Introduction to Drawdown Georgia's Emissions Dashboard Project

DRAWDOWN GA

www.DrawdownGA.org

Forestry and Agriculture Sectors
Experts Meeting
October 29, 2021

Drs. Jackie Mohan and Jeff Mullen, University of Georgia
Dr. Bill Drummond, Georgia Institute of Technology

Agenda

10:00 Welcome & Intro to Drawdown Georgia
(Drs. Jackie Mohan and Jeff Mullen)
-- Please use “chat” for asking questions
– Ollie Chapman will collect and read them out
-- The session will be recorded but not shared publicly

10:10 Forestry sector emissions (Dr. Bill Drummond)
10:25 Q&A

10:35 Agriculture sector emissions (Dr. Bill Drummond)
10:45 Q&A

10:55 Next Steps and Wrap up (Drs. Jackie Mohan and Jeff Mullen)

Localized climate solutions can help during this “decisive decade” — but where is the atlas of state and local roadmaps?

- The **Drawdown Georgia** project aims to identify and activate the most promising solutions to significantly reduce Georgia’s net carbon emissions by 2030.

- Our methodology can be adapted to fit other states, counties and even cities.

DRAWDOWN GA

bringing climate solutions home

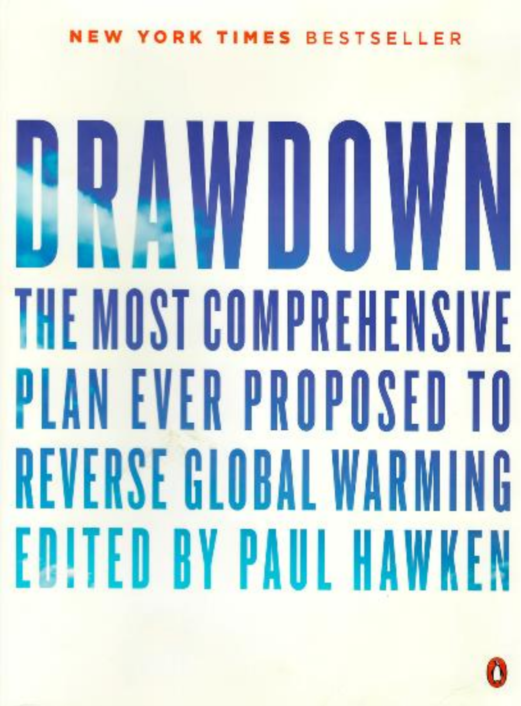
drawdownga.org

Research conducted at Georgia Tech, University of Georgia, Emory University, Georgia State and other partners.
Funded by the Ray C. Anderson Foundation.

Trajectory of the Drawdown Georgia Project

We're bringing climate solutions home.

Inspired by Project Drawdown®, we are building a movement in Georgia to accelerate progress toward net zero greenhouse gas emissions.



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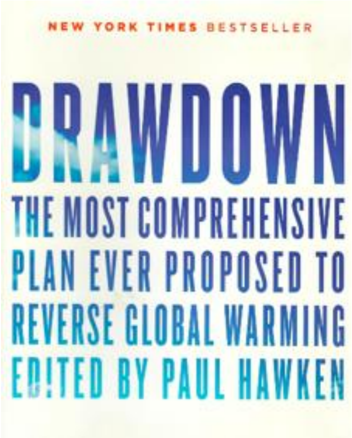
bringing climate solutions home

Starting Point: Project Drawdown Solutions

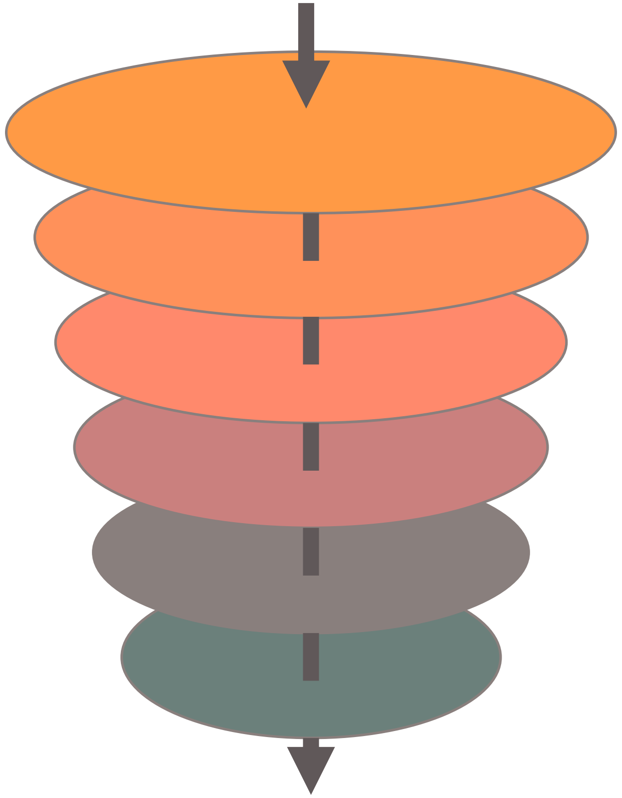


Paul Hawken
environmentalist, entrepreneur, journalist, and author
pioneer in sustainability

Which are best for Georgia?

Trajectory of the Drawdown Georgia Project

The Drawdown Georgia research team ran ~100 global solutions through a series of filters:



- Is the solution relevant in Georgia?
- Is it technology and market ready to scale by 2030?
- Is there sufficient local experience and available data?
- Can the solution deliver 1 million metric tons of annual GHG reduction by 2030?
- Is it cost competitive with other solutions?
- Are there significant "beyond carbon" impacts?

Brown, Marilyn A., et al. (2021) "Translating a Global Emission-Reduction Framework for Subnational Climate Action: A Case Study from the State of Georgia," *Environmental Management.* 67: 205-227. https://doi.org/10.1007/s00267-020-01406-1.

Result: 20 Drawdown Georgia Solutions for 2030 + Beyond Carbon Dimensions

Electricity

- Cogeneration
- Demand Response
- Rooftop Solar
- Large-Scale Solar
- Landfill Methane

Transportation

- Electric Vehicles
- Energy-Efficient Cars
- Energy-Efficient Trucks
- Mass Transit
- Alternative Mobility

Food & Agriculture

- Composting
- Conservation Agriculture
- Plant Rich Diet
- Reduced Food Waste

Buildings & Materials

- Recycling
- Refrigerant Management
- Retrofitting Buildings

Land Sinks

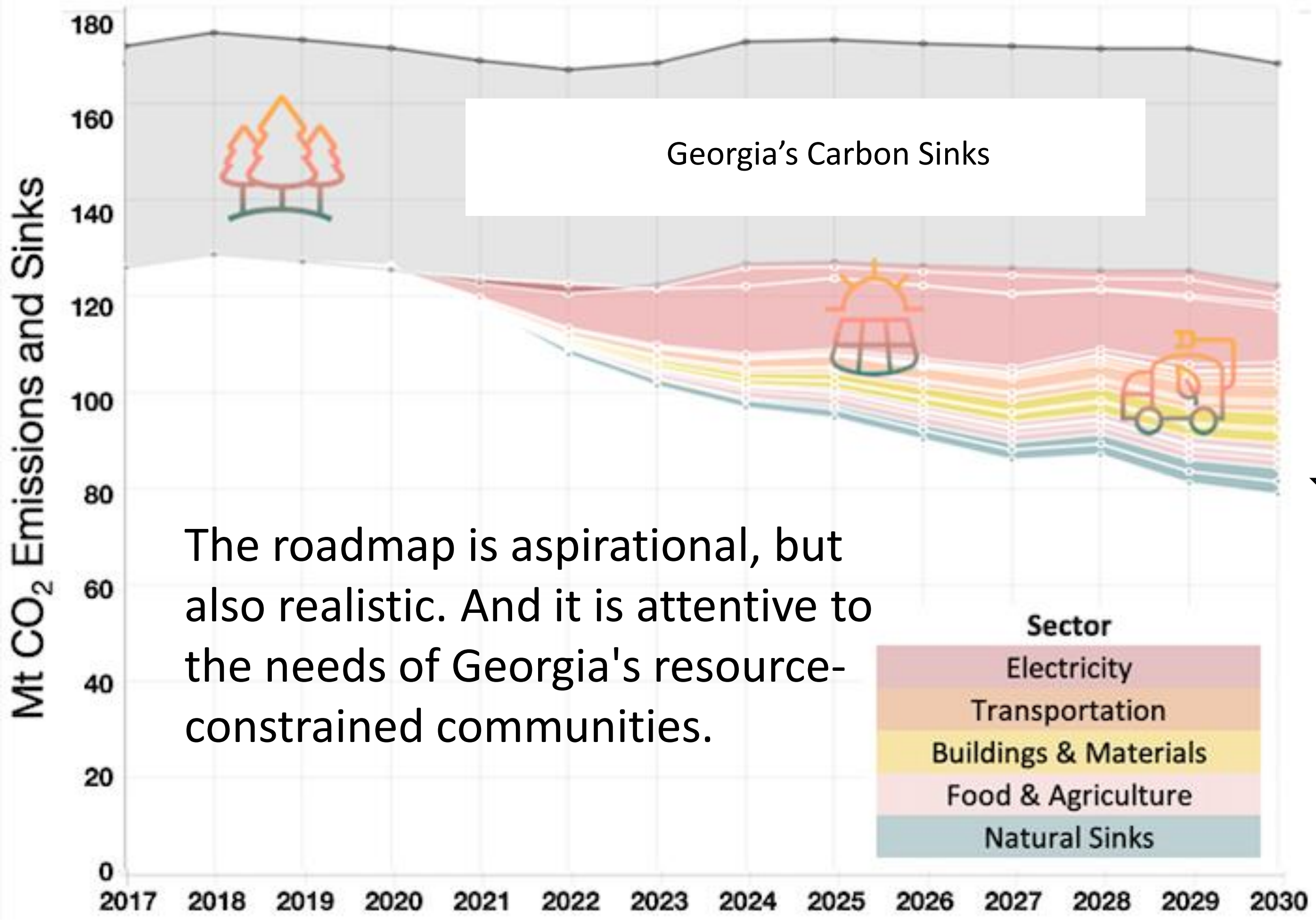
- Afforestation & Silvopasture
- Coastal Wetlands
- Temperate Forest Protection & Management

