Data Analysis in MHA Population Dataset from Kaggle

In [53]:

```
# At first, let's import some useful libraries
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
```

Data pre-processing

In [54]:

```
# Now let's import our data from our Computer.
My_Data = pd.read_csv(r"C:/Users/USER/Downloads/archive (29)/MHA Population Report.csv")
```

In [55]:

```
# Let's understand our data
My_Data.shape
```

Out[55]:

```
(132315, 29)
```

In [56]:
```
# Show the first 5 rows
My_Data.head()
```

Out[56]:

	Census Year	District	Taluka	Town/Village	No. of households	Total population	Total male population	Total female population	Total 0 to 6 year children	Male 0 to 6 year children	...	Female literates	Total iliterates	ilite
0	2011	AHMADNAGAR	AKOLA	ABIT KHIND	201	732	359	373	73	36	...	175	313.0	
1	2011	AHMADNAGAR	AKOLA	AGAR	37	247	162	85	27	15	...	53	58.0	
2	2011	AHMADNAGAR	AKOLA	AGASTINAGAR	357	1536	799	737	178	97	...	467	462.0	
3	2011	AHMADNAGAR	AKOLA	AKOLA	3861	18278	9381	8897	2066	1101	...	6437	4400.0	1
4	2011	AHMADNAGAR	AKOLA	AMBAD	529	2590	1352	1238	333	189	...	743	845.0	

5 rows × 29 columns

In [57]:
```
# Columns of Dataset
My_Data.columns
```

Out[57]:
```
Index(['Census Year', 'District', 'Taluka', 'Town/Village',
       'No. of households', 'Total population', 'Total male population',
       'Total female population', 'Total 0 to 6 year children',
       'Male 0 to 6 year children', 'Female 0 to 6 year children',
       'Total SC population', 'Male SC population', 'Female SC population',
       'Total ST population', 'Male ST population', 'Female ST population',
       'Total literates', 'Male literates', 'Female literates',
       'Total iliterates', 'Male iliterates', 'Female iliterates',
       'Total main workers', 'Male main workers', 'Female main workers',
       'Total non workers', 'Male non workers', 'Female non workers'],
      dtype='object')
```

In [58]:
```
# Types of the columns
My_Data.dtypes
```

Out[58]:
```
Census Year                      int64
District                        object
Taluka                          object
Town/Village                    object
No. of households                int64
Total population                 int64
Total male population            int64
Total female population          int64
Total 0 to 6 year children       int64
Male 0 to 6 year children        int64
Female 0 to 6 year children      int64
Total SC population              int64
Male SC population               int64
Female SC population             int64
Total ST population              int64
Male ST population               int64
Female ST population             int64
Total literates                  int64
Male literates                   int64
Female literates                 int64
Total iliterates               float64
Male iliterates                float64
Female iliterates              float64
Total main workers               int64
Male main workers                int64
Female main workers              int64
Total non workers                int64
Male non workers                 int64
Female non workers               int64
dtype: object
```

In [59]:
```
# Let's see for missing values
missing_values = My_Data.isna().sum()

# Print the result
missing_values
```

Out[59]:
```
Census Year                        0
District                           0
Taluka                            16
Town/Village                    1036
No. of households                  0
Total population                   0
Total male population              0
Total female population            0
Total 0 to 6 year children         0
Male 0 to 6 year children          0
Female 0 to 6 year children        0
Total SC population                0
Male SC population                 0
Female SC population               0
Total ST population                0
Male ST population                 0
Female ST population               0
Total literates                    0
Male literates                     0
Female literates                   0
Total iliterates               49347
Male iliterates                49347
Female iliterates              49347
Total main workers                 0
Male main workers                  0
Female main workers                0
Total non workers                  0
Male non workers                   0
Female non workers                 0
dtype: int64
```

As we see, there are 49347 missing values from three columns:Total literates, Male iliterates and Female iliterates. Let's create new columns that they will not have missing values using some other columns in our calculations.

In [60]:

```
#Create a new column : Total_iliterates
My_Data['Total_iliterates'] = np.where(
    (My_Data['Total population'].isna())
    | (My_Data['Total literates'].isna()),
    np.nan,
    My_Data['Total population'] - My_Data['Total literates'])

# Create a new column : Male_iliterates
My_Data['Male_iliterates'] = np.where(
    (My_Data['Total male population'].isna())
    | (My_Data['Male literates'].isna()),
    np.nan,
    My_Data['Total male population'] - My_Data['Male literates'])

# Create a new column : Female_iliterates
My_Data['Female_iliterates'] = np.where(
    (My_Data['Total female population'].isna())
    | (My_Data['Female literates'].isna()),
    np.nan,
    My_Data['Total female population'] - My_Data['Female literates'])
```

In [61]:

```
#Remove the old columns,Total iliterates, Male iliterates,Female iliterates
My_Data.drop(['Total iliterates', 'Male iliterates', 'Female iliterates'],
             axis=1, inplace=True)
```

We need to change the type of the elements of our new columns to integers so that they don't create any problems in our analysis afterwards.

In [62]:

```
# Convert Total_iliterates, Male_iliterates, Female_iliterates to integers
My_Data['Total_iliterates'] = My_Data['Total_iliterates'].astype('int64')
My_Data['Male_iliterates'] = My_Data['Male_iliterates'].astype('int64')
My_Data['Female_iliterates'] = My_Data['Female_iliterates'].astype('int64')
```

In [63]:

```
# Ok let's see our data frame's types again
My_Data.dtypes
```

Out[63]:

```
Census Year                      int64
District                        object
Taluka                          object
Town/Village                    object
No. of households                int64
Total population                 int64
Total male population            int64
Total female population          int64
Total 0 to 6 year children       int64
Male 0 to 6 year children        int64
Female 0 to 6 year children      int64
Total SC population              int64
Male SC population               int64
Female SC population             int64
Total ST population              int64
Male ST population               int64
Female ST population             int64
Total literates                  int64
Male literates                   int64
Female literates                 int64
Total main workers               int64
Male main workers                int64
Female main workers              int64
Total non workers                int64
Male non workers                 int64
Female non workers               int64
Total_iliterates                 int64
Male_iliterates                  int64
Female_iliterates                int64
dtype: object
```

In [64]:
```
# Check some statistics about numeric data
My_Data.describe()
```

Out[64]:

	Census Year	No. of households	Total population	Total male population	Total female population	Total 0 to 6 year children	Male 0 to 6 year children	Female 0 to 6 year children	Total SC population	p
count	132315.000000	1.323150e+05	1.323150e+05	1.323150e+05	1.323150e+05	1.323150e+05	132315.000000	132315.000000	132315.000000	1323
mean	2000.406492	8.222010e+02	4.144163e+03	2.156298e+03	1.987865e+03	6.286691e+02	326.209719	302.459358	493.478041	2
std	8.264585	1.213648e+04	5.730412e+04	3.084739e+04	2.648095e+04	7.273950e+03	3782.663981	3491.664407	5835.730419	30
min	1991.000000	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000	0.000000	0.000000	
25%	1991.000000	1.020000e+02	4.930000e+02	2.460000e+02	2.450000e+02	7.300000e+01	37.000000	35.000000	4.000000	
50%	2001.000000	1.930000e+02	9.460000e+02	4.780000e+02	4.680000e+02	1.440000e+02	74.000000	69.000000	73.000000	
75%	2011.000000	3.610000e+02	1.785000e+03	9.090000e+02	8.770000e+02	2.730000e+02	142.000000	131.000000	234.000000	1
max	2011.000000	2.105604e+06	9.925891e+06	5.460145e+06	4.465746e+06	1.340673e+06	698357.000000	642316.000000	646914.000000	3440

8 rows × 26 columns

In [65]:
```
# Now want to see how many of Town/Villages have Total Population=0
zero_population_df = My_Data[My_Data['Total population'] == 0]

# Get the count of rows
num_zero_population_towns_villages = len(zero_population_df)

# Print the count
print("Number of Towns/Villages with Total Population = 0:",
      num_zero_population_towns_villages)
```

```
Number of Towns/Villages with Total Population = 0: 2616
```

In [66]:

```
# We will delete these rows because our analysis will not focus there.
My_Data = My_Data[My_Data['Total population'] != 0]

# Reset the index after removing rows
My_Data.reset_index(drop=True, inplace=True)
```

We will create a new column named as Population_Group, which will separate the districts into villages, towns and cities according to their population in accordance with the division of the Indians

In [67]:

```
# Define the bin breaks and labels
bin_breaks = [0, 15000, 100000, 100000000]
bin_labels = ["Village", "Town", "City"]

# Create a copy of the DataFrame
My_Data = My_Data.copy()

My_Data['Population_Group'] = pd.cut(My_Data['Total population'],
                                     bins=bin_breaks, labels=bin_labels)
```

In [68]:

```
My_Data = My_Data.copy()
My_Data['Part_time_workers'] = My_Data['Total population'] - (My_Data['Total main workers'] +
                                                               My_Data['Total non workers'])

#Check the columns
My_Data.columns
```

Out[68]:

```
Index(['Census Year', 'District', 'Taluka', 'Town/Village',
       'No. of households', 'Total population', 'Total male population',
       'Total female population', 'Total 0 to 6 year children',
       'Male 0 to 6 year children', 'Female 0 to 6 year children',
       'Total SC population', 'Male SC population', 'Female SC population',
       'Total ST population', 'Male ST population', 'Female ST population',
       'Total literates', 'Male literates', 'Female literates',
       'Total main workers', 'Male main workers', 'Female main workers',
       'Total non workers', 'Male non workers', 'Female non workers',
       'Total_iliterates', 'Male_iliterates', 'Female_iliterates',
       'Population_Group', 'Part_time_workers'],
      dtype='object')
```

In [69]:
```
#Remove columns:Taluka and Town/Village because we will not use them anymore in the analysis process
My_Data.drop(['Taluka', 'Town/Village'], axis=1, inplace=True)
```

Now we have 29 columns and 129699 rows and we are ready to start our analysis process

In [70]:
```
My_Data.head()
```

Out[70]:

	Census Year	District	No. of households	Total population	Total male population	Total female population	Total 0 to 6 year children	Male 0 to 6 year children	Female 0 to 6 year children	Total SC population	...	Male main workers	Female main workers	Tota no worker
0	2011	AHMADNAGAR	201	732	359	373	73	36	37	12	...	204	220	28
1	2011	AHMADNAGAR	37	247	162	85	27	15	12	9	...	58	48	14
2	2011	AHMADNAGAR	357	1536	799	737	178	97	81	157	...	439	348	68
3	2011	AHMADNAGAR	3861	18278	9381	8897	2066	1101	965	1496	...	4599	2089	1093
4	2011	AHMADNAGAR	529	2590	1352	1238	333	189	144	87	...	763	728	108

