



HACETTEPE UNIVERSITY

DEPARTMENT OF COMPUTER ENGINEERING
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BBM 415
Image Processing Laboratory
Problem Set-4

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Subject:

Segmentation of
Multispectral Remote
Sensing Images

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1 Introduction

In this experiment, the purpose is doing K-Means image segmentation on multispectral images by using superpixels. Also i show in each part how effects the image features to segmentation with creating feature matrix using the multispectral images bands. Feature vectors creation and creating boundaries and making normalization, converting image 8 bit in the right place was difficult. But in general i didn't have much trouble. In the end i had to do a lot of tests to see more accurate results in this assignment. Bands features:

Band 1 - Blue 0.45 - 0.52 Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation

Band 2 - Green 0.52 - 0.60 Emphasizes peak vegetation, which is useful for assessing plant vigor

Band 3 - Red 0.63 - 0.69 Discriminates vegetation slopes

Band 4 - Near Infrared 0.77 - 0.90 Emphasizes biomass content and shorelines

Band 5 - Short-wave Infrared 1.55 - 1.75 Discriminates moisture content of soil and vegetation; penetrates thin clouds

Band 6 - Thermal Infrared 10.40 - 12.50 Thermal mapping and estimated soil moisture

Band 7 - Short-wave Infrared 2.09 - 2.35 Hydrothermally altered rocks associated with mineral deposits

2 Implementation Details

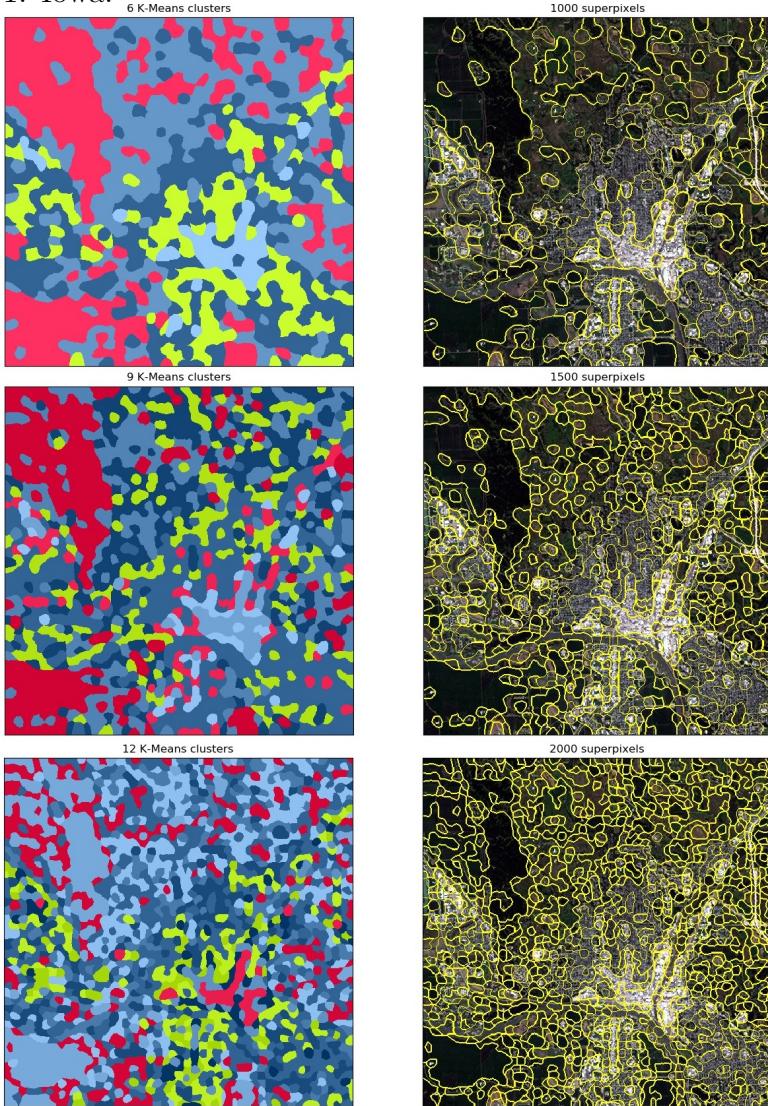
At first i didn't know which band has what feature. I realized that with quick search. It was easy to create superpixels but it was hard to create feature vectors for each superpixel. I handle that using with np.where, np.unique and creating feature matrix. I used if statement for feature partitioning for part1, part2 and part3. Also i merged rgb bands and convert it to lab format and take the l channel for adding feature. I use merged rgb bands in creating superpixels, creating rgb format like colorful segmented image, showing boundaries. K-means clustering and colorizing segmented image was difficult. I used segmentedimage[:, :, 0] += 'random int value' for each channel, it gives random values to colorize image. I used kmeans.labels_[superpixel], it gets the labels of each superpixels and i used mark_boundaries for showing image with boundaries.

3 Experimental Results

3.1 PART 1: Segmentation with k-means

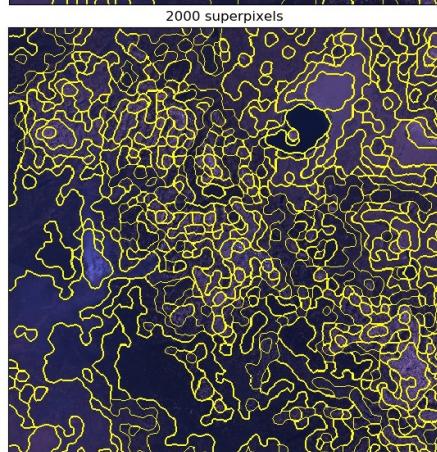
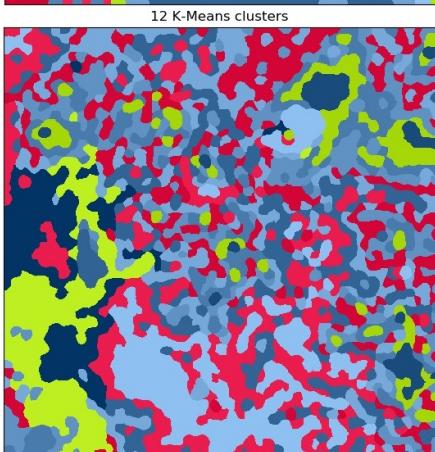
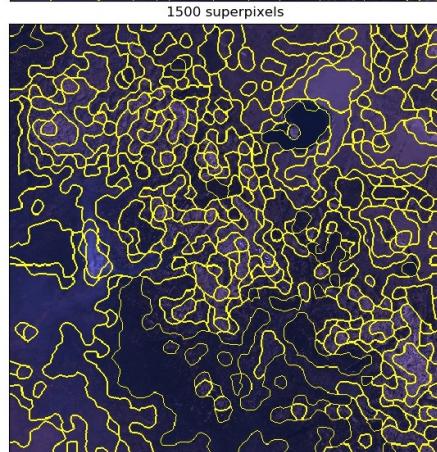
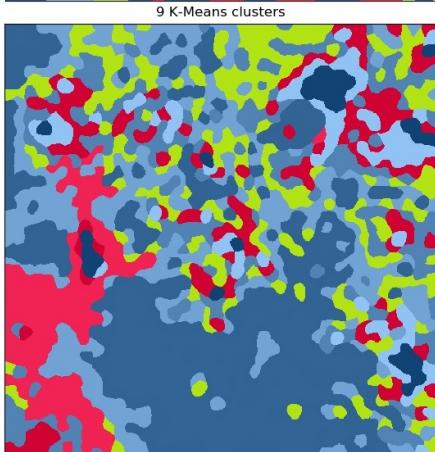
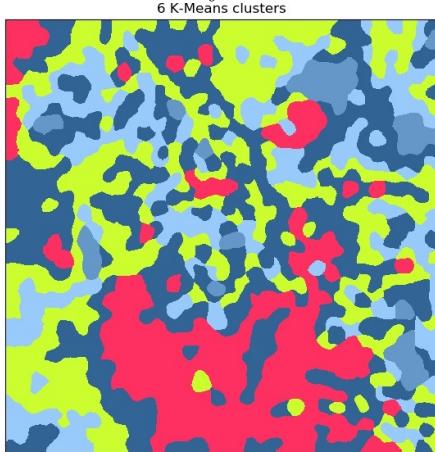
This part only has segmentation operation using rgb bands.

