pw_eda_2023

September 29, 2025

1 Exploratory Data Analysis: Global Plastic Waste (2023)

1.0.1 Objective

This project explores patterns in **plastic consumption, waste generation, and mismanagement** across countries in 2023.
The goal is to answer:
- Which countries contribute the most to plastic use and waste?
- How do per-capita trends differ from total consumption trends?
- Which nations have the highest levels of **mismanaged plastic waste** (both absolute and relative)?
- What does this reveal about global waste management capacity?

1.0.2 Dataset Description

The primary dataset used is from **World Population Review (2023)**, containing information on plastic use and waste by country.

Columns included:
- `Total Plastic Use (2023, Tons)` – total plastic consumed by each country.
- `Plastic Use per Person (2023, KG)` – per-capita plastic use.
- `Total Waste Produced (2023, Tons)` – estimated total plastic waste generated.
- `Waste per Person (2023, kg)` – waste per person, derived from total waste and population.
- `Mismanaged Waste (2023, Tons)` – total mismanaged plastic waste.
- `Mismanaged Waste % (2023)` – percentage of waste that is mismanaged.
- `Population (2023)` – country population estimate.

Dataset Size:
- Number of rows: 212
- Number of columns: 8

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.ticker as ticker
import seaborn as sns
```

1.1 Loading Datasets

[2]:
```
df_mwi = pd.read_csv("plastic-pollution-by-country-2025.csv")
df_pc = pd.read_csv("plastic-consumption-by-country-2025.csv")

# Merging both datasets on country
df_merged = pd.merge(df_mwi, df_pc, on=["flagCode", "country"])
df_merged.set_index("country", inplace=True)

# Dropping unecessary columns
df_merged.drop(columns="MWILevel_2023", inplace=True)

df_merged.head()
```

[2]:

country	flagCode	MismanagedWasteIndex_2023	TotalPlasticConsumption_2023	MismanagedWasteExpected_2023	PerCapitaPlasticConsumption_2023
Afghanistan	AF	98.06	447766	439097	11.5
Albania	AL	69.90	109725	76692	38.7
Algeria	DZ	12.82	2092007	268285	48.1
American Samoa	AS	53.03	2431	1289	52.6
Andorra	AD	44.77	4859	2176	62.5

1.1.1 Data Check

Quick shape/columns check and float display prefs (commas, no decimals for large integers).

[3]:
```
print(df_merged.shape)
print(df_merged.columns)
pd.set_option("display.float_format", "{:,.0f}".format)  # no decimals, comma␣
↪separator
```

```
(212, 5)
Index(['flagCode', 'MismanagedWasteIndex_2023', 'TotalPlasticConsumption_2023',
```

```
       'MismanagedWasteExpected_2023', 'PerCapitaPlasticConsumption_2023'],
      dtype='object')
```

[4]:
```
# Renaming columns for clarity
df_merged = df_merged.rename(columns={
    "flagCode": "Country Code",
    "MismanagedWasteIndex_2023": "Mismanaged Waste % (2023)",
    "TotalPlasticConsumption_2023": "Total Plastic Use (2023, Tons)",
    "MismanagedWasteExpected_2023": "Mismanaged Waste (2023, Tons)",
    "PerCapitaPlasticConsumption_2023": "Plastic Use per Person (2023, KG)",
})
```

1.1.2 Converting text columns to numeric

Some numeric columns arrived as strings (with commas)

[5]:
```
# Converting text to numbers
df_merged["Mismanaged Waste (2023, Tons)"] = pd.
 ↪to_numeric(df_merged["Mismanaged Waste (2023, Tons)"], errors="coerce")
df_merged["Mismanaged Waste % (2023)"] = pd.to_numeric(df_merged["Mismanaged␣
 ↪Waste % (2023)"], errors="coerce")
```

1.1.3 Derived Data

Computing **Total Waste Produced** from mismanaged waste and mismanagement rate. Computing **Population** from Total plastic waste and plastic waste per person. Computing **Waste per Person** from Total Waste Produced and Population

[6]:
```
# Calculating Total Waste
df_merged["Total Waste Produced (2023, Tons)"] = (df_merged["Mismanaged Waste␣
 ↪(2023, Tons)"] / (df_merged["Mismanaged Waste % (2023)"] / 100))


df_merged["Population (2023)"] = (df_merged["Total Plastic Use (2023, Tons)"] *␣
 ↪1000 / df_merged["Plastic Use per Person (2023, KG)"])

df_merged["Waste per Person (2023, kg)"] = (df_merged["Total Waste Produced␣
 ↪(2023, Tons)"] * 1000 / df_merged["Population (2023)"])



df_merged.head()
```

[6]:

country	Country Code	Mismanaged Waste % (2023)	\
Afghanistan	AF	98	
Albania	AL	70	
Algeria	DZ	13	

```
American Samoa           AS                        53
Andorra                  AD                        45

                Total Plastic Use (2023, Tons)  Mismanaged Waste (2023, Tons)  \
country
Afghanistan                             447766                        439,097
Albania                                 109725                         76,692
Algeria                                2092007                        268,285
American Samoa                            2431                          1,289
Andorra                                   4859                          2,176

                Plastic Use per Person (2023, KG)  \
country
Afghanistan                                    12
Albania                                        39
Algeria                                        48
American Samoa                                 53
Andorra                                        62

                Total Waste Produced (2023, Tons)  Population (2023)  \
country
Afghanistan                               447,784        38,936,174
Albania                                   109,717         2,835,271
Algeria                                 2,092,707        43,492,869
American Samoa                              2,431            46,217
Andorra                                     4,860            77,744

                Waste per Person (2023, kg)
country
Afghanistan                              12
Albania                                  39
Algeria                                  48
American Samoa                           53
Andorra                                  63
```

1.1.4 Nulls & data fixes

Identify remaining nulls / zeros; apply targeted fixes if needed (documented below).

[7]:
```
mask = df_merged.isnull() | (df_merged == 0)

print(mask.sum().sum()) # number of null cells
df_merged[mask.any(axis=1)] # affected rows
```

```
4
```

[7]:
```
                      Country Code  Mismanaged Waste % (2023)  \
country
```

```
Namibia                          NaN                          96
Sao Tome and Principe             ST                          88

                        Total Plastic Use (2023, Tons)  \
country
Namibia                                          31516
Sao Tome and Principe                             2727

                        Mismanaged Waste (2023, Tons)  \
country
Namibia                                        30,120
Sao Tome and Principe                             NaN

                        Plastic Use per Person (2023, KG)  \
country
Namibia                                              13
Sao Tome and Principe                                12

                        Total Waste Produced (2023, Tons)  Population (2023)  \
country
Namibia                                           31,516          2,481,575
Sao Tome and Principe                                NaN            218,160

                        Waste per Person (2023, kg)
country
Namibia                                          13
Sao Tome and Principe                           NaN
```

[8]:
```
df_merged.dropna(subset=df_merged.columns.difference(["Country Code"]))
df_merged[mask.any(axis=1)]
```

[8]:
```
                       Country Code  Mismanaged Waste % (2023)  \
country
Namibia                          NaN                          96
Sao Tome and Principe             ST                          88

                        Total Plastic Use (2023, Tons)  \
country
Namibia                                          31516
Sao Tome and Principe                             2727

                        Mismanaged Waste (2023, Tons)  \
country
Namibia                                        30,120
Sao Tome and Principe                             NaN

                        Plastic Use per Person (2023, KG)  \
```

```
country
Namibia                                                13
Sao Tome and Principe                                  12

                        Total Waste Produced (2023, Tons)  Population (2023)  \
country
Namibia                                            31,516          2,481,575
Sao Tome and Principe                                 NaN            218,160

                        Waste per Person (2023, kg)
country
Namibia                                          13
Sao Tome and Principe                           NaN
```

[9]:
```
# Setting Namibia's country code to "NA"
df_merged.loc[df_merged.index == "Namibia", "Country Code"] = "NA"
```

[10]:
```
df_merged.describe().T
```

[10]:
```
                                   count       mean         std    min  \
Mismanaged Waste % (2023)            212         61          36      0
Total Plastic Use (2023, Tons)       212    771,852   3,119,078    460
Mismanaged Waste (2023, Tons)        211    323,579     873,334     14
Plastic Use per Person (2023, KG)    212         39          41      1
Total Waste Produced (2023, Tons)    211    781,764   3,125,628    458
Population (2023)                    212 36,744,588 141,316,198 11,059
Waste per Person (2023, kg)          211        204       2,386      1

                                     25%       50%        75%           max
Mismanaged Waste % (2023)             22        74         96           100
Total Plastic Use (2023, Tons)    23,720   141,862    473,718    37,606,230
Mismanaged Waste (2023, Tons)      8,309    63,784    264,354     7,300,752
Plastic Use per Person (2023, KG)     13        27         48           328
Total Waste Produced (2023, Tons) 24,180   150,261    476,308    37,600,597
Population (2023)                791,911 6,640,059 25,841,811 1,408,473,034
Waste per Person (2023, kg)           13        28         49        34,694
```

1.1.5 Outlier Check

- Ran an outlier check on *Waste per Person (2023, kg)* to identify unusual values.
- Found **Poland** with an unrealistically high value (~34,694 kg/person).
- Inspection showed this was due to a typo in `Total Plastic Use (2023, Tons)` (1,315 instead of 1,315,000).
- Corrected the value manually.

[11]:
```
col = "Waste per Person (2023, kg)"

# Calculate Q1, Q3, and IQR
Q1 = df_merged[col].quantile(0.25)
Q3 = df_merged[col].quantile(0.75)
IQR = Q3 - Q1

# Define bounds
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Find outliers
outliers = df_merged[(df_merged[col] < lower_bound) | (df_merged[col] >␣
 ↪upper_bound)]

print("Outlier countries based on Waste per Person (2023, kg):")
print(outliers[["Country Code", col]])
```

```
Outlier countries based on Waste per Person (2023, kg):
                        Country Code  Waste per Person (2023, kg)
country
Aruba                             AW                          110
Barbados                          BB                          106
Bermuda                           BM                          169
Faroe Islands                     FO                          155
Guam                              GU                          104
Hong Kong                         HK                          168
Iceland                           IS                          129
Israel                            IL                          105
Macau                             MO                          328
Moldova                           MD                          151
Mongolia                          MN                          128
Northern Mariana Islands          MP                          109
Palau                             PW                          168
Poland                            PL                       34,694
Puerto Rico                       PR                          132
Saint Kitts and Nevis             KN                          160
Singapore                         SG                          104
United Arab Emirates              AE                          116
```

[12]:
```
df_merged.loc["Poland"]
```

[12]:
```
Country Code                          PL
Mismanaged Waste % (2023)             13
Total Plastic Use (2023, Tons)      1315
Mismanaged Waste (2023, Tons)    177,365
Plastic Use per Person (2023, KG)     35
Total Waste Produced (2023, Tons)  1,314,789
```

