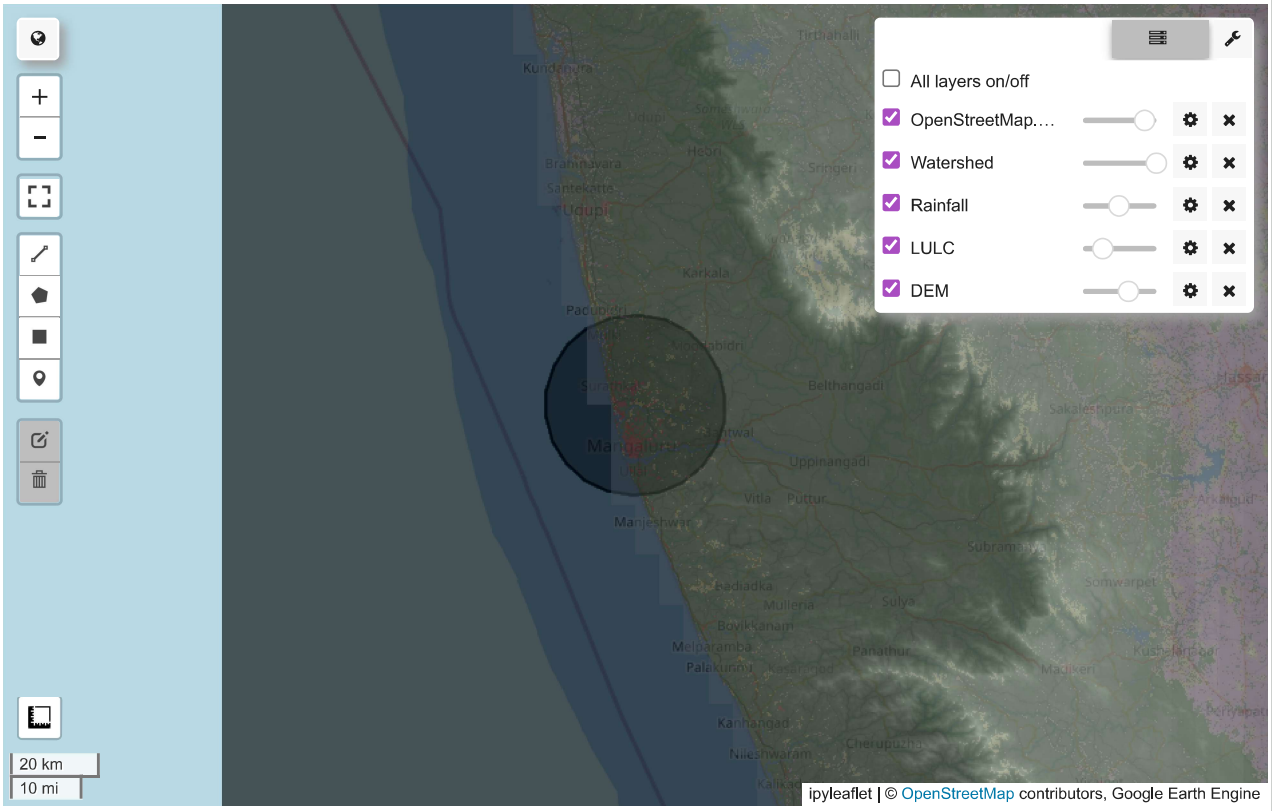
```
import ee
ee.Authenticate()
ee.Initialize(project='nitk25')
```

```
import geemap

Map = geemap.Map()

point = ee.Geometry.Point([74.85, 12.95])  # Karnataka region
basin = point.buffer(20000)  # 20 km buffer

Map.centerObject(basin, 9)
Map.addLayer(basin, {}, "Watershed")
Map
```




```
rain = ee.ImageCollection("UCSB-CHG/CHIRPS/DAILY") \
        .filterDate("2020-01-01", "2020-12-31") \
        .filterBounds(basin) \
        .sum()

Map.addLayer(rain, {"min":0, "max":2000}, "Rainfall")
```

```
lulc = ee.Image("ESA/WorldCover/v100/2020")

Map.addLayer(lulc, {}, "LULC")
```

```
dem = ee.Image("USGS/SRTMGL1_003")

Map.addLayer(dem, {"min":0, "max":3000}, "DEM")
```

```
stack = rain.addBands(lulc).addBands(dem)
```

```
samples = stack.sample(
    region=basin,
    scale=1000,
    numPixels=1000,
    geometries=False
)

import pandas as pd
df = geemap.ee_to_df(samples)
df.head()
```

	Map	elevation	precipitation
0	80	0	4698.899600
1	80	0	4698.899600
2	80	0	4698.899600
3	80	0	4698.899600
4	10	15	4694.636597

