

**Effects of Climate and Anthropogenic Drivers on Surface Water Area in the  
Southeastern United States**

Mollie D. Gaines<sup>1\*</sup>, Mirela G. Tulbure<sup>1,2</sup>, Vinicius Perin<sup>1</sup>

<sup>1</sup>Center for Geospatial Analytics, North Carolina State University, 2800 Faucette Drive, Raleigh, NC 27695, USA.

<sup>2</sup>Department of Forestry and Environmental Resources, North Carolina State University, 2820 Faucette Drive, Raleigh, NC 27695, USA.

\*Corresponding author: Mollie Gaines (mdgaines@ncsu.edu)

**Contents of this file**

Figure S1  
Tables S1 to S4

**Additional Supporting Information (Files uploaded separately)**

None

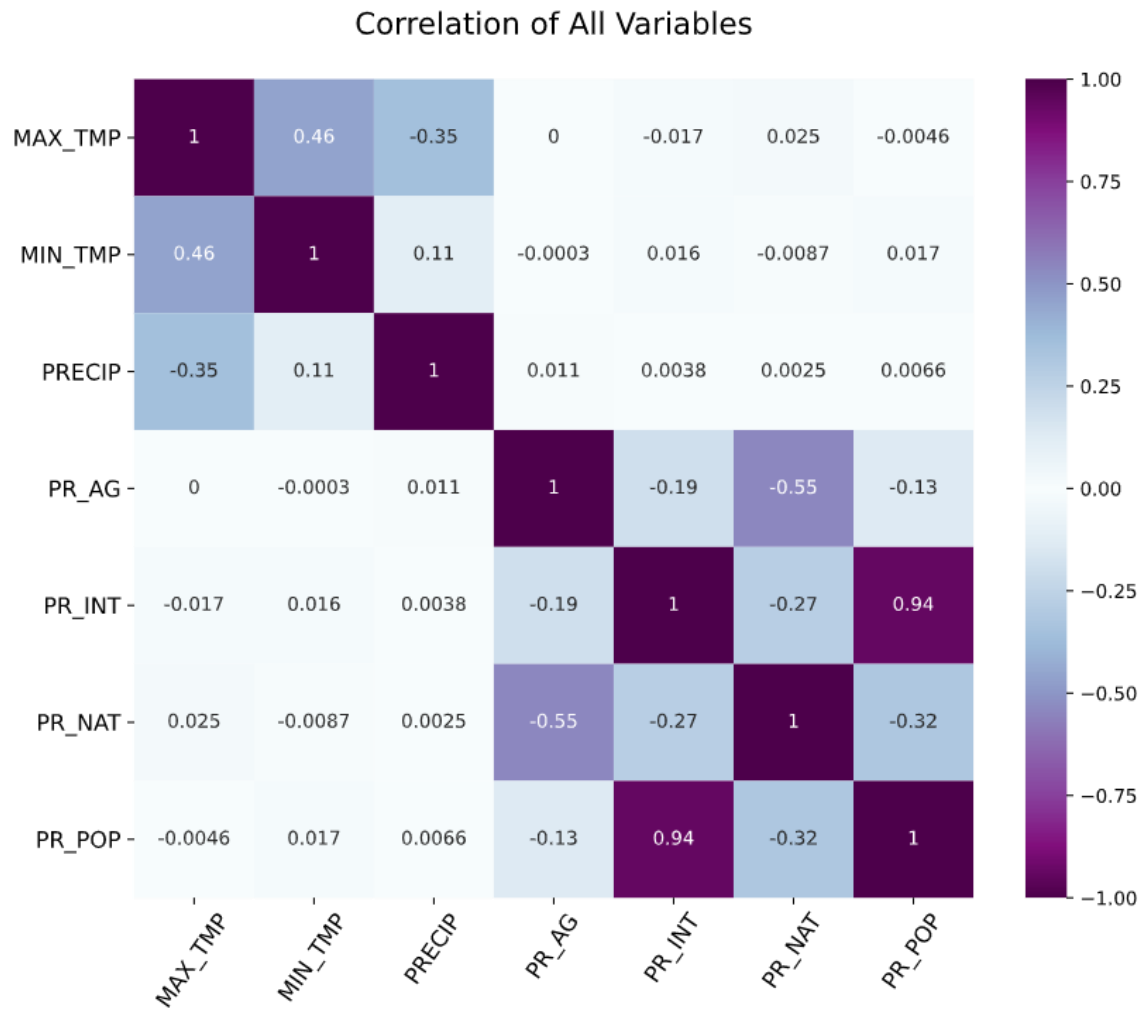
**Introduction**

The figure and tables in this document are meant to provide additional, more specific information regarding the methods and model validation reported in the main article. The data used for these figures and tables includes the Dynamic Surface Water Extent (DSWE) data product from the U.S. Geological Survey (USGS; Jones, 2015, 2019), Gridded Surface Meteorological (GRIDMET) dataset from the University of Idaho (Abatzoglou, 2013), the Cropland Data Layer (CDL) dataset from the U.S. Department of Agriculture

National Agricultural Statistics Services ("CropScape - NASS CDL Program"), the National Land Cover Dataset from the USGS (Homer et al., 2020), and LandScan data produced by Oak Ridge National Laboratory (Rose et al., 2020).

