Mangrove ecosystems and shrimp farming interactions along tropical coastlines;
a selective review

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Shrimp farm in Vietnam

Institut de recherche pour le développement

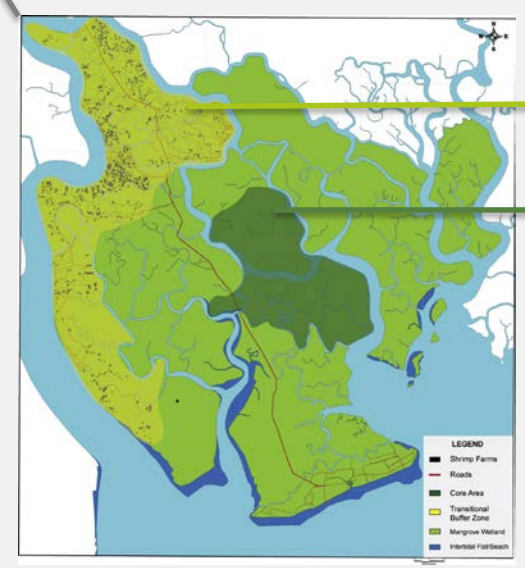
Why am I here today ?

Team 6: Source and transfer of organic matter in aquatic ecosystems

PhD Subject :

Impact of shrimp farming on trophic webs of Can Gio Mangrove (southern Vietnam)

To Ho Chi Minh City (30 km) ; 8M inhabitants

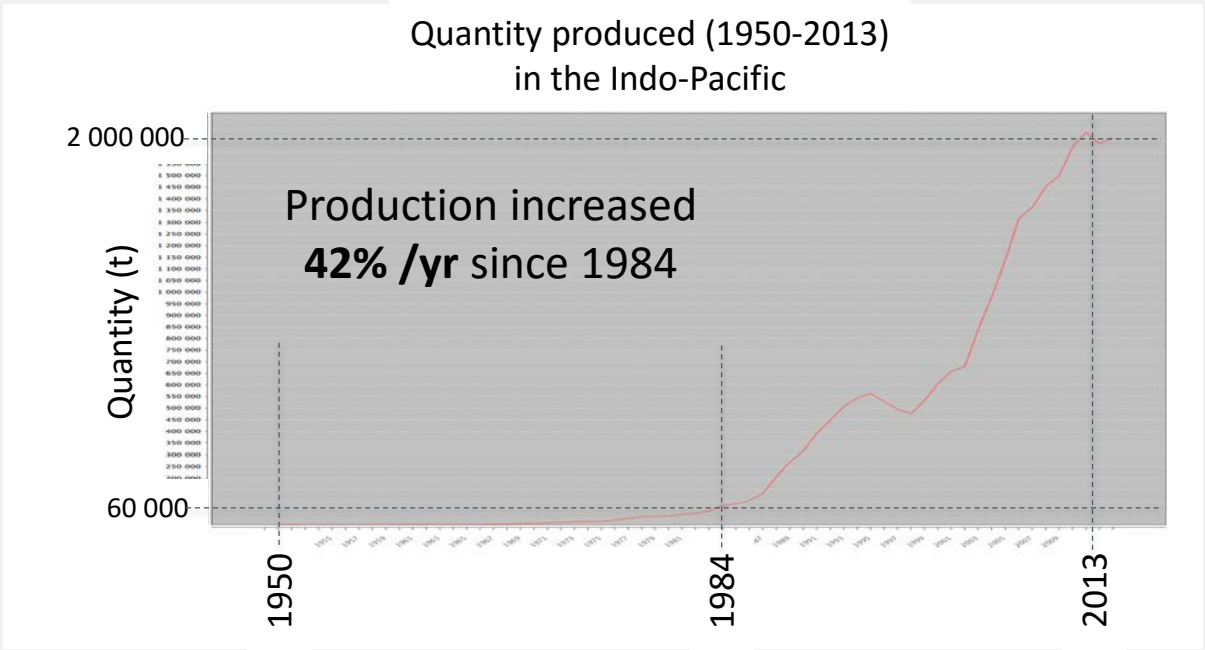


Shrimp farms

UNESCO Biosphere reserve (2000)

Source: McDonough *et al.* 2014

Why should tropical coastlines be impacted by shrimp farming ?



Shrimp farms are set up on intertidal wetlands

1

Shrimps assimilate only 30% of N and 15% of P
(Avnimelech & Ritvo 2003)

2

Shrimps are particularly sensitive to pathogens

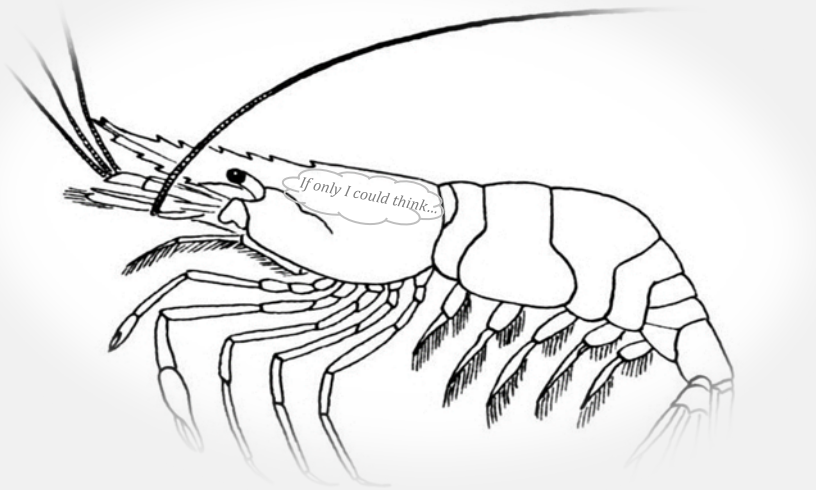
3

An overview of shrimp farming impacts along tropical coastlines:

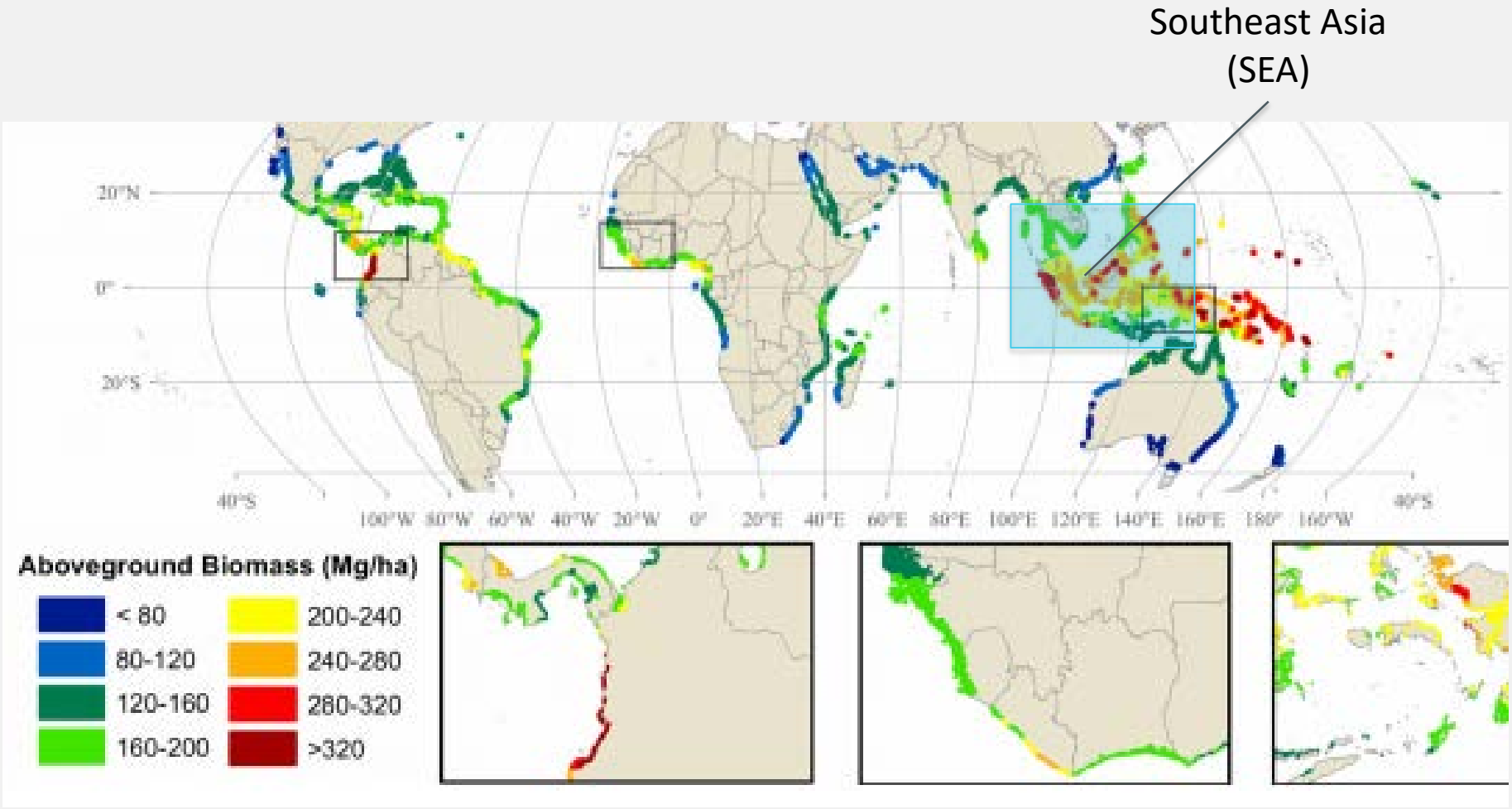
1. Deforestation and carbon release

2. Eutrophication and change in community structure

3. Release of antibiotics and soil abilities change



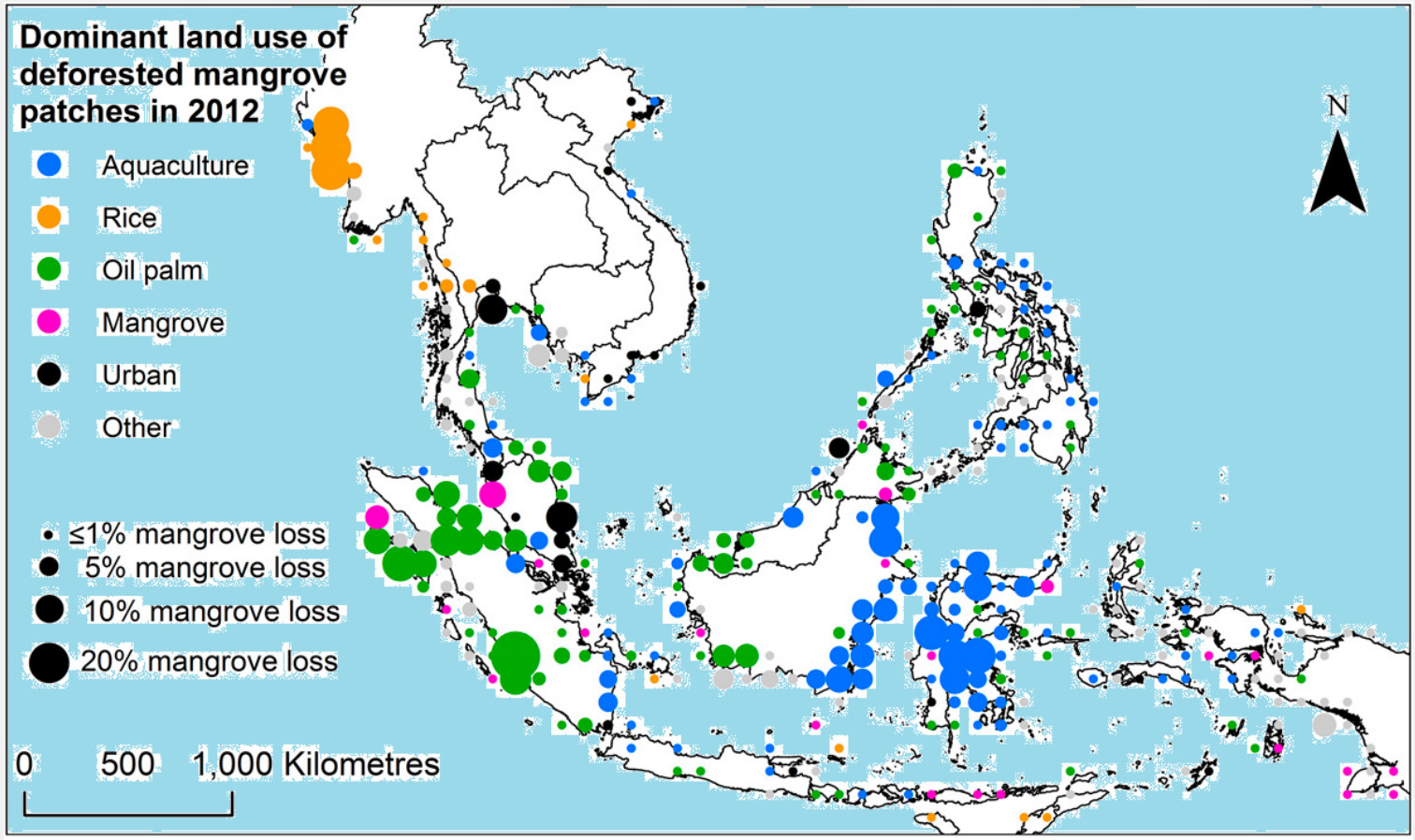
- Aboveground Biomass along tropical coastlines



Hutchison *et al.* 2014

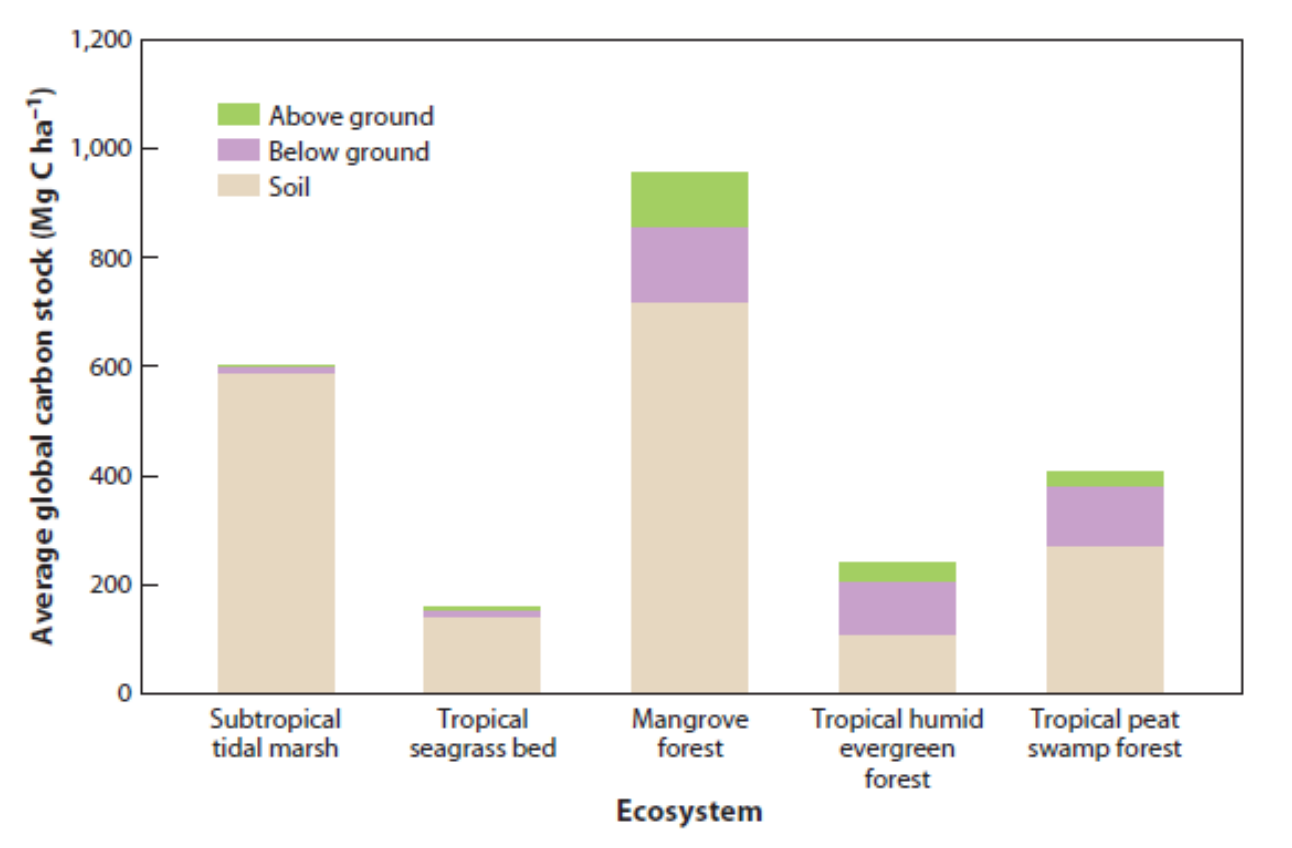
- Mangroves deforestation in SEA (2000-2012)

