

In [1]:

```
from scipy.sparse import csr_matrix
from scipy.sparse.csgraph import minimum_spanning_tree as mst
from scipy.optimize import fmin
from copy import copy
import pandas as pd
from mpl_toolkits.mplot3d import Axes3D
import json
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np
```

In [2]:

```
def distance(coor1, coor2):
    return ((coor1[0] - coor2[0])**2 + (coor1[1] - coor2[1])**2)**0.5

def plt2coor(coor):
    return 73.4 + coor[0]*(13.16/600), 52.4 + (450-coor[1])*(5.63/450)
```

In [3]:

```
def coordinate_descent(f, x0, e=0.001):
    iter_list = [0]
    m_list = [-1]
    dist_list = [-1]
    f_list = [f(x0)]
    x_list = [x0]

    def f_1(x, *args):
        return f([x, args[0]])

    def f_2(y, *args):
        return f([args[0], y])

    x1 = copy(x0)
    iteration = 0
    while distance(x0, x1)>e or iteration == 0:
        x0 = copy(x1)
        x_new = fmin(f_1, x0[0], args=tuple([x0[1]]), disp=False)[0]
        y_new = fmin(f_2, x0[1], args=tuple([x0[0]]), disp=False)[0]
        m = 0
        if abs(x_new - x0[0]) > abs(y_new - x0[1]):
            x1[0] = x_new
        else:
            x1[1] = y_new
            m = 1
        iteration += 1
        iter_list.append(iteration)
        m_list.append(m)
        dist_list.append(distance(x0, x1))
        f_list.append(copy(f(x1)))
        x_list.append(copy(x1))

    data = {'Итерация': iter_list,
            'Изменяемая координата': m_list,
            'Размер шара': dist_list,
            'f(x)': f_list,
            'x': x_list}
    return x1, data
```

1. Поиск без учета пассажиропотока

In [4]:

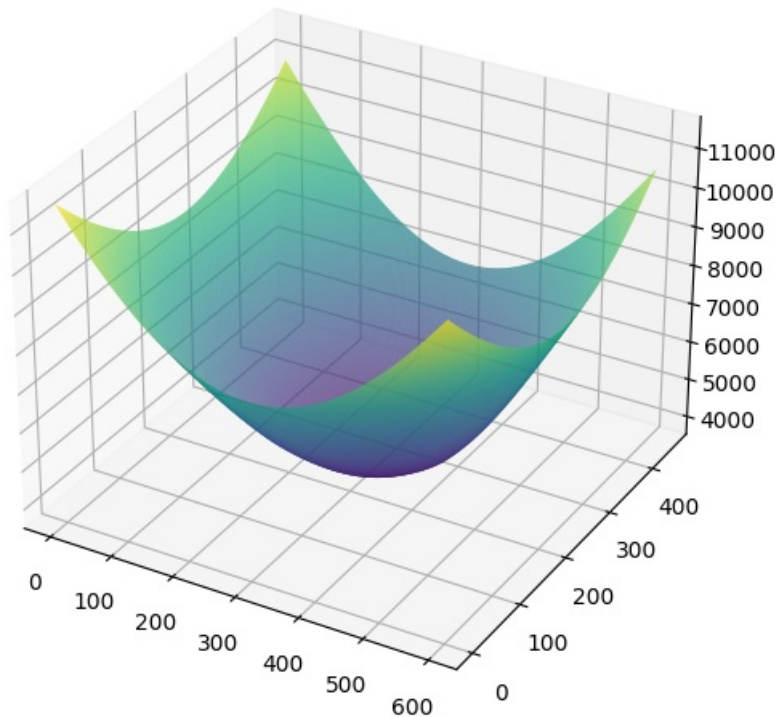
```
with open("new_coordinates_of_district_center.json", "r") as read_file:
    new_data = json.load(read_file)
```

In [5]:

```
def f(x):
    s = 0
    for coor in new_data.values():
        s += distance(x, coor)
    return s
```

In [6]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
plt.show()
```



In [7]:

```
p, data = coordinate_descent(f, [400, 150])
```

In [8]:

```
plt2coor(p)
```

Out[8]:

