Universal Soil Loss Equation (USLE)

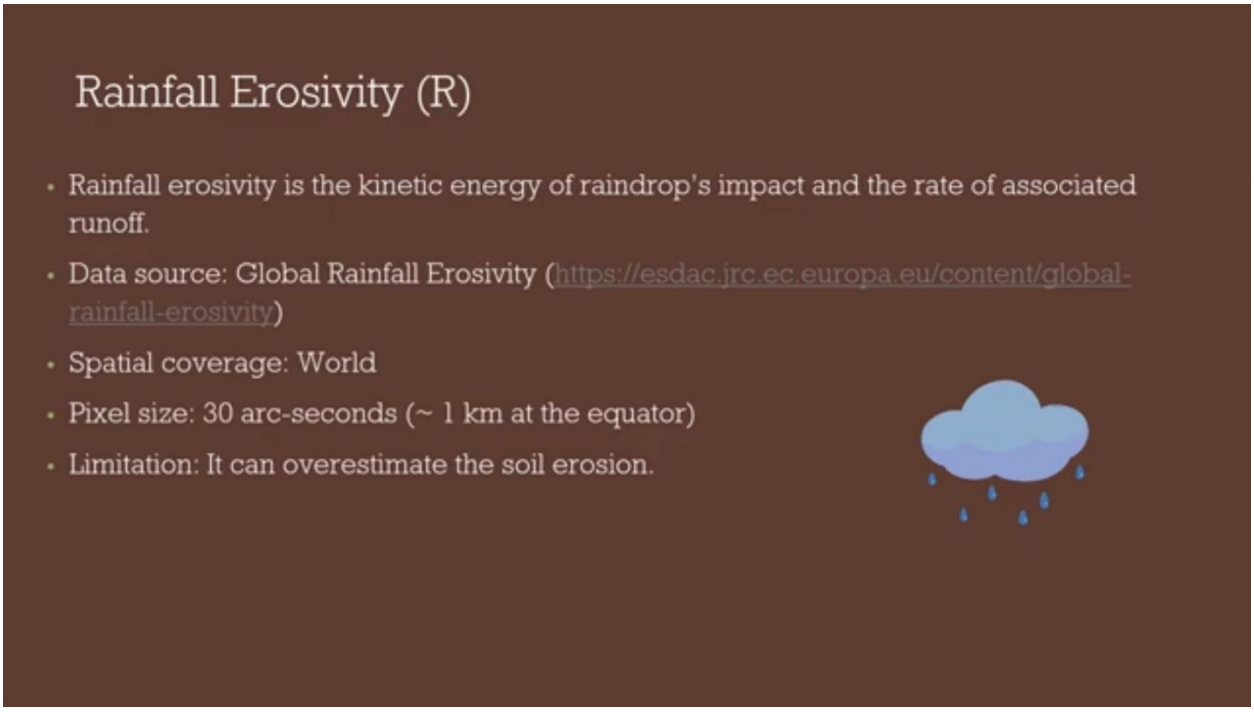
Introduction

The Universal Soil Loss Equation (USLE) is a widely used mathematical model that describes soil erosion processes.

$$\boldsymbol{A = R \times K \times LS \times C \times P} \left(\boldsymbol{metric}: \frac{\frac{\boldsymbol{tonnes}}{\boldsymbol{ha}}}{\boldsymbol{yr}} \right)$$

- ✓ R - rainfall Erosivity
- ✓ K - soil erodibility;
- ✓ L - slope length;
- ✓ S -slope steepness;
- ✓ C - cover and management;
- ✓ P - support practice.

1. Rainfall erosivity



Datasets needed:

1. Global Rainfall erosivity from here
2. Boundary shapefile

Downloading process

- ✓ Visit the web link given above

Get the Request Form

- ✓ Scroll down on the web page until you reach the request form section.

Enter the Request Form

- ✓ Give the necessary information like:
  - Full Name
  - Email Address
  - Organization
  - Type of the organization
  - Purpose of use

Submit the Request

Click on submit button when you complete filling up the form.

Wait for Email Confirmation

Wait for the confirmation email after submission. It will be anywhere between a few hours to a few minutes.

Download the Dataset

Open the sent email and press on the link described to download and utilize the dataset.

How to Compute the R-Factor (Rainfall Erosivity) for Your Area of Interest (AOI)

Method 1: Employing the Global Rainfall Erosivity Dataset (Pre-calculated R-factor)

Step 1: Download and Unzip the Dataset

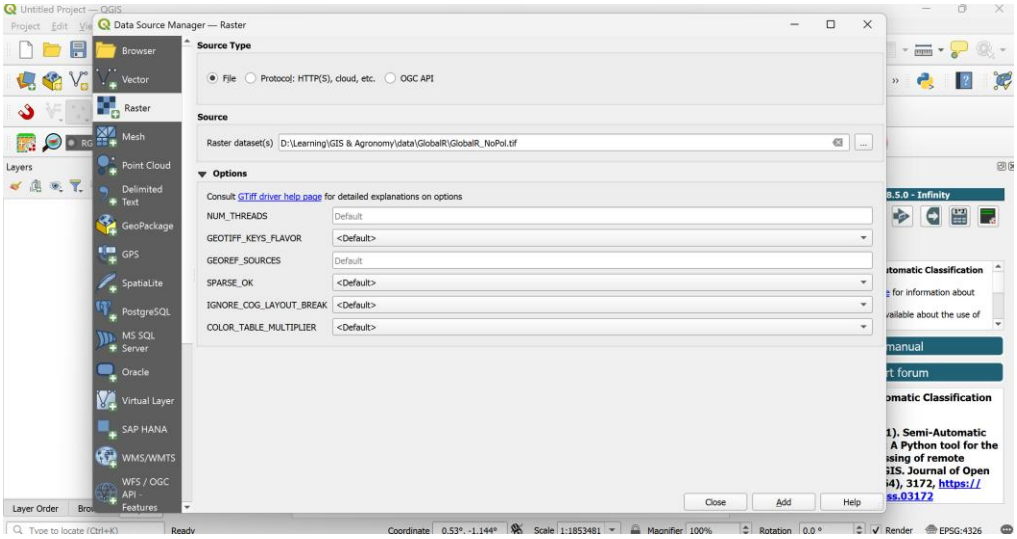
- ✓ Save the ZIP file data to the path they give you when you ask for it.
- ✓ Unzip the ZIP file to your target directory.
- ✓ You will have a .tif file in the directory where you unzipped the ZIP file—this is your global rainfall erosivity (R-factor) raster.

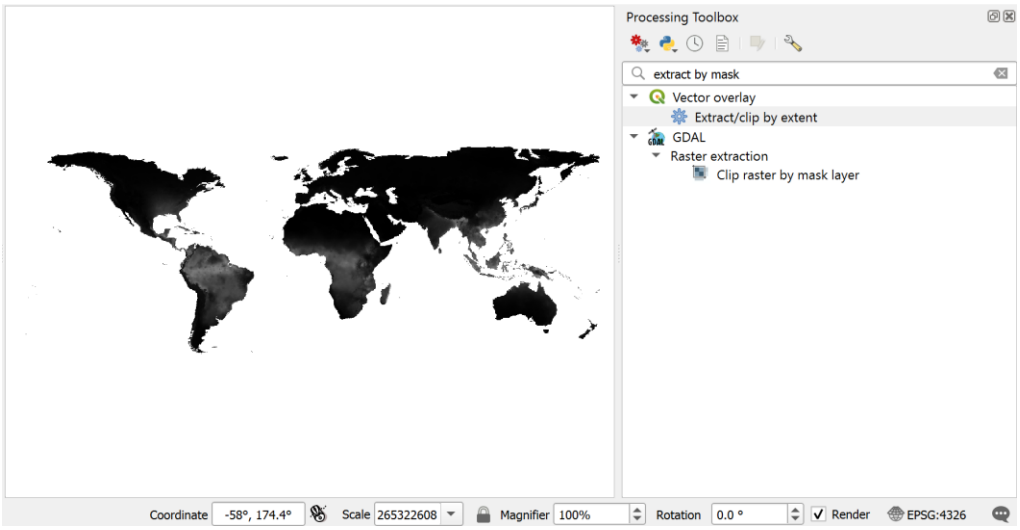
Step 2: Load Data in QGIS

1. Open QGIS.

2. Add the.tif file into QGIS:

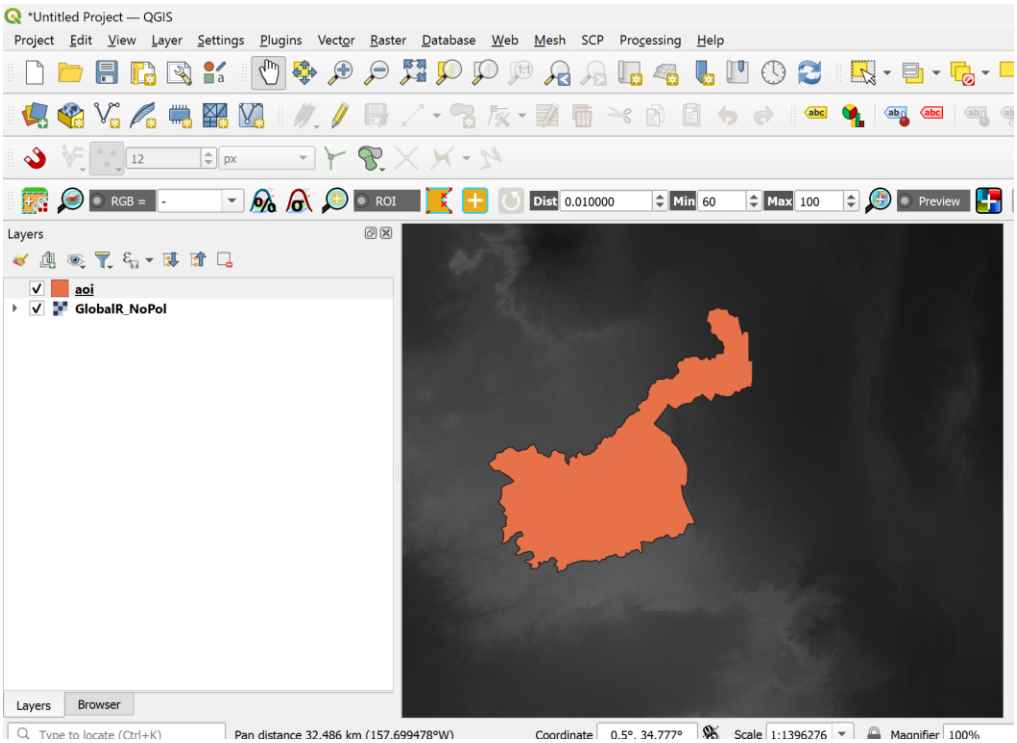
$$Layer > Add\ Layer > Add\ Raster\ Layer > Find\ your\ .tif\ file.$$





3. Insert your Area of Interest (AOI) shapefile:

$$Layer > Add\ Layer > Add\ Vector\ Layer > Browse\ your\ AOI\ shapefile.$$



Step 3: Extract R-Factor for Your AOI

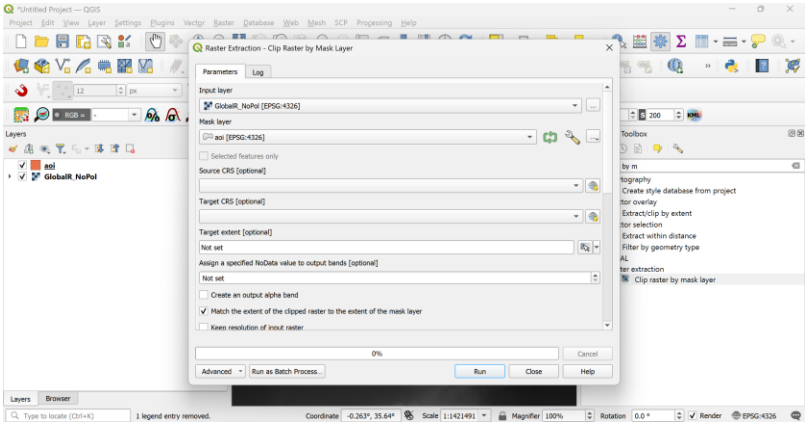
1.Enable Processing Toolbox (or $Ctrl + Alt + T$).

2.Search for "Clip raster layer by mask layer".

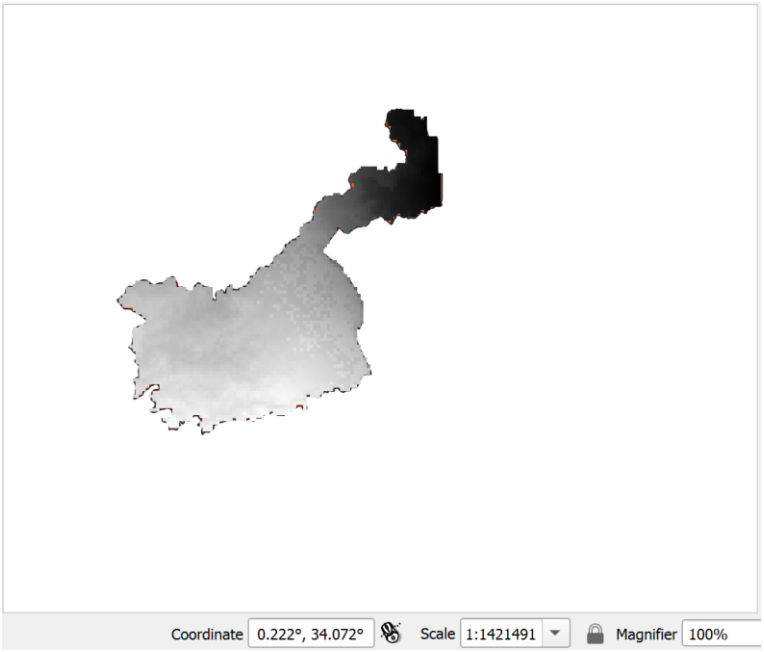
3.Select:

- ✓ Input layer: The rainfall erosivity.tif raster.
- ✓ Mask layer: Your AOI shapefile.
- ✓ Output file: Select a location and name to save the clipped raster.
- ✓ Leave everything as default

4.Run.



You now have the R-factor raster clipped to your area of interest.



Method 2: Estimating the R-Factor from Mean Annual Rainfall (Excel Dataset)

Why Interpolation is Needed

Rainfall in Excel is usually a point dataset—every row is rainfall at one station (latitude, longitude, and amount of rainfall).

But in order to do raster-based calculations (e.g., calculating $R = 0.5 \times P$), we need a continuous surface raster of rainfall across the area.

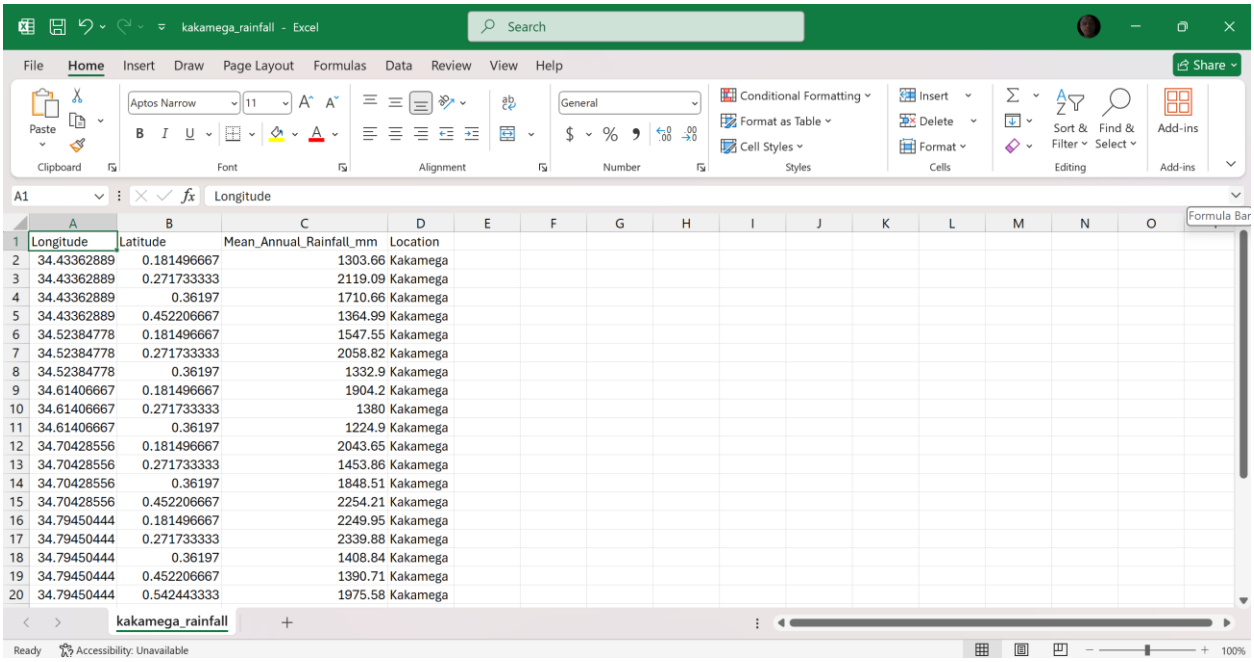
That is where inverse distance weighting (IDW) interpolation is required—it fills in rainfall values at unsampled points with the station values around it.

Step-by-Step Procedure

Step 1: Prepare the Excel Data

1.Ensure your Excel (.xlsx or.csv) has the columns listed below:

- ✓ Longitude
- ✓ Latitude
- ✓ Rainfall (mean annual rainfall in mm)



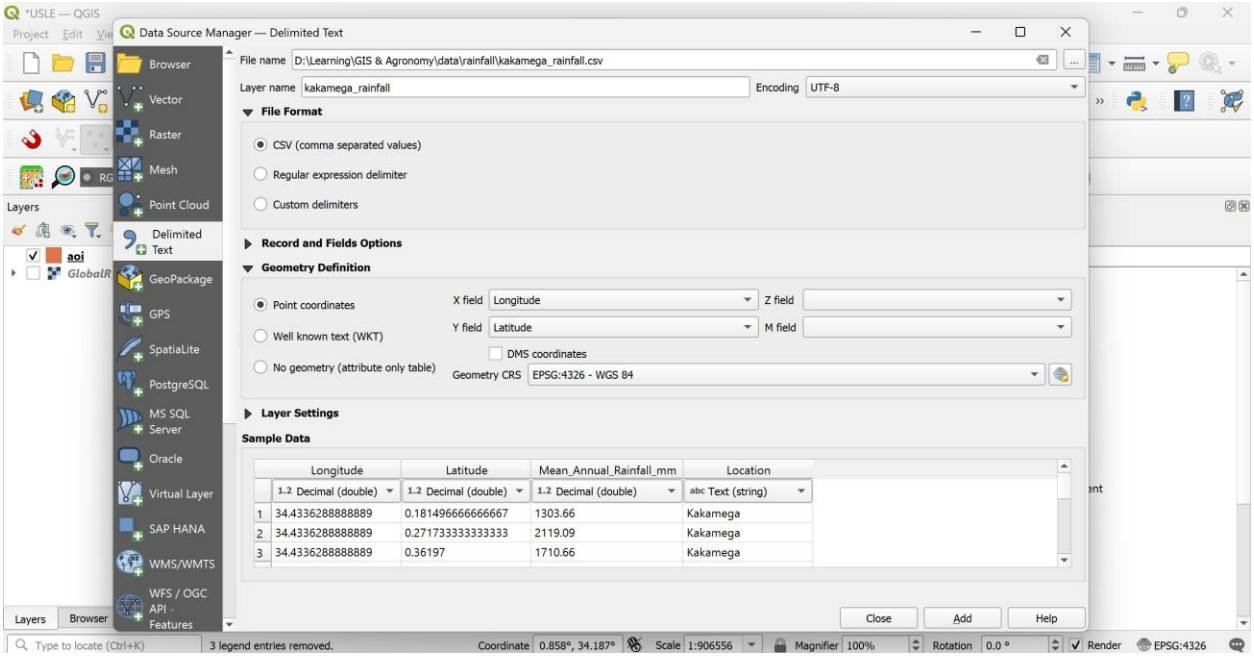
	A	B	C	D
1	Longitude	Latitude	Mean_Annual_Rainfall_mm	Location
2	34.43362889	0.181496667	1303.66	Kakamega
3	34.43362889	0.271733333	2119.09	Kakamega
4	34.43362889	0.36197	1710.66	Kakamega
5	34.43362889	0.452206667	1364.99	Kakamega
6	34.52384778	0.181496667	1547.55	Kakamega
7	34.52384778	0.271733333	2058.82	Kakamega
8	34.52384778	0.36197	1332.9	Kakamega
9	34.61406667	0.181496667	1904.2	Kakamega
10	34.61406667	0.271733333	1380	Kakamega
11	34.61406667	0.36197	1224.9	Kakamega
12	34.70428556	0.181496667	2043.65	Kakamega
13	34.70428556	0.271733333	1453.86	Kakamega
14	34.70428556	0.36197	1848.51	Kakamega
15	34.70428556	0.452206667	2254.21	Kakamega
16	34.79450444	0.181496667	2249.95	Kakamega
17	34.79450444	0.271733333	2339.88	Kakamega
18	34.79450444	0.36197	1408.84	Kakamega
19	34.79450444	0.452206667	1390.71	Kakamega
20	34.79450444	0.542443333	1975.58	Kakamega

2.Save as CSV if not already saved as CSV format:

- ✓ In Excel: File > Save As > CSV (Comma delimited)

Step 2: Import CSV to QGIS

- ✓ QGIS.
- ✓ Layer > Add Layer > Add Delimited Text Layer.
- ✓ Go to your CSV file.
- ✓ Set X field to Longitude and Y field to Latitude.
- ✓ Click Add → This will create your rainfall stations as a point layer.

