Data Cleaning and Transformation

In [1]:
```
import pandas as pd
from functions import run
data = run()
data['world_cases'].head(5)
```

Out[1]:

	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	..
0	NaN	Afghanistan	33.93911	67.709953	0	0	0	0	0	0	..
1	NaN	Albania	41.15330	20.168300	0	0	0	0	0	0	..
2	NaN	Algeria	28.03390	1.659600	0	0	0	0	0	0	..
3	NaN	Andorra	42.50630	1.521800	0	0	0	0	0	0	..
4	NaN	Angola	-11.20270	17.873900	0	0	0	0	0	0	..

5 rows × 1147 columns

In [2]:
```
data['usa_cases'].head(5)
```

Out[2]:

	UID	iso2	iso3	code3	FIPS	Admin2	Province_State	Country_Region	Lat	Long_	...	2/
0	84001001	US	USA	840	1001.0	Autauga	Alabama	US	32.539527	-86.644082	...	
1	84001003	US	USA	840	1003.0	Baldwin	Alabama	US	30.727750	-87.722071	...	6
2	84001005	US	USA	840	1005.0	Barbour	Alabama	US	31.868263	-85.387129	...	
3	84001007	US	USA	840	1007.0	Bibb	Alabama	US	32.996421	-87.125115	...	
4	84001009	US	USA	840	1009.0	Blount	Alabama	US	33.982109	-86.567906	...	

5 rows × 1154 columns

Selecting the Correct Columns

In [3]:
```
def select_columns(df):
    """
    Filters the DataFrame to include only relevant columns for analysis.

    Parameters
    ----------
    df : DataFrame
        Input DataFrame to filter.

    Returns
    -------
    DataFrame
    """
    cols = df.columns

    # we don't need to know the group since the world and usa have
    # different column names for their areas
    areas = ["Country/Region", "Province_State"]
    is_area = cols.isin(areas)

    # date columns are the only ones with two slashes
    has_two_slashes = cols.str.count("/") == 2
    filt = is_area | has_two_slashes
    return df.loc[:, filt]
```

In [4]:
```
select_columns(data['world_cases']).head(3)
```

Out[4]:

	Country/Region	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	1/28/20	1/29/20	1/30/20	...	2/28/23
0	Afghanistan	0	0	0	0	0	0	0	0	0	...	209322
1	Albania	0	0	0	0	0	0	0	0	0	...	334391
2	Algeria	0	0	0	0	0	0	0	0	0	...	271441

3 rows × 1144 columns

In [5]:
```
select_columns(data['usa_cases']).head(3)
```

Out[5]:

	Province_State	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	1/28/20	1/29/20	1/30/20	...	2/28/23	3
0	Alabama	0	0	0	0	0	0	0	0	0	...	19732	
1	Alabama	0	0	0	0	0	0	0	0	0	...	69641	6
2	Alabama	0	0	0	0	0	0	0	0	0	...	7451	

3 rows × 1144 columns

Updating the `run` Function

In [6]:
```
#Updating run()function to include the steps above.
def run2():
    """
    Executes a sequence of data loading, transformation, and column selection step

    Returns
    -------
    dict
        Dictionary of processed DataFrames.
    """
    data = {}
    for group in GROUPS:
        for kind in KINDS:
            df = read_local_data(group, kind, "data/raw")
            df = select_columns(df)
            data[f"{group}_{kind}"] = df
    return data
```

In [7]:
```
data = run2()
data['usa_cases'].head(5)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[7], line 1
----> 1 data = run2()
      2 data['usa_cases'].head(5)

Cell In[6], line 12, in run2()
      3 """
      4 Executes a sequence of data loading, transformation, and column selection
steps.
      5
   (...)
      9     Dictionary of processed DataFrames.
     10 """
     11 data = {}
---> 12 for group in GROUPS:
     13     for kind in KINDS:
     14         df = read_local_data(group, kind, "data/raw")

NameError: name 'GROUPS' is not defined
```

Updating Area Names

In the "World" data frame, there are three cruise ships. For simplicity, all cruise ships will be titled "Cruise Ship". The United States has an individual summary table, so we will remove it from the "World" data frame.

