Methane distribution and methane oxidation in the water column

of the Elbe estuary, Germany

* Hamburg to Cuxhafen
* High Methan Concentration In Hamburg Habour
* 10 Times Lower in lower estury.
* No Clear relation to Suspendet particular metter
* Correlation with Methan in water and temperature
* High methan oxidation in summer, low oxidation in winter
* Methanotroph reduces CH4 Emissions from sediments
* „We found that when the water   
  level was dropping the higher CH 4 concentrations were   
  observed (r 2 = 0.86, n = 10) in the upper estuary, but no   
  correlation was found in the lower estuary.“
* We found significantly higher CH 4 concentrations at   
  falling water levels in the upper estuary. Grunwald et al.  
  (2009) suggested that CH 4 concentrations usually peaked   
  during low tide, probably due to the CH 4 -rich freshwater   
  input and that, conversely, low values may be caused by   
  dilution with CH 4 -poor marine water and degassing pro-  
  cesses. This was revealed and postulated also by others   
  (Kone ́ et al. 2010; Upstill-Goddard and Barnes 2016).   
  However, we did not find a correlation to water gauge/   
  level, like Grunwald, but with the ‘‘falling water level’’.  
  We assume that our sampling strategy from a moving boat   
  versus fixed stations biased this effect. For the North Sea   
  the tidal flat have been shown to be a methane source (Wu   
  et al. 2015), and we assume that the strong surge at falling   
  water levels results in the release of methane into the river/   
  estuary.
* Methane in the whole estuary but more specifically in its   
  upper part is positively correlated with the BOD-7, which   
  represents a measure of the bioavailability of degraded   
  organic matter. The high CH 4 concentrations in the upper

part of the Elbe estuary likely result from the high het-  
erotrophic activity related to remineralization processes of   
high loads of labile organic matter.

* Turnover and temperature is improtent
* Upper esury, methane due to the river (pollution , biomas etc.)
* Lower Methane due to Wadden see
* Methane from Upper duse not reach the lower estury
* Despite active methane oxidation, the microbial filter was esti-  
  mated to be responsible for 5–41 % of the methane total   
  loss. The other part was attributed to methane diffusion   
  into the atmosphere

Sediment methane dynamics along the Elbe River

* Biological methane -> wet anoxix soils and sediments
* Frequently observed inverse relationship between discharge and CH4   
  concentration is most probably given either by dilution (Kone et al.,   
  2010; Anthony et al., 2012) or by higher temperature during low water   
  periods. Increased temperature further enhances microbial activity and   
  thus decreases oxygen levels (Borges et al., 2018).
* (Teodoru et al., 2015; Barbosa et al., 2016)
* This implies that the CH 4 input into the water   
  column may originate in some hot-spots of CH4 production rather than   
  a continuous supply from the sediment.
* Alles nicht so nützlich….

Methane dynamics in a large river: a case study of the Elbe River

* The highest methane concentrations were found in human-altered riverine habitats, i.e., in a harbor (1,888 nmol L−1 ), in a lock and weirs (1409 ± 1545 nmol L −1 ), and in general in the whole “impounded” river segment (383 ± 215 nmol L −1 )
* The methane oxidation rate was more efficient in the “natural” segment (71 ± 113 nmol L −1 day −1 , which means a turnover time of 49 ± 83 day −1 ) than in the “lowland” segment (4 ± 3 nmol L −1 day −1 , which means   
  a turnover time of 39 ± 45 day −1)
* Methane emissions from the surface water into the atmosphere ranged from 0.4 to 11.9 mg   
  m −2 day −1 (mean 2.1 ± 0.6 mg m −2 day −1 ) with the highest CH 4 emissions at the Meissen harbor (94 kg CH 4 year −1 )
* Such human-altered riverine habitats (i.e., harbors and similar) have not been taken into consideration in the CH 4 budget before, despite them being part of the river ecosystems, they may be significant CH 4 hot-spots
* The aerobic CH 4 consumption (methanotrophy) by   
  methane-oxidizing bacteria (MOB) is, so far, the best   
  known process providing a natural barrier of CH 4 being   
  released from different ecosystems into the atmosphere.
  + Not happening in impunded riveres
* On the other hand, in the water col-  
  umns of rivers, microbial CH 4 oxidation is believed to be   
  much less efficient (Zaiss et al. 1982)
* Many authors pro-  
  pose that river impoundments (weirs, locks, dams, reser-  
  voirs) represent the hot-spots CH 4 emissions due to high   
  CH 4 production in these man-made habitats (e.g., Guérin   
  and Abril 2007; Hertwich 2013; Maeck et al. 2013).
* However, the reason for the   
  inhibition of CH 4 oxidation in these habitats still remains   
  unexplained and so needs further research
* Nevertheless, our data show   
  that both damming of the river as in the “impounded” seg-  
  ment of the Elbe and the occurrence of CH 4 hot-spots (e.g.,   
  harbors), may promote CH 4 emissions and contribute to the   
  high variations of CH 4 fluxes at the river scale

Two temperature optima of methane production in a typical soil of the Elbe river marshland

* Methanogenic bacteria were found in oxic as well as in anoxic soil layers
* The highest methane production rates were measured at 10°C and 20°C
* Moore and Roulet [32] showed that methane production in peat-  
  land soils decreased in relation to a lowered water   
  table.
* Different Bactreia produce methane at low temperature 10°C…

Reservoir Water-Level Drawdowns Accelerate and Amplify Methane Emission

* Water-level fluctuations due to reservoir management could substantially affect the timing and magnitude of reservoir methane (CH 4 ) fluxes to the atmosphere
* Reduction in Waterlevel invreases methande flux to atmosphere due to minimiesed Oxidation of Methane in water collum
* In fact, a recent review of nine lakes   
  with both CH 4 production and oxidation measurements   
  conservatively estimated that methanotrophs consume 50−  
  95% (median: 90%) of all CH 4 produced in lakes and an even   
  greater fraction of the nonebullitive CH 4 flux
* More Buble released due do drop in Hydro statik preasure
* With Lots of seliment , the seliment can store lots of methan and release it by low water event
* Increases methan wenn seliments are “reset” or mixed up.
* The sensitivity of reservoirs to   
  drawdowns is likely to be a function of sediment characteristics   
  (e.g., sediment cohesiveness and, especially, organic matter   
  content 13 ), reservoir average depth, the frequency of draw-  
  downs, rates of methanogenesis, and CH 4 oxidation, and is a   
  topic meriting further attention in future work.

Methane emissions from Mexican freshwater bodies:   
correlations with water pollution

* Polution generates more methane emission