Reservoirs in Alabama are sources of greenhouse gas emissions

Executive Summary

- Both R. L. Harris and Weiss reservoirs are sources of greenhouse gasses.
- At Weiss Reservoir, greenhouse gas emissions for attributed to hydroelectric generation were five times greater than the proposed Clean Energy threshold.
- Emissions at Weiss Reservoir were comparable to the 2020 average of emission intensity from Southern Company electric utility plants in Alabama using coal and gas.
- At R. L. Harris Reservoir, greenhouse gas emissions during 2021 attributed to hydroelectric generation were 1.5 times greater than the proposed Clean Energy threshold.
- The G-RES tool is web-based, has excellent documentation and responsive technical support staff and is a useful tool for a broad audience, including researchers, regulators, and advocates.

About this report: This independent analysis was completed by the Virginia Scientist-Community Interface (V-SCI). V-SCI is a graduate student organization dedicated to reviewing and synthesizing science related to environmental issues across the southeastern United States. V-SCI analysts on this project include graduate students with formal training and expertise in civil and environmental engineering, biosystems engineering, reservoir biogeochemistry, hydrology, and stream ecology. We are happy to discuss our findings in more detail if we can be of greater service.
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1. Rationale and background

Damming of rivers alters the movement of carbon through rivers and streams (Deemer et al., 2016). Rivers transport large amounts of carbon to estuaries and oceans, and when rivers are dammed to provide power, water, or flood control, a substantial portion of carbon entering these newly-created reservoirs can be buried. Much of this carbon can be stored in reservoir sediments over long-term timescales (years to millennia). However, organic carbon inputs can also be broken down by microbes, forming carbon dioxide (CO_2) and methane (CH_4), making reservoirs a large source of global greenhouse gas emissions (equivalent to 20% of the global emissions from fossil fuels; Deemer et al. 2016; DelSontro et al. 2018).

Importantly, the creation of reservoirs increases the ratio of CH_4 to CO_2 produced by rivers and CH_4 is a much more potent greenhouse gas than CO_2. Reservoirs often experience low to no oxygen conditions, leading to a greater production of CH_4 relative to CO_2 (Hounshell et al. 2021; McClure et al. 2021). CH_4 can then be emitted to the atmosphere through dam degassing[1], ebullition[2], or diffusion processes[3]; quantities of these greenhouse gas (GHG) emissions vary by reservoir (Maeck et al., 2013). CH_4 has a shorter atmospheric lifetime than CO_2, but it is at least 25 times more effective at trapping heat over a 100 year timeframe (Bruhwiler et al., 2018). Because CH_4 is a potent GHG, it is important to be aware of how natural sources and sinks of CH_4 are impacted by human activities, such as the damming of rivers.

The G-RES tool estimates a reservoir's net GHG emission footprint with user-provided inputs that are entered in an easy-to-use, web-based application (www.hydropower.org/gres-

[1] Degassing is when CH_4-rich water flows through turbines, releasing CH_4 into the atmosphere.
[2] Ebullition is when CH_4 bubbles are released from reservoir sediments and then released into the atmosphere.
[3] Diffusion is when CH_4 dissolves into reservoir water, and is exchanged into the atmosphere at the water's surface.

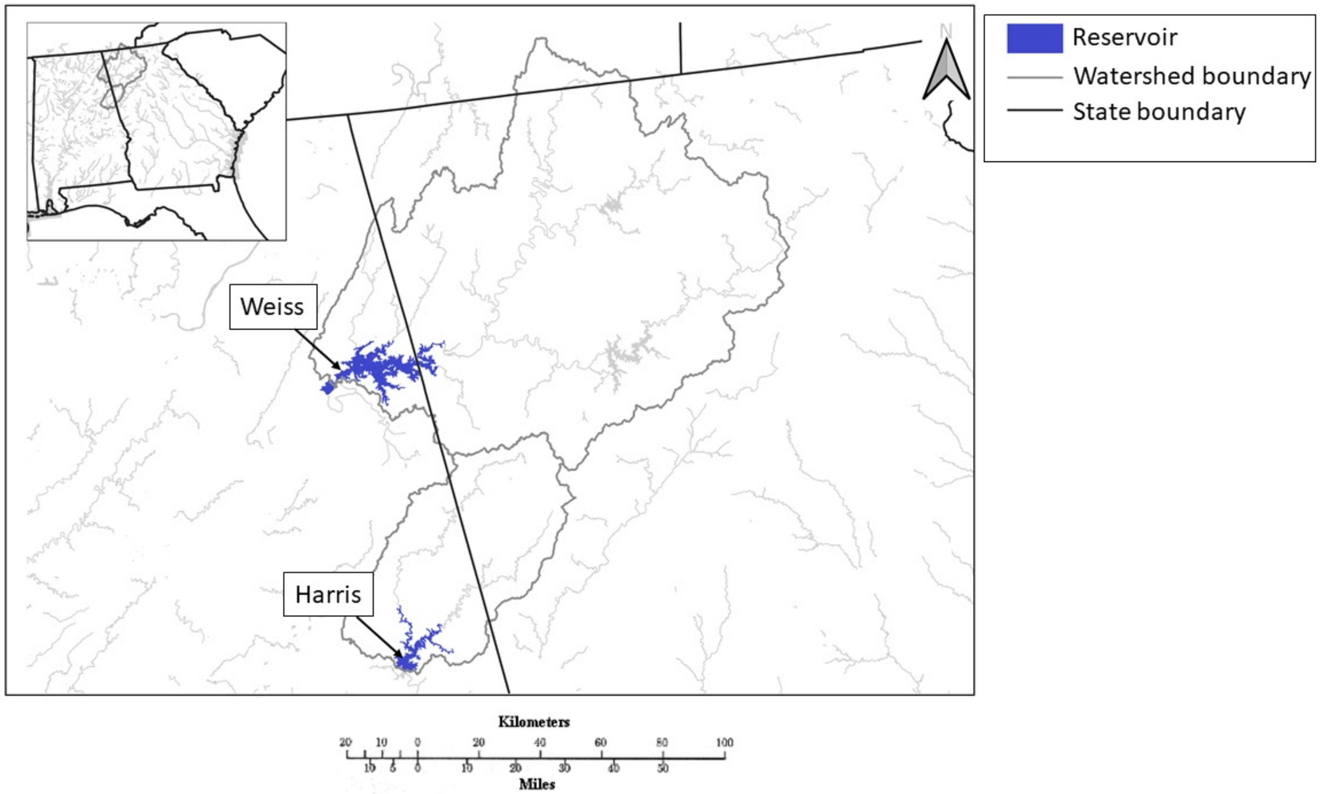

Figure 1. Location map of R.L. Harris and Weiss Reservoirs in Alabama, USA.

tool). G-RES was developed by the International Hydropower Association and the UNESCO Chair in Global Environmental Change to assist researchers and hydropower operators in quantifying and reporting reservoir GHG emissions (Prairie et al. 2021). GHG emissions are calculated based on user-provided inputs related to catchment attributes (e.g., land-use and mean temperature), reservoir characteristics (e.g., mean depth and shallow area along the shoreline), services provided by the reservoir, and GHG emissions associated with reservoir construction. Google Earth Engine, a web based geographical information system (GIS), can be used to estimate certain user-inputs and code is provided for this purpose. Using Google Earth Engine increases ease-of-use, but provides a less precise estimate than using on-the-ground observations.

In this report, we used the G-RES tool (v3.1) to analyze GHG emissions from two reservoirs, R. L. Harris and Weiss Reservoirs, located in Alabama, USA (Fig. 1). This is the first analysis of GHG emissions at these two reservoirs. For the analysis of R. L. Harris and Weiss Reservoirs below we did not use any Google Earth Engine inputs and instead used known values from previous publications about the reservoirs. We compared rates of GHG emissions from reservoirs to the proposed Clean Energy Threshold of 0.1000 tCO_2e/MWh (Lawson 2021). This threshold represents an emission intensity (GHG emissions per unit of power) limit above which energy generation would no longer qualify as ”clean energy”, and was proposed in recent Federal infrastructure legislation.

2. Explaining the model

The G-RES model is web based and consists of four separate pages where model inputs are entered.

Reservoir page The “Reservoir” tab of G-RES asks for general descriptive information about the reservoir, which was generally available from published relicensing documents. Outflow from the R. L. Harris dam was calculated as the mean flow measured at a United States Geological Survey stream gauge downstream of the reservoir (Tallapoosa River at Wadley, AL) using data from gauge installation in 1984 to present. We gathered data about soil carbon content and wind speed from maps produced by the Food and Agriculture Organization (FAO) and the US Office of Energy Efficiency and Renewable Energy, respectively. For mean global horizontal radiance, we used a multiannual average of data from the National Solar Radiation Database (NSRDB; GOES PSM v3).

Catchment page We delineated catchments (watersheds) in StreamStats (USGS 2016), a web-based watershed analysis tool. To determine land cover classification for each catchment, we used the 2019 National Land Cover Dataset (NLCD 2019) which uses 30 m resolution Landsat satellite imagery to estimate different land cover classes across the United States. The four NLCD “developed” classes were summed and entered in the G-RES tool as “settlement”. This analysis was

Table 1. Definitions of reservoir service rankings and the percentage of emissions allocated to each service.

Importance	Operating rule curve definition	Percentage allocated
Primary	Operating rules are designed to maximize the benefits of this service for part or all of the year.	80%
Secondary	The service places operational constraints on the operating level of the reservoir for part or the whole of the year.	15%
Tertiary	The service has little impact on the operation of the reservoir.	5%
n.a.	The service has no impact on the operation of the reservoir.	0%

completed using R statistical software (R Core team 2020).

Reservoir services page Service ranking is simply an accounting method to allocate GHG emissions from the reservoir to different reservoir services (hydropower, flood control, irrigation, navigation, water supply, recreation, fisheries, and environmental flow) and these rankings do not affect total GHG emissions (see page 17 of G-RES user manual for more discussion). To rank services, we used the operating rule curve definitions of importance (Table 1). If there are multiple services at the same ranking, G-RES equally splits the allocation percentage between the services. To determine the importance of each service to reservoir operations, we consulted the R.L. Harris Hydroelectric Project Preliminary Information Document (R. L. Harris PID; Kleinschmidt Group 2017) and the Alabama-Coosa-Tallapoosa River Basin Water Control Manual Appendix I R. L. Harris Dam and Lake (USACE 2015) for the R. L. Harris Reservoir and the Alabama-Coosa-Tallapoosa River Basin Water Control Manual Appendix XYZ Weiss Dam (USACE 2021) for the Weiss Reservoir.

Construction page GRES also considers GHG emissions from initial construction when calculating the total emissions from a reservoir. For R. L. Harris dam, we used construction progress charts provided by the Federal Energy Regulatory Commission (FERC) to gather information on the use of concrete, earthworks, and access roads (FERC, 1982). For project completion information that couldn't be accessed via FERC's eLibrary, we searched through published magazine articles by Alabama Power and other publications from the time of construction. This information was useful to cross-check construction documents. For Weiss Dam, we found concrete and earthwork data in an in-house magazine (Em Kayan 1960) published by the construction company (Morrison-Knudsen) that built Weiss Dam. We were unable to locate some construction information under the "more detailed assessment" section, and therefore chose to only enter available construction data in the "basic assessment" section.

Sensitivity analysis The accuracy of the G-RES model depends upon model parameterization. To assess how variation in model parameters would affect emissions estimates, we conducted a one-at-a-time (OAT) sensitivity analysis. We tested the sensitivity of the model to changes in 19 key parameters (Supplement 1, 2) by individually increasing and decreasing the value of each parameter by 10%. We recorded the resulting post-impoundment emissions, and report this value as a fraction of the original post-impoundment emissions estimate.

3. G-RES model validation

The G-RES terms of service stipulate that while the tool is free to use, the "G-RES Expert Committee retains the the right to oversee the appropriateness of any use of the Tool". Additionally, for commercial use, the results must be validated by a "qualified person who has been nominated by the G-RES Expert Committee". The validation process represents an independent verification of appropriate use of the tool and the results produced.

