Mapping Seagrass meadows in the South of Crete

Posidonia oceanica in Plakias Bay

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Abstract

The importance of Seagrass meadows throughout the Mediterranean sea is of uttermost importance - supporting fish stocks, fisheries, sediment stabilization, nurseries and adding stability to substrate and ecological balance in and around their meadows. The extend of Seagrass meadows is widely unknown even though they are reported to decline throughout the Mediterranean sea. Since it is a key habitat a careful evaluation of the amount is the key to discussing their future development and evaluate the current state.

With our methods we can quantify the overall coverage of Seagrass meadows in a confined space with high accuracy and in the future with follow up surveys get an accurate idea of the development of these meadows. With a coverage of 40% seagrass within the bay of Plakias the south of crete appears in a healthy state in terms of seagrass coverage, maintaining the nurseries for a majority of the local fish species, ensuring a big diversity and healthy eco system.

Introduction

While Seagrass meadows of *Posidonia oceanica* show annual fluctuations in size and density (Alcoverro et al., 1995) the overall annual size variation should not exceed 7 percent – in the case of Plakias bay (6 square kilometers) this would equal as much as 0.42 square kilometers in fluctuation on an annual basis. The fluctuations in biomass and productivity can be significant (Ziemann 1975, Duarte 1989). The main factors for those seasonal changes are believed to be solar energy, irradiance and temperature (Sand Jensen 1975, Perez & Romero 1992). Other defining factors are the availability of nutrients, which can be highly dependent on input from land (Hemminga et al. 1991) as in the location of Plakias there are several small river inlets into the bay. A consideration in that regard would be that the water input from land declines during the summer when the nutrient needs of the seagrass meadows is the highest (Perez et al. 1991).

Even though *Posidonia oceanica* is considered vulnerable species it still is the dominant kind of seagrass in the Mediterranean sea covering wide areas from shallow (1 meter) to up to 35 meters. Just like other seagrass meadows they do show an annual fluctuation which has a high in spring and the lowest point in fall (Alcoverro et. Al 1995)

However dense the coverage of Posidonia oceanica is at this stage there is no baseline for the area around Crete and quantification of the meadows is crucial to observe future development of the meadows in the area.
Goals

With a wider monitoring program for Seagrass meadows we hope to long term evaluate the state and development of the coverage with Posidonia oceanica in the respective area. The missing link in the observation is the baseline. Various studies have been conducted on Seagrass, the inhabitants, stability of the substrate etc. But quantifying the actual coverage of Seagrass in an area was a costly undertaking involving side scan sonar tows and big ships capable of carrying and towing this equipment. With the approach from the air a wide area can be covered in relatively short period of time and still give high accuracy output with a certain depth limitation due to visibility restrictions. However it is a good baseline to up to 35 meters on clear days and no limitations towards the coast, where big research vessels can’t go because of the deeper draft. With the importance of Seagrass for the eco system we hope to add a valuable insight in the extend of the meadows and push for better understanding and better care for this incredible system below the surface.

Importance of Seagrass meadows

While coral reefs offer a variety of colors and important niches for a magnitude of different species they do not occur in the Mediterranean sea. On the other hand Posidonia oceanica is endemic in the same sea filling the niche of reef structures. And as such fills various key roles within the Mediterranean:

- As a root building plant, seagrass grows into the ground, stabilizing the sediment around it and limiting erosion from land. In many cases destructive fisheries such as bottom trawling completely diminished the seagrass meadows and as an effect smaller islands in the north sea are eroding into the sea with nothing holding the fine sediment in place.

*Figure 1: Sediment fixation capabilities of Posidonia oceanica*

*Figure 2: Posidonia meadows building barrier reef structures avoiding land erosion*
- Since Posidonia is growing in dense meadows it creates an incredible habitat for sessile organisms. Various sponges, algae and other filter feeders could not survive in the mobile substrate of sand, however they do grow on the leaves as rhizomes of Posidonia in big abundance increasing the productivity of seagrass meadows even more and making it an extremely valuable habitat for sessile organisms.

- Seagrass meadows act as nurseries for juvenile fish throughout the Mediterranean sea. Especially juvenile labridae are spending their first months in the dense seagrass habitat, finding valuable shelter from predators and possible strong currents. Around Plakias there is various blockfield areas offering similar shelter, but the density of hiding spots inside a seagrass meadow is much higher and the preferred hiding spot for various juvenile organisms.

- The big meadows of Posidonia are not only habitat for juveniles but also important hunting grounds for various kinds of Serranidae and other big hunters with an abundance of prey.

*Figure 3: Visible layer of epiphytes covering the leaves of Posidonia oceanica*
Inhabitants in Seagrass meadows

Posidonia oceanica is a key habitat in the Mediterranean sea offering food, shelter and the substrate for a variety of organisms.

- Filter feeders: With a lack of suitable habitats for sessile organisms in open sand areas Seagrass is the perfect habitat for epiphytes, plants and animals growing on other plants — including sponges, tube worms, anemones and algae.

- Animals that use the Seagrass as a direct food source such as Sarpa salpa or the loggerhead turtle Caretta caretta which is also red listed and sightings are declining in the focus area.

- Animals that need seagrass to survive include Pinna nobilis, a giant clam growing in the sediment. Since their size can exceed one meter they are easily affected by waves, currents and mechanical damage. With the seagrass around them additional stability of substrate and a decline of water movement is provided and the clam has better chances of survival — Pinnar nobilis is also listed as an endangered and protected species.

Figure 4: Various sessile animals are common Epiphytes of Posidonia

Figure 5: Group of Sarpa salpa feeding on Seagrass
- Various animals are only living in seagrass and would disappear with the meadows, like Syngnathus typhle, the broadnose pipefish which is incredibly well adapted to a life in seagrass but is unable to survive outside the meadows, lacking shelter and food sources.

- A variety of fish species is indirectly linked to seagrass meadows: While juveniles of different labridae species spend their entire juvenile life in seagrass meadows, they could survive outside of them, however they are perfectly adapted with coloration to seek shelter in between the leaves. Others like Serranus scriba use Posidonia as their hunting grounds.

## Methods

### Image Collection

For the first step in Data collection a “DJI Mavic Pro” Drone was used in combination with “Precision mapper” software. The app gets linked directly to the remote of the Drone, while Internet connection has to be available. The Software provides a Satellite overlay on the screen enabling the operator to choose an area to be surveyed from above. In the settings the height of flight for the Drone can be chosen (for our mapping purpose a height of 110m was chosen, delivering a resolution of 2.3cm per pixel) and the Drone will automatically fly a roster across the selected area covering each square in the area at least 8 times throughout the flight for sufficient overlay to generate an accurate map. Before letting the Drone lift of ensure that all parts of the system (Remote, Tablet/Phone and Drone) are fully charged and the flight time does not exceed the battery life of any of the components! Since most of the flight is out above water a failure of any of the components means a loss of the key element.

### Stitching the images

Ones the pictures are taken all the images are by default stored on the memory card in the Drone, so everything needs to be copied (and backed up) on computer and at least one extra hard drive before uploading to precision maps. For best use a Software called “Precision Viewer” can be downloaded and used for initial import and compression of images to safe on Data and internet use. This already compresses the image load to about 1/10th of the initial size.

The actual stitching process happens online and takes approximately 2 hours fully automated after which the files are ready for download in various formats. For the purpose of our survey the download of *.kml was chosen. This file format enables the user to create an overlay for google
maps directly in the program – Google earth Pro software is free to download and supports kml files. .

The stitching is where limits are reached for Seagrass mapping. The software needs a certain amount of discernable structure in each picture to stitch them together. Ones the separate images appear too similar (even though exact GPS coordinates are available) the software will not put them into the overlay, which is also the explanation for “gap areas” in the overlay. Those points are generally reached when either the depth is getting too much and the bottom can’t be seen anymore or if the substrate is plain sand with no discernable structure. Therefore it can be assumed that in those areas there is no major occurrence of *Posidonia oceanica*. The other key factor is timing of flights. If the sun is too high up in the sky there is a big reflection area in the single images causing problems for the stitching process. If the sun is too low less light penetrates the surface and the visibility to the bottom is limited. The best times we found were about 3-4 hours after sunrise and 3 hours before sunset, giving a big quantity of light in the images and little reflection in the flight altitude of 110m above sea-level.

**Using the stitched images**

Ones the kml image (a folder full of png images and one data file) is imported it delivers a extremely high resolution overlay making it easy to recognize even small objects in the observed area. In the case of Plakias Bay even the buoys of Dive2Gether were easily recognizeable (5 liter canisters 5 meters below the surface) making it possible to pinpoint the diving locations of the center on the maps. To import the overlays simply choose the *.kml file in the respective folders and drag and drop it into Google Earth Pro – or any other software that supports this file format. The program will instantly zoom in to the newly imported area and present the overlay.
Quantification of Seagrass coverage

With the accurate overlays from precision viewer on top of the original satellite images the measuring polygon tool is used to outline all the seagrass areas and get an accurate number for the surface area of *Posidonia Oceanica* in the surveyed areas. These can be broken down to a percentage of coverage for Seagrass versus other substrates (sand areas, block field etc) and should be observed more times in the future to get a better understanding of the changes over time. The recommendation would be to at least make a partial repetition of this survey in one year’s time to see if/what changed in a small area and if changes are instantly visible extend the area to the full range again.

With the polygon tool a good overview of the coverage can be reached, the recommendation for future observations would be to import the original overlay from this report as well as a future follow up and layer them on top of each other. Any change in the outlines and missing patches could be instantly seen and focused on.

**Results**

Over the cause of every single wind free day spent in Plakias we managed to get pictures of the entire coastline starting 1 mile west of dragon’s nose and until the wall of Paligremnos, covering from shore to a depth that makes it impossible to discern the substrates for the software and therefore stitching would become a massive manual labor. The base files are delivered with this document so ones the software gets better we can try again to merge the same files into one overlay. The depth limit encountered lies around 35m and is fluctuating with light availability and daily visibility.
Figure 7: Dragon's nose Drone map – Whenever “patchy” seagrass areas were observed the polygon for meadows was drawn in a fashion that more than 50% coverage are considered Seagrass, less than 50% coverage are skipped as sand.

Figure 8: Shinaria Bay drone image - No seagrass coverage except for small patches on sandy areas in deeper water
Inside the Bay of Plakias big meadows of *Posidonia oceanica* were observed in almost all areas. The majority of the meadows is on the western side of the bay, close to Souda Beach and Dragon’s nose. The eastern side of the bay (east of the old harbor and towards Paligremnos wall) is free of seagrass all together. The only exception in the eastern part of the bay is close to Paligremnos wall with a meadow stretching from approximately 5 meters down to 40 meters depth.

With those images and the completed google maps overlays it becomes a very straight forward process to do the next evaluation. With the same method another survey of the same or similar magnitude can be done and the images simply overlayed. Therefore all differences become obvious right away. All the images as well as the source files can be found in the appendix and source locations.

After completing the image collection in Plakias we also added Shinaria Bay to the survey, since it shows some seagrass and is an easily replicable ground for a follow up study in the future. With a confined area it should be very simple to pick it up and work from there with a baseline.

*Figure 9: Posidonia oceanica acting as barrier reef structure in the "wave breaking" area*
Discussion

Posidonia oceanica is a slow growing and long lived species that will have difficulties responding to rapid environmental changes it is exposed to and therefore needs careful observation as the surroundings are changing – one of the key features for those observations is to quantify the amount of change and with meadows throughout the Mediterranean sea declining Plakias seems to be (yet) unchanged, however there is no quantitative data to proof the solid state. In order to make sure a decline is not on the rise and the meadows will remain healthy a careful observation of the overall extend of meadows and the health has to be attempted as well as finding potential sources of decrease in the meadows if they occur.

Even inside the bay of Plakias a fluctuation of seagrass quantity could be observed. While in proximity to Dragon’s nose and Souda beach the amount of meadows is the highest close to Plakias beach there is no seagrass at all. This fact is most likely an effect of the southerly winds that come into the bay on a regular basis, creating a big wake in this relatively shallow areas, making it near impossible to seagrass to settle. All the sheltered areas and deeper grounds are presenting a good coverage with seagrass exceeding 40% throughout the bay in the depth range observed!

Since nutrition and fresh water can be defining factors when it comes to the meadow density as well as the annual fluctuation of the coverage the river inlets throughout the bay should be considered for future observation. Not only the water input throughout the year and seasonal fluctuations in actual fresh water brought into the bay but also nutrients brought in to the sea. With the water clarity that is shown in the bay of Plakias the assumption is the nutrient intake is minimal, however a closer look would add valuable information!

Posidonia oceanica meadows are declining throughout the Spanish coast because the majority of meadows is declining in shoot density (Marba et al 1996) therefore observation of shoot density as well as the overall size of meadows is a key objective in Plakias. In the Spanish waters entire meadows deteriorated within only 3 years from a living Posidonia meadow to single lumps of Rhizome (Marba et al 1996) proofing that the reduction of meadows can happen within a very short period of time making an annual comparison and observation of the outlines of uttermost importance. The massive reduction of meadows throughout the Mediterranean could be linked to sewage treatment plants, construction along the shoreline and other effects changing the mobility of the substrate that Posidonia is growing in as well as natural changes in sea level and sediment balances (Marba et al 1996).
References