1. Iowa:



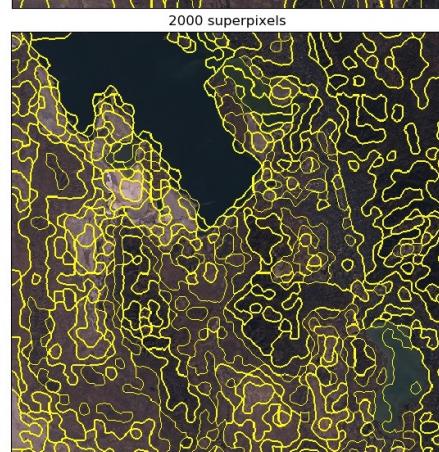
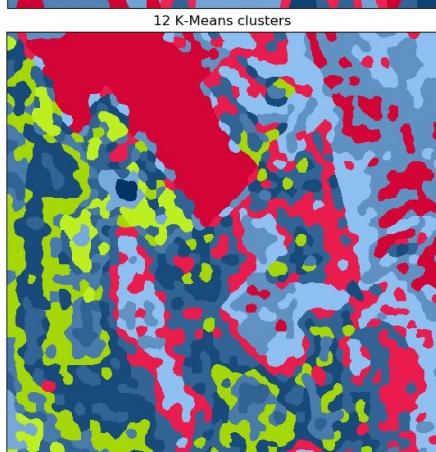
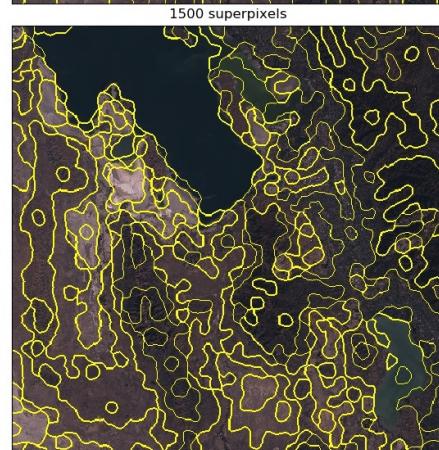
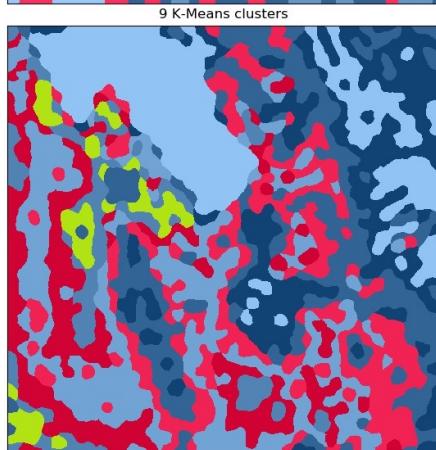
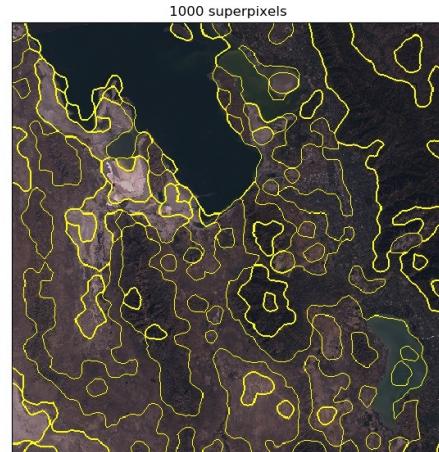
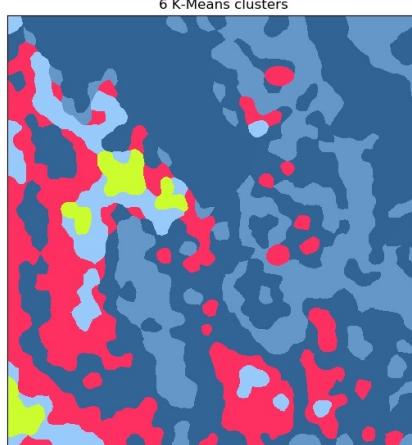
In this image, only the green area on the upper left side and the pixel colors in the middle white area are similar to each other, so they managed to stay together with the low number of clusters. But since the number of clusters increased and the location feature was not included, the picture becomes very complex because each pixel of similar color exists elsewhere.

2. Owens Valley:



The same things mentioned above also apply to this image. Because the colors are the same, only the small lake on the upper right side remains together.

3. Salt Lake:

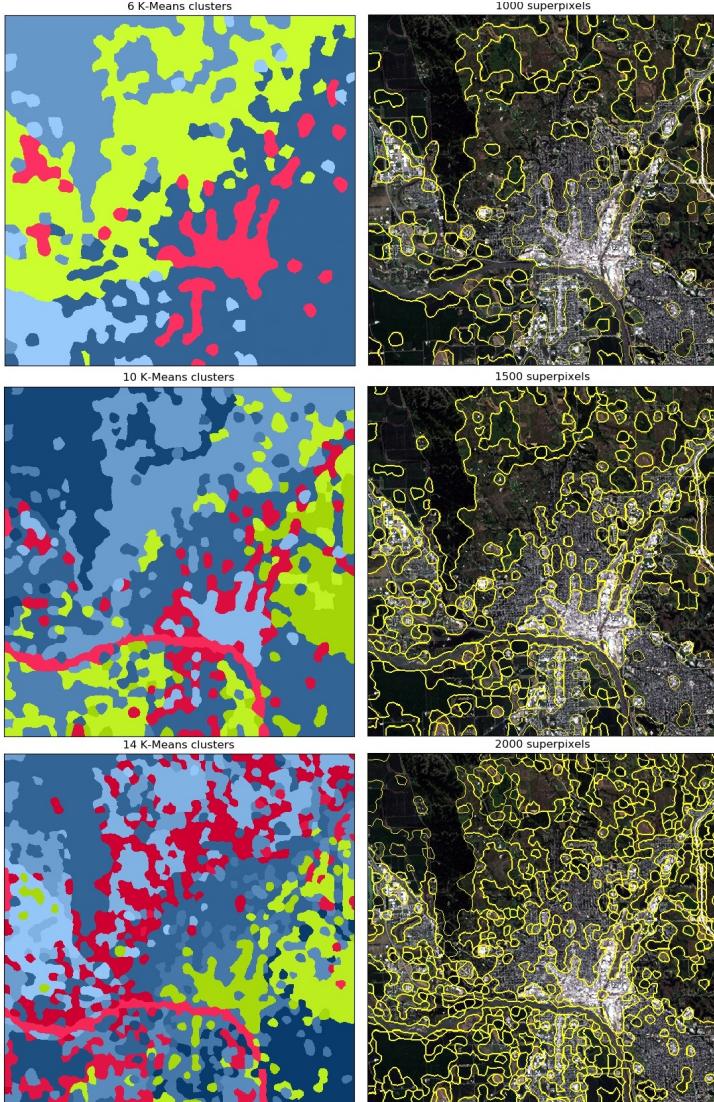


Since the color of the pixels in the big lake is the same, it is a whole cluster. Even if the number of cluster increases, they are not divided because they are the same color.

