

Vermont's Agricultural GHG Emissions Inventory & Mitigation Strategies

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Ag & Ecosystems Subcommittee recommends:

1. Support for the RFI outlined in the ‘Recommendations Regarding GHG Inventory and Supplemental Accounting’ Memo from the Science & Data Subcommittee which will review methodological gaps for agricultural and associated land use GHG emissions.
2. Noting that the current Agricultural GHG emissions inventory does not account for farm management and associated GHG mitigation pathways from agriculture.
3. Noting that the 2006 & 2019 refinement to IPCC standards for the Agriculture, Forestry and Other Land Use (AFOLU) sector considers sectoral emissions reporting on a comprehensive basis, reporting both GHG emissions and sinks.

Science and Data Subcommittee RFI Language

- 1) Develop and issue one or more a Request(s) for Information (RFI) regarding questions related to:

b) Methodological gaps of emission inventory tools currently used by the State of Vermont to quantify greenhouse gas emissions for evaluating changes in the agriculture and related land use sectors and the tools' alignment with the Intergovernmental Panel on Climate Change (IPCC), Environmental Protection Agency (EPA), and peer state methodologies and approaches.

AFOLU Emissions RFI Details

This should include:

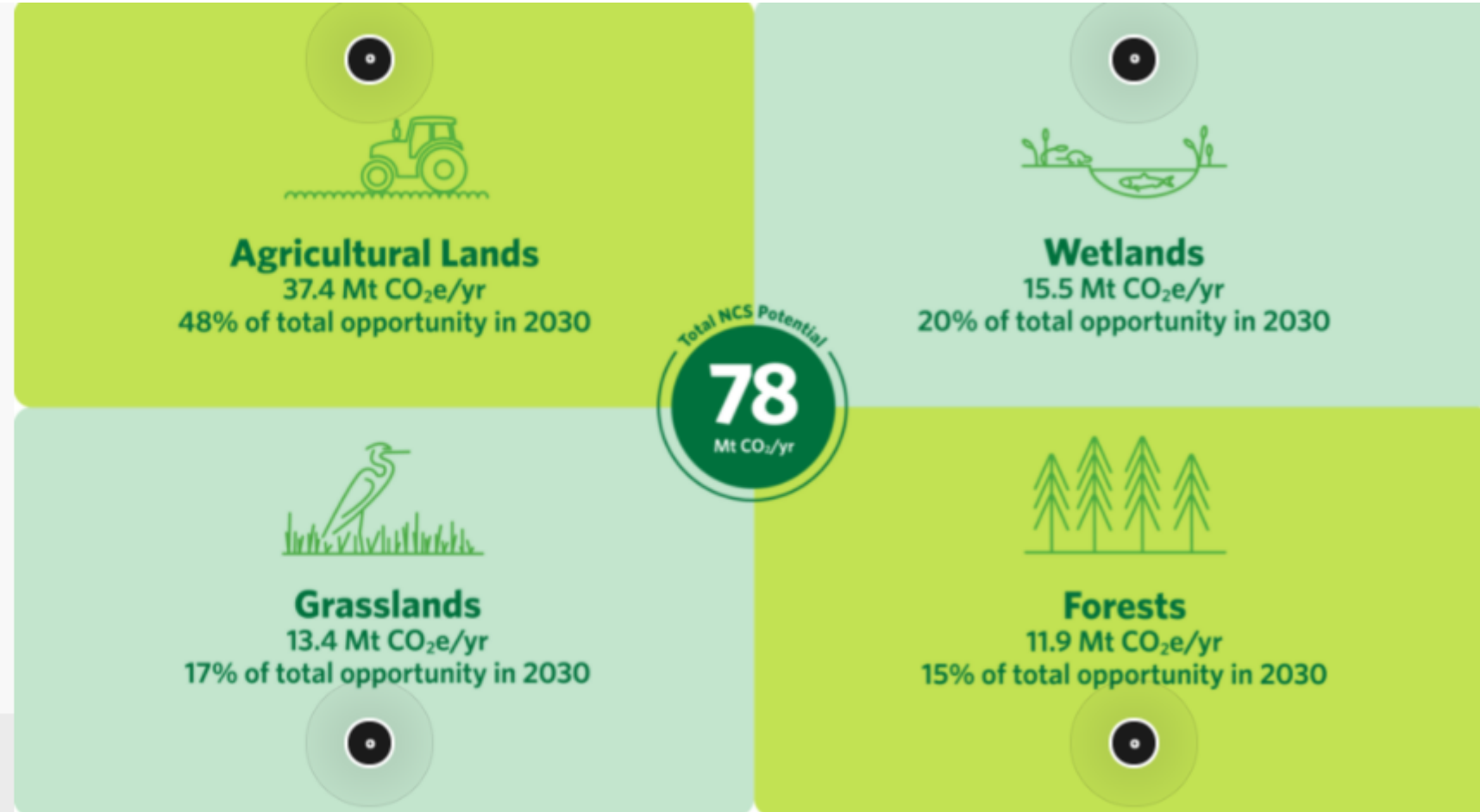
- 1) a comparison of the three quantification tools already informing the GWSA (SIT, LEAP and EX-ACT), plus at least the DNDC model which is used by other states [e.g. California] and was identified in the recently released Carbon Budget Report for the VCC;
- 2) background research describing both the IPCC rationale for using net GHG emissions quantification in AFOLU sectors, and peer state's deliberations on accounting GHG in AFOLU as net or gross; and
- 3) describe the additional staff or technical support needed to include more accurate and nuanced accounting of GHG from AFOLU.