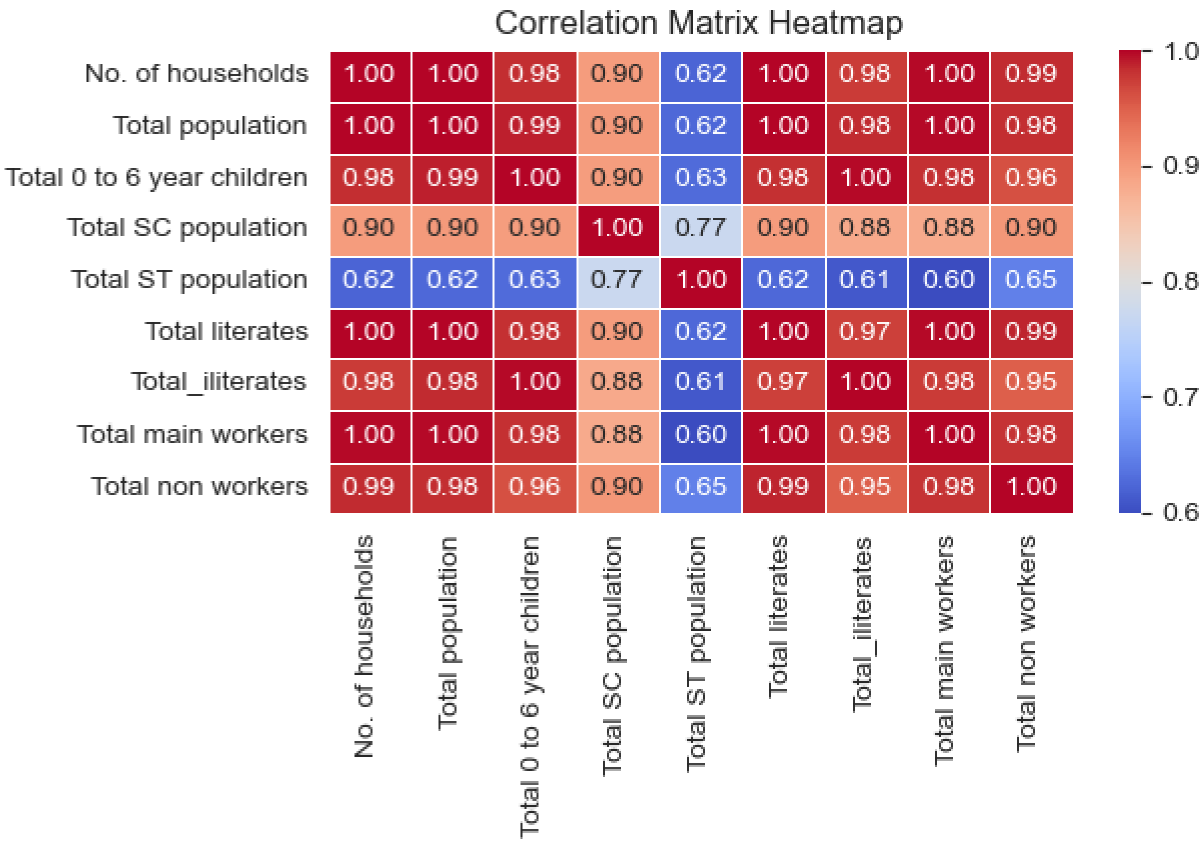
5 rows × 29 columns

In [71]:
```
# Remove any duplicate value
My_Data.drop_duplicates(inplace=True)
```

Data analysis and visualization

In [72]:

```
# Starting with correlation matrix to understand how our data are related
# Select the above numerical columns
numerical_data = My_Data[[
    "No. of households",
    "Total population",
    "Total 0 to 6 year children",
    "Total SC population",
    "Total ST population",
    "Total literates",
    "Total_iliterates",
    "Total main workers",
    "Total non workers"
]]

# Calculate the correlation matrix
cor_matrix = numerical_data.corr()

# Plot the correlation matrix using a heatmap
plt.figure(figsize=(6, 3))
sns.heatmap(cor_matrix, annot=True, cmap="coolwarm", fmt=".2f", linewidths=0.5)
plt.title("Correlation Matrix Heatmap")
plt.show()
```



Correlation Matrix Heatmap

	No. of households	Total population	Total 0 to 6 year children	Total SC population	Total ST population	Total literates	Total_iliterates	Total main workers	Total non workers
No. of households	1.00	1.00	0.98	0.90	0.62	1.00	0.98	1.00	0.99
Total population	1.00	1.00	0.99	0.90	0.62	1.00	0.98	1.00	0.98
Total 0 to 6 year children	0.98	0.99	1.00	0.90	0.63	0.98	1.00	0.98	0.96
Total SC population	0.90	0.90	0.90	1.00	0.77	0.90	0.88	0.88	0.90
Total ST population	0.62	0.62	0.63	0.77	1.00	0.62	0.61	0.60	0.65
Total literates	1.00	1.00	0.98	0.90	0.62	1.00	0.97	1.00	0.99
Total_iliterates	0.98	0.98	1.00	0.88	0.61	0.97	1.00	0.98	0.95
Total main workers	1.00	1.00	0.98	0.88	0.60	1.00	0.98	1.00	0.98
Total non workers	0.99	0.98	0.96	0.90	0.65	0.99	0.95	0.98	1.00

In [73]:

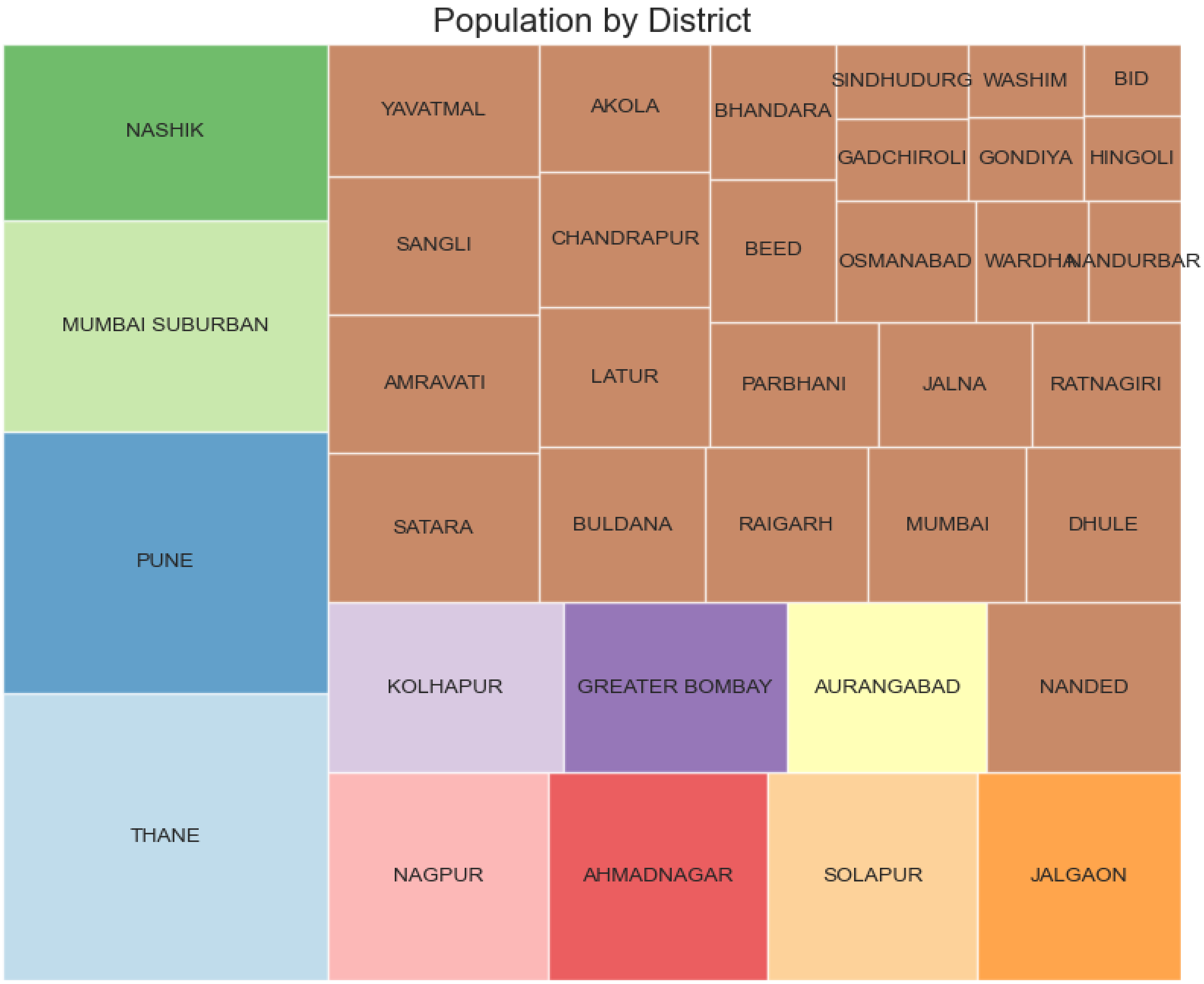
```
# Group by district in descending total population
Pop_by_District=My_Data.groupby("District")["Total population"].sum()
Pop_by_District = Pop_by_District.sort_values(ascending=False)
Pop_by_District = Pop_by_District.reset_index()
Pop_by_District.columns = ["District", "Total Population"]

# Display the DataFrame
Pop_by_District.head(5)
```

Out[73]:

	District	Total Population
0	THANE	24441123
1	PUNE	22194495
2	MUMBAI SUBURBAN	17997381
3	NASHIK	14952335
4	NAGPUR	12008346

In [74]:

```
# import squarify
import squarify
districts = Pop_by_District['District']
population = Pop_by_District['Total Population']
# Treemap of all Districts in our Dataset
plt.figure(figsize=(10, 8))

squarify.plot(sizes=population, label=districts, alpha=0.7,
              color=plt.cm.Paired(range(len(districts))))
plt.title('Population by District', fontsize=16)
plt.axis('off')

plt.show()
```


Population by District
NASHIK
MUMBAI SUBURBAN
PUNE
THANE
YAVATMAL
AKOLA
BHANDARA
SINDHUDURG
WASHIM
BID
GADCHIROLI
GONDIYA
HINGOLI
SANGLI
CHANDRAPUR
BEED
OSMANABAD
WARDHA
NANDURBAR
AMRAVATI
LATUR
PARBHANI
JALNA
RATNAGIRI
SATARA
BULDANA
RAIGARH
MUMBAI
DHULE
KOLHAPUR
GREATER BOMBAY
AURANGABAD
NANDED
NAGPUR
AHMADNAGAR
SOLAPUR
JALGAON

In [75]:

```
# New dataframe of Census Year, Population_Group and Total population
grouping_data_by_CensusYear_PopGroup= My_Data.groupby(['Census Year', 'Population_Group'])['Total population'].sum().r
grouping_data_by_CensusYear_PopGroup
```

Out[75]:

	Census Year	Population_Group	Total population
0	1991	Village	48637372
1	1991	Town	7408775
2	1991	City	22890821
3	2001	Village	55028462
4	2001	Town	9901011
5	2001	City	31949146
6	2011	Village	61101342
7	2011	Town	12304055
8	2011	City	38968920

In [76]:

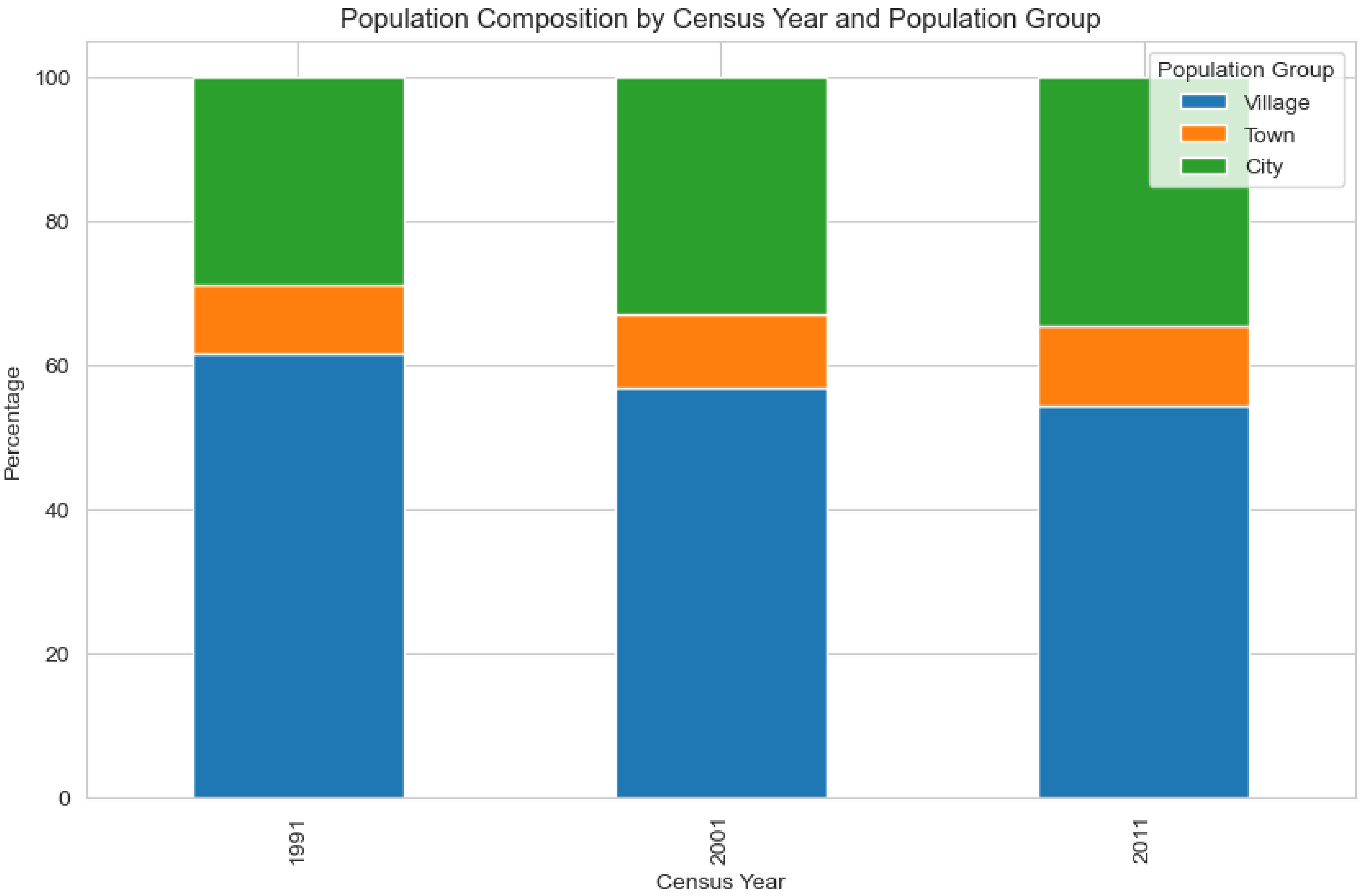
```
# Adding a Percentage column of each Population group in each year
grouping_data_by_CensusYear_PopGroup['Percentage'] = (grouping_data_by_CensusYear_PopGroup.groupby('Census Year')['Tot
                                                      .transform(lambda x: (x / x.sum()) * 100))

grouping_data_by_CensusYear_PopGroup['Percentage'] = grouping_data_by_CensusYear_PopGroup['Percentage'].apply(lambda x

grouping_data_by_CensusYear_PopGroup
```