```
(80.0952913967677, 54.88455362929275)
```

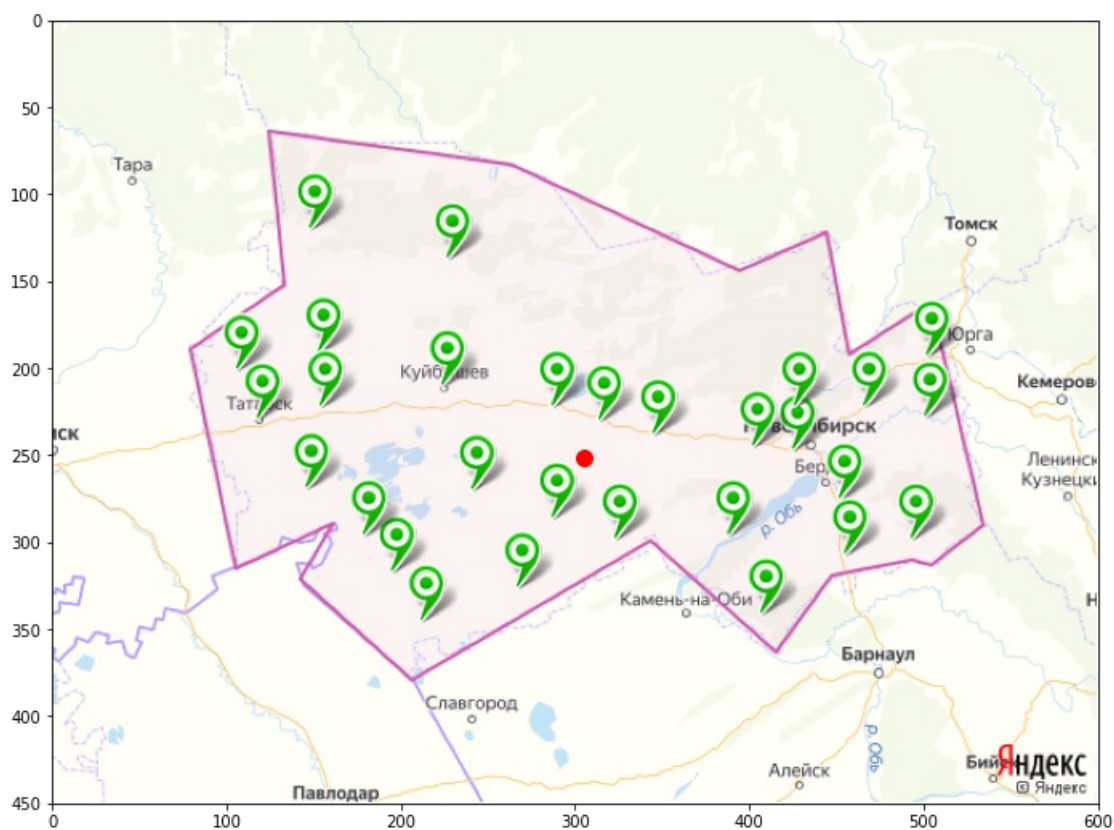
In [9]:

```
df = pd.DataFrame(data)
x = []
y = []
z = []
x_list = data['x']
dist_list = data['f(x)']
for i in range(len(x_list)):
    x.append(x_list[i][0])
    y.append(x_list[i][1])
    z.append(dist_list[i])
```

In [10]:

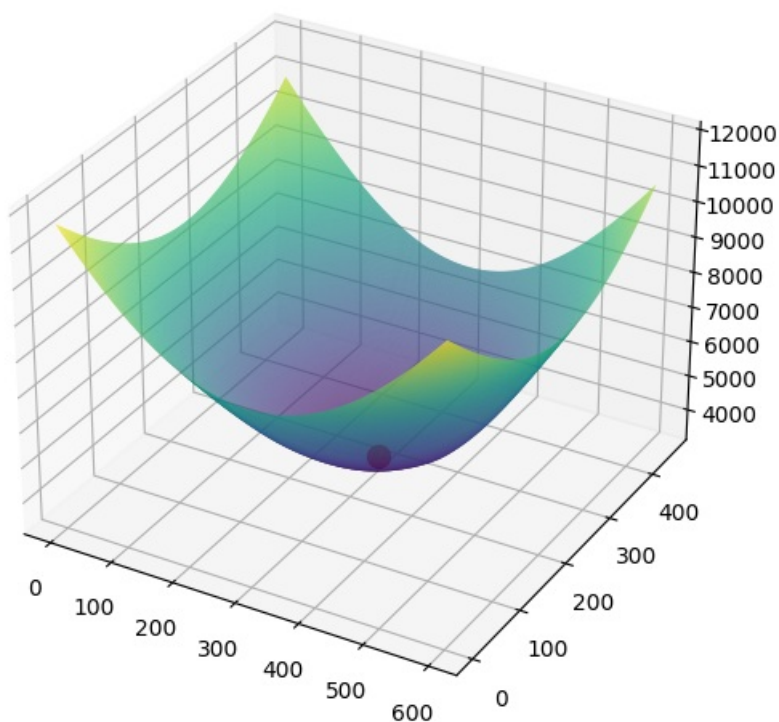
```
%matplotlib inline
plt.figure(figsize=(12, 9))
plt.axis([0, 600, 450, 0])
image = mpimg.imread("map.png")
plt.imshow(image)

plt.scatter(x[-1], y[-1], s=100, c='r')
plt.show()
```



In [11]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
ax.scatter(x[-1], y[-1], z[-1], s=100, c='r')
plt.show()
```