Beyond Carbon

- Equity
- Economic Development & Jobs
- Public Health
- Environmental Quality

Georgia can reduce its carbon footprint by 50% by 2030 below its 2005 baseline

28 Mt CO_2 reduction from 156 Mt CO_2 in 2005 to 128 in 2017 (12 years)

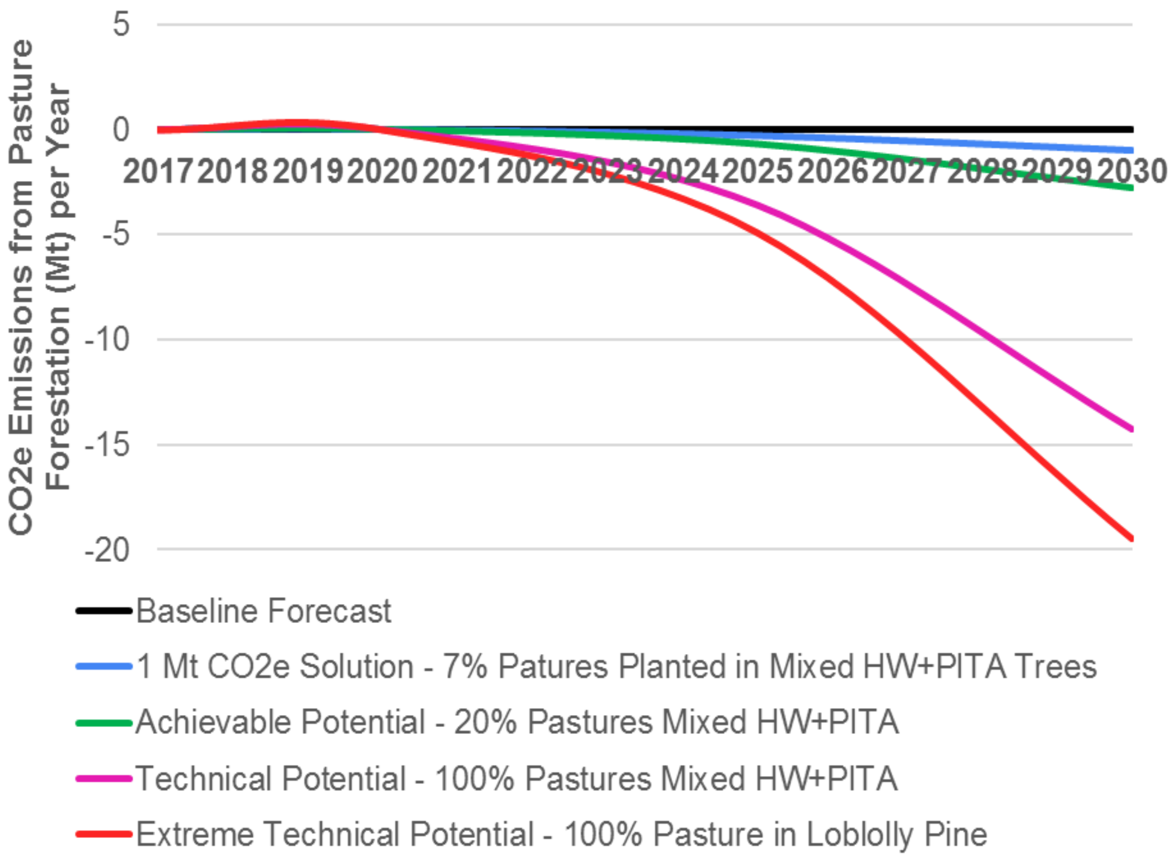


The roadmap is aspirational, but also realistic. And it is attentive to the needs of Georgia's resource-constrained communities.

49 Mt CO_2 reduction from 128 Mt CO_2 in 2017 to 79 in 2030 (13 years)

Source: Brown, et al. 2021. Framework for Localizing Global Climate Solutions and their Carbon Reduction Potential," *Proceedings of the National Academy of Sciences*, https://doi.org/10.1073/pnas.2100008118

Annual CO_2e Storage from Afforestation + Silvopasture (in PASTURES Only)



Baseline = Currently very little Silvopasture efforts in Georgia.

Achievable Potential = **2.8 $MtCO_2e$** per year by 2030.

Technical Potential = **14.3 $MtCO_2e$**

Extreme Technical Potential = **19.5 $MtCO_2e$**

1 $MtCO_2e$ solution in 2030 = Planting **7%** of current Pasture lands with mixed hardwood & loblolly tree species using staggered planting times.

+Improved health & productivity of livestock
+Biodiversity
+Improved stream water quality
- Potential slight reduction in forage availability

Silvopasture Summary

- Planting current GA Pastures with **7% Tree Density** would annually sequester **1 $MtCO_2e$ by 2030**
- Higher planting densities (20%, 100%), more CO_2e sequestration
- Pines more productive that Hardwoods, but Caveats
- Scattered shade increases Health and Productivity of Livestock, thus benefits farmers.
- Federal and NGO programs that compensate farmers for planting trees

Georgia Soil Carbon Photos (Dr. Carl Jordan's Athens EcoFarm)

Old-growth HW Forest
~12" Dark soil C

A

Pine Stand,
little Dark soil C

B

C

1993 Farm Soil, very little Dark soil C

D

2020 Farm Soil, ~15" Dark C-rich soil

Photos depict **dark carbon-rich soil** & red-orange carbon-poor clay mineral soil

Tracking Composting

- Focus on Food Waste Stream in Public K-12 School Districts
- Identify type and volume of food service items purchased, and expenditures using publicly available procurement portals
- Compare cost of procuring compostable and non-compostable food packaging and service ware with and without current federal and state subsidies
- Integrate cost comparisons into the dashboard to illustrate the effect of federal and state subsidies on expenditures at the school district level

Tracking Composting

- Conduct a Life-Cycle Analysis (LCA) of GHG emissions for compostable v. non-compostable food packaging and service ware
- Integrate LCAs into the dashboard to illustrate the GHG emission reduction potential of adopting a compost-oriented food waste disposal system by school district
- Compare the disposal costs of a compostable v. non-compostable food waste stream by school district given the current composting infrastructure
- Identify the optimal location of compost sites within the state to minimize the cost of disposal of compostable food waste and food packaging and service ware
- Integrate the optimal compost sites into the dashboard

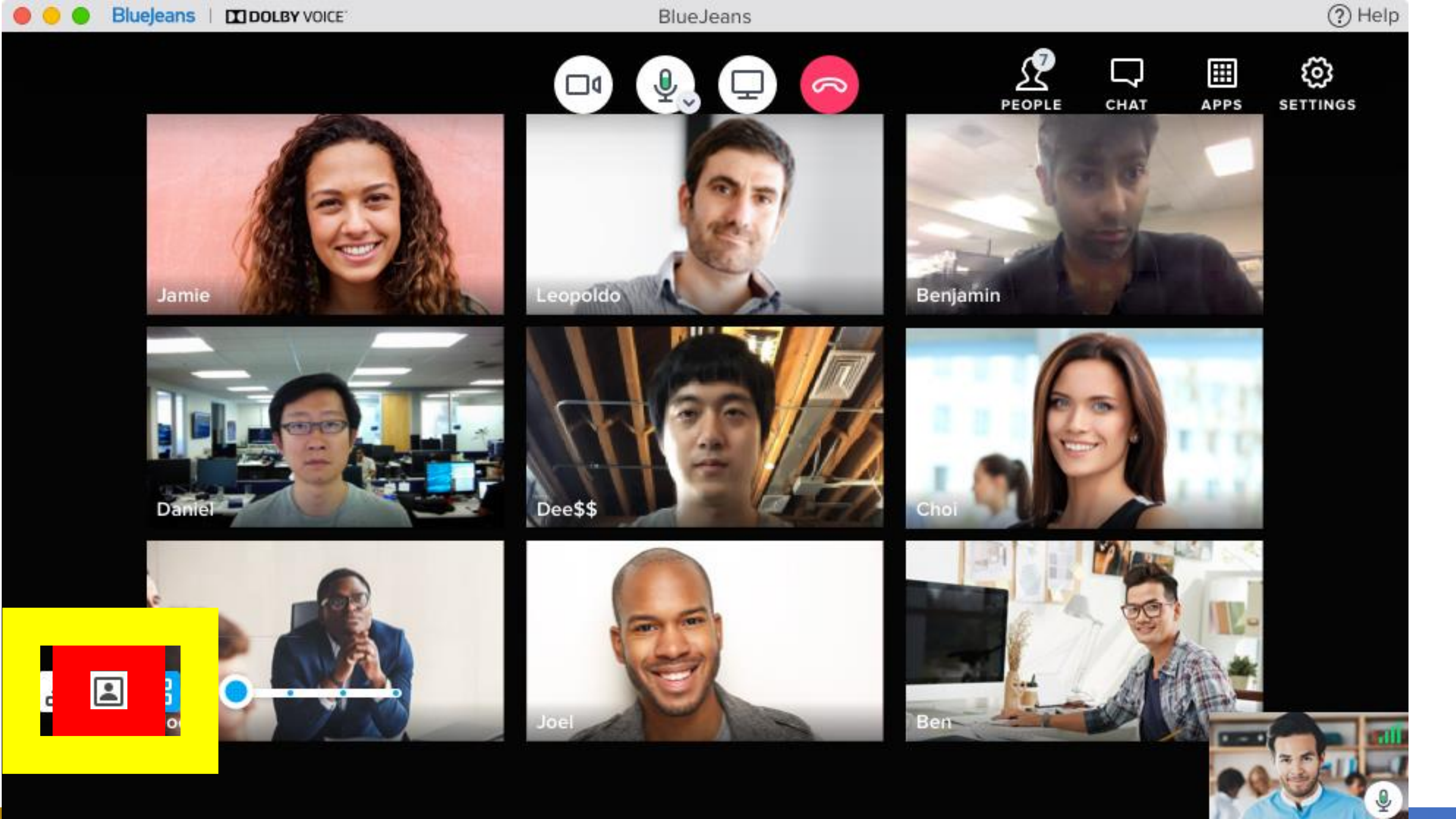
Our current task focus on solution activation

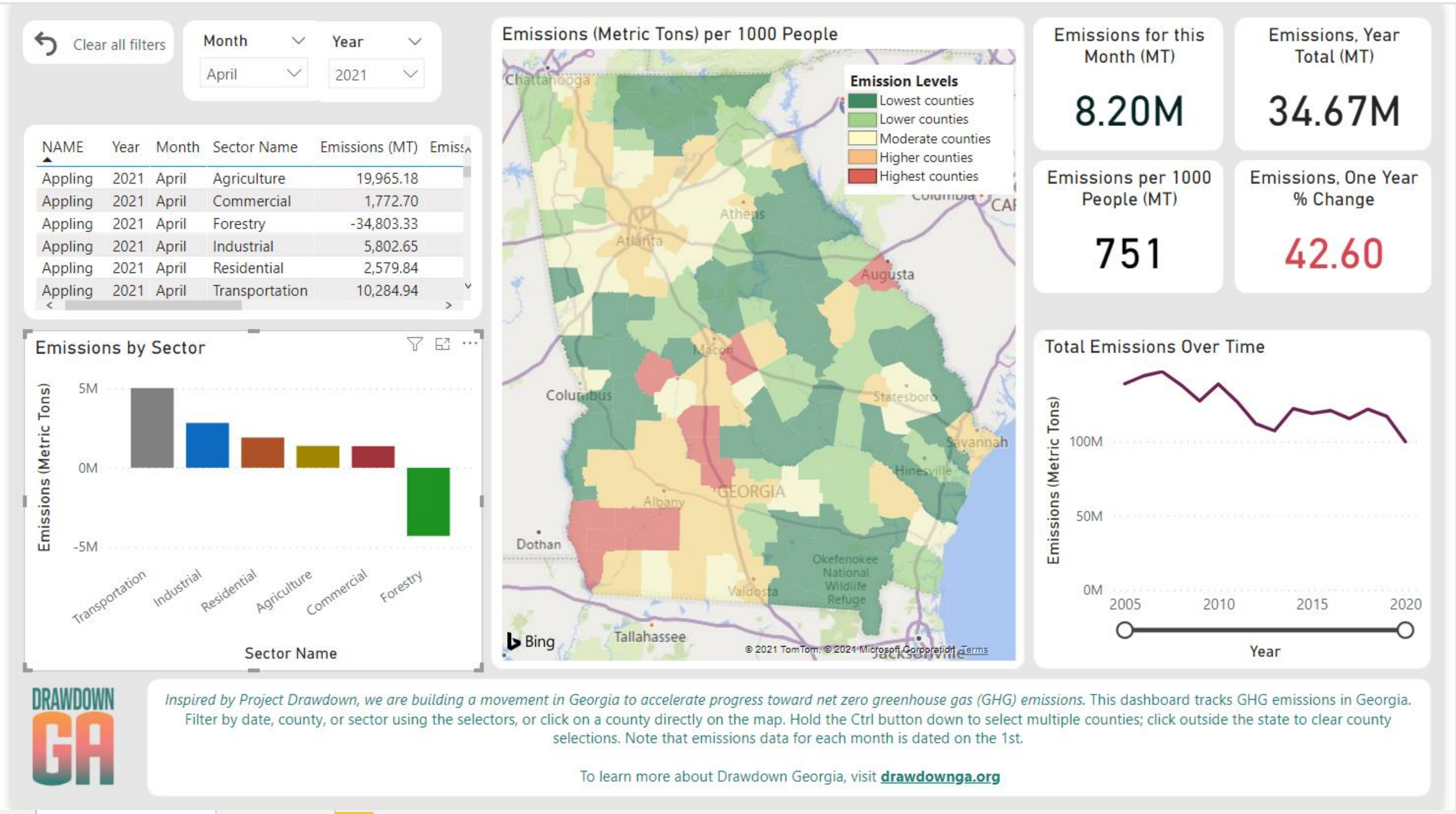
1. Tracking GHG Footprint of Georgia's Counties