The validation process typically requires the reservoir operator's consent to a G-RES GHG emission analysis, but this permission was denied by Alabama Power, the operator of both reservoirs. Our analysis represented the first time permission had been denied to perform this type of analysis with the G-RES tool, and the G-RES team consented to validating our results but notably not our service allocations. **For our analysis, we independently used the service allocation ranking provided by G-RES to determine service allocation and GHG intensity; these results were *not* valdiated by the G-RES team. Additionally, we examined GHG emission intensity under the assumption that 100% of emissions were due to hydropower generation.**

4. G-RES model results and discussion

We used the G-RES tool (v3.1) to analyze GHG emissions from two reservoirs located in Alabama, USA. The R. L. Harris Reservoir, known locally as Lake Wedowee, is 39.9 km^2, with a mean depth of 13.1 m, and the dam generates 151.9 GWh/year. The Weiss dam reservoir, known as Weiss Lake, is 122.2 km^2, with a mean depth of only 3.1 m, and the dam generates 254.6 GWh/year. These reservoirs provide a unique opportunity to assess GHG emissions in two different reser-

Table 2. Net estimated annual CO_2e emissions for R. L. Harris Reservoir. From the G-RES tool report.

	Post-impoundment	Pre-impoundment	Net GHG footprint
Annual emission rate (tCO_2e/yr)	14,682	−14,012	28,694 (26,984-30,631)
Of which CO_2	4,575	-14,133	18,707
Of which CH_4	10,107	121	9,986
Areal emission rate ($gCO_2e/m^2/yr$)	368	-351	719 (676-768)
Of which CO_2	115	-354	469
Of which CH_4	253	3	250
Areal emissions ($gCO_2e/m^2/yr$)	368	-351	719 (676-768)
Reservoir wide emissions (tCO_2e/yr)	14,682	-14,012	29,722 (28,012-31,659)
Total lifetime emissions (tCO_2e)	1,468,216	-1,401,159	2,972,147 (2,801,237-3,165,923)

Table 3. Net estimated annual CO_2e emissions for Weiss Reservoir. From the G-RES tool report.

	Post-impoundment	Pre-impoundment	Net GHG footprint
Annual emission rate (tCO_2e/yr)	144,062	-24,841	168,903 (152,170-187,844)
Of which CO_2	20,576	-25,095	45,671
Of which CH_4	123,486	254	123,233
Areal emission rate ($gCO_2e/m^2/yr$)	1,179	-203	1,382 (1,245-1,537)
Of which CO_2	168	-205	374
Of which CH_4	1,010	2	1,008
Areal emissions ($gCO_2e/m^2/yr$)	1,179	-203	1,382 (1,245-1,537)
Reservoir wide emissions (tCO_2e/yr)	144,062	-24,841	169,379 (152,646-188,320)
Total lifetime emissions (tCO_2e)	14,406,206	-2,484,121	16,937,933 (15,264,590-18,832,046)