In [8]:
```python
# Use the DataFram "replace" method to replace the names in the first column with
# we will also remove all rows with "US" data from the world Data Frame.

REPLACE_AREA = {
    "Korea, South": "South Korea",
    "Taiwan*": "Taiwan",
    "Burma": "Myanmar",
    "Holy See": "Vatican City",
    "Diamond Princess": "Cruise Ship",
    "Grand Princess": "Cruise Ship",
    "MS Zaandam": "Cruise Ship",
}


def update_areas(df):
    """
    Updates area names in the DataFrame using a predefined mapping.

    Parameters
    ----------
    df : DataFrame

    Returns
    -------
    DataFrame
    """
    area_col = df.columns[0]
    df[area_col] = df[area_col].replace(REPLACE_AREA)
    return df
```

Updating run()

In [9]:
```python
#Updating run()function to include the steps above.
def run3():
    """
    Executes data loading, transformation, column selection, and area update steps

    Returns
    -------
    dict
        Dictionary of fully processed DataFrames.
    """
    data = {}
    for group in GROUPS:
        for kind in KINDS:
            df = read_local_data(group, kind, "data/raw")
            df = select_columns(df)
            df = update_areas(df)
            data[f"{group}_{kind}"] = df
    return data
```

In [10]:
```
from functions import run3
data = run3()
data['usa_cases'].query("Province_State == 'Cruise Ship'")
```

Out[10]:

	Province_State	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	1/28/20	1/29/20	1/30/20	...	2/28/23
338	Cruise Ship	0	0	0	0	0	0	0	0	0	...	49
572	Cruise Ship	0	0	0	0	0	0	0	0	0	...	103

2 rows × 1144 columns

Aggregate Repeating Areas

The values in the "area" column have replicated values. The values in the "area" column are used to track deaths/cases by the province/state/county. Group by "area" column and sum up the date columns.

In [11]:
```
def group_area(df):
    """
    Aggregates data by area, summing up all values.

    Parameters
    ----------
    df : DataFrame

    Returns
    -------
    DataFrame
    """
    grouping_col = df.columns[0]
    return df.groupby(grouping_col).sum()
```

Updating run()

In [12]:
```
#Updating run()function to include the steps above.
def run4():
    """
    Carries out a complete data processing pipeline including grouping by area.

    Returns
    -------
    dict
        Dictionary of aggregated DataFrames.
    """
    data = {}
    for group in GROUPS:
        for kind in KINDS:
            df = read_local_data(group, kind, "data/raw")
            df = select_columns(df)
            df = update_areas(df)
            df = group_area(df)
            data[f"{group}_{kind}"] = df
    return data
```

In [13]:
```
from functions import run4
data = run4()
data['usa_cases'].head(3)
```

Out[13]:

Province_State	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	1/28/20	1/29/20	1/30/20	1/31/20	...	2/2
Alabama	0	0	0	0	0	0	0	0	0	0	...	1638
Alaska	0	0	0	0	0	0	0	0	0	0	...	307
American Samoa	0	0	0	0	0	0	0	0	0	0	...	8

3 rows × 1143 columns

Transposing the Data to Time Series

Rearrange the time series data so the date is along the verticle axis.