```
Population (2023)                       37,896
Waste per Person (2023, kg)             34,694
Name: Poland, dtype: object
```

[13]:
```
# Manual change of value
df_merged.loc["Poland", "Total Plastic Use (2023, Tons)"] = 1315000
```

[14]:
```
# Recalculating Population and Waste per Person after manual change

df_merged["Population (2023)"] = (df_merged["Total Plastic Use (2023, Tons)"] *␣
 ↪1000 / df_merged["Plastic Use per Person (2023, KG)"])
df_merged["Waste per Person (2023, kg)"] = (df_merged["Total Waste Produced␣
 ↪(2023, Tons)"] * 1000 / df_merged["Population (2023)"])
```

[15]:
```
df_merged.loc["Poland"]
```

[15]:
```
Country Code                                PL
Mismanaged Waste % (2023)                   13
Total Plastic Use (2023, Tons)         1315000
Mismanaged Waste (2023, Tons)           177,365
Plastic Use per Person (2023, KG)            35
Total Waste Produced (2023, Tons)     1,314,789
Population (2023)                    37,896,254
Waste per Person (2023, kg)                  35
Name: Poland, dtype: object
```

1.1.6 Final check: structure & ranges

Confirm dtypes, descriptive stats.

[16]:
```
df_merged.info()
df_merged.describe().T
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 212 entries, Afghanistan to Zimbabwe
Data columns (total 8 columns):
 #   Column                              Non-Null Count  Dtype
---  ------                              --------------  -----
 0   Country Code                        212 non-null    object
 1   Mismanaged Waste % (2023)           212 non-null    float64
 2   Total Plastic Use (2023, Tons)      212 non-null    int64
 3   Mismanaged Waste (2023, Tons)       211 non-null    float64
 4   Plastic Use per Person (2023, KG)   212 non-null    float64
 5   Total Waste Produced (2023, Tons)   211 non-null    float64
 6   Population (2023)                   212 non-null    float64
 7   Waste per Person (2023, kg)         211 non-null    float64
dtypes: float64(6), int64(1), object(1)
memory usage: 23.0+ KB
```

[16]:

	count	mean	std	min	\
Mismanaged Waste % (2023)	212	61	36	0	
Total Plastic Use (2023, Tons)	212	778,048	3,118,845	460	
Mismanaged Waste (2023, Tons)	211	323,579	873,334	14	
Plastic Use per Person (2023, KG)	212	39	41	1	
Total Waste Produced (2023, Tons)	211	781,764	3,125,628	458	
Population (2023)	212	36,923,165	141,293,511	11,059	
Waste per Person (2023, kg)	211	39	41	1	

	25%	50%	75%	max
Mismanaged Waste % (2023)	22	74	96	100
Total Plastic Use (2023, Tons)	23,969	146,224	475,551	37,606,230
Mismanaged Waste (2023, Tons)	8,309	63,784	264,354	7,300,752
Plastic Use per Person (2023, KG)	13	27	48	328
Total Waste Produced (2023, Tons)	24,180	150,261	476,308	37,600,597
Population (2023)	808,992	6,707,893	26,427,332	1,408,473,034
Waste per Person (2023, kg)	13	28	48	328

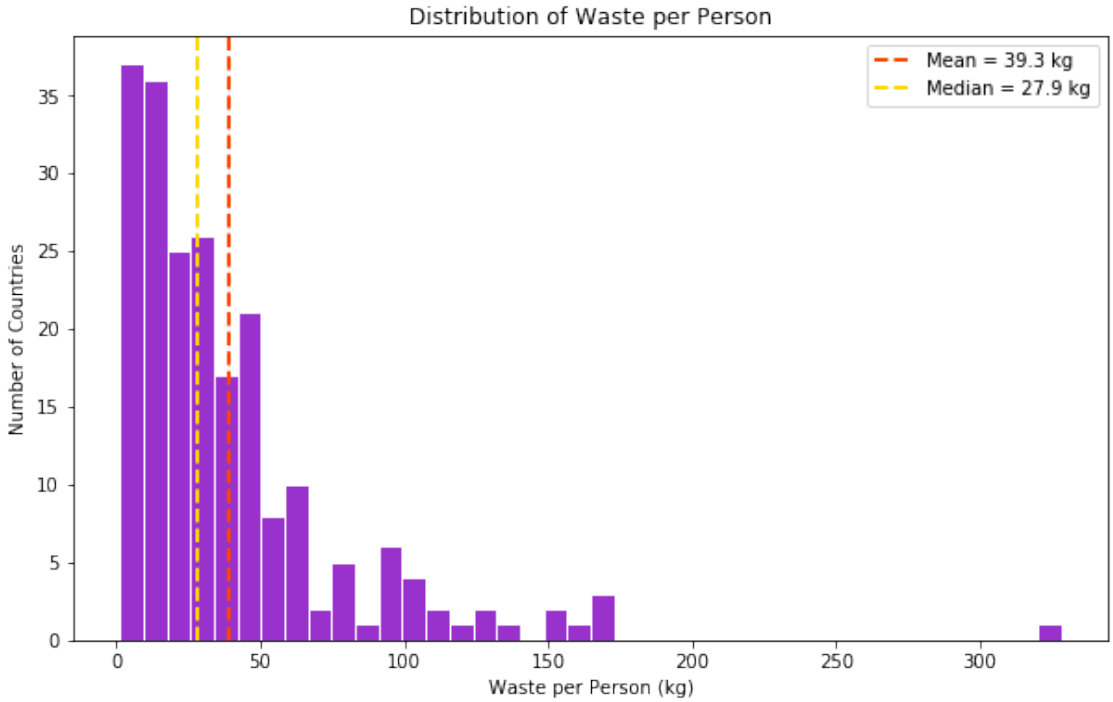
1.1.7 Exploratory Data Analysis (EDA)

The analysis is divided into three parts:
1. **Consumption & Waste** – who uses and produces the most plastic, both in totals and per person.
2. **Mismanagement** – who mismanages the most plastic, in both absolute and relative terms.
3. **Distributions & Comparisons** – how consumption, waste, and mismanagement vary globally.

Each section includes visualizations with **interpretation of results**.

[17]:
```
# Plot 1

