq. Agropec. Bras. Vol 47 (5).

Bu, X. Xue, J. Wu, Y., Ma, W. 2020. Effect of biochar on seed germination and seedling growth of Robinia pseudoacacia L. in karst calcareous soils. Comm. In Soil Science and Plant Analysis. Vol. 51 (3), 352-363.

Burrell, L.D., F. Zehetner, N. Rampazzo, B. Wimmer, and G. Soja. 2016. Long-term effects of biochar on soil physical properties. Geoderma 282:96-102.

CCE of Suffolk County. 2020. Biochar Basics: https://vod.video.cornell.edu/media/1_0zozgaa6

Cheng, C.H., J. Lehmann, and M.H. Engelhard. 2008. Natural oxidation of black carbon in soils: Changes in molecular form and surface charge along a climosequence. Geochimica et Cosmochimica Acta 72:1598–1610.

Dokoohaki, H., Miguez, F.E., Laird, D., Dumortier, J. 2019. Where should we apply biochar? Environ. Res. Lett. 14 044005.

Fidel, R.B., Laird, D.A., Thompson, M.L., Lawrinenko, M. 2016. Characterization and quantification of biochar alkalinity. Chemosphere. 167, 367-373.

Gunes, A., Inal, A., Taskin, M.B., Sahin, O., Kaya, E.C., Atakol, A.R.D.A. 2014. Effect of phosphorus-enriched biochar and poultry manure on growth and mineral composition of lettuce (Lactuca sativa L. cv.) grown in alkaline soil.

Ibrahim, H.M., Al-Wabel, M.I., Usman, A.R.A., Al-Omran, A. 2013. Effect of Conocarpus biochar application on the hydraulic properties of a sandy loam soil. Soil Science. 178 (4), 165-173.

Kishimoto S. and Sugiura, G. 1985. Charcoal as a soil conditioner. Symposium on Forest Products Research International Achievements for the Future 5, 12–23.

Li, G.Z., Zhang C.R., Ibrahim, M., Zhang, G., Wang, L., Zhang, R., Chen, F. and Liu, Y. 2017. The beneficial effect induced by biochar on soil erosion and nutrient loss of sloping land under natural rainfall conditions in central China. Agric. Water Manage. 185:145–150. 43.

Liu, Z., Dugan, B., Masiello, C.A., Gonnermann, H.M. 2017. Biochar particle size, shape, and porosity act together to influence soil water properties. PLoS ONE 12(6): e0179079. https://doi.org/10.1371/journal.pone.0179079.

Major, J., Rondon, M., Molina, D., Riha, S.J., Lehmann, J. 2010. Maize yield and nutrition during 4 years after biochar application to a Colombian savanna oxisol. Plant Soil, 333, pp. 117-128

Mukherjee, A., A.R. Zimmerman, and W. Harris. 2011. Surface chemistry variations among a series of laboratory-produced biochars. Geoderma 163:247-255.

Novak, J.M., W.J. Busscher, D.L. Laird, M. Ahmedna, D.W. Watts, and M.A.S. Niandou. 2009. Impact of Biochar Amendment on Fertility of a Southeastern Coastal Plain Soil. Soil Science 174:105-112.

Pituello, C.; Ferro, N. dal; Francisco, O.; Simonetti, G.; Berti, A.; Piccoli, I.; Pisi, A.; Morari, F. Effects of biochar on the dynamics of aggregate stability in clay and sandy clay loam soils. European Journal of Soil Science. 69 (5) Oxford; Wiley, 2019, pp. 827-842.

Silva, F.C., C. Borrego, J.J. Keizer, J.H. Amorim, and F.G.A. Verheijen. 2015. Effects of moisture content on wind erosion thresholds of biochar. Atmospheric Environment 123:121-128.

Vaccari, F.P., Baronti, S., Lugato, E., Genesio, L., Castaldi, S., Fornasier, F. Miglietta, F. 2011. Biochar as a strategy to sequester carbon and increase yield in durum wheat. Eur. J. Agron., 34, pp. 231-238

Zhang, M., Riaz, M., Zhang, L, El-desouki, Z., Jiang, C. 2019. Biochar induces changes to basic soil properties and bacterial communities of different soils to varying degrees at 25 mm rainfall: more effective on acidic soils. Front. Microbiol. 10:1321. doi: 10.3389/fmicb.2019.01321

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher