FACT ! SHEET

ZMT LEIBNIZ CENTRE for Tropical Marine Research

EUTROPHICATION AND GREENHOUSE GASES in Hainan, China

Eutrophication is the enrichment of nutrients such as phosphate (PO_4^{3-}) or nitrate (NO_3^-) in a water body. This stimulates algal growth and can result in a serious decline in water quality. For decades, eutrophication and associated risks such as oxygen and biodiversity decline have been recognized as a serious issue globally. But there is still no uniform method for quantification of the trophic state.

Nutrient rich creek with intense algal blooms © M. Drews

FACTS

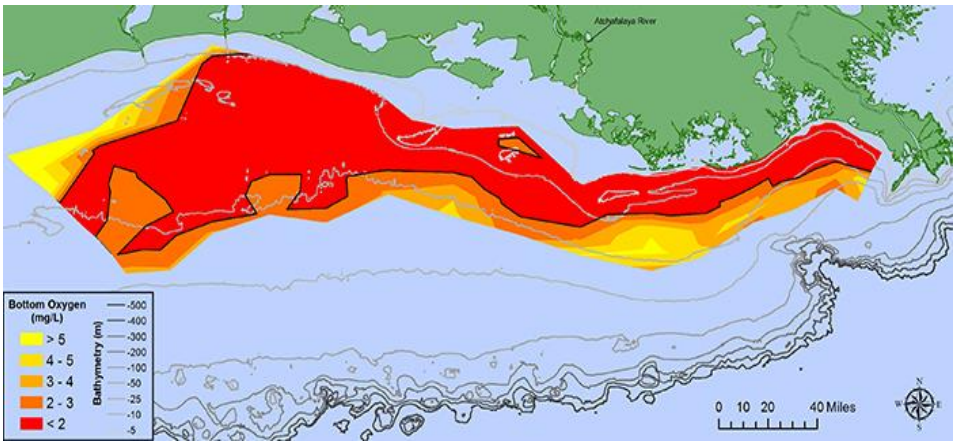
What causes eutrophication?

Excess nutrients being released into coastal or estuarine systems originate from fertilizers and/or excess feedings used in agri- and aquaculture. Pollution and eutrophication have been increasing with the intensive growth of this sector. Thus, eutrophication of natural water bodies caused by insufficiently treated effluents can result in pollution of water resources used in the aquaculture industry.

Wastewater channel of an aquaculture farm at Hainan island, China © M. Drews

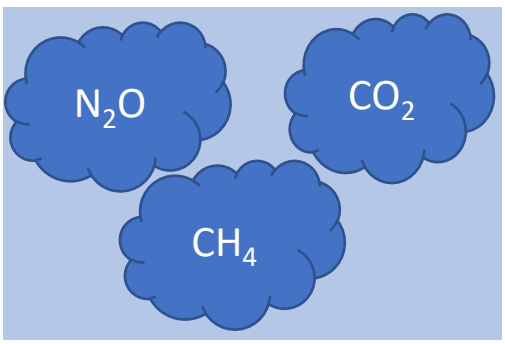
Consequences for organisms

As algal growth increases, less sun light reaches the bottom layer causing aquatic plants to die. Both, the dead plants and dying phytoplankton from upper water layers are consumed by microbes alongside with dissolved oxygen (O_2). O_2 is essential for the well-being of higher organisms such as fish. But, if O_2 declines seriously, a sufficient supply is not granted anymore. Mobile species migrate away from regimes of low O_2 concentration (hypoxia) or are threatened to suffocate if they cannot. Anoxic (without O_2) conditions will cause all higher organisms to die. These regimes are therefore called dead zones.



