Nitrous Oxide from South West Irish grasslands and its relationship with important parameters

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Introduction

The emission of the greenhouse gas (GHG), nitrous oxide (N_2O) from human activities are contributing to global climate change. An estimated 29% of Ireland's GHG emissions are from the agricultural sector and N_2O make half of these [1]. Soil microbes produce and consume N_2O during the process of nitrification and denitrification [2]. The interplay between the amount of nitrogen cycling, soil environmental conditions and climatic parameters govern microbial processes. This study shows the current N_2O emission from South West part of Ireland and also shows the relationship of different N_2O controlling players with N_2O emissions.

Objectives

- To find the current N_2O emission from Irish grassland soils
- To investigate the correlation between N_2O emissions and different controlling parameters.

Study Sites

Total of eight sites are being analysed for soil N_2O emissions. These sites are dispersed throughout the south west part of the country (Fig. 1). Each site has small weather station with data logger to record the soil moisture, soil temperature and rainfall data on half hour basis. Site names are:

Ballinhassig (BH), Kiloworth (KW), Clonakilty (CK), Dripsey (D)

and Carrig na Bh fear (CF) (Co, Cork),

Palliskenry (PK) (Co, Limerick) , Solohead (SH) 1 & 2 (Co, Tipperary)

The latitude, longitude, elevation and soil types are given in table 1.

Fig 1: Location of sites

Fig 2: weather station

Site name	Latitude	Longitude	Elevation, m	Soil type
Ballinhassig	IW 62179	61176	79	Grey brown podzolic
Carraig na bhFear	IW 67979	81215	104	Brown podzolic
Clonakilty	IW 41377	42064	69	Brown podzolic
Donoughmore	IW 48413	81773	187	Gley (ground water)
Kilworth	IR 83597	41850	51	Brown earth
Pallaskenry	IR 41445	56315	15	Grey brown podzolic
Solohead 1 (dry)	IR 86063	39614	102	Gley
Solohead 2 (wet)	IR 86215	39415	98	Gley

Table 1: Soil types

Methods

Closed chambers were used to collect soil emitted air samples. The enclosure period was kept 60 min with headspace samples extracted with 100 ml syringe via needles through a luer valve at 0 and 60 min after coverage. With every visit to each site the weather station data was collected regularly to observe the temporal trend of different climatic parameters. Soil moisture and soil temperature were also measured manually with each sampling event. Gas samples were analysed on gas chromatograph (Varian 3800 equipped with ^{63}Ni Electron Capture Detector). N_2O fluxes were calculated by using linear equations provided by Holland et al 1999 [3] , and expressed as N_2O-N μg m^{-2} h^{-1}. N_2O-N/N-input ratio was found from N_2O-N kg/ha/8 months (Mar-Oct 08) and total N input kg/ha/8 months (Mar-Oct 08). To find the correlation between N_2O-N/N-input and different N_2O controlling parameters ,Pearson correlation analysis was performed by using SPSS.

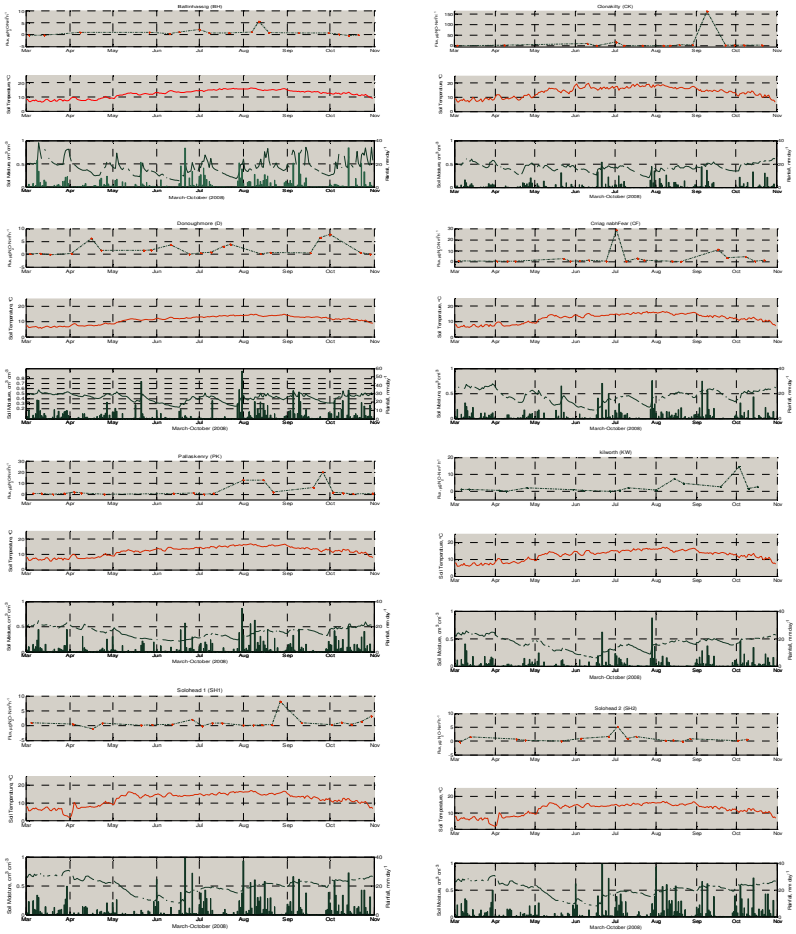

Fig 3: Temporal variation of N2O flux, soil moisture, rainfall and soil temperature over the period of 8 months

