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Supplement of

Landslide Susceptibility Assessment Tools v1.0.0b – Project Manager Suite: a new modular toolkit for landslide susceptibility assessment

Jewgenij Torizin et al.

Correspondence to: Jewgenij Torizin (jewgenij.torizin@bgr.de)

LSAT PM

Release 1.0.0b2

Federal Institute for Geosciences and Natural Resources

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CONTENTS:

This manual provides a brief overview of LSAT PM v1.0.0b2 and its basic functionalities.

CHAPTER

ONE

INTRODUCTION

Introducing LSAT PM.

1.1 Abstract

The Landslide Susceptibility Assessment Tools – Project Manager Suite (LSAT PM) provides a framework for conducting landslide susceptibility analyses on regional scales based on heuristic and statistical approaches and machine learning algorithms. However, the application is not limited to this issue and applies to any supervised binary classification analysis with spatial data. The current version of LSAT PM incorporates algorithms for heuristic Analytical Hierarchy Process (AHP), bivariate statistical analysis with Weights of Evidence (WoE), and multivariate statistical analysis/ machine learning with Logistic regression (LR) and artificial neural networks (ANN).

1.2 General Information

General Information about LSAT and how to use it.

1.2.1 Installation

LSAT is distributed in two ways: Installer for Windows and as source code.

Installation with the installer (Windows)

1. Download the newest LSAT installer
2. Run the installer and follow the instructions.

Installation with source code on Windows

1. Make sure you have Python 3 installed (3.7 tested), if not you can get it from python.org/downloads
2. Download LSAT
3. Navigate to the LSAT directory and open a PowerShell window (if you downloaded a zipped version you will need to unzip LSAT first).
4. Create a virtual environment

```
python -m venv venv
```

5. Activate the virtual environment (venv should appear in the command line, indicating you were successful)

```
.\venv\Scripts\activate
```

6. Install the required packages

```
python -m pip install -r requirements.txt
```

Additionally to the packages listed in the requirements.txt you will need GDAL (3.3.1 tested). Unfortunately, GDAL can usually not simply be installed with a pip command. You can either download a .whl file from Christoph Gohlkes fantastic website or build it yourself. Installing a .whl file:

```
python -m pip install *path to .whl file*
```

7. Start LSAT PM

```
python startMenu_main.py
```

Installation with source code on Linux (Ubuntu 20.04.3 tested)

1. Download LSAT
2. Navigate to the LSAT directory and open a Terminal (if you downloaded a zipped version you will need to extract LSAT first).
3. Install Python packages (venv, pip, python development tools), gdal and libraries for Qt

```
sudo apt install python3-venv python3-pip gdal-bin libgdal-dev python3-dev '^libxcb.*-dev
↪'
```

4. Create a virtual environment

```
python3 -m venv venv
```

5. Activate the virtual environment (venv should appear in the command line, indicating you were successful)

```
source venv/bin/activate
```

6. Install the required packages

```
python3 -m pip install -r requirements.txt
```

Additionally to the packages listed in the requirements.txt you will need GDAL (3.0.4 tested). Unfortunately, GDAL can usually not simply be installed with the standard pip command. You need to specify the version based on the gdal version installed. To get the installed version run

```
ogrinfo --version
```

It will output something like: “GDAL $VERSION, released $RELEASEDATE”. Now install that version

```
python3 -m pip install gdal==$VERSION
```

7. Start LSAT PM

```
python3 startMenu_main.py
```

1.2.2 License

It is important to us that LSAT PM is freely available and changes are accessible to everyone.

LSAT PM License

LSAT PM is licensed under the GNU General Public License v3.0. LSAT PM contains the license text as LICENSE.txt.

LSAT PM Documentation License

The LSAT PM documentation is licensed under the XXXXXX.

1.2.3 First start and start menu

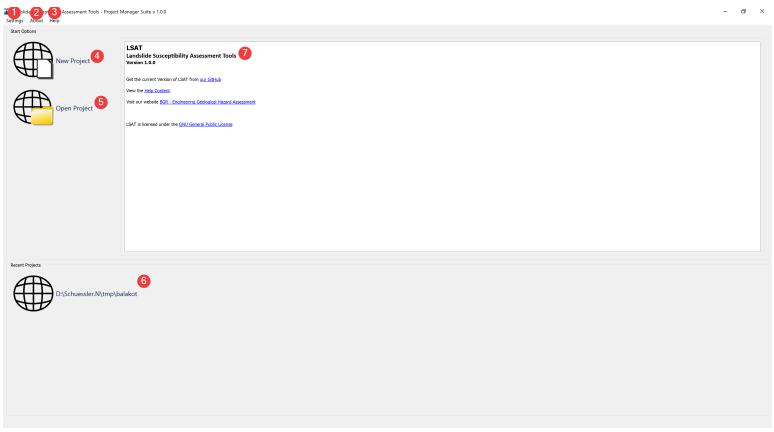


Fig. 1.1: LSAT Start Menu

The start menu appears when LSAT starts. You can quickly create new projects and open existing ones. Settings can be adjusted and the documentation opened.

Overview

Settings (1) contains the *Language Settings*.

About (2) contains Information about LSAT.

Help (3) leads to the documentation.

New Project (4) opens the *New Project Widget*.

Open Project (5) opens *a dialog to load an old project*.

Recent Projects (6) shows up to three of the most recent projects. Clicking on them instantly loads them into LSAT.

Note: To replace the default thumbnail with a custom one save an image as thumb.png in the project root folder.

The information text (7) contains information where you can get the newest LSAT version, license information and ways to contact the developers.

1.2.4 System Requirements

Suggested minimum system requirements:

OS	Windows 10, Linux (Ubuntu tested)
CPU	> 2 GHz
RAM	> 2 GB

The exact requirements vary based on the Project you are working on.

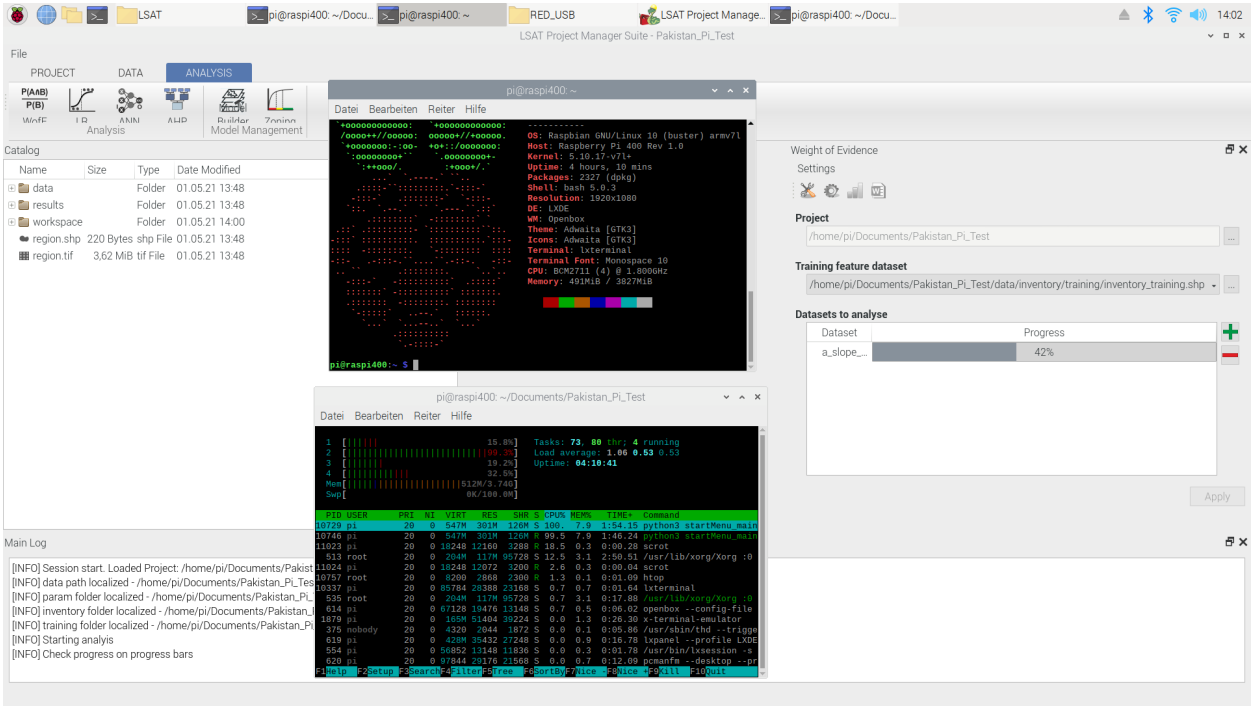


Fig. 1.2: Development Version of LSAT running on a Raspberry Pi 400.

1.2.5 Uninstall

To uninstall LSAT PM simply delete the folder. LSAT does not write into the windows registry or stores data outside its folder, besides the projects.

If you uninstalled LSAT, because it lacks features or something does not work correctly, please let us know, so we can fix/enhance it.

CHAPTER

TWO

PROJECT

Create or Open LSAT Projects, change Settings/Ui and view help files.

2.1 Project

Start a new project, open an existing project or get information about the current project.

2.1.1 New Project

Widget to create new LSAT projects.

Usage

1. Specify the project location by picking a folder (1)
2. Name the project (2)
3. (Optional) Provide a description (3)
4. **Provide spatial reference (2 Options):**
    1. Use a mask raster (4).
       Specify a mask raster dataset (6). This will attempt to auto fill EPSG code (7), Extent (9) and cellsize (10)
    2. Use a custom extent (5)
       Fill EPSG code (6), Extent (9) and cellsize (10) by hand. Open the *Coordinate System Widget* (8) to help with the EPSG Code.
5. Create a new project (11) (If you provided a mask you may *import it into the new project*)

To achieve the best results in later *analyses* use a mask raster dataset.

You can later change the project description with the *Project Info Widget*

Some raster datasets use underscores instead of spaces in the name of the coordinate system. If that is the case you can still use it as a mask but will have to provide the EPSG Code (7) by hand (8) using the *Coordinate System Widget*.

