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# Risk Mapper

QGIS Processing provider for fine-scale hazard, exposure, vulnerability, and risk mapping.

International Water Management Institute

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# Risk Mapper: QGIS plugin for fine-scale hazard, exposure, vulnerability, and risk mapping

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# Introduction

The Risk Mapper plugin for QGIS is designed to support risk assessment by integrating diverse spatial datasets. It focuses on climate and water related hazards and evaluates how these hazards interact with communities, agriculture, infrastructure, and the environment to quantify hazard, exposure and vulnerability. The plugin allows calculation of risk using user-defined formulas by combining hazard, exposure, vulnerability, and adaptive capacity. Overall, the plugin is flexible and capable of processing any dataset that contributes to understanding and quantifying risk regardless of its specific use case. This makes it a versatile tool for planners, researchers, and decision-makers seeking to evaluate and visualize risk across multiple sectors and regions.

# Installation

Installation of the *Risk Mapper* plugin is straightforward. The plugin can be installed either manually from a ZIP archive or directly through the QGIS Plugin Manager (once published).

## Installation from ZIP

If you have downloaded the plugin as a ZIP file:

1. Open QGIS.
2. Go to *Plugins* → *Manage and Install Plugins*...
3. Click the *Install from ZIP* tab.
4.  Browse to the downloaded ZIP file and open it.
5. Click *Install Plugin*.
6. Once installed, the plugin will appear in the Processing Toolbox under *Risk Mapper*.

## Installation through Plugin Manager

Once the plugin is published in the official QGIS Plugin Repository, it can be installed directly from the Plugin Manager:

1. Open QGIS.
2. Go to *Plugins* → *Manage and Install Plugins...*
3. In the search bar, type *Risk Mapper*.
4. Select the plugin from the list and click *Install Plugin*.
5. The plugin will be automatically available under the Processing Toolbox.

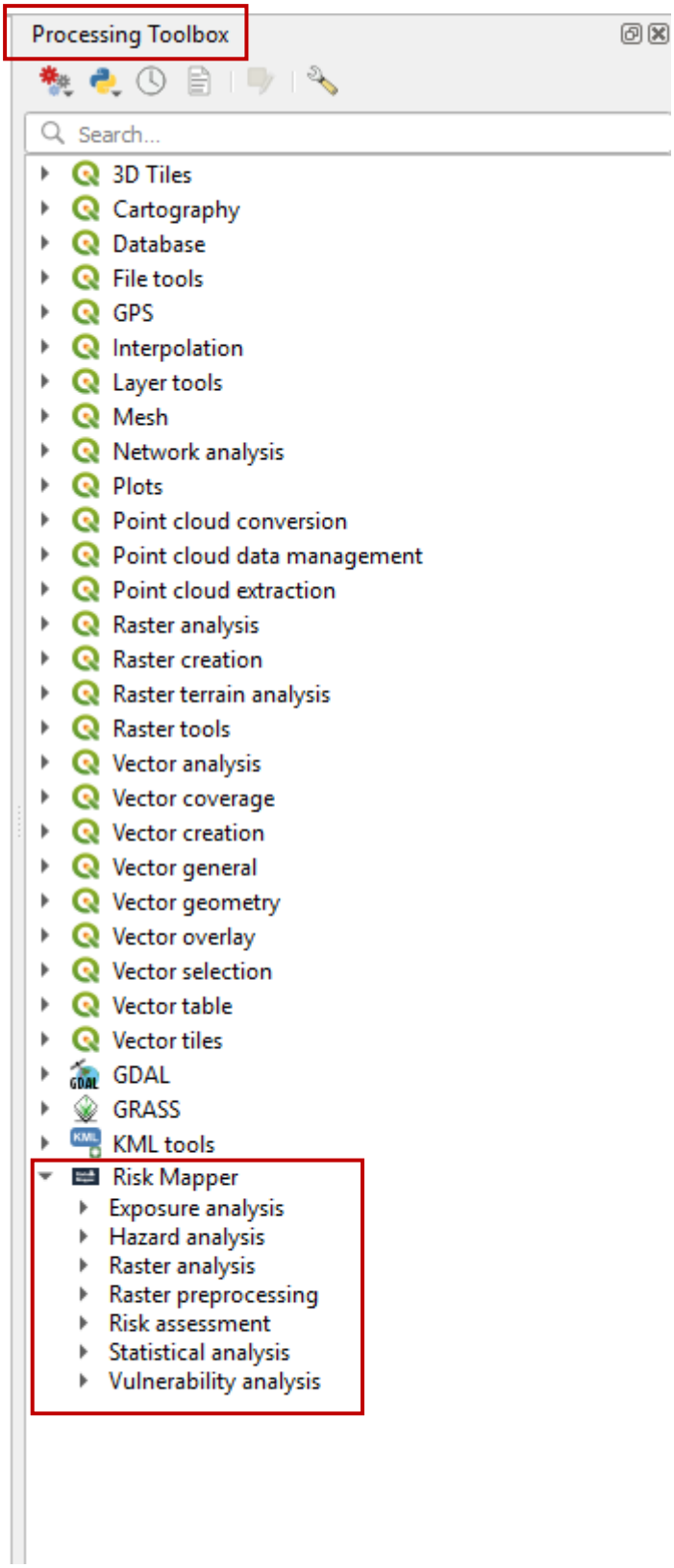



**Figure 1: Risk Mapper plugin in the Processing Toolbox**

## Sample Data

The *Risk Mapper* plugin is distributed with a set of test data included in the plugin ZIP file. The data are provided in a folder named `test_data`, which can be used to explore the functionality of the plugin and reproduce the examples shown in this user guide.

The `test_data` folder contains the following subfolders:

- `AOI-` contains all vector files defining the study area of interest (AOI) including the boundary and grid layers used for statistical analysis.
- `data_for_risk_assessment-` pre-calculated indices and supporting data for hazard, exposure, vulnerability, and adaptive capacity. This folder also contains the weights used in the assessment.
- `exposureData-` supporting exposure-related datasets.
- `FloodLayerZambia-` raw flood data extracted from Google Earth Engine (GEE).
- `monthlyFloodDataforEthiopia-` raw monthly flood data from Google Earth Engine (GEE) for few months in Ethiopia.
- `vulnerabilityData-` datasets related to vulnerability analysis.

The test data are intended for demonstration and training purposes. They allow users to quickly test plugin functions without the need to prepare their own input datasets.

## Conventions


Browse for a file


Select data destination


Select an existing QGIS layer


Specify a Coordinate Reference System (CRS)


Checkbox

## Raster Filename Convention

**All raw input raster filenames must include a date string formatted as YYYY-MM-DD.** This format allows the tools to automatically extract the year and month from each file and group them for temporal analysis.

### Accepted Format

<AnyName>_YYYY-MM-DD.tif

**Examples:**

- flood_2025-01-10_2025-01-21.tif → January 10, 2025 to January 21, 2025
- rainfall_2024-12-31.tif → December 31, 2024

**Notes:**

- Files not following this convention will be skipped.
- Consistent naming ensures correct sorting, summation, and mapping.

## Risk Mapper Tools

When the *Risk Mapper* plugin is installed, the tools are available in the Processing Toolbox under the *Risk Mapper* provider. The tools are organized into seven functional groups:

1. Exposure Analysis
2. Hazard Analysis
3. Raster Analysis
4. Raster Preprocessing
5. Risk Assessment
6. Statistical Analysis
7. Vulnerability Analysis

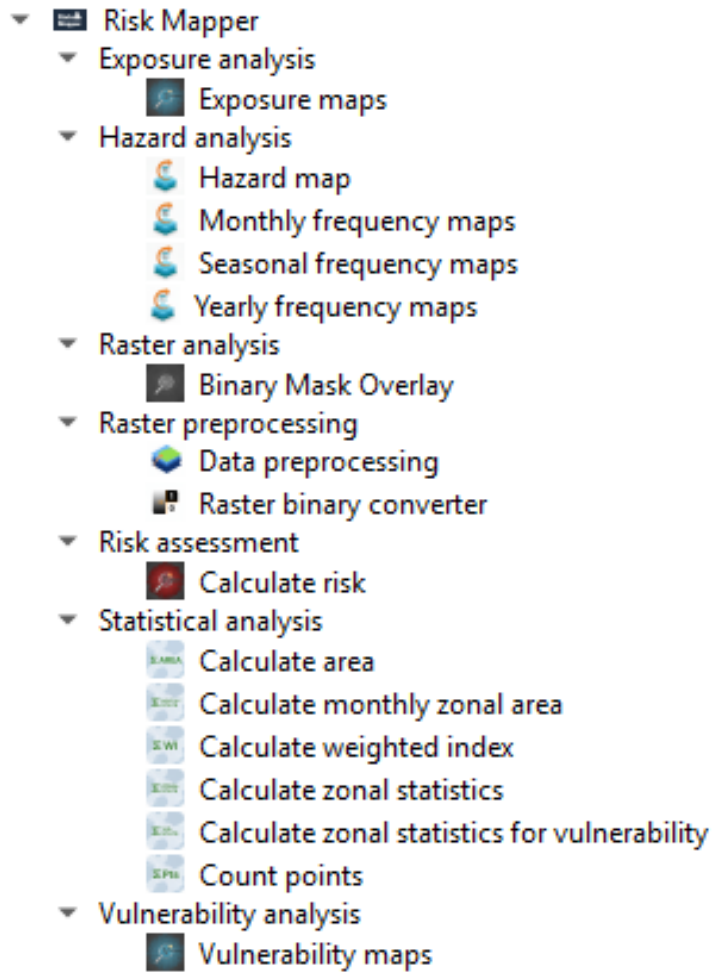
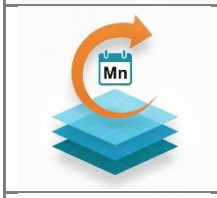
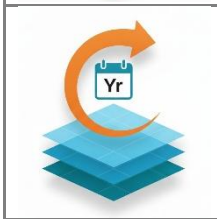
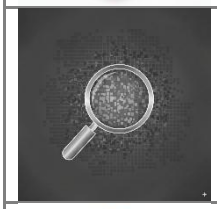
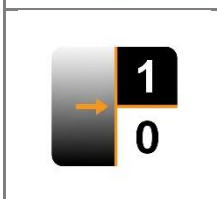
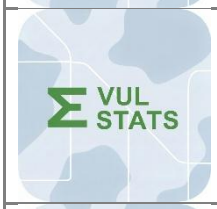