Why is this RFI being requested?

Natural Climate Solutions in Action

The study examined four ecosystems and 24 pathways that, undertaken in the next decade, have the potential to cut Canada's greenhouse gas emissions by an amount equal to 11% of our current annual emissions.

EXPLORE



Source: C Ronnie Drever et al., Natural Climate Solutions for Canada, 7 Science Advances 1 (2021)

Source: <https://www.natureunited.ca/what-we-do/our-priorities/innovating-for-climate-change/natural-climate-solutions/>

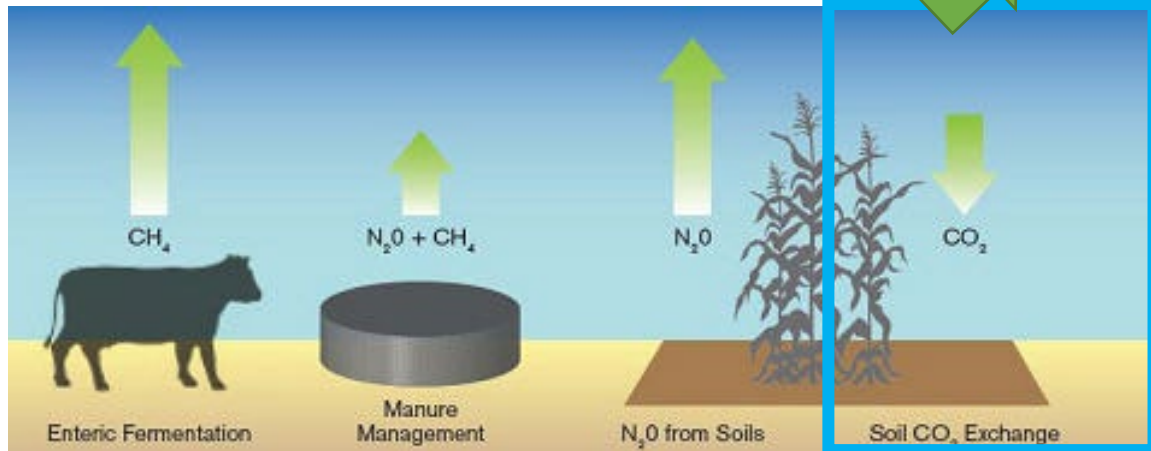
EPA SIT Emission Inventory

Agriculture
Enteric Fermentation
Manure Management
Agricultural Soils
Liming and Urea Fertilization

AFOLU Emission RFI

1. IPCC Definition of AFOLU
2. IPCC & GWSA Definition of 'Mitigation'
3. 2016 Paris Agreement & VT USCA Membership
4. 2019 Refinement to 2006 IPCC National Greenhouse Gas Inventories
5. 300,000+ acres of agricultural conservation practices since 2016

