Experimental study of GHG flux dynamics at "Le Viote" alpine peatland (Italy), in a climate change perspective.

Laura Rubriante[1,2*], Damiano Gianelle[1], Dario Papale[3], Luca Belelli Marchesini[1]

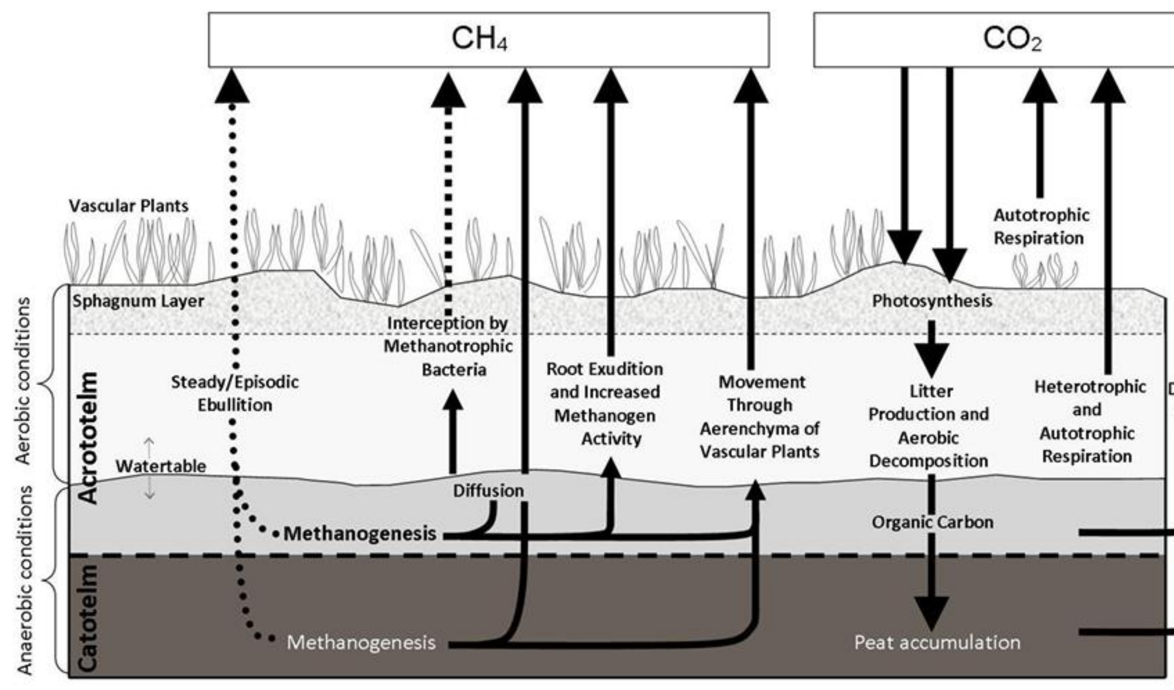
[1]Forest Ecology Unit, Research and Innovation Centre, Edmund Mach Foundation, San Michele all'Adige (Italy)
[2]Department of Innovation in Biological, Agri–Food and Forestry Systems (DIBAF), University of Tuscia, Viterbo (Italy)
[3]Iret–Cnr (Institute of Research on Terrestrial Ecosystems of the National Research Council), Montelibretti (Italy)

* laura.rubriante@fmach.it

Why Study Peatlands?

- Peatlands are ecosystems particularly threatened by climate change and anthropogenic activities.
- Peatlands stock about 30% of Earth's carbon and can be sources or sinks of greenhouse gases (GHGs), like methane (CH_4) and carbon dioxide (CO_2).
- Climate change can alter fluctuations in space and time of peatland environmental drivers (temperature, soil moisture, water-table depth), making peatlands possible hot spots of GHGs emissions in the coming years.
- Worldwide, around 12% of current peatlands are degraded and drained for activities like agriculture, forestry or mining, contributing to at least 4% of annual global human-induced emissions.

Figure 1: Schematic diagram of CO_2 and CH_4 fluxes in a peatland ecosystem

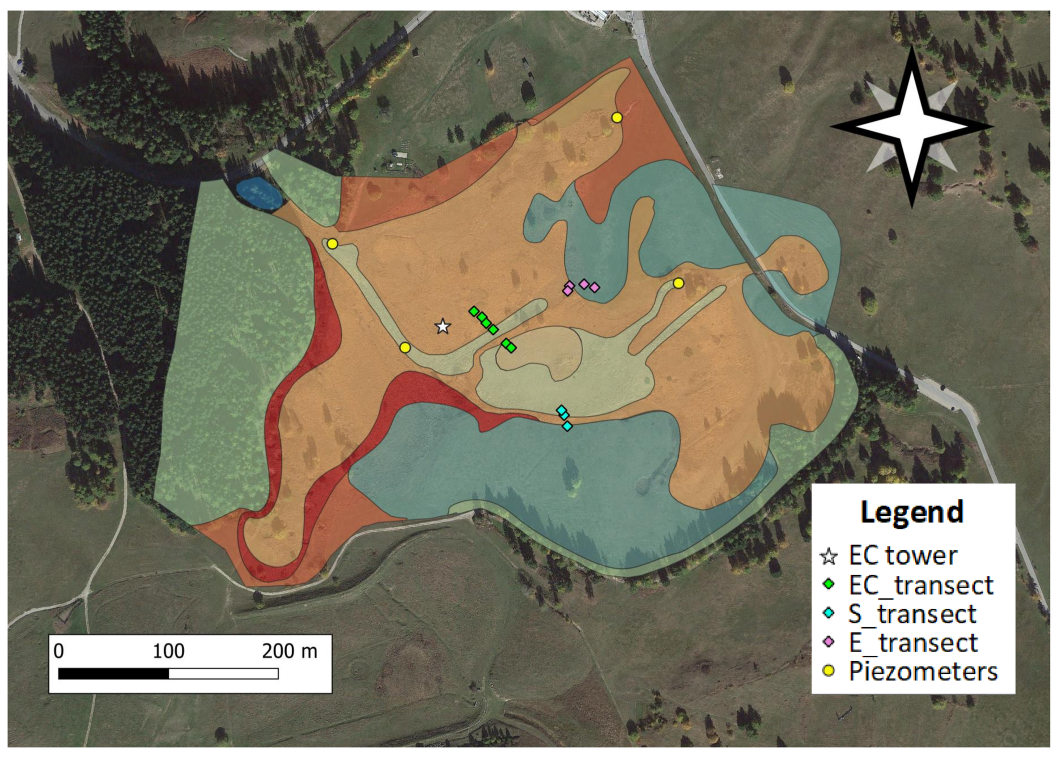


(Taylor, 2014)

Table 1: Carbon and GHG budget of ''Le Viote'' alpine peatland from historical data

Variable	Mean ± std.dev	Unit	Year
NEE (Net Ecosystem Exchange)	180.7 ± 65.2	$gC\text{-}CO_2\ m^{-2}yr^{-1}$	2012-2014
GPP (Gross Primary Production)	1191.0 ± 42.9	$gC\text{-}CO_2\ m^{-2}yr^{-1}$	2012-2014
Reco (Ecosystem Respiration)	1307.7 ± 25.4	$gC\text{-}CO_2\ m^{-2}yr^{-1}$	2012-2014
CH_4 (Methane flux)	3.2	$gC\text{-}CH_4\ m^{-2}yr^{-1}$	2014
DOC (Dissolved Organic Carbon) export fluxes	10.9 ± 4.1	$gC\ m^{-2}yr^{-1}$	2014-2015
NECB *	**-194,8 ± 46,19**	$gC\ m^{-2}yr^{-1}$	
GHG budget **	**-281.2 ± 46,19**	$gC\text{-}CO_2eq\ m^{-2}yr^{-1}$	
* NECB=-NEE-CH_4-DOC			
** 100 yrs GWP CH_4 (IPCC, AR6)			
*** CH_4 flux uncertainty not included in cumulative uncertainty			

(Pullens, 2017)



Vegetation classes

- "Carex fusca" and "Deschampsia caespitosa" aggr.
- "Festuca nigrescens" and "Stellaria graminea" aggr.
- "Caricetum goodenowii" Braun 1915 var. a "Molinia caerulea"
- "Caricetum lasiocarpae" Osvald 1923 em. Dierssen 1982
- "Caricetum rostratae" Osvald 1923 em. Dierssen 1982
- "Picea abies" (L.) H.Karst., 1881 forest plantation
- "Sieversio-Nardetum strictae" Luedi 1948
- Peatland outflow area

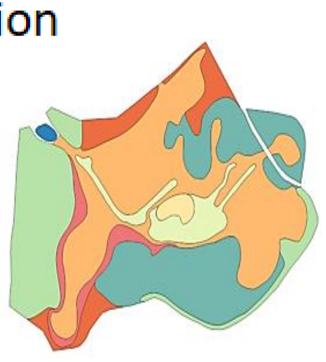


Figure 2: ''Le Viote'' alpine peatland vegetation map

Research Goals

- To monitor the spatial and temporal dynamics of methane (CH_4) and carbon dioxide (CO_2) exchanges between the "Le Viote" peatland and the atmosphere.
- To analyze the response of GHG fluxes to water table depth variations and climate warming.
- To produce an updated GHG budget assessment of the peatland site.

