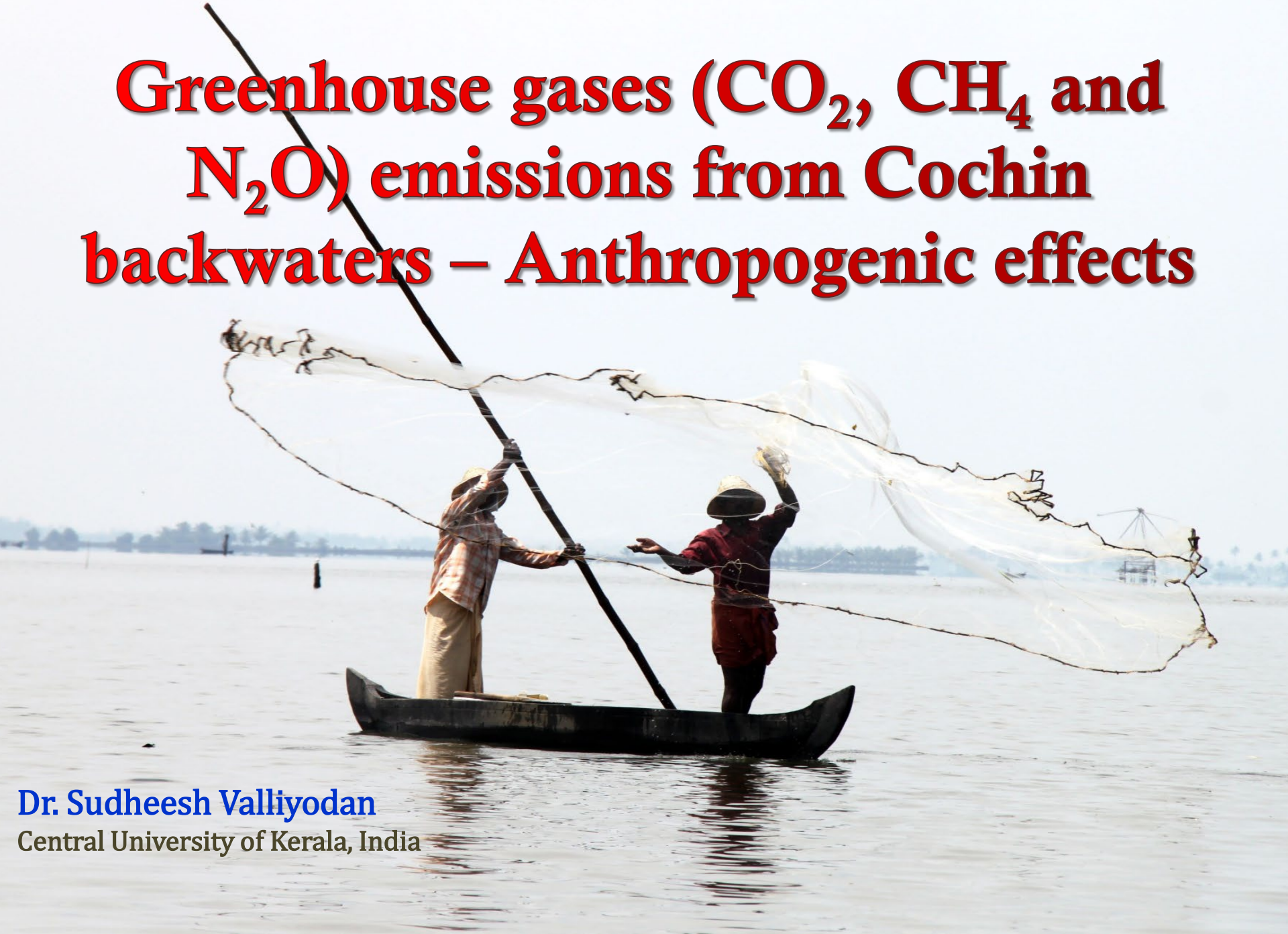
Greenhouse gases (CO_2, CH_4 and N_2O) emissions from Cochin backwaters – Anthropogenic effects



