Mission Space Lab Phase 4 report

Name team: Seekers

Chosen theme: Life on Earth

Organization name: Itis Delpozzo Cuneo

Country: Italy

Introduction

We decided to base our research on two main points:

- analysis on drainage of the Aral Sea;
- night pollution, with a detection of bright spots in the mainland.

After we downloaded the pictures, we started our analysis: for the day-time pictures we modified them in false colours (with NDVI) to divide the green zones (the ones with vegetation). Unfortunately, we have not found something interesting to analyse using the vegetation index of our pictures.
During our experiment the ISS has flown over some interesting areas:

- Volga river, the longest of Europe
- Balqas Lake,
- English Channel
- Ukraina border
- Aral Sea,
- Sampeyre that is a nice mountain town very near where we live!

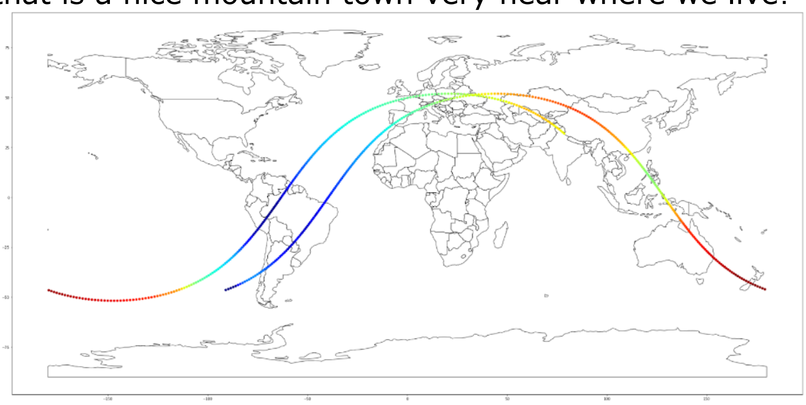

Figure 1 ISS orbit of our experiment

We choose Aral Sea to do a detailed analysis. The Aral Sea is a Salt Lake of oceanic origin located on the border of Uzbekistan and Kazakhstan. Until 50 years ago, the Aral Sea was among the largest lakes in the world, with a total area of 68,000 square kilometres. This area has shrunk by 75% since 1960.
The reduction in the lake's (senza ‘s) flow began during the Cold War: the Soviet regime at that time drew up a project to divert the course of two rivers that flowed into the lake so as to irrigate the fields of the new intensive cotton crops.
The consequences of the drying up of the Aral Sea also induced a severe weather change in the area and killed the sea ecosystem.

Methods

For the night time pictures we analyse every pixel of our photos and we calculate, with a Python program, the number of the pixels brighter than a fixed value. Using Numpy the algorithm is quite simple and fast.

Using our image n° 523 (below), the best one of the Aral Sea in which we can study its progressive drainage.

