Argonne NATIONAL LABORATORY

Welcome to SUPERBEEST

superbeest.evs.anl.gov

Updated Oct 2023

Scaling **U**p **PER**ennial **B**ioenergy **E**conomics and **E**cosystem **S**ervices **T**ool

SUPERBEEST is on online geospatial tool being developed to assist in decision making by various stakeholders regarding the adoption of perennial bioenergy crops on current row crop land (corn, soybean, pasture) in the U.S. Midwest

The adoption of perennial bioenergy crops can be a WIN for …

- ✔ Win *Farmers*
- ✔ Win *Environment*
- ✔ Win *Bioeconomy*

Goals

- ☑ Provide farmers the opportunity to be valued stakeholders in the Bioeconomy and leverage marginal land to produce biomass & ecosystem services (ES)
- ☑ Create resilient rural communities by offering diversified opportunities for entrepreneurships, jobs, & a clean environment
- ☑ Help decarbonize community energy requirements

Intended Users: **EVERYBODY** (farmers, landowners, researchers, watershed managers, water quality regulators, biorefinery planners, etc.)

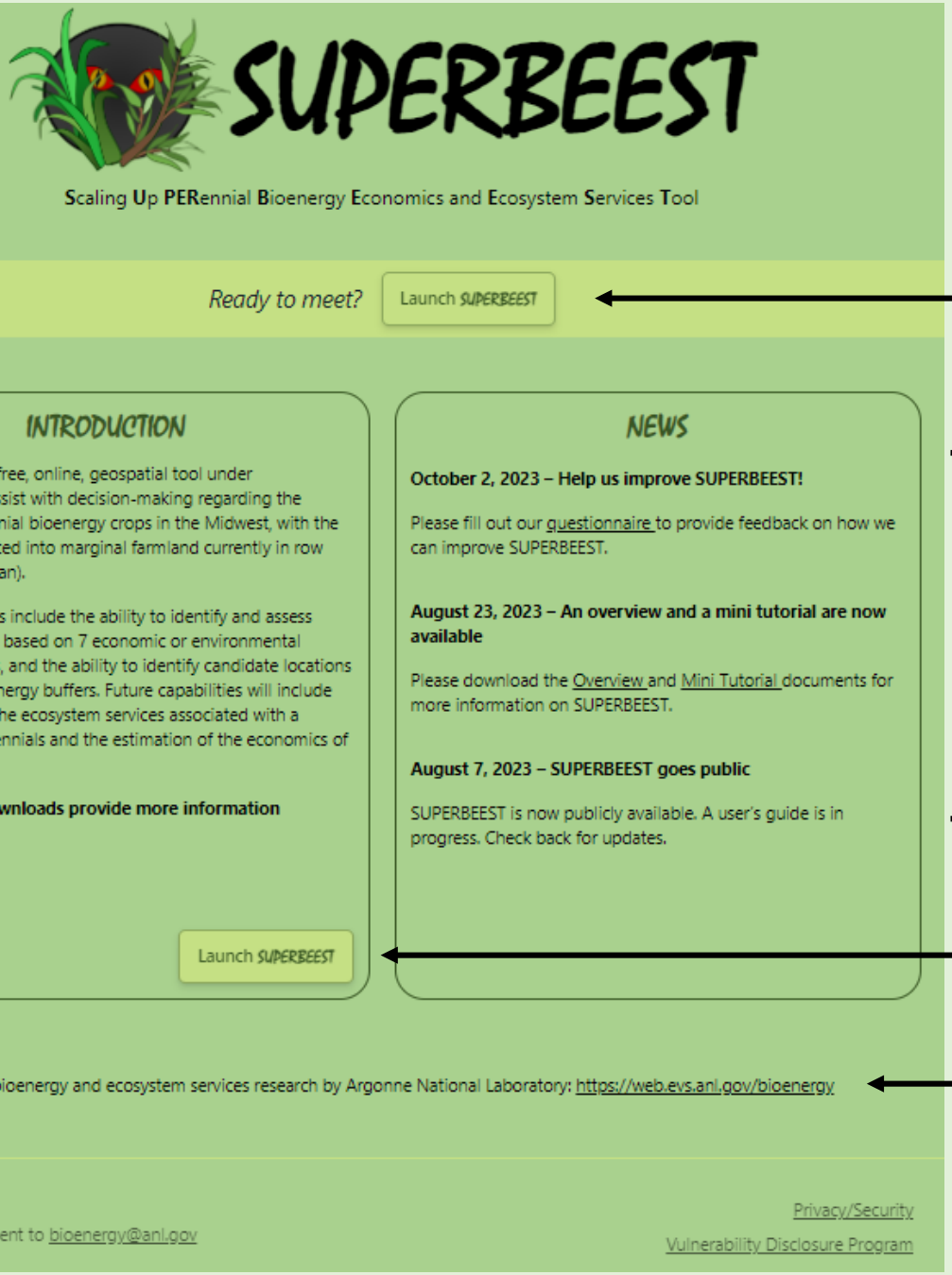
✦ Current & Future Capabilities

✦ Identify Marginal Land	✦ Identify Suitable Areas for Saturated Bioenergy Buffers	Ecosystem Services Realized from Crop Change	Economics Realized from Crop Change
• Economically or environmentally marginal • Reduced land-use change	• Used for nutrient management in tile-drained land • Suitable acres based on specific criteria	a) Water quality b) Carbon sequestration c) Greenhouse gases d) Hunting & recreation	a) Net economic value b) ES value c) Crop return d) Change of inputs