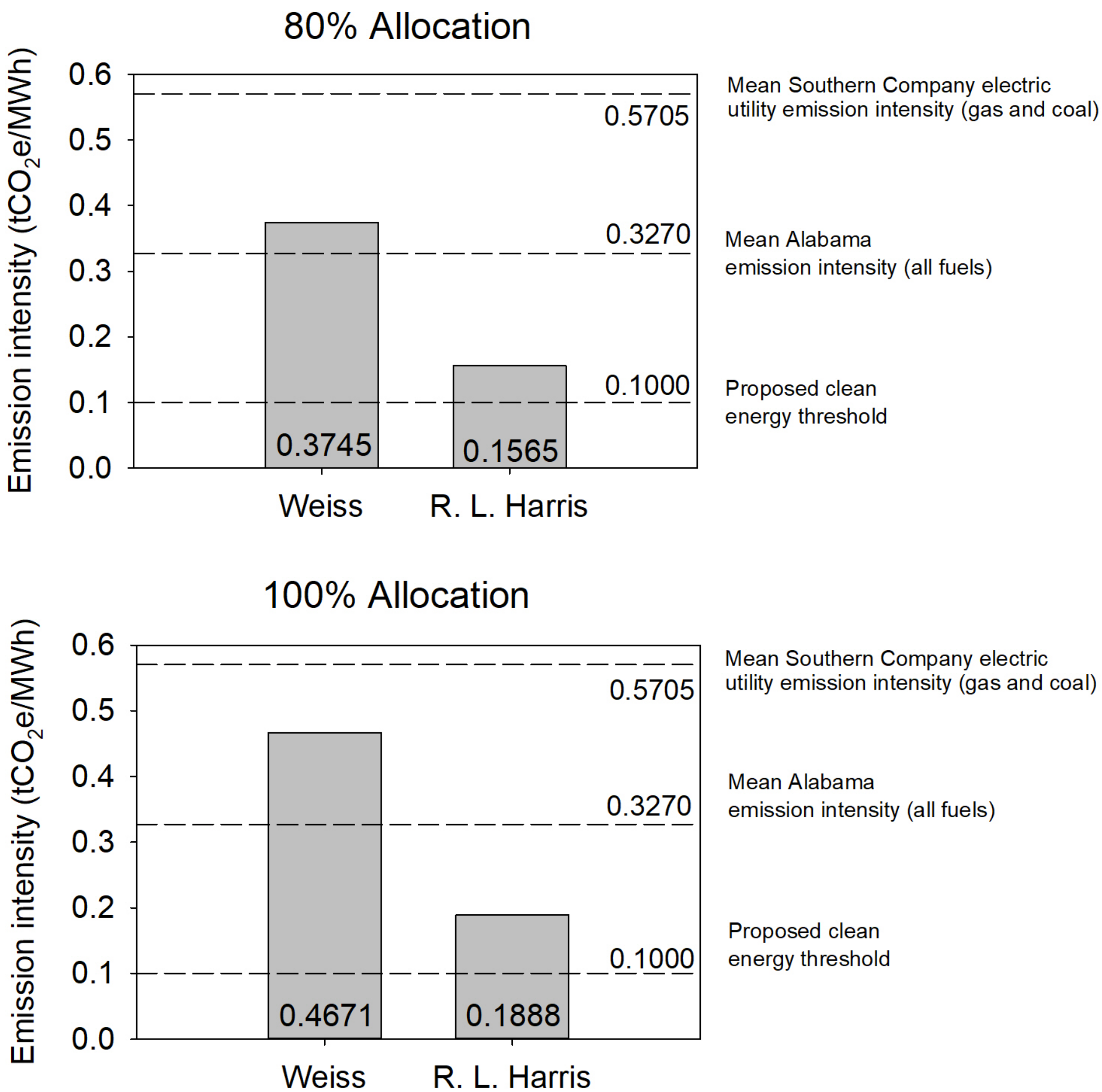

Figure 2. Emission intensity (tCO_2e/MWh) at Weiss and R. L. Harris Reservoirs attributing 80% of emissions to electricity generation using the G-RES service allocation method (top) and attributing 100% of emissions to electricity generation (bottom). Dashed horizontal lines represent the mean emission intensity at all Southern Company electric utilities using gas and coal (top line), the mean emission intensity for all fuels within the state of Alabama (middle line), and the proposed clean energy threshold (bottom line).

voirs located in the same region. While these reservoirs are only 100 km apart, one is small and deep (R. L. Harris), and one is large and shallow (Weiss), which resulted in distinct GHG emission profiles.

Both R. L. Harris and Weiss reservoirs are GHG sources in the landscape, emitting 28,694 (95% confidence interval 26,984-30,631) tCO_2e/yr and 118,913 (95% confidence interval 108,319-130,855) tCO_2e/yr, respectively (Tables 2 and 3). When using an 80% service allocation, GHG emissions attributed to hydroelectric generation at Weiss Reservoir were 0.3745 tCO_2e/MWh (Table 4), more than 3.5 times greater than the proposed Clean Energy threshold of 0.1000 tCO_2e/MWh (Lawson 2021) (Fig. 2). When using an 80% service allocation, GHG emissions attributed to hydroelectric generation at R. L. Harris Reservoir were 0.1565 tCO_2e/MWh (Table 5), well over the proposed threshold of 0.1000 tCO_2e/MWh (Lawson 2021) (Fig. 2).

The G-RES tool uses a service allocation method (reported here based on the operating rule curve) to determine what percentage of total emissions are due to the different services provided by the reservoir. Because these reservoirs were explicitly built for hydropower generation, another service allocation approach is the simply allocate *all emissions* to hydropower generation. When using a 100% service allocation, GHG emssions attributed to hydropower generation at Weiss Reservoir were 0.4671 tCO_2e/MWh and at R. L. Harris

Reservoir were 0.1888 tCO_2e/MWh.

