How is shrimp farming impacting mangrove ecosystems in the Indo-Pacific?

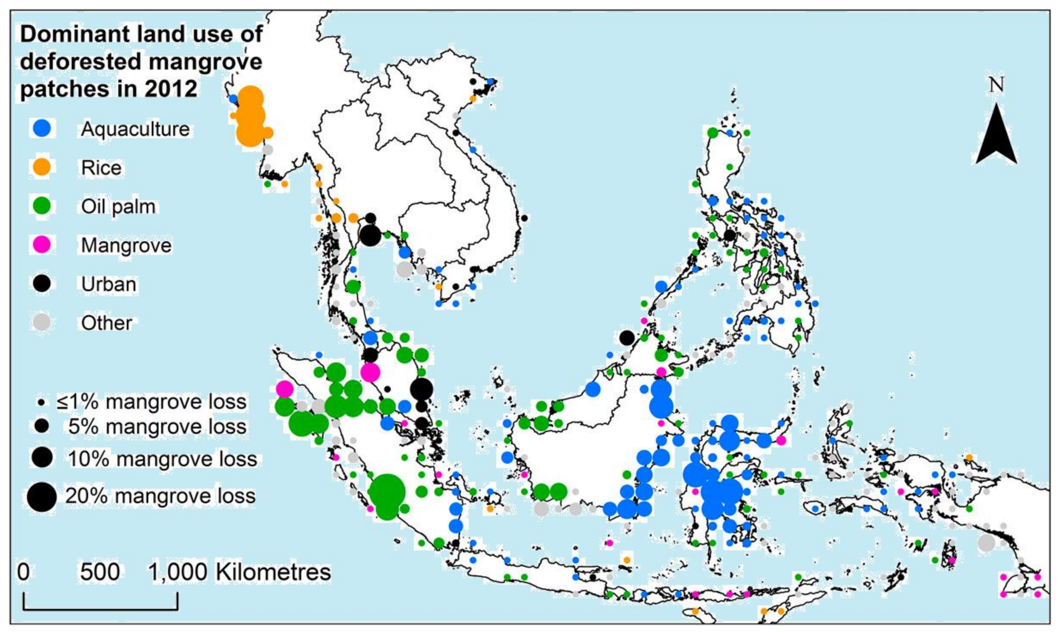
INTRODUCTION

The Indo-Pacific provides nearly **half of the world's shrimp production** and their production has been increasing by 42% a year since 1984 (FAO data).

This increase has contributed to one third of the **2% loss of Southeast Asian mangroves** between 2000 and 2012, with an average loss of 9 535 ha per year (Richard and Friess, 2016). It has resulted in massive releases of nutrients in the environment and a widespread use of antibiotics to avoid diseases and maintain productivity.

This selective review focuses on the impact of shrimp farming on Indo-Pacific coastlines.

1 Deforestation and loss of carbon stocks



In 2016, Richard & Friess studied mangrove deforestation in Southeast Asia between 2000 and 2012.

Land use and land cover change (LULCC) were quantified at a relatively fine resolution (deforested patches > 0.5 ha) using remote sensing method on satellite imagery.

Results and discussion

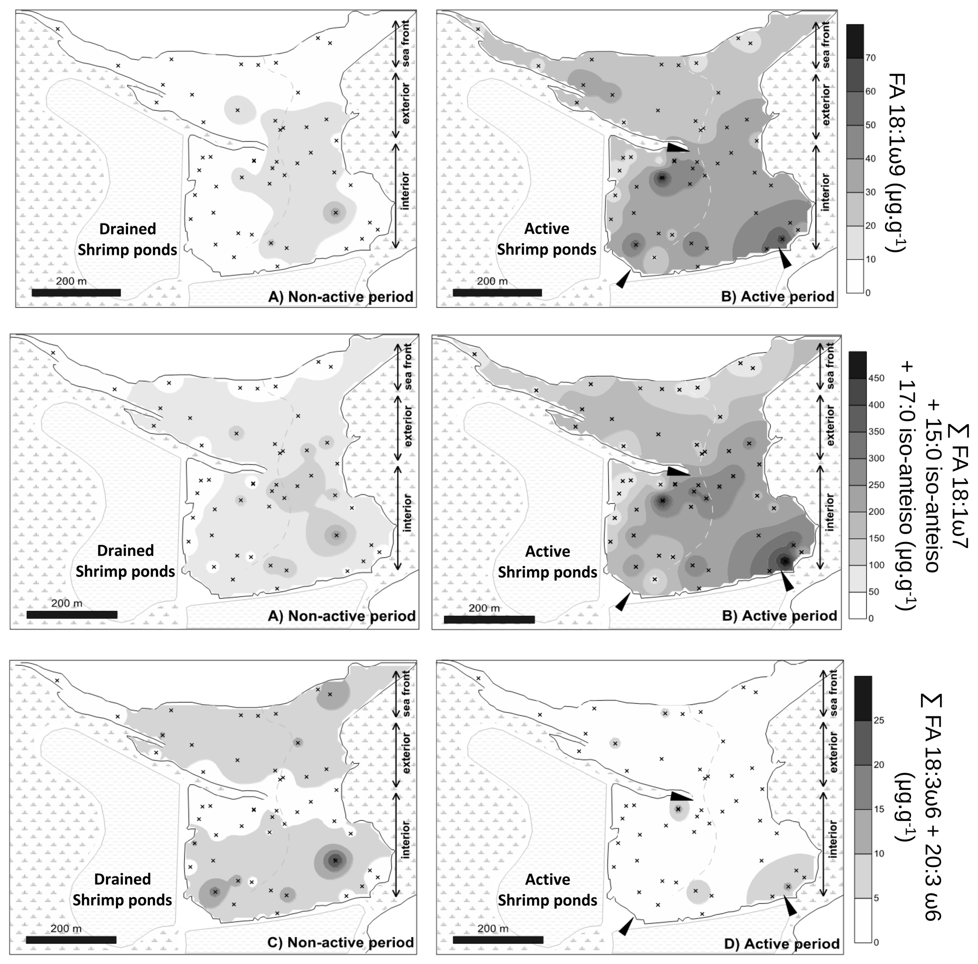
More than **100 000 ha** of mangroves have been lost in Southeast Asia since 2000. **Aquaculture has replaced 30%** of lost mangroves, mostly in Indonesia and the Philippines. This land conversion is similar to what happened during the 1980's and the 1990's in Thailand and Vietnam, the two countries that initiated intensive shrimp production in this area.

References: Richards, D.R., Friess, D.A., 2016. Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. Proceedings of the National Academy of Sciences 113, 344–349.

2 Eutrophication and change in community structure

In 2015, Aschenbroich *et al.* analyzed the fatty acid (FA) composition of sediments in a mangrove receiving shrimp farm effluents on the west coast of New Caledonia.

Fatty acids were quantified using gas chromatography (GC) and identified with mass spectrometry (GC-MS).



Concentration of selected fatty acids in surface sediments of mangrove receiving shrimp farm effluents
(arrows represent effluent inputs from ponds)

Results and discussion

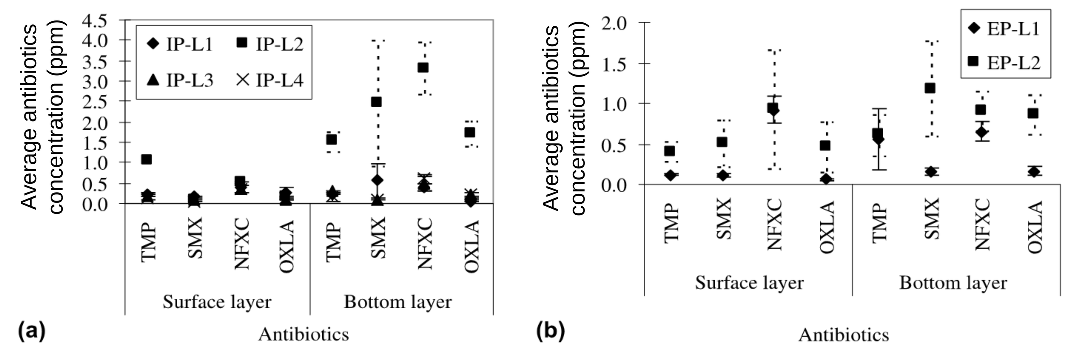
It is likely that FA 18:1ω9 originated from FA 18:2ω6, which is to be found in great quantities both in ponds and shrimp food pellets. **Higher microbial activity** during active period was supported by the higher abundance of bacterial biomarkers, such as 18:1ω7 and odd-chained branched FAs. Moreover, **changes in microphytobentic community composition** were observed through differences in abundance of FA 18:3ω6 and 20:3ω6, implying a possible shift in the ecosystem food chain balance.

References: Aschenbroich, A., Marchand, C., Molnar, N., Deborde, J., Hubas, C., Rybarczyk, H., Meziane, T., 2015. Spatio-temporal variations in the composition of organic matter in surface sediments of a mangrove receiving shrimp farm effluents (New Caledonia). Science of The Total Environment 512, 296–307.

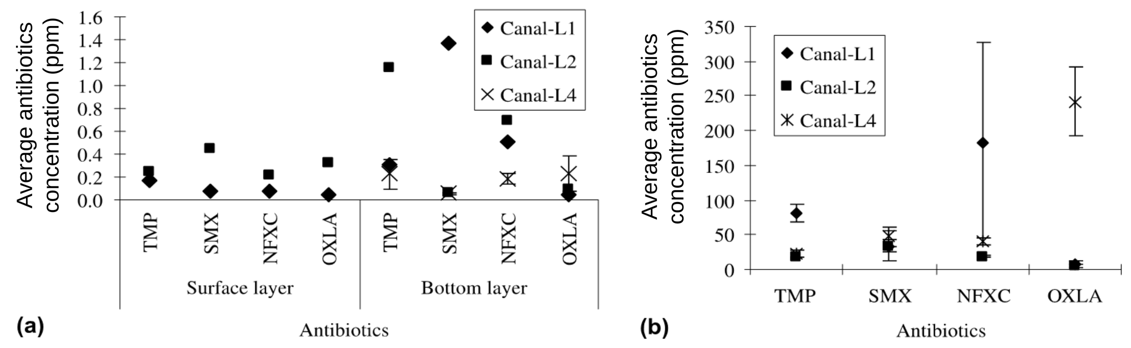
3 Release of antibiotics and change in soil properties

In 2004, Le & Munekage measured the concentration of four antibiotics in water and mud from shrimp ponds and adjacent ecosystems of Vietnam.

Antibiotics were quantified using high pressure liquid chromatography (HPLC).



Average concentration of antibiotics in water samples from:
(a) intensive ponds by location and
(b) improved extensive ponds by location



Average concentration of antibiotics in:
(a) water samples from surrounding canals by location and
(b) mud samples from surrounding canals by location

Results and discussion

High concentrations of antibiotics were detected in **both ponds and adjacent ecosystems**. In experimental conditions, exposure to 0.25 ppm of the antibiotic sulfametoxazole (SMX) in water reduced nitrate reduction rate potentials and inhibited by 50% the growth of bacteria *Pseudomonas putida,* involved in organic matter decomposition (Underwood *et al.* 2011; Al-Ahmad *et al.* 1999). This level of exposure was more than 100 times higher in sediments, leading to suspected **highly detrimental effects on bacterial communities** and their associated functions, such as denitrification or the degradation of organic compounds.

References: Le, T.X., Munekage, Y., 2004. Residues of selected antibiotics in water and mud from shrimp ponds in mangrove areas in Viet Nam. Marine Pollution Bulletin 49, 922–929.

Al-Ahmad, A., Daschner, F.D., Kümmerer, K., 1999. Biodegradability of cefotiam, ciprofloxacin, meropenem, penicillin G, and sulfamethoxazole and inhibition of waste water bacteria. Archives of environmental contamination and toxicology 37, 158–163.

Underwood, J.C., Harvey, R.W., Metge, D.W., Repert, D.A., Baumgartner, L.K., Smith, R.L., Roane, T.M., Barber, L.B., 2011. Effects of the Antimicrobial Sulfamethoxazole on Groundwater Bacterial Enrichment. Environmental Science & Technology 45, 3096–3101.

CONCLUSION

Mangroves have been **greatly affected** by the increase of shrimp farming over the last 30 years.

Their destruction led to a decrease in coastal protection, food resources for local communities and carbon storage. However, new approaches were initiated to both **maintain productivity and preserve coastal ecosystems**, such as closed recirculating systems or integrated multi-trophic aquaculture systems.

A change in practices could allow the preservation of healthy coastal ecosystems to become **a very real possibility**.

Thus, who is ready to get involved?

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