Methane Emissions from Impounded Rivers: Examples from Southern Germany

Andreas Lorke

Institute for Environmental Sciences, University of Koblenz-Landau
Landau, Germany

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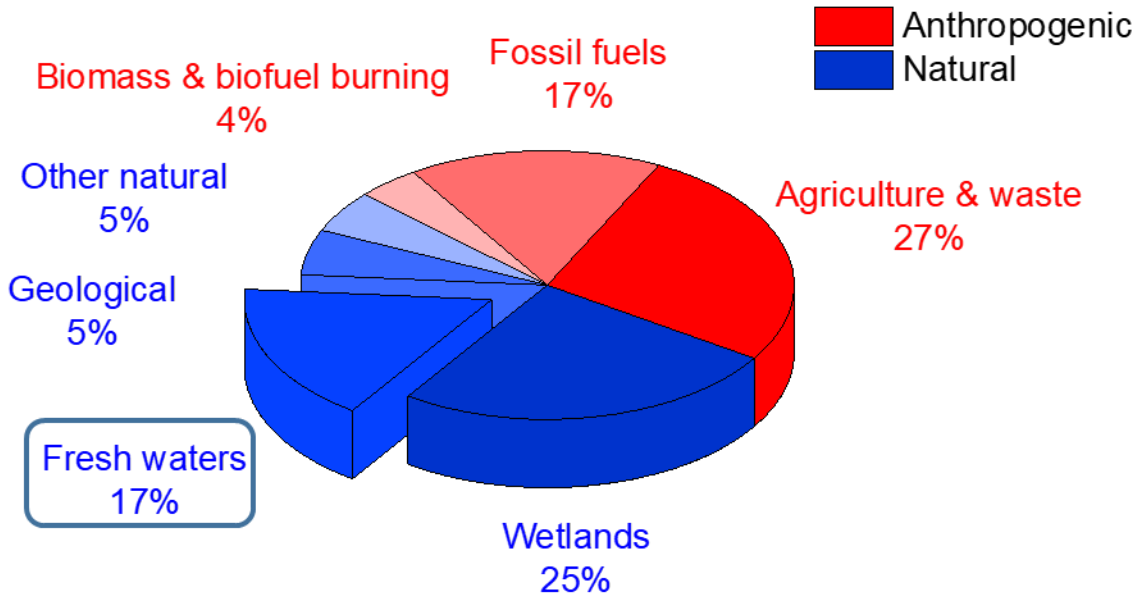
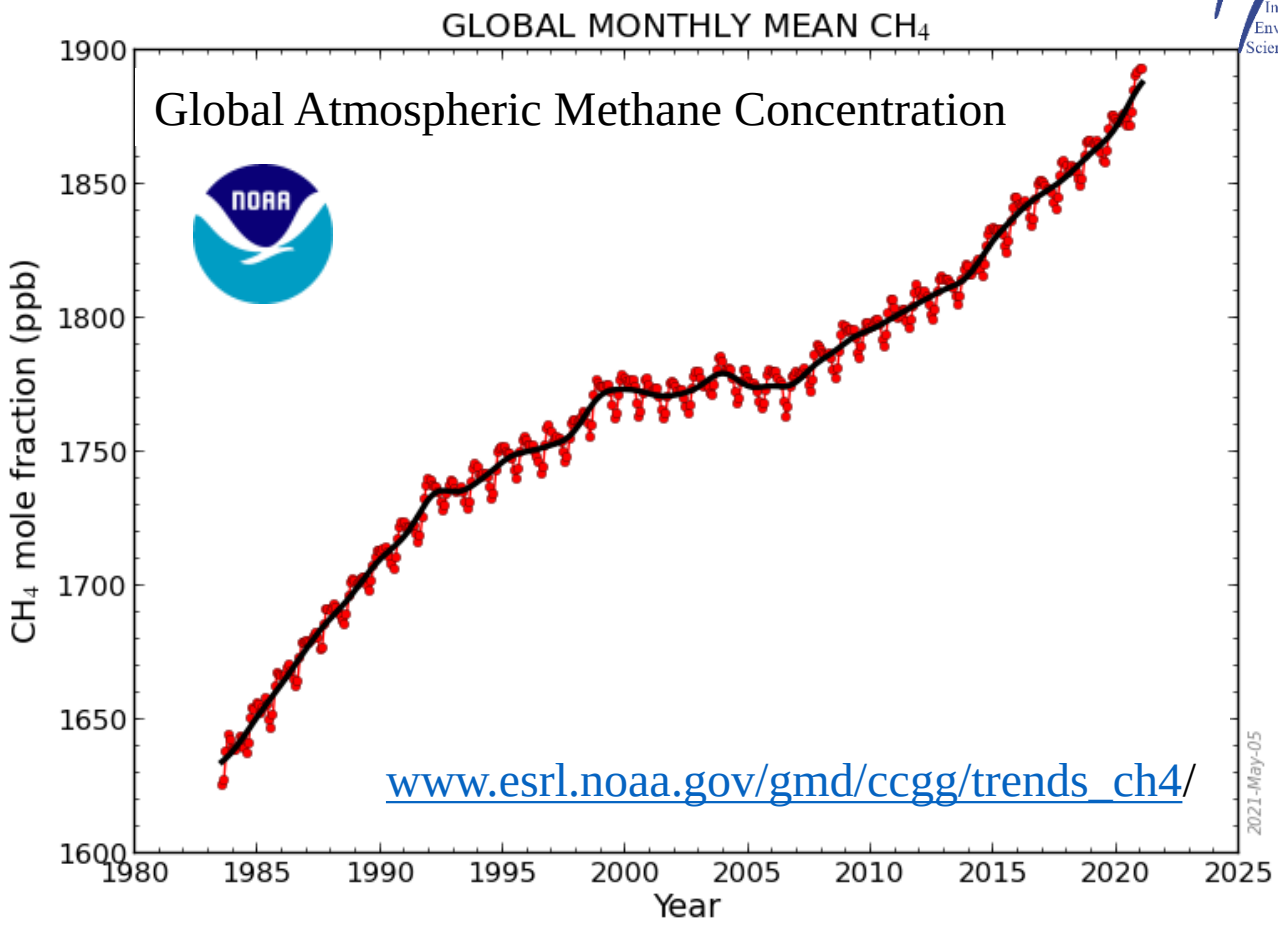
Methane Emissions from Inland Waters