3.2 PART 2: Infrared Band

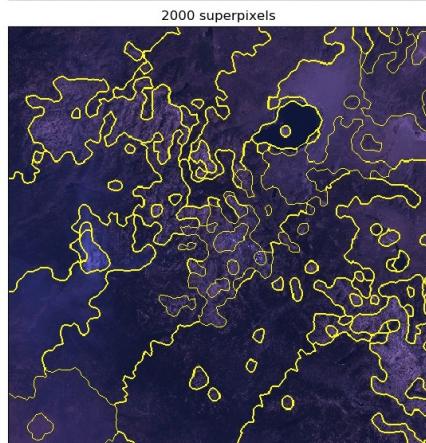
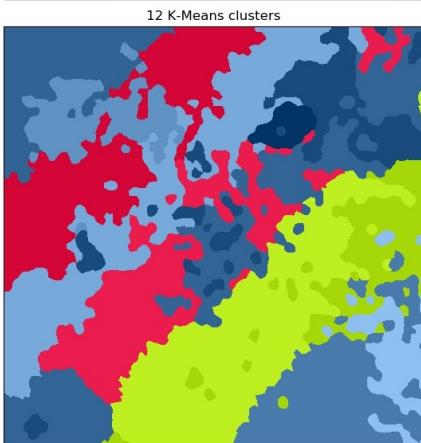
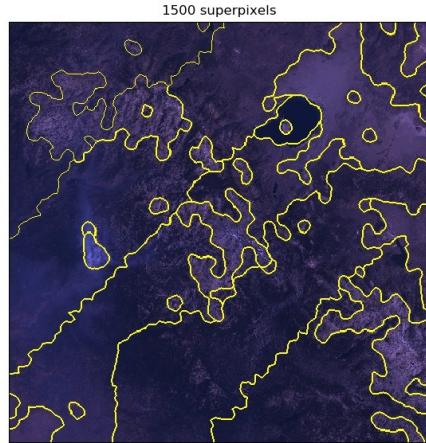
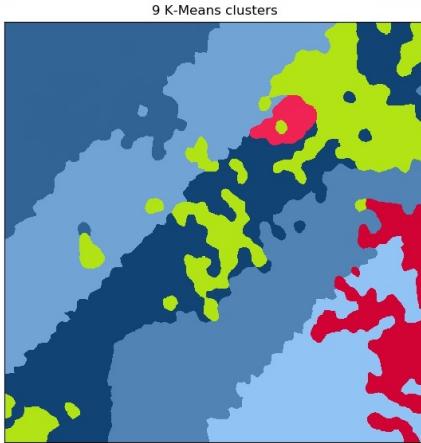
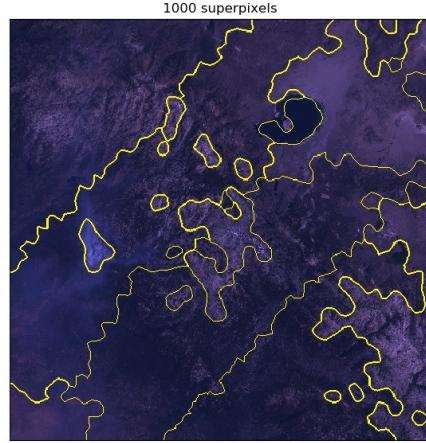
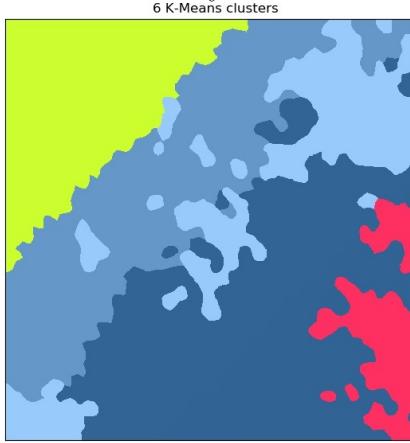
In this part, in addition to the RGB band, i have added infrared, the L channel of the LAB color space and location features.

1. Iowa:



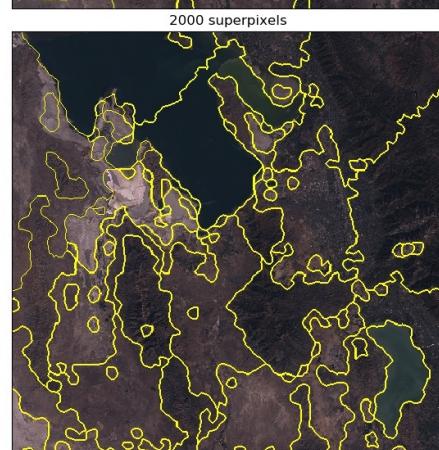
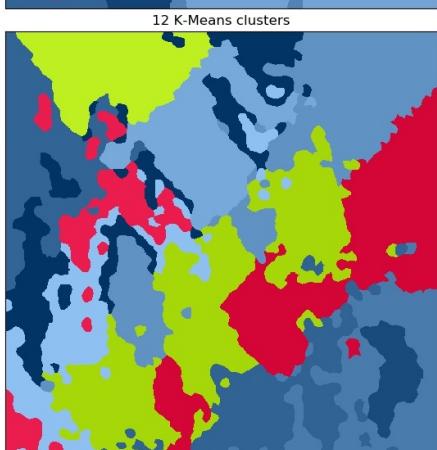
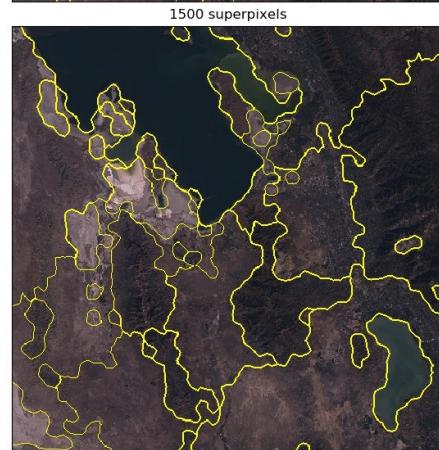
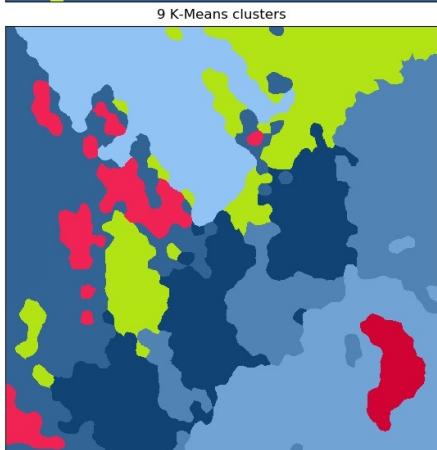
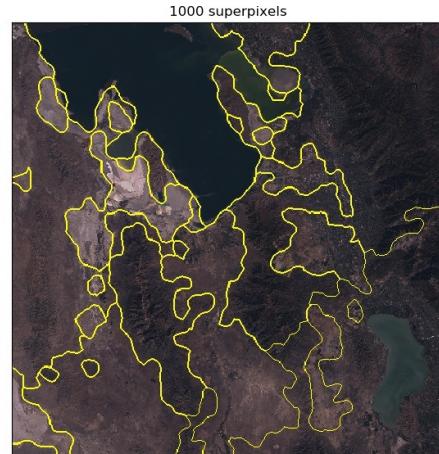
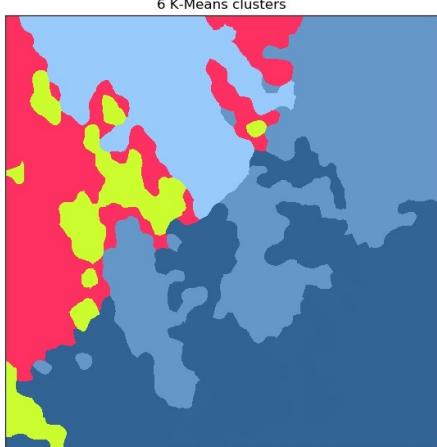
When i add the infrared band in the feature matrix, the land and the river looks separate from each other as infrared feature. Thus the river is clustered independently of land. In addition, since the location feature is also added, in segmentation, the pixels of the same color in different places are replaced with pixels that are close and the same color. Also, because there is so much variety of colors, the number of clusters should be a bit too much for the river to emerge.

