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Development of a model framework for terrestrial carbon flux prediction: the Regional Carbon and Climate Analytics Tool (RCCAT) applied to non-tidal wetlands

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Carbon Sequestration in Nontidal Wetlands

Various studies have documented substantial rates of carbon uptake in nontidal wetlands. Table 1 summarizes reported carbon sequestration rates from prominent publications.

Table S1: Reported Carbon Sequestration Rates in Nontidal Wetlands

Location	**Method**	**Climate**	**Scale (# of Sites)**	**Descriptors**	**Sequestration Rate (g C/m²/year)**	**Cited Study**
San Francisco Bay-Delta (Young Wetlands)	Soil coring, 210Pb radiometric dating, eddy covariance	Mediterranean	1 site	Nontidal managed wetland dominated by Typha spp., Phragmites	334 ± 70	Arias-Ortiz et al. (2021) (Arias-Ortiz et al., 2021)
San Francisco Bay-Delta (Old Wetlands)	Soil coring, 210Pb radiometric dating, eddy covariance	Mediterranean	1 site	Nontidal managed wetland dominated by dense Typha spp. canopy	357 ± 102	Arias-Ortiz et al. (2021) (Arias-Ortiz et al., 2021)
Central Ohio (Gahanna Woods)	137Cs and 210Pb radiometric dating	Temperate	1 site, small scale	Depressional wetland -Shrub dominated by Cephalanthus occidentalis	202	Bernal and Mitsch (2012) (Bernal and Mitsch, 2012)
Central Ohio (Gahanna Woods)	137Cs and 210Pb radiometric dating	Temperate	1 site, small scale	Depressional wetland -Forested dominated by Quercus palustris	473	Bernal and Mitsch (2012)(Bernal and Mitsch, 2012)
Central Ohio	137Cs and 210Pb radiometric dating	Temperate	1 site, small	Depressional wetland -Marsh	210	Bernal and Mitsch

(Gahanna Woods)			scale	dominated by Typha spp.		(2012)(Bernal and Mitsch, 2012)
Northern Ohio (Old Woman Creek)	137Cs and 210Pb radiometric dating	Temperate	1 site, medium scale	Riverine wetland -Marsh dominated by Phragmites australis, Scirpus fluviatilis	105	Bernal and Mitsch (2012)(Bernal and Mitsch, 2012)
Northern Ohio (Old Woman Creek)	137Cs and 210Pb radiometric dating	Temperate	1 site, medium scale	Riverine wetland -Mudflat dominated by Leersia oryzoides	112	Bernal and Mitsch (2012)(Bernal and Mitsch, 2012)
Northern Ohio (Old Woman Creek)	137Cs and 210Pb radiometric dating	Temperate	1 site, medium scale	Riverine wetland -Floating bed dominated by Nelumbo lutea	160	Bernal and Mitsch (2012)(Bernal and Mitsch, 2012)
Victoria, Australia	Core sampling, model (Appleby & Oldfield, 1978; Krishnaswami, Lal, Martin, & Meybeck, 1971)	Temperate	19 sites	Shallow freshwater marsh: moderate carbon stocks	91	Carnell et al. (2018)(Carnell et al., 2018)
Victoria, Australia	Core sampling, model (Appleby & Oldfield, 1978; Krishnaswami, Lal, Martin, & Meybeck, 1971)	Temperate	22 sites	Permanent open freshwater wetlands: low carbon stock	230	Carnell et al. (2018)(Carnell et al., 2018)
Victoria, Australia	Core sampling, model (Appleby & Oldfield, 1978; Krishnaswami, Lal, Martin, & Meybeck, 1971)	Temperate	33 sites	Deep freshwater marsh: high carbon stocks	160	Carnell et al. (2018)(Carnell et al., 2018)

Netherlands	Biomass measurement	Temperate	1 site	Constructed wetland with emergent vegetation (Phragmites)	797 (average)	De Klein and van der Werf (2014)(de Klein and van der Werf, 2014)
Global	Soil coring	Temperate & tropical	7 sites	Includes natural and created wetlands	118 (average)	Mitsch et al. (2013)(Mitsch et al., 2013)
Global	Marker horizons, 137Cs and 210Pb radiometric dating	Temperate /Tropical	186 sites	Inland wetland -Permanent Freshwater Marsh	122.6	Villa and Bernal (2018)(Villa and Bernal, 2018)
Global	Radiometric dating (14C)	Temperate /Boreal	88 sites	Rain-fed bogs/mires -Non-forested Peatland	26.1	Villa and Bernal (2018)(Villa and Bernal, 2018)
Global	Dendrogeomorphic techniques, 14C and 210Pb radiometric dating	Temperate /Tropical in riparian settings	117 sites	Riparian/Bottomland Forests -Freshwater Tree-Dominated Wetland	176	Villa and Bernal (2018)(Villa and Bernal, 2018)

Methane Emissions in Nontidal Wetlands

While nontidal wetlands sequester carbon, they can also emit methane, potentially offsetting some climate mitigation benefits. Table 2 presents methane emission rates from various studies.

