International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 6 Ver IV || June 2018 || PP 16-19

Methane: A Need of Hour

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Abstract:*Methane is a green house gas, its presence in the atmosphere affects the earth's temperature and climate system. The mean monthly Flux rate of methane (CH_4) were measured for two years fromSolahSagar Pond, Grassland, Agricultural field and Forest in Ujjain and Indore city, Madhya Pradesh. The flux rates were then averaged to compute seasonal and annual flux rates. Results showed that the wetland is a continuous source of CH_4(718-2086 mg m^{-2} d^{-1}). Agricultural field is also found to be the emitter of CH_4 (-0.32-8.75 mg m^{-2} d^{-1}). In contrast, the natural habitats forest and grassland are found to be the strongest absorber for methane (-7.78 to -13.83 mg m^{-2} d^{-1}),(-4.70 to -11.66 mg m^{-2} d^{-1}). The effect of different water-sediments-soil property variables on methane fluxes were also quantified. CH_4 emissions were positively, negatively and significantly correlated with factors like organic matter, moisture. The study concluded that the natural system should we maintained and minimization strategies should be opted for controlling methane, a green house gas.*

Keywords :*Methane, Sink, Source,Minimization strategies*

Date of Submission: 07-06-2018 Date of acceptance: 22-06-2018

I. Introduction

Methane is amongst the worst of the greenhouse gases. Because of its effective absorption of infra-red radiation, atmospheric methane plays a direct role as a greenhouse gas in our global climate. Methane has 21 times more global warming potential than CO_2 and contributessignificantly to global warming [IPCC 1992]. It controls level of ozone in troposphere and stratosphere, the level of hydroxyl radical in troposphere and chlorine chemistry of stratosphere (Wuebbles and Edmonds 1991)methane have strong absorption bands and trap part of the thermal radiations from the earth surface. Therefore, it is of concern that the increasing concentration of methane may affect significantly on the global heat balance, causing a possible elevation of the global surface temperature (Ciceron and Oremland 1988). The concentration of atmospheric methane has been increasing since the beginning of the 19th century: current levels 1721 ppbv, are the highest ever observed (Chappellaz et al., 1990). Therefore the above concern requires research to construct an accurate budget relating sources and sinks of methane to atmospheric concentration. The efforts were generated to work out:

- Measurement of methane fluxes on landscape/waterscape basis from wetland, grassland, forest and agricultural crop field.
- Analysis of various related parameters in soil-water-sediments under diverse vegetation in these habitats influencing the methane emission.
- Strategies for minimization of its efflux in global warming.

II. Materials and Methods

To study the methane fluxes from different ecosystem, typical representative sites of natural and managed plant communities in habitats crossing the seasonal dry tropical climate was selected in western part Madhya Pradesh, India. The selected sites were tropical dried deciduous forest dominated by *Tectroglands* , moderately grazed grassland dominated by *Iseilemalaxum*,eutrophicated shallow water bodies the SolahSagar Pond (The pond is utilized for the cultivation of water-chestnut *Trapabispinosa*), Legumes (Soybean/Chickpea) sown agro-ecosystem.

The selected deciduous forest site is located 20 km southward from Indore (22°44'N latitude and 75°50'E longitude) at an elevation of 573M mean sea level and other three sites geographically located in the holy city Ujjain situated at the bank of river Kshipra (23°11'N latitude and 75°43'E longitude) at an elevation of 515.45M mean sea level.