In [12]:

```
df.head(-1)
```

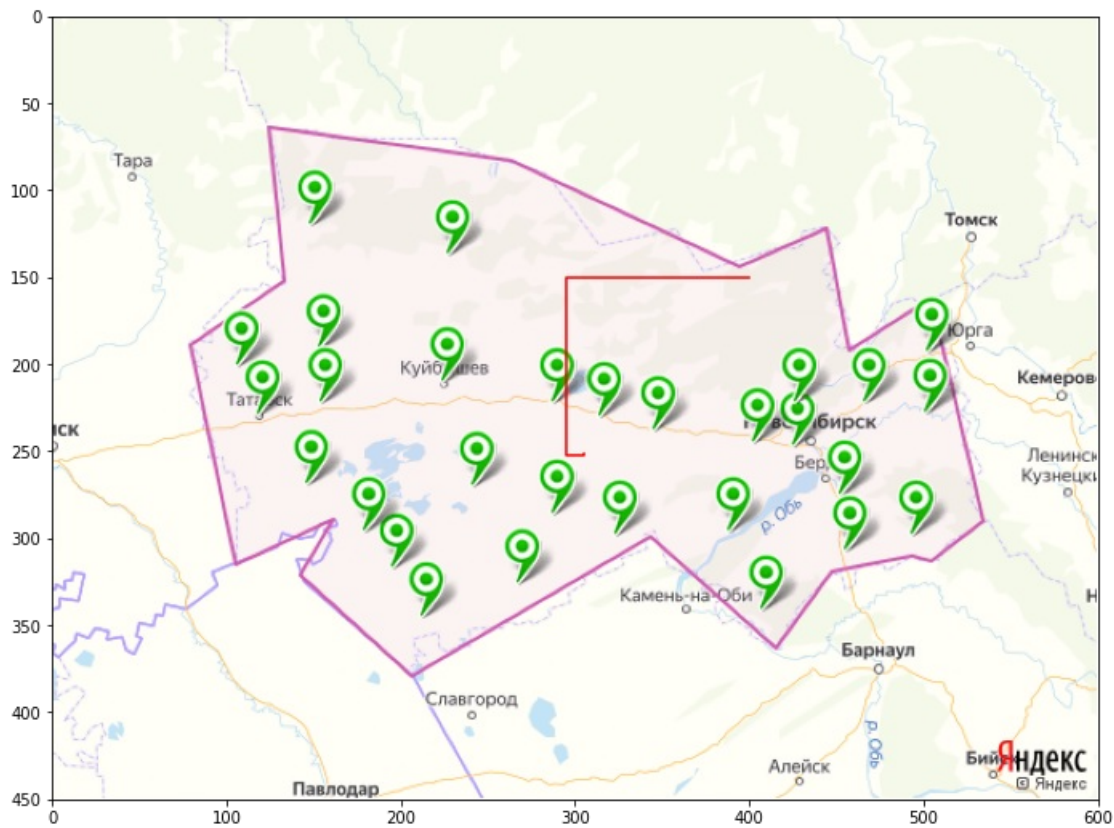
Out[12]:

Итерация	Изменяемая координата	Размер шага	f(x)	x
0	0	-1	-1.000000	5282.491033
1	1	0	105.053482	4729.176323
2	2	1	102.086906	3696.743444
3	3	0	10.252706	3689.866059
4	4	1	0.671318	3689.824389
5	5	0	0.056931	3689.824177
6	6	1	0.003357	3689.824176

In [13]:

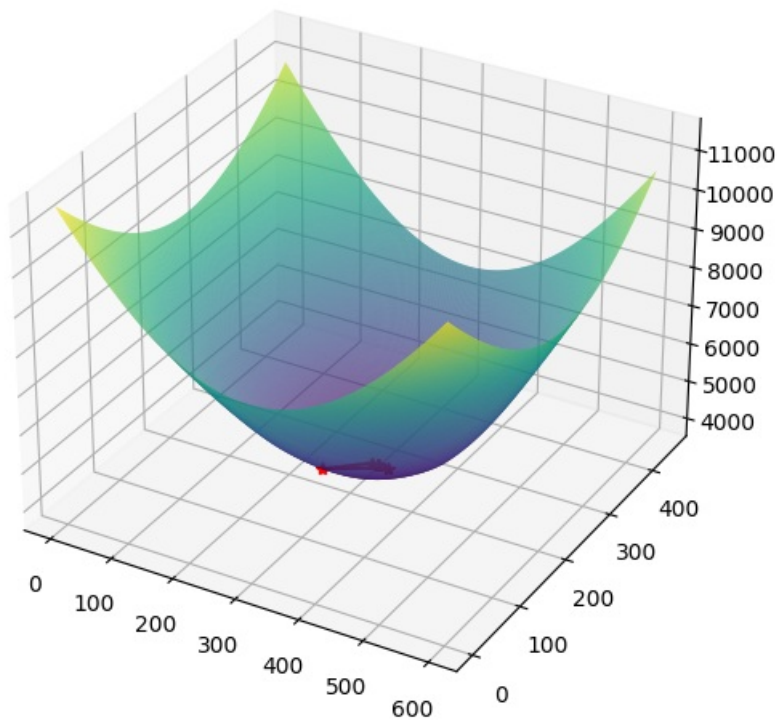
```
%matplotlib inline
plt.figure(figsize=(12, 9))
plt.axis([0, 600, 450, 0])
image = mpimg.imread("map.png")
plt.imshow(image)

plt.plot(x, y, 'r')
plt.show()
```



In [14]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
ax.plot(x, y, z, 'r-*')
plt.show()
```



2. Поиск с учетом пассажиропотока

In [15]:

```
with open("new_coordinates_of_district_center.json", "r") as read_file:
    new_data = json.load(read_file)
```

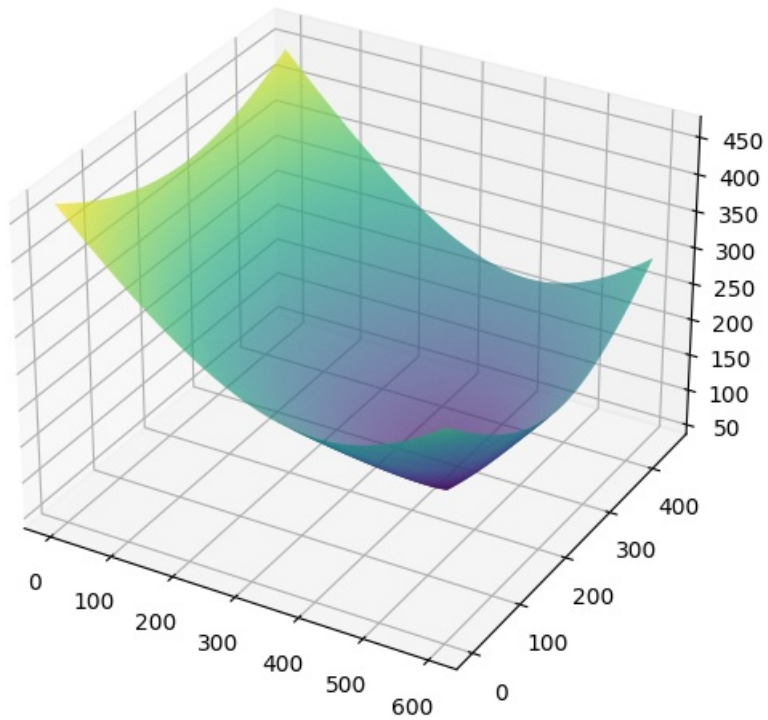
In [16]:

```
S = 0
for v in new_data.values():
    S += v[-1]

def f(x):
    s = 0
    for coor in new_data.values():
        s += distance(x, coor)*(coor[-1]/S)
    return s
```

In [17]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
plt.show()
```



In [18]:

```
p, data = coordinate_descent(f, [100, 100])
```

In [19]:

```
plt2coor(p)
```

Out[19]:

```
(82.71250038856705, 54.99166968593075)
```

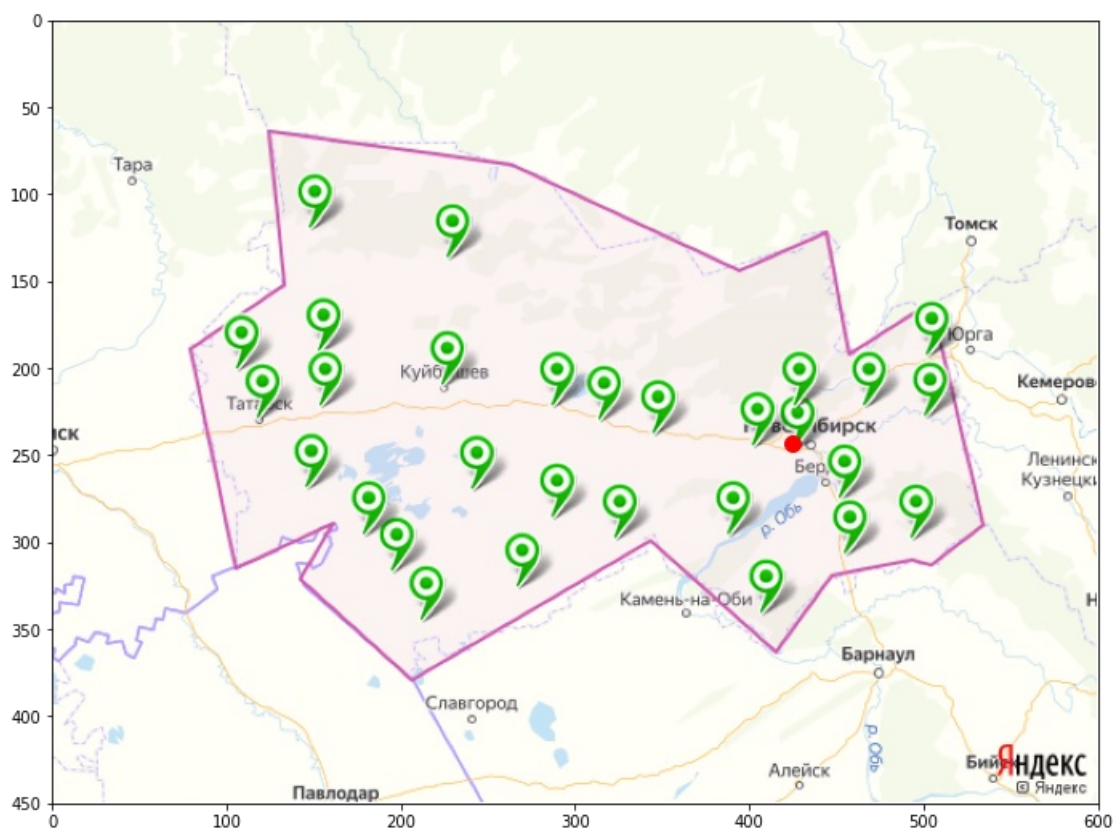
In [20]:

```
df = pd.DataFrame(data)
x = []
y = []
z = []
x_list = data['x']
dist_list = data['f(x)']
for i in range(len(x_list)):
    x.append(x_list[i][0])
    y.append(x_list[i][1])
    z.append(dist_list[i])
```

