In [ ]:

```
import numpy as np
import pandas as pd
import os
import re
import seaborn as sns
import matplotlib.pyplot as plt
import sklearn
from sklearn import linear_model
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, mean_absolute_error
from sklearn import preprocessing
from matplotlib.dates import DateFormatter
from sklearn.base import BaseEstimator, RegressorMixin
from sklearn.utils.validation import check_X_y, check_array, check_is_fitted
```

In [ ]:

```
df = pd.read_csv("Work Term Report Data.csv")
df.head()
```

Out[ ]:

	Date	Barcelona_Fabra Daily Rainfall [mm]	Barcelona Daily Rainfall [mm]	Sabadell_Aero Daily Rainfall [mm]	Garriga Discharge [m^3]	Castellar Discharge [m^3]	Llica Discharge [m^3]
0	1/1/2003	0.0	0.0	0.0	0.254	0.0327	0.155
1	1/2/2003	0.0	0.0	NaN	0.254	0.0281	0.151
2	1/3/2003	0.0	0.0	NaN	0.246	0.0225	0.145
3	1/4/2003	0.0	0.0	0.0	0.251	0.0300	0.145
4	1/5/2003	18.1	16.4	2.1	0.241	0.0328	0.146

In [ ]:

```
plt.figure(figsize=(20, 60))
```

Out[ ]:

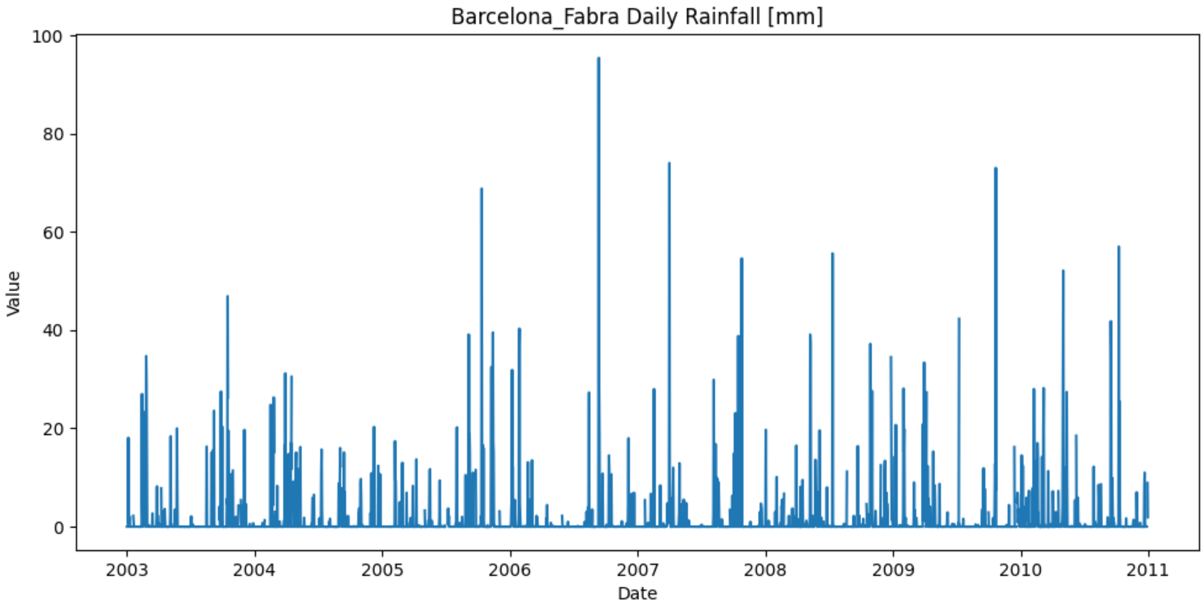
```
<Figure size 2000x6000 with 0 Axes>
```

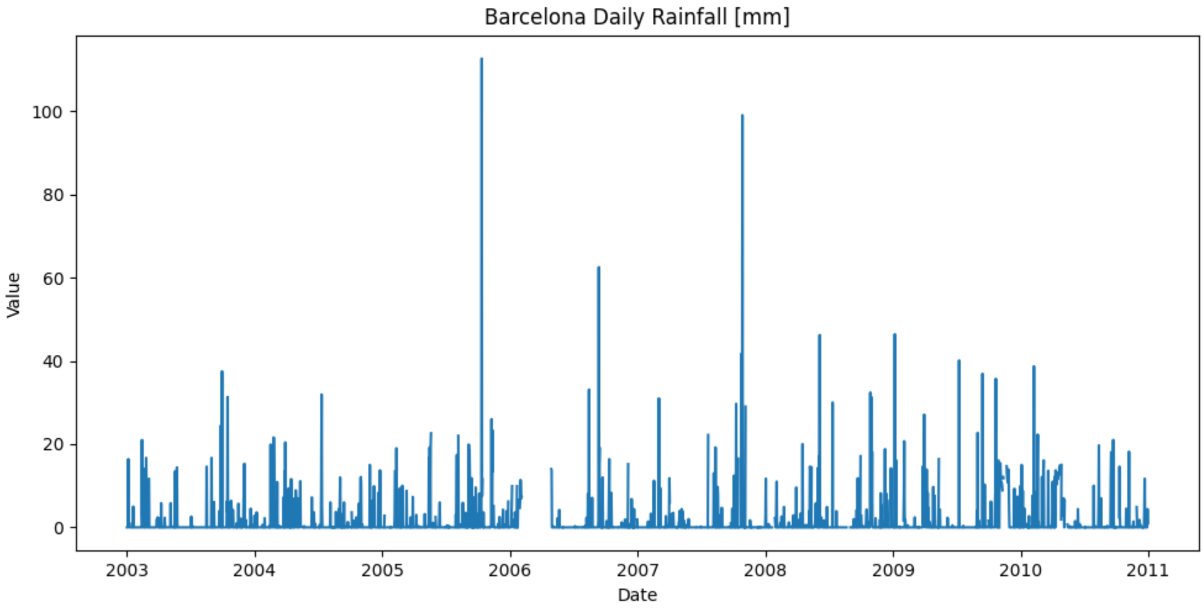
```
<Figure size 2000x6000 with 0 Axes>
```

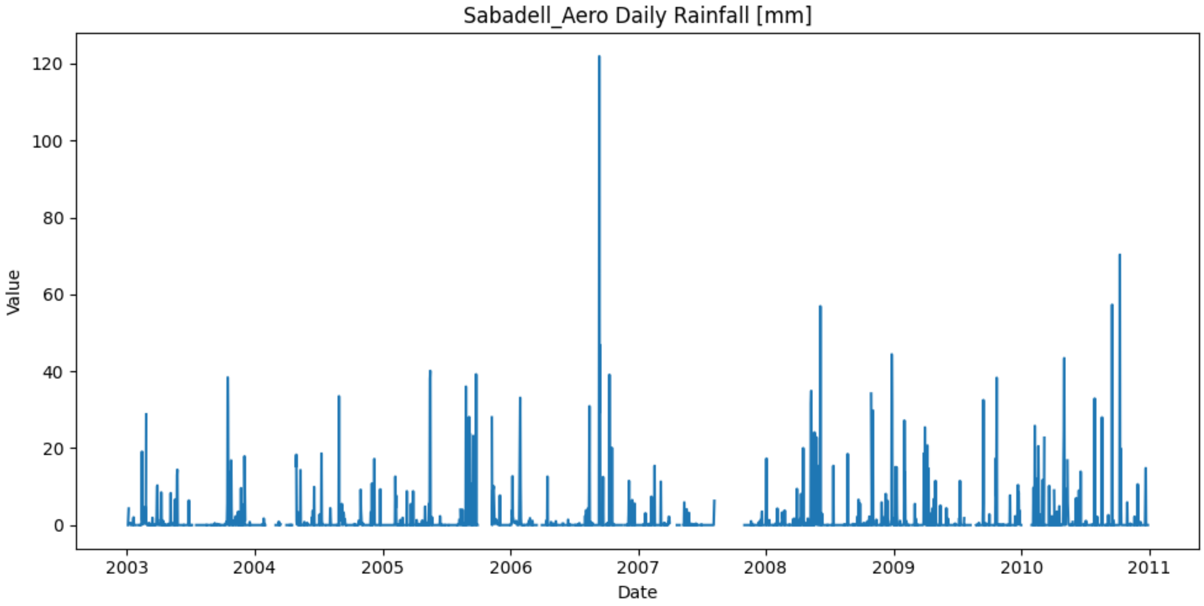
In [ ]:

```
dates = pd.to_datetime(df.iloc[:,0])  # Convert the first column to datetime
num_cols = len(df.columns) - 1  # Number of columns to plot, excluding the first co

# Create subplots for each column
fig, axs = plt.subplots(num_cols, 1, figsize=(10, 5*num_cols))

# Plot each column as a separate plot
for i, col in enumerate(df.columns[1:]):
    axs[i].plot(dates, df[col])
    axs[i].set_title(col)
    axs[i].set_ylabel('Value')
    axs[i].set_xlabel('Date')

# Set the x-axis label for the last plot
```

```python


# Adjust subplot spacing
fig.tight_layout()

# Show the plot
plt.show()
```


