Crop Production Analysis and Prediction

In [1]:

```
# Importing Important Libraries
import numpy as np
import pandas as pd

import matplotlib.pyplot as plt
import seaborn as sns
import geopandas as gpd

from sklearn.preprocessing import LabelEncoder,OneHotEncoder
from sklearn.metrics import mean_absolute_error,r2_score
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
%matplotlib inline
```

In [2]:

```
# Loading Crop production data
data = pd.read_csv('Crop Production data.csv')

# Loading India map shape file
shapfile = gpd.read_file('India-map/IND_adm2.shp')
```

In [3]:

```
# Statistical overview of the data
data.describe(include='all')
```

Out[3]:

	State_Name	District_Name	Crop_Year	Season	Crop	Area	Productio
count	246091	246091	246091.000000	246091	246091	2.460910e+05	2.423610e+0
unique	34	644	NaN	8	126	NaN	Na
top	Uttar Pradesh	BIJAPUR	NaN	Kharif	Rice	NaN	Na
freq	33306	945	NaN	93584	15104	NaN	Na
mean	NaN	NaN	2005.643018	NaN	NaN	1.200282e+04	5.825034e+0
std	NaN	NaN	4.952164	NaN	NaN	5.052340e+04	1.706581e+0
min	NaN	NaN	1997.000000	NaN	NaN	4.000000e-02	0.000000e+0
25%	NaN	NaN	2002.000000	NaN	NaN	8.000000e+01	8.800000e+0
50%	NaN	NaN	2006.000000	NaN	NaN	5.820000e+02	7.290000e+0
75%	NaN	NaN	2010.000000	NaN	NaN	4.392000e+03	7.023000e+0
max	NaN	NaN	2015.000000	NaN	NaN	8.580100e+06	1.250800e+0

In [4]:

```
# Basic info about features datatype
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 246091 entries, 0 to 246090
Data columns (total 7 columns):
 #   Column         Non-Null Count   Dtype  
---  ------         --------------   -----  
 0   State_Name     246091 non-null  object 
 1   District_Name  246091 non-null  object 
 2   Crop_Year      246091 non-null  int64  
 3   Season         246091 non-null  object 
 4   Crop           246091 non-null  object 
 5   Area           246091 non-null  float64
 6   Production     242361 non-null  float64
dtypes: float64(2), int64(1), object(4)
memory usage: 13.1+ MB
```

In [5]:

```
# Checking for missing values
data.isnull().sum()
```

Out[5]:

```
State_Name          0
District_Name       0
Crop_Year           0
Season              0
Crop                0
Area                0
Production       3730
dtype: int64
```

In [6]:

```
# Overview of the raw data
data.head()
```

Out[6]:

	State_Name	District_Name	Crop_Year	Season	Crop	Area	Production
0	ANDAMAN AND NICOBAR	NICOBAR ISLANDS	2000	Kharif	Arecanut	1254.0	2000.0
1	ANDAMAN AND NICOBAR	NICOBAR ISLANDS	2000	Kharif	Other Kharif pulses	2.0	1.0
2	ANDAMAN AND NICOBAR	NICOBAR ISLANDS	2000	Kharif	Rice	102.0	321.0
3	ANDAMAN AND NICOBAR	NICOBAR ISLANDS	2000	Whole Year	Banana	176.0	641.0
4	ANDAMAN AND NICOBAR	NICOBAR ISLANDS	2000	Whole Year	Cashewnut	720.0	165.0

In [7]:

```
# Dropping uneccessary features from the mapping dataframe
shapfile.drop(['ID_0', 'ISO', 'NAME_0', 'ID_1', 'ID_2',
'HASC_2',
       'CCN_2', 'CCA_2', 'TYPE_2', 'ENGTYPE_2', 'NL_NAME_2',
'VARNAME_2'],inplace=True,axis=1)
shapfile.columns = ['State','District','geometry']
shapfile.head()
```

Out[7]:

	State	District	geometry
0	Andaman and Nicobar	Nicobar Islands	MULTIPOLYGON (((92.78778 9.24417, 92.78889 9.2...
1	Andaman and Nicobar	North and Middle Andaman	MULTIPOLYGON (((93.64841 14.93487, 93.64917 14...
2	Andaman and Nicobar	South Andaman	MULTIPOLYGON (((93.8397 12.32082, 93.85775 12....
3	Andhra Pradesh	Anantapur	POLYGON ((77.69 15.17628, 77.69378 15.17347, 7...
4	Andhra Pradesh	Chittoor	POLYGON ((78.47611 13.9368, 78.48208 13.93007,...

In [8]:

```
# Removing extra space and Capitaizing each word
shapfile['District'] =
shapfile['District'].str.strip().str.upper()
shapfile['State'] = shapfile['State'].str.strip().str.upper()
```

In [9]:

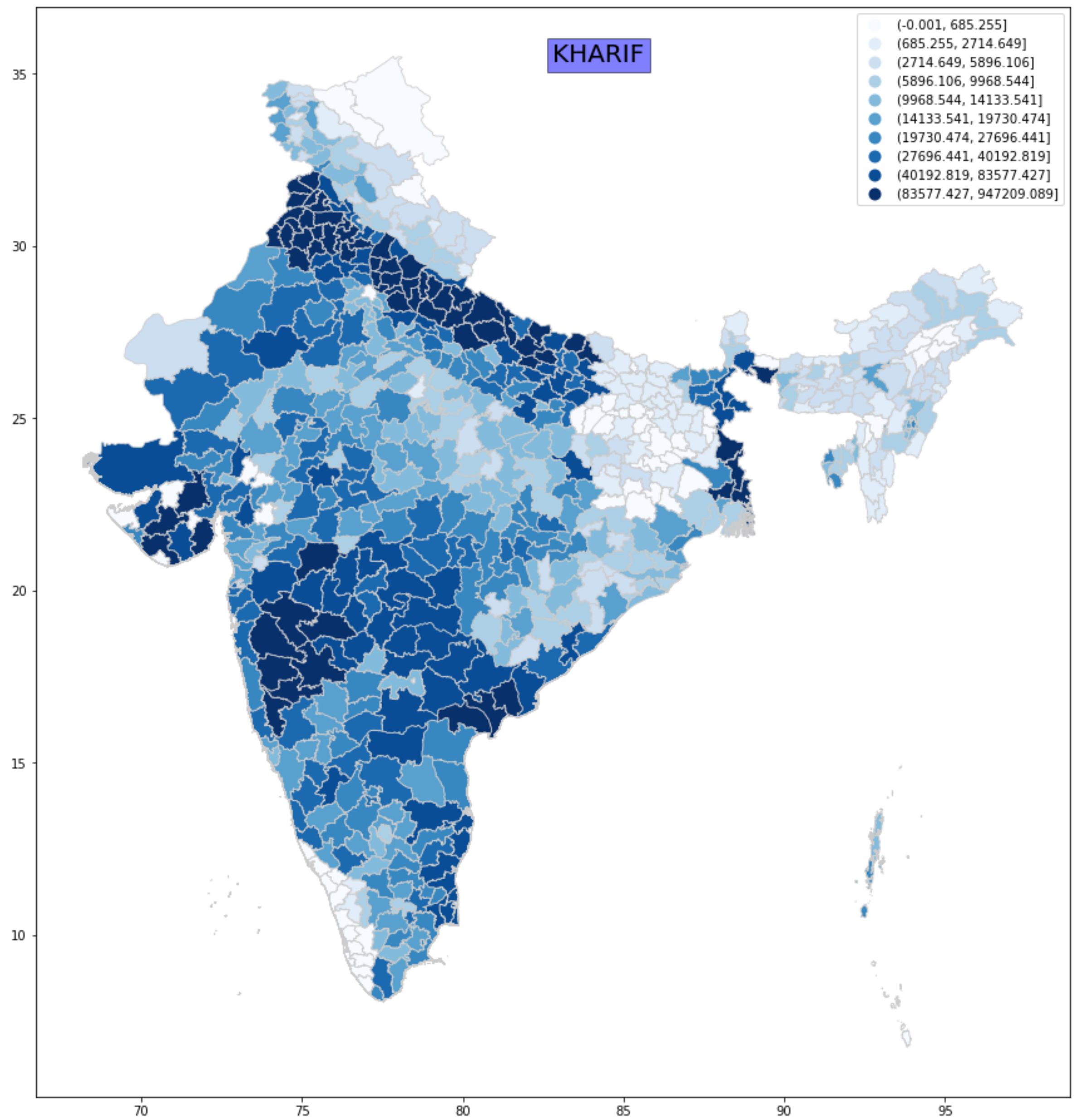
```
# Removing extra space and Capitaizing each word
data['State_Name'] = data['State_Name'].str.strip().str.upper()
data['District_Name'] =
data['District_Name'].str.strip().str.upper()
data['Season'] = data['Season'].str.strip().str.upper()
```

