Carbon Storage and Methane Flux in the Peruvian Andes: Are Bofedales Net Carbon Sinks or Sources?

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Abstract

Bofedales are high altitude peat, wetland systems that present the potential to combat climate change by sequestering large amounts of carbon that would otherwise be released into the atmosphere as greenhouse gases in the form of CO_2. However, they are also natural sources of methane, a greenhouse gas with 25 times the warming potential of CO_2 over 100 years. Methane flux rates and carbon accumulation rates were measured to determine if the wetlands are acting as carbon sinks or carbon sources. Methane was measured by capturing methane in gas flux chambers and carbon accumulation was measured from a soil core taken at the site (Ausengate.) Our results for this one site determined an average ratio for carbon stored in the wetlands to methane released of 0.301:1, indicating that these wetlands in the Peruvian Andes may be acting as carbon sources instead of sinks.

Introduction

Wetlands, known as bofedales, located in the high Andes of Peru provide many ecosystem services and play a critical role in maintaining biodiversity, supporting indigenous communities through agriculture and livestock grazing, and also supplying a storage area for water and carbon. These unique systems are under threat from the mining industry, development, and most importantly anthropogenic climate change. The wet, densely-packed bofedales are ideal environments to store atmospheric carbon. Conversely, wetlands release large quantities of methane into the atmosphere due to the anaerobic conditions of the system. In terms of gloabl warming potential, methane is 25 times more potent as a greenhouse gas than carbon dioxide. Through measurements of methane flux and carbon sequestration in the bofedales, a net carbon ratio can be calculated to determine if the bofedales are contributing to climate change or lessening its effect by acting as carbon sinks.

Methods

To calculate methane flux, sealed methane chambers made of PVC pipe were used to capture methane released from the bofedales over a period of 25 minutes. The accumulation of methane in the chambers over time is shown in Figure 1. After allowing the methane capture device to equilibrate with the ground for a half hour, gas samples were extracted from the methane chambers via a syringe at 5 minute increments until 6 samples were obtained. These samples were then stored in vacuum sealed tubes and sent to the laboratory for analysis of methane present in the sample. From this data, the amount of carbon from methane released from the bofedales was determined as the methane flux rate.