Barcelona_Fabra Daily Rainfall [mm]
Value
100
80
60
40
20
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date


Barcelona Daily Rainfall [mm]
Value
100
80
60
40
20
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date

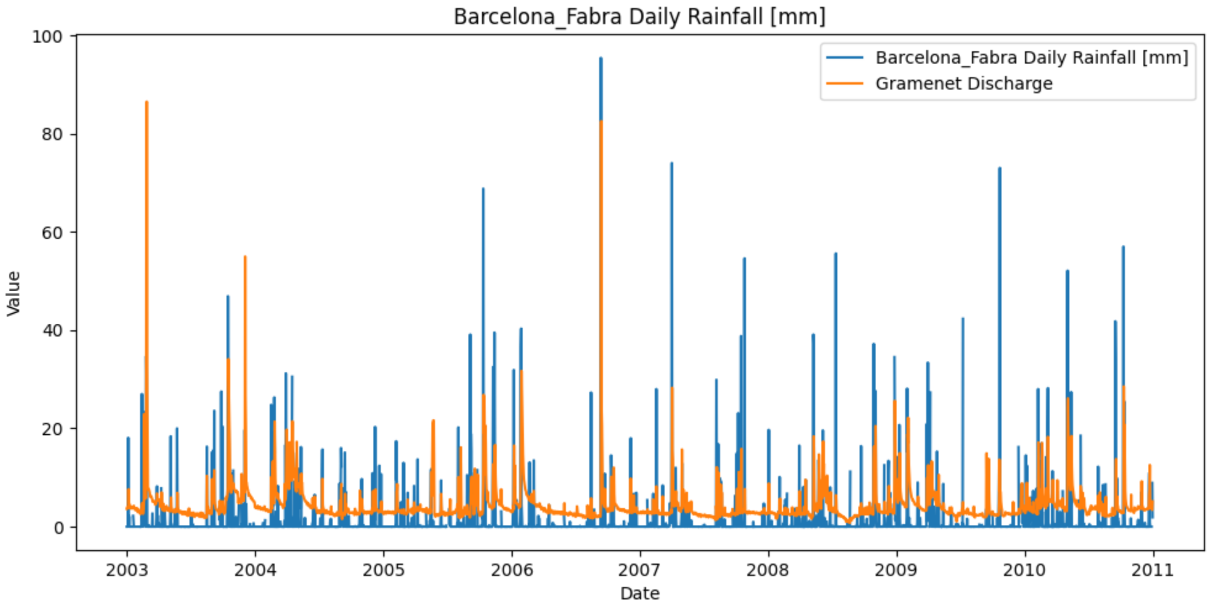

Sabadell_Aero Daily Rainfall [mm]
Value
120
100
80
60
40
20
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date

