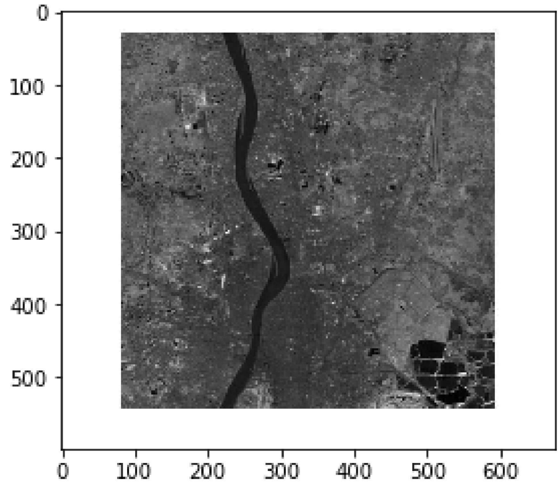
In [1]:

```
# importing libraries

import numpy as np
from PIL import Image
%pylab inline
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import cv2
import time
```

```
Populating the interactive namespace from numpy and matplotlib
```

In [2]:

```
# displaying input images

img=mpimg.imread('4.jpg')
imgplot = plt.imshow(img)
plt.show()
```



In [3]:

```
#loading images for R, G, B and I

im = Image.open('4.jpg')

pix = im.load()
```

In [4]:

```
# utility function for plotting multiple images

def show_images(images, cols = 1, titles = None):
    """Display a list of images in a single figure with matplotlib.

    Parameters
    ---------
    images: List of np.arrays compatible with plt.imshow.

    cols (Default = 1): Number of columns in figure (number of rows is
                        set to np.ceil(n_images/float(cols))).

    titles: List of titles corresponding to each image. Must have
            the same length as titles.
    """
    assert((titles is None)or (len(images) == len(titles)))
    n_images = len(images)
    if titles is None: titles = ['Image for k = %d' % i for i in range(2, 6)]
    fig = plt.figure()
    for n, (image, title) in enumerate(zip(images, titles)):
        a = fig.add_subplot(cols, np.ceil(n_images/float(cols)), n + 1)
        if image.ndim == 2:
            plt.gray()
        plt.imshow(image)
        a.set_title(title)
    fig.set_size_inches(np.array(fig.get_size_inches()) * n_images)
    plt.show()
```

In [5]:

```
# creating feature vector from 4 images

feature_vec = []

for i in range(83, 595) : # 512 rows
    for j in range(30, 542) : # 512 cols

        feature_vec.append([pix[i, j][0]])

feature_vec = np.array(feature_vec)
print(feature_vec)
print(feature_vec.shape)

num_points, num_feature = feature_vec.shape
```

```
[[108]
 [122]
 [111]
 ...
 [255]
 [255]
 [237]]
(262144, 1)
```

In [6]:

```
print(num_points)
```

```
262144
```

In [7]:

```
# selecting k colours

color = [(255, 0, 0), (0, 255, 0), (0, 0, 255), (0, 0, 0), (255, 255, 255)]
```

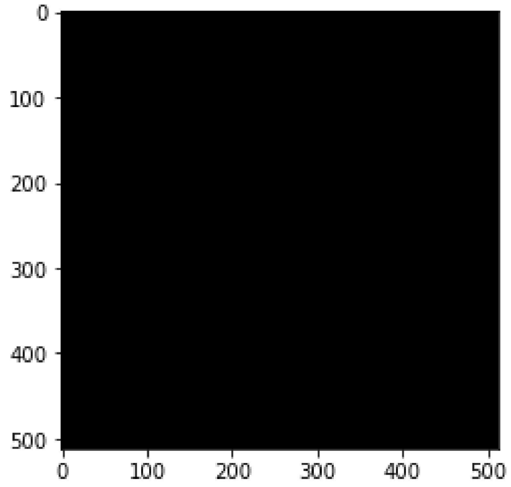
In [8]:

```
# initializing vector for final cluster values

final_clus = np.zeros((num_points, 1))
print(final_clus)
```

```
[[0.]
 [0.]
 [0.]
 ...
 [0.]
 [0.]
 [0.]]
```

In [9]:

```
# creating blank image for final output

km = Image.new('RGB', (512, 512))
km.save('blank.png')
pix_km = km.load()

plt.imshow(km)
plt.show()
```



In [10]:

```
def choose_k_random_points(k) :

    # taking random k points
    clus = []

    for i in range(k) :
        clus.append(feature_vec[random.randint(0, num_points - 1)])

    clus = np.array(clus)
    print(clus)
    return clus
```

In [11]:

```
def population_clus(k) :
    # creating array for number of points in each cluster

    clus_pop = np.zeros((k, 1))
    print(clus_pop)
    return clus_pop
```

