OCEAN CARBON FROM SPACE WORKSHOP 2022

Mapping and Monitoring 'Blue Carbon' Ecosystems at Scale with Copernicus Sentinel-2 Imagery

A use case from Sweden

Silvia Huber, PhD

DHI, Denmark

Acknowledgements:

Länsstyrelsen Västerbotten

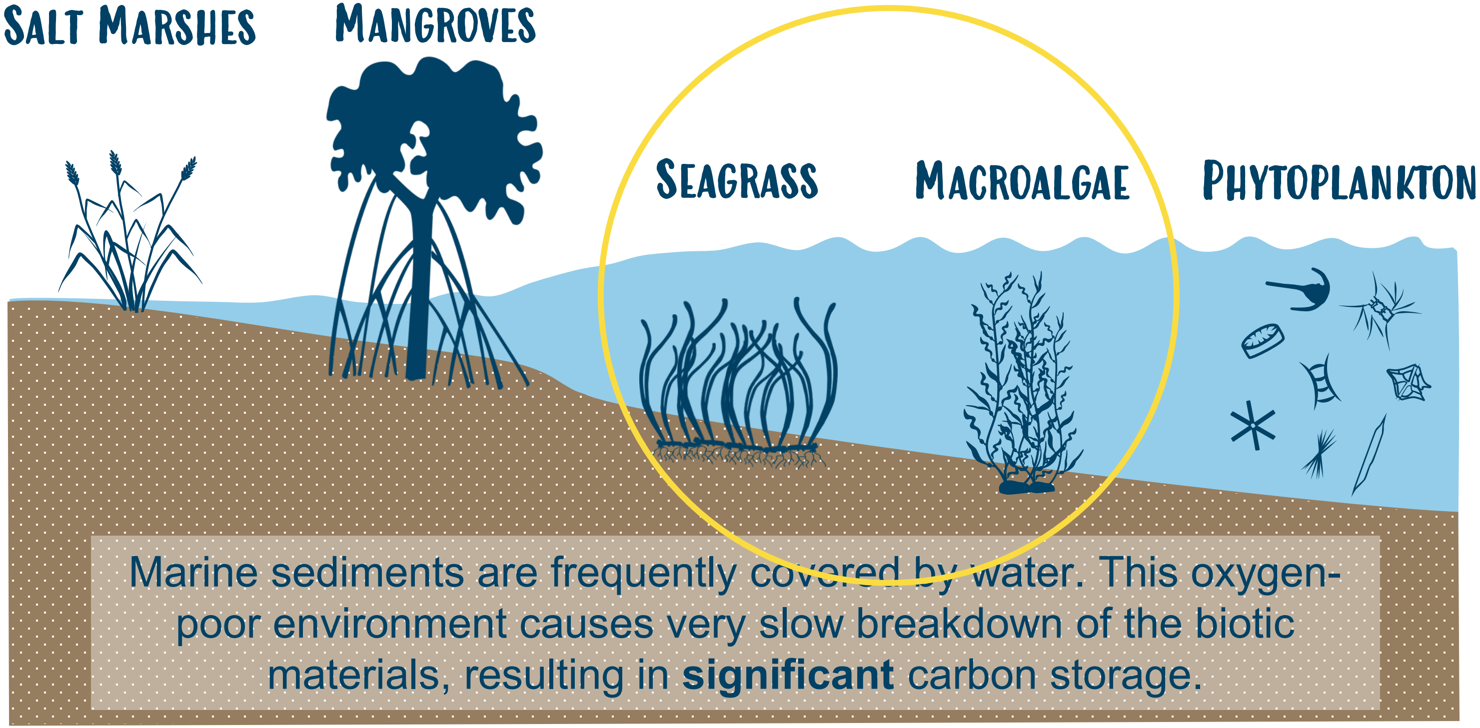
Länsstyrelsen Kalmar län

UNIVERSITY OF GOTHENBURG

Swedish Agency Marine and Water Management

DHI GRAS

Blue Carbon is carbon that is removed from the atmosphere by ocean systems



In biotic elements…

… and in sediments

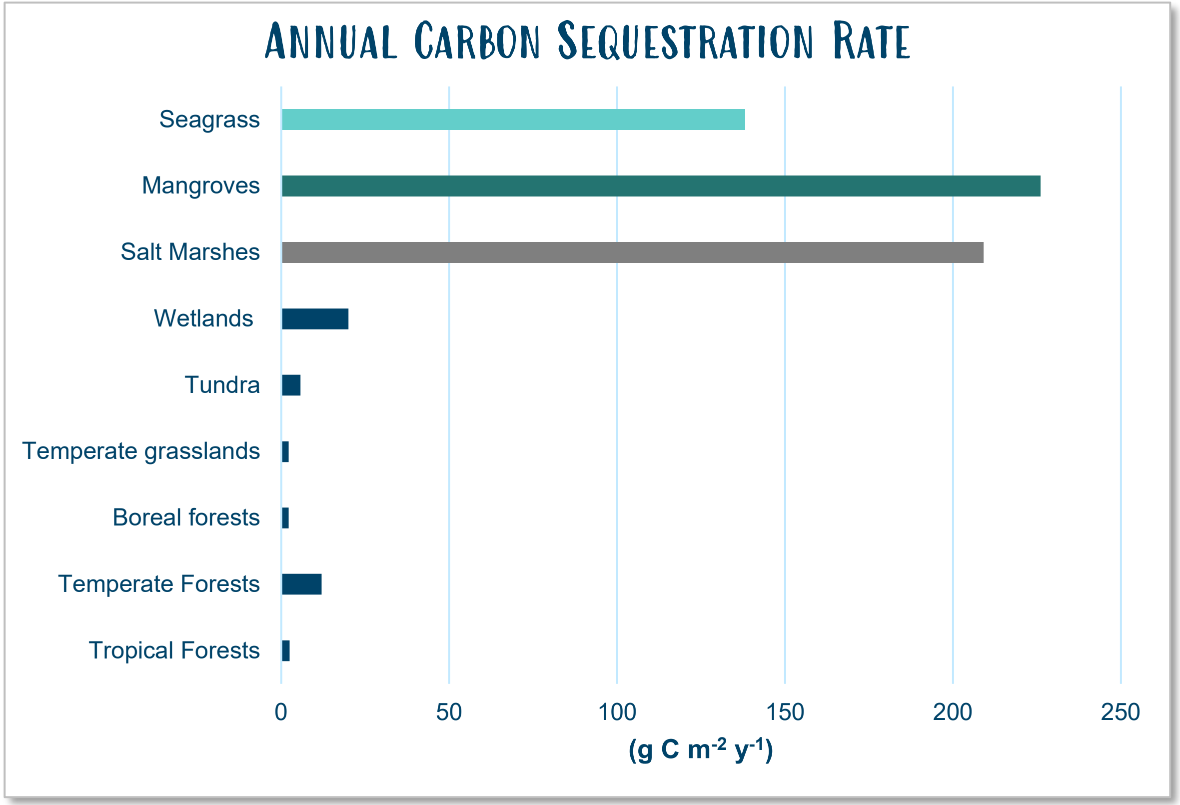
DHI GRAS

Why is submerged vegetation so important?

Atm. corrected Sentinel-2 image from 6 June 2019 showing Skanör south of Malmö (Sweden). The image reveals the fine structures of submerged aquatic vegetation as seen in 10 m satellite data.

- Seagrass and seaweeds are among the most efficient natural carbon storage environments
- Seagrass is one of the key indicators of ecological status of coastal ecosystems

Comparison of carbon sequestration rates

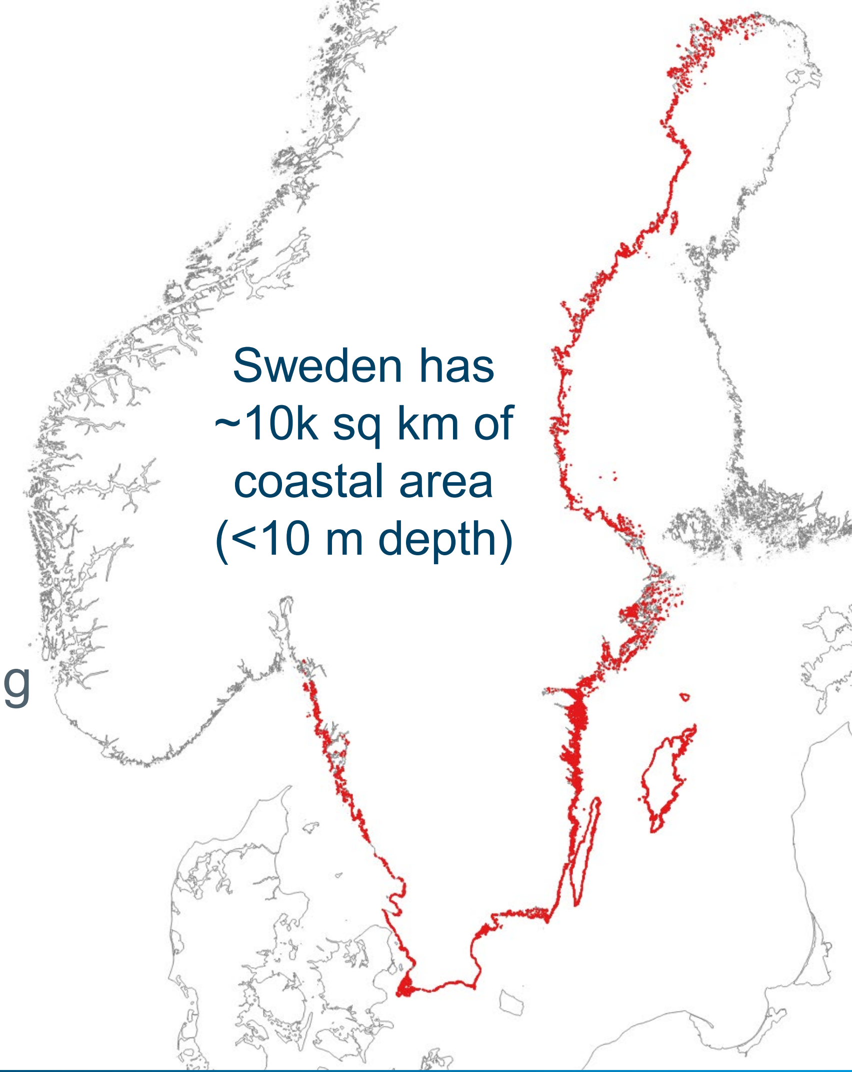


- Marine habitats sequester more carbon annually compared to terrestrial ecosystems
  - Immense storage potential in marine soils
- Per m^2 of habitat, between 50 – 100 times more carbon captured annually by seagrass and mangroves compared to tropical forests

Data from Lafolley & Grimsditch (2009)

Motivation

- Tremendous coastal area with major gradients in env. conditions
- Incomplete information about areal distribution of submerged aquatic vegetation (SAV) growing on soft seafloor
- Need for regular, systematic monitoring of SAV at country-wide scale
- Limited budget and time

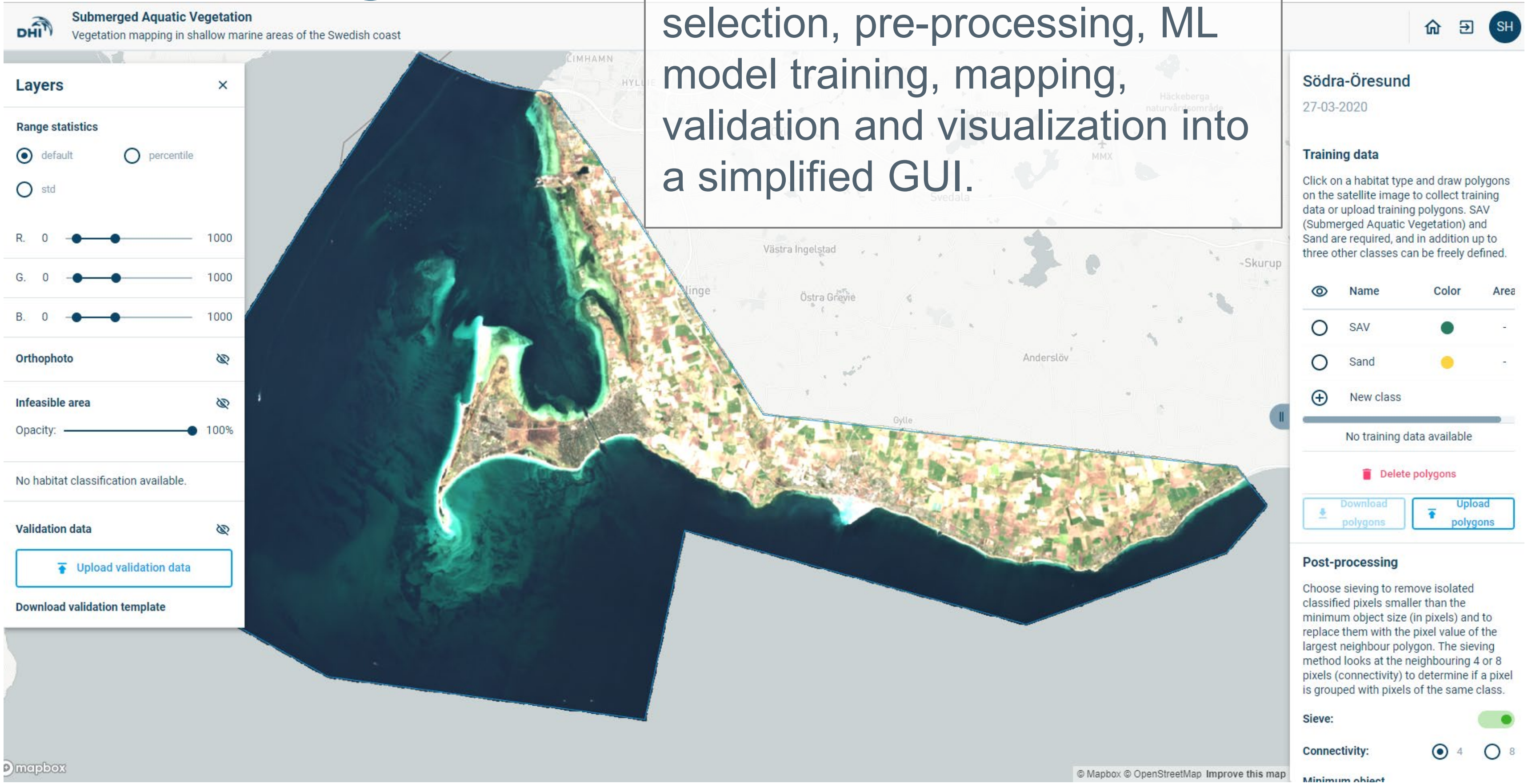


The Goal

- Supplement current monitoring with free EO data and create the first country-wide SAV map at 10m with ref. 2019/2020
- Wrap mapping workflow into a **cloud-based portal** (prototype) using ML methods and Sentinel-2 imagery
- Design the portal for non-EO specialists so that biologists with local expertise can perform mapping with timely data.

Portal Design

Combine the whole mapping workflow from Sentinel-2 image selection, pre-processing, ML model training, mapping, validation and visualization into a simplified GUI.

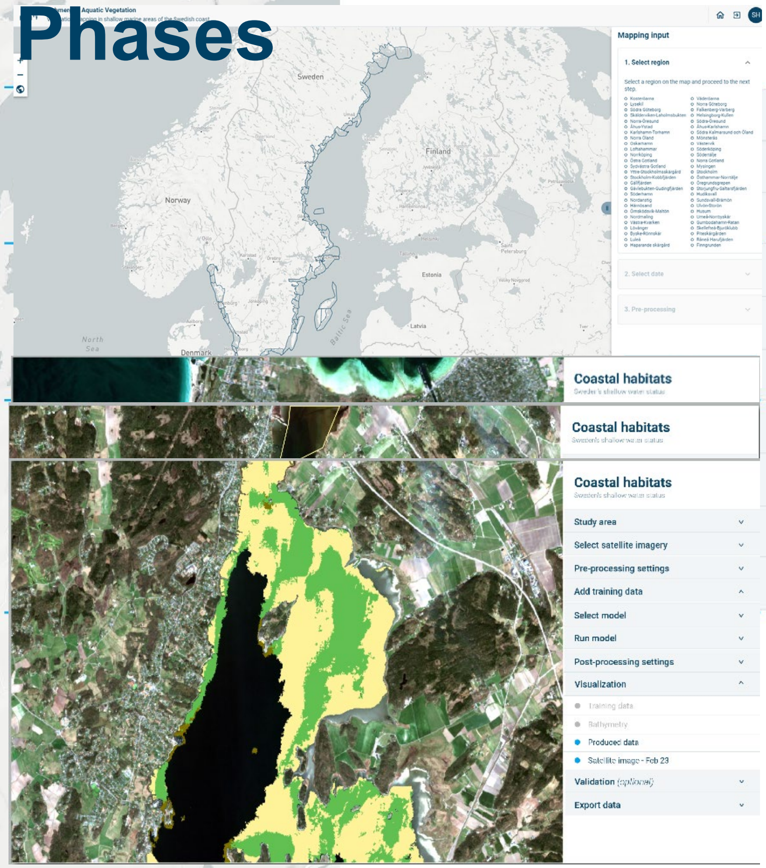


User is guided through 3 Phases

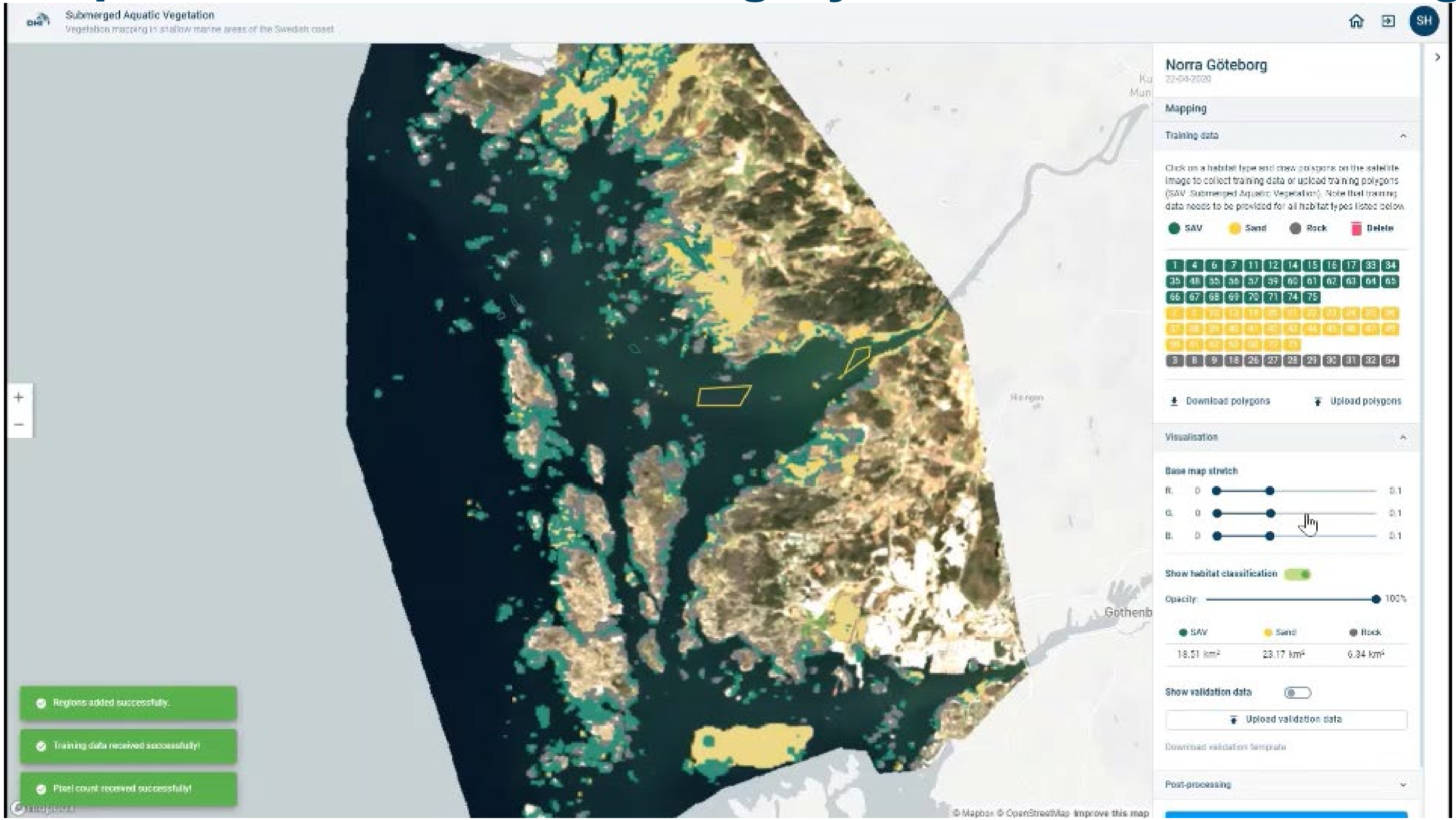
Phase 1: Setup

Phase 2: Train model

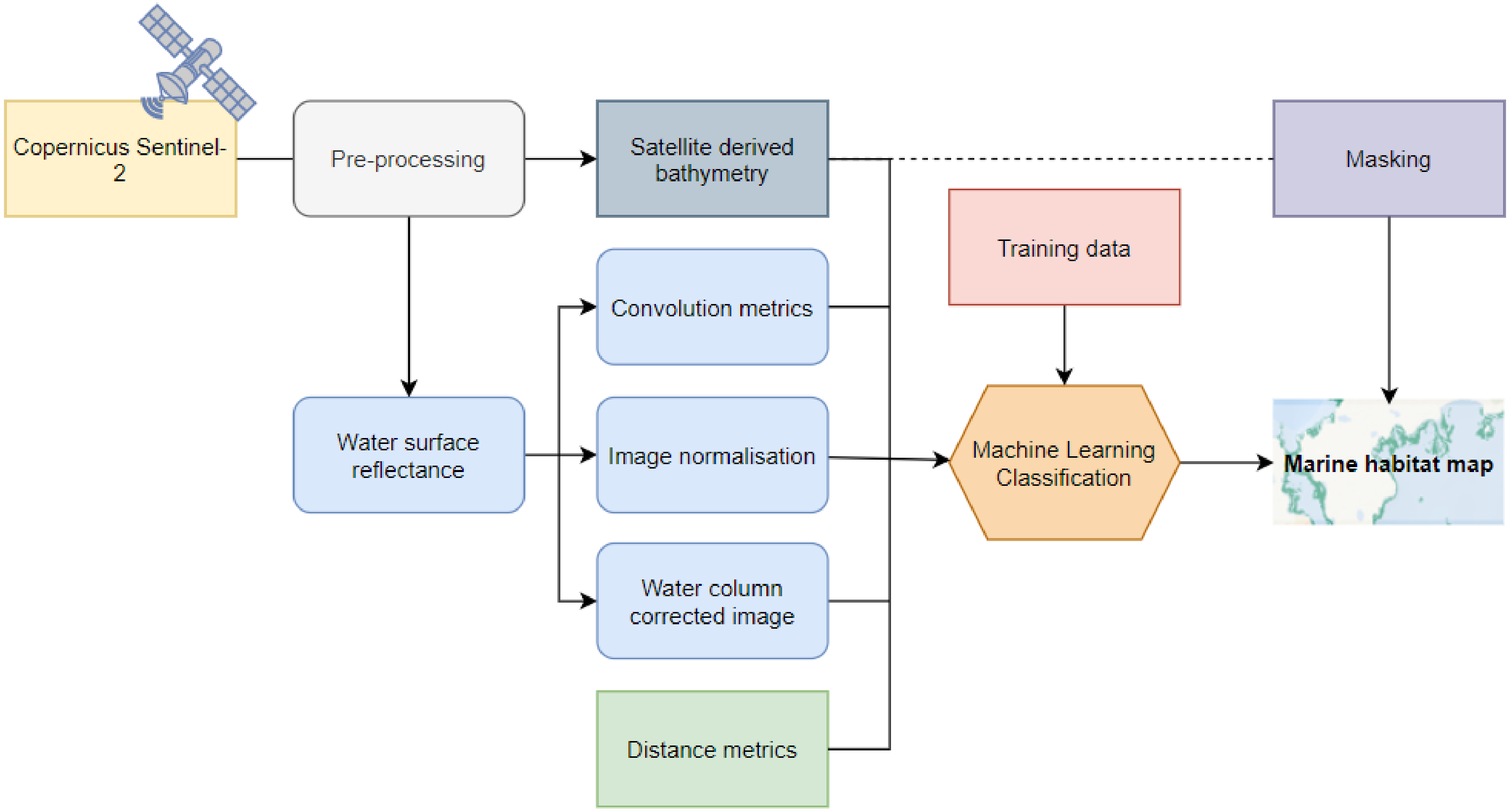
Phase 3: Result



Web-tool for classification of shallow marine habitats based on Copernicus Sentinel-2 imagery and machine learning



Methodological implementation



Country-wide SAV map derived with Sentinel-2 data 2019/2020

- In total it was feasible to map an area of 3,860 km^2 of the Swedish coast with S2 imagery.
- 1,550 km^2 (41 % of total area) were mapped as SAV
- Almost all (99 %) of the S2 derived data is from 0 to 6,5 m depth

How accurate are the SAV maps?

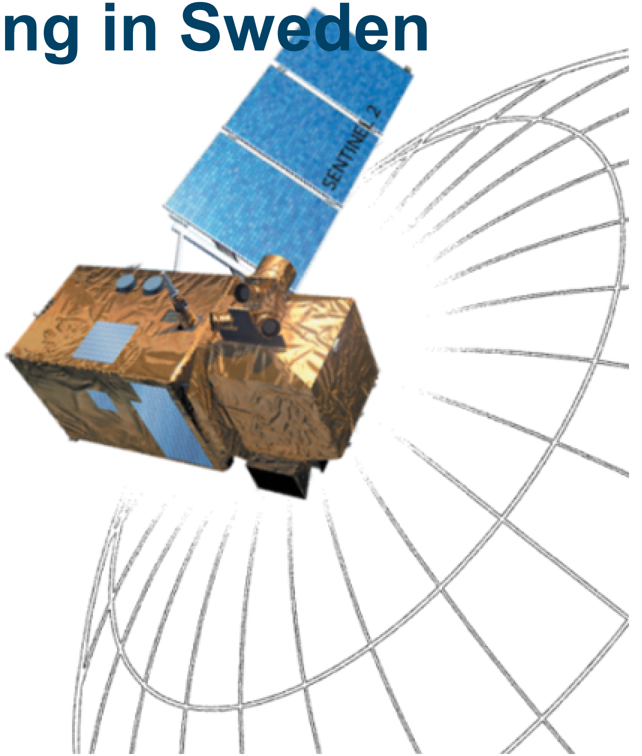
Comparison with independent field data from three different regions along the Swedish coast

- Average total accuracy per region 0.60-0.77.
- On average 31-50 % of vegetation growing in 3-5m not detected
- Only 6% of unvegetated substrate was classified wrongly as vegetated
- Poor performance in areas with fragmented sparse vegetation and poor water quality, e.g. Bothnian Bay

DHI GRAS

Some challenges with S2 SAV mapping in Sweden

- Highly variable water conditions (clouds, wind, waves..)
- Deeper and/or turbid waters
- Differentiation between optically deep and dark sea floor
- Lower growth limit of seagrass
- Areas with highly fragmented and sparse marine plants and algae
- Species differentiation



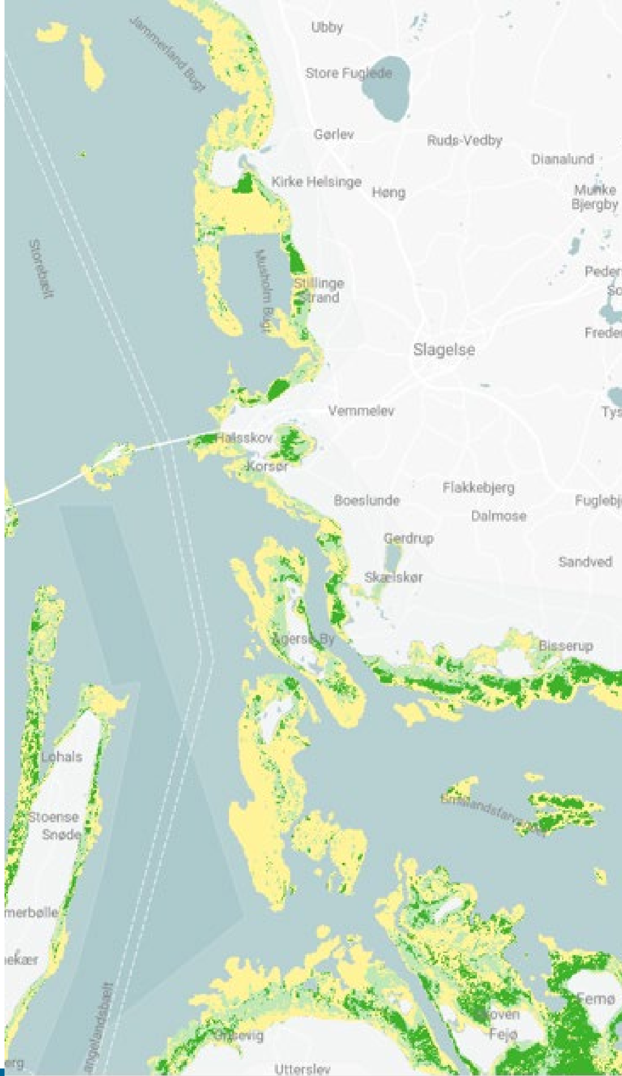
Conclusions

- Good approach to map vegetation coverage at **large scale,** systematically and regularly
- Good results in clear water down to 6m (best to 3m)
- Potential for improvement, as training data is key to achieve a good result and attribution of mixed pixels has a big impact on classification result.

Next steps

- Continuous improvement of web-portal with additional features, e.g. orthophotos
- Optimisation in satellite image pre-processing
- Testing of new ML approaches

Vision is to have a fully automated system in the coming 3-5 years, integrating various scales such as field inventory, drone and spaceborne sources.



Thank you!

For more information:

Huber et al., (2021) Novel approach to large-scale monitoring of submerged aquatic vegetation: A nationwide example from Sweden https://doi.org/10.1002/ieam.4493

Silvia Huber (shu@dhigroup.com)

https://www.dhi-gras.com/


Copernicus Sentinel-2