Landing Page

Launch the tool

superbeest.evs.anl.gov/tool



Links to the SUPERBEEST Tool

Introduction for the tool

News on tool updates and website changes

Resources for download

Link to our research team's work related to bioenergy crops

Contact information

The Tutorial

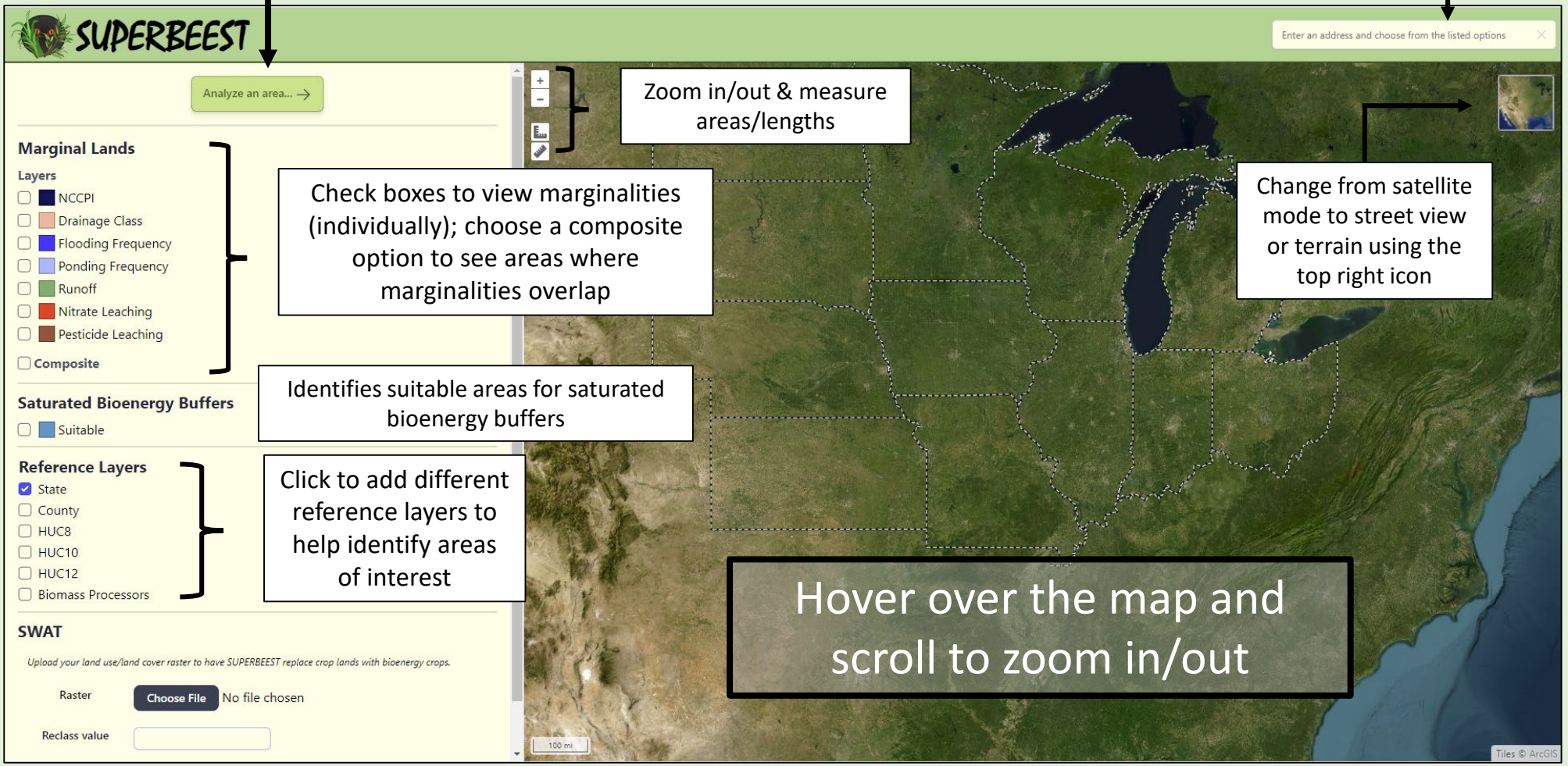
Launch the tool

superbeest.evs.anl.gov/tool

Home Page

Click the analyze an area icon to select your area of interest

Search for a location using an address



Zoom in/out & measure areas/lengths

Check boxes to view marginalities (individually); choose a composite option to see areas where marginalities overlap

Change from satellite mode to street view or terrain using the top right icon

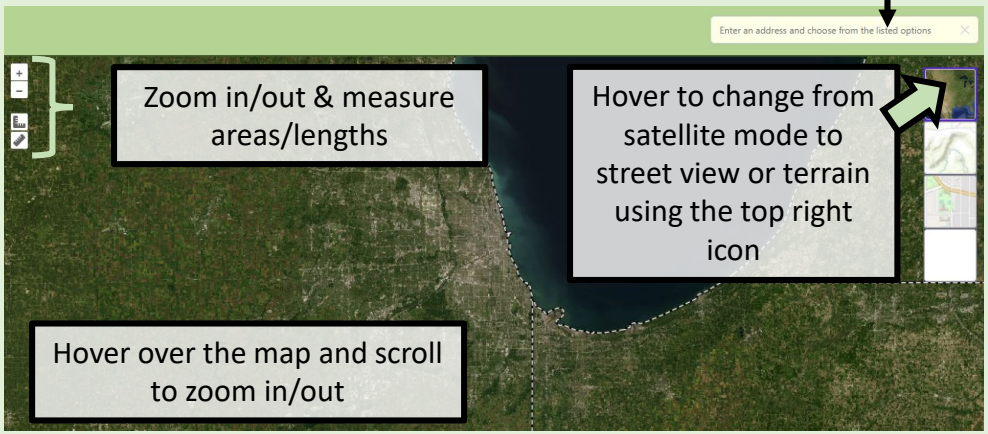
Identifies suitable areas for saturated bioenergy buffers

Click to add different reference layers to help identify areas of interest

Hover over the map and scroll to zoom in/out

Step 1: Find Your Area of Interest

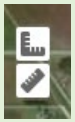
Map functions



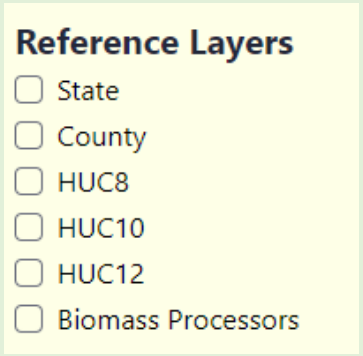
Address Toolbar:
Type in a specific address, street corner, town or county and select an option from the dropdown menu

Measure Tools : used to measure distances and areas

- Click on tool to start measuring
- Click tool to turn off
- Single click to create a vertex
- Double click to finish a line or polygon



Adding Reference Layers



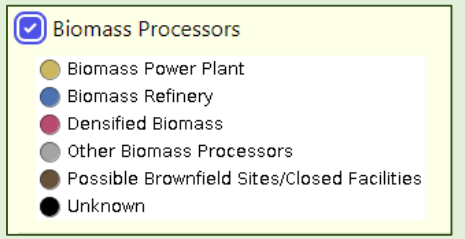
One or more reference layers can be added to the map

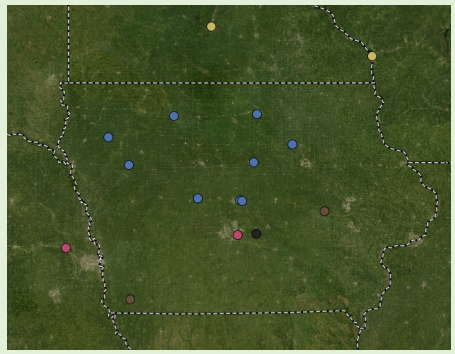
Examples below show counties and watersheds

HUC = Hydrologic Unit Codes

Biomass Processors

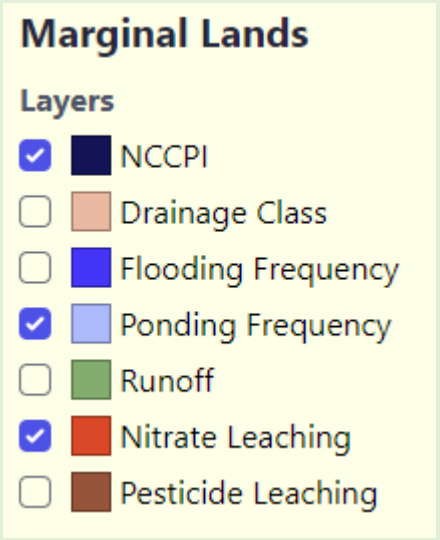
- Power plants – burn biomass for electricity or heat
- Refineries – generate fuels
- Densified biomass – pellet plants
- Other – R&D and other bioproducts (biochar, erosion socks, pulp, etc.)
- Closed facilities – maintained in the database as possible "brownfield" sites, facilities that may be repurposed again as future biomass processor sites



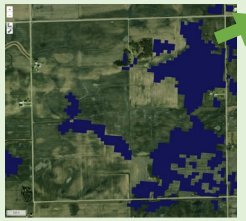


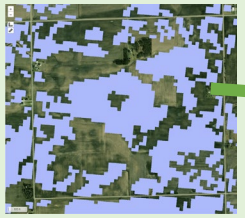
Step 2: Identify Marginal Land & Areas Suitable for Saturated Bioenergy Buffers

Economic and environmental land marginalities can be displayed for the row crop and pasture lands in your area of interest by checking the boxes. One or multiple marginalities can be displayed at a time.



SSURGO = Soil Survey Geographic Database (USDA-NRCS)





- NCCPI : national commodity crop productivity index (economics) - average and fair classified as marginal
- Drainage Class: SSURGO drainage classes - somewhat poor, poorly drained, and very poorly drained classified as marginal
- Flooding Frequency : SSURGO Flooding frequency classes - occasional common, frequent, and very frequent classified as marginal
- Ponding Frequency : SSURGO ponding frequency classes - occasional, common, and frequent classified as marginal
- Runoff : SSURGO surface runoff classes - high and very high classified as marginal
- Nitrate Leaching : USGS data – classified as marginal if a significantly thick surficial aquifer or carbonate (karst) bedrock is close to the surface
- Pesticide Leaching : a subset of the nitrate leaching layer where SSURGO data also indicates 3% organic matter content in the soil

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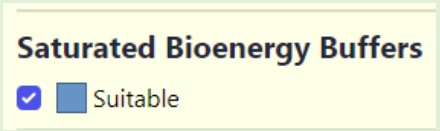
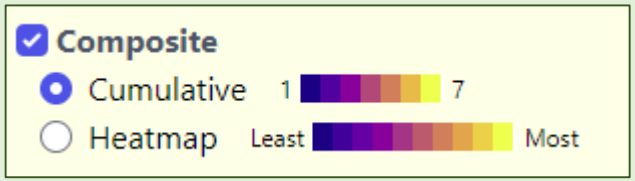
Check the **Saturated Bioenergy Buffers** to identify suitable areas to place saturated bioenergy buffers in tile-drained agricultural lands



Saturated Bioenergy Buffers: For tile-drained land. Suitability is limited to placement along ditch or stream channels. Based on soil drainage, topography, soil organic matter content, soil erodibility factor, and hydraulically restricting layers

Step 2: Identify Marginal Land & Areas Suitable for Saturated Bioenergy Buffers

Use **Composite** to identify areas where multiple marginalities overlap. These areas might be the most problematic for production of traditional row crops or pasture and may be preferred areas to covert to perennial bioenergy crops.

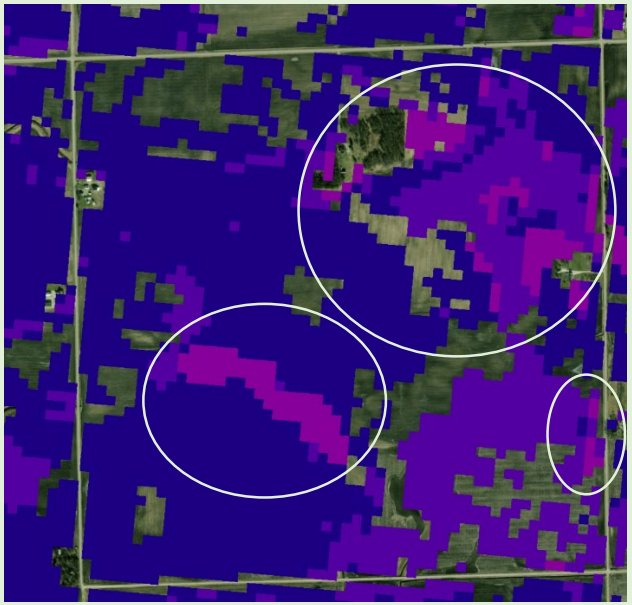


There are **two options** that can be used to display this information

- These composite layers are based upon the 7 marginalities only, excluding saturated bioenergy buffer layers

Cumulative:

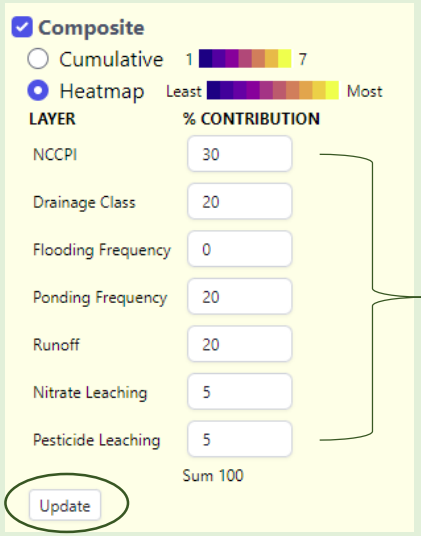
Shows areas where the marginalities overlap with color coding based upon the number of marginalities present from 1 to 7



Lighter colored areas (circled) show where multiple marginalities are present and are optimal for conversion to perennial bioenergy crops to achieve multiple environmental benefits

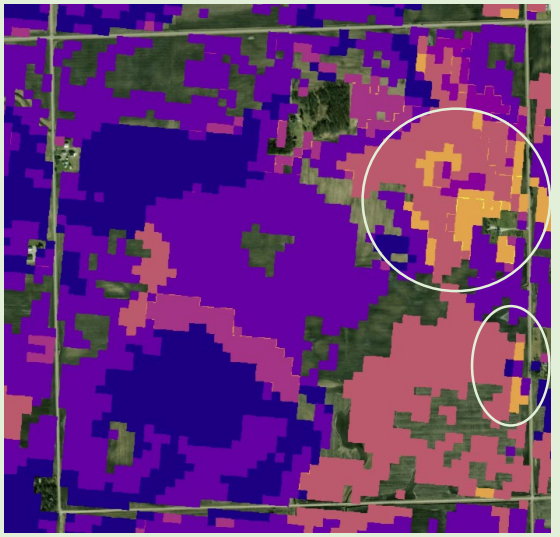
Heatmap:

Allows users to weigh the marginalities based on their goals and preferences

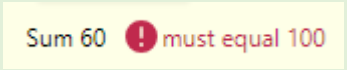


Add % contributions to each marginality from 1 to 100 %, then hit Update to generate the map

The higher the percent, the higher that marginality will be weighted



In this example we weighted NCCPI the highest at 30%, followed by drainage, ponding, and runoff at 20% each, with less interest in nitrate and pesticide leaching (5%). The lighter areas fit the preferences best and are optimal for conversion to perennial bioenergy crops



*When adding %, the total for all 7 marginalities needs to add up to 100%. A total sum is shown for all categories and a warning is given when the total is not 100%

Step 3: Analyze your Area of Interest

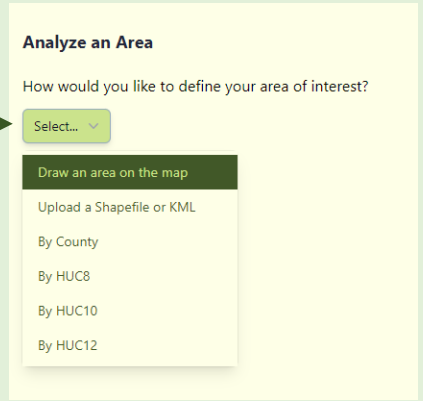
1

When you are ready to analyze your area of interest (AOI) and generate output

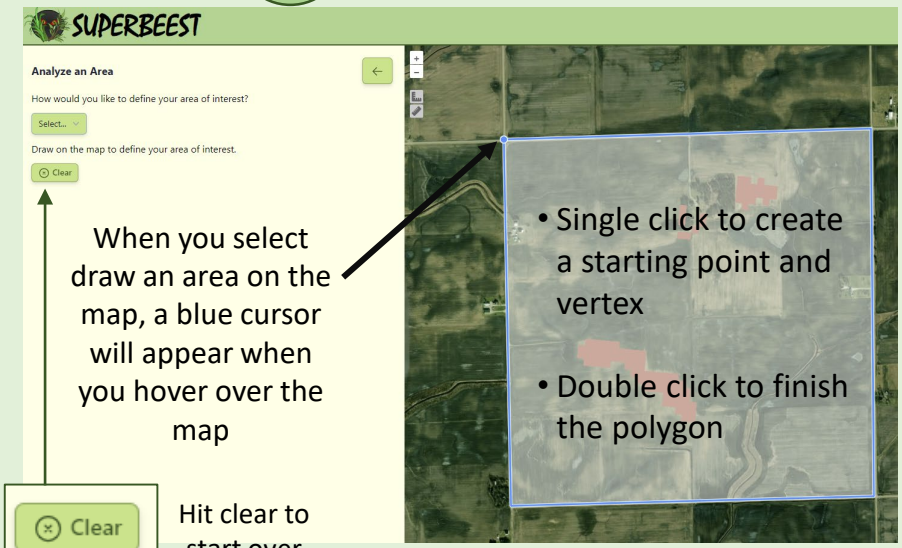
2

Select how you want to define your AOI

You can choose to draw your own boundary on the map as shown in the figure on the top right, or select one or more counties or watersheds (HUC 8,10, or 12 levels)



