ASSIGNMENT

HYPERSPECTRAL REGRESSION BASED UNMIXING

Muhammad Bilal

S1093347

Data Visualization

For this Spectral Unmixing assignment I loaded example data that is basically of some part of berlin Germany contains two raster layers one is high resolution image with three bands named hired_berlin, the second is hyperspectral image that have more than hundred bands and coarser spatial resolution named enmap_berlin. Further in this dataset we have vector points that represent different landcover type of berlin use for generating spectral profile for different feature or end member from raster dataset. Figure 1 Shows Dataset Views

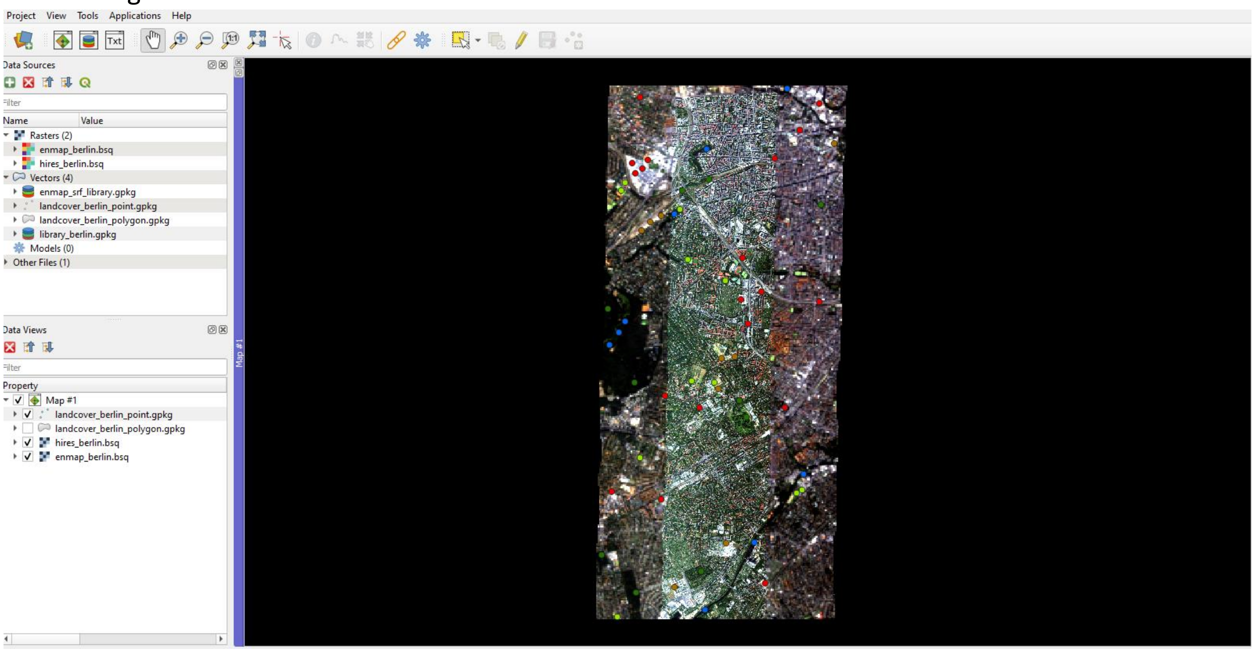

Figure 1

Further I have compare spectral signature of RGB Image and hyperspectral image of football field. In Figure 2 as you can see RGB capture little information about field as compare to hyperspectral image because it stores each pixel information in hundreds of bands.

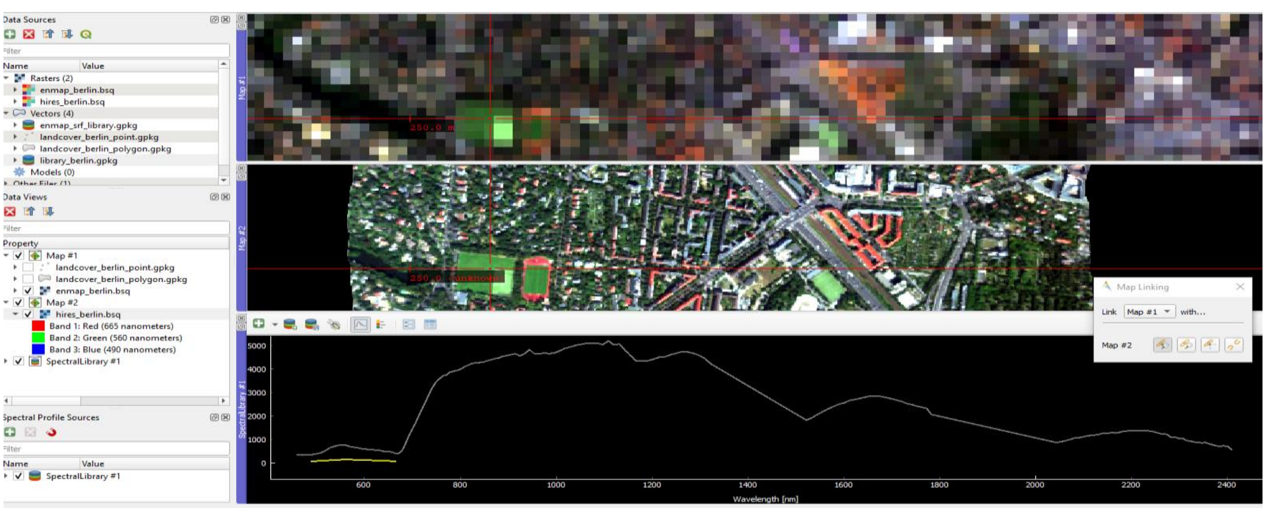

Figure 2

Regression Based Unmixing Process

The idea of spectral unmixing is originate from mixing that contain reflected light from multiple surface. If I want to classify different feature types in an image, certain pixel does not fall into any one category and its actually mixed. So in that case I want to know how much percentage of each end member or feature present in that pixel. The spectral unmixing using spectra of features or endmembers in my case I utilized landcover points to generate spectra for different feature that is useful to calculate fractions of the materials per pixel as shown in figure 3.

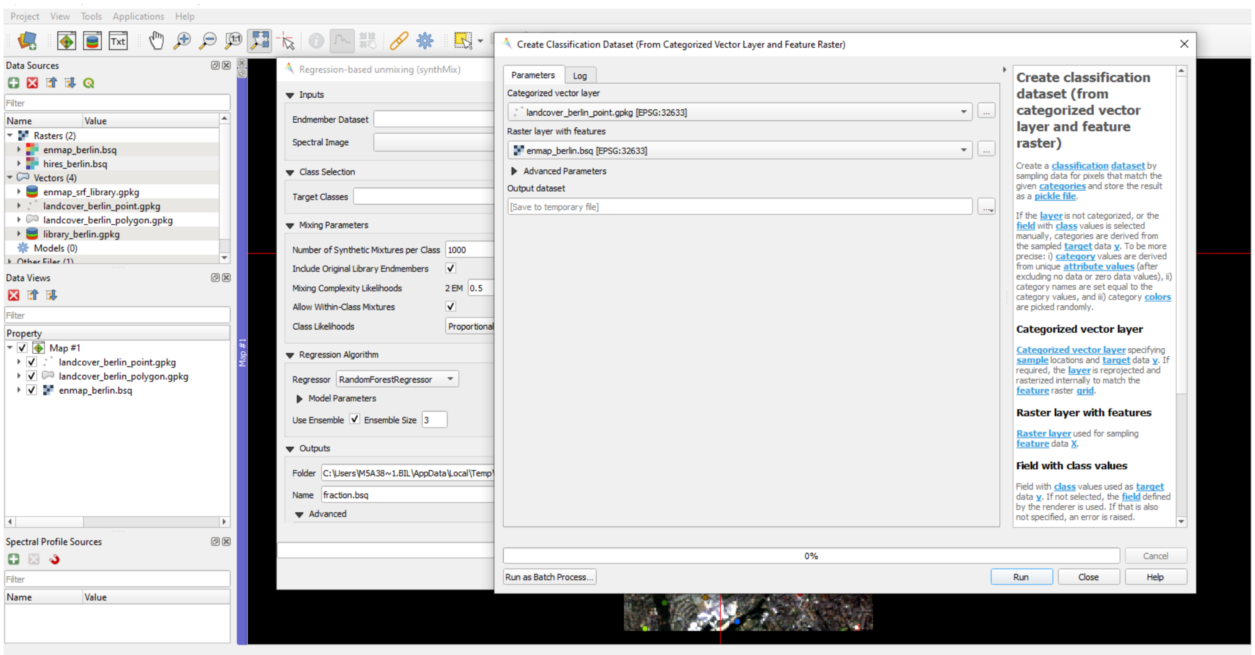

Figure 3

Moreover, in linear Regression based unmixing approach we assume that pixel reflectance is the summation of individual material or endmembers reflectance. The Regression based Unmixing algorithm works in three steps. The first step is an endmembers spectral library associated with class labels used to randomly create synthetically mixed datasets. Then in Second step the synthetically mixed dataset is used to train a regression model for each class. In last step the regression model applied to an image to derive a fraction map for each class. This approach submerged with ensemble framework so these three steps iterated to n-times and the final fraction map for each class is generated.

In figure 4 for **first step** synthetically mixed dataset creation I set the parameters that are **endmember library** generated from landcover points, **spectral image** is set to enmap_berlin, set the **target classes** impervious, vegetation, soil, water for these classes synthetically mixed data, regression model and fraction maps will be created while spectra of other feature classes are still used in background process of synthetically mixing process. In Mixing parameters, I set 1000 synthetic mixture per class, check the endmember library to add into synthetically mixture data, **mixing complexity likelihoods** set to 0.5 for both 2 and 3 endmember means that there is a 50% likelihood or probability that the mixture is made up of two endmembers and three endmembers. The second step is to train regression model on the basis of synthetic mixture datasets so the parameter of **Regressor** set to linear regression and **Ensemble size** to 3 so this model iterated to three times and mean fractional map generated for each class.

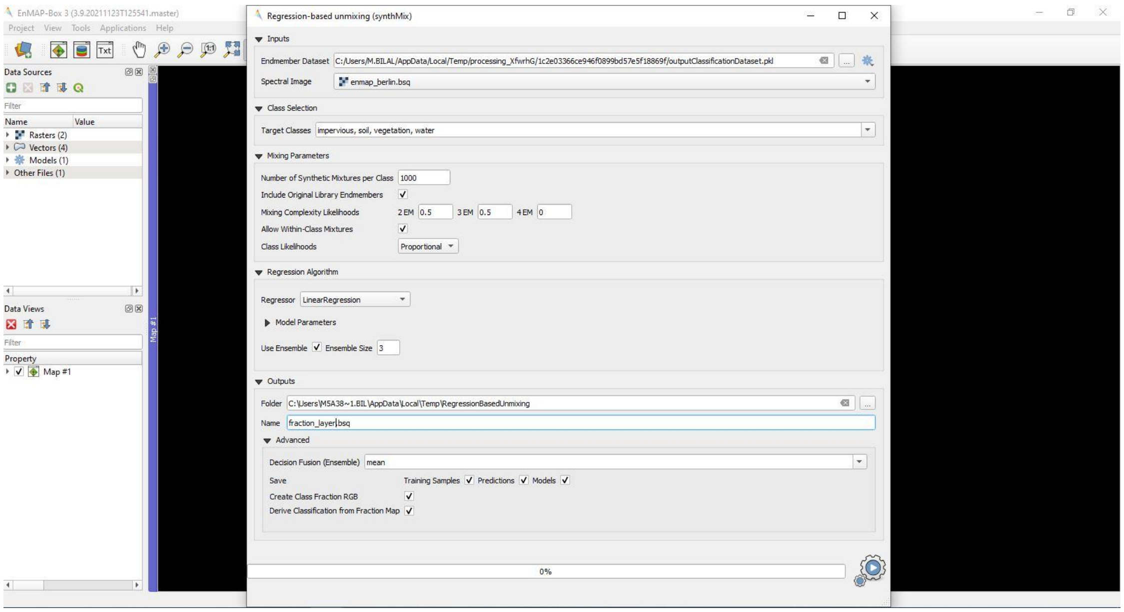

Figure 4

Regression Unmixing Algorithm Output

So three layer generated from regression unmixing algorithm one is **fraction layer mean** that is unmixing layer represent a set of fractions that indicate the proportion of each endmember present in the pixel, second is fraction mean layer in **RGB format** and third is **fraction mean classification** that is discrete classified map from final fraction map representing different feature classes like soil, vegetation, water for visual purpose as shown in figure 5.

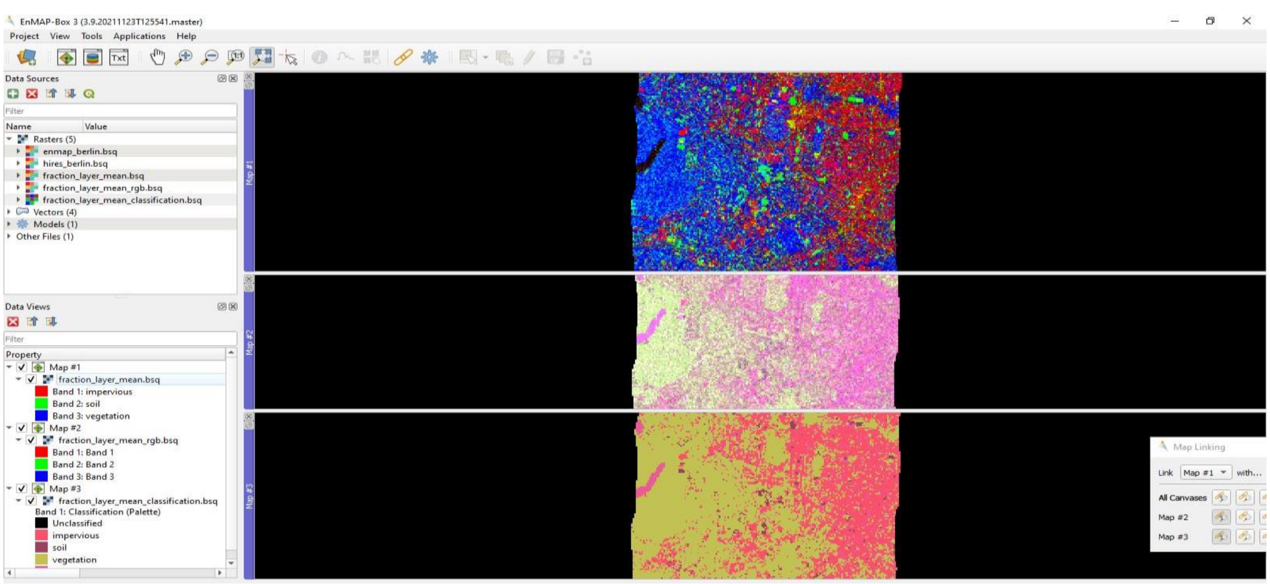

Figure 5

Comparison Fraction layer and High Resolution Image

I compare fractional mean layer and high resolution image to identify the performance of each class. In figure 6a the Vegetation class in fractional image correctly indicate the proportion of vegetation endmember present in the pixel. In figure 6b I changed the symbology of fraction mean layer to single band of vegetation to better visualize endmember pixel.

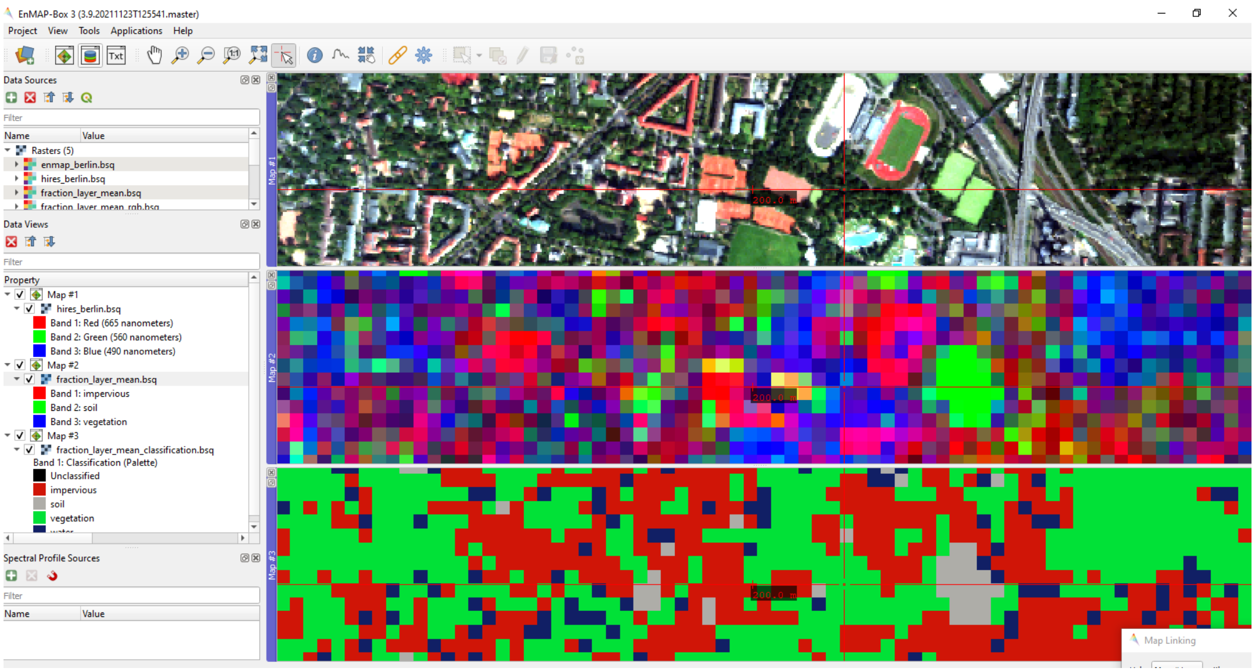

Figure 6a

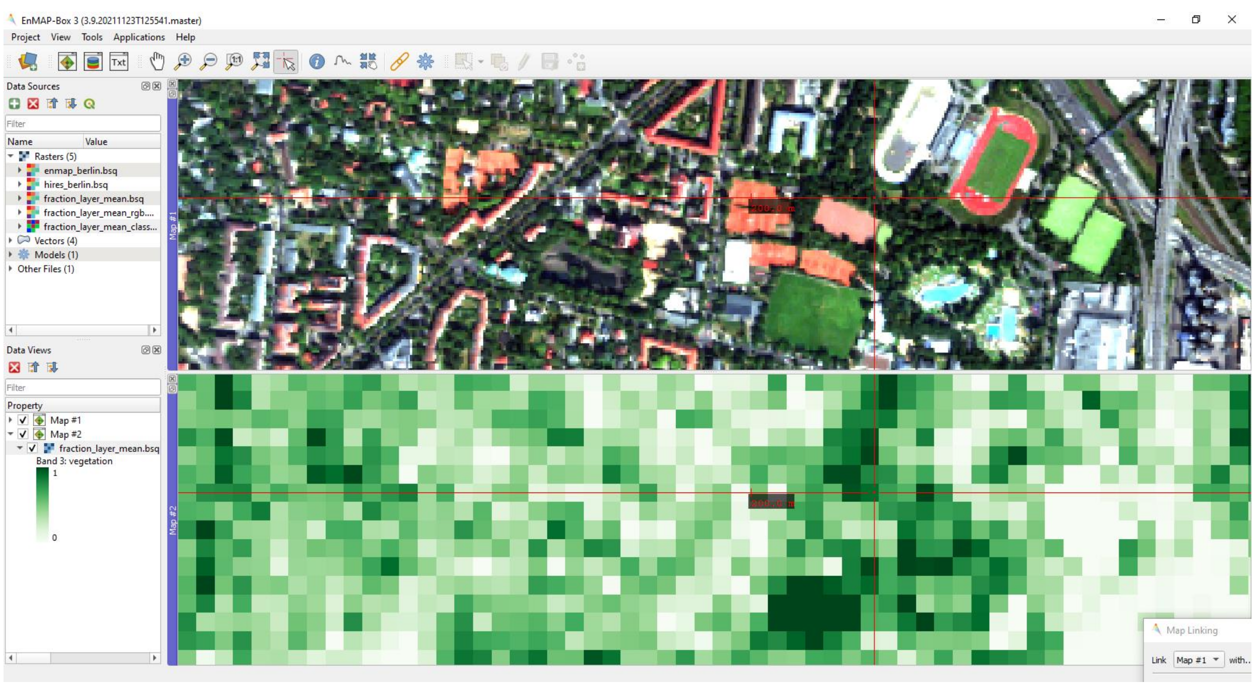

Figure 6b

In this the water class in fractional image correctly indicate the proportion of water endmember present in the pixel as shown in figure 7a. In figure 7b I changed the symbology of fraction mean layer to single band of water to better visualize endmember pixel.

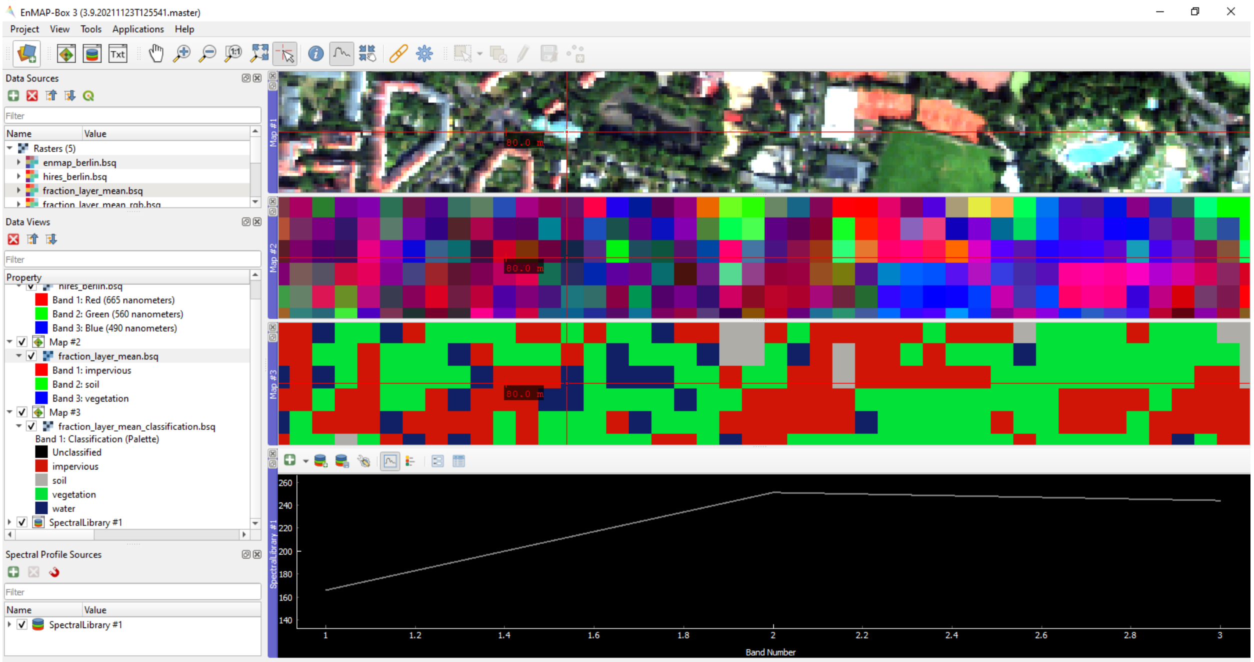

Figure 7a

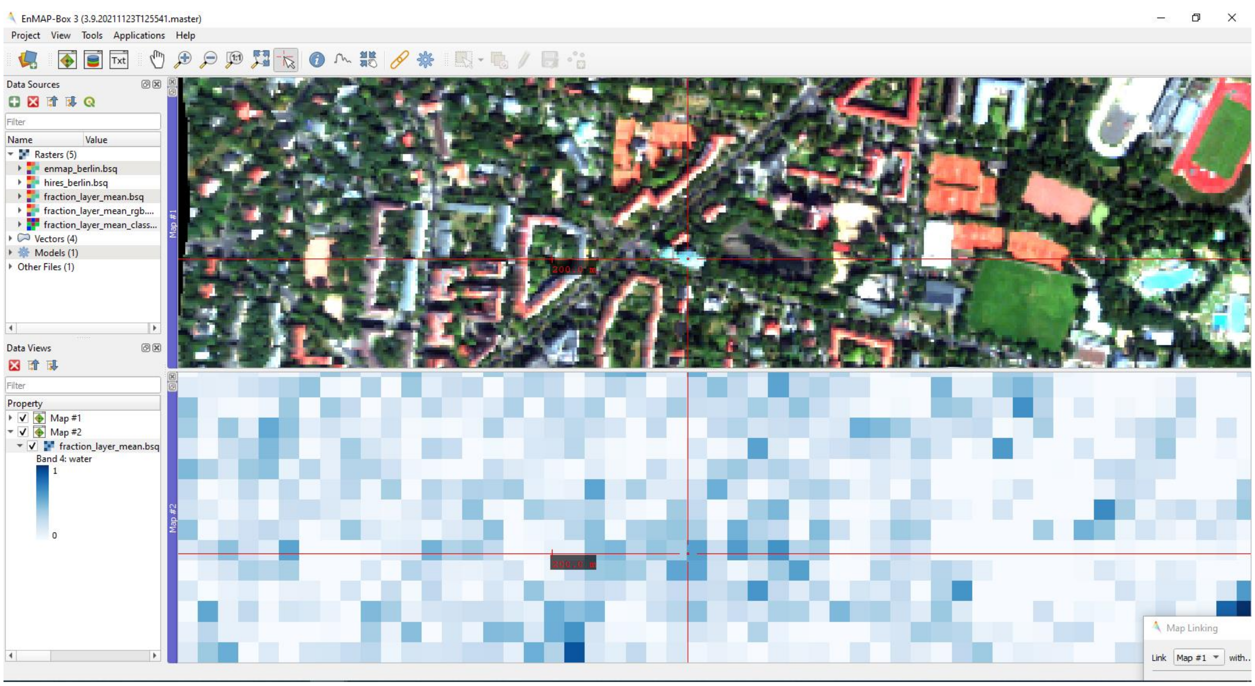

Figure 7b

In this the Soil class in fractional image correctly indicate the proportion of Soil endmember present in the pixel as shown in figure 8

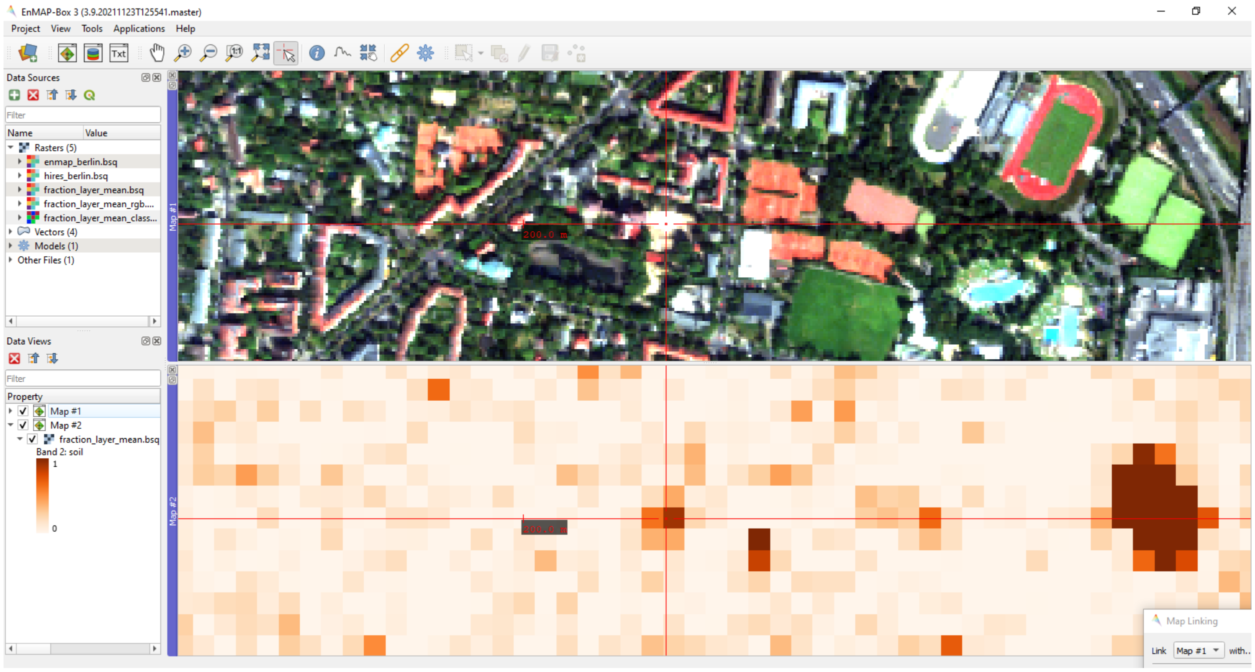

Figure 8