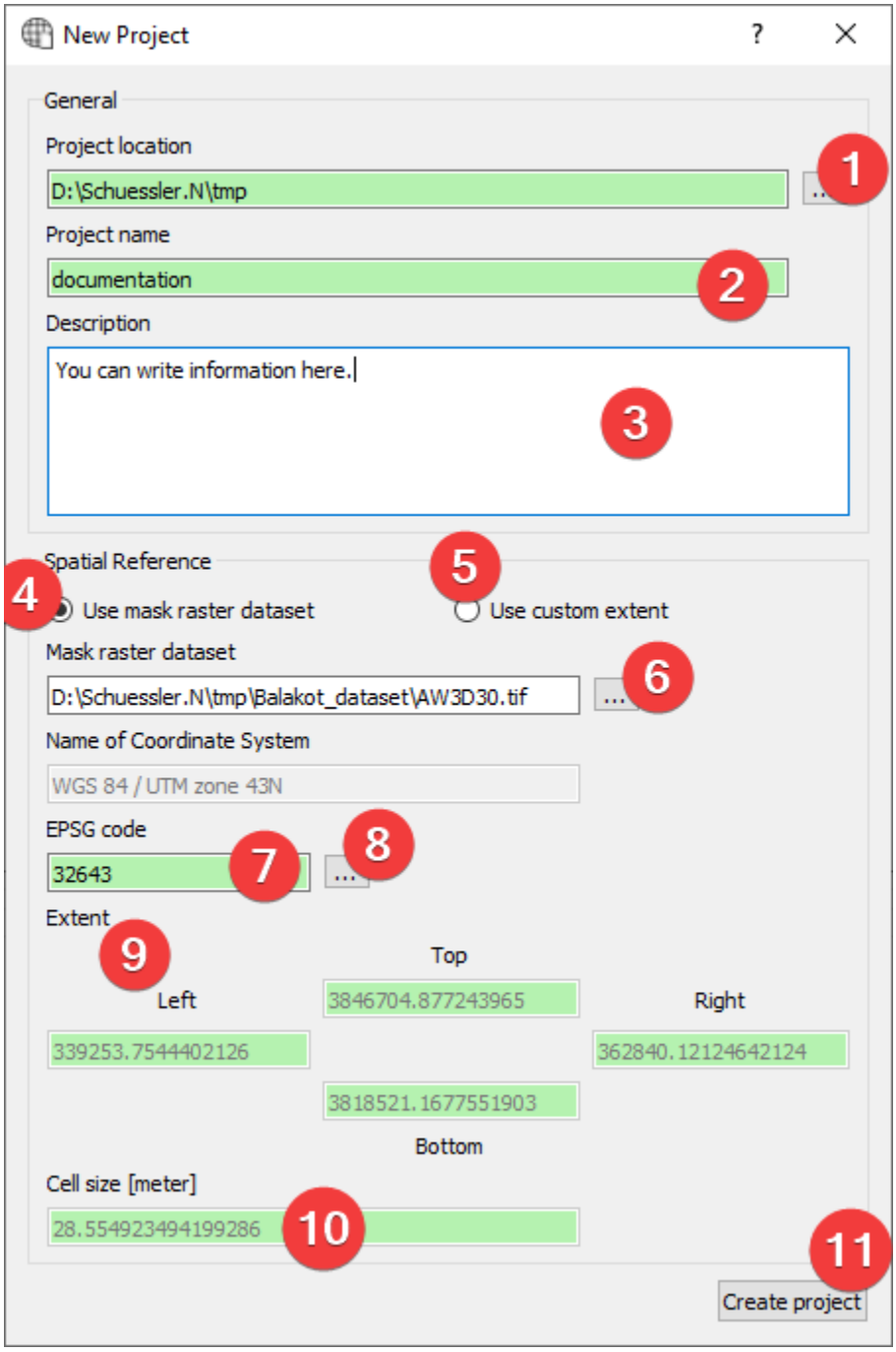


Fig. 2.1: New Project Widget

Coordinate System Widget

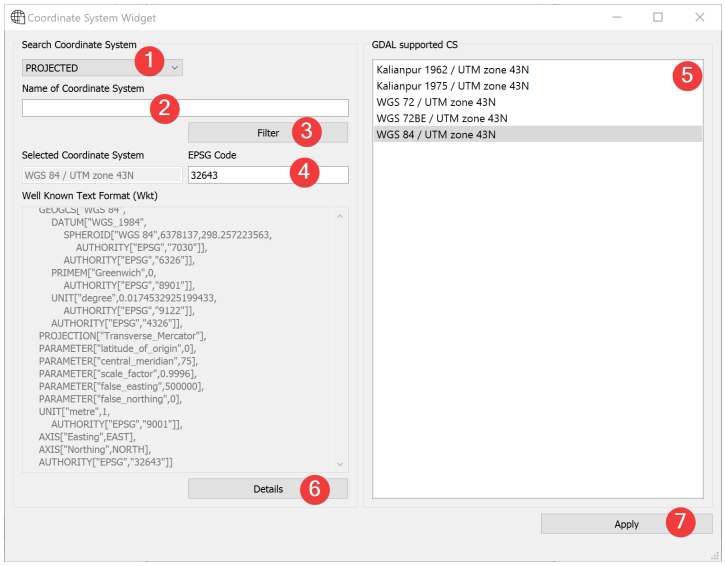


Fig. 2.2: Coordinate System Widget

With the coordinate system widget you can alter the EPSG code the project uses.

Usage

1. Use the combo box (1) to choose either projected or geographic coordinate systems.
2. **Select the coordinate system (2 Options):**
    1. Type the EPSG Code into (4) and press Enter.
    2. Type the name of the coordinate system into (2) and press Enter or click (3) and then click on the coordinate system in (5).
3. Click (7) to use the selected coordinate system.

Clicking on Details (6) will open epsg.io with information about the coordinate system. If there is no EPSG Code (4) it will open epsg.io itself.

Mask raster dataset import

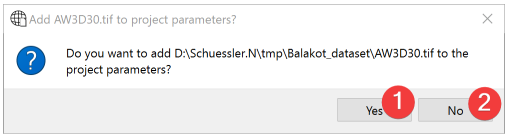


Fig. 2.3: Mask raster dataset import dialog

Usage

1. Choose to import the mask (1) or don't (2).

If you import the mask raster dataset the *raster import dialog* opens, guiding you through the process.

2.1.2 Open Project

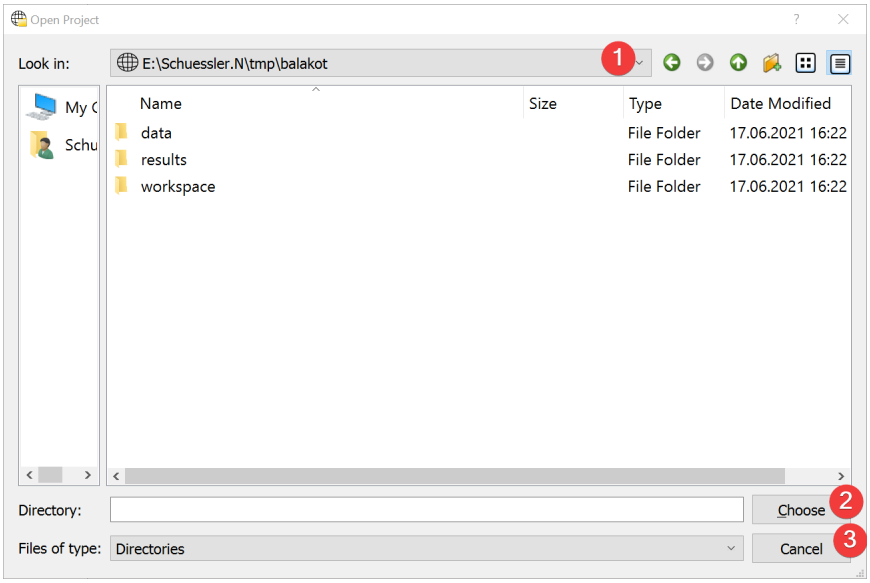


Fig. 2.4: Open Project Widget

Dialog to open an existing LSAT Project.

Usage

1. Navigate to the project on your PC (1).
2. Select the project and choose it (2)

You can either select the Project folder in its parent directory and choose it (2) or open it and select (2) without selecting a sub folder.

You can cancel (3) the dialog at any point.

Information

LSAT highlights project folders in this dialog.

If you open the Dialog from an existing project you will start the dialog in that projects folder. If you use it to open a project from the *Start Menu* you will start at the LSAT folder.

2.1.3 Project Info

Displays information and a user provided description of the project.