2. Business Engagement

3. Planning and Tracking Solution Activation

Georgia Tech | University of Georgia | Emory University | the Ray C. Anderson foundation


BlueJeans
DOLBY VOICE
BlueJeans
Help
PEOPLE
CHAT
APPS
SETTINGS
Jamie
Leopoldo
Benjamin
Daniel
Dee$$
Choi
Joel
Ben


Clear all filters
Month
April
Year
2021
NAME
Year
Month
Sector Name
Emissions (MT)
Appling 2021 April Agriculture 19,965.18
Appling 2021 April Commercial 1,772.70
Appling 2021 April Forestry -34,803.33
Appling 2021 April Industrial 5,802.65
Appling 2021 April Residential 2,579.84
Appling 2021 April Transportation 10,284.94
Emissions by Sector
Emissions (Metric Tons)
5M
0M
-5M
Transportation
Industrial
Residential
Agriculture
Commercial
Forestry
Sector Name
Emissions (Metric Tons) per 1000 People
Emission Levels
Lowest counties
Lower counties
Moderate counties
Higher counties
Highest counties
Chattanooga
Athens
Atlanta
Augusta
Macon
Columbus
Statesboro
Savannah
Hinesville
GEORGIA
Albany
Dothan
Okefenokee National Wildlife Refuge
Valdosta
Tallahassee
Bing
© 2021 TomTom, © 2021 Microsoft Corporation Terms
Emissions for this Month (MT)
8.20M
Emissions, Year Total (MT)
34.67M
Emissions per 1000 People (MT)
751
Emissions, One Year % Change
42.60
Total Emissions Over Time
Emissions (Metric Tons)
100M
50M
0M
2005
2010
2015
2020
Year
DRAWDOWN GA
Inspired by Project Drawdown, we are building a movement in Georgia to accelerate progress toward net zero greenhouse gas (GHG) emissions. This dashboard tracks GHG emissions in Georgia.
Filter by date, county, or sector using the selectors, or click on a county directly on the map. Hold the Ctrl button down to select multiple counties; click outside the state to clear county selections. Note that emissions data for each month is dated on the 1st.
To learn more about Drawdown Georgia, visit drawdownga.org

Why Geospatial Tracking?

- Our goal is to construct an interactive, online dashboard to
- Give people **reasonable estimates** of their **local area** emissions up to the **most recent month** possible,
- In seven major sectors:
  - Electricity
  - Industrial
  - Commercial
  - Residential
  - Transportation
  - Agriculture
  - Forestry
- Using (mostly) open-source software and publicly available data

Our general strategy

- Identify **recent annual or monthly data sources** for Georgia statewide emissions, including
  - EPA's State Inventory Tool
  - EIA's Open Data API
  - US-DOT's Traffic Trends monthly VMT
- Allocate the statewide totals to individual counties with **plausible indicator variables**
- **Interpolate** annual data to monthly data when needed
- **Avoid** proprietary data
- **Avoid** data that is specific to a single state

Forestry sector emissions

Forestry data sources

- EPA State Inventory Tool (SIT) for statewide forestry uptake
- National Land Cover Dataset (NLCD)
  - 30-meter raster coverage with
  - 19 land use categories, including
  - Deciduous, evergreen, and mixed forest, and woody wetlands
- NOAA 1990-2020 station-level climatology with growing degree days between 50 and 86 degrees F
- Oak Ridge National Laboratory estimates of county forest flux from 2010-2016

Forestry strategy

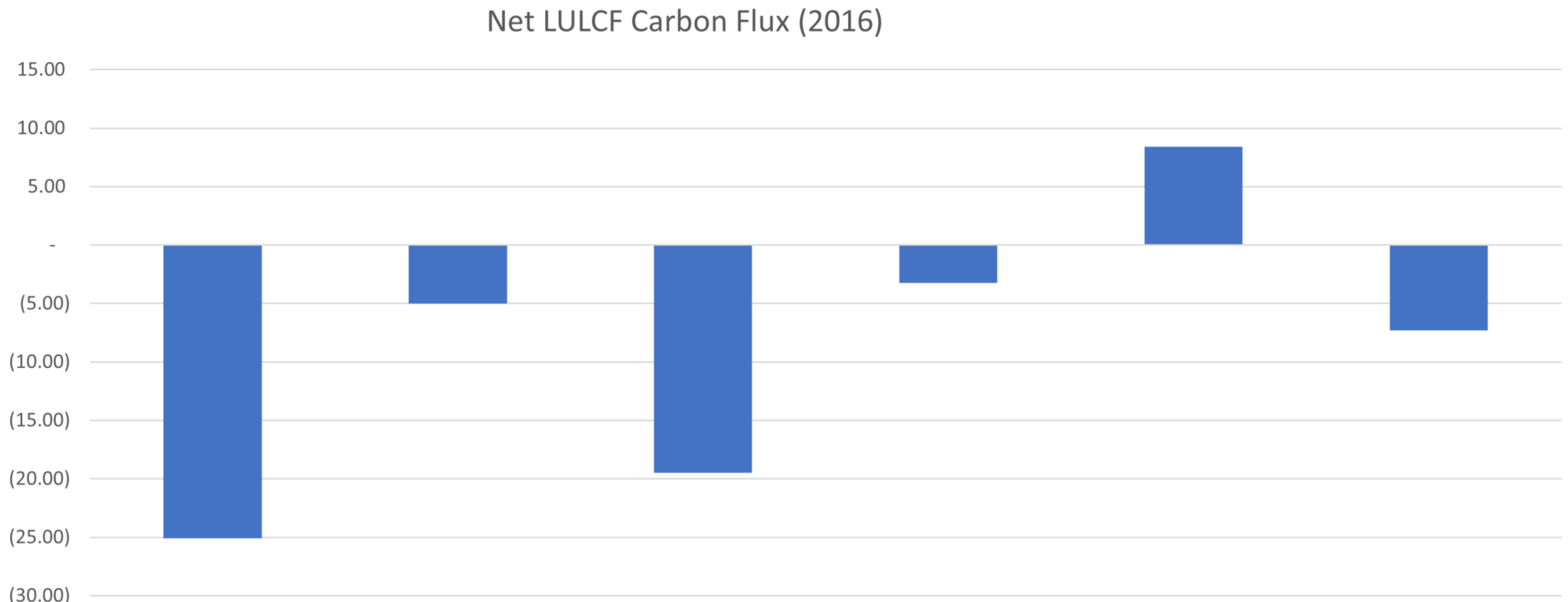
- Use **NLCD** to sum forestry area by county from four classes
- Interpolate between years and forecast by 10-year linear trend
- Use **ORNL** data to calculate county uptake per acre
- Multiply uptake per acre by county forest acres to calculate county uptake
- Calculate county percentage shares of statewide uptake
- Multiply **SIT** annual forestry uptake times county shares to calculate county annual uptake
- Calculate each county's total **GDDs** and each month's percentage of the annual total
- Multiply county GDD monthly shares times annual uptake to calculate monthly uptake

EPA State Inventory Tool for Georgia Forestry Emissions and Uptake in $MMTCO_2e$

Emissions by Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Energy	191.21	188.49	190.81	176.97	167.23	176.31	160.59	140.25	138.24	142.76	140.30	140.12	138.15	137.54	89%
CO_2 from Fossil Fuel Combustion	186.77	184.32	186.86	173.34	163.85	172.97	157.47	137.36	135.39	139.91	137.60	137.42	135.57	134.96	87%
Stationary Combustion	0.88	0.88	0.89	0.81	0.77	0.85	0.78	0.66	0.71	0.77	0.66	0.67	0.61	0.62	0%
Mobile Combustion	2.11	1.86	1.62	1.38	1.18	1.05	0.90	0.79	0.70	0.64	0.60	0.59	0.53	0.52	0%
Coal Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0%
Natural Gas and Oil Systems	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1%
Industrial Processes	4.66	4.98	5.20	5.65	5.92	6.20	6.38	6.51	6.59	6.88	7.00	6.96	7.03	7.13	5%
Agriculture	7.62	7.69	7.93	7.52	7.40	7.13	6.80	7.15	7.26	7.35	7.57	7.19	7.25	7.07	5%
Enteric Fermentation	2.15	2.11	2.10	2.02	1.97	1.92	1.87	1.90	1.86	1.90	1.89	1.99	1.99	1.92	1%
Manure Management	1.67	1.65	1.71	1.67	1.60	1.58	1.62	1.63	1.62	1.66	1.71	1.72	1.72	1.75	1%
Agricultural Soil Management	3.77	3.79	4.00	3.81	3.80	3.56	3.24	3.58	3.74	3.75	3.94	3.45	3.51	3.38	2%
Rice Cultivation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0%
Liming	0.03	0.12	0.10	-	-	0.03	0.05	-	-	-	-	-	-	-	0%
Urea	0.01	0.01	0.02	0.02	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0%
Burning of Agricultural Crop Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%
LULUCF	(48.77)	(49.14)	(49.37)	(49.65)	(49.93)	(50.71)	(51.63)	(52.49)	(53.13)	(53.88)	(53.17)	(52.59)	(51.89)	(51.19)	-33%
Waste	5.92	5.26	5.26	5.32	5.73	5.05	4.72	3.82	3.90	4.11	3.79	3.83	3.84	2.68	2%
Municipal Solid Waste	4.91	4.22	4.20	4.25	4.65	3.98	3.65	2.74	2.81	3.00	2.67	2.70	2.69	1.52	1%
Wastewater	1.01	1.04	1.06	1.07	1.08	1.07	1.07	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1%
Indirect CO_2 from Electricity Consumption*	89.93	91.95	94.02	88.30	81.42	87.56	79.49	70.98	69.78	71.67	68.36	66.08	61.29	61.80	40%
Gross Emissions	**209.40**	**206.42**	**209.20**	**195.46**	**186.29**	**194.69**	**178.50**	**157.73**	**155.99**	**161.09**	**158.66**	**158.10**	**156.27**	**154.42**	
Sinks	**(48.77)**	**(49.14)**	**(49.37)**	**(49.65)**	**(49.93)**	**(50.71)**	**(51.63)**	**(52.49)**	**(53.13)**	**(53.88)**	**(53.17)**	**(52.59)**	**(51.89)**	**(51.19)**	-33%
Net Emissions	**160.63**	**157.27**	**159.83**	**145.81**	**136.36**	**143.98**	**126.87**	**105.24**	**102.86**	**107.21**	**105.49**	**105.51**	**104.38**	**103.23**	

