Emerging Pressure on Mangrove Forest Environments as a Result of Shrimp Farming Expansion – A Remote Sensing based Analyses for an Exemplary Coastal Site at the Pacific Coast in South America

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Background: Aquaculture

- Aquaculture is a major protein source and important for food security
- Latin America and Southeast Asia are the largest producers of farmed shrimp in the world (FAO)
Aquaculture Expansion & Mangrove Loss

- Aquaculture development is transforming coastal ecosystems and leads to environmental degradation and conversion of wetlands to shrimp farming
- Mangrove deforestation in the course of coastward aquaculture expansion

Pond Aquaculture in Earth Observation Data

Images of different aquaculture production systems (cages, raceways, ponds). Image source: Google Earth. Modified according to Ottinger et al. (2016).
Potential of Spaceborne Earth Observation

SAR sensors
a - Envisat ASAR  
b - Sentinel-1  
c - TerraSAR-X

Optical sensors

d - Landsat  
e - Sentinel-2  
f - Quickbird-02

Potential of SAR Data

SAR backscatter characteristics of pond systems (water: diffuse reflection; dams: corner reflection)

Cloud independence \(\rightarrow\) improved monitoring capabilities in cloud-prone coastal areas (tropical regions)

Dense time series (e.g. Sentinel-1 mission)

Derivation of SAR temporal signatures

Source: Ottinger (2018)
Automatic Shrimp Pond Extraction with SAR Time Series

- Aquaculture processor for automatic extraction of aquaculture ponds in coastal regions with C-Band and L-Band SAR time series data

- Histogram-based water thresholding and image segmentation based on shape features to map rectangular shrimp ponds
Aquaculture ponds in coastal mangrove environment
Location: Gulf of Guayaquil, Ecuador
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Emerging pressure on mangrove forest environments as a result of shrimp farming expansion. 

Location: Gulf of Guayaquil, Ecuador

Deforestation
Emerging pressure on mangrove forest environments as a result of shrimp farming expansion.

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Aquaculture ponds in coastal mangrove environment.

Deforestation.

Mapped aquaculture ponds.

© Google Sentinel - 1A, IW - GRDH VV, 10m Pxl spacing, Year 2015.
Outlook

Mangrove forest mapping and monitoring with L-band SAR

• Sensitivity of SAR signals to vegetation structure; scattering mechanism in mangrove forest strongly depends on canopy structure
• Better canopy penetration capabilities with long wavelength SAR → detection of flooded vegetation and wetlands (mangroves)

Impact analysis

• Loss of resources (mangrove area)
• fragile surrounding areas (e.g. freshwater resources)
• Rate and amount of land use changes

References


