Asian Journal of Water, Environment and Pollution, Vol. 3, No. 1, pp. 1-5.

Reduction in Methane Emission from Kerala Estuaries

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Received February 20, 2005; revised and accepted November 15, 2005

Abstract: Methane is the second most important greenhouse gas after carbon dioxide, and is expected to contribute nearly 18% of the total global warming during the present half-century. Wetlands are the largest natural source of methane. Kerala has a total of 127,930 ha of wetland area. Measurements show that methane fluxes from Kerala's coastal lakes have decreased during the past decade. This could be due to the reduction in coconut husk retting activity in these lakes. Results of methane flux measurements from some of the coastal lakes in Kerala and statistics relating to the quantity of husk retted are reported and discussed here.

Key words: Wetlands, methane emission, greenhouse gases, coconut husk retting.

Introduction

The contribution to global warming from the increase of greenhouse gases in the atmosphere has become a major global concern. Major greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), etc. The major human activities that contribute to the increase of the greenhouse gases are fossil fuel and biomass burning, transport, mining, landfills and agriculture.

Methane is an important greenhouse gas with a high potential for climate change. This gas has an estimated Global Warming Potential (GWP) of 21 compared to carbon dioxide on a molar basis. The sources and sinks of atmospheric methane, as well as its role in the atmosphere have been studied by a number of researchers (Badr et al., 1991; Cao et al., 1998; Khalil & Ramsussen, 1983). The relative contributions of CH_4 and CO_2 to global warming are estimated to be 18% and 50% of the total. The present concentration of methane in the atmosphere is 1.9 ppmv as against 330 ppmv of carbon dioxide. Methane is produced during the anaerobic decomposition of any biological matter. It is also produced during combustion, and released during mining of coal and petroleum. Enteric fermentation in the guts of ruminant animals is another source of methane. A number of studies have been carried out in India to determine the greenhouse gas emissions from various sources (Anuradha et al., 2002; Mitra, 1992, 1996; Ramesh et al., 1997; Ramesh & Purvaja, 1998; Reddy et al., 2004; Zachariah, 1993, 1995).

Methane is produced during anaerobic decay of biological matter, under the influence of micro-organisms. Methanogenesis is influenced by temperature, with an optimum temperature of ~ 32-34 ºC. Sulphates are known to inhibit the activity of the methane producing bacteria. Hence salinity in the coastal environment has a negative influence on methanogenesis.

Wetlands, both natural and under cultivation, are major sources of methane. It has been estimated that Kerala has a total of 127,930.07 ha of wetland area, of which 85,671.50 ha is natural wetlands in the coastal area (Sankar et al., 1998). The fluxes from the natural wetlands like lakes and estuaries are influenced by human activities. Coconut husk retting, discharge of sewerage and domestic wastes, etc., are some of the major human influences affecting methane fluxes from estuaries. There had been some investigations on methane flux from the wetlands of Kerala (Anuradha et al., 2002; Mitra, 1996; Zachariah & Murudharan, 1993, 1995, 2002) in the past.

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Coconut husk retting is carried out in almost all backwaters and estuaries of Kerala, to extract coir fibre from the husk. This had been a traditional rural industry in the coastal regions of Kerala for many centuries. Retting is an anaerobic bacteriological process by which the binding material in the coconut husk is decomposed to facilitate easy removal of the fibre. For this, large quantities of fresh coconut husk are bundled together using coir nets and immersed in water. Bacterial action taking place on the husk breaks down the binding materials in the husk. Extensive studies of the microbiology of the retteries had been carried out by a number of researchers (Abdul & Nair, 1978; Bhat & Nambudiri, 1991; Jayasankar, 1962). The process of retting takes about eight months for completion. This anaerobic decomposition is accompanied by the production of methane in substantial quantities (Abdul & Nair, 1978; Bhat & Nambudiri, 1991; Jayasankar, 1962). It is found that on an average 0.12 m^3 gas containing 60% methane is released daily from the husk bundles per ton of coconut husk. This starts by the end of the second month of retting and continues for a period of about six months resulting in a total emission of ~13 m^3 (~ 9 kg) of methane per ton of coconut husk retted. As the retteries are part of the lakes and are not physically isolated, the diffusion of ret liquids and particulate matter from the coconut husk undergoing retting diffuses into the lake influence methane flux from other parts of the lake also. Generally many hundreds of tons of husk undergo retting in a rettery at any given time. On completion of retting the coconut husk bundles are taken out and the coir fibre is extracted through simple mechanical methods.