EPA SIT Land Use, Land Change, Forestry (LULCF)

major categories in $MMTCO_2e$



	Aboveground Biomass	Belowground Biomass	Total wood products and landfills	Land Converted to Forest Land	Forest Land Converted to Land	Urban Trees
Net LULCF Carbon Flux (2016)	(25.08)	(5.01)	(19.48)	(3.22)	8.41	(7.28)

EPA
State Inventory Tool

Land Use,
Land Use Change,
Forestry

Emissions* (MMTCO2E)	2005	2010	2016	2017	2018
Net Forest Carbon Flux	(42.31)	(43.67)	(44.72)	(43.91)	(43.11)
Forest Land Remaining Forest Land	(46.83)	(48.47)	(49.91)	(49.10)	(48.30)
Aboveground Biomass	(24.10)	(24.69)	(25.08)	(24.47)	(23.87)
Belowground Biomass	(4.92)	(4.99)	(5.01)	(4.88)	(4.75)
Deadwood	1.05	0.57	0.05	0.07	0.09
Litter	(0.79)	(0.77)	(0.69)	(0.64)	(0.60)
Soil (Mineral)	1.46	0.87	0.23	0.24	0.26
Soil (Organic)	(0.08)	(0.01)	0.03	0.02	0.02
Drained Organic Soil	0.04	0.04	0.04	0.04	0.04
Total wood products and landfills	(19.48)	(19.48)	(19.48)	(19.48)	(19.48)
Land Converted to Forest Land	(3.28)	(3.25)	(3.22)	(3.22)	(3.22)
Aboveground Biomass	(2.12)	(2.10)	(2.08)	(2.08)	(2.08)
Belowground Biomass	(0.40)	(0.40)	(0.39)	(0.39)	(0.39)
Deadwood	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
Litter	(0.58)	(0.58)	(0.57)	(0.57)	(0.57)
Soil (Mineral)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Forest Land Converted to Land	7.80	8.06	8.41	8.41	8.41
Aboveground Biomass	5.30	5.48	5.71	5.71	5.71
Belowground Biomass	1.05	1.09	1.13	1.13	1.13
Deadwood	0.32	0.33	0.34	0.34	0.34
Litter	1.03	1.07	1.11	1.11	1.11
Soil (Mineral)	0.10	0.10	0.11	0.11	0.11
Urban Trees	(5.73)	(6.44)	(7.28)	(7.43)	(7.57)
Landfilled Yard Trimmings and Food Scraps	-	-	-	-	-
Grass	-	-	-	-	-
Leaves	-	-	-	-	-
Branches	-	-	-	-	-
Landfilled Food Scraps	-	-	-	-	-
Forest Fires	-	-	-	-	-
CH4	-	-	-	-	-
N2O	-	-	-	-	-
N2O from Settlement Soils	-	-	-	-	-
Agricultural Soil Carbon Flux	(0.46)	(0.29)	(0.32)	(0.31)	(0.27)
Total	(48.51)	(50.39)	(52.32)	(51.65)	(50.95)

Georgia SIT harvested wood products in use and sequestered in land fills

- **US** 2019 total: **108.5** MMT
- **Georgia** SIT annual totals 1994-2018: **19.48** MMT
- If the Georgia SIT is correct,
  Georgia is sequestering 18% of US total harvested wood products, with about 3% of the US population
- Experts in an earlier session recommended omitting this category due to uncertainty and unavailability of reasonable substitute values

NLCD Forest Totals by County

COUNTY	Acres	Deciduous Forest 2000	Evergreen Forest 2000	Mixed Forest 2000	Woody Wetlands 2000	**Non-wetland Forest 2000**	**All Forest 2000**	Deciduous Forest 2011	Evergreen Forest 2011	Mixed Forest 2011	Woody Wetlands 2011	**Non-wetland Forest 2011**	**All Forest 2011**	Deciduous Forest 2016	Evergreen Forest 2016	Mixed Forest 2016	Woody Wetlands 2016	**Non-wetland Forest 2016**	**All Forest 2016**	**Square Miles**
Appling	328,027	1,686	94,684	3,933	94,916	100,304	195,220	1,403	91,944	3,562	89,603	96,908	186,511	1,084	85,222	3,119	91,312	89,425	180,738	**512.54**
Atkinson	220,550	1,302	72,091	2,357	67,065	75,750	142,816	1,173	74,499	1,830	65,340	77,502	142,842	967	71,801	1,539	66,463	74,306	140,769	**344.61**
Bacon	182,977	611	53,620	1,031	50,737	55,261	105,998	509	46,773	876	48,993	48,157	97,150	407	42,121	790	49,214	43,317	92,532	**285.90**
Baker	223,242	5,649	51,744	9,840	35,972	67,232	103,204	5,119	52,177	9,773	35,885	67,069	102,953	4,989	52,555	9,793	35,470	67,338	102,808	**348.82**
Baldwin	171,703	38,024	40,594	19,023	11,706	97,641	109,346	37,137	42,508	20,200	11,762	99,845	111,607	35,474	43,918	20,526	11,535	99,918	111,453	**268.29**
Banks	149,684	72,180	6,904	11,797	4,426	90,881	95,306	67,682	7,279	12,993	4,301	87,954	92,255	68,275	7,331	13,615	4,434	89,220	93,654	**233.88**
Barrow	104,266	30,118	8,464	8,215	3,129	46,797	49,926	26,753	7,738	8,652	3,038	43,143	46,181	27,217	7,851	8,922	3,060	43,989	47,050	**162.91**
Bartow	300,837	85,168	54,212	27,728	841	167,108	167,949	76,639	51,624	27,583	768	155,846	156,614	76,835	53,442	28,472	756	158,749	159,505	**470.06**
Ben Hill	162,501	2,343	57,668	3,702	32,614	63,713	96,326	2,270	61,862	3,597	32,665	67,730	100,395	1,951	56,321	3,322	32,503	61,593	94,096	**253.91**
Berrien	293,055	1,796	83,649	4,099	81,176	89,544	170,720	1,725	85,836	3,934	81,001	91,494	172,495	1,659	82,373	3,669	80,945	87,701	168,646	**457.90**
Bibb	163,448	21,764	17,080	23,063	23,280	61,906	85,187	18,274	16,065	22,601	23,171	56,940	80,110	18,428	17,128	23,019	23,512	58,575	82,087	**255.39**
Bleckley	140,238	6,283	31,192	10,387	23,439	47,863	71,303	5,259	30,068	9,421	23,191	44,747	67,938	4,971	30,840	9,477	23,449	45,289	68,737	**219.12**
Brantley	286,511	122	105,503	273	111,557	105,898	217,454	189	84,285	127	109,293	84,600	193,893	222	72,684	83	111,863	72,988	184,851	**447.67**
Brooks	318,554	3,534	80,412	14,501	76,565	98,446	175,011	3,197	81,683	13,549	77,226	98,429	175,655	2,933	79,508	13,219	77,358	95,660	173,018	**497.74**
Bryan	291,266	540	112,638	2,431	95,289	115,609	210,898	491	110,326	2,011	95,327	112,829	208,155	469	105,024	1,612	95,856	107,105	202,961	**455.10**
Bulloch	441,196	2,427	75,402	5,676	147,359	83,504	230,864	2,406	81,330	5,091	145,979	88,827	234,806	2,157	77,574	4,628	146,529	84,358	230,887	**689.37**
Burke	534,000	34,811	103,084	6,587	146,332	144,482	290,814	36,446	100,322	6,070	145,435	142,838	288,273	39,009	92,067	5,714	145,233	136,790	282,023	**834.37**
Butts	120,326	34,483	32,155	7,940	4,706	74,578	79,284	33,449	31,364	8,774	4,412	73,587	77,999	34,191	31,625	8,943	4,518	74,759	79,277	**188.01**
Calhoun	181,777	5,789	26,281	9,440	51,569	41,511	93,079	5,226	28,226	9,328	51,737	42,780	94,516	5,009	27,771	9,291	51,554	42,070	93,624	**284.03**
Camden	501,016	2,598	142,536	254	122,720	145,389	268,109	3,037	139,720	191	122,311	142,948	265,259	3,173	134,097	160	122,830	137,430	260,259	**782.84**
Candler	159,389	945	34,240	2,695	45,029	37,881	82,910	956	34,646	2,640	44,771	38,242	83,013	861	33,356	2,546	44,571	36,763	81,334	**249.05**

National Land Cover Database for Georgia

Four forest categories

	2000	2011	2016
Class	Acres	Acres	Acres
Open Water	1,050,574	1,050,929	1,060,373
Developed, Open Space	1,986,056	2,126,078	2,127,867
Developed, Low Intensity	943,459	1,050,108	1,067,677
Developed, Medium intensity	244,865	327,416	346,458
Developed, High Intensity	120,131	152,025	159,294
Barren Land (Rock/sand/clay)	108,446	97,624	96,830
Deciduous Forest	5,354,596	5,030,301	5,007,394
Evergreen Forest	9,113,839	9,027,059	8,869,614
Mixed Forest	2,506,163	2,520,095	2,535,707
Shrub/Scrub	966,344	1,283,361	1,305,342
Grassland/Herbaceous	1,699,585	1,733,657	1,761,765
Pasture/Hay	2,865,822	2,627,972	2,634,059
Cultivated Crops	4,499,754	4,437,127	4,495,167
Woody Wetlands	5,977,217	5,900,898	5,957,339
Emergent Herbaceous Wetlands	600,522	672,752	612,572
	38,037,374	38,037,402	38,037,458

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CMS: Forest Carbon Stocks, Emissions, and Net Flux for the Conterminous US: 2005-2010