Gas Sampling Technique

Gas samplings were carried out using closed chamber technique as standardized by National Physical Laboratory (NPL), New Delhi (Parashar,and. Gupta et al, 1993). In wetland, a circular motorcycle rubber tube filled with air was attached to the bottom rim of a transparent Perspex chamber made from 6 mm plexi glass sheet to make it float on the surface of the water. The chamber cover is fitted with a sampling port ad a port and to which aplastic pressing pump is attached for uniform mixing of air inside the chamber. The sampling port is a hole plugged with a rubber septum through which a 50 ml glass syringe was inserted with hypodermic needle to collect gas samples from the chamber. Gas samples were transferred to pre evacuated, sealed glass vials of 100°Cml volume at 0, 10, 20 and 30 min intervals and ambient air sample was also collected near the chamber to compare with 0 min flux at the time of calculation. In the forest aluminium base (54L × 33W × 10H cm) with internal groove size (48L × 27W × 2H cm) were installed manually. The base was embedded in the soil a few hours in advance to ensure that ambient soil atmosphere was maintained in a stabilized condition. The airtight Perspex chamber (50L×30W×50H cm) which fitted into the groove of the aluminium base was put in place at the time of sampling covering an area of. The air inside the chamber was isolated from the outside atmosphere and the system was made airtight by filling the groove in the aluminium base with water. Flux measurements were made in the late morning at 10 am and afternoon by 3 pm on each sampling day. The temperature inside the Perspex chamber was recorded at the time of sample collection (0, 10, 20, 30 min) using a thermometer (010 to100°C range, Co Immersion Zeal, England) fixed on the inside wall of the chamber for calculation of box volume at STP. Water temperature was also measured with a thermometer adjacent to the chamber. The collected gas samples in 100 ml glass vials were brought to the laboratory and analyzed for methane on a gas chromatograph (Nucon series 4 5700, India) equipped with a Flame Ionization Detector (F.I.D) and a column of stainless steel 1/8" O.D.× 6 feet length packed with molecular sieve 5A, 60/80 mesh column. Injector and detector temperature were maintained 0at 80,100 and 110C respectively. The gas chromatograph was attached with integrator (Oracle 3). Ultrapure nitrogen -1served as carrier gas (flow rate 30 ml min-1). Hydrogen was taken as the fuel gas and zero air as the supporting gas with flow rates of respectively. Gas chromatograph was calibrated by repeated injections of methane standards in the nitroge andambient air samples. After confirming the peak and retention time for methane in ambient samples, collected gas samples were analysed for methane. Gas chromatograph was also calibrated before and after each set of measurement. Samples analysed at Vikram University were authenticated (in aliquot) at NPL for reconfirmation. As it was calculated

CH4 flux F(mg m-2h-1) =BV STP × CH4 ×16×1000×60/106×22400×A×t

Where BV STP (Chamber air volume in cc at STP) = BV ×B.P ×273/ (273+ T) × 760

Box Volume (BV) = [(H-h) LW-Biomass volume inside box)

Where H= Chamber height H= Chamber height, h= channel above soil /chamber above water level L= chamber length (cm), W=chamber width (cm), B.P= Barometpressure chamber air temperature at the time of sampling (C) Δ CH4 = change in CH4 concentration in ppmv from zero minute to the t minute sampling A= area covered by the box (m), t = time in minutes The physico-chemical characteristics of wetland sediment, water column and forest soil were also analysed. Organic carbon in sediment and soil sample was estimated by dichromate oxidation and titration with ferrous ammonium sulphate. pH was measured using a pH meter equipped with glass electrode (1:25 soil : water ratio, w/v).

III. Results And Discussion

Eutrophicated wetland showed methane emission reflecting to enhanced input of autochnous organic matter in the sediment and related methanogenesis processes. Annual methane emission was found to be 4308 kg ha^{-1} yr^{-}1.(Table 2) Marked seasonality in methane fluxes was observed, higher emission during the summer and low during the winter season. Water temperature in the surface 5cm water column ranged from 20 to 32^{o}C. Dissolved oxygen in the water column varied from 3.40 to 6.00mgl^{-1}. (Table1). Methane fluxes in moderately grazed grassland and Tropical Dry Deciduous forest were found to be sink for methane. *Annual* methane fluxes in two natural terrestrial habitats were found to be -11.02kg ha^{-1} yr^{-1} and -22.45kg ha^{-1} yr^{-1}.5.09 kg h^{-1}yr^{1},(Table 2) The result indicated that the methane consumption in soil was maximum in the winter and minimum in summer season. Soil moisture in both the ecosystems was analyzed to be 10.18-30.62 % d.w.10.51-25.31% d.w.while organic matter in forest soil ranged from 1.03 to 1.29. (Table 1) In contrast to natural terrestrial systems Soybean / Chickpea agro ecosystem showed annual methane emission Table 2) due to N-input through symbiotic nitrogen fixation or fertilizer as well as mechanized treatment of soils to boost crop production. Soil moisture varied from 12.68-30.21%d.w. while organic carbon ranged from 0.87-1.07%. (Table 1)

Table 1: Physical and Chemical characteristics of water column-sediment-soil of diversed habitats.