2. Owens Valley:



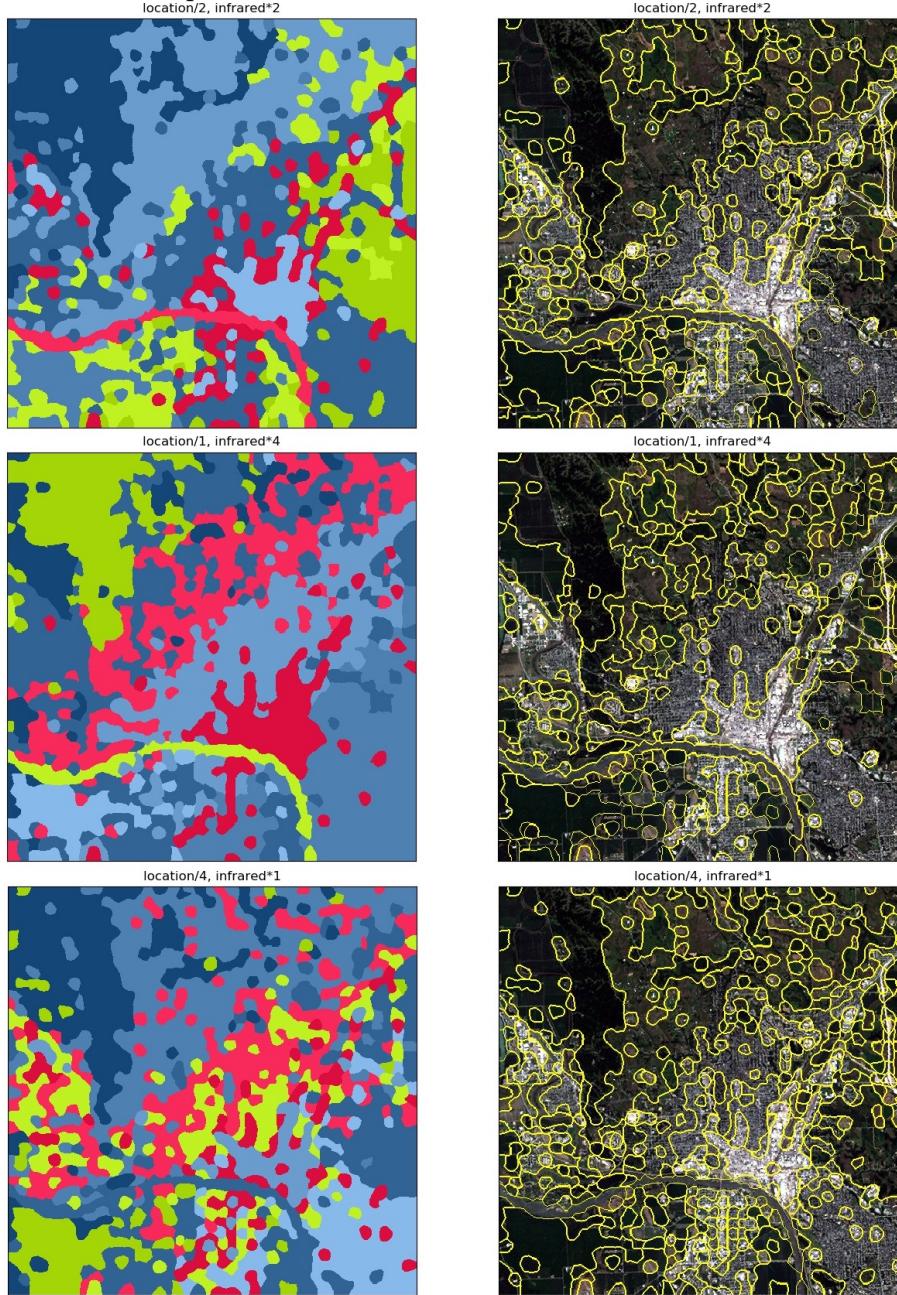
The same things is true for this picture. However, when the low number of clusters is given, the color of the pixels is similar to one another, so that the location feature outweighs. But when the number of clusters increases, more satisfactory results are produced. Small lakes becomes visible with the effect of infrared feature and soils are better segmented.

3. Salt Lake:



Here, when the number of clusters is high, the large lake is divided in to two. When the cluster number increases, the location feature is shows effect because the lake is in a very wide area. But the other lake is not affected because it is small

Features comparison:

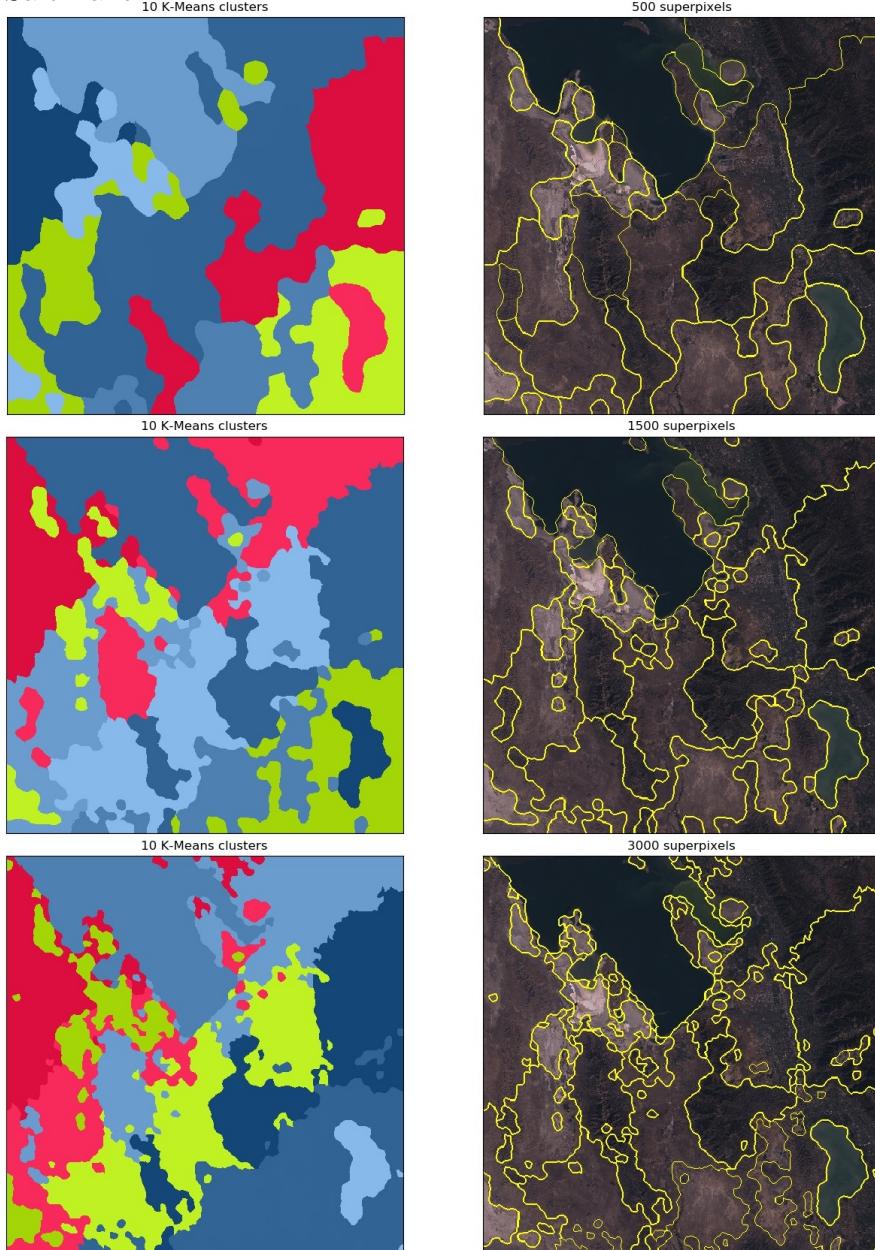


The above picture shows the results i get when i play with feature weights. The most ideal is to reduce the weight of the location feature by dividing into two and multiply the infrared feature by two for increase the weight. But as shown in the bottom picture, if the location feature weight is reduced to much, segmentation becomes irregular. Also if i increase the infrared weight too much, the places outside the river are not much good segmented like the top of the mid picture.

Superpixel Segmentation Effect:

9 K-Means clusters with 500,1500,3000 superpixels

Salt Lake:

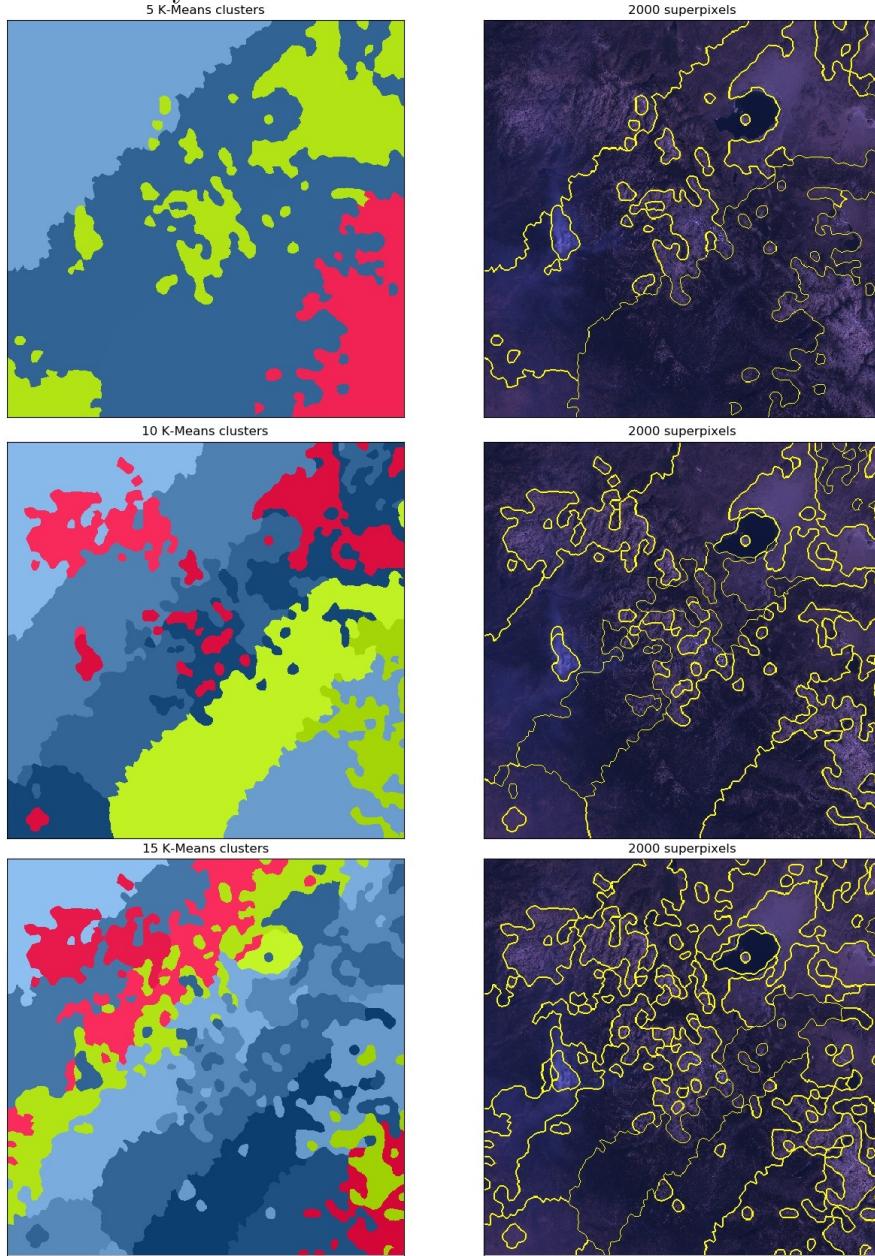


For example in salt lake, in fact the number of 500 superpixel does not look bad, 3000 superpixels revealing unnecessary details, but around 1500 superpixels looks good.

K-Means Clusters Effect:

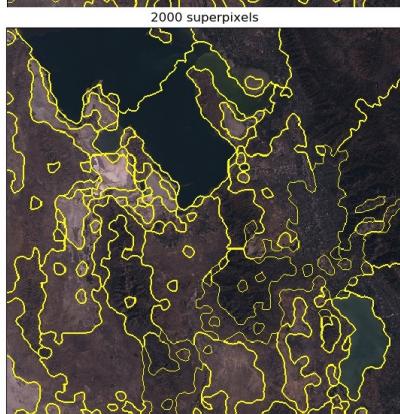
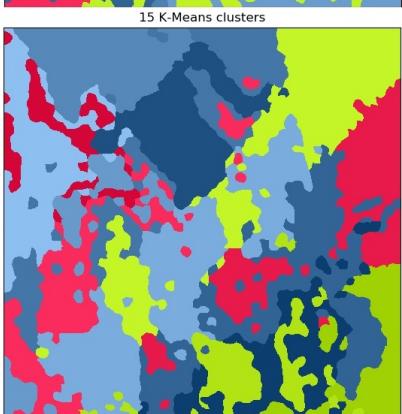
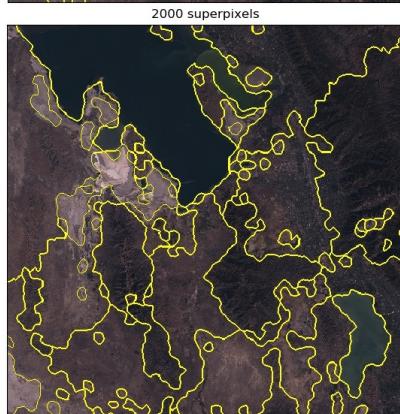
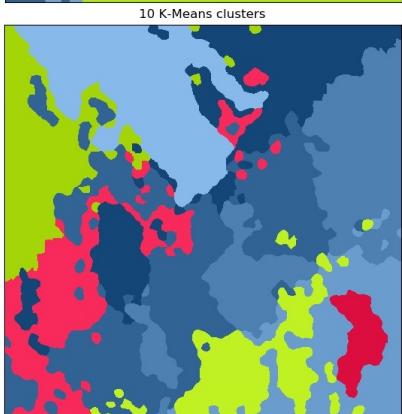
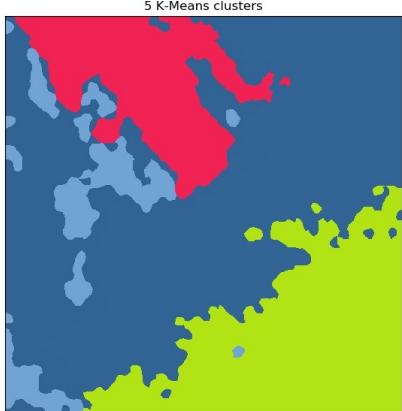
2000 superpixels, 5 k-means - 10 k-means - 15 k-means

Owens Valley



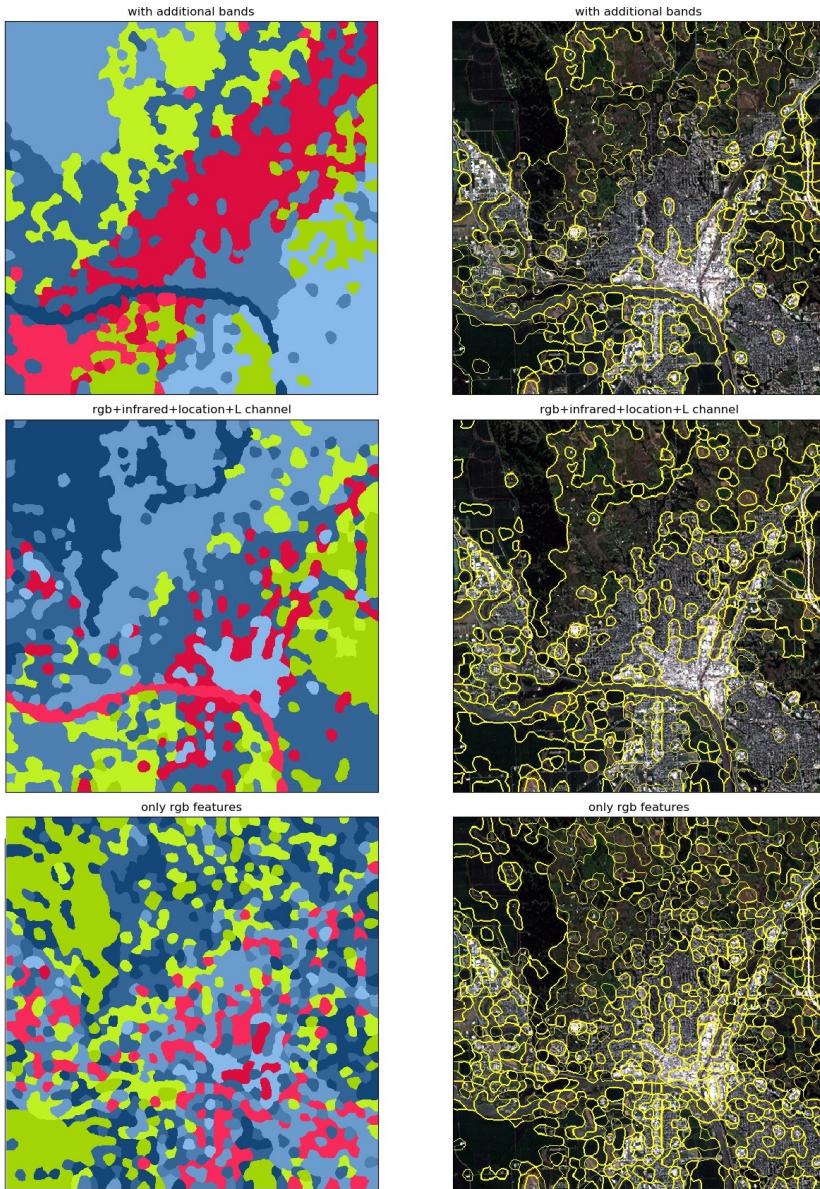
Here in fact, the segmentation with low clusters stands not bad but better to increase for show details and location features

Salt Lake.