In [21]:

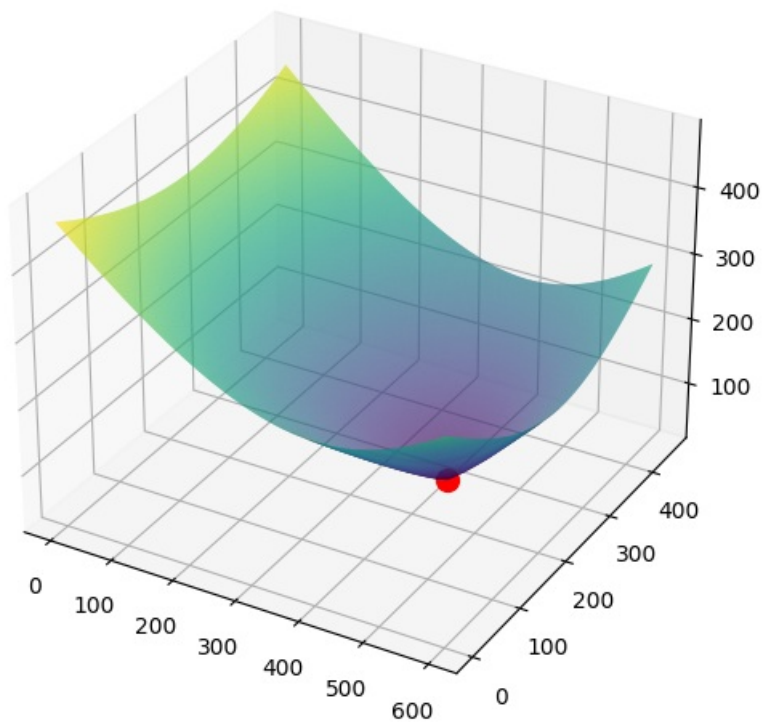
```
%matplotlib inline
plt.figure(figsize=(12, 9))
plt.axis([0, 600, 450, 0])
image = mpimg.imread("map.png")
plt.imshow(image)

plt.scatter(x[-1], y[-1], s=100, c='r')
plt.show()
```

In [22]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
ax.scatter(x[-1], y[-1], z[-1], s=100, c='r')
plt.show()
```



In [23]:

```
df.head(-1)
```

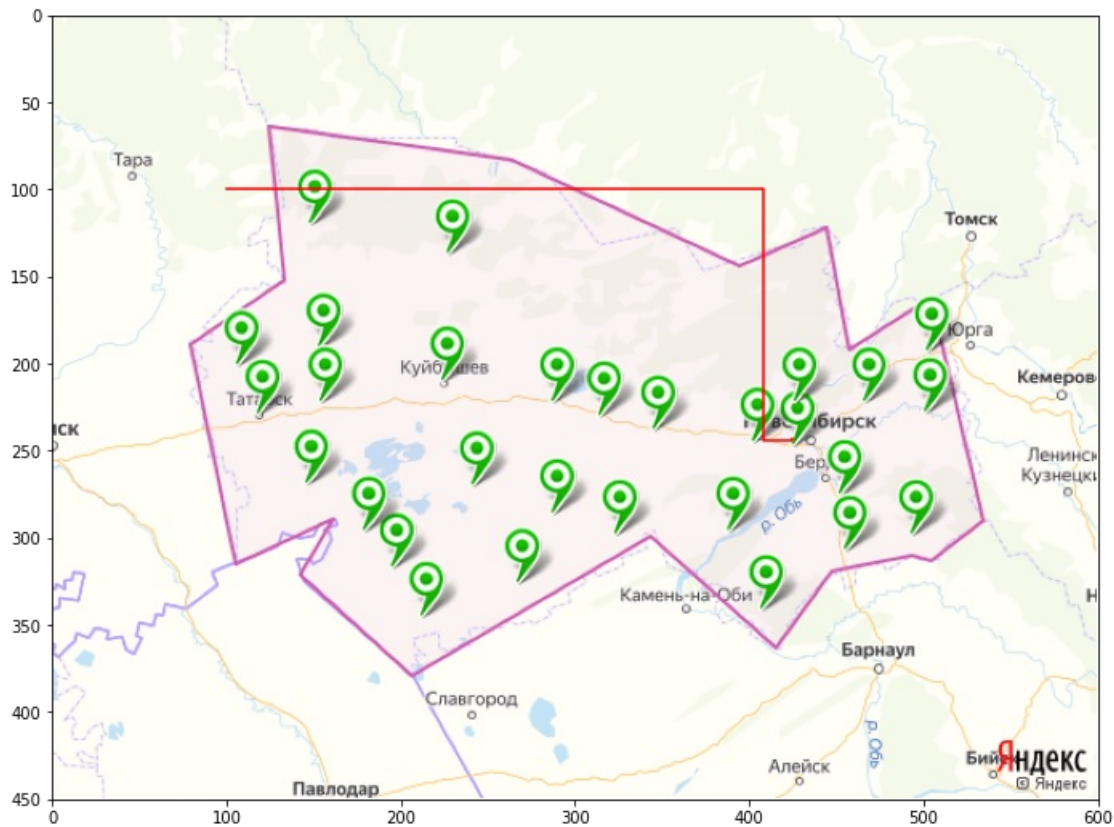
Out[23]:

Итерация	Изменяемая координата	Размер шага	f(x)	x
0	0	-1	-1.000000	334.474633 [100, 100]
1	1	0	307.971573	166.162456 [407.97157287597656, 100]
2	2	1	143.699570	54.670683 [407.97157287597656, 243.69956970214844]
3	3	0	16.475799	45.548239 [424.44737187732244, 243.69956970214844]
4	4	1	0.840766	45.091304 [424.44737187732244, 242.85880321182776]
5	5	0	0.133417	45.019748 [424.58078886738394, 242.85880321182776]
6	6	1	0.008153	45.015288 [424.58078886738394, 242.85065060307738]
7	7	0	0.001296	45.014637 [424.5820845851234, 242.85065060307738]

In [24]:

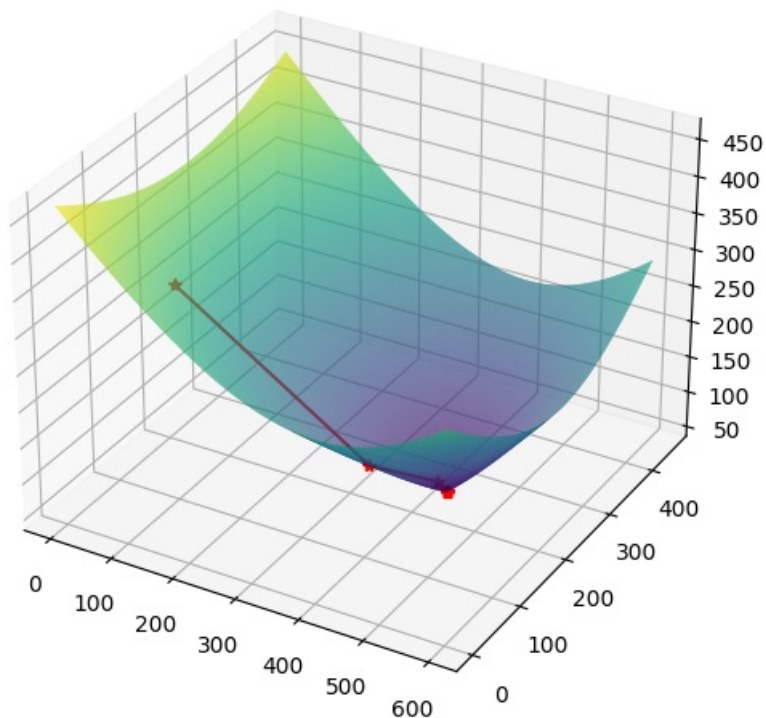
```
%matplotlib inline
plt.figure(figsize=(12, 9))
plt.axis([0, 600, 450, 0])
image = mpimg.imread("map.png")
plt.imshow(image)

plt.plot(x, y, 'r')
plt.show()
```



In [25]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
ax.plot(x, y, z, 'r-*')
plt.show()
```

3. Поиск без учета пассажиропотока г. Новосибирска

In [26]:

```
with open("new_coordinates_of_district_center.json", "r") as read_file:
    new_data = json.load(read_file)

c = new_data['Объ']
c[-1] = 0
new_data['Объ'] = c
```

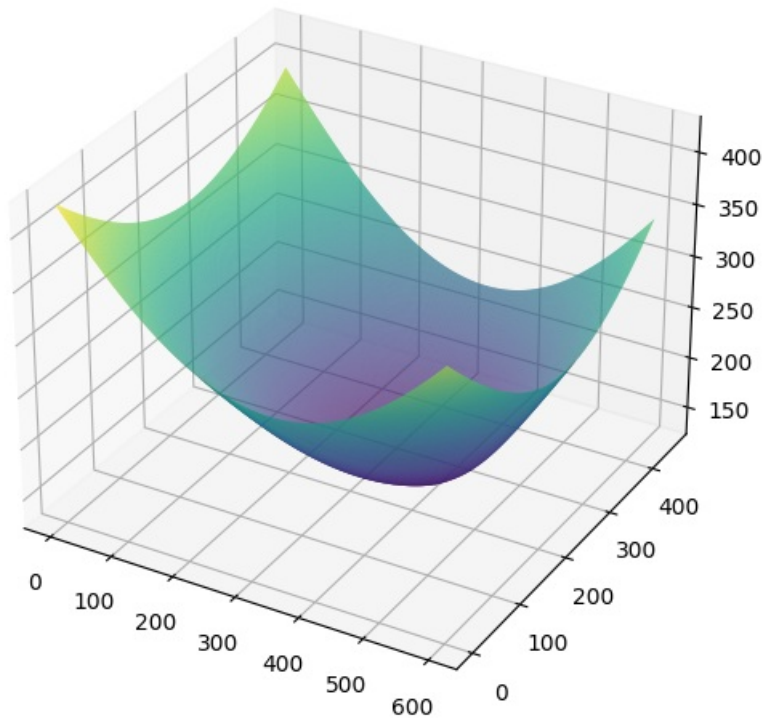
In [27]:

```
S = 0
for v in new_data.values():
    S += v[-1]

def f(x):
    s = 0
    for coor in new_data.values():
        s += distance(x, coor)*(coor[-1]/S)
    return s
```