SITE	PARAMETERS	SUMMER	RAINY	WINTER
Wetland Water	Water Temperature (^oC)	30.70 (2.89)	30.50 (2.01)	20.51 (1.71)
	Dissolved oxygen (mgl^{-1})	3.50 (0.38)	6.00 (0.20)	5.00 (0.45)
	Organic C (mg 1^{-1})	780.00 (26.00)	661.0 (21.0)	795.00 (30.00)
	NH_4^+N (mg 1^{-1})	1.02 (0.06)	4.80 (2.49)	3.79 (0.61)
Wetland Pond	Sediment pH	7.80 (0.28)	8.20 (0.62)	7.80 (0.13)
	Organic Matter (%)	6.23 (0.80)	5.51 (0.57)	4.28 (0.82)
	NH_4^+ -N (mg N $100g^{-1}$ ODS)	22.50 (6.41)	12.20 (1.94)	20.70 (1.60)
	NO_3^-N (mg N $100g^{-1}$ ODS)	2.25 (0.44)	4.23 (2.49)	3.75 (0.62)
Forest	Soil Temp(^oC)	39.50 (5.75)	28.50 (0.52)	25.00 (1.51)
	Soil Moisture (% d.w.)	10.51 (3.84)	25.30 (1.81)	21.45 (2.08)
	Organic Matter (%)	1.29 (0.02)	1.03 (0.01)	1.12 (0.02)
	Microbial Biomass C (mg C $100g^{-1}$ ODS)	32.17 (5.06)	24.87 (1.24)	-102.98 (1.32)
Grassland	Soil Temp (^oC)	33.01 (3.03)	27.51 (2.51)	20.51 (2.56)
	Soil Moisture (% d.w.)	10.18 (1.07)	30.62 (2.01)	20.42 (0.99)
	Soil pH	8.26 (0.19)	8.11 (0.16)	8.10 (0.16)
	Organic Carbon (%)	0.60 (0.03)	0.50 (0.11)	0.64 (0.15)
	NH_4^+ N (mg N $100g^{-1}$ ODS)	2.42 (0.14)	4.02 (0.08)	1.88 (0.25)
	NO_3^-N (mg N $100g^{-1}$ ODS)	1.89 (0.13)	3.82 (0.21)	1.96 (0.41)
Agricultural field	Soil Temp (^oC)	33.51 (3.68)	29.00 (5.06)	24.50 (1.54)
	Soil Moisture (% d.w.)	12.68 (3.40)	30.21 (2.18)	28.00 (1.96)
	Soil pH	8.59 (0.31)	8.27 (0.30)	8.54 (0.25)
	Organic Carbon (%)	1.07 (0.02)	0.87 (0.03)	0.97 (0.01)
	NH_4^+ N (mg N $100g^{-1}$ ODS)	1.14 (0.12)	3.87 (0.06)	2.04 (0.08)
	NO_3^-N (mg N $100g^{-1}$ ODS)	1.83 (0.03)	3.32 (0.29)	2.68 (0.37)

Values in Parenthesis are standard variation

Table 2: Annual CH_4 fluxes from Diversed Habitats

Ecosystem	Annual CH_4 flux rate ($kg\ ha^{-1}\ yr^{-1}$)
Wetland	4308
Grassland	-11.02
Forest	-22.45
Agricultural field	5.09

SolahSagar Pond harbors natural water receiving input of domestic waste water and agricultural drained water from surrounding fields during the rainy season. The wet is used for cultivation of Trapa.and fish production. Before and after nut sowing and harvesting, the water body gets abandoned and eutrophicated by infestation by weeds dominated by water hyacinth (Billore et al. 1998). The year growth of vegetation in the wetland and perennial accumulation of debris in the bottom of pond, constitute a dominant component in the sediments which is a key source in methane dynamics. Methane uptake has been attributed to oxidation of methane by methanotrophic bacteria to methanol by the enzyme methane monooxygenase, which is oxidized means of dehydrogenises and the bacterial electron respiratory chain to CO_2 (Conrad 1989). Forest represents a successional climax community, while the grassland has been derived from the forest through biotic factors and is maintained in the seral stage by grazing, burning and recurrent manual harvesting. The climax system has a higher capacity to interact and hold nutrients for close cycling within the system . Only very small amounts of nutrients are lost from mature system as compared to disturbed one. Thus the forest has higher sink capacity as compared to grassland. Methane fluxes in managed agro ecosystem were affected by agricultural management practices. Agricultural field has been derived from the grassland at some time in the past. Two types of leguminous crops mainly Soybean and Chickpea are cultivated in the field conversion from native grasslands and forest to managed pastures and cultivated crops appear to decrease the normal aerobic soil methane sink. Although soil texture, bulk density, water status, nitrogen fertilization (urea, diammonum phosphate, nitrogen from symbiotic nitrogen fixation) play a role, intensity of soil perturbation appears to play a part in the magnitude of this decrease (Mosier et al. 1997).

The study stressed the importance of natural plant communities as methane inhibitor. Forest and grassland should be maintained. Green cover should be extended. A thorough study to minimizing strategies, large scale methane flux estimation is required urgently to save climate. Some of the way outs to methane can be use of biofertilizer. Switch over to organic farming.

Acknowledgment

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