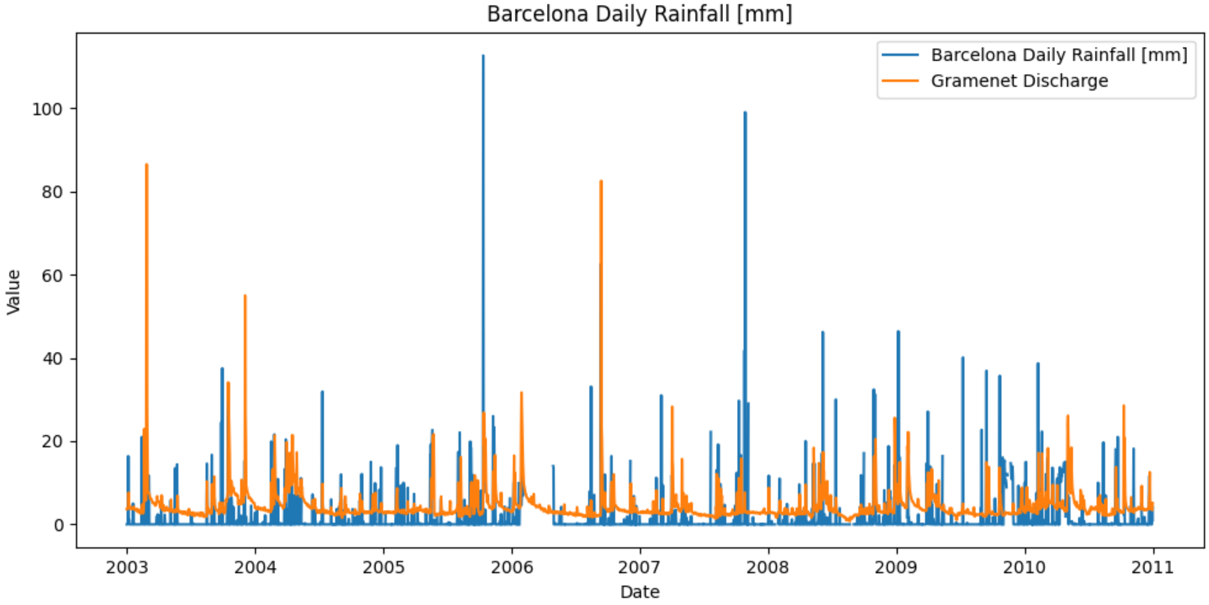
Garriga Discharge [m^3]
20.0

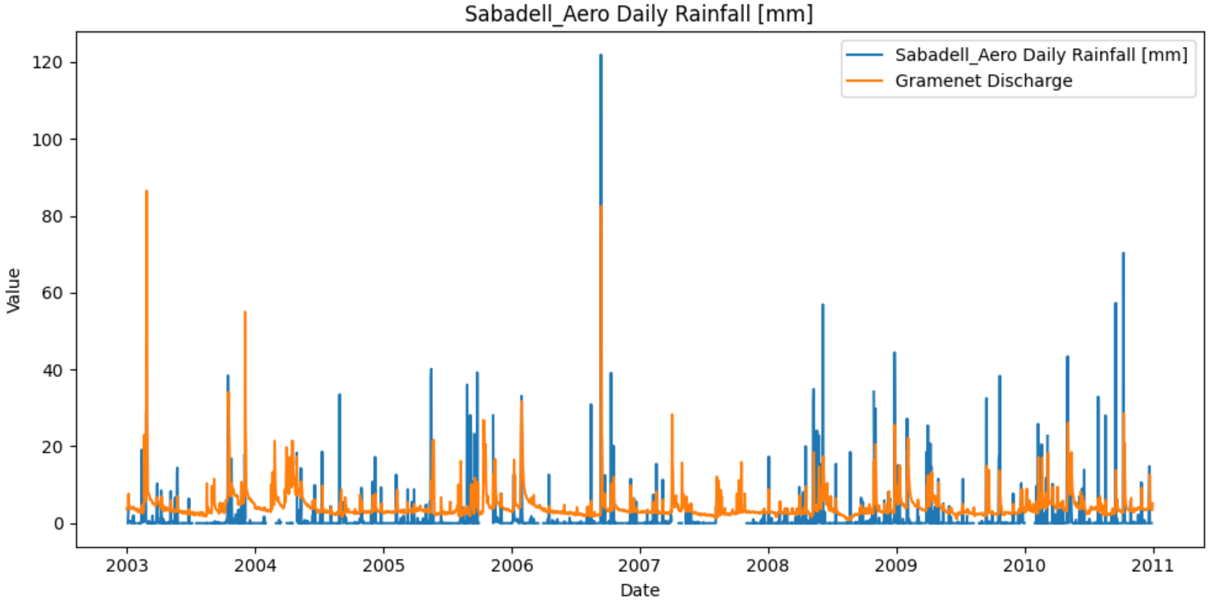
In [ ]:

```
dates = pd.to_datetime(df.iloc[:,0])  # Convert the first column to datetime
num_cols = len(df.columns) - 1  # Number of columns to plot, excluding the first co

# Create subplots for each column
fig, axs = plt.subplots(num_cols, 1, figsize=(10, 5*num_cols))
```

```
# Plot each column as a separate plot
for i, col in enumerate(df.columns[1:]):
    axs[i].plot(dates, df[col], label=col)
    axs[i].set_title(col)
    axs[i].set_ylabel('Value')
    axs[i].set_xlabel('Date')

    axs[i].plot(dates, df.iloc[:, -1], label='Gramenet Discharge')
    axs[i].legend()

# Adjust subplot spacing
fig.tight_layout()
# Show the plot
plt.show()
```


Barcelona_Fabra Daily Rainfall [mm]
Barcelona_Fabra Daily Rainfall [mm]
Gramenet Discharge
Value
0
20
40
60
80
100
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date

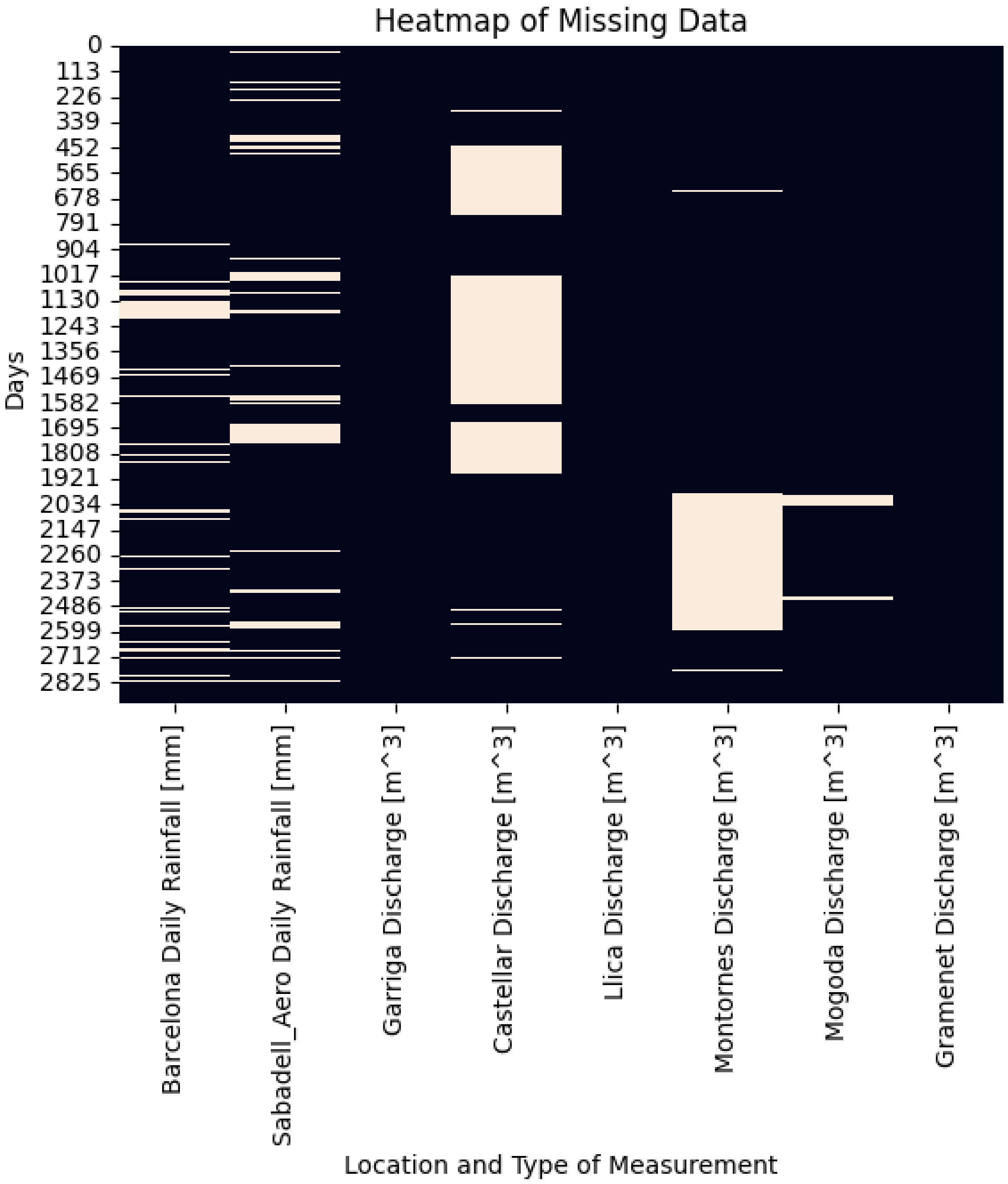

Barcelona Daily Rainfall [mm]
Barcelona Daily Rainfall [mm]
Gramenet Discharge
Value
0
20
40
60
80
100
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date


Sabadell_Aero Daily Rainfall [mm]
Sabadell_Aero Daily Rainfall [mm]
Gramenet Discharge
Value
0
20
40
60
80
100
120
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date

Garriga Discharge [m^3]
Garriga Discharge [m^3]

In [ ]:

```
sns.heatmap(df.iloc[:,2:].isnull(), cbar=False)
plt.ylabel('Days')
plt.xlabel('Location and Type of Measurement')
plt.title('Heatmap of Missing Data')
plt.show()
```