114,424 ha deforested / 30% replaced by aquaculture



Colored from Richards & Friess 2016

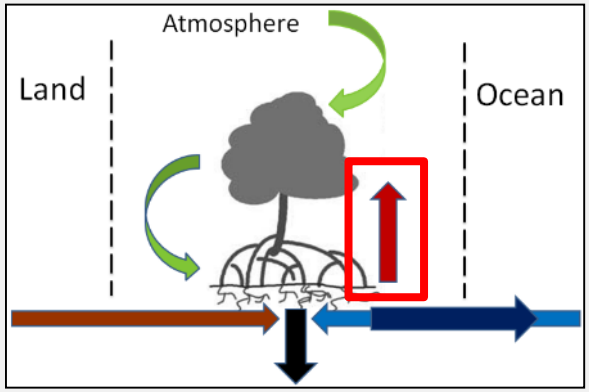
- Carbon stocks in tropical ecosystems

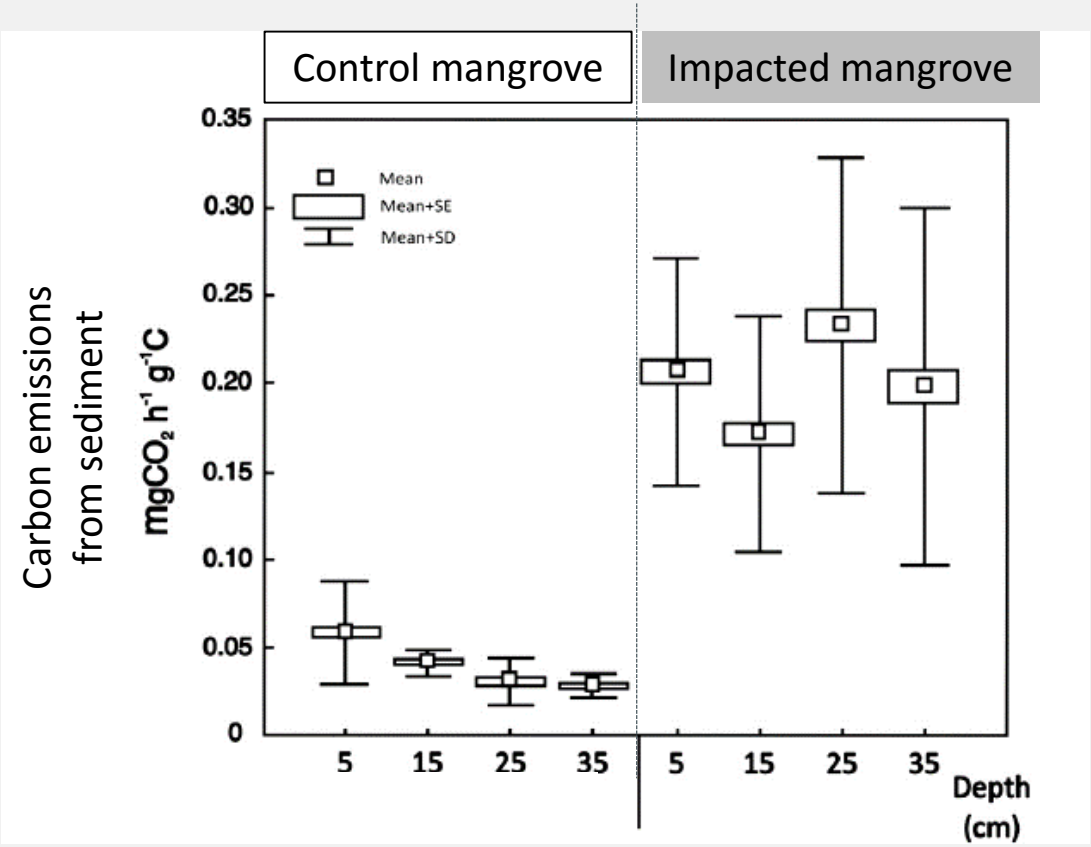


Alongi *et al.* 2014

- Brazil (northeast coast)

Sediment CO_2 emissions





Suarez *et al.* 2014

- Higher release of CO_2 in impacted mangroves
- Lower OC content in soils of impacted mangroves

Shrimp farming contributes to CO_2 increase in the atmosphere

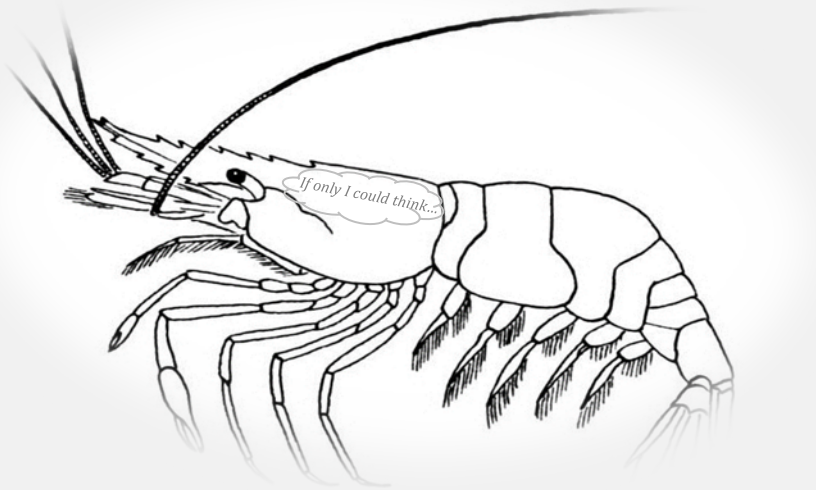
- Because of deforestation
- Due to changes in soil processes of adjacent mangroves

An overview of shrimp farming impacts along tropical coastlines:

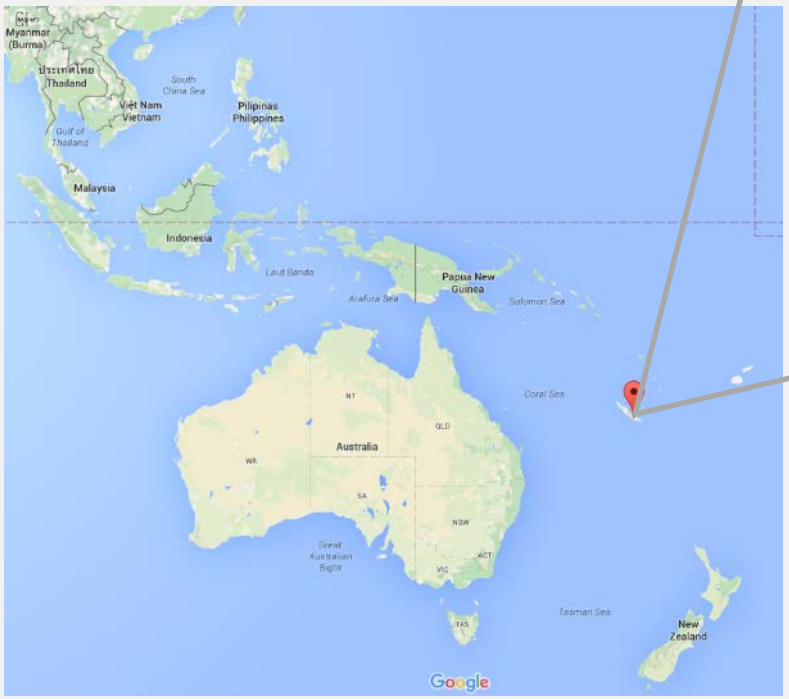
1. Deforestation and carbon release

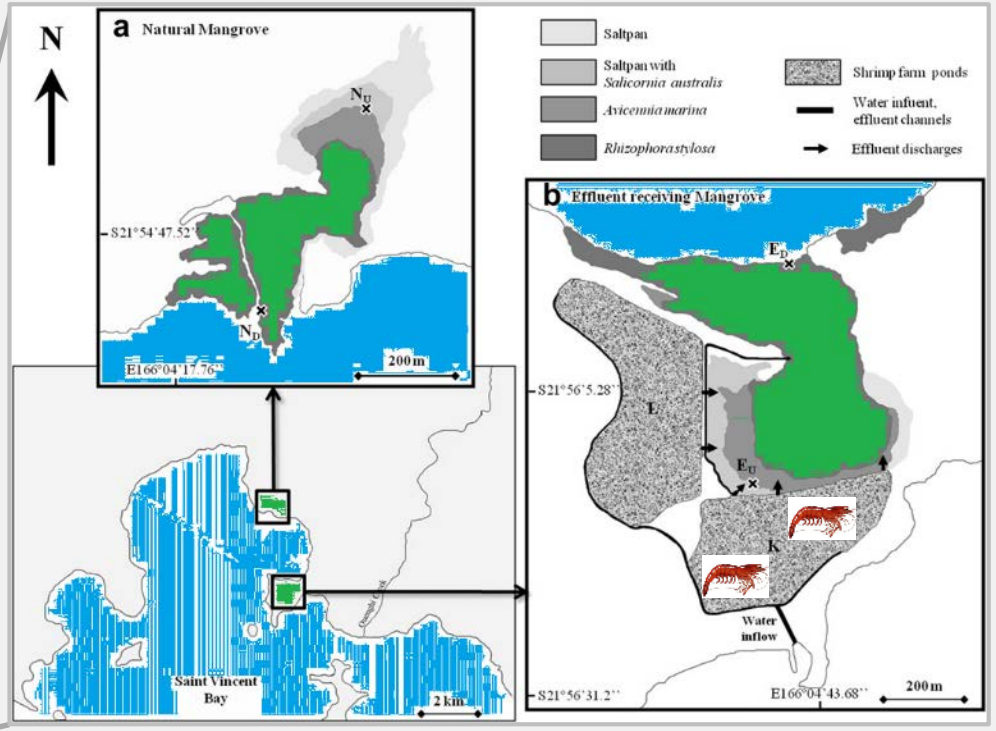
2. Eutrophication and change in community structure

3. Release of antibiotics and soil abilities change



- Saint Vincent Bay (southern New Caledonia)





Colored from Molnar *et al.* 2013

- Active period (Feb-Aug)
- Non active period (Sep-Jan)

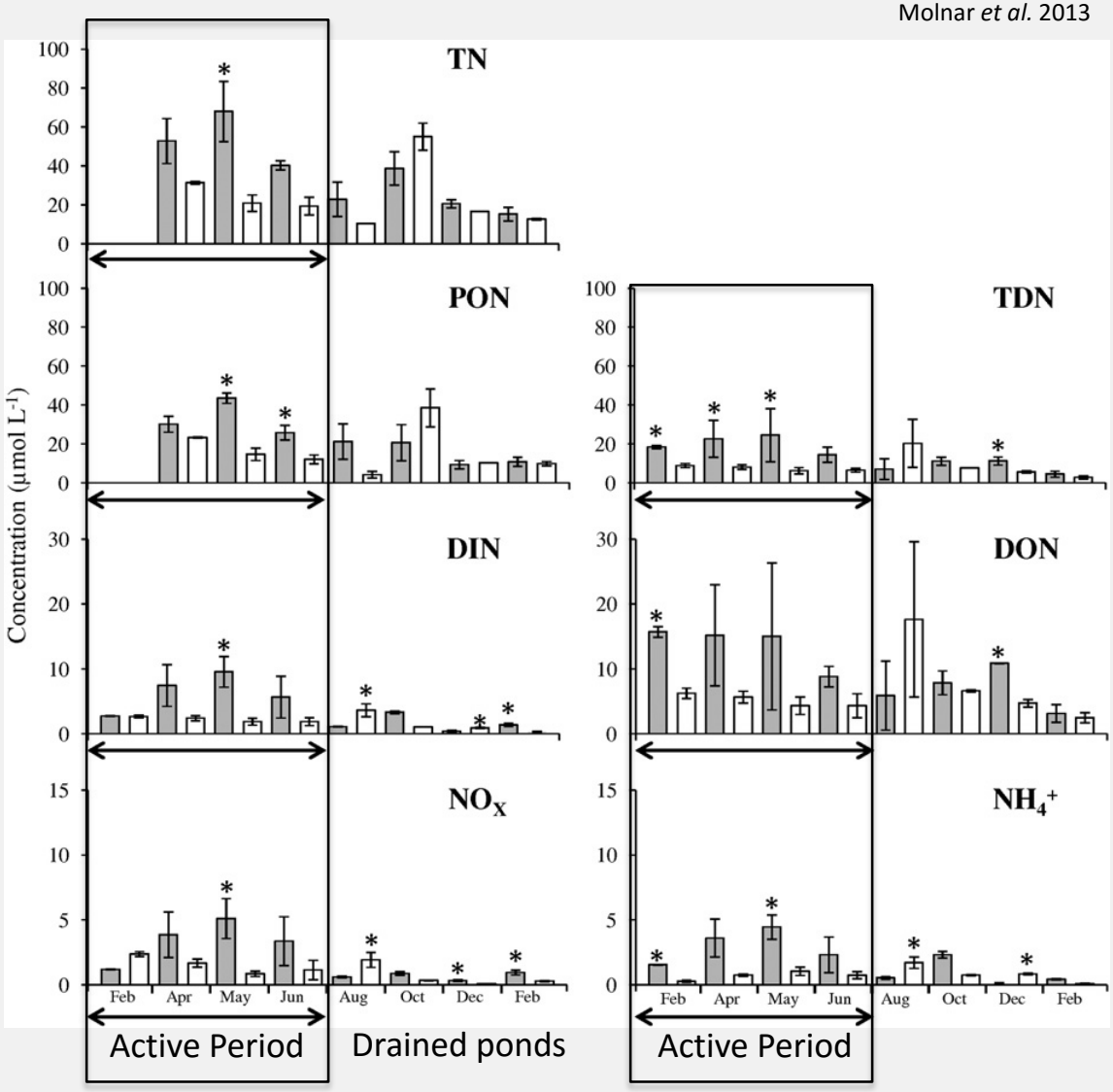
- Saint Vincent Bay (southern New Caledonia)

All forms of Nitrogen
Marine creek after mangrove

Impacted mangrove

Control mangrove

Molnar *et al.* 2013



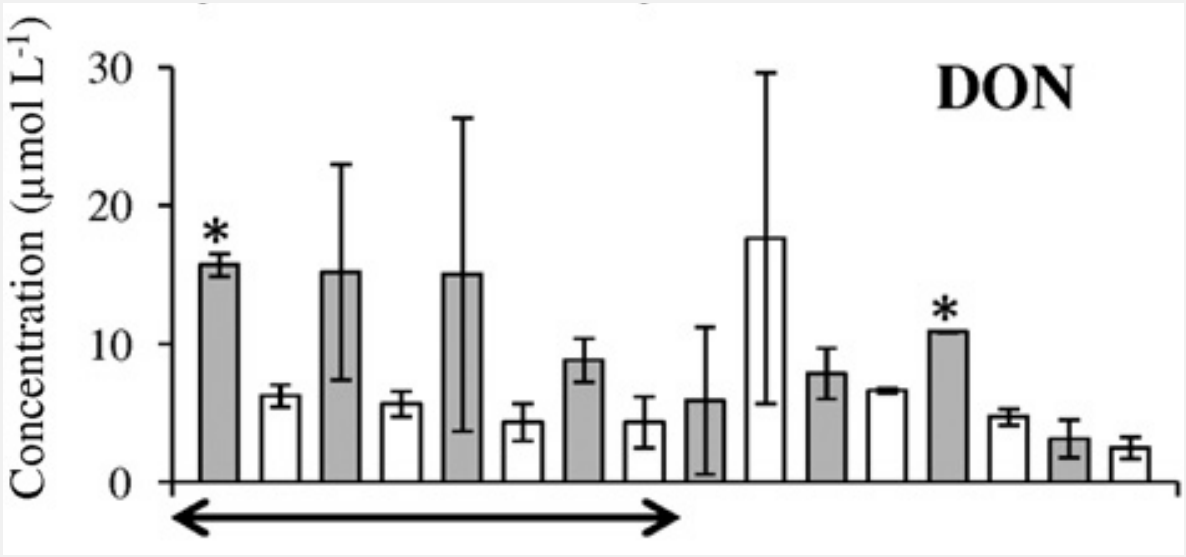
- Saint Vincent Bay (southern New Caledonia)