2a Draw your own AOI



When you select draw an area on the map, a blue cursor will appear when you hover over the map

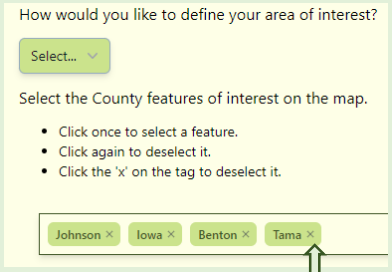
Clear

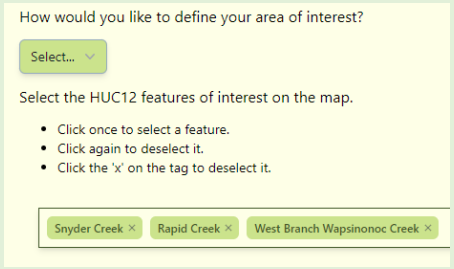
Hit clear to start over

Can draw one or more AOI

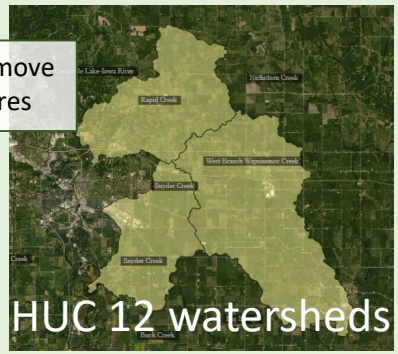
2b When you choose to select by county or HUC (watershed)

The map will show counties or HUCs (you'll see the labels appear) – click on the ones you want to select





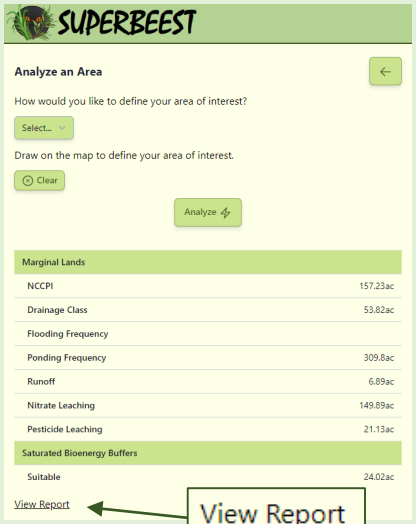
Hit the "x" to remove selected features



3

Hit analyze once you've selected your AOI

A summary of the total acreage per marginality is reported along with the amount of suitable acres for saturated bioenergy buffers.

