Quantification of Nitrous Oxide Emissions in Soils of Chihuahua México

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INTRODUCTION

Nitrous oxide (N_2O) absorbs infrared radiation in the atmosphere, contributing to the greenhouse gas effect. This currently accounts for 5% of global warming, and could reach values of 10% in the short term future, according to projections. The nitrous oxide emitted to the atmosphere comes from various sources of pollution, identified by classifications: point or area, and mobile or fixed. This work focuses on the process of surface emission estimation.

The emission of N_2O, as evaluated from within the biosphere, comes from the soil through the processes of nitrification and denitrification. From 20 to 70% of N_2O emissions are from agriculture, mobilized by intense nitrogen fertilization of agricultural crops. Understanding the denitrification potential of the subsurface provides greater insight into the relationship of the concentrations of nitrate and ammonia nitrogen delivery to groundwater and indirect N_2O.

The ability of the soil to reduce N_2O to N_2 depends largely on the content of NO_3^-.Low concentrations of NO_3- delay reduction of N_2O to N_2, by soil microorganisms, and high concentrations of NO_3- almost completely inhibit this process.[1] The potential rates of denitrification, relative to N_2O ratios in soil cores, have been investigated previously for agricultural land.[2] In this paper the soil cores have been evaluated in non-agricultural land, but with similar conditions, such as urban areas like parks, golf courses, and green areas in the main avenues of the city.

The areas investigated were selected for the parks that were watered with treated wastewater, the quality of water containing high levels of nitrate and ammonium nitrogen derived from domestic sewage of the city. This treated wastewater is a substitute for beneficial inorganic nitrogen based fertilizer used in agriculture. There are many studies showing that N_2O is released into the atmosphere. In this case because the organic nitrogen base is necessary to characterize the elements external to the earth, the meteorological parameters affect the amount of emissions.

The emission rate of N_2O from agricultural soils is generally calculated using the default emission factor of 1%from IPCC (FE). Also, this rate has been calculated using estimation methods in other investigations to determine the N_2O emissions depending upon the sources of N-input and other environmental factors.[3] In this paper, the quantification was accomplished by direct sampling and subsequent analysis of the gas.[4]

Experimental Methods

The potential rates of denitrification and N_2O ratios were investigated in soil horizons in the experimental prototypes, where sensors were placed to sequester the gas in depths ranging from 0 to 15 cm, 0 to 45 cm, and 0 to 1m. These sensors were assigned the numbers 1, 2 and 3, respectively.

Four sites were selected to place each of the three different depths of gas catchers, including the four green fields irrigated with treated wastewater. The main vegetation is grass and it provides a recreation area for people who use the parks. The land in these four areas was moderately well drained green space with two fine soil textures, classified as sandy and clay loam.

The moisture content was maintained within the soil equal to field capacity during the investigation, and allowed the flowering process of the grass, in order to have the entire vegetative phase.[5] Quantification was performed using a gas chromatograph equipped with packed semi column, electron capture detectors, and flame induction.

The analysis included a year of observations to determine the behavior in both summer and winter.

Results and Discussion

There was a significant difference ($p < 0.01$) of the concentration of N_2O between the soil surface horizons to that of from 0 to 15 cm in all soil classifications, both sand and clay. In the deeper soil horizons, from 0 to 1 m, concentration values of nitrous oxide were almost imperceptible. Nitrous oxide concentrations differed significantly ($p<0.05$) between Horizons 1 and 2.

Multiple regression analysis revealed that N_2O concentration increases with temperature and with a higher content of NO_3-N in the treated wastewater, (Figure 1 y Figure 2) which together explained 88% of the variance ($p < 0.001$). The results suggest that the potential rate of denitrification below the root zone was low. Therefore the nitrate depletion occurs through denitrification during diffusion transport through the soil profile to the atmosphere and/or groundwater.

