In [ ]:

```
import pandas as pd
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn import metrics
from sklearn import tree
from sklearn.ensemble import ExtraTreesRegressor
from sklearn.neighbors import KNeighborsClassifier
from sklearn.preprocessing import StandardScaler, MinMaxScaler, RobustScale
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from imblearn import under_sampling
```

In [ ]:

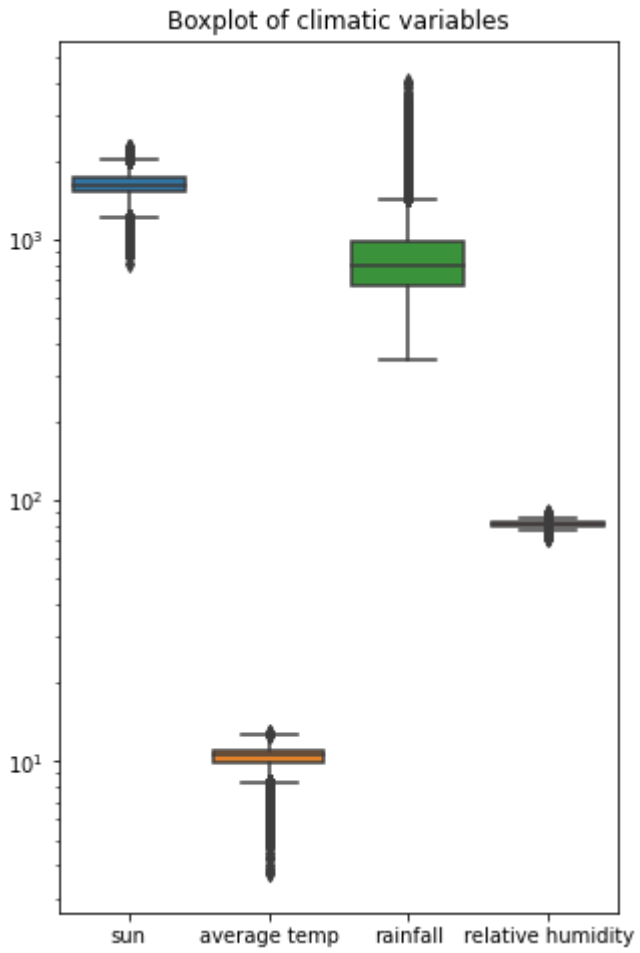
```
#loading intermediate dataset ukbms and haduk, created in  HADUK_intermedia
df = pd.read_csv('BioD_year_site_latlong.csv')
df.drop(columns=df.columns[0], inplace = True)
```

In [ ]:

```
df1_climate = df.drop(columns=['Simpsons Index','SPECIES RICHNESS','TOTAL S
df1_climate.describe()

fig,ax = plt.subplots(figsize=(5,8))
bxplot = sns.boxplot(data=df1_climate)
bxplot.set_yscale('log')
plt.title('Boxplot of climatic variables')
```