The EPA's Clean Air Markets Division monitors air pollution from power plants around the United States and that data is compiled in the Emission and Generation Resource Integrated Database (eGRID; US EPA 2022a). Notably, the EPA assumes that CO_2 emissions from hydropower are zero (US EPA 20222b), but this is not the case for either R. L. Harris Reservoir or Weiss Reservoir (Tables 2 and 3). In 2020, the Alabama average energy intensity across the entire power sector was 0.3270 tCO_2e/MWh and the average intensity at Southern Company (Alabama Power's holding company) electric utilities using gas and coal was 0.5705 tCO_2e/MWh (US EPA 2022b). Weiss Reservoir's emission intensity of 0.3745 (80% allocation) tCO_2e/MWh is greater than the state average, and the 100% allocation of 0.4671 tCO_2e/MWh is on par with the Southern Company gas and coal generation (Fig. 2). **These findings suggest hydropower generated at Weiss Reservoir results in GHG emissions per MWh on par with fossil fuel power generation in Alabama and would not qualify as clean energy. Even though R. L. Harris Resevoir's energy intensity is lower than other fossil fuel plants in Alabama, it would also be well over the proposed clean energy threshold.**

These reservoirs are located only 100 km from each other, but are different in terms of GHG emissions. GHG emissions at R. L. Harris Reservoir (Table 2) were much lower than at Weiss Reservoir (Table 3). While many climatic variables are similar between both reservoirs, the physical characteristics of the reservoirs differ substantially. Weiss Reservoir covers a larger area, but it is shallower and has a lower reservoir volume (0.38 km^3) compared to R. L. Harris (0.52 km^3), which is deeper and covers a smaller area. Additionally, littoral area (the shallow area along the reservoir's edge where there is enough light to support photosynthesis) is also an important determinant of GHG emissions in these two reservoirs (Tables 6 and 7).

Because G-RES is a web based tool with excellent documentation and technical support staff, we believe this tool can be used by a broad audience, including researchers, regulators, and advocates. While we were able to find data for both reservoirs in operator and regulator documents, these data might not always be readily available. G-RES suggests using user-provided inputs when possible but provides code and documentation to use Google Earth Engine to fill in data gaps (catchment area, land cover, population, runoff, mean temperatures, solar radiance). We did not compare our user-provided input results to Google Earth Engine input results and are therefore unable to assess whether using Google Earth Engine would provide substantial differences in GHG emissions estimates. However, our sensitivity analysis results indicate that the most important parameters to constrain using either method include reservoir size (area and volume), mean global horizontal radiance, and temperature (Tables 6 and 7).

The G-RES tool, like other modeling approaches, has limitations. For example, the G-RES tool is based on a regression model and is therefore limited by the variables obtained from the GRanD database used to build the model (Prairie et al. 2021). The GRanD database (Lehrner et al. 2011) is a dataset of physical characteristics from large reservoirs (>0.1 km^3) around the world, and both R. L. Harris and Weiss Reservoirs are near the low end of this dataset in terms of area. Reservoir drawdown as a result of hydropower generation has also been identified as a major pathway of GHG emissions from reservoirs, and its exclusion from reservoir carbon budgeting may result in underestimating nearly 200% of the CO_2 emissions (Marcé et al. 2019). Hydropower generation at both R. L. Harris and Weiss Reservoirs results in large fluctuations in reservoir level, often over the course of a single day, and the emissions estimates provided by G-RES are therefore likely underestimates. Because of these and other limitations (for more discussion see Prairie et al. 2021) it is hard to fully quantify GHG emissions from a reservoir over the course of a year. However, even with these inherent limitations, the G-RES tool is useful as the only currently available tool for researchers, regulators, operators, and advocates to quantify reservoir GHG emissions in a globally-consistent manner.

Conflicts of interest

This report was prepared by members of Virginia Scientist-Community Interface. The analysis presented is entirely our own and does not represent the position of our respective affiliations. Affiliation is for identification purposes only. We have no conflicts of interest to declare.

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References

Alabama Department of Environmental Management (ADEM) (1999). Intensive Water Quality Survey of Coosa and Tallapoosa River Reservoirs 1997. Page 206. Water Quality Reports, Environmental Indicators Section, Field Operations Division, Alabama Department of Environmental Management.