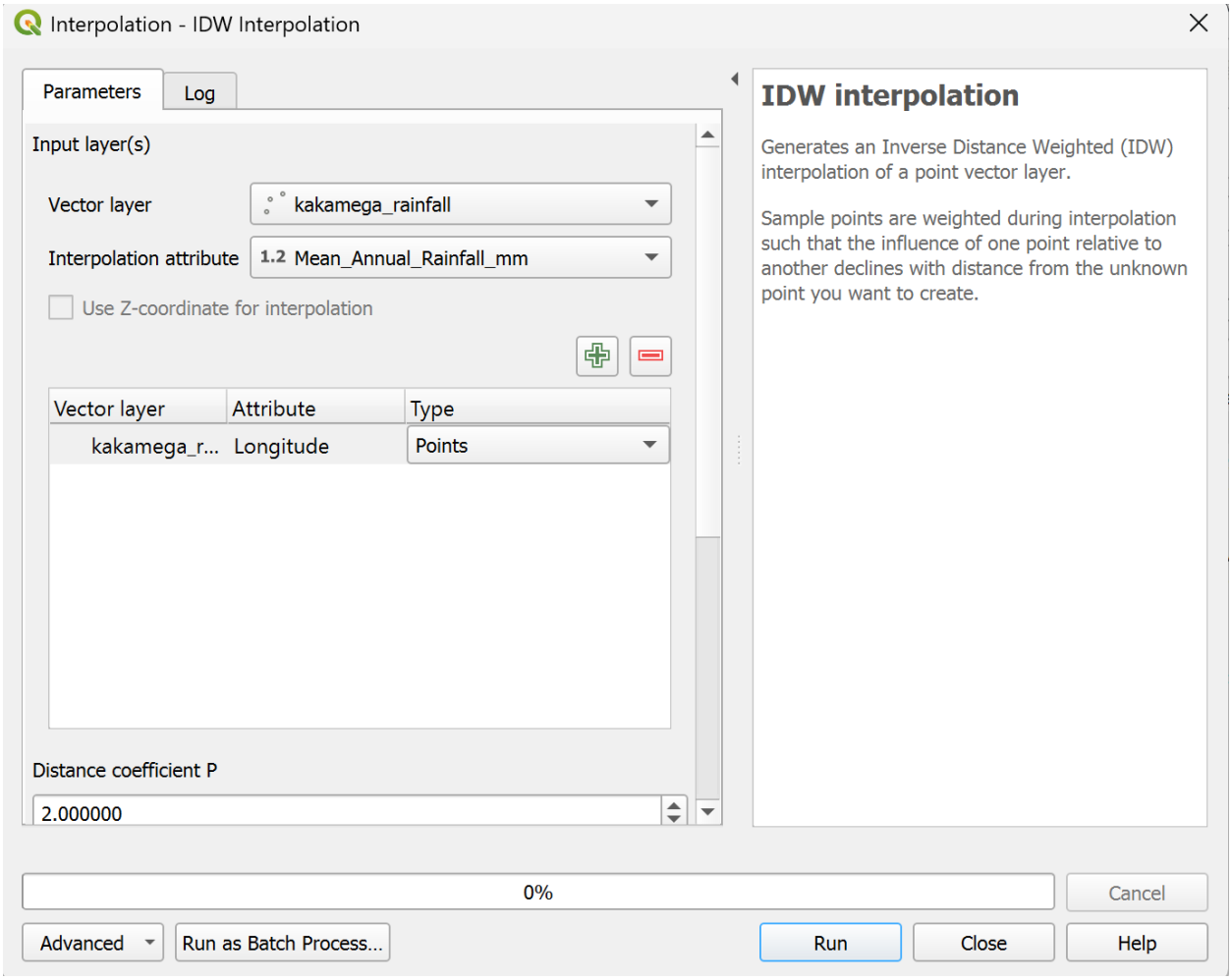


Step 3: Run IDW Interpolation

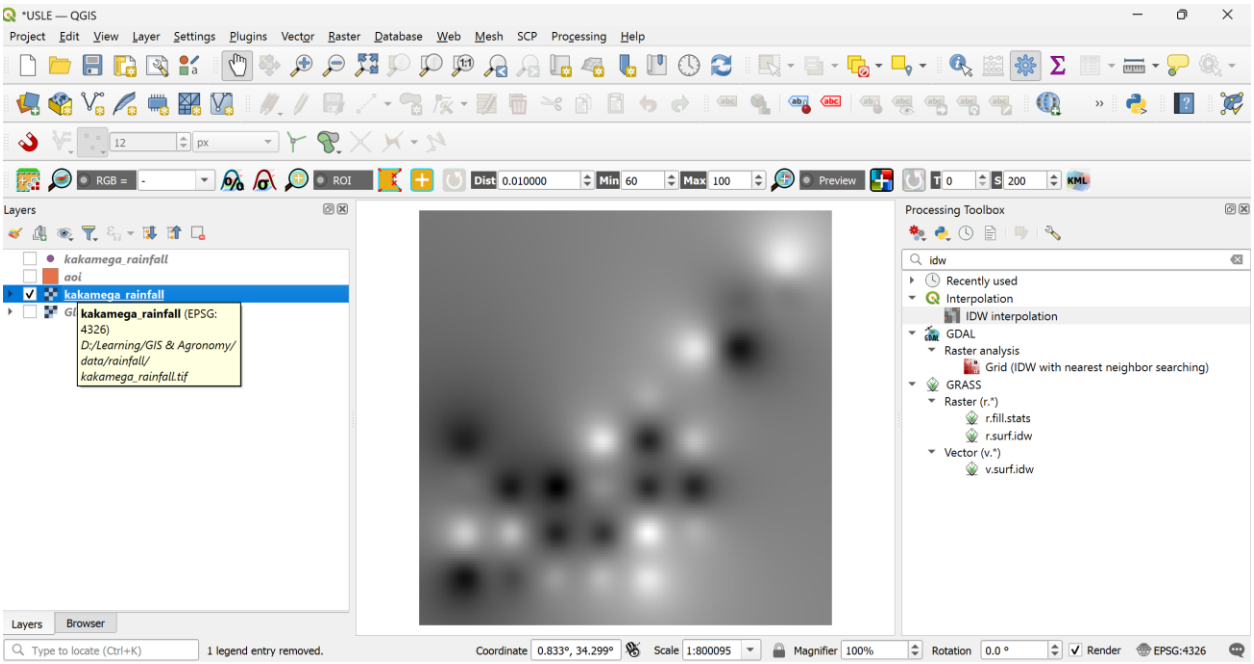
- ✓ Open the Processing Toolbox ($Ctrl + Alt + T$).
- ✓ Find "IDW Interpolation".