Methodology

A sketch map of the study locations is given in Figure 1. All of these are on the coast and are linked to the sea through bar mouths and tidal channels. Coconut husk retting was being carried out in these lakes extensively in the past, though it has reduced now. Statistics on coconut husk retting relevant to the region during the period 1990-2004 is given in Table 1.

Emission samples were collected from a number of locations within the lakes to obtain data representative of the lake. A distance of at least 100m from the shore was maintained, wherever possible, to avoid biases due to non-representative and very localised influences like drains, etc. Disturbing the water and sediments during the collection of samples were minimised by switching off the boat engine in advance and drifting or rowing to

Figure 1: Sketch map of Kerala (India) showing the study locations.

Table 1: Quantity of Husk Retted during 1994-2004

Year	*Kadinamkulam lake (at Kaniyapuram) (× 10^3 ton)*	*Total for Kerala (× 10^6 tons)*
1990-'91	1.22	-
1991-'92	1.14	-
1992-'93	1.06	-
1993-'94	0.63	-
1994-'95	0.57	1.55
1995-'96	0.82	1.56
1996-'97	0.90	1.55
1997-'98	0.58	1.55
1998-'99	0.69	1.51
1999-'00	0.50	1.46
2000-'01	0.38	1.46
2001-'02	-	1.49
2002-'03	-	1.37
2003-'04	0.64	1.37

the location. No poles were used for pushing the boat to avoid disturbing sediments which might release methane bubbles trapped in it.

Methane emission at the water air interface was collected using floating box type sampler. This consists of a shallow cylindrical box whose one end is open. An inflated pneumatic tube of the type used in automobile tyres was attached to this box to float in water. The box was floated on the water surface with its open end pointing downwards. Any gas emission from the water surface enclosed by the open mouth of the box gets trapped inside and mixes with the air in the enclosed space above water level. Air samples from within the box could be withdrawn for analysis using syringe and needle, through a septum port on the top end of the box.

The methane flux could be determined by measuring the rate of change of methane concentration in the box with time. For this, samples were withdrawn from the box at known intervals of time (~ 30 minutes) and concentration of methane in them determined through gas chromatography. Samples for analysis were collected and stored either in gas sampling bottles made of glass or syringes and taken to laboratory.

Concentration of methane in the sample was determined by analysis using a Flame Ionisation Detector (FID) on a Gas Chromatograph (Nucon 5765). Isothermal separation at 70 ^{0}C was done in a five-metre long Porapak Q (80/100 mesh) packed column. High purity nitrogen (30 ml/minute) was used as carrier gas and zero air in cylinder was used for supporting the flame. Periodic calibration of the detector was done using standard calibration gas mixtures of 3.5, 11.9, 27 and 119 ppm methane in pure nitrogen.

Results

The measured methane flux values from the estuaries are given in Table 2. The high and low values given indicate the range of values observed at the number of sampling points indicated. The mean values reported here are the average of fluxes from all the sampling points indicated. These measurements were carried out during the pre-monsoon period (January – March 2004).

It is observed that the methane fluxes from all sites are, in general, moderate. Earlier observations have shown that the salinity in these estuaries is relatively high. The salinity values reported range between 35.05 and 28.91 ppt in the bottom waters of Ashtamudi estuary (Nair & Abdul, 1987) during pre-monsoon period, and between 7.80 and 28.95 ppt during the course of a year

Table 2: Methane Flux Measured in 2004 at some of the Estuaries in Kerala

Name of the estuary	*Area* (× 100 ha)*	*No of sampling points*	*Methane flux (mg/m^2/hr)*		
			High	*Low*	*Mean*
Kadinamkulam Lake	3.7	10	1.61	0.27	0.94
Paravoor Lake	1.9	8	0.75	0.05	0.17
Ashtamudi Lake	55.7	31	2.73	0.06	0.56
Kayamkulam Lake	25.2	6	0.62	0.24	0.45

*Indicative only.

in Kadinamkulam lake (Shobha & Ignatius, 1987). The generally moderate methane fluxes from these estuaries can be related to this.

A comparison of the methane flux from Kadinamkulam, Ashtamudi and Kayamkulam lakes, measured in 1994 and 2004 is given in Table 3. Both sets of measurements were made during pre-monsoon periods. It is seen that methane emission observed in 2004 is significantly lower than that during 1994.