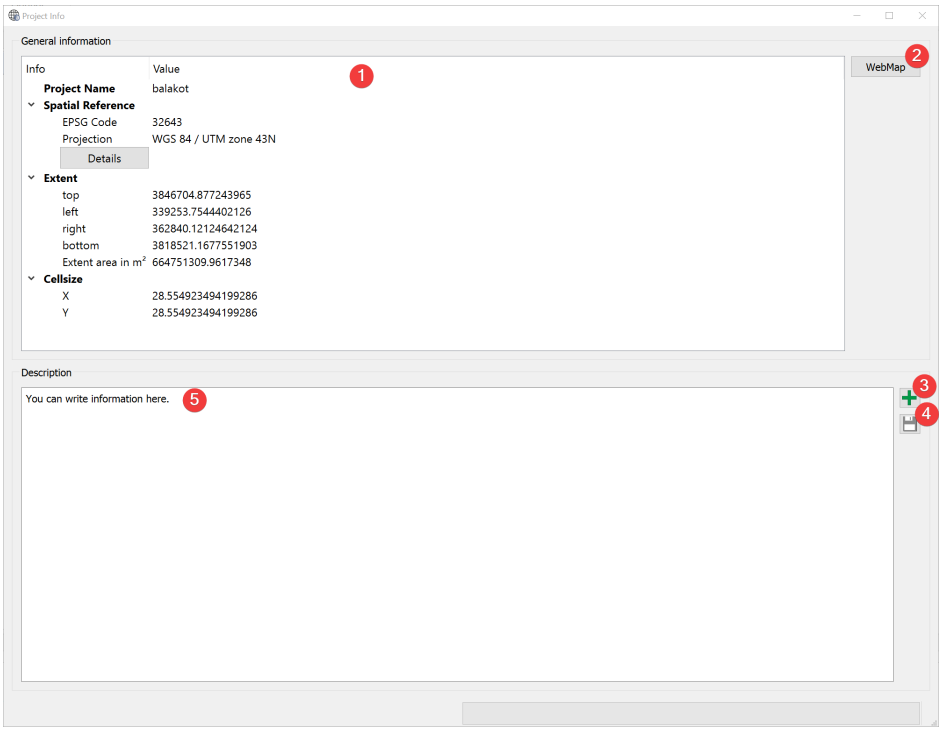


Fig. 2.5: Project Info Widget

Usage

You can view spatial information about the project (1).

You can read and alter the provided description (5). Clicking on (3) opens a dialog to replace the Description with text from a .txt or .docx file. If you want to save changes to the description click (4).

You can open a WebMap (2) in your default browser:

The map shows the projects borders (2) with OpenStreetMap as background. If you *imported an inventory* these datasets will also be displayed. You can hide/show layers in the menu (1)

Information

The general information (1) shows a slightly modified and embedded version of the *Raster Info Widget* for the mask raster dataset (region.tif).

WebMap requires an internet connection to display the OpenStreetMap layer.

The WebMap is stored in /workspace/*project name*.html. It is independent of LSAT so it can be shared among peers and colleagues.

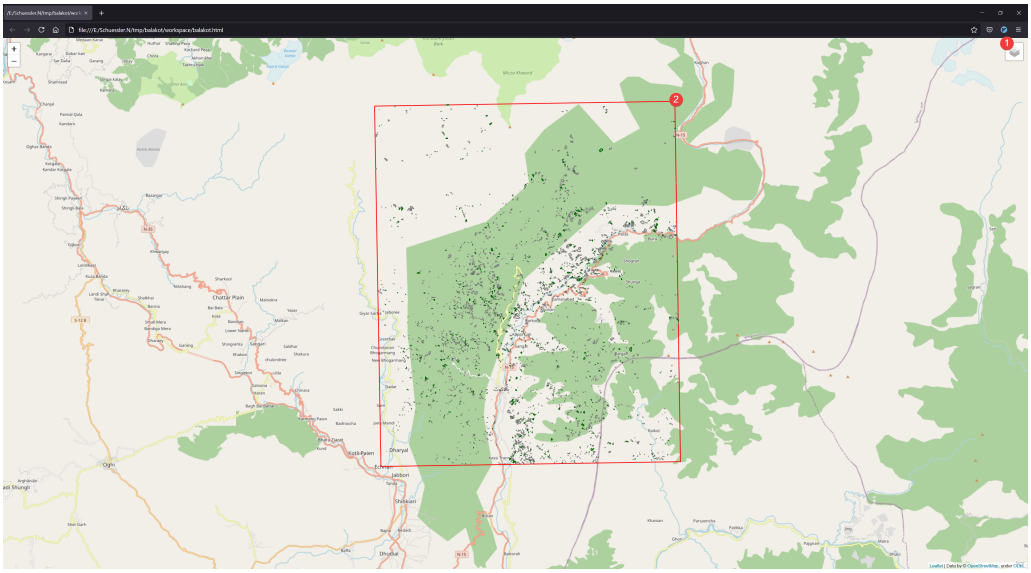


Fig. 2.6: WebMap

2.2 View

The Main Log, Catalog and its sub menus.

2.2.1 Catalog

View and work with your LSAT project and its files.

Overview

The Catalog Widget displays the *folder and file structure of your selected LSAT Project*.

data

Input data.

inventory

Input vector data.

test

Default path for *test part of the inventory*

training

Default path for *training part of the inventory*

params

Input *raster data*

results

AHP

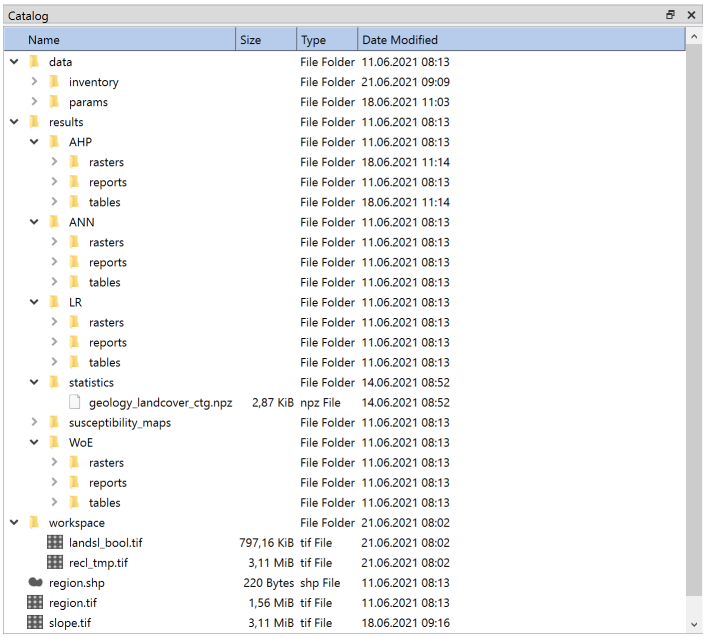


Fig. 2.7: Catalog Widget

rasters

Raster dataset output of the *AHP*

reports

Reports of the *AHP*

tables

Results of the *AHP*

ANN

rasters

Raster dataset output of the *ANN analysis*

reports

Reports of the *ANN analysis* (coming soon)

tables

Results of the *ANN analysis*

LR

rasters

Raster dataset output of the *LR analysis*

reports

Reports of the *LR analysis* (coming soon)

tables

Results of the *LR analysis*

statistics

Results of the *contingency analysis widget*.

susceptibility_maps

Results of the *Model Builder* and *Zoning Widget*.

WoE

rasters

Raster dataset output of the *WoE analysis*

reports

Reports of the *WoE analysis*

tables

Results of the *WoE analysis*

Right click on any folder to open it in your file manager.