Dissolved Organic Nitrogen
Marine creek after mangrove

Impacted mangrove

Control mangrove

Molnar *et al.* 2013



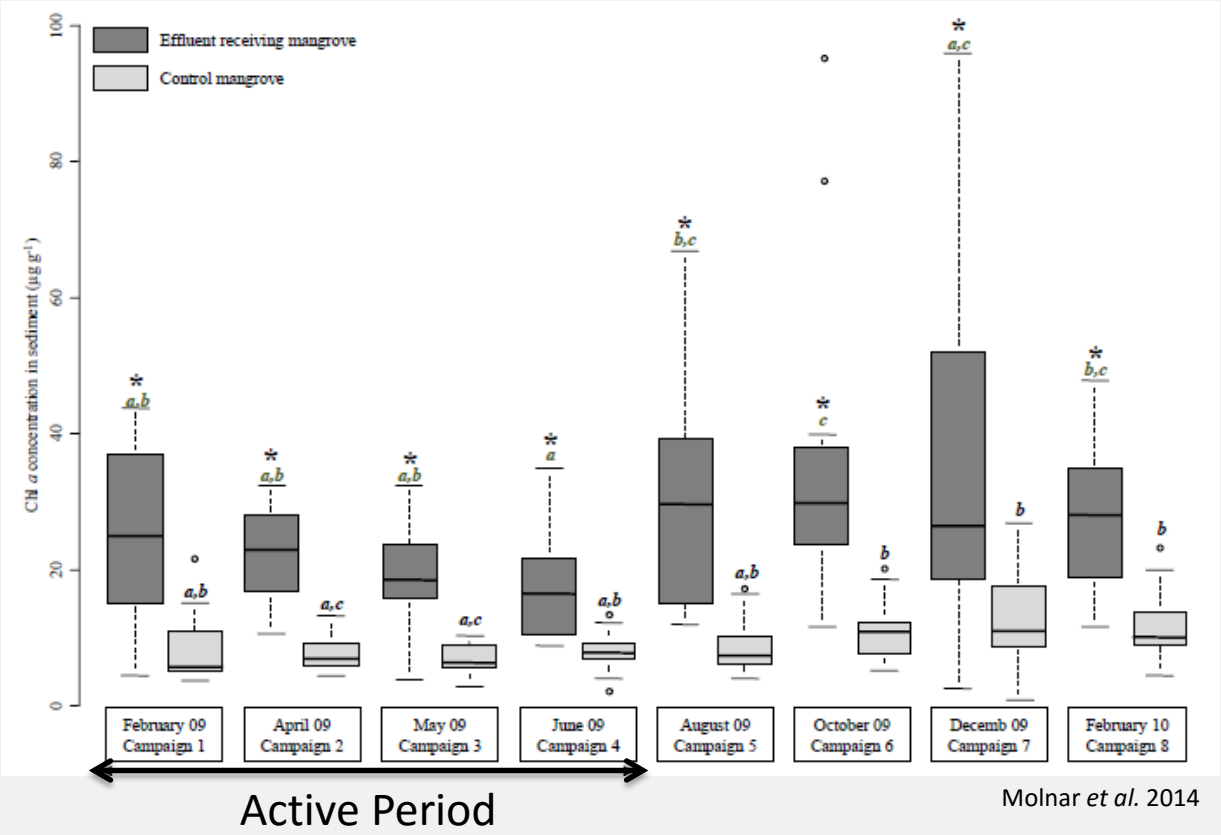
- Seasonal variations
- Higher concentrations in impacted mangrove

- Saint Vincent Bay (southern New Caledonia)

Chlorophyll *a*
Mangrove surface sediments

Impacted mangrove

Control mangrove



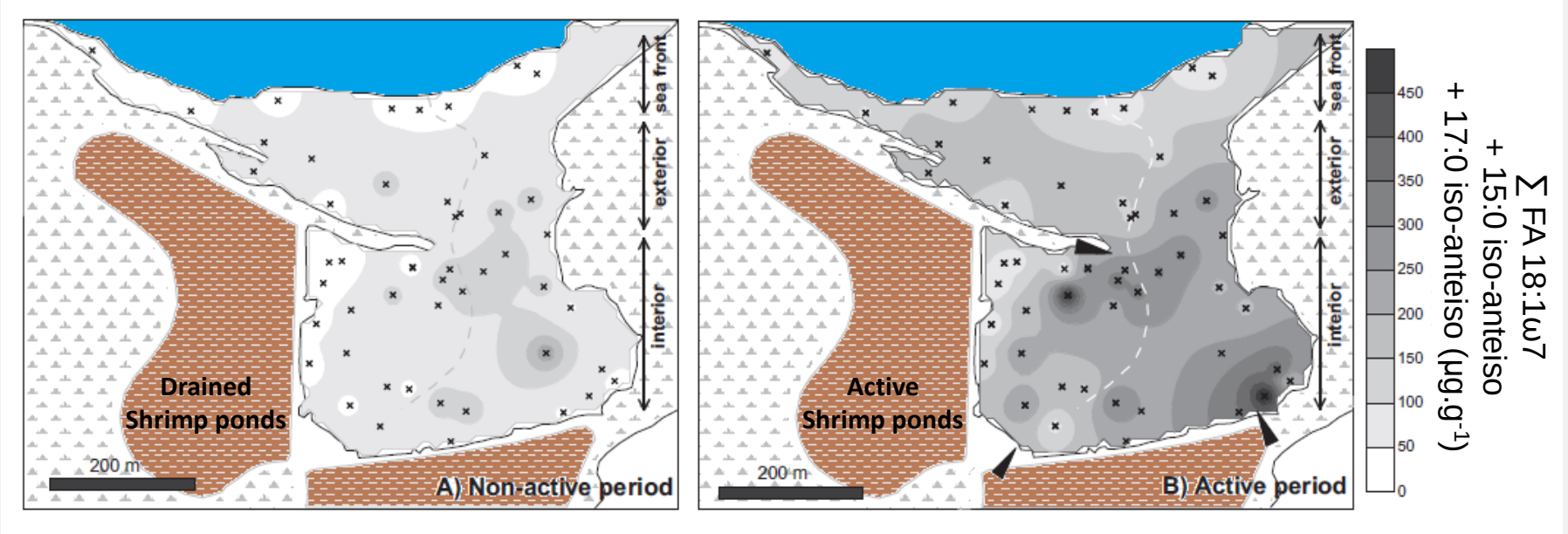
Molnar *et al.* 2014

- Chlorophyll *a* 3 to 12 times higher in impacted mangrove
- Difference maintained throughout seasons

- Saint Vincent Bay (southern New Caledonia)