3. Set parameters:

- ✓ Input point layer: Your rainfall station points.
- ✓ Interpolation attribute: Rainfall column (e.g., Rainfall).
- ✓ Distance coefficient (Power): 2 (default; adjust as necessary based on your data).
- ✓ Extent and resolution: Set input output raster extent (use AOI extent if necessary).
- ✓ Output raster: Choose where to output interpolated rainfall raster.
- ✓ Click Run.



You now have a mean annual rainfall raster surface.

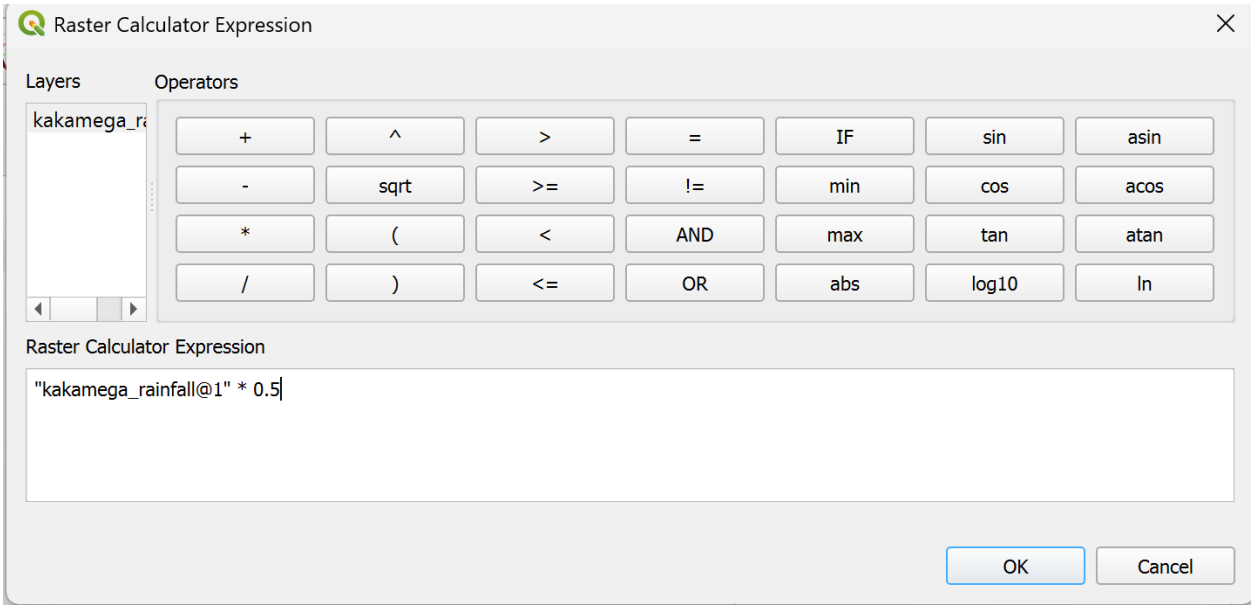


Step 4: Calculate R-Factor Using Raster Calculator

1. In Raster, select Raster > Raster Calculator.
2. Use the formula:

$$0.5 \times \text{Rainfall\_Interpolated@1}$$

(*Insert "Rainfall_Interpolated@1" with your layer name.*)



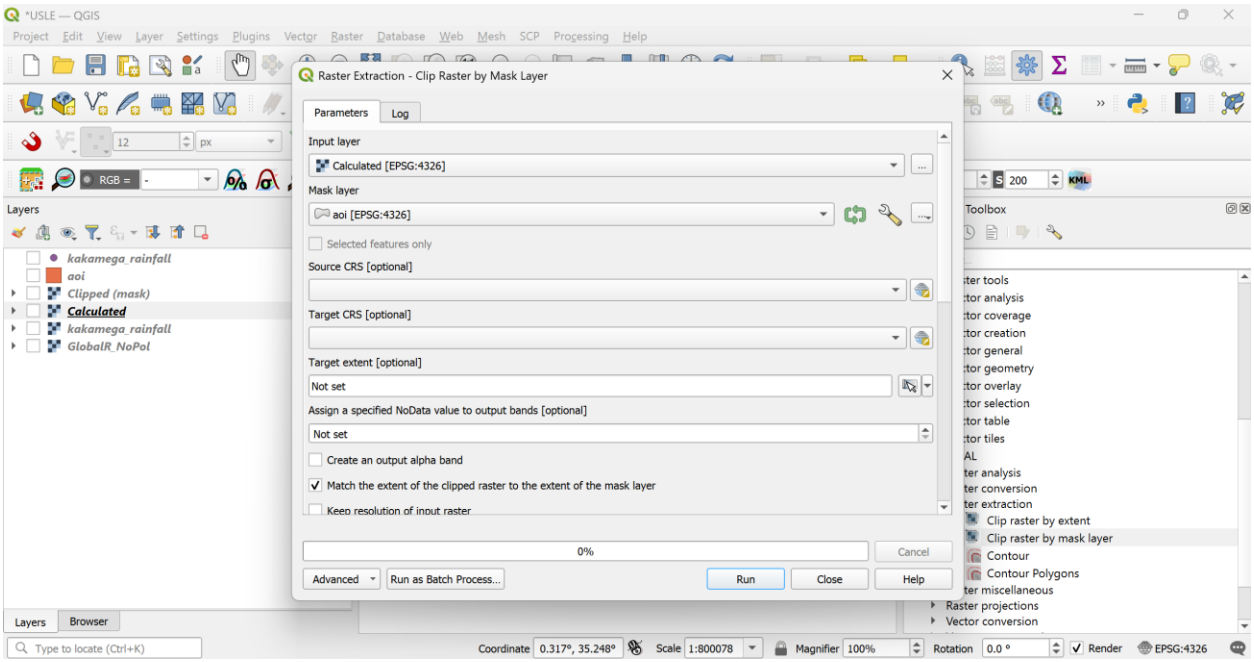
3. Define the output location and filename.

