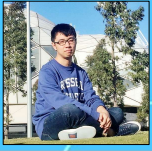# Assessing Present and Future Benthic Primary Productivity in a Large Intertidal Estuary Using Remote Sensing and Machine Learning
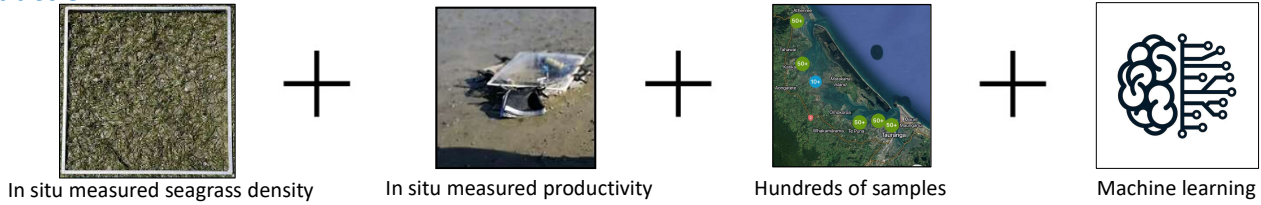
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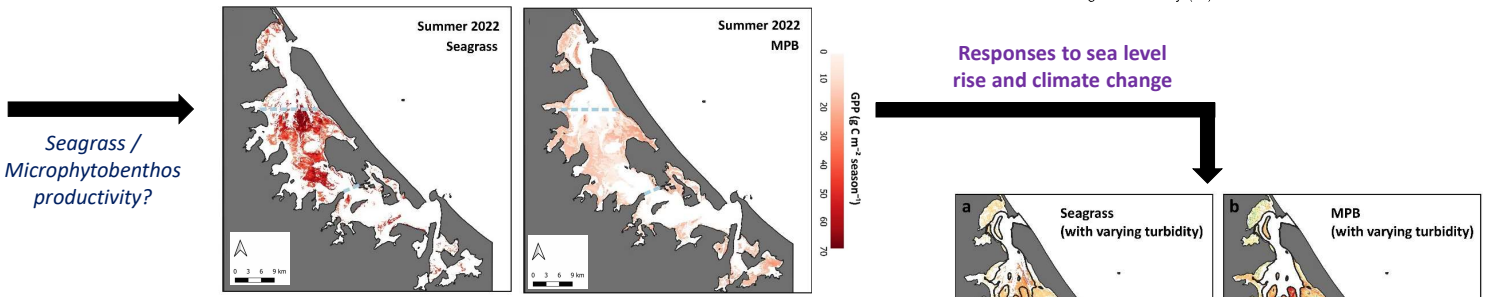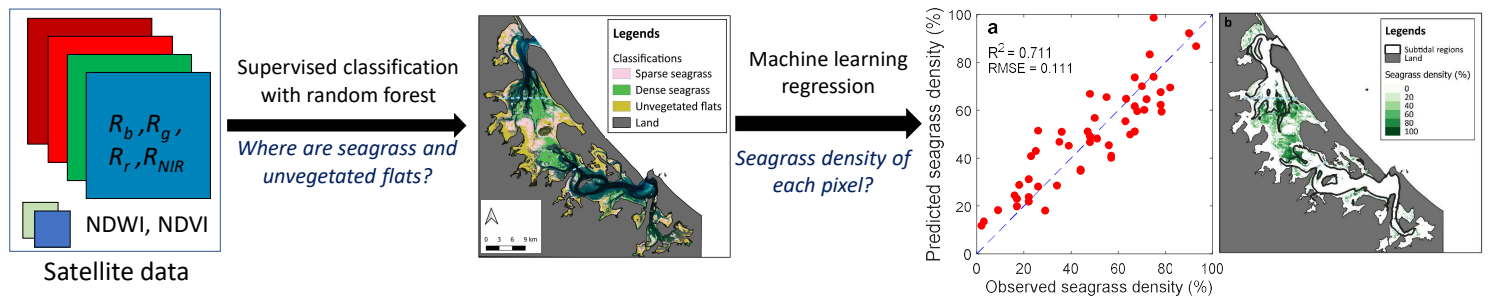ZhanchaoShao   zs94@students.waikato.ac.nz

Introduction

In situ measured seagrass density + In situ measured productivity + Hundreds of samples + Machine learning
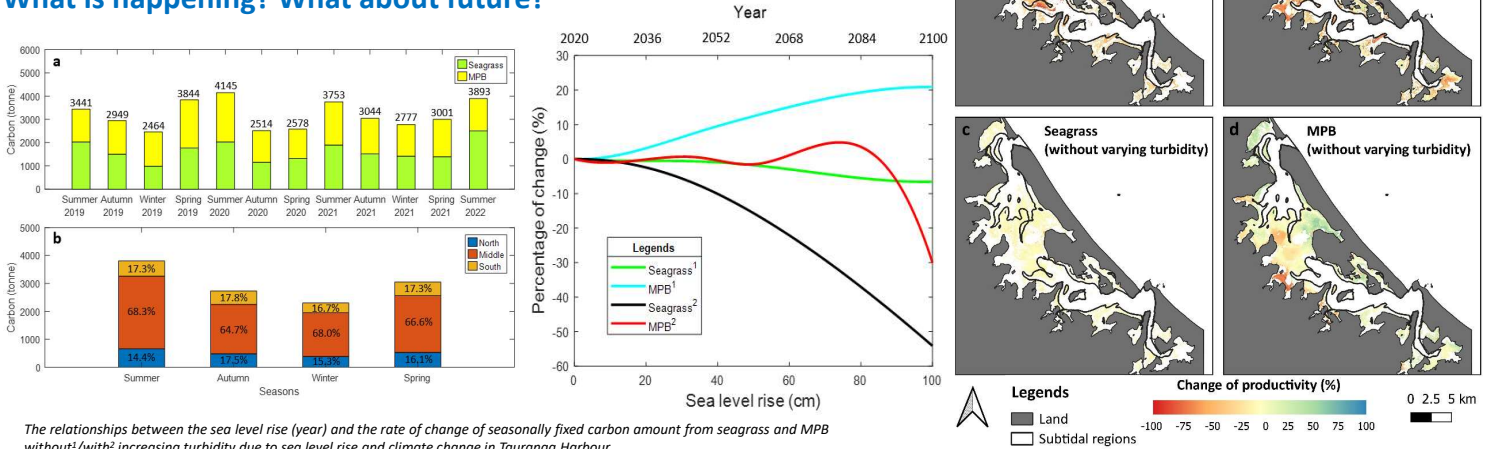
Aims

- To upscale limited sampling information to a spatial distribution map of productivity;
- To predict the response of productivity with the effect of sea level rise and climate change.

Methods and Results

Satellite data: R_b, R_g, R_r, R_{NIR}; NDWI, NDVI

Supervised classification with random forest — *Where are seagrass and unvegetated flats?*

Legends — Classifications: Sparse seagrass, Dense seagrass, Unvegetated flats, Land

Machine learning regression — *Seagrass density of each pixel?*

a. $R^2 = 0.711$, RMSE = 0.111. Predicted seagrass density (%) vs Observed seagrass density (%)

b. Legends — Subtidal regions, Land, Seagrass density (%): 0, 20, 40, 60, 80, 100

Seagrass / Microphytobenthos productivity?

Summer 2022 Seagrass

Summer 2022 MPB — GPP (g C m^{-2} season^{-1}): 0, 10, 20, 30, 40, 50, 60, 70

Responses to sea level rise and climate change

a. Seagrass (with varying turbidity)
b. MPB (with varying turbidity)
c. Seagrass (without varying turbidity)
d. MPB (without varying turbidity)

Legends — Land, Subtidal regions. Change of productivity (%): -100, -75, -50, -25, 0, 25, 50, 75, 100

What is happening? What about future?

a. Carbon (tonne) by season: Summer 2019: 3441, Autumn 2019: 2949, Winter 2019: 2464, Spring 2019: 3844, Summer 2020: 4145, Autumn 2020: 2514, Spring 2020: 2578, Summer 2021: 3753, Autumn 2021: 3044, Winter 2021: 2777, Spring 2021: 3001, Summer 2022: 3893. Legends: Seagrass, MPB

b. Carbon (tonne) by region/season: Summer — North 14.4%, Middle 68.3%, South 17.3%; Autumn — North 17.5%, Middle 64.7%, South 17.8%; Winter — North 15.3%, Middle 68.0%, South 16.7%; Spring — North 16.1%, Middle 66.6%, South 17.3%. Legends: North, Middle, South

Percentage of change vs Sea level rise (cm) / Year (2020–2100). Legends: Seagrass[1], MPB[1], Seagrass[2], MPB[2]

The relationships between the sea level rise (year) and the rate of change of seasonally fixed carbon amount from seagrass and MPB without[1]/with[2] increasing turbidity due to sea level rise and climate change in Tauranga Harbour.

- Currently, seagrass and MPB contribute evenly to the total GPP in the harbour;
- The dominant contributor of the total GPP depends on location and season;
- MPB is less threatened than seagrass when sea level rises significantly;
- Maintaining the current turbidity is the optimum measure to prevent the loss of GPP.

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