col = "Waste per Person (2023, kg)"


plt.figure(figsize=(10,6))
plt.hist(df_merged[col].dropna(), bins = 40, edgecolor = "white", color =␣
 ↪"darkorchid")


mean_value = df_merged[col].mean()
median_value = df_merged[col].median()

plt.axvline(mean_value, color="orangered", linestyle="dashed", linewidth=2,␣
 ↪label=f"Mean = {mean_value:.1f} kg")
plt.axvline(median_value, color="gold", linestyle="dashed", linewidth=2,␣
 ↪label=f"Median = {median_value:.1f} kg")


plt.xlabel("Waste per Person (kg)")
```

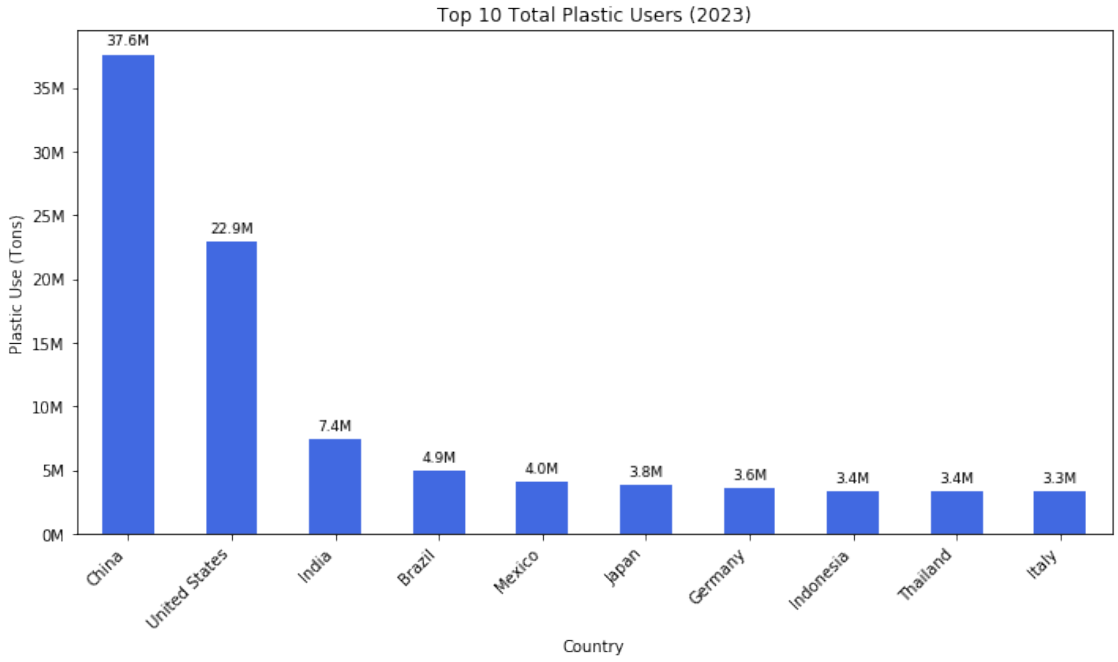
```
plt.ylabel("Number of Countries")
plt.title("Distribution of Waste per Person")