In [14]:
```
def transpose_to_ts(df):
    """
    Transposes the DataFrame and converts the index to datetime format.

    Parameters
    ----------
    df : DataFrame

    Returns
    -------
    DataFrame
    """
    df = df.T
    df.index = pd.to_datetime(df.index)
    return df
```

Update run()

In [15]:
```
#Updating run()function to include the steps above.
def run5():
    """
    Executes a comprehensive data processing pipeline, including transposition to

    Returns
    -------
    dict
        Dictionary of processed timeseries DataFrames.
    """
    data = {}
    for group in GROUPS:
        for kind in KINDS:
            df = read_local_data(group, kind, "data/raw")
            df = select_columns(df)
            df = update_areas(df)
            df = group_area(df)
            df = transpose_to_ts(df)
            data[f"{group}_{kind}"] = df
    return data
```

In [16]:
```
from functions import run5
data = run5()
data['usa_cases'].tail(3)
```

Out[16]:

Province_State	Alabama	Alaska	American Samoa	Arizona	Arkansas	California	Colorado	Connecticut	Cruise Ship	Del
2023-03-07	1642062	307655	8320	2440294	1006336	12120965	1763574	976310	152	3
2023-03-08	1644533	307655	8320	2443514	1006622	12120965	1764401	976494	152	3
2023-03-09	1644533	307655	8320	2443514	1006883	12129699	1764401	976657	152	3

3 rows × 57 columns

Finding and Handling Bad Data - World Deaths DataFrame

This DataFrames tracks the total number of deaths and cases by date and location. Since these numbers are cumulative, they should always be the same or increase over time but never decrease. The 'cummax' method helps sum each date's numbers and compare them with all the previous dates to confirm that they're not smaller. This ensures our cumulative counts are continuously increasing.

In [17]:
```
world_deaths = data['world_deaths']
bad_data = world_deaths < world_deaths.cummax()
bad_data.tail(5)
```

Out[17]:

Country/Region	Afghanistan	Albania	Algeria	Andorra	Angola	Antarctica	Antigua and Barbuda	Argentina	Armenia	Austr
2023-03-05	False	False	False	False	False	False	False	False	False	F
2023-03-06	False	False	False	False	False	False	False	False	False	F
2023-03-07	False	False	False	False	False	False	False	False	False	F
2023-03-08	False	False	False	False	False	False	False	False	False	F
2023-03-09	False	False	False	False	False	False	False	False	False	F

5 rows × 200 columns

If any values are "True" this indicates bad data. We can see what countries have the most bad data by summing up each column and sorting.

In [18]:
```
bad_data.sum().sort_values(ascending=False).head(10)
```

Out[18]:
```
Country/Region
Senegal                 351
Kyrgyzstan              221
Andorra                 166
Honduras                153
Monaco                  128
Congo (Brazzaville)     127
Malawi                  108
Spain                   106
Sao Tome and Principe   103
Estonia                  80
dtype: int64
```

Locate the bad data for a few countries with the highest amounts of bad data.

Senegal Bad Data

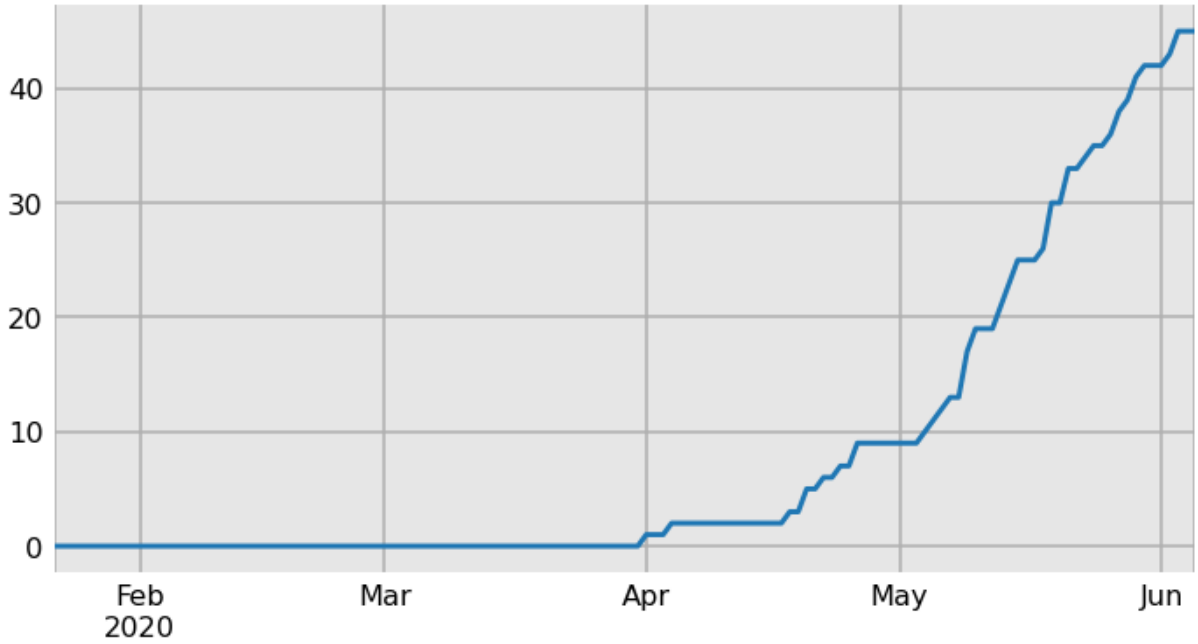
In [19]:
```
senegal_bad = bad_data['Senegal']
senegal_bad[senegal_bad].head(10)
```

Out[19]:
```
2022-03-24    True
2022-03-25    True
2022-03-26    True
2022-03-27    True
2022-03-28    True
2022-03-29    True
2022-03-30    True
2022-03-31    True
2022-04-01    True
2022-04-02    True
Name: Senegal, dtype: bool
```

In [20]:
```
world_deaths.loc['2020-03-24':'2020-04-02', 'Senegal']
```

Out[20]:
```
2020-03-24    0
2020-03-25    0
2020-03-26    0
2020-03-27    0
2020-03-28    0
2020-03-29    0
2020-03-30    0
2020-03-31    0
2020-04-01    1
2020-04-02    1
Name: Senegal, dtype: int64
```

In [21]:
```
import matplotlib.pyplot as plt
plt.style.use('dashboard.mplstyle')
world_deaths.loc['2020-01-20':'2020-06-05', 'Senegal'].plot();
```



Malawi Bad Data

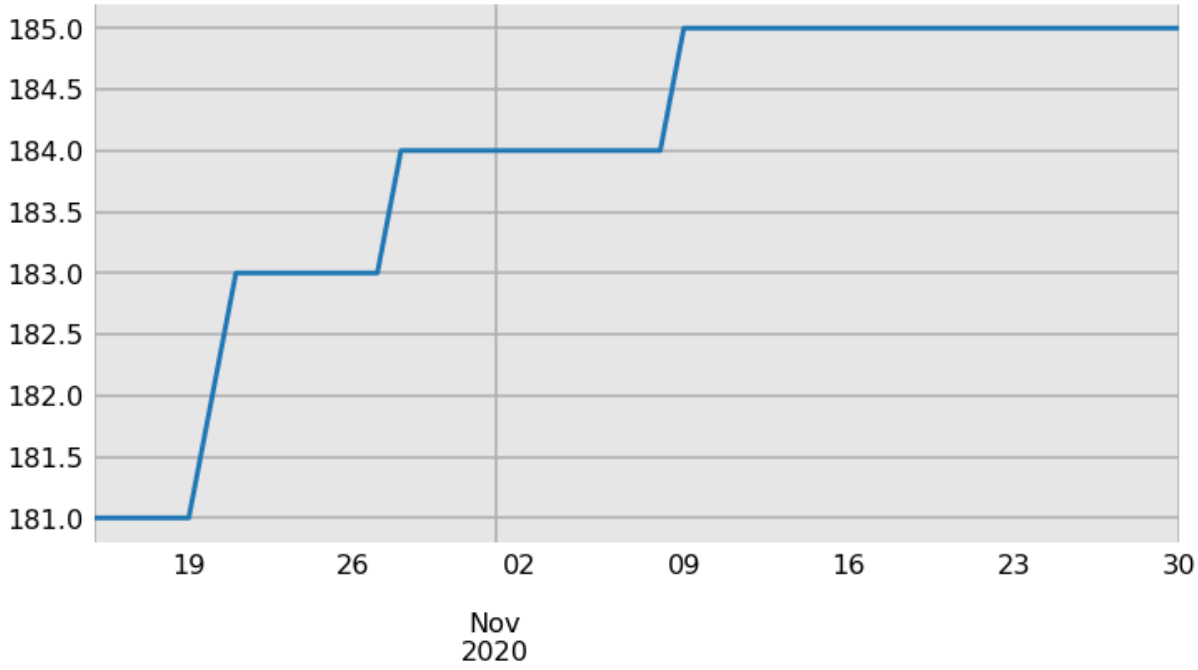
In [22]:
```
malawi_bad = bad_data['Malawi']
malawi_bad[malawi_bad].head()
```

Out[22]:
```
2022-11-22    True
2022-11-23    True
2022-11-24    True
2022-11-25    True
2022-11-26    True
Name: Malawi, dtype: bool
```

In [23]:
```
world_deaths.loc['2020-11-22':'2020-11-28', 'Malawi']
```

Out[23]:
```
2020-11-22    185
2020-11-23    185
2020-11-24    185
2020-11-25    185
2020-11-26    185
2020-11-27    185
2020-11-28    185
Name: Malawi, dtype: int64
```

In [24]:
```
import matplotlib.pyplot as plt
plt.style.use('dashboard.mplstyle')
world_deaths.loc['2020-10-15':'2020-11-30', 'Malawi'].plot();
```



Estonia Bad Data

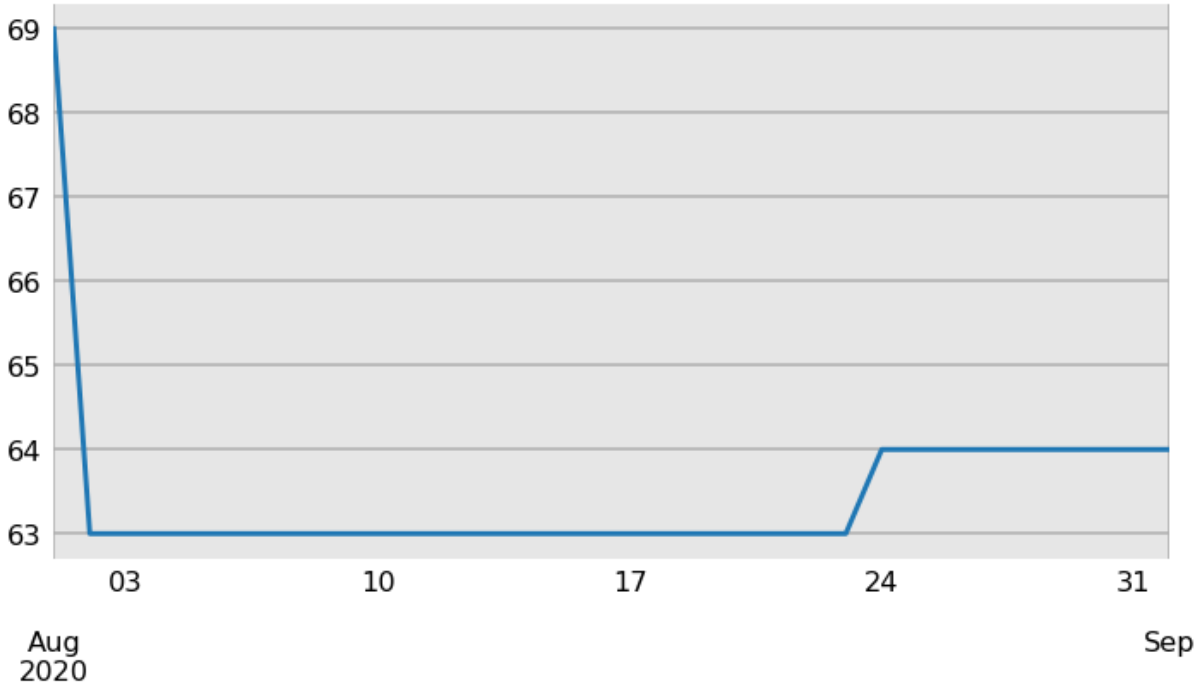
In [25]:
```
estonia_bad = bad_data['Estonia']
estonia_bad[estonia_bad].head()
```