Figure 1. Variation in Clay soils irrigated with treated wastewater

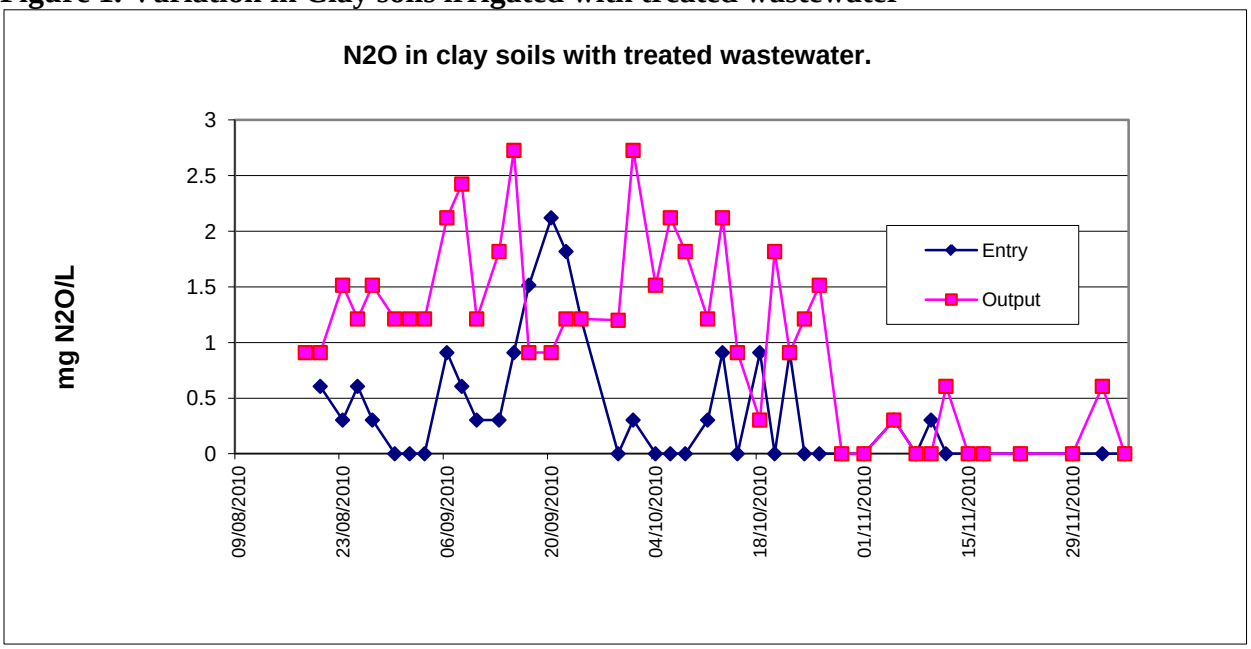
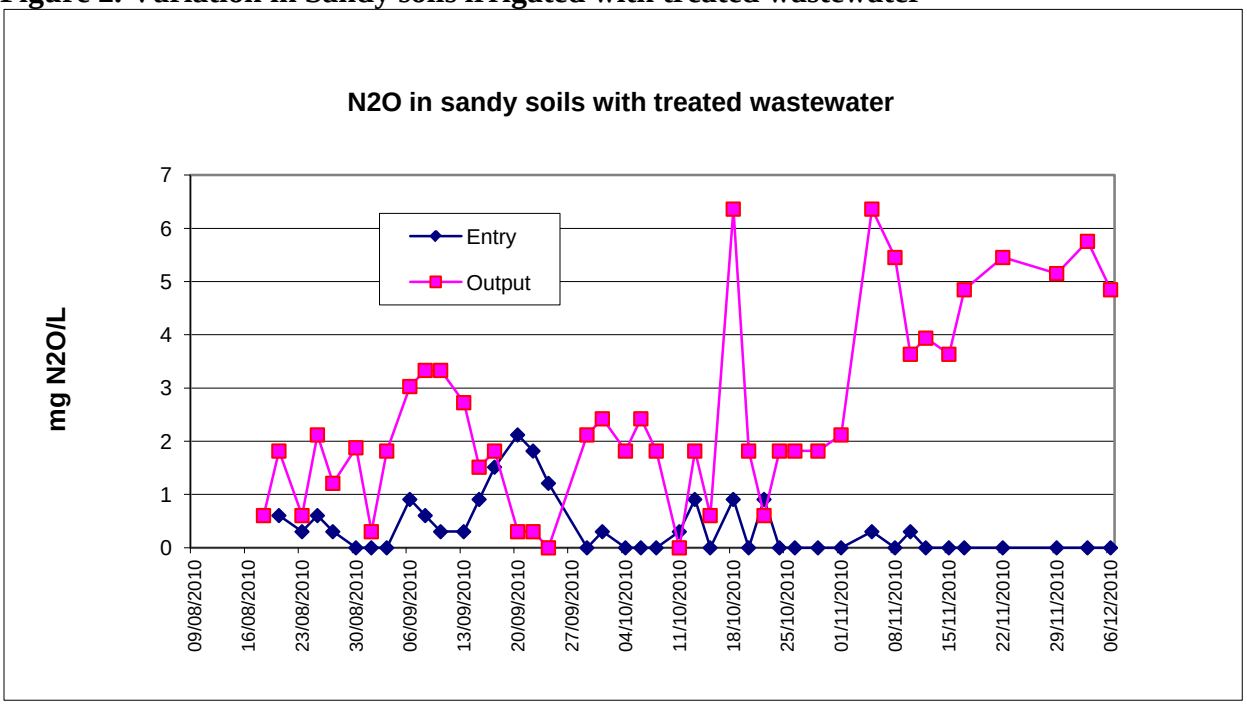


