Regression with a Flood Prediction Dataset

(Playground Series - Season 4, Episode 5)

Using Stacking Regressor

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Descriptions

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The dataset for this competition (both train and test) was generated from a deep learning model trained on the Flood Prediction Factors dataset. Feature distributions are close to, but not exactly the same, as the original.

Files train.csv - the training dataset; FloodProbability is the target
test.csv - the test dataset; your objective is to predict the FloodProbability for each row
sample_submission.csv - a sample submission file in the correct format

Objectives

The goal of this competition is to predict the probability of a region flooding based on various factors.

About Author

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1. Importing Libraries and Data sets

1.1 Libraries

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import sklearn
import plotly.express as px
import warnings
```

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1.2 Data Sets

In [2]:
```
df_train = pd.read_csv(r"C:\Users\shuve\Desktop\ML((GFG)\Kaggle Comp\Fload\train.csv")
df_test = pd.read_csv(r"C:\Users\shuve\Desktop\ML((GFG)\Kaggle Comp\Fload\test.csv")
```

In [3]:
```
df_train.head(3)
```

Out[3]:

	id	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	Siltation	AgriculturalPracti
0	0	5	8	5	8	6	4	4	3	
1	1	6	7	4	4	8	8	3	5	
2	2	6	5	6	7	3	7	1	5	

3 rows × 22 columns

In [4]:
```
df_test.head(3)
```

Out[4]:

	id	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	Siltation	Agricultural
0	1117957	4	6	3	5	6	7	8	7	
1	1117958	4	4	2	9	5	5	4	7	
2	1117959	1	3	6	5	7	2	4	6	

3 rows × 21 columns

In [5]:
```
df_train.columns
```

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Out[5]:
```
Index(['id', 'MonsoonIntensity', 'TopographyDrainage', 'RiverManagement',
       'Deforestation', 'Urbanization', 'ClimateChange', 'DamsQuality',
       'Siltation', 'AgriculturalPractices', 'Encroachments',
       'IneffectiveDisasterPreparedness', 'DrainageSystems',
       'CoastalVulnerability', 'Landslides', 'Watersheds',
       'DeterioratingInfrastructure', 'PopulationScore', 'WetlandLoss',
       'InadequatePlanning', 'PoliticalFactors', 'FloodProbability'],
      dtype='object')
```

In [6]:
```
df_test.columns
```

Out[6]:
```
Index(['id', 'MonsoonIntensity', 'TopographyDrainage', 'RiverManagement',
       'Deforestation', 'Urbanization', 'ClimateChange', 'DamsQuality',
       'Siltation', 'AgriculturalPractices', 'Encroachments',
       'IneffectiveDisasterPreparedness', 'DrainageSystems',
       'CoastalVulnerability', 'Landslides', 'Watersheds',
       'DeterioratingInfrastructure', 'PopulationScore', 'WetlandLoss',
       'InadequatePlanning', 'PoliticalFactors'],
      dtype='object')
```

1.3 Defining Features and Targets

Features:

1. 'id'
2. 'MonsoonIntensity'
3. 'TopographyDrainage'
4. 'RiverManagement'
5. 'Deforestation'
6. 'Urbanization'
7. 'ClimateChange'
8. 'DamsQuality'
9. 'Siltation'
10. 'AgriculturalPractices'
11. 'Encroachments'
12. 'IneffectiveDisasterPreparedness'
13. 'DrainageSystems'

14. 'CoastalVulnerability'

15. 'Landslides'
16. 'Watersheds'
17. 'DeterioratingInfrastructure'
18. 'PopulationScore'
19. 'WetlandLoss'
20. 'InadequatePlanning'
21. 'PoliticalFactors'
    #### **Target**:
22. 'FloodProbability'

2.Data Exploration

2.1 Dimensions

In [7]:
```
# df_train.shape,df_test.shape
```

2.2 Statistical Summary

In [8]:
```
# df_train.info()
```

2.3 Dropping Id Column

In [9]:
```
df_train.drop(columns= ["id"], inplace=True)
df_train.head(2)
```

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Out[9]:

	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	Siltation	AgriculturalPractices
0	5	8	5	8	6	4	4	3	3
1	6	7	4	4	8	8	3	5	4

2 rows × 21 columns

2.4 Check for Duplicacy

In [10]:
```
df_train.duplicated().sum()
```

Out[10]:
```
0
```

Remark: No duplicacy found

2.5 Check for Null values

In [11]:
```
df_train.isnull().sum()
```

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Out[11]:
```
MonsoonIntensity                   0
TopographyDrainage                 0
RiverManagement                    0
Deforestation                      0
Urbanization                       0
ClimateChange                      0
DamsQuality                        0
Siltation                          0
AgriculturalPractices              0
Encroachments                      0
IneffectiveDisasterPreparedness    0
DrainageSystems                    0
CoastalVulnerability               0
Landslides                         0
Watersheds                         0
DeterioratingInfrastructure        0
PopulationScore                    0
WetlandLoss                        0
InadequatePlanning                 0
PoliticalFactors                   0
FloodProbability                   0
dtype: int64
```

Remark: No Null value Found

2.6 Descriptive Analytics

In [12]:
```
df_train.describe()
```

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Out[12]:

	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	Siltation	Agricultural
count	1.117957e+06	1.117957e+06	1.117957e+06	1.117957e+06	1.117957e+06	1.117957e+06	1.117957e+06	1.117957e+06	1.11
mean	4.921450e+00	4.926671e+00	4.955322e+00	4.942240e+00	4.942517e+00	4.934093e+00	4.955878e+00	4.927791e+00	4.94
std	2.056387e+00	2.093879e+00	2.072186e+00	2.051689e+00	2.083391e+00	2.057742e+00	2.083063e+00	2.065992e+00	2.06
min	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.00
25%	3.000000e+00	3.000000e+00	4.000000e+00	4.000000e+00	3.000000e+00	3.000000e+00	4.000000e+00	3.000000e+00	3.00
50%	5.000000e+00	5.000000e+00	5.000000e+00	5.000000e+00	5.000000e+00	5.000000e+00	5.000000e+00	5.000000e+00	5.00
75%	6.000000e+00	6.000000e+00	6.000000e+00	6.000000e+00	6.000000e+00	6.000000e+00	6.000000e+00	6.000000e+00	6.00
max	1.600000e+01	1.800000e+01	1.600000e+01	1.700000e+01	1.700000e+01	1.700000e+01	1.600000e+01	1.600000e+01	1.60

8 rows × 21 columns

3. EDA

3.1 Univariate Analysis

3.1.1 Distributions

In [13]:

```
for i in df_train.columns:
    plt.figure(figsize = (3,3))
    print(sns.histplot(df_train[i],kde = True))
    plt.show()
```

```
Axes(0.125,0.11;0.775x0.77)
```

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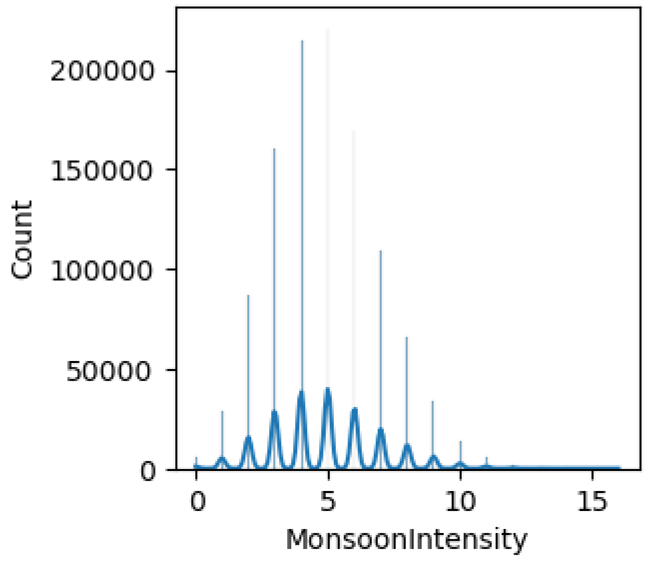
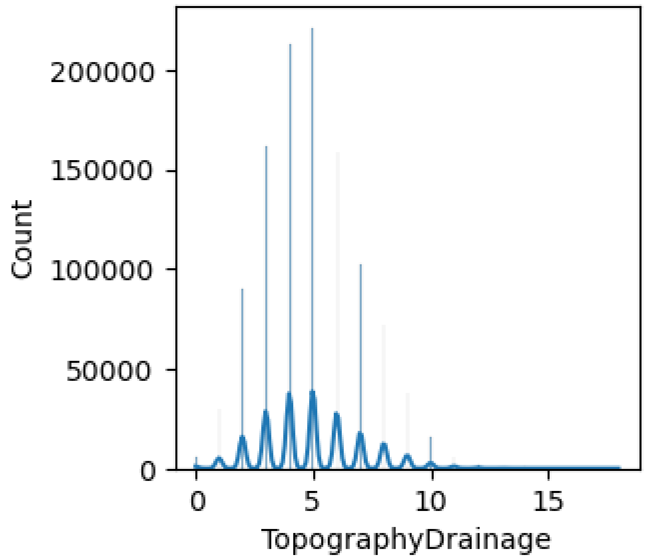



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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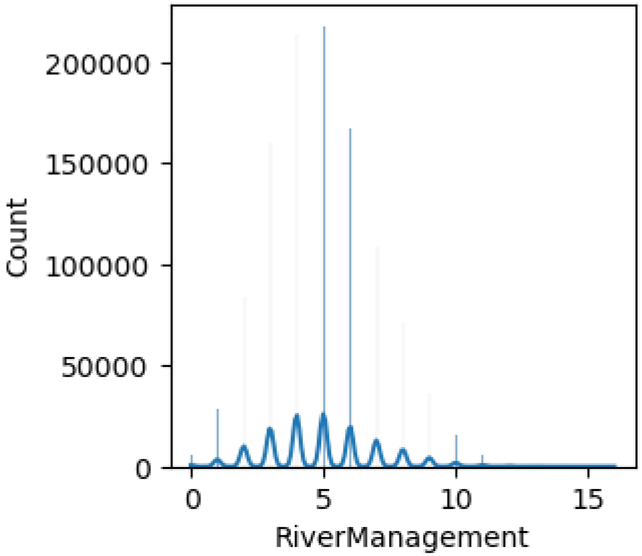
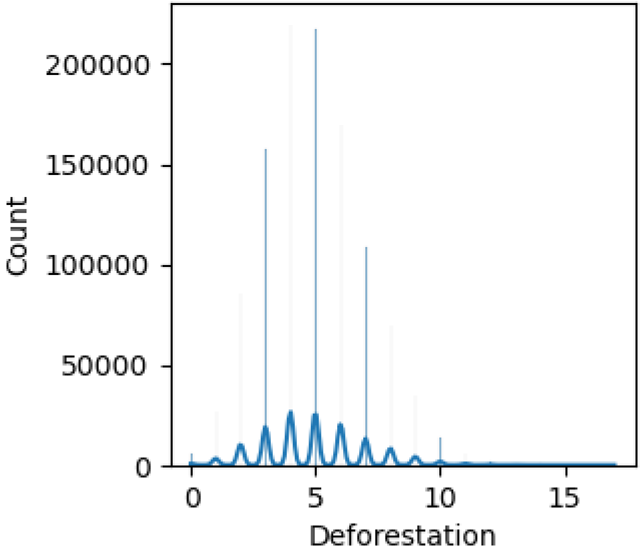



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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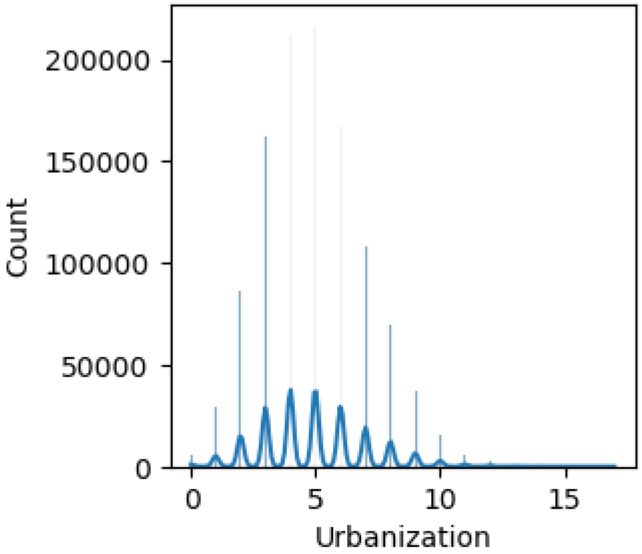
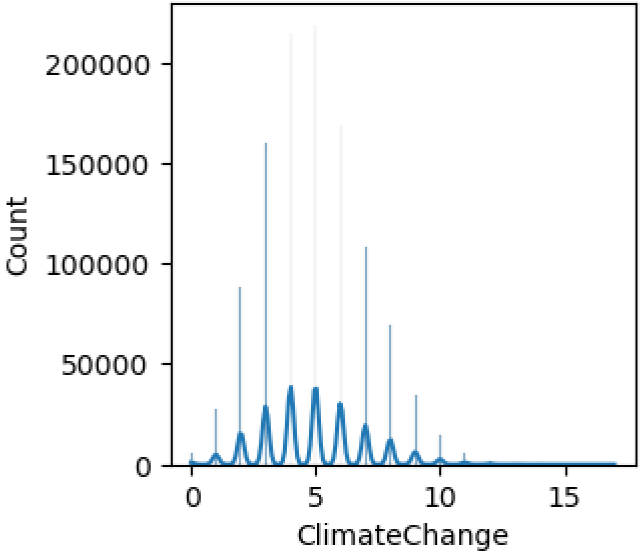



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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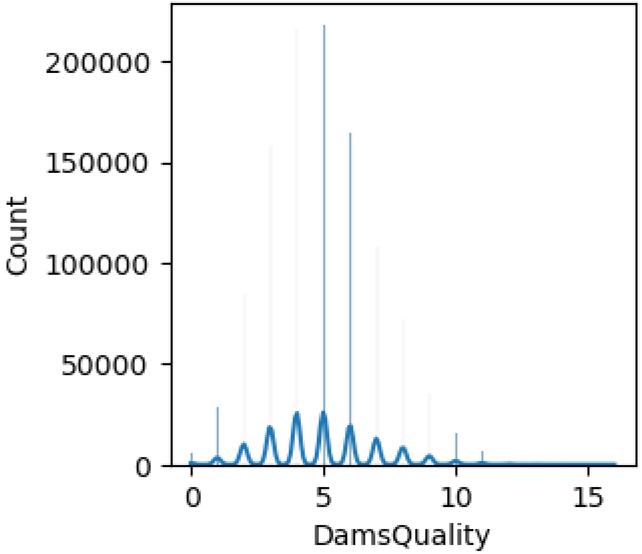
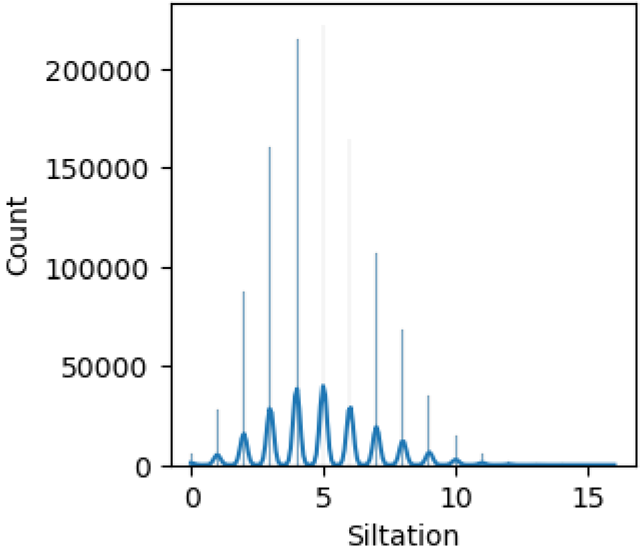


Axes(0.125,0.11;0.775x0.77)



Axes(0.125,0.11;0.775x0.77)

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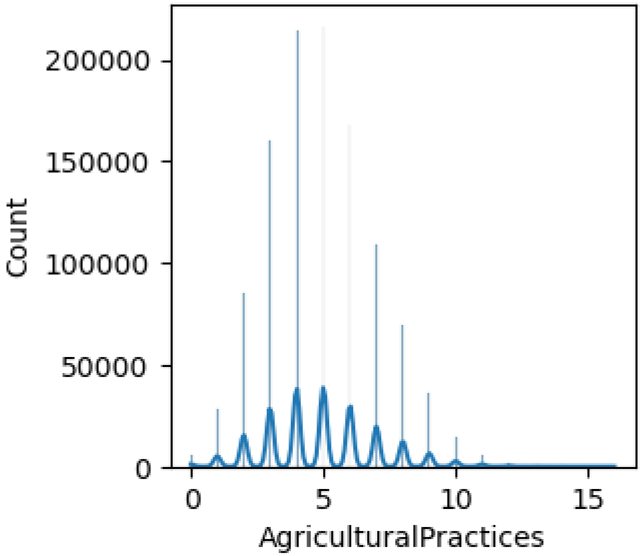
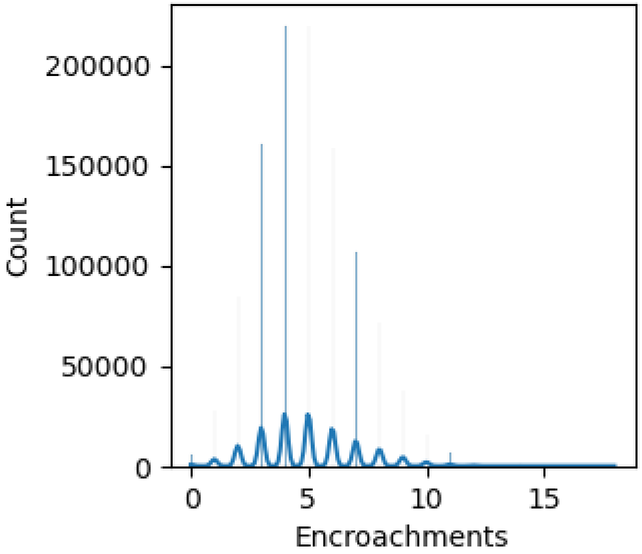



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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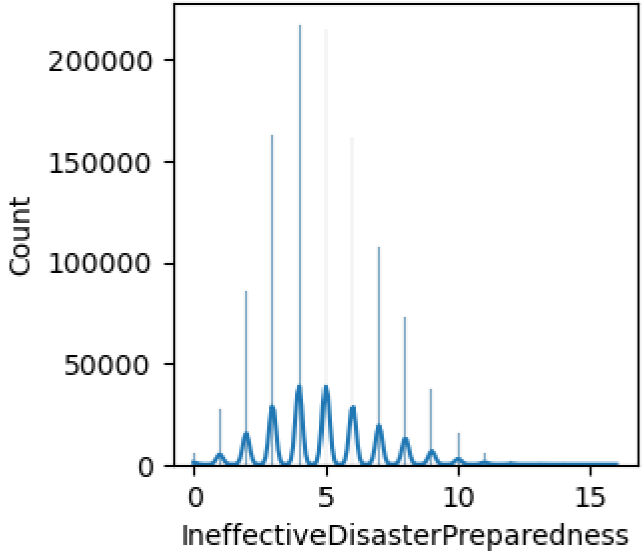
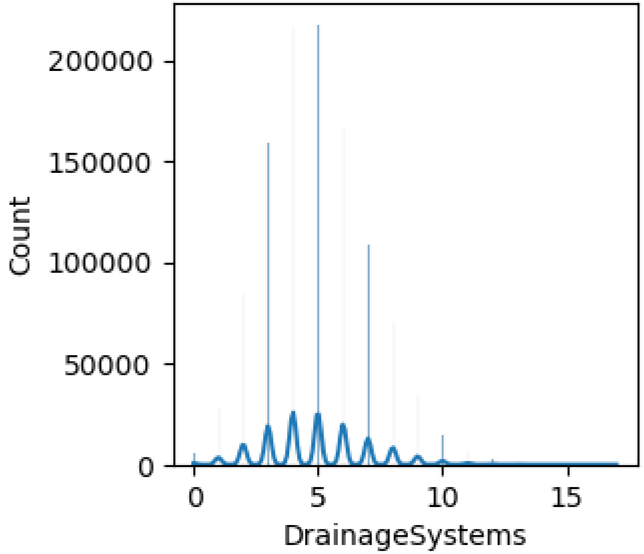
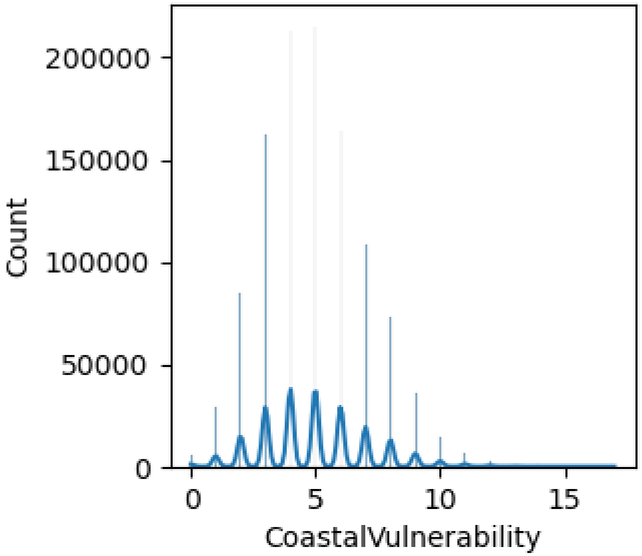


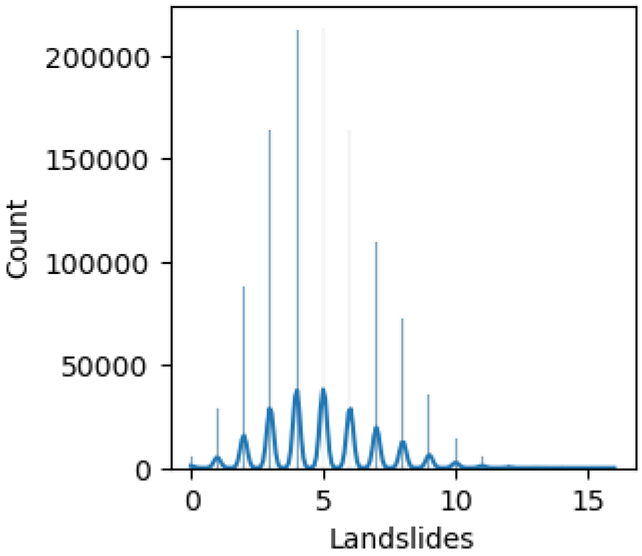

```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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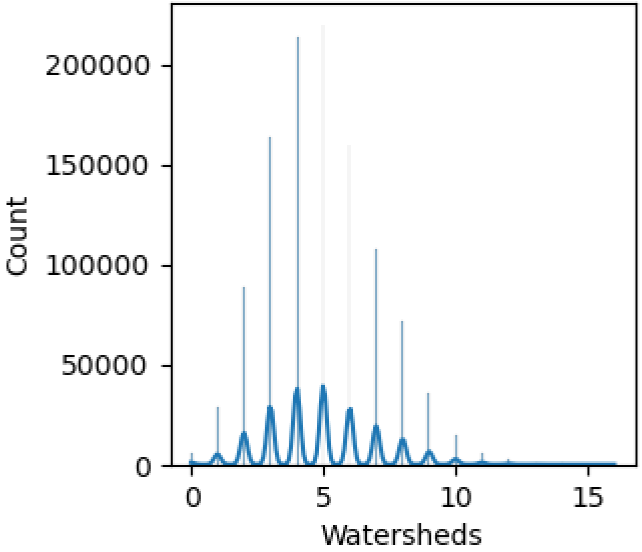
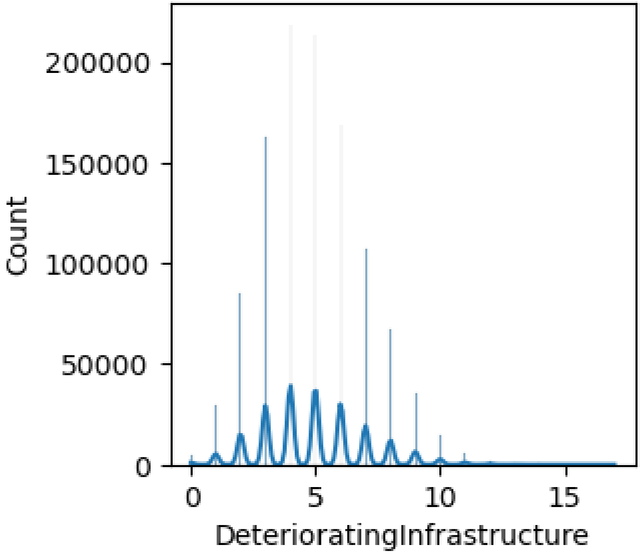



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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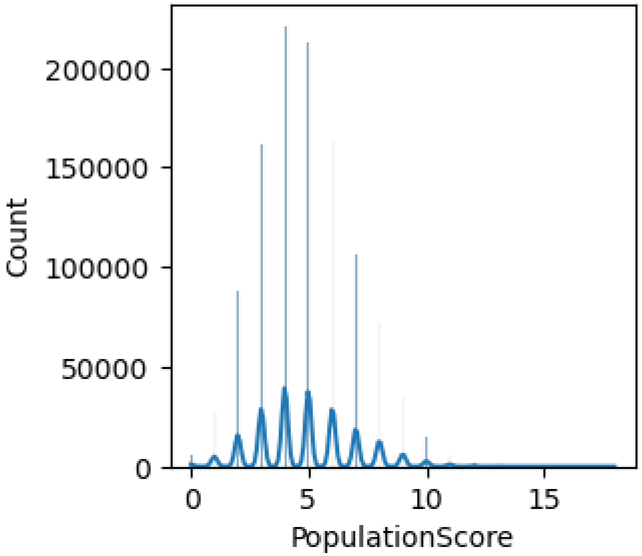
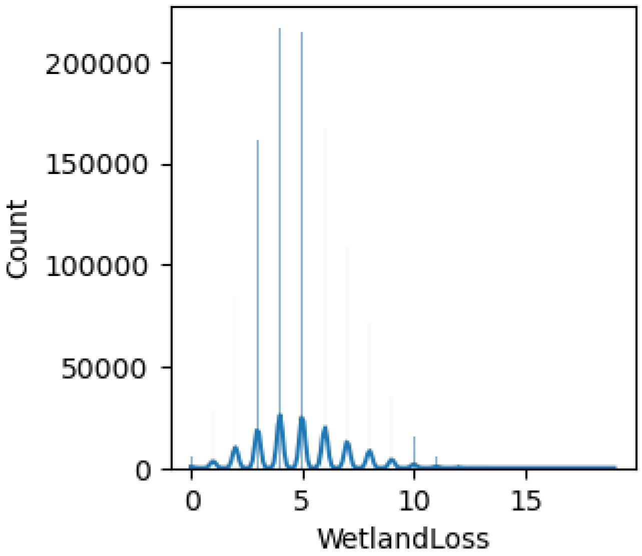



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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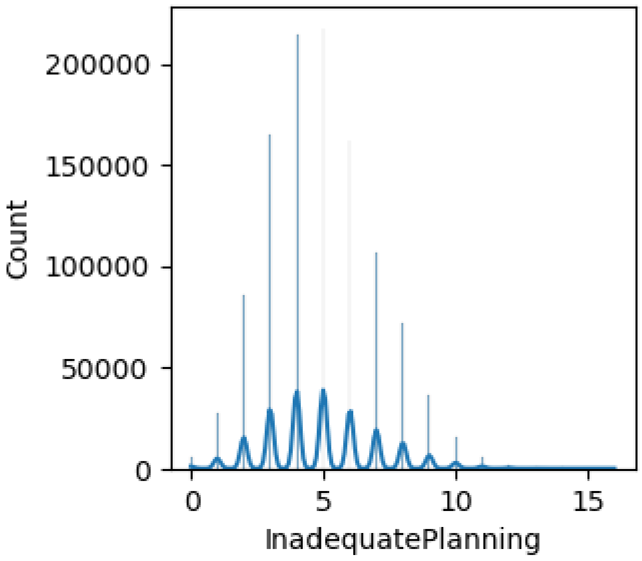
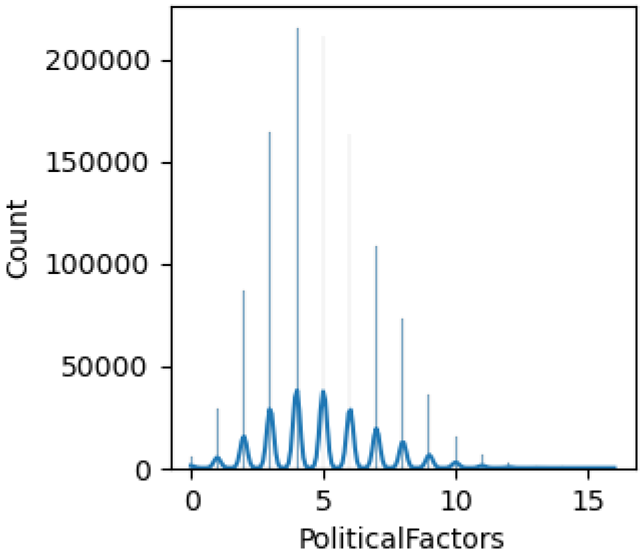



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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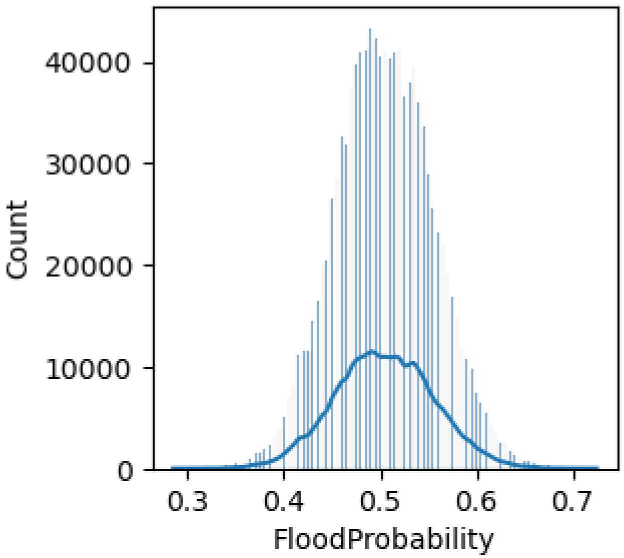

3.1.2 Box-Plot

In [14]:
```
for i in df_train.columns:
    plt.figure(figsize = (3,3))
    print(sns.boxplot(df_train[i]), end = " ")
    plt.title(i)
    plt.show()
```

```
Axes(0.125,0.11;0.775x0.77)
```

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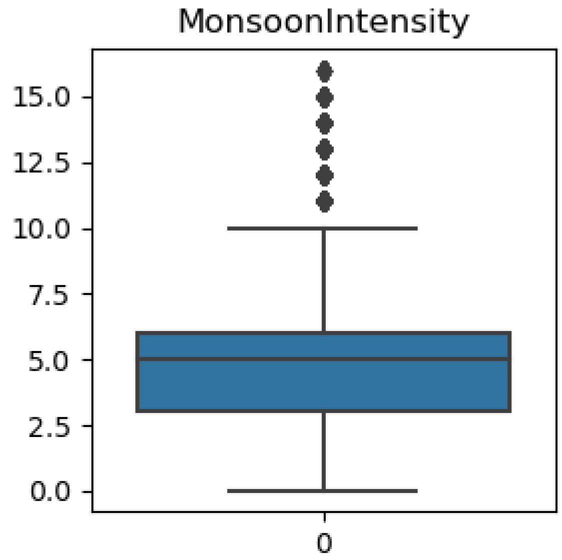
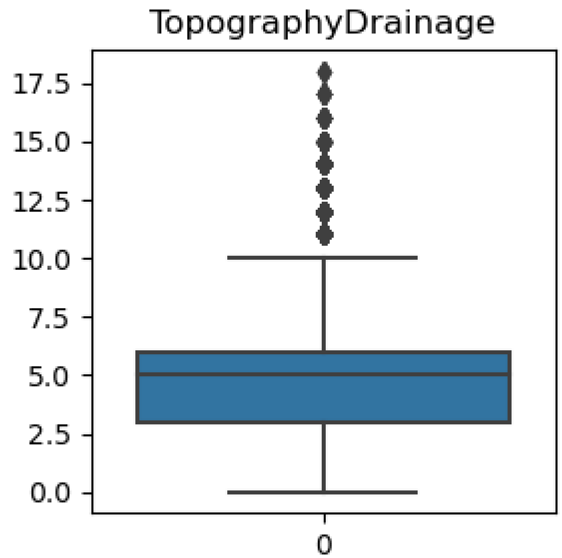


Axes(0.125,0.11;0.775x0.77)



Axes(0.125,0.11;0.775x0.77)

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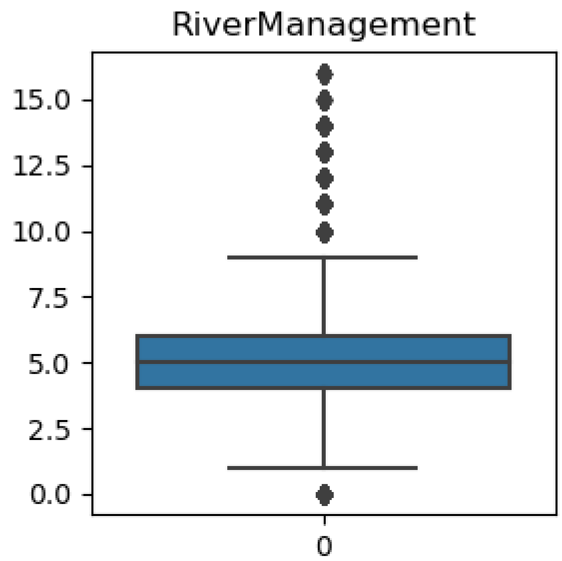
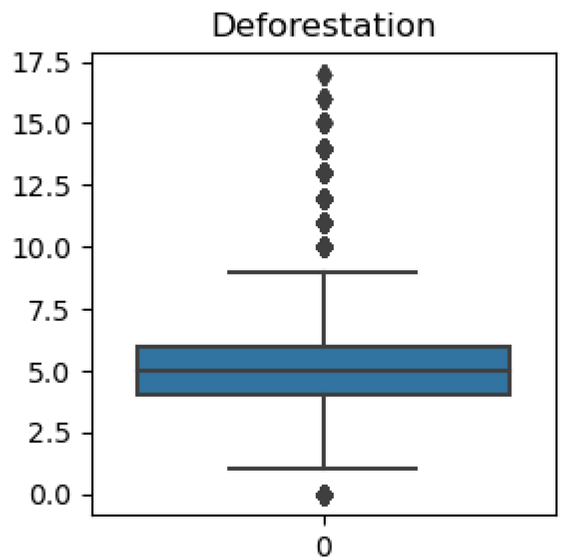



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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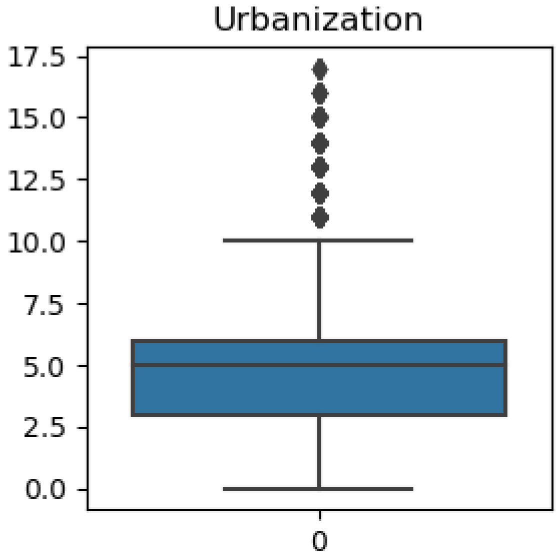


```
Axes(0.125,0.11;0.775x0.77)
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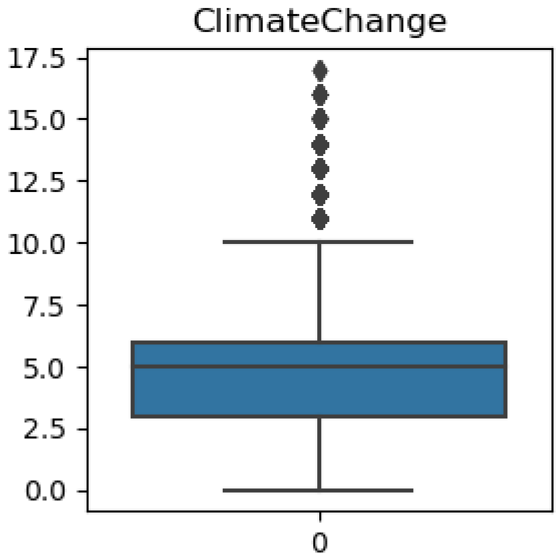


```
Axes(0.125,0.11;0.775x0.77)
```

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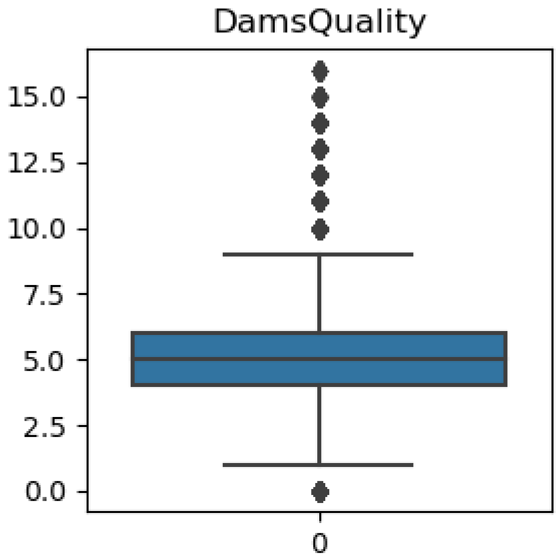


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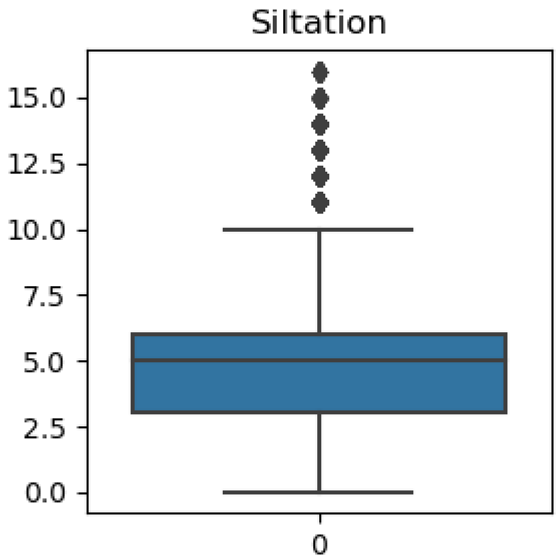
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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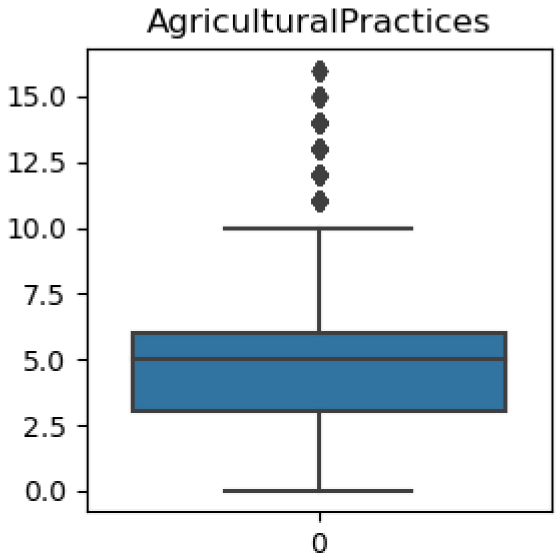
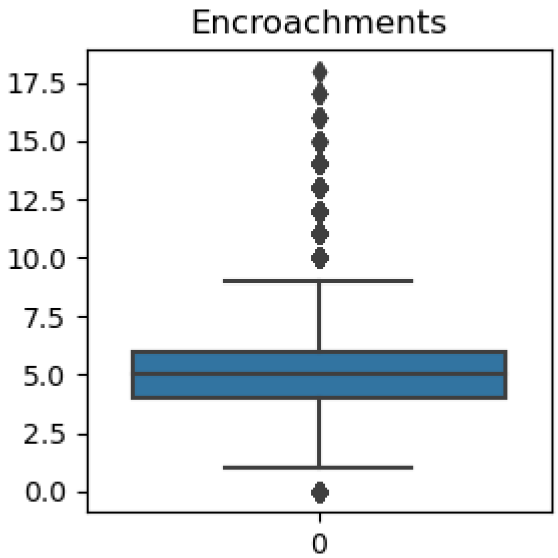



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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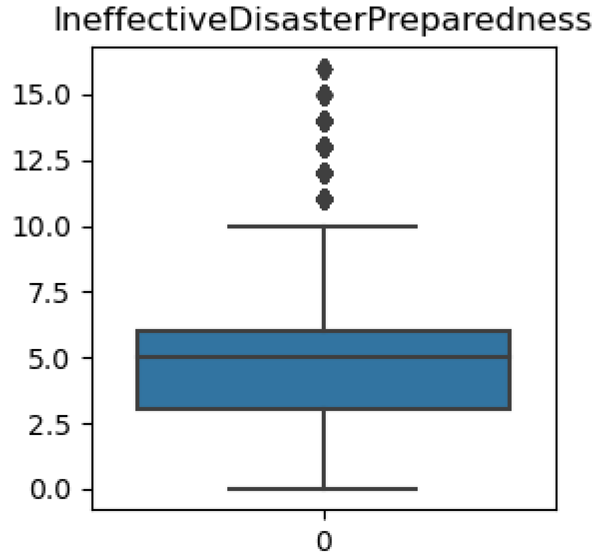
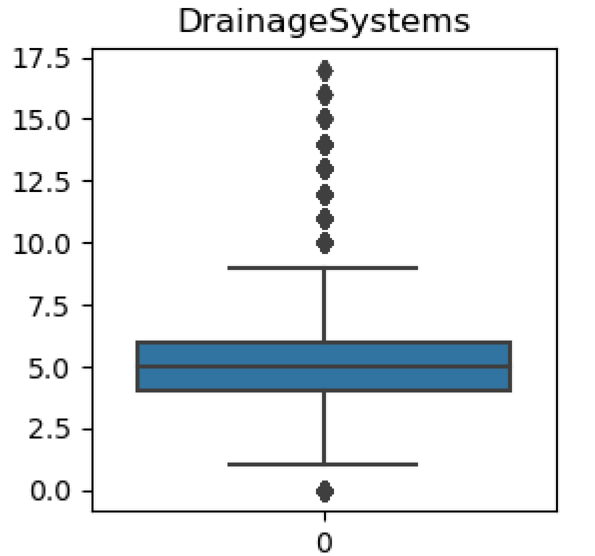



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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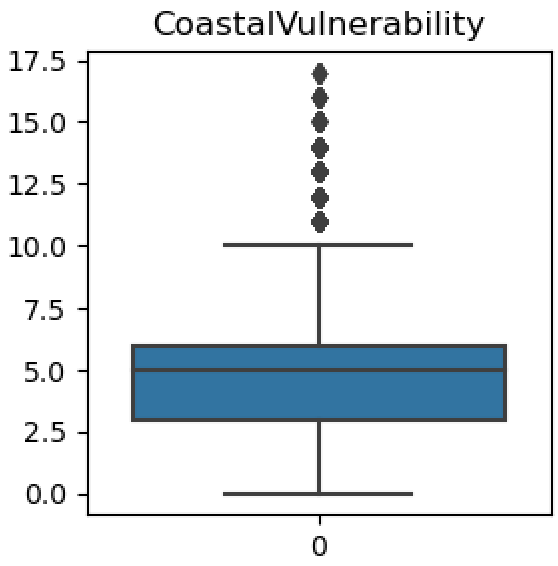
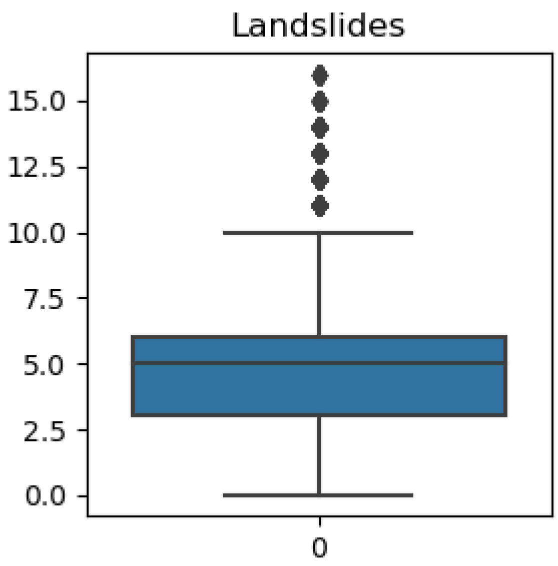



```
Axes(0.125,0.11;0.775x0.77)
```

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Axes(0.125,0.11;0.775x0.77)
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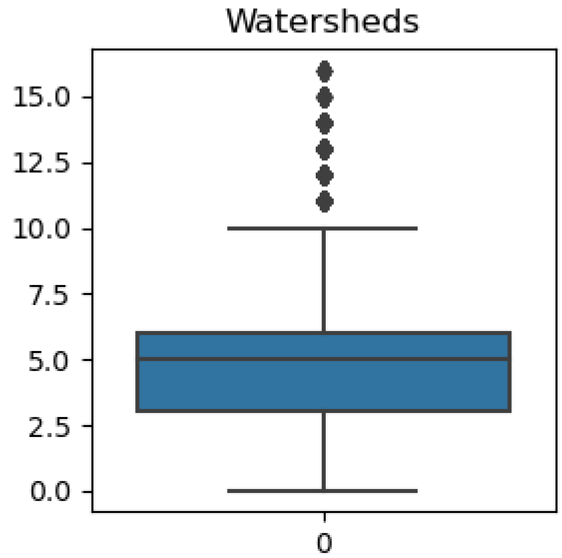


```
Axes(0.125,0.11;0.775x0.77)
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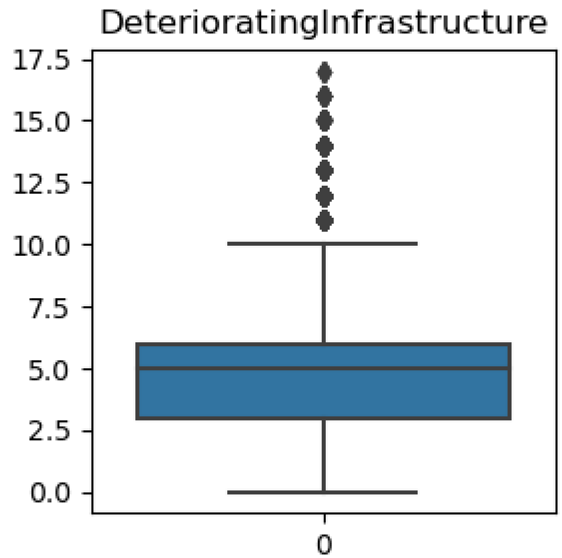


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Axes(0.125,0.11;0.775x0.77)
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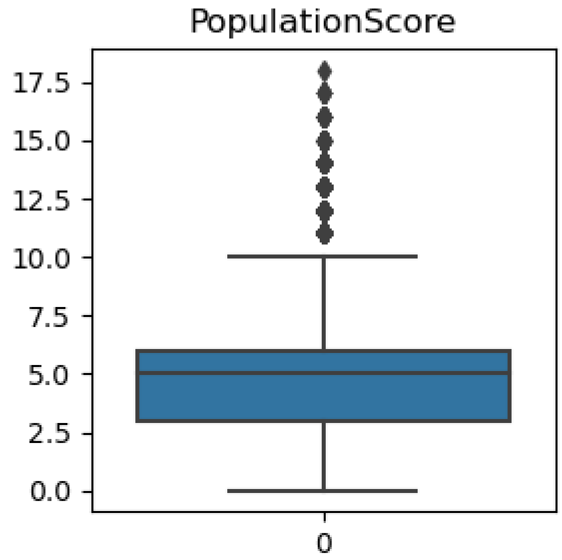
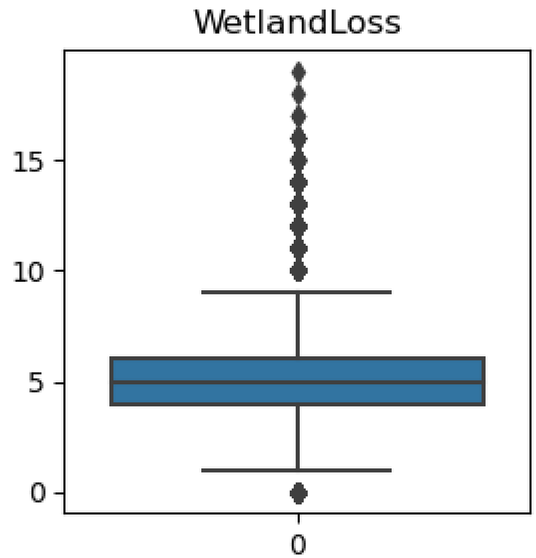



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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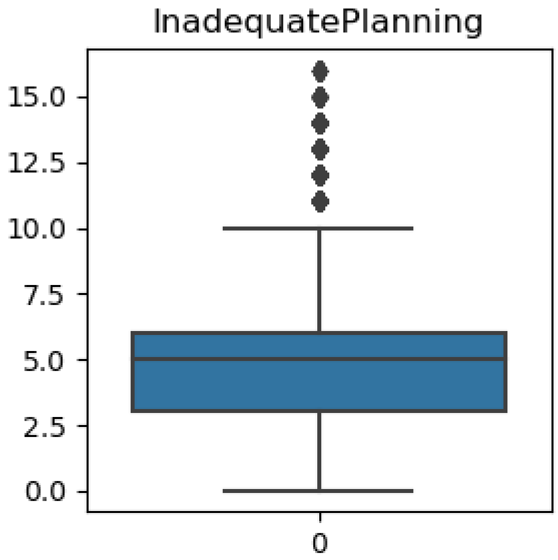
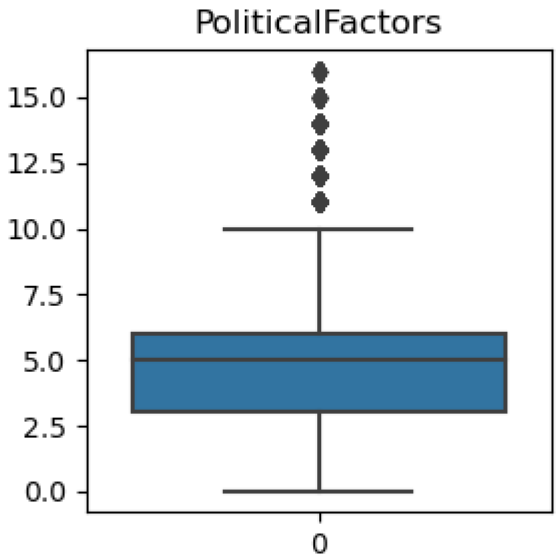



```
Axes(0.125,0.11;0.775x0.77)
```




```
Axes(0.125,0.11;0.775x0.77)
```

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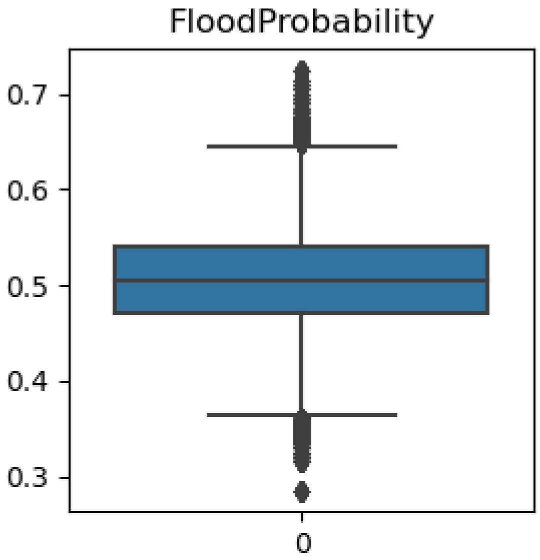

3.2 Multivariate Analysis

3.2.2 Correlation Matrix

In [15]:
```
df_train.corr()
```

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Out[15]:

	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	S
MonsoonIntensity	1.000000	-0.007362	-0.008070	-0.007251	-0.009309	-0.008031	-0.007787	-0
TopographyDrainage	-0.007362	1.000000	-0.009924	-0.008548	-0.010532	-0.009619	-0.007607	-0
RiverManagement	-0.008070	-0.009924	1.000000	-0.008574	-0.012292	-0.009237	-0.008711	-0
Deforestation	-0.007251	-0.008548	-0.008574	1.000000	-0.012248	-0.008266	-0.009356	-0
Urbanization	-0.009309	-0.010532	-0.012292	-0.012248	1.000000	-0.011199	-0.011128	-0
ClimateChange	-0.008031	-0.009619	-0.009237	-0.008266	-0.011199	1.000000	-0.008427	-0
DamsQuality	-0.007787	-0.007607	-0.008711	-0.009356	-0.011128	-0.008427	1.000000	-0
Siltation	-0.007836	-0.009824	-0.010058	-0.011536	-0.010153	-0.009457	-0.009401	1
AgriculturalPractices	-0.008232	-0.009496	-0.010783	-0.010039	-0.010559	-0.011517	-0.009033	-0
Encroachments	-0.010309	-0.012887	-0.011615	-0.013175	-0.010784	-0.012533	-0.010890	-0
IneffectiveDisasterPreparedness	-0.008032	-0.010746	-0.010675	-0.009512	-0.012685	-0.011346	-0.009515	-0
DrainageSystems	-0.009716	-0.010056	-0.011277	-0.010490	-0.012572	-0.009650	-0.010439	-0
CoastalVulnerability	-0.010659	-0.012526	-0.011680	-0.012388	-0.014497	-0.013005	-0.012096	-0
Landslides	-0.009121	-0.010240	-0.008994	-0.009257	-0.010582	-0.009352	-0.009924	-0
Watersheds	-0.008900	-0.011067	-0.011412	-0.010671	-0.012107	-0.009882	-0.009085	-0
DeterioratingInfrastructure	-0.008486	-0.006628	-0.005827	-0.008862	-0.010656	-0.006324	-0.009831	-0
PopulationScore	-0.008679	-0.010815	-0.006727	-0.011777	-0.011485	-0.010332	-0.009599	-0
WetlandLoss	-0.006811	-0.010267	-0.010069	-0.011004	-0.011023	-0.009376	-0.009372	-0
InadequatePlanning	-0.008155	-0.011617	-0.009673	-0.010424	-0.011584	-0.010772	-0.011374	-0
PoliticalFactors	-0.008474	-0.012350	-0.011550	-0.009661	-0.013005	-0.011379	-0.013081	-0
FloodProbability	0.189098	0.187635	0.187131	0.184001	0.180861	0.184761	0.187996	0

21 rows × 21 columns

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Remark: As correlation coefficients are tends to `0`, no `dependent feature` exists

3.2.3 Correlation Heatmap

In [16]:
```
plt.figure(figsize =(15,10))
sns.heatmap(df_train.corr())
plt.show()
```

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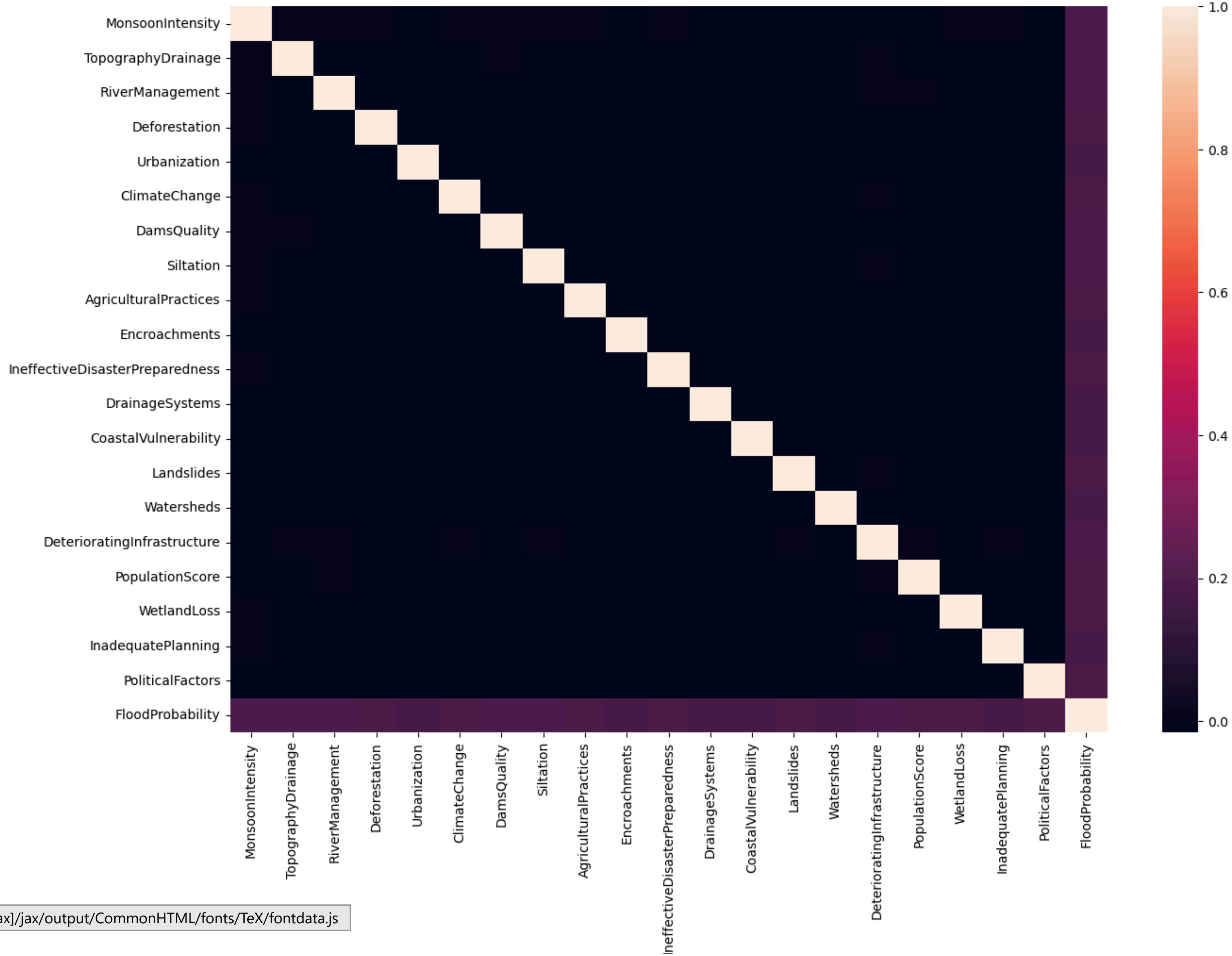

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4. Feature Engineering

4.1 Feature Transformation

4.1.2 Scaling

4.1.2.1 Standardization

In [17]:
```
x_train = df_train.iloc[:,:20]
y_train = df_train.iloc[:,-1]
x_test = df_test.iloc[:,1:]
```

In [18]:
```
x_train = (x_train - x_train.mean())/x_train.std()
x_test = (x_test - x_test.mean())/x_test.std()
```

In [19]:
```
x_train.head(2)
```

Out[19]:

	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	Siltation	AgriculturalPractices
0	0.038198	1.467768	0.021561	1.490362	0.507578	-0.453941	-0.458881	-0.933107	-0.939124
1	0.524488	0.990186	-0.461021	-0.459251	1.467551	1.489938	-0.938943	0.034951	-0.455692

4.2 Feature Extreaction

4.2.1 Principal Component Analysis

In [20]:
```
from sklearn.decomposition import PCA
```

In [21]:
```
x_trn = x_train

      PCA()
x_trn = pca.fit_transform(x_train)
```

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```
explained_variance = pca.explained_variance_ratio_
print(explained_variance)
```

```
[0.05098534 0.05087619 0.0508146  0.05078321 0.0506943  0.05066361
 0.05063026 0.05061952 0.05058528 0.05051905 0.05045643 0.05041462
 0.05038968 0.05034189 0.0503254  0.05029073 0.05025888 0.05023953
 0.05011    0.04000149]
```

Remark : As it can be observed that for `95%` proportion of variance explained, the number of principal components are `20`. So, it is not suggested to go for `PCA`, as it will not reduce a significant dimension.

4.3 Feature Selection

4.3.1 Filter Method (Pearson Correlation Coefficient)

In [22]:
```
for i in x_train.columns:
    if np.corrcoef(x_train[i],y_train)[1][0] > 0.56:
        print(i,"is poorly related to `Target Variable","Corr_coeff :",np.corrcoef(x_train[i],y_train)[1][0])
else:
    print("All are considered to be significant for now.")
```

```
All are considered to be significant for now.
```

Remark: As, `no` independent variable is `highly` related to dependent variable, all are taken into consideration.

5. Model Building

5.1 Splitting `Training data` into `Model Training` and `Hold data` (For Model Training)

In [23]:
```
from sklearn.model_selection import train_test_split
x_trn,x_tst,y_trn,y_tst=train_test_split(x_train,y_train,test_size=0.25)
```

5.1.1 Shape of Training and Test Data for Models

In [24]:
```
x_trn.shape,x_tst.shape,y_trn.shape,y_tst.shape
```

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Out[24]:
```
((838467, 20), (279490, 20), (838467,), (279490,))
```

5.2 Model Building

5.2.1 Importing Libraries

In [25]:
```python
import xgboost as xgb
import lightgbm as lgb
import catboost as cb
from sklearn.svm import SVR
```

5.2.2 Baseline Models

In [26]:
```python
base_model_xgb = xgb.XGBRegressor(random_state=42)
base_model_cb = cb.CatBoostRegressor(random_state=42, verbose=False)
base_model_SVR = SVR()
```

5.2.3 Model Accuracy of each Base models

In [27]:
```python
from sklearn.metrics import mean_squared_error,r2_score
```

5.2.3.1 Model Accuracy of XGBoostingRegressor

In [28]:
```python
base_model_xgb.fit(x_trn, y_trn)
y_prd_2 = base_model_xgb.predict(x_tst)
mse_trn_2 = mean_squared_error(y_tst, y_prd_2)
r2_score_trn_2 = r2_score(y_tst, y_prd_2)
print("XG Boosting MSE:", mse_trn_2)
print("XG r2_score:", r2_score_trn_2)
```

```
XG Boosting MSE: 0.000497271555534172
XG r2_score: 0.8096917261595232
```

5.2.3.2 Model Accuracy of CatBoostRegressor

In [29]:
```python
base_model_cb.fit(x_trn, y_trn)
y_prd_4 = base_model_cb.predict(x_tst)
, y_prd_4)
r2_score_trn_4 = r2_score(y_tst, y_prd_4)
```

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```
print("cat Boosting MSE:", mse_trn_4)
print("cat r2_score:", r2_score_trn_4)
```

```
cat Boosting MSE: 0.0004011605310292122
cat r2_score: 0.8464738886762002
```

5.2.3.3 Model Accuracy of SVR

In [30]:
```
base_model_SVR.fit(x_trn, y_trn)
y_prd_5 = base_model_SVR.predict(x_tst)
mse_trn_5 = mean_squared_error(y_tst, y_prd_5)
r2_score_trn_5 = r2_score(y_tst, y_prd_5)
print("Hist Gradient Boosting MSE:", mse_trn_5)
print("Hist Gradient r2_score:", r2_score_trn_5)
```

```
Hist Gradient Boosting MSE: 0.0010134904735254254
Hist Gradient r2_score: 0.6121322033728573
```

5.2.4 Stacking Regressor

In [31]:
```
from sklearn.ensemble import StackingRegressor
from sklearn.neural_network import MLPRegressor
```

5.2.5 Final Estimator

In [32]:
```
final_estimator = MLPRegressor()
```

In [33]:
```
stacking_regressor = StackingRegressor(estimators=[
    ('xgb', base_model_xgb),
    ('cb', base_model_cb),
    ('SVR', base_model_SVR)
],final_estimator = final_estimator)
```

5.2.6 Final Model

In [34]:
```
stacking_regressor.fit(x_trn, y_trn)
```

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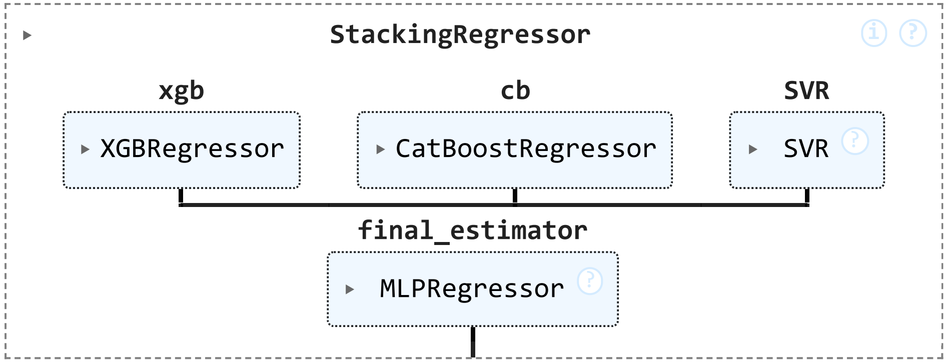
Out[34]:



6.Model Accuracy

6.1 Model Accuracy on `Hold data` (Model Training Data)

In [35]:
```
y_prd = stacking_regressor.predict(x_tst)
mse_trn = mean_squared_error(y_tst, y_prd)
r2_score_trn = r2_score(y_tst, y_prd)
print("Final model MSE:", mse_trn)
print("Final model r2_score:", r2_score_trn)
```

```
Final model MSE: 0.0003787025582490078
Final model r2_score: 0.8550686654861588
```

7. Model Prediction

7.1 Model Prediction on `Test data` (Model Testing Data)

In [36]:
```
y_test = stacking_regressor.predict(x_test)
```

In [37]:
```
y_test
```

Out[37]:
```
array([0.57330199, 0.44394068, 0.44221133, ..., 0.62352514, 0.55090508,
       0.50850966])
```

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7.2.1 Addition of `Id` in final submission

In [38]:
```
df_test.head()
```

Out[38]:

	id	MonsoonIntensity	TopographyDrainage	RiverManagement	Deforestation	Urbanization	ClimateChange	DamsQuality	Siltation	Agricultural
0	1117957	4	6	3	5	6	7	8	7	
1	1117958	4	4	2	9	5	5	4	7	
2	1117959	1	3	6	5	7	2	4	6	
3	1117960	2	4	4	6	4	5	4	3	
4	1117961	6	3	2	4	6	4	5	5	

5 rows × 21 columns

In [39]:
```
submission_df = pd.DataFrame({
    'id': df_test['id'],
    'FoodPrediction': y_test
})
```

In [40]:
```
submission_df.head()
```

Out[40]:

	id	FoodPrediction
0	1117957	0.573302
1	1117958	0.443941
2	1117959	0.442211
3	1117960	0.458675
4	1117961	0.457712

In [41]:
```
submission_df.to_csv('submission_stacking.csv', index=False)
print("Submission file created successfully.")
```

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```
Submission file created successfully.
```

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