In [10]:

```
# Separating NULL production data
pred_data = data[data.Production.isnull()]
data = data[~data.Production.isnull()]
```

In [11]:

```
# Creating charts for each seasons
for season in data.Season.unique():
    plt.figure(figsize=(20,16))

    plt_data = data[data.Season==season]\
        .groupby(['State_Name','District_Name'])['Production']\
        .mean()\
        .reset_index()

    merged_data =
pd.merge(shapfile,plt_data,how='left',left_on=['State','District']

merged_data.drop(['State_Name','District_Name'],inplace=True,axis=

    merged_data.Production = merged_data.Production.fillna(0)
    merged_data.Production =
pd.qcut(merged_data.Production,q=10,duplicates='drop')

    ax = merged_data.plot(column='Production',cmap='Blues',
linewidth=0.8, ax=plt.gca(), edgecolor='0.8', legend=True)
    plt.text(0.5,0.95,season.strip(),transform=ax.transAxes,
bbox=dict(facecolor='blue',alpha=0.5),fontsize=20)

    plt.show()
```


KHARIF
(-0.001, 685.255]
(685.255, 2714.649]
(2714.649, 5896.106]
(5896.106, 9968.544]
(9968.544, 14133.541]
(14133.541, 19730.474]
(19730.474, 27696.441]
(27696.441, 40192.819]
(40192.819, 83577.427]
(83577.427, 947209.089]
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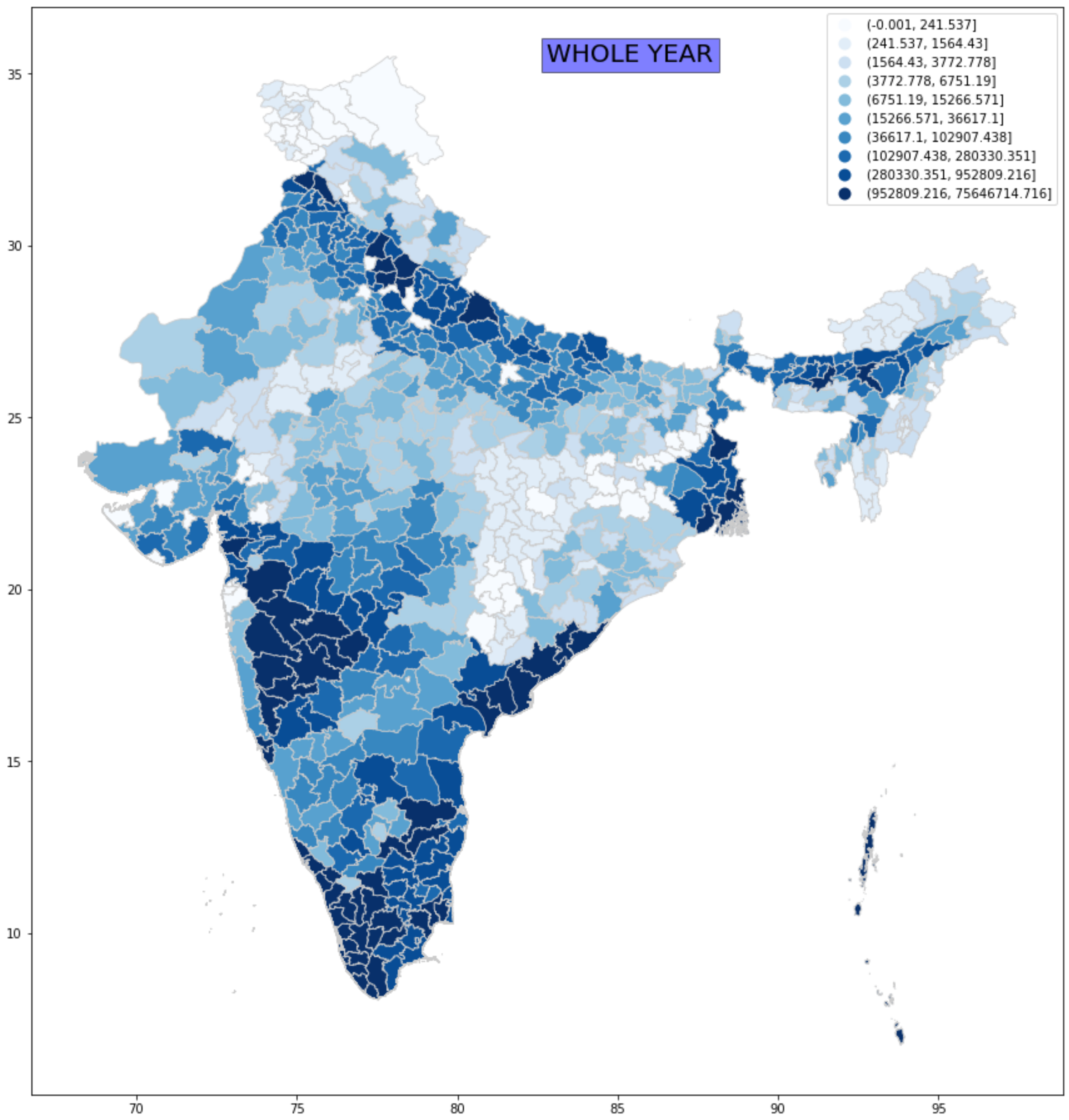
WHOLE YEAR
(-0.001, 241.537]
(241.537, 1564.43]
(1564.43, 3772.778]
(3772.778, 6751.19]
(6751.19, 15266.571]
(15266.571, 36617.1]
(36617.1, 102907.438]
(102907.438, 280330.351]
(280330.351, 952809.216]
(952809.216, 75646714.716]
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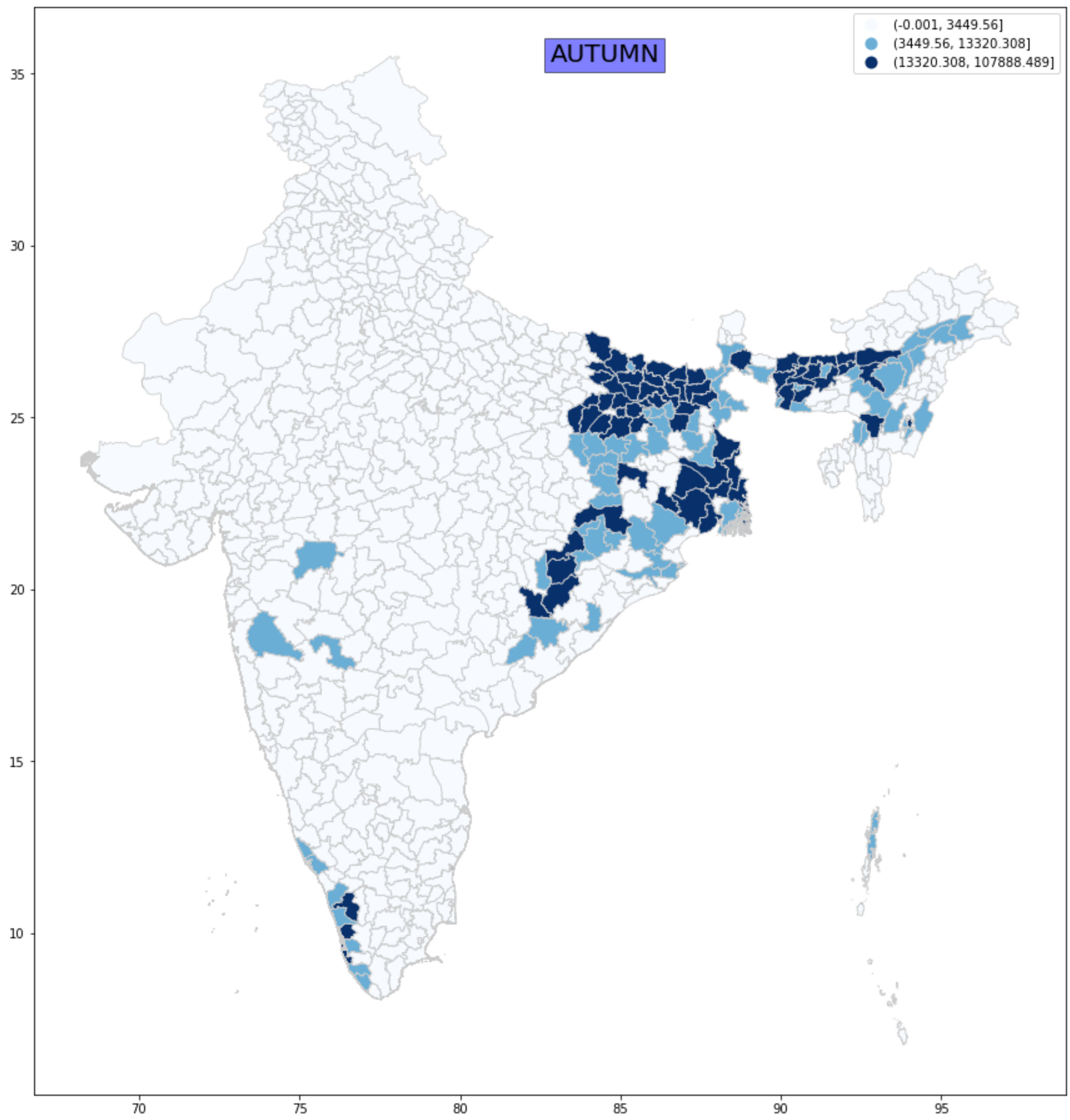
AUTUMN
(-0.001, 3449.56]
(3449.56, 13320.308]
(13320.308, 107888.489]
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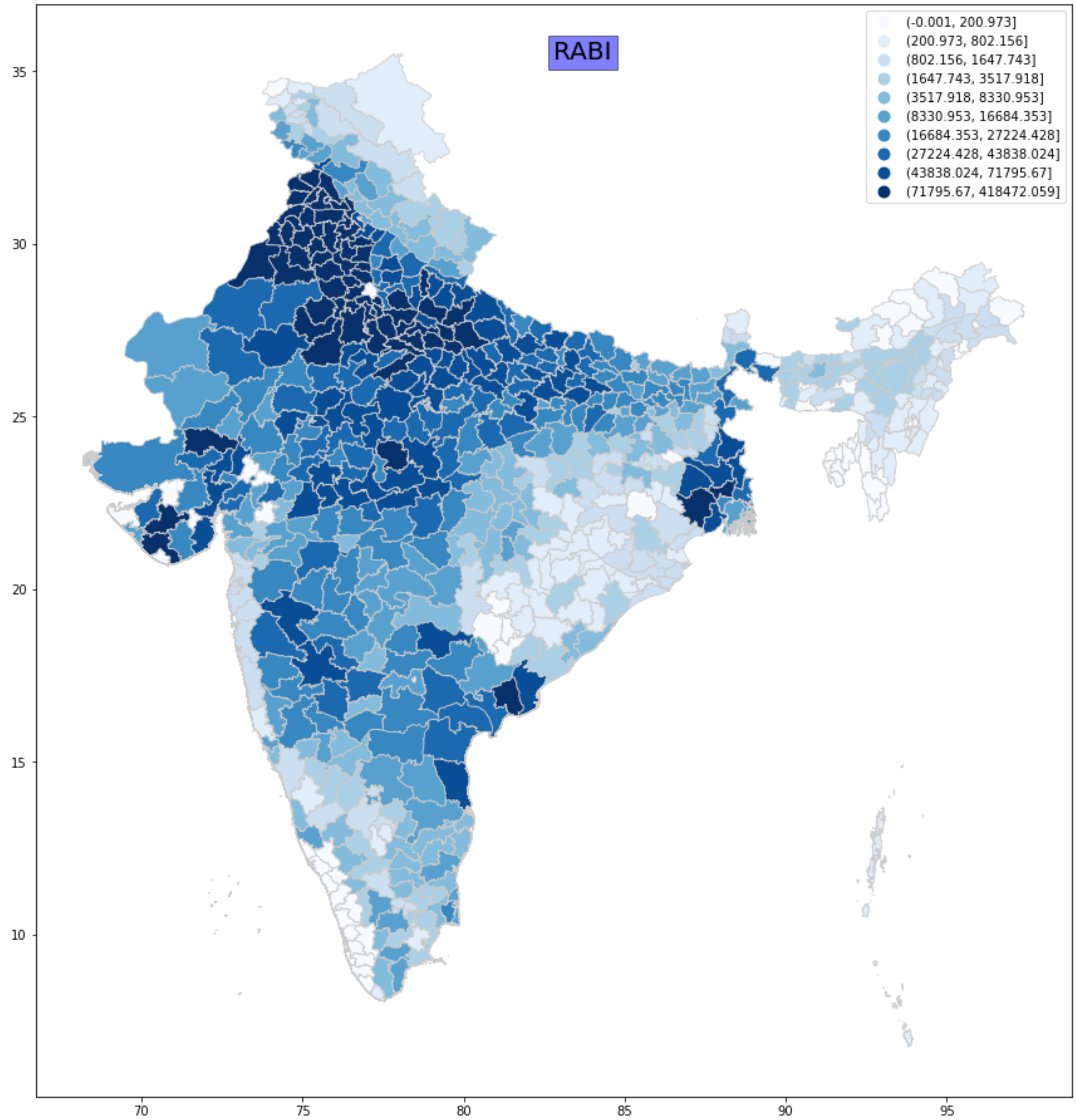
RABI
(-0.001, 200.973]
(200.973, 802.156]
(802.156, 1647.743]
(1647.743, 3517.918]
(3517.918, 8330.953]
(8330.953, 16684.353]
(16684.353, 27224.428]
(27224.428, 43838.024]
(43838.024, 71795.67]
(71795.67, 418472.059]
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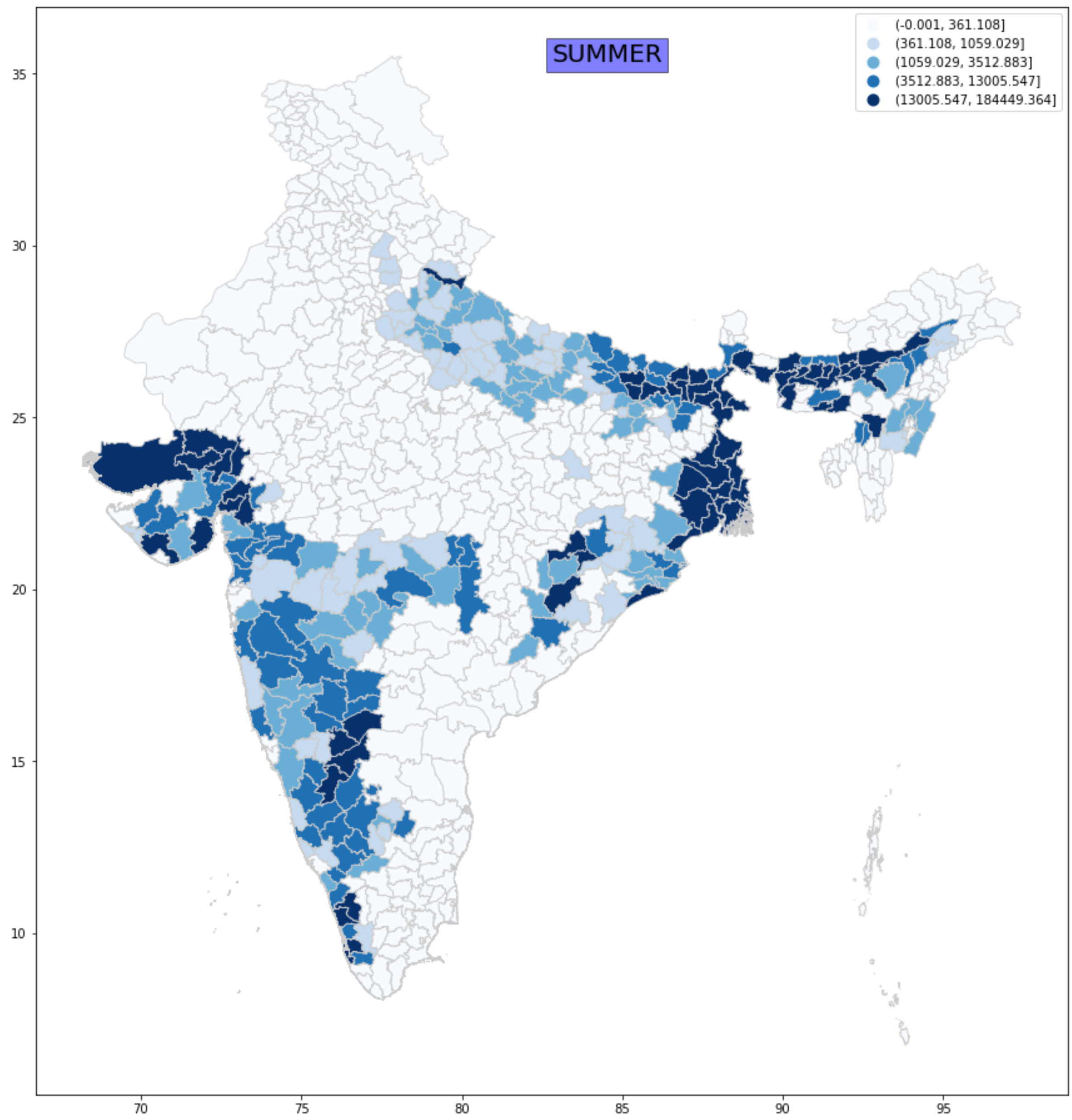
SUMMER
