

Earth Observation and Data Analysis

Homework 2

Submitted by:

Pratuan Amatya (Matricola ID: 1800063)
Giannis Lakafosis

1. Data set acquisition

We downloaded Sentinel-2 MSI Level 1C data from Copernicus website acquired over the month of March 2019 for the temporal analysis of Chrolophyll A (Chla) and Total Suspended Sediments (TSS). The target area was Tiber river estuary in the outskirt of Rome.

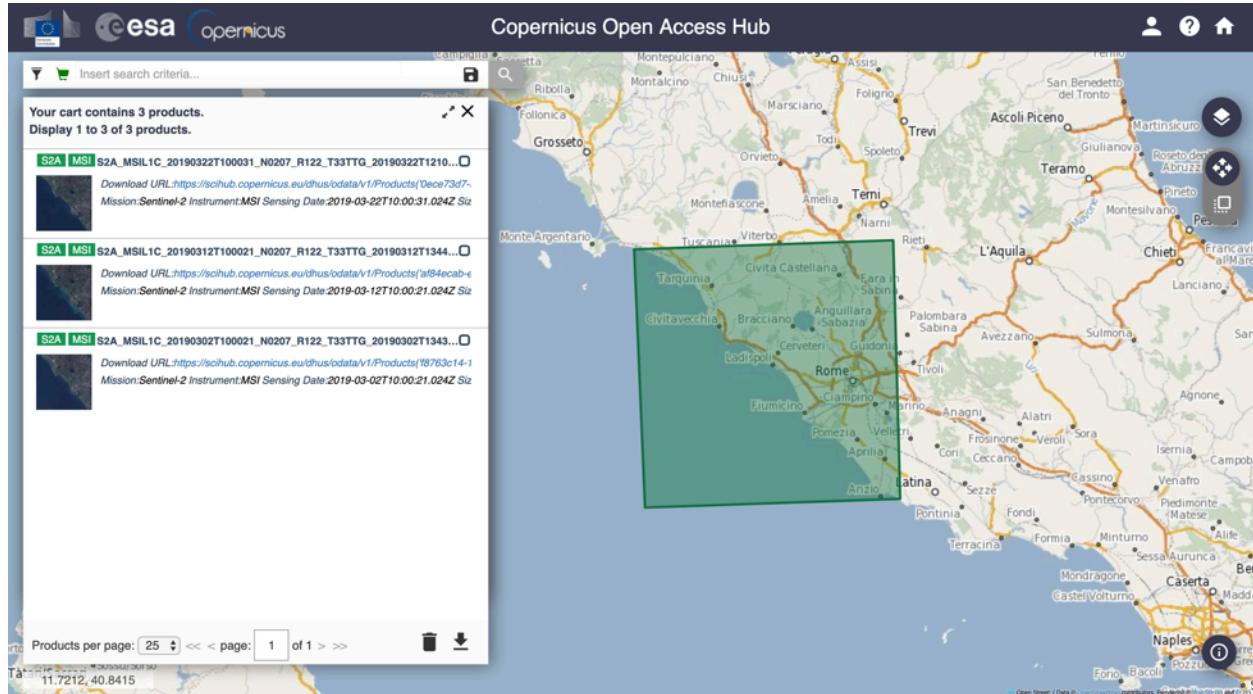


Fig 1.1 Copernicus schihub web application to fetch Sentinel-2 Level 1C data

We used SNAP raster tool to perform resampling of all the bands to the resolution of 10m and further on used rectangular vector container to further subset the data over the region of interest.