plt.legend()
plt.show()
```



Insights: - The distribution is right-skewed, with most countries generating less than approximately 50 kg/person annually.
- The **median (27.9 kg)** is notably lower than the **mean (39.3 kg)**, highlighting the impact of high-waste outliers.
- A handful of countries exceed 100 kg/person annually, with one extreme case above 300 kg/person.
- This pattern highlights the unequality, most countries contribute modestly per person, but a few high-consumption nations disproportionately raise the global average.

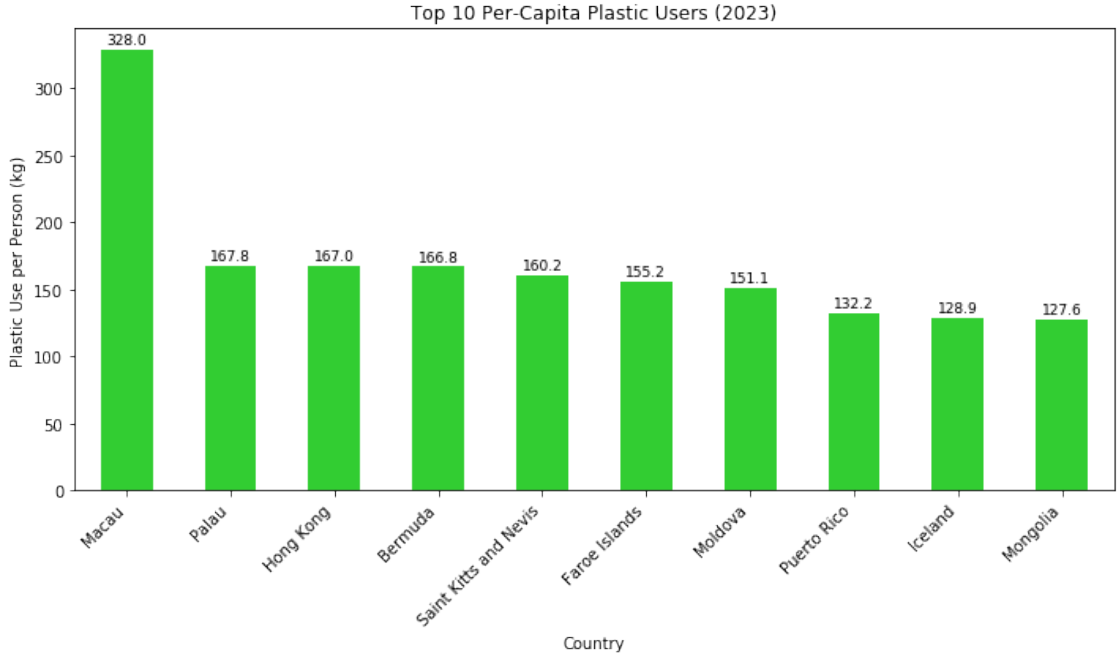
[18]:
```
# Plot 2

col = "Total Plastic Use (2023, Tons)"

top10_total_user = df_merged.nlargest(10, col)

gph = top10_total_user.plot.bar(y=col, legend=False, figsize=(10,6),␣
 ↪color="royalblue")

plt.title("Top 10 Total Plastic Users (2023)")
```

```
plt.ylabel("Plastic Use (Tons)")
plt.xlabel("Country")
plt.xticks(rotation=45, ha="right")


gph.yaxis.set_major_formatter(ticker.FuncFormatter(lambda x, _: f"{x/1e6:.
  ↪0f}M"))

# Add value labels on top of bars
for i, val in enumerate(top10_total_user[col]):
    gph.text(i, val + 5e5, f"{val/1e6:.1f}M", ha="center", va="bottom",␣
  ↪fontsize=9)

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



Insights: - **China (37.6M tons)** and the **United States (22.9M tons)** dominate global plastic use, far exceeding other countries.
- Together, these two account for well over half of the world's top-10 consumption.
- **India (7.4M tons)**, despite having the world's largest population, consumes much less in absolute terms than China or the U.S.
- This ranking reflects **scale of population**, countries with massive populations naturally use more in total.