Out[76]:

	Census Year	Population_Group	Total population	Percentage
0	1991	Village	48637372	61.62
1	1991	Town	7408775	9.39
2	1991	City	22890821	29.00
3	2001	Village	55028462	56.80
4	2001	Town	9901011	10.22
5	2001	City	31949146	32.98
6	2011	Village	61101342	54.37
7	2011	Town	12304055	10.95
8	2011	City	38968920	34.68

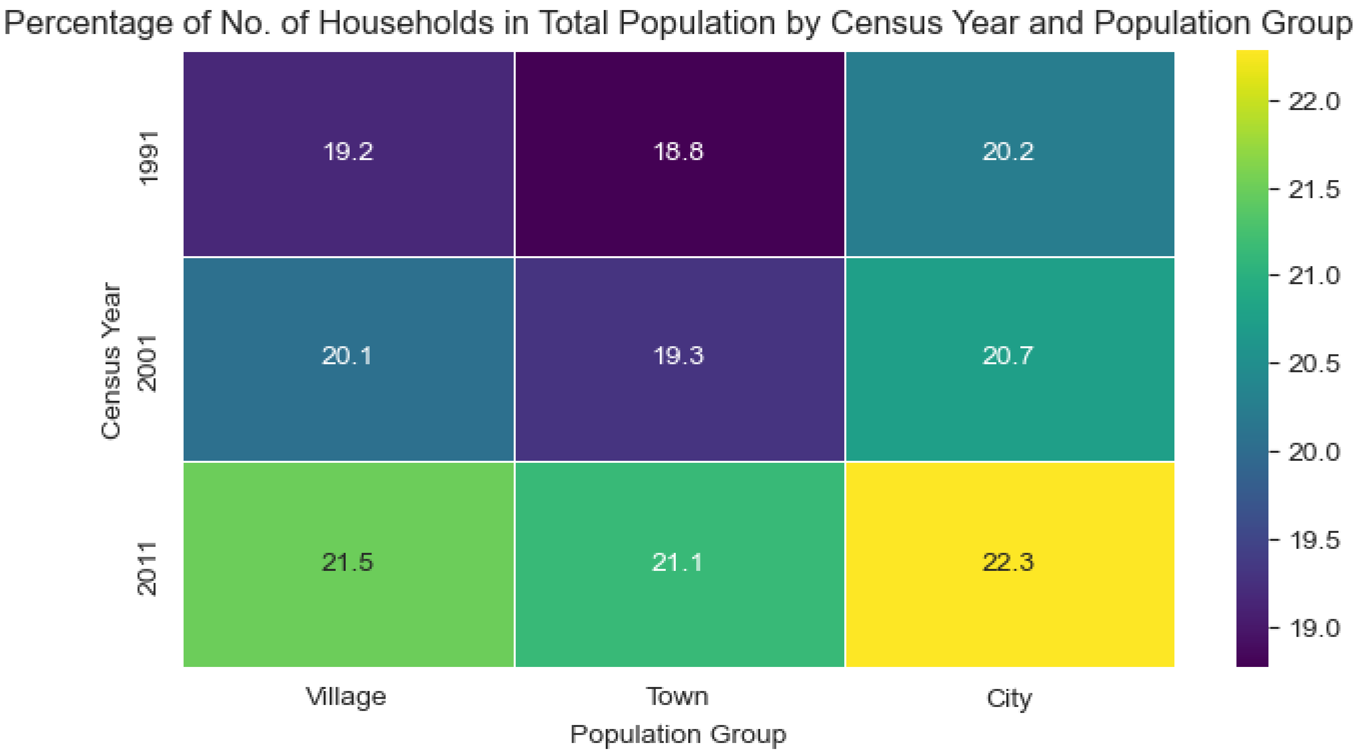
In [77]:

```
# Stacked bar chart showing the composition of population by Census Year and Population Group
grouped_data = grouping_data_by_CensusYear_PopGroup.groupby(['Census Year', 'Population_Group'])['Percentage'].sum().u

stacked = grouped_data.plot(kind='bar', stacked=True, figsize=(10, 6))

stacked.set_xlabel('Census Year')
stacked.set_ylabel('Percentage')
stacked.set_title('Population Composition by Census Year and Population Group')
stacked.legend(title='Population Group')

plt.show()
```


Population Composition by Census Year and Population Group
Percentage
0
20
40
60
80
100
1991
2001
2011
Census Year
Population Group
Village
Town
City

In [78]:

```
# Creation of new Data Frame of number of Households in total population
percentage_data_Households_Total_Pop = My_Data.groupby(['Census Year', 'Population_Group'])['No. of households'].sum()
/ My_Data.groupby(['Census Year', 'Population_Group'])['Total population'].sum() * 100
percentage_data_Households_Total_Pop = percentage_data_Households_Total_Pop.reset_index()
percentage_data_Households_Total_Pop.rename(columns={0: 'Percentage'}, inplace=True)
percentage_data_Households_Total_Pop['Percentage'] = percentage_data_Households_Total_Pop['Percentage'].astype(float)


# Heatmap showing the percentage of Number of Households in Total Population by Census Year and Population Group
plt.figure(figsize=(8, 4))
sns.set_style("whitegrid")
ax = sns.heatmap(data=percentage_data_Households_Total_Pop.pivot(index='Census Year',
                                                                 columns='Population_Group', values='Percentage'),
                 annot=True, cmap='viridis', fmt=".1f", linewidths=.5)
ax.set_xlabel('Population Group')
ax.set_ylabel('Census Year')
ax.set_title('Percentage of No. of Households in Total Population by Census Year and Population Group')
plt.show()
```



In [79]:

```
# Filtering the data to continue our analysis
filtered_data = My_Data[My_Data['Census Year'].isin([1991, 2001, 2011])]

# Calculation of the percentage of children aged 0-6 by Census Year
percentage_data1 = (filtered_data.groupby('Census Year')['Total 0 to 6 year children']
                   .sum() / filtered_data.groupby('Census Year')['Total population']
                   .sum() * 100).reset_index()
```

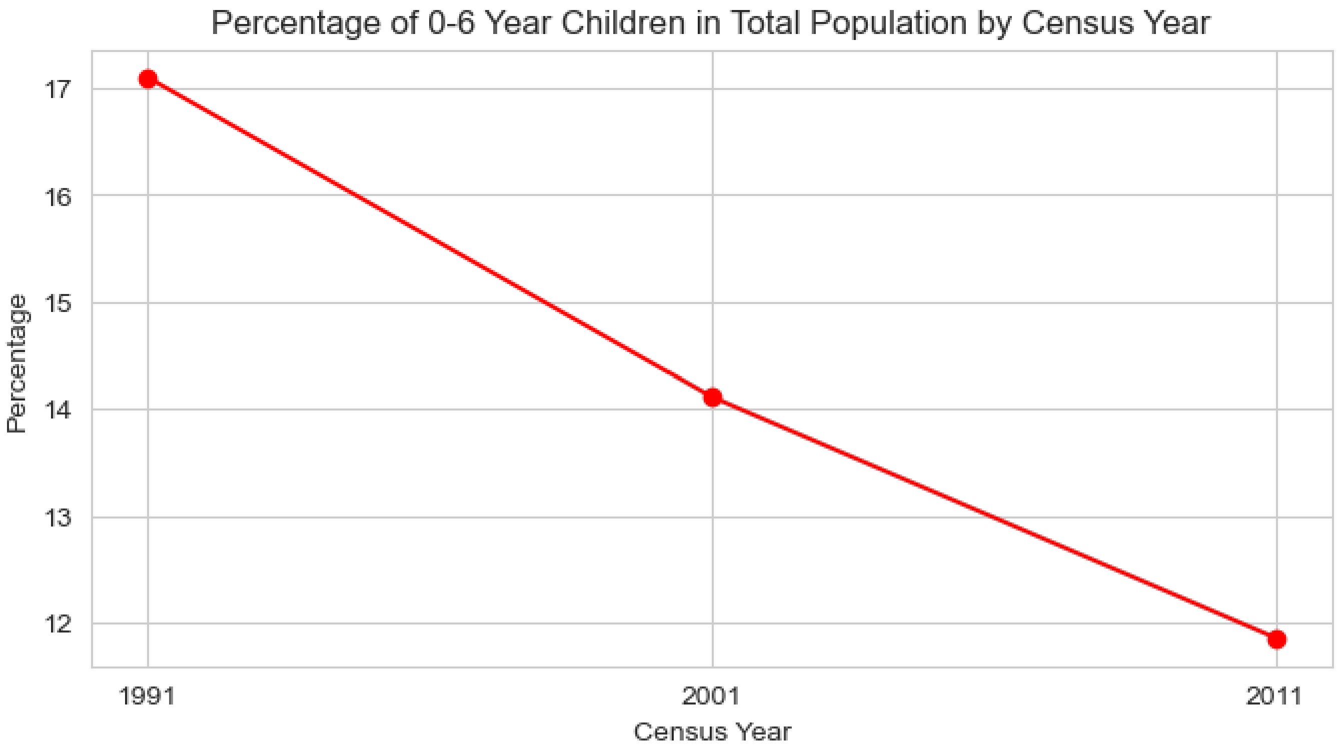
In [101]:

```
# Making the data frame of percentage_data1 containing Census Year and Percentage of children aged 0-6 years old in to
percentage_data1.rename(columns={0: 'Percentage'}, inplace=True)
percentage_data1
```

Out[101]:

	Census Year	Percentage
0	1991	17.096115
1	2001	14.111603
2	2011	11.859042

```
In [81]: # Line chart showing the percentage of 0-6 year children in Total Population by Census Year

         plt.figure(figsize=(8, 4))
         plt.plot(percentage_data1['Census Year'], percentage_data1['Percentage'], marker='o', linestyle='-', color='r')
         plt.xlabel('Census Year')
         plt.ylabel('Percentage')
         plt.title('Percentage of 0-6 Year Children in Total Population by Census Year')
         plt.grid(True)
         plt.xticks([1991, 2001, 2011])
         plt.show()
```