Bruhwiler, L., A. M. Michalak, R. Birdsey, J. B. Fisher, R. A. Houghton, D. N. Huntzinger, and J. B. Miller (2018). Chapter 1: Overview of the global carbon cycle. In Second State of the Carbon Cycle Report (SOCCR2): A Sustained Assessment Report [Cavallaro, N., G. Shrestha, R. Birdsey, M. A. Mayes, R. G. Najjar, S. C. Reed, P. Romero-Lankao, and Z. Zhu (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 42-70, https://doi.org/10.7930/SOCCR2.2018.Ch1.

Federal Energy Regulatory Commission (FERC) (1982). File name 200201050009_01_001.JPG. https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20020105-0009&optimized=false

Deemer, B. R., J. A. Harrison, S. Li, J. J. Beaulieu, T. DelSontro, N. Barros, J. F. Bezerra-Neto, S. M. Powers, M. A. dos Santos, and J. A. Vonk (2016). Greenhouse gas emissions from reservoir water surfaces: A new global synthesis. BioScience, 66(11), 949-964, DOI: 10.1093/biosci/biw117.

Harrison, J. A., Y. T. Prairie, S. Mercier-Blais, and C. Soued (2021). Year-2020 Global Distribution and Pathways of Reservoir Methane and Carbon Dioxide Emissions According to the Greenhouse Gas From Reservoirs (G-res) Model. Global Biogeochemical Cycles 35.

Kleinschmidt Group (2017). R. L. Harris Hydroelectric Project Preliminary Information Document. Alabama Power Company, Birmingham, Alabama.

Lawson, A. (2021). The Clean Electricity Performance Program (CEPP): In Brief. Page 11. R46934, Congressional Research Service. (Available from: https://sgp.fas.org/crs/misc/R46934.pdf)

Marcé, R., B. Obrador, L. Gómez-Gener, N. Catalán, M. Koschorreck, M. I. Arce, G. Singer, and D. von Schiller (2019). Emissions from dry inland waters are a blind spot in the global carbon cycle. Earth-Science Reviews 188, 240–248.

Maeck, A., T. DelSontro, D. F. McGinnis, H. Fischer, S. Flury, M. Schmidt, P. Fietzek, and A. Lorke (2013). Sediment Trapping by Dams Creates Methane Emission Hot Spots. Environmental Science & Technology, 47(15), 8130-8137, DOI: 10.1021/es4003907.

Prairie, Y. T., S. Mercier-Blais, J. A. Harrison, C. Soued, P. del Giorgio, A. Harby, J. Alm, V. Chanudet, and R. Nahas (2021). A new modeling framework to assess biogenic GHG emissions from reservoirs: The G-res tool. Environmental Modeling & Software 143, 105117.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

U.S. Army Corp of Engineers (USACE) (2021). Alabama-Coosa-Tallapoosa River Basin Water Control Manual Appendix B - Weiss Reservoir. U.S. Army Corp of Engineers, Mobile District, Mobile, Alabama.

U.S. Army Corp of Engineers (USACE) (2015). Alabama-Coosa-Tallapoosa River Basin Water Control Manual Appendix I - R. L. Harris Dam and Lake. U.S. Army Corp of Engineers, Mobile District, Mobile, Alabama.

United States Environmental Protection Agency (EPA) (2022a). “Emissions & Generation Resource Integrated Database (eGRID), 2020” Washington, DC: Office of Atmospheric Programs, Clean Air Markets Division. Available from EPA’s eGRID web site: https://www.epa.gov/egrid.

United States Environmental Protection Agency (EPA) (2022b). The Emission and Generation Resource Integrated Database eGRID Technical Guide with Year 2020 Data. Page 129. United States Environmental Protection Agency, Office of Atmospheric Programs, Clean Air Markets Division.

U.S. Geological Survey (USGS) (2016). The StreamStats program for Alabama, online at http://water.usgs.gov/osw/streamstats/Alabama.html,accessedon2021/11/01.

5. Supplemental Materials

Table 4. Net GHG contributions for each reservoir service at Weiss Reservoir. From the G-RES tool report.