Next steps: Generate code with df | New interactive sheet

```
df["Runoff"] = 0.3 * df["precipitation"]   # simple assumption
```

```
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import r2_score

X = df[["precipitation", "Map", "elevation"]]
y = df["Runoff"]

X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42
)

model = RandomForestRegressor(n_estimators=100)
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

print("R² Score:", r2_score(y_test, y_pred))
```

```
R² Score: 0.999994565856143
```

```
model.feature_importances_
```

```
array([9.99693108e-01, 1.32070275e-05, 2.93684850e-04])
```

```
# Create comparison dataframe
comparison = X_test.copy()
comparison["Actual_Runoff"] = y_test.values
comparison["Predicted_Runoff"] = y_pred

# Show first 10 samples
comparison.head(10)
```

	precipitation	Map	elevation	Actual_Runoff	Predicted_Runoff
468	4457.863006	10	60	1337.358902	1337.538964
148	4599.136962	10	29	1379.741089	1379.741089
302	4730.214947	10	77	1419.064484	1419.064484
355	4683.301293	10	17	1404.990388	1404.990388
515	4451.800117	10	73	1335.540035	1335.540035
266	4730.214947	10	14	1419.064484	1419.064484
72	4678.591260	80	8	1403.577378	1403.577378
81	4717.142127	10	36	1415.142638	1415.127691
133	4661.303193	80	17	1398.390958	1398.390958
342	4634.648430	10	19	1390.394529	1390.460709

Next steps: Generate code with comparison | New interactive sheet

```
comparison["Error"] = comparison["Actual_Runoff"] - comparison["Predicted_Runoff"]
comparison["Absolute_Error"] = abs(comparison["Error"])

comparison.head()
```

	precipitation	Map	elevation	Actual_Runoff	Predicted_Runoff	Error	Absolute_Error
468	4457.863006	10	60	1337.358902	1337.538964	-1.800618e-01	1.800618e-01
148	4599.136962	10	29	1379.741089	1379.741089	-1.136868e-12	1.136868e-12
302	4730.214947	10	77	1419.064484	1419.064484	-2.728484e-12	2.728484e-12
355	4683.301293	10	17	1404.990388	1404.990388	1.136868e-12	1.136868e-12
515	4451.800117	10	73	1335.540035	1335.540035	-2.501110e-12	2.501110e-12

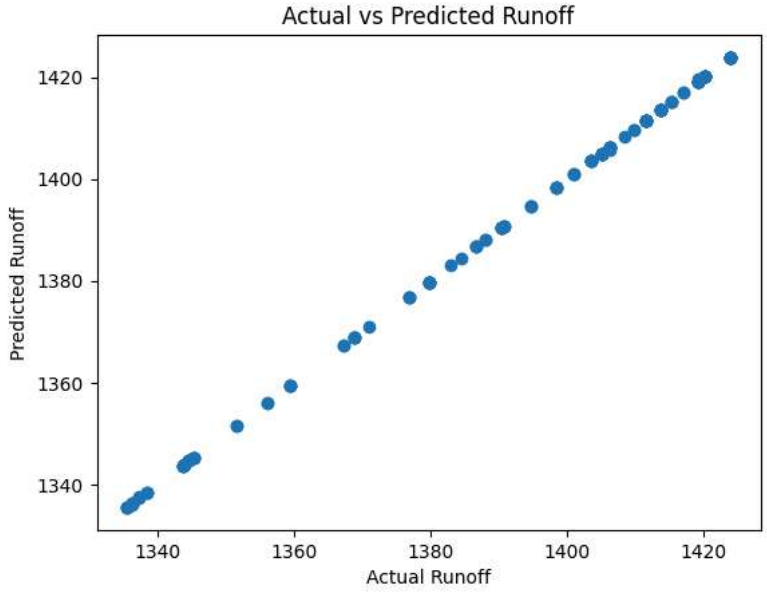
Next steps: Generate code with comparison | New interactive sheet

```
comparison["Absolute_Error"].mean()
```

```
np.float64(0.015681930303651215)
```

```
import matplotlib.pyplot as plt

plt.scatter(comparison["Actual_Runoff"], comparison["Predicted_Runoff"])
plt.xlabel("Actual Runoff")
plt.ylabel("Predicted Runoff")
plt.title("Actual vs Predicted Runoff")
plt.show()
```



```
comparison.sample(5)
```

	precipitation	Map	elevation	Actual_Runoff	Predicted_Runoff	Error	Absolute_Error
716	4557.248295	10	20	1367.174489	1367.289954	-1.154649e-01	1.154649e-01
208	4661.303193	10	87	1398.390958	1398.390958	-2.728484e-12	2.728484e-12
674	4505.527659	10	23	1351.658298	1351.658298	-1.591616e-12	1.591616e-12
33	4678.591260	10	21	1403.577378	1403.577378	0.000000e+00	0.000000e+00
44	4746.168743	80	0	1423.850623	1423.850623	0.000000e+00	0.000000e+00

```
from sklearn.metrics import mean_absolute_error

mae = mean_absolute_error(y_test, y_pred)
print("MAE:", mae)
```

```
MAE: 0.015681930303651215
```