In [28]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
plt.show()
```



In [29]:

```
p, data = coordinate_descent(f, [100, 100])
```

In [30]:

```
plt2coor(p)
```

Out[30]:

```
(81.20057892431248, 54.80067788839758)
```

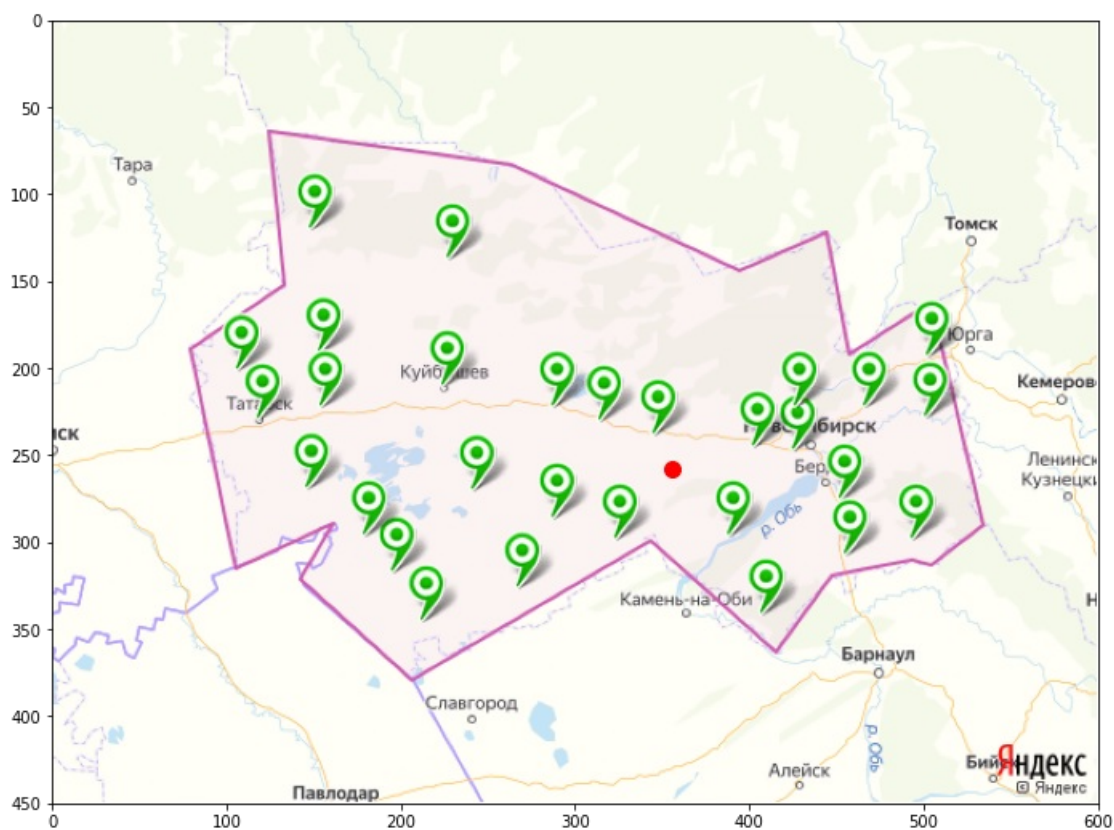
In [31]:

```
df = pd.DataFrame(data)
x = []
y = []
z = []
x_list = data['x']
dist_list = data['f(x)']
for i in range(len(x_list)):
    x.append(x_list[i][0])
    y.append(x_list[i][1])
    z.append(dist_list[i])
```

In [32]:

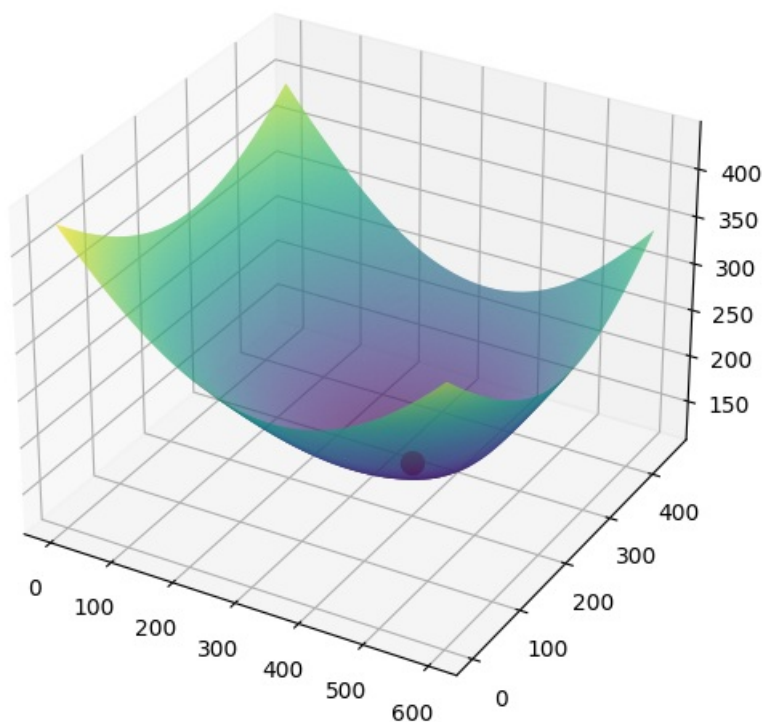
```
%matplotlib inline
plt.figure(figsize=(12, 9))
plt.axis([0, 600, 450, 0])
image = mpimg.imread("map.png")
plt.imshow(image)

plt.scatter(x[-1], y[-1], s=100, c='r')
plt.show()
```



In [33]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
ax.scatter(x[-1], y[-1], z[-1], s=100, c='r')
plt.show()
```



