Exemplos com Geopandas

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Set/2018

In [1]:

```
# https://pypi.org/project/geopy/
# https://geoffboeing.com/2014/09/using-geopandas-windows/
# https://github.com/gboeing/2014-summer-travels/blob/master/trip-visualization.ipynb
# https://geoffboeing.com/2014/07/visualizing-summer-travels-part-1-openpaths/
# https://www.fintu.ai/en/working-with-geodata-in-python/
# https://geopandas.readthedocs.io/en/latest/gallery/create_geopandas_from_pandas.html#
sphx-glr-gallery-create-geopandas-from-pandas-py
# http://geopandas.org/aggregation_with_dissolve.html
# http://www.net-analysis.com/blog/maprotation.html
# http://darribas.org/gds15/content/labs/lab_03.html
```

In [17]:

```
# command to display matplotlib plots inline within the ipython notebook
%matplotlib inline

# import necessary modules
import pandas as pd, numpy as np, matplotlib.pyplot as plt
import matplotlib.cm as cm, matplotlib.font_manager as fm
from datetime import datetime as dt
from time import time
from shapely.geometry import Polygon
from geopy.distance import great_circle
from geopandas import GeoDataFrame as gdp
```

In [2]:

```
# load the gps coordinate data, using the date as the full set's index
# the data files are encoded as utf-8: specify so to prevent matplotlib from choking on
 diacritics

df = pd.read_csv('ml/summer/data/summer-travel-gps-full.csv', encoding='utf-8', index_c
ol='date', parse_dates=True)
rs = pd.read_csv('ml/summer/data/summer-travel-gps-dbscan.csv', encoding='utf-8')
```

In [3]:

```
df.head()
```

Out[3]:

	lat	lon	city	country
date				
2014-05-14 09:07:00	51.481292	-0.451011	West Drayton	United Kingdom
2014-05-14 09:22:00	51.474005	-0.450999	Hounslow	United Kingdom
2014-05-14 10:51:00	51.478199	-0.446081	Hounslow	United Kingdom
2014-05-14 11:24:00	51.478199	-0.446081	Hounslow	United Kingdom
2014-05-14 11:38:00	51.474146	-0.451562	Hounslow	United Kingdom

In [4]:

```
rs.head()
```

Out[4]:

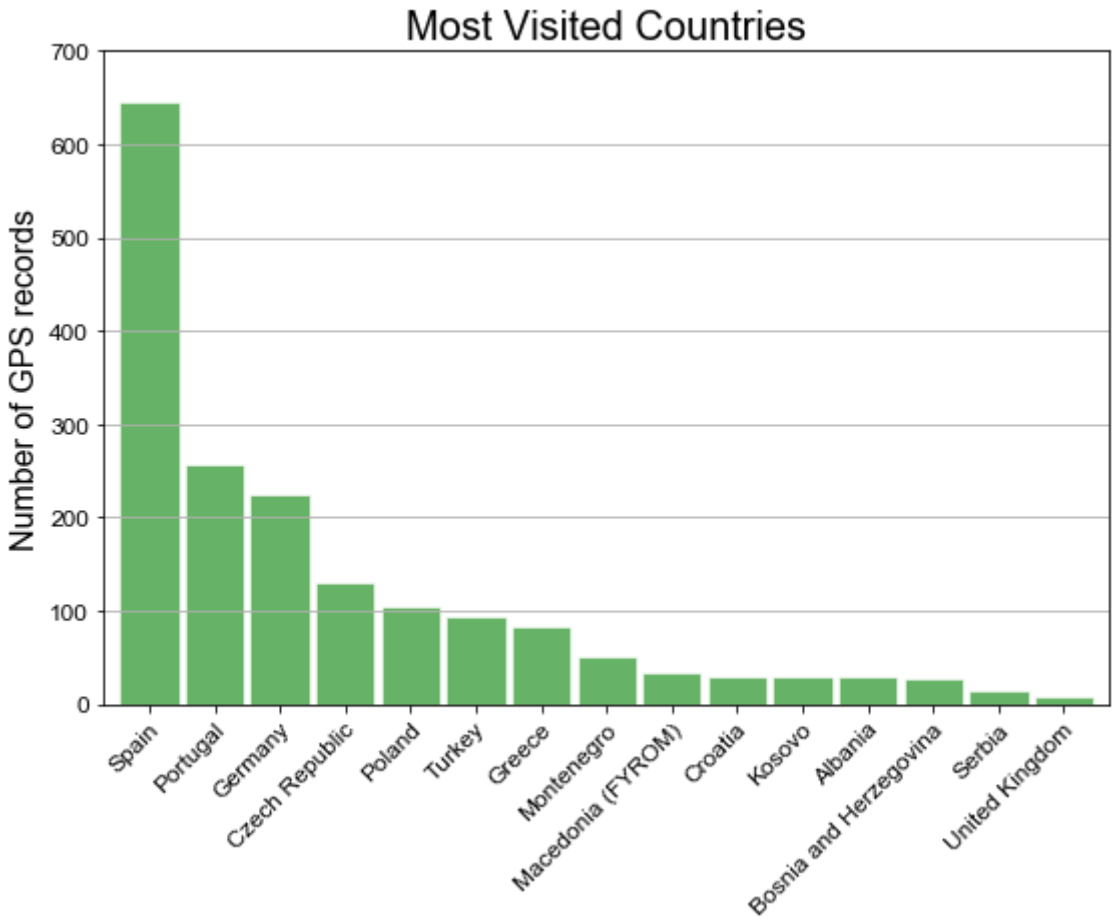
	Unnamed: 0	lat	lon	date	city	country
0	0	51.478199	-0.446081	05/14/2014 10:51	Hounslow	United Kingdom
1	1	38.774422	-9.129195	05/14/2014 15:25	Lisbon	Portugal
2	2	38.742987	-9.147780	05/14/2014 16:11	Lisbon	Portugal
3	3	38.712325	-9.137434	05/17/2014 08:09	Lisbon	Portugal
4	4	38.693780	-9.206363	05/15/2014 14:19	Lisbon	Portugal

In [5]:

```
title_font = fm.FontProperties(family='Arial', style='normal', size=20, weight='normal'
, stretch='normal')
label_font = fm.FontProperties(family='Arial', style='normal', size=16, weight='normal'
, stretch='normal')
ticks_font = fm.FontProperties(family='Arial', style='normal', size=12, weight='normal'
, stretch='normal')
annotation_font = fm.FontProperties(family='Arial', style='normal', size=11, weight='no
rmal', stretch='normal')
```

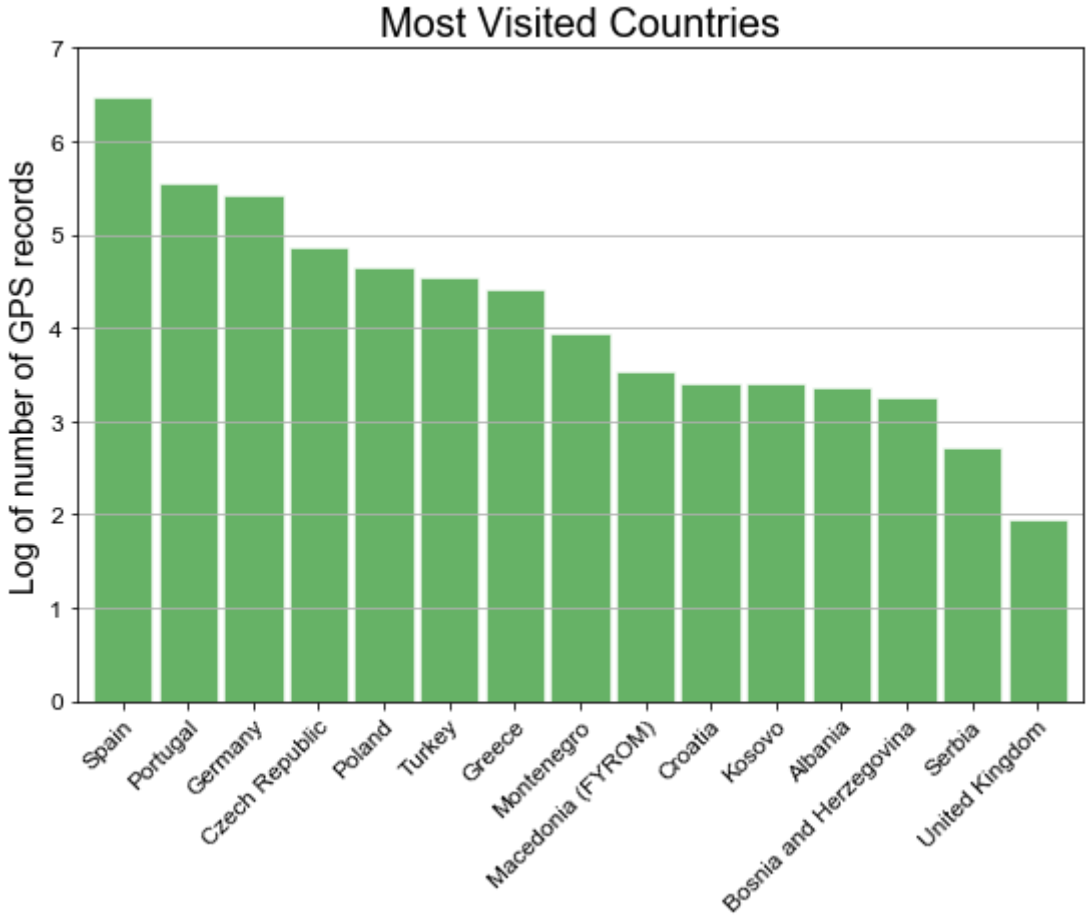
In [6]:

```
# plot a histogram of the countries I visited
countdata = df['country'].value_counts()
ax = countdata.plot(kind='bar',
                    figsize=[9, 6],
                    width=0.9,
                    alpha=0.6,
                    color='g',
                    edgecolor='w',
                    grid=False,
                    ylim=[0, 700])

ax.set_xticks(range(len(countdata)))
ax.set_xticklabels(countdata.index, rotation=45, rotation_mode='anchor', ha='right', fo
ntproperties=ticks_font)
ax.yaxis.grid(True)
for label in ax.get_yticklabels():
    label.set_fontproperties(ticks_font)

ax.set_title('Most Visited Countries', fontproperties=title_font)
ax.set_xlabel('', fontproperties=label_font)
ax.set_ylabel('Number of GPS records', fontproperties=label_font)

plt.show()
```



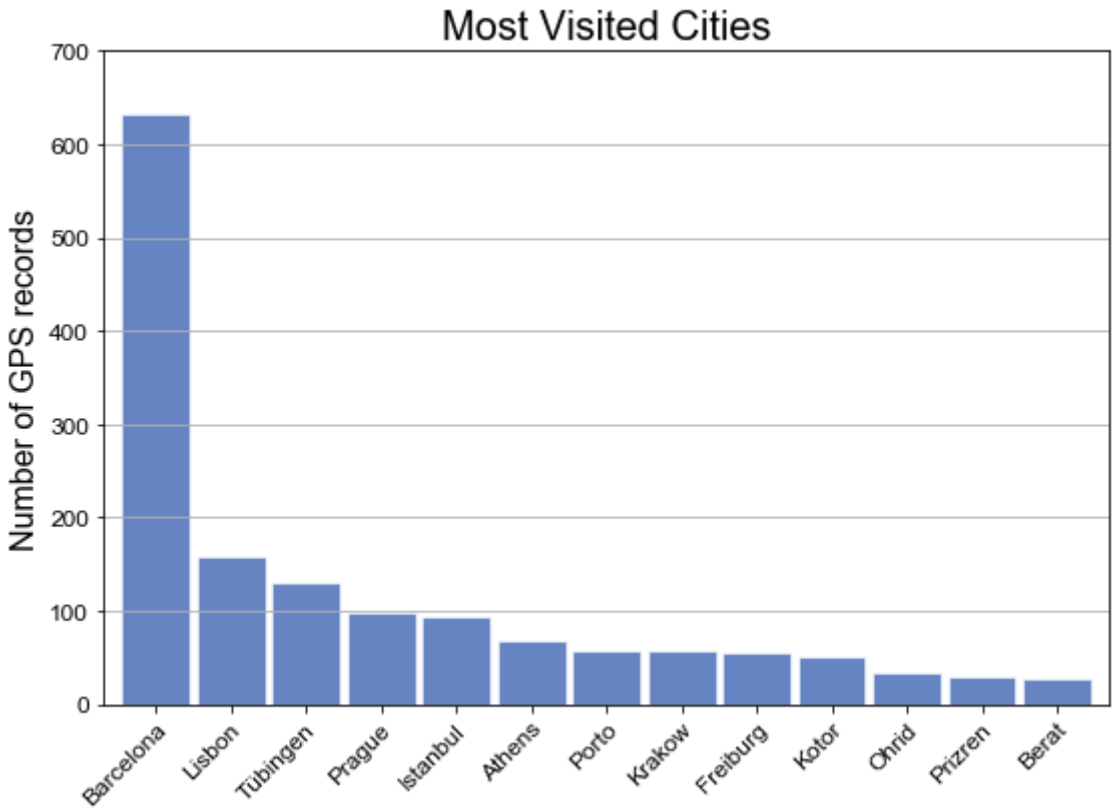
In [7]:

```
# let's re-scale that to make it look better
countdata = np.log(df['country'].value_counts())
ax = countdata.plot(kind='bar',
                    figsize=[9, 6],
                    width=0.9,
                    alpha=0.6,
                    color='g',
                    edgecolor='w',
                    grid=False,
                    ylim=[0, 7])

ax.set_xticks(range(len(countdata)))
ax.set_xticklabels(countdata.index, rotation=45, rotation_mode='anchor', ha='right', fo
ntproperties=ticks_font)
ax.yaxis.grid(True)
for label in ax.get_yticklabels():
    label.set_fontproperties(ticks_font)

ax.set_title('Most Visited Countries', fontproperties=title_font)
ax.set_xlabel('', fontproperties=label_font)
ax.set_ylabel('Log of number of GPS records', fontproperties=label_font)

plt.show()
```