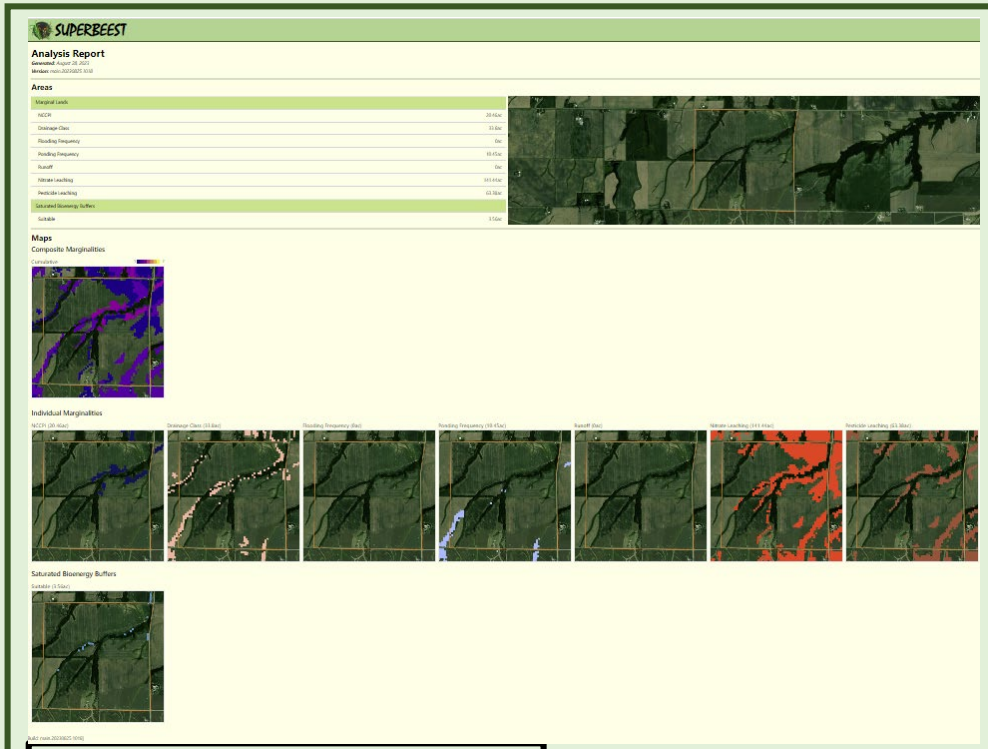


Click to generate a printable report

View Report

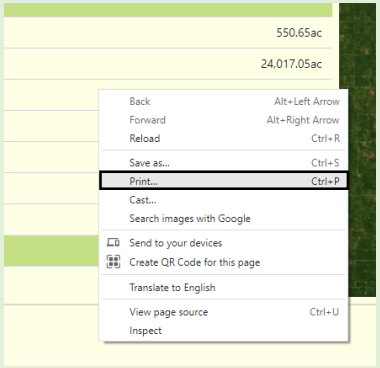
Step 4: Printable Report

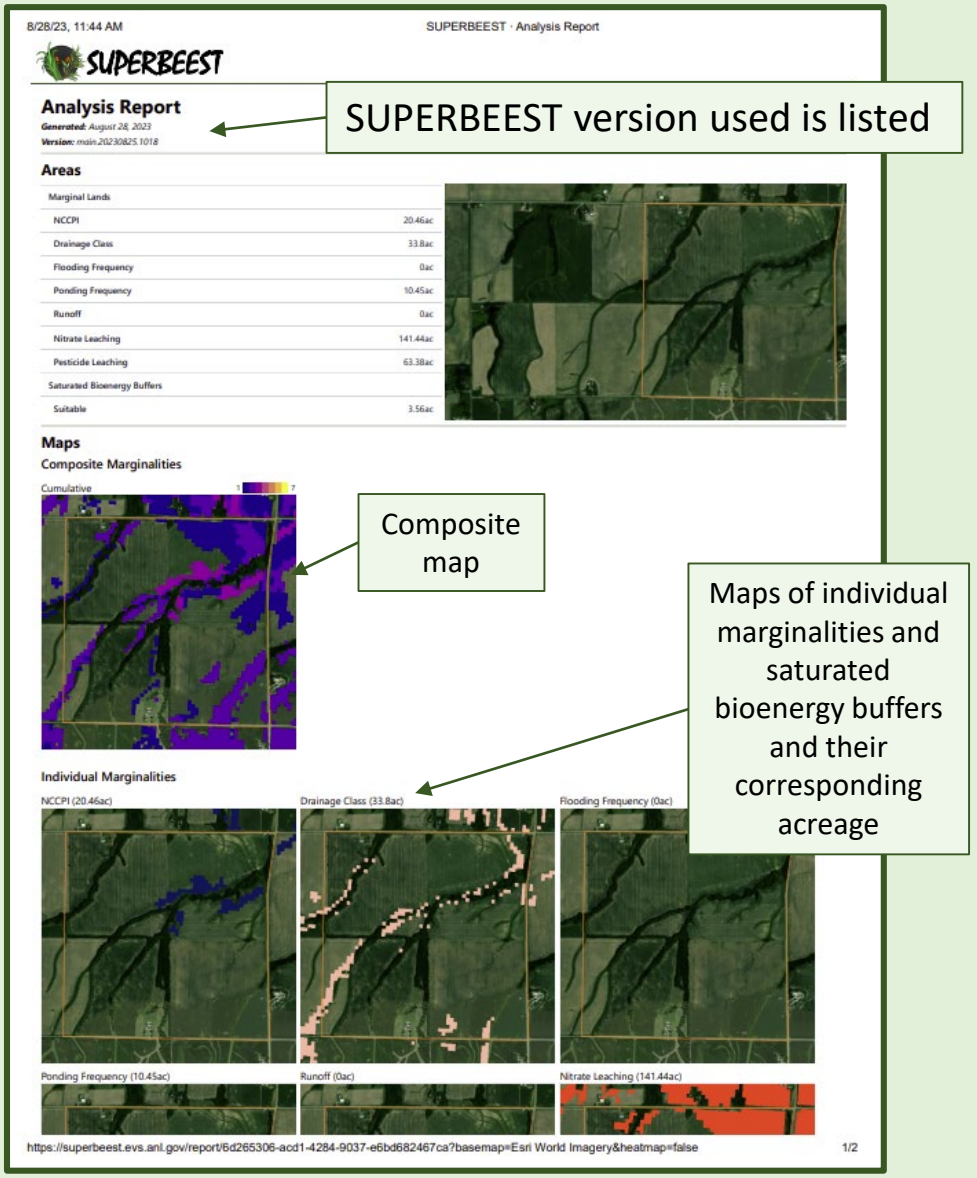
When you select “View Report” a new window will open which will generate a report with the same marginal lands table presented previously as well as maps of the AOI, marginalities, and suitable areas for saturated bioenergy buffers.



To print the report –

1) Either right click anywhere on the screen to open up the window shown (right) and choose print
2) Or press Ctrl+P





Feedback

SUPERBEEST

Provide Feedback

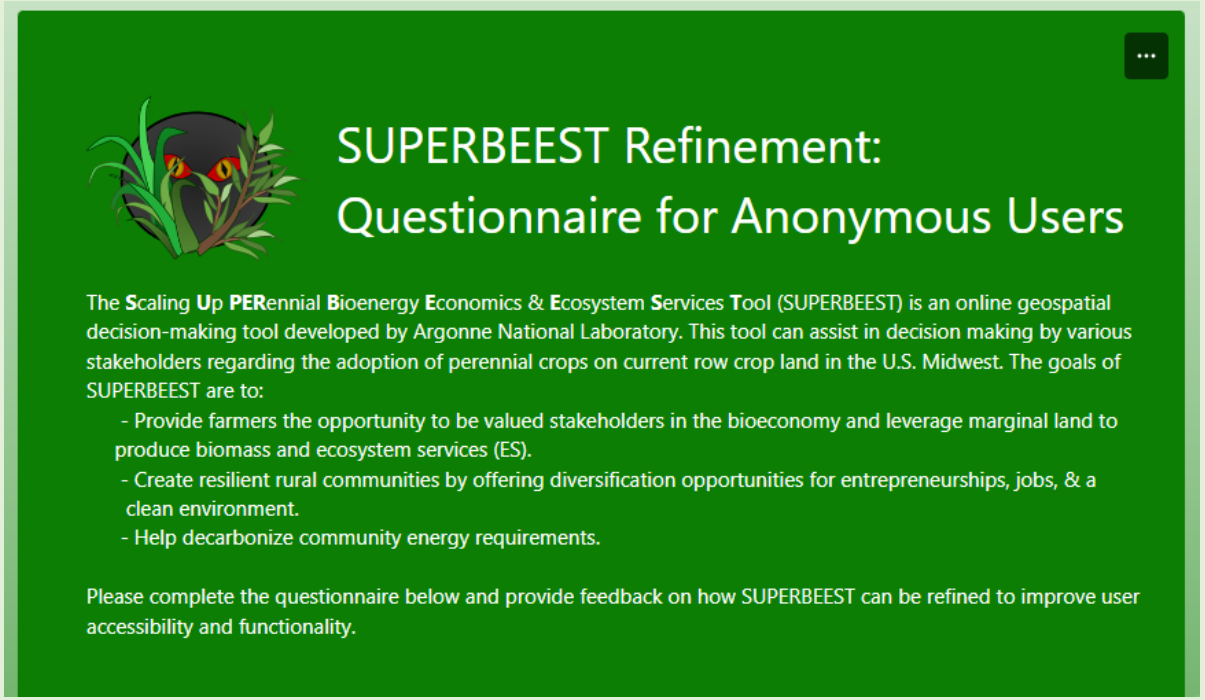
We'd love to hear about your experience using the tool

Analysis Report

Thank you for taking the time to use SUPERBEEST!