- Methane (CH_4) is the 2nd most important atmospheric greenhouse gas, with a global warming potential of 28 to 35-fold that of CO_2
- Its temporal dynamics (sources and sinks) are poorly understood

Global Sources of Atmospheric Methane:
(Saunois et al. 2016)





Global Sources of Atmospheric Methane:
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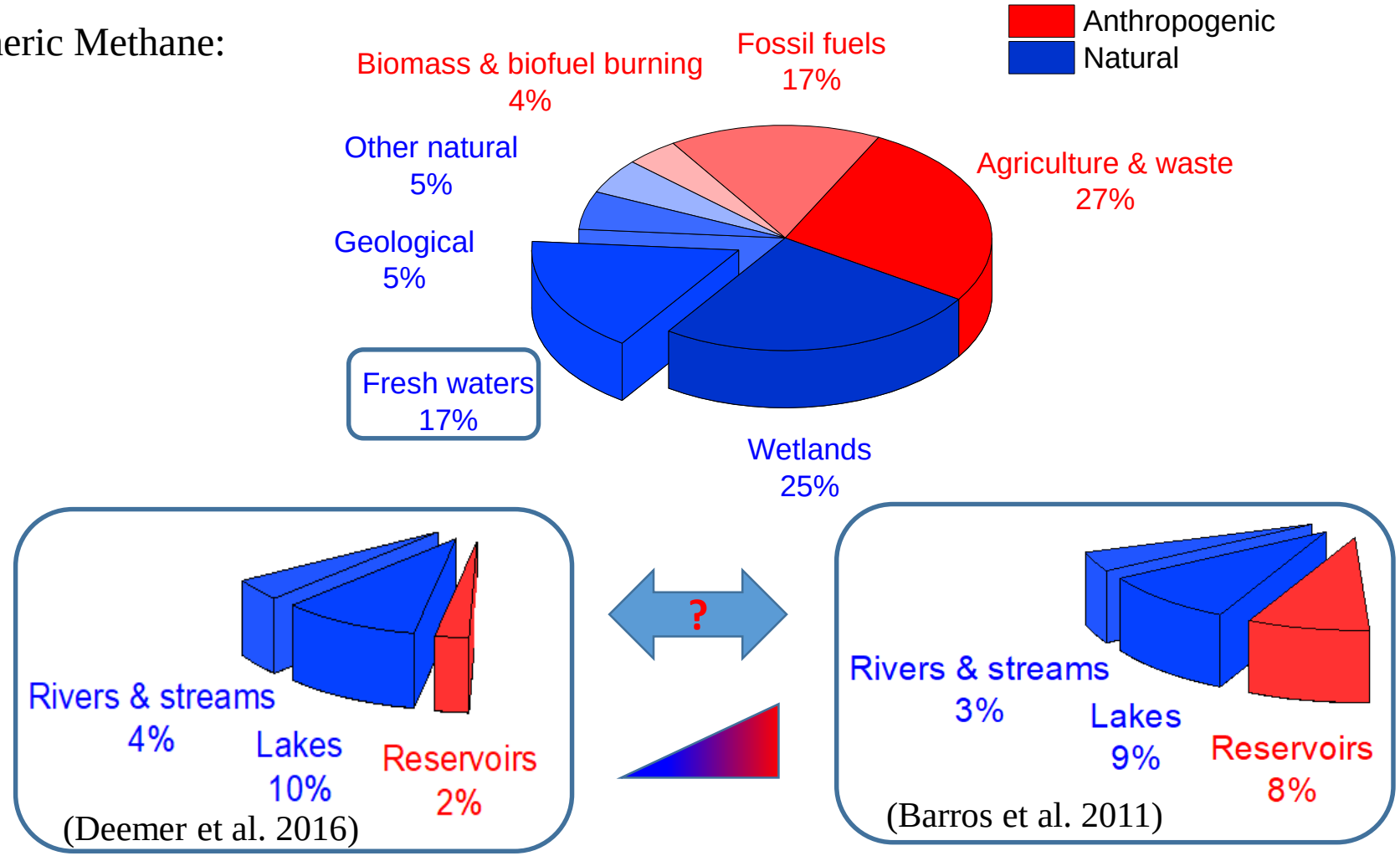
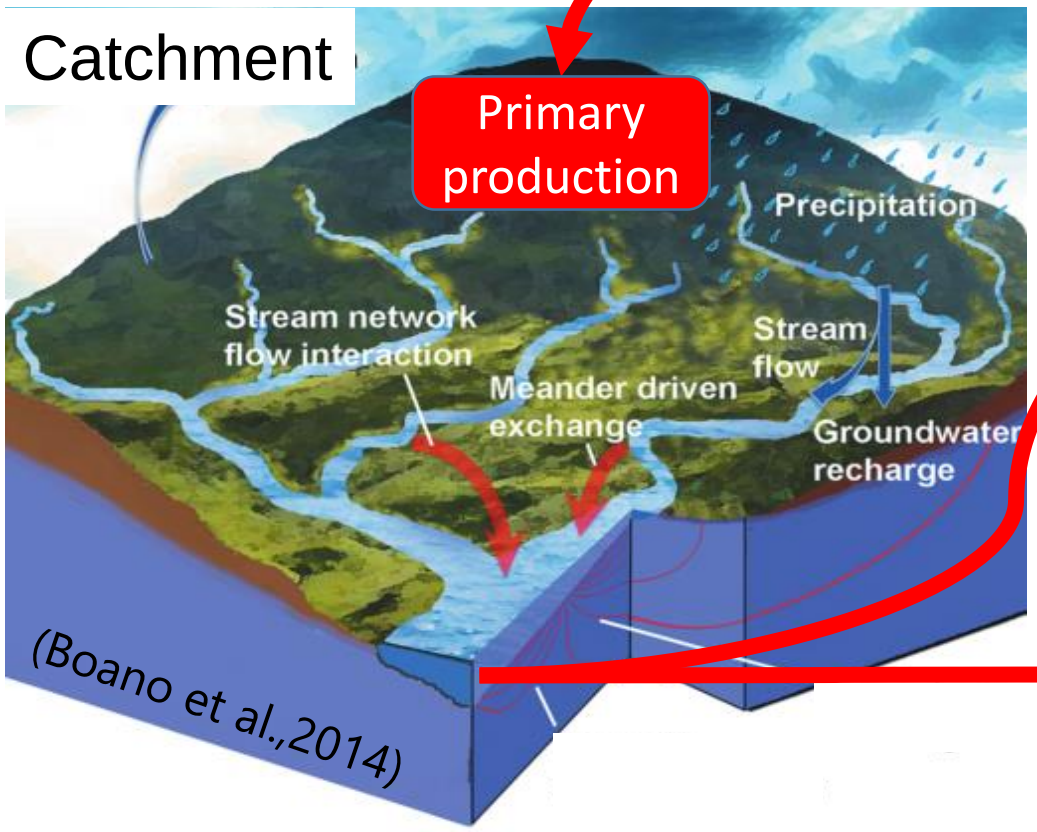
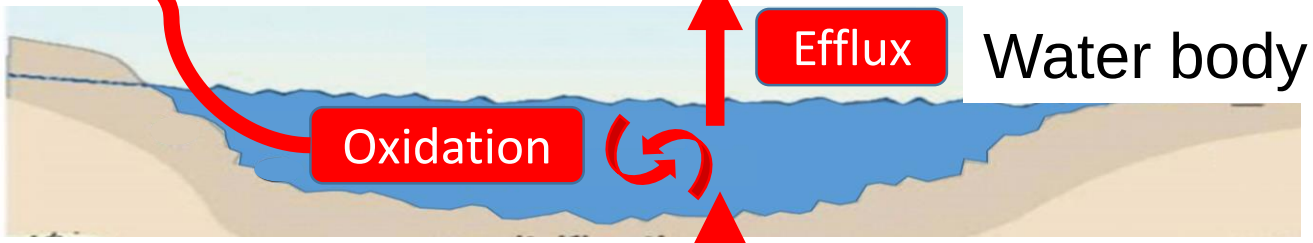
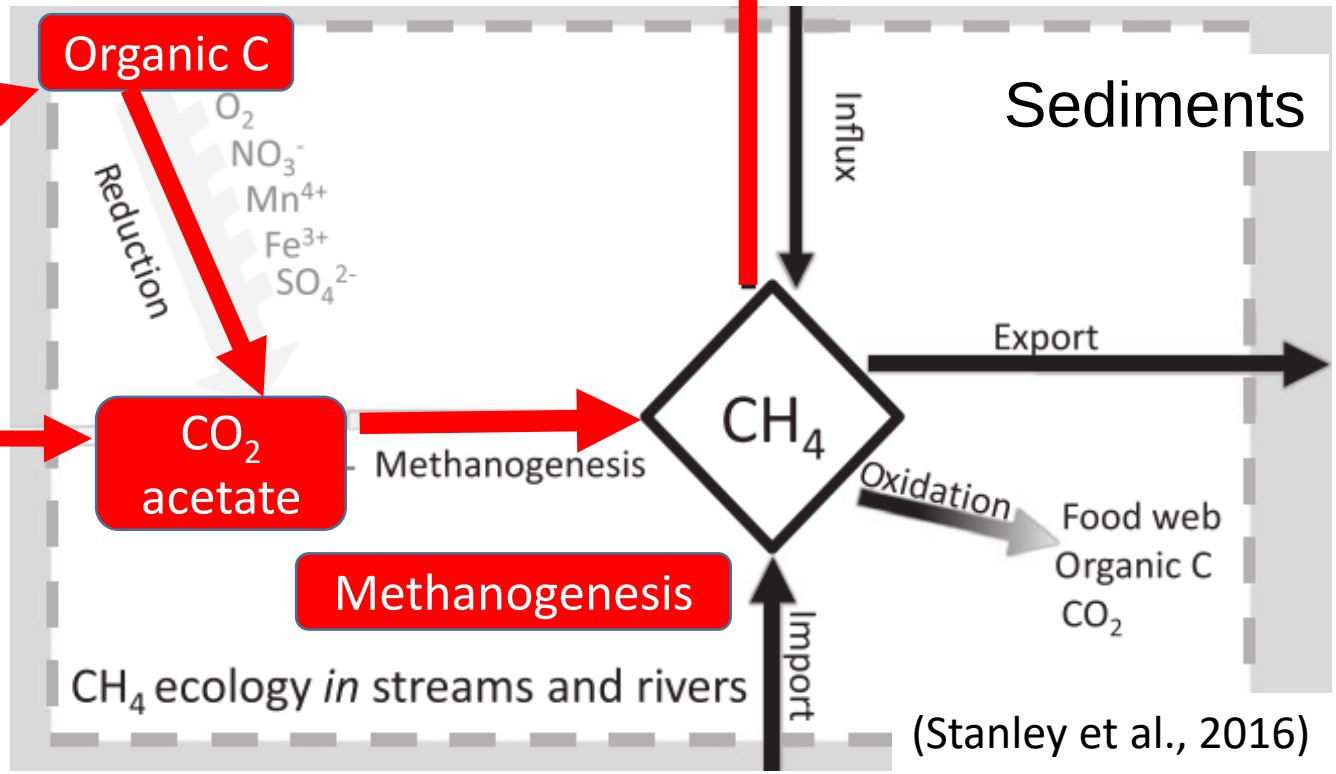