4. OK.

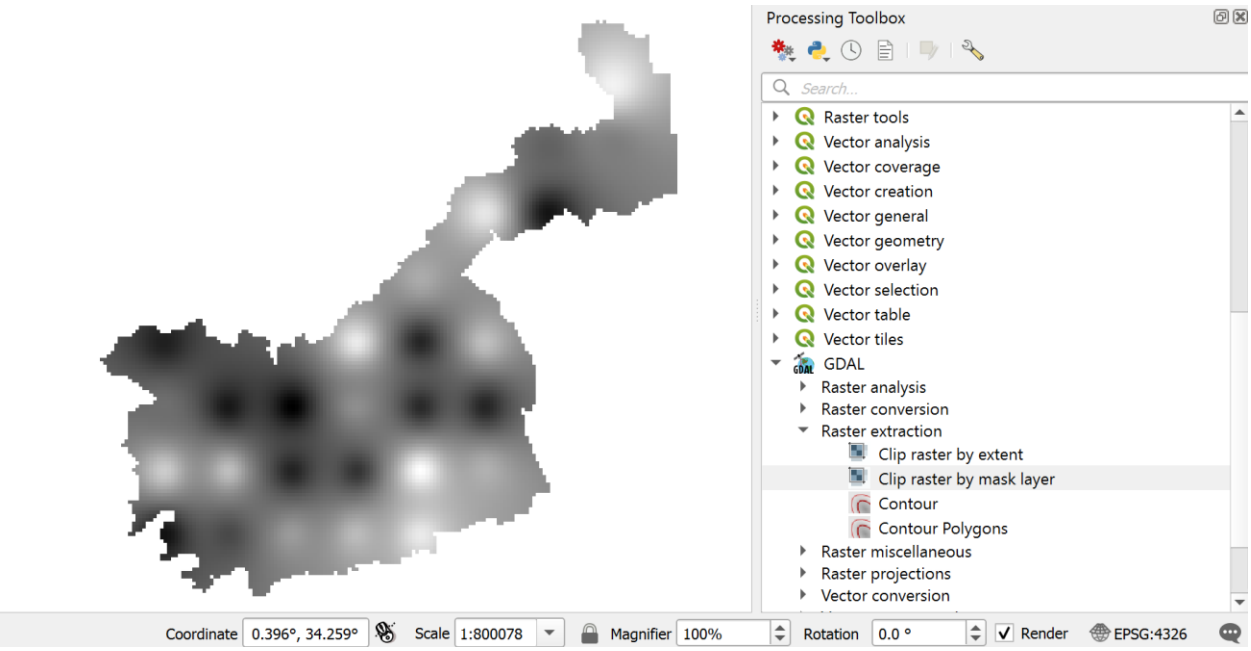
This produces a raster of R-factor values ($MJ \cdot mm \cdot ha^{-1} \cdot h^{-1} \cdot yr^{-1}$) for your entire study area.

Step 5: Clip R-Factor Raster to AOI

- ✓ In the Processing Toolbox, find "Extract by mask".
- ✓ Enter:
    - Input layer: R-factor raster you have just created.
    - Mask layer: Your AOI shapefile.
    - Output file: Choose a location and name for saving.



3. Run.



Congratulations! You have just managed to estimate the R-factor from rain station data.

References

Cruz, A. M. D., Maniquiz-Redillas, M. C., Tanhueco, R. M., & De Leon, M. P. (2025). Estimation of the Rainfall Erosivity Factor (R-Factor) for application in soil loss models. *Water*, *17*(6), 837. https://doi.org/10.3390/w17060837

QGIS Training Manual — QGIS Documentation documentation. (n.d.). https://docs.qgis.org/3.40/en/docs/training_manual/