Out[ ]:

```
Text(0.5, 1.0, 'Boxplot of climatic variables')
```

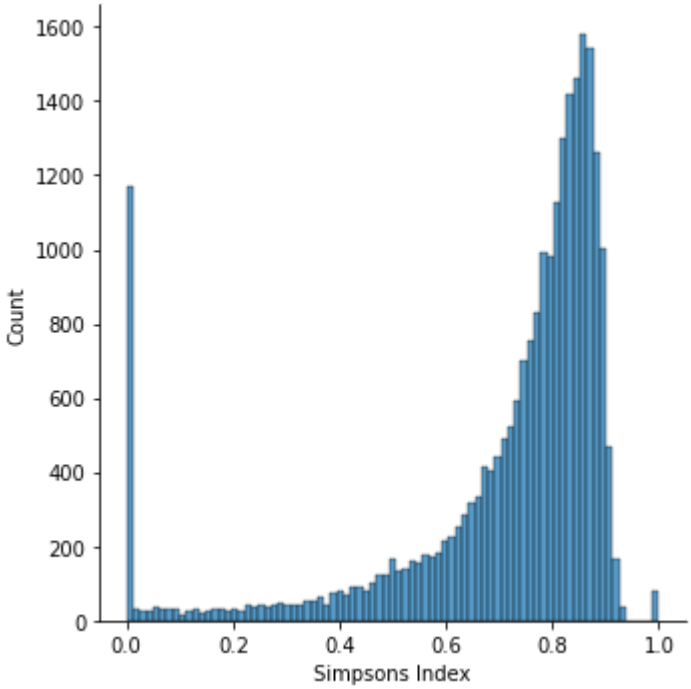


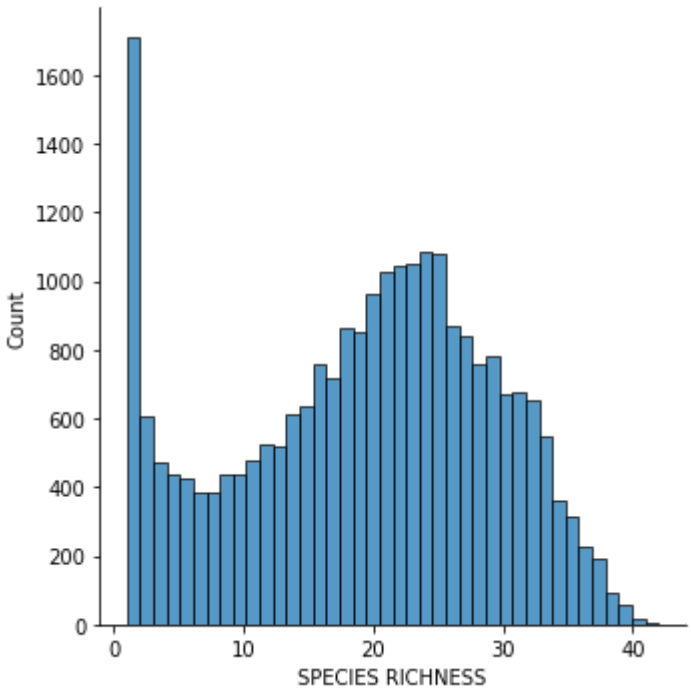
In [ ]:

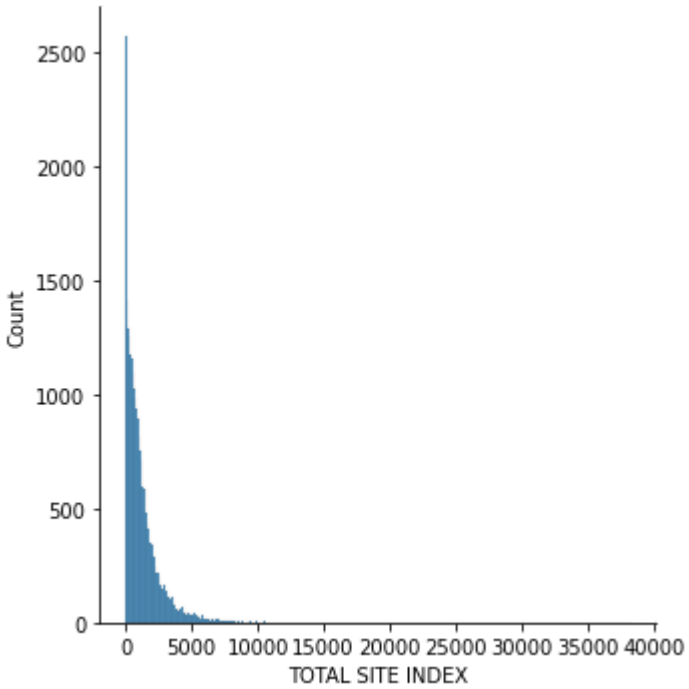
```
sns.displot(df['Simpsons Index'])
```

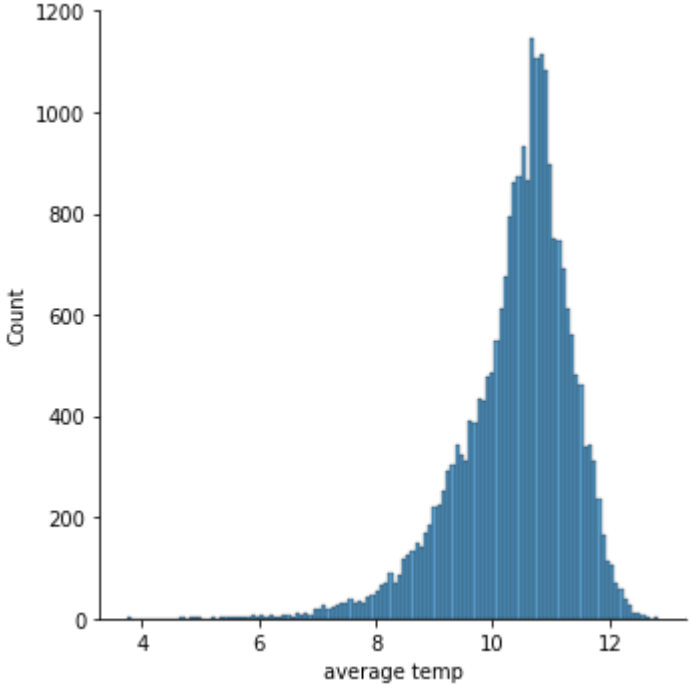
```
sns.displot(df['SPECIES RICHNESS'])
sns.displot(df['TOTAL SITE INDEX'])
sns.displot(df['average temp'])
sns.displot(df['sun'])
sns.displot(df['rainfall'])
sns.displot(df['relative humidity'])
```

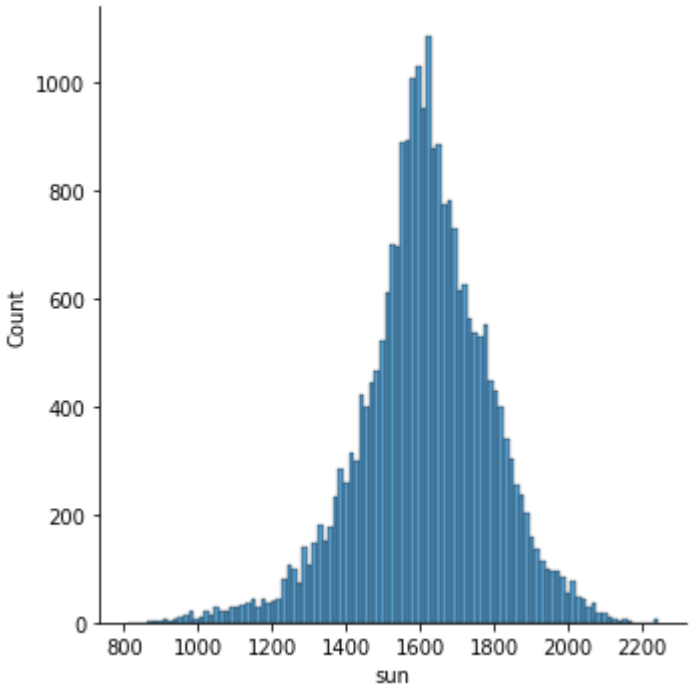
Out[ ]: <seaborn.axisgrid.FacetGrid at 0x7fc2a6c1b220>

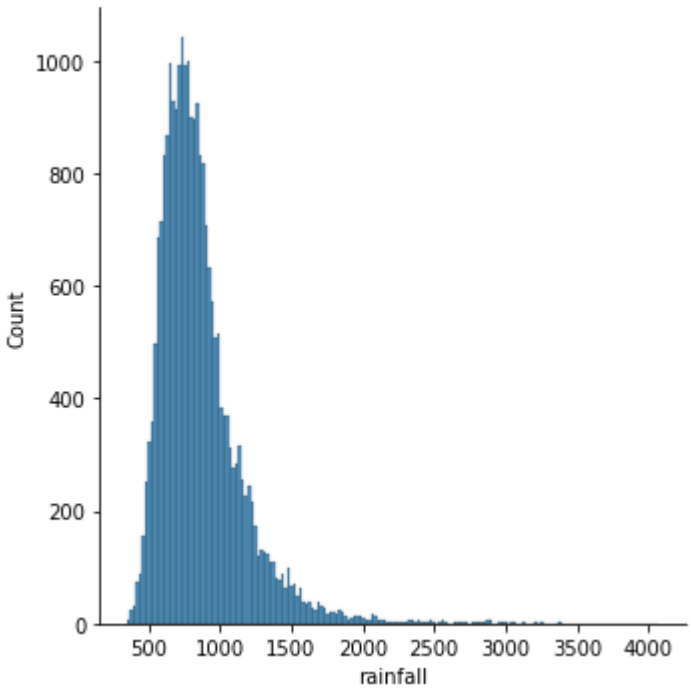


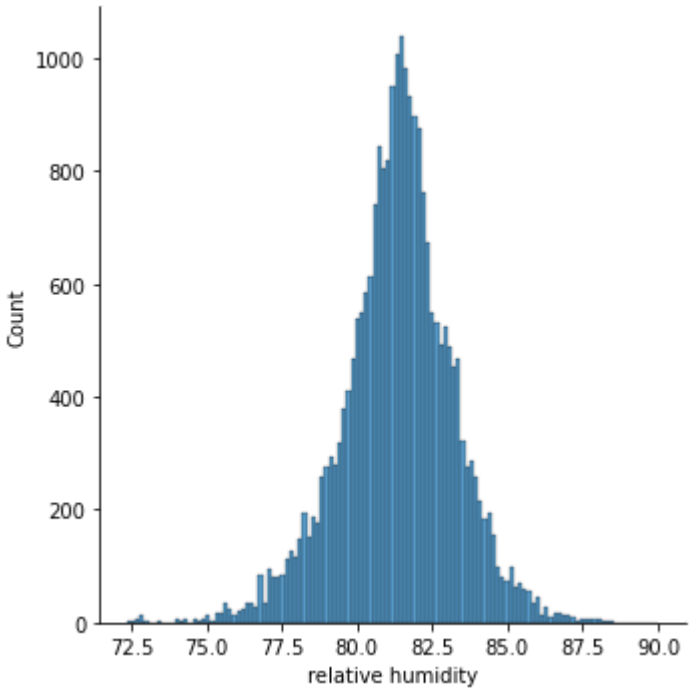



2500
2000
1500
1000
500
0
Count
0
5000
10000
15000
20000
25000
30000
35000
40000
TOTAL SITE INDEX


1200
1000
800
600
400
200
0
Count
4
6
8
10
12
average temp


Count
1000
800
600
400
200
0
800
1000
1200
1400
1600
1800
2000
2200
sun


Count
1000
800
600
400
200
0
500
1000
1500
2000
2500
3000
3500
4000
rainfall

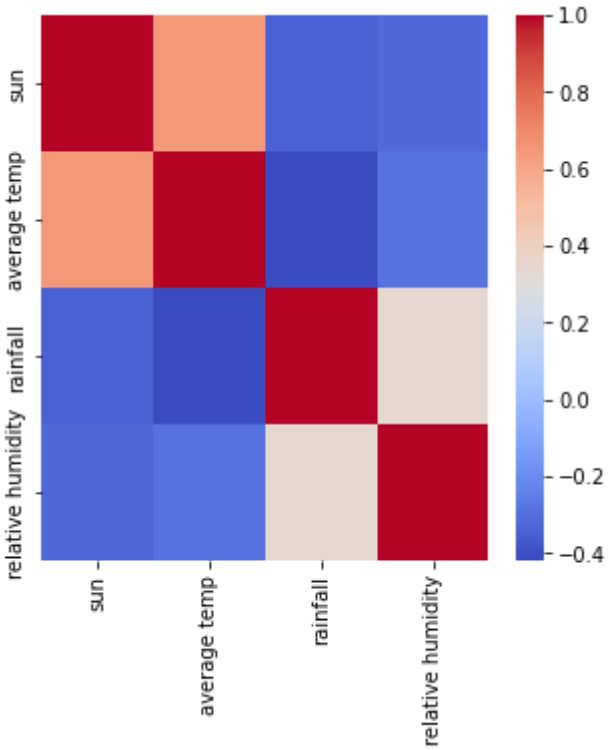


Multiple Linear Regression, carried out on climatic variables (x) and species richness (y):

In [ ]:
```
x = df[['sun','average temp','rainfall','relative humidity']]
y= df[['SPECIES RICHNESS']]
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.3, random_
```

In [ ]:
```
corr = x_train.corr()
plt.figure(figsize=(5,5))
sns.heatmap(corr, cmap='coolwarm')
```

Out[ ]:
```
<AxesSubplot:>
```



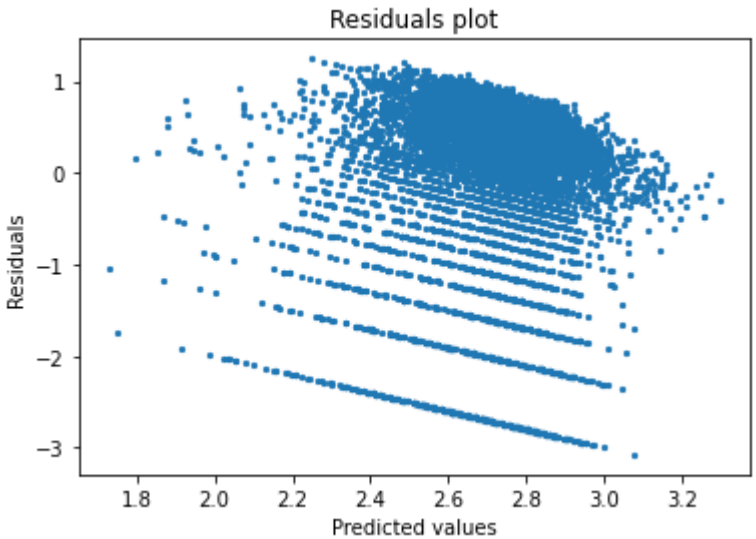
In [ ]:
```
x_train.drop(columns=['sun'],inplace=True)
x_test.drop(columns=['sun'],inplace=True)
```

In [ ]:
```
#training multiple linear regression model
model = LinearRegression()
model.fit(x_train, np.log(y_train))
print(model.coef_)
print(model.intercept_)
```

```
[[ 0.06703855 -0.00027393 -0.04370613]]
[5.80492544]
```

In [ ]:
```
preds_SR = model.predict(x_test)
```

In [ ]:
```
#plotting residuals
residuals = np.log(y_test)-preds_SR
plt.scatter(preds_SR,residuals,5)
plt.ylabel('Residuals')
plt.xlabel('Predicted values')
plt.title('Residuals plot')
plt.show()
```



In [ ]:
```
mse = metrics.mean_squared_error(np.log(y_test),preds_SR)
r2 = metrics.r2_score(np.log(y_test),preds_SR)
print(mse)
print(np.sqrt(mse))
print(r2)
```

```
0.7450615386919197
0.8631694727525526
0.04805919630695088
```

In [ ]:
```
#Checking diversity
x = df[['average temp','rainfall','relative humidity']]
y= df[['Simpsons Index']]
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.3, random_
model1 = LinearRegression()
model1.fit(x_train, y_train)
print(model1.coef_)
print(model1.intercept_)
preds_Div = model1.predict(x_test)
mse = metrics.mean_squared_error(y_test,preds_Div)
r2 = metrics.r2_score(y_test,preds_Div)
print('mse: ' + str(mse))
```

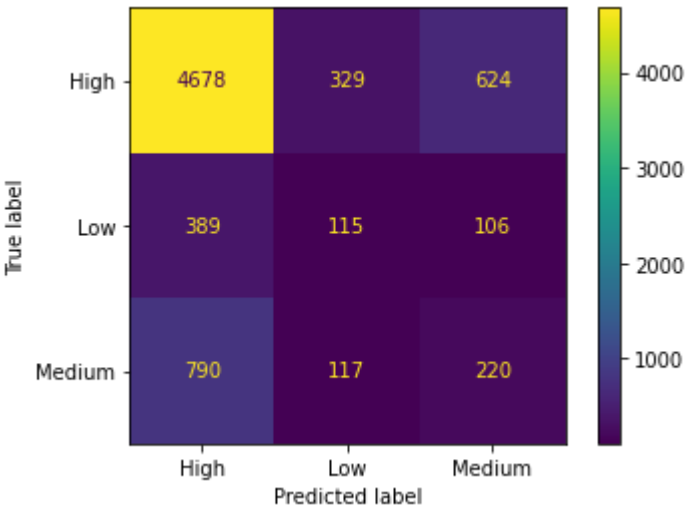
```
print('rmse: ' + str(np.sqrt(mse)))
print('r2: ' + str(r2))
```

```
[[ 9.50157468e-03 -7.94726070e-05 -8.92072927e-03]]
[1.40639564]
mse: 0.04964239506285567
rmse: 0.22280573390928626
r2: 0.03478576404689471
```

Decision tree classifier:

In [ ]:
```
#multiclass classifcation decision tree classifier
x_c = df[['sun','average temp','rainfall','relative humidity']]
y_c = df[['Diversity']]
x_ctrain,x_ctest,y_ctrain,y_ctest = train_test_split(x_c,y_c,test_size=0.3,

dtree_model = tree.DecisionTreeClassifier()
dtree_model.fit(x_ctrain,y_ctrain)
dtree_preds = dtree_model.predict(x_ctest)

cm = metrics.confusion_matrix(y_ctest,dtree_preds)
acc = metrics.accuracy_score(y_ctest, dtree_preds)

metrics.ConfusionMatrixDisplay.from_predictions(y_ctest,dtree_preds)
print(acc)
```

```
0.6803745928338762
```

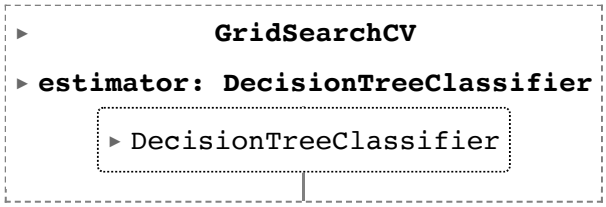


In [ ]:
```
#hyperparameter tuning
parameters={"splitter":["best","random"],
            "max_depth" : [1,3,5,7,9,11],
           "min_samples_leaf":[1,3,5,7,9],
           "min_weight_fraction_leaf":[0.1,0.2,0.3,0.4],
           "max_features":[1,"log2","sqrt",None],
           "max_leaf_nodes":[None,10,30,50,70,90] }
```

In [ ]:
```
#d tree classifier tunin
ctree_tuning = tree.DecisionTreeClassifier()
c_tuning_model=GridSearchCV(ctree_tuning,param_grid=parameters,scoring='acc
tuning_sample = df.sample(frac=0.3) #sampling dataset to prevent crashses w
x_ctuning = tuning_sample[['sun','average temp','relative humidity','rainfa
y_ctuning = tuning_sample[['Diversity']]
```

In [ ]:
```
c_tuning_model.fit(x_ctuning,y_ctuning)
```

Out[ ]:



In [ ]:

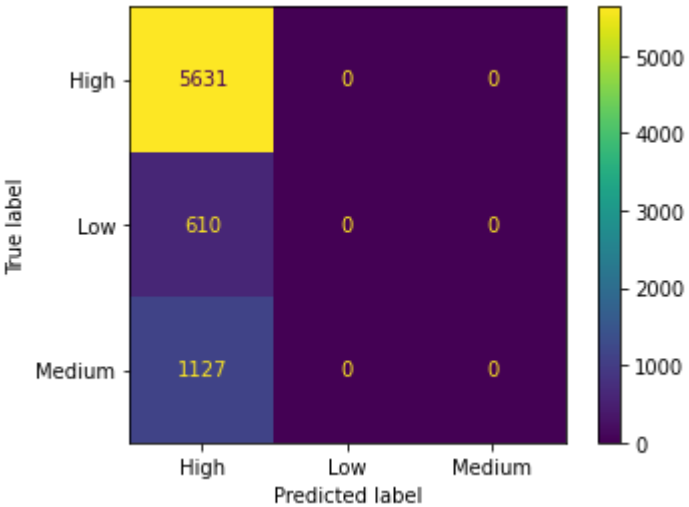
```
print(c_tuning_model.best_params_)
print(c_tuning_model.best_score_)
```

```
{'max_depth': 1, 'max_features': 1, 'max_leaf_nodes': None, 'min_samples_lea
f': 1, 'min_weight_fraction_leaf': 0.1, 'splitter': 'best'}
0.7659834678944121
```

In [ ]:

```
tuned_ctree = tree.DecisionTreeClassifier(max_depth=1,max_features='auto',m
tuned_ctree.fit(x_ctrain,y_ctrain)
tuned_ctree_preds = tuned_ctree.predict(x_ctest)

acc = metrics.accuracy_score(y_ctest, tuned_ctree_preds)

metrics.ConfusionMatrixDisplay.from_predictions(y_ctest,tuned_ctree_preds)
print(acc)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-package
s/sklearn/tree/_classes.py:298: FutureWarning: `max_features='auto'` has bee
n deprecated in 1.1 and will be removed in 1.3. To keep the past behaviour,
explicitly set `max_features='sqrt'`.
  warnings.warn(
0.7642508143322475
```



KNN CLASSIFICATION:

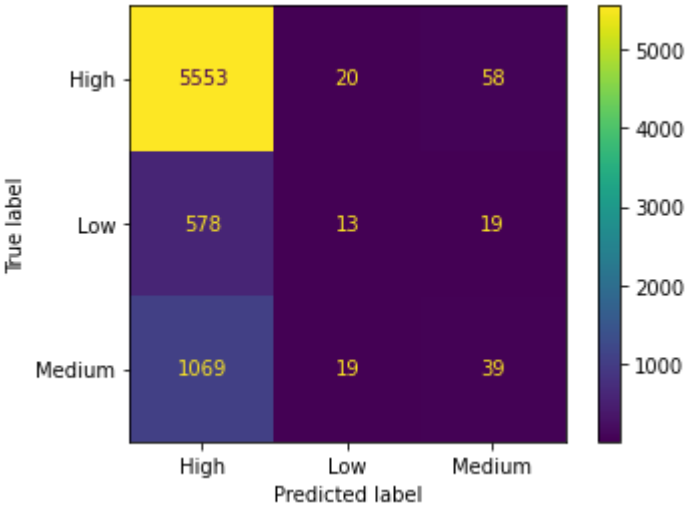
In [ ]:

```
#multiclass classifcation k-nearest neighbours
knn_model = KNeighborsClassifier(n_neighbors = 10).fit(x_ctrain,y_ctrain)
#accuracy = knn_model.score(x_ctest,y_ctest)

knn_preds = knn_model.predict(x_ctest)
cm_knn = metrics.confusion_matrix(y_ctest,knn_preds)
acc_knn =metrics.accuracy_score(y_ctest,knn_preds)

metrics.ConfusionMatrixDisplay.from_predictions(y_ctest,knn_preds)
print(acc_knn)
metrics.f1_score(y_ctest,knn_preds, average='weighted')
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-package
s/sklearn/neighbors/_classification.py:207: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of
y to (n_samples,), for example using ravel().
  return self._fit(X, y)
0.7607220412595005
```

Out[ ]:

```
0.6743548782062548
```

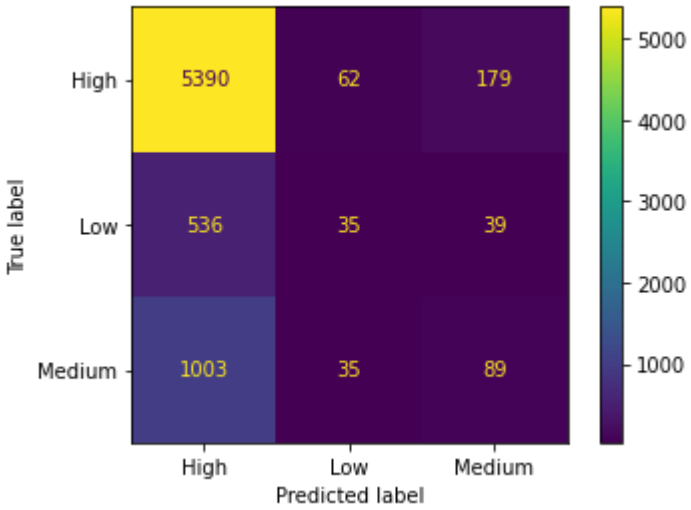


KNN SCALED X VARIABLES:

In [ ]:

```
#scaled knn
scaler = StandardScaler()
df_scale = df.copy()
features = [['sun','average temp','rainfall','relative humidity']]
for feature in features:
    df_scale[feature] = scaler.fit_transform(df_scale[feature])

x_scaled  = df_scale[['sun','average temp','rainfall','relative humidity']]
y_s = df_scale[['Diversity']]

x_strain,x_stest,y_strain,y_stest = train_test_split(x_scaled,y_s,test_size
knn_scaled_model = KNeighborsClassifier()
knn_scaled_model.fit(x_strain,y_strain)

knn_scaled_preds = knn_scaled_model.predict(x_stest)
acc_scaled = metrics.accuracy_score(y_stest,knn_scaled_preds)

metrics.ConfusionMatrixDisplay.from_predictions(y_stest,knn_scaled_preds)
print(acc_scaled)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-package
s/sklearn/neighbors/_classification.py:207: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of
y to (n_samples,), for example using ravel().
  return self._fit(X, y)
0.748371335504886
```



In [ ]:
```
metrics.f1_score(y_stest,knn_scaled_preds, average='weighted')
```

Out[ ]:
```
0.682738313321154
```

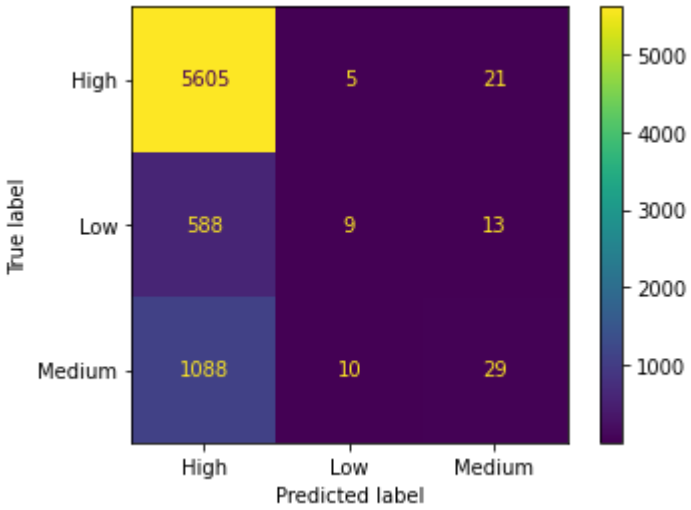
In [ ]:
```
#knn  hyperparameter tuning
n_neighbors = [5,10,15,20,25,30]
leaf_size= list(range(1,25))
p=[1,2]

knn_hyperparameters = dict(n_neighbors=n_neighbors,leaf_size=leaf_size,p=p)
knn_tuned = KNeighborsClassifier()
knn_tuned_model = GridSearchCV(knn_tuned,knn_hyperparameters, cv=3)
```

In [ ]:
```
knn_tuned_model.fit(x_strain,y_strain.values.ravel())
print('best leaf size:', knn_tuned_model.best_estimator_.get_params()['leaf
print('best p:', knn_tuned_model.best_estimator_.get_params()['p'])
print('best n_neighbors:', knn_tuned_model.best_estimator_.get_params()['n_
```

```
best leaf size: 2
best p: 1
best n_neighbors: 30
```

In [ ]:
```
tuned_knn_model = KNeighborsClassifier(leaf_size=2,p=1,n_neighbors=30)
tuned_knn_model.fit(x_strain,y_strain)
tuned_knn_preds = tuned_knn_model.predict(x_stest)

acc_tuned_knn = metrics.accuracy_score(y_stest,tuned_knn_preds)

metrics.ConfusionMatrixDisplay.from_predictions(y_stest,tuned_knn_preds)
print(acc_tuned_knn)
print(metrics.f1_score(y_stest,tuned_knn_preds, average='weighted'))
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-package
s/sklearn/neighbors/_classification.py:207: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of
y to (n_samples,), for example using ravel().
  return self._fit(X, y)
0.7658794788273615
0.6733164631286662
```

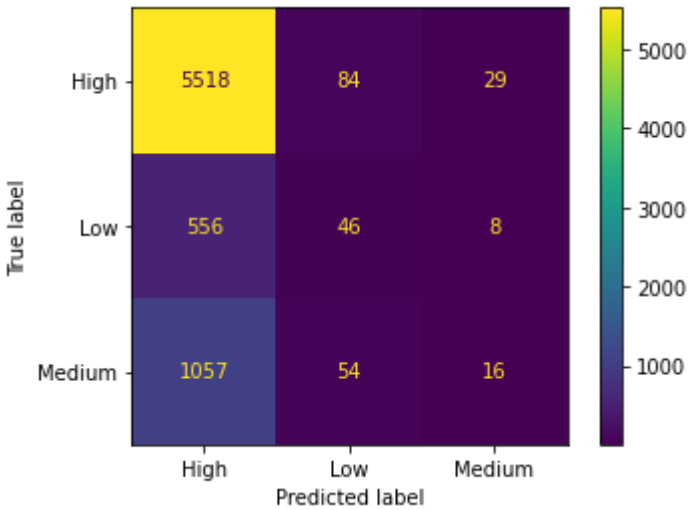


Condensed Neareset Neighbor Undersamling:

In [ ]:
```
undersample = under_sampling.CondensedNearestNeighbour()
x_under,y_under = undersample.fit_resample(x_strain,y_strain)
```

In [ ]:
```
cnn_knn = KNeighborsClassifier(leaf_size=2,p=1,n_neighbors=30)
cnn_knn.fit(x_under,y_under)
cnn_knn_preds = cnn_knn.predict(x_stest)


acc_knn_cnn = metrics.accuracy_score(y_stest,cnn_knn_preds)
metrics.ConfusionMatrixDisplay.from_predictions(y_stest,cnn_knn_preds)
print(acc_knn_cnn)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-package
s/sklearn/neighbors/_classification.py:207: DataConversionWarning: A column-
vector y was passed when a 1d array was expected. Please change the shape of
y to (n_samples,), for example using ravel().
  return self._fit(X, y)
0.757328990228013
```



In [ ]:
```
rus_undersample = under_sampling.RandomUnderSampler(random_state=44,replace
x_rus,y_rus = undersample.fit_resample(x_strain,y_strain)
```

In [ ]:
```
rus_knn = KNeighborsClassifier(leaf_size=2,p=1,n_neighbors=30)
rus_knn.fit(x_rus,y_rus)
```

```
rus_knn_preds = rus_knn.predict(x_stest)


acc_knn_rus = metrics.accuracy_score(y_stest,rus_knn_preds)
metrics.ConfusionMatrixDisplay.from_predictions(y_stest,rus_knn_preds)
print(acc_knn_rus)
```

```
/Library/Frameworks/Python.framework/Versions/3.9/lib/python3.9/site-packages/sklearn/neighbors/_classification.py:207: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for example using ravel().
  return self._fit(X, y)
0.756786102062975
```