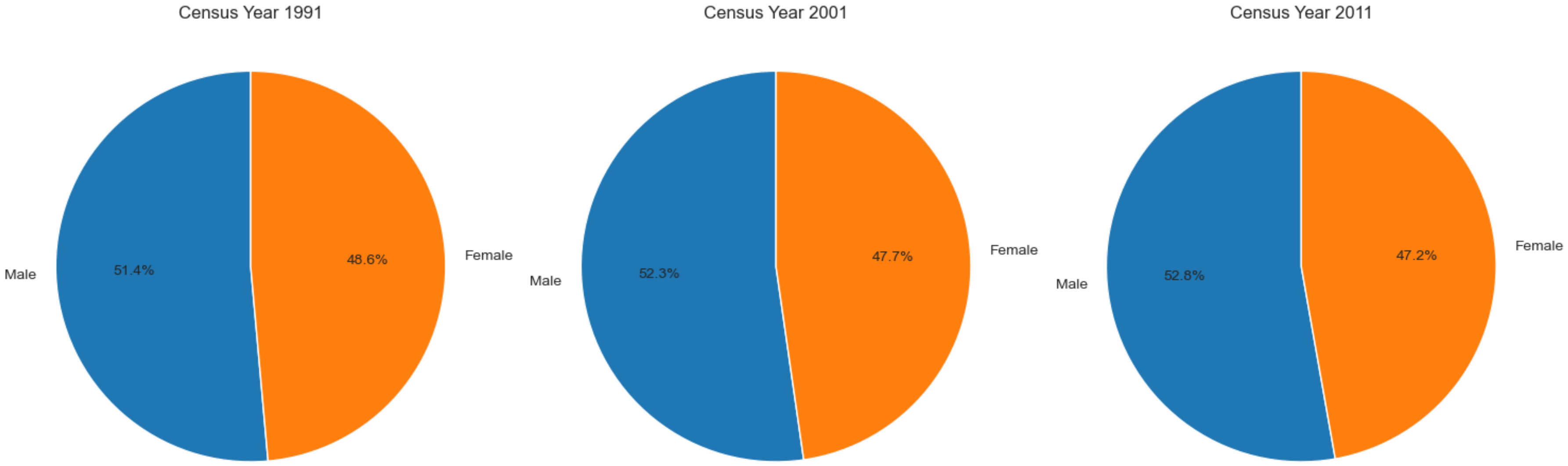


In [82]:

```
# Calculation of the percentage of boys 0-6 years old per census year
male_percentage_data = (My_Data.groupby('Census Year')['Male 0 to 6 year children']
                        .sum() / My_Data.groupby('Census Year')['Total 0 to 6 year children']
                        .sum() * 100).reset_index()
male_percentage_data.rename(columns={0: "Percentage"},inplace=True)

# Calculation of the percentage of girls 0-6 years old per census year
female_percentage_data = (My_Data.groupby('Census Year')['Female 0 to 6 year children']
                          .sum() / My_Data.groupby('Census Year')['Total 0 to 6 year children']
                          .sum() * 100).reset_index()
female_percentage_data.rename(columns={0: "Percentage"}, inplace=True)
```

In [83]:

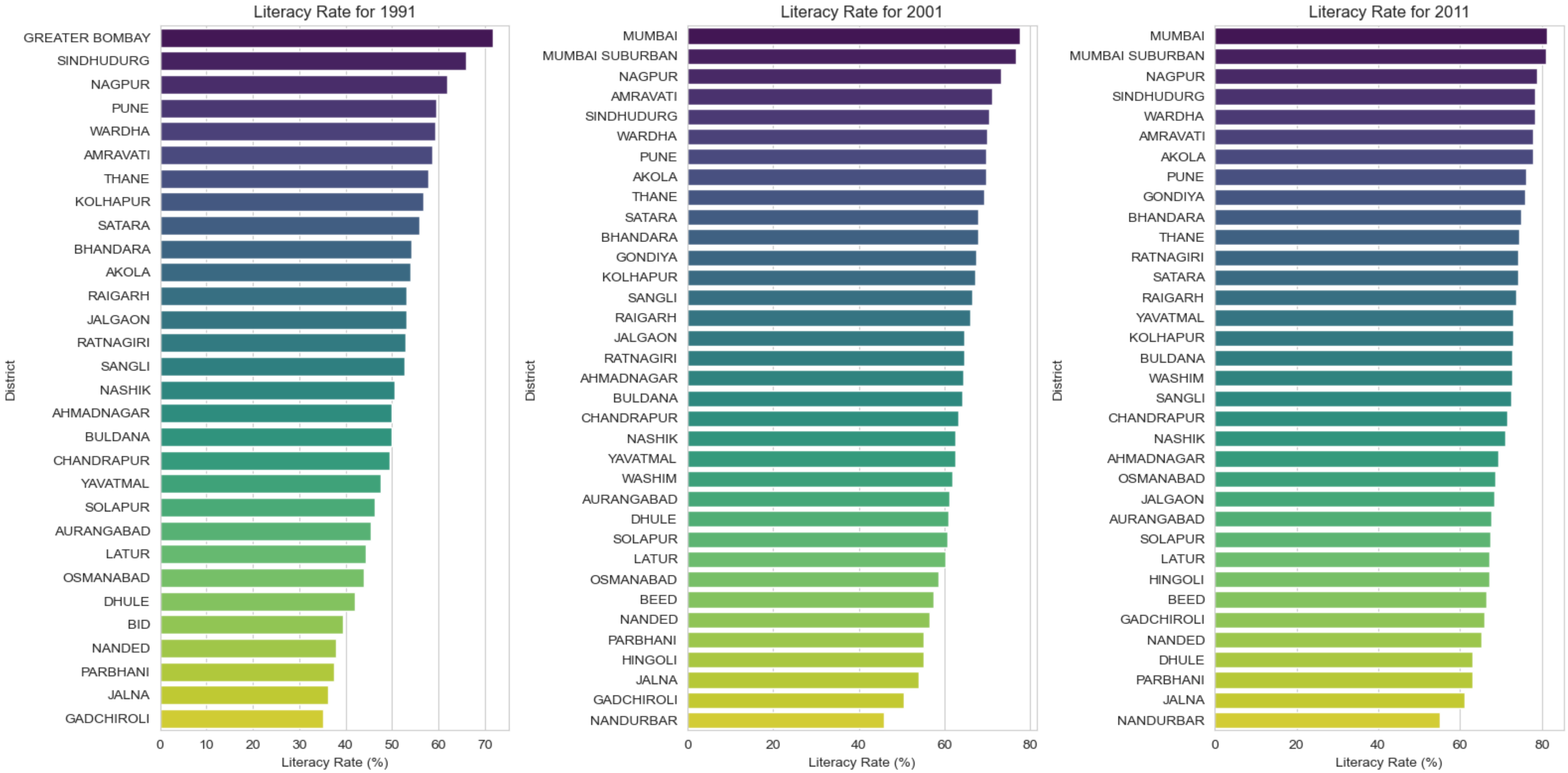
```
#Create the pie charts for each year

fig, axs = plt.subplots(1, 3, figsize=(15, 5))

for i, year in enumerate([1991, 2001, 2011]):
    male_data = male_percentage_data[male_percentage_data['Census Year'] == year]
    female_data = female_percentage_data[female_percentage_data['Census Year'] == year]

    ax = axs[i]
    ax.pie(
        [male_data['Percentage'].values[0], female_data['Percentage'].values[0]],
        labels=['Male', 'Female'],
        autopct='%1.1f%%',
        startangle=90,
    )
    ax.axis('equal')
    ax.set_title(f'Census Year {year}')

plt.tight_layout()
plt.show()
```



Now we are going to explore how literacy rate change by years

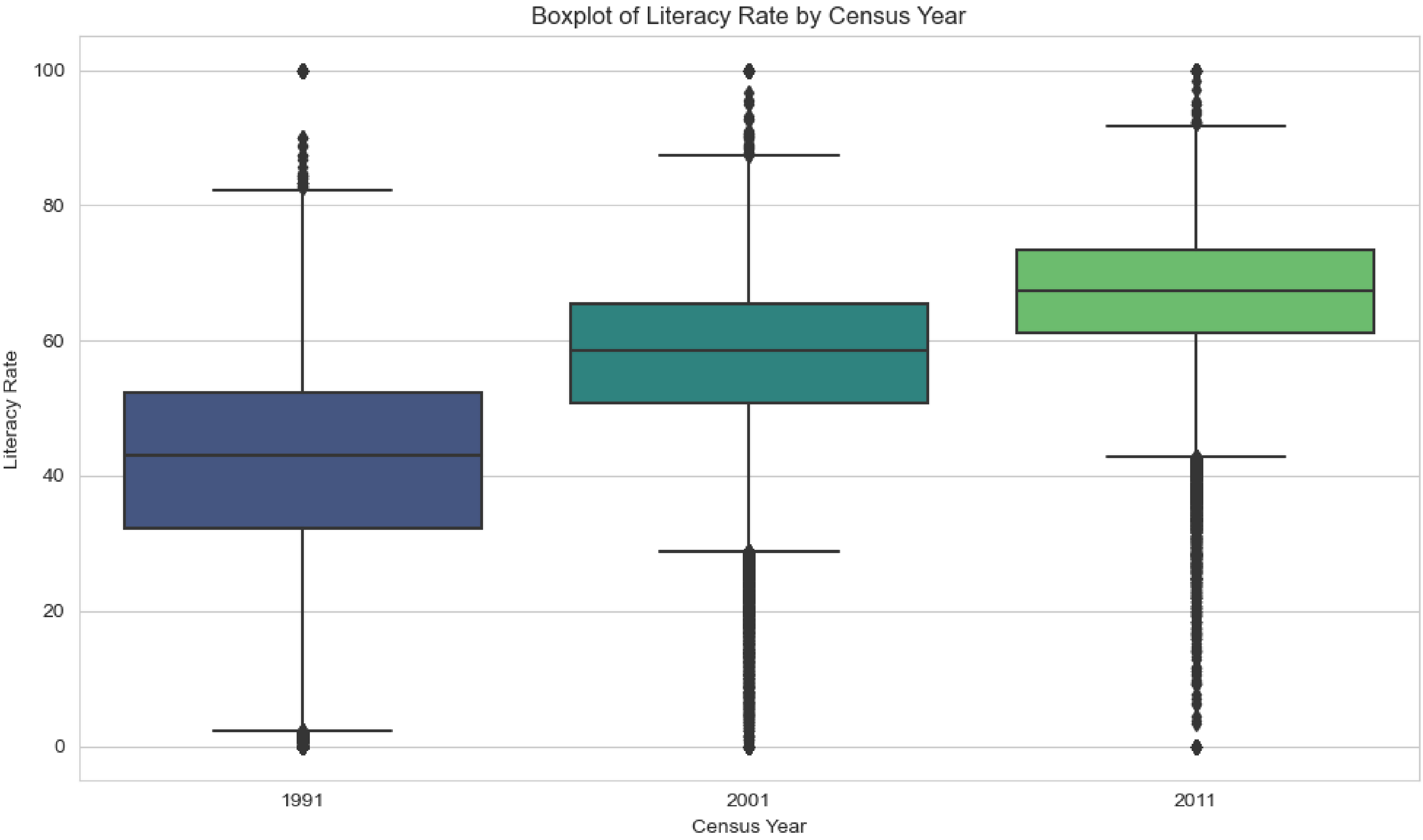
In [84]:

```
# Create an empty list to store data for each year
data_by_year = []
#define the census years
census_years = [1991, 2001, 2011]
for year in census_years:
    data_year = My_Data[My_Data["Census Year"] == year]
    literacy_rate_year = data_year.groupby(["District"])["Total literates"].sum()
    / data_year.groupby(["District"])["Total population"].sum() * 100
    sorted_year = literacy_rate_year.sort_values(ascending=False)

    data_by_year.append(sorted_year)

# Create horizontal bar charts for each year with sorted districts and color mapping for literacy rate of every Distri
plt.figure(figsize=(16, 8))
palette = "viridis"

for i, sorted_data in enumerate(data_by_year):
    plt.subplot(131 + i)
    sns.barplot(x=sorted_data, y=sorted_data.index, orient="h", palette=palette)
    plt.xlabel('Literacy Rate (%)')
    plt.ylabel('District')
    plt.title(f'Literacy Rate for {census_years[i]}')

plt.tight_layout()
plt.show()
```