Out[25]:
```
2020-08-02    True
2020-08-03    True
2020-08-04    True
2020-08-05    True
2020-08-06    True
Name: Estonia, dtype: bool
```

In [26]:
```
world_deaths.loc['2020-08-01':'2020-08-10', 'Estonia']
```

Out[26]:
```
2020-08-01    69
2020-08-02    63
2020-08-03    63
2020-08-04    63
2020-08-05    63
2020-08-06    63
2020-08-07    63
2020-08-08    63
2020-08-09    63
2020-08-10    63
Name: Estonia, dtype: int64
```

In [27]:
```
import matplotlib.pyplot as plt
plt.style.use('dashboard.mplstyle')
world_deaths.loc['2020-08-01':'2020-09-01', 'Estonia'].plot();
```



Spain Bad Data

In [28]:
```
spain_bad = bad_data['Spain']
spain_bad[spain_bad].head()
```

Out[28]:
```
2020-05-25    True
2020-05-26    True
2020-05-27    True
2020-05-28    True
2020-05-29    True
Name: Spain, dtype: bool
```

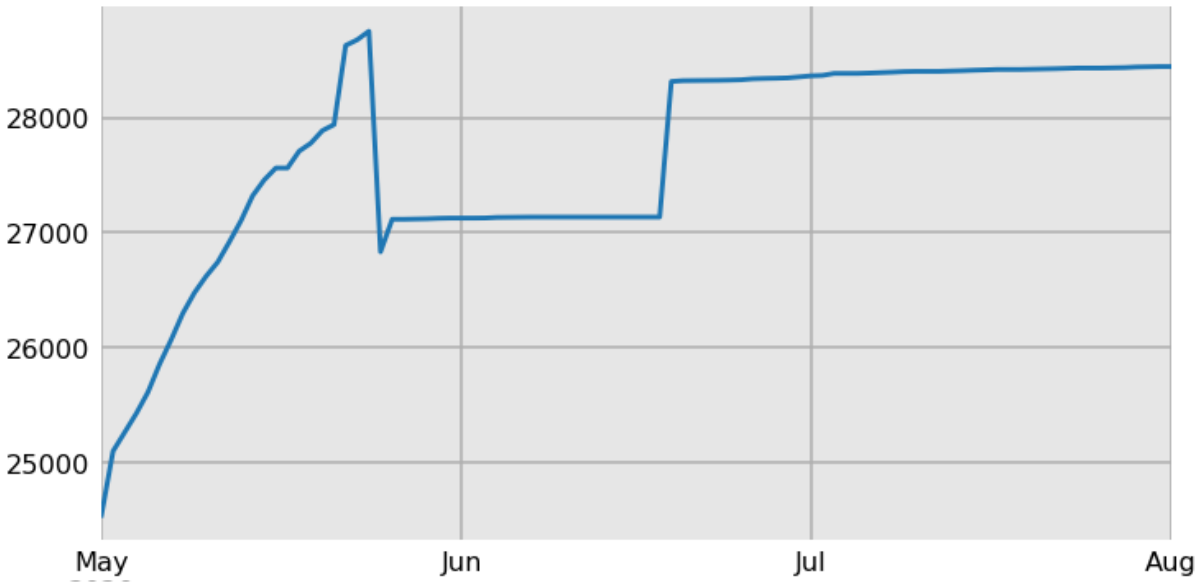
Inspect a subset of the data around the first sighting of bad data.