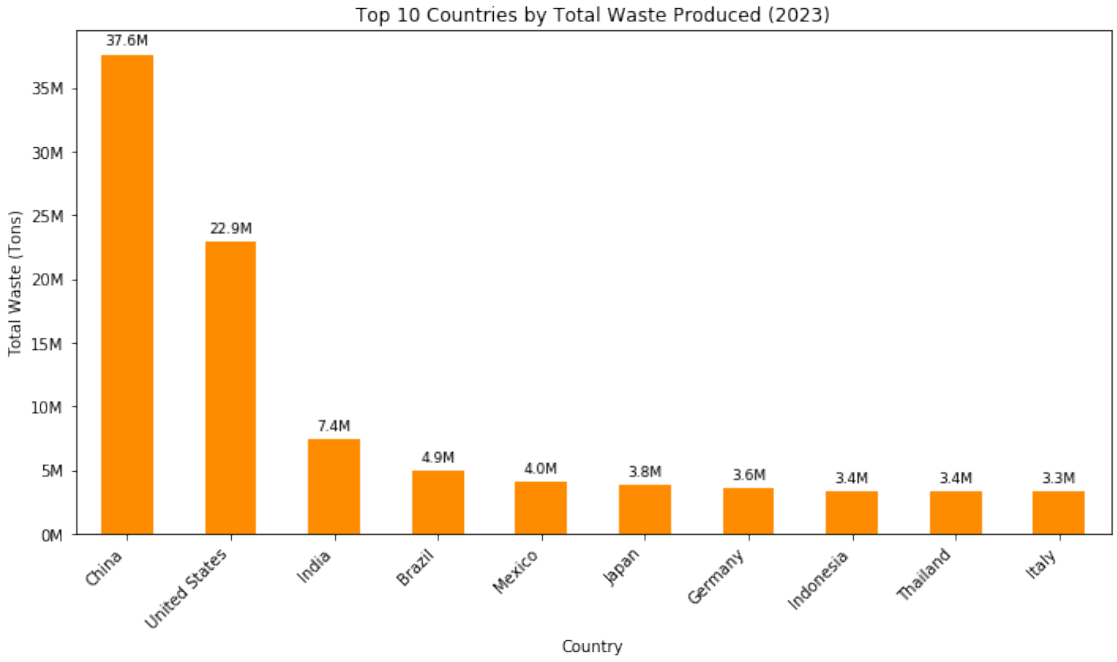
[19]:
```
# Plot 3

col = "Plastic Use per Person (2023, KG)"
top10_pc_user = df_merged.nlargest(10, col)

gph = top10_pc_user.plot.bar(y=col, legend=False, figsize=(10,6),␣
 ↪color="limegreen")

plt.title("Top 10 Per-Capita Plastic Users (2023)")
plt.ylabel("Plastic Use per Person (kg)")
plt.xlabel("Country")
plt.xticks(rotation=45, ha="right")

# Add value labels on top of bars
for i, val in enumerate(top10_pc_user[col]):
    gph.text(i, val + 2, f"{val:.1f}", ha="center", va="bottom", fontsize=9)

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



Insights: - **Macau (328 kg/person)** stands out dramatically, using nearly double the plastic per person compared to the next country.
- Other top per-capita consumers include **Palau (167.8), Hong Kong (167.0), and Bermuda (166.8)** — mostly small or high-income regions.
- These figures are far above the global average (~39 kg/person from Plot 1).
- This highlights how **scale and intensity differ**: large populations dominate in totals, but

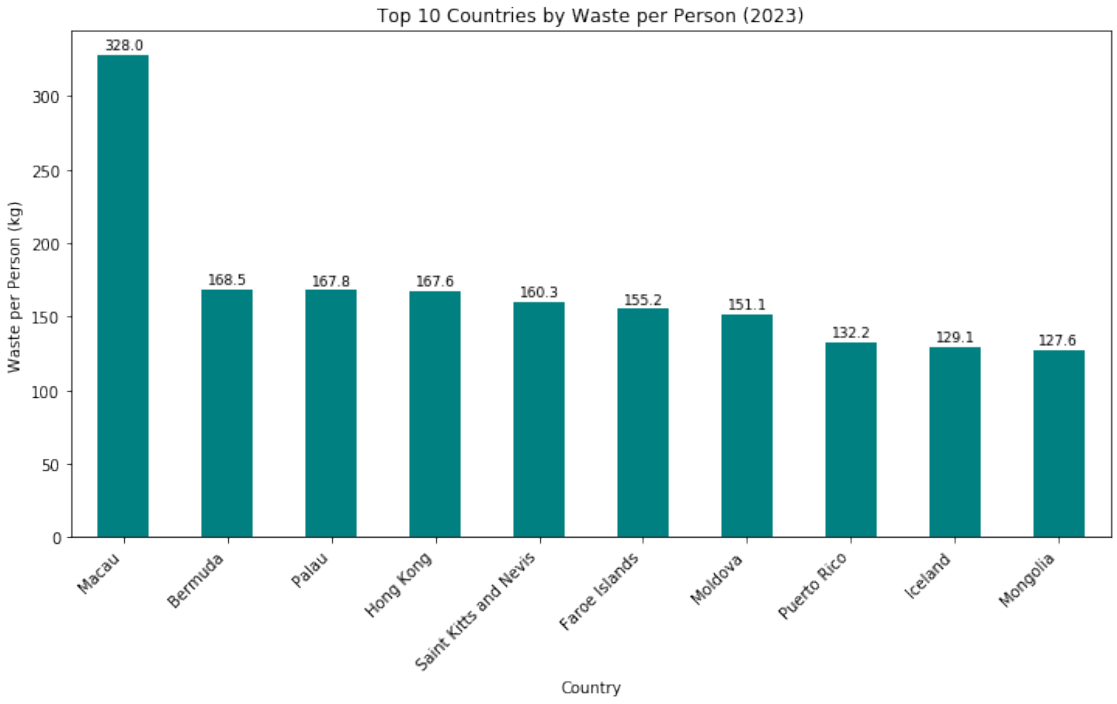
the per-capita leaders are **smaller populations**, where usage intensity is disproportionately high relative to population size.

[20]:
```
# Plot 4

col = "Total Waste Produced (2023, Tons)"
top10_total_waste = df_merged.nlargest(10, col)

gph = top10_total_waste.plot.bar(y=col, legend=False, figsize=(10,6),␣
 ↪color="darkorange")

plt.title("Top 10 Countries by Total Waste Produced (2023)")
plt.ylabel("Total Waste (Tons)")
plt.xlabel("Country")
plt.xticks(rotation=45, ha="right")


gph.yaxis.set_major_formatter(ticker.FuncFormatter(lambda x, _: f"{x/1e6:.
 ↪0f}M"))

# Add value labels on top of bars
for i, val in enumerate(top10_total_waste[col]):
    gph.text(i, val + 5e5, f"{val/1e6:.1f}M", ha="center", va="bottom",␣
 ↪fontsize=9)

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



Insights: - The ranking is almost identical to total plastic use (Plot 2), showing that consumption translates almost directly into waste generation. - This step makes clear that high consumption translates almost directly into high waste volumes, setting the stage for examining how much of this waste is **properly managed vs. mismanaged**.