Bacterial indicators fatty acids
Mangrove surface sediments

Colored from Aschenbroich *et al.* 2015



Non Active Period

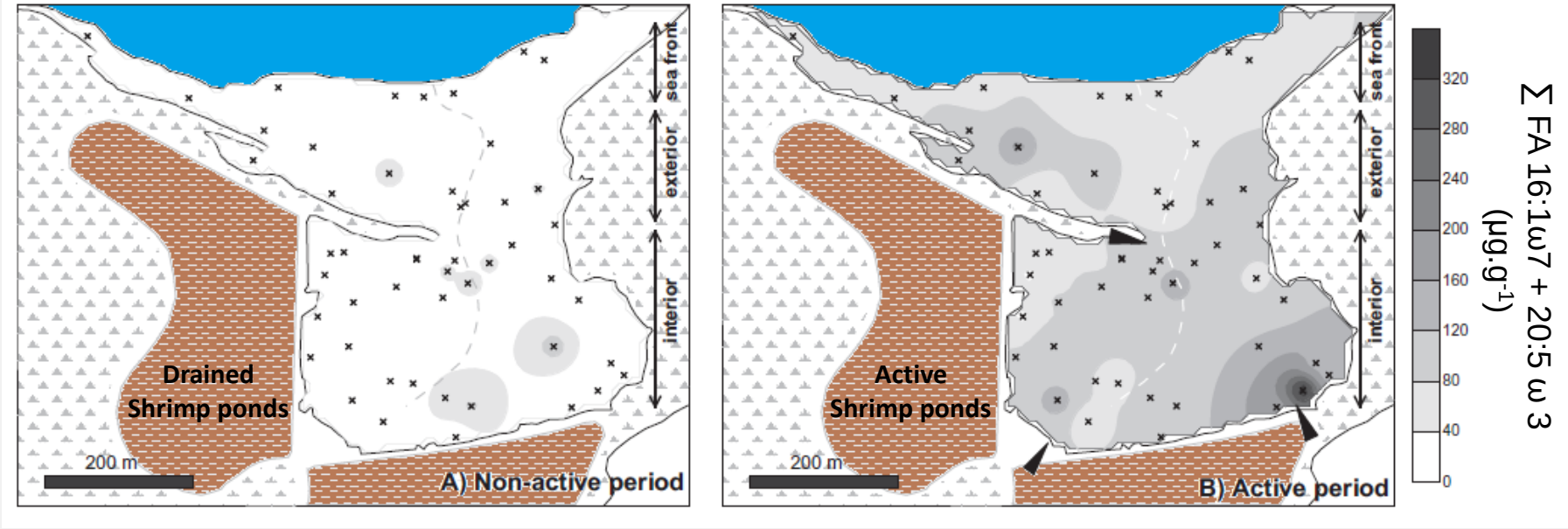
Active Period

- 18:1ω7 + 15:0 iso-anteiso + 17:0 iso-anteiso = **Bacterial indicators**
- Higher concentration during active period

- Saint Vincent Bay (southern New Caledonia)

Diatom indicators fatty acids
Mangrove surface sediments

Colored from Aschenbroich *et al.* 2015



Non Active Period

Active Period

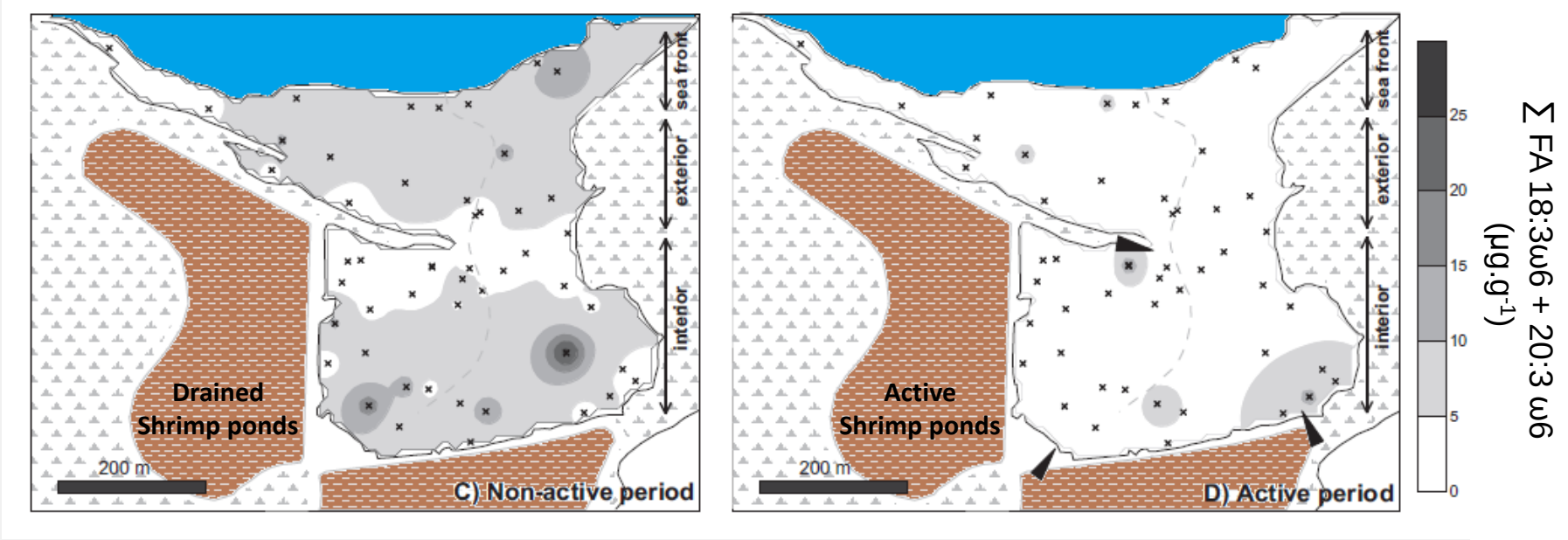
- 16:1ω7 + 20:5ω3 = **Diatom indicators**
- Higher concentration during active period

- Saint Vincent Bay (southern New Caledonia)

Micro-phytobenthos indicators fatty acids

Mangrove surface sediments

Colored from Aschenbroich *et al.* 2015



Non Active Period

Active Period

- 18:3ω6 + 20:3ω6 = **Micro-phytobenthic indicators**
- Lower concentration during active period

=> Change in phytobenthic communities

Shrimp farming affects soils processes of adjacent mangroves

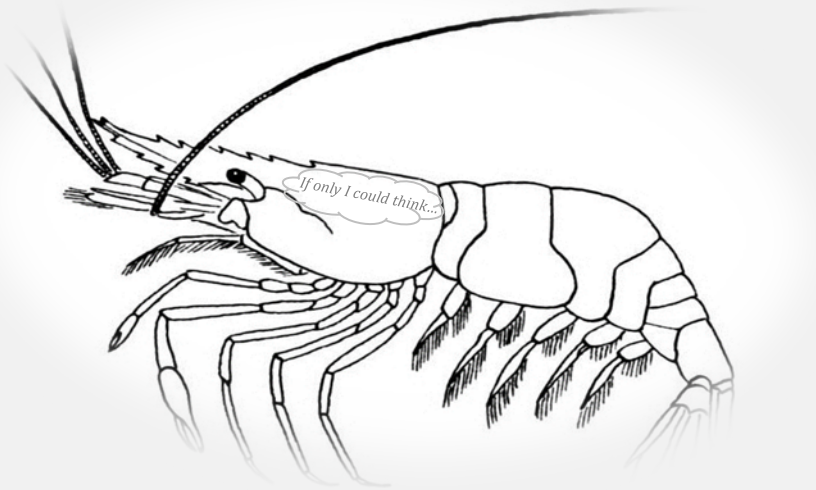
- Through high nutrient release
- By the release of organic compounds such as lipids

An overview of shrimp farming impacts along tropical coastlines:

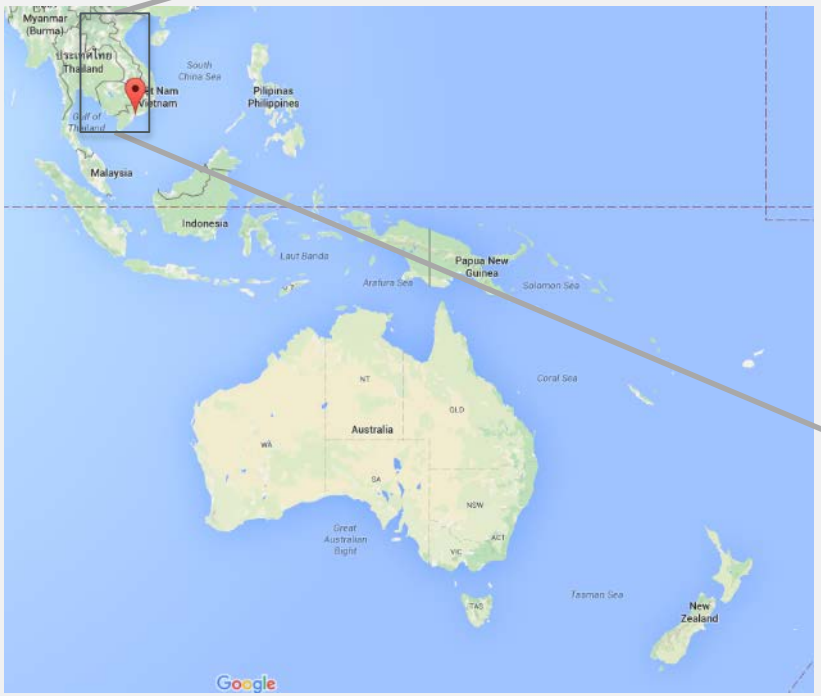
1. Deforestation and carbon release

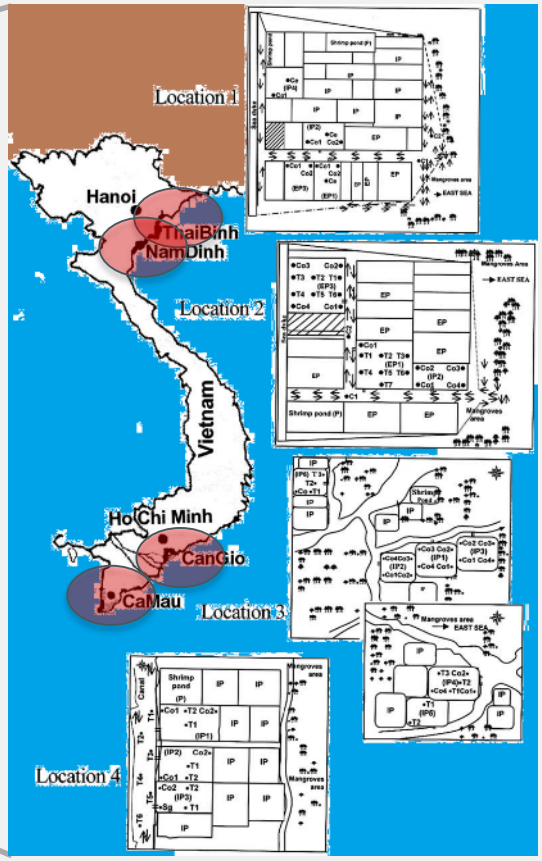
2. Eutrophication and change in community structure

3. Release of antibiotics and soil abilities change



- Vietnam (4 locations)





Colored from Le & Munekage 2004

- Concentration of 4 antibiotics

- Vietnam (4 locations)

Sampling strategy

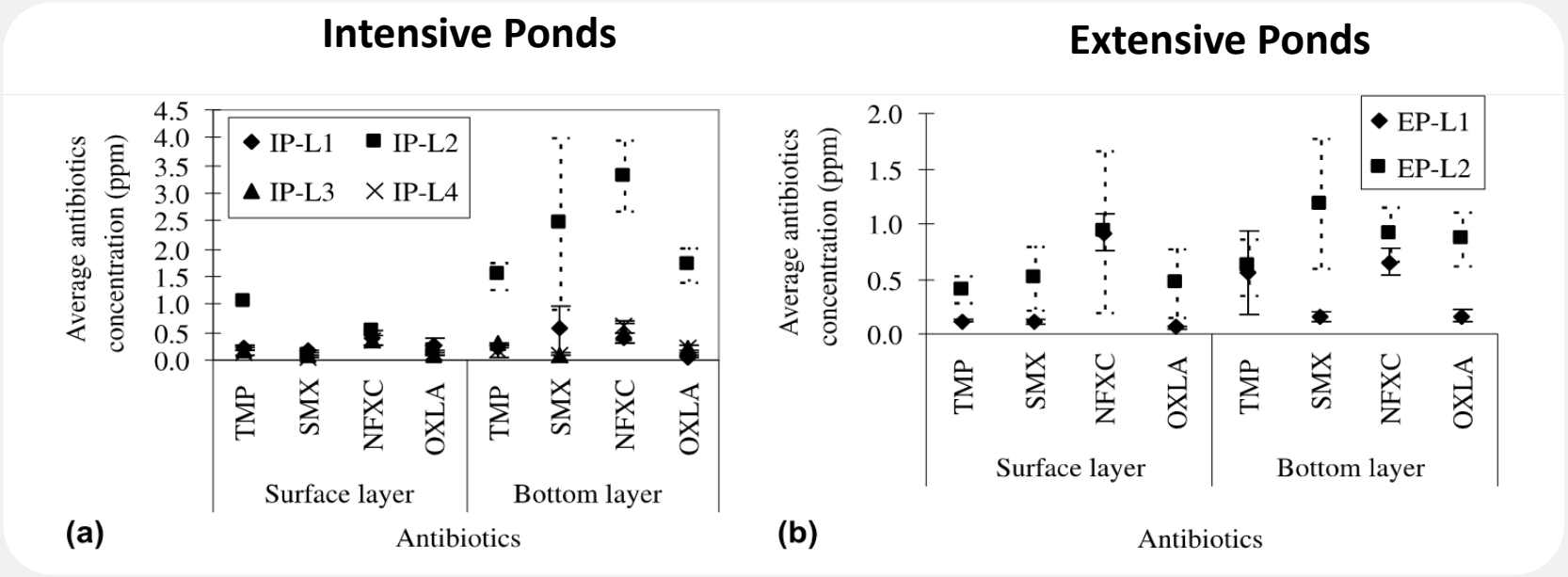
Intensive Ponds
(25-40 shrimp/m2)

Adjacent canals
(receiving effluents)

Extensive Ponds
(2-7 shrimp/m2)

- Vietnam (4 locations)

Water concentration

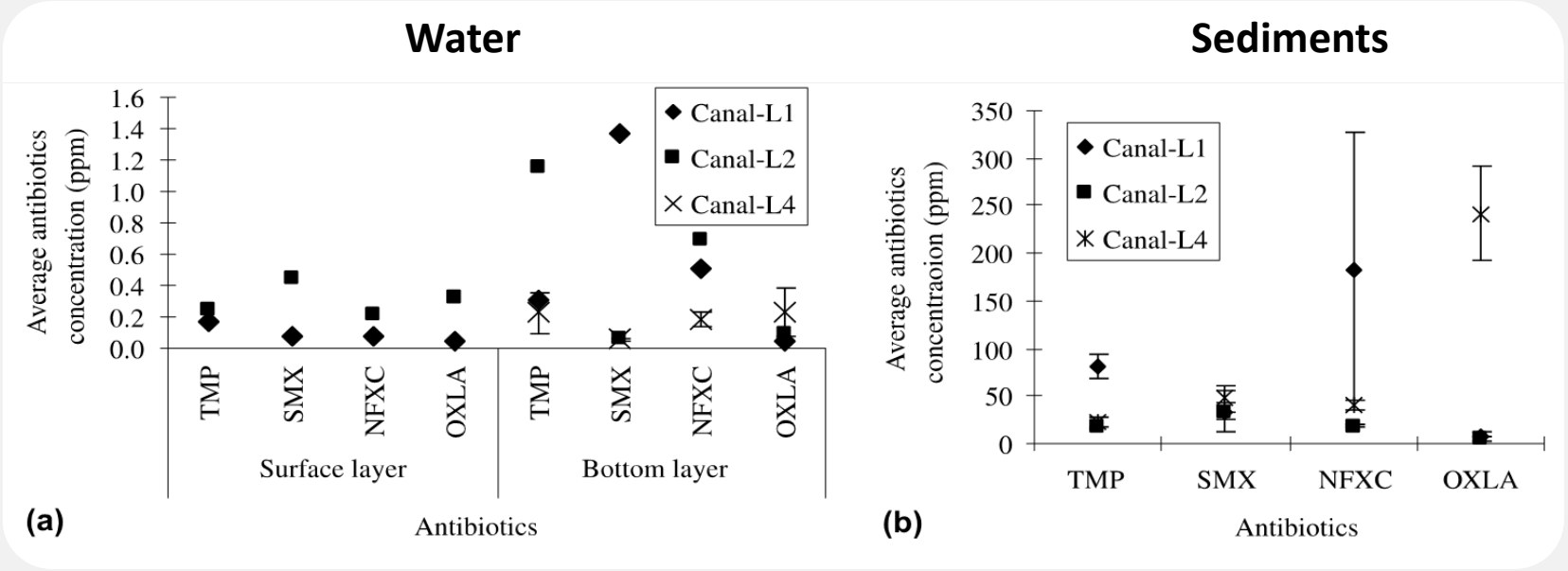


Le & Munekage 2004

NFXC norfloxacin
OXLA oxolinic acid
TMP trimethoprim
SMX sulfamethoxazole

- Vietnam (4 locations)