Get Data

Documentation Revision Date: 2016-05-31

Data Set Version: V1

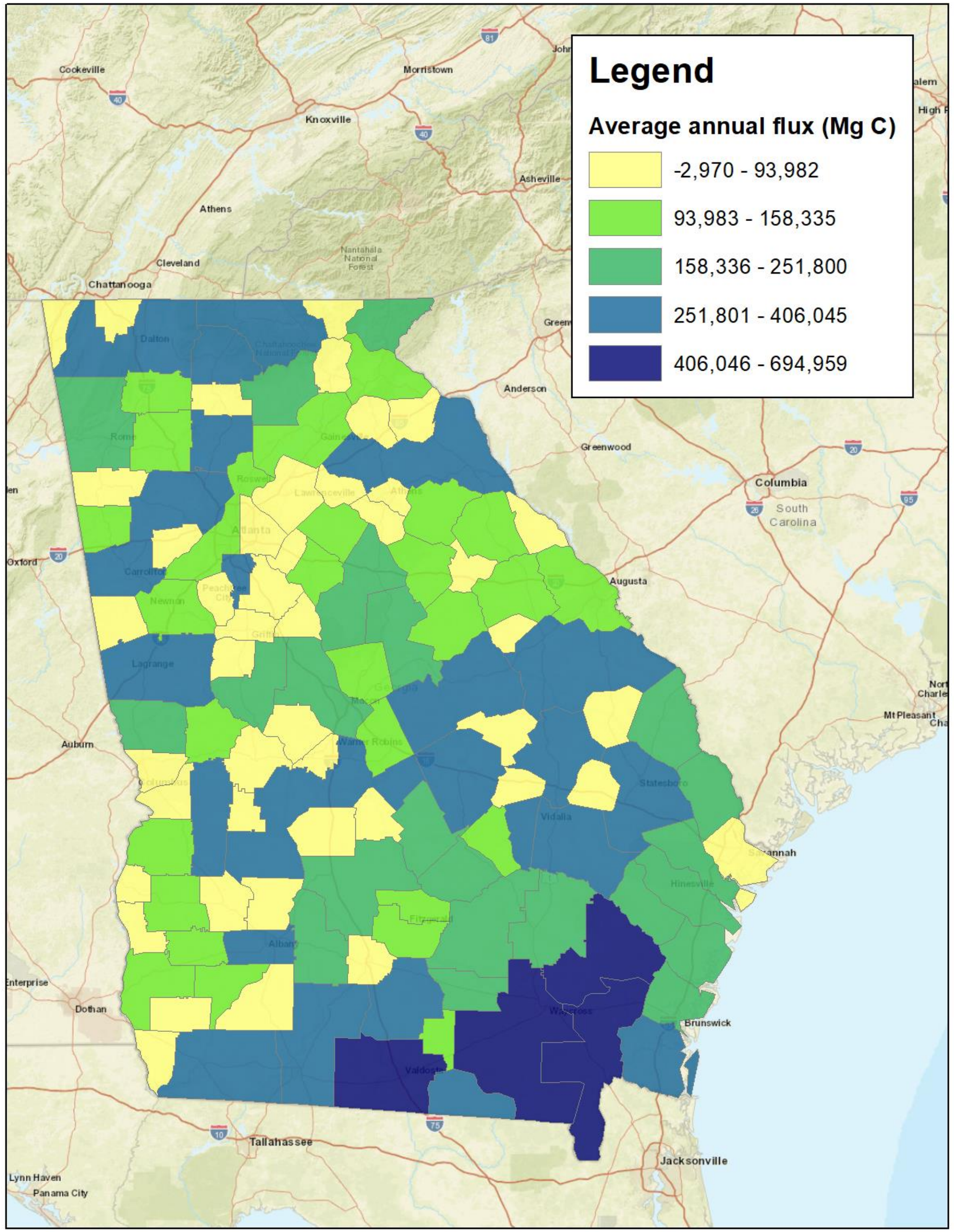
Summary

This data set provides maps of estimated carbon in forests of the 48 continental states of the US for the years 2005-2010. Carbon (termed committed carbon) stocks were estimated for forest aboveground biomass, belowground biomass, standing dead stems, and litter for the year 2005. Carbon emissions were estimated from land use conversion to agriculture, insect damage, logging, wind, and weather events in the forests for the years 2006 - 2010. Committed net carbon flux was estimated as the sum of carbon emissions and sequestration. The maps are provided at 100-m spatial resolution in GeoTIFF format. Average annual carbon estimates, by US county, for (1) emissions for the multiple disturbance sources, (2) sequestration, and (3) the committed net carbon flux are provided in an ESRI shapefile.

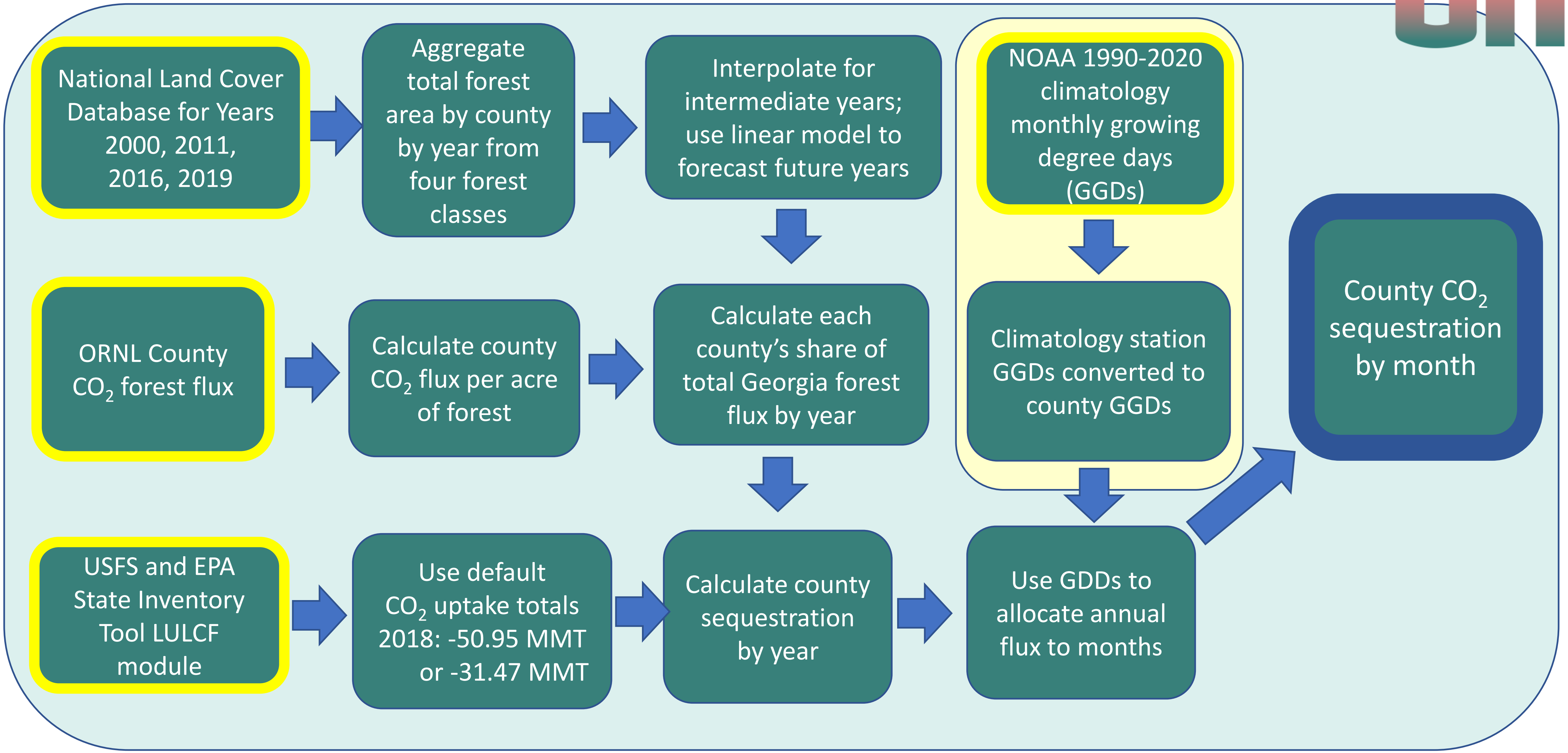
Data sources included forest carbon stock maps, tree cover change data, Forest Inventory and Analysis Database (FIA) plot data, biomass derived from Geoscience Laser Altimeter System (GLAS) data, and auxiliary spatial data sets collected by various US agencies on types of forest disturbances. The data were integrated into a synthesis framework to attribute changes in forest carbon stocks to specific disturbances in the forests and to estimate the spatial distribution of carbon emissions and removals across US forest lands.

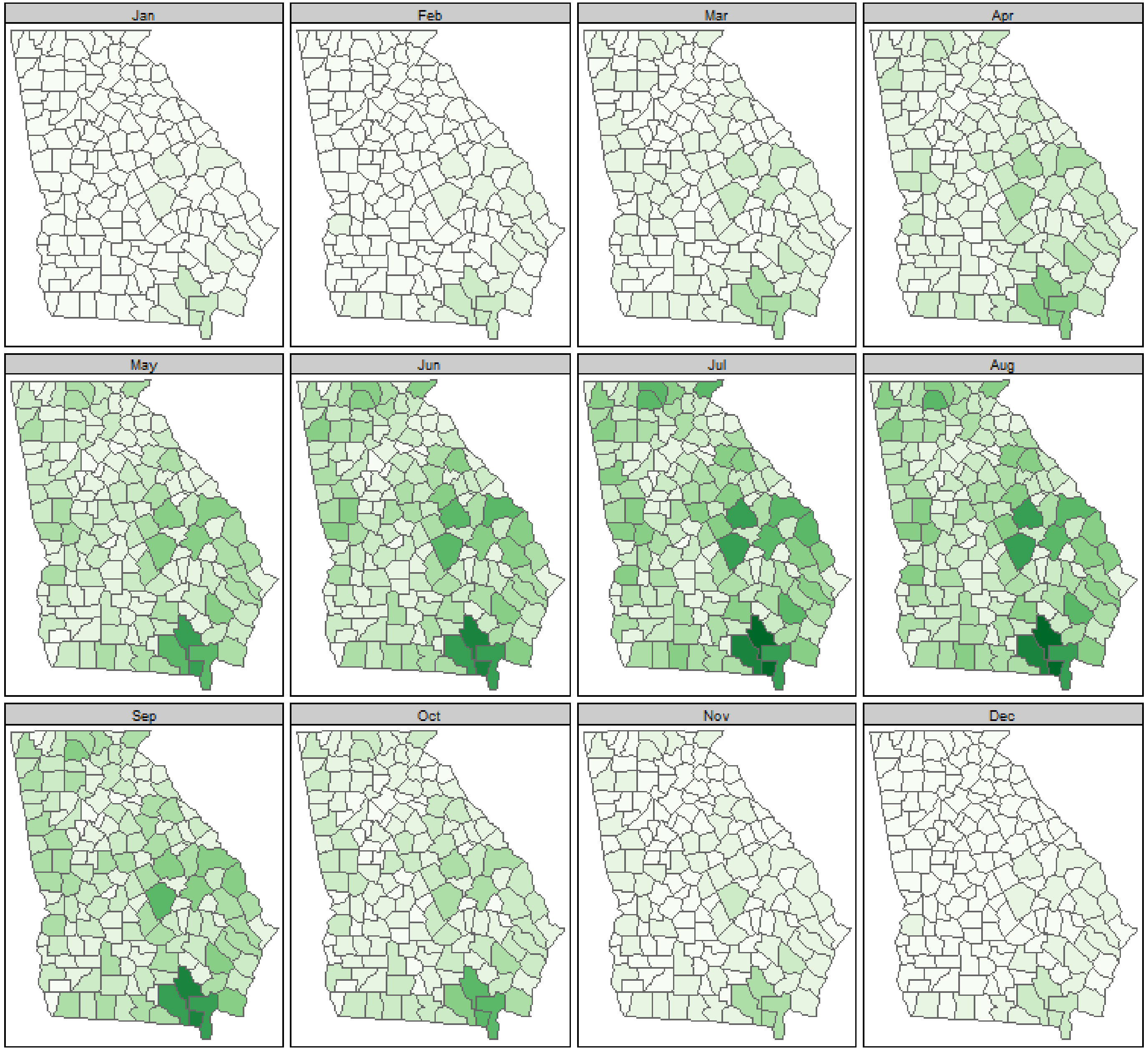
Committed net carbon flux was estimated as the sum of gross committed carbon emissions and carbon sequestration. This committed net carbon flux includes future emissions from decomposing plant matter killed during disturbances occurring between 2006 and 2010 and does not include the same type of flux resulting from disturbances occurring before 2006.

Hagen, S., N. Harris, S.S. Saatchi, T. Pearson, C.W. Woodall, S. Ganguly, G.M. Domke, B.H. Braswell, B.F. Walters, J.C. Jenkins, S. Brown, W.A. Salas, A. Fore, Y. Yu, R.R. Nemani, C. Ipsan, and K.R. Brown. 2016. CMS: Forest Carbon Stocks, Emissions, and Net Flux for the Conterminous US: 2005-2010. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1313



Forestry calculations





2018 Monthly Forest Uptake in Metric Tons of CO_2

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Agriculture sector emissions

Agriculture data sources

1. EPA State Inventory Tool **(SIT)** for statewide agriculture emissions in three categories:
   a. Agricultural soil management **(ASM)**
   b. Enteric fermentation **(EF)**
   c. Manure management **(MM)**
2. NOAA 1990-2020 station-level climatology with number of growing degree days **(GGDs)** between 50 and 86 degrees F
3. US Department of Agriculture **(USDOA)** Census of Agriculture data for 2002, 2007, 2012, and 2017 for area of harvested **cropland** and **animal inventory counts** by county
4. US Department of Agriculture "Animal Feeding Operations" webpage on **animal unit** definitions
5. US Department of Agriculture "Agricultural Waste Management Field Handbook" on **manure generation** values by animal unit

Agriculture basic strategy

1. Download USDOA Census county-level values for harvested cropland, layer chickens, broiler chickens, dairy cattle, beef cattle, and hogs; interpolate annual values between Census years
2. Calculate county annual shares of cropland; distribute to months based on GDDs for ASM shares
3. Calculate each county's share of cattle for EF shares
4. Divide animal inventory counts by animal unit factors, multiply times manure generation factor, sum across animal types, calculate county shares of statewide manure for MM shares
5. Read SIT values for three agricultural emissions categories (ASM, EF, and MM), use 2009-2018 linear trend to forecast 2019-2021 values
6. Multiply SIT statewide ASM, EF, and MM values by shares of cropland, cattle, and manure generated; add county emissions from agricultural distillate fuel for total county agriculture sector emissions

EPA State Inventory Tool for Georgia Agriculture and Forestry Emissions and Uptake in $MMTCO_2e$

Emissions by Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Energy	191.21	188.49	190.81	176.97	167.23	176.31	160.59	140.25	138.24	142.76	140.30	140.12	138.15	137.54	89%
CO_2 from Fossil Fuel Combustion	186.77	184.32	186.86	173.34	163.85	172.97	157.47	137.36	135.39	139.91	137.60	137.42	135.57	134.96	87%
Stationary Combustion	0.88	0.88	0.89	0.81	0.77	0.85	0.78	0.66	0.71	0.77	0.66	0.67	0.61	0.62	0%
Mobile Combustion	2.11	1.86	1.62	1.38	1.18	1.05	0.90	0.79	0.70	0.64	0.60	0.59	0.53	0.52	0%
Coal Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0%
Natural Gas and Oil Systems	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1%
Industrial Processes	4.66	4.98	5.20	5.65	5.92	6.20	6.38	6.51	6.59	6.88	7.00	6.96	7.03	7.13	5%
Agriculture	7.62	7.69	7.93	7.52	7.40	7.13	6.80	7.15	7.26	7.35	7.57	7.19	7.25	7.07	5%
Enteric Fermentation	2.15	2.11	2.10	2.02	1.97	1.92	1.87	1.90	1.86	1.90	1.89	1.99	1.99	1.92	1%
Manure Management	1.67	1.65	1.71	1.67	1.60	1.58	1.62	1.63	1.62	1.66	1.71	1.72	1.72	1.75	1%
Agricultural Soil Management	3.77	3.79	4.00	3.81	3.80	3.56	3.24	3.58	3.74	3.75	3.94	3.45	3.51	3.38	2%
Rice Cultivation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0%
Liming	0.03	0.12	0.10	-	-	0.03	0.05	-	-	-	-	-	-	-	0%
Urea	0.01	0.01	0.02	0.02	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0%
Burning of Agricultural Crop Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%
LULUCF	(48.77)	(49.14)	(49.37)	(49.65)	(49.93)	(50.71)	(51.63)	(52.49)	(53.13)	(53.88)	(53.17)	(52.59)	(51.89)	(51.19)	-33%
Waste	5.92	5.26	5.26	5.32	5.73	5.05	4.72	3.82	3.90	4.11	3.79	3.83	3.84	2.68	2%
Municipal Solid Waste	4.91	4.22	4.20	4.25	4.65	3.98	3.65	2.74	2.81	3.00	2.67	2.70	2.69	1.52	1%
Wastewater	1.01	1.04	1.06	1.07	1.08	1.07	1.07	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1%
Indirect CO_2 from Electricity Consumption*	89.93	91.95	94.02	88.30	81.42	87.56	79.49	70.98	69.78	71.67	68.36	66.08	61.29	61.80	40%
Gross Emissions	**209.40**	**206.42**	**209.20**	**195.46**	**186.29**	**194.69**	**178.50**	**157.73**	**155.99**	**161.09**	**158.66**	**158.10**	**156.27**	**154.42**	
Sinks	**(48.77)**	**(49.14)**	**(49.37)**	**(49.65)**	**(49.93)**	**(50.71)**	**(51.63)**	**(52.49)**	**(53.13)**	**(53.88)**	**(53.17)**	**(52.59)**	**(51.89)**	**(51.19)**	-33%
Net Emissions	**160.63**	**157.27**	**159.83**	**145.81**	**136.36**	**143.98**	**126.87**	**105.24**	**102.86**	**107.21**	**105.49**	**105.51**	**104.38**	**103.23**	

USDA animal units

- An animal unit is defined as an animal equivalent of 1000 pounds live weight and equates to

  1000 head of beef cattle,
  700 dairy cows,
  2500 swine weighing more than 55 lbs,
  125 thousand broiler chickens, or
  82 thousand laying hens or pullets

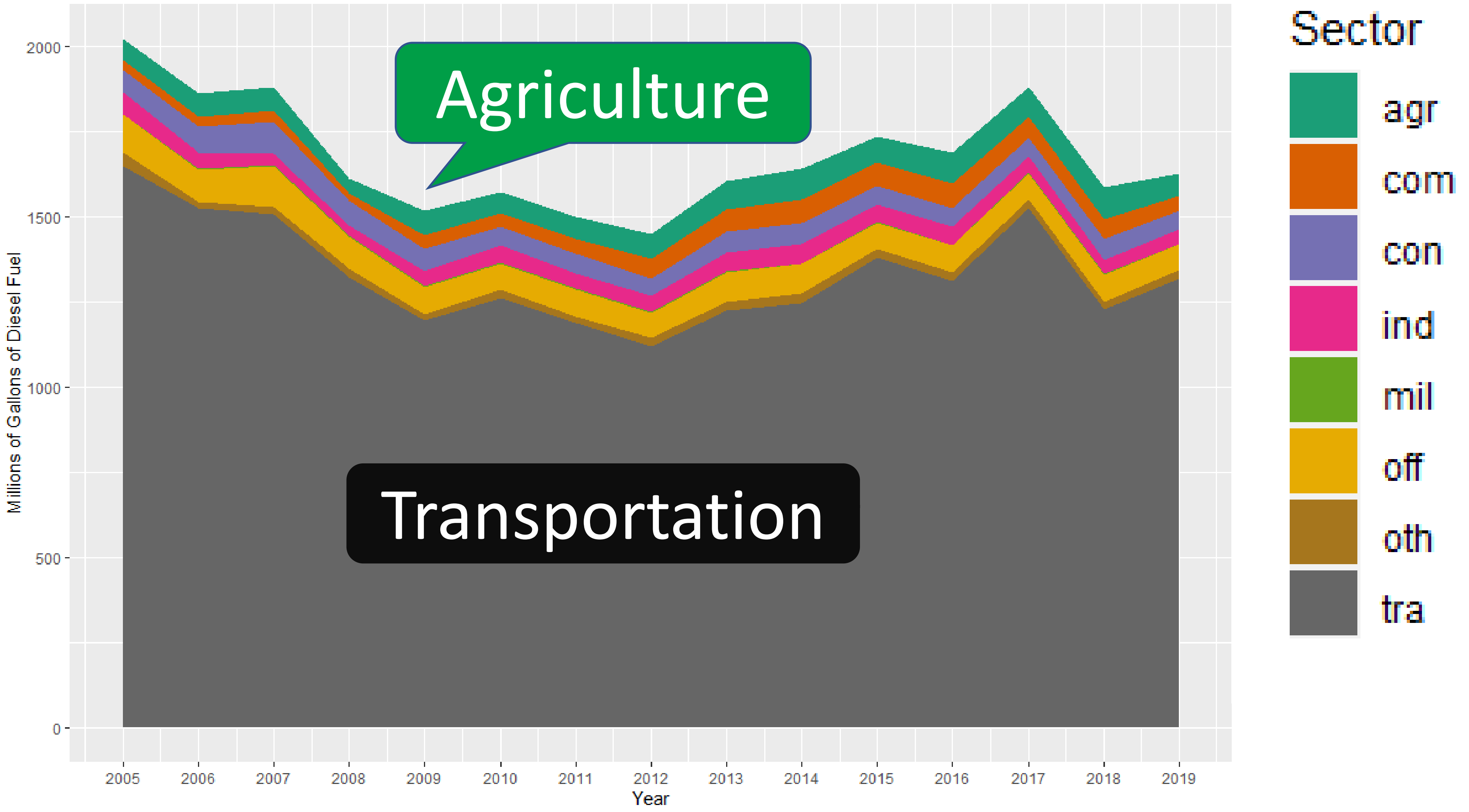
USDA manure generation by livestock type