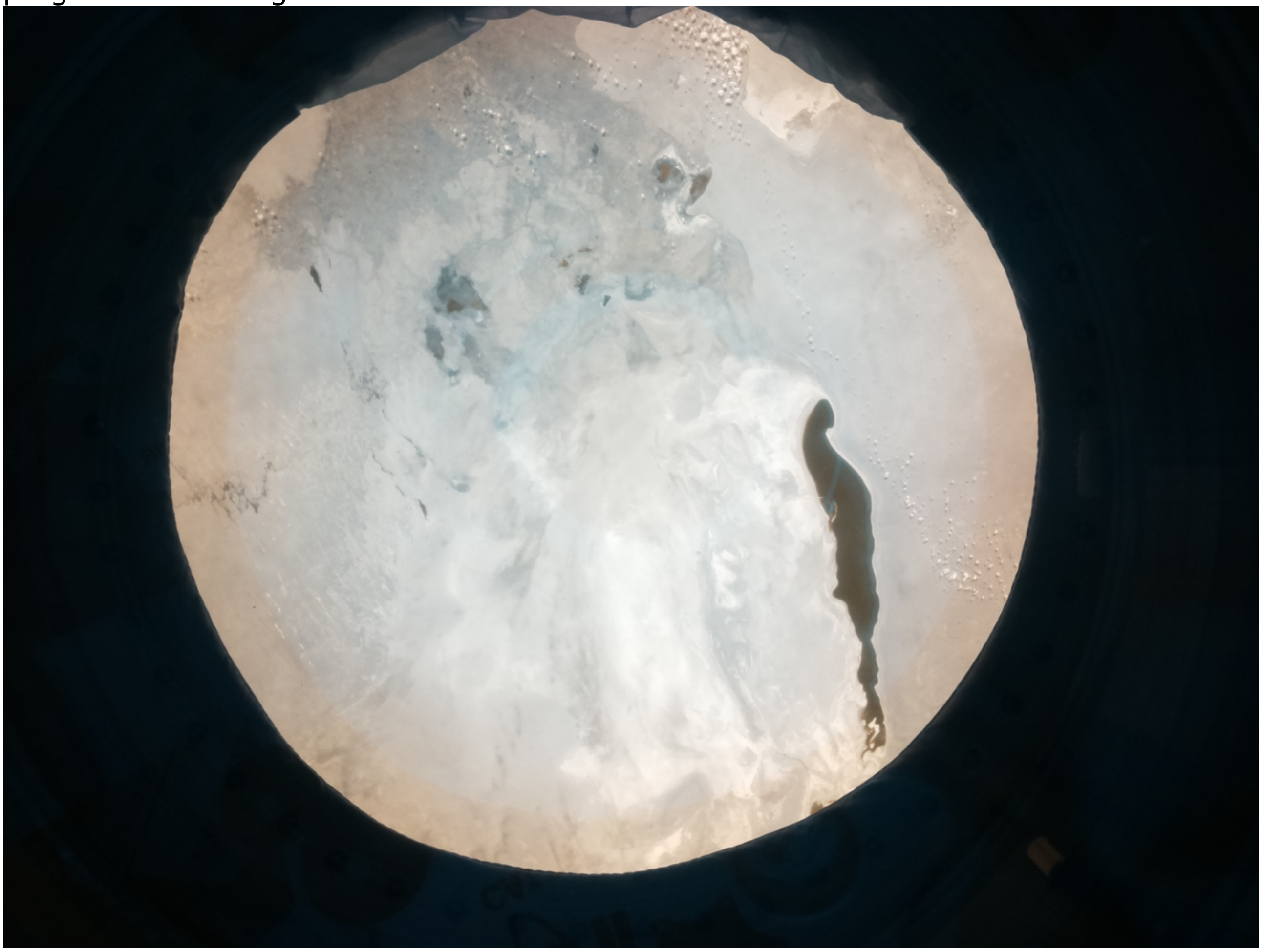

Figure 2 Aral Sea in our image n° 523

The image shows what remains of the sea.
We assume a link between the land color and the number of years since a portion of the lake basin has been dried up. Darker areas are the last to be dried up: in some of the alpine lakes near our town that’s right.
Our analysis algorithm, built inside a jupyter notebook in Python, uses Numpy, Matplotib and OpenCV.

OpenCV methods *threshold* and *findContours* allow us to find out contours of areas of different colors. We have chosen to use grays scale image and to apply a threshold on the gray level. Different thresholds correspond to different portions of the lake basin as we can see in the three pictures below in which area contours are highlighted in green.