In [29]:
```
world_deaths.loc['2020-05-21':'2020-05-26', 'Spain']
```

Out[29]:
```
2020-05-21    27940
2020-05-22    28628
2020-05-23    28678
2020-05-24    28752
2020-05-25    26834
2020-05-26    27117
Name: Spain, dtype: int64
```

A drop of nearly 2,000 deaths occurred on May 25th. Plotting Spain's total deaths starting from the beginning of May will provide a better plot of what is happening.

In [30]:
```
import matplotlib.pyplot as plt
plt.style.use('dashboard.mplstyle')
world_deaths.loc['2020-05-01':'2020-08-01', 'Spain'].plot();
```



No new deaths were reported after the decline on May 25th, but in the second half of June, there was a significant increase in deaths shortly after there was a period with a low amount of deaths.

It is necessary to ensure all dates have a value greater than or equal to the previous day. A practical approach is creating a series of booleans with the same length as the original data series that meets some criteria using the mask method.

In [31]:
```
spain = world_deaths['Spain']
mask = spain < spain.cummax()
mask.tail()
```

Out[31]:
```
2023-03-05    False
2023-03-06    False
2023-03-07    False
2023-03-08    False
2023-03-09    False
Name: Spain, dtype: bool
```

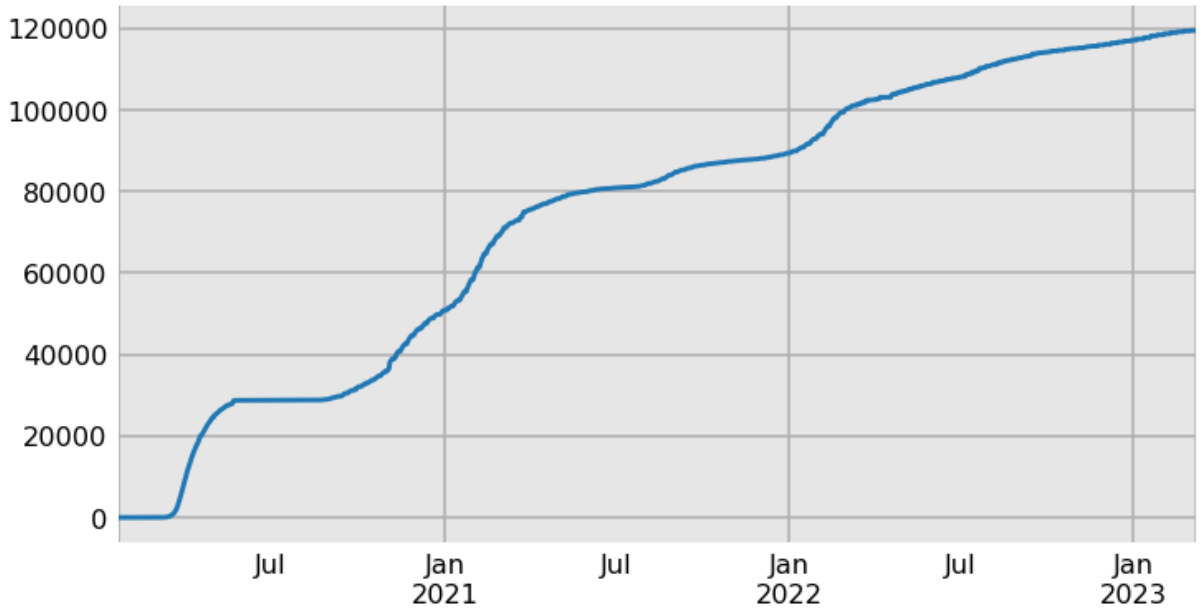
Values that don't meet the criteria specified above will replaced with missing values.