**Figure 2: plugin tools in the Processing Toolbox**

**Table 1: Overview of Risk Mapper Tools**

| Icon | Tool Name | Recursive | Group |
|---|---|---|---|
|  | Exposure maps | × | Exposure analysis |
| | Masks binary frequency rasters with an exposure dataset (e.g. GDP, population) to generate yearly exposure rasters. | | |
|  | Hazard map | ✓ | Hazard analysis |
| | Recursively sums all rasters in a folder to create a hazard map. | | |
|  | Monthly frequency maps | ✓ | Hazard analysis |
| | Generates monthly frequency maps from input rasters. | | |
|  | Yearly frequency maps | ✓ | Hazard analysis |
| | Generates yearly frequency maps from input rasters. | | |
|  | Seasonal frequency maps | ✓ | Hazard analysis |
| | Generates seasonal frequency maps from input rasters. Seasons are defined by the user in a table. Consecutive months spanning years are handled correctly, and missing months are filled with zeros. | | |
|  | Binary mask overlay | × | Raster analysis |
| | Applies a binary mask to an input raster to generate a masked raster for exposure and vulnerability analysis. This retains values only in areas defined by the mask | | |
|  | Data preprocessing | ✓ | Raster preprocessing |
| | Merges rasters based on a user-defined regex pattern, applies a vector mask, reprojects to a target CRS, and preserves the input subfolder structure. | | |
|  | Raster binary converter | × | Raster preprocessing |
| | Converts an input raster to a binary raster (0/1) based on a threshold. Values greater than the threshold are set to 1, otherwise 0. Compression can be chosen. | | |
|  | Calculate risk | × | Risk assessment |
| | Combines hazard, vulnerability, exposure, and adaptive capacity using a user-defined formula and assess risk. User selects which fields to use from each layer. | | |
| | Calculate area | × | Statistical analysis |

| | | | |
|---|---|---|---|
|  | Calculates zonal statistics for multiple rasters, derives areas based on pixel counts or sums. | | |
|  | Calculate monthly zonal area | × | Statistical analysis |
| | Calculates monthly zonal statistics for multiple rasters and derives area (km²) using either Count or Sum statistics. Suffix for output fields can be extracted using user-defined slicing (e.g., '2:7'). | | |
|  | Calculate weighted index | × | Statistical analysis |
| | Calculates a Weighted Index (wi, FWI) for hazard, exposure and vulnerability from CSV and joins results to a shapefile. | | |
|  | Calculate zonal statistics | × | Statistical analysis |
| | Calculates zonal statistics for all rasters in a folder and appends the results to the input vector layer. | | |
|  | Zonal statistics for vulnerability | × | Statistical analysis |
| | Runs zonal statistics for a raster and joins results to an input vector layer. | | |
|  | Count points | × | Statistical analysis |
| | Samples multiple rasters at centroids, aggregates all sampled fields into one layer, and summarizes counts per admin unit in one step. | | |
|  | Vulnerability maps | × | Vulnerability analysis |
| | Generates vulnerability rasters by masking vulnerability indices rasters with the hazard raster. | | |

# Raster Preprocessing

## Data Preprocessing

This tool automates three common raster preprocessing steps:

- **Merging** rasters based on a user-defined regex pattern.
- **Masking** rasters using a vector boundary.
- **Reprojecting** to a target Coordinate Reference System (CRS).

**Note:** The tool preserves subfolder structures in the output directory and allows you to apply a prefix to all output raster names.

## Description

This tool is designed for batch raster preprocessing. It searches through all subfolders of the input directory, groups rasters using a regex pattern (if merging is enabled), masks them with a vector boundary, and optionally reprojects them to a chosen CRS.

## Parameters

**Table 2: Input parameters - Data Preprocessing**

| Parameter | Description |
|---|---|
| Main input folder | Folder containing raster files (.tif). All subfolders are processed recursively. |
| Vector mask layer | A vector layer (polygon) used to clip the rasters. |
| Output folder | Destination folder where processed rasters will be saved. Subfolder structures are preserved. |
| Merge rasters before masking | Boolean option (Yes/No). If enabled, rasters will be merged based on a regex pattern. |
| Regex pattern to group rasters for merging | Regular expression used to identify which rasters to merge. Example: (flood_\d{4}-\d{2}-\d{2}_\d{4}-\d{2}-\d{2}) groups rasters by date ranges. |
| Target CRS | Select a CRS to reproject rasters. If left empty, rasters retain their original CRS. |
| Prefix for output rasters | Optional prefix (default: mod_) to add to the beginning of all output file names. |

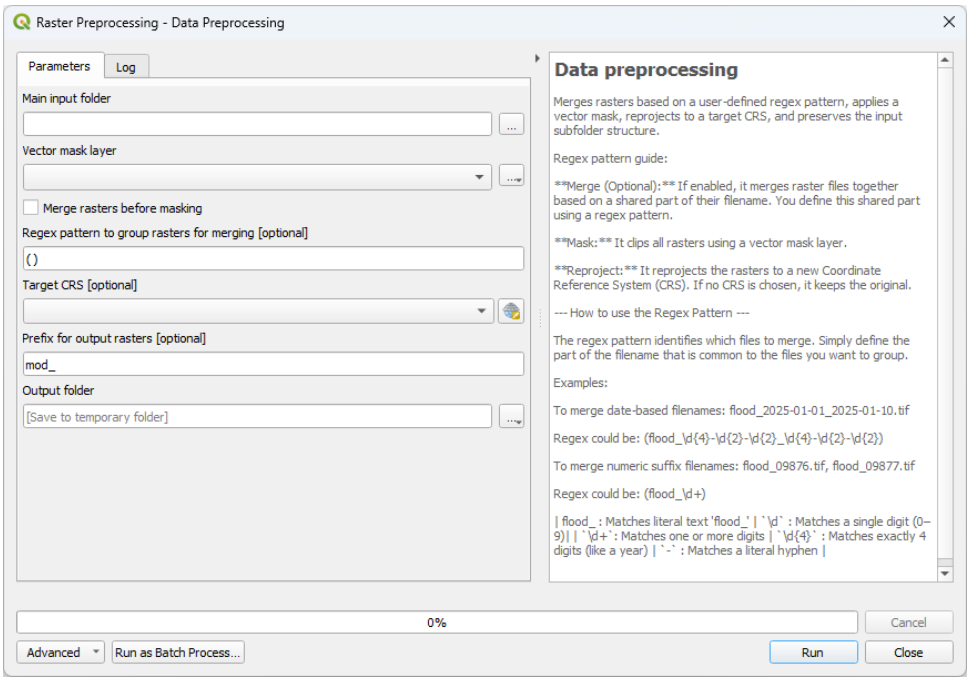



**Figure 3: Data Preprocessing Dialog**

## Outputs

- Preprocessed rasters (.tif) saved to the specified output folder.
- The folder structure of the input is mirrored in the output directory.
- Rasters are compressed using LZW compression.

## Workflow

- Open the *Risk Mapper → Raster preprocessing* group in the Processing Toolbox.
- Select Data preprocessing.
- Choose the *Main input folder* containing raw rasters.
- Load a polygon layer as the *Vector mask*.
- Enable *Merge rasters before masking* if you want to combine rasters first.
- Enter a regex pattern to group rasters for rasters named flood_001.tif, flood_002.tif).
- (Optional) Choose a *Target CRS.*
- Specify an Output folder and a Prefix.
- Click *Run.*

## How to use the Regex Pattern

The regex pattern identifies which files to merge. Simply define the part of the filename that is common to the files you want to group.

Examples:

To merge date-based filenames: flood_2025-01-01_2025-01-10.tif

Regex could be: (flood_\d{4}-\d{2}-\d{2}_\d{4}-\d{2}-\d{2})

To merge numeric suffix filenames: flood_09876.tif, flood_09877.tif

Regex could be: (flood_\d+)

- flood_: Matches literal text 'flood_'
- `\d`: Matches a single digit (0–9)|
- `\d+`: Matches one or more digits
- `\d{4}`: Matches exactly 4 digits (like a year)
- `-`: Matches a literal hyphen

**Notes:**

- If merging is enabled, but the regex pattern does not match filenames, no groups will be created.
- CRS detection is automatic if the input raster already has a projection defined. If not, a warning is raised.

# Raster Binary Converter

This tool converts a raster into a binary raster (0/1) based on a user-defined threshold.

## Description

The Raster Binary Converter takes a continuous or categorical raster as input and generates a binary raster using a threshold value. Compression options are available to reduce output file size.

- Values above the threshold → set to 1
- Values below or equal to the threshold → set to 0

## Parameters

**Table 3: Input parameters - Raster Binary Converter**

| Parameter | Description |
|---|---|
| Input raster | Raster layer to be converted. |
| Threshold | Numeric threshold to separate 0 and 1. Values above this threshold become 1; others become 0. Default = 0. |
| Compression | Choose raster compression: None, LZW, DEFLATE, PACKBITS. Default = None. |
| Output binary raster | Destination path for the resulting binary raster. |

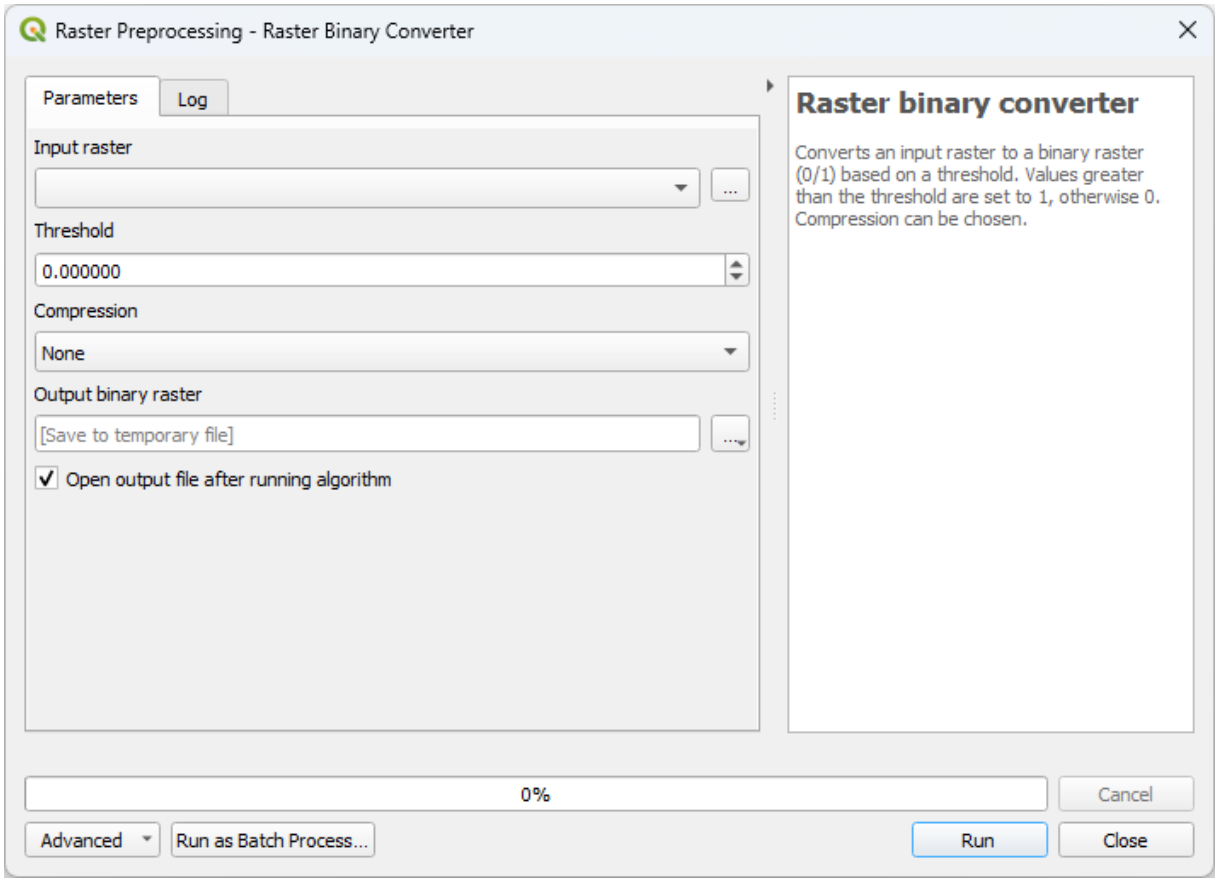



**Figure 4: Raster Binary Converter Dialog**

## Outputs

- GeoTIFF binary raster with values 0 or 1.
- NoData pixels in the input raster are converted to 0.
- Optional compression can reduce file size.

## Workflow

1. Open *Risk Mapper → Raster preprocessing* in the Processing Toolbox.
2. Select *Raster binary converter*.
3. Select the *Input raster*.
4. Enter a *Threshold* value.
5. Choose *Compression* (optional).
6. Specify *Output binary raster* path.
7. Click *Run*.