Land Use Flux



LEAP Model Accounting



100-Year GWP: Direct (At Point of Emissions)
Scenario: Mitigation Pathway, All Fuels, All GHGs

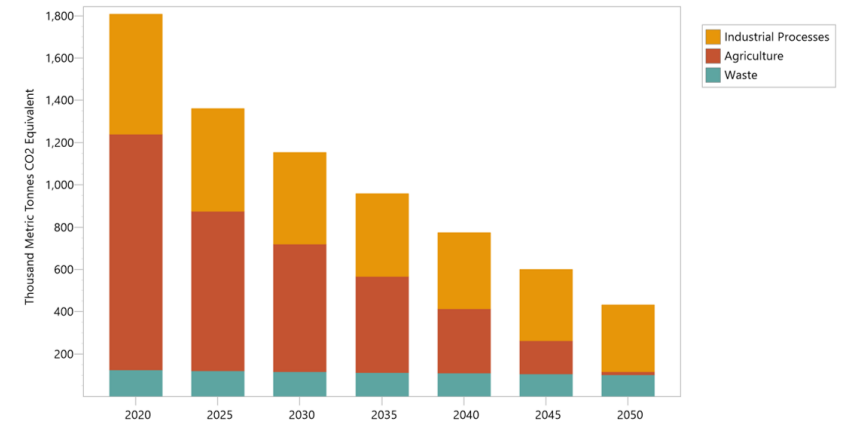


Figure 11: Emissions from non-energy sector in the LEAP Mitigation Pathway broken out into Industrial Processes, Agriculture, and Waste.

Agriculture Soils - Emissions from Residues, Legumes, & Histosols

2016

Default Crop Data?

Legumes and Crop Residue Calculations

	Units	Crop Production	Crop Production (metric tons)	N Returned to Soils (kg)	N-Fixed by Crops (kg)
Alfalfa	'000 tons	75	68,040	NA	1,735,020
Corn for Grain	'000 bushels	12,000	304,814	1,447,926	NA
All Wheat	'000 bushels	-	-	-	NA
Barley	'000 bushels	-	-	-	NA
Sorghum for Grain	'000 bushels	-	-	-	NA
Oats	'000 bushels	-	-	-	NA
Rye	'000 bushels	-	-	-	NA
Millet	'000 bushels	-	-	-	NA
Rice	'000 hundredweight	-	-	-	NA
Soybeans	'000 bushels	-	-	-	-
Peanuts	'000 lbs	-	-	-	-
Dry Edible Beans	'000 hundredweight	-	-	-	-
Dry Edible Peas	'000 hundredweight	-	-	-	-
Austrian Winter Peas	'000 hundredweight	-	-	-	-
Lentils	'000 hundredweight	-	-	-	-
Wrinkled Seed Peas	'000 hundredweight	-	-	-	-
Red Clover	metric tons	-	-	NA	-
White Clover	metric tons	-	-	NA	-
Birdsfoot Trefoil	metric tons	-	-	NA	-
Arrowleaf Clover	metric tons	-	-	NA	-
Crimson Clover	metric tons	-	-	NA	-
TOTAL			372,854	1,447,926	1,735,020

	Direct N ₂ O Emissions (metric tons N ₂ O)	Direct Emissions (MMTCE)	Direct Emissions (MMTCO ₂ E)
Residues	22.8	0.0018	0.0068
Legumes	27.3	0.0022	0.0081

- Emissions from SIT are unit based
- How land is managed is not considered
- Emission factors are static for soil and climate
- Separate SIT Ag Emissions from LULUCF – Divergent from AFOLU IPCC Guidance

Methods for Growing Corn have different outcomes



Management:

- Full width tillage
- No Nutrient Management
- No Field specific conservation practices



Management:

Cover crop	0.15 tons CO ₂ e/ac/yr
Reduced and No-Till technology	0.19 tons CO ₂ e/ac/yr
Nutrient Management	0.37 tons CO ₂ e/ac/yr
Riparian Buffers	0.74 tons CO ₂ e/ac/yr
Crop Rotation	0.22 tons CO ₂ e/ac/yr

USDA COMET ERCs:

TNC Canada: NCS Categories

Cover crops
Crop residue - biochar
Nutrient management
Tree intercropping (trees in agricultural lands pathway)
Manure Management
Silvopasture (trees in agricultural lands pathway)
Legume crops
Reduced tillage
Riparian tree planting (trees in agricultural lands pathway)
Legumes in pastures
Avoided conversion of shelterbelts (trees in agricultural lands pathway)
Avoided wetland conversion
Wetland restoration
Avoided grassland conversion
Riparian grassland restoration
Improved forest management
Avoided forest conversion
Restoration of forest cover
Urban canopy cover

							(Sorted by Acreage)	
Practice Code	Practice Name	TOTAL					Total	Average
		2016	2017	2018	2019	2020		
340	Cover Crop	28,381	23,408	29,615	24,114	36,885	142,404	28,481
590	Nutrient Management	12,992	10,012	9,792	8,051	14,545	55,393	11,079
345	Conservation Tillage	8,940	9,506	10,703	12,143	8,142	49,434	9,887
328	Conservation Crop Rotation	10,516	11,709	13,156	4,632	2,181	42,194	8,439
329	Residue and Tillage Management, No Till	2,963	2,900	3,098	6,322	3,275	18,559	3,712
512	Pasture and Hay Planting	2,080	1,713	2,450	1,455	1,917	9,613	1,923
913VTAg	Precision Agriculture	0	0	0	4,041	4,297	8,338	1,668
528	Prescribed Grazing	1,808	1,224	1,472	1,826	1,074	7,404	1,481
901VTAg	Manure Injection	0	0	0	2,247	3,787	6,034	1,207
911VTAg	Rotational Grazing	0	0	0	2,889	2,563	5,452	1,090
902VTAg	Aeration	433	475	2,023	572	1,797	5,300	1,060
314	Brush Management	708	782	1,058	1,219	1,450	5,217	1,043
633	Waste Recycling	2,220	1,181	548	0	92	4,041	808
PAC	Production Area Compliance	0	792	540	1,185	1,385	3,902	780

Mitigation in GWSA:

10 V.S.A. § 590(3) “Mitigation” means reduction of anthropogenic greenhouse gas emissions, and preservation and enhancement of natural systems to sequester and store carbon, in order to stabilize and reduce greenhouse gases in the atmosphere.

Source: https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/2021-01-15_CleanWaterPerformanceReport_SFY2020-FINA-PDF-A.pdf

Source: C Ronnie Drever et al., *Natural Climate Solutions for Canada*, 7 Science Advances 1 (2021)

EPA SIT & National Inventory Currently Two Chapters

SIT Chapter 5

EPA SIT	Category	GHG	VT	DEC
Agriculture (emissions)				
2	Enteric Fermentation	CH4	Yes	Yes
3	Manure Management	CH4, N2O	Yes	Yes
4	Agriculture Soils	N2O		
4a	Plant Residues & Legumes	N2O	Yes	Yes
	Histosols (conversion)	N2O	Yes	No
4b	Plant Fertilizers	N2O	Yes	Yes
4c	Animal Calculation Values	N2O	Yes	Yes
5	Rice Cultivation	CH4	No	No
6	Liming of Soils	CO2	Yes	Yes
7	Urea Fertilization	CO2	Yes	Yes
8	Ag Residue Burning	CH4, N2O	No	No

SIT Chapter 6

EPA SIT	Category	GHG	VT	DEC
Land Use, Land-Use Change, and Forestry (sequestration)				
7	Ag Soil Carbon Flux (Cropland and Grassland)		Yes	No
	Cropland Remaining Cropland			
	Land Converted to Cropland			
	Grassland Remaining Grassland			
	Land Converted to Grassland			
2	Forest Carbon Flux	flux	Yes	No
2a	Forest Remaining Forest			
	Land Converted to Forest			
	Forest Converted to Land			
3	C Storage in Urban Trees	storage	Yes	Yes
4	Settlement Soils (developed land)	N2O	Unknown	No
5	Forest Fires	CH4, N2O	No	No
6	Food Scraps & Yard Trimmings (le flux)		Unknown	No

IPCC AR5 Revised Ag & LULUCF to a Single Chapter

IPCC AR4 (IPCC WGIII, 2007)
Agricultural and forestry mitigation were dealt with in separate chapters

IPCC AR5
First time - the terrestrial land surface, comprising agriculture, forestry and other land use (AFOLU), is considered together in a single chapter.



- Ensure all land based mitigation options can be considered together
- Minimise the risk of double counting or inconsistent treatment (e.g. different assumptions about available land)
- Consider systemic feedbacks between mitigation options related to the land surface

Working Group III contribution to the
IPCC Fifth Assessment Report

EPA SIT Tool Planned Updates (?)

- Planned updates to include the 2006 Intergovernmental Panel on Climate Change (IPCC) Updates
- Specifically, the Agriculture and LULUCF chapters were going to be combined, thereby accounting for GHG Flux from AFOLU

2006 IPCC Guidelines for National Greenhouse Gas Inventories

The release of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 GL) may bring some structural and organizational changes to the SIT LUCF and Agriculture modules as well as prompting updates to some emission and stock change factors. Nearly 140 scientists and national experts from more than thirty countries collaborated in the creation of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* to ensure that the emission inventories submitted to the UNFCCC are consistent and comparable between nations. These guidelines were recently updated and revised to produce the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

When the organizational structure outlined in the 2006 IPCC Guidelines is fully implemented, the Agriculture and LULUCF chapters of the NIR will be combined into a single Agriculture, Forestry, and Other Land Uses (AFOLU) chapter covering six land-use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land). The Agriculture and LUCF modules of the SIT may be similarly combined and reorganized to maintain consistency with national and international inventory approaches. These changes will likely be incorporated in the next round of revisions to the SIT modules.

Crop-DNDC: A simulation model linking crop growth and soil biogeochemistry for sustainable agriculture

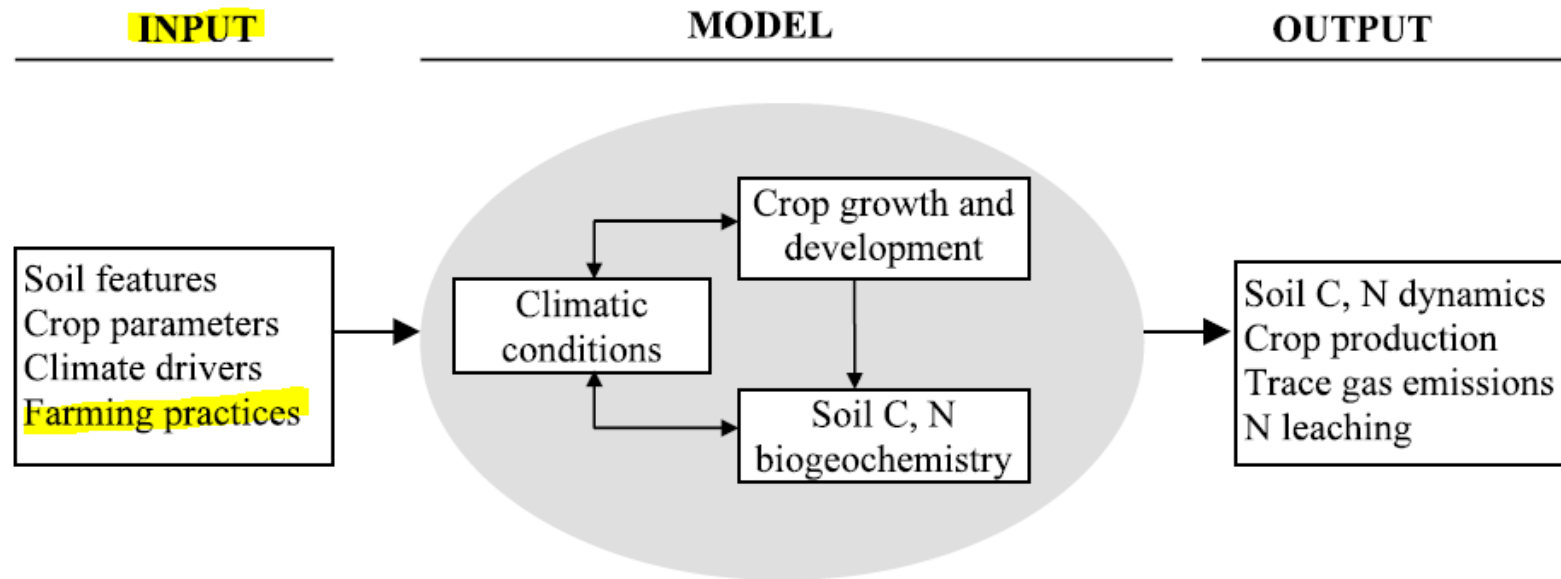
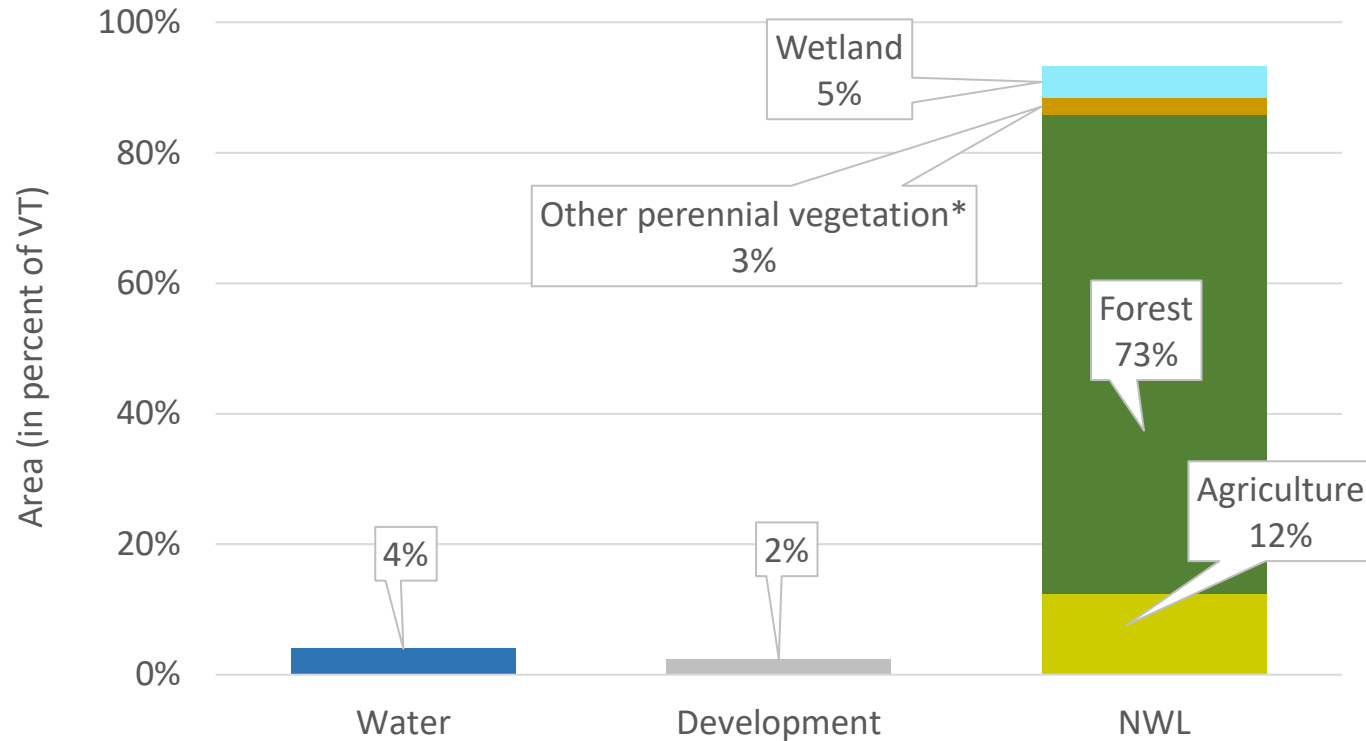


Fig. 1. The overall structure of the Crop-DNDC model.

Natural & Working Lands (NWL) cover 94% of Vermont



*Other perennial vegetation includes grasslands, shrub/scrublands, and turf

Summary

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