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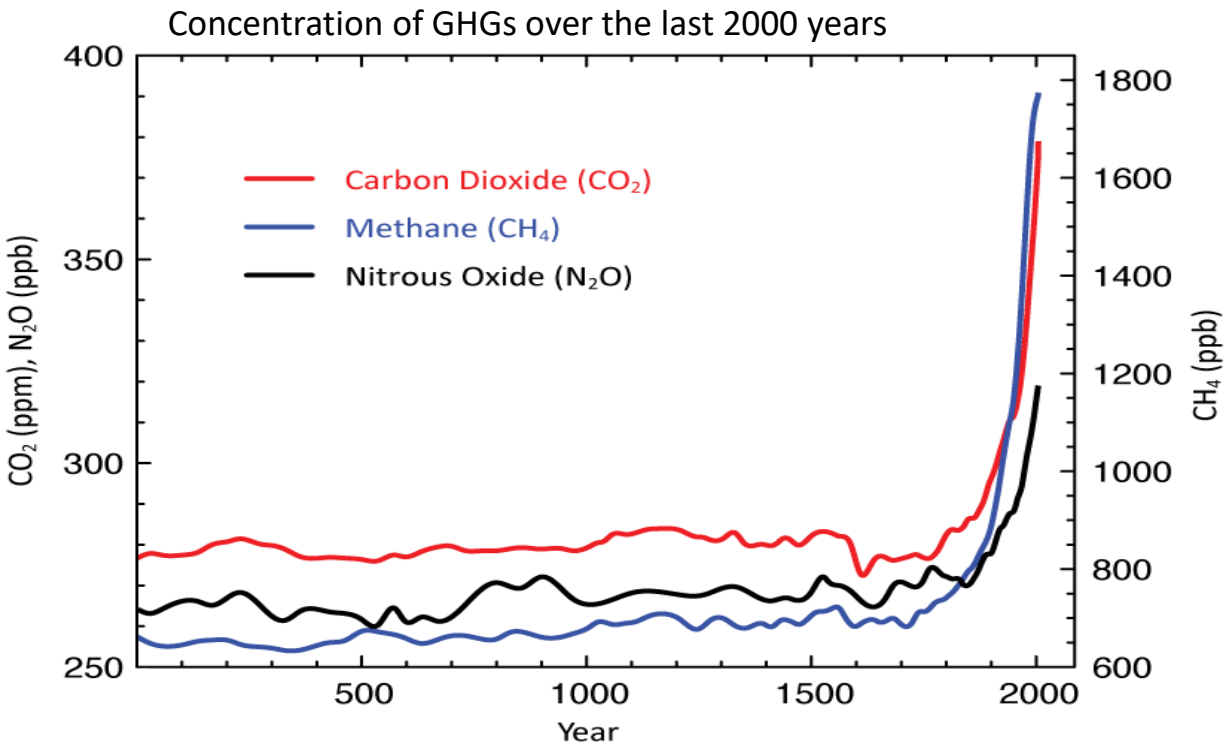
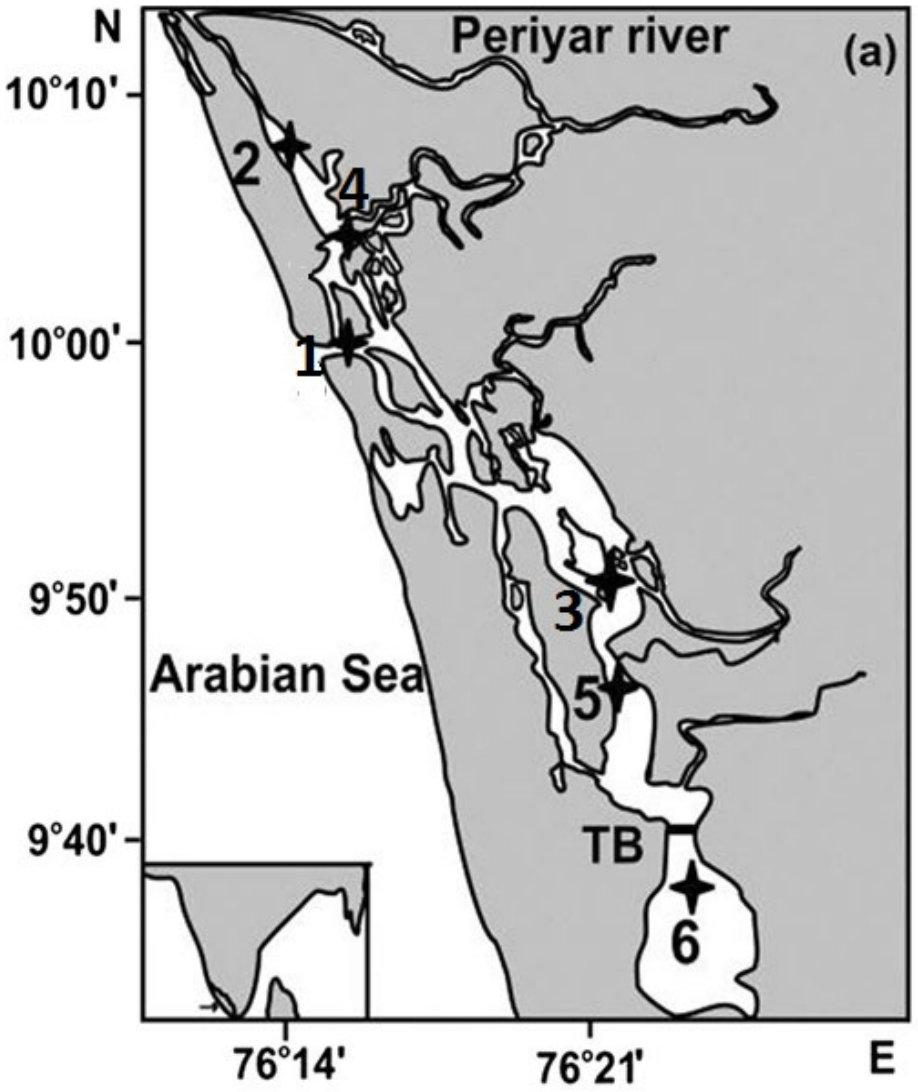
Greenhouse Gases



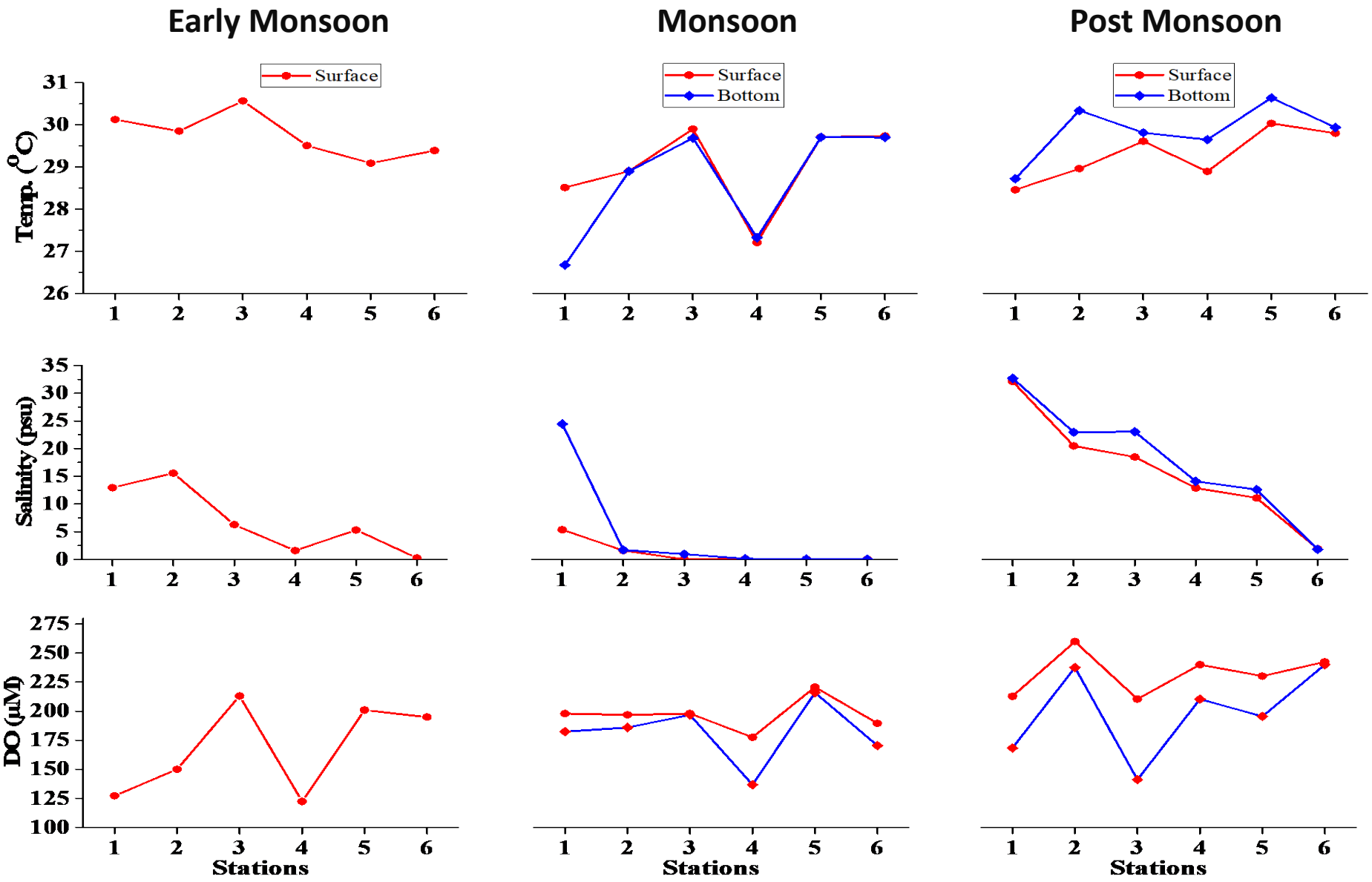
- ✓ Inland ecosystems are major source of CH_4, N_2O and CO_2 to the atmosphere
- ✓ But their fluxes remains poorly quantified
- ✓ The limited database, their seasonal and inter annual variability and strong spatial heterogeneity challenges the quality of marine estimates of CO_2, CH_4 and N_2O.