Literacy Rate for 1991
GREATER BOMBAY
SINDHUDURG
NAGPUR
PUNE
WARDHA
AMRAVATI
THANE
KOLHAPUR
SATARA
BHANDARA
AKOLA
RAIGARH
JALGAON
RATNAGIRI
SANGLI
NASHIK
AHMADNAGAR
BULDANA
CHANDRAPUR
YAVATMAL
SOLAPUR
AURANGABAD
LATUR
OSMANABAD
DHULE
BID
NANDED
PARBHANI
JALNA
GADCHIROLI
District
0
10
20
30
40
50
60
70
Literacy Rate (%)
Literacy Rate for 2001
MUMBAI
MUMBAI SUBURBAN
NAGPUR
AMRAVATI
SINDHUDURG
WARDHA
PUNE
AKOLA
THANE
SATARA
BHANDARA
GONDIYA
KOLHAPUR
SANGLI
RAIGARH
JALGAON
RATNAGIRI
AHMADNAGAR
BULDANA
CHANDRAPUR
NASHIK
YAVATMAL
WASHIM
AURANGABAD
DHULE
SOLAPUR
LATUR
OSMANABAD
BEED
NANDED
PARBHANI
HINGOLI
JALNA
GADCHIROLI
NANDURBAR
District
0
20
40
60
80
Literacy Rate (%)
Literacy Rate for 2011
MUMBAI
MUMBAI SUBURBAN
NAGPUR
SINDHUDURG
WARDHA
AMRAVATI
AKOLA
PUNE
GONDIYA
BHANDARA
THANE
RATNAGIRI
SATARA
RAIGARH
YAVATMAL
KOLHAPUR
BULDANA
WASHIM
SANGLI
CHANDRAPUR
NASHIK
AHMADNAGAR
OSMANABAD
JALGAON
AURANGABAD
SOLAPUR
LATUR
HINGOLI
BEED
GADCHIROLI
NANDED
DHULE
PARBHANI
JALNA
NANDURBAR
District
0
20
40
60
80
Literacy Rate (%)

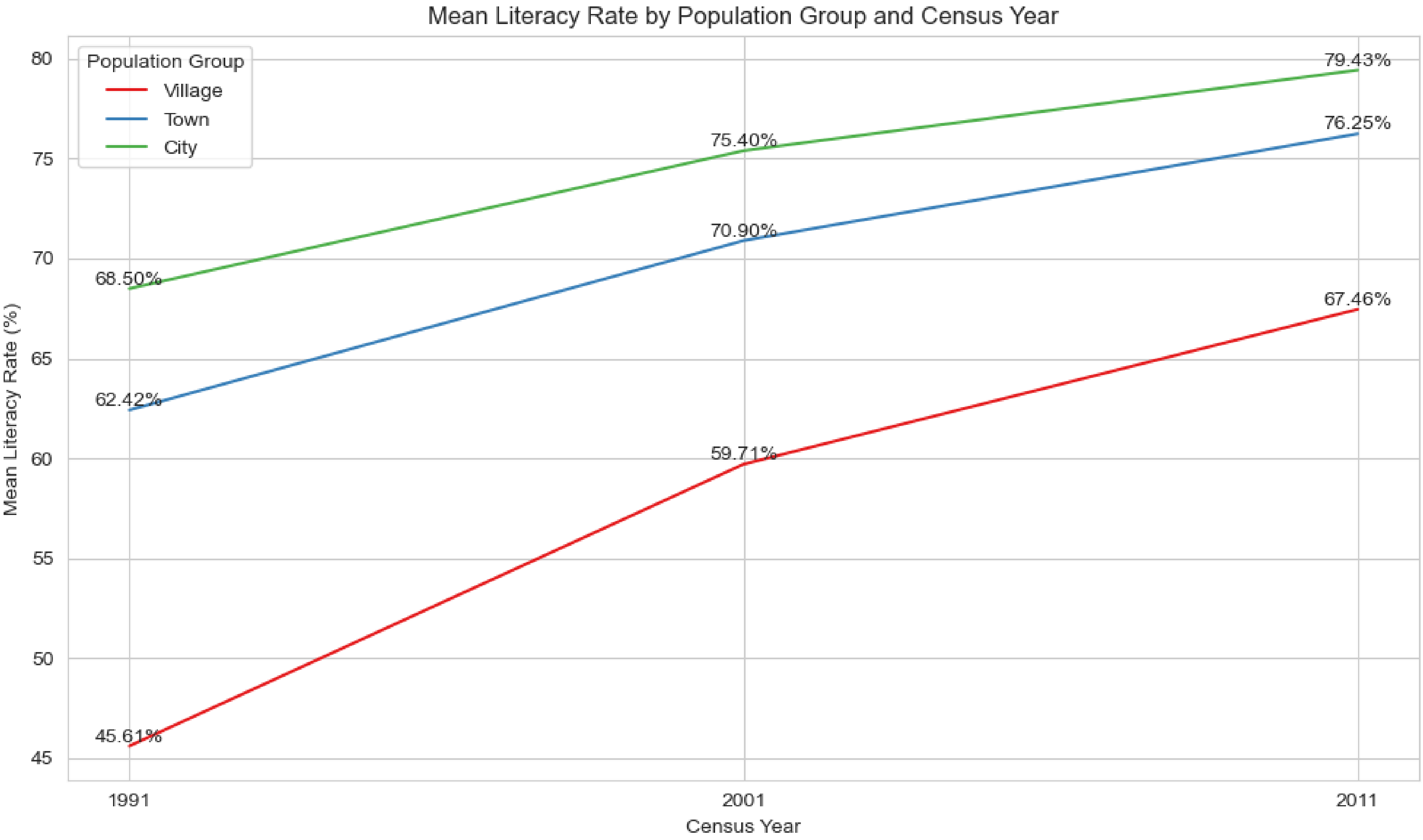
In [85]:

```
# Calculation of Literacy Rate column
My_Data["Literacy Rate"] = (My_Data["Total literates"] / My_Data["Total population"]) * 100

# Creation of a new Data frame with columns: District, Census Year, Literacy Rate
districts_census_years_df = My_Data[["District", "Census Year", "Literacy Rate"]]

# Data frame display
districts_census_years_df

# Boxplot with axes :Literacy Rate and Census Year
plt.figure(figsize=(10, 6))
sns.boxplot(data=districts_census_years_df, x="Census Year", y="Literacy Rate", palette="viridis")
plt.xlabel("Census Year")
plt.ylabel("Literacy Rate")
plt.title("Boxplot of Literacy Rate by Census Year")
plt.tight_layout()
plt.show()
```


Boxplot of Literacy Rate by Census Year
Literacy Rate
100
80
60
40
20
0
1991
2001
2011
Census Year

In [86]:

```
# Group the data by "Population_Group" and "Census Year" and calculate the mean literacy rate
grouped_data1 = My_Data.groupby(["Population_Group", "Census Year"])["Total literates"].sum()
/ My_Data.groupby(["Population_Group", "Census Year"])["Total population"].sum() * 100

# Create a DataFrame with the grouped data
grouped_df = grouped_data1.reset_index()
grouped_df.columns = ["Population_Group", "Census Year", "Mean Literacy Rate"]

# Create a line chart
plt.figure(figsize=(10, 6))
sns.lineplot(data=grouped_df, x="Census Year", y="Mean Literacy Rate", hue="Population_Group", palette="Set1")
plt.xlabel("Census Year")
plt.ylabel("Mean Literacy Rate (%)")
plt.title("Mean Literacy Rate by Population Group and Census Year")
plt.legend(title="Population Group")

# Add percentage labels to the line chart
for _, row in grouped_df.iterrows():
    plt.text(row["Census Year"], row["Mean Literacy Rate"], f"{row['Mean Literacy Rate']:.2f}%", ha='center', va='bott

# Set the x-axis ticks to only display 1991, 2001, and 2011
plt.xticks([1991, 2001, 2011])

plt.tight_layout()
plt.show()
```


Mean Literacy Rate by Population Group and Census Year
Population Group
Village
Town
City
80
75
70
65
60
55
50
45
Mean Literacy Rate (%)
1991
2001
2011
Census Year
68.50%
62.42%
45.61%
75.40%
70.90%
59.71%
79.43%
76.25%
67.46%

In [87]:

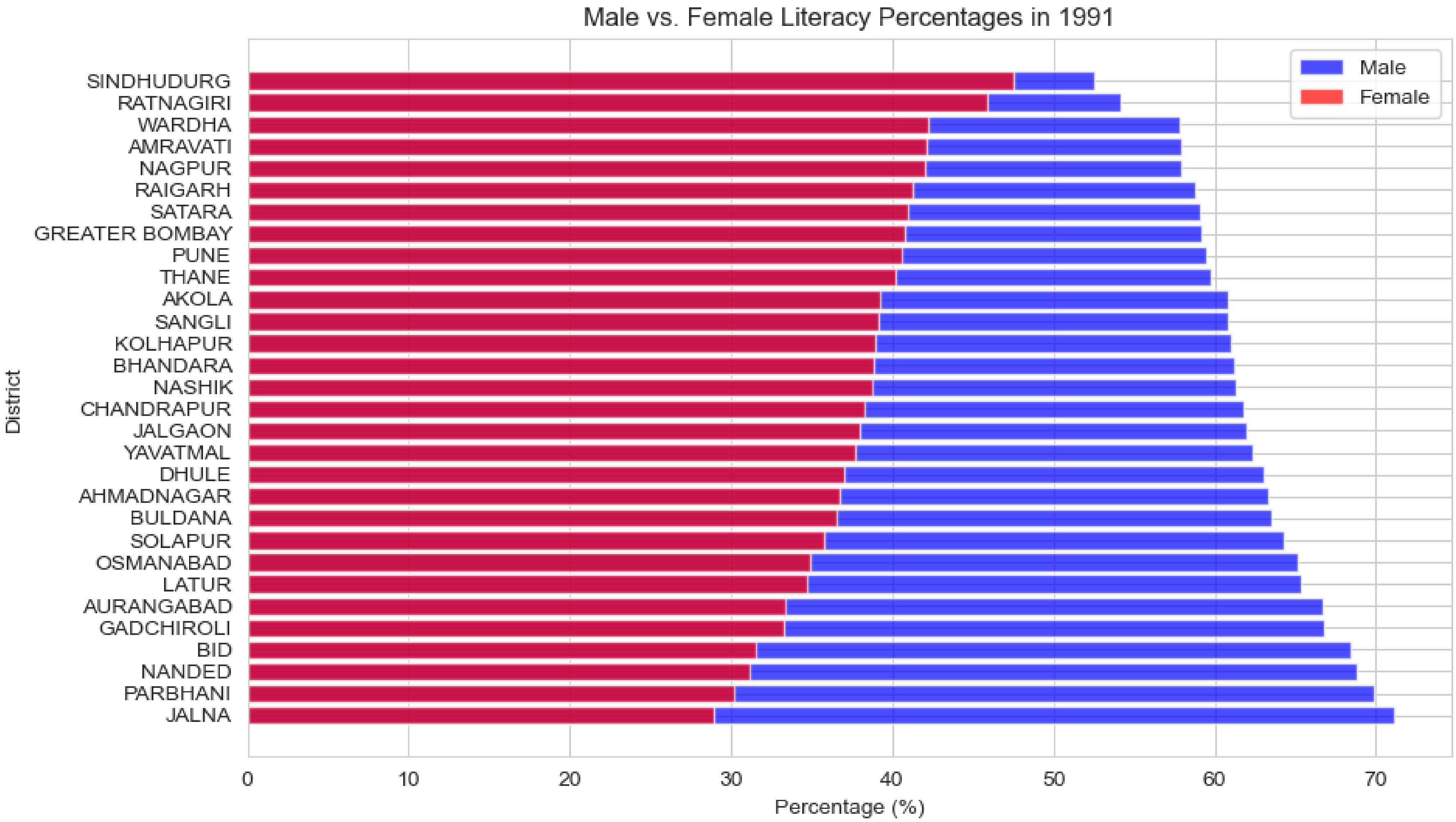
```
# Filter the data for the year 1991
data_1991 = My_Data[My_Data["Census Year"] == 1991]

# Calculate the percentage of male literates by district
male_lit_per_1991 = data_1991.groupby("District").apply(lambda x: (x["Male literates"].sum()
                                                                   / x["Total literates"].sum()) * 100).reset_index()
male_lit_per_1991.columns = ["District", "Percentage_Male"]

# Calculate the percentage of female literates by district
female_lit_per_1991 = data_1991.groupby("District").apply(lambda x: (x["Female literates"].sum()
                                                                     / x["Total literates"].sum()) * 100).reset_index(
female_lit_per_1991.columns = ["District", "Percentage_Female"]

# Now we have two DataFrames: male_lit_per_1991 and female_lit_per_1991
# Merge the male and female DataFrames on the "District" column
merged_lit_per_1991 = male_lit_per_1991.merge(female_lit_per_1991, on="District")

# Now we have a single DataFrame with both male and female percentages for 1991
merged_lit_per_1991.head(3)
```