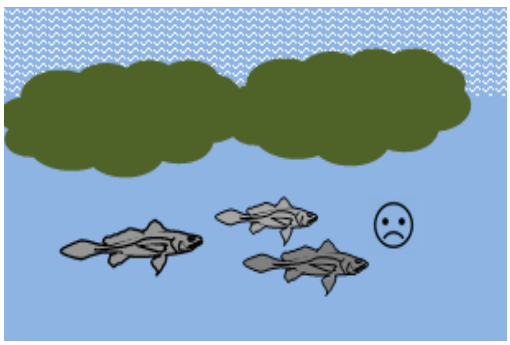
The largest dead zone in the Gulf of Mexico spanned over approx. 22,700 km² (2017).

© N. Rabalais, LSU/LUMCON, Retrieved from https://www.noaa.gov/media-release/gulf-of-mexico-dead-zone-is-largest-ever-measured



GHGs

Under low oxygen conditions, microbes produce greenhouse gases (GHG), such as nitrous oxide (N_2O) and methane (CH_4) through biochemical processes that keep them alive. These gases are partially released to the atmosphere as their solubility in water is low. There they can contribute to global warming.



Eutrophication

Hypoxia and dead zones are increasing globally. Global warming supports this process as temperature increase stimulates microbial activity in favor of algae growth
and decreases oxygen and GHG solubility.

Interesting links

https://www.youtube.com/watch?v=6LAT1gLMPu4
http://speakingofseafood.org/modules/seafood-in-the-global-protein-market/climate-impacts-seafood-capture-production-processing

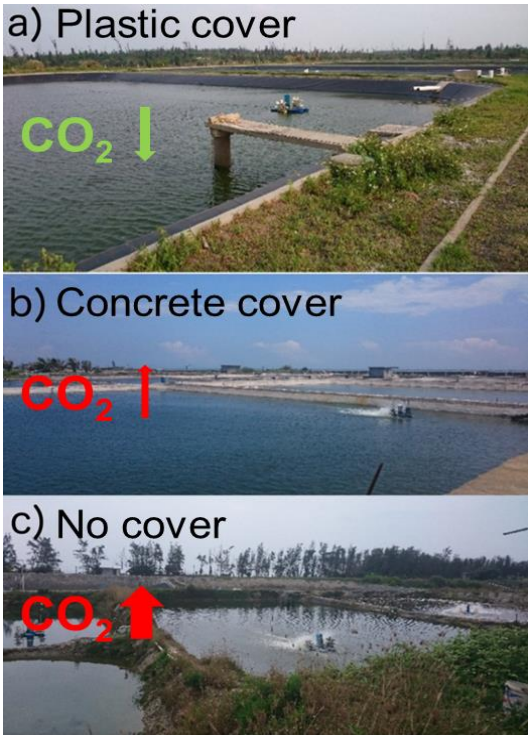
https://oceanservice.noaa.gov/facts/eutrophication.html
http://www.fao.org/3/a-i7558e.pdf

Aquaculture & GHG

It is important to understand aquaculture's contribution to GHG emissions and how it can be mitigated. We screened the impact of aquaculture activity along its north-eastern coast of Hainan and estimated the impact of eutrophication on oxygen in adjacent waters.

Does aquaculture mitigate CO_2 emissions?

We found that, unsealed ponds acted as CO_2 source to the atmosphere due to decomposition of soil organic matter, accumulating surplus feedings and possibly intrusion of CO_2-rich groundwater. In contrast, a sealed and well-managed pond could absorb atmospheric CO_2 through conversion into phytoplankton and finally shrimp biomass.



Aquaculture facilities lined with plastic (a), with concrete (b) and without cover (c). (right). © M. Drews

Use of sealed aquaculture ponds with improved operational and management strategies will reduce CO_2 emissions.

Take home messages

- → **Results of Eutrophication can be a serious decline in water quality and production of GHGs, posing risks such as a decline in oxygen and biodiversity**
- → **Uniform methods for quantification of the trophic state are still lacking**
- → **Improved pond operational strategies could help to minimize GHG emissions associated with aquaculture**

Impressum

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