Study Area

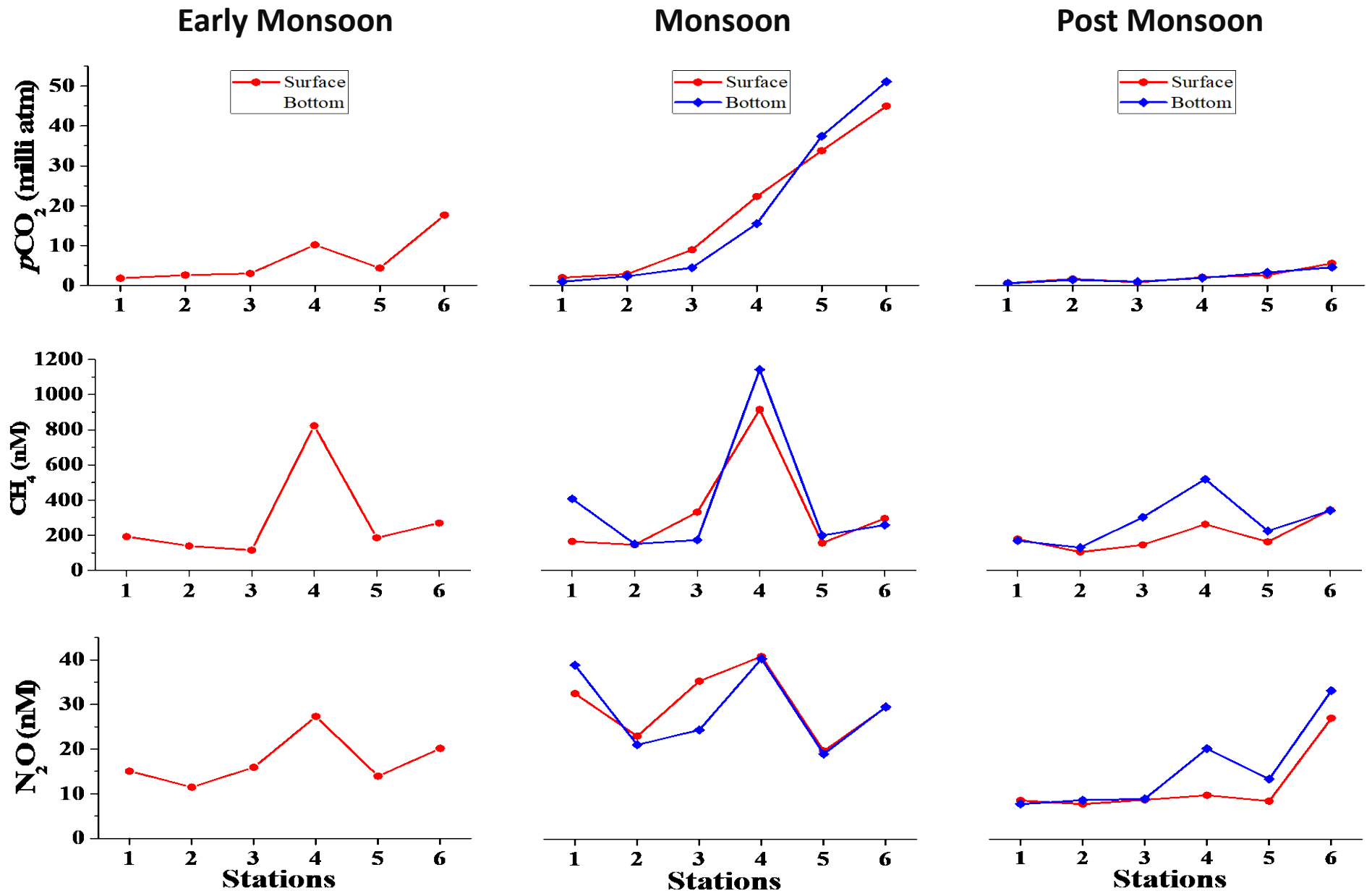


- **Eutrophic estuary**
- **CE reported to be highly autotrophic five decades ago**
- **Shifted to heterotrophy due to vast urbanisation**
- **Station 1-** Barmouth
- **Station 2-** Null zone
- **Station 3-** R. Muvattupuzha meeting point
- **Station 4-** R. Periyar meeting point (Null zone)
- **Station 5-** Vaikam
- **Station 6-** Freshwater

