

Part I: Cross-Cut Analysis of Crediting Models for Carbon/GHG, Water Quality and Water Quantity - Capabilities (2018)

Quantification Model	Type (Empirical, Mechanistic)	Intended Region of Use (International, U.S., Region, State)	Temporal Scale (Daily/Annual)	Spatial Scale (cropping/production areas, field/farm, HUC)	CAPABILITIES																	
					OUTPUTS							Hydrology				AGRICULTURAL PRACTICE SIMULATION						
					Carbon (Soil Organic Matter/Carbon Long-Term Simulation, Nitrogen Fluxes, Enteric Fermentation, Manure)	Water Quality (Sediment, Phosphorus, Nitrogen, BOD, Pathogens, Salinity, Temperature, Algae, Toxins)	Water Quantity (Conserved Water Volume)	Soil Health (Y/N)	Groundwater Recharge (Y/N)	Flood Reduction (Y/N)	Streamflow (Y/N)	Streambank Erosion (Y/N)	Vegetation Growth (Commodity Crops and/or Foliage Plants)	Animal Grazing (Cutting and Grazing Practices, Manure Management)	Multiple Cropping/Agricultural Production Systems (Y/N)	Field/Pasture Management BMPs (Y/N)	Tillage Practices (Y/N)	Irrigation Practices (Y/N)	Flooding Practices (Y/N)	Harvest Practices (Y/N)		
Carbon/GHG Models																						
DNDC (Denitrification-DeComposition)	Mechanistic	Global	Daily	Field, Watershed	Plant Residue (stable, labile and very labile), Microbial Biomass (labile and stable), Humus and Passive-Humus (stable and labile); CO2, CH4, N2O, NH3 Fluxes	Nitrogen	Unknown	No	No	No	No	No	No	Grass, Crop, Forest	Cutting and Grazing Practices; Manure Management*	Yes	Yes	Yes	Yes	Yes	Yes	
DAYCENT (Daily Century Model)	Mechanistic	North America	Daily	Field, Watershed	Soil Water Content and Temperature by layer, Plant Production and Allocation of Net Primary Production (NPP), Decomposition of Litter and Soil Organic Matter, Mineralization of Nutrients, N Gas Emissions from nitrification and denitrification, CH4 Oxidation in non-saturated soils; Daily N-Gas Flux (N2O, NOx, N2), CO2 Flux from heterotrophic soil respiration	Nitrogen	Unknown	No	No	No	No	No	No	Crop, Grass, Forest, Savannah	Grazing, Cultivation, Fire, Organic Matter/Fertilizer Addition	Unknown	Yes	Yes	Yes	Unknown	Yes	
RothC (Rothamsted Carbon Model)	Mechanistic	TBD	Monthly	Field	Soil Carbon in each Pool and 14C, CO2	No	No	No	No	No	No	No	No	Grassland, Woodland	Indirectly	Indirectly	Indirectly	Indirectly	Indirectly	Indirectly	Indirectly	
PuSIM (Pasture Simulation Model)	Mechanistic	Europe	Hourly	Field	CO2, CH4, N2O	TBD	TBD	TBD	No	No	No	No	No	Pasture, Grassland	Cutting and Grazing Practices; Manure Management	TBD	TBD	TBD	TBD	TBD	TBD	TBD
AgroC	Mechanistic	TBD	Hourly, Daily	TBD	Soil Organic Carbon Pools, CO2	TBD	TBD	TBD	No	No	No	No	No	Agricultural Systems	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ECOSSE (Estimation of Carbon in Organic Soils - Sequestration and Emissions)	Mechanistic	TBD	Daily, Monthly	Field, National	Soil Organic Carbon, Soil Greenhouse-Gas Emissions, Inert Organic Matter, Humus, Biomass, Resistant Plant Material, Decomposable Plant Material, CO2, CH4, N2O, N2	TBD	TBD	TBD	No	No	No	No	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ORCHIDEE (Organising Carbon and Hydrology in Dynamic Ecosystems)	Mechanistic	Global	Daily	Watershed, Continental	Soil Carbon Dynamics, Litter Decomposition	TBD	TBD	TBD	No	No	No	No	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Water Quality Models																						
APEX (Agricultural Policy/Environmental eXtender)	Mechanistic & Empirical	U.S.	Daily	Small Watersheds (HUC14-HUC12)	Soil Organic Carbon Long-Term Nitrogen* Carbon from Manure	Sediment Phosphorus Nitrogen	Yes	Yes	Yes	Yes	Yes	No	No	Commodity Crops and Foliage Plants	Cutting and Grazing Practices; Manure Management	Yes	Yes	Yes	Yes	TBD	Yes	
NTT (Nutrient Tracking Tool with APEX)	Mechanistic & Empirical	U.S.	Monthly, Annual	Small Watersheds (HUC14-HUC12)	None	Sediment Phosphorus Nitrogen	Yes	No	No	Yes	No	No	No	Commodity Crops and Foliage Plants	Cutting and Grazing Practices	Yes	Yes	Yes	Yes	TBD	Yes	
Snap-Plus (VI Soil Nutrient Application Planner)	Empirical*	Wisconsin	Annual	Field	None	Sediment Phosphorus Nitrogen	No	No	No	No	No	No	No	Manure Management	Manure Management	Yes	Yes	Yes	Yes	TBD	Yes	
EPA Region 5 Calculator	Empirical	EPA Region 5	Annual	Field	None	Sediment Phosphorus Nitrogen	TBD	No	No	No	No	No	Yes	No	Manure Management	Manure Management	No	Yes	No	No	TBD	No
STEPL (Spreadsheet Tool for Estimating Pollutant Load)	Empirical	U.S.	Annual	Field	None	Sediment Phosphorus Nitrogen BOD E. coli	TBD	No	No	No	No	No	Yes	No	Manure Management	Manure Management	No	Yes	No	No	TBD	No
Nonpoint Source Nitrogen Calculation Spreadsheet; Nonpoint Source Phosphorus Calculation Spreadsheet (PA)	Empirical	Pennsylvania	Annual	Field	None	Sediment Phosphorus Nitrogen	TBD	No	No	Yes	No	Yes	Yes	No	Manure Management	Manure Management	No	Yes	Yes	No	TBD	No
SWAT (Soil Water Assessment Tool)*	Mechanistic & Empirical	U.S.	Daily	Field, Watersheds (HUC8*)	Soil Organic Carbon Long-Term Nitrogen Carbon from Manure	Sediment Phosphorus Nitrogen BOD Pathogens Salinity Temperature Algae	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Commodity Crops and Foliage Plants	Cutting and Grazing Practices; Manure Deposit	Yes	Yes	Yes	Yes	Unknown	Yes	
HSPF (Hydrologic Simulation Program-FORTRAN*)	Mechanistic & Empirical	U.S.	Hourly	Fields, Watersheds (HUC8*)	Nitrogen Fluxes	Sediment Phosphorus Nitrogen BOD Pathogens Salinity Temperature Algae Toxins	Yes	No	Yes	Yes	Yes	Yes	Yes	Commodity Crops and Foliage Plants	Cutting and Grazing Practices; Manure Deposit; Manure Management	Yes	Yes	Yes	Yes	Unknown	Yes	
MIKE-SHE*	Mechanistic	Global	Sub-Hourly, Hourly*	Fields, Watersheds (HUC8*)	None	None	Yes	No	Yes	Yes	Yes*	Yes*	Yes*	No	No	No	No	No	Yes	Unknown	No	
WARMP (Watershed Analysis Risk Management Framework*)	Mechanistic & Empirical	U.S.	Minutes, Hourly, Daily	Watersheds (HUC8*)	None	Sediment Phosphorus Nitrogen BOD Pathogens Salinity Temperature Algae Toxins Metals	Yes	No	No	No (?)	Yes	No (?)	No (?)	No	No	No	No	No	Yes (?)	Unknown	No	
NutrientNet (with APEX)*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Virginia BMP Enhancement and Land Conversion Offsets Calculations Worksheet (based on HSPF)*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Quantity Models																						
SWAP (Statewide Agricultural Production Model)	Mechanistic & Empirical	International	Hourly, Daily	Field	Some	Some	Yes	No	Yes	No	Yes	No	No	Yes	TBD	TBD	TBD	No	Yes	TBD	Yes	
IDSCU (Integrated Decision Support Consumptive Use)	Mechanistic & Empirical	State (CO)	Daily, Monthly	Field	None	None	Yes	No	No	No	No	No	No	Yes	TBD	TBD	TBD	No	Yes	TBD	Yes	
CROPWAT	Mechanistic & Empirical	International	Daily	Field	None	None	Yes	No	No	No	No	No	No	Yes	TBD	Yes	TBD	No	Yes	TBD	Yes	
Custom Spreadsheet Model	Mechanistic & Empirical	Local	Daily, Monthly	Field	None	None	Yes	No	Yes	No	Yes	No	Yes	Yes	TBD	Yes	TBD	No	Yes	TBD	Yes	

Legend: | Model either: 1) is related to WQT but does not currently have a WQT crediting application OR 2) has a WQT crediting application but was not assessed in this analysis (further explained in the model's notes column)