Figure 2. Variation in Sandy soils irrigated with treated wastewater



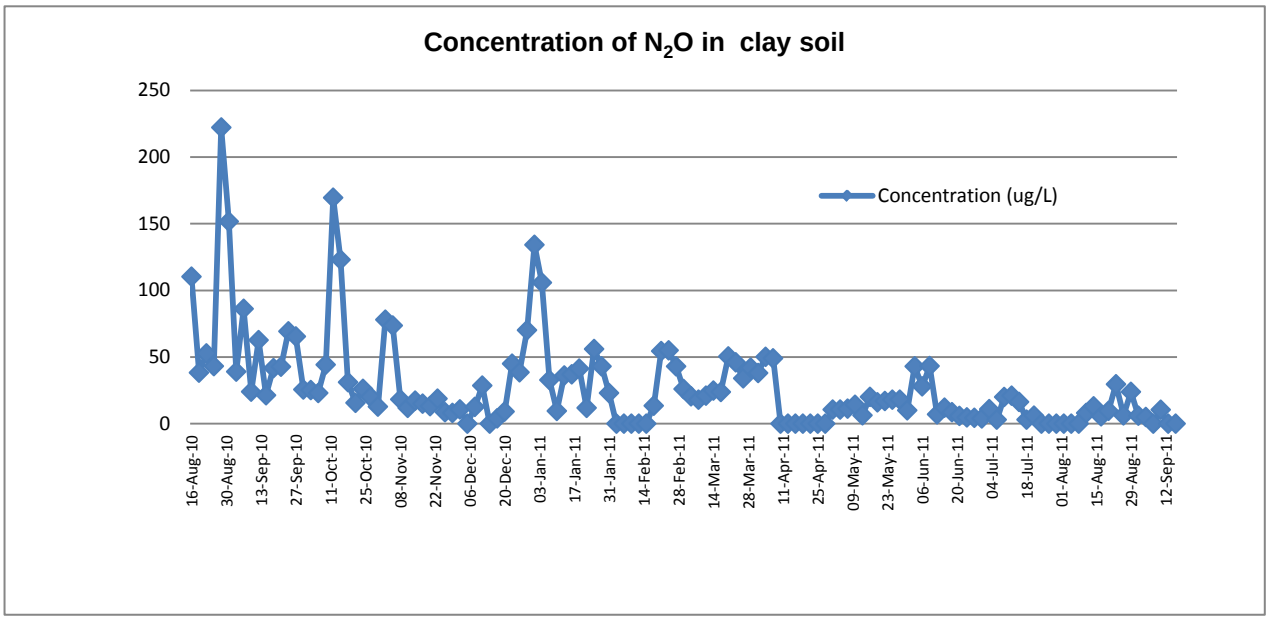
Soils are the main sources of greenhouse gas N_2O. Nitrous oxide emissions in the surface soil are the result of production processes and consumption at the root.[6]

High mineral content and high humidity favor the production of N_2O, as occurs in clay soils where moisture retention is strong and higher mineral content is evident in the soil characteristics.[7]

The parameters that influence the concentration N_2O emissions are independent of the type of soil as: the temperature, humidity and pH (Figure 3). From Figure 3 it can be seen that when the temperature is high the concentration of N_2O is greatest.

The temperature response is a function in the regression analysis because it has a direct and indirect effect on rates and product ratios of nitrification and denitrification.[8]

Figure 3. Variation concentration of nitrous oxide in the period August 2010 to September 2011.



SUMMARY

This study determined the effects of the rainy and dry gas emissions from soils in the city of Chihuahua, defined as semi-arid. The N_2O emissions from soil were three times higher in the dry season than in the rainy season.

The emissions were twice as high in the sensors placed on the horizons of 0 to 15 cm, versus the captors of 0 to 45 cm. It was also found that the concentration ranges with state of the process, depending upon the vegetative and climatic conditions, causing values to vary by tens to hundreds of µg/L.

Emissions were higher in clayey soils by up to 2 times that from sandy soils. It was found that the soil sampling time and water content had a significant effect on N_2O emissions.

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KEYWORDS

Nitrous Oxide, Arid Soils, Treated Wastewater.