When the number of cluster increases too much, the location feature is manifested and also the clutter increases

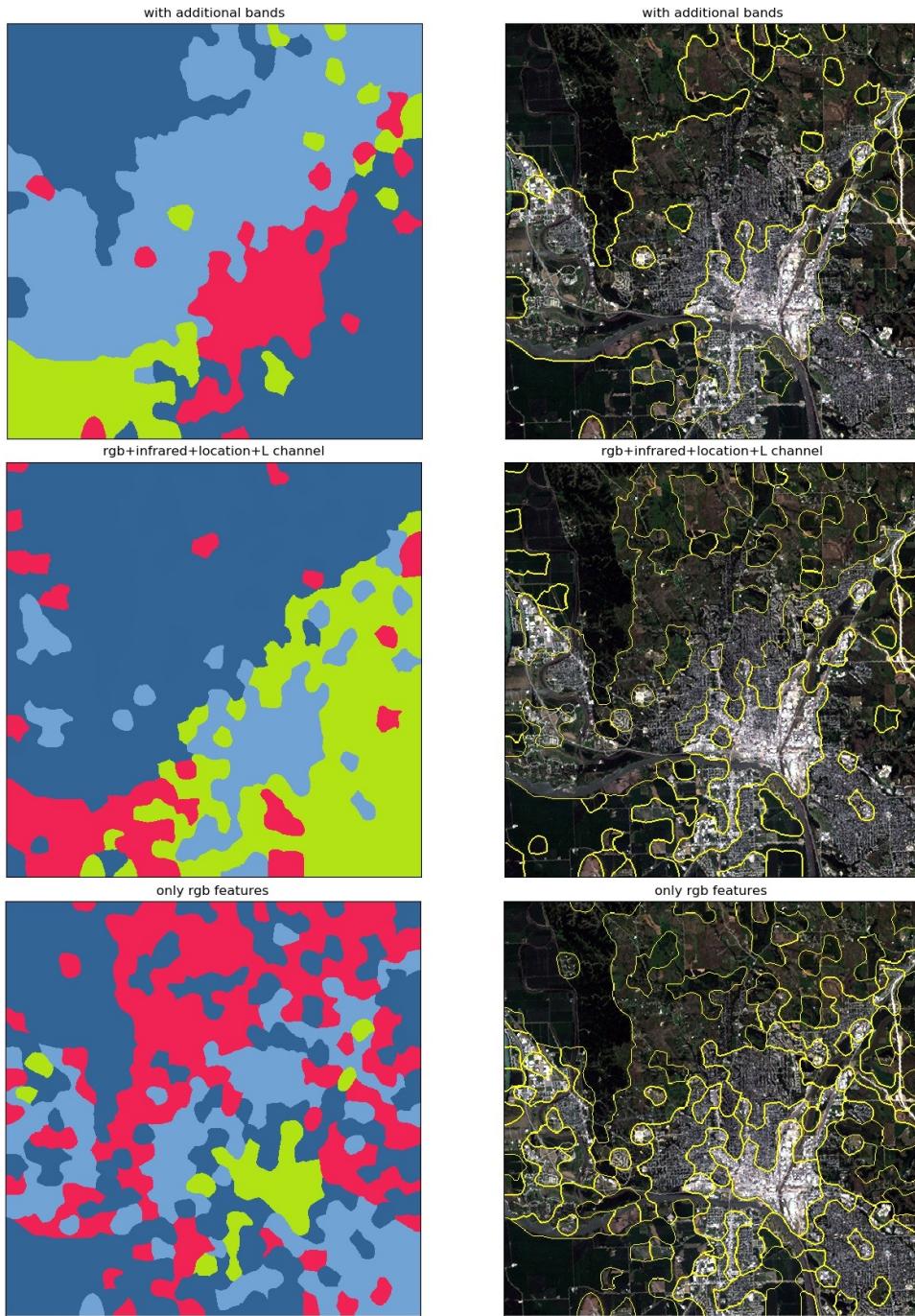
3.3 PART 3: Additional Bands



This image has 10 clusters and 1500 segmentations. I think these are the most ideal numbers.

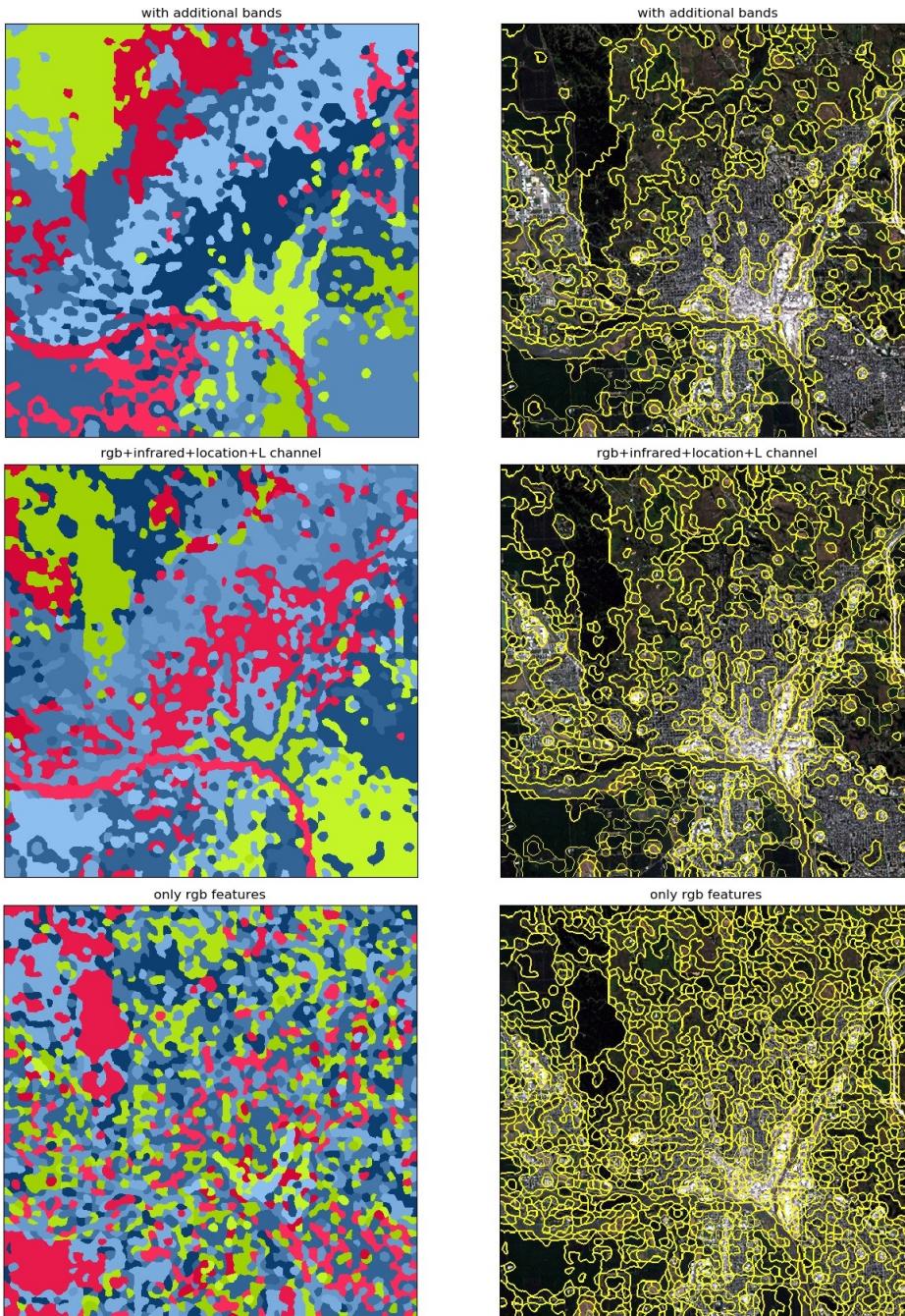
In first part only with rgb, in second part rgb + (L)AB channel + location + infrared and in this part 3 i append middle infrared and far infrared bands.

In the part2 image, the reason why the river is obvious is that i increased the infrared weight. Normally it's not that obvious. But with appended mid and far infrared, it did more effective segmentation in flat areas besides increasing river obvious.



This image has 5 clusters and 500 segmentations.