The following table describes the options available by right clicking a file based on their type independent from their location:

File type	Available actions
Vector	*Attribute Table* *Properties*
Raster	*Attribute Table* *View Data* *Properties*
Docx	Open Document - Opens the .docx in your default program for this file type

In addition to the actions described above you can also delete all non essential files from the catalog. To do so right click and select delete or select the file/folder and press the 'delete' key.

LSAT Project structure

Files and folders in a newly created LSAT Project with a mask raster:

```
   *project name*.log
   metadata.xml
   region.dbf
   region.prj
   region.shp
   region.shx
   region.tif
   region.tif.aux.xml

├──data
   ├──inventory
      ├──test
      └──training
   └──params
├──results
   ├──AHP
```

(continues on next page)

(continued from previous page)

```
        ├──rasters
        ├──reports
        └──tables
    ├──ANN
        ├──rasters
        ├──reports
        └──tables
    ├──LR
        ├──rasters
        ├──reports
        └──tables
    ├──statistics
    ├──susceptibility_maps
    └──WoE
        ├──rasters
        ├──reports
        └──tables
└──workspace
```

2.2.2 Feature Attribute Table

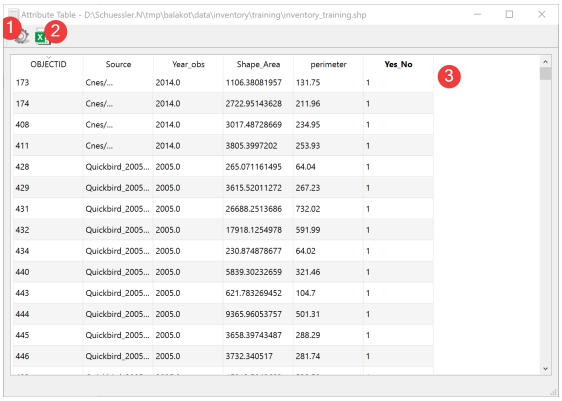


Fig. 2.8: Feature Attribute Table Widget

Widget to display the Feature Attribute Table (FAT).

Overview

Open the *Feature Info Widget* by clicking on the gear (1).

Export the FAT (3) as an excel file (2).

Each Row in the FAT (3) represents a shape of the feature.

2.2.3 Feature Info

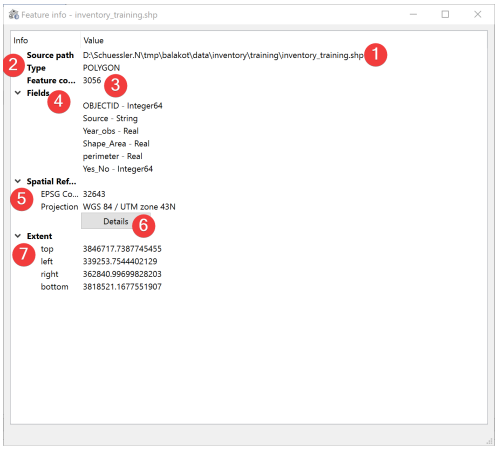


Fig. 2.9: Feature Info Widget

Displays information about the selected vector file.

Overview

The source path (1) is the absolute path to the feature you selected.

The type (2) is the type of geometry in the vector file (e.g. POINT, LINE, POLYGON etc.)

The feature count (3) is the amount of shapes in the file.

The fields (4) show the names of feature attributes their types. To view a detailed Feature Attribute Table (FAT) open the *FAT Widget*

The spatial reference (5) shows the features projection and corresponding EPSG Code. Clicking on Details (6) will open epsg.io with information about the coordinate system.

The extent (7) of the feature is displayed in units of the files spatial reference.

2.2.4 Main Log

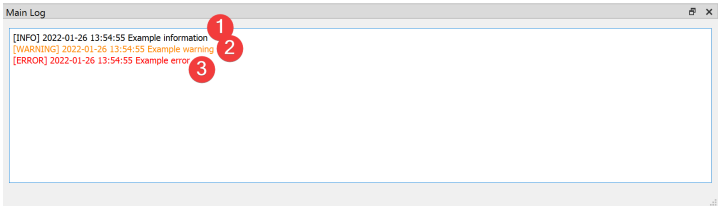


Fig. 2.10: Main Log Widget

Widget to inform you of events inside LSAT.

Information

There a three types of logging you will see in the Main Log:

1. [INFO] (1)

   The black text indicates normal behavior. Most LSAT widgets use the Main Log to inform the user what they are doing, e.g. where they create a file or if they started an analysis.

2. [WARNING] (2)

   The orange text indicates that something is not optimal. An example for a warning would be that a package used by LSAT will drop support for a feature LSAT uses. Please let us know if you think the warning breaks or will break LSAT in the future.

3. [ERROR] (3)

   The red text indicates that something inside LSAT broke. If LSAT created an output file after an error you should not use it, as it may contain corrupted data. If you see errors in you Log please file a bug report.

In addition to the Main Log each LSAT PM project contains a .log file with its full history of logging outputs.

2.2.5 Model Info

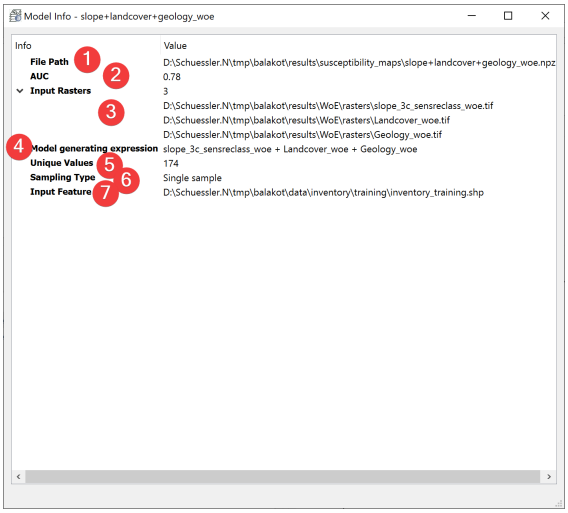


Fig. 2.11: Model Info Widget

Displays information about the selected model.

Overview

The file path (1) is the absolute path to the model you selected.

AUC (Area under Curve) (2) indicates the quality of the model. Hover your mouse over the number to display all available digits.

(3) shows the amount of input rasters and their absolute file path.

The model generating expression (4) shows in which way the datasets where combined to form the model.

(5) shows the amount of unique values in the model.

The Sampling Type (6) shows how the input feature dataset (7) was used during the creation of the model. The models use either predefined subsamples, on the fly sampled samples or a single sample.