Adjacent canals concentration



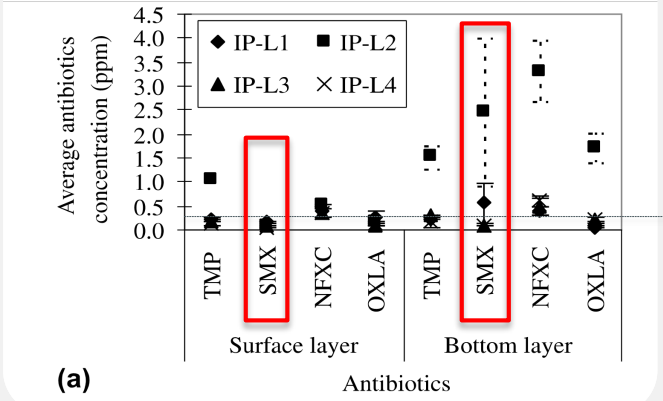
Le & Munekage 2004

NFXC norfloxacin
OXLA oxolinic acid
TMP trimethoprim
SMX sulfamethoxazole

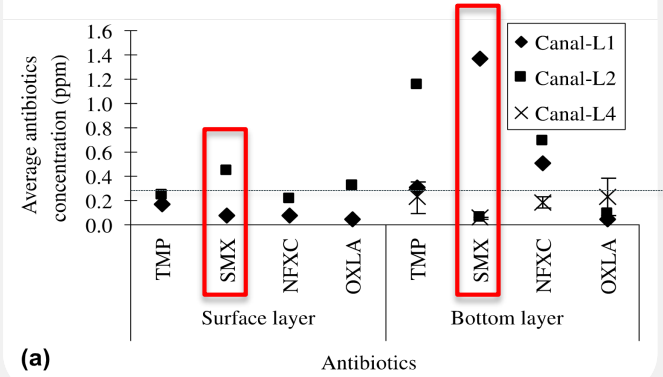
- Values highly variable
- Clear accumulation in sediments (100 X)

- Vietnam (4 locations)

Intensive Ponds



Adjacent Canals



Le & Munekage 2004

Experimental effect (**SMX** sulfamethoxazole)

Underwood *et al.* 2011 ; Al-Ahmad *et al.* 1999

- reduced growth rates and nitrate reduction rate
- *Pseudomonas putida* inhibited by 50% (IC50)

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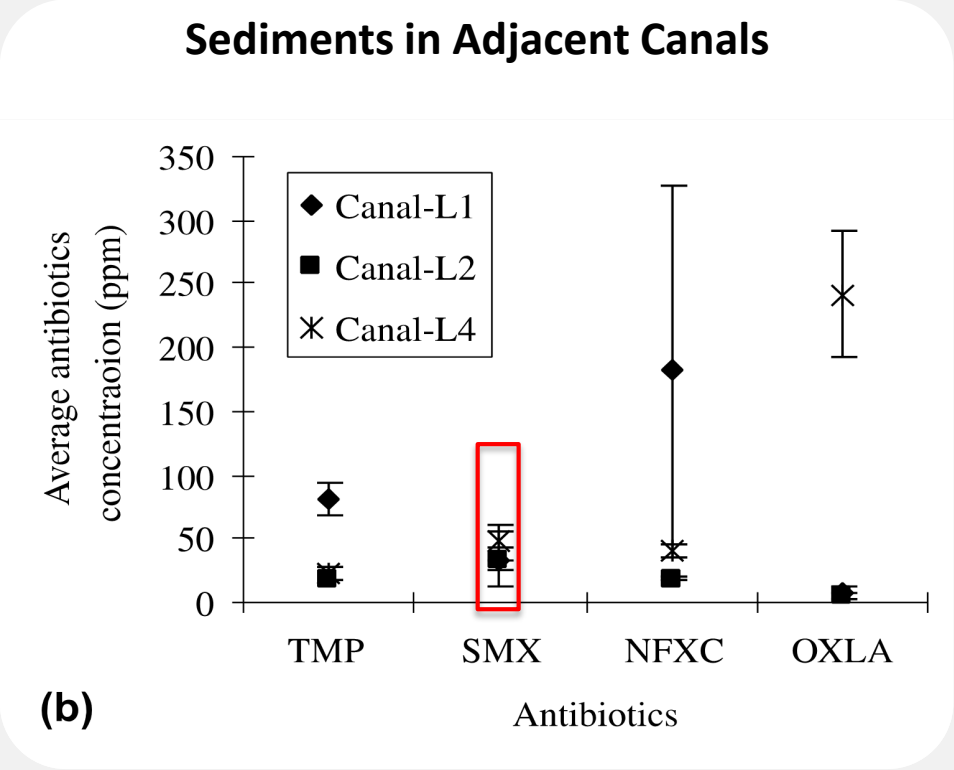
- *Pseudomonas putida* inhibited by 50% (IC50)

- Vietnam (4 locations)



Le & Munekage 2004

- Sediments 100 times more concentrated than waters
- Unknown effects on microbial communities

Shrimp farming may affect soils processes of adjacent mangroves

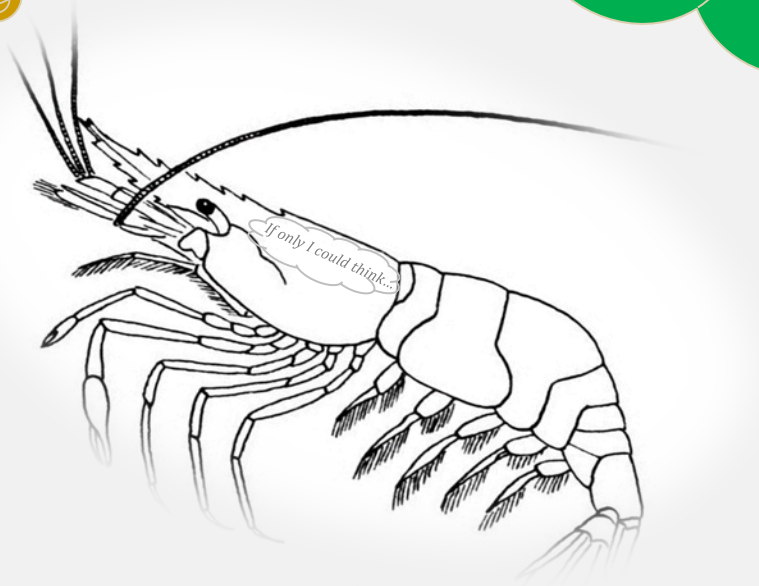
- By the release of antibiotics that accumulate in sediments

An overview of shrimp farming impacts along tropical coastlines:

Increasing production contributes to global warming

Nutrient release stimulates eutrophication

Antibiotics accumulation affect bacterial activity



Finally, what could be alternatives?

Today

- Produce on plastic liners to stop abandoning ponds

- Use decantation ponds and manage effluent release

- Reduce density and use antibiotics only when needed

Finally, what could be alternatives?

Tomorrow

- Promote closed recirculating systems

- Reutilize nutrients (Integrated Multi-Trophic Aquaculture)

- Select resisting strains or domesticate new species

References

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Thank you
for your attention