(-0.001, 361.108]
(361.108, 1059.029]
(1059.029, 3512.883]
(3512.883, 13005.547]
(13005.547, 184449.364]
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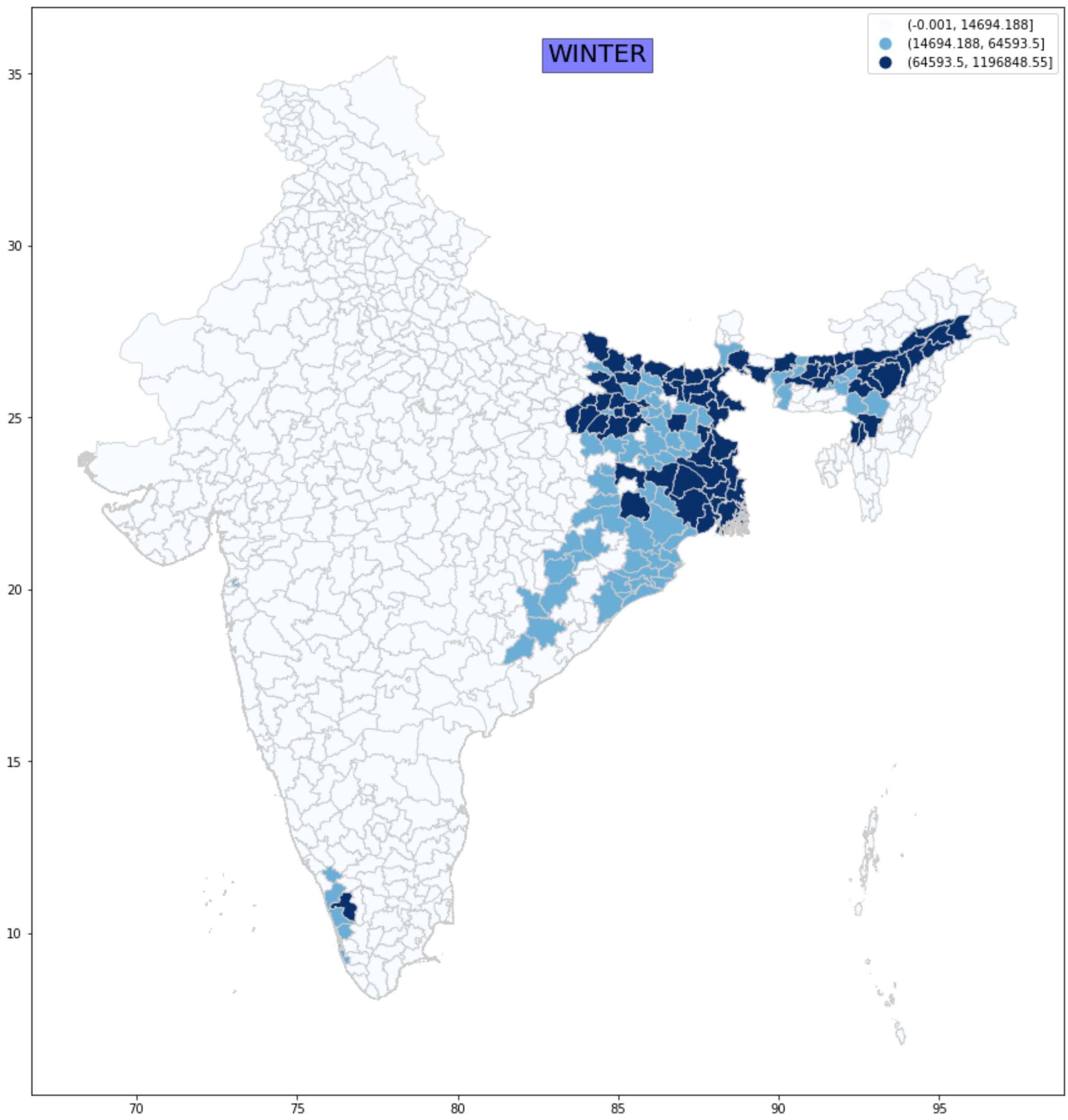
WINTER
(-0.001, 14694.188]
(14694.188, 64593.5]
(64593.5, 1196848.55]
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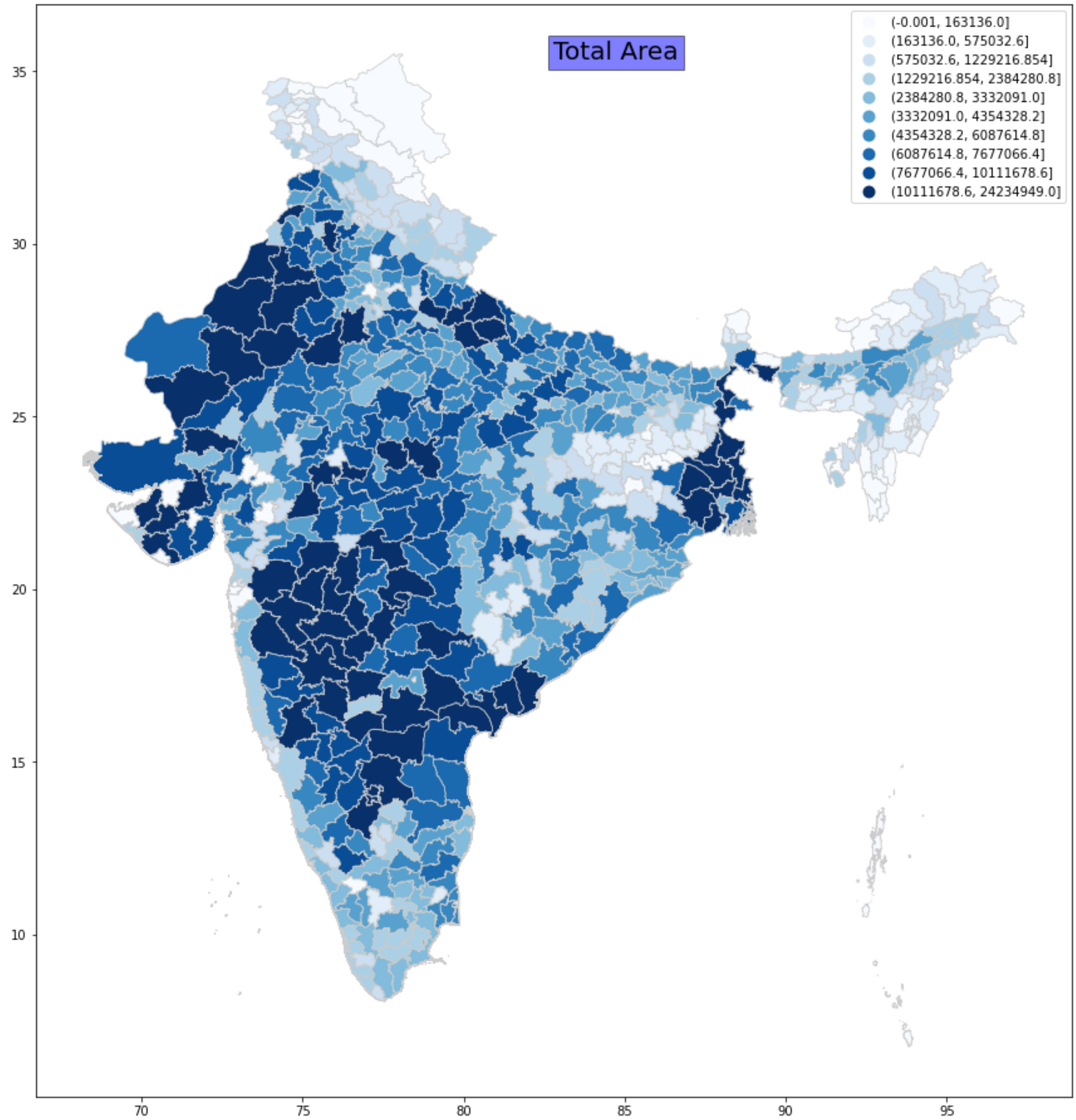
In [12]:

```
# Creating charts for Total Area
plt.figure(figsize=(20,16))

plt_data = data\
    .groupby(['State_Name','District_Name'])['Area']\
    .sum()\
    .reset_index()

merged_data =
pd.merge(shapfile,plt_data,how='left',left_on=['State','District']
merged_data.drop(['State_Name','District_Name'],inplace=True,axis=

merged_data.Area = merged_data.Area.fillna(0)
merged_data.Area =
pd.qcut(merged_data.Area,q=10,duplicates='drop')

ax = merged_data.plot(column='Area',cmap='Blues', linewidth=0.8,
ax=plt.gca(), edgecolor='0.8', legend=True)
plt.text(0.5,0.95,'Total Area',transform=ax.transAxes,
bbox=dict(facecolor='blue',alpha=0.5),fontsize=20)

plt.show()
```