Table S2: Reported Methane Emissions in Nontidal Wetlands

Location	Method	Climate	Scale (# of Sites)	Descriptors	Methane Emissions (g C-CH4 m^{-2} yr^{-1})	Cited Study
San Francisco Bay-Delta (Young Wetlands)	Eddy covariance	Mediterranean	1 site	Nontidal managed wetland dominated by Typha spp., Phragmites	44 ± 5	Arias-Ortiz et al. (2021) (Arias-Ortiz et al., 2021)
San Francisco Bay-Delta (Old Wetlands)	Eddy covariance	Mediterranean	1 site	Nontidal managed wetland dominated by dense Typha spp. canopy	37 ± 4	Arias-Ortiz et al. (2021) (Arias-Ortiz et al., 2021)
Maryland	Static chambers and eddy covariance (combined in a Bayesian framework)	Humid subtropical	1 site	Restored freshwater wetlands with graminoid patches dominated by grasses and sedges	~142 (median)	Stewart et al. (2024) (Stewart et al., 2024)
Delmarva Peninsula, Maryland	Static chambers and eddy covariance (combined in a Bayesian framework)	Humid subtropical	1 site	Open water areas	~5	Stewart et al. (2024) (Stewart et al., 2024)
Louisiana	Gas diffusion chambers	Humid subtropical	3 sites	Freshwater marshes	3–225	Delaune and Pezeshki (2003)(DeLaune and Pezeshki, 2003)
Ohio	Non-steady state gas sampling chamber method (Altor and Mitsch	Temperate	1 site	Natural wetland	57	Mitsch et al. (2013)(Mit

	(2006, 2008) and Nahlik and Mitsch (2010, 2011))					sch et al., 2013)
Ohio	Non-steady state gas sampling chamber method (Altor and Mitsch (2006, 2008) and Nahlik and Mitsch (2010, 2011))	Temperate	2 sites	Created marshes	30	Mitsch et al. (2013)(Mitsch et al., 2013)
Costa Rica	Non-steady state gas sampling chamber method (Altor and Mitsch (2006, 2008) and Nahlik and Mitsch (2010, 2011))	Tropical	3 sites	Isolated & floodplain wetlands	Highest 220–263	Mitsch et al. (2013)(Mitsch et al., 2013)
Costa Rica	Non-steady state gas sampling chamber method (Altor and Mitsch (2006, 2008) and Nahlik and Mitsch (2010, 2011))	Tropical	1 site	Flow-through tropical wetland	33	Mitsch et al. (2013)(Mitsch et al., 2013)
Randers Fjord, Denmark	Sediment core	Temperate	1 site	Estuarine Environments (Freshwater Zones)	2.08	Abril and Iversen (2002)(Abril and Iversen, 2002)
Randers Fjord, Denmark	Sediment core	Temperate	1 site	Estuarine Environments (Saltwater Zones)	0.23	Abril and Iversen (2002)(Abril and Iversen, 2002)
Global	Eddy covariance	Boreal, temperate, tropical/subtropical	23 sites	Freshwater Wetlands	0.25–271	Knox et al. (2021)(Knox et al., 2021)

Table S3: Feature pool

Variable Name	Full Variable Name	Variable Name	Full Variable Name
WLDAS variables: https://ldas.gsfc.nasa.gov/wldas/model-output			
AvgSurfT_tavg	Surface Temperature	Rainf_f_tavg	Rainfall Flux (Rain + Snow)
BareSoilT_tavg	Bare Soil Temperature	Rainf_tavg	Precipitation Rate
CanopInt_tavg	Total Canopy Water Storage	SWdown_f_tavg	Surface Downwelling Shortwave Flux
ECanop_tavg	Interception Evaporation	Soil Moisture	Soil Moisture (0-200 cm), $m^3 m^{-3}$
ESoil_tavg	Bare Soil Evaporation	Soil Temperature	Soil Temperature (0-100 cm), K
Evap_tavg	Total Evapotranspiration	Swnet_tavg	Surface Net Downward Shortwave Flux
LWdown_f_tavg	Surface Downwelling Longwave Flux	TVeg_tavg	Vegetation Transpiration
Lwnet_tavg	Surface Net Downward Longwave Flux	Tair_f_tavg	Air Temperature

Psurf_f_tavg	Surface Pressure	VegT_tavg	Canopy Temperature
Qair_f_tavg	Specific Humidity	Wind_f_tavg	Wind Speed
Qg_tavg	Downward Heat Flux in Soil	WT_tavg	Water in Aquifer and Saturated Soil
Qh_tavg	Surface Upward Sensible Heat Flux	WaterTableD_tavg	Water Table Depth
Qle_tavg	Surface Upward Latent Heat Flux	Qs_tavg	Surface Runoff Amount
LANDSAT variables: https://landsat.gsfc.nasa.gov/data/data-access/			
NDVI	Normalized Difference Vegetation Index	EVI	Enhanced Vegetation Index
SAVI	Soil-Adjusted Vegetation Index	NDWI	Normalized Difference Water Index
NDMI	Normalized Difference Moisture Index	NDGI	Normalized Difference Greenness Index
MNDWI	Modified Normalized Difference Water Index		