Out[87]:

```
      District  Percentage_Male  Percentage_Female
0   AHMADNAGAR        63.306984          36.693016
1        AKOLA        60.792484          39.207516
2     AMRAVATI        57.879250          42.120750
```

In [88]:

```
# Sort the DataFrame by Percentage_Male in ascending order
sorted_df = merged_lit_per_1991.sort_values(by="Percentage_Male")

# Create a horizontal bar plot
plt.figure(figsize=(10, 6))
plt.barh(sorted_df["District"], sorted_df["Percentage_Male"], label="Male", color="blue", alpha=0.7)
plt.barh(sorted_df["District"], sorted_df["Percentage_Female"], label="Female", color="red", alpha=0.7)
plt.xlabel("Percentage (%)")
plt.ylabel("District")
plt.title("Male vs. Female Literacy Percentages in 1991")
plt.legend()

# Invert the y-axis to display the highest value at the top
plt.gca().invert_yaxis()

plt.show()
```


Male vs. Female Literacy Percentages in 1991
Male
Female
District
SINDHUDURG
RATNAGIRI
WARDHA
AMRAVATI
NAGPUR
RAIGARH
SATARA
GREATER BOMBAY
PUNE
THANE
AKOLA
SANGLI
KOLHAPUR
BHANDARA
NASHIK
CHANDRAPUR
JALGAON
YAVATMAL
DHULE
AHMADNAGAR
BULDANA
SOLAPUR
OSMANABAD
LATUR
AURANGABAD
GADCHIROLI
BID
NANDED
PARBHANI
JALNA
0
10
20
30
40
50
60
70
Percentage (%)

In [89]:

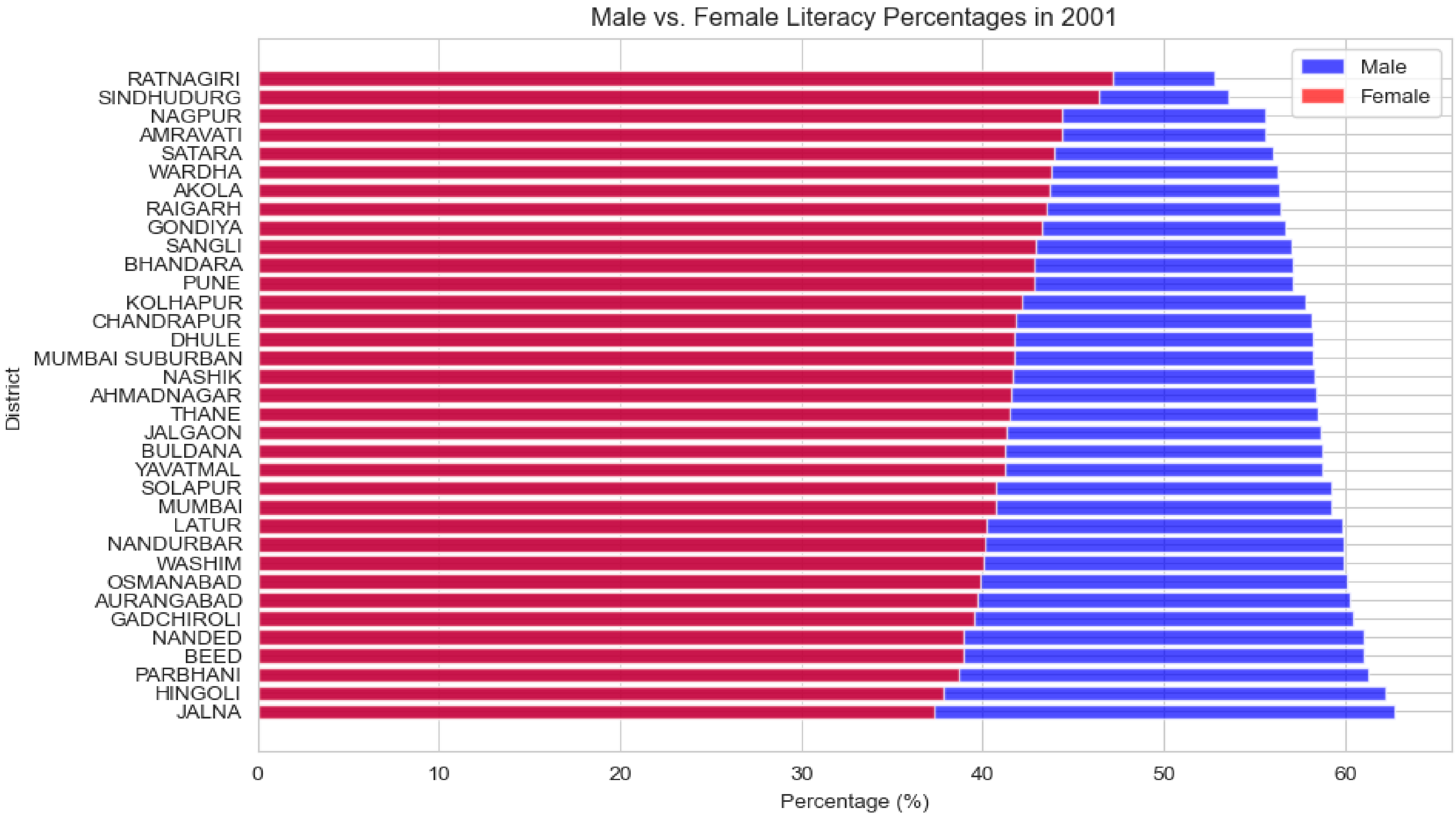
```
# Filter the data for the year 1991
data_2001 = My_Data[My_Data["Census Year"] == 2001]

# Calculate the percentage of male literates by district
male_lit_per_2001 = data_2001.groupby("District").apply(lambda x: (x["Male literates"].sum()
                                                                    / x["Total literates"].sum()) * 100).reset_index()
male_lit_per_2001.columns = ["District", "Percentage_Male"]

# Calculate the percentage of female literates by district
female_lit_per_2001 = data_2001.groupby("District").apply(lambda x: (x["Female literates"].sum()
                                                                      / x["Total literates"].sum()) * 100).reset_index(
female_lit_per_2001.columns = ["District", "Percentage_Female"]

# Now you have two DataFrames: male_lit_per_1991 and female_lit_per_1991
# Merge the male and female DataFrames on the "District" column
merged_lit_per_2001 = male_lit_per_2001.merge(female_lit_per_2001, on="District")

# Now you have a single DataFrame with both male and female percentages for 1991
merged_lit_per_2001.head(3)
```

Out[89]:

	District	Percentage_Male	Percentage_Female
0	AHMADNAGAR	58.378771	41.621229
1	AKOLA	56.329955	43.670045
2	AMRAVATI	55.616391	44.383609

In [90]:

```
# Sort the DataFrame by Percentage_Male in ascending order
sorted_df = merged_lit_per_2001.sort_values(by="Percentage_Male")

# Create a horizontal bar plot
plt.figure(figsize=(10, 6))
plt.barh(sorted_df["District"], sorted_df["Percentage_Male"], label="Male", color="blue", alpha=0.7)
plt.barh(sorted_df["District"], sorted_df["Percentage_Female"], label="Female", color="red", alpha=0.7)
plt.xlabel("Percentage (%)")
plt.ylabel("District")
plt.title("Male vs. Female Literacy Percentages in 2001")
plt.legend()

# Invert the y-axis to display the highest value at the top
plt.gca().invert_yaxis()

plt.show()
```


Male vs. Female Literacy Percentages in 2001
Male
Female
District
RATNAGIRI
SINDHUDURG
NAGPUR
AMRAVATI
SATARA
WARDHA
AKOLA
RAIGARH
GONDIYA
SANGLI
BHANDARA
PUNE
KOLHAPUR
CHANDRAPUR
DHULE
MUMBAI SUBURBAN
NASHIK
AHMADNAGAR
THANE
JALGAON
BULDANA
YAVATMAL
SOLAPUR
MUMBAI
LATUR
NANDURBAR
WASHIM
OSMANABAD
AURANGABAD
GADCHIROLI
NANDED
BEED
PARBHANI
HINGOLI
JALNA
0
10
20
30
40
50
60
Percentage (%)

In [91]:

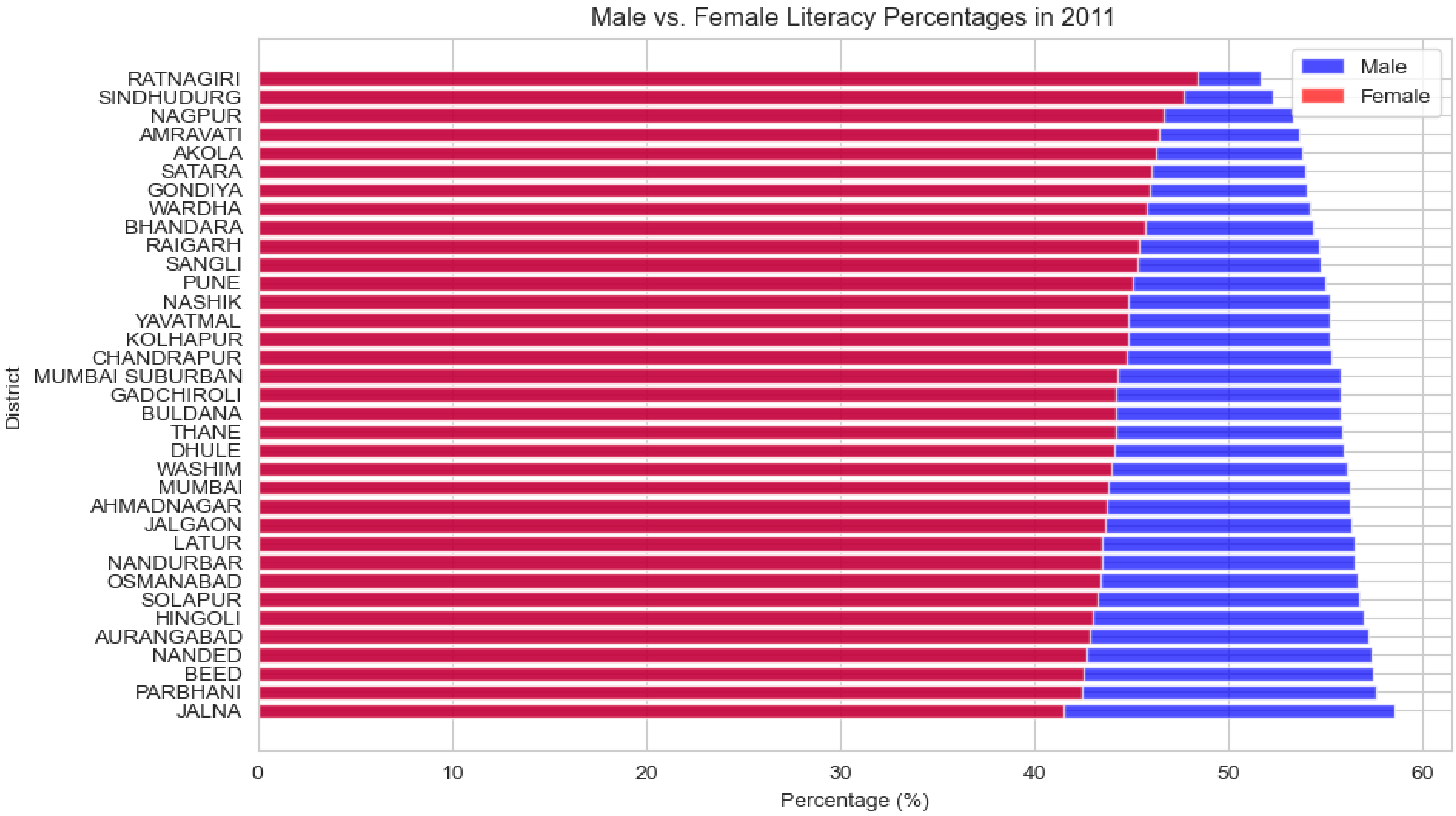
```
# Filter the data for the year 1991
data_2011 = My_Data[My_Data["Census Year"] == 2011]

# Calculate the percentage of male literates by district
male_lit_per_2011 = data_2011.groupby("District").apply(lambda x: (x["Male literates"].sum()
                                                                   / x["Total literates"].sum()) * 100).reset_index()
male_lit_per_2011.columns = ["District", "Percentage_Male"]

# Calculate the percentage of female literates by district
female_lit_per_2011 = data_2011.groupby("District").apply(lambda x: (x["Female literates"].sum()
                                                                     / x["Total literates"].sum()) * 100).reset_index(
female_lit_per_2011.columns = ["District", "Percentage_Female"]

# Now you have two DataFrames: male_lit_per_1991 and female_lit_per_1991
# Merge the male and female DataFrames on the "District" column
merged_lit_per_2011 = male_lit_per_2011.merge(female_lit_per_2011, on="District")

# Now you have a single DataFrame with both male and female percentages for 1991
merged_lit_per_2011.head(3)
```

