```
pip install pandas numpy matplotlib seaborn scikit-learn
```

```
Requirement already satisfied: pandas in /usr/local/lib/python3.11/dist-packages (2.2.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.11/dist-packages (2.0.2)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.11/dist-packages (3.10.0)
Requirement already satisfied: seaborn in /usr/local/lib/python3.11/dist-packages (0.13.2)
Requirement already satisfied: scikit-learn in /usr/local/lib/python3.11/dist-packages (1.6.1)
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.11/dist-packages (from pandas) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.11/dist-packages (from pandas) (2025.2)
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.11/dist-packages (from pandas) (2025.2)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (1.3.2)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (4.58.2)
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (1.4.8)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (24.2)
Requirement already satisfied: pillow>=8 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (11.2.1)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib) (3.2.3)
Requirement already satisfied: scipy>=1.6.0 in /usr/local/lib/python3.11/dist-packages (from scikit-learn) (1.15.3)
Requirement already satisfied: joblib>=1.2.0 in /usr/local/lib/python3.11/dist-packages (from scikit-learn) (1.5.1)
Requirement already satisfied: threadpoolctl>=3.1.0 in /usr/local/lib/python3.11/dist-packages (from scikit-learn) (3.6.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.11/dist-packages (from python-dateutil>=2.8.2->pandas) (1.17.0)
```

```
import pandas as pd
import numpy as np

from sklearn.multioutput import MultiOutputRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, r2_score
```

```
df=pd.read_csv('/content/afa2e701598d20110228.csv', sep=';')
df
```

| | id | date | NH4 | BSK5 | Suspended | O2 | NO3 | NO2 | SO4 | PO4 | CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 17.02.2000 | 0.330 | 2.77 | 12.0 | 12.30 | 9.50 | 0.057 | 154.00 | 0.454 | 289.50 |
| **1** | 1 | 11.05.2000 | 0.044 | 3.00 | 51.6 | 14.61 | 17.75 | 0.034 | 352.00 | 0.090 | 1792.00 |
| **2** | 1 | 11.09.2000 | 0.032 | 2.10 | 24.5 | 9.87 | 13.80 | 0.173 | 416.00 | 0.200 | 2509.00 |
| **3** | 1 | 13.12.2000 | 0.170 | 2.23 | 35.6 | 12.40 | 17.13 | 0.099 | 275.20 | 0.377 | 1264.00 |
| **4** | 1 | 02.03.2001 | 0.000 | 3.03 | 48.8 | 14.69 | 10.00 | 0.065 | 281.60 | 0.134 | 1462.00 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2856** | 22 | 06.10.2020 | 0.046 | 2.69 | 3.6 | 8.28 | 3.80 | 0.038 | 160.00 | 0.726 | 77.85 |
| **2857** | 22 | 27.10.2020 | 0.000 | 1.52 | 0.5 | 11.26 | 0.56 | 0.031 | 147.20 | 0.634 | 71.95 |
| **2858** | 22 | 03.12.2020 | 0.034 | 0.29 | 0.8 | 11.09 | 2.58 | 0.042 | 209.92 | 0.484 | 61.17 |
| **2859** | 22 | 12.01.2021 | 0.000 | 2.10 | 0.0 | 14.31 | 3.94 | 0.034 | 121.60 | 0.424 | 63.49 |
| **2860** | 22 | 10.02.2021 | 0.000 | 1.78 | 0.0 | 14.30 | 6.30 | 0.033 | 134.40 | 0.582 | 66.31 |

2861 rows × 11 columns

Next steps: Generate code with df | View recommended plots | New interactive sheet

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2861 entries, 0 to 2860
Data columns (total 11 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   id         2861 non-null   int64
 1   date       2861 non-null   object
 2   NH4        2858 non-null   float64
 3   BSK5       2860 non-null   float64
 4   Suspended  2845 non-null   float64
 5   O2         2858 non-null   float64
 6   NO3        2860 non-null   float64
 7   NO2        2858 non-null   float64
 8   SO4        2812 non-null   float64
 9   PO4        2833 non-null   float64
 10  CL         2812 non-null   float64
dtypes: float64(9), int64(1), object(1)
memory usage: 246.0+ KB
```

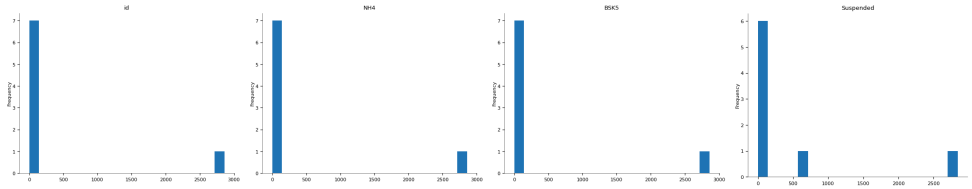
```
df.shape
```

```
(2861, 11)
```

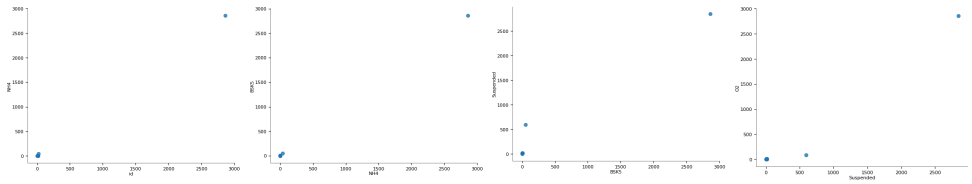
```
df.describe()
```

| | id | NH4 | BSK5 | Suspended | O2 | NO3 | NO2 | SO4 | PO4 | CL |
|---|---|---|---|---|---|---|---|---|---|---|
| **count** | 2861.000000 | 2858.000000 | 2860.000000 | 2845.000000 | 2858.000000 | 2860.000000 | 2858.000000 | 2812.000000 | 2833.000000 | 2812.000000 |
| **mean** | 12.397064 | 0.758734 | 4.316182 | 12.931905 | 9.508902 | 4.316846 | 0.246128 | 59.362313 | 0.418626 | 93.731991 |
| **std** | 6.084226 | 2.486247 | 2.973997 | 16.543097 | 4.428260 | 6.881188 | 2.182777 | 96.582641 | 0.771326 | 394.512184 |
| **min** | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.020000 |
| **25%** | 8.000000 | 0.080000 | 2.160000 | 6.000000 | 7.092500 | 1.390000 | 0.030000 | 27.052500 | 0.130000 | 26.800000 |
| **50%** | 14.000000 | 0.220000 | 3.800000 | 10.000000 | 8.995000 | 2.800000 | 0.059000 | 37.800000 | 0.270000 | 33.900000 |
| **75%** | 16.000000 | 0.500000 | 5.800000 | 15.000000 | 11.520000 | 5.582500 | 0.125750 | 64.640000 | 0.470000 | 45.607500 |
| **max** | 22.000000 | 39.427000 | 50.900000 | 595.000000 | 90.000000 | 133.400000 | 109.000000 | 3573.400000 | 13.879000 | 5615.280000 |

**Distributions**




**2-d distributions**

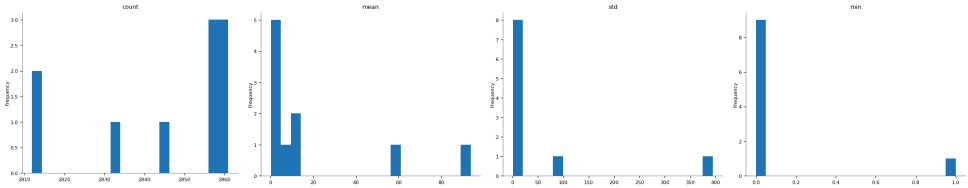


**Values**

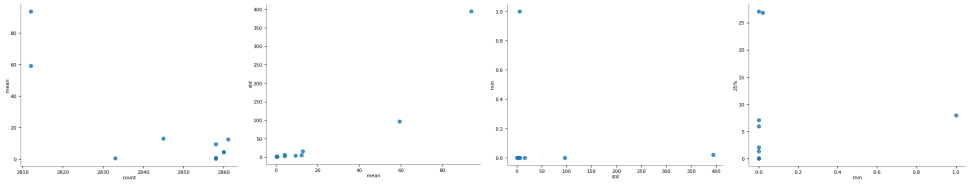

```
df.describe().T
```

| | count | mean | std | min | 25% | 50% | 75% | max |
|---|---|---|---|---|---|---|---|---|
| **id** | 2861.0 | 12.397064 | 6.084226 | 1.00 | 8.0000 | 14.000 | 16.00000 | 22.000 |
| **NH4** | 2858.0 | 0.758734 | 2.486247 | 0.00 | 0.0800 | 0.220 | 0.50000 | 39.427 |
| **BSK5** | 2860.0 | 4.316182 | 2.973997 | 0.00 | 2.1600 | 3.800 | 5.80000 | 50.900 |
| **Suspended** | 2845.0 | 12.931905 | 16.543097 | 0.00 | 6.0000 | 10.000 | 15.00000 | 595.000 |
| **O2** | 2858.0 | 9.508902 | 4.428260 | 0.00 | 7.0925 | 8.995 | 11.52000 | 90.000 |
| **NO3** | 2860.0 | 4.316846 | 6.881188 | 0.00 | 1.3900 | 2.800 | 5.58250 | 133.400 |
| **NO2** | 2858.0 | 0.246128 | 2.182777 | 0.00 | 0.0300 | 0.059 | 0.12575 | 109.000 |
| **SO4** | 2812.0 | 59.362313 | 96.582641 | 0.00 | 27.0525 | 37.800 | 64.64000 | 3573.400 |
| **PO4** | 2833.0 | 0.418626 | 0.771326 | 0.00 | 0.1300 | 0.270 | 0.47000 | 13.879 |
| **CL** | 2812.0 | 93.731991 | 394.512184 | 0.02 | 26.8000 | 33.900 | 45.60750 | 5615.280 |

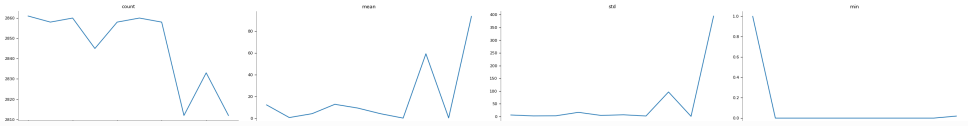
**Distributions**




**2-d distributions**



**Values**




```
df.isnull().sum()
```

| | 0 |
|---|---|
| **id** | 0 |
| **date** | 0 |
| **NH4** | 3 |
| **BSK5** | 1 |
| **Suspended** | 16 |
| **O2** | 3 |
| **NO3** | 1 |
| **NO2** | 3 |
| **SO4** | 49 |
| **PO4** | 28 |
| **CL** | 49 |

```
# Convert the 'date' column to datetime objects, using the correct format
df['date'] = pd.to_datetime(df['date'], format='%d.%m.%Y')
df
```

| | id | date | NH4 | BSK5 | Suspended | O2 | NO3 | NO2 | SO4 | PO4 | CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 2000-02-17 | 0.330 | 2.77 | 12.0 | 12.30 | 9.50 | 0.057 | 154.00 | 0.454 | 289.50 |
| **1** | 1 | 2000-05-11 | 0.044 | 3.00 | 51.6 | 14.61 | 17.75 | 0.034 | 352.00 | 0.090 | 1792.00 |
| **2** | 1 | 2000-09-11 | 0.032 | 2.10 | 24.5 | 9.87 | 13.80 | 0.173 | 416.00 | 0.200 | 2509.00 |
| **3** | 1 | 2000-12-13 | 0.170 | 2.23 | 35.6 | 12.40 | 17.13 | 0.099 | 275.20 | 0.377 | 1264.00 |
| **4** | 1 | 2001-03-02 | 0.000 | 3.03 | 48.8 | 14.69 | 10.00 | 0.065 | 281.60 | 0.134 | 1462.00 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2856** | 22 | 2020-10-06 | 0.046 | 2.69 | 3.6 | 8.28 | 3.80 | 0.038 | 160.00 | 0.726 | 77.85 |
| **2857** | 22 | 2020-10-27 | 0.000 | 1.52 | 0.5 | 11.26 | 0.56 | 0.031 | 147.20 | 0.634 | 71.95 |
| **2858** | 22 | 2020-12-03 | 0.034 | 0.29 | 0.8 | 11.09 | 2.58 | 0.042 | 209.92 | 0.484 | 61.17 |
| **2859** | 22 | 2021-01-12 | 0.000 | 2.10 | 0.0 | 14.31 | 3.94 | 0.034 | 121.60 | 0.424 | 63.49 |
| **2860** | 22 | 2021-02-10 | 0.000 | 1.78 | 0.0 | 14.30 | 6.30 | 0.033 | 134.40 | 0.582 | 66.31 |

2861 rows × 11 columns

Next steps: Generate code with df | View recommended plots | New interactive sheet

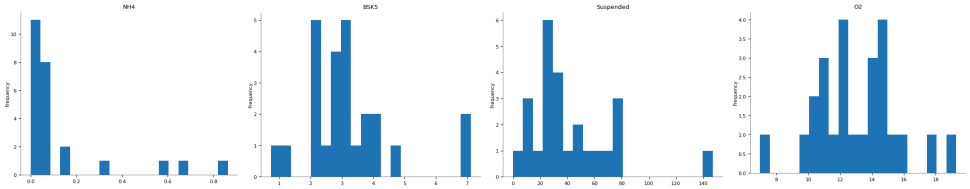
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2861 entries, 0 to 2860
Data columns (total 11 columns):
 #   Column     Non-Null Count  Dtype         
---  ------     --------------  -----         
 0   id         2861 non-null   int64         
 1   date       2861 non-null   datetime64[ns]
 2   NH4        2858 non-null   float64       
 3   BSK5       2860 non-null   float64       
 4   Suspended  2845 non-null   float64       
 5   O2         2858 non-null   float64       
 6   NO3        2860 non-null   float64       
 7   NO2        2858 non-null   float64       
 8   SO4        2812 non-null   float64       
 9   PO4        2833 non-null   float64       
 10  CL         2812 non-null   float64       
dtypes: datetime64[ns](1), float64(9), int64(1)
memory usage: 246.0 KB
```

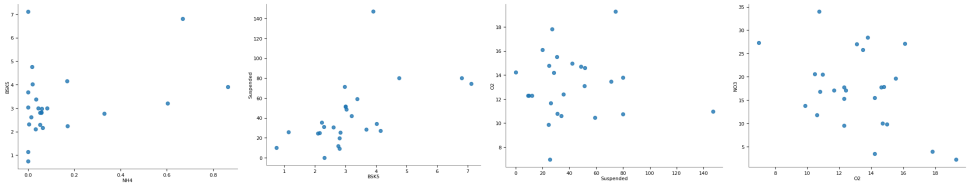
```
df = df.sort_values(by=['id','date'])
df.head(25)
```

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 2000-02-17 | 0.330 | 2.77 | 12.0 | 12.30 | 9.500 | 0.057 | 154.00 | 0.454 | 289.50 |
| **1** | 1 | 2000-05-11 | 0.044 | 3.00 | 51.6 | 14.61 | 17.750 | 0.034 | 352.00 | 0.090 | 1792.00 |
| **2** | 1 | 2000-09-11 | 0.032 | 2.10 | 24.5 | 9.87 | 13.800 | 0.173 | 416.00 | 0.200 | 2509.00 |
| **3** | 1 | 2000-12-13 | 0.170 | 2.23 | 35.6 | 12.40 | 17.130 | 0.099 | 275.20 | 0.377 | 1264.00 |
| **4** | 1 | 2001-03-02 | 0.000 | 3.03 | 48.8 | 14.69 | 10.000 | 0.065 | 281.60 | 0.134 | 1462.00 |
| **5** | 1 | 2001-06-07 | 0.020 | 4.02 | 34.0 | 10.61 | 11.800 | 0.016 | 287.00 | 0.208 | 1183.00 |
| **6** | 1 | 2001-09-10 | 0.863 | 3.91 | 147.0 | 10.96 | 20.500 | 0.284 | 595.20 | 0.674 | 4023.00 |
| **7** | 1 | 2001-11-06 | 0.060 | 2.97 | 71.2 | 13.47 | 25.800 | 0.095 | 314.00 | 0.390 | 1907.00 |
| **8** | 1 | 2002-03-12 | 0.168 | 4.15 | 27.0 | 17.82 | 3.945 | 0.058 | 153.60 | 0.110 | 473.00 |
| **9** | 1 | 2002-06-06 | 0.001 | 7.11 | 74.4 | 19.28 | 2.260 | 0.017 | 409.60 | 0.181 | 1782.00 |
| **10** | 1 | 2002-07-15 | 0.668 | 6.81 | 80.0 | 10.74 | 34.000 | 0.020 | 505.60 | 0.222 | 3160.00 |
| **11** | 1 | 2002-11-07 | 0.082 | 3.00 | 51.4 | 13.08 | 27.050 | 0.092 | 314.00 | 0.179 | 1907.00 |
| **12** | 1 | 2003-02-24 | 0.603 | 3.20 | 42.0 | 14.97 | 9.870 | 0.169 | 160.00 | 0.130 | 403.70 |
| **13** | 1 | 2003-06-13 | 0.058 | 2.80 | 9.3 | 12.30 | 15.300 | 0.060 | 500.00 | 0.300 | 2325.00 |
| **14** | 1 | 2003-09-16 | 0.053 | 2.30 | 31.2 | 10.80 | 16.800 | 0.078 | 498.50 | 0.380 | 2375.00 |
| **15** | 1 | 2003-10-14 | 0.017 | 4.76 | 80.0 | 13.77 | 28.400 | 0.048 | 518.40 | 0.371 | 3304.50 |
| **16** | 1 | 2004-03-15 | 0.014 | 2.61 | 30.8 | 15.51 | 19.610 | 0.052 | 557.80 | 0.150 | 1075.00 |
| **17** | 1 | 2004-06-10 | 0.035 | 3.38 | 59.2 | 10.47 | 20.610 | 0.081 | 708.40 | 0.200 | 2122.83 |
| **18** | 1 | 2004-09-06 | 0.057 | 2.83 | 25.6 | 6.97 | 27.300 | 0.120 | 416.16 | 0.780 | 2669.60 |
| **19** | 1 | 2004-12-14 | 0.053 | 2.80 | 19.9 | 16.10 | 27.080 | 0.130 | 540.60 | 0.820 | 2425.00 |
| **20** | 1 | 2005-01-17 | 0.000 | 1.14 | 26.0 | 11.66 | 17.100 | 0.043 | 262.40 | 0.530 | 836.60 |
| **21** | 1 | 2005-05-14 | 0.004 | 2.31 | 0.0 | 14.21 | 3.480 | 0.044 | 183.40 | 0.000 | 463.30 |
| **22** | 1 | 2005-09-02 | 0.000 | 3.68 | 28.5 | 14.20 | 15.510 | 0.033 | 422.40 | 0.900 | 2063.80 |
| **23** | 1 | 2005-12-22 | 0.063 | 2.16 | 24.8 | 14.78 | 17.900 | 0.052 | 288.00 | 0.380 | 1291.60 |
| **24** | 1 | 2006-03-20 | 0.000 | 0.74 | 10.0 | 12.30 | 17.730 | 0.087 | 224.00 | 0.270 | 489.00 |

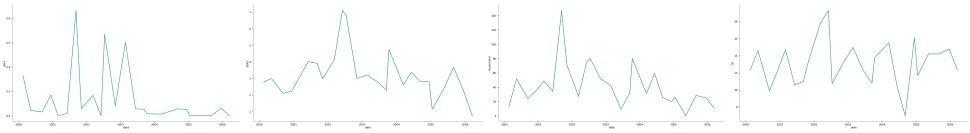
**Distributions**



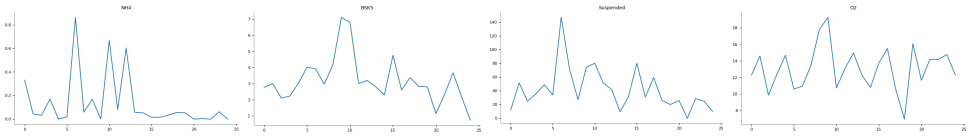

**2-d distributions**



**Time series**



**Values**




Next steps: Generate code with df | View recommended plots | New interactive sheet

```
df['year']=df['date'].dt.year
df['month']=df['date'].dt.month
```