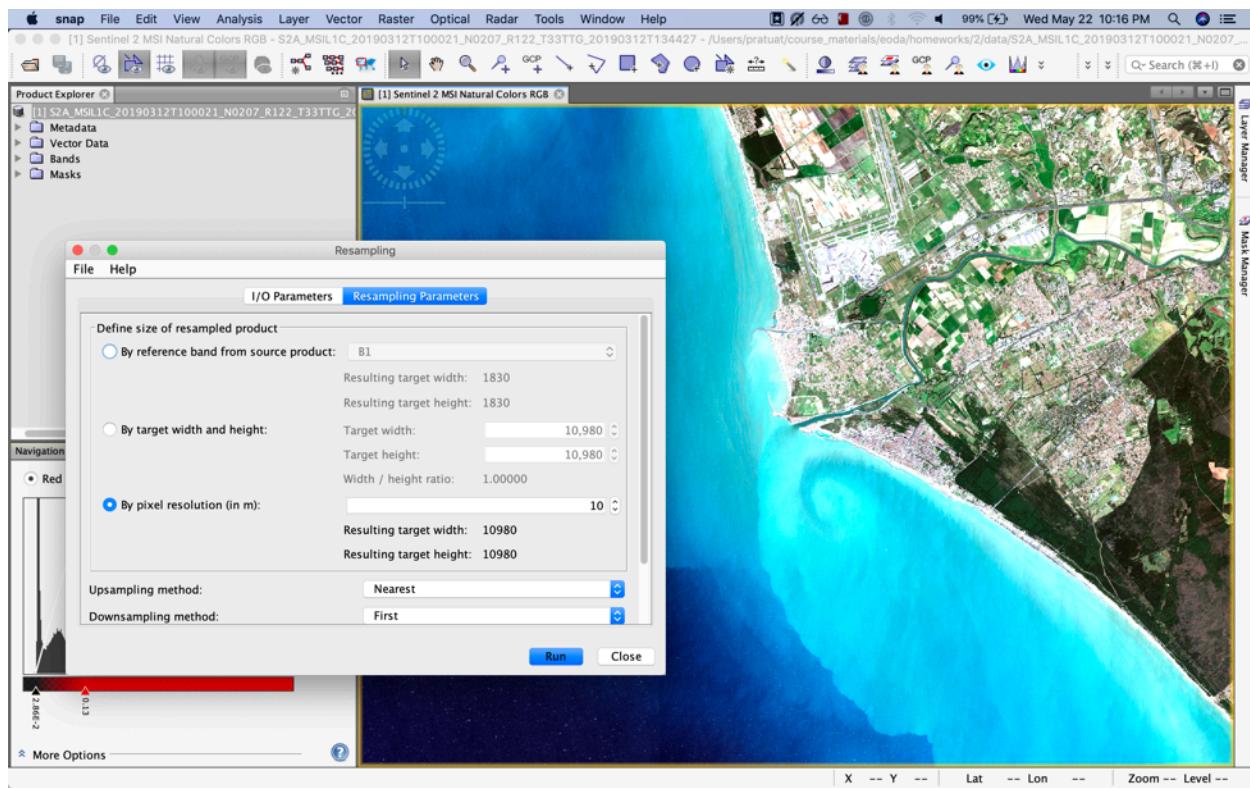


Fig 1.2 SNAP resampling tool

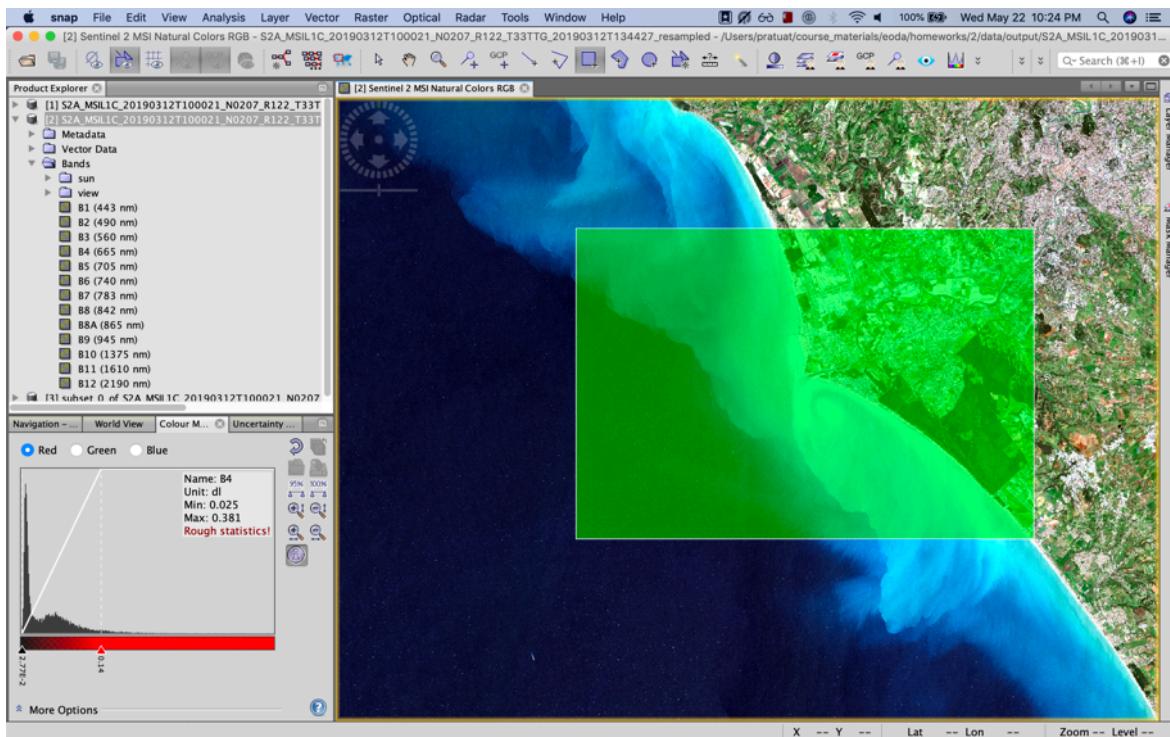


Fig 1.3 Region of Interest selection over Tiber estuary for subset data

Following is the imagery of visual bands across the Tiber river estuary we generated from the data under consideration.



Fig 1.4 RGB visual composite of subset data

2. Data quality check

All data bands were visually inspected and found to be of good quality without any considerable noise.