Out[91]:

	District	Percentage_Male	Percentage_Female
0	AHMADNAGAR	56.263226	43.736774
1	AKOLA	53.779297	46.220703
2	AMRAVATI	53.604335	46.395665

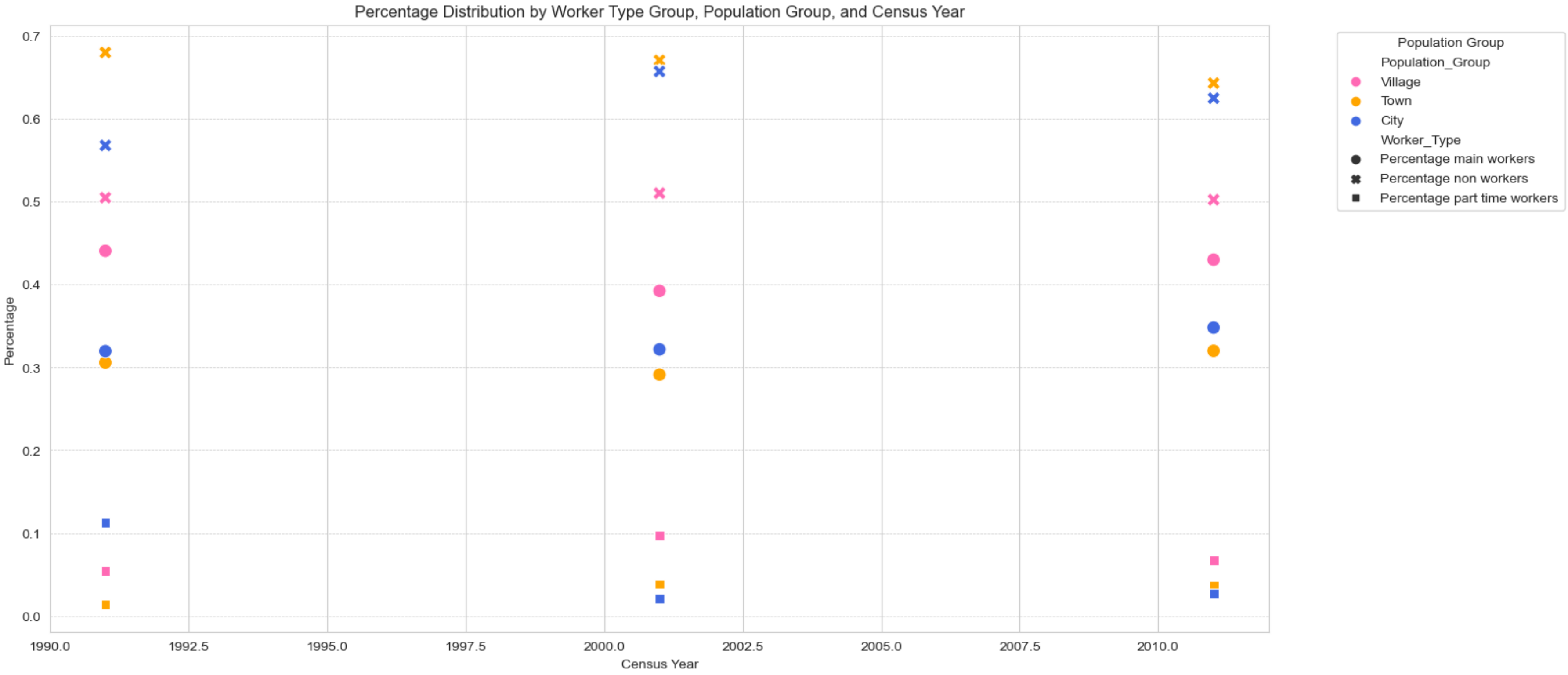
In [92]:

```
# Sort the DataFrame by Percentage_Male in ascending order
sorted_df = merged_lit_per_2011.sort_values(by="Percentage_Male")

# Create a horizontal bar plot
plt.figure(figsize=(10, 6))
plt.barh(sorted_df["District"], sorted_df["Percentage_Male"], label="Male", color="blue", alpha=0.7)
plt.barh(sorted_df["District"], sorted_df["Percentage_Female"], label="Female", color="red", alpha=0.7)
plt.xlabel("Percentage (%)")
plt.ylabel("District")
plt.title("Male vs. Female Literacy Percentages in 2011")
plt.legend()

# Invert the y-axis to display the highest value at the top
plt.gca().invert_yaxis()

plt.show()
```


Male vs. Female Literacy Percentages in 2011
Male
Female
District
RATNAGIRI
SINDHUDURG
NAGPUR
AMRAVATI
AKOLA
SATARA
GONDIYA
WARDHA
BHANDARA
RAIGARH
SANGLI
PUNE
NASHIK
YAVATMAL
KOLHAPUR
CHANDRAPUR
MUMBAI SUBURBAN
GADCHIROLI
BULDANA
THANE
DHULE
WASHIM
MUMBAI
AHMADNAGAR
JALGAON
LATUR
NANDURBAR
OSMANABAD
SOLAPUR
HINGOLI
AURANGABAD
NANDED
BEED
PARBHANI
JALNA
0
10
20
30
40
50
60
Percentage (%)

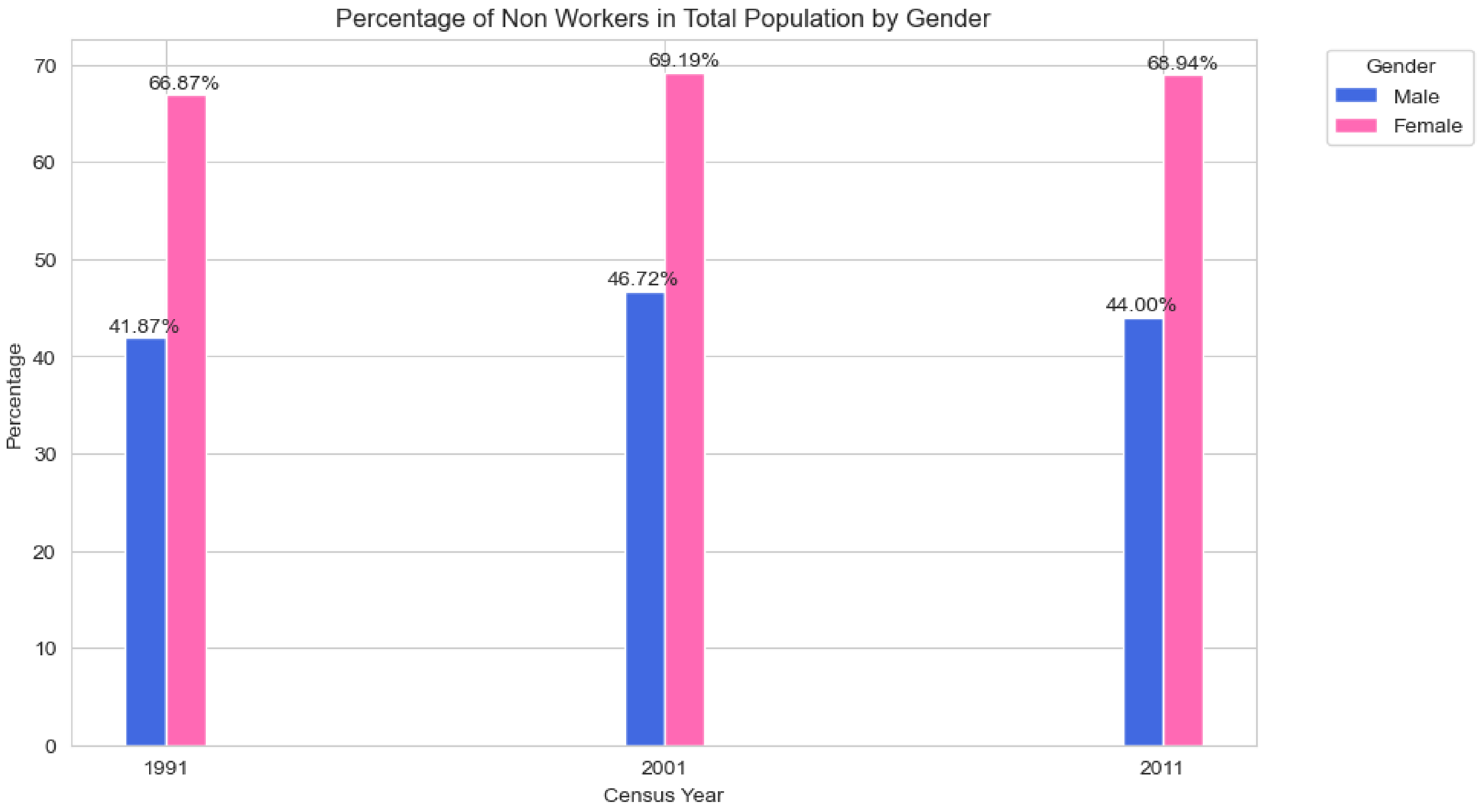
In [100]:

```
# Group the data by Census Year and Population_Group and aggregate them in a new Data frame named grouped_data2
grouped_data2 = My_Data.groupby(['Census Year', 'Population_Group']).agg({
    'Total main workers': 'sum',
    'Total non workers': 'sum',
    'Part_time_workers': 'sum',
    'Total population': 'sum'
}).reset_index()

# Calculate percentages
grouped_data2['Percentage main workers'] = grouped_data2['Total main workers'] / grouped_data2['Total population']
grouped_data2['Percentage non workers'] = grouped_data2['Total non workers'] / grouped_data2['Total population']
grouped_data2['Percentage part time workers'] = grouped_data2['Part_time_workers'] / grouped_data2['Total population']

# Reshape the data for plotting
grouped_data2_long = pd.melt(grouped_data2, id_vars=['Census Year', 'Population_Group'],
                             value_vars=['Percentage main workers', 'Percentage non workers', 'Percentage part time wo
                             var_name='Worker_Type', value_name='Percentage')

# Create the plot using seaborn
plt.figure(figsize=(16, 8))
sns.scatterplot(data=grouped_data2_long, x='Census Year', y='Percentage', hue='Population_Group', style='Worker_Type',
                palette={"City": "#4169E1", "Town": "#FFA500", "Village": "#FF69B4"}, s=100)
plt.title("Percentage Distribution by Worker Type Group, Population Group, and Census Year")
plt.xlabel("Census Year")
plt.ylabel("Percentage")
plt.legend(title="Population Group", bbox_to_anchor=(1.05, 1), loc='upper left')
plt.grid(True, axis='y', linestyle='--', linewidth=0.5)
plt.show()
```


Percentage Distribution by Worker Type Group, Population Group, and Census Year
Percentage
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1990.0
1992.5
1995.0
1997.5
2000.0
2002.5
2005.0
2007.5
2010.0
Census Year
Population Group
Population_Group
Village
Town
City
Worker_Type
Percentage main workers
Percentage non workers
Percentage part time workers