Reservoir Service	GHG footprint (tCO_2e/yr)	Percent allocation (%)	GHG emission intensity (tCO_2e/MWh)
Flood Control	17,776	15	n/a
Fisheries	2,013	1.7	n/a
Irrigation	0	0	n/a
Navigation	2,013	1.7	n/a
Environmental flow	2,013	1.7	n/a
Recreation	0	0	n/a
Water Supply	0	0	n/a
Hydroelectricity	94,750	80	0.3745 (0.3400- 0.4110)

Table 5. Net GHG contributions for each reservoir service from R. L. Harris Reservoir. From the G-RES tool report.

Reservoir Service	GHG footprint (tCO_2e/yr)	Percent allocation (%)	GHG emission intensity (tCO_2e/MWh)
Flood Control	4,304	15	n/a
Fisheries	488	2	n/a
Irrigation	0	0	n/a
Navigation	488	2	n/a
Environmental flow	488	2	n/a
Recreation	0	0	n/a
Water Supply	0	0	n/a
Hydroelectricity	22,955	80	0.1565 (0.142-0.161)

Table 6. Sensitivity analysis of parameters effects on post-impoundment emissions at R. L. Harris Reservoir. Columns for 10% increase and 10% decrease indicate the ratio of the total emissions estimated using the modified parameter value (either increased or decreased by 10%) to total emissions using the original parameter value.

Parameter	GRES unit	Value	10% decrease	10% increase
Reservoir area	km2	39.9	0.84	1.17
Reservoir volume	km3	0.5242	1.07	0.94
Water level	m above sea level			
Max depth	m	41.15	0.98	1.02
Mean depth	m	13.138	1.07	0.94
Littoral area	%	14.905	0.95	1.04
Thermocline depth	m	10	No change	No change
Soil carbon content	kgC/m2	1.72	1	1
Wind value from earth engine		No		
Annual wind speed	m/s	4	No change	No change
Water intake depth	m	8.883	No change	1.4
Water intake elevation	m above sea level			
Phosphorus concentration	ug/L	30	0.99	1.01
Reservoir mean global horizontal radiance	kWh/m2/d	4.7	0.82	1.36
Mean annual air temperature	C		0.82	1.19
CATCHMENT				
Catchment Area	km2	3,755.48	1	1
Catchment population		109,309	No change	No change
Current Land Use:				
Bare areas	%	0.2	No change	No change
Croplands	%	0.1	No change	No change
Forest	%	61.2	No change	No change
Grassland/shrubland	%	26.2	No change	No change
Permanent snow/ice	%	0		
Settlements	%	9.2	No change	No change
Water bodies	%	1.7	No change	No change
Wetlands	%	1.6	No change	No change
Drained peatlands	%	0		

Table 7. Sensitivity analysis of parameters effects on post-impoundment emissions at Weiss Reservoir.

Parameter	GRES unit	Value	10% decrease	10% increase
Reservoir area	km2	122.215	0.86	1.15
Reservoir volume	km3	0.38	1.04	0.96
Water level	m above sea level	171.9	No change	No change
Max depth	m	18.9	0.99	1
Mean depth	m	3.109	1.04	0.96
Littoral area	%	58.434	0.94	1.05
Thermocline depth	m	No thermocline	0	0
Soil carbon content	kgC/m2	2.67	0.99	1
Wind value from earth engine		no	0	0
Annual wind speed	m/s	4	No change	No change
Water intake depth	m	3.05	No change	No change
Water intake elevation	m above sea level	na	0	0
Phosphorus concentration	ug/L	90	0.99	1
Reservoir mean global horizontal radiance	kWh/m2/d	4.6	0.76	1.46
Mean annual air temperature	C	17.1	0.91	1.12
CATCHMENT				
Catchment Area	km2	13,660.45	1	0.99
Catchment population		912,916	No change	No change
Current Land Use:			No change	No change
Bare areas	%	0.2	No change	No change
Croplands	%	1.6	No change	No change
Forest	%	61.3	No change	No change
Grassland/shrubland	%	19.6	No change	No change
Permanent snow/ice	%	0	No change	No change
Settlements	%	14.7	No change	No change
Water bodies	%	1.8	No change	No change
Wetlands	%	0.7	No change	No change
Drained peatlands	%	0	0	0