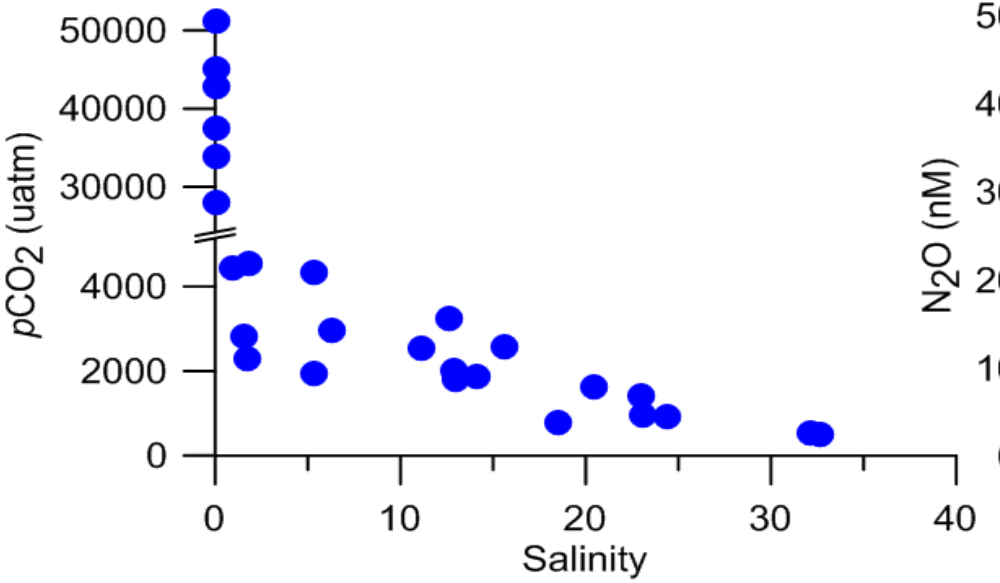
Distribution of Temp., Salinity and DO

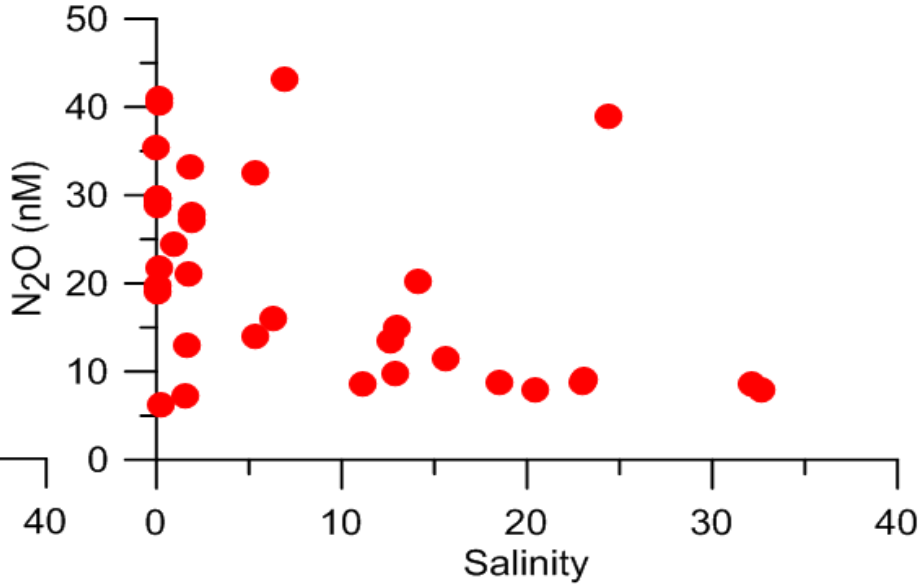


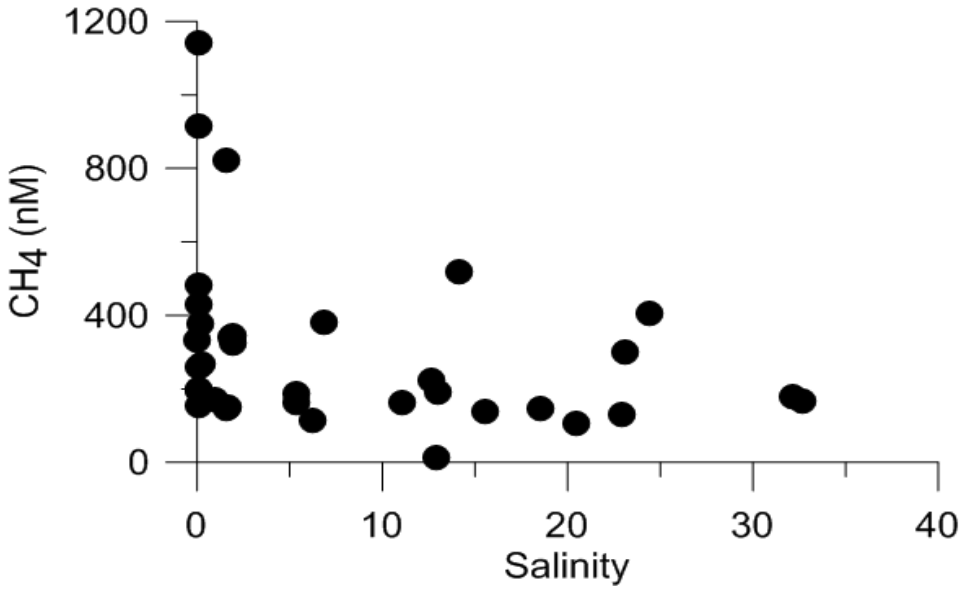
Distribution of GHGs in the CE



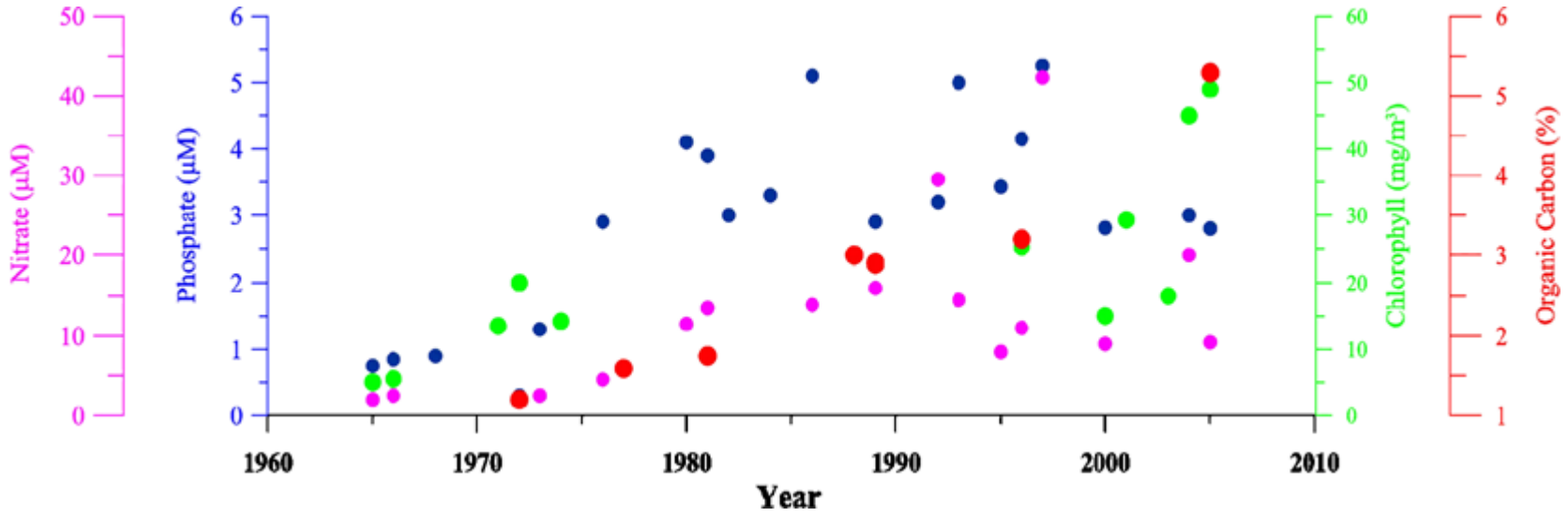
Salinity vs GHGs



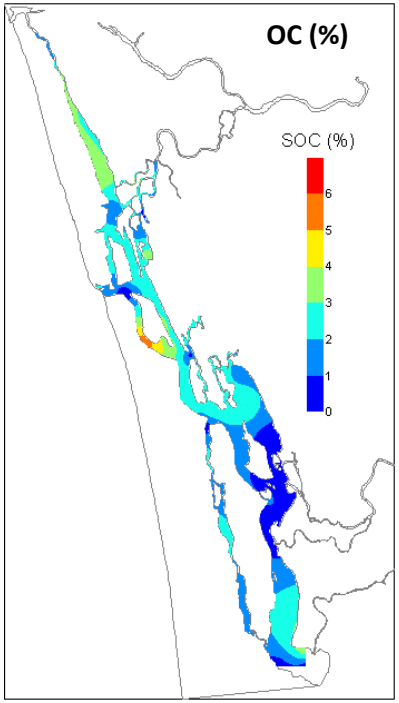


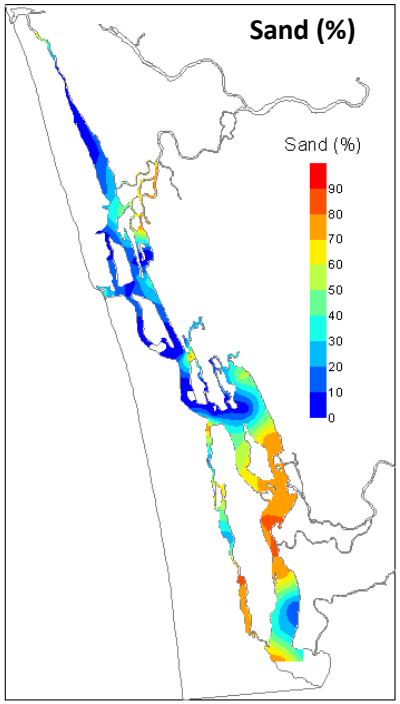