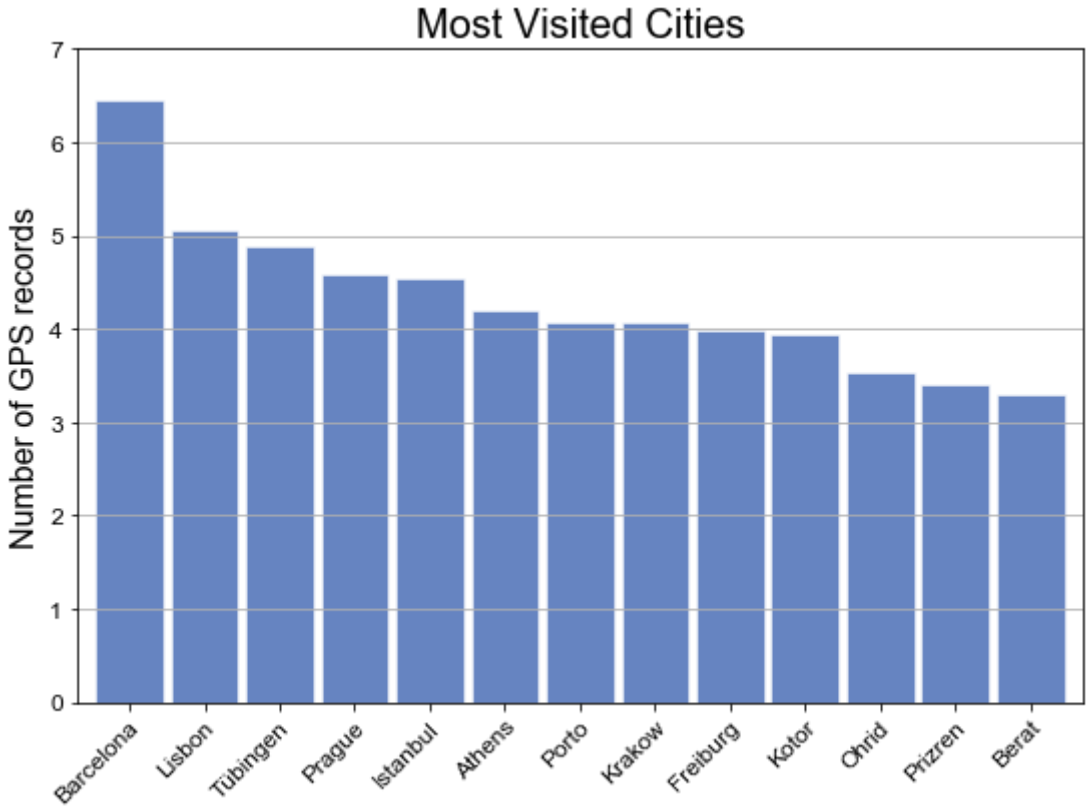
In [8]:

```
# plot a histogram of the cities I visited most
countdata = df['city'].value_counts().head(13)
xlabels = pd.Series(countdata.index)

ax = countdata.plot(kind='bar',
                    figsize=[9, 6],
                    width=0.9,
                    alpha=0.6,
                    color='#003399',
                    edgecolor='w',
                    grid=False,
                    ylim=[0, 700])

ax.set_xticks(range(len(countdata)))
ax.set_xticklabels(countdata.index, rotation=45, rotation_mode='anchor', ha='right', fo
ntproperties=ticks_font)
ax.yaxis.grid(True)
for label in ax.get_yticklabels():
    label.set_fontproperties(ticks_font)

ax.set_title('Most Visited Cities', fontproperties=title_font)
ax.set_xlabel('', fontproperties=label_font)
ax.set_ylabel('Number of GPS records', fontproperties=label_font)

plt.show()
```



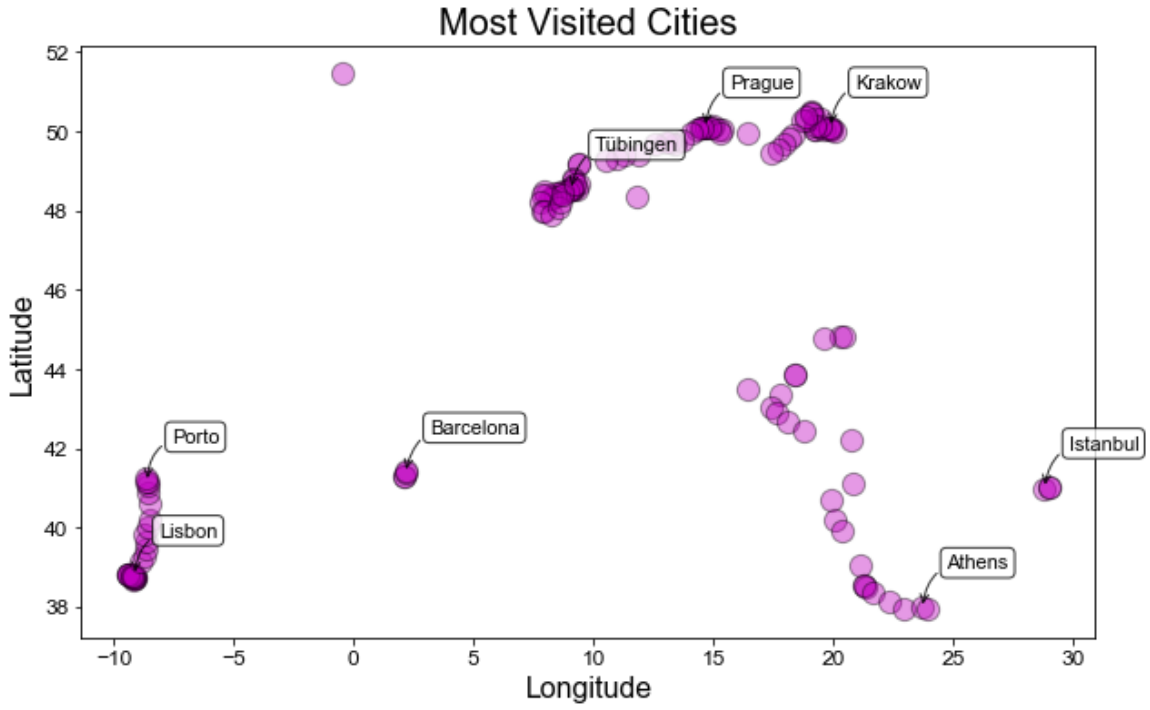
In [9]:

```
# let's re-scale that to make it look better
countdata = np.log(df['city'].value_counts().head(13))
ax = countdata.plot(kind='bar',
                    figsize=[9, 6],
                    width=0.9,
                    alpha=0.6,
                    color='#003399',
                    edgecolor='w',
                    grid=False,
                    ylim=[0, 7])

ax.set_xticks(range(len(countdata)))
ax.set_xticklabels(countdata.index, rotation=45, rotation_mode='anchor', ha='right', fo
ntproperties=ticks_font)
ax.yaxis.grid(True)
for label in ax.get_yticklabels():
    label.set_fontproperties(ticks_font)

ax.set_title('Most Visited Cities', fontproperties=title_font)
ax.set_xlabel('', fontproperties=label_font)
ax.set_ylabel('Number of GPS records', fontproperties=label_font)

plt.show()
```



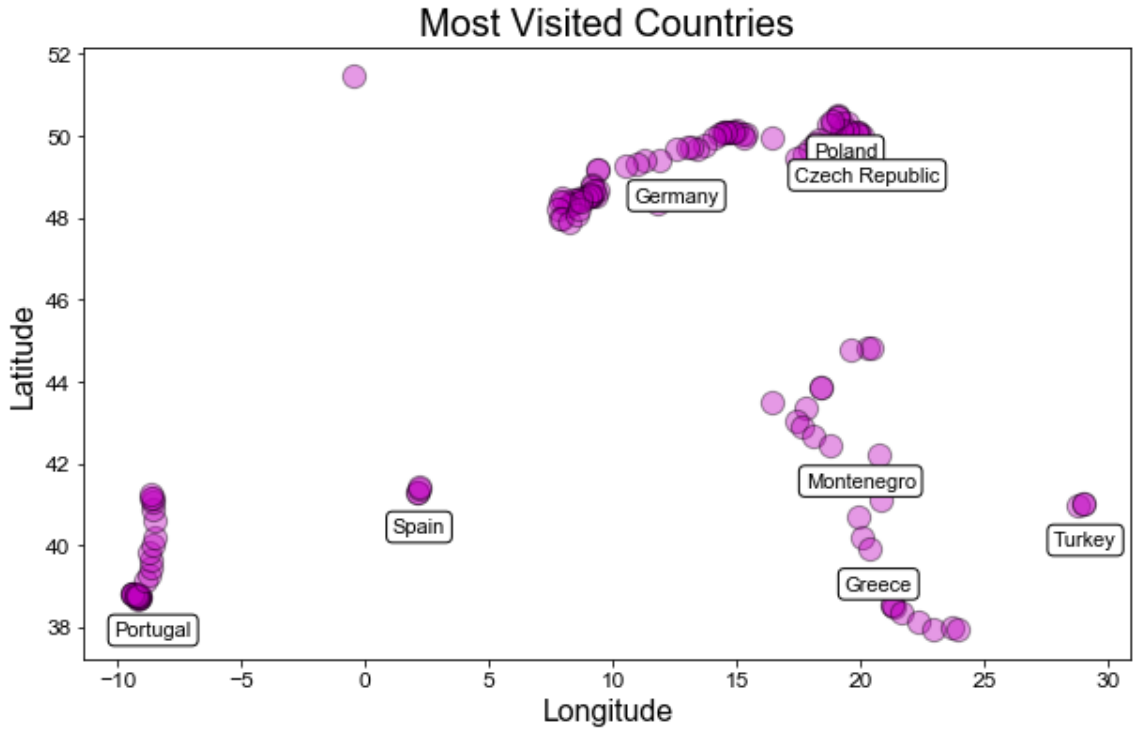
In [10]:

```
# get a representative point from the reduced data set for each of the most visited cit
ies in the full set
most_index = df['city'].value_counts().head(8).index
most = pd.DataFrame(df[df['city'].isin(most_index)])
most.drop_duplicates(subset=['city'], keep='first', inplace=True)

# plot the final reduced set of coordinate points vs the original full set
fig, ax = plt.subplots(figsize=[10, 6])
rs_scatter = ax.scatter(rs['lon'], rs['lat'], c='m', edgecolor='k', alpha=.4, s=150)

# set axis labels, tick labels, and title
for label in ax.get_xticklabels():
    label.set_fontproperties(ticks_font)
for label in ax.get_yticklabels():
    label.set_fontproperties(ticks_font)
ax.set_title('Most Visited Cities', fontproperties=title_font)
ax.set_xlabel('Longitude', fontproperties=label_font)
ax.set_ylabel('Latitude', fontproperties=label_font)

# annotate the most visited cities
for _, row in most.iterrows():
    ax.annotate(row['city'],
                xy=(row['lon'], row['lat']),
                xytext=(row['lon'] + 1, row['lat'] + 1),
                fontproperties=annotation_font,
                bbox=dict(boxstyle='round', color='k', fc='w', alpha=0.8),
                xycoords='data',
                arrowprops=dict(arrowstyle='->', connectionstyle='arc3,rad=0.5', color=
'k', alpha=0.8))
plt.show()
```



In [13]:

```
# get a representative point from the reduced data set for each of the most visited cou
ntries in the full set
most_index = df['country'].value_counts().head(8).index
most = pd.DataFrame(df[df['country'].isin(most_index)])
most.drop_duplicates(subset=['country'], keep='first', inplace=True)

# plot the final reduced set of coordinate points vs the original full set
fig, ax = plt.subplots(figsize=[10, 6])
rs_scatter = ax.scatter(rs['lon'], rs['lat'], c='m', edgecolor='k', alpha=.4, s=150)

# set axis labels, tick labels, and title
for label in ax.get_xticklabels():
    label.set_fontproperties(ticks_font)
for label in ax.get_yticklabels():
    label.set_fontproperties(ticks_font)
ax.set_title('Most Visited Countries', fontproperties=title_font)
ax.set_xlabel('Longitude', fontproperties=label_font)
ax.set_ylabel('Latitude', fontproperties=label_font)

# annotate the most visited countries
for _, row in most.iterrows():
    ax.annotate(row['country'],
                xy=(row['lon'], row['lat']),
                xytext=(row['lon'] - 1, row['lat'] - 1),
                fontproperties=annotation_font,
                bbox=dict(boxstyle="round", fc="1"),
                xycoords='data')
plt.show()
```



In [19]:

```
#load the shapefile of all countries in the world
all_countries = gdp.from_file('ml/summer/shapefiles/countries_shp/world_country_admin_b
oundary_shapefile_with_fips_codes.shp')
all_countries.head(10)
```

Out[19]:

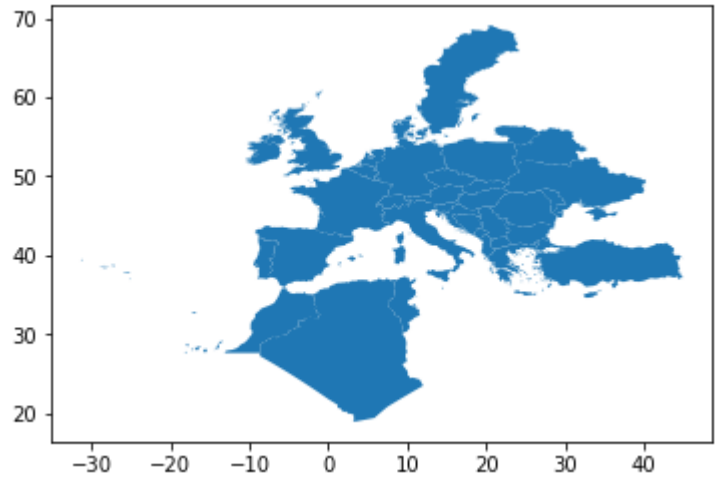
	FIPS_CNTRY	CNTRY_NAME	geometry
0	AA	Aruba	POLYGON ((-69.88223266601563 12.41110992431641...
1	AC	Antigua & Barbuda	(POLYGON ((-61.7388916015625 17.54055404663086...
2	AE	United Arab Emirates	(POLYGON ((56.28047180175781 24.85727310180664...
3	AF	Afghanistan	POLYGON ((61.27655792236328 35.60724639892578,...
4	AG	Algeria	POLYGON ((-5.152134895324707 30.18046951293945...
5	AJ	Azerbaijan	(POLYGON ((51.2927131652832 38.71485137939453,...
6	AL	Albania	POLYGON ((20.79192352294922 40.43154144287109,...
7	AM	Armenia	(POLYGON ((46.54037475585938 38.87558746337891...
8	AN	Andorra	POLYGON ((1.445833206176758 42.60194396972656,...
9	AO	Angola	(POLYGON ((13.09138870239258 -4.63305568695068...