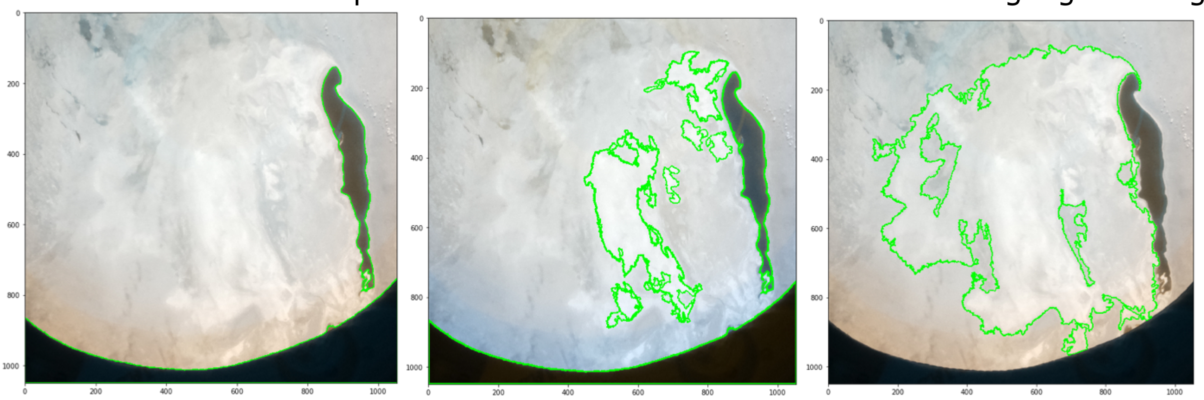

Figure 3 thresholds 140, 234 and 214 from left to right.

If our assumption is true, brighter areas correspond to areas drained in older periods, and we can estimate the rate of drainage in time.
We do this by calculating the number of pixels inside each countor using the *contourArea* OpenCV method for different gray thresholds levels from 213 to 247 (brightest pixels have 255 value).

Results

The following plot shows the result of our night time analysis: the new HQ camera is capable of reveal anthropic lights in night time pictures!

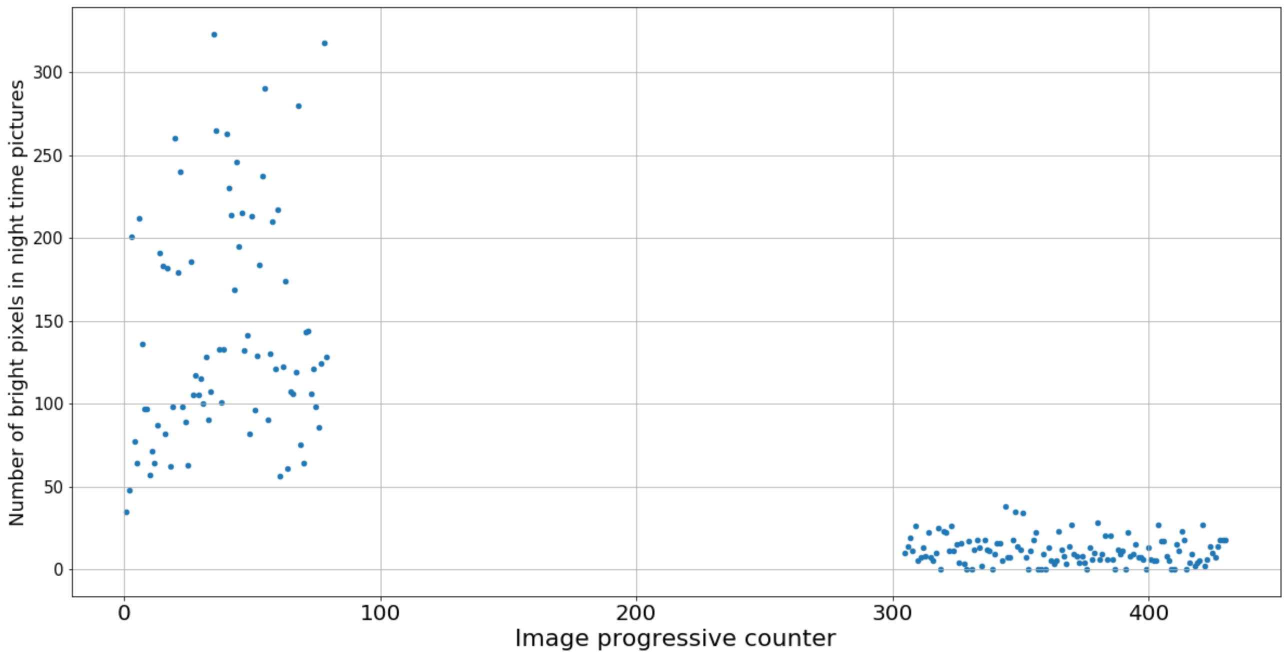

Figure 4 the result of our night time analysis. Only night time pictures are considered.

In the left part of the plot (below counter 100) the ISS has flown above Brazil and we checked that bright pixels correspond to towns.