- Current estimates suggest that freshwater reservoirs contribute 2 – 8% to the global CH_4 emissions (5 - 18% of the global anthropogenic emissions)
- *"The most important source of uncertainty on the global methane budget is attributable to emissions from wetlands and other inland waters."* (Saunois et al., 2020)

Catchment





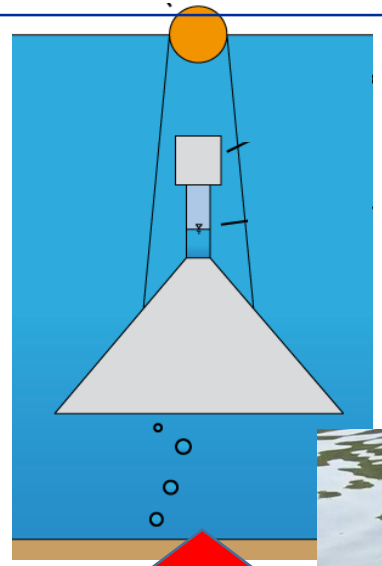


(Stanley et al., 2016)

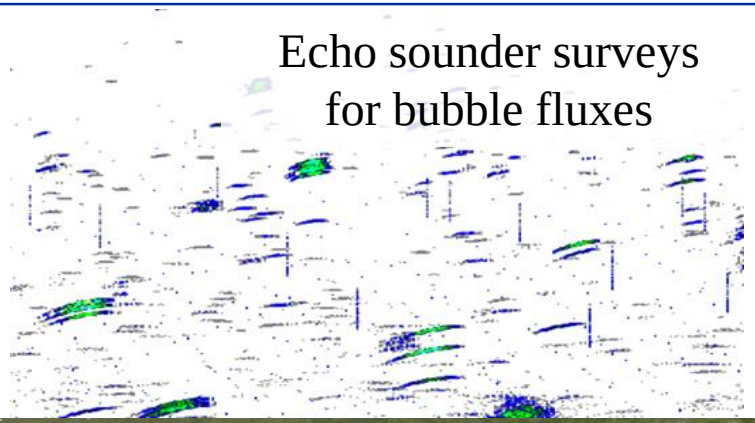
Freshwater CH_4 emission constitutes a process converting atmospheric CO_2 to CH_4

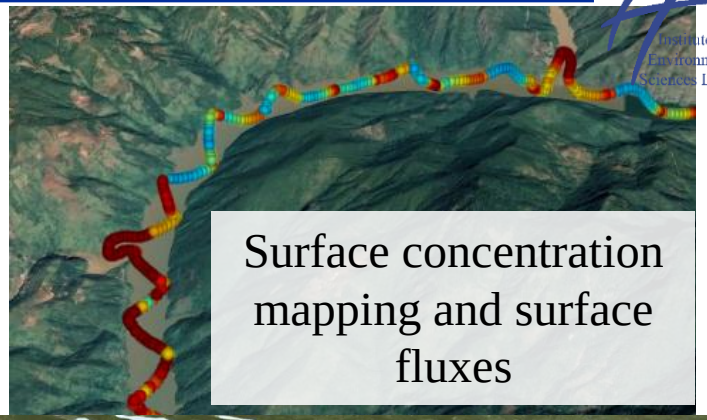
Methane Emissions from Reservoirs

Installation of automated bubble traps



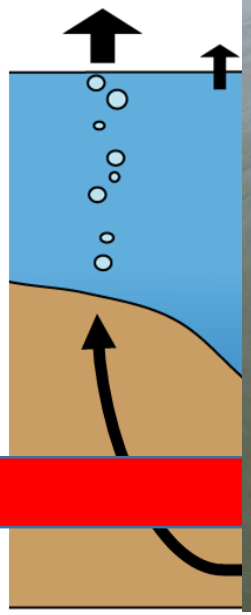
Echo sounder surveys for bubble fluxes





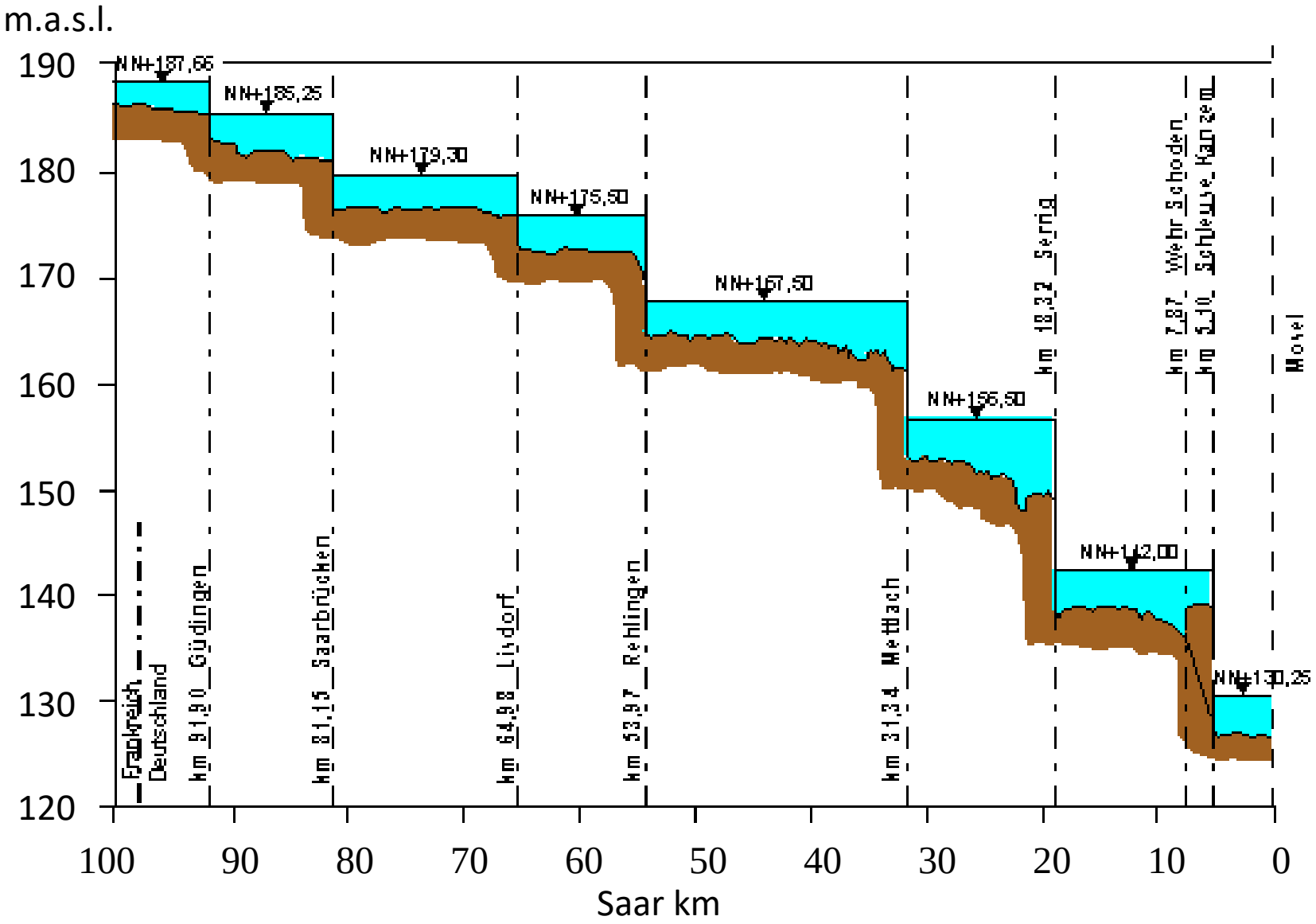
Surface concentration mapping and surface fluxes

Gas Bubbles



Sediment sampling & incubation experiments

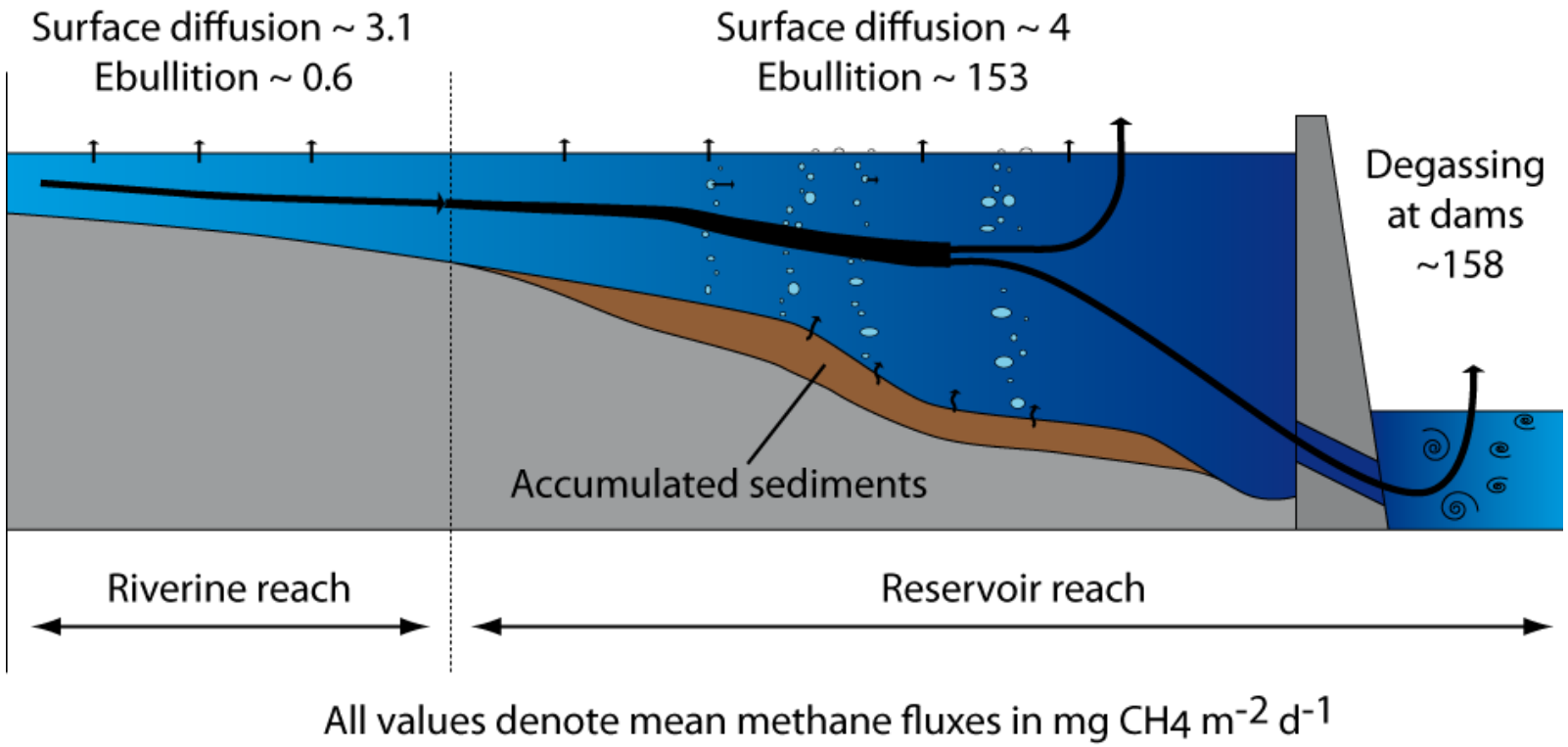
The Saar River (Germany):



Mean CH_4 emissions for 6 cascading river impoundment at the Saar River (Germany):

Riverine section: **4 mg CH_4 m^{-2} d^{-1}** << Impoundment: **315 mg CH_4 m^{-2} d^{-1}**

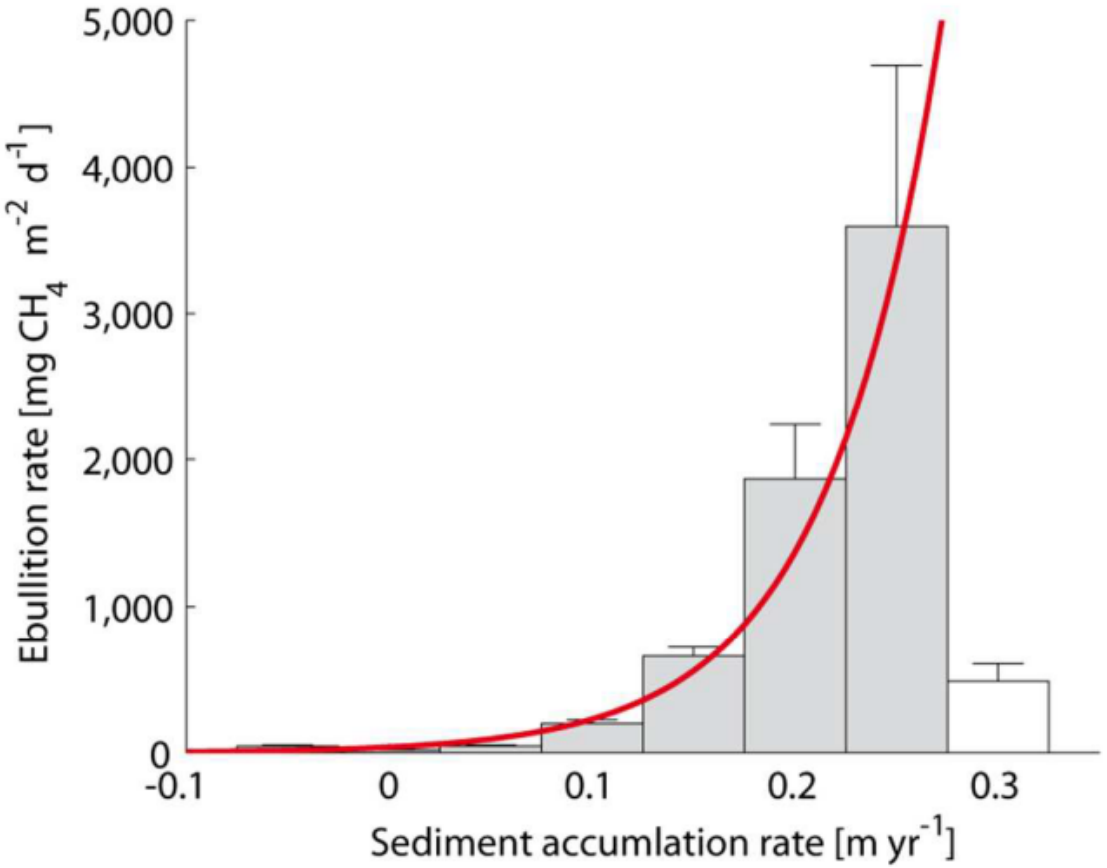
Average emission rate from tropical reservoirs: **> 250 mg CH_4 m^{-2} d^{-1}**

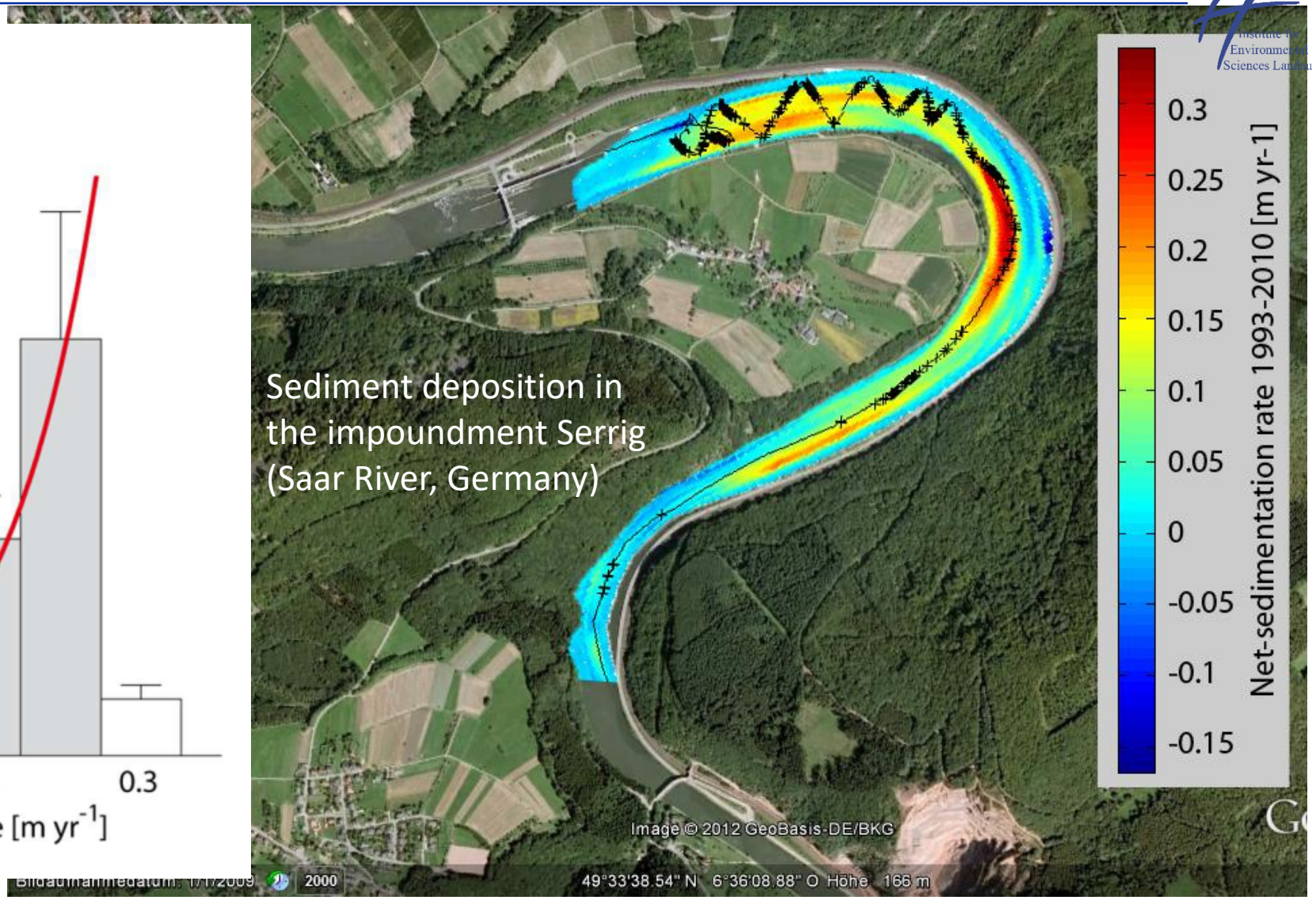


- 80-fold higher CH_4 emissions in impounded sections compared to riverine sections
- Large contribution of gas bubbles (ebullition) and degassing at the dam

Methane Emissions from Reservoirs: Measurements in Southern Germany

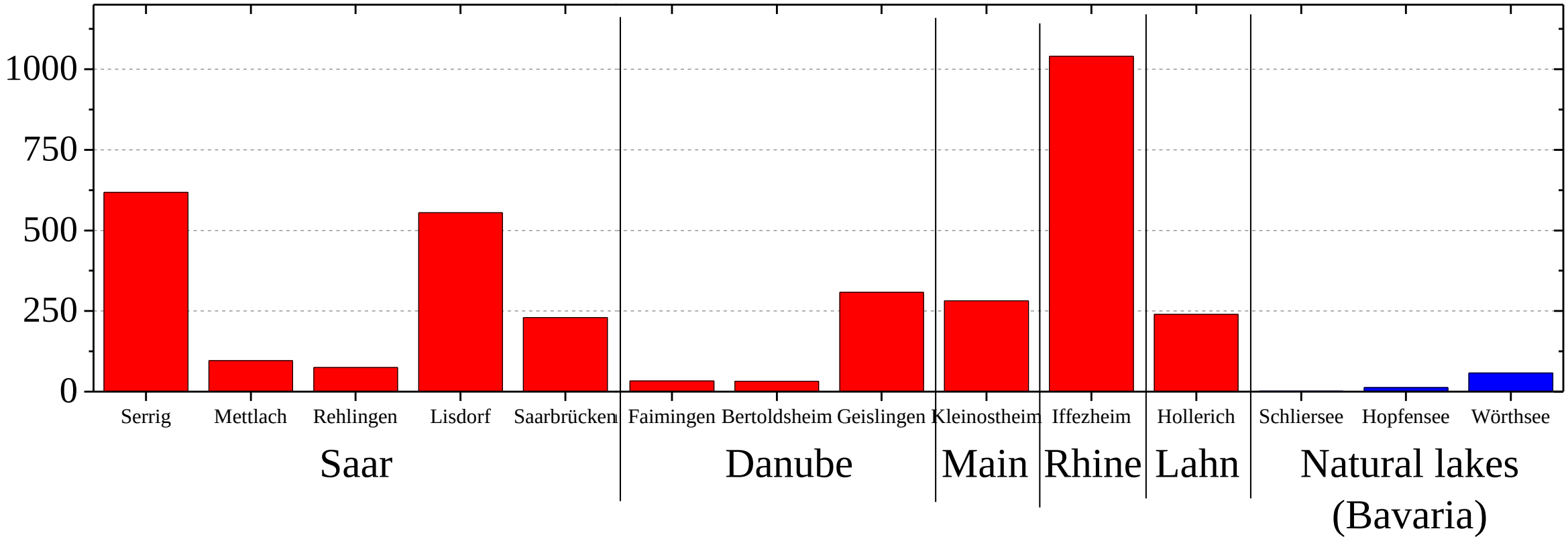
(R^2 = 0.91; p < 0.001; n = 7)





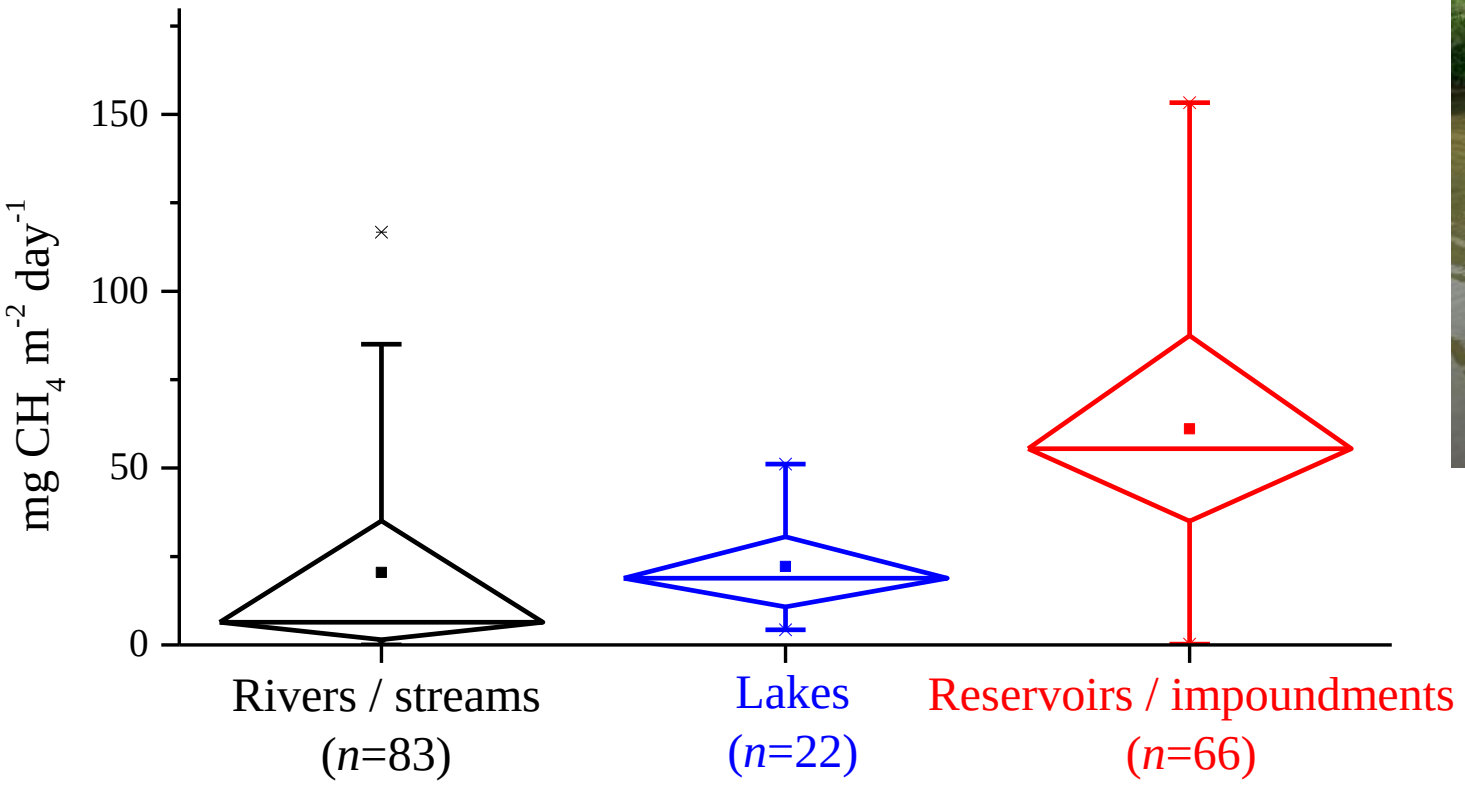
- Sediment deposition zones are hotspots of bubble emissions

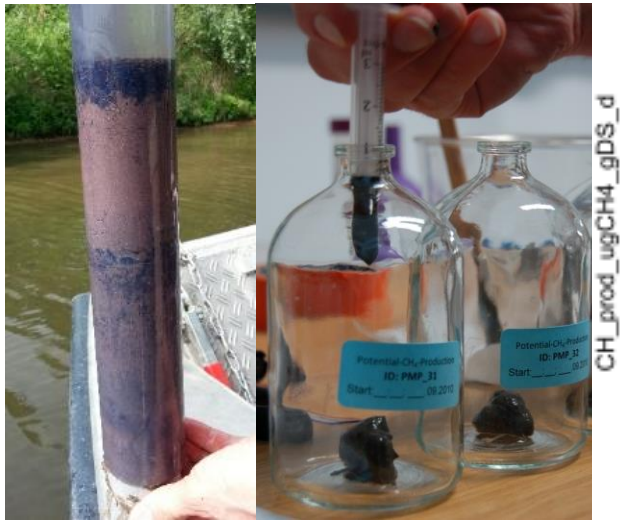
CH_4 Emission (mg CH_4 m^{-2} d^{-1}) from different impoundments

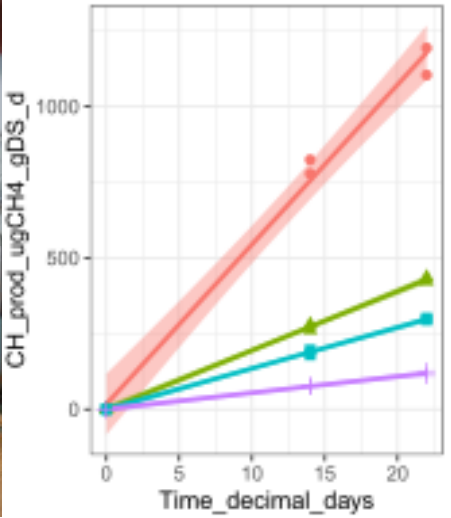


- large variability in CH_4 emissions among different river impoundments
- poor / no predicatability

CH_4 production rates in the sediment (global meta analysis):







- Reservoirs sediments have higher CH_4 production potential than that in rivers and lakes.
- Possibly related to higher sedimentation rates in reservoirs

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Ongoing research:
Harvesting of CH_4 bubbles during sediment remobilization

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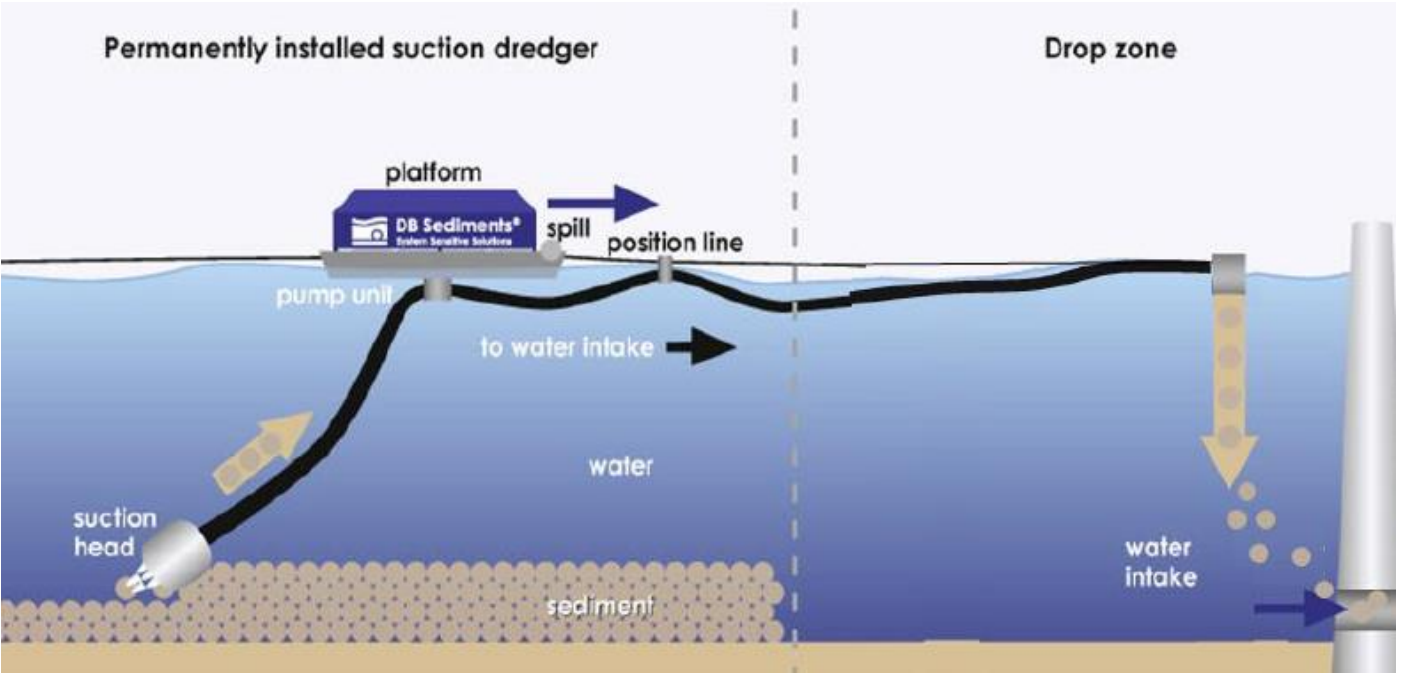

Pilot campaign for CH_4 harvesting from aquatic sediments, July 2020, Wupper Vorsperre

Take Home Messages

- Reservoir surfaces are a globally significant source of the greenhouse gas methane (… not only in the tropics)
- Methane production and emission is mainly caused by sediment accumulation in impoundments
- Dam removal can be expected to results in a strong reduction of methane emissions from impounded area - not only for larger dams
- Emission monitoring should be implemented in future removal projects!

Thank you for your attention!

Andreas Mäck

Jeremy Wilkinson

Christoph Bors

Florian Burgis

Pascal Bodmer

Bayerisches Landesamt für Umwelt

Deutsche Bundesstiftung Umwelt

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