

README: VTCarbonBudget.Rproj” & “EX-ACT_V9.0VT.xlsm”

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Summary

This file provides documentation of the supporting analysis for the 2021 Vermont Carbon Budget for agricultural, forestry and other land uses (AFOLU). This analysis can be compartmentalized into three sections: data, code, and the EX-ACT Model.

The raw data files are comprised of U.S. Department of Agriculture (USDA) for the Survey and Census years dating back to 1990, Vermont Agency of Agriculture and Farm Management (VAAFAM) reports, supplemental reports and interviews. These raw data are processed with interpolation used in cases of unreported years.

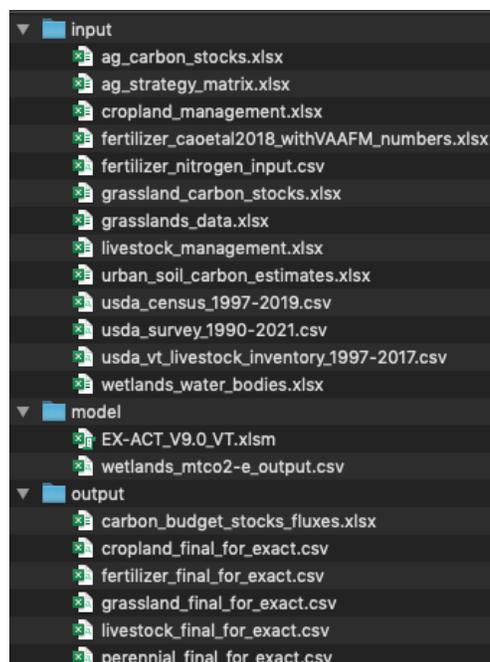
This report makes use of the computer programming language R, a programming language for data engineering, statistical computing, and graphics. Scripts were written to process raw data and output plots used in the Carbon Budget report.

The model, EX-Ante Carbon-balance Tool (EX-ACT version 9.0), is an open-source greenhouse gas (GHG) emissions model for AFOLU, inland and coastal wetlands, fisheries and aquaculture, agricultural inputs, and infrastructure. It is supported by Intergovernmental Panel on Climate Change (IPCC) methodologies for GHG emissions inventories and provides ex ante and ex post evaluations of a diverse set of land use practices. A Microsoft Excel macro is used to populate the EX-ACT v.9.0 model and collate results.

See Vermont Carbon Report for further detail on the methodology used.

Data

There are three subfolders that includes various types of datasets. The input sources include raw data from the USDA, Vermont Agency of Agriculture Food and Markets (VAAFAM), Vermont State reports, and other reports and interviews. These sources are documents in further detail in the Carbon Budget Report. The R-code scripts (described below) process the Input files and generate the six (6) output data files in the output subfolder. These six files are loaded into the “EX-ACT_V9.0_VT.xlsm” on the “calculations” tab, located in the model subfolder. As EX-ACT handles inputs for a fixed number of entries (limited to 10), a macro was used to evaluate the tons of CO₂-equivalent (tCO₂-e) across the 5 inputs. This was necessary as over 3,000 variations in land-use practices required evaluation. This process is described in further detail under the EX-ACT section beginning on step 4, below.



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R-code

Five (5) R script files have been used to process the data sources, which are stored in the data subfolders. These data are merged and manipulated to achieve a desired structure allowing them to be inputted into the EX-ACT model. An overarching R-script has been written that can execute the 5 subsequent R-scripts, described below.

The steps for opening this file assume the user has R and R-studio downloaded on their computer and some familiarity with this programming language.

1. Select the “VTCarbonBudget.Rproj” to open the R project (image below).



2. Open the “run_all_scripts.R file within this project
 - a. This file includes all dependent libraries necessary for executing the 5 R scripts and allows the user to run one file to process the data. Every library used is open access.
 - b. The files that are run include the following:
 - i. “cropland.R”
 - ii. “grassland.R”
 - iii. “livestock.R”
 - iv. “fertilizer.R”
 - v. “ex_act.R”
3. When running these files, plots will be saved to /plots subfolder and data will be saved to /output. These data that are saved include:
 - a. “cropland_final_for_exact.csv”
 - b. “fertilizer_final_for_exact.csv”
 - c. “grassland_final_for_exact.csv”
 - d. “livestock_final_for_exact.csv”
 - e. “perennial_final_for_exact.csv”

EX-ACT Model

4. The files contained in /output (listed above) are used as the inputs for the EX-ACT model on the calculations tab. Five different macros, described next, are used to loop the data through EX-ACT.
5. EX-ACT limits the number of rows that can be used as inputs (~10 rows), necessitating the use of a macro to save time when inputting these agriculture combinations. Five (5) macros are written to loop over the input rows (identified in 3).

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- a. If changes are made to the length of the inputted data on the Calculations tab, make sure the macro is adjusted to the new length

Source	Stock (MMT CO ₂ -e)	Estimated flux (MMT CO ₂ -e yr ⁻¹) *			
	2020	1990	2005	2020	
Forests	1,859	- 5.10	- 3.20	- 3.20	
Agriculture	63	- 0.70	- 0.61	- 0.49	
Wetlands and water bodies	57	- 0.01	- 0.01	- 0.01	
Grasslands and shrublands	41	- 0.06	- 0.05	- 0.05	
Urban and developed	15	- 0.26	- 0.27	- 0.28	
NET (AFOLU)	1,978	- 4.61	- 2.82	- 2.95	
Fossil fuels**	N/A	8.64	9.97	8.60	
Net (Fossil fuels and AFOLU)		4.03	7.15	5.65	

- b. The macros populate each of the five input fields shown on the Calculations tab in area: A4:M27
- c. The respective tCO₂-e value is saved for the represented row of data.

6. Finally, after the macros have been run, the ex_act.R script takes in the compiled data with the populated tCO₂-e columns and creates more plots that are saved in /plots.

Adjustments to the input files and slight restructuring of the code and EX-ACT macros will allow the user to use the structure of this code to update the model as new data becomes available.