In [20]:

```
# define the coordinates at the extent of our point data for our map
margin_width = 4
lon_range = [rs['lon'].min() - margin_width, rs['lon'].max() + margin_width]
lat_range = [rs['lat'].min() - margin_width, rs['lat'].max() + margin_width]

# create a rectangle from these coordinates
spatial_extent = Polygon([(lon_range[0], lat_range[0]),
                          (lon_range[0], lat_range[1]),
                          (lon_range[1], lat_range[1]),
                          (lon_range[1], lat_range[0])])

# one way to get the shapes is with geopandas intersection, but that chops the shapes o
ff at the extent
#countries = all_countries['geometry'].intersection(spatial_extent)

# another way to get the shapes is geopandas intersects, which pulls the full shape
# but let's remove russia because it's too big
countries = all_countries[all_countries['geometry'].intersects(spatial_extent)]
countries = countries[countries['CNTRY_NAME'] != 'Russia']

countries.plot()
```

Out[20]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x204ac1bd828>
```



Geocoding

In [21]:

```
#Prerequisites
#The libraries required for this section can be installed with PyPI as follows (here fo
r Python3):

# conda install -c conda-forge geopy
# conda install -c conda-forge ratelimit
# conda install -c conda-forge tqdm # for progress bars
# conda install -c conda-forge ipyleaflet
```

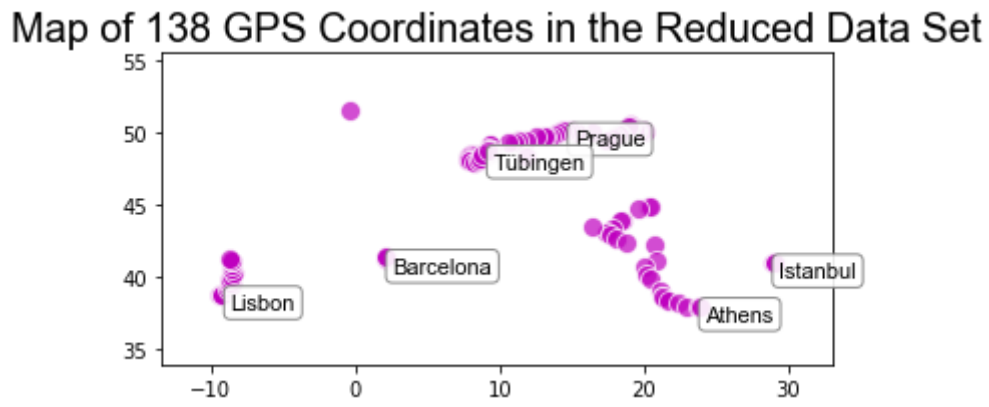
In [22]:

```
# get a representative point for each of the most visited cities
most_index = df['city'].value_counts().head(6).index
most = pd.DataFrame(rs[rs['city'].isin(most_index)])
most.drop_duplicates(subset=['city'], keep='first', inplace=True)
```

In [23]:

```
# draw a map of our point data on top of a basemap of country boundaries
fig = plt.figure()

# set the figure dimensions to the extent of the coordinates in our data
ydimension = int((lat_range[1] - lat_range[0]) / 4)
xdimension = int((lon_range[1] - lon_range[0]) / 4)
fig.set_size_inches(xdimension, ydimension)

# plot the country boundaries and then our point data
countries.plot(alpha=0)
rs_scatter = plt.scatter(x=rs['lon'], y=rs['lat'], c='m', edgecolor='w', alpha=0.7, s=1
00)

# annotate the most visited cities in the data set
for _, row in most.iterrows():
    plt.annotate(row['city'],
                 xy=(row['lon'], row['lat']),
                 xytext=(row['lon'] + 0.5, row['lat'] - 1),
                 fontproperties=annotation_font,
                 bbox=dict(boxstyle='round', color='gray', fc='w', alpha=0.9),
                 xycoords='data')

# limit the coordinate space shown to the extent of our point data
plt.xlim(lon_range)
plt.ylim(lat_range)

# set axis labels and title
plt.title('Map of {} GPS Coordinates in the Reduced Data Set'.format(len(rs)), fontprop
erties=title_font)

plt.show()
```

```
<matplotlib.figure.Figure at 0x204abf47630>
```



Now draw some pie charts to show proportions

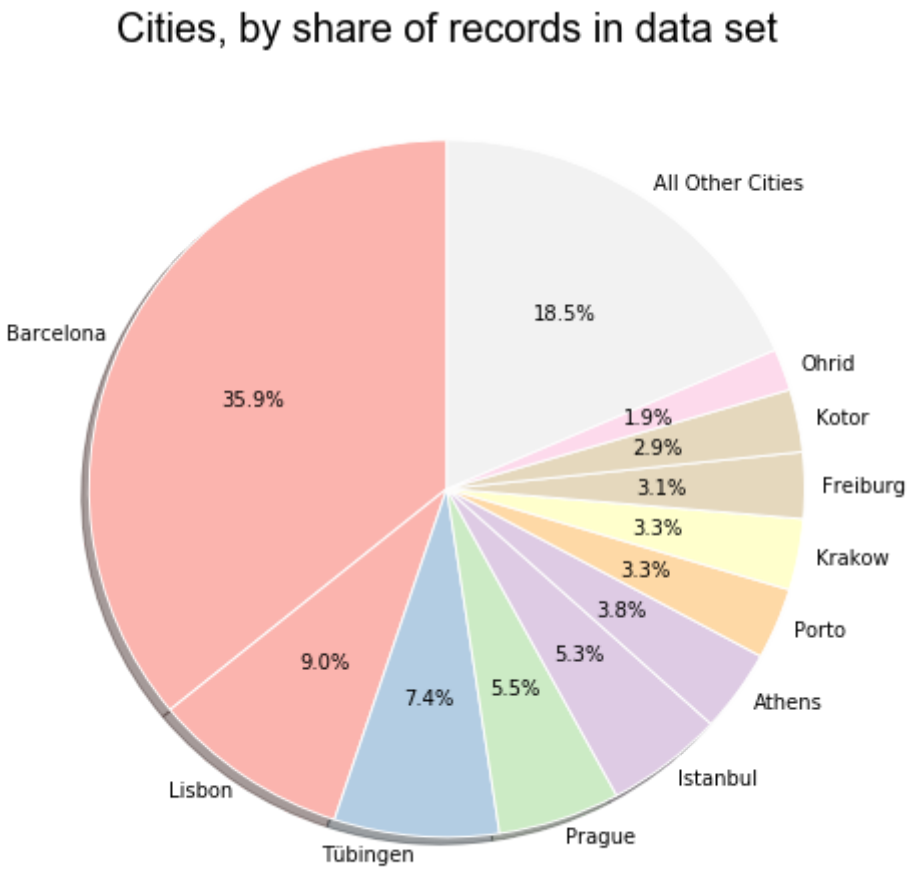
In [24]:

```
# function to produce more beautiful pie charts with matplotlib
def gbplot_pie(fractions, #values for the wedges
               labels, #labels for the wedges
               title = '', #title of the pie chart
               cm_name = 'Pastel1', #name of the matplotlib colormap to use
               autopct = '%1.1f%%', #format the value text on each pie wedge
               labeldistance = 1.05, #where to place wedge labels in relation to pie wed
ges
               shadow = True, #shadow around the pie
               startangle = 90, #rotate 90 degrees to start the top of the data set on t
he top of the pie
               edgecolor = 'w', #color of pie wedge edges
               width = 8, #width of the figure in inches
               height = 8, #height of the figure in inches
               grouping_threshold = None, #group all wedges below this value into one 'a
ll others' wedge
               grouping_label = None): #what the label the grouped wedge

    # if the user passed a threshold value, group all fractions lower than it into one
 'misc' pie wedge
    if not grouping_threshold==None:

        # if user didn't pass a label, apply a default text
        if grouping_label == None:
            grouping_label = 'Others'

        # select the rows greater than the cutoff value
        row_mask = fractions > grouping_threshold
        meets_threshold = fractions[row_mask]

        # group all other rows below the cutoff value
        all_others = pd.Series(fractions[~row_mask].sum())
        all_others.index = [grouping_label]

        # append the grouped row to the bottom of the rows to display
        fractions = meets_threshold.append(all_others)
        labels = fractions.index

    # get the color map then pull 1 color from it for each pie wedge we'll draw
    color_map = cm.get_cmap(cm_name)
    num_of_colors = len(fractions)
    colors = color_map([x/float(num_of_colors) for x in range(num_of_colors)])

    # create the figure and an axis to plot on
    fig, ax = plt.subplots(figsize=[width, height])

    # plot the pie
    wedges = ax.pie(fractions,
                    labels = labels,
                    labeldistance = labeldistance,
                    autopct = autopct,
                    colors = colors,
                    shadow = shadow,
                    startangle = startangle)

    # change the edgecolor for each wedge
    for wedge in wedges[0]:
        wedge.set_edgecolor(edgecolor)
```

```
    # set the title and show the plot
    ax.set_title(title, fontproperties=title_font)
    plt.show()
```

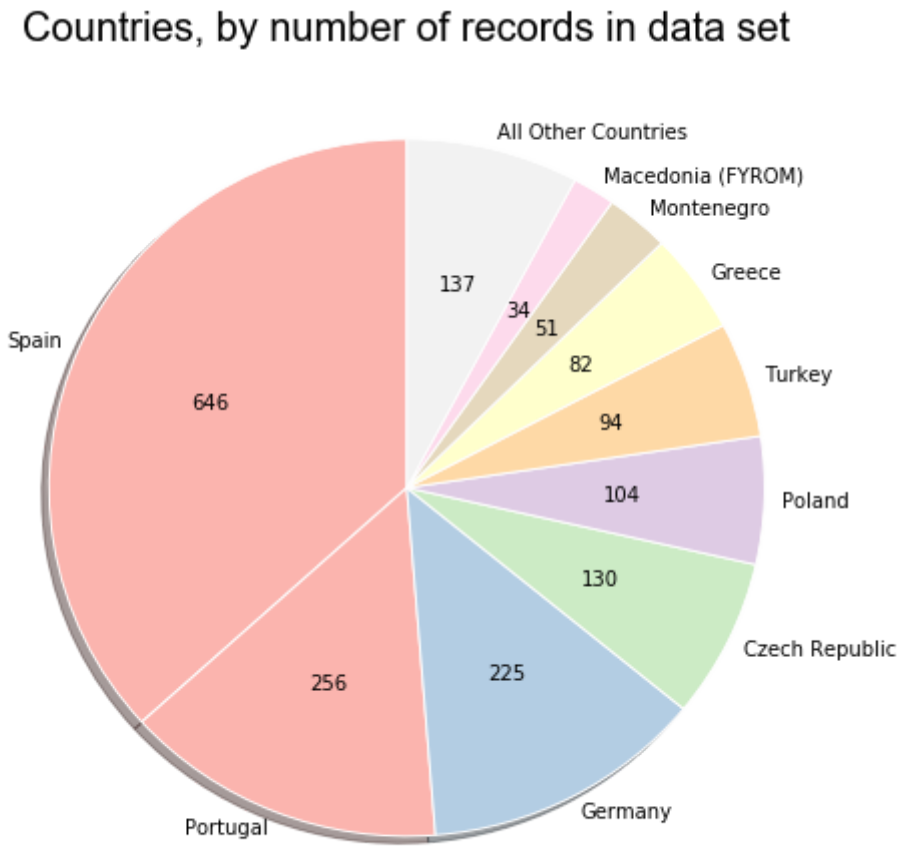
In [25]:

```
countdata = df['city'].value_counts()
gbplot_pie(fractions = countdata,
           labels = countdata.index,
           title = 'Cities, by share of records in data set',
           grouping_threshold = 30,
           grouping_label = 'All Other Cities')
```



In [26]:

```
countdata = df['country'].value_counts()

# convert the pie wedge percentage into its absolute value
def my_autopct(pct):
    total = sum(countdata)
    val = int(round(pct*total)/100.0000)
    return '{v:d}'.format(v=val)

gbplot_pie(fractions = countdata,
           labels = countdata.index,
           title = 'Countries, by number of records in data set',
           autopct=my_autopct,
           grouping_threshold = 30,
           grouping_label = 'All Other Countries')
```



Geocoding -To geolocate a query to an address and coordinates:

In [27]:

```
from geopy.geocoders import Nominatim

geolocator = Nominatim(user_agent="specify_your_app_name_here")
location = geolocator.geocode("175 5th Avenue NYC")
print(location.address)
```

```
Flatiron Building, 175, 5th Avenue, Flatiron District, Manhattan, Manhatta
n Community Board 5, New York County, NYC, New York, 10010, USA
```

In [28]:

```
#Flatiron Building, 175, 5th Avenue, Flatiron, New York, NYC, New York, ...
print((location.latitude, location.longitude))
print(location.raw)
```

```
(40.7410861, -73.9896298241625)
{'place_id': '138642704', 'licence': 'Data © OpenStreetMap contributors, O
DbL 1.0. https://osm.org/copyright', 'osm_type': 'way', 'osm_id': '2647688
96', 'boundingbox': ['40.7407597', '40.7413004', '-73.9898715', '-73.98950
14'], 'lat': '40.7410861', 'lon': '-73.9896298241625', 'display_name': 'Fl
atiron Building, 175, 5th Avenue, Flatiron District, Manhattan, Manhattan
Community Board 5, New York County, NYC, New York, 10010, USA', 'class':
'tourism', 'type': 'attraction', 'importance': 0.793003315521974, 'icon':
'https://nominatim.openstreetmap.org/images/mapicons/poi_point_of_interes
t.p.20.png'}
```

In [29]:

```
# To find the address corresponding to a set of coordinates:

from geopy.geocoders import Nominatim
geolocator = Nominatim(user_agent="specify_your_app_name_here")
location = geolocator.reverse("52.509669, 13.376294")
print(location.address)
```

```
Potsdamer Platz, Tiergarten, Mitte, Berlin, 10785, Deutschland
```

In [30]:

```
#Potsdamer Platz, Mitte, Berlin, 10117, Deutschland, European Union
print((location.latitude, location.longitude))
print(location.raw)
```