Total Area
(-0.001, 163136.0]
(163136.0, 575032.6]
(575032.6, 1229216.854]
(1229216.854, 2384280.8]
(2384280.8, 3332091.0]
(3332091.0, 4354328.2]
(4354328.2, 6087614.8]
(6087614.8, 7677066.4]
(7677066.4, 10111678.6]
(10111678.6, 24234949.0]
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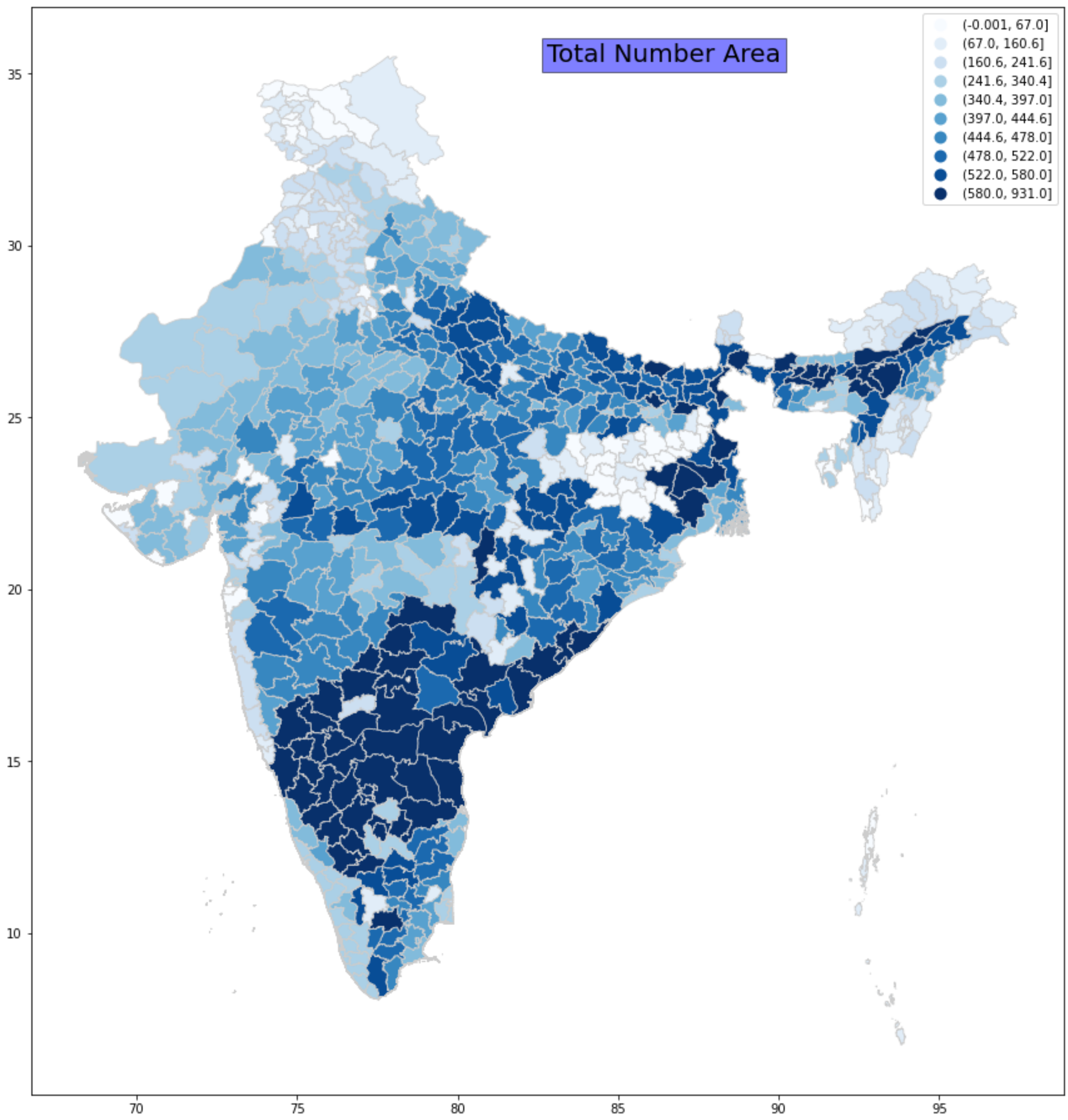
In [13]:

```
# Creating charts for Number of fields
plt.figure(figsize=(20,16))

plt_data = data\
    .groupby(['State_Name','District_Name'])['Area']\
    .count()\
    .reset_index()

merged_data =
pd.merge(shapfile,plt_data,how='left',left_on=['State','District']
merged_data.drop(['State_Name','District_Name'],inplace=True,axis=

merged_data.Area = merged_data.Area.fillna(0)
merged_data.Area =
pd.qcut(merged_data.Area,q=10,duplicates='drop')

ax = merged_data.plot(column='Area',cmap='Blues', linewidth=0.8,
ax=plt.gca(), edgecolor='0.8', legend=True)
plt.text(0.5,0.95,'Total Number Area',transform=ax.transAxes,
bbox=dict(facecolor='blue',alpha=0.5),fontsize=20)

plt.show()
```