The data have been processed such that satellite-derived surface water data (DSWE) were aggregated as total maximum percent surface water area seasonally at the watershed scale for 2000-2018. Gridded daily climate data (GRIDMET) were aggregated to seasonal anomalies at the watershed (8-digit Hydrological Unit Code) scale for 2000-2018. Land cover data were reclassified (CDL and NLCD, specific reclassifications outlined in Tables S1 and S2), combined (Table S3), and aggregated annually at the watershed scale for 2000-2018. Population data (LandScan) were aggregated annually in conjunction with watershed area to population density data at the watershed scale for 2000-2018.

DSWE has been shown to have approximately 80% accuracy, with some reports of cloud shadow anomalies and artifacts contributing to small errors (Jones, 2015, 2019; Soulard et al., 2020; Walker et al., 2020). GRIDMET data have been shown to have a small station bias (+0.54 °C; Blankenau et al., 2020). The CDL has a slightly negative bias and an accuracy of > 90% for major crops (Lark et al., 2017). The NLCD has an overall accuracy of > 80% and a standard error of 0.5 (Wickham et al., 2021). LandScan data has been validated with county census data and found to have an accuracy of > 85% (Dobson et al., 2000).



**Figure S1.** Correlation of all potential fixed effects tested for the climate, anthropogenic, and combination linear mixed effect models. Axes are fixed effect variable names. MAX\_TMP, MIN\_TMP, and PRECIP indicate maximum temperature anomaly, minimum temperature anomaly, and precipitation anomaly, respectively. PR\_AG, PR\_INT, and PR\_NAT indicate the percentages of agricultural, intensive, and natural land cover/land use, respectively. PR\_POP indicates population density. Each variable was centered and standardized before correlation was assessed. Darker purple indicates higher correlation, lighter blue indicates less correlation.

Cropland Data Layer Reclassification					
Value	Description	Reclass	Value	Description	Reclass
1	Corn	Crop	83	Water	NA
2	Cotton	Crop	87	Wetlands	Natural
3	Rice	Crop	88	Non ag/Undefined	Natural
4	Sorghum	Crop	92	Aquaculture	Crop
5	Soybeans	Crop	111	Open Water	Crop
6	Sunflower	Crop	112	Perennial Ice/Snow	Crop
10	Peanuts	Crop	121	Developed/Open Space	Intensive
11	Tobacco	Crop	122	Developed/Low Intensity	Intensive
12	Sweet Corn	Crop	123	Developed/Med Intensity	Intensive
13	Pop or Orn Corn	Crop	124	Developed/High Intensity	Intensive
14	Mint	Crop	131	Barren	Intensive
21	Barley	Crop	141	Deciduous Forest	Natural
22	Durum Wheat	Crop	142	Evergreen Forest	Natural
23	Spring Wheat	Crop	143	Mixed Forest	Natural
24	Winter Wheat	Crop	152	Shrubland	Natural
25	Other Small Grains	Crop	176	Grassland/Pasture	Natural
26	Double Crop Winter Wheat/Soybeans	Crop	190	Woody Wetlands	Natural
27	Rye	Crop	195	Herbaceous Wetlands	Natural
28	Oats	Crop	204	Pistachios	Crop
29	Millet	Crop	205	Triticale	Crop
30	Speltz	Crop	206	Carrots	Crop
31	Canola	Crop	207	Asparagus	Crop
32	Flaxseed	Crop	208	Garlic	Crop
33	Safflower	Crop	209	Cantaloupes	Crop
34	Rape Seed	Crop	210	Prunes	Crop
35	Mustard	Crop	211	Olives	Crop
36	Alfalfa	Crop	212	Oranges	Crop
37	Other Hay/Non Alfalfa	Natural	213	Honeydew Melons	Crop
38	Camelina	Crop	214	Broccoli	Crop
39	Buckwheat	Crop	215	Avocados	Crop
41	Sugarbeets	Crop	216	Peppers	Crop
42	Dry Beans	Crop	217	Pomegranates	Crop
43	Potatoes	Crop	218	Nectarines	Crop
44	Other Crops	Crop	219	Greens	Crop
45	Sugarcane	Crop	220	Plums	Crop
46	Sweet Potatoes	Crop	221	Strawberries	Crop
47	Misc Veggies & Fruits	Crop	222	Squash	Crop
48	Watermelons	Crop	223	Apricots	Crop
49	Onions	Crop	224	Vetch	Crop
50	Cucumbers	Crop	225	Double Crop Winter Wheat/Corn	Crop
51	Chickpeas	Crop	226	Double Crop Oats/Corn	Crop
52	Lentils	Crop	227	Lettuce	Crop

