SPECTROSCOPIC ASSESMENT OF SOIL ORGANIC MATTER STABILITY IN PEATLANDS FROM THE HIGH ANDES

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INTRODUCTION

In the Central Andes, peatlands (a.k.a. bofedales) are a source of good quality pastures for wild and domestic South American camelids. Bofedales are threatened by climate change, which is altering the water input from glacier snowmelt and increasing the variability of rainfall. A related thread is the pressure exerted by Andean peasants to convert them into cropping and pasturelands.

The objectives of this study were: 1) to determine carbon stocks in the upper layers of seasonal and permanent (water-logged) Peruvian bofedales in the Central Andes; 2) to use Electron Paramagnetic Resonance (EPR) and Laser Induced Fluorescence (LIF) spectroscopic techniques to evaluate the organic matter stability of whole soils sampled from these bofedales; and, 3) to test a portable LIF for assessing soil organic matter (SOM) stability and its suitability for field-level studies.

MATERIAL & METHODS

❖ Experimental sites and soil sampling

Figure 1. View of two Andean wetlands (Bofedales), specific agro ecosystems from Andean mountains, located in Puno, Peruvian Altiplano, at 3,881 m.a.s.l. (a) wet grasslands (seasonal water-logged bofedales) and (b) permanent bofedales (permanent water-logged).

➢ soil samples were collected in April 2008 at different depths: 0-2.5, 2.5-5, 5-10, 10-20 and 20-30 cm;

➢ samples were dried at 50-60º C and the roots were removed. Dry soil samples were grounded and sieved to pass 0.250 mm particle size;

➢soil pH: ~7.7; Mean annual temperature: 8.1 °C; Mean annual precipitation: 762 mm.

➢ Granulometry:

Wet grasslands: 25% clay, 49% silt and 26% sand - loamy texture;

Permanent bofedales: 12% clay, 30% silt and 58% sand - sandy loam texture.

❖ Spectroscopical analyses for whole soils

Electron Paramagnetic Resonance (EPR)
EPR quartz tubes (2.5 mm I.D.) were filled with 20-30 mg of soil sample. The relative concentration for semiquinone-type free radicals was obtained by using a strong pitch reference of known free radical content (Saab & Martin-Neto, 2008), which is proportional to the OM humification.

Laser-Induced Fluorescence (LIF)
Soil pellets 1 cm diameter and 2 mm thick were prepared with 0.5g sample. LIF analyses were done using a home-assembled apparatus described by Milori et al. (2006). Samples were excited by an argon laser at 458 nm with power around 300 mW. Humification index (H_{LIF}) of SOM was obtained by the ratio of the area under the LIF spectrum to total carbon concentration.

Portable LIF system
The system was developed by the Lasers and Optics Laboratory to analyse humification index of SOM at field conditions. The excitation is produced by a cw laser at 405 nm with 20 mW power. An optical bundle collects the emitted light and takes it to a minispectrometer.

RESULTS

Table 1. Soil carbon stocks (CS) by soil layer and total (0-30 cm).

	Wet grasslands			permanent bofedales		
depth (cm)	carbon (g kg^{-1})	bulk density (g cm^{-3})	CS# (Mg ha^{-1})	carbon (g kg^{-1})	bulk density (g cm^{-3})	CS# (Mg ha^{-1})
0-2.5	132.9 ± 0.3	0.4	11.9	215.6 ± 0.0	0.4	22.1
2.5-5	128.6 ± 0.2	0.4	11.5	181.6 ± 0.4	0.4	18.6
5-10	123.0 ± 0.9	0.9	53.8	158.2 ± 0.1	0.3	22.3
10-20	121.7 ± 0.8	0.9	116.0	141.9 ± 1.8	0.7	94.3
20-30	128.0 ± 1.4	0.9	108.4	135 ± 0.0	0.5	71.5
Total (0-30)	634.2 ± 3.6	-	**301.7**	832.3 ± 2.3	-	**228.9**

 # CS = 10 × (C × d × T); *C* is the carbon content in g kg^{-1}; *T* the sample layer thickness in meters and *d* the soil layer bulk density in Mg m^{-3};

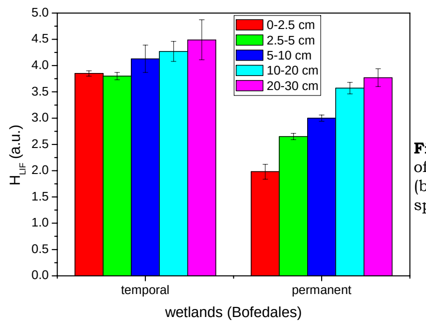
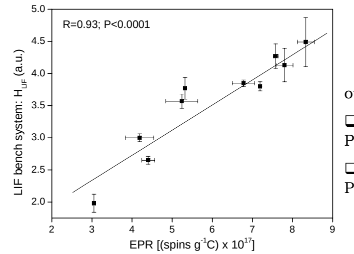


Figure 2. Humification degree (H_{LIF}) of Peruvian mountain wetlands (bofedales) soils obtained through LIF spectroscopy.



other linear correlations:

❑ bench LIF and portable LIF: R= 0.98; P<0.0001;

❑ portable LIF and EPR: R= 0.92; P<0.0001.

Figure 3. Data showing the close relationship between the concentrations of semiquinone-type free radicals, measured by EPR and the results of the H_{LIF}, measured by LIF technique to evaluate humification index from Andean wetlands (bofedales) soils.

CONCLUSIONS

✓ greater amount of carbon yield indicates a possible alternative for carbon accumulation in bofedales (229-302 Mg ha^{-1} of carbon stocks);

✓ the spectroscopic techniques used in this study demonstrated that the two types of dominant wetlands in Peruvian Andes differed in organic matter stability;

✓ LIF spectroscopy constitutes a promising technique for OM evaluation with whole soil samples, as evidenced by the good agreements with EPR results;

✓ water-logging (anaerobiosis effect in wetland systems) prevents microorganisms from degrading OM;

✓ wet grasslands presented higher carbon accumulation and higher stable carbon, compared to permanent bofedales;

✓ the soil characterization using portable systems can be done in the field with whole soil samples thus avoiding transporting through rough terrains like the Andean mountains.

REFERENCES

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