In [12]:

```
# function for euclidean distance

def euclidean_dist(a, b) :
    a = a.reshape((a.shape[0], 1))
    b = b.reshape((b.shape[0], 1))
    dist = a - b
    sq_dist = np.dot(np.transpose(dist), dist)
    sq_dist = np.sqrt(sq_dist)
    return sq_dist
```

In [13]:

```
def final_cluster(k, clus, clus_pop) :
    # running clustering algo

    sum_clus = np.zeros((k, 1))
    for i in range(10) :
        dist = np.absolute(feature_vec - clus.T)
        min_idx = np.argmin(dist, axis = 1)
        min_idx = np.reshape(min_idx, (num_points,1))
        freq = np.zeros((k, 1))

        for j in range(num_points) :
            idx = min_idx[j]
            sum_clus[idx] = sum_clus[idx] + feature_vec[j]
            if i > 0 :
                idx_prev = min_idx_prev[j]
                sum_clus[idx_prev] = sum_clus[idx_prev] - feature_vec[j]
            freq[idx] += 1
        clus = np.divide(sum_clus, freq)
        min_idx_prev = min_idx
        freq_prev = freq

    final_clus = min_idx
    print(final_clus)
    return final_clus
```

In [14]:

```
def frequency_clusters(final_clus) :
    unique_elements, counts_elements = np.unique(final_clus, return_counts=True)
    print(unique_elements)
    print(counts_elements)
```

In [15]:

```
def k_means_clustering(k) :

    # choosing k random initial points
    clus = choose_k_random_points(k)
    print(clus.shape)

    # getting initial population
    clus_pop = population_clus(k)

    # getting final clusters
    final_clus = final_cluster(k, clus, clus_pop)

    # frequency of each cluster
    frequency_clusters(final_clus)

    c = 0
    for i in range(512) :
        for j in range(512) :
            pix_km[i,j] =  color[int(final_clus[c][0])]
            c = c + 1

    final_file = 'output' + str(k) + '.png'
    km.save(final_file)
```

In [16]:

```
start=time.time()

k_means_clustering(2)
k_means_clustering(3)
k_means_clustering(4)
k_means_clustering(5)

end = time.time()
```

```
[[107]
 [ 88]]
(2, 1)
[[0.]
 [0.]]
[[0]
 [0]
 [0]
 ...
 [0]
 [0]
 [0]]
[0 1]
[120600 141544]
[[ 71]
 [135]
 [ 81]]
(3, 1)
[[0.]
 [0.]
 [0.]]
[[1]
 [1]
 [1]
 ...
 [1]
 [1]
 [1]]
[0 1 2]
[ 78571  54728 128845]
[[33]
 [96]
 [98]
 [62]]
(4, 1)
[[0.]
 [0.]
 [0.]
 [0.]]
[[2]
 [2]
 [2]
 ...
 [2]
 [2]
 [2]]
[0 1 2 3]
[ 21055 104103  39767  97219]
[[86]
 [93]
 [72]
 [84]
 [87]]
(5, 1)
[[0.]
 [0.]
 [0.]
 [0.]
 [0.]]
[[4]
 [1]
 [4]
 ...
 [1]
 [1]
 [1]]
[0 1 2 3 4]
[86929  9690 21055 78762 65708]
```

In [22]:

```
print("Total time taken 'in seconds' = ", end - start)
```

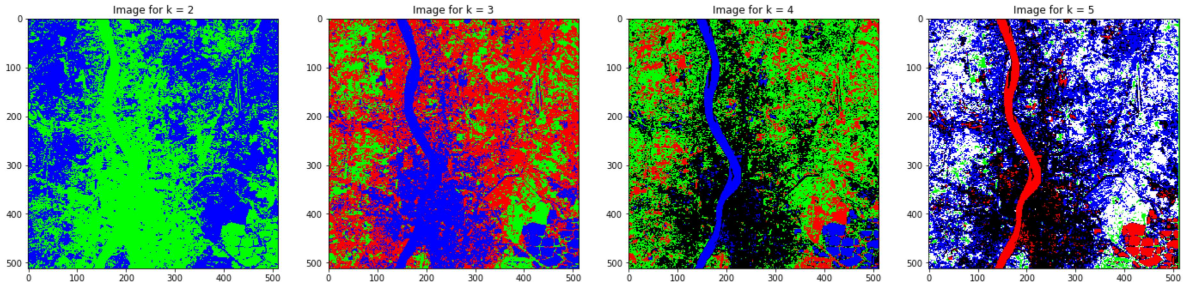
```
Total time taken 'in seconds' =  159.59404754638672
```

In [18]:

```
images = []

img = cv2.imread('output2.png')
images.append(img)

img = cv2.imread('output3.png')
images.append(img)

img = cv2.imread('output4.png')
images.append(img)

img = cv2.imread('output5.png')
images.append(img)
```

In [19]:

```
show_images(images)
```



In [ ]:

```
```