In [14]:

```
# Finding Top States by Production
top_10 = data\
    .groupby(['State_Name'])['Production']\
    .sum()\
    .reset_index()\
    .sort_values(by='Production',ascending=False)[:10]
top_10
```

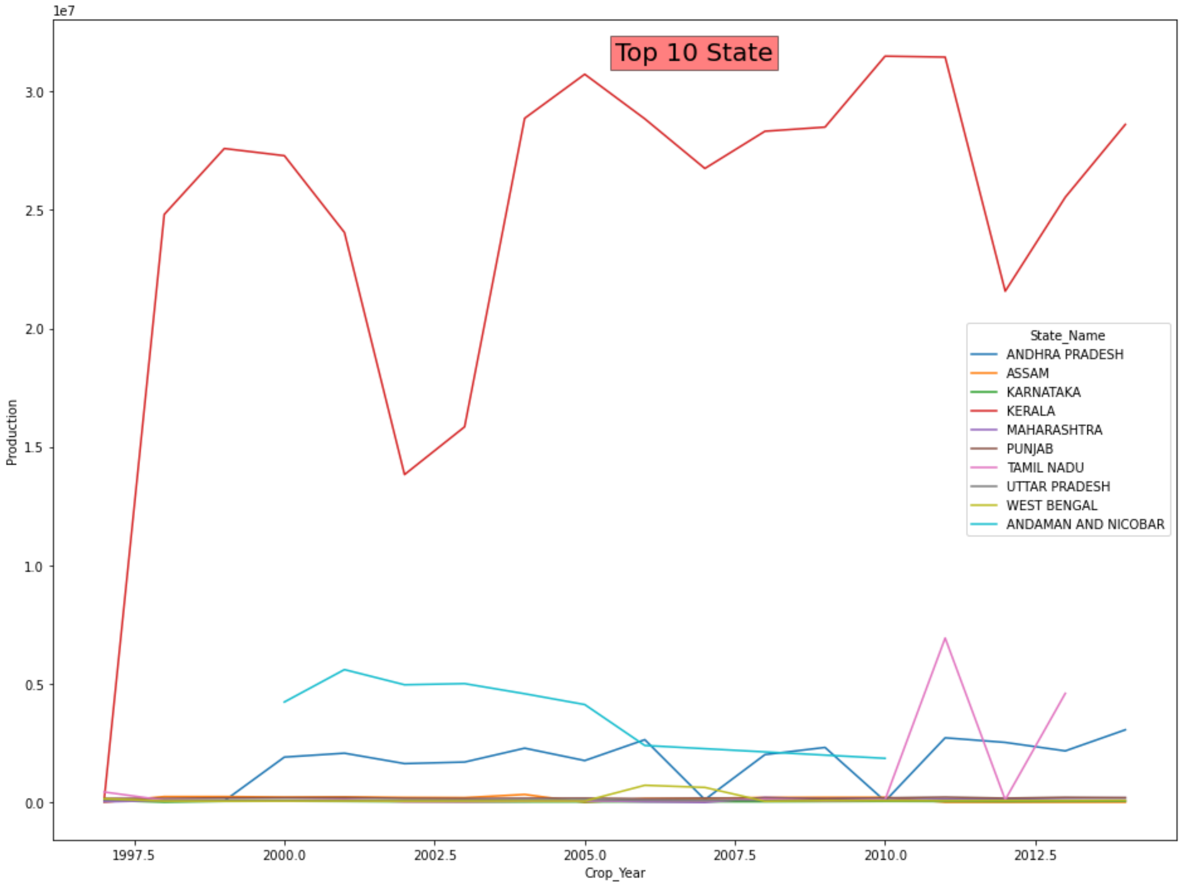
Out[14]:

	State_Name	Production
15	KERALA	9.788005e+10
1	ANDHRA PRADESH	1.732459e+10
27	TAMIL NADU	1.207644e+10
30	UTTAR PRADESH	3.234493e+09
3	ASSAM	2.111752e+09
32	WEST BENGAL	1.397904e+09

	State_Name	Production
17	MAHARASHTRA	1.263641e+09
14	KARNATAKA	8.634298e+08
0	ANDAMAN AND NICOBAR	7.182232e+08
24	PUNJAB	5.863850e+08

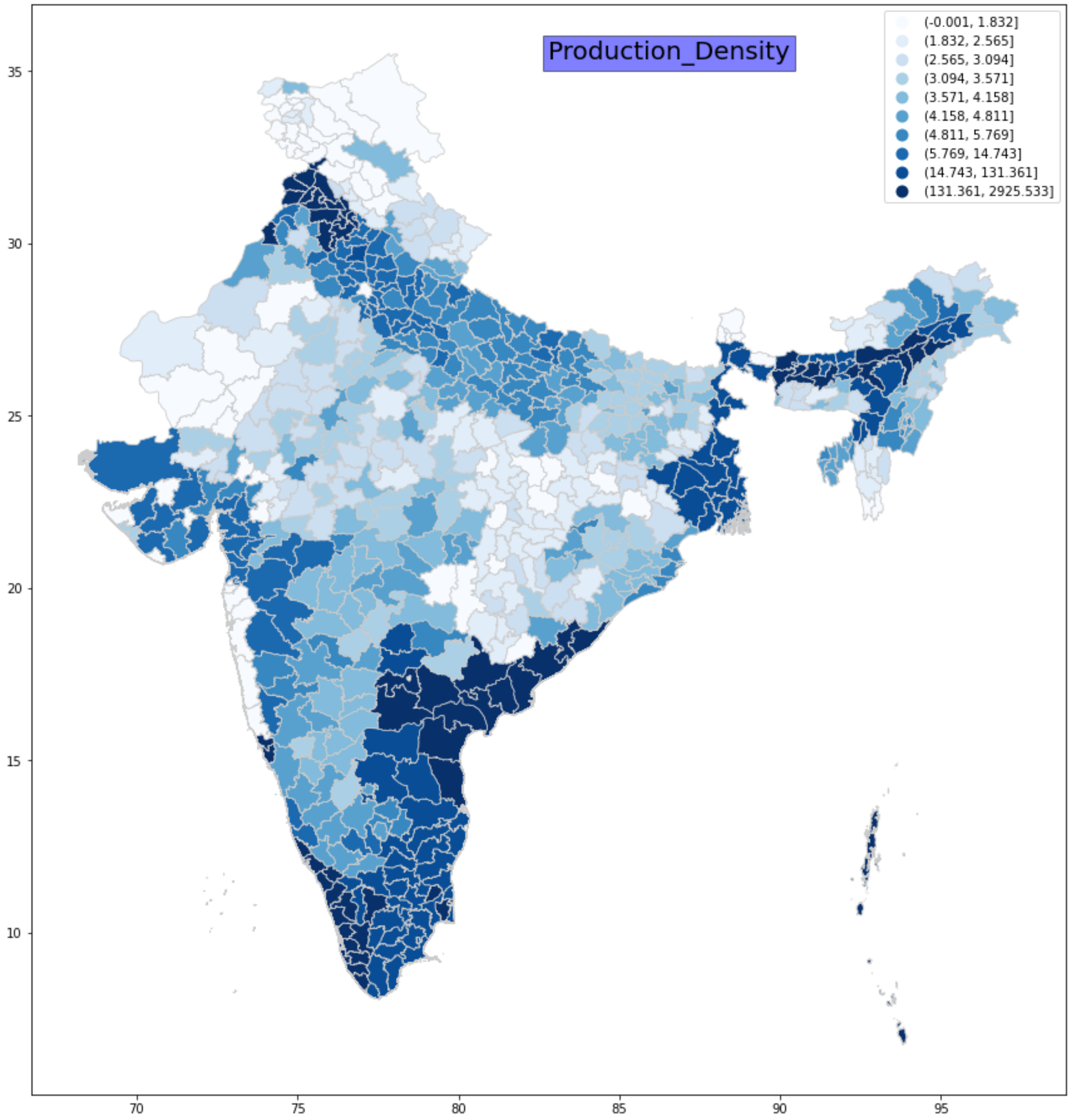
In [15]:

```
# Ploting Top 10 states year wise production
plt_data = data[data.State_Name.isin(top_10.State_Name)]\
    .groupby(['Crop_Year','State_Name'])['Production']\
    .mean()\
    .reset_index()
plt.figure(figsize=(16,12))
ax =
sns.lineplot(x=plt_data.Crop_Year,y=plt_data.Production,hue=plt_da
plt.text(0.5,0.95,'Top 10 State',transform=ax.transAxes,
bbox=dict(facecolor='red',alpha=0.5),fontsize=20)
plt.show()
```



In [16]:

```
# Creating chart for Production density
plt.figure(figsize=(20,16))

data['Production_Density'] = data.Production/data.Area
plt_data = data.groupby(['State_Name','District_Name'])
['Production_Density']\
    .mean()\
    .reset_index()

merged_data =
pd.merge(shapfile,plt_data,how='left',left_on=['State','District']
merged_data.drop(['State_Name','District_Name'],inplace=True,axis=

merged_data.Production_Density =
merged_data.Production_Density.fillna(0)
merged_data.Production_Density =
pd.qcut(merged_data.Production_Density,q=10,duplicates='drop')

ax = merged_data.plot(column='Production_Density',cmap='Blues',
linewidth=0.8, ax=plt.gca(), edgecolor='0.8', legend=True)
plt.text(0.5,0.95,'Production_Density',transform=ax.transAxes,
bbox=dict(facecolor='blue',alpha=0.5),fontsize=20)

plt.show()
```