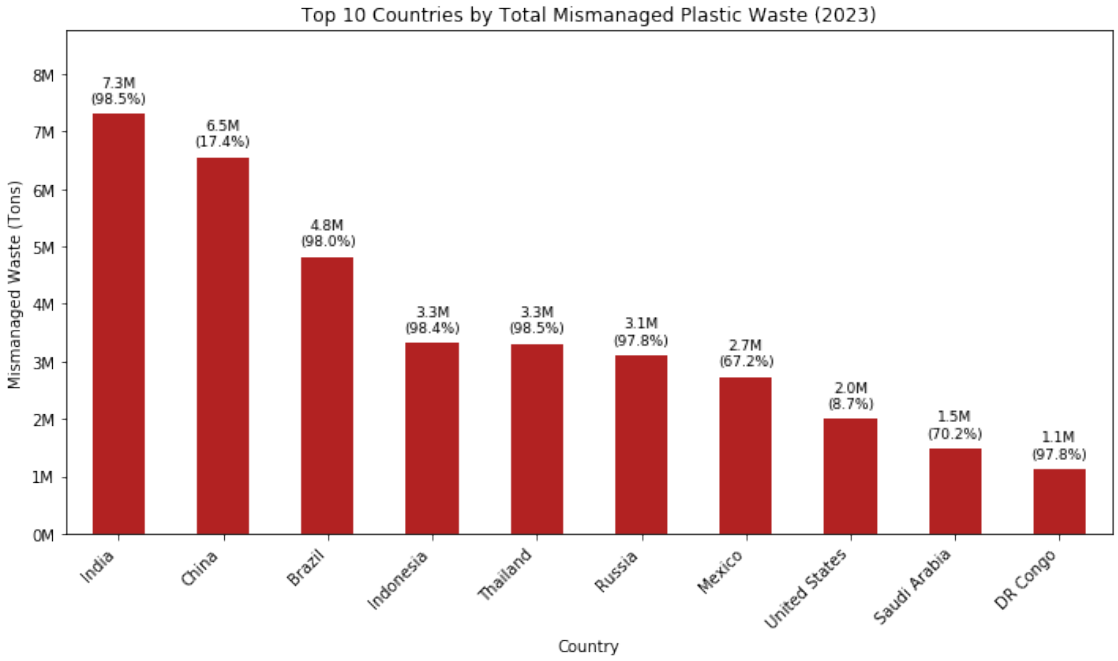
[21]:
```
# Plot 5

col_percap = "Waste per Person (2023, kg)"
top10_percap_waste = df_merged.nlargest(10, col_percap)

gph = top10_percap_waste.plot.bar(y=col_percap, legend=False, figsize=(12,6),␣
 ↪color="teal")

plt.title("Top 10 Countries by Waste per Person (2023)")
plt.ylabel("Waste per Person (kg)")
plt.xlabel("Country")
plt.xticks(rotation=45, ha="right")

for i, val in enumerate(top10_percap_waste[col_percap]):
    gph.text(i, val + 2, f"{val:.1f}", ha="center", va="bottom", fontsize=9)

plt.show()
```



Insights: - **Macau (328 kg/person)** leads by a wide margin, producing nearly double the waste per person compared to the next highest countries, similar to plastic consumption.