**Notes:**

- Always check that the input raster's **CRS and resolution** match downstream layers.
- Uses Byte data type for output rasters for efficiency.
- Missing or nodata pixels are automatically set to 0.

# Hazard Analysis

## Hazard Map

This tool recursively sums all rasters in a folder to produce a hazard map that represents the cumulative hazard intensity. It is useful when you want to aggregate hazard occurrence across multiple time steps or sources.

## Description

The *Hazard Map* tool aggregates all raster layers in the input folder (including subfolders) into a single cumulative raster. Each input raster contributes to the sum while NoData values are treated as zeros.

## Parameters

**Table 4: Input parameters - Hazard Map**

| Parameter | Description |
|---|---|
| Input main folder | Folder containing raster files (.tif) to sum. All subfolders are included recursively. |
| Output raster | Destination file path for the summed hazard raster (.tif). |
| Output data type | Data type of the output raster. Options: Byte, UInt16, UInt32, Int16, Int32, Float32, Float64. Default: UInt16. |
| Compression | Compression type for the output raster: None, LZW, DEFLATE, PACKBITS. Default: None. |
| Load layers on completion | Boolean option (Yes/No) to automatically load the resulting raster into QGIS. Default: Yes. |

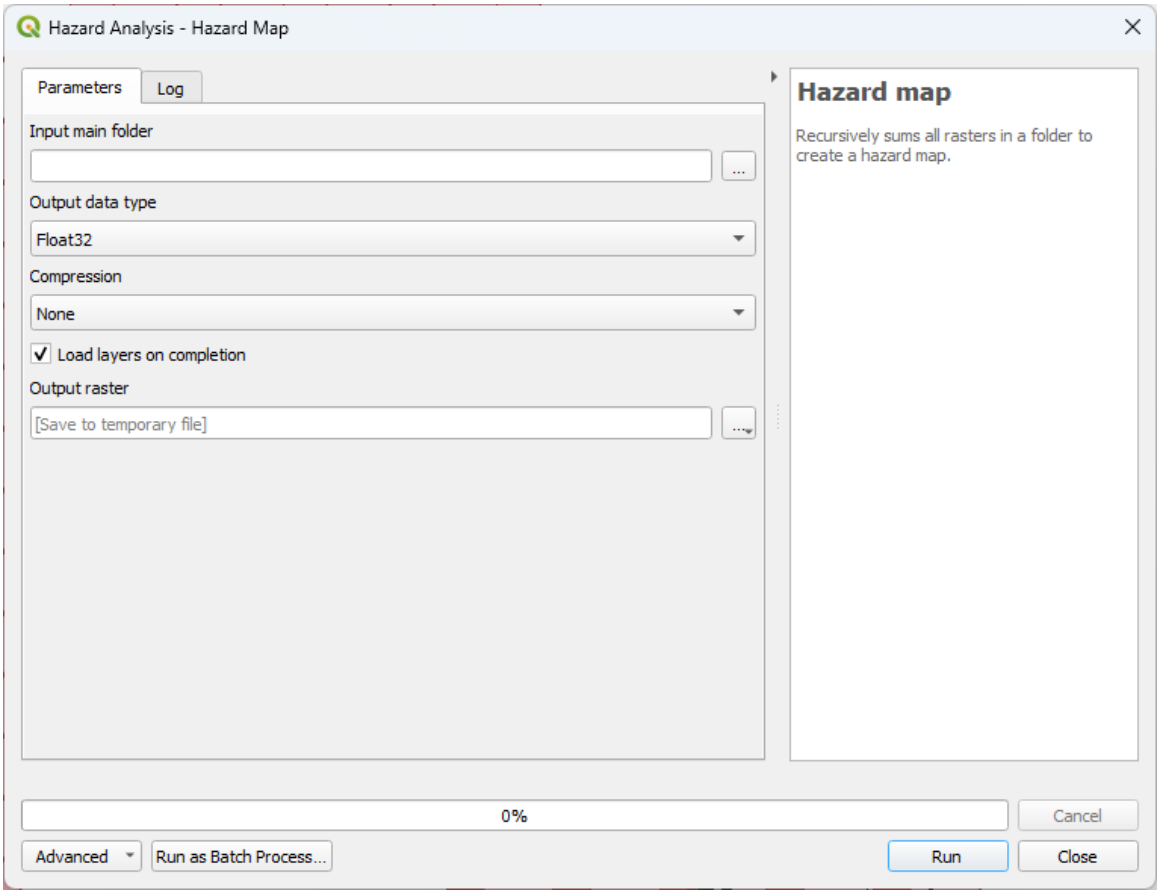



**Figure 5: Hazard Map Dialog**

## Outputs

- A single GeoTIFF raster representing the sum of all input rasters.
- Stored at the specified output location.
- Optionally loaded into QGIS if the checkbox is selected.

## Workflow

1. Open *Risk Mapper → Hazard analysis* in the Processing Toolbox.
2. Select *Hazard map*.
3. Choose the *Input main folder* containing hazard rasters.
4. Specify the *Output raster* path.
5. Select the *Output data type* (e.g., UInt16) and *Compression* (e.g., LZW).
6. Enable or disable *Load layers on completion*.
7. Click *Run*.

**Notes:**

- NoData values are automatically treated as zeros during summation.
- Ensure all input rasters have the same resolution and CRS for correct alignment.
- Large raster stacks may take several minutes to process depending on system memory and raster size.

# Monthly Frequency Maps

This tool generates monthly frequency maps from rasters stored in a folder structure. It automatically groups rasters by month based on the **YYYY-MM-DD** convention in the filenames and sums their values to create a cumulative monthly raster.

## Description

The *Monthly Frequency Maps* tool is used to aggregate raster data by month producing one raster per month representing cumulative occurrences.

## Parameters

**Table 5: Input parameters - Monthly Frequency Maps**

| Parameter | Description |
|---|---|
| Main input folder | Folder containing .tif rasters. All subfolders are processed recursively. |
| Output folder | Destination folder where monthly frequency rasters will be saved. |
| Prefix | Optional prefix added to all output raster filenames (default: frequencymaps_). |
| Load layers on completion | Boolean option (Yes/No) to automatically load generated monthly rasters into QGIS (default: Yes). |

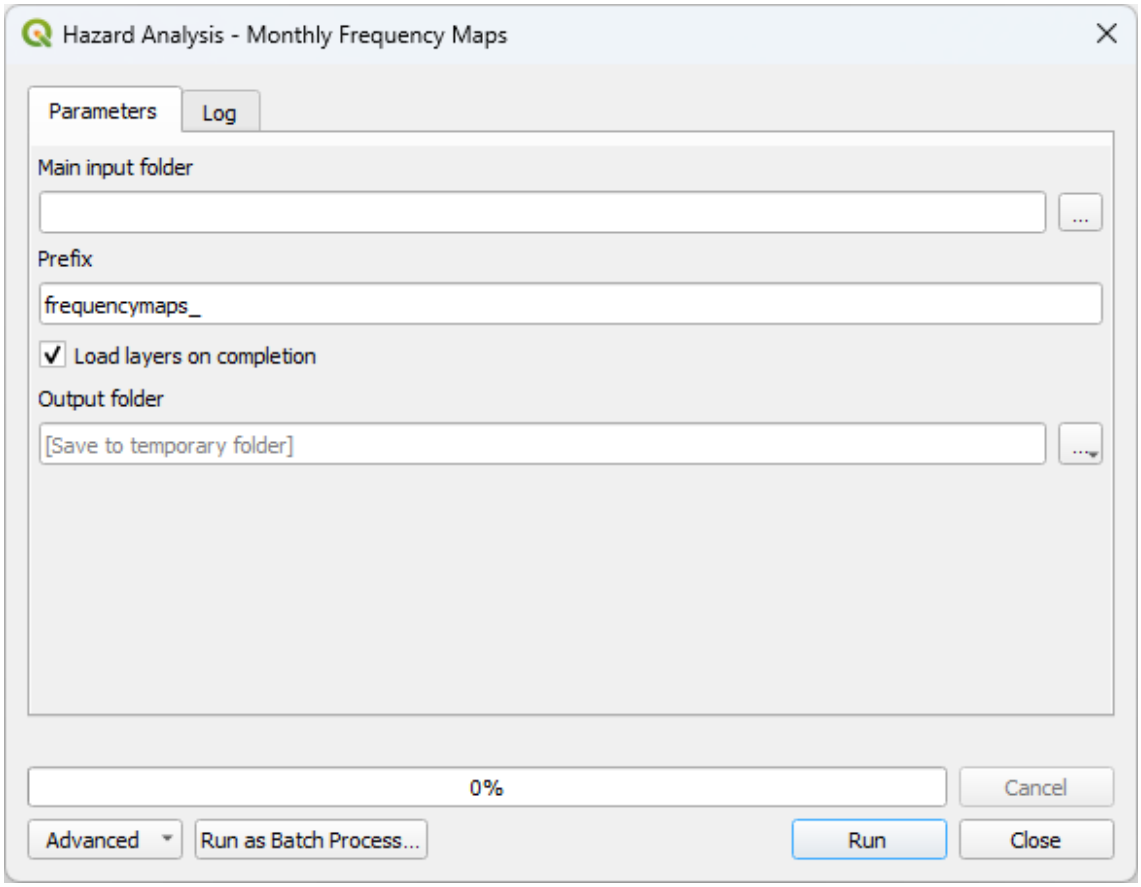



**Figure 6: Monthly Frequency Maps Dialog**

## Outputs

- One GeoTIFF raster per month stored in the output folder.
- Each raster represents the summed values of all input rasters for that month.
- Optionally loaded into QGIS if the checkbox is selected.

## Workflow

1. Open *Risk Mapper → Hazard analysis* in the Processing Toolbox.
2. Select *Monthly frequency maps*.
3. Choose the *Main input folder* containing hazard rasters named with YYYY-MM-DD.
4. Specify an *Output folder*.
5. (Optional) Enter a *Prefix* for output rasters.
6. Enable or disable *Load layers on completion*.
7. Click *Run*.

**Notes:**

- Filenames must include the date in YYYY-MM-DD format. Files not matching this pattern are skipped.
- All rasters must have the same CRS and resolution for correct alignment.
- Processing large datasets may take several minutes depending on raster size and number of files.

# Yearly Frequency Maps

This tool generates yearly frequency maps by summing rasters based on the year extracted from filenames. It assumes that raster filenames follow the **YYYY-MM-DD** convention and aggregates rasters into a single raster per year.

## Description

The *Yearly Frequency Maps* tool is used to analyze temporal hazard patterns across years. It produces one raster per year representing cumulative hazard occurrences.

## Parameters

**Table 6: Input parameters - Yearly Frequency Maps**

| Parameter | Description |
|---|---|
| Main input folder | Folder containing .tif rasters. All subfolders are included recursively. |
| Output folder | Destination folder for yearly frequency rasters. |
| Prefix | Optional prefix added to all output raster filenames (default: frequencymap_). |
| Load layers on completion | Boolean option (Yes/No) to automatically load generated yearly rasters into QGIS (default: Yes). |

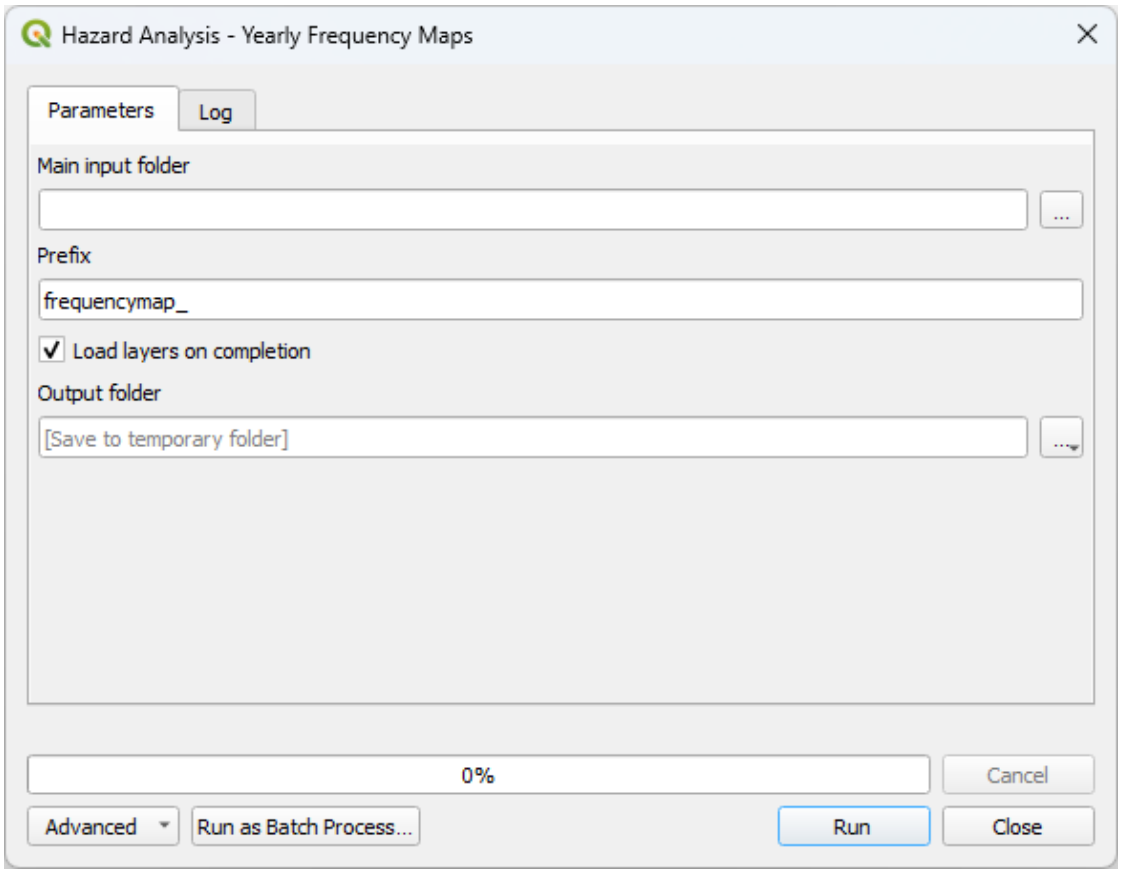



**Figure 7: Yearly Frequency Maps Dialog**

## Outputs

- One GeoTIFF raster per year.
- Each raster represents the summed values of all input rasters for that year.
- Optionally loaded into QGIS if the checkbox is selected.

## Workflow

1. Open *Risk Mapper* → *Hazard analysis* in the Processing Toolbox.
2. Select *Yearly frequency maps*.
3. Choose the *Main input folder* containing rasters with filenames in YYYY-MM-DD format.
4. Specify an *Output folder*.
5. (Optional) Enter a *Prefix* for output rasters (e.g., year_).
6. Enable or disable *Load layers on completion*.
7. Click *Run*.

**Notes:**

- Filenames must follow YYYY-MM-DD. Files not matching this pattern are skipped.
- Ensure all input rasters have the same CRS and resolution.
- Large datasets may take several minutes depending on raster size and number of files.

# Seasonal Frequency Maps

This tool generates seasonal frequency maps by summing rasters based on user-defined seasons.

## Description

The *Seasonal Frequency Maps* tool is used to analyze temporal hazard patterns across user-defined seasons. Users define seasons as a table with season names and lists of months. The tool aggregates rasters per season-year combination summing values for all months in the season.

## Parameters

**Table 7: Input parameters - Seasonal Frequency Maps**

| Parameter | Description |
|---|---|
| Main input folder | Folder containing .tif rasters. All subfolders are included recursively. |
| Output folder | Destination folder for seasonal frequency rasters. |
| Prefix | Optional prefix added to all output raster filenames (default: frequencymaps_). |
| Load layers on completion | Boolean option (Yes/No) to automatically load generated rasters into QGIS (default: Yes). |
| Seasons Definition | Matrix table defining season names and corresponding months. Consecutive months spanning years are allowed (e.g., 11,12,01,02). |

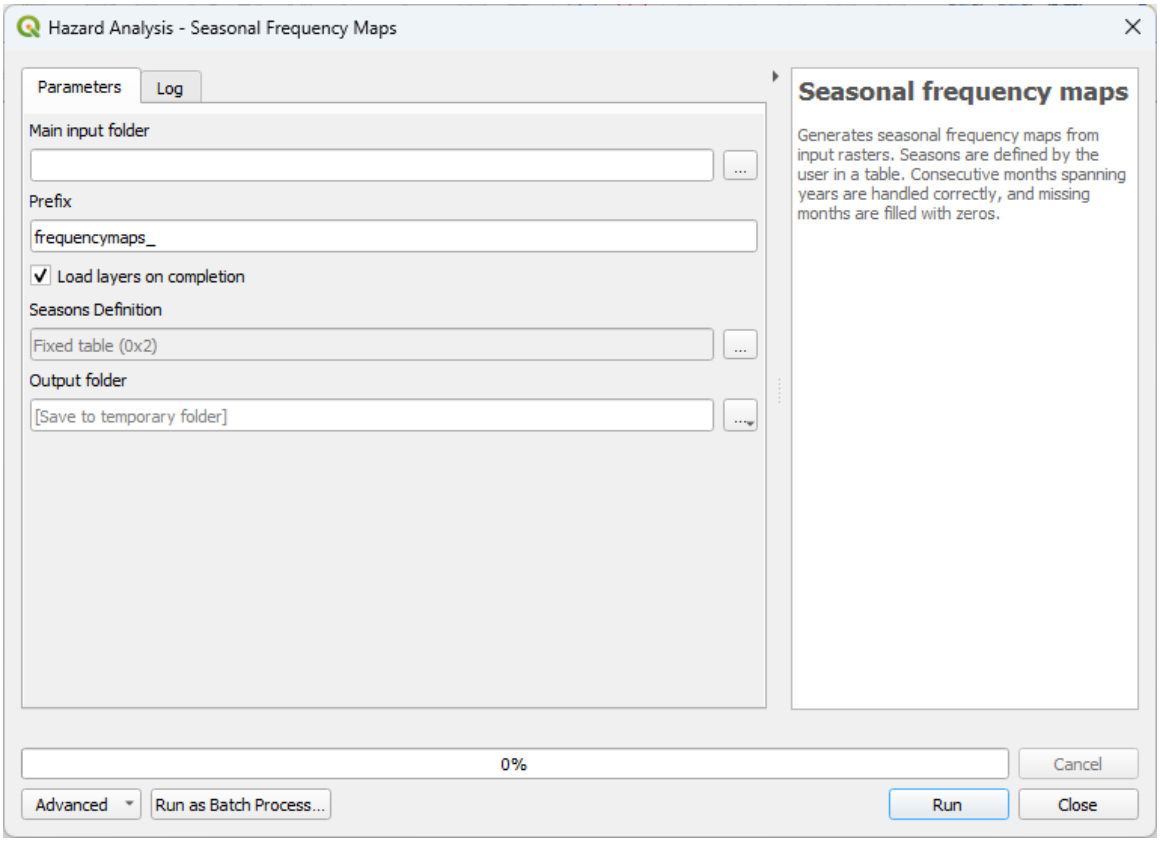



**Figure 8: Seasonal Frequency Maps Dialog**

## Outputs

- One GeoTIFF raster per season-year, stored in the output folder.
- Each raster represents the summed values of all input rasters for that season-year.
- Optionally loaded into QGIS if the checkbox is selected.

## Workflow

1. Open *Risk Mapper → Hazard analysis* in the Processing Toolbox.
2. Select *Seasonal frequency maps*.
3. Choose the *Main input folder* containing rasters named in YYYY-MM-DD format.
4. Specify an *Output folder*.
5. (Optional) Enter a *Prefix* for output rasters.
6. Define *Seasons* using a matrix table with season names and corresponding months.
7. Enable or disable *Load layers on completion*.
8. Click *Run*.

**Notes:**

- Filenames must follow YYYY-MM-DD. Files not matching this pattern are skipped.
- Missing months in a season are automatically filled with zeros.
- Ensure all input rasters have the same CRS and resolution.
- Large datasets may take several minutes depending on raster size, number of files, and season definitions.

# Exposure Analysis

## Exposure Maps

This tool generates exposure maps by masking exposure dataset (e.g., population, GDP, cropland) with binary frequency rasters. It produces yearly exposure rasters that show the overlap between hazard occurrence and exposed elements.

## Description

The *Exposure Maps* tool overlays a set of binary hazard rasters with an exposure raster to estimate the number of exposed elements (e.g., people, economic assets, or cropland) for each year.

- Each binary raster represents hazard occurrence in a given year.
- The exposure raster provides values of the elements at risk.
- Overlaying both rasters generates annual exposure maps.

## Parameters

**Table 8: Input parameters - Exposure Maps**

| Parameter | Description |
|---|---|
| Binary raster folder | Directory containing yearly binary hazard rasters (GeoTIFF). |
| Exposure raster | Raster layer representing the exposed element (e.g., GDP, cropland, or population). |
| Output folder | Directory where exposure rasters will be saved. |
| Output file prefix | Prefix string added to the output filenames. Default = _. |
| Load layers on completion | If checked, generated rasters are automatically added to the QGIS project. |

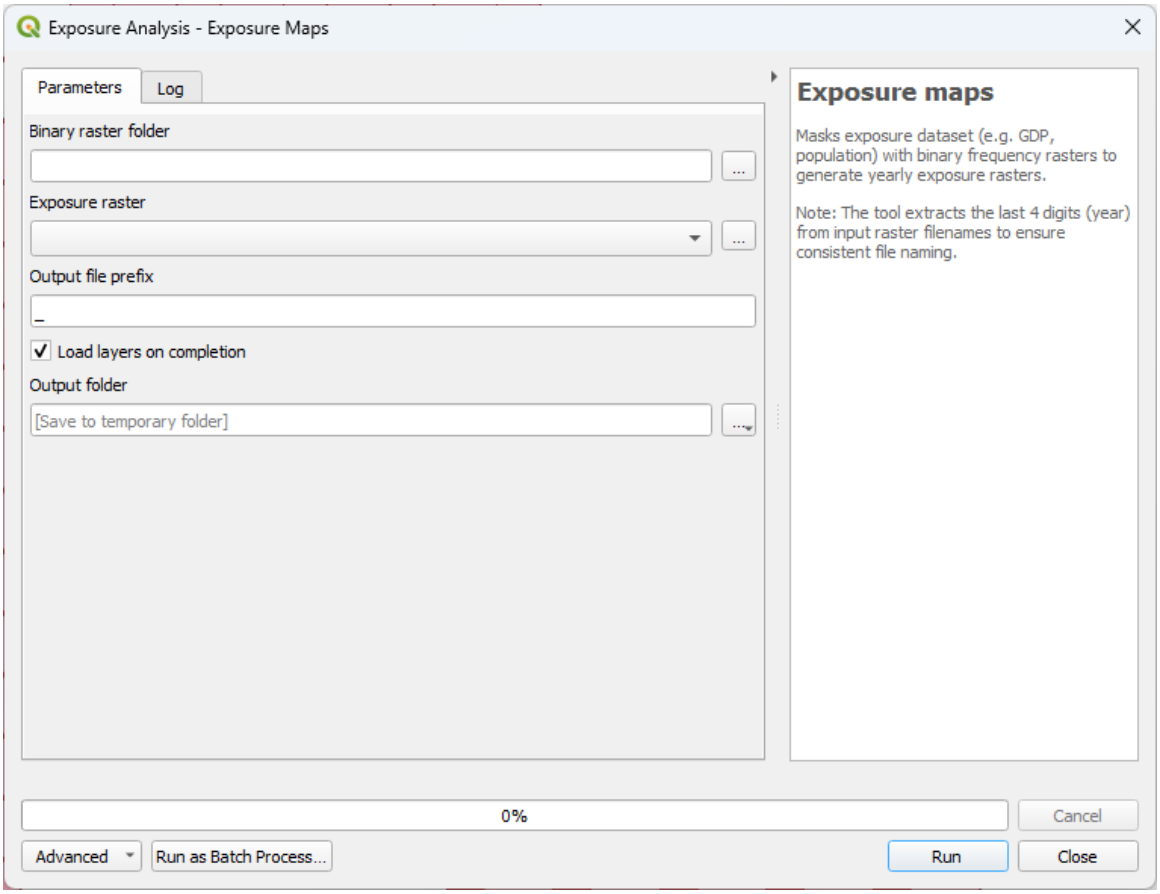



**Figure 9: Exposure Maps Dialog**

## Outputs

- A series of GeoTIFF exposure rasters, one per year (e.g., prefix_exposure_2018.tif).
- Outputs are compressed using LZW for efficient storage.
- If enabled, results are automatically added to the QGIS project.