Table 3: Changes in Average Methane Flux in some of the Estuaries in Kerala, during the Period 1994-2004

Name of the estuary	*Area* (× 100 ha)*	*Methane flux (mg/m^2/hr)*		*% Change*
		1994	*2004*	
Kadinamkulam Lake	3.7	**1.95	0.94	- 51.79
Ashtamudi Lake	55.7	**1.54	0.56	- 63.64
Kayamkulam Lake	25.2	**0.94	0.45	- 52.12

*Indicative only. **ref. 17

Coconut husk retting activity in these lakes has reduced considerably during this period. Table 1 gives the statistics of coconut husk retted relevant to the period. The computation of the total quantity of husk retted annually in Kerala is based on the statistics of annual production of retted fibre in Kerala, obtained from the Coir Board. Kaniyapuram Coir Vyavasaya Co-operative Society is the major player involved in coconut husk retting in the Kadinamkulam lake. The quantity of husk reported under Kadinamkulam Lake in Table 1 is that processed by this Society alone, which was taken as representative of the trend in husk retting activity in the region for the purpose of the present study.

Figure 2 shows the variation in coconut husk retting activity in the region during the period 1990-2004. There

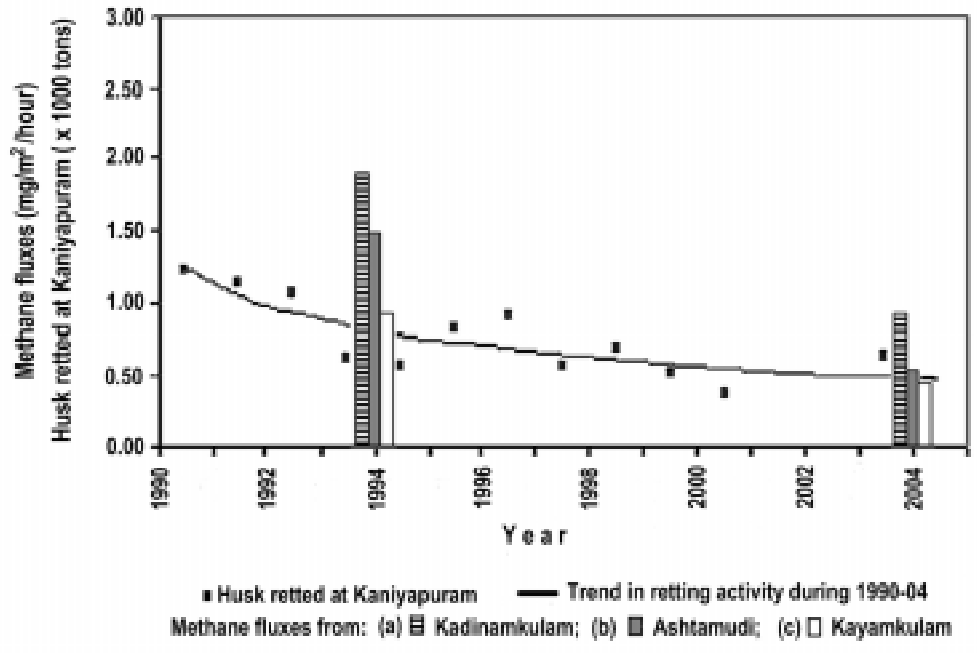

Figure 2: Methane fluxes from major water bodies in Southern Kerala, during 1994 and 2004 and the changing trend in the coconut husk retting activity.

had been a significant decline in the quantity of coconut husk retted in the estuaries during this period due to social and economic factors that affected the industry. Since coconut husk retting is known to increase loading of biological matter into the lake as well as create anoxic conditions in the water (Abdul & Nair, 1978; Bhat & Nambudiri, 1971), its reduction can be understood to correct those conditions. The methane flux values from some of the lakes in the region during the years 1994 and 2004 has been overlaid on the curve showing the trend in husk retting for comparison. It is seen that the reduction in the methane fluxes observed in 2004 relative to that in 1994 is similar to the reduction in the quantity of coconut husk retted.

Conclusions

Methane fluxes from Kadinamkulam, Paravoor, Ashtamudi and Kayamkulam estuaries, in Kerala, are moderate. The generally high salinity in these lakes, as reported by earlier investigators (Nair Abdul, 1987; Shobha & Ignatius, 1987), could be the reason for this. It is also noted that the methane fluxes from Ashtamudi, Kadinamkulam and Kayamkulam lakes have reduced by more than 50% during the period 1994-2004. This could be due to the reduction in the coconut husk retting activity in these lakes during the period.

Acknowledgements

We thank Mr. Kumaraswamy Pillai, Coir Board, Kochi, and Mr. Subhash Chandran, Secretary, Kaniyapuram Coir Vyavasaya Co-operative Society, for providing us statistics relating to coconut husk retting. We gratefully acknowledge the support and encouragement received from the Research Council of CESS, Dr. M. Baba, Director, CESS, and Dr. S. Sampath, Head, ASD, CESS.

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