Using our method described above we study the drainage of the Aral Sea. Using a threshold of 140 we estimate that the actual area of the sea is 31075 pixels. Applying different gray thresholds, from 213 to 247, we calculate areas (in pixels) of the portions of the basin drained in different times. The site https://public.wmo.int/en/resources/bulletin/future-of-aral-sea-lies-transboundary-co–operation reports the time series of real areas in km^2 of the Aral Sea since 1960. Using this time series we try to match our datas (gray threshold – areas in pixels) to real datas (years – areas in km^2).
Our result is shown in the following graph which shows a quite good match!

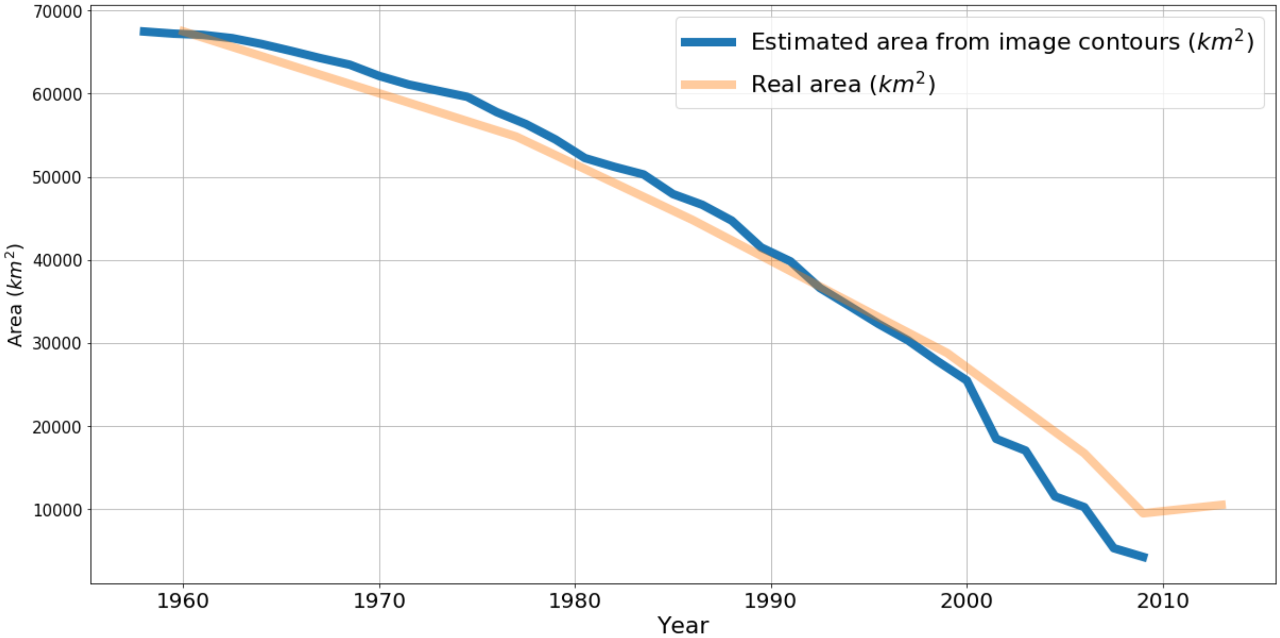

Figure 5 The surface area of Aral Sea in time. Our reconstructed time series of the drainage matches quite well with the real time series.

We find the best match using this mapping between different variables:

$$Area(km^2) \sim \frac{Area(pixels)}{7.7}$$

$$Year = (threshold - 214) * 1.5 + 1958$$

Learnings

Our group was divided into two, those who worked more on code and those who focused on the research part.
We learned a lot especially in using Python, Jupiter and in STEM. It is awesome having to opportunity to execute an experiment in space!

Conclusion

We had to change the aim of our experiment because our initial idea about ocean needed ocean images, instead we had almost only mainland images. Therefore, our team refocused on another big problem: desertification and lack of water. Water shortage is a big problem for ecosystem and for human health and development. In the last ten years there were more than 200 wars involving water. The history of Aral Sea is emblematic and we tried to estimate time rate of the Aral drainage from a detailed analysis of a single image. We are satisfied of the obtained result and we hope to validate our method analysing images of other sea or lake images. Our dream is to apply our method, hoping it could be useful for desertification prevention!