In [95]:

```
# Calculate male non-workers' percentages by Census Year
male_non_workers = My_Data.groupby('Census Year').apply(
    lambda x: (x['Male non workers'].sum() / x['Total male population'].sum()) * 100
).reset_index(name='Male_Percentage')

# Calculate female non-workers' percentages by Census Year
female_non_workers = My_Data.groupby('Census Year').apply(
    lambda x: (x['Female non workers'].sum() / x['Total female population'].sum()) * 100
).reset_index(name='Female_Percentage')

# Combine male_non_workers and female_non_workers DataFrames
combined_data = pd.merge(male_non_workers, female_non_workers, on='Census Year')

# Create the bar plot
plt.figure(figsize=(10, 6))
colors = ["#4169E1", "#FF69B4"]

bar_width = 0.8
index = combined_data['Census Year']

bars1 = plt.bar(index, combined_data['Male_Percentage'],
                bar_width, label='Male', color=colors[0])
bars2 = plt.bar(index + bar_width, combined_data['Female_Percentage'],
                bar_width, label='Female', color=colors[1])

plt.title("Percentage of Non Workers in Total Population by Gender")
plt.xlabel("Census Year")
plt.ylabel("Percentage")
plt.xticks(index + bar_width / 2, combined_data['Census Year'])
plt.legend(title="Gender",bbox_to_anchor=(1.05,1),loc="upper left")

# Add percentage labels on top of each bar
for bar in bars1 + bars2:
    height = bar.get_height()
    plt.annotate(f'{height:.2f}%', xy=(bar.get_x() + bar.get_width() / 2, height),
                 xytext=(0, 3), textcoords='offset points', ha='center')

plt.show()
```


Percentage of Non Workers in Total Population by Gender
Percentage
70
60
50
40
30
20
10
0
66.87%
69.19%
68.94%
41.87%
46.72%
44.00%
1991
2001
2011
Census Year
Gender
Male
Female

```
In [96]: My_Data['Sum_ST_SC_Population'] = My_Data['Total ST population'] + My_Data['Total SC population']
         My_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 123678 entries, 0 to 129698
Data columns (total 31 columns):
 #   Column                       Non-Null Count   Dtype
---  ------                       --------------   -----
 0   Census Year                  123678 non-null  int64
 1   District                     123678 non-null  object
 2   No. of households            123678 non-null  int64
 3   Total population             123678 non-null  int64
 4   Total male population        123678 non-null  int64
 5   Total female population      123678 non-null  int64
 6   Total 0 to 6 year children   123678 non-null  int64
 7   Male 0 to 6 year children    123678 non-null  int64
 8   Female 0 to 6 year children  123678 non-null  int64
 9   Total SC population          123678 non-null  int64
 10  Male SC population           123678 non-null  int64
 11  Female SC population         123678 non-null  int64
 12  Total ST population          123678 non-null  int64
 13  Male ST population           123678 non-null  int64
 14  Female ST population         123678 non-null  int64
 15  Total literates              123678 non-null  int64
 16  Male literates               123678 non-null  int64
 17  Female literates             123678 non-null  int64
 18  Total main workers           123678 non-null  int64
 19  Male main workers            123678 non-null  int64
 20  Female main workers          123678 non-null  int64
 21  Total non workers            123678 non-null  int64
 22  Male non workers             123678 non-null  int64
 23  Female non workers           123678 non-null  int64
 24  Total_iliterates             123678 non-null  int64
 25  Male_iliterates              123678 non-null  int64
 26  Female_iliterates            123678 non-null  int64
 27  Population_Group             123678 non-null  category
 28  Part_time_workers            123678 non-null  int64
 29  Literacy Rate                123678 non-null  float64
 30  Sum_ST_SC_Population         123678 non-null  int64
dtypes: category(1), float64(1), int64(28), object(1)
memory usage: 29.4+ MB
```

In [97]:

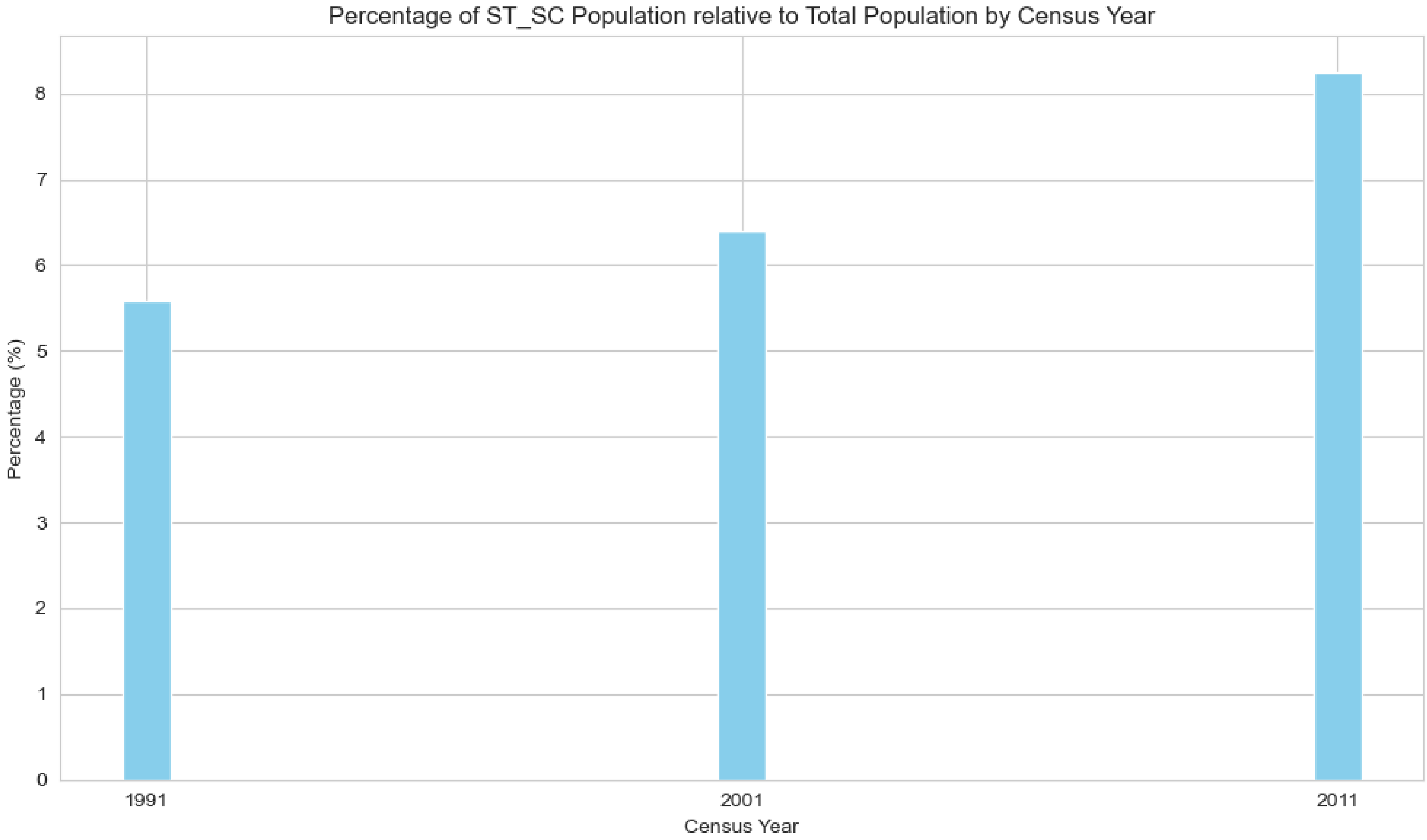
```
# Percentage of ST and SC population in Total Population
Perc_Sum_ST_SC_Population = (My_Data.groupby(["Census Year"])['Sum_ST_SC_Population'].sum()
                             / My_Data['Total population'].sum()) * 100

# Create a DataFrame with the result
ST_SC_in_totalpop_per_year= pd.DataFrame({'Census Year': Perc_Sum_ST_SC_Population.index,
                                          'Perc_ST_SC': Perc_Sum_ST_SC_Population.values})
ST_SC_in_totalpop_per_year
```

Out[97]:

	Census Year	Perc_ST_SC
0	1991	5.578241
1	2001	6.405128
2	2011	8.253623

In [98]:

```
#Bar plot of ST and SC pop in total population by year
plt.figure(figsize=(10, 6))
plt.bar(ST_SC_in_totalpop_per_year['Census Year'], ST_SC_in_totalpop_per_year['Perc_ST_SC'], color='skyblue')
plt.xlabel('Census Year')
plt.ylabel('Percentage (%)')
plt.title('Percentage of ST_SC Population relative to Total Population by Census Year')
plt.xticks(ST_SC_in_totalpop_per_year['Census Year'])
plt.tight_layout()
plt.show()
```


Percentage of ST_SC Population relative to Total Population by Census Year
Percentage (%)
0
1
2
3
4
5
6
7
8
1991
2001
2011
Census Year

In [99]:

```
# Creation of a new column: Percentage_ST_SC_in_TotalPop
My_Data["Percentage_ST_SC_in_TotalPop"] = (My_Data["Sum_ST_SC_Population"] / My_Data["Total population"]) * 100

# Grouping by District and Population_Group
grouped_data3 = My_Data.groupby(["District", "Population_Group"])["Percentage_ST_SC_in_TotalPop"].mean().reset_index()

#
top_10_districts = grouped_data3.nlargest(10, "Percentage_ST_SC_in_TotalPop")

# We want to see the top 10 villages with the highest percentage ratio of ST and SC combined in Total Population
top_10_districts
```

Out[99]:

	District	Population_Group	Percentage_ST_SC_in_TotalPop
66	NANDURBAR	Village	86.505187
30	GADCHIROLI	Village	72.355157
27	DHULE	Village	60.232107
69	NASHIK	Village	56.097628
99	THANE	Village	54.010450
6	AMRAVATI	Village	48.459964
24	CHANDRAPUR	Village	44.453276
60	NAGPUR	Village	40.066494
108	YAVATMAL	Village	39.817312
33	GONDIYA	Village	37.021420

Conclusions

1. Introduction:

2. Children's Population:

A concerning trend emerged in the proportion of children aged 0-6 within the total population. In 1991, they made up 17.1%, but this percentage steadily declined to 11.9% in 2011, reflecting challenges faced by disadvantaged populations

3. Gender Disparity Among Children:

Our findings depicted a growing gender disparity among children. In 1991, female children accounted for 48.6%, but by 2011, this number had dropped to 47.2%, possibly influenced by cultural preferences.

4. Literacy Rates:

In the realm of literacy rates, Greater Bombay consistently stood out with almost double the percentage of literates compared to other districts. Thane and Mumbai Suburban traded positions between 2001 and 2011, highlighting changes in literacy dynamics.

5. Employment Patterns:

Over the years, there was a notable shift in employment patterns. In 1991, cities saw 11.3% part-time workers, 32% full-time workers, and 56.8% non-workers. By 2001, the numbers transformed to 2.1%, 32.2%, and 65.7%, respectively, indicating evolving work patterns. Villages, on the other hand, consistently had a higher percentage of main workers across all population groups.

6. Educational Dynamics in Villages: Migration's Impact on Literacy Rates

The most remarkable surge in literacy rates occurred within the Population Group of Villages. Starting at 45.61% in the initial period, the proportion of literates in villages significantly rose to 59.71% and further soared to 67.46%.Consequently, we can infer that those who moved were predominantly illiterate individuals seeking better opportunities in larger cities, while the literate population largely remained behind. This dynamic sheds light on the shifting educational landscape and the impact of migration on literacy rates.

7. Women's Employment Status:

Despite increasing literacy rates among women, the majority remained outside the workforce. In 1991, 66.87% of women were non-workers, and this percentage remained high in subsequent years. Conversely, men experienced fluctuations in their non-worker percentages, eventually settling at 44%.

8. Social Vulnerability:

The populations of Scheduled Tribes (ST) and Scheduled Castes (SC) increased from 5.57% to 8.25% between 1991 and 2011. Interestingly, the first ten areas inhabited by ST and SC populations are all villages.