2.2.6 Parameter Selection

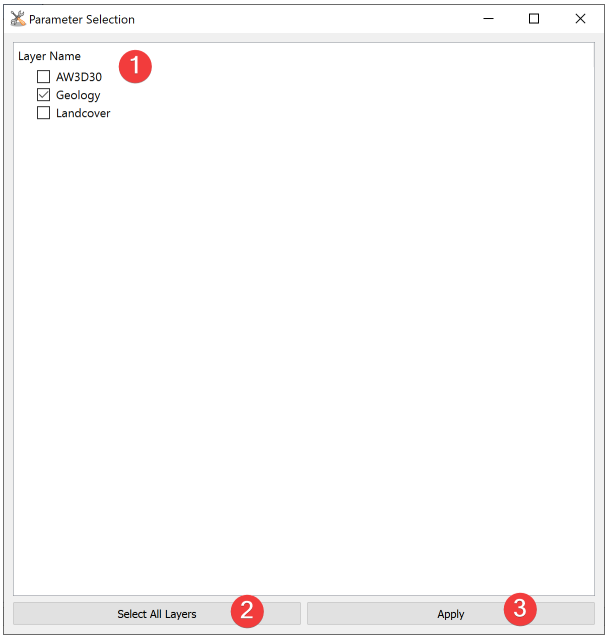


Fig. 2.12: Parameter Selection Dialog

Select imported raster datasets for use in an *analysis*.

Usage

1. Check the raster datasets you want to use in the *analysis*.
   You can select individual ones (1) or all imported ones (2).
2. Click apply (3) to start the analysis widget with the selected parameters preselected.

When you close the Parameter Selection Widget the selected Analysis will not start.

Information

After starting the Analysis Widget from the Parameter Selection you can still remove and add raster datasets.

Parameter Selection shows .tif files in data/params.

2.2.7 Raster Attribute Table

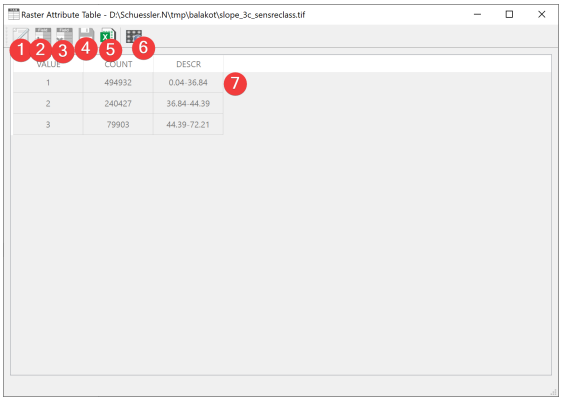


Fig. 2.13: Raster Attribute Table Widget

Widget to display and modify the Raster Attribute Table (RAT).

Overview

Clicking on the pen and paper (1) enables editing the RAT (7), adding new fields (2) and deleting existing ones (3).

To add a new field press the button (2) opening a *dialog*.

Delete a field by clicking the delete button (3). LSAT requires confirmation before deletion.

After modifying the RAT (7) save the changes made (4).

Export the RAT (7) as an excel file (5).

To open the raster in the *Raster Info Widget* click (6).

New field dialog

Fig. 2.14: New field dialog

Name the field (1), define its type (2) and confirm your choices (3) to add the new field to your RAT. You can cancel (4) the dialog at any time.

Information

After *importing a raster dataset* LSAT will create a basic RAT for Non-float raster datasets with under 500 unique values if they don't have one.

Certain fields can not be modified or deleted (e.g. VALUE, COUNT).

2.2.8 Raster Info

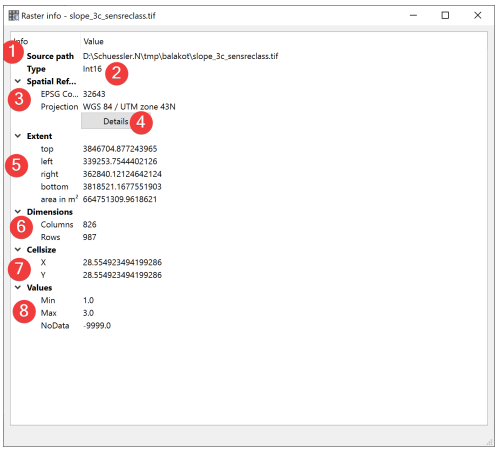


Fig. 2.15: Raster Info Widget

Displays information about the selected raster dataset.

Usage

The source path (1) is the absolute path to the raster you selected.

The type (2) is the type of values stored in the raster (e.g. INT16, FLOAT32 etc.)

The spatial reference (3) shows the features projection and corresponding EPSG Code. Clicking on Details (4) will open epsg.io with information about the coordinate system.

The extent (7) of the feature is displayed in units of the files spatial reference. Based on the cellsize (7) and dimensions (6) LSAT calculates the raster datasets area.

Values (8) shows the minimal and maximal values in addition to the NoData value of the raster dataset.

2.2.9 Results - AHP

Display the results of the *Analytic Hierarchy Process (AHP) analysis*.

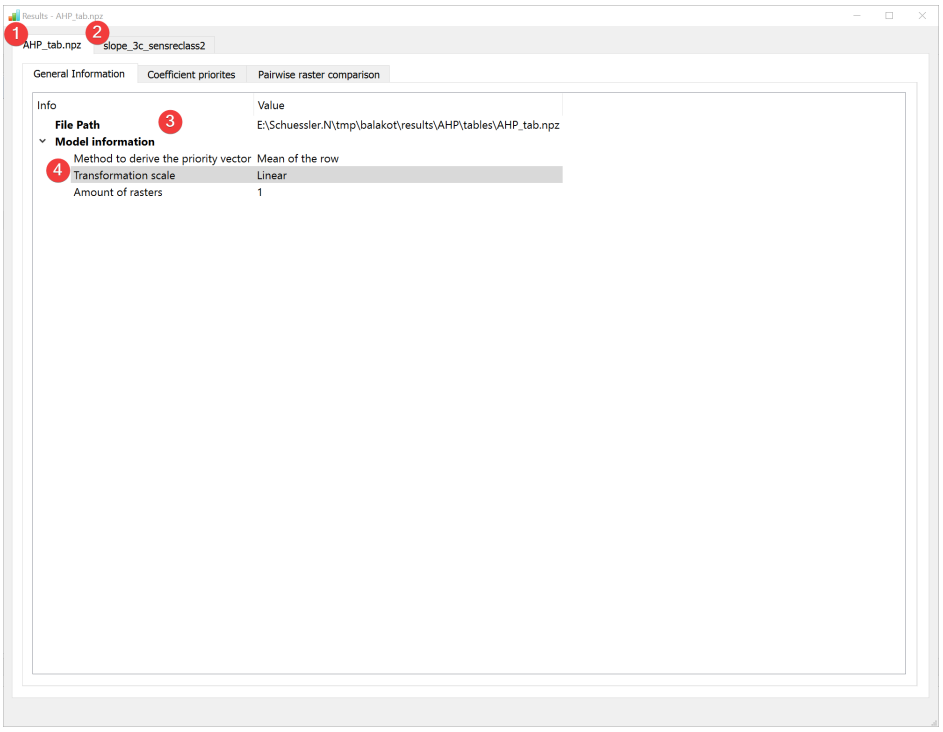


Fig. 2.16: AHP Results Widget - general information raster comparison

Overview

The result viewer shows a tab for the raster comparison (1) and for each raster dataset used in the analysis (2).

The general information tab shows the path to the .npz containing the information (3) and basic information about the model (2).

The coefficient priorities tab contains a table with each raster datasets path (1), its values (2) and the corresponding priorities (3).

The pairwise raster comparison tab contains the untransformed pairwise raster comparison table (1).

The general information tab shows information (1) unique to each raster. To see all available digits hover your mouse over the values.

The raster value priorities tab shows a table of the raster values (1) its priority vectors in the dataset itself (2) and the coefficient priorities (3) when compared with other raster datasets. To see all available digits hover your mouse over the values.

The raster value comparison tab shows the raster value comparison table with as defined during the analysis.

The raster value comparison tab shows the raster value comparison table modified by the user defined scale. Because LSAT PM supports only linear transformation at the moment the normal pairwise raster value comparison is the same as the pairwise transformed raster value comparison.

Open this widget by right clicking the output .npz of an *Analytic Hierarchy Process (AHP) analysis* in the *catalog*.

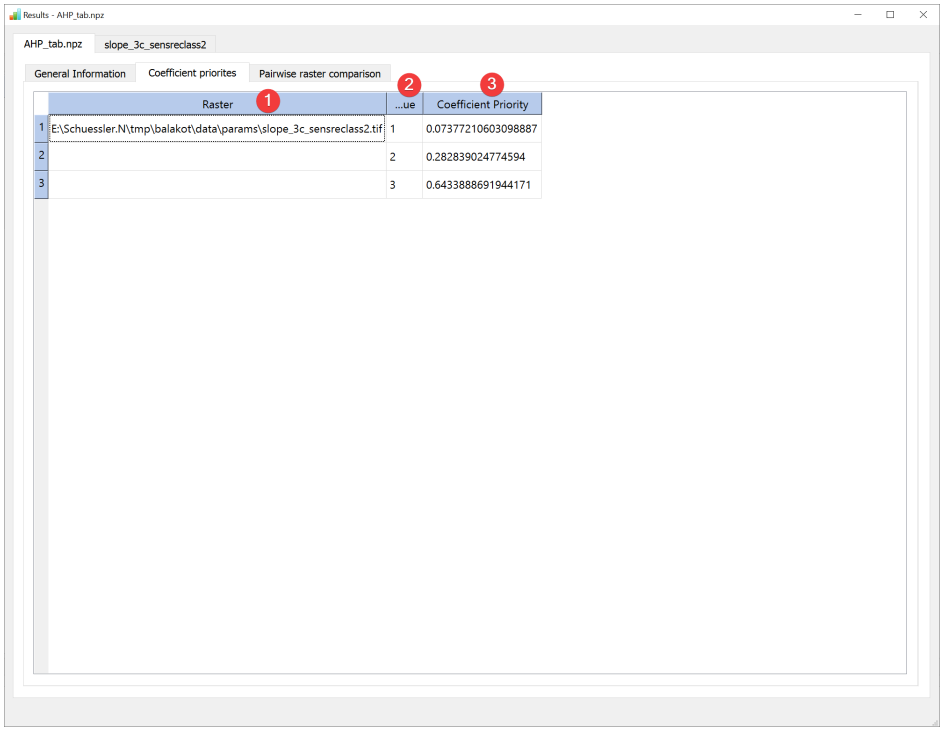


Fig. 2.17: AHP Results Widget - coefficient priorities raster comparison

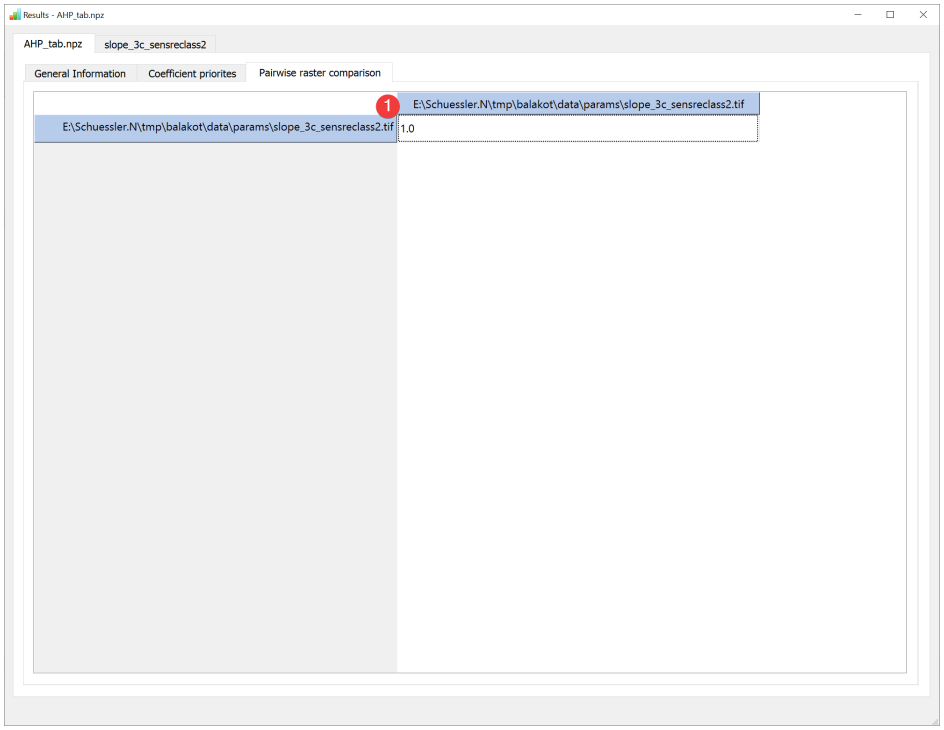


Fig. 2.18: AHP Results Widget - pairwise raster comparison

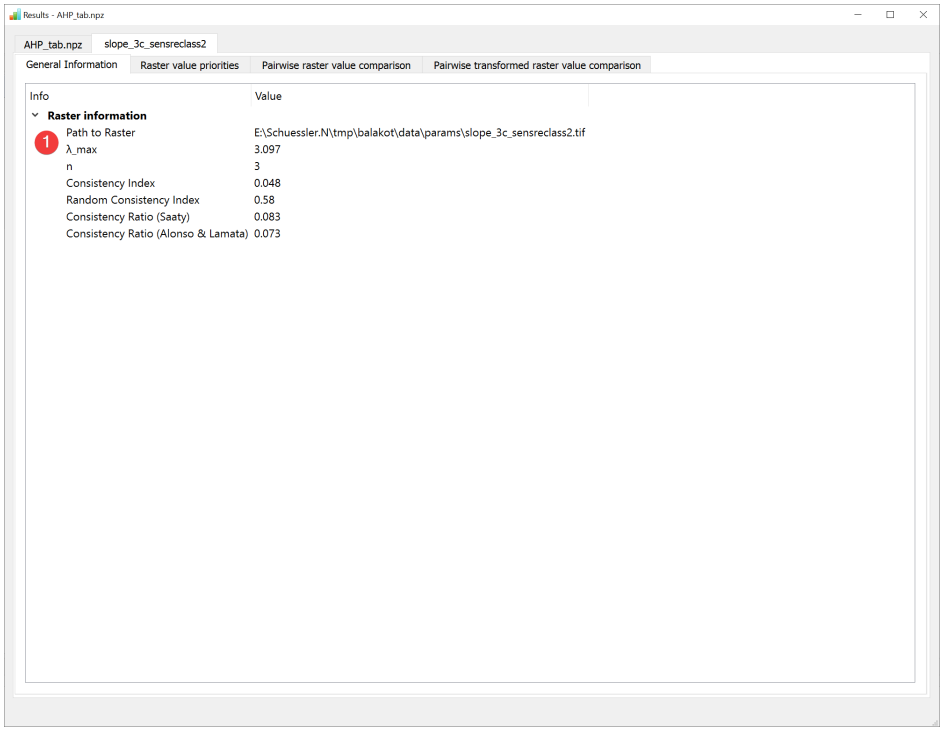


Fig. 2.19: AHP Results Widget - raster dataset general information

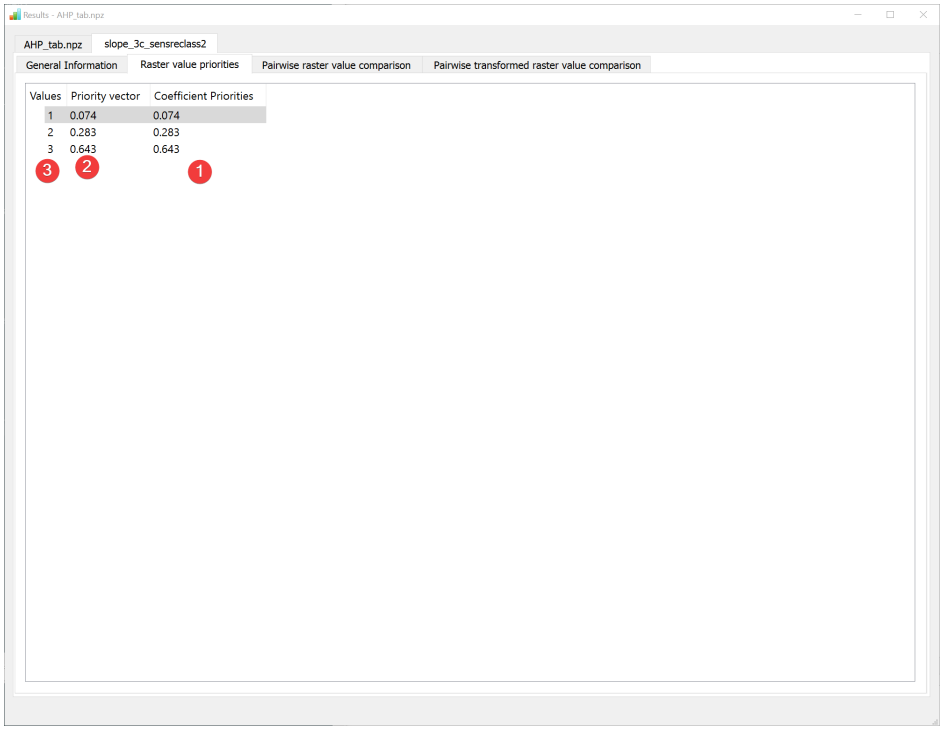


Fig. 2.20: AHP Results Widget - raster value priorities

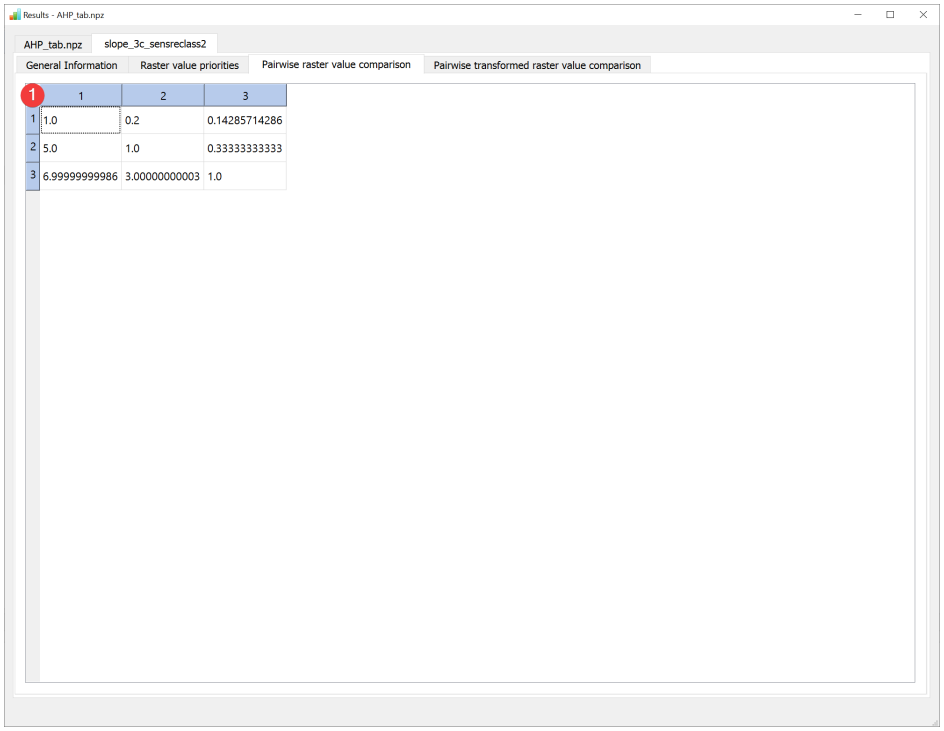


Fig. 2.21: AHP Results Widget - pairwise raster value comparison