Production_Density
● (-0.001, 1.832]
● (1.832, 2.565]
● (2.565, 3.094]
● (3.094, 3.571]
● (3.571, 4.158]
● (4.158, 4.811]
● (4.811, 5.769]
● (5.769, 14.743]
● (14.743, 131.361]
● (131.361, 2925.533]
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In [17]:

```
# Initialling Label encoder for encoding State, District and Crops names
le = LabelEncoder()

# performing Label encoding on district name
le.fit(data.District_Name)
data.District_Name = le.transform(data.District_Name)

# performing Label encoding on State name
le.fit(data.State_Name)
data.State_Name = le.transform(data.State_Name)

# performing Label encoding on Crop name
le.fit(data.Crop)
data.Crop = le.transform(data.Crop)

# performing One Hot encoding on seasons
data = pd.concat([data,pd.get_dummies(data.Season)],axis=1)
```

In [18]:

```
# Dropping extra features
data.drop(['Production_Density','WHOLE YEAR','Season'],axis=1,inplace=True)
data.head()
```

Out[18]:

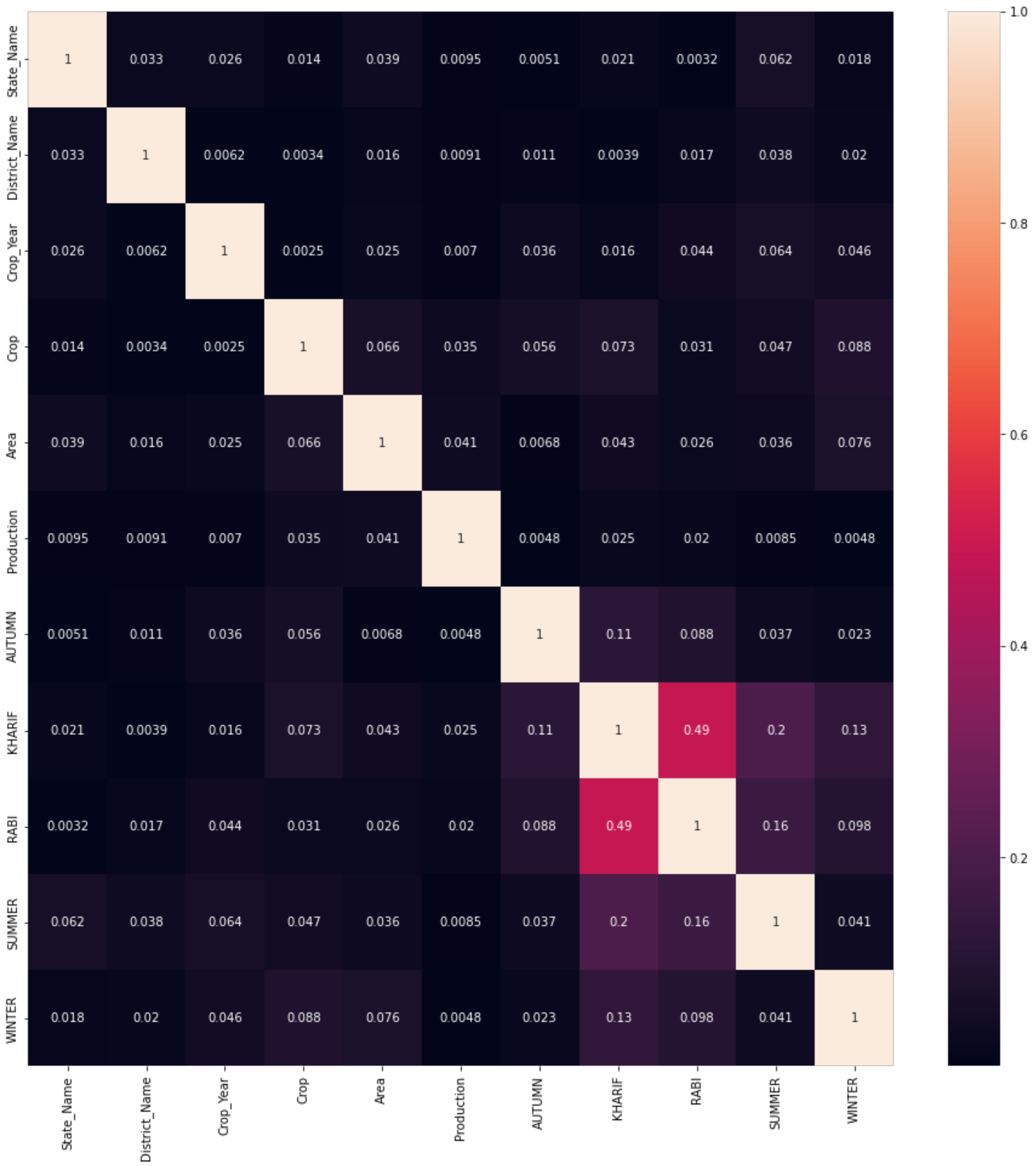
	State_Name	District_Name	Crop_Year	Crop	Area	Production	AUTUMN	KHARIF	RABI
0	0	418	2000	2	1254.0	2000.0	0	1	0
1	0	418	2000	74	2.0	1.0	0	1	0
2	0	418	2000	97	102.0	321.0	0	1	0
3	0	418	2000	7	176.0	641.0	0	0	0
4	0	418	2000	22	720.0	165.0	0	0	0

In [19]:

```
# Showing data heatmap
plt.figure(figsize=(16,16))
sns.heatmap(abs(data.corr()),annot=True,ax=plt.gca())
```

Out[19]:

```
<AxesSubplot:>
```



In [20]:

```
# performing train test split for the data validation
X  = data.drop('Production',axis=1)
y = data.Production
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2)
```

In [26]:

```
# Initializing RandomForest model and fitting the model with train data
rf = RandomForestRegressor(n_estimators=500,max_depth=7,)
rf.fit(X_train,y_train)
```

Out[26]:

```
▾                     RandomForestRegressor
RandomForestRegressor(max_depth=7, n_estimators=500)
```

In [27]:

```
# Predicting the data with Test data
y_pred = rf.predict(X_test)
print('Mean Abosolute Error:
',mean_absolute_error(y_test,y_pred))
print('R-Squared Error: ',r2_score(y_test,y_pred))
```

```
Mean Abosolute Error:  215652.28864114734
R-Squared Error:  0.7766972103854695
```

In [29]:

```
# Predicting the data with Train data
y_pred = rf.predict(X_train)
print('Mean Abosolute Error:
',mean_absolute_error(y_train,y_pred))
print('R-Squared Error: ',r2_score(y_train,y_pred))
```

```
Mean Abosolute Error:  168985.14962020074
R-Squared Error:  0.9459877809490216
```