53	Peas	Crop	228	Double Crop Triticale/Corn	Crop
54	Tomatoes	Crop	229	Pumpkins	Crop
55	Cranberries	Crop	230	Double Crop Lettuce/Durum Wht	Crop
56	Hops	Crop	231	Double Crop Lettuce/Cantaloupe	Crop
57	Herbs	Crop	232	Double Crop Lettuce/Cotton	Crop
58	Clover/Wildflowers	Natural	233	Double Crop Lettuce/Barley	Crop
59	Sod/Grass Seed	Crop	234	Double Crop Durum Wheat/Sorghum	Crop
60	Switchgrass	Natural	235	Double Crop Barley/Sorghum	Crop
61	Fallow/Idle Cropland	Crop	236	Double Crop Winter Wheat/Sorghum	Crop
63	Forest	Natural	237	Double Crop Barley/Corn	Crop
64	Shrubland	Natural	238	Double Crop Winter Wheat/Cotton	Crop
65	Barren	Intensive	239	Double Crop Soybeans/Cotton	Crop
66	Cherries	Crop	240	Double Crop Soybeans/Oats	Crop
67	Peaches	Crop	241	Double Crop Corn/Soybeans	Crop
68	Apples	Crop	242	Blueberries	Crop
69	Grapes	Crop	243	Cabbage	Crop
70	Christmas Trees	Crop	244	Cauliflower	Crop
71	Other Tree Crops	Crop	245	Celery	Crop
72	Citrus	Crop	246	Radishes	Crop
74	Pecans	Crop	247	Turnips	Crop
75	Almonds	Crop	248	Eggplants	Crop
76	Walnuts	Crop	249	Gourds	Crop
77	Pears	Crop	250	Cranberries	Crop
81	Clouds/No Data	Crop	254	Double Crop Barley/Soybeans	Crop
82	Developed	Intensive			

**Table S1.** Cropland Data Layer Reclassification.

National Land Cover Dataset Reclassification		
Value	Description	Reclass
11	Open water	NA
12	Perennial ice/snow	NA
21	Developed, open space	Intensive
22	Developed, low intensity	Intensive
23	Developed, medium intensity	Intensive
24	Developed high intensity	Intensive
31	Barren land (rock/sand/clay)	Intensive
41	Deciduous forest	Natural
42	Evergreen forest	Natural
43	Mixed forest	Natural
51	Dwarf scrub	Natural
52	Shrub/scrub	Natural
71	Grassland/herbaceous	Natural
72	Sedge/herbaceous	Natural
73	Lichens: Alaska only	Natural
74	Moss: Alaska only	Natural
81	Pasture/hay	Natural
82	Cultivated crops	Crop
90	Woody wetlands	Natural
95	Emergent herbaceous wetlands	Natural

**Table S2.** National Land Cover Dataset Reclassification.

Year	Equation
2000	$LCLU_{2000} = NLCD_{2001}$
2001	$LCLU_{2001} = NLCD_{2001}$
2002	$LCLU_{2002} = 0.8 (NLCD_{2001}) + 0.2 (NLCD_{2006})$
2003	$LCLU_{2003} = 0.4 (NLCD_{2001}) + 0.6 (NLCD_{2006})$
2004	$LCLU_{2004} = 0.6 (NLCD_{2001}) + 0.4 (NLCD_{2006})$
2005	$LCLU_{2005} = 0.2 (NLCD_{2001}) + 0.8 (NLCD_{2006})$
2006	$LCLU_{2006} = NLCD_{2006}$
2007	$LCLU_{2007} = 0.5 (NLCD_{2006}) + 0.5 (CDL_{2008})$

**Table S3.** Land Cover Equations 2000-2007 Using NLCD and CDL.

		Training $R^2$	Testing $R^2$	OOB
RF	Climate	0.846	-0.131	-0.140
	Anthropogenic	0.974	0.945	0.950
	Combination	0.994	0.948	0.953
MERF	Climate	0.982	0.997	NA
	Anthropogenic	0.989	0.980	NA
	Combination	0.998	0.982	NA

**Table S4.** Training and Testing  $R^2$  and Out Of Bag Scores for RF and MERF Models.