In [32]:
```
#shows us missing values
spain_masked = spain.mask(mask)
spain_masked[spain_masked.isna()].head(10)
```

Out[32]:
```
2020-05-25   NaN
2020-05-26   NaN
2020-05-27   NaN
2020-05-28   NaN
2020-05-29   NaN
2020-05-30   NaN
2020-05-31   NaN
2020-06-01   NaN
2020-06-02   NaN
2020-06-03   NaN
Name: Spain, dtype: float64
```

Using linear interpolation the "fixed" data can be plotted.

In [33]:
```
spain_masked.interpolate().plot();
```



The values are now constantly increasing appropriately. The values are always at least as large as the preceding value. Smoothing the graph will help deal with uneven jumps in the data, making the graphs more straightforward.

Fixing All Bad Data

The "cummax" method can be applied similar to above. It is also helpful to round totals to whole numbers.

In [34]:
```
mask = world_deaths < world_deaths.cummax()
world_deaths_fixed = world_deaths.mask(mask).interpolate().round(0).astype('int64'
world_deaths_fixed.tail(3)
```

Out[34]:

Country/Region	Afghanistan	Albania	Algeria	Andorra	Angola	Antarctica	Antigua and Barbuda	Argentina	Armenia	Austr
2023-03-07	7896	3598	6881	165	1933	0	146	130472	8721	19
2023-03-08	7896	3598	6881	165	1933	0	146	130472	8727	19
2023-03-09	7896	3598	6881	165	1933	0	146	130472	8727	19

3 rows × 200 columns

In [35]:
```
mask = world_deaths_fixed < world_deaths_fixed.cummax()
mask.sum().sum()
```

Out[35]:
```
0
```

In [36]:
```
def fix_bad_data(df):
    """
    Corrects any anomalies in the data where daily counts decrease.

    Parameters
    ----------
    df : DataFrame

    Returns
    -------
    DataFrame
    """
    mask = df < df.cummax()
    df = df.mask(mask).interpolate().round(0).astype("int64")
    return df
```

In [37]:
```
#Updating run()function to include the steps above.
def run6():
    """
    Executes a complete data processing and cleaning pipeline.

    Returns
    -------
    dict
        Dictionary of cleaned and processed DataFrames.
    """
    data = {}
    for group in GROUPS:
        for kind in KINDS:
            df = read_local_data(group, kind, "data/raw")
            df = select_columns(df)
            df = update_areas(df)
            df = group_area(df)
            df = transpose_to_ts(df)
            df = fix_bad_data(df)
            data[f"{group}_{kind}"] = df
    return data
```

In [38]:
```
from functions import run6
data = run6()
data['world_cases'].head(3)
```

Out[38]:

Country/Region	Afghanistan	Albania	Algeria	Andorra	Angola	Antarctica	Antigua and Barbuda	Argentina	Armenia	Austr
2020-01-22	0	0	0	0	0	0	0	0	0	
2020-01-23	0	0	0	0	0	0	0	0	0	
2020-01-24	0	0	0	0	0	0	0	0	0	

3 rows × 200 columns

Data Preparation Complete

In [39]:
```
from functions import write_data
write_data(data, 'data/prepared', index=True, index_label='date')
```

Encapsulate all Steps into a Single Class

Combine all data preparation steps into a single class.

In [40]:
```
class PrepareData:
    def __init__(self, download_new=True):
        self.download_new = download_new
```

To check your work run the following code:

In [41]:
```
from prepare import PrepareData
prepare_data = PrepareData()
data = prepare_data.run()
data['world_deaths'].head()
```

Out[41]:

Country/Region	Afghanistan	Albania	Algeria	Andorra	Angola	Antarctica	Antigua and Barbuda	Argentina	Armenia	Aust
2020-01-22	0	0	0	0	0	0	0	0	0	
2020-01-23	0	0	0	0	0	0	0	0	0	
2020-01-24	0	0	0	0	0	0	0	0	0	
2020-01-25	0	0	0	0	0	0	0	0	0	
2020-01-26	0	0	0	0	0	0	0	0	0	

5 rows × 199 columns