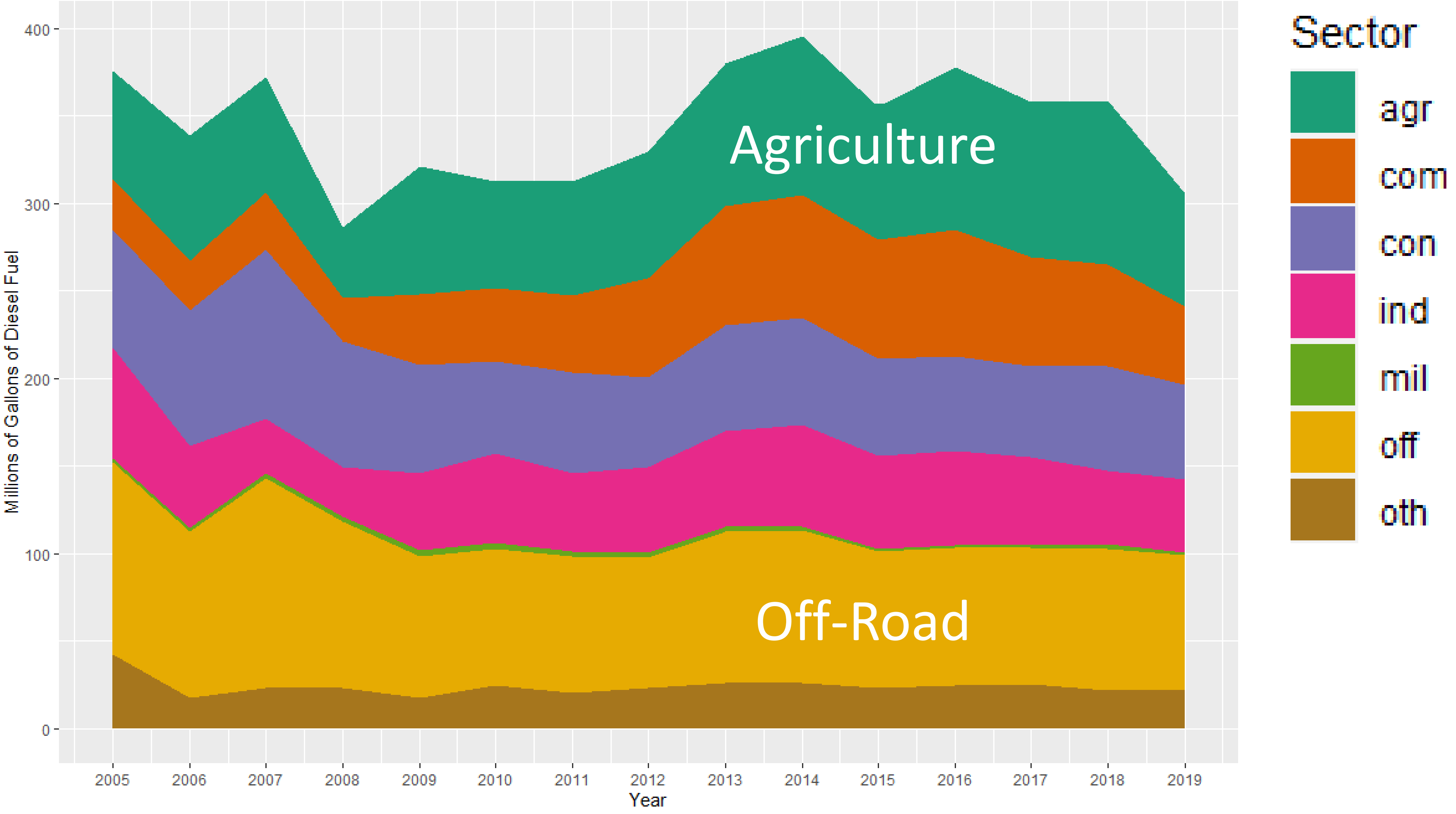
Livestock type	Total manure	Nitrogen	Phosphorus
	------- lbs/day/1000-lb animal unit -------		
Beef[1]	59.1	0.31	0.11
Dairy[2]	80.0	0.45	0.07
Hogs and pigs[3]	63.1	0.42	0.16
Chickens (layers)	60.5	0.83	0.31
Chickens (broilers)	80.0	1.10	0.34
Turkeys	43.6	0.74	0.28

[1]High forage diet. [2]Lactating cow. [3]Grower.

Source: USDA Natural Resources Conservation Service. Agricultural Waste Management Handbook (1992)

Georgia Diesel Fuel Consumption by Sector




Agriculture
Off-Road
Millions of Gallons of Diesel Fuel
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
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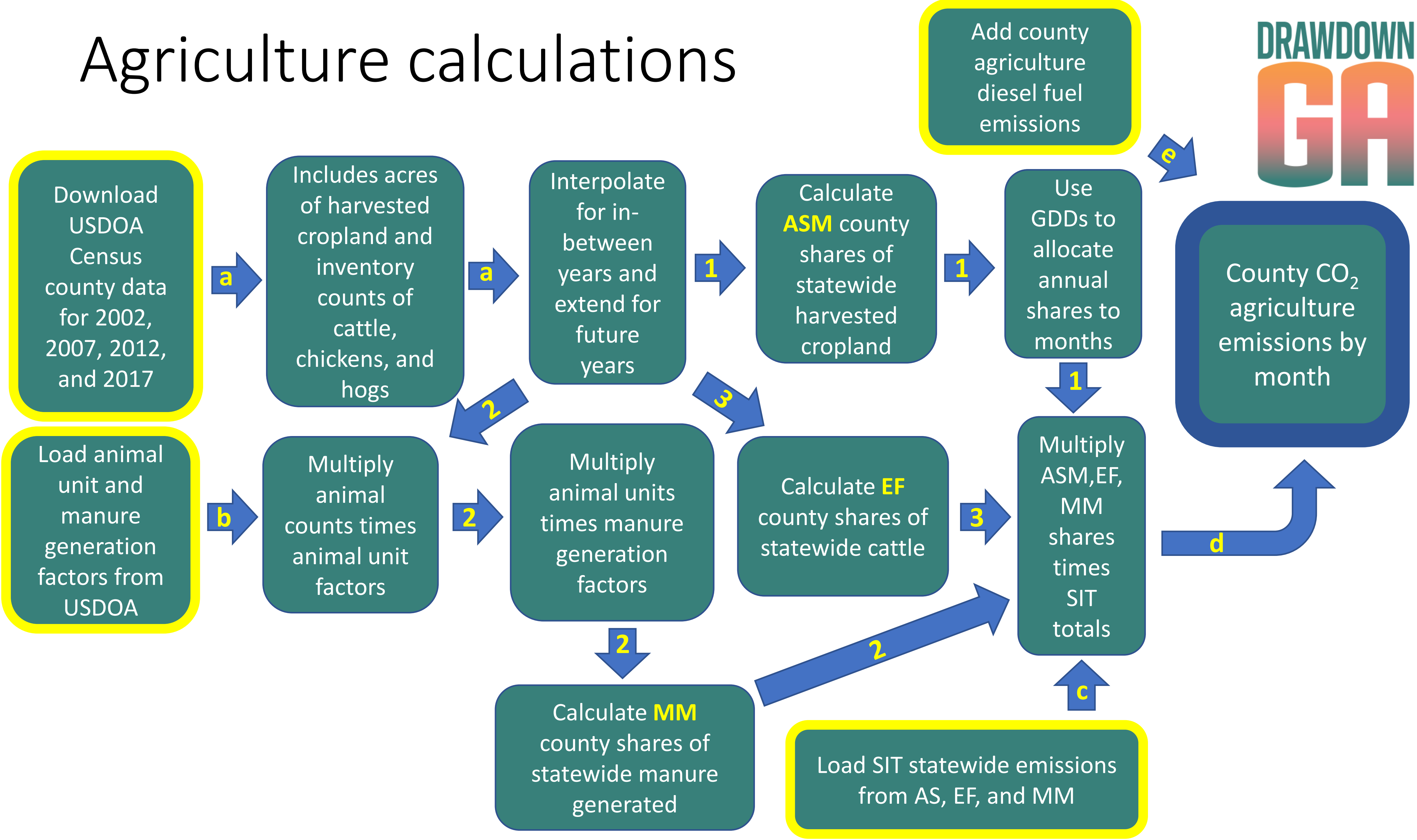
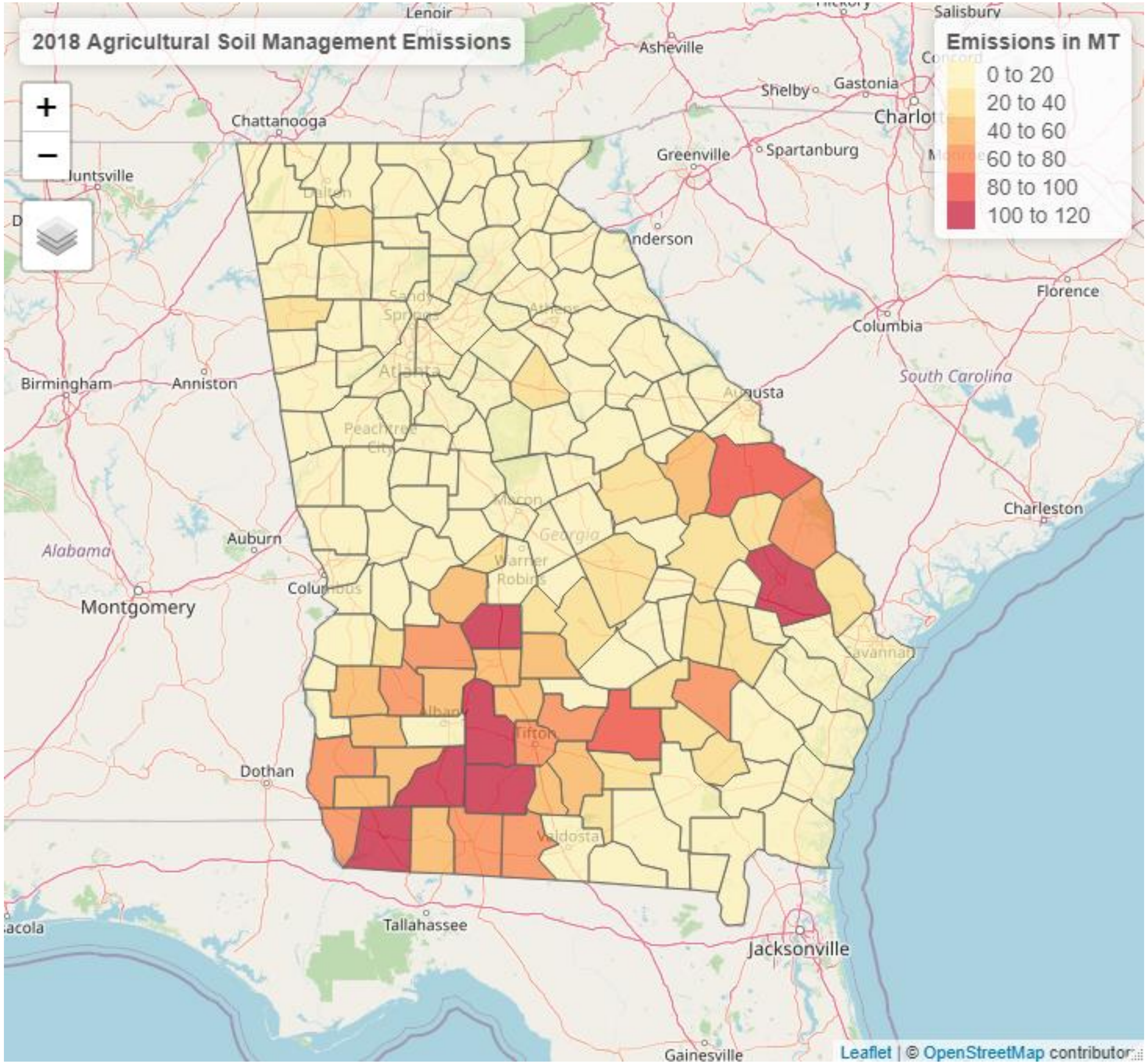
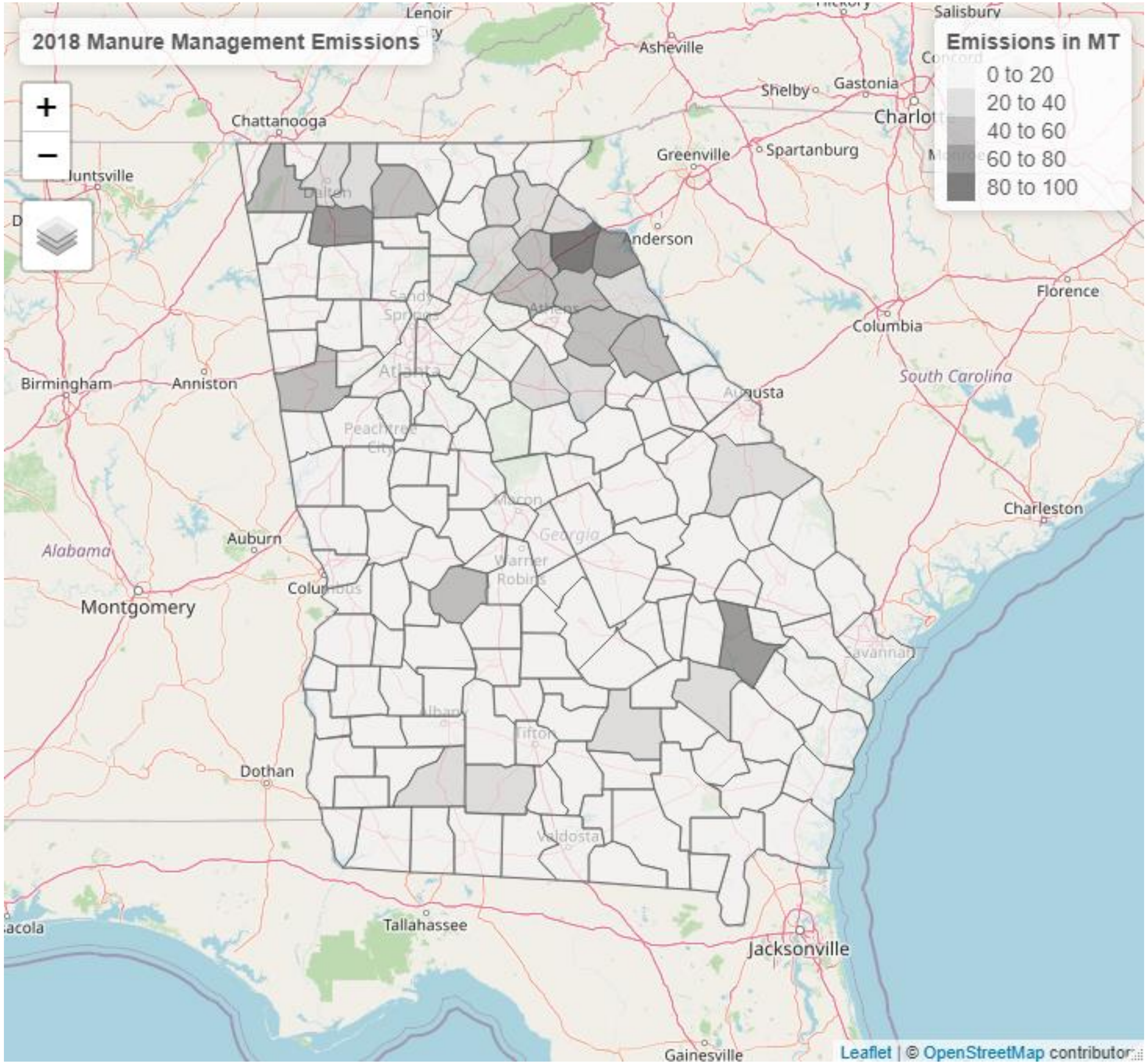
Agriculture calculations