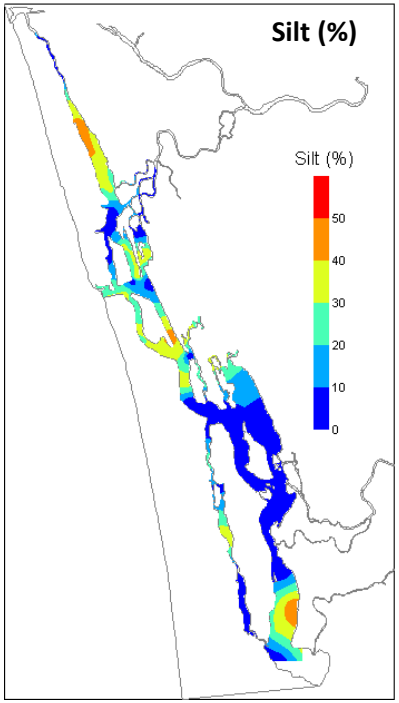
Increased anthropogenic nutrient load…??

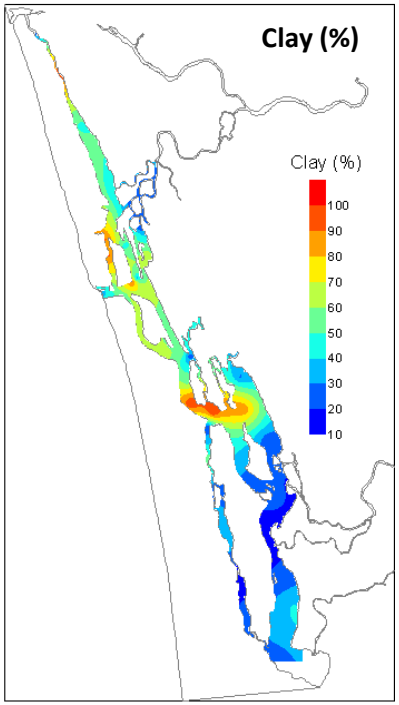


A six fold increase in nitrate and phosphate concentrations and fourfold increase in sediment OC in the lower reaches of the adjoining Cochin estuary (CE) between 1965 and 2005 due to large-scale developmental activities (fig. from Martin et al., 2010).







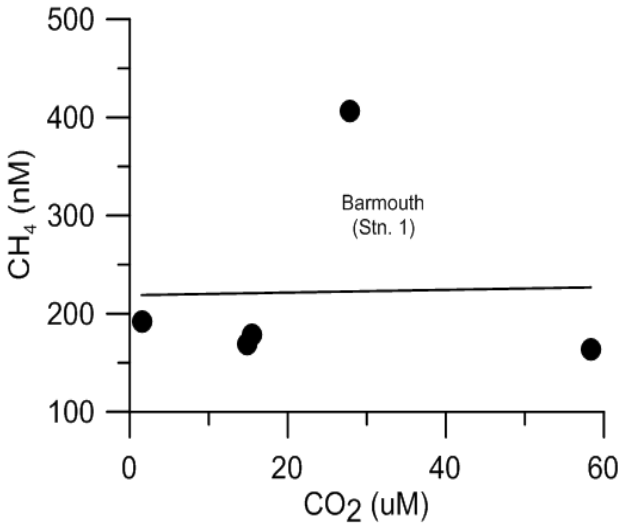


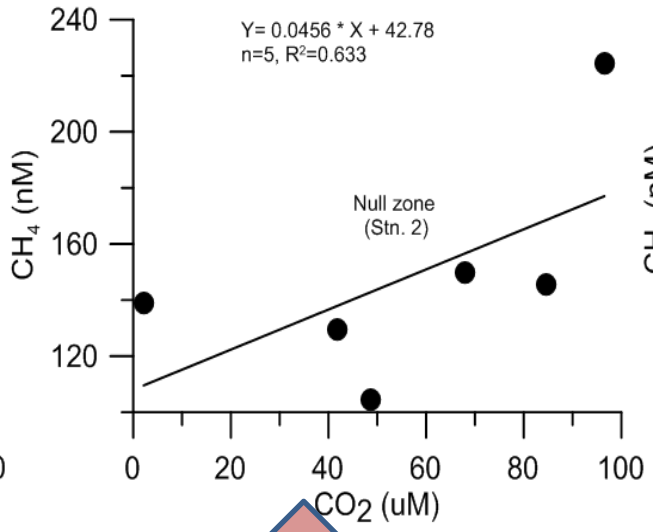
Sediment

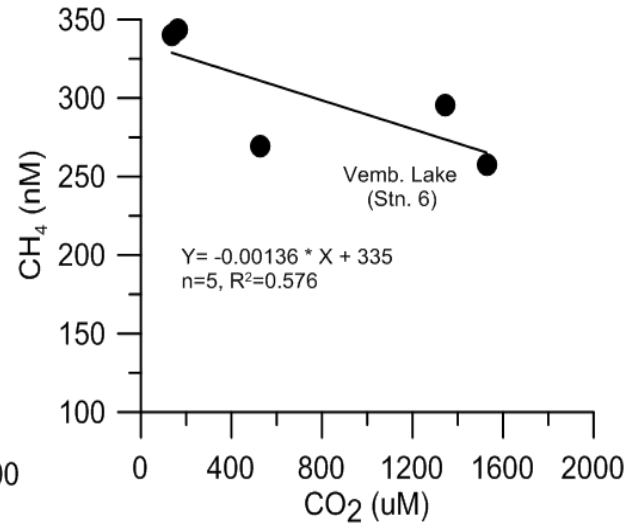
North – highly clayey with OC

South – more of sandy

CO_2 vs CH_4

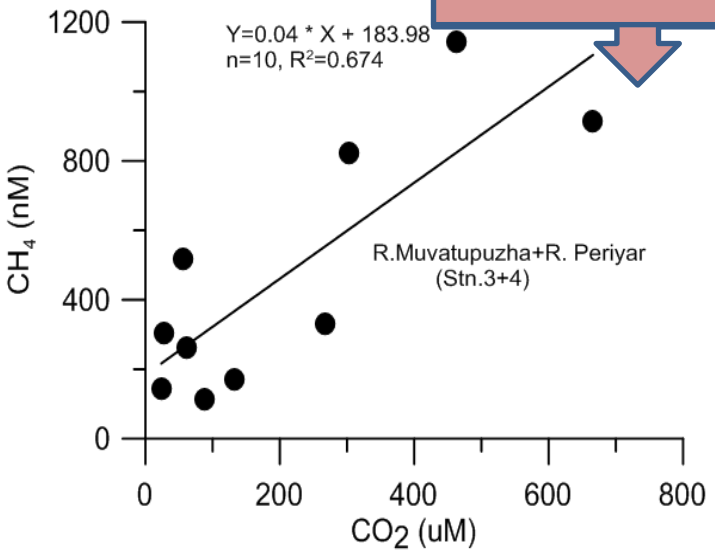


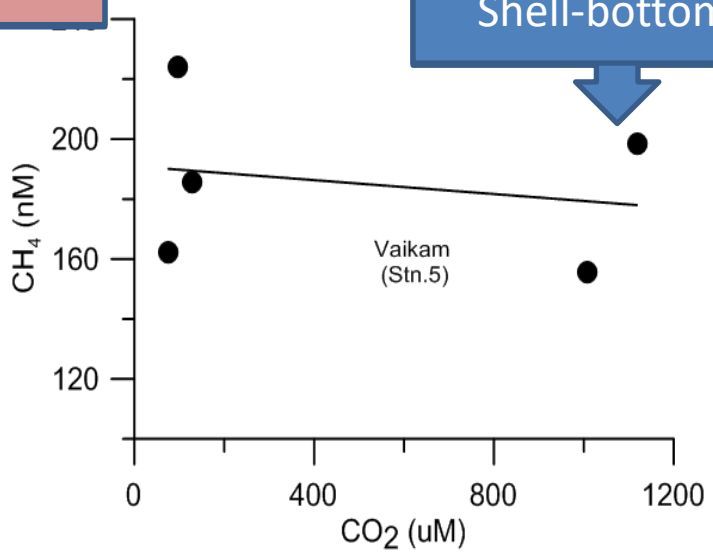




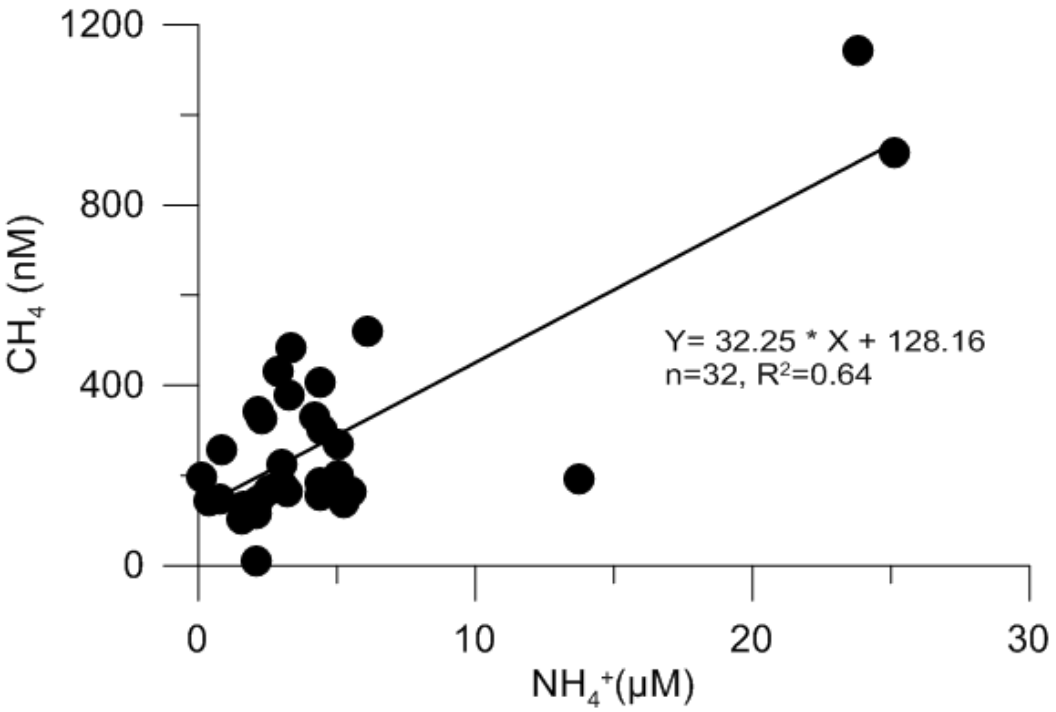
Clayey bottom

Shell-bottom



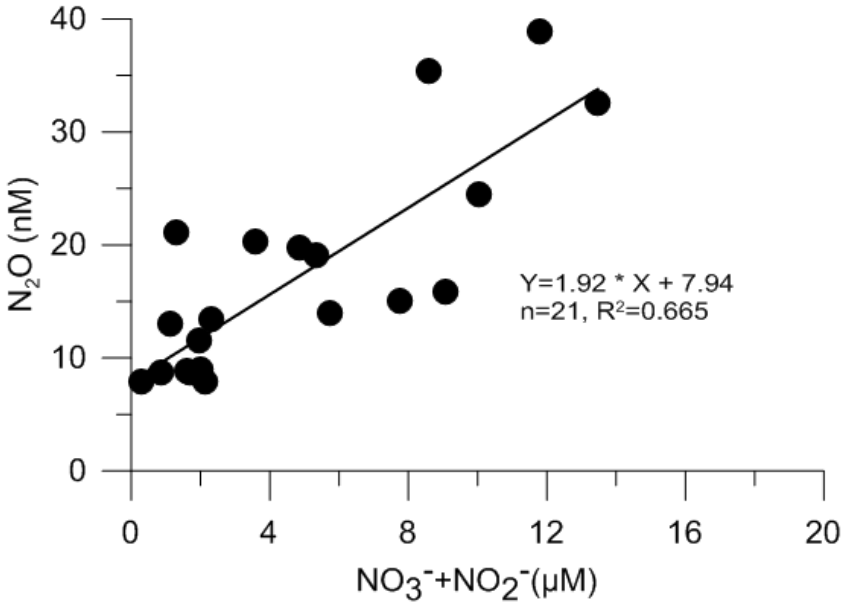


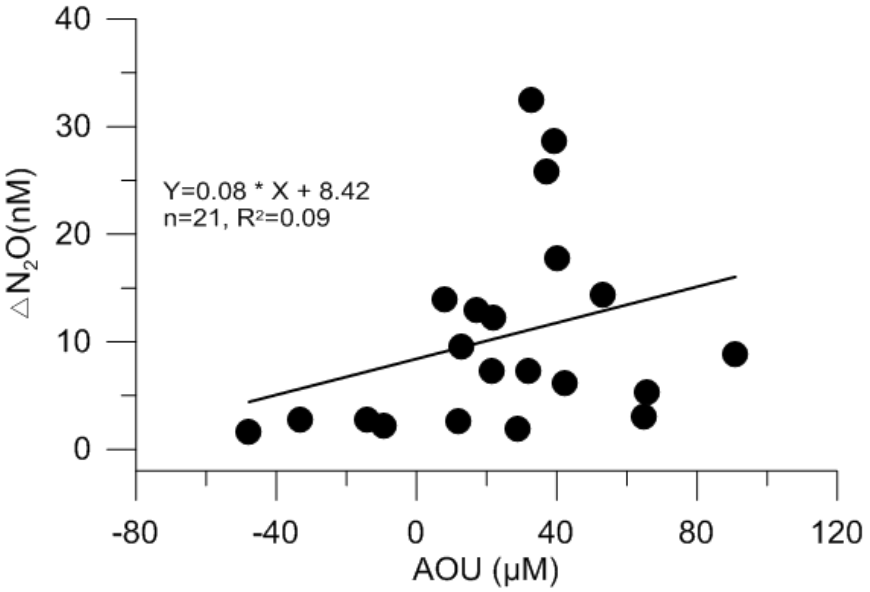
OM decomposition/methanogenesis as CH_4 source..?



- **The heterotrophic nature of CE and high rate of OM decomposition in the sediments responsible for high CH_4 in CE**
- **Benthic chamber experiments showed high methane fluxes (2.54 to 210 mg m^{-2} h^{-1}) from sediments (Verma et al., 2002)**
- **Significant positive correlation of CH_4 with ammonia indicates sediment methanogenesis could be the major CH_4 contributor**

Nitrification as N_2O source..?





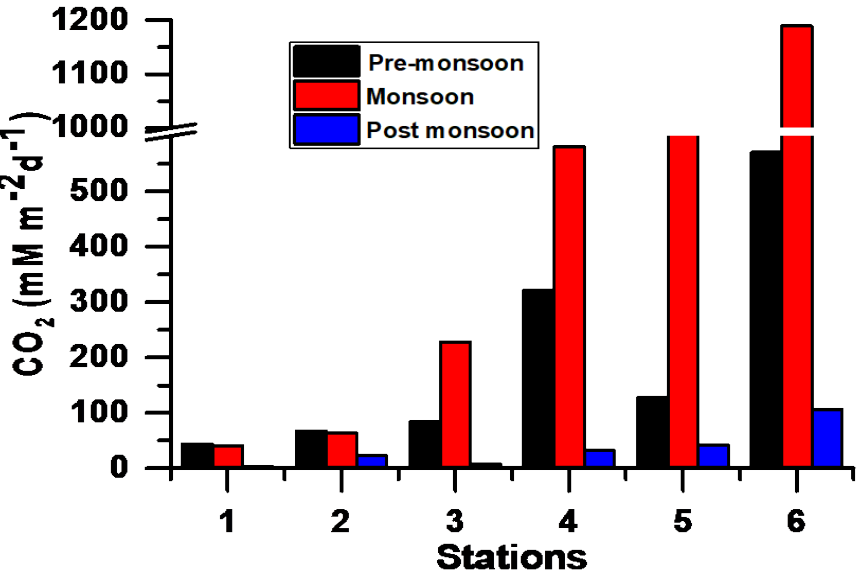
- **No denitrification but mild nitrification**
- **Balance between potential nitrification (800 nmol N L^{-1} h^{-1}) and conservative ammonification (~1 μmol L^{-1} h^{-1}) rates in CE (Miranda et al., 2008)**

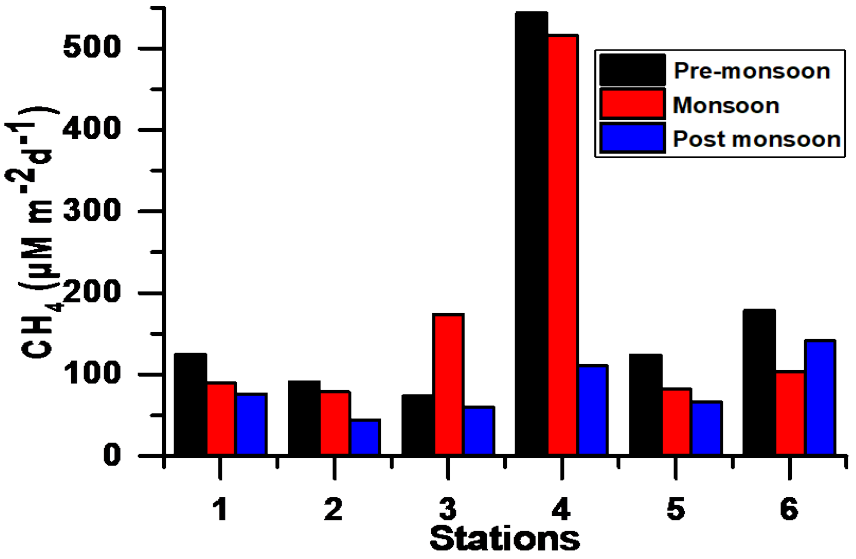
❖ **Turn over time of DIN pool was very fast (11 ± 7.6 h for NH_4 and 118 ± 115 h for NO_3) (Bhavya et al., 2016)**

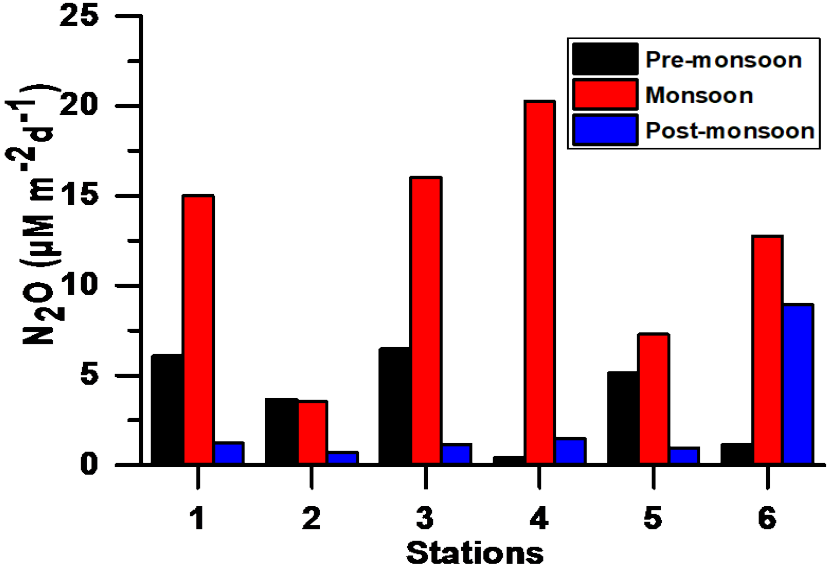
❖ **Low water residence time- ~5 days (Gupta et al., 2009)**

❖ **Much of the anthropogenic DIN is utilized within the estuary**

Seasonal fluxes







CE is a significant source of GHGs to the atmosphere

Annual GHG Fluxes

	Cochin Estuary*	Vembanad Lake#	Indian Estuaries
CO_2 (Tg y^{-1})	0.70	0.681	1.92
CH_4 (Gg y^{-1})	0.23	0.056	3.90
N_2O (Gg y^{-1})	0.03	0.008	0.60

* Area - 256 km^2

\# Area - 68 km^2

Conclusions

- The Cochin estuary is a significant source of CO_2 and CH_4, and minor source of N_2O.
- Fast turn-over times for anthropogenic N does not support N_2O production.
- Sediment OC decomposition and Methanogenesis mainly responsible for high CH_4 production mainly at river confluence points.
- Freshwater regions are high sources of CO_2.
- GHG export fluxes from CE to the adjacent coastal waters were significant as it will affect the coastal biogeochemistry.
- Integrated estuary-coastal coupled study is most important for better understanding of coastal biogeochemistry.


Thank
You