In [ ]:
```
df.drop('Castellar Discharge [m^3]', inplace = True, axis=1)
df.drop('Montornes Discharge [m^3]', inplace = True, axis=1)
df.head()
```

Out[ ]:

	Date	Barcelona_Fabra Daily Rainfall [mm]	Barcelona Daily Rainfall [mm]	Sabadell_Aero Daily Rainfall [mm]	Garriga Discharge [m^3]	Llica Discharge [m^3]	Mogoda Discharge [m^3]
0	1/1/2003	0.0	0.0	0.0	0.254	0.155	0.120
1	1/2/2003	0.0	0.0	NaN	0.254	0.151	0.106
2	1/3/2003	0.0	0.0	NaN	0.246	0.145	0.101
3	1/4/2003	0.0	0.0	0.0	0.251	0.145	0.099
4	1/5/2003	18.1	16.4	2.1	0.241	0.146	0.097

In [ ]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2922 entries, 0 to 2921
Data columns (total 8 columns):
 #   Column                              Non-Null Count  Dtype  
---  ------                              --------------  -----  
 0   Date                                2922 non-null   object 
 1   Barcelona_Fabra Daily Rainfall [mm]  2679 non-null   float64
 2   Barcelona Daily Rainfall [mm]        2699 non-null   float64
 3   Sabadell_Aero Daily Rainfall [mm]    2516 non-null   float64
 4   Garriga Discharge [m^3]              2922 non-null   float64
 5   Llica Discharge [m^3]                2922 non-null   float64
 6   Mogoda Discharge [m^3]               2852 non-null   float64
 7   Gramenet Discharge [m^3]             2922 non-null   float64
dtypes: float64(7), object(1)
memory usage: 182.8+ KB
```

In [ ]:

```
df.corr()
```

```
C:\Users\hocke\AppData\Local\Temp\ipykernel_9684\1134722465.py:1: FutureWarning: The
default value of numeric_only in DataFrame.corr is deprecated. In a future version,
it will default to False. Select only valid columns or specify the value of numeric_
only to silence this warning.
  df.corr()
```

Out[ ]:

	Barcelona_Fabra Daily Rainfall [mm]	Barcelona Daily Rainfall [mm]	Sabadell_Aero Daily Rainfall [mm]	Garriga Discharge [m^3]	Llica Discharge [m^3]	Mogod Discharg [m^
Barcelona_Fabra Daily Rainfall [mm]	1.000000	0.680609	0.806012	0.170962	0.202106	0.36965
Barcelona Daily Rainfall [mm]	0.680609	1.000000	0.646151	0.090237	0.126251	0.23346
Sabadell_Aero Daily Rainfall [mm]	0.806012	0.646151	1.000000	0.217428	0.178946	0.40014
Garriga Discharge [m^3]	0.170962	0.090237	0.217428	1.000000	0.611243	0.62549
Llica Discharge [m^3]	0.202106	0.126251	0.178946	0.611243	1.000000	0.61212
Mogoda Discharge [m^3]	0.369651	0.233462	0.400147	0.625492	0.612124	1.00000
Gramenet Discharge [m^3]	0.330710	0.201358	0.338390	0.757268	0.655422	0.80298

In [ ]:

```
df2 = df.copy(deep=True)
```

In [ ]:

```
df = df.dropna()
```

In [ ]:

```
df.info()
#Now we have clean data that can be used for the MLR analysis.
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 2076 entries, 0 to 2918
Data columns (total 8 columns):
 #   Column                               Non-Null Count  Dtype  
---  ------                               --------------  -----  
 0   Date                                 2076 non-null   object 
 1   Barcelona_Fabra Daily Rainfall [mm]  2076 non-null   float64
 2   Barcelona Daily Rainfall [mm]        2076 non-null   float64
 3   Sabadell_Aero Daily Rainfall [mm]    2076 non-null   float64
 4   Garriga Discharge [m^3]              2076 non-null   float64
 5   Llica Discharge [m^3]                2076 non-null   float64
 6   Mogoda Discharge [m^3]               2076 non-null   float64
 7   Gramenet Discharge [m^3]             2076 non-null   float64
dtypes: float64(7), object(1)
memory usage: 146.0+ KB
```

In [ ]:

```
x = df.drop(['Date', 'Gramenet Discharge [m^3]'], axis=1)
y = df['Gramenet Discharge [m^3]']
```

In [ ]:

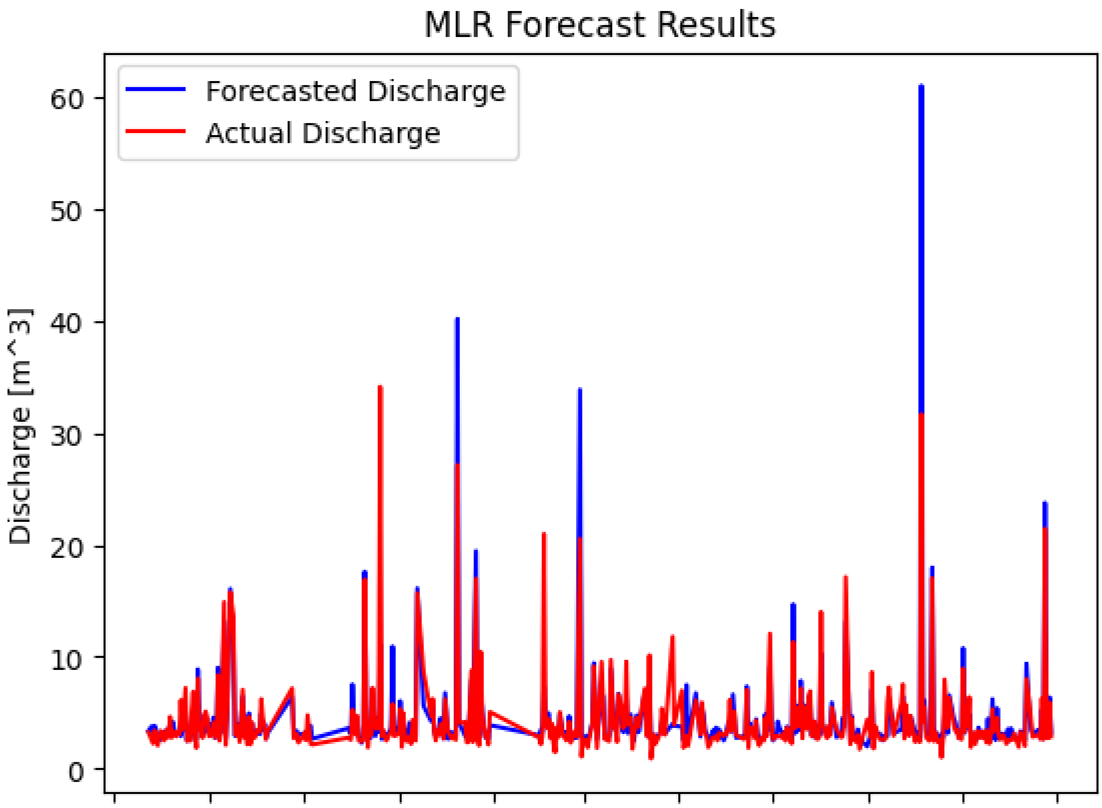
```
x_train, x_test, y_train, y_test = train_test_split(
    x, y, test_size=0.2, random_state=101)
```

In [ ]:

```
# Create a linear regression model and train it using the specified training data.
model = LinearRegression()
model.fit(x_train, y_train)

predictions = model.predict(x_test)
```

In [ ]:

```
fig, ax = plt.subplots()

forecast_dates = pd.to_datetime(df['Date'][-len(predictions):])

# Plot the two columns against each other
ax.plot(forecast_dates, predictions, color='blue')
ax.set_ylabel('Discharge [m^3]')
ax.set_xticklabels([])
ax.plot(forecast_dates, y_test, color='red')

ax.legend(['Forecasted Discharge', 'Actual Discharge'])
plt.title('MLR Forecast Results')




# Show the plot
plt.show()
```



```
In [ ]: export = pd.DataFrame({'List1': y_test, 'List2': predictions})