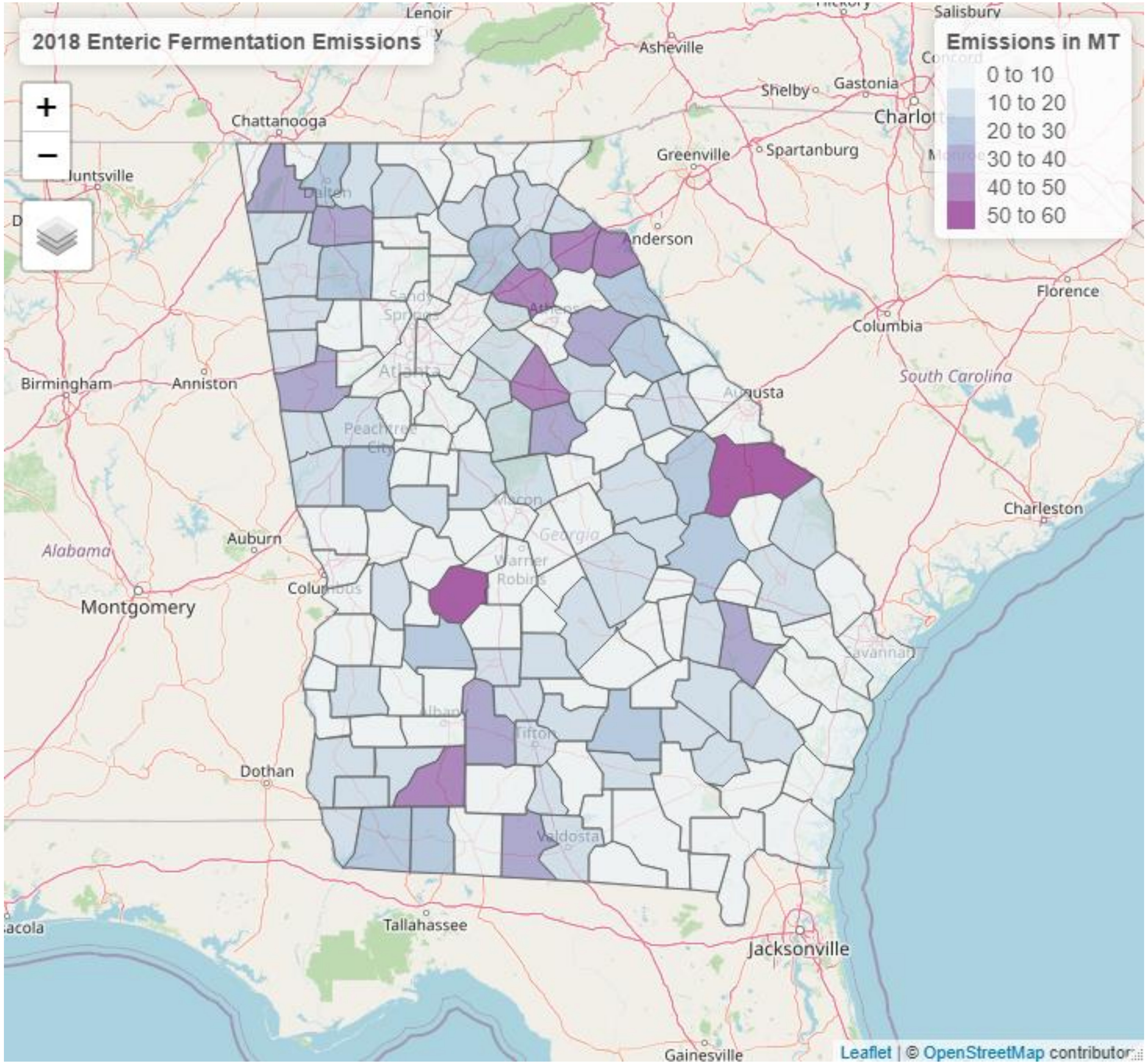
Total 2018 agricultural soil management emissions in metric tons of CO_2e



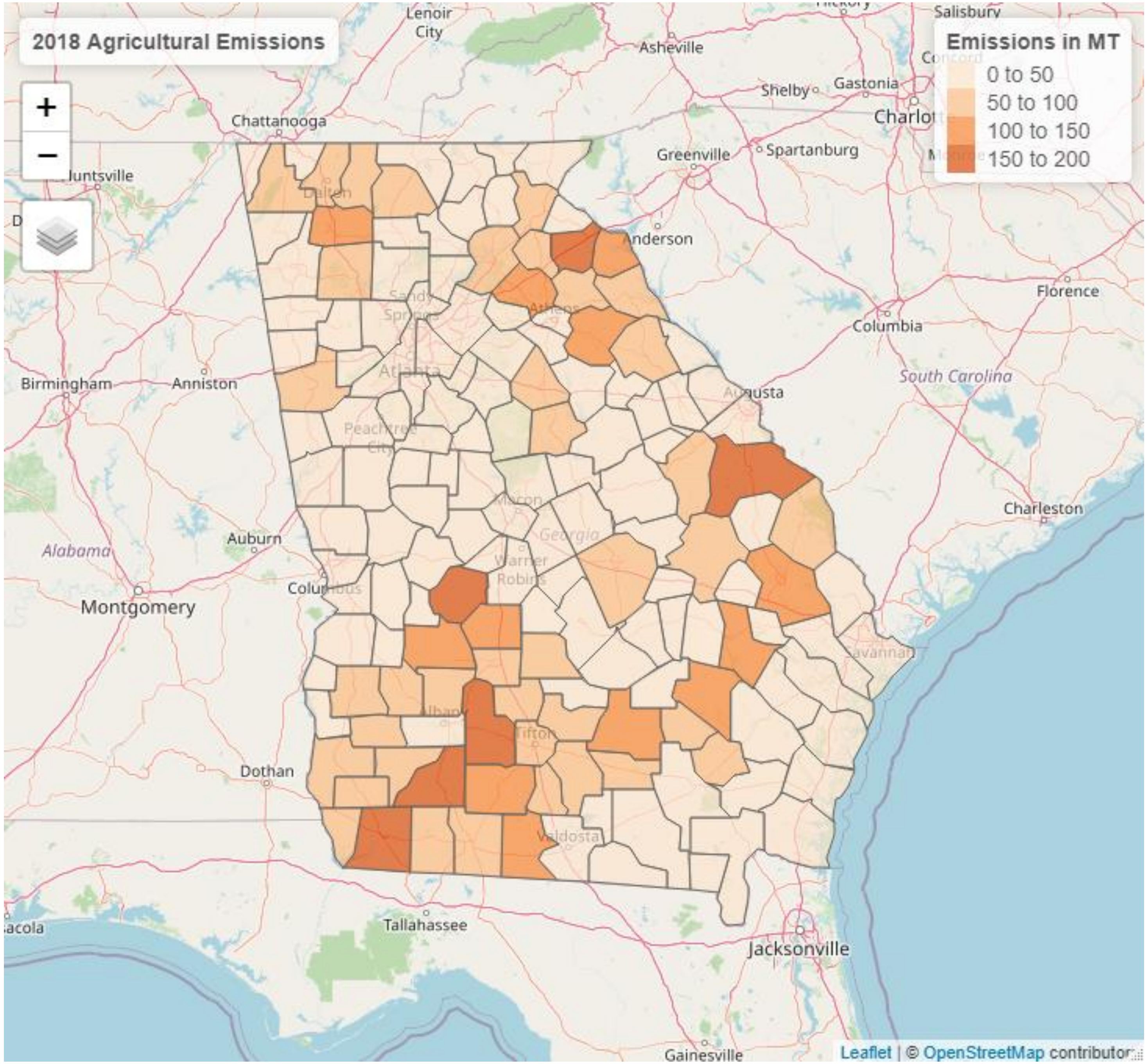
Total 2018 manure management emissions in metric tons of CO_2e



Total 2018 enteric fermentation emissions in metric tons of CO_2e



Total 2018 agricultural emissions in metric tons of CO_2e



Agriculture and forestry sectors discussion and questions

Possible discussion questions

- Are there better data sources for **state-level forest emissions/uptake** than the State Inventory Tool, and for 2005-present **local-level forest land cover** than the NLCD?
- Can you recommend a published or standard source for **CO_2 per acre forest uptake factors** for the Georgia NLCD forest categories: deciduous, evergreen, mixed, and woody wetlands?
- How should we handle the county locations for **harvested wood products** and landfill wood products (38% of total Georgia LULUCF flux)?
- Are there more direct (and less complex) ways to calculate county **manure management** values?
- Are the **SIT** overall agricultural values reasonable?

THANKS!

For more information:
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