## Workflow

1. Open *Risk Mapper* → *Exposure analysis* in the Processing Toolbox.
2. Select *Exposure maps*.
3. Choose the folder with *binary rasters*.
4. Select the *exposure raster* (e.g., population).
5. Set the *output folder*.
6. Optionally define an *output prefix*.
7. Tick *Load layers on completion* if you want results added automatically.
8. Click *Run*.

**Notes:**

- The tool extracts the **year** from raster filenames (last 4 digits). Use binary yearly frequency rasters (*Yearly frequency maps* → *Raster binary converter*) as input to ensure consistent file naming.
- Works best when hazard and exposure rasters have the same CRS, resolution, and extent.
- Large exposure rasters may increase processing time.

# Vulnerability Analysis

## Vulnerability Maps

This tool generates vulnerability maps by combining vulnerability indicators with a hazard extent raster. It masks each vulnerability layer against the hazard area that highlight exposed areas with different vulnerability levels.

## Description

The *Vulnerability Maps* tool overlays a set of vulnerability rasters with a hazard mask raster. Each vulnerability raster represents social, economic, or physical vulnerability across the study area. The hazard raster defines the extent of hazard exposure while resulting rasters show vulnerability within hazard-prone areas only.

## Parameters

**Table 9: Input parameters - Vulnerability Maps**

| Parameter | Description |
|---|---|
| Input folder | Directory containing vulnerability rasters (GeoTIFF). |
| Extent raster | Binary hazard raster defining the hazard-affected area. |
| Output folder | Directory where masked vulnerability rasters will be saved. |
| Output file prefix | Prefix string added to the output filenames. Default = _. |
| Load layers on completion | If checked, generated rasters are automatically added to the QGIS project. |

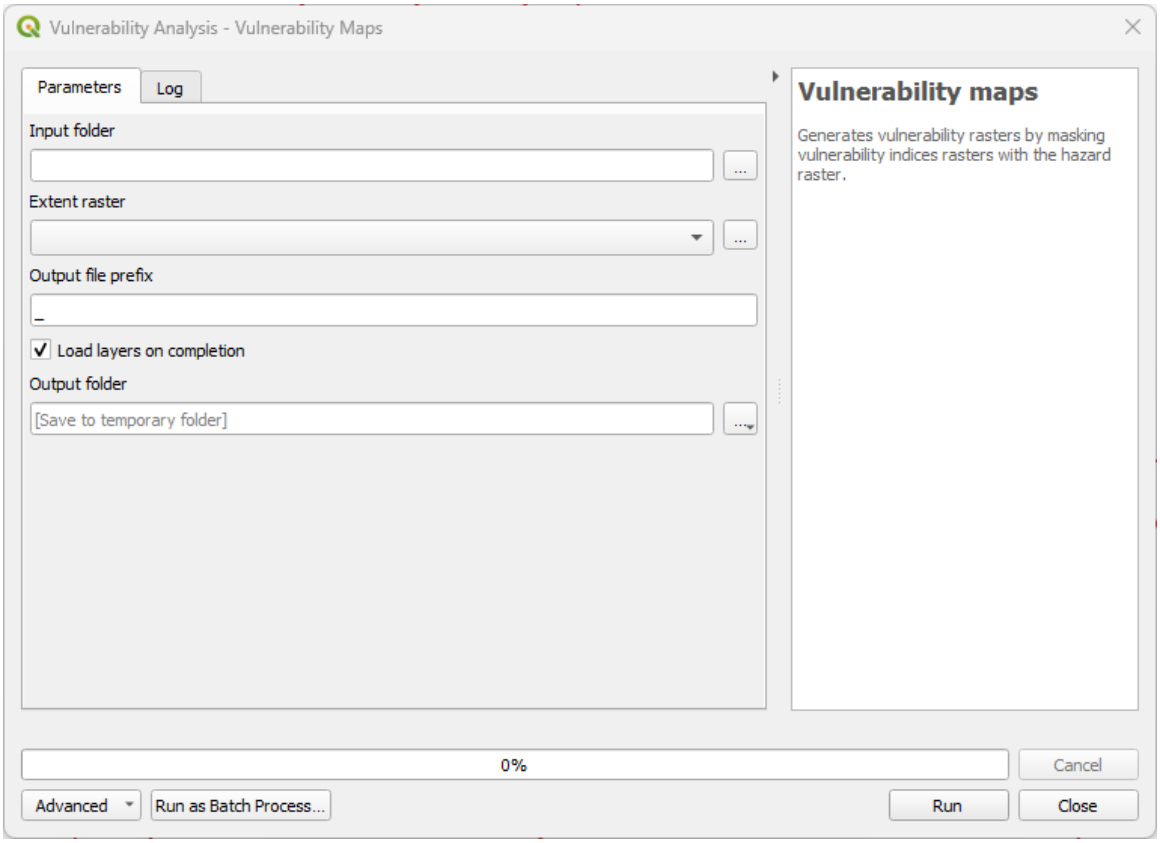



**Figure 10: Vulnerability Maps Dialog**

## Outputs

- A set of GeoTIFF vulnerability rasters, masked to hazard areas.
- Outputs are compressed using LZW for efficient storage.
- If enabled, results are automatically loaded into the QGIS project.

## Workflow

1. Open *Risk Mapper → Vulnerability analysis* in the Processing Toolbox.
2. Select *Vulnerability maps*.
3. Choose the folder with vulnerability rasters (e.g., socioeconomic indices).
4. Select the *hazard extent raster*.
5. Define an *output folder*.
6. Optionally set an *output prefix*.
7. Tick *Load layers on completion* if you want results automatically loaded.
8. Click *Run*.

**Notes:**

- Ensure that all input rasters have the same CRS, resolution, and extent.
- Works best when vulnerability rasters are normalized or scaled before use.
- File naming is preserved, with the defined prefix added to each output.

# Raster Analysis

## Binary Mask Overlay

This tool applies a **binary mask** to an input raster and produces a new raster where values are retained only inside the masked area. It is designed as a **general-purpose masking tool** for exposure and vulnerability analysis but can also be used to mask any raster dataset.

## Description

Only relevant areas are preserved for further analysis. If you need to mask any raster outside of the dedicated exposure or vulnerability workflows, use Binary Mask Overlay.

## Parameters

**Table 10: Input parameters - Binary Mask Overlay**

| Parameter | Description |
|---|---|
| Input binary raster | Raster to be masked |
| Mask raster | Binary raster used to define the area of interest (1 = keep, 0 = mask out). |
| Output raster | Destination path for the masked raster. |

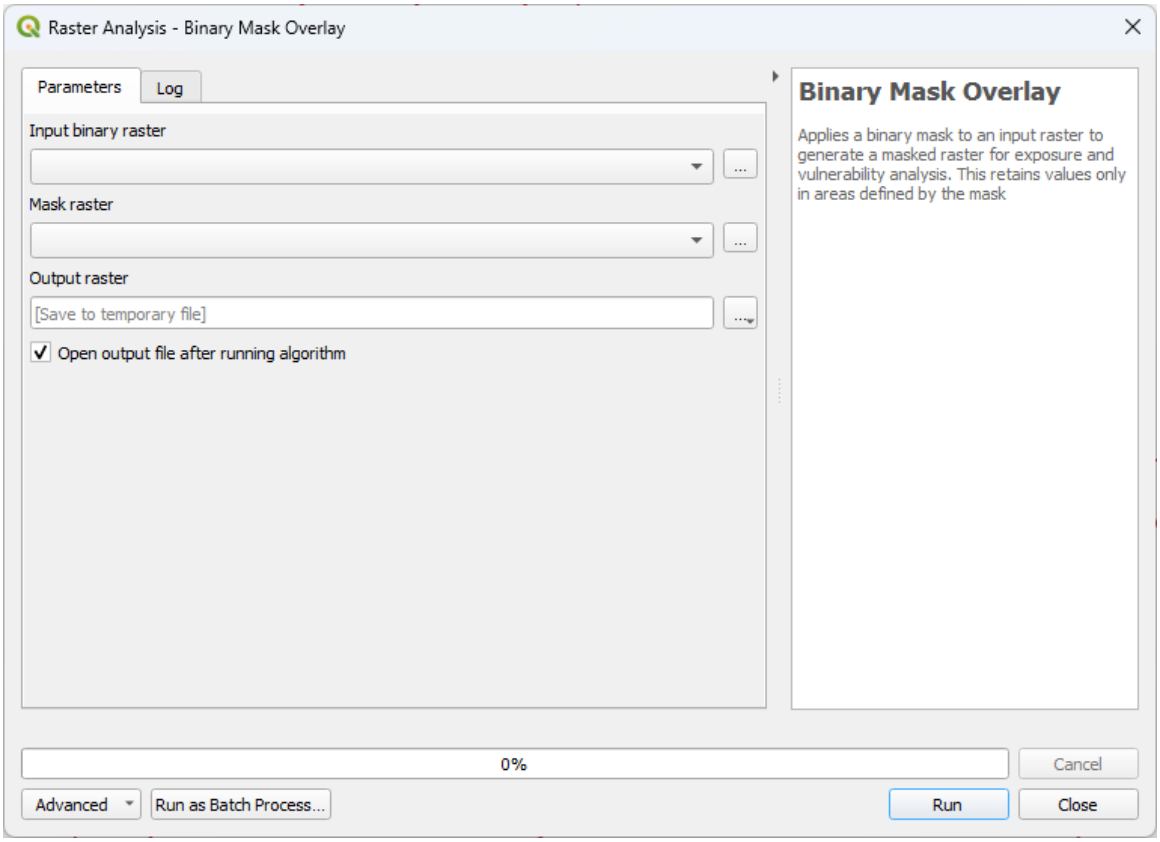



**Figure 11: Binary Mask Overlay Dialog**

## Outputs

- A GeoTIFF raster masked using the binary overlay.
- Compression is applied using LZW to optimize storage.

## Workflow

1. Open *Risk Mapper* → *Raster analysis* in the Processing Toolbox.
2. Select *Binary mask overlay*.
3. Provide the *input raster*.
4. Select a *mask raster*.
5. Specify the *output raster path.*
6. Click *Run*.

**Notes:**

- The input raster should share the same CRS, extent, and resolution as the mask raster.
- **Use when masking is needed outside the dedicated Exposure Maps or Vulnerability Maps tools.**

# Statistical Analysis

## Calculate Area

This tool calculates zonal statistics for multiple rasters over a polygon vector layer and derives areas based on pixel counts or sums. It is useful for quantifying exposure, vulnerability, or any raster-based indicator within administrative or other polygonal units.

### Description

The *Calculate area* tool computes statistics (count or sum) for each raster within polygons, converts the results to area (km²) based on pixel count or sum and the pixel size. User can define the pixel area or derive it from raster resolution. Output vector layer has new fields containing the calculated areas.

### Parameters

**Table 11: Input parameters - Calculate Area**

| Parameter | Description |
|---|---|
| Input vector layer | Polygon layer defining zones for statistics (e.g., administrative boundaries). |
| Input folder with rasters | Folder containing raster layers to process. |
| Output column prefix | Prefix added to output fields for clarity. |
| Statistic for area calculation | Choice of **Count** (number of pixels) or **Sum** (sum of raster values). |
| Pixel area (m²) | Optional. Specify the pixel area manually; otherwise, derived from raster resolution. |
| Output vector layer | Destination vector layer storing calculated statistics and areas. |

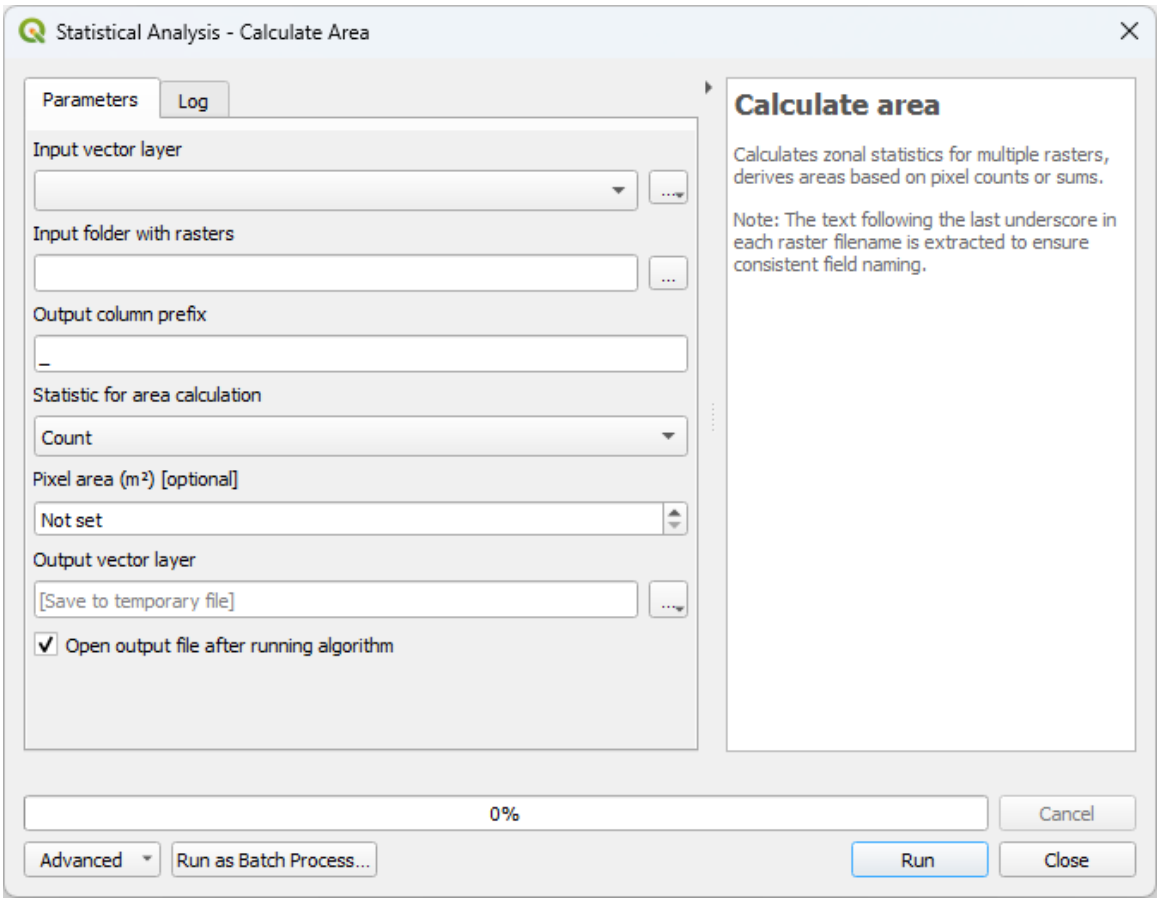



**Figure 12: Calculate Area Dialog**

## Outputs

- A polygon vector layer with new fields for: Raster-based statistic (count or sum) and derived area in km²

## Workflow

1. Open *Risk Mapper* → *Statistical analysis*.
2. Select *Calculate area*.
3. Choose an *input polygon layer* (e.g., administrative boundaries).
4. Provide the *folder containing rasters*.
5. Select the *statistic* and optionally define the *pixel area*.
6. Define the *output vector layer* path.
7. Click *Run*.

**Notes:**

- Ensure that the CRS and extent of raster layers match the polygon layer.
- Output field names are automatically generated using the raster name suffix (**suffix** is extracted from the raster filename, typically as the text following the last underscore**)** and the chosen column prefix.
- This tool is useful for quantifying raster-based indicators within administrative units for calculating affected areas.

# Calculate Monthly Zonal Area

This tool calculates monthly zonal statistics for multiple rasters over a polygon vector layer and derives area (km²) based on pixel size and Count or Sum statistics. Date-specific suffixes are extracted from raster filenames to automatically generate meaningful output field names.

## Description

The *Calculate monthly zonal area* tool computes a selected statistic (Count or Sum) for each raster within polygons and converts the result to area (km²) based on pixel size or user-defined pixel area. The tool also allows date-based suffix extraction from raster filenames using a slice string (e.g., 2:7 or -8:-4) for generating output field names. It then produces an output vector layer containing zonal statistics and derived areas for each polygon.

## Parameters

**Table 12: Input parameters - Calculate Monthly Zonal Area**

| Parameter | Description |
|---|---|
| Input vector layer | Polygon layer defining zones for statistics (e.g., administrative boundaries). |
| Input folder with rasters | Folder containing raster layers to process. |
| Output column prefix | Prefix added to output fields for clarity (default: fd_). |
| Date identifier | Slice for extracting a portion of the raster filename for the output field name (e.g., 2:7, -8:-4). |
| Statistic for area calculation | Choice of **Count** (number of pixels) or **Sum** (sum of raster values). |
| Pixel area (m²) | Optional. Specify the pixel area manually; otherwise, derived from raster resolution. |
| Output vector layer | Destination vector layer storing calculated statistics and areas. |

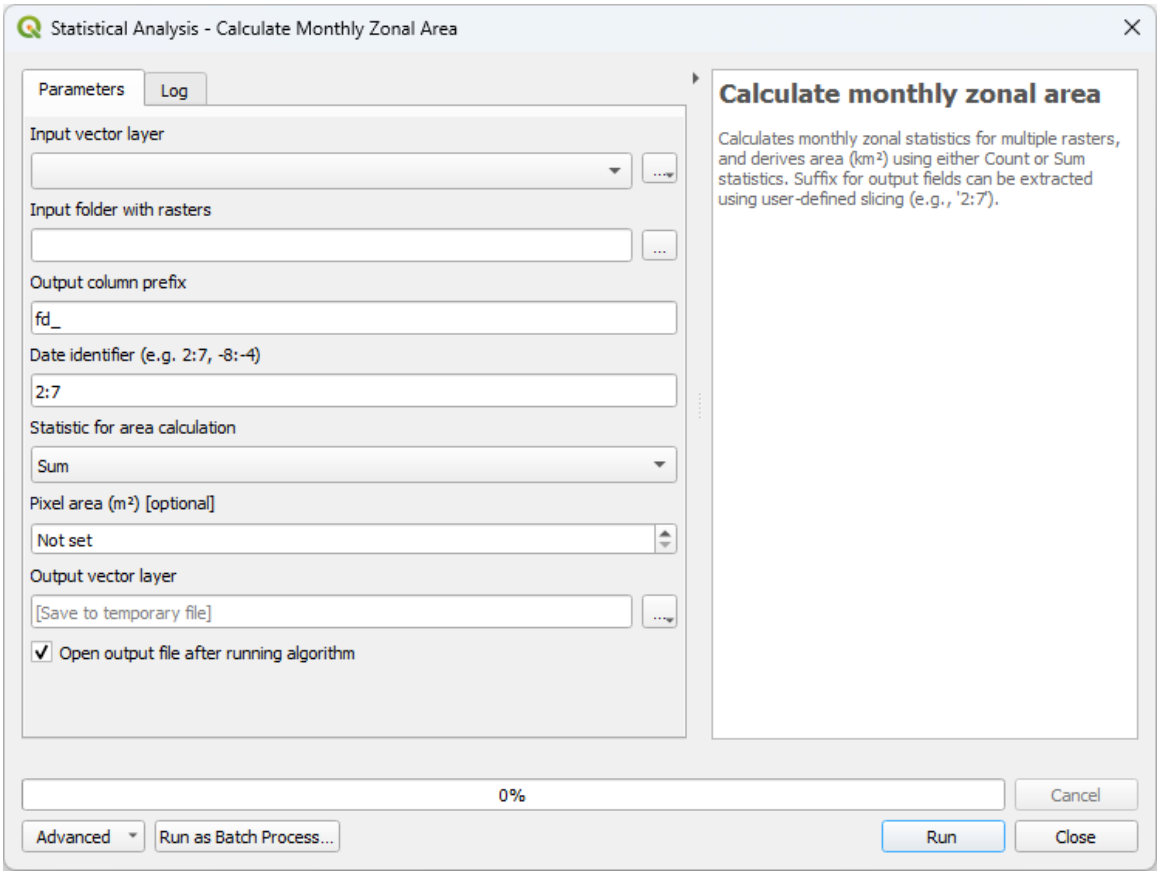



**Figure 13: Calculate Monthly Zonal Area**

## Outputs

- A polygon vector layer with new fields for raster-based statistic (count or sum) and derived area in km² for each month or raster suffix

## Workflow

1. Open *Risk Mapper* → *Statistical analysis* → *Calculate monthly zonal area*.
2. Select an *input polygon layer* (e.g., administrative boundaries).
3. Provide the *folder containing monthly rasters*.
4. Specify the *date identifier slice* to extract the date portion of filenames.
5. Select the *statistic* and optionally define the *pixel area*.
6. Set the *output vector layer* path.
7. Click *Run*.

**Notes:**

- Ensure CRS and extent of raster layers match the polygon layer.
- Use the date identifier slice carefully to match the filename pattern; incorrect slices may cause field naming errors.
- This tool is ideal for time-series area calculations, e.g., monthly crop area, hazard extent, or flood monitoring.

# Count Points

This tool samples multiple rasters at centroid points and summarizes counts per administrative unit in a single step.

## Description

The *Count point* tool samples multiple raster layers at centroid points, aggregates the sampled raster values into a single memory layer, performs a spatial join with administrative polygons summarizing counts per admin unit. The output vector layer has number of affected points (e.g., buildings, settlements) per administrative polygon.

## Parameters

**Table 13: Input parameters - Count Points**

| Parameter | Description |
|---|---|
| Admin boundaries | Polygon layer defining administrative zones for summerizing. |
| Centroid points layer | Points representing the centroids of polygons where rasters are sampled. |
| Folder containing raster files | Folder containing raster layers to sample. |
| Output column prefix | Prefix added to sampled raster fields (default: pts_). |
| Final output | Destination vector layer storing aggregated counts. |

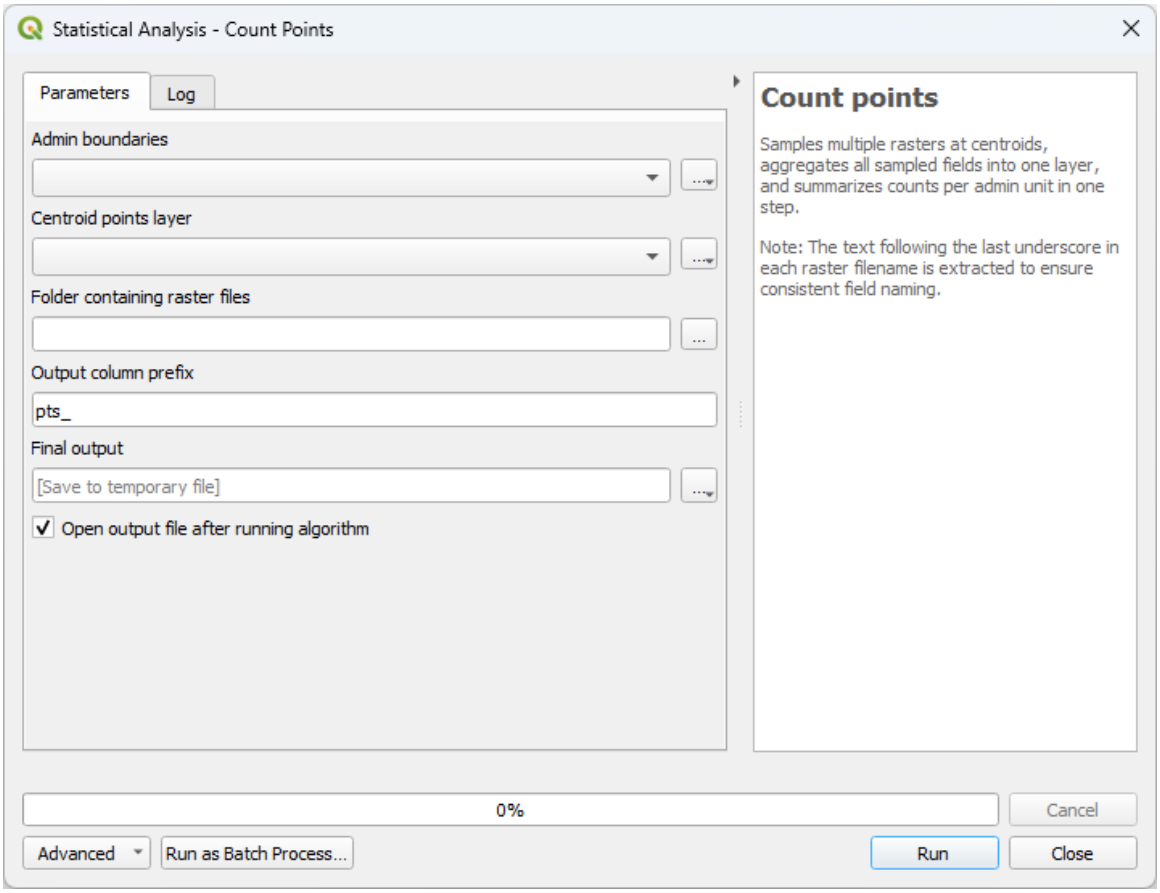



**Figure 14: Cpont Points Dialog**

## Outputs

- A polygon vector layer with count of raster occurrences at centroid points per admin unit.

## Workflow

1. Open *Risk Mapper → Statistical analysis → Count points*.
2. Select the *admin boundaries layer*.
3. Provide the *centroid points layer*.
4. Select the *folder containing raster layers*.
5. Specify an *output column prefix* if needed.
6. Set the *final output vector layer* path.
7. Click *Run.*

**Notes:**

- The text following the last underscore in each raster filename is extracted to ensure consistent field naming.
- The tool automatically handles all rasters in the folder and aggregates their counts.
- Ensure CRS alignment between centroids, rasters, and admin polygons.

# Calculate Zonal Statistics

This tool calculates zonal statistics for all rasters in a folder and appends the results to a polygon vector layer.

## Description

The *Calculate zonal statistics* tool performs zonal statistics (Sum, Mean, Min, Max, Count) for each raster in a folder. Field names are generated from the raster filenames (text after the last underscore). Output vector layer is enriched with statistics for all rasters.

## Parameters

**Table 14: Input parameters - Calculate Zonal Statistics**

| Parameter | Description |
|---|---|
| Input vector layer | Polygon layer for zonal statistics calculation. |
| Input folder with rasters | Folder containing raster layers for analysis. |
| Output column prefix | Prefix added to output fields (default: stat_). |
| Statistic to calculate | Statistic to compute for each raster: Sum, Mean, Min, Max, Count. |
| Output vector layer | Destination vector layer to store the final statistics. |

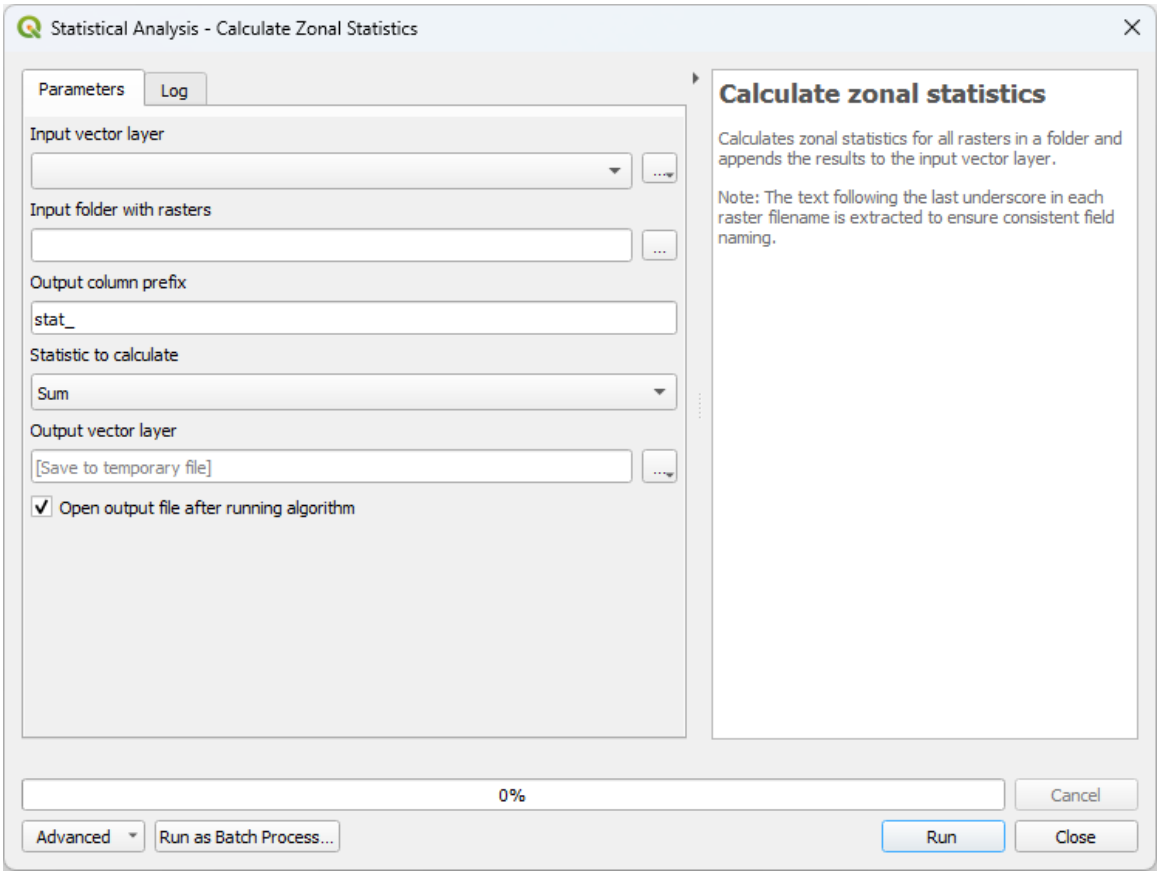



**Figure 15: Calculate Zonal Statistics**

## Outputs

- A polygon vector layer containing calculated statistics for each raster.

## Workflow

1. Open *Risk Mapper* → *Statistical analysis* → *Calculate zonal statistics*.
2. Select the *input vector layer* (polygons).
3. Provide the *folder containing rasters.*
4. Set an *output column prefix.*
5. Choose the *statistic* to calculate (Sum, Mean, Min, Max, Count).
6. Specify the *final output vector layer* path.
7. Click *Run*.

**Notes:**

- Ensure raster and vector layers share the same CRS.
- Field naming is based on the text following the last underscore for consistency.

# Calculate Zonal Statistics for Vulnerability

This tool calculates zonal statistics for a single raster. Users can choose from multiple statistics and define a column prefix for output fields.

## Description

The *Calculate zonal statistics* for vulnerability tool performs zonal statistics for a single input raster. The tool supports multiple statistics including Count, Sum, Mean, Median, StDev, Min, Max, Range, Minority, Majority, Variety.

## Parameters

**Table 15: Input parameters - Calculate Zonal Statistics for Vulnerability**

| Parameter | Description |
|---|---|
| Input vector layer | Polygon layer where statistics will be calculated and joined. |
| Input raster layer | Raster layer representing vulnerability indices. |
| Statistic to calculate | Statistic to compute: Count, Sum, Mean, Median, StDev, Min, Max, Range, Minority, Majority, Variety. |
| Output column prefix | Prefix added to all output fields (default: stat_). |
| Final output | Destination vector layer to save results. |

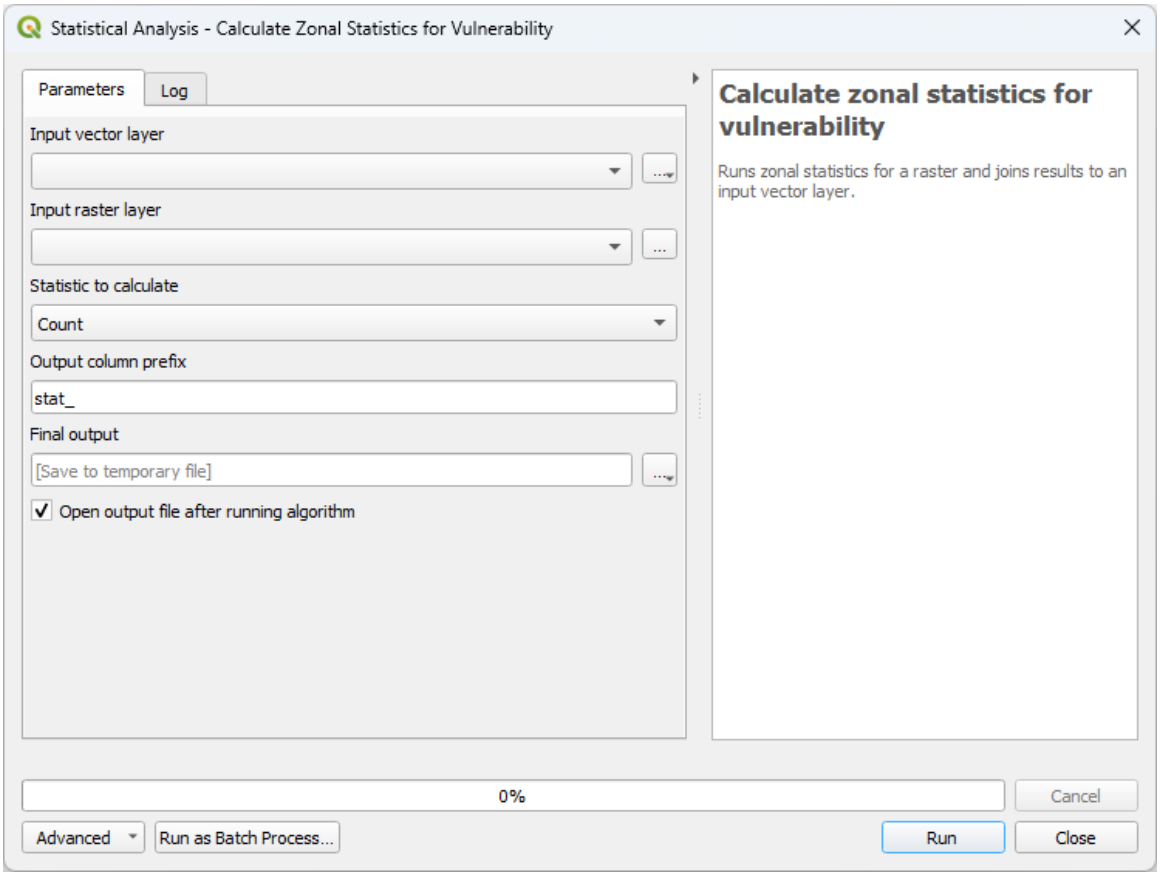



**Figure 16: Calculate Zonal Statistics for Vulnerability**

## Outputs

- A polygon vector layer containing the selected zonal statistic.