In [34]:

```
df.head(-1)
```

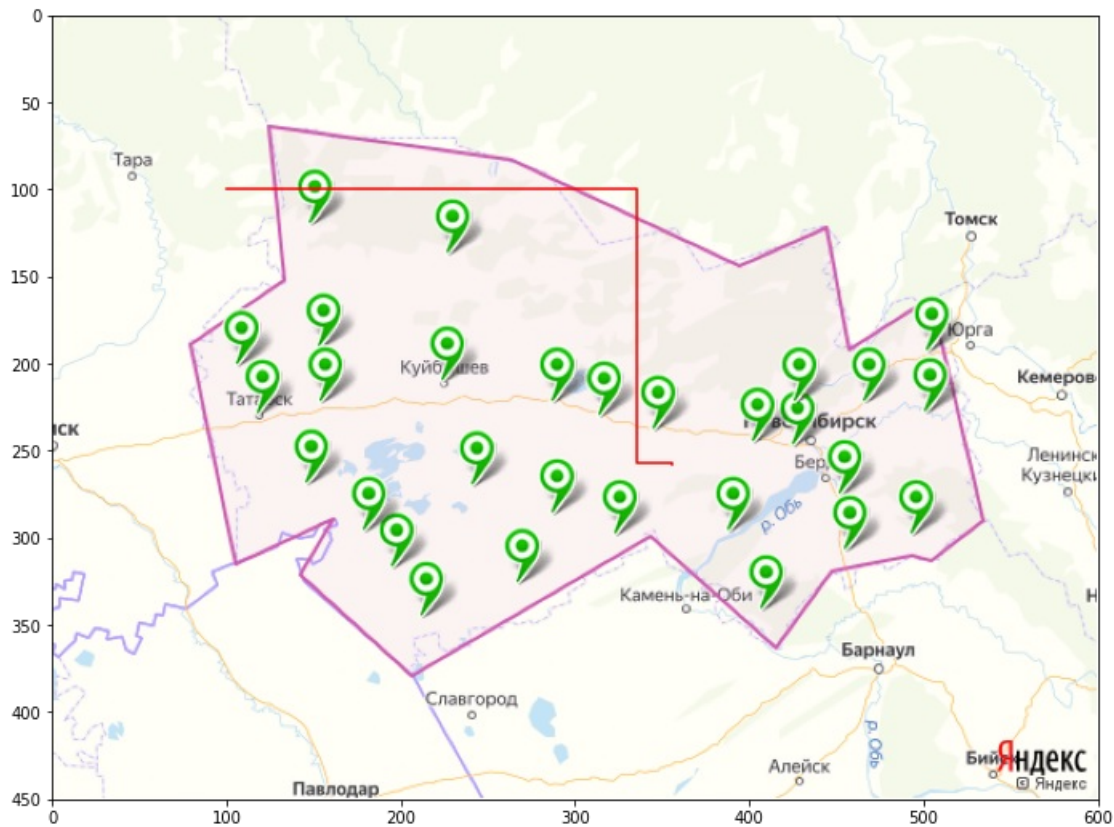
Out[34]:

Итерация	Изменяемая координата	Размер шага	f(x)	x	
0	0	-1	-1.000000	292.173793	[100, 100]
1	1	0	235.084763	204.394465	[335.0847625732422, 100]
2	2	1	157.475433	129.654684	[335.0847625732422, 257.4754333496094]
3	3	0	20.451823	129.003557	[355.5365855892014, 257.4754333496094]
4	4	1	0.633022	129.002095	[355.5365855892014, 258.1084553405526]
5	5	0	0.111553	129.002077	[355.64813833946346, 258.1084553405526]
6	6	1	0.007778	129.002077	[355.64813833946346, 258.1162337249413]
7	7	0	0.001357	129.002077	[355.6494950294443, 258.1162337249413]

In [35]:

```
%matplotlib inline
plt.figure(figsize=(12, 9))
plt.axis([0, 600, 450, 0])
image = mpimg.imread("map.png")
plt.imshow(image)

plt.plot(x, y, 'r')
plt.show()
```



In [36]:

```
%matplotlib notebook
fig = plt.figure()
ax = Axes3D(fig)
X = np.arange(0, 600, 1)
Y = np.arange(0, 450, 1)
X,Y = np.meshgrid(X,Y)
ax.plot_surface(X,Y,f([X,Y]), rstride=1, cstride=1, cmap='viridis')
ax.plot(x, y, z, 'r-*')
plt.show()
```