We are always continuing to update this tool's capabilities and refine the user's experience.

If there are any changes or suggestions that you'd like to see to improve the tool's value to you or improve its ease of use, please use the link at the top of the analysis report page to provide feedback.



Contact Us

Argonne NATIONAL LABORATORY

Need Assistance with SUPERBEEST or interested in a specific analysis for your area of interest?

Contact us at: bioenergy@anl.gov or Brad Kasberg at bkasberg@anl.gov

Want to learn more about our research on bioenergy crops and ecosystem services?

Visit our website : web.evs.anl.gov/bioenergy

BIOENERGY & ECOSYSTEM SERVICES
IN THE ENVIRONMENTAL SCIENCE DIVISION AT ARGONNE NATIONAL LABORATORY

ACKNOWLEDGEMENTS

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More Info - Defining Marginalities

The following datasets were used to define the marginalities used in SUPERBEEST

- National Commodity Crop Productivity Index (NCCPI)
- Soil Survey Geographic Database (SSURGO)
  - Soil drainage
  - Frequency of water ponding
  - Frequency of flooding
  - Surface runoff

NCCPI & SSURGO Classifications

Sustainability Metric	Classification	Marginality
Crop Productivity Index	Fair; CPI < 100	1
	Average; CPI = 100 - 116	1
	Good; CPI =117 – 132	0
	Excellent; CPI ≥ 133	0
Soil Drainage	Very Poorly Drained	1
	Poorly Drained	1
	Somewhat Poorly Drained	1
	Moderately Well Drained	0
	Well Drained	0
	No Data	No Data
Frequency of Water Ponding	Rare	0
	Frequent	1
Frequency of Flooding	Rare	0
	Frequent	1
Surface Runoff	Negligible	0
	Very Low	0
	Low	0
	Medium	0
	High	1
	Very High	1
	No data	No Data

0 = not marginal
1 = marginal

For more information: Ssegane, H. and M.C. Negri, 2016, An Integrated Landscape Designed for Commodity and Bioenergy Crops in a Tile-Drained Agricultural Watershed. Journal of Environmental Quality, 45:1588–1596, DOI:10.2134/jeq2015.10.0518.

More Info - Defining Marginalities

The following datasets were used to define the nitrate and pesticide leaching marginalities in SUPERBEEST

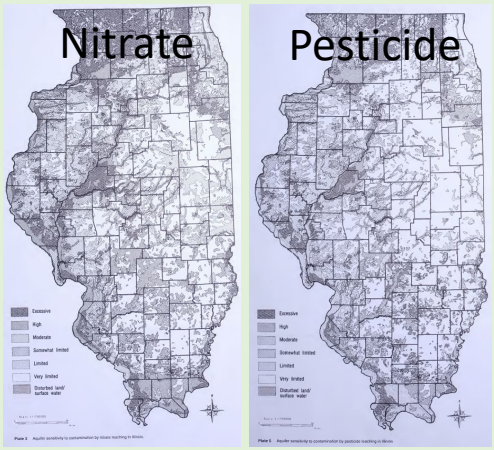
- U.S. Geological Survey products: to asses potential for nitrate and pesticide leaching

Leaching in Illinois

Past work in Illinois was based on the Keefer (1995) method

Sustainability Metric	Classification	Marginality
Nitrate Leaching	Very Limited	0
	Somewhat Limited	0
	Limited	0
	Moderate	1
	High	1
Pesticide Leaching	Very Limited	0
	Somewhat Limited	0
	Limited	0
	Moderate	1
	High	1

0 = not marginal; 1 = marginal



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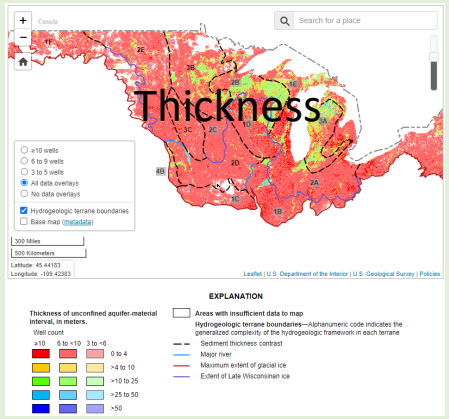
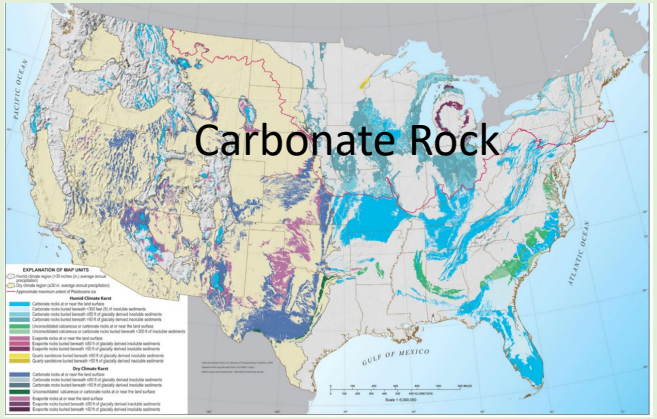
Leaching for the U.S. Midwest