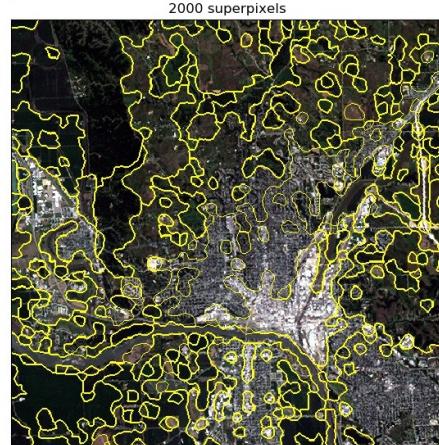
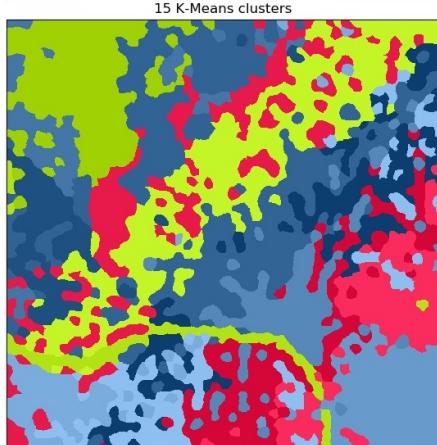
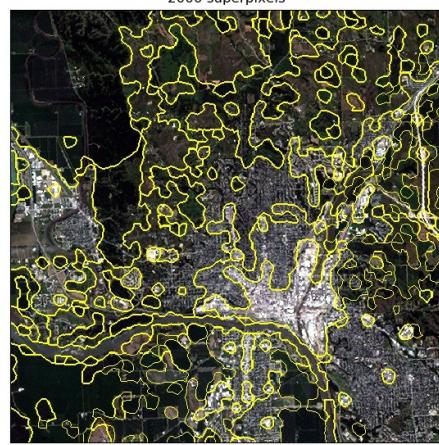
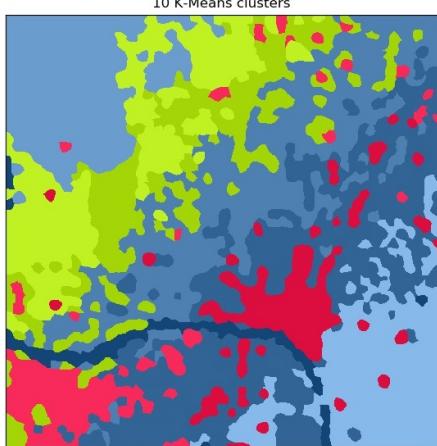
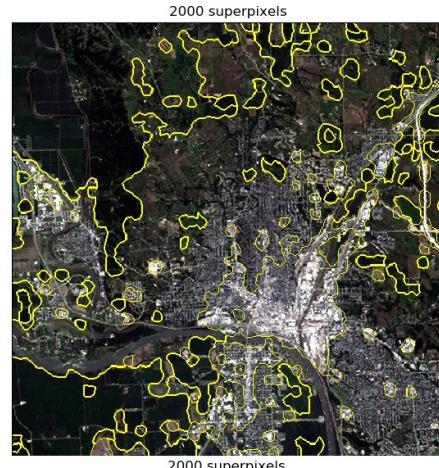
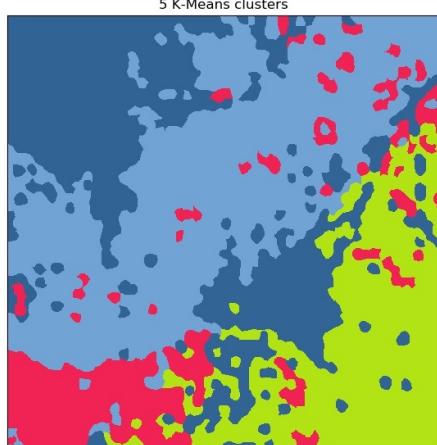
When the features added here, for example, the left above green place is separated clearly and accurately.



This image has 15 clusters and 3000 segmentations.

If we only look at rgb bands, there is complexity everywhere because of the variety of colors. Also segmentation becomes more regular than part2 image when additional bands are added.

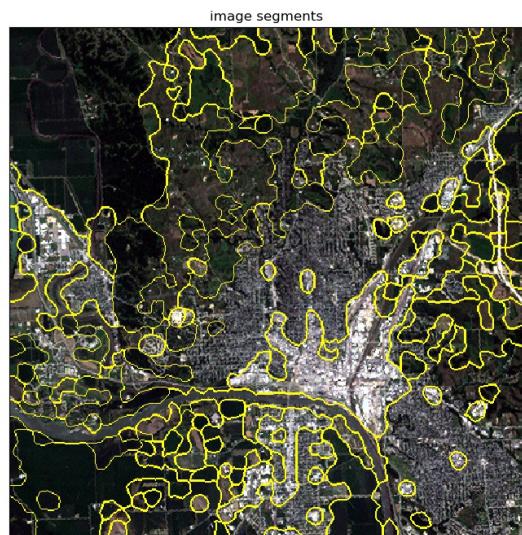
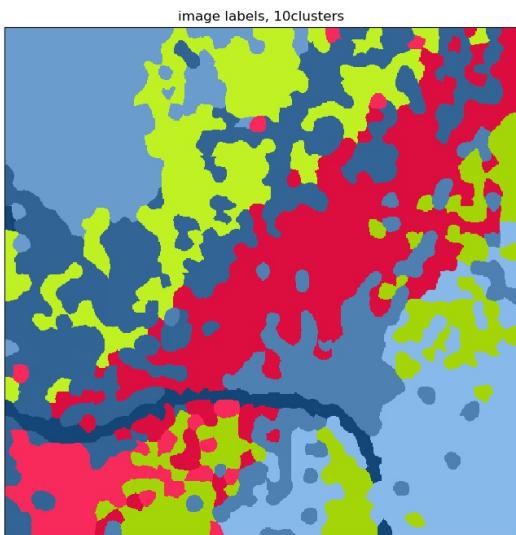
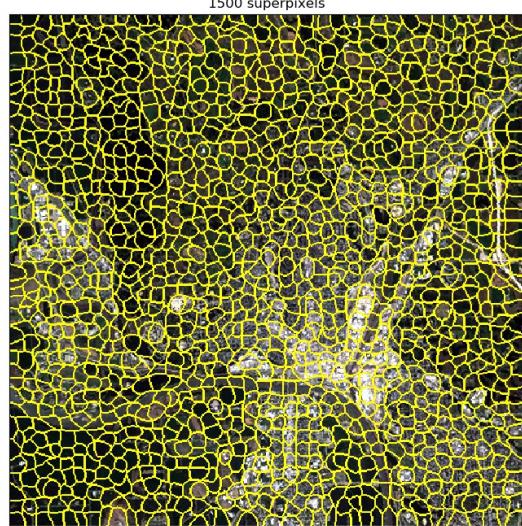
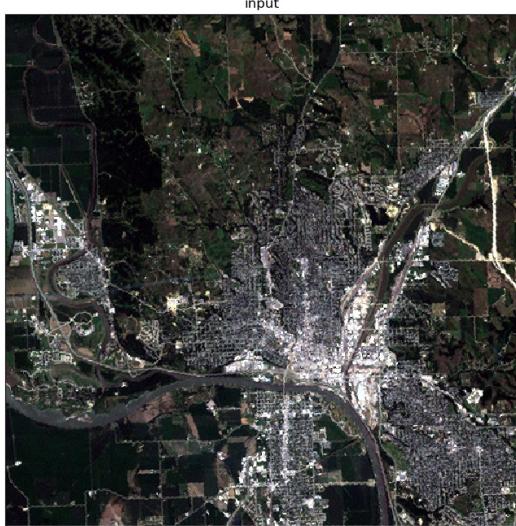
cluster effect:



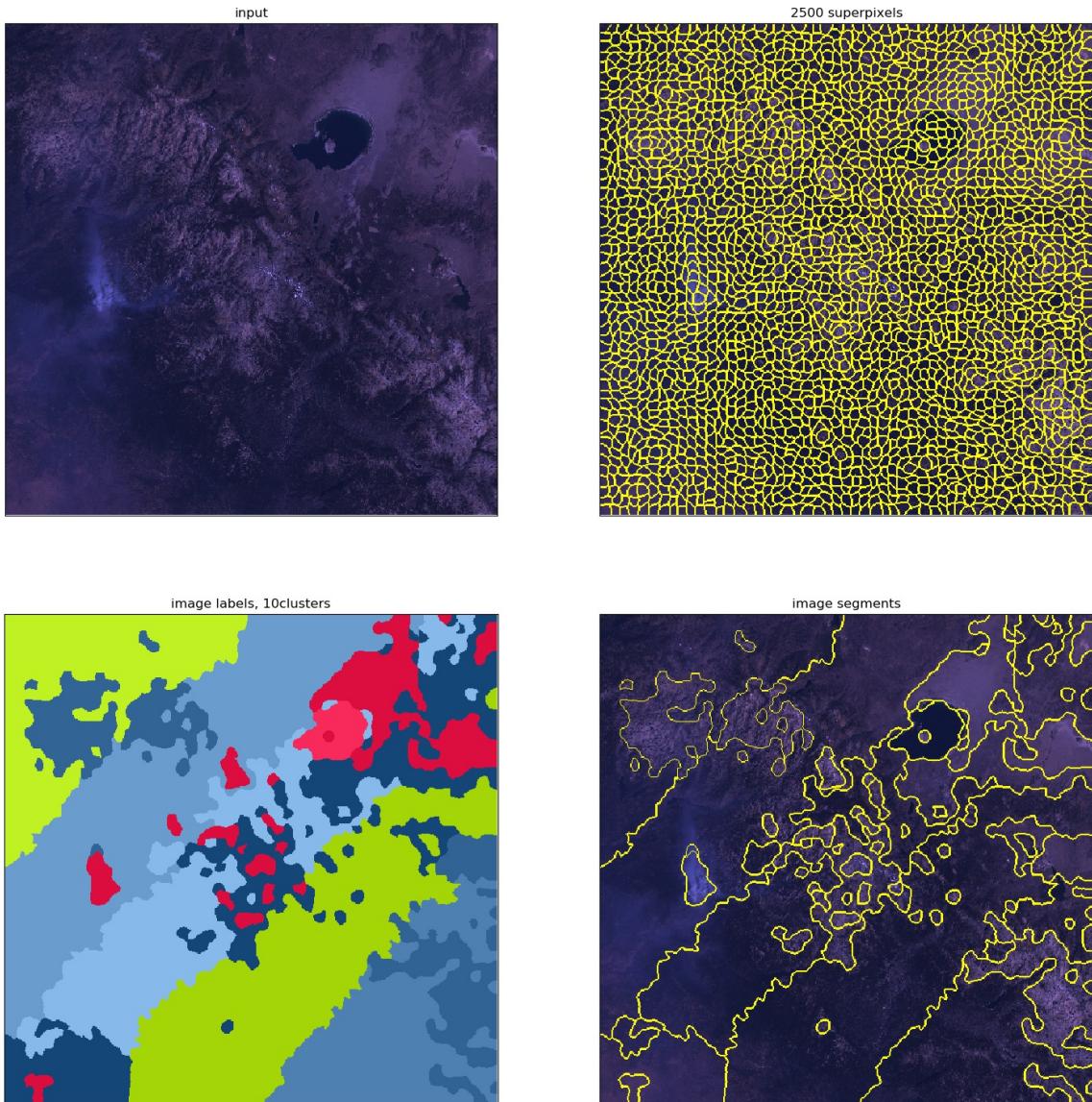
Details escape when the number of clusters decrease, for example the river disappears. But when the number of clusters is high, the complexity in the picture is increasing and it doesn't look good.

3.4 Best Results and Comments

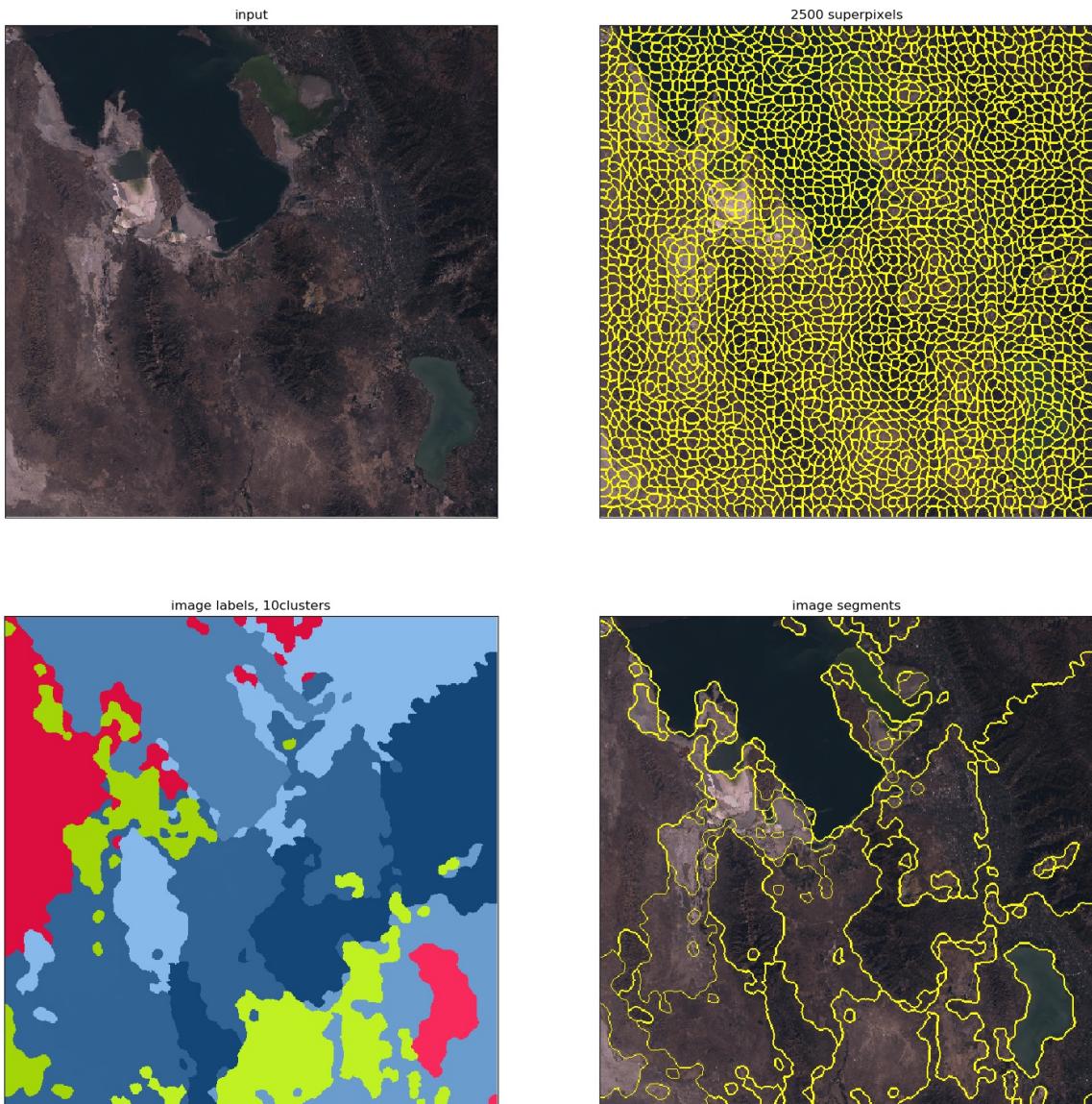
I think these are the best results i did get:



I did not give much number of superpixels in this picture as much as the others because there are many kinds of pixels. If the number of superpixels were more than the number of junk small segments would be more and complexity would increase. I also increased the weight of the infrared feature to make the river more visible and i used other infrared bands. These are middle infrared and far infrared. Thus, especially the river was more visible and segmentation became more regular.



2500 superpixels good for this image. Because the pixels already look alike and if i kept the number of superpixels low, it would be difficult for me to do the correct segmentation and i would not catch the differences on the superpixels. Also since the pixels already look alike location feature becomes more effective and boundaries are looks like line. I reduced location feature weight and increased the infrared feature weight. That's why small lakes can appear.



I think 10 clusters are the ideal number and it shows more segmentation details. In this picture, I increased the infrared weight to keep the lakes complete. If the infrared weight did not increase, the location feature appears and large lake was divided into two or the small lake did not appear.

4 Conclusion

This assignment taught me comprehensive knowledge about segmentation. Effects of superpixel numbers, K-means segmentation, feature vector, image features and the importance of each feature, image band types etc. I have very different results and they all have a separate explanation. I tried to get the most successful results by playing with arguments and I tried to show their differences. It was a good but hard experiment.