## Workflow

1. Open *Risk Mapper → Statistical analysis → Calculate zonal statistics for vulnerability.*
2. Select the *input vector layer* (polygons).
3. Select the *input raster layer* representing vulnerability.
4. Choose the *statistic* to calculate.
5. Set an *output column prefix* (optional).
6. Specify the *final output vector layer* path.
7. Click *Run*.

**Notes:**

- Ensure raster and vector layers share the same CRS.

# Calculate Weighted Index

This tool calculates weighted index (WI) and final weighted index (FWI) from indicator data and user-defined weights and joins results to a polygon or point vector layer.

## Description

The *Calculate weighted index* tool loads indicator values from a CSV file and weights from another CSV, standardizes all indicators to the 0–1 range, computes weighted index (WI) as the weighted mean of standardized indicators. It then computes final weighted index (FWI) by normalizing WI to 0-1. The calculated WI and FWI is joined to polygon or point shapefile based on a common join field.

## Parameters

**Table 16: Input parameters - Calculate Weighted Index**

| Parameter | Description |
|---|---|
| Input vector layer | Polygon or point layer to which WI / FWI values will be joined. |
| Join field | Field used to join the CSV values back to the shapefile. |
| Input CSV with indicators | CSV file containing indicator values for each unit. |
| Weights CSV (indicator, weight) | CSV file with indicator names and their corresponding weights. |
| Output vector layer | Shapefile where WI and FWI values will be saved. |

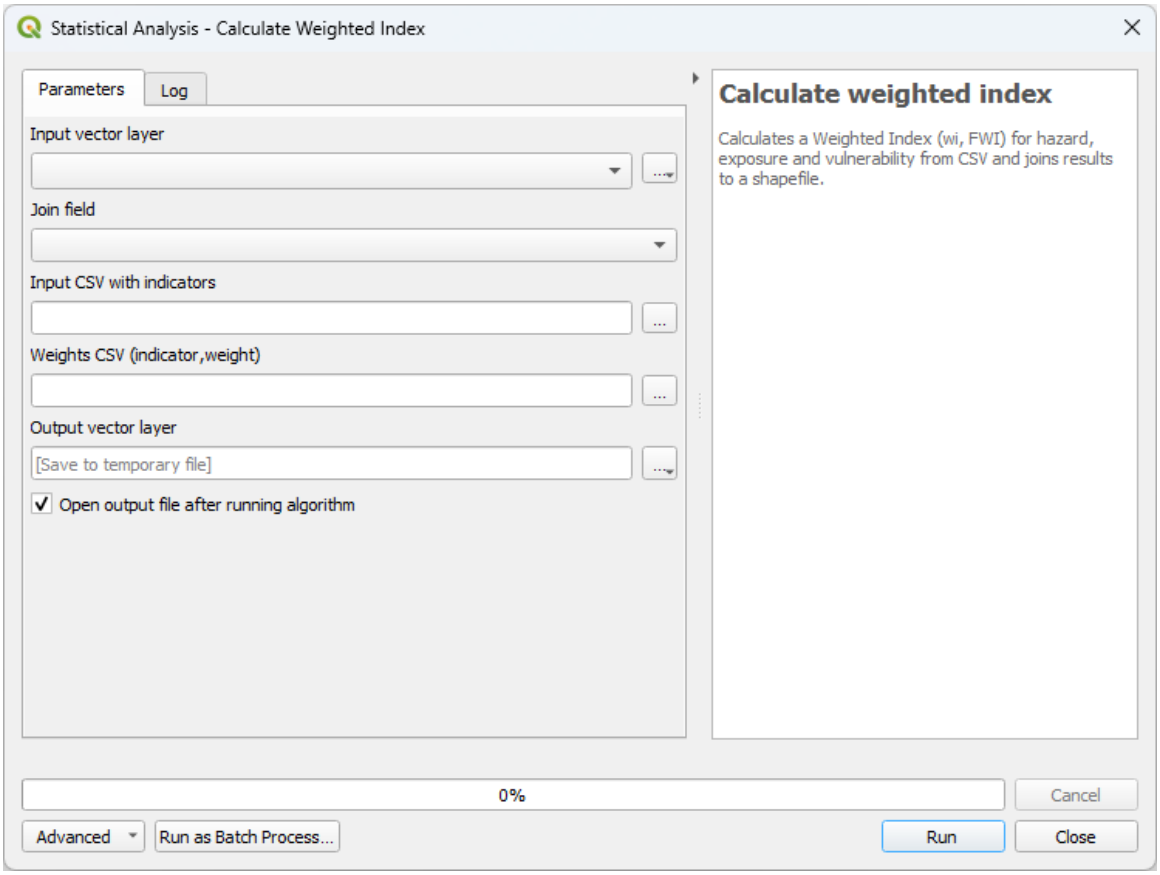



**Figure 17: Calculate Weighted Index Dialog**

## Outputs

- Shapefile with WI and FWI values added.
- CSV copy of WI / FWI for reference.

## Workflow

1. Open *Risk Mapper → Statistical analysis → Calculate weighted index.*
2. Select the *input shapefile* (polygon or points).
3. Select the *join field* (common field for the shapefile and csv).
4. Provide the *indicator CSV* and *weights CSV*.
5. Specify the *output shapefile* path.
6. Click *Run*.

**Notes:**

- Ensure join field values match between CSV and shapefile (string types are recommended).
- Standardization uses min-max normalization, so all indicators are scaled to 0–1.
- WI and FWI computation ignore missing values.

# Risk Assessment

## Calculate Risk

This tool calculates risk by combining hazard, vulnerability, exposure, and adaptive capacity layers using a user-defined formula.

### Description

The *Risk assessment* tool accepts a base vector layer (polygon or point) as the primary analysis unit. User can select hazard, vulnerability, exposure, and adaptive capacity layers. The tool then joins selected fields from these layers to the base layer based on a common join field and calculates risk using a custom user-defined formula, e.g., FHI * FEI * FVI / AC.

### Parameters

**Table 17: Input parameters - Calculate Risk**

| Parameter | Description |
|---|---|
| Input vector layer | Base layer to calculate risk for each polygon or point. |
| Join field | Field used to link base layer with hazard, vulnerability, exposure, and adaptive layers. |
| Hazard layer | Optional vector layer containing hazard values. |
| Field from Hazard layer | Field to extract from the hazard layer. |
| Vulnerability layer | Optional vector layer containing vulnerability values. |
| Field from Vulnerability layer | Field to extract from the vulnerability layer. |
| Exposure layer | Optional vector layer containing exposure values. |
| Field from Exposure layer | Field to extract from the exposure layer. |
| Adaptive capacity layer | Optional vector layer containing adaptive capacity values. |
| Field from Adaptive capacity layer | Field to extract from the adaptive layer. |
| Formula / Expression | Custom risk formula using joined fields (e.g., FHI * FEI * FVI / AC). |
| Output layer | Vector layer where the computed **RISK** field will be saved. |

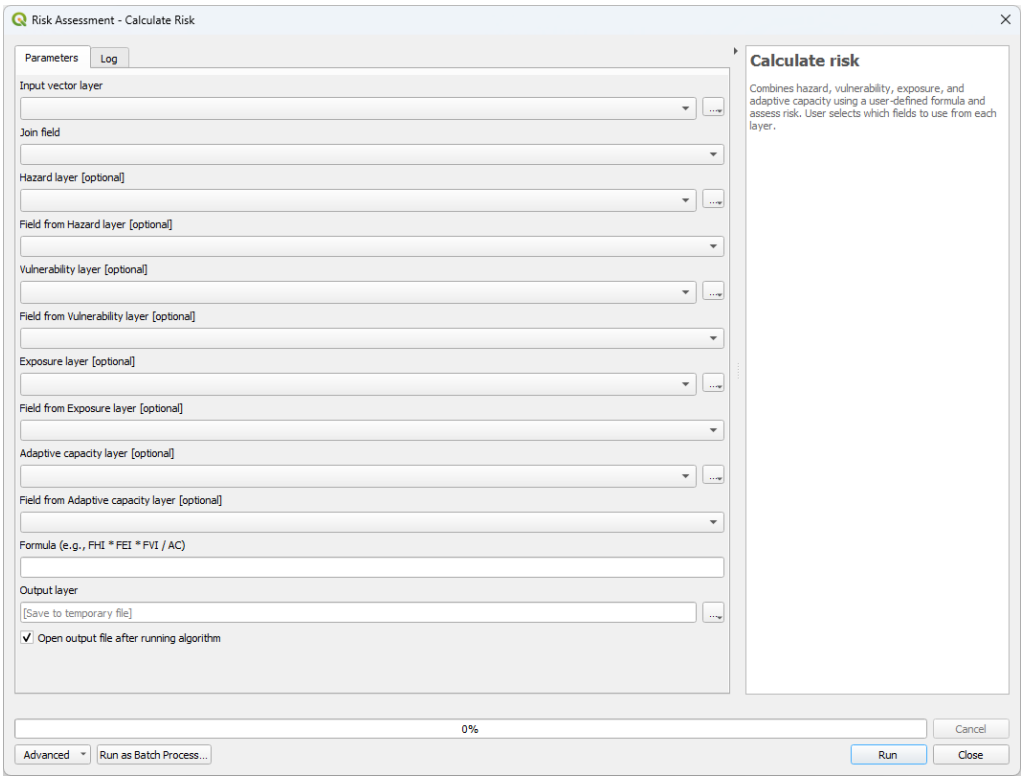



**Figure 18: Calculate Risk Dialog**

## Outputs

- Vector layer with a final risk index (FRI) calculated from the user-defined formula.

## Workflow

1. Open *Risk Mapper → Risk assessment → Calculate risk.*
2. Select a *base vector layer* (polygon or points).
3. Choose the *join field.*
4. Add optional *hazard, vulnerability, exposure,* and *adaptive layers* and select the specific field from each layer to be used in the risk calculation.
5. Specify the *formula for risk calculation.*
6. Choose the *output layer location.*
7. Click *Run.*

**Notes:**

- Only selected fields are joined; the **join field itself is skipped automatically** to avoid duplication.
- Layers not provided or fields not selected will be ignored in the calculation.
- The tool is compatible with polygons or point layers for risk aggregation.


# End of the User Manual