Required additional information to map the U.S. Midwest

Data Source	Marginal Classification
USGS mapping of the thickness of unconfined (surficial) quaternary aquifers in the Midwest	Areas with unconfined aquifers that are more then 4 m thick (for pesticide, organic matter < 3%)
USGS mapping of karst – susceptible areas with carbonate rocks near the land surface	Areas with carbonate rock at or near the surface (for pesticide, organic matter < 3%)



source: modified from Yager et al. 2020

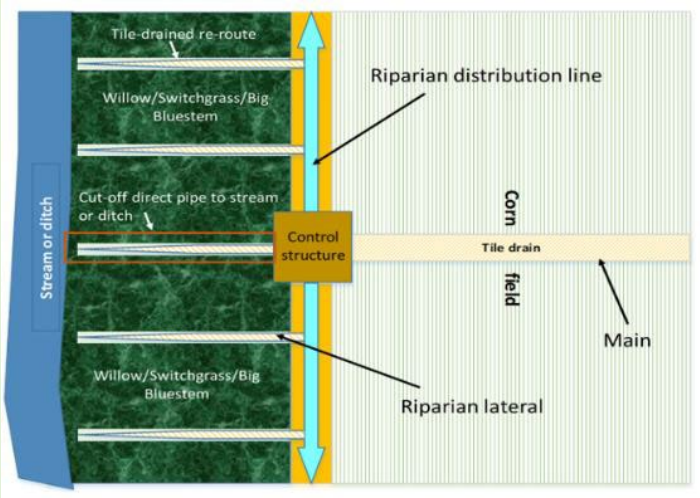


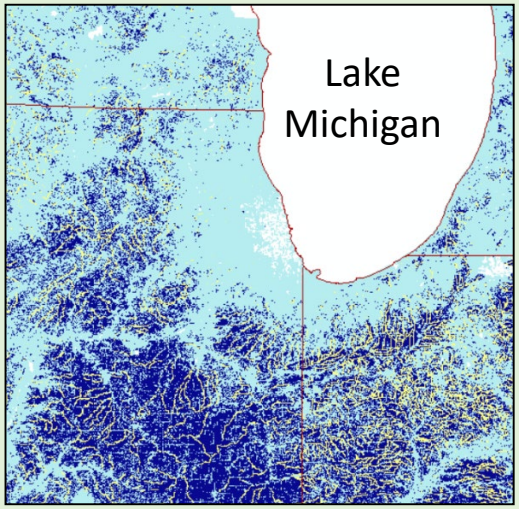
source: Weary and Doctor 2014

More Info – Defining Saturated Bioenergy Buffers

Saturated Bioenergy Buffers (SBBs) can capture nutrient-rich, drainage water from a tile-drained system via a control structure and utilize it for growing bioenergy crops to:

1. Improve farm economics
2. Protect the environment from nutrient loss





Site Suitability

- Riparian land only with width of 20-30m from the ditch or stream edge
- Requires inputs on soil, topography/slope, landuse/landcover, and drainageway locations
- Analysis is a GIS-based multicriteria decision analysis

SBB Site Suitability Classification

Environmental Metric	Classification	Suitability
1. Soil drainage	Somewhat poorly drained	1
	Poorly drained	1
	Very poorly drained	1
	Moderately well drained	0
	Well drained	0
	Somewhat excessively drained	0
	Missing data	Null
2. Topography	Very flat (≤1% slope)	1
	Flat (>1% to ≤2% slope)	1
	Moderately flat (>2% to ≤3% slope)	1
	Slightly flat (>3% to <5% slope)	1
	Not flat (≥5% slope)	0
	Missing data	Null
3. Land use land cover	Corn/soybean	1
	Others	0
	Missing data	Null
4. SOC content in the top 76 cm	Low (<1%)	0
	Medium (1-2%)	1
	High (>2%)	1
	Missing data	Null
5. Depth to hydraulically restricting layer	1.2 - 2.5 m	1
	Otherwise	0
	Missing data	Null
6. Soil erodibility factor (whole soil profile)	Low (≤0.44)	1
	High (>0.44)	0
	Missing data	Null

0 = not suitable
1 = suitable

For more info: Cacho, J.F, J.J. Quinn, C.R. Zumpf, and M.C. Negri, 2021, Saturated Bioenergy Buffers: Site Suitability Classification and Estimated Areas of Candidate Sites in the U.S. Midwest under Three Scenarios: Argonne Technical Report ANL/EVS-21/2. https://publications.anl.gov/anlpubs/2021/05/166535.pdf

More Info – Biomass Processors

- This table lists the major sources used for defining the locations for biomass processors.
- Biomass processors were separated by type based on data sources.
- Operational status of facilities listed was based on available information on the facility's operational status such as an operating website, news articles, or other resources.

Data Sources		
Name	**Website**	**Last Modified**
IEA Bioenergy Technology Collaboration Programme	https://www.ieabioenergy.com/installations/	2023
Renewable Fuels Association	https://ethanolrfa.org/resources/ethanol-biorefinery-locations	Not specified
US DOE Office of Energy Efficiency and Renewable Energy	https://www.energy.gov/eere/bioenergy/integrated-biorefineries	2022
ArcGIS resource: uploaded by Krista Merry	https://www.arcgis.com/home/item.html?id=4be8ec6968d34eadb027bfec1ceb947a	2014
US Biochar Initiative	https://biochar-us.org	2023
EPA Risk Management Plan (RMP) – The Right-To-Know Network	various	Not specified
Biomass Magazine	https://biomassmagazine.com/plants/listplants/biomass/US/page:1/sort:feedstock/direction:desc	2022
Association of Warm Season Grass Producers	https://www.awsgp.org/	2022
U.S Energy Information Administration (EIA)	https://www.eia.gov/biofuels/biomass/#dashboard	2023
National Renewable Energy Laboratories (NREL)	https://maps.nrel.gov/?da=biofuels-atlas	2014