Results and discussion: The temporal variation of N_2O flux, soil moisture contents, rainfall and soil temperature from all sites are shown in the fig 3. Three sites BH, SH1 and SH2 showed both positive and negative fluxes while all other sites gave positive flux. The total N_2O emissions, N input, N_2O/N input, soil properties and cumulative rainfall are given in table 2. Fig 4 shows a very week relationship between N_2O emission and N-input. The correlation between N_2O/N-input with other few controlling parameter i.e. % C, % N, pH, Organic matter, NO_3-N, NH_4-N, bulk density, porosity, WFP % and rainfall was also checked. We found a significant relation with rainfall and NO3-N contents as shown in table 3. Rainfall gave negative correlation while NO_3-N contents gave a positive relationship as shown in fig 5 and fig 6. NO_3-N positve correlation shows that the N_2O emission is manily from denitrification.

Table 2: Total N2O flux, N input, soil properties, WFPS %, cumulative rainfall over the period of 8 months from all sites

Site names	N^2O (kg ha^{-1} $year^{-1}$)	N input (Kg/ha)	N^2O-N/N input ratio	% C	% N	ph	Organic matter	NO3-N ppm	NH4-N ppm	Bulk density (g/cm^{-3})	Porosity	WFPS % (% of data with 60-80% WFPS)	Rainfall mm
BH	0.49	111.64	0.004	3.42	0.39	5.8	7.24	3.7	50	1.04	0.61	26.67	693.9
CK	5.7	333.4	0.017	4.77	0.57	5.9	9.22	74.05	35.4	0.99	0.63	50	385
D	1.11	335.58	0.003	4.5	0.35	6.7	8.45	5.3	46.1	1.02	0.62	17.65	1051.2
CF	1.6	241.65	0.007	5.67	0.64	6.4	9.9	36.1	60.35	0.88	0.67	57.14	604.6
PK	2.02	246.68	0.008	4.84	0.56	5.4	9.62	22.9	53.05	1.05	0.6	22.22	755
KW	1.37	174.76	0.008	4.17	0.49	5.7	7.87	23.2	19.65	1.08	0.59	35.71	520.2
SH1	0.48	243.49	0.002	4.73	0.57	6.3	8.48	30.6	14.55	0.99	0.63	47.06	980
SH2	0.44	74.18	0.006	7.82	0.97	6.5	14.77	11.45	30.6	0.85	0.68	45.45	980

Table 3: Correlation analysis of N2O-N/N-input with important parameters

Parameters	Correlation co-efficient (r)	Significance value (p)
%C	0.24	.....
%N	0.37	.....
pH	0.24	.....
Organic matter	0.24	.....
NO3-N ppm	0.83	0.05
NH4-N ppm	0.24	.....
Bulk density	0.04	.....
Porosity	-0.04	.....
WFPS %	0.35	.....
Rainfall	-0.8	0.05

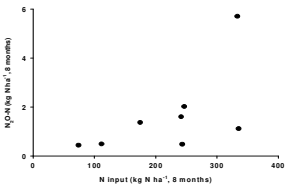

Fig 4: Relationship of N_2O with N-input

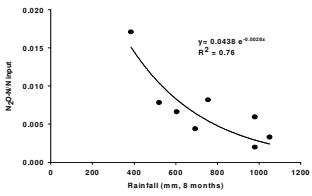

Fig 5: Correlation of N_2O/N-input with rainfall

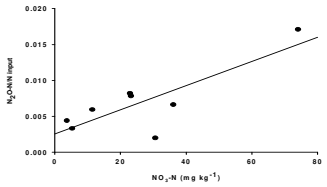

Fig 6: Correlation of N_2O/N input with NO_3-N

Conclusion: CK, PK and KW are giving the high emission as compare to all other sites. BH, SH1 and SH2 are giving lowest emissions. 3 sites out of 8 are giving both positive and negative fluxes. There was nor significant relatioship beteen N_2O emission and N-inputs. N_2O/N-input showed a significant positive correlation with NO_3-N contents and a negative correlation with rainfall.

References

[1] Ireland`s Environment 2008, report, Environmental Protection Agency, 2008.

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[3] Holland, EA., Robertson, G.P., Greenberg, J., Groffman, P.M., Boone, R.D., Gosz, J.R., Standard soil method for long term ecological research.

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