```
(52.5098014, 13.3755897912911)
{'place_id': '198746248', 'licence': 'Data © OpenStreetMap contributors, O
DbL 1.0. https://osm.org/copyright', 'osm_type': 'relation', 'osm_id': '32
00536', 'lat': '52.5098014', 'lon': '13.3755897912911', 'display_name': 'P
otsdamer Platz, Tiergarten, Mitte, Berlin, 10785, Deutschland', 'address':
{'attraction': 'Potsdamer Platz', 'footway': 'Potsdamer Platz', 'suburb':
'Tiergarten', 'city_district': 'Mitte', 'state': 'Berlin', 'postcode': '10
785', 'country': 'Deutschland', 'country_code': 'de'}, 'boundingbox': ['5
2.5082999', '52.5100374', '13.3750548', '13.3769528']}
```

In [31]:

```
# Measuring Distance

from geopy.distance import geodesic
newport_ri = (41.49008, -71.312796)
cleveland_oh = (41.499498, -81.695391)
print(geodesic(newport_ri, cleveland_oh).miles)
```

```
538.3904453677205
```

In [32]:

```
# Using great-circle distance:

from geopy.distance import great_circle
newport_ri = (41.49008, -71.312796)
cleveland_oh = (41.499498, -81.695391)
print(great_circle(newport_ri, cleveland_oh).miles)
```

```
536.9979906964345
```

Geocoding with GeoPy and Nominatim

In [33]:

```
from geopy.geocoders import Nominatim
gc = Nominatim(user_agent="fintu-blog-geocoding-python")
x = gc.geocode("Berlin Deutschland")
# Location(Kommandantenhaus, 1, Unter den Linden, Spandauer Vorstadt, Mitte, Berlin, 10
117, Deutschland, (52.51720765, 13.3978343993255, 0.0)
x
```

Out[33]:

```
Location(Berlin, 10117, Deutschland, (52.5170365, 13.3888599, 0.0))
```

In [34]:

```
geolocator = Nominatim(user_agent="fintu-blog-geocoding-python")
location = geolocator.geocode("Julio Cesar Fortaleza Brazil")
print(location.address)
```

```
Rua Julio César, Montese, Fortaleza, Microrregião de Fortaleza, Mesorregiã
o Metropolitana de Fortaleza, CE, Região Nordeste, 60425351, Brasil
```

In [35]:

```
print((location.latitude, location.longitude))
print(location.raw)
```

```
(-3.7602552, -38.5513155)
{'place_id': '174400257', 'licence': 'Data © OpenStreetMap contributors, O
DbL 1.0. https://osm.org/copyright', 'osm_type': 'way', 'osm_id': '4522589
07', 'boundingbox': ['-3.7608307', '-3.7602552', '-38.5517902', '-38.55131
55'], 'lat': '-3.7602552', 'lon': '-38.5513155', 'display_name': 'Rua Juli
o César, Montese, Fortaleza, Microrregião de Fortaleza, Mesorregião Metrop
olitana de Fortaleza, CE, Região Nordeste, 60425351, Brasil', 'class': 'hi
ghway', 'type': 'residential', 'importance': 0.31000000000000005}
```

Creating a GeoDataFrame from a DataFrame with coordinates

In [36]:

```
import pandas as pd
import geopandas
from shapely.geometry import Point
import matplotlib.pyplot as plt
```

In [37]:

```
# Creating a dataframe
df = pd.DataFrame(
    {'City': ['Buenos Aires', 'Brasilia', 'Santiago', 'Bogota', 'Caracas'],
     'Country': ['Argentina', 'Brazil', 'Chile', 'Colombia', 'Venezuela'],
     'Latitude': [-34.58, -15.78, -33.45, 4.60, 10.48],
     'Longitude': [-58.66, -47.91, -70.66, -74.08, -66.86]})
```

In [38]:

```
df
```

Out[38]:

	City	Country	Latitude	Longitude
0	Buenos Aires	Argentina	-34.58	-58.66
1	Brasilia	Brazil	-15.78	-47.91
2	Santiago	Chile	-33.45	-70.66
3	Bogota	Colombia	4.60	-74.08
4	Caracas	Venezuela	10.48	-66.86

In [39]:

```
# A GeoDataFrame needs a shapely object, so we create a new column Coordinates as a tup
le of Longitude and Latitude :
df['Coordinates'] = list(zip(df.Longitude, df.Latitude))
```

In [40]:

```
df
```

Out[40]:

	City	Country	Latitude	Longitude	Coordinates
0	Buenos Aires	Argentina	-34.58	-58.66	(-58.66, -34.58)
1	Brasilia	Brazil	-15.78	-47.91	(-47.91, -15.78)
2	Santiago	Chile	-33.45	-70.66	(-70.66, -33.45)
3	Bogota	Colombia	4.60	-74.08	(-74.08, 4.6)
4	Caracas	Venezuela	10.48	-66.86	(-66.86, 10.48)

In [41]:

```
# transform tuples to Point :
df['Coordinates'] = df['Coordinates'].apply(Point)
df
```

Out[41]:

	City	Country	Latitude	Longitude	Coordinates
0	Buenos Aires	Argentina	-34.58	-58.66	POINT (-58.66 -34.58)
1	Brasilia	Brazil	-15.78	-47.91	POINT (-47.91 -15.78)
2	Santiago	Chile	-33.45	-70.66	POINT (-70.66 -33.45)
3	Bogota	Colombia	4.60	-74.08	POINT (-74.08 4.6)
4	Caracas	Venezuela	10.48	-66.86	POINT (-66.86 10.48)

In [42]:

```
# create the GeoDataFrame by setting geometry with the coordinates created previously.
gdf = geopandas.GeoDataFrame(df, geometry='Coordinates')
gdf
```

Out[42]:

	City	Country	Latitude	Longitude	Coordinates
0	Buenos Aires	Argentina	-34.58	-58.66	POINT (-58.66 -34.58)
1	Brasilia	Brazil	-15.78	-47.91	POINT (-47.91 -15.78)
2	Santiago	Chile	-33.45	-70.66	POINT (-70.66 -33.45)
3	Bogota	Colombia	4.60	-74.08	POINT (-74.08 4.6)
4	Caracas	Venezuela	10.48	-66.86	POINT (-66.86 10.48)

In [43]:

```
gdf.type
```

Out[43]:

```
0    Point
1    Point
2    Point
3    Point
4    Point
dtype: object
```

In [44]:

```
print(gdf.head())
```

```
           City    Country  Latitude  Longitude           Coordinates
0  Buenos Aires  Argentina    -34.58     -58.66  POINT (-58.66 -34.58)
1      Brasilia     Brazil    -15.78     -47.91  POINT (-47.91 -15.78)
2      Santiago      Chile    -33.45     -70.66  POINT (-70.66 -33.45)
3        Bogota   Colombia      4.60     -74.08     POINT (-74.08 4.6)
4       Caracas  Venezuela     10.48     -66.86   POINT (-66.86 10.48)
```

Plot only continent South America

In [45]:

```
# plot the coordinates over a country-level map.
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
# We restrict to South America.
gdf = world[world.continent == 'South America'].plot(color='white', edgecolor='black')

water = 'lightskyblue'
earth = 'tan'
gdf.set_facecolor(water)

# We can now plot our GeoDataFrame.
gdf.plot( color='red', facecolor=earth, linewidth=1, alpha=1)
```

Out[45]:

```
[]
```

Aggregation with dissolve Geopandas

In [46]:

```
geopandas.datasets.available
```

Out[46]:

```
['naturalearth_cities', 'naturalearth_lowres', 'nybb']
```

In [47]:

```
# Information by city
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
world.head()
```

Out[47]:

	name	geometry
0	Vatican City	POINT (12.45338654497177 41.90328217996012)
1	San Marino	POINT (12.44177015780014 43.936095834768)
2	Vaduz	POINT (9.516669472907267 47.13372377429357)
3	Luxembourg	POINT (6.130002806227083 49.61166037912108)
4	Palikir	POINT (158.1499743237623 6.916643696007725)

In [48]:

```
world.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
RangeIndex: 202 entries, 0 to 201
Data columns (total 2 columns):
name        202 non-null object
geometry    202 non-null object
dtypes: object(2)
memory usage: 3.2+ KB
```

In [49]:

```
# Information by country and continent
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
world.sort_values("continent", inplace=True)
world.head()
```

Out[49]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
176	12619600.0	Africa	Zimbabwe	ZWE	9323.0	POLYGON ((31.19140913262129 -22.2515096981724,...
31	20617068.0	Africa	Côte d'Ivoire	CIV	33850.0	POLYGON ((-2.856125047202397 4.994475816259509...
32	18879301.0	Africa	Cameroon	CMR	42750.0	POLYGON ((13.07582238124675 2.267097072759015,...
33	68692542.0	Africa	Dem. Rep. Congo	COD	20640.0	POLYGON ((30.83385989759381 3.509165961110341,...
34	4012809.0	Africa	Congo	COG	15350.0	POLYGON ((12.99551720546518 -4.781103203961884...

In [50]:

```
world.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 177 entries, 176 to 46
Data columns (total 6 columns):
pop_est       177 non-null float64
continent     177 non-null object
name          177 non-null object
iso_a3        177 non-null object
gdp_md_est    177 non-null float64
geometry      177 non-null object
dtypes: float64(2), object(4)
memory usage: 9.7+ KB
```

In [51]:

```
# Information by continent
world = geopandas.read_file(geopandas.datasets.get_path('nybb'))
world.head()
```

Out[51]:

	BoroCode	BoroName	Shape_Leng	Shape_Area	geometry
0	5	Staten Island	330470.010332	1.623820e+09	(POLYGON ((970217.0223999023 145643.3322143555...
1	4	Queens	896344.047763	3.045213e+09	(POLYGON ((1029606.076599121 156073.8142089844...
2	3	Brooklyn	741080.523166	1.937479e+09	(POLYGON ((1021176.479003906 151374.7969970703...
3	1	Manhattan	359299.096471	6.364715e+08	(POLYGON ((981219.0557861328 188655.3157958984...
4	2	Bronx	464392.991824	1.186925e+09	(POLYGON ((1012821.805786133 229228.2645874023...

In [52]:

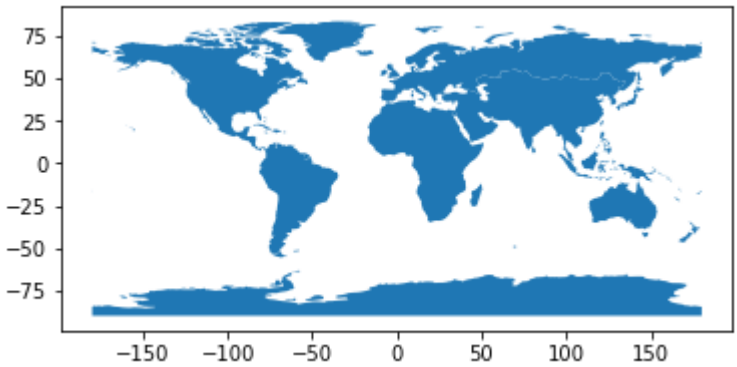
```
world.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
RangeIndex: 5 entries, 0 to 4
Data columns (total 5 columns):
BoroCode      5 non-null int64
BoroName      5 non-null object
Shape_Leng    5 non-null float64
Shape_Area    5 non-null float64
geometry      5 non-null object
dtypes: float64(2), int64(1), object(2)
memory usage: 280.0+ bytes
```

Plot Continent

In [53]:

```
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))

world = world[['continent', 'geometry']]
continents = world.dissolve(by='continent')
continents.plot();
plt.show()
continents.head(10)
```



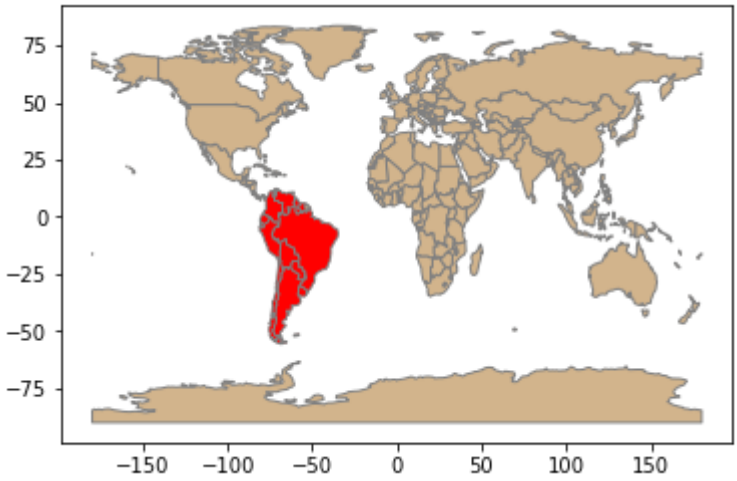
Out[53]:

	geometry
continent	
Africa	(POLYGON ((49.54351891459575 -12.4698328589405...
Antarctica	(POLYGON ((-159.2081835601977 -79.497059421708...
Asia	(POLYGON ((120.7156087586305 -10.2395813940878...
Europe	(POLYGON ((-52.55642473001839 2.50470530843705...
North America	(POLYGON ((-61.68000000000001 10.76, -61.105 1...
Oceania	(POLYGON ((173.0203747907408 -40.9190524228564...
Seven seas (open ocean)	POLYGON ((68.935 -48.62500000000001, 69.58 -48...
South America	(POLYGON ((-68.63401022758316 -52.636370458874...

Plot Continent and point out South America

In [54]:

```
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))

world = world[['continent', 'geometry']]
continents = world.dissolve(by='continent')
#continents.plot();

fig, ax = plt.subplots()
world[world['continent']!='South America'].\
            plot(ax=ax, edgecolor='grey', facecolor=earth, linewidth=1, alpha=1)

world[world['continent']=='South America'].\
           plot(ax=ax, edgecolor='grey', facecolor='red', linewidth=1, alpha=1)
plt.show()
continents.head(15)
```



Out[54]:

	geometry
continent	
Africa	(POLYGON ((49.54351891459575 -12.4698328589405...
Antarctica	(POLYGON ((-159.2081835601977 -79.497059421708...
Asia	(POLYGON ((120.7156087586305 -10.2395813940878...
Europe	(POLYGON ((-52.55642473001839 2.50470530843705...
North America	(POLYGON ((-61.68000000000001 10.76, -61.105 1...
Oceania	(POLYGON ((173.0203747907408 -40.9190524228564...
Seven seas (open ocean)	POLYGON ((68.935 -48.62500000000001, 69.58 -48...
South America	(POLYGON ((-68.63401022758316 -52.636370458874...

In [55]:

```
continents.index == 'South America'
```

Out[55]:

```
array([False, False, False, False, False, False, False,  True], dtype=boo
l)
```

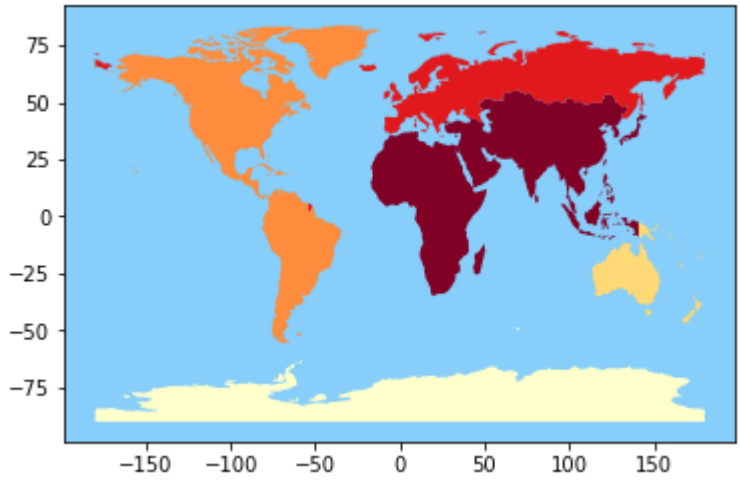
Plot world map by aggregate population

In [57]:

```
# If we are interested in aggregate populations, however, we can pass different functio
ns to the dissolve method to aggregate populations:
fig, ax = plt.subplots()

world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
world = world[['continent', 'geometry', 'pop_est']]
continents = world.dissolve(by='continent', aggfunc='sum')

water = 'lightskyblue'
earth = 'tan'
ax.set_facecolor(water)

continents.plot(ax=ax, column = 'pop_est', scheme='quantiles', cmap='YlOrRd', facecolor
=earth, linewidth=1, alpha=1);

continents.head()
```

Out[57]:

	geometry	pop_est
continent		
Africa	(POLYGON ((49.54351891459575 -12.4698328589405...	9.932819e+08
Antarctica	(POLYGON ((-159.2081835601977 -79.497059421708...	3.802000e+03
Asia	(POLYGON ((120.7156087586305 -10.2395813940878...	4.085853e+09
Europe	(POLYGON ((-52.55642473001839 2.50470530843705...	7.281312e+08
North America	(POLYGON ((-61.68000000000001 10.76, -61.105 1...	5.393510e+08



Paint a Country point out Brazil

In [58]:

```
import geopandas as gpd
```

In [59]:

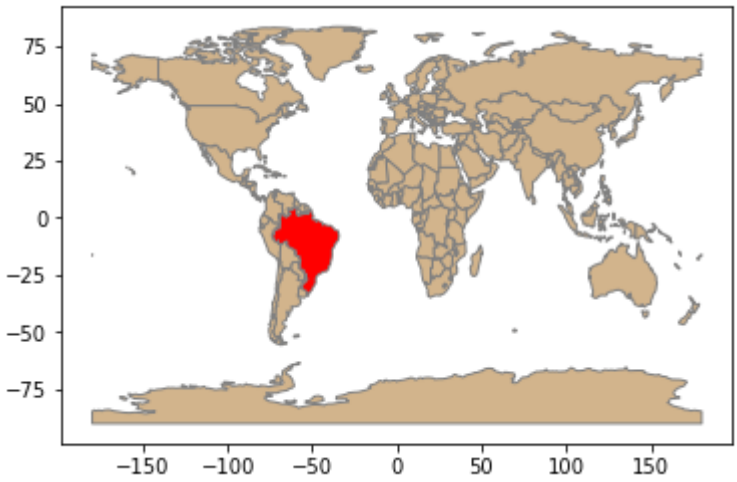
```
world = gpd.read_file(gpd.datasets.get_path('naturalearth_lowres'))
# create a GeoSeries from the GeoDataFrame
wgs = gpd.GeoSeries([g for  g in world['geometry']])

# rotate the world
wgs2 = wgs.rotate(360, origin = (0,0), use_radians=False)
wgs = wgs2
world['geometry'] = wgs2
world.head()
```

Out[59]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POLYGON ((61.21081709172574 35.65007233330923,...
1	12799293.0	Africa	Angola	AGO	110300.0	(POLYGON ((16.32652835456705 -5.87747039146621...
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POLYGON ((51.57951867046327 24.24549713795111,...
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...

In [60]:

```
fig, ax = plt.subplots()
world[world['name']!='Brazil'].\
            plot(ax=ax, edgecolor='grey', facecolor=earth, linewidth=1, alpha=1)

world[world['name']=='Brazil'].\
           plot(ax=ax, edgecolor='grey', facecolor='red', linewidth=1, alpha=1)
plt.show()
```



In [61]:

```
import geopandas as gpd
cont = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
cont.head()
```

Out[61]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POLYGON ((61.21081709172574 35.65007233330923,...
1	12799293.0	Africa	Angola	AGO	110300.0	(POLYGON ((16.32652835456705 -5.87747039146621...
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POLYGON ((51.57951867046327 24.24549713795111,...
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...

In [62]:

```
cont = cont[cont.continent == 'South America']
contx = cont[['name', 'geometry']]
conty = contx.dissolve(by='name')
cont.describe
```

Out[62]:

```
<bound method NDFrame.describe of          pop_est      continent
name iso_a3  gdp_md_est  \
4     40913584.0  South America     Argentina    ARG    573900.0
21     9775246.0  South America       Bolivia    BOL     43270.0
22   198739269.0  South America        Brazil    BRA   1993000.0
29    16601707.0  South America         Chile    CHL    244500.0
35    45644023.0  South America      Colombia    COL    395400.0
46    14573101.0  South America       Ecuador    ECU    107700.0
54        3140.0  South America  Falkland Is.    FLK       105.1
67      772298.0  South America        Guyana    GUY      2966.0
124   29546963.0  South America          Peru    PER    247300.0
131    6995655.0  South America      Paraguay    PRY     28890.0
148     481267.0  South America      Suriname    SUR      4254.0
167    3494382.0  South America       Uruguay    URY     43160.0
170   26814843.0  South America     Venezuela    VEN    357400.0

                                              geometry
4    (POLYGON ((-65.50000000000003 -55.199999999999...
21   POLYGON ((-62.84646847192156 -22.0349854468694...
22   POLYGON ((-57.62513342958296 -30.2162948544542...
29   (POLYGON ((-68.63401022758316 -52.636370458874...
35   POLYGON ((-75.37322323271385 -0.15203175212045...
46   POLYGON ((-80.30256059438722 -3.40485645916471...
54   POLYGON ((-61.2 -51.85, -60 -51.25, -59.15 -51...
67   POLYGON ((-59.75828487815919 8.367034816924047...
124  POLYGON ((-69.59042375352405 -17.5800118954193...
131  POLYGON ((-62.68505713565789 -22.2490292294223...
148  POLYGON ((-57.14743648947689 5.973149929219161...
167  POLYGON ((-57.62513342958296 -30.2162948544542...
170  POLYGON ((-71.3315836249503 11.77628408451581,...  >
```

In [63]:

```
contx.head()
```

Out[63]:

	name	geometry
4	Argentina	(POLYGON ((-65.50000000000003 -55.199999999999...
21	Bolivia	POLYGON ((-62.84646847192156 -22.0349854468694...
22	Brazil	POLYGON ((-57.62513342958296 -30.2162948544542...
29	Chile	(POLYGON ((-68.63401022758316 -52.636370458874...
35	Colombia	POLYGON ((-75.37322323271385 -0.15203175212045...

In [64]:

```
gdf = contx
col = gdf.columns.tolist()[0:4]
print (col)
```

```
['name', 'geometry']
```

In [65]:

```
# Plot only row 22 - BRAZIL
gdf.loc[22, 'geometry']
```

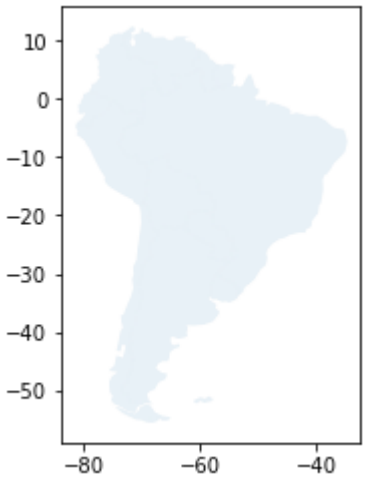
Out[65]:

In [66]:

```
# Intensity off color map
gdf.plot(alpha=0.1)
```

Out[66]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x204aff5fa58>
```

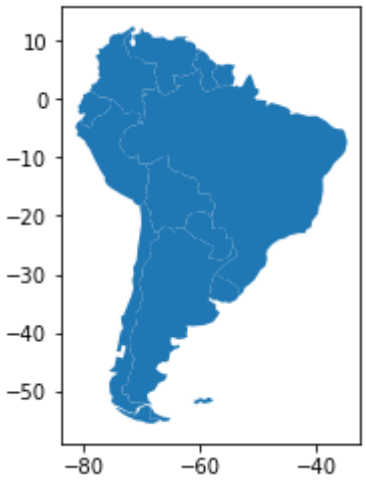


In [67]:

```
# Intensity off color map
gdf.plot(alpha=1)
```

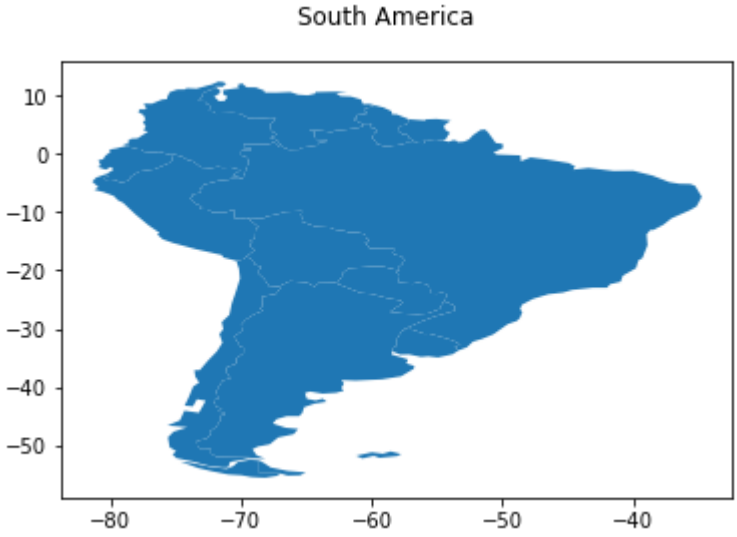
Out[67]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x204b00e2a90>
```



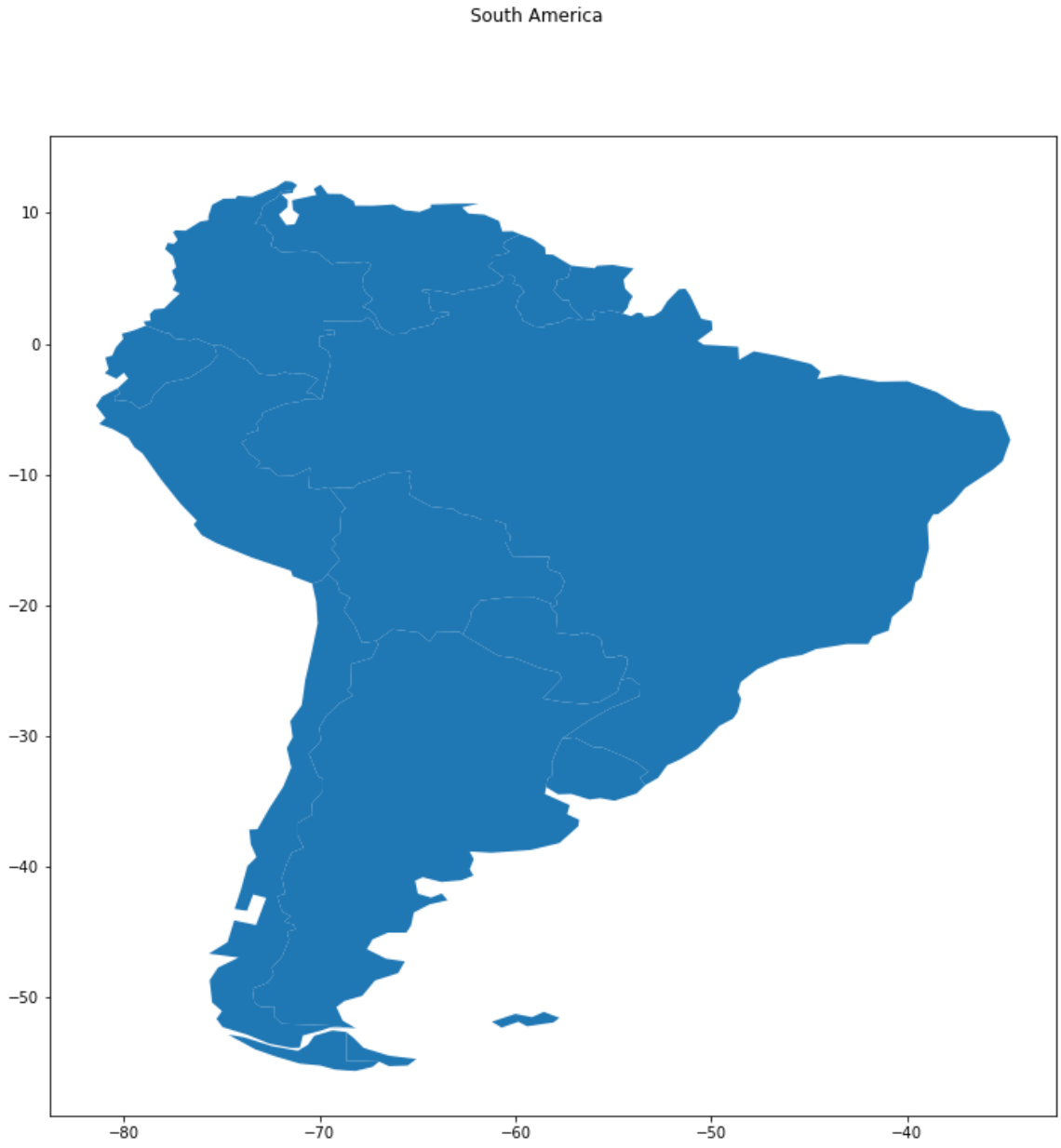
In [68]:

```
# Intensity off color map
fig, ax = plt.subplots(1)
gdf.plot(ax=ax)
fig.suptitle('South America')
plt.show()
```



In [69]:

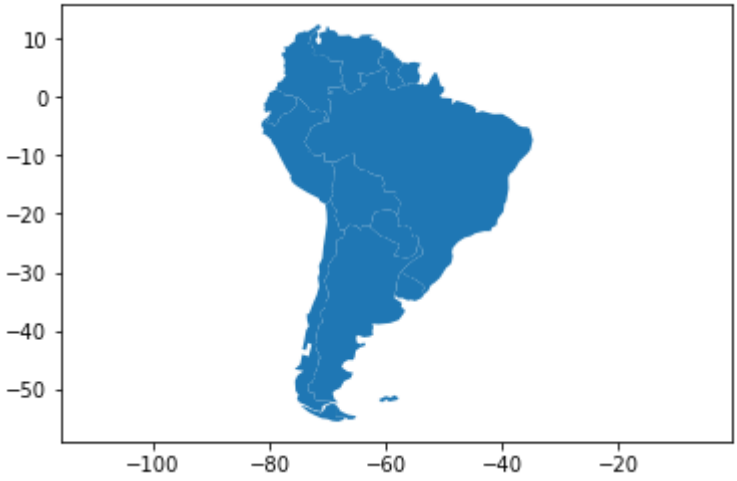
```
f, ax = plt.subplots(1, figsize=(12, 12))
ax = gdf.plot(ax=ax)
f.suptitle('South America')
plt.show()
```



In [70]:

```
# transform the dataset into lat/lon coordinates, we would use its EPSG code, 4326:
print (gdf.crs)
gdf.to_crs(epsg=4326).plot()
lims = plt.axis('equal')
```

```
{'init': 'epsg:4326'}
```



In [71]:

```
df.head()
```

Out[71]:

	City	Country	Latitude	Longitude	Coordinates
0	Buenos Aires	Argentina	-34.58	-58.66	POINT (-58.66 -34.58)
1	Brasilia	Brazil	-15.78	-47.91	POINT (-47.91 -15.78)
2	Santiago	Chile	-33.45	-70.66	POINT (-70.66 -33.45)
3	Bogota	Colombia	4.60	-74.08	POINT (-74.08 4.6)
4	Caracas	Venezuela	10.48	-66.86	POINT (-66.86 10.48)

In [72]:

```
cont.head()
```

Out[72]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...
21	9775246.0	South America	Bolivia	BOL	43270.0	POLYGON ((-62.84646847192156 -22.0349854468694...
22	198739269.0	South America	Brazil	BRA	1993000.0	POLYGON ((-57.62513342958296 -30.2162948544542...
29	16601707.0	South America	Chile	CHL	244500.0	(POLYGON ((-68.63401022758316 -52.636370458874...
35	45644023.0	South America	Colombia	COL	395400.0	POLYGON ((-75.37322323271385 -0.15203175212045...

In [73]:

```
# The country with smallest population
smallest = cont.sort_values('pop_est').head(6)
smallest
```

Out[73]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
54	3140.0	South America	Falkland Is.	FLK	105.1	POLYGON ((-61.2 -51.85, -60 -51.25, -59.15 -51...
148	481267.0	South America	Suriname	SUR	4254.0	POLYGON ((-57.14743648947689 5.973149929219161...
67	772298.0	South America	Guyana	GUY	2966.0	POLYGON ((-59.75828487815919 8.367034816924047...
167	3494382.0	South America	Uruguay	URY	43160.0	POLYGON ((-57.62513342958296 -30.2162948544542...
131	6995655.0	South America	Paraguay	PRY	28890.0	POLYGON ((-62.68505713565789 -22.2490292294223...
21	9775246.0	South America	Bolivia	BOL	43270.0	POLYGON ((-62.84646847192156 -22.0349854468694...

In [74]:

```
# PLOT - The country with smallest population
f, ax = plt.subplots(1, figsize=(6, 6))
# Base layer with all the areas for the background
for geometry in cont['geometry']:
    cont.plot(ax=ax, facecolor='black', linewidth=0.025)

# Smallest areas
for name in smallest['geometry']:
    smallest.plot(ax=ax, alpha=1, facecolor='red', linewidth=0)

ax.set_axis_off()
f.suptitle('Areas with smallest population')
plt.axis('equal')
plt.show()
```

In [75]:

```
# Exemple for test transform polygon to point
from shapely.geometry import Point, Polygon
import geopandas

polys = geopandas.GeoSeries({
    'foo': Polygon([(5, 5), (5, 13), (13, 13), (13, 5)]),
    'bar': Polygon([(10, 10), (10, 15), (15, 15), (15, 10)]),
})

polys
```

Out[75]:

```
foo          POLYGON ((5 5, 5 13, 13 13, 13 5, 5 5))
bar    POLYGON ((10 10, 10 15, 15 15, 15 10, 10 10))
dtype: object
```

In [76]:

```
_pnts = [Point(3, 3), Point(8, 8), Point(11, 11)]
pnts = geopandas.GeoDataFrame(geometry=_pnts, index=['A', 'B', 'C'])
pnts = pnts.assign(**{key: pnts.within(geom) for key, geom in polys.items()})

print(pnts)
```

```
        geometry    foo    bar
A    POINT (3 3)  False  False
B    POINT (8 8)   True  False
C  POINT (11 11)   True   True
```

In [79]:

```
cities = geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
cities.describe
```

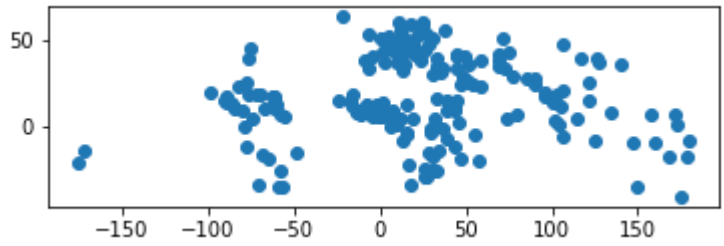
Out[79]:

```
<bound method NDFrame.describe of                  name
                    geometry
0         Vatican City    POINT (12.45338654497177 41.90328217996012)
1           San Marino      POINT (12.44177015780014 43.936095834768)
2                Vaduz    POINT (9.516669472907267 47.13372377429357)
3           Luxembourg    POINT (6.130002806227083 49.61166037912108)
4              Palikir    POINT (158.1499743237623 6.916643696007725)
5                Majuro    POINT (171.3800001757465 7.103004311216239)
6              Funafuti   POINT (179.2166470940289 -8.516651999041073)
7              Melekeok    POINT (134.6265484669922 7.487396172977981)
8                Monaco    POINT (7.406913173465057 43.73964568785249)
9                Tarawa    POINT (173.0175708285494 1.338187505624603)
10               Moroni   POINT (43.24024409869332 -11.70415769566847)
11              Andorra      POINT (1.51648596050552 42.5000014435459)
12       Port-of-Spain   POINT (-61.51703088544974 10.65199708957726)
13               Kigali    POINT (30.05858591906411 -1.95164421006325)
14              Mbabane   POINT (31.13333451205636 -26.31665077840921)
15                 Juba    POINT (31.58002559278731 4.829975198277964)
16            Ljubljana     POINT (14.51496903347413 46.0552883087945)
17           Bratislava    POINT (17.11698075223461 48.15001832996171)
18                Doha     POINT (51.5329678942993 25.28655600890659)
19            Podgorica    POINT (19.26630692411823 42.46597251288171)
20                 Bern    POINT (7.466975462482424 46.91668275866772)
21            Pristina    POINT (21.16598425159987 42.66670961411938)
22              Roseau   POINT (-61.38701298180337 15.30101564428332)
23            Djibouti    POINT (43.14800166705226 11.59501446425548)
24              Banjul    POINT (-16.5917014892126 13.45387646031594)
25              Skopje     POINT (21.4334614651425 42.00000612290586)
26           Bridgetown   POINT (-59.61652673505159 13.10200258275114)
27            Bujumbura    POINT (29.3600060615284 -3.376087220374643)
28            Kingstown   POINT (-61.21206242027932 13.14827882786841)
29             Castries   POINT (-61.00000818036955 14.00197348933034)
..                   ...                                          ...
172           Amsterdam    POINT (4.914694317400972 52.35191454666443)
173               Seoul    POINT (126.9977851382019 37.56829495838895)
174              Manila    POINT (120.9802713035424 14.60610481344054)
175              Berlin    POINT (13.39960276470055 52.52376452225116)
176            Kinshasa   POINT (15.31302602317174 -4.327778243275986)
177           New Delhi    POINT (77.19998002005303 28.60002300924543)
178              Athens    POINT (23.73137522567936 37.98527209055226)
179             Baghdad    POINT (44.39192291456413 33.34059435615865)
180        Addis Ababa    POINT (38.69805857534868 9.035256221295754)
181              Tehran     POINT (51.42239817500899 35.6738886270013)
182        Buenos Aires  POINT (-58.39947723233144 -34.60055574990741)
183               Kabul    POINT (69.18131419070505 34.51863614490031)
184              Vienna    POINT (16.36469309674374 48.20196113681686)
185              Taipei      POINT (121.568333333333 25.0358333333333)
186  Washington, D.C.   POINT (-77.01136443943716 38.90149523508705)
187              London   POINT (-0.1186677024759319 51.5019405883275)
188              Riyadh    POINT (46.77079579868825 24.64277900781644)
189          Cape Town   POINT (18.43304229922603 -33.91806510862875)
190              Moscow     POINT (37.6135769672714 55.75410998124818)
191        Mexico City   POINT (-99.13293406029391 19.44438830141547)
192                Rome      POINT (12.481312562874 41.89790148509894)
193             Beijing    POINT (116.3863398256594 39.93083808990906)
194             Nairobi   POINT (36.81471100047145 -1.281400883237779)
195             Jakarta   POINT (106.8274917624701 -6.172471846798885)
196              Bogota   POINT (-74.08528981377441 4.598369421147822)
197               Cairo    POINT (31.24802236112612 30.05190620510371)
```

```
198            Tokyo    POINT (139.7494615705447 35.68696276437117)
199            Paris     POINT (2.33138946713035 48.86863878981461)
200         Santiago   POINT (-70.66898671317483 -33.4480679569341)
201        Singapore     POINT (103.853874819099 1.294979325105942)

[202 rows x 2 columns]>
```

In [80]:

```
xx = cities.plot()

for x, y, label in zip(cities.geometry.x, cities.geometry.y, cities.name):
    ax.annotate(label, xy=(x, y), xytext=(3, 3), textcoords="offset points")
```



Creating interactive maps

In [218]:

```
import geopandas
cont1 = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
cont1.head()
```

Out[218]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POLYGON ((61.21081709172574 35.65007233330923,...
1	12799293.0	Africa	Angola	AGO	110300.0	(POLYGON ((16.32652835456705 -5.87747039146621...
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POLYGON ((51.57951867046327 24.24549713795111,...
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...

In [219]:

```
# Transform POLYGON to POINT
# copy poly to new GeoDataFrame
points = cont1.copy()
# change the geometry
points.geometry = points['geometry'].centroid
# same crs
#points.crs = poly.crs
points.head()
```

Out[219]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POINT (66.08669022192834 33.85639928169076)
1	12799293.0	Africa	Angola	AGO	110300.0	POINT (17.47057255231345 -12.24586903613316)
2	3639453.0	Europe	Albania	ALB	21810.0	POINT (20.03242643144321 41.14135330604877)
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POINT (54.20671476159633 23.86863365334761)
4	40913584.0	South America	Argentina	ARG	573900.0	POINT (-65.17536077114174 -35.44682148949509)

In [220]:

```
# Filter for South America - All counties from filter continent
cont_sa = cont1[cont1.continent == 'South America']
cont_sa
```

Out[220]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...
21	9775246.0	South America	Bolivia	BOL	43270.0	POLYGON ((-62.84646847192156 -22.0349854468694...
22	198739269.0	South America	Brazil	BRA	1993000.0	POLYGON ((-57.62513342958296 -30.2162948544542...
29	16601707.0	South America	Chile	CHL	244500.0	(POLYGON ((-68.63401022758316 -52.636370458874...
35	45644023.0	South America	Colombia	COL	395400.0	POLYGON ((-75.37322323271385 -0.15203175212045...
46	14573101.0	South America	Ecuador	ECU	107700.0	POLYGON ((-80.30256059438722 -3.40485645916471...
54	3140.0	South America	Falkland Is.	FLK	105.1	POLYGON ((-61.2 -51.85, -60 -51.25, -59.15 -51...
67	772298.0	South America	Guyana	GUY	2966.0	POLYGON ((-59.75828487815919 8.367034816924047...
124	29546963.0	South America	Peru	PER	247300.0	POLYGON ((-69.59042375352405 -17.5800118954193...
131	6995655.0	South America	Paraguay	PRY	28890.0	POLYGON ((-62.68505713565789 -22.2490292294223...
148	481267.0	South America	Suriname	SUR	4254.0	POLYGON ((-57.14743648947689 5.973149929219161...
167	3494382.0	South America	Uruguay	URY	43160.0	POLYGON ((-57.62513342958296 -30.2162948544542...
170	26814843.0	South America	Venezuela	VEN	357400.0	POLYGON ((-71.3315836249503 11.77628408451581,...

In [296]:

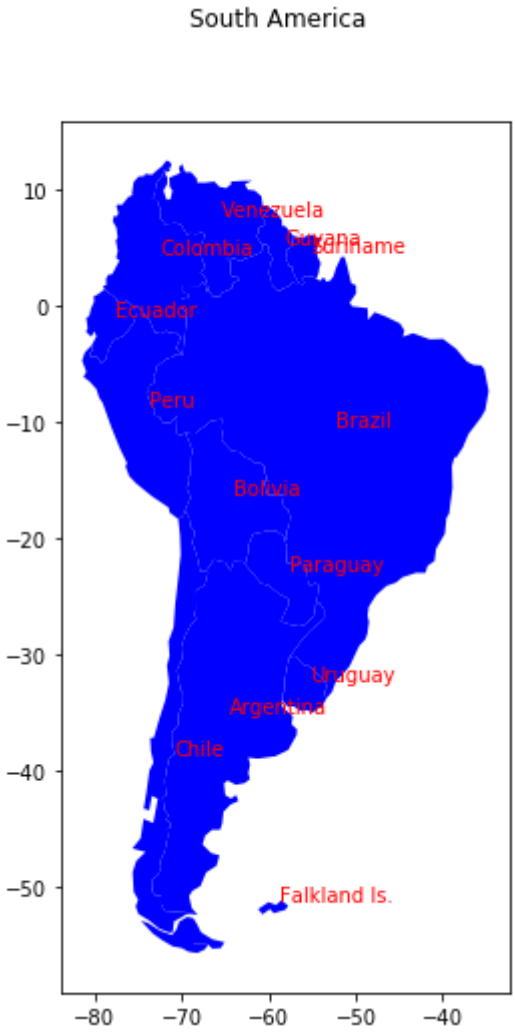
```
# Filter for South America
cont = points[points.continent == 'South America']
contx = cont[['name', 'geometry']]
contx.head()
#contx.type
```

Out[296]:

	name	geometry
4	Argentina	POINT (-65.17536077114174 -35.44682148949509)
21	Bolivia	POINT (-64.64140560603109 -16.72898701530583)
22	Brazil	POINT (-53.0543400357671 -10.80677364349892)
29	Chile	POINT (-71.52064394516432 -39.04701430994845)
35	Colombia	POINT (-73.07773208697481 3.927213862709704)

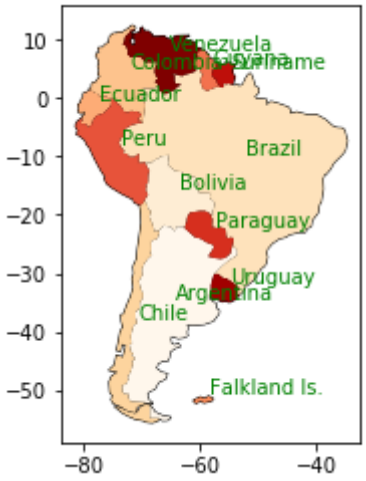
In [226]:

```
f, ax = plt.subplots(1, figsize=(4,8))
ax.set_axis_on()
f.suptitle('South America')

ax = cont_sa.plot(ax=ax, facecolor='blue', alpha=1, linewidth=0)


for x, y, label in zip(contx.geometry.x, contx.geometry.y, contx.name):
    ax.annotate(label, xy=(x, y), xytext=(3, 3), alpha=3, textcoords="offset points",co
lor='red')
#    plt.show()
```


South America
Venezuela
Guyana
Suriname
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Uruguay
Argentina
Chile
Falkland Is.
10
0
−10
−20
−30
−40
−50
−80
−70
−60
−50
−40

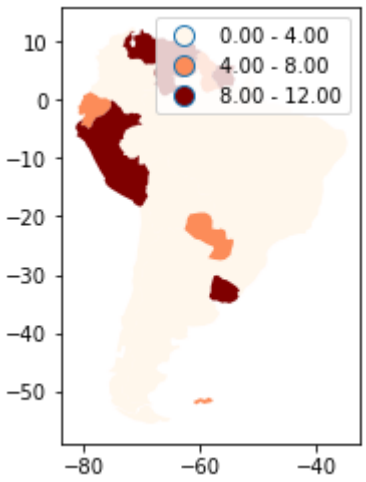
In [233]:

```
# Plot Base continent and capitals
base = cont_sa.plot(color='grey', edgecolor='black', cmap='OrRd')
# Plot Base continent - Cities
ax = cont_sa.plot(ax=base, facecolor='blue', alpha=1, linewidth=0,  cmap='OrRd')
f.suptitle('South America')
# Plot Base continent - Cities
for x, y, label in zip(contx.geometry.x, contx.geometry.y, contx.name):
    ax.annotate(label, xy=(x, y), xytext=(3, 3), textcoords="offset points",color='gree
n')
```



In [235]:

```
ax = cont_sa.plot( column='name', scheme='QUANTILES', k=3, cmap='OrRd', legend=True)
```



Obtain cities from a country - Geo spacial intersection

In [169]:

```
# cities
cities = geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
cities.head()
```

Out[169]:

	name	geometry
0	Vatican City	POINT (12.45338654497177 41.90328217996012)
1	San Marino	POINT (12.44177015780014 43.936095834768)
2	Vaduz	POINT (9.516669472907267 47.13372377429357)
3	Luxembourg	POINT (6.130002806227083 49.61166037912108)
4	Palikir	POINT (158.1499743237623 6.916643696007725)

In [170]:

```
cont = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
cont.head()
```

Out[170]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POLYGON ((61.21081709172574 35.65007233330923,...
1	12799293.0	Africa	Angola	AGO	110300.0	(POLYGON ((16.32652835456705 -5.87747039146621...
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POLYGON ((51.57951867046327 24.24549713795111,...
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...

In [171]:

```
# filter countries from Europe
country = cont[(cont['continent'] == 'Europe')]
country.head()
```

Out[171]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
9	8210281.0	Europe	Austria	AUT	329500.0	POLYGON ((16.97966678230404 48.12349701597631,...
12	10414336.0	Europe	Belgium	BEL	389300.0	POLYGON ((3.314971144228537 51.34578095153609,...
16	7204687.0	Europe	Bulgaria	BGR	93750.0	POLYGON ((22.65714969248299 44.23492300066128,...
18	4613414.0	Europe	Bosnia and Herz.	BIH	29700.0	POLYGON ((19.00548628101012 44.86023366960916,...

In [172]:

```
# Filter to country Italy
country_xx = cont[(cont['iso_a3'] == 'ITA')]
country_xx
```

Out[172]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
79	58126212.0	Europe	Italy	ITA	1823000.0	(POLYGON ((15.52037601081383 38.23115509699147...

In [173]:

```
country_xx = country_br[['geometry', 'name']]
country_xx
```

Out[173]:

	geometry	name
index_right		
79	(POLYGON ((15.52037601081383 38.23115509699147...	Italy

In [196]:

```
# Transform POLYGON to POINT
#
points = country_xx.copy()
# change the geometry
points.geometry = points['geometry'].centroid
points.head()
```

Out[196]:

	geometry	name
index_right		
79	POINT (12.1407883722359 42.75118305296424)	Italy

In [195]:

```
br_x=points.geometry.x
br_y=points.geometry.y
print ('Coordenadas do país : ', br_x, br_y)
```

```
Coordenadas do país :  index_right
79    12.140788
dtype: float64 index_right
79    42.751183
dtype: float64
```

In [176]:

```
xcountries = country_xx.to_crs('+init=epsg:3395')

xcities = cities.to_crs('+init=epsg:3395')
```

In [177]:

```
xcountries
```

Out[177]:

	geometry	name
index_right		
79	(POLYGON ((1727720.354443935 4585686.481436529...	Italy

In [178]:

```
xcities.head()
```

Out[178]:

	name	geometry
0	Vatican City	POINT (1386304.648838061 5117957.424166164)
1	San Marino	POINT (1385011.518533259 5425900.2767389)
2	Vaduz	POINT (1059390.799771928 5932596.001064743)
3	Luxembourg	POINT (682388.790950537 6346728.171340298)
4	Palikir	POINT (17605174.61069051 766692.1365341047)

In [179]:

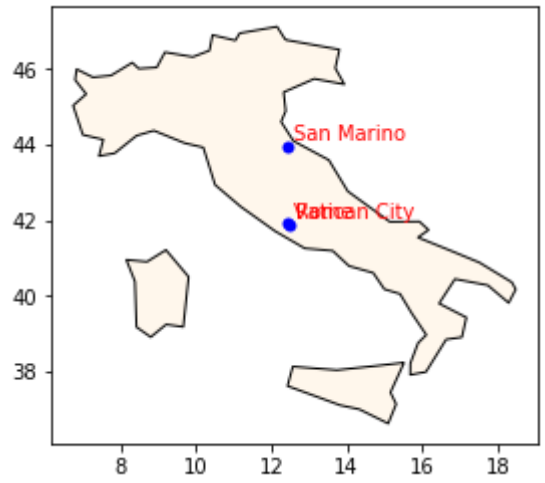
```
# Execute spatial join Country with cities to obtain the Cities from Country
cities_with_country = geopandas.sjoin(cities, country_br, how="inner", op='intersects')

cities_with_country.head()
```

Out[179]:

	name_left	geometry	index_right	name_right
0	Vatican City	POINT (12.45338654497177 41.90328217996012)	79	Italy
1	San Marino	POINT (12.44177015780014 43.936095834768)	79	Italy
192	Rome	POINT (12.481312562874 41.89790148509894)	79	Italy

In [236]:

```
# PLOT Geopandas result

ax.set_axis_on()
f.suptitle(xcountries.name.values)

base = country_xx.plot(color='grey', edgecolor='black', cmap='OrRd')
ax = cities_with_country.plot(ax=base, facecolor='blue', alpha=1, linewidth=0)

for x, y, label in zip(cities_with_country.geometry.x, cities_with_country.geometry.y,
cities_with_country.name_left):
    ax.annotate(label, xy=(x, y), xytext=(3, 3), alpha=3, textcoords="offset points",co
lor='red')
```



Mapping Tools

In [197]:

```
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))

cities = geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
```

In [199]:

```
world.head()
```

Out[199]:

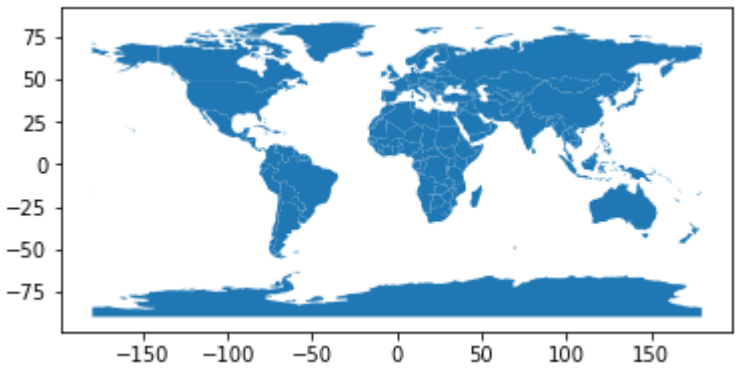
	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POLYGON ((61.21081709172574 35.65007233330923,...
1	12799293.0	Africa	Angola	AGO	110300.0	(POLYGON ((16.32652835456705 -5.87747039146621...
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POLYGON ((51.57951867046327 24.24549713795111,...
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...

In [198]:

```
# Plot the world
world.plot()
```

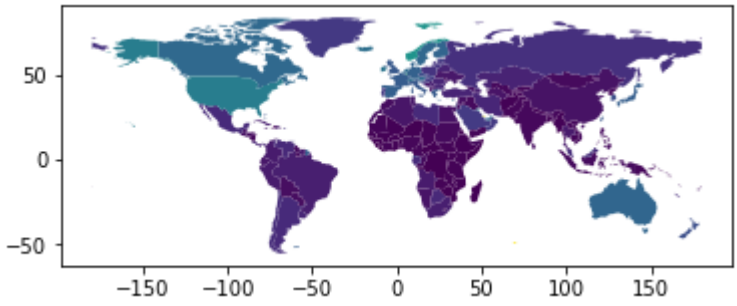
Out[198]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x204b029ef28>
```



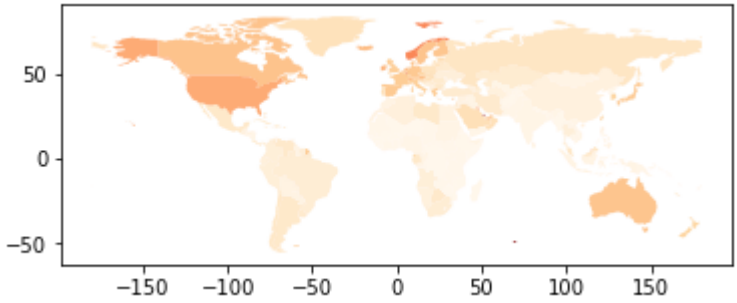
In [200]:

```
# Plot by GDP per capta
world = world[(world.pop_est>0) & (world.name!="Antarctica")]

world['gdp_per_cap'] = world.gdp_md_est / world.pop_est

world.plot(column='gdp_per_cap');
```



In [201]:

```
# Using colors
world.plot(column='gdp_per_cap', cmap='OrRd');
```

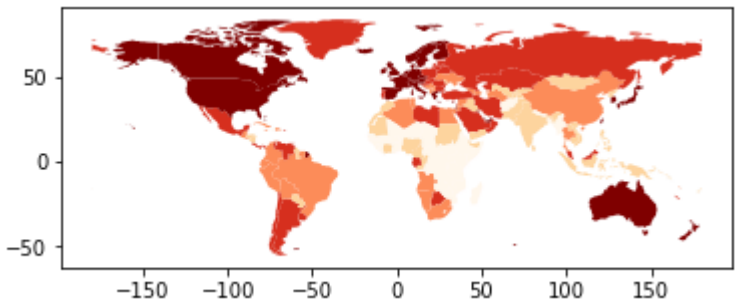


In [202]:

```
# color maps scaled can also be manipulated with the scheme
world.plot(column='gdp_per_cap', cmap='OrRd', scheme='quantiles')
```

Out[202]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x204b03f0240>
```



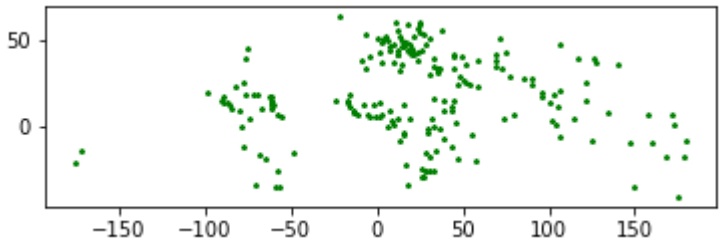
Maps with Layers

There are two strategies for making a map with multiple layers – one more succinct, and one that is a little more flexible.

Before combining maps, however, remember to always ensure they share a

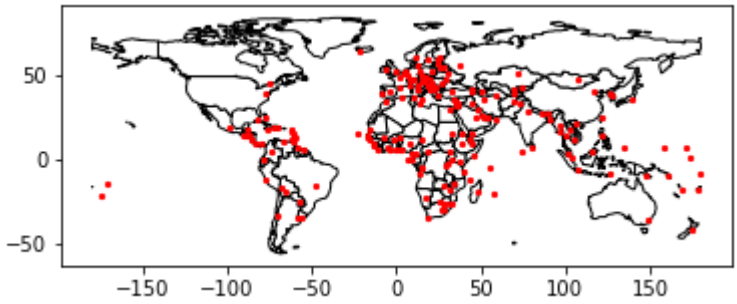
In [203]:

```
# Look at capitals
# Note use of standard `pyplot` line style options
cities.plot(marker='*', color='green', markersize=5);