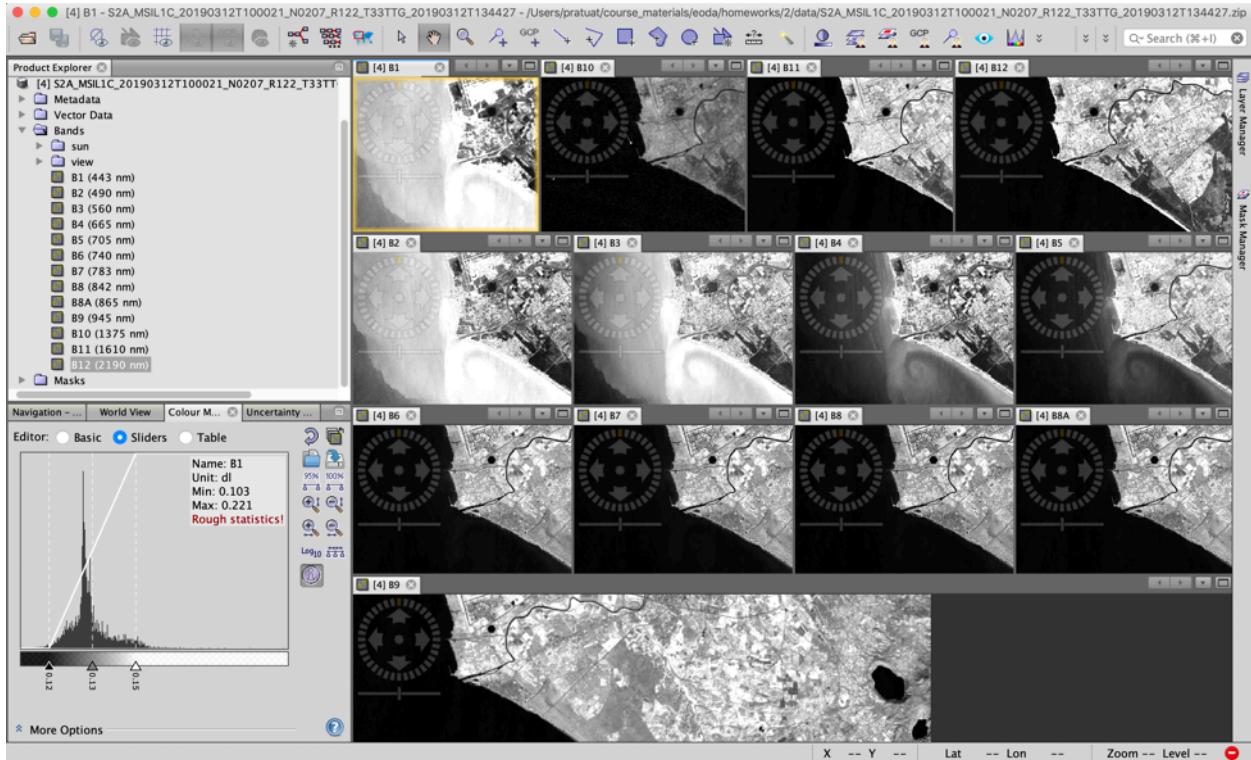


Fig 2.1 Visual overview of all the bands

3. Atmospheric correction

The downloaded data is S2-MSI level 1C product accounting top-of-atmosphere observation. Here we apply C2RCC tool to perform atmospheric correction to both original and subset data to obtain bottom-of-atmosphere estimation.

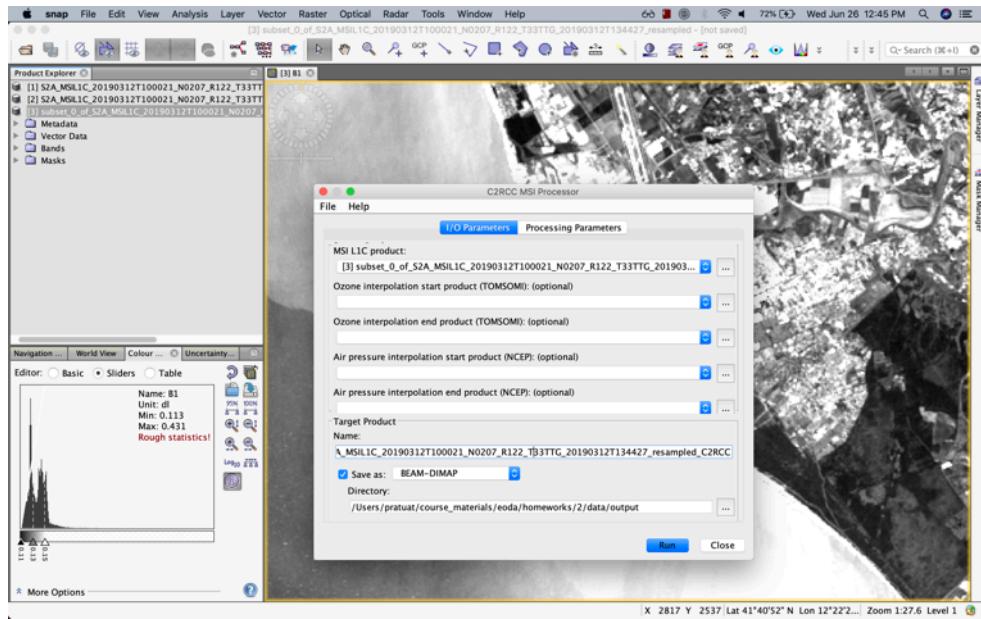


Fig 3.1 SNAP C2RCC configuration for atmospheric correction

On visually inspecting the visible bands for original and corrected data, no substantial difference was observed.

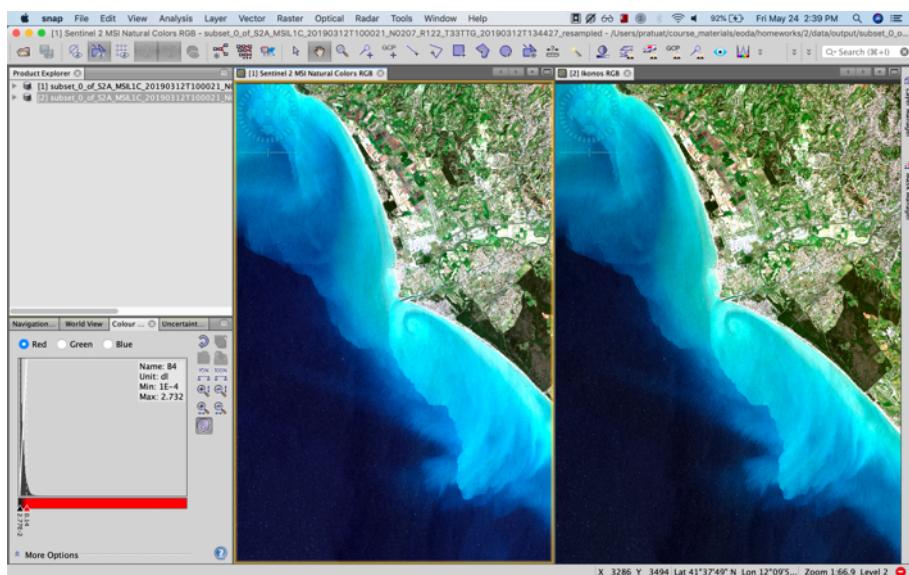


Fig 3.2 Qualitative comparison of original and atmospheric corrected data

4. Channel Data Correlation of ROI

We used SNAP scatter plot analysis tool to generate a correlation graphs between the data bands.

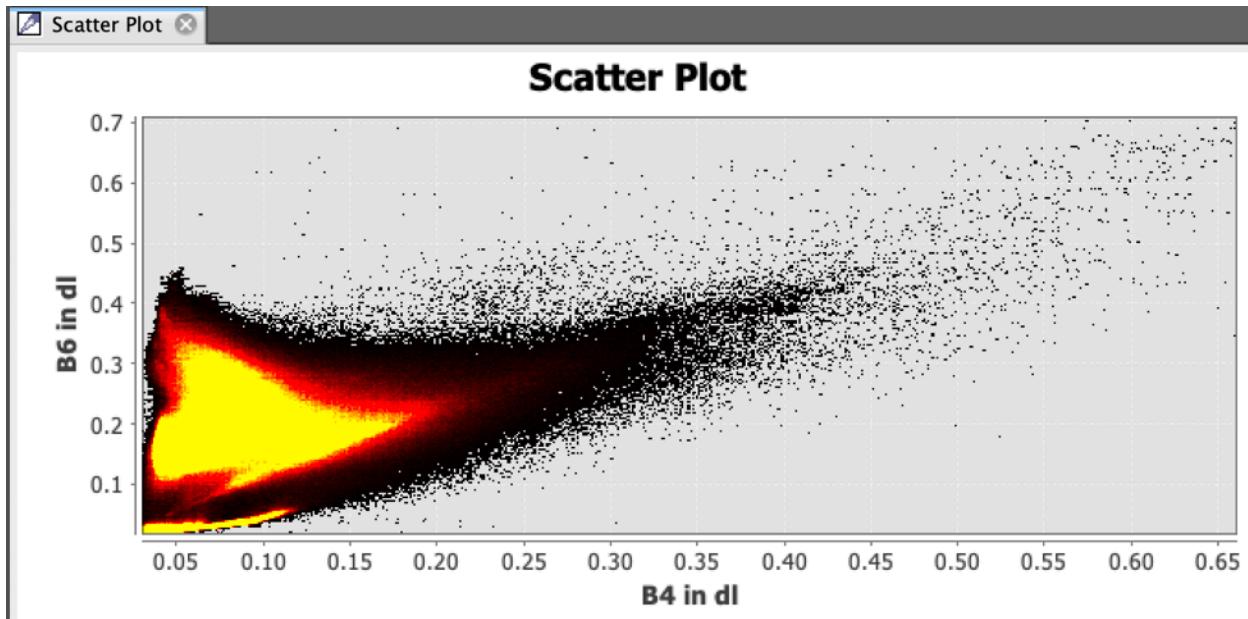


Fig 4.1 A sample scatter plot for correlation between bands B4 and B6

5. Implementation of 3 regressive algorithms to estimate chlorophyll-a (Chl-a)

Following are the algorithms used to estimate Chlorophyll-A using S2 MSI L1C data.

5.1 First Algorithm

$$Chl_A = B_3 - (B_2 + \frac{(\lambda_3 - \lambda_2)}{(\lambda_4 - \lambda_2)}(B_4 - B_2))$$

5.2 Second Algorithm

$$Chl_A = 0.80 \exp(0.35 \frac{B_3}{B_4})$$

5.3 Third Algorithm

$$Chl_A = 1.7541 \exp(-1.547 \frac{\max(B_1, B_2)}{B_3})$$

Results:



Fig 5.1 Qualitative comparison of Chlorophyll-A detection algorithms

We clearly observe that the outcome of third algorithm has better contrast for representing the range of values and has less grain noise compared to first two algorithms.

6. Implementation of 2 regressive algorithms to estimate Total Suspended Sediments (TSS)

We used following two algorithms to estimate the Total Suspended Sediments for given products.

6.1 First Algorithm

$$TSS = 23.26 \frac{B_4}{B_2} + 0.61$$

6.2 Second Algorithm

$$TSS = 15.15 \left(\frac{B_4}{B_2} \right)^2$$

Results:

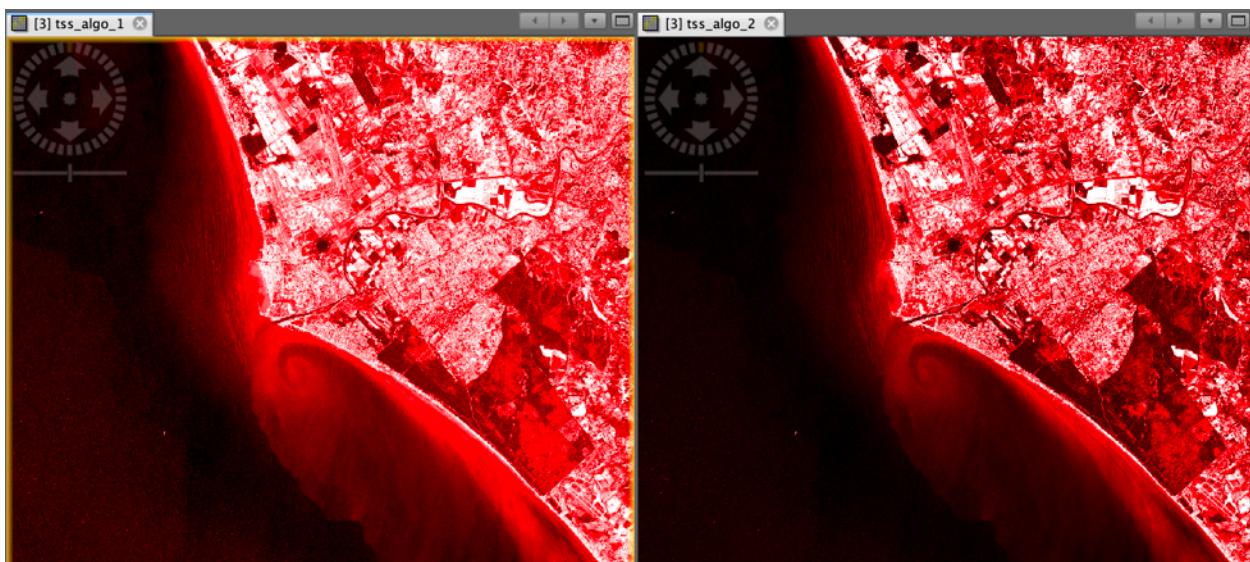


Fig 6.1 Qualitative comparison of TSS detection algorithms

On comparing the two outcomes, we see first algorithm is more sensitive compared to second one as such that TSS level is detectable far into the sea apart from shore lines.

7. Time series evaluation of Chl-a and TSS over 3 week period

7.1 Time-series of Chlorophyll A in March 2, March 12 and March 22



Fig 7.1 Time-series qualitative comparison of Chlorophyll A

7.2 Time-series of TSS in March 2, March 12 and March 22

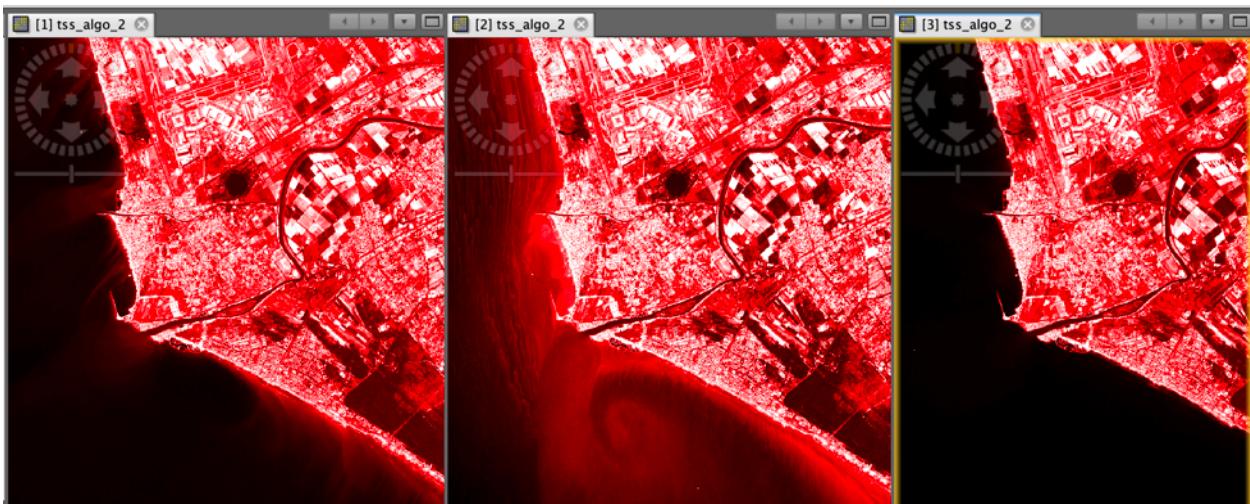


Fig 7.2 Time-series qualitative comparison of TSS

Results:

In this section, we made time-series evaluation of ChlA and TSS content in the Tiber estuary shore line over three week span of time with data points at 2019-03-02, 2019-03-12, and 2019-03-22. There was substantial increase in both ChlA and TSS content in the middle of the month but later on depleted completely by the third week.

8. Comparative evaluation with data generated from Copernicus Marine Service

We obtained the Chlorophyll A observation from Copernicus Marine Service with data dated on March 14, and March 22.

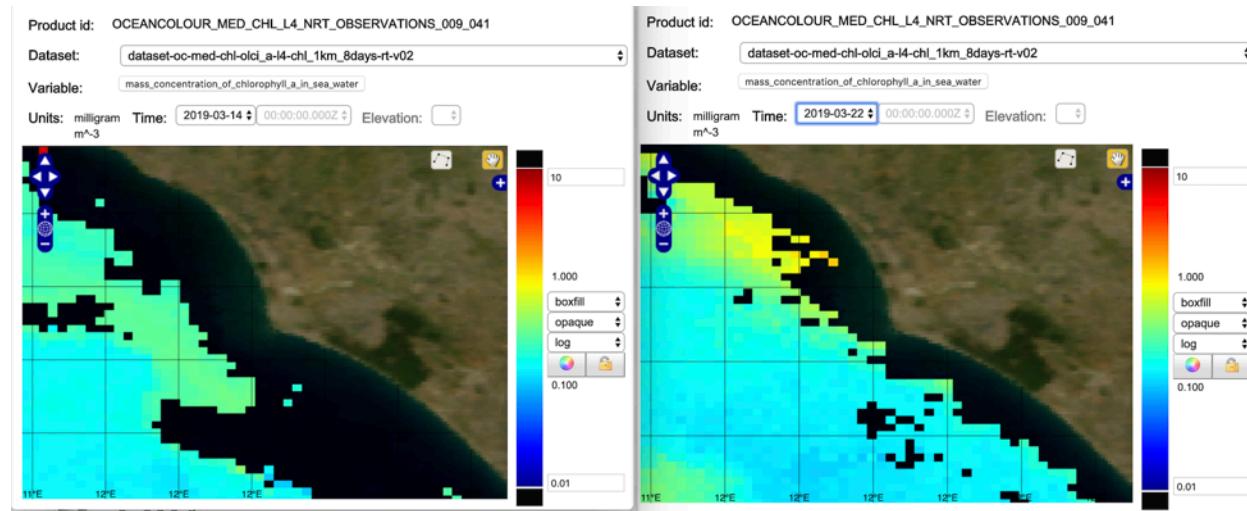


Fig 8.1 Time-series qualitative comparison of Chlorophyll A from Copernicus Marine Service

Result:

We observe higher Chl-A content during the end of second week, visible in pale pixels around the estuary shore line. On the other hand, the blue pixel represents depleted level of Chl-A by the end of third week. This observation corroborate our previous observation using S2 MSI data.