        # Save the dataframe to an Excel file
        export.to_excel('my_lists.xlsx', index=False)
```

```
In [ ]: mlr_mse = sklearn.metrics.mean_squared_error(y_test, predictions, squared = False)
        print(mlr_mse)
        mlr_mae = sklearn.metrics.mean_absolute_error(y_test, predictions)
        print(mlr_mae)
```

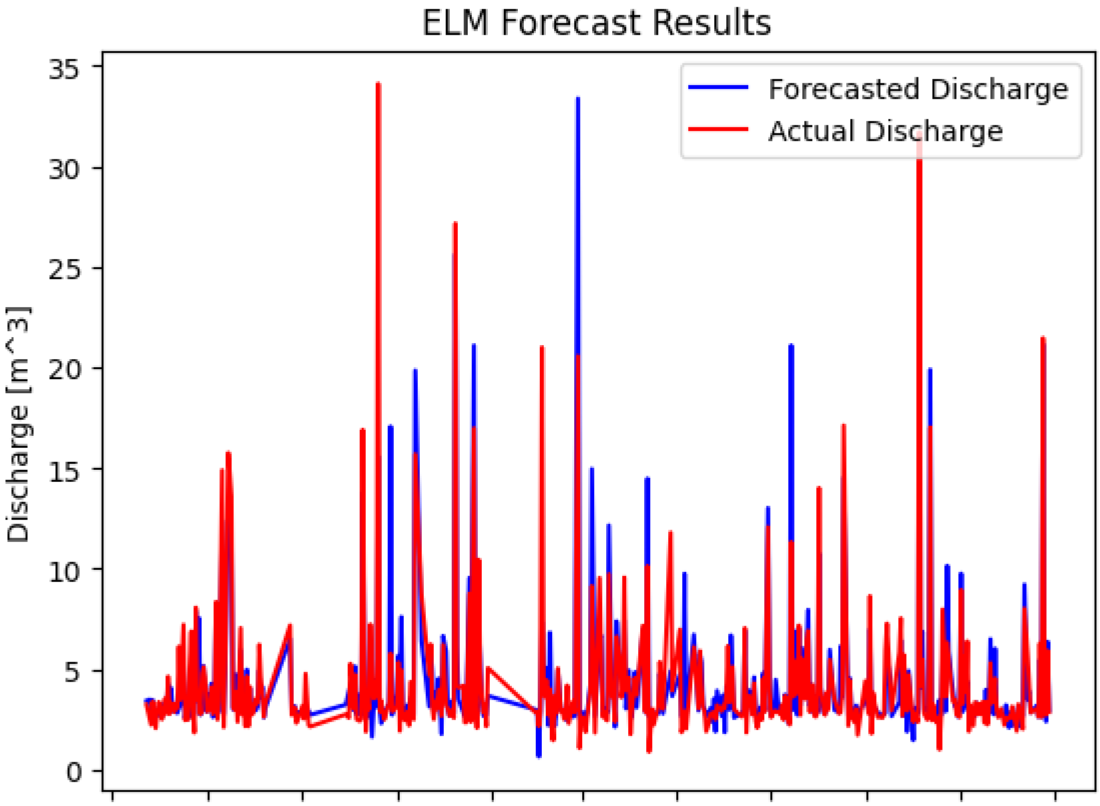
```
2.3824622880655144
0.8509254103634573
```

```
In [ ]: def sigmoid_activation(x):
            return 1/(1+np.exp(-x))

        p = 6
        N = 2076
```

```
In [ ]: elm_mse_list = []
        elm_mae_list = []
        ELM_predictions_list = []

        for i in range(100):
            W, b = np.random.random((p, i)), np.random.random(i)
            H = sigmoid_activation((x_train @ W) + b)                # Step 2: Hidden lay
            beta_hat = np.linalg.pinv(H) @ y_train

            H = sigmoid_activation((x_test @ W) + b)
            ELM_predictions = H @ beta_hat
```

```
    ELM_predictions_list.append(ELM_predictions)
    elm_mse = sklearn.metrics.mean_squared_error(y_test, ELM_predictions, squared =
    elm_mse_list.append(elm_mse)
    elm_mae = sklearn.metrics.mean_absolute_error(y_test, ELM_predictions)
    elm_mae_list.append(elm_mae)


print(min(elm_mse_list))
print(min(elm_mae_list))

min_mse_index = elm_mse_list.index(min(elm_mse_list))
min_mae_index = elm_mae_list.index(min(elm_mae_list))

min_overall_index = round((min_mse_index + min_mae_index)/2)

print(min_overall_index)

fig, ax = plt.subplots()

forecast_dates = pd.to_datetime(df['Date'][-len(predictions):])

# Plot the two columns against each other
ax.plot(forecast_dates, ELM_predictions_list[min_overall_index], color = 'blue')
ax.set_ylabel('Discharge [m^3]')
ax.set_xticklabels([])
ax.plot(forecast_dates, y_test, color='red')

ax.legend(['Forecasted Discharge', 'Actual Discharge'])
plt.title('ELM Forecast Results')




# Show the plot
plt.show()
```

```
1.90755786619104
0.8736766948413008
62
```


ELM Forecast Results
Forecasted Discharge
Actual Discharge
Discharge [m^3]
35
30
25
20
15
10
5
0