Figure 1. Methane Concentration (ppm) over Time

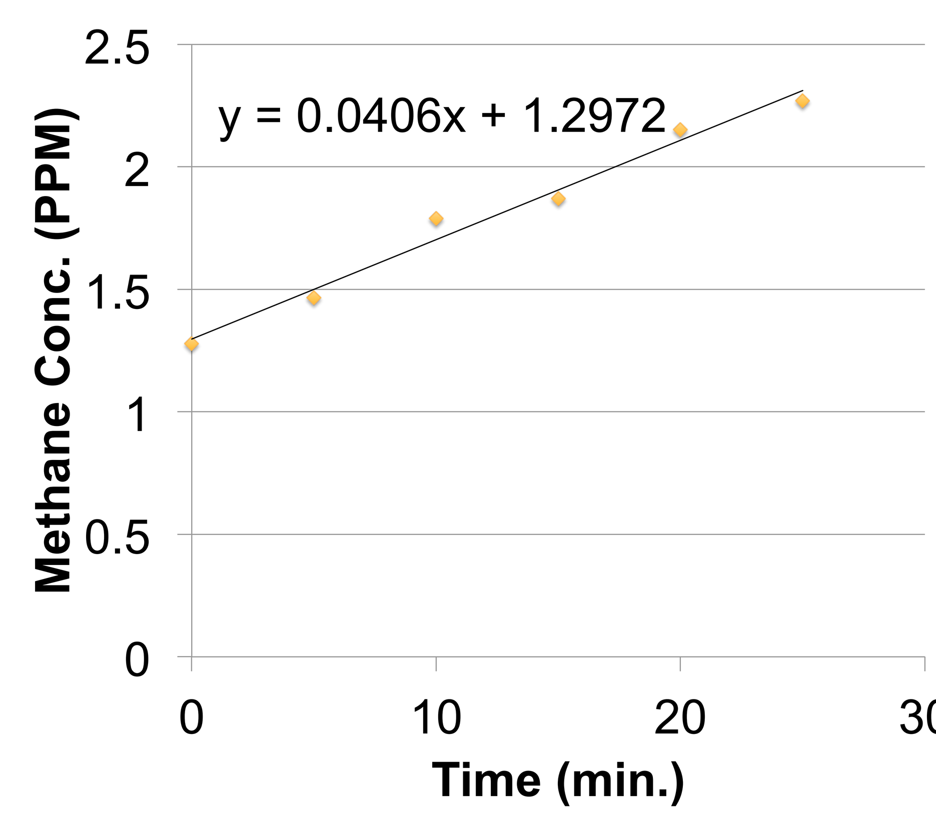
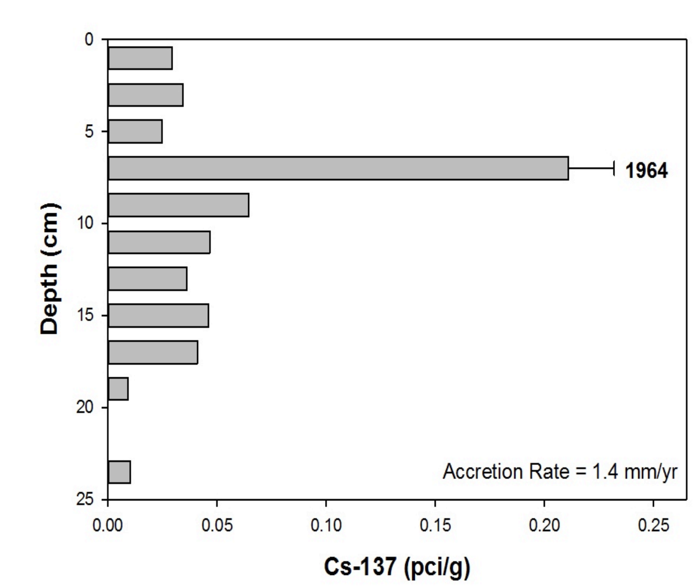


Figure 2. Cesium-137 Marker Determination in Soil Cores



For carbon data, ground core samples were extruded using a hand core. The core samples were divided into two inch segments and analyzed for Cesium-137 and Pb-210 markers in the soil, shown in Figure 2. The indication of the presence of Cesium-137 was used to determine the amount of organic matter that had accumulated in the bofedales over time. The amount of carbon present in the soil was then determined, producing an annual carbon accumulation rate.

Results

Given time constraints, the data presented is from the Ausengate bofedale due to the fact that all data from this site is available. The data showed that there was a higher rate of carbon accumulation in the bofedale than methane released, as shown in Table 1. The ratio of carbon stored to methane released was calculated to be an average of 7.515. However, methane has a 25 times greater warming potential (GWP) than carbon dioxide. After adjusting for the GWP, the ratio of carbon to methane was 0.301.

Table 1. Carbon Accumulation and Methane Flux Rates in Ausengate

Site Name	Methane Flux ($g/m^2/yr$)	Carbon Accumulation ($g/m^2/yr$)
Ausengate Chamber 8	11.521	115.327
Ausengate Chamber 10	36.622	115.327
Ausengate Chamber 12	108.720	115.327
Ausengate Chamber 14	7.281	115.327

Discussion

The data shows that the high altitude bofedales in Peru are acting as carbon sources for global warming, not carbon sinks. Individual chamber ratios showed considerable spatial variability across the bofedale. Figure 3 shows the four chamber locations in the Ausengate bofedale and Figure 4 shows the variance in methane flux. The spatial variability exemplifies that homogeneity cannot be assumed throughout the wetland. Previous research regarding CH_4 to CO_2 ratios for global wetlands found that ratios may range from 0.9:1 to 57:1, although these studies did not examine high altitude wetlands in the tropics. Our ratio of 0.301:1 indicates that our site is acting as a carbon source, not a sink.

Figure 3. Spatial Variability of Methane Flux

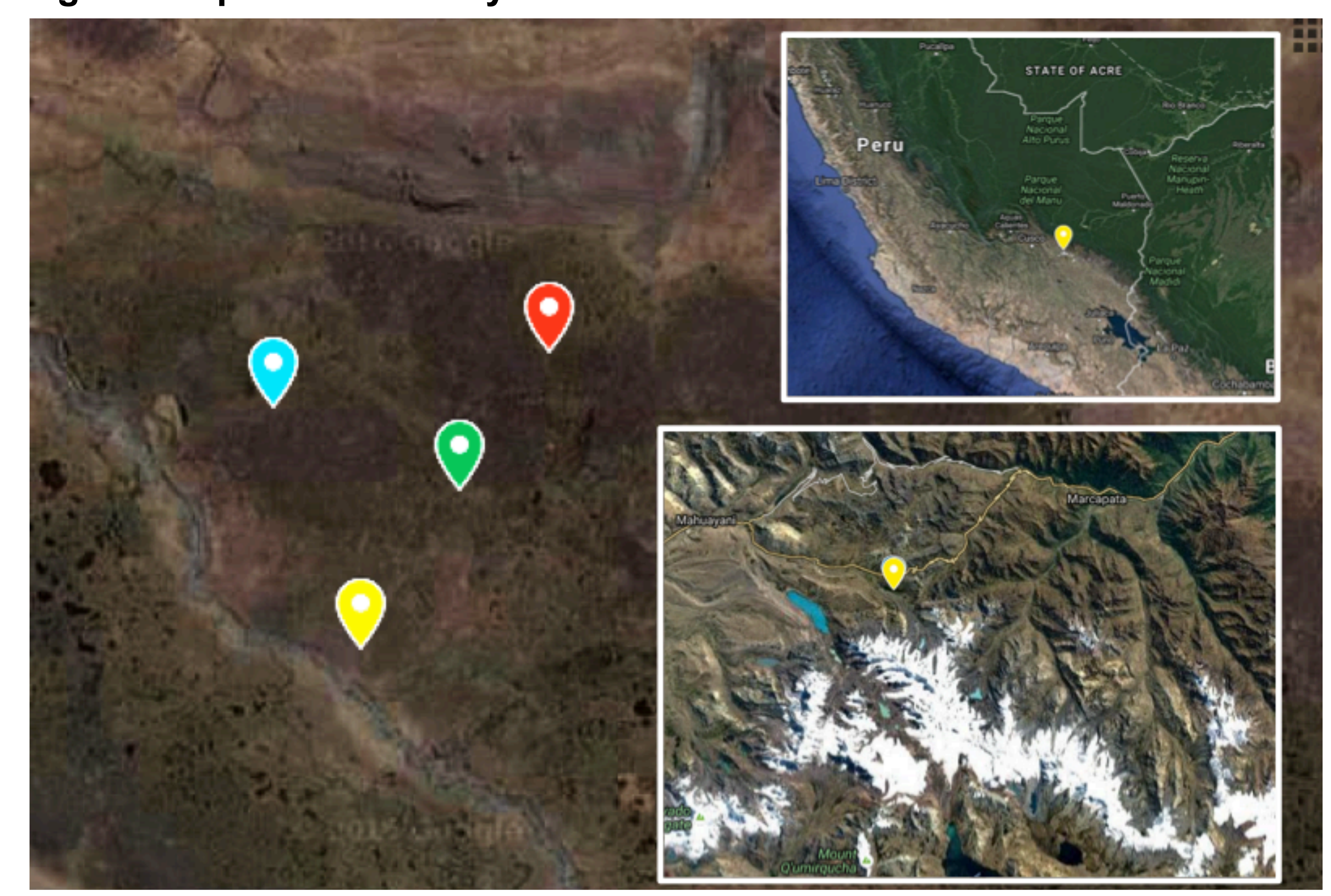
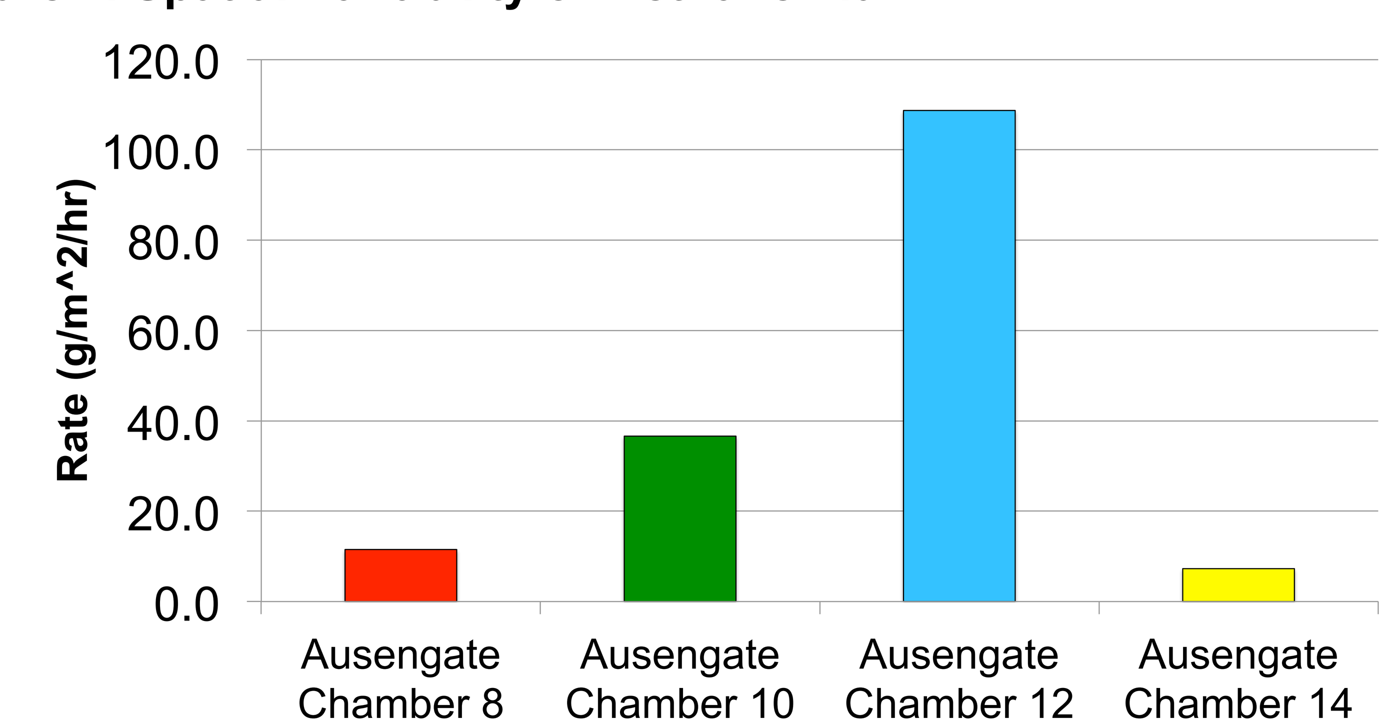


Figure 4. Spatial Variability of Methane Flux



References

Mitsch, William J., Blanca Bernal, Amanda M. Nahlik, Ulo Mander, Li Zhang, Christopher J. Anderson, Sven E. Jorgensen, and Hans Brix. "Wetlands, Carbon, and Climate Change." *Landscape Ecology* 28.4 (2012): 583-97. *Springer Link*. Web. 1 Nov. 2016.

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