[22]:
```
# Plot 6

col_mis_total = "Mismanaged Waste (2023, Tons)"
col_mis_pct = "Mismanaged Waste % (2023)"
top10_mis_total = df_merged.nlargest(10, col_mis_total)

gph = top10_mis_total.plot.bar(y=col_mis_total, legend=False, figsize=(10,6),␣
 ↪color="firebrick")


plt.title("Top 10 Countries by Total Mismanaged Plastic Waste (2023)")
plt.ylabel("Mismanaged Waste (Tons)")
plt.xlabel("Country")
plt.xticks(rotation=45, ha="right")

ymax = top10_mis_total[col_mis_total].max()
print(ymax)
gph.set_ylim(0, ymax * 1.2)

gph.yaxis.set_major_formatter(ticker.FuncFormatter(lambda x, _: f"{x/1e6:.
 ↪0f}M"))

for i, (val, pct) in enumerate(zip(top10_mis_total[col_mis_total],␣
 ↪top10_mis_total[col_mis_pct])):
    gph.text(i, val + (ymax * 0.02), f"{val/1e6:.1f}M\n({pct:.1f}%)",␣
 ↪ha="center", va="bottom", fontsize=9)

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

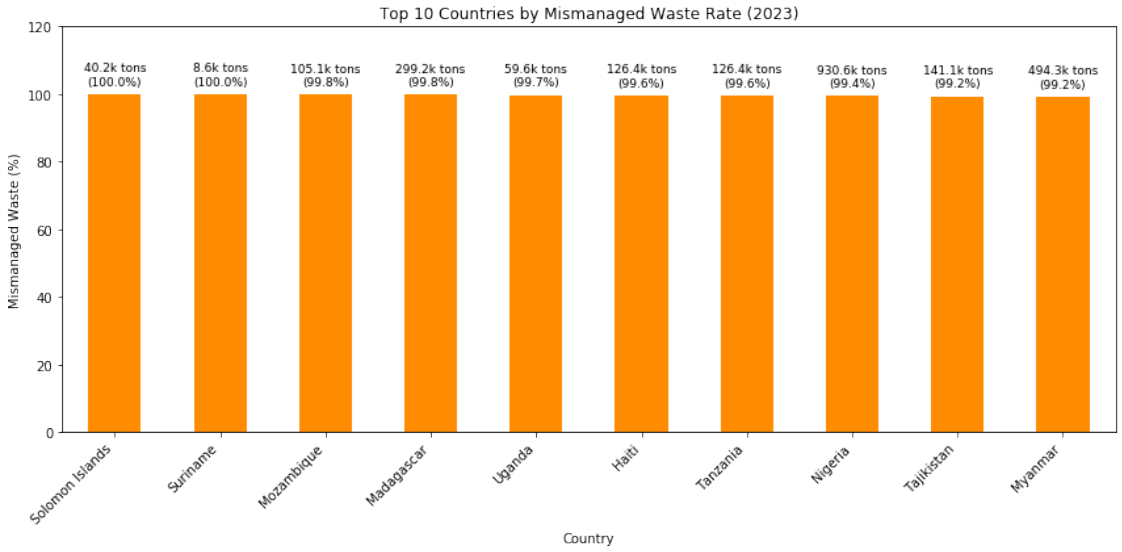
```
7300752.0
```



Insights: - **India (7.3M tons)**, **China (6.5M tons)** and **Brazil (4.8M tons)** top the list of mismanaged plastic waste in absolute terms.
- This chart highlights that mismanagement is not only about how much plastic is consumed, but also about the **capacity of national waste management systems** to handle it effectively.
- **India (7.3M tons, 98.5%)** and **Brazil (4.8M tons, 98.0%)** show extremely high mismanagement rates, meaning nearly all plastic waste generated ends up improperly handled.
- **China (6.5M tons, 17.4%)** produces a large volume but mismanages a much smaller share relative to its scale, reflecting stronger waste-handling capacity and infrastructure.
- **The U.S. (2.0M tons, 8.7%)** appears in the top 10 by volume, but with one of the lowest mismanagement rates, reflecting more effective systems and infrastructure.
- Countries like **Indonesia (98.4%)**, **Thailand (98.5%)**, and **DR Congo (97.8%)** also highlight regions where weak infrastructure drives extremely high mismanagement risk.
- Overall, the data shows that the **global challenge is twofold**:
- **Scale problem** - massive plastic waste generators.
- **System problem** - insufficient waste management infrastructure leading to high leakage.

[23]:
```
# Plot 7

col_mis_pct = "Mismanaged Waste % (2023)"
col_mis_total = "Mismanaged Waste (2023, Tons)"
top10_mis_pct = df_merged.nlargest(10, col_mis_pct)

gph = top10_mis_pct.plot.bar(y=col_mis_pct, legend=False, figsize=(12,6),␣
 ↪color="darkorange")

plt.title("Top 10 Countries by Mismanaged Waste Rate (2023)")
```

```
plt.ylabel("Mismanaged Waste (%)")
plt.xlabel("Country")
plt.xticks(rotation=45, ha="right")

ymax = top10_mis_pct[col_mis_pct].max()
gph.set_ylim(0, ymax * 1.2)

# Label with both tons + percentage
for i, (tons, pct) in enumerate(zip(top10_mis_pct[col_mis_total],␣
 ↪top10_mis_pct[col_mis_pct])):
    gph.text(i, pct + (ymax * 0.02), f"{tons/1e3:.1f}k tons\n({pct:.1f}%)",␣
 ↪ha="center", va="bottom", fontsize=9)

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



Insights:
- These countries record **near-100% mismanagement rates**, showing an almost complete absence of functioning waste management systems.
- Nations like **Nigeria (930k tons, 99%)** and **Myanmar (494k tons, 99%)** stand out where both **volume and rate are critically high**, amplifying environmental risks.
- The findings highlight that **systemic weakness, not just absolute waste volumes**, can turn countries into mismanagement hotspots when infrastructure is lacking.

1.1.8 Conclusion

Key findings from this EDA:
- Plastic use and waste are highly concentrated: **China, the U.S., and India** dominate in absolute totals.

- Per-capita measures tell a different story: small or wealthy regions like **Macau, Bermuda, and Palau** have the highest per-person waste footprints.
- **India and Brazil** show extremely high mismanagement rates (~98%), while **China and the U.S.** generate massive totals but mismanage a much smaller share.
- Several nations face **near-100% mismanagement** despite producing relatively small waste volumes, an indication of absent waste management infrastructure.

Overall, the global plastic waste challenge is **twofold**:
- **Scale problem** - massive waste generators like China, India, and the U.S.
- **System problem** - countries with insufficient infrastructure that mismanage nearly all plastic waste produced.

This analysis demonstrates how combining **totals, per-capita measures, and mismanagement efficiency** gives a more complete picture of global plastic pollution.

1.2 Conclusion

- Totals are concentrated in a few large economies (China, U.S., India); per-capita leaders are small/high-consumption regions.

- Mismanagement shows two problems: **scale** (big generators) and **system capacity** (near-100% MWI in some countries).

- Combining totals, per-capita metrics, and mismanagement % yields a fuller picture than any single view.