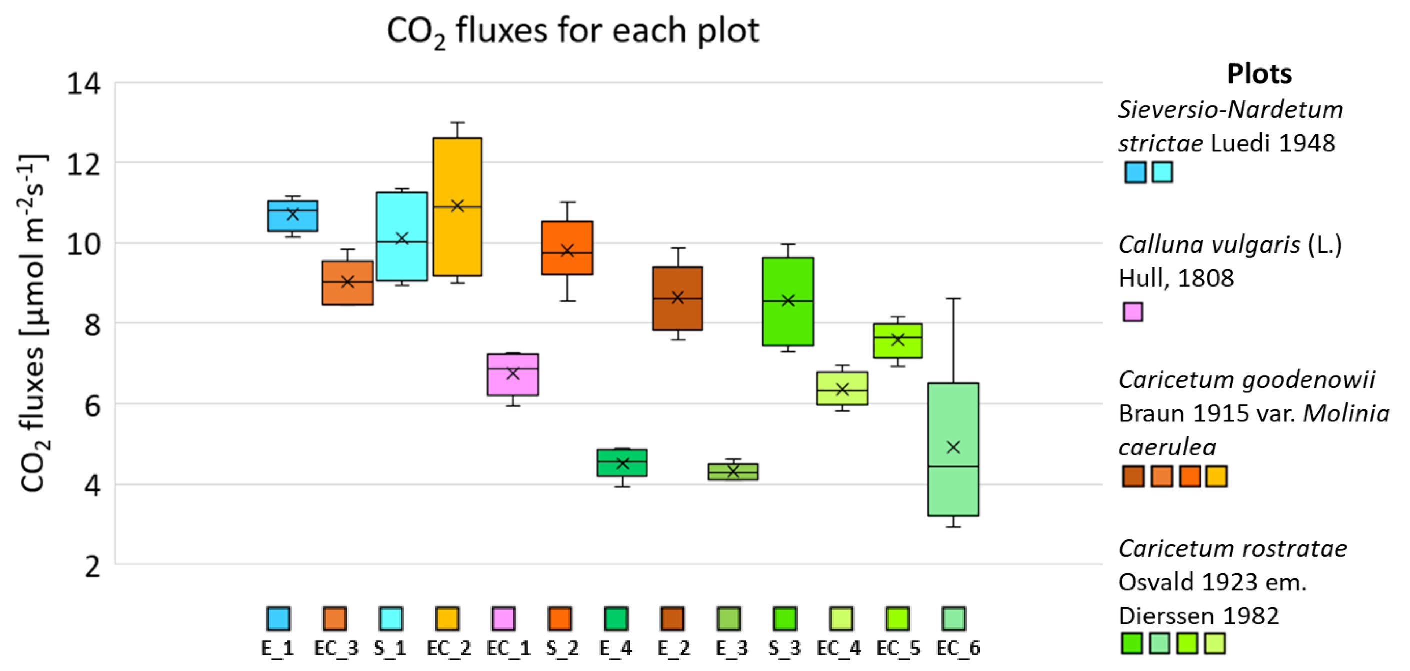
Materials and Methods

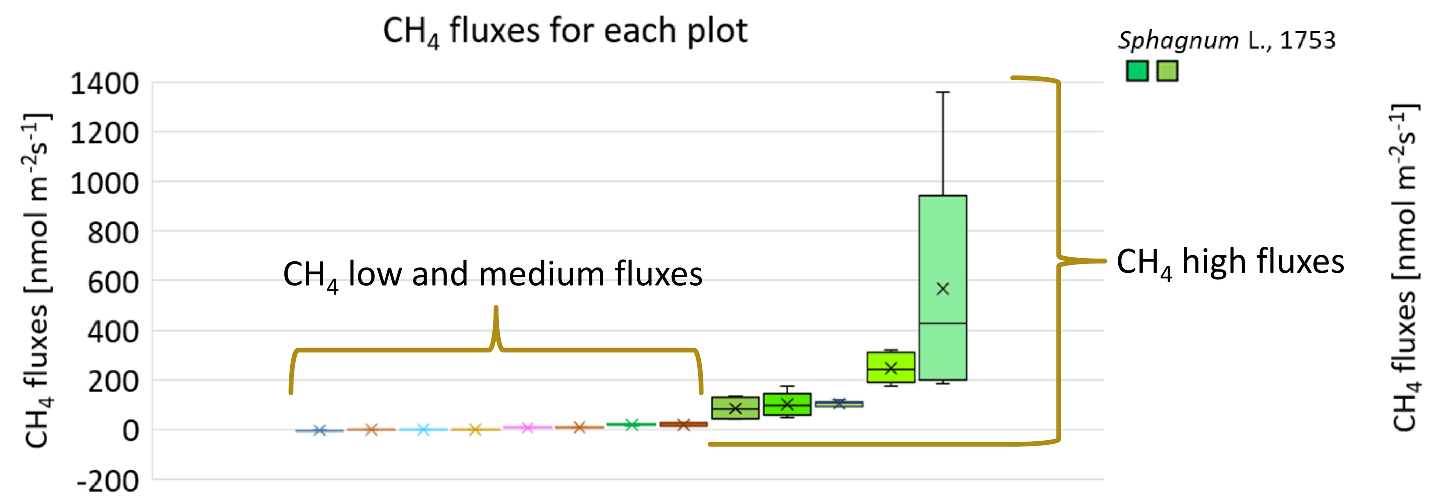
- Study site: the alpine peatland "Le Viote" (46°01'07" N, 11°02'34" E), located in the middle of a plateau in the Mt. Bondone area, in the eastern Alps (Italy), at a mean altitude of 1560 m a.s.l.. Close to the ICOS IT-Mbo site, an alpine grassland (~0.5 km).
- GHG fluxes measured by eddy covariance and chamber based techniques. CO_2 fluxes monitored since 2012; CH_4 fluxes measured in 2014 and since August 2024 (this study).
- Climate and soil physical variables measured at the micrometeorological (EC) tower and water table depth monitored at 4 locations in the peatland.

Figure 3: LiCor Smart Chamber (above); LiCor 7810 CH_4/CO_2/H_2O Trace Gas Analyzer and studied peatland site (right)

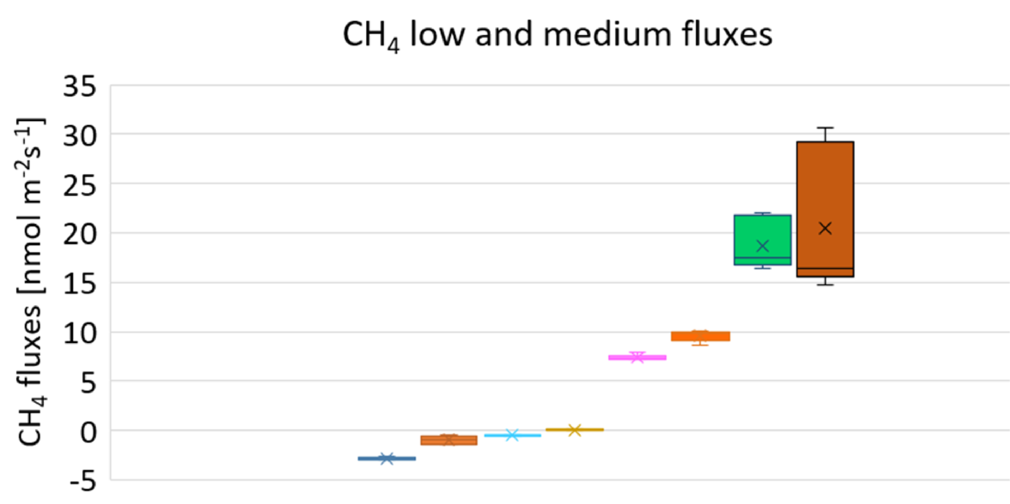
Preliminary Results

Figure 4: Chamber based CO_2 and CH_4 fluxes in August 2024





- Large spatial variability in GHG fluxes (2 orders of magnitude for CH_4 fluxes).
- Weak CH_4 sink from surrounding grassland, low to null CH_4 source from graminoids dominated drier peatland areas and strong emissions from water logged areas.
- Spatial variability of CO_2 fluxes (ecosystem respiration) featuring inverse pattern than CH_4 fluxes.



Outlook

- To carry out automated and manual chamber measurements of GHG fluxes in the EC tower footprint and other peatland areas respectively, starting in spring 2025.
- To include methane fluxes in eddy covariance based measurements.

References

- Carbognani M., Tomaselli M. & Petraglia A. (2023). Interactions and Covariation of Ecological Drivers Control CO_2 Fluxes in an Alpine Peatland. Wetlands, 43(5). https://doi.org/10.1007/s13157-023-01692-5
- Pullens J.W.M. (2017). Measurements of the carbon, energy and water balance in an Italian alpine peatland and simulating the vegetation and carbon dynamics in three different peatlands. https://hdl.handle.net/10468/6482
- Taylor E.S. (2014). The Impact of Fire on Blanket Bogs: Implications for Vegetation and the Carbon Cycle. http://hdl.handle.net/1842/10554