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30 Years National Scale Seagrass Mapping in Vietnam with Landsat and Sentinel Imagery on Google Earth Engine

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Abstract: Seagrass beds, one of the blue carbon ecosystems, are crucial for mitigating climate change. However, their distribution is decreasing at an alarming rate. To provide a baseline for seagrass area change, this paper aims to monitor changes in seagrass distribution in the entire Vietnam over 30 years with Landsat and Sentinel-2 multispectral images. Vietnam was chosen as the study site because the country exemplifies a diversity of coastal environment. Due to the rapidly changing nature of tropical coastal waters, the surface reflectance over water pixels changes constantly. By carefully selecting images and masking out turbid water pixels, we estimate the changes in seagrass with a Random Forest classifier. All documented seagrass beds in Vietnam were analyzed in this framework. In total, Vietnam lost about 50% of seagrass beds between 1989 and 2019. Some major seagrass beds in Vietnam, such as in Cam Ranh Bay, Van Phong Bay, and Tam Giang Lagoon, as much as 60-80% of seagrass beds were lost. Most lost was due to the direct impacts of land use conversion for aquaculture use. Some seagrass beds appear unchanged, however, the degraded water quality suggests that the productivity of these seagrass beds may have decreased. These trends are common in places where pressure on coastal development are high. This research is the first to give a spatially explicit estimate for the inventory of seagrass in Vietnam with a consistent method nationwide. Hence, it contributes to the understanding of seagrass distribution in the Tropical Indo-pacific region and provides the foundation for the conservation of these valuable ecosystems.





Flowers of Enhalus acoroides on a sandy III. Results

Introduction

- Known:
 - Seagrass beds are crucial for their ecosystem services in preventing erosion, provision for fishery, water quality improvement and carbon sequestration. (Duarte et al., 2008)
 - Coastal development by human and water quality degradation are the main causes of seagrass loss. (Waycott et al., 2009)
 - Remote sensing-based seagrass monitoring is cost-effective, appropriate for large-scale monitoring. (Hossain, 2015; Hossain, 2019, Phinn et al., 2018)
 - Seagrass in Vietnam has been decreasing due to coastal development (Cao, 2012)
- Unknown:
 - There is no spatially explicit maps of seagrass distribution changes for Vietnam with a consistent methodology applied in every region over 30 years.







Changes in seagrass areas (ha) in major sites in Vietnam, between 1985-2019.

1985-1990 1990-1995 1995-2000 2000-2005 2005-2010 2010-2015 2015-2019 Time

Figure 2: Changes in seagrass areas (ha) in major sites in Vietnam, between 1985-1990

- About 15,000 Landsat & Sentinel-2 images were analyzed.
- Accuracy assessment of selected sites were at 95%, however our area estimates are about 3-5 times higher than field survey results from the national reports. Fluctuations in identified areas hint at large uncertainties.
- Overall, there are rapid lost in seagrass areas, most seagrass lost are in areas with aquaculture developments. Rapid loss in late 1990s, coincide with National Decree 773-TTg (approved on December 21, 1994) that encouraged reclamation of coastal lands for shrimp farming.

Discussion - Significance

- This is the first spatially comprehensive and temporally continuous estimate of seagrass distribution at a national level for a 30 year period. Additionally, some relative minor seagrass beds were discovered.
- As field surveys are expensive, and are rarely done in developing countries, this result highlights the importance of remote sensing techniques for seagrass ecosystem conservation.
- This result provides the foundation for the modelling of the future distribution of seagrass.
- This result can be used to estimate the biomass and carbon sequestration value of seagrass ecosystems. This adds to the carbon stock inventory of each country and provides economic basis for conservation.
- Observing the changes in seagrass ecosystem is also an indicator of environmental quality. This is crucial for risk assessment in fisheries.
- There are similarities between seagrass loss and mangrove loss in Vietnam, this could be due to changes in coastal land use policies.

Conclusion:

- Even though there can be improvements in accuracy, this result means:
- We could monitor the seagrass distribution in the most recent 30 years who most of Vietnam. This would provide a cost-effective method to assist in the monitoring of seagrass.
- Areas with extensive human activities lost 50-80% of their seagrass in between 1985-2019. Most relevant drivers to changes are land reclamation and aquaculture. Most seagrass was lost during the late 1990s, due to aggressive land use policy and has been better controlled recently.
- This paper highlighted the need to update the global estimate of Blue carbon stocks.

Next step:

- Estimate the ecosystem values for these seagrass beds by incorporating biomass estimates, density, species.
- Further validation and share these results as a database.
- Analyze factors that influence distribution (impacts of land reclamation, aquaculture)

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