CE-712: Digital Image Processing of Remotely Sensed Data

Laboratory Exercise #

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Lab Part I

4*4 matrices

```
>> a=[[4:2:10];[1,12,4,8];rand(1,4);[1,2,3,4]]

a =

    4.0000    6.0000    8.0000   10.0000
    1.0000   12.0000    4.0000    8.0000
    0.6557    0.0357    0.8491    0.9340
    1.0000    2.0000    3.0000    4.0000
```

```
>> b= rand(4,4)

b =

    0.6324    0.9575    0.9572    0.4218
    0.0975    0.9649    0.4854    0.9157
    0.2785    0.1576    0.8003    0.7922
    0.5469    0.9706    0.1419    0.9595
```

4*1 vector

```
>> c= [9,8,7,6]

c =

     9     8     7     6
```

Basic operations on a and b

```
>> a_transpose = a'

a_transpose =

    4.0000    1.0000    0.6557    1.0000
    6.0000   12.0000    0.0357    2.0000
    8.0000    4.0000    0.8491    3.0000
   10.0000    8.0000    0.9340    4.0000

>> b_transpose = b'

b_transpose =

    0.6324    0.0975    0.2785    0.5469
    0.9575    0.9649    0.1576    0.9706
    0.9572    0.4854    0.8003    0.1419
    0.4218    0.9157    0.7922    0.9595

>> mult_a_b = a*b

mult_a_b =

   10.8115   20.5862   14.5620   23.1140
    7.2919   20.9314   11.1179   22.2554
    1.1654    1.7027    1.4570    1.8781
    3.8505    7.2425    4.8963    8.4678

>> div_a_b = a/b

div_a_b =

    0.9632    1.9172    7.3023    2.1398
    1.6756   11.5642   -3.9953   -0.1369
    0.0457   -0.8196    1.4008    0.5790
   -0.2491    1.5359    3.0652    0.2818

>> div_a_b_rev = a\b

div_a_b_rev =

    0.4655   -0.1728    2.6674    2.1966
   -0.5219   -0.4990   -0.8938   -1.6578
   -1.8224   -1.4216   -5.0096   -7.2281
    1.6481    1.6016    3.5728    5.9407
```

Genreating three 5*5 random array

```
>> arr0_5_5 = rand(5,5)

arr0_5_5 =

    0.8173    0.8001    0.1455    0.1450    0.4018
    0.8687    0.4314    0.1361    0.8530    0.0760
    0.0844    0.9106    0.8693    0.6221    0.2399
    0.3998    0.1818    0.5797    0.3510    0.1233
    0.2599    0.2638    0.5499    0.5132    0.1839

>> arr1_5_5 = rand(5,5)

arr1_5_5 =

    0.9293    0.4733    0.9172    0.5678    0.9340
    0.3500    0.3517    0.2858    0.0759    0.1299
    0.1966    0.8308    0.7572    0.0540    0.5688
    0.2511    0.5853    0.7537    0.5308    0.4694
    0.6160    0.5497    0.3804    0.7792    0.0119

>> arr2_5_5 = rand(5,5)

arr2_5_5 =

    0.3371    0.1656    0.7482    0.1524    0.4427
    0.1622    0.6020    0.4505    0.8258    0.1067
    0.7943    0.2630    0.0838    0.5383    0.9619
    0.3112    0.6541    0.2290    0.9961    0.0046
    0.5285    0.6892    0.9133    0.0782    0.7749
```

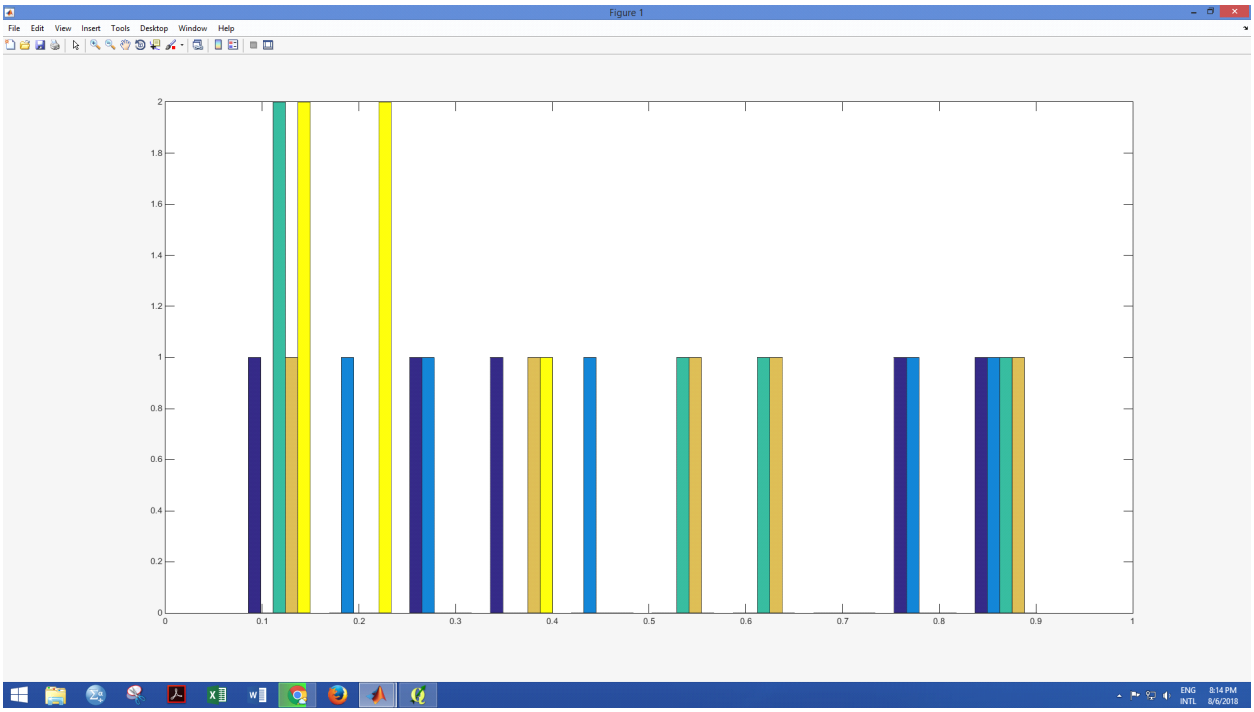
Concatenating array:

```
>> concat_a_b_multAB = cat(3,a,b,mult_a_b)

concat_a_b_multAB(:,:,1) =

    4.0000    6.0000    8.0000   10.0000
    1.0000   12.0000    4.0000    8.0000
    0.6557    0.0357    0.8491    0.9340
    1.0000    2.0000    3.0000    4.0000


concat_a_b_multAB(:,:,2) =

    0.6324    0.9575    0.9572    0.4218
    0.0975    0.9649    0.4854    0.9157
    0.2785    0.1576    0.8003    0.7922
    0.5469    0.9706    0.1419    0.9595


concat_a_b_multAB(:,:,3) =

   10.8115   20.5862   14.5620   23.1140
    7.2919   20.9314   11.1179   22.2554
    1.1654    1.7027    1.4570    1.8781
    3.8505    7.2425    4.8963    8.4678
```

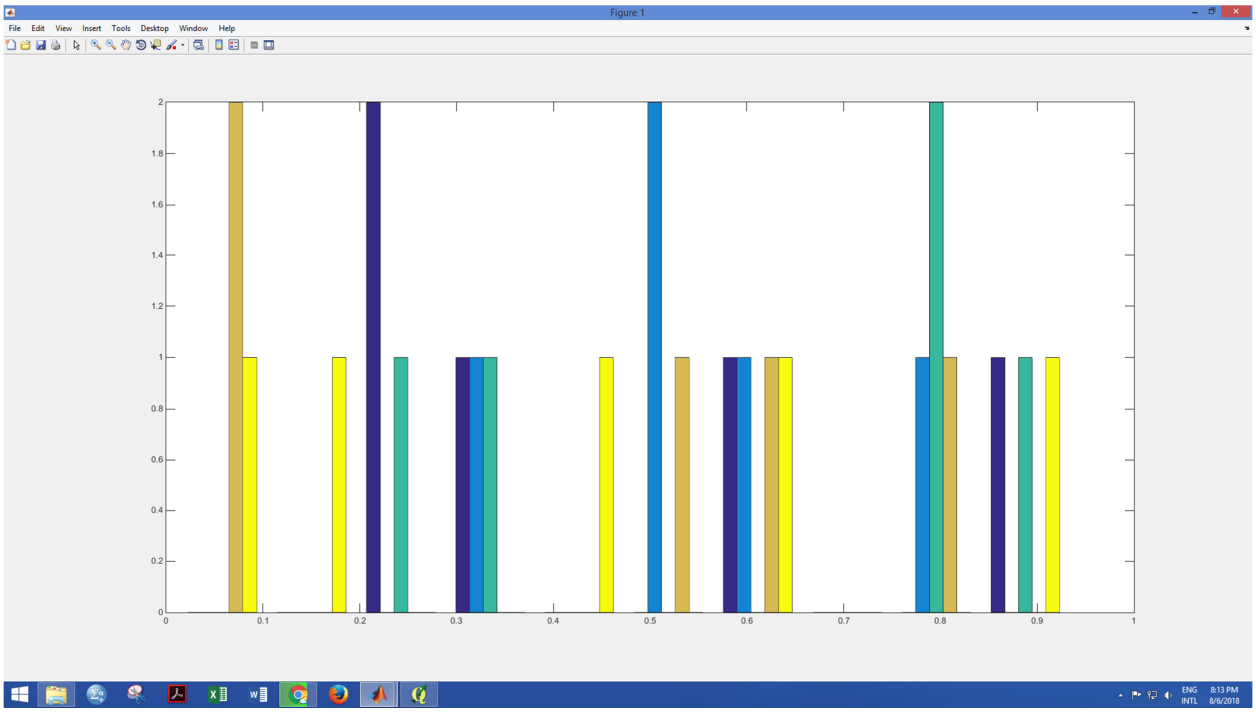
Multiplication of vector and constant with matrix:

```
>> mult_c_a = c*a

mult_c_a =

   54.5902  162.2500  127.9439  184.5380

>> mult_2_a = 2*a

mult_2_a =

    8.0000   12.0000   16.0000   20.0000
    2.0000   24.0000    8.0000   16.0000
    1.3115    0.0714    1.6983    1.8680
    2.0000    4.0000    6.0000    8.0000
```

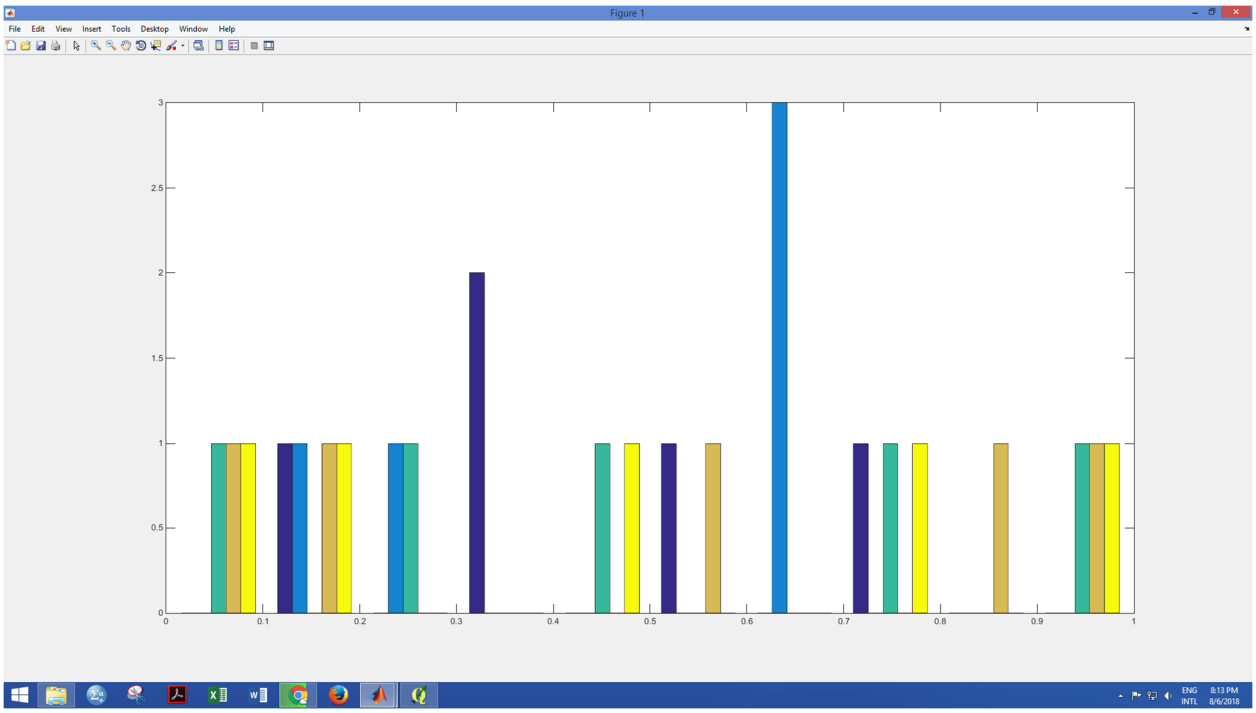
Histogram_Array_1:



Histogram_array_2:



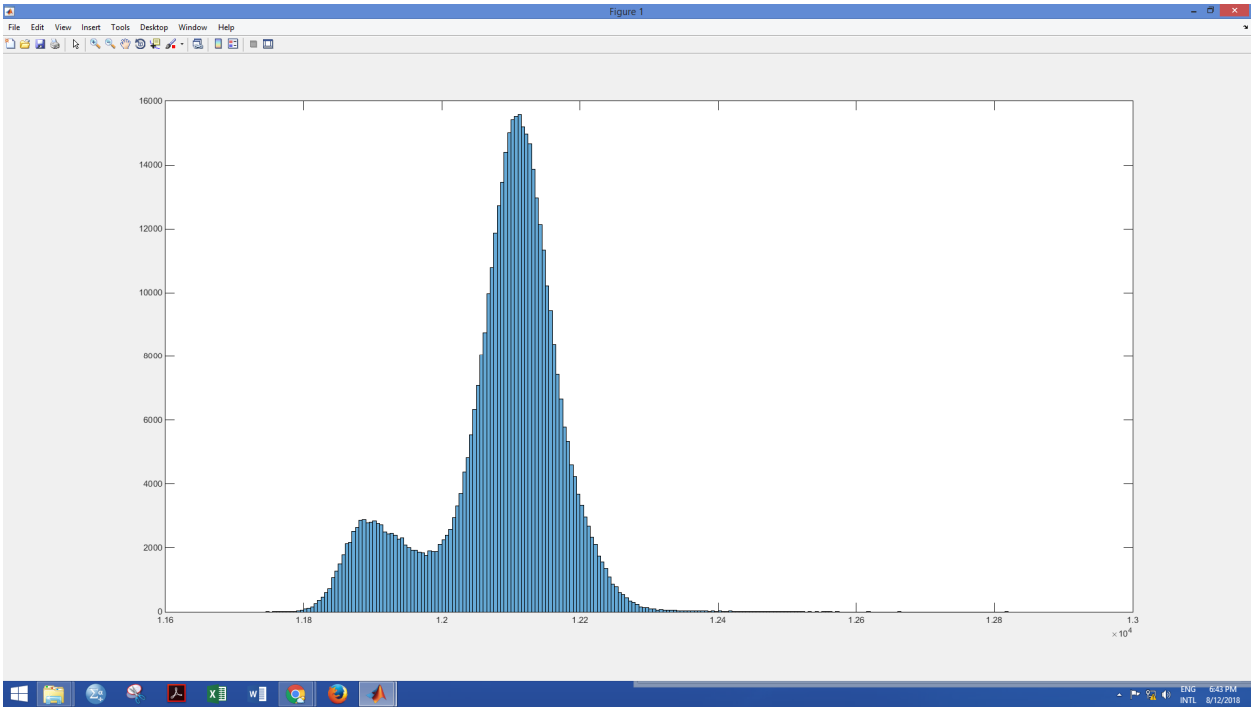
Histogram_array_3:



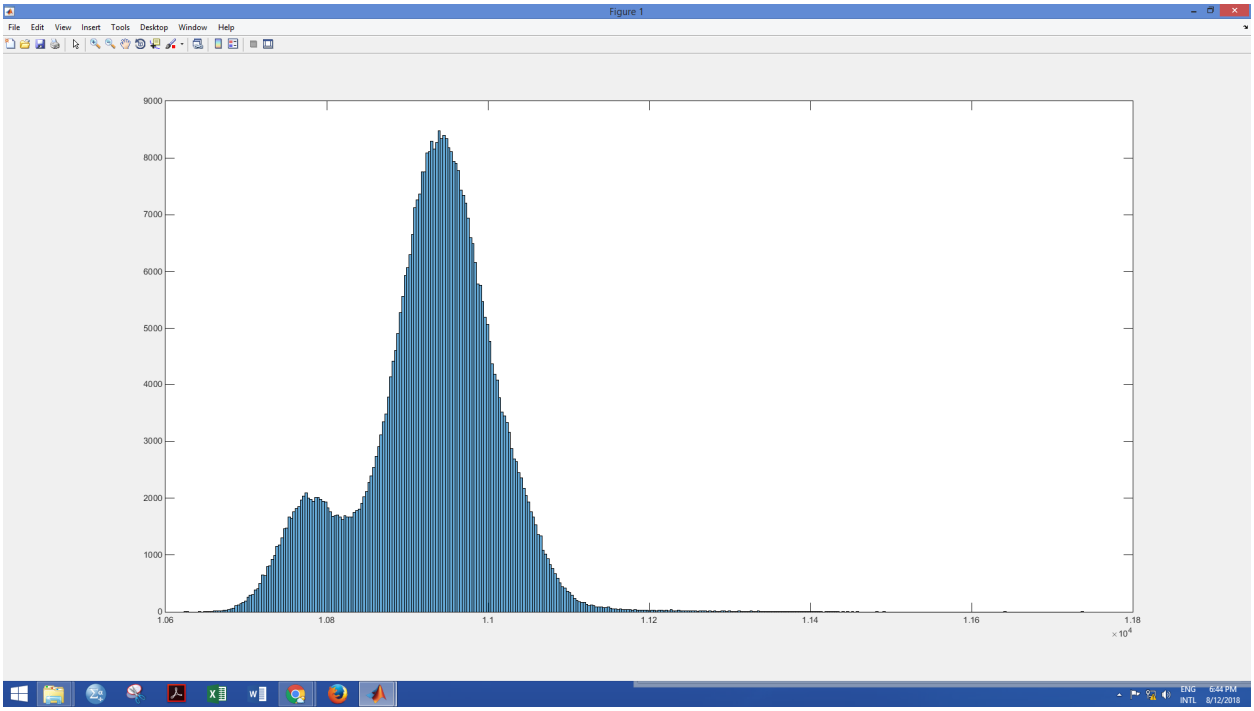
Lab Part II:

Histogram for ocean:

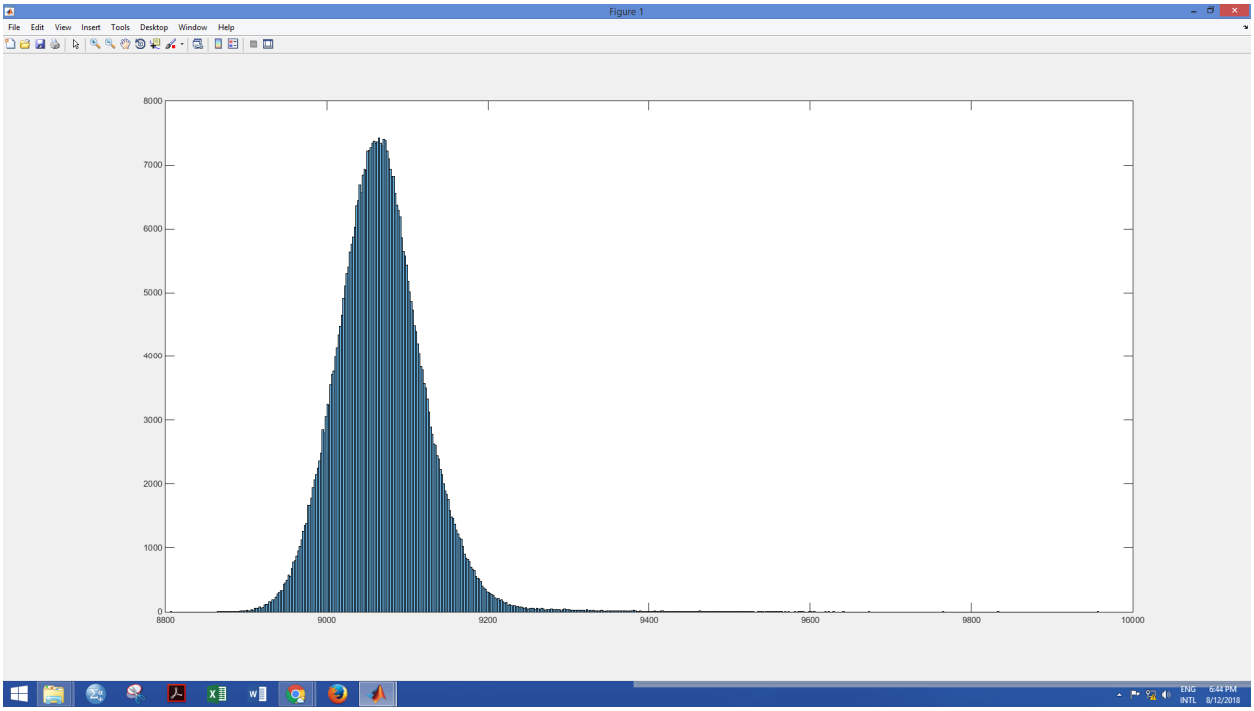
Ocean Band 1:



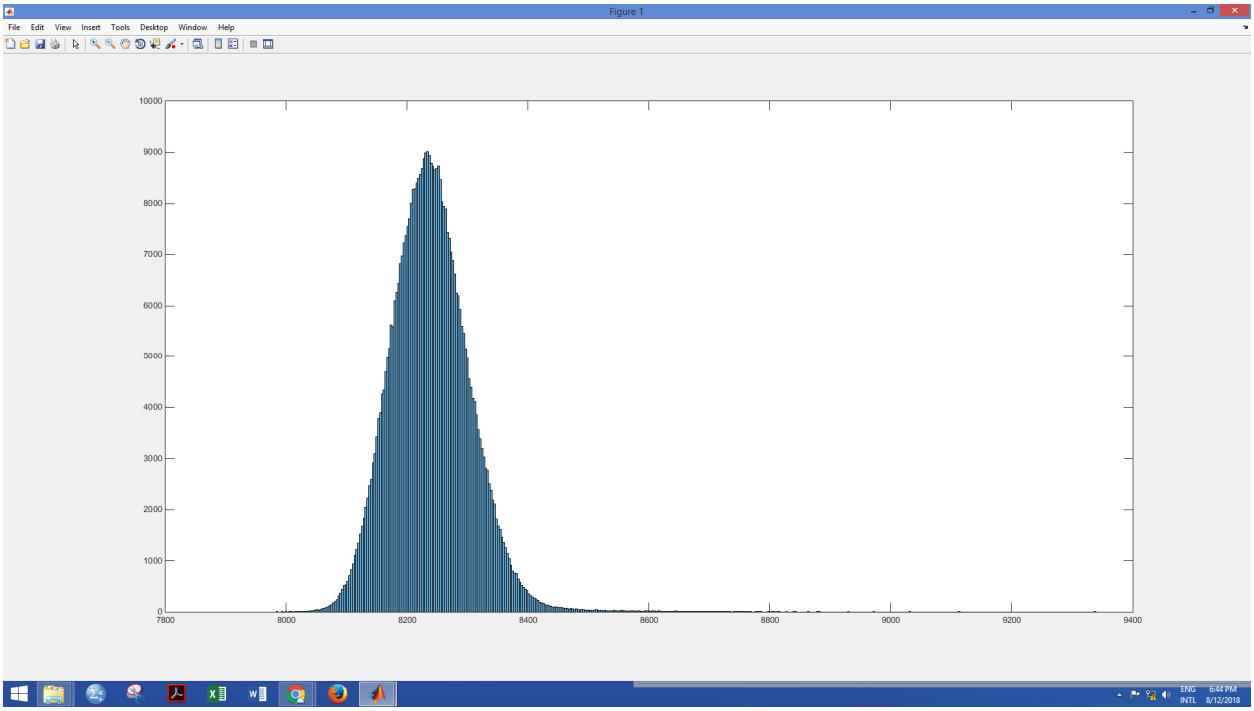
Ocean Band 2:



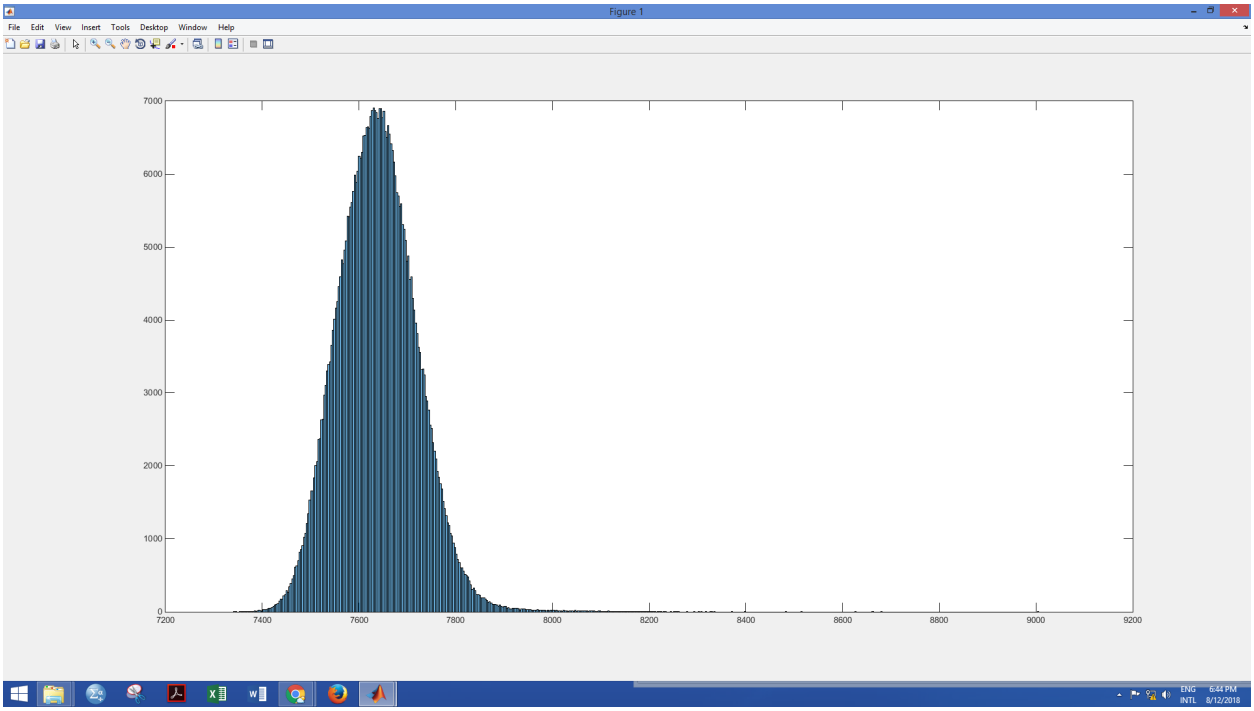
Ocean Band 3:



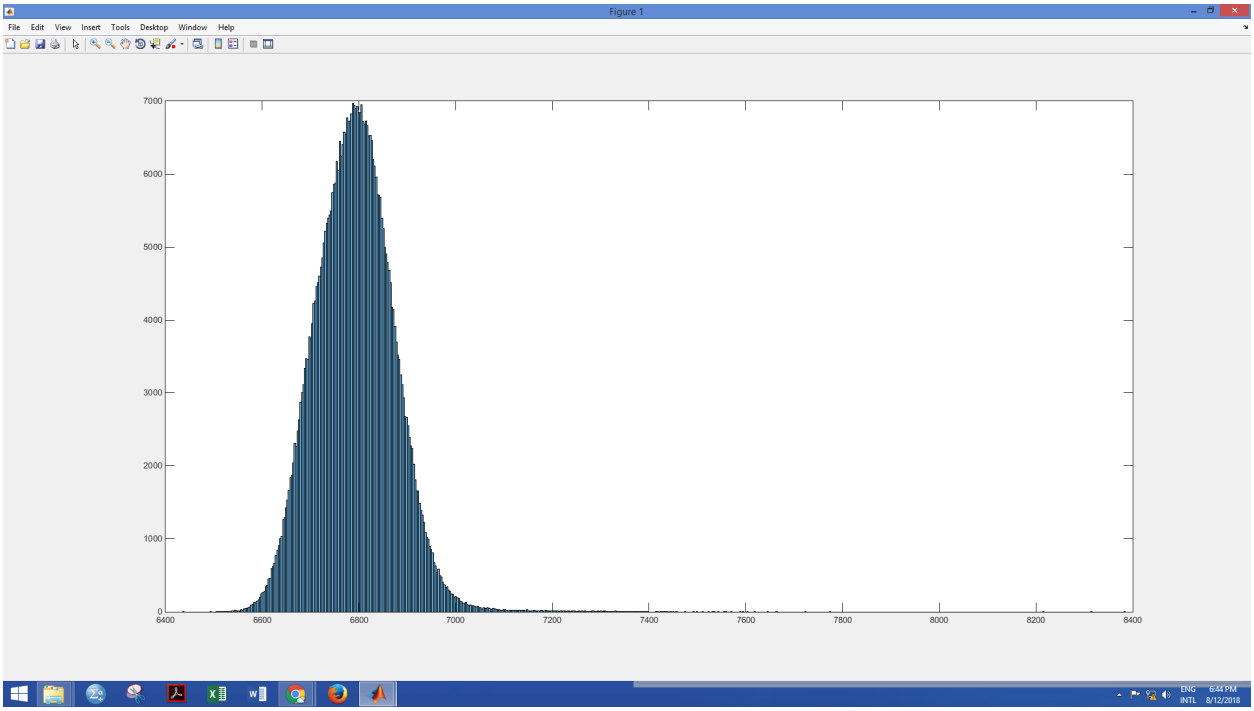
Ocean Band 4:



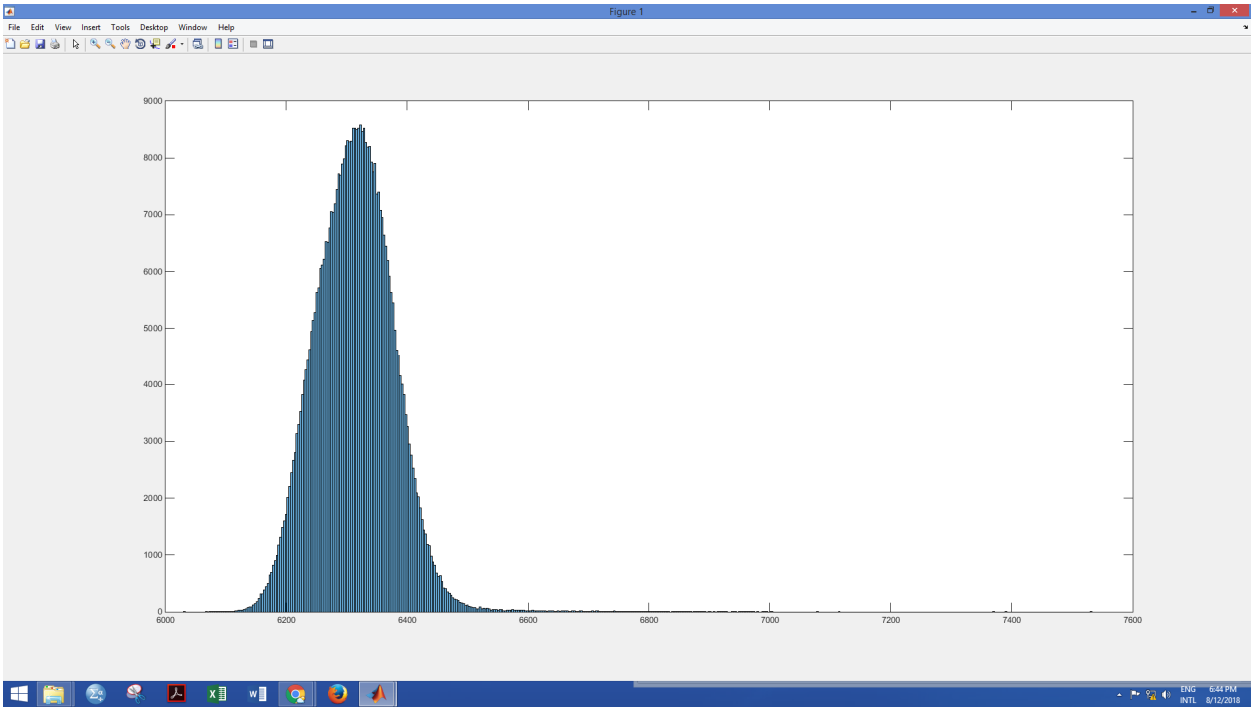
Ocean Band 5:



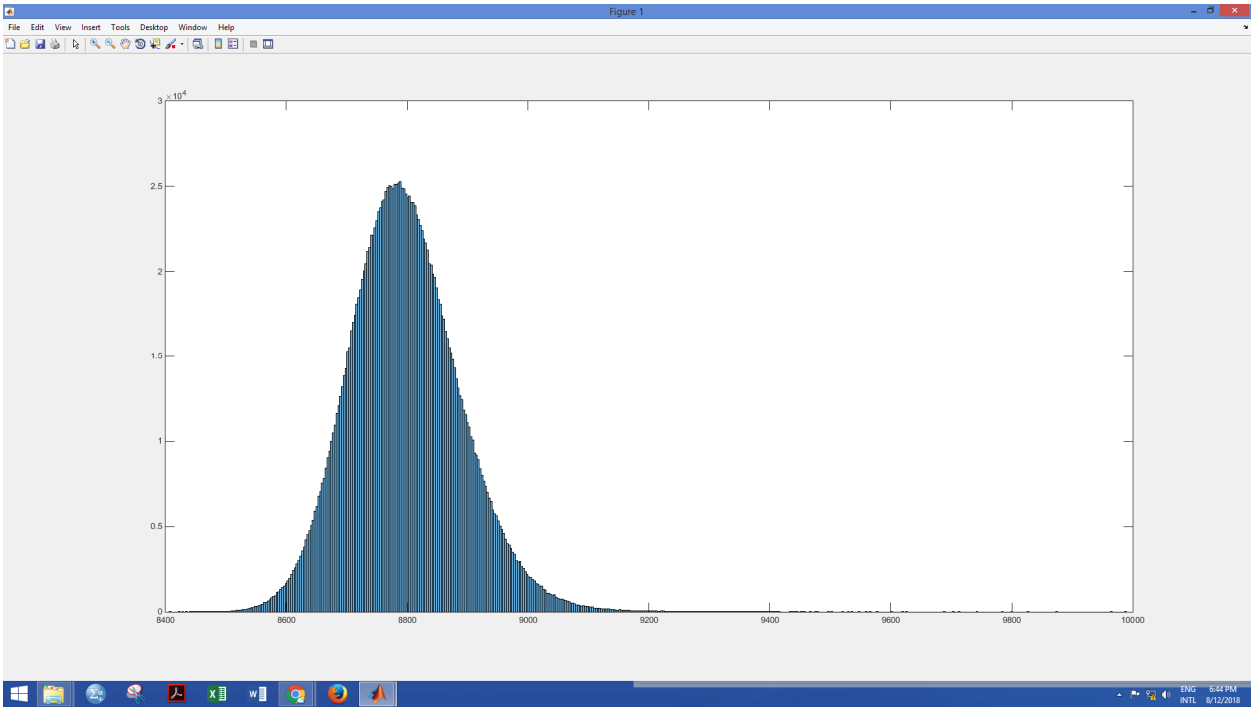
Ocean Band 6:



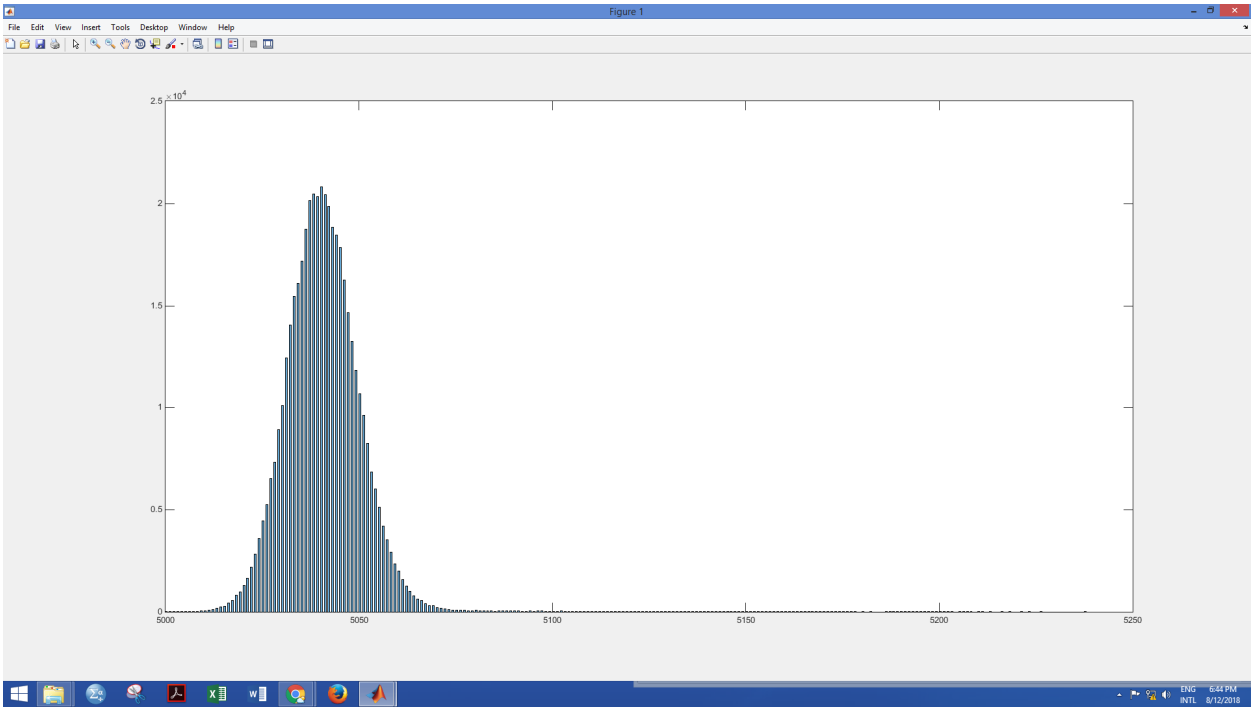
Ocean Band 7:



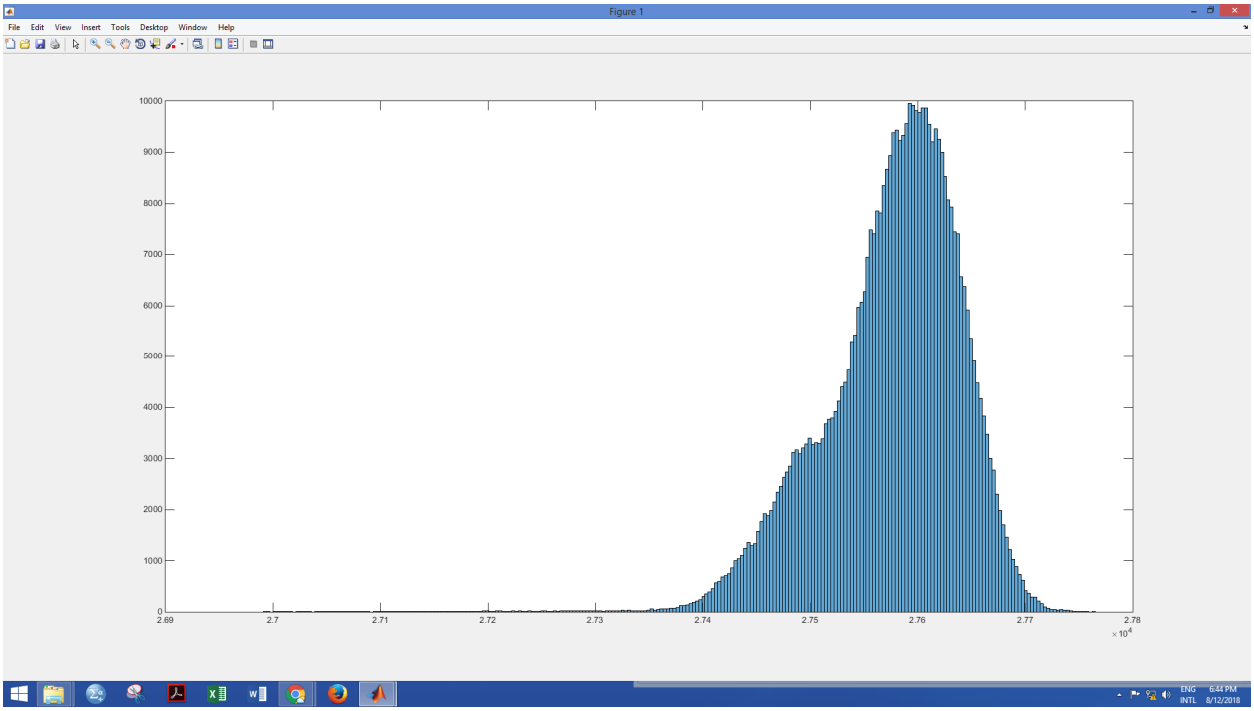
Ocean Band 8:



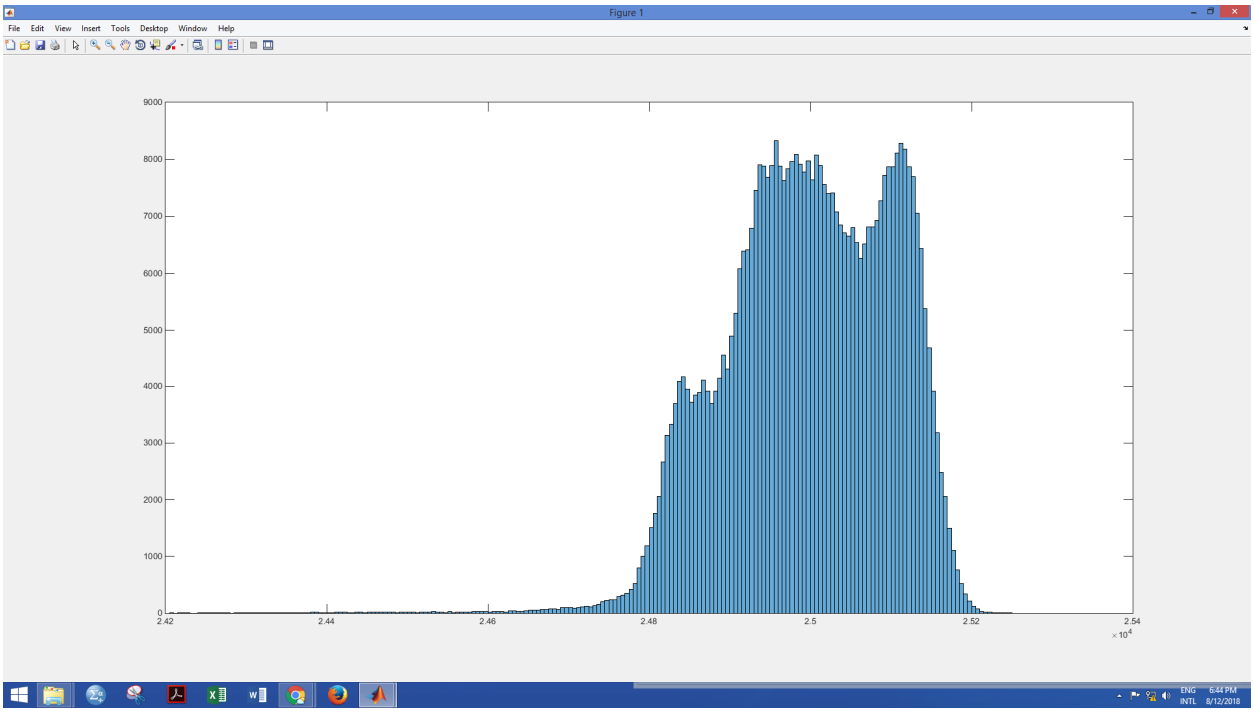
Ocean Band 9:



Ocean Band 10:

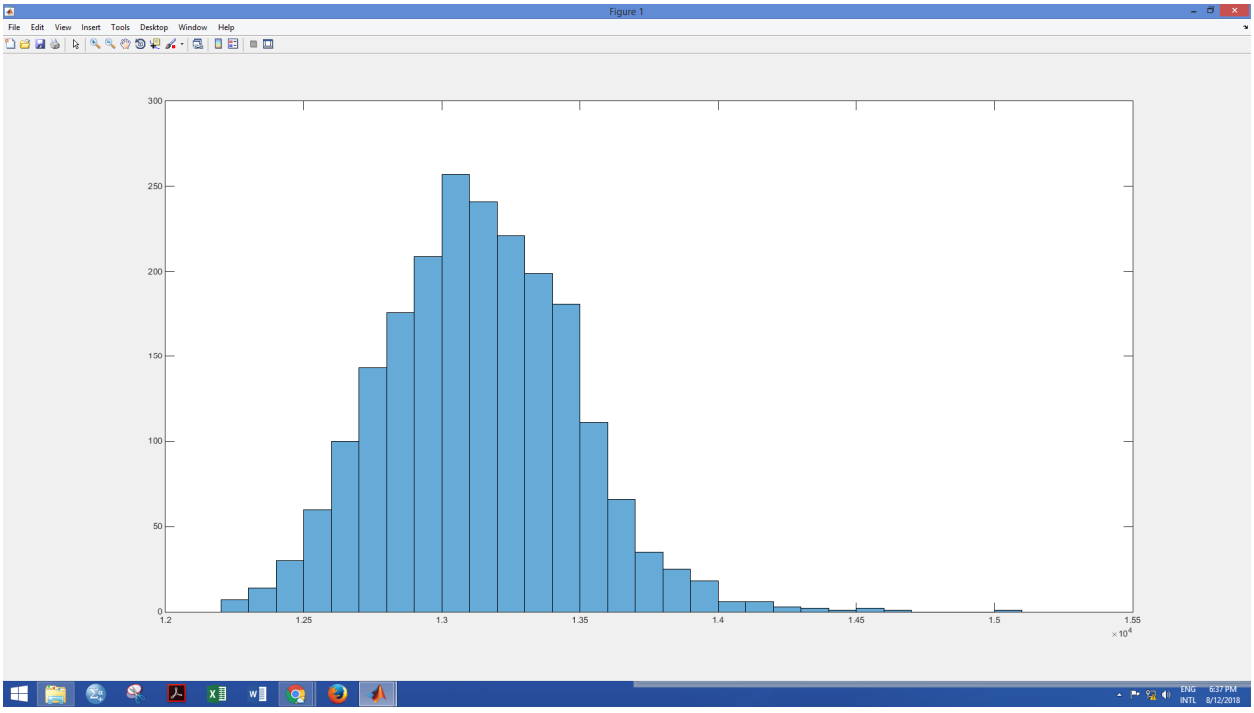


Ocean Band 11:

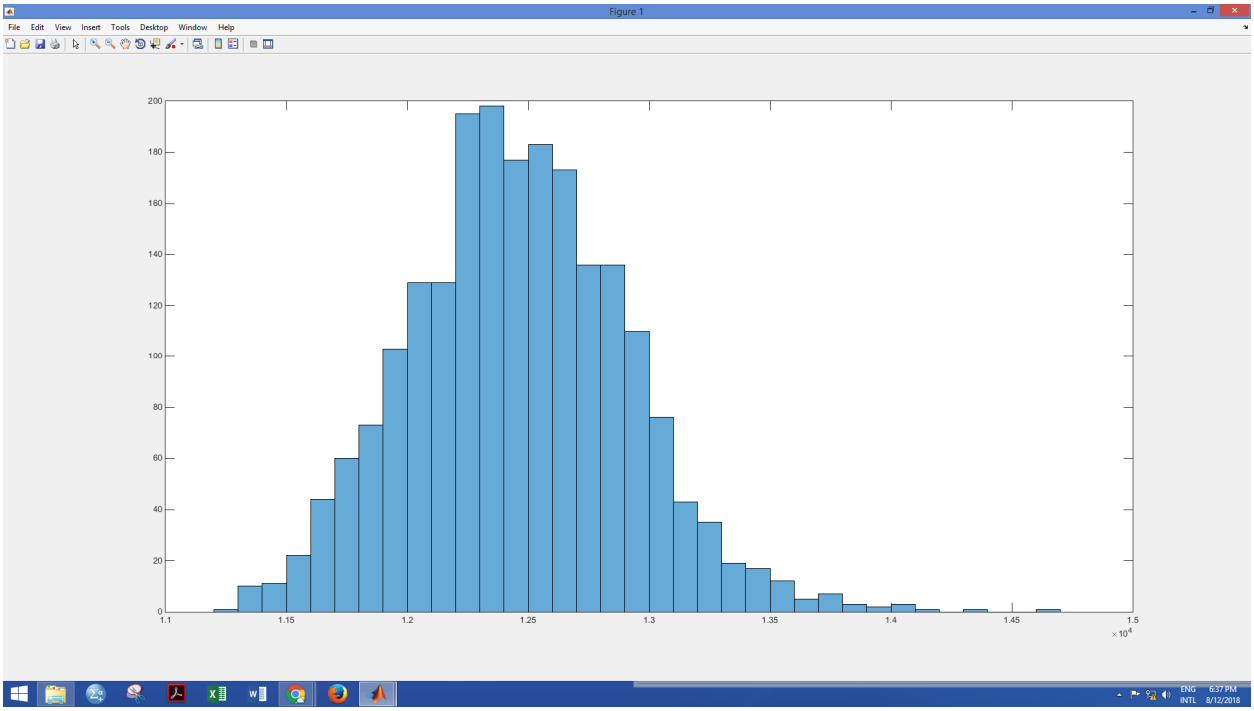


Histogram for Buildings:

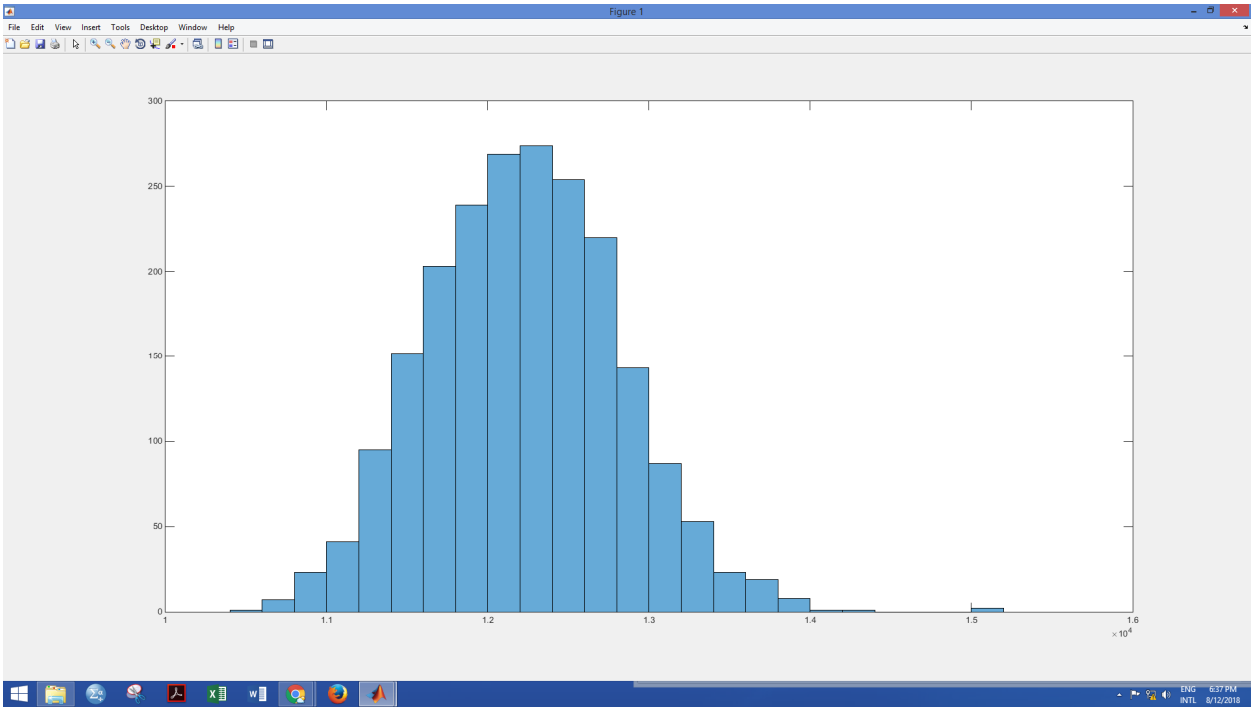
Buildings Band 1:



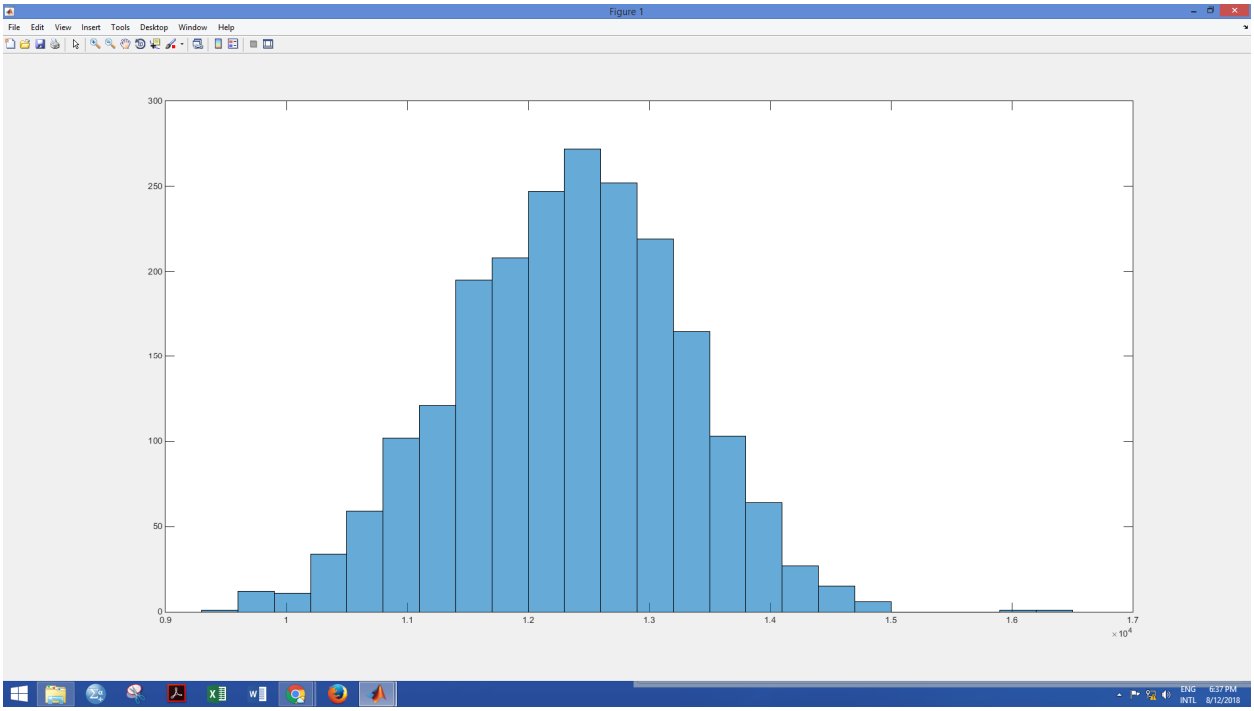
Buildings Band 2:



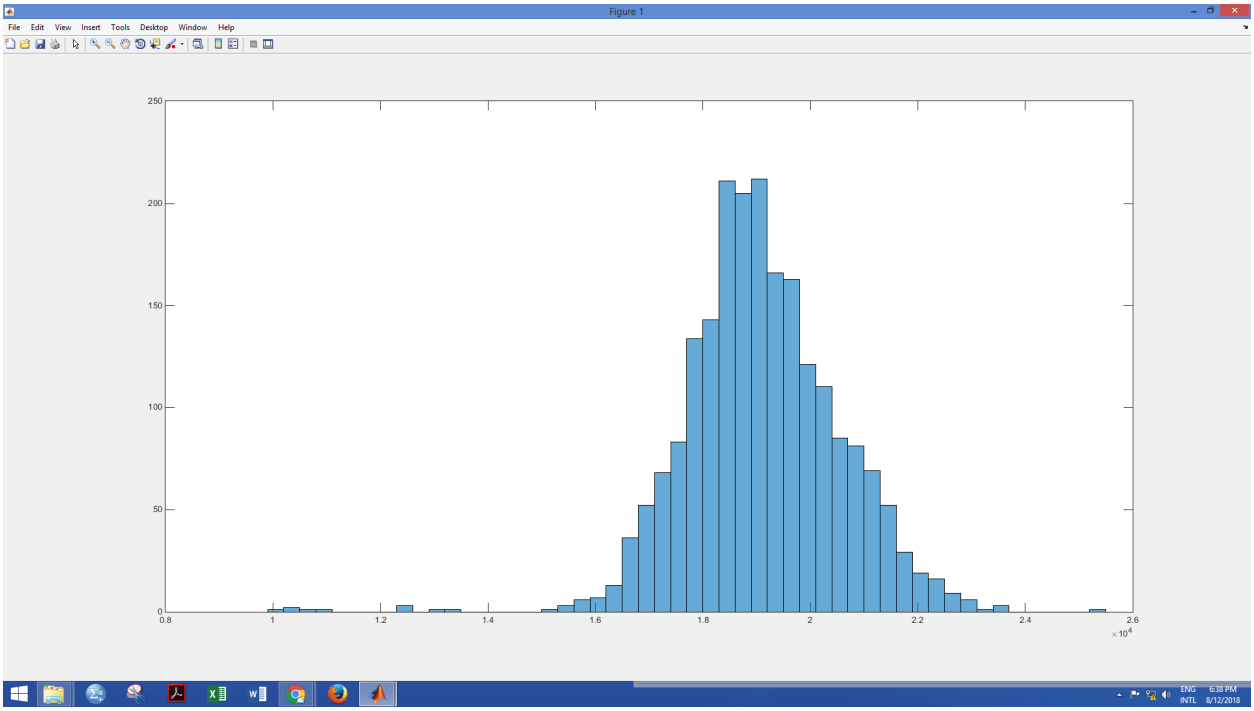
Buildings Band 3:



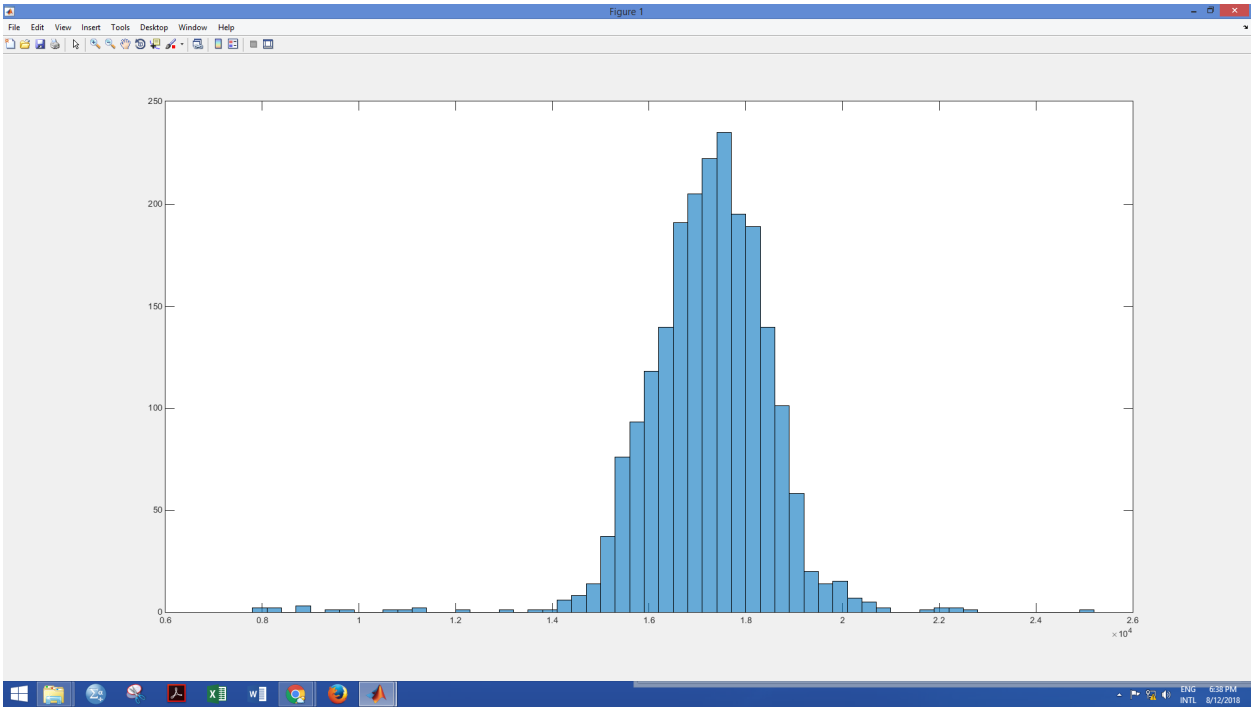
Buildings Band 4:



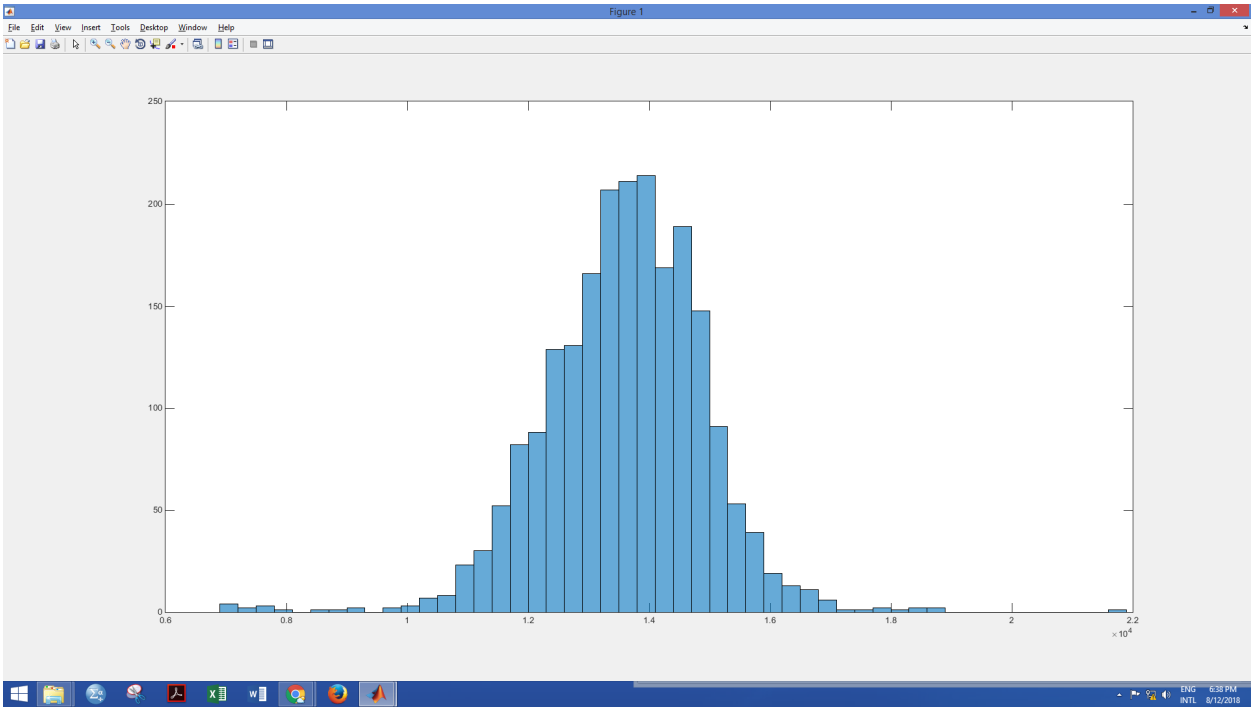
Buildings Band 5:



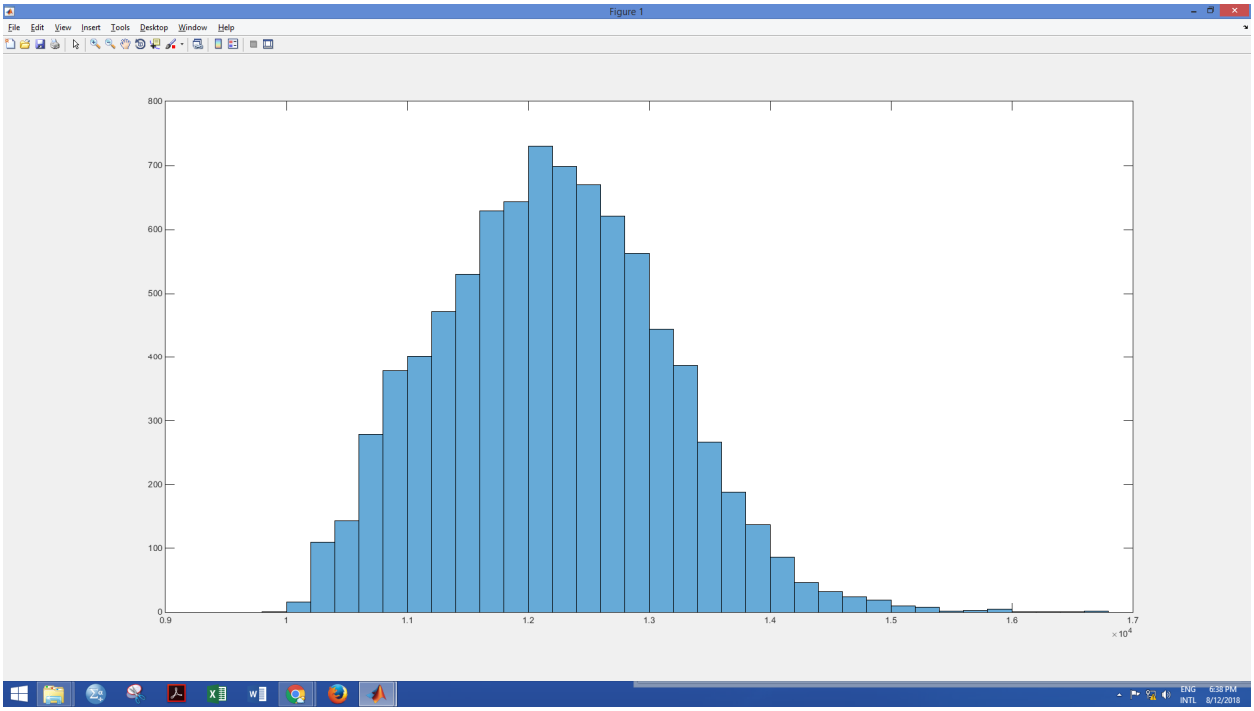
Buildings Band 6:



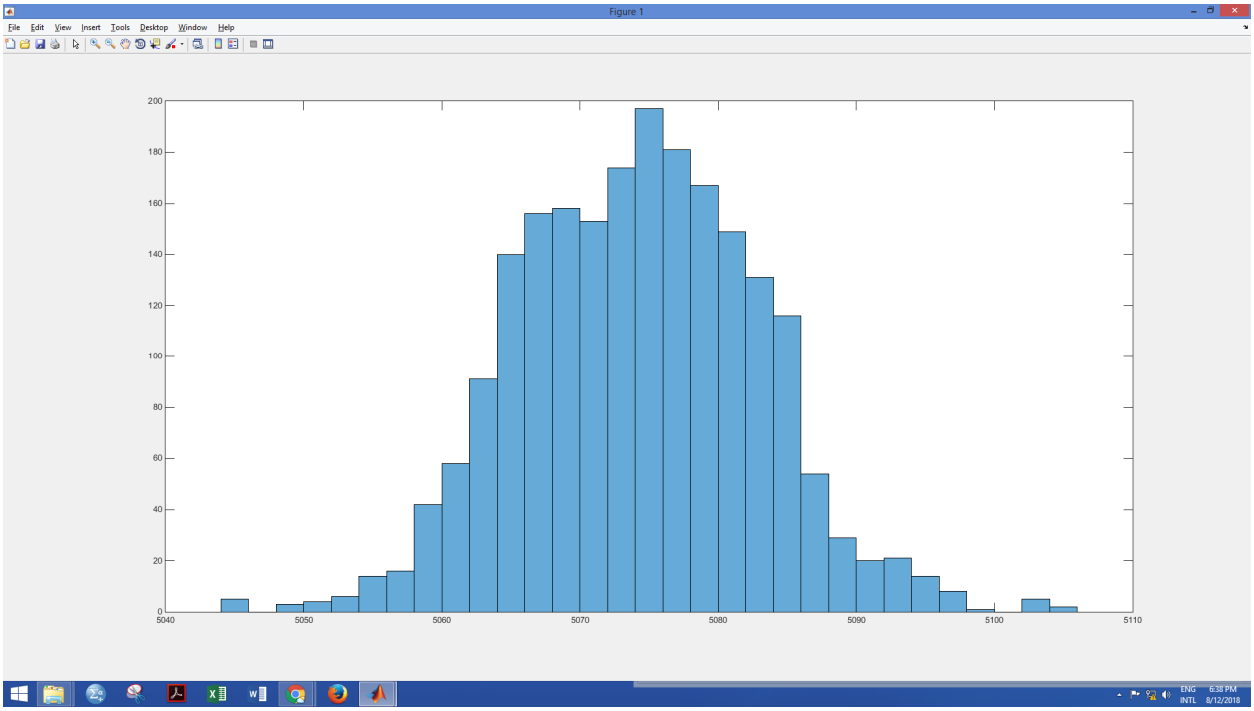
Buildings Band 7:



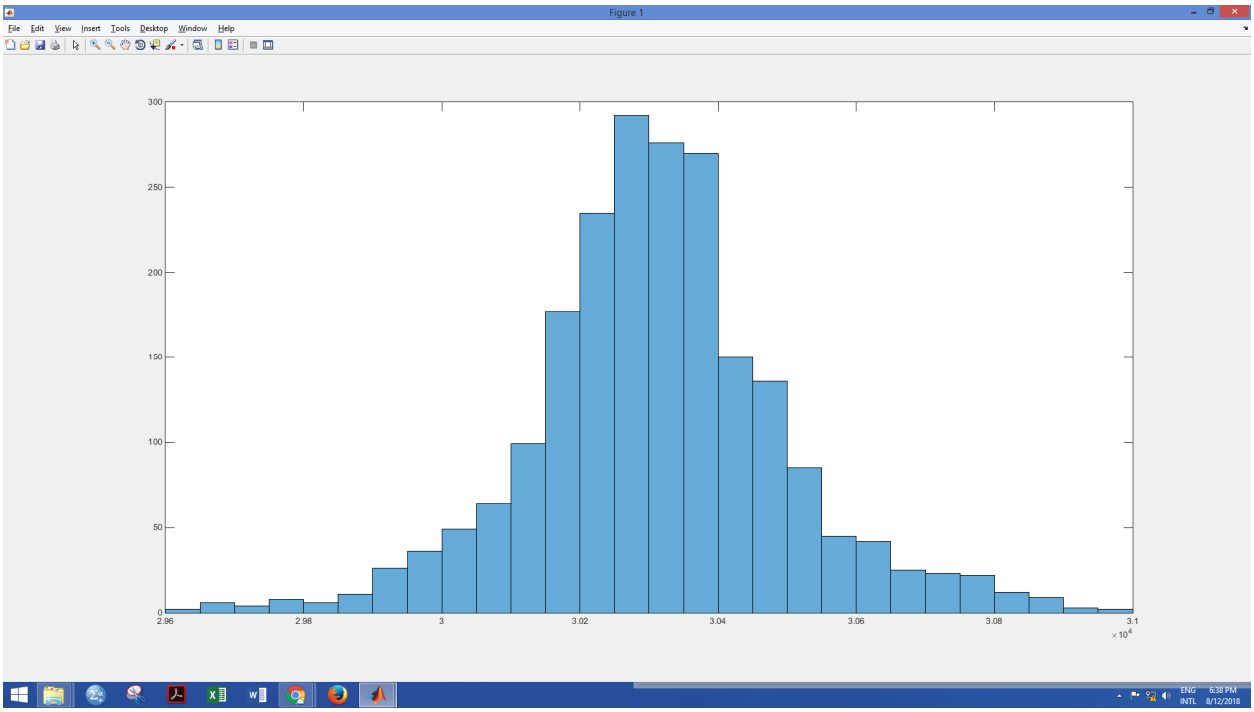
Buildings Band 8:



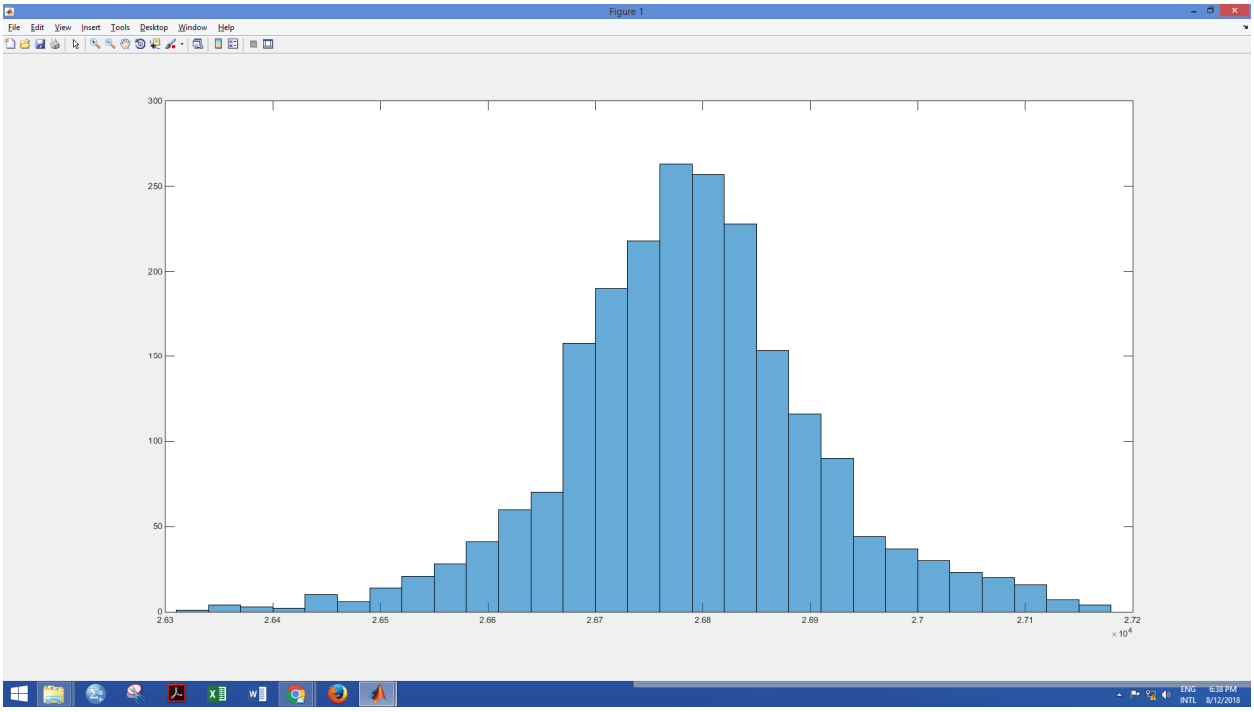
Buildings Band 9:



Buildings Band 10:

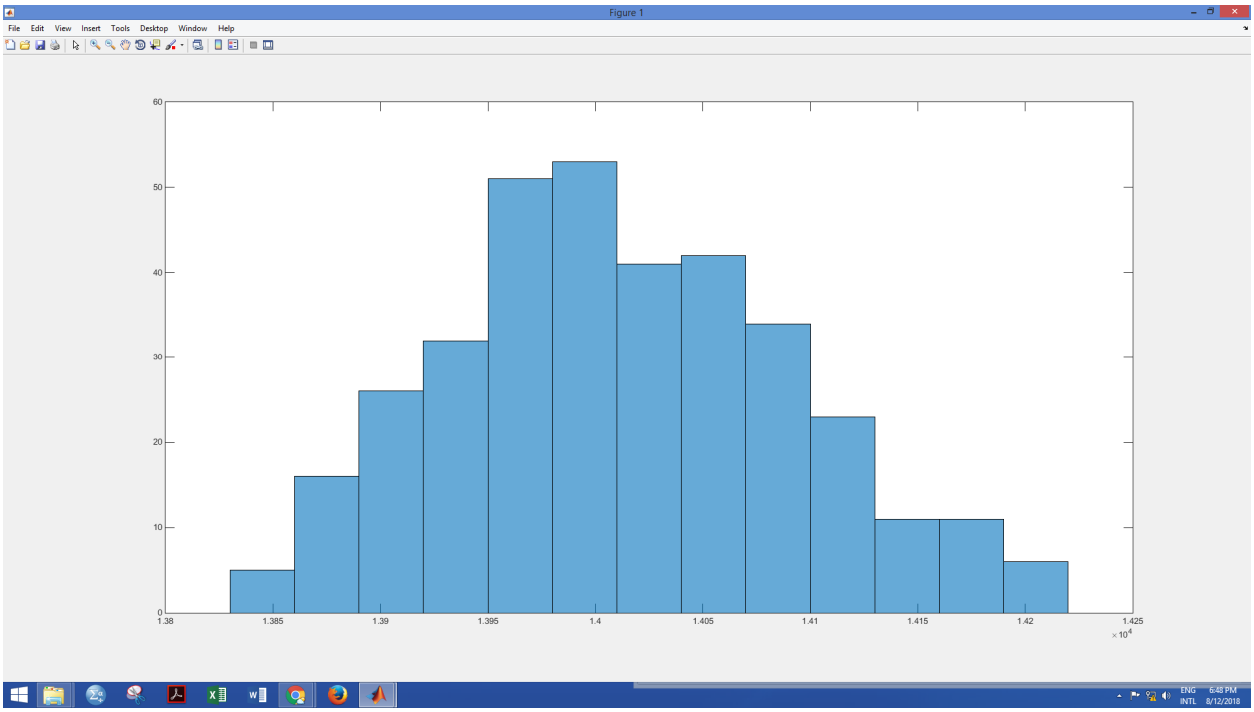


Buildings Band 11:

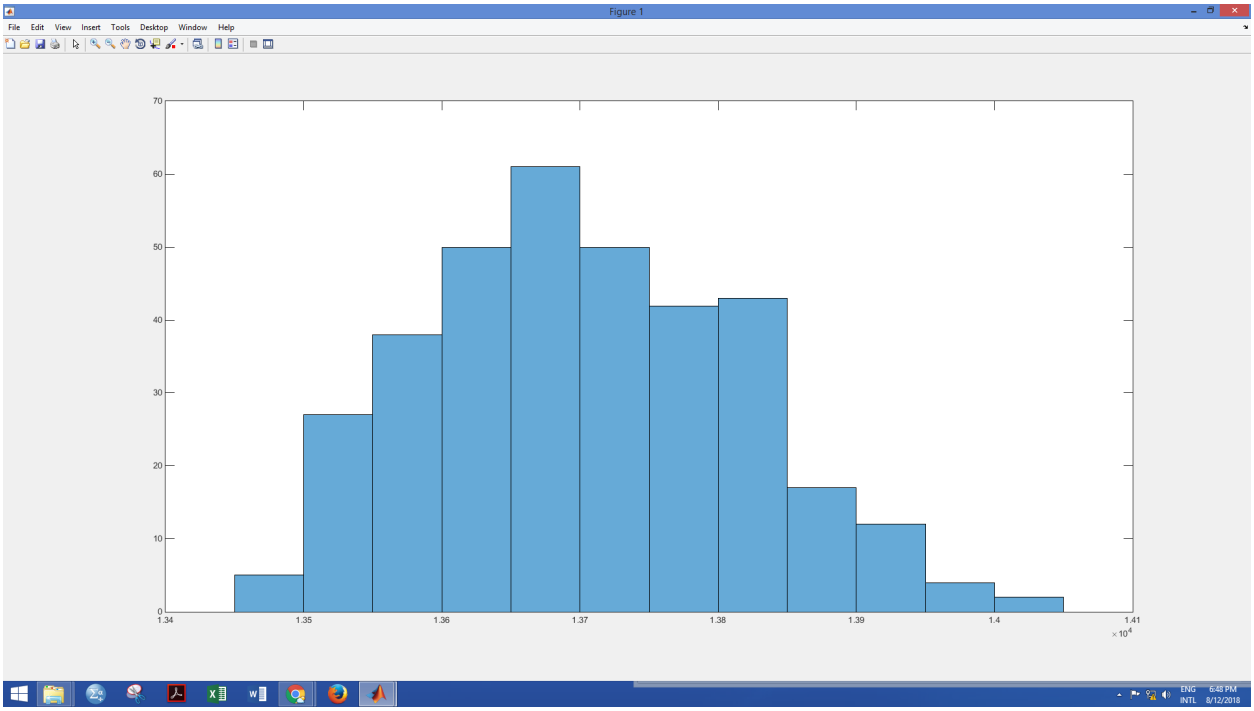


Histogram for sandy area:

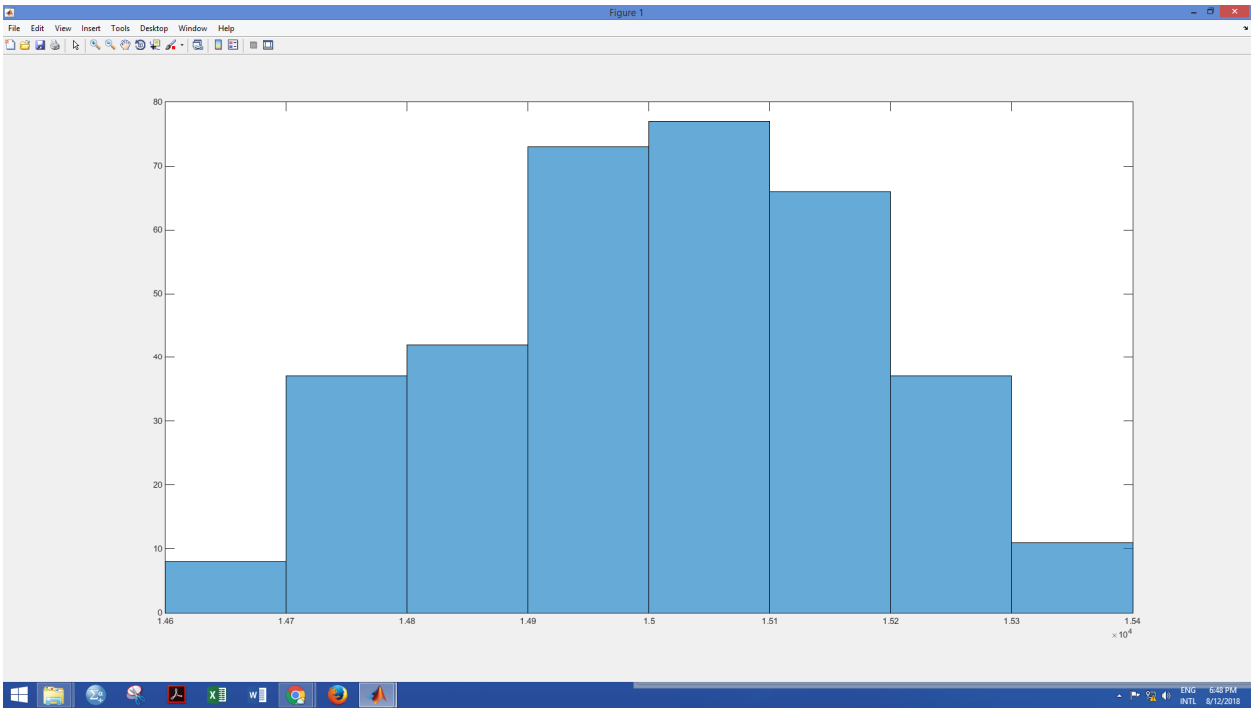
Sand Band 1:



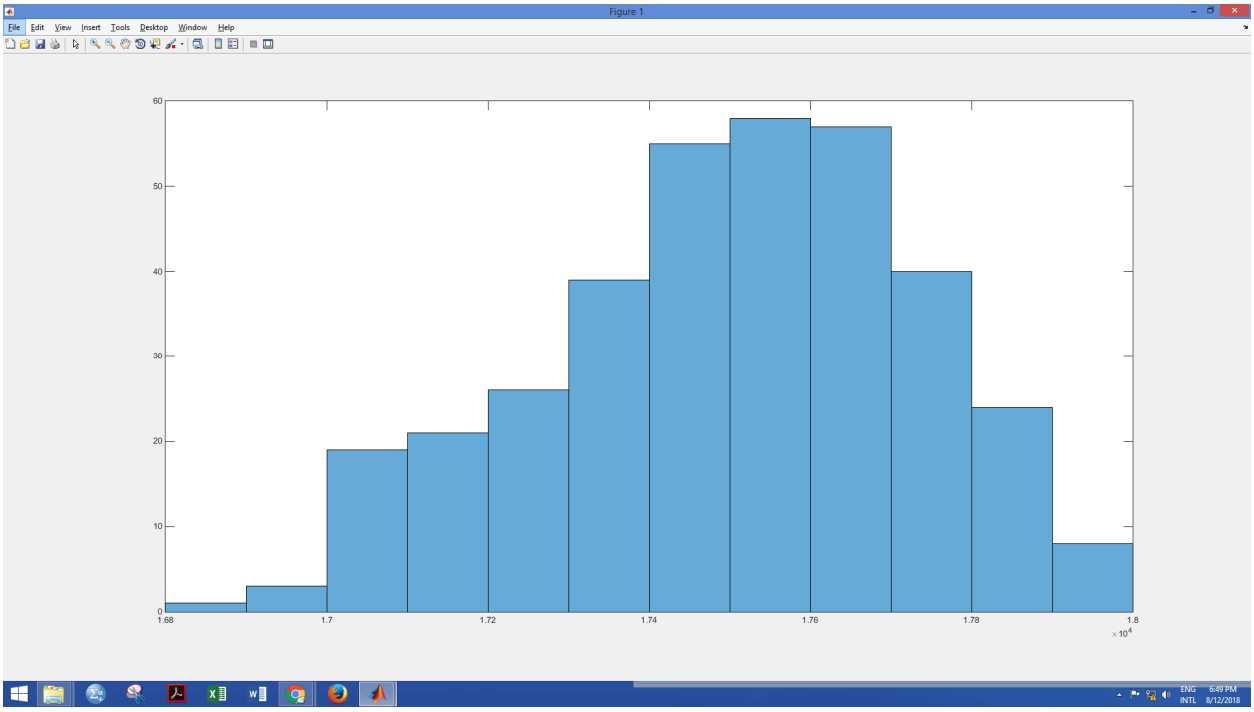
Sand Band 2:



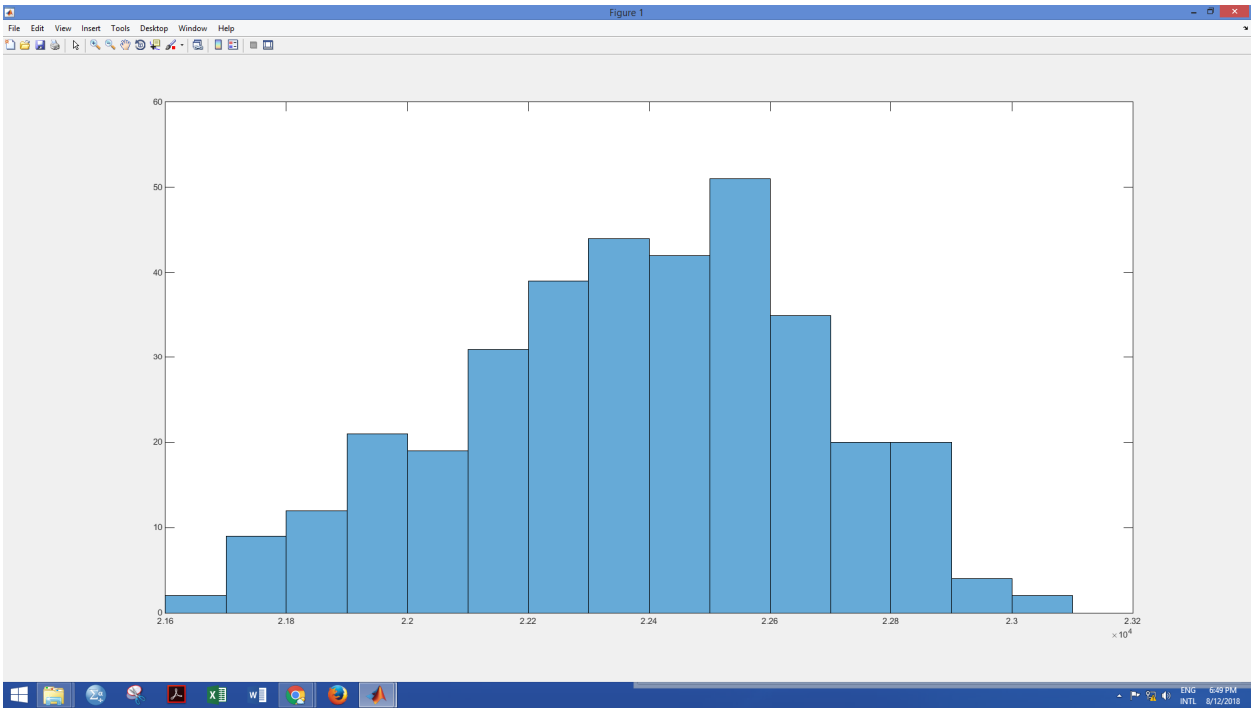
Sand Band 3:



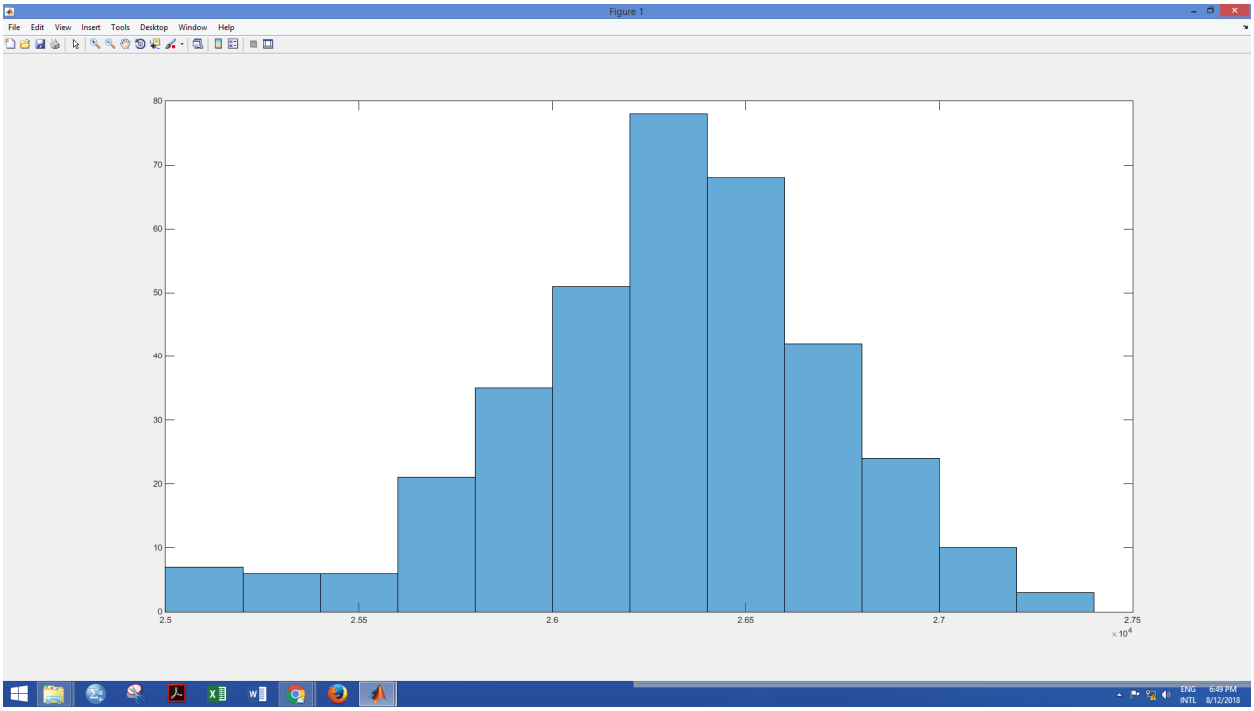
Sand Band 4:



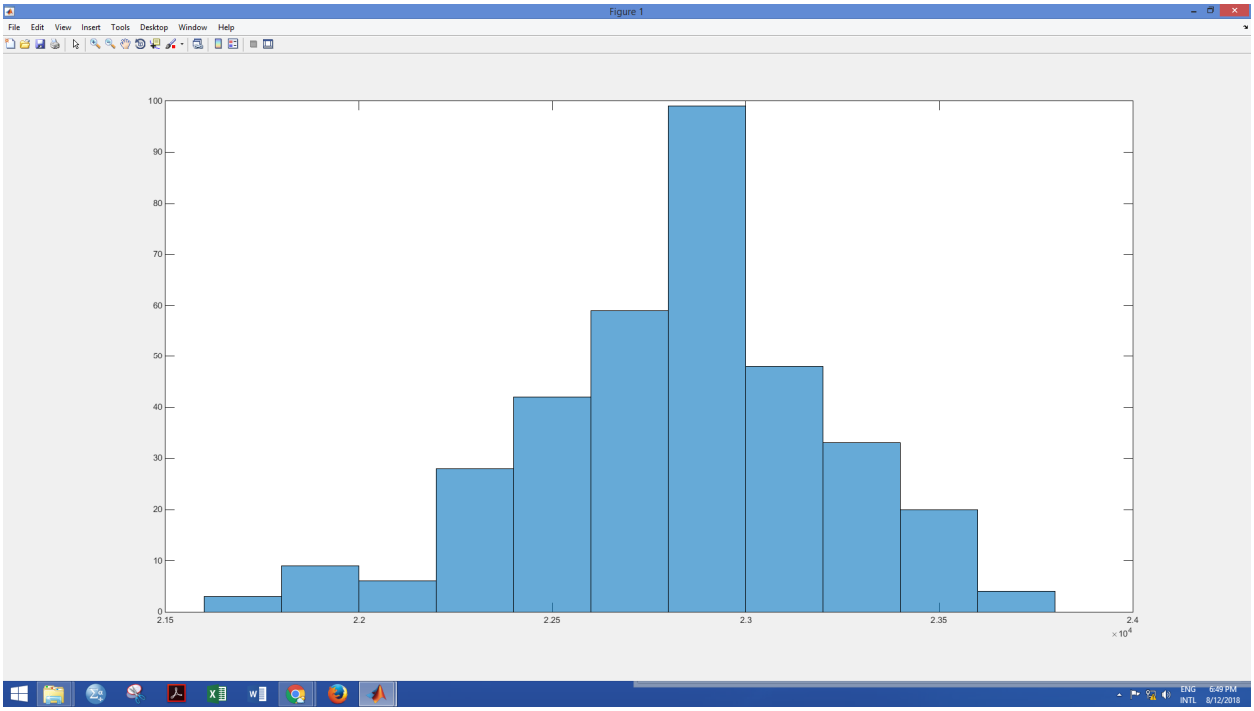
Sand Band 5:



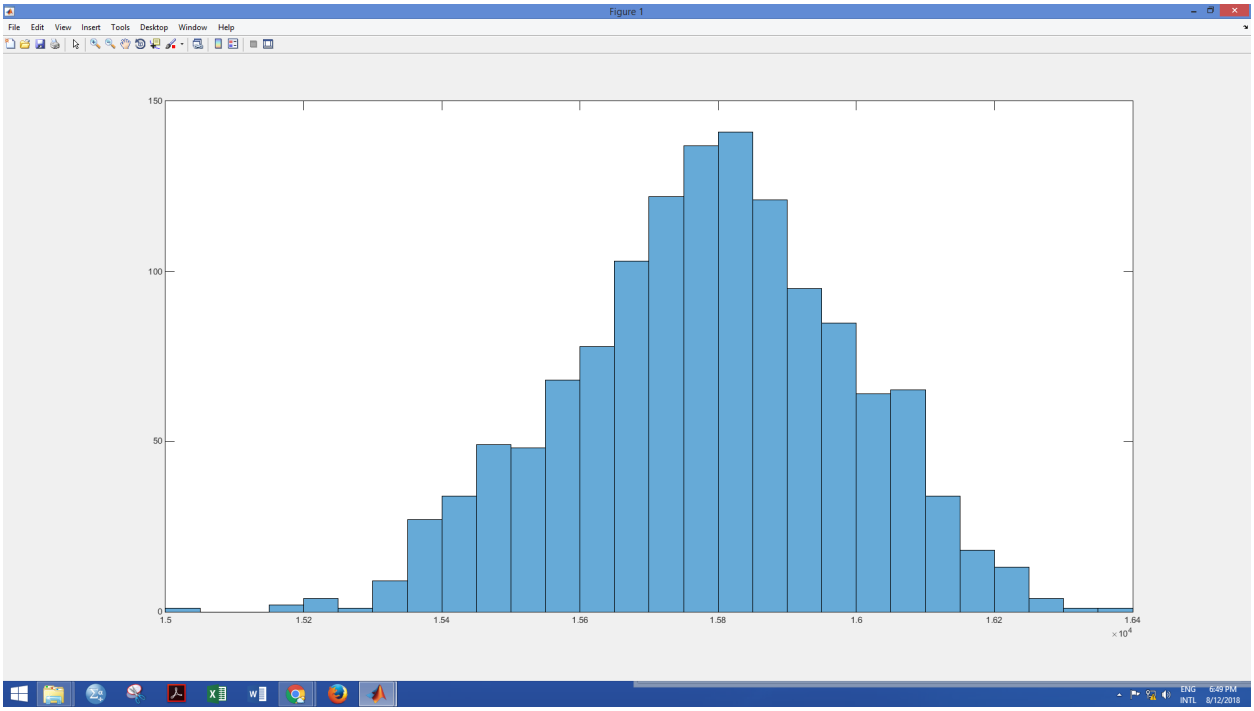
Sand Band 6:



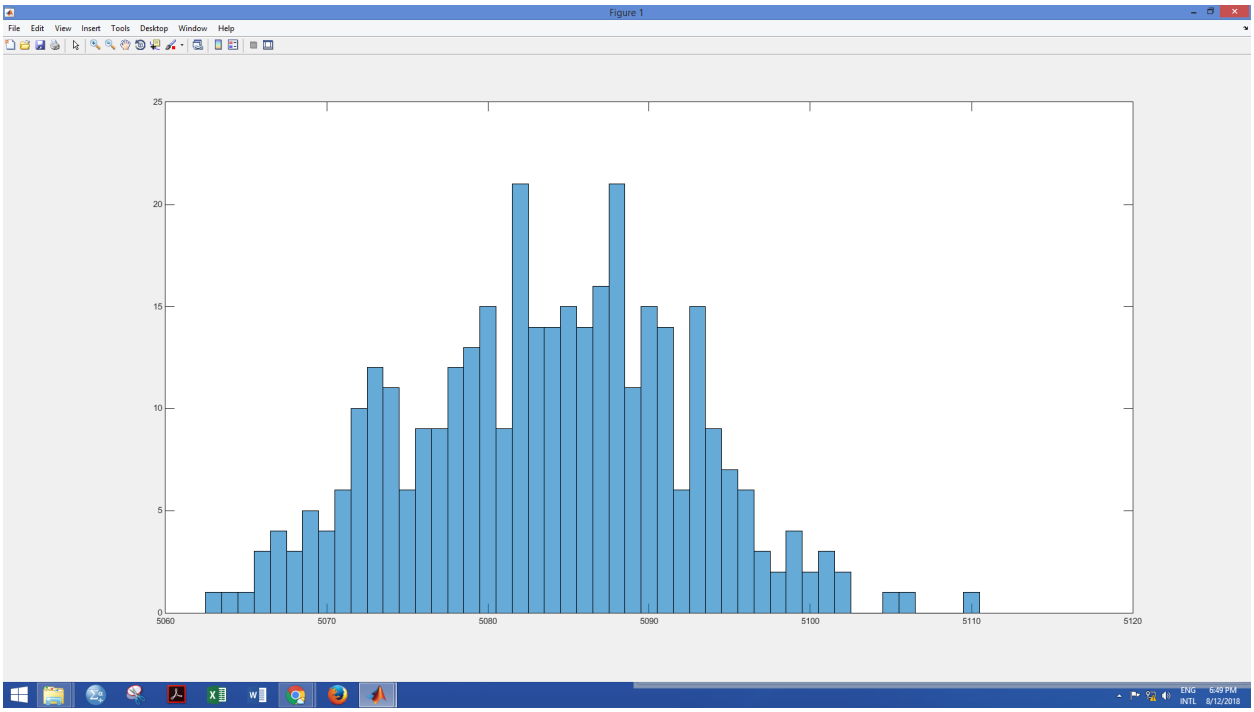
Sand Band 7:



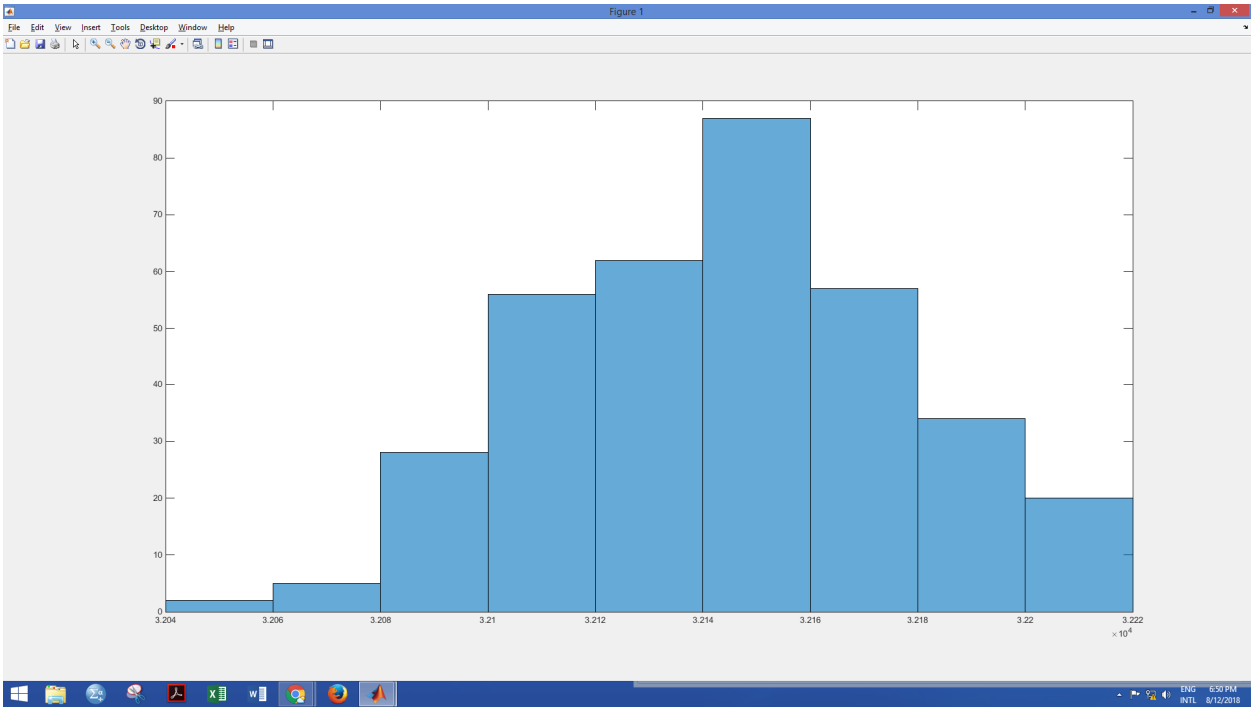
Sand Band 8:



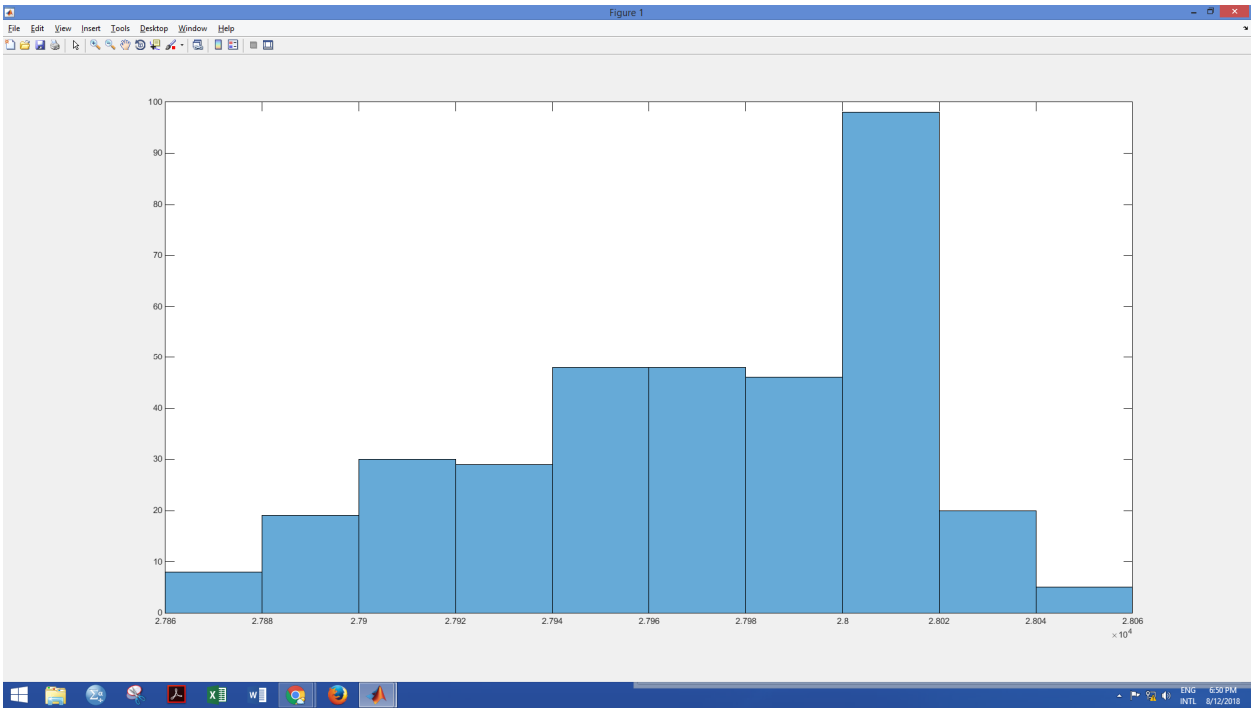
Sand Band 9:



Sand Band 10:

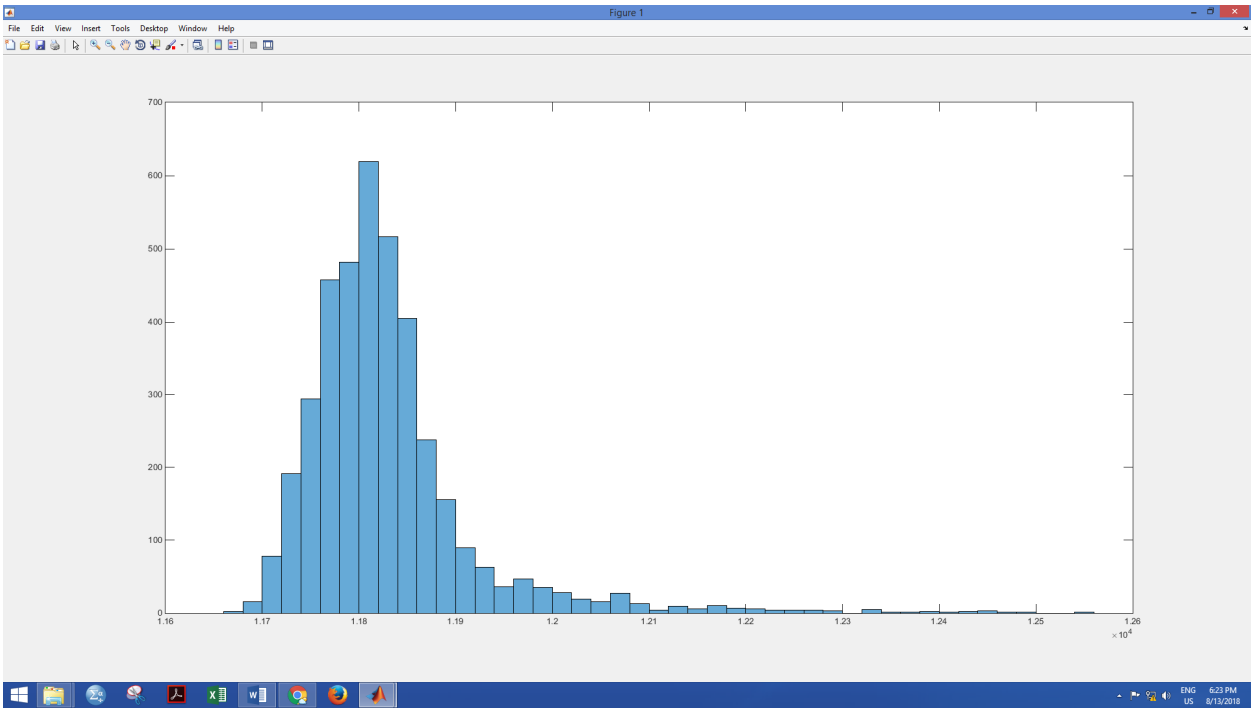


Sand Band 11:

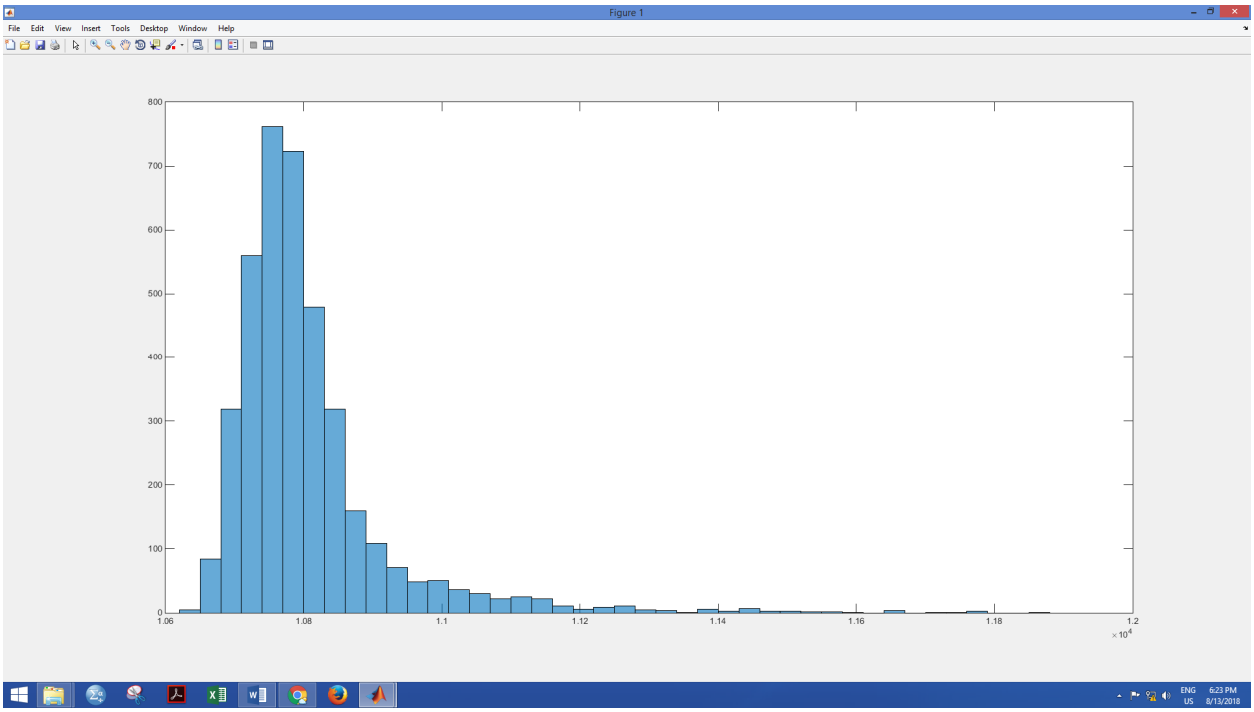


Histogram for vegetation

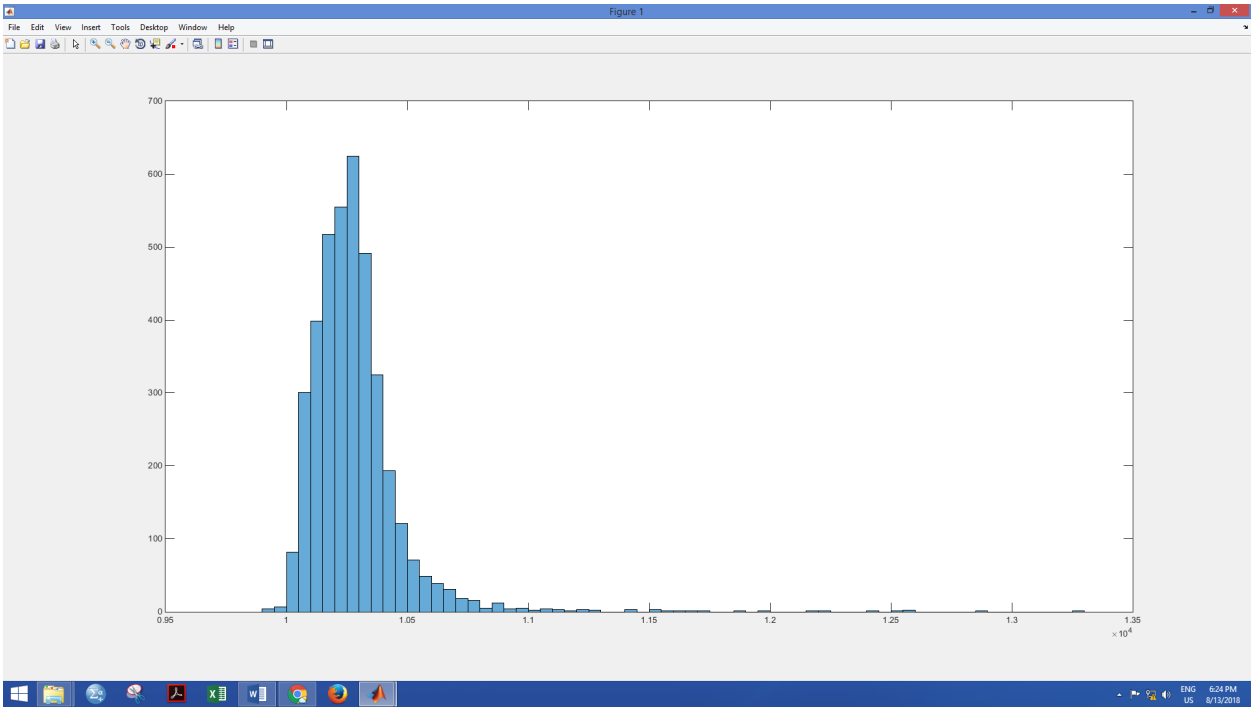
Vegetation Band 1:



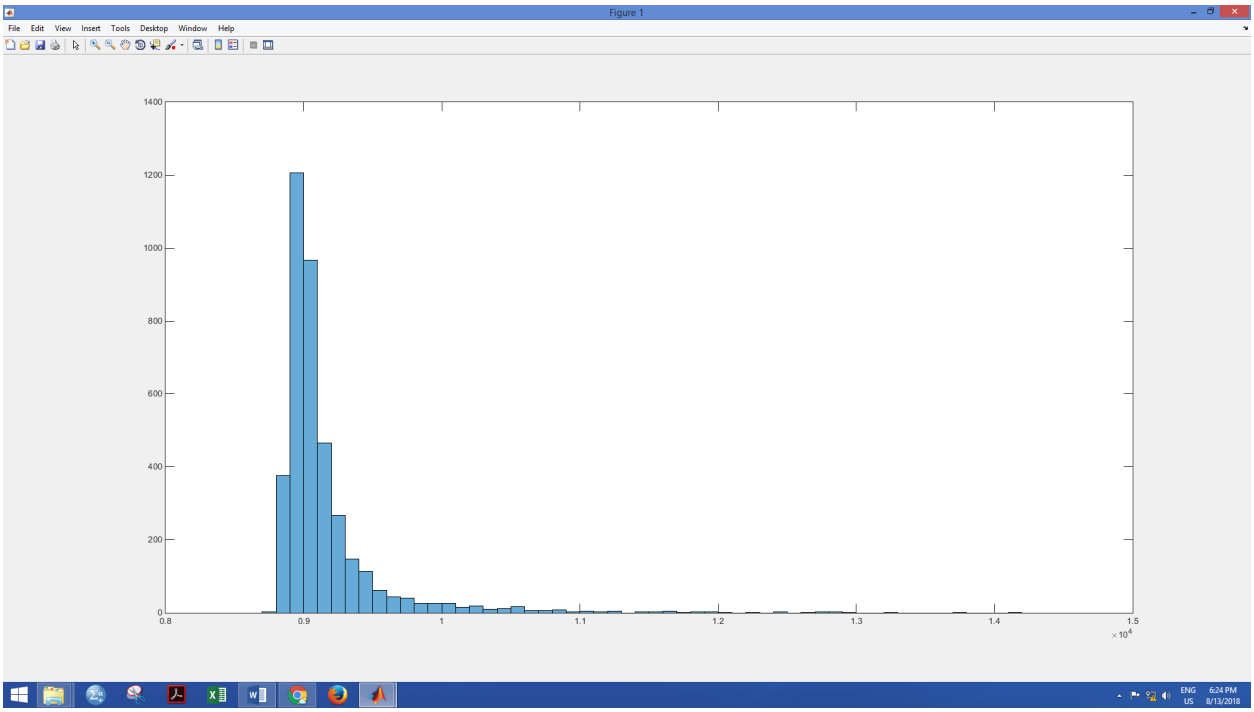
Vegetation Band 2:



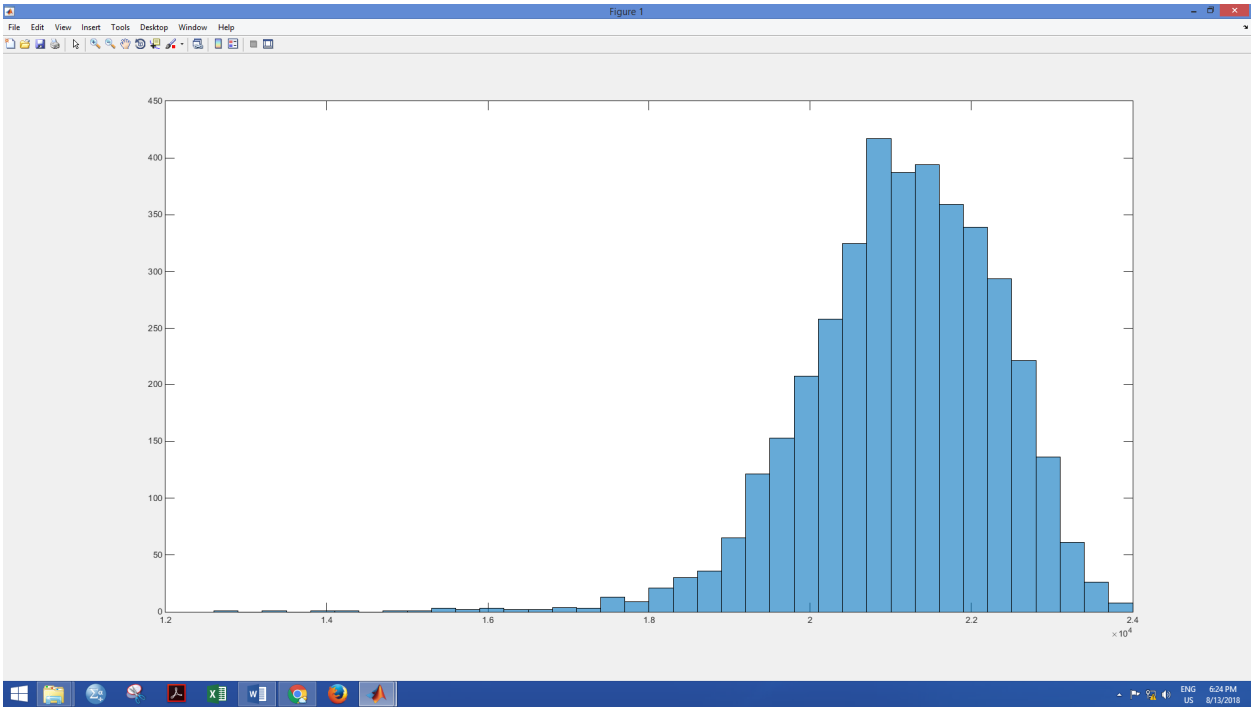
Vegetation Band 3:



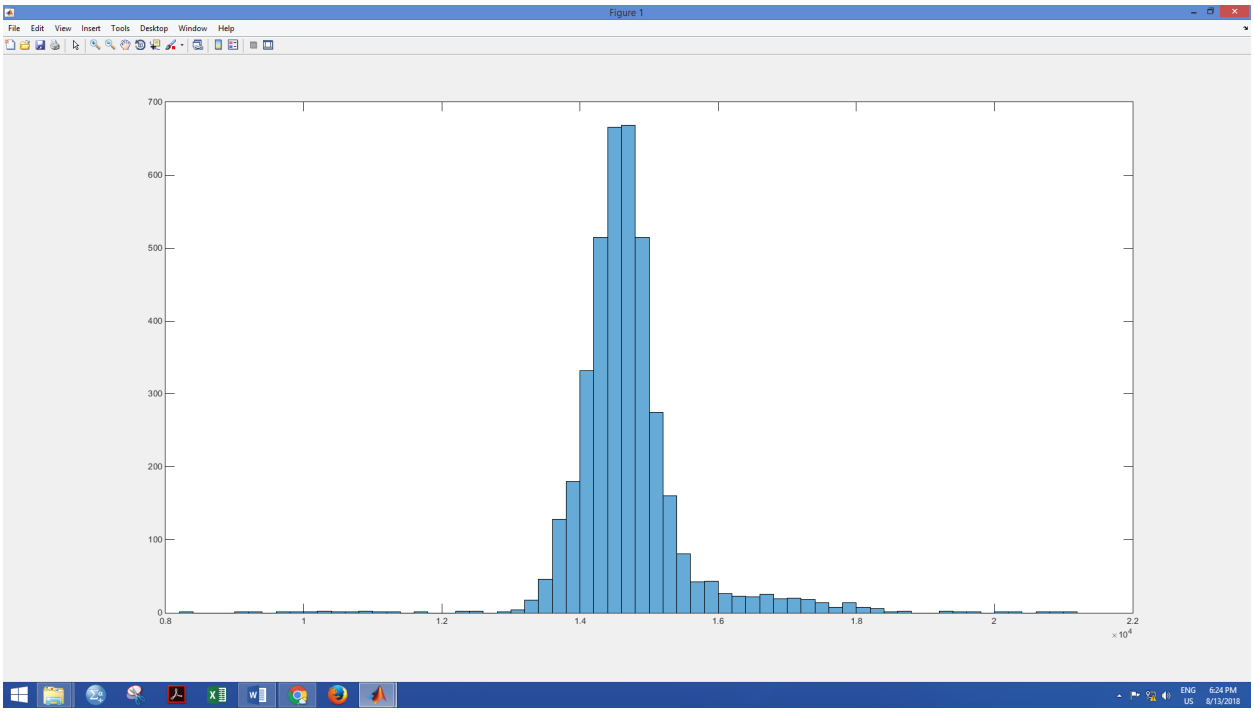
Vegetation Band 4:



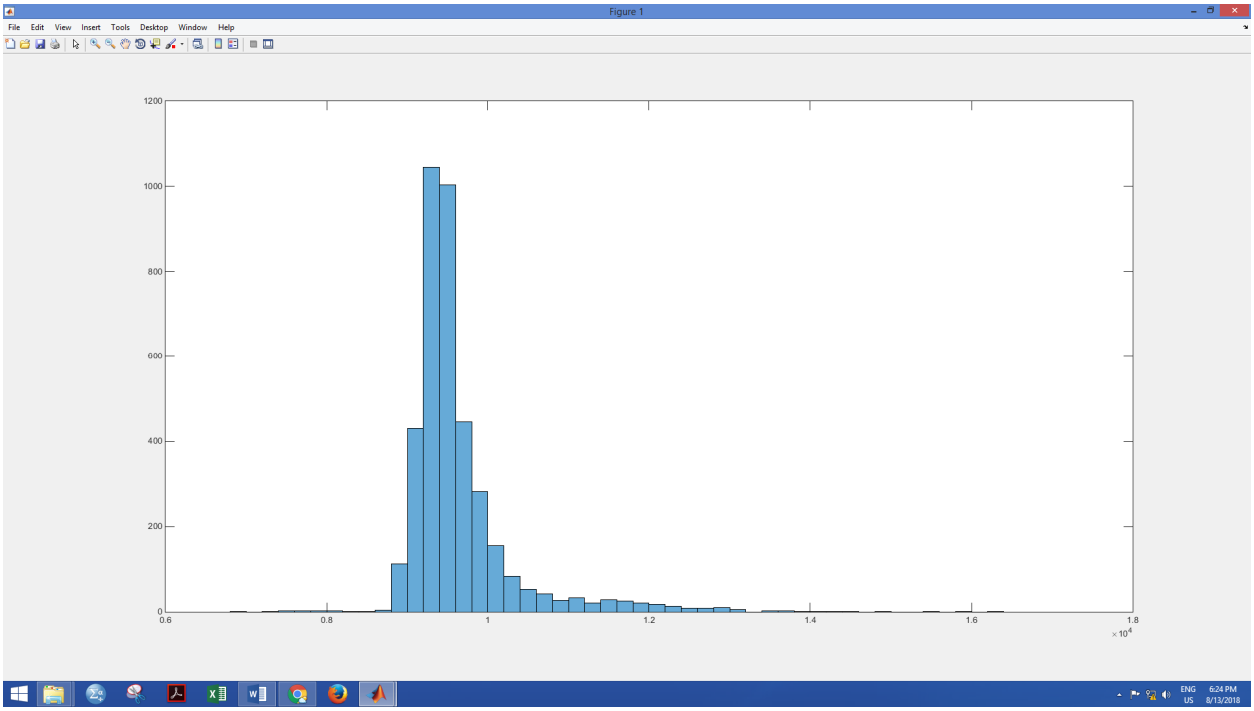
Vegetation Band 5:



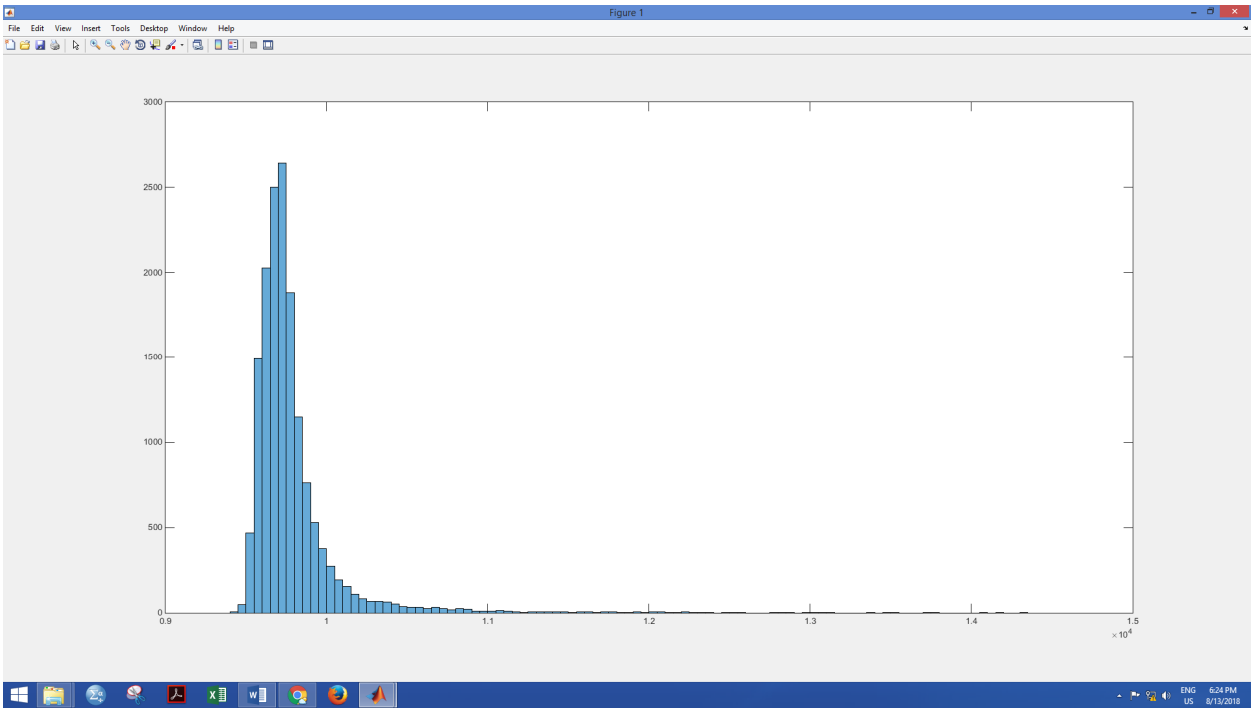
Vegetation Band 6:



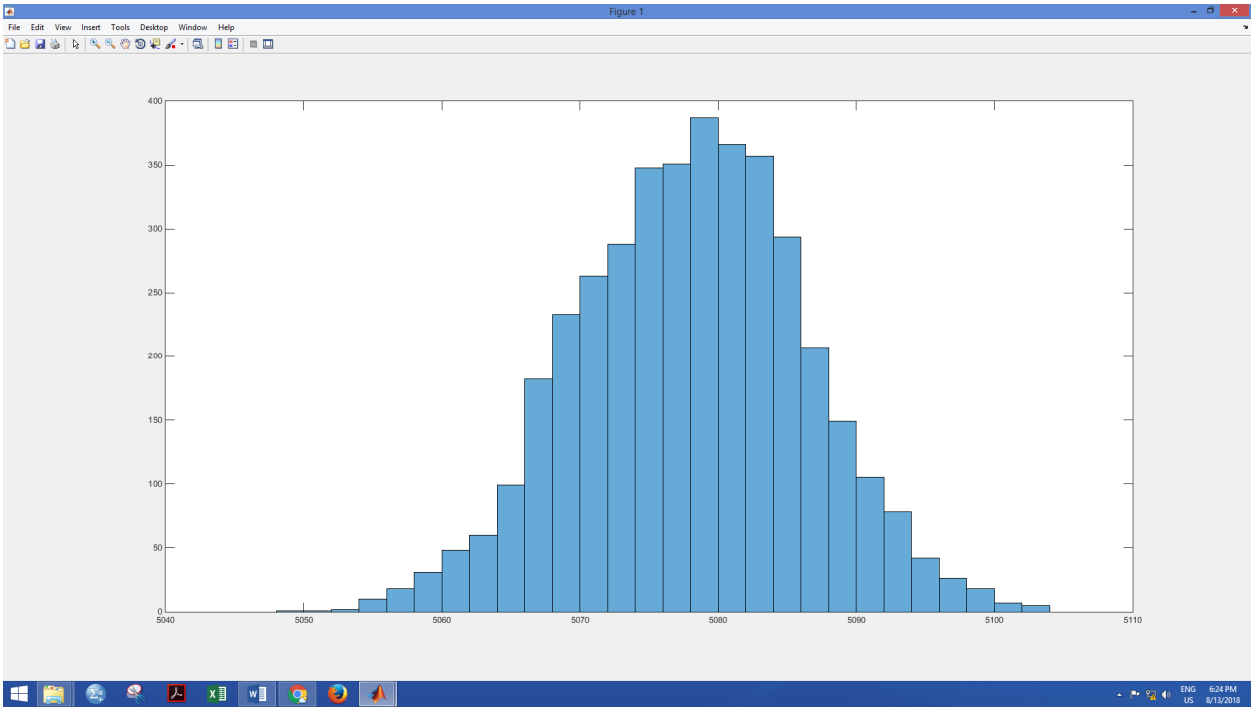
Vegetation Band 7:



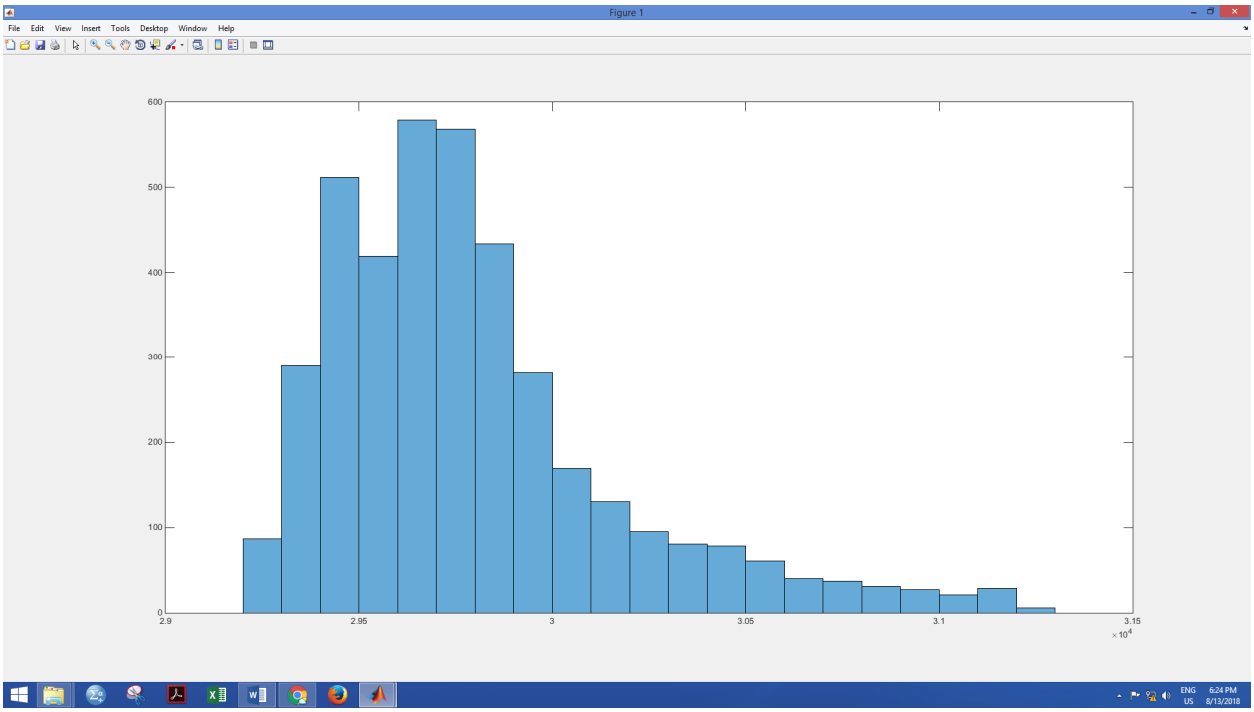
Vegetation Band 8:



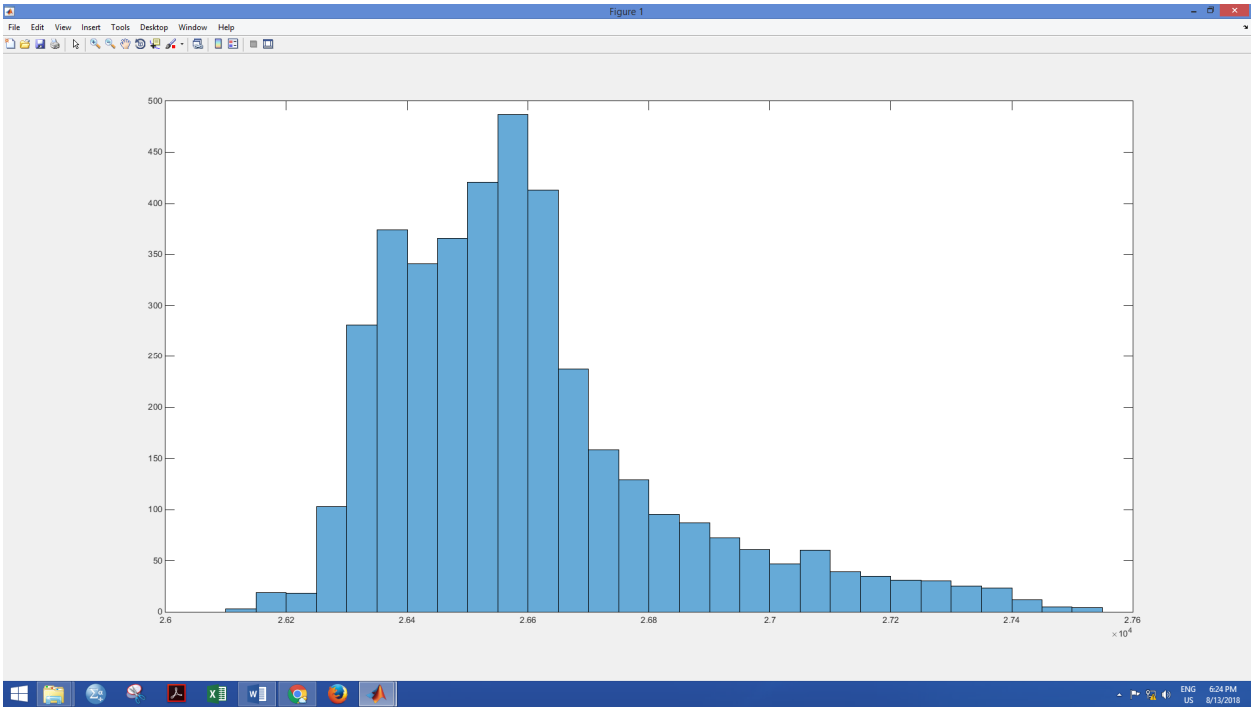
Vegetation Band 9:



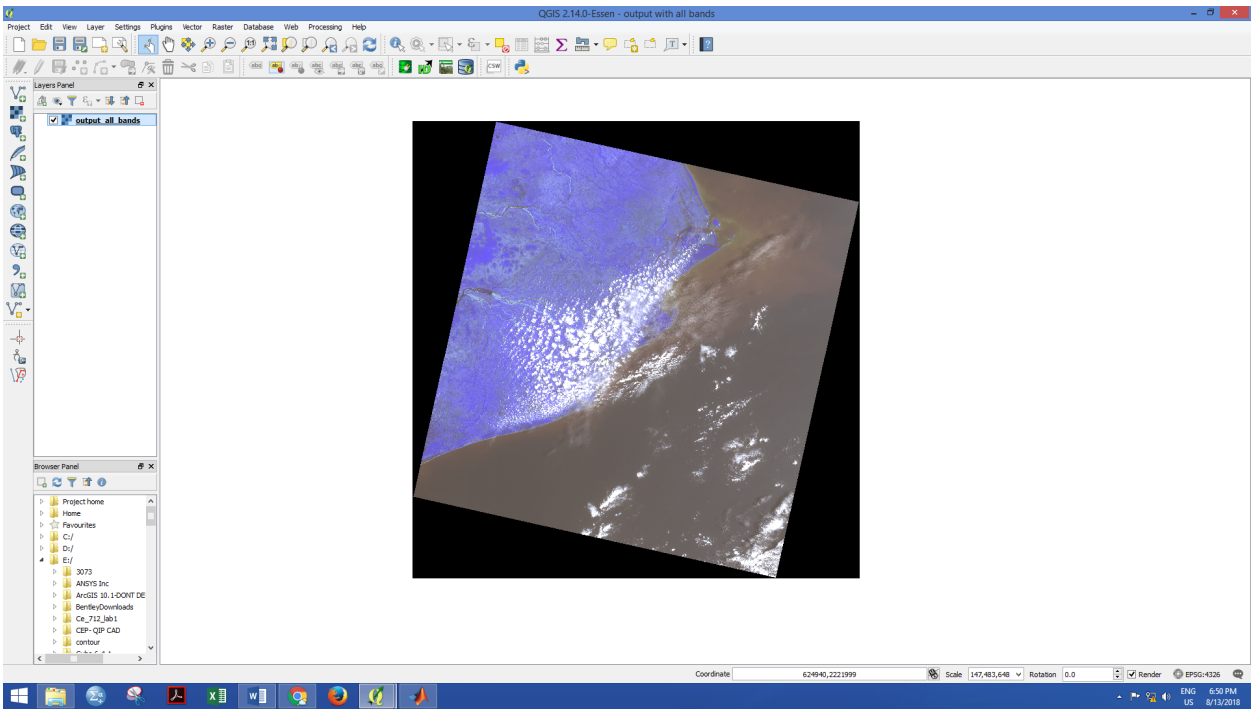
Vegetation Band 10:



Vegetation Band 11:

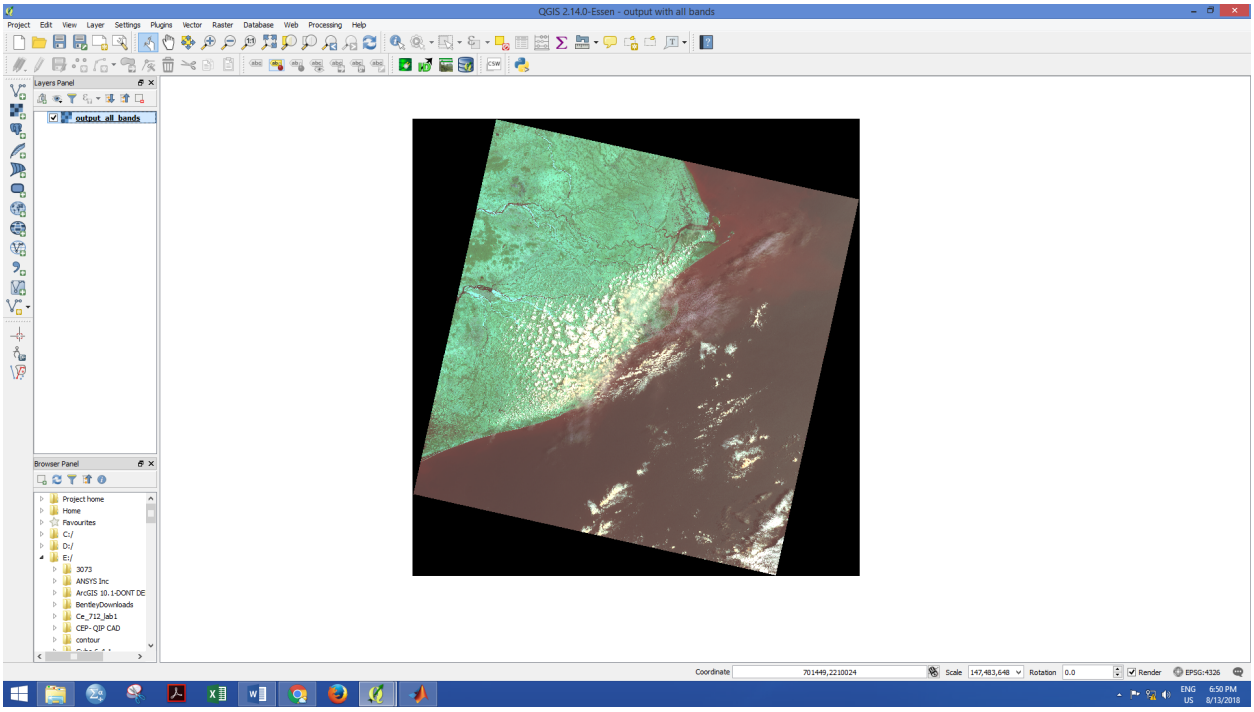


Using Band 3,4 and 5:



^As seen water becomes black

Using Band 3,6 and 7:



^Land gives a greenish tint and water blackish.

Conclusion:

In this lab, we learnt about matrix and vector operations, differentiated objects in map using grayscale images of 3 different bands. We also made histograms for different bands and analysed the output.

In an image processing context, the histogram of an image normally refers to a histogram of the pixel intensity values. This histogram is a graph showing the number of pixels in an image at each different intensity value found in that image. For an 8-bit grayscale image there are 256 different possible intensities, and so the histogram will graphically display 256 numbers showing the distribution of pixels amongst those grayscale values. Histograms can also be taken of color images --- either individual histograms of red, green and blue channels can be taken, or a 3-D histogram can be produced, with the three axes representing the red, blue and green channels, and brightness at each point representing the pixel count. The exact output from the operation depends upon the implementation --- it may simply be a picture of the required histogram in a suitable image format, or it may be a data file of some sort representing the histogram statistics.

The histogram of a digital image is a distribution of its discrete intensity levels in the range [0,L-1]. The distribution is a discrete function h associating to each intensity level: rk the number of pixel with this intensity: n_k.

Different surface features reflect or absorb the sun's electromagnetic radiation in different ways. The reflectance properties of an object depend on the material and its physical and chemical state, the surface roughness as well as the geometric circumstances (e.g. incidence angle of the sunlight). The reflectance of a material also varies with the wavelength of the electromagnetic energy. These differences in reflectance make it possible to identify different earth surface features or materials by analysing their spectral reflectance signatures

So in a region of wavelengths(band), a body might be reflecting more of a certain wavelength whereas in another band it would be another. Energy associated with that wavelength will have been scaled to a digital number as per the spectral resolution. So frequency of that digital no. should be high.

Vegetation
In general, healthy vegetation is a very good absorber of electromagnetic energy in the visible region. Chlorophyll strongly absorbs light at wavelengths around 0.45 (blue) and 0.67 µm (red) and reflects strongly in green light, therefore our eyes perceive healthy vegetation as green. Healthy plants have a high reflectance in the near-infrared between 0.7 and 1.3 µm. This is primarily due to the internal structure of plant leaves. As this internal structure varies amongst different plant species, the near infrared wavelengths can be used to discriminate between different plant species.

Water
In its liquid state, water has relatively low reflectance, with clear water having the greatest reflectance in the blue portion of the visible part of the spectrum. Water has high absorption and virtually no reflectance in near infrared wavelengths range and beyond. Hence it will appear dark in the combination of band 3,4 and 5