# Check crs
cities = cities.to_crs(world.crs)

# Now we can overlay over country outlines
# And yes, there are lots of island capitals
# apparently in the middle of the ocean!
```



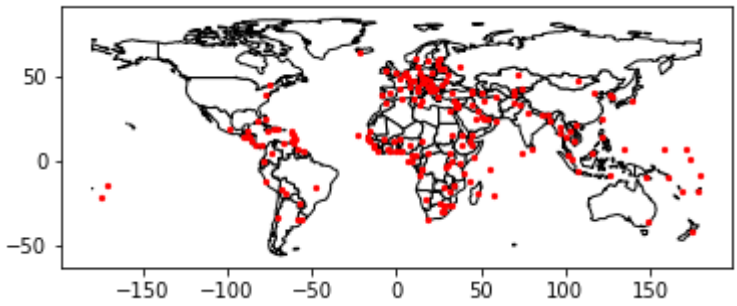
In [237]:

```
base = world.plot(color='white', edgecolor='black')

cities.plot(ax=base, marker='o', color='red', markersize=5);
```



In [241]:

```
# Same PLOT using subplots
fig, ax = plt.subplots()

# set aspect to equal. This is done automatically
# when using *geopandas* plot on it's own, but not when
# working with pyplot directly.

ax.set_aspect('equal')

world.plot(ax=ax, color='white', edgecolor='black')

cities.plot(ax=ax, marker='o', color='red', markersize=5)
plt.show();
```



Another Example - Plot Basil Map with cities labels

reading City Points from a File XLS

In [252]:

```
c_br = pd.read_excel('ml/GeoPandas/cities_of_brazil.xls')
```

In [258]:

```
# delete column
del c_br['SNo']
```

In [349]:

```
c_br.head()
```

Out[349]:

	City	State	Latitude	Longitude	Coordinates
0	Aracaju	Sergipe	-10.55	-37.03	POINT (-37.03 -10.55)
1	Araraquara	Sao Paulo	-21.48	-48.11	POINT (-48.11 -21.48)
2	Assis	Sao Paulo	-22.40	-50.25	POINT (-50.25 -22.4)
3	Bauru	Sao Paulo	-22.19	-49.04	POINT (-49.04 -22.19)
4	Belém	Para	-1.27	-48.30	POINT (-48.3 -1.27)

In [260]:

```
# Transform Latitude and Longitude to a POINT
# A GeoDataFrame needs a shapely object, so we create a new column Coordinates as a tup
le of Longitude and Latitude :
c_br['Coordinates'] = list(zip(c_br.Longitude, c_br.Latitude))
```

In [350]:

```
c_br.head()
```

Out[350]:

	City	State	Latitude	Longitude	Coordinates
0	Aracaju	Sergipe	-10.55	-37.03	POINT (-37.03 -10.55)
1	Araraquara	Sao Paulo	-21.48	-48.11	POINT (-48.11 -21.48)
2	Assis	Sao Paulo	-22.40	-50.25	POINT (-50.25 -22.4)
3	Bauru	Sao Paulo	-22.19	-49.04	POINT (-49.04 -22.19)
4	Belém	Para	-1.27	-48.30	POINT (-48.3 -1.27)

In [319]:

```
# transform tuples to Point :
c_br['Coordinates'] = c_br['Coordinates'].apply(Point)
# Transform to geo spacial table
c_br = geopandas.GeoDataFrame(c_br, geometry='Coordinates')
c_br.head()
```

Out[319]:

	City	State	Latitude	Longitude	Coordinates
0	Aracaju	Sergipe	-10.55	-37.03	POINT (-37.03 -10.55)
1	Araraquara	Sao Paulo	-21.48	-48.11	POINT (-48.11 -21.48)
2	Assis	Sao Paulo	-22.40	-50.25	POINT (-50.25 -22.4)
3	Bauru	Sao Paulo	-22.19	-49.04	POINT (-49.04 -22.19)
4	Belém	Para	-1.27	-48.30	POINT (-48.3 -1.27)

In [320]:

```
# plot the coordinates over a country-level map.
world = geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
world.head()
```

Out[320]:

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	28400000.0	Asia	Afghanistan	AFG	22270.0	POLYGON ((61.21081709172574 35.65007233330923,...
1	12799293.0	Africa	Angola	AGO	110300.0	(POLYGON ((16.32652835456705 -5.87747039146621...
2	3639453.0	Europe	Albania	ALB	21810.0	POLYGON ((20.59024743010491 41.85540416113361,...
3	4798491.0	Asia	United Arab Emirates	ARE	184300.0	POLYGON ((51.57951867046327 24.24549713795111,...
4	40913584.0	South America	Argentina	ARG	573900.0	(POLYGON ((-65.50000000000003 -55.199999999999...

In [321]:

```
# We restrict to South America - Brazil.
#gdf = world[world.continent == 'South America']
gdf = world[world.name == 'Brazil']
gdf
```

Out[321]:

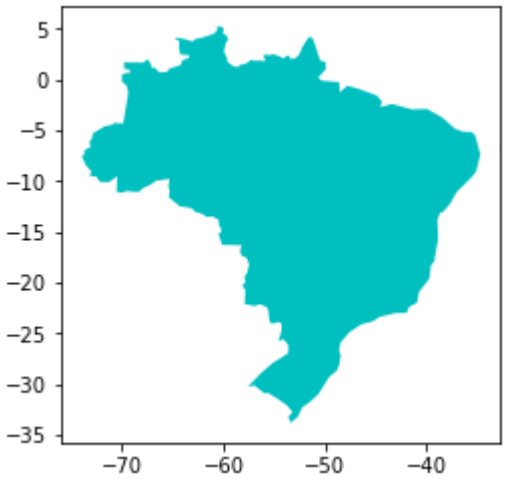
	pop_est	continent	name	iso_a3	gdp_md_est	geometry
22	198739269.0	South America	Brazil	BRA	1993000.0	POLYGON ((-57.62513342958296 -30.2162948544542...

In [322]:

```
water = 'lightskyblue'
earth = 'tan'
#gdf.set_facecolor(water)

# We can now plot our GeoDataFrame.
gdf.plot( color='cy', facecolor=earth, linewidth=1, alpha=1)
# Plot only row 22 - BRAZIL
#gdf.loc[22, 'geometry']
```

Out[322]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x204b25e2438>
```



In [323]:

```
# Create a subset with partial columns
cities_with_country = c_br[['City','Coordinates']]
cities_with_country.head()
```

Out[323]:

	City	Coordinates
0	Aracaju	POINT (-37.03 -10.55)
1	Araraquara	POINT (-48.11 -21.48)
2	Assis	POINT (-50.25 -22.4)
3	Bauru	POINT (-49.04 -22.19)
4	Belém	POINT (-48.3 -1.27)

In [324]:

```
# Rename columns
new_df = cities_with_country.rename(columns={'Coordinates':'geometry'})
new_df.head()
```

Out[324]:

	City	geometry
0	Aracaju	POINT (-37.03 -10.55)
1	Araraquara	POINT (-48.11 -21.48)
2	Assis	POINT (-50.25 -22.4)
3	Bauru	POINT (-49.04 -22.19)
4	Belém	POINT (-48.3 -1.27)

In [348]:

```
new_df.type.head()
```

Out[348]:

```
0    Point
1    Point
2    Point
3    Point
4    Point
dtype: object
```

In [335]:

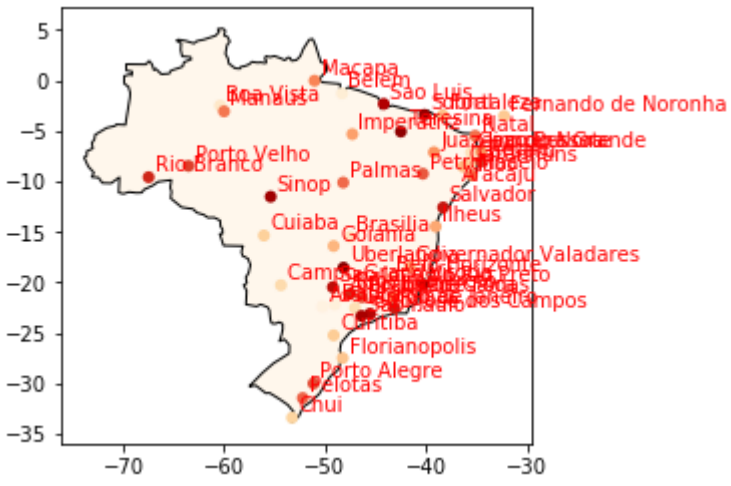
```
# Transform DataFrame with geometry capabilities
cities_with_country = geopandas.GeoDataFrame(new_df, geometry='geometry')
cities_with_country.head()
```

Out[335]:

	City	geometry
0	Aracaju	POINT (-37.03 -10.55)
1	Araraquara	POINT (-48.11 -21.48)
2	Assis	POINT (-50.25 -22.4)
3	Bauru	POINT (-49.04 -22.19)
4	Belém	POINT (-48.3 -1.27)

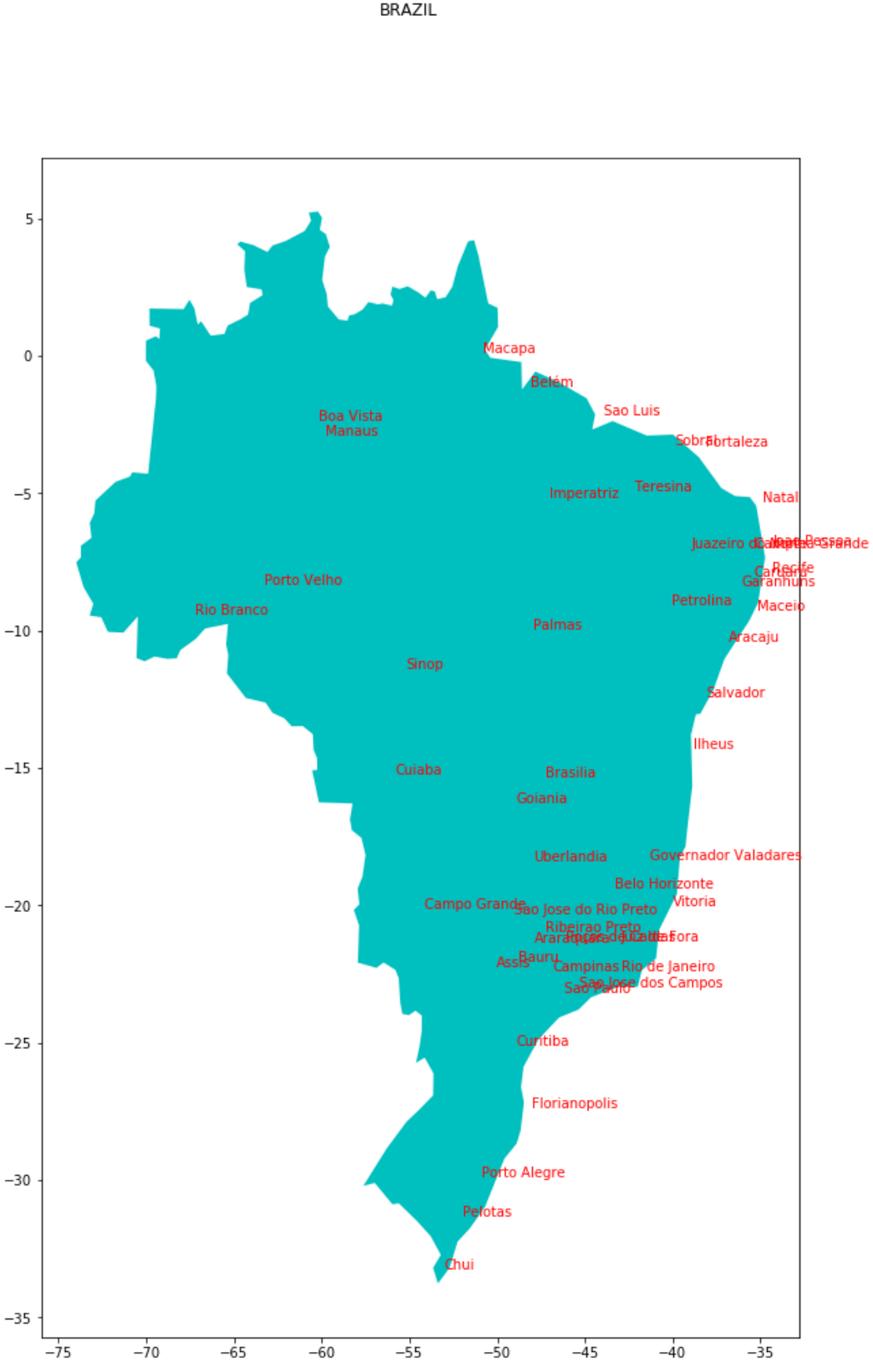
In [338]:

```
# PLOT Geopandas result
xx.set_axis_on()

base = gdf.plot(color='grey', edgecolor='black', cmap='OrRd')
ax = cities_with_country.plot(ax=base,  alpha=1, linewidth=0, cmap='OrRd')

for x, y, label in zip(cities_with_country.geometry.x, cities_with_country.geometry.y,
cities_with_country.City):
    ax.annotate(label, xy=(x, y), xytext=(3, 3), alpha=3, textcoords="offset points", c
olor='red')
```



In [353]:

```
# PLOT Geopandas with labels
f, ax = plt.subplots(1, figsize=(10,16))
ax.set_axis_on()
f.suptitle('BRAZIL')
# Plot the Map
ax = gdf.plot(ax=ax, facecolor='cy', alpha=1, linewidth=1)
# Write labels
for x, y, label in zip(cities_with_country.geometry.x, cities_with_country.geometry.y,
cities_with_country.City):
    ax.annotate(label, xy=(x, y), xytext=(3, 3), alpha=3, textcoords="offset points",co
lor='red')
```


BRAZIL
Macapa
Belém
Sao Luis
Boa Vista
Manaus
Fortaleza
Imperatriz
Teresina
Natal
Juazeiro do Norte
Recife
Caruaru
Garanhuns
Petrolina
Maceio
Porto Velho
Rio Branco
Palmas
Aracaju
Sinop
Salvador
Ilheus
Cuiaba
Brasilia
Goiania
Uberlandia
Governador Valadares
Belo Horizonte
Vitoria
Campo Grande
Sao Jose do Rio Preto
Ribeirao Preto
Juiz de Fora
Assis
Bauru
Campinas
Rio de Janeiro
Sao Jose dos Campos
Sao Paulo
Curitiba
Florianopolis
Porto Alegre
Pelotas
Chui
5
0
−5
−10
−15
−20
−25
−30
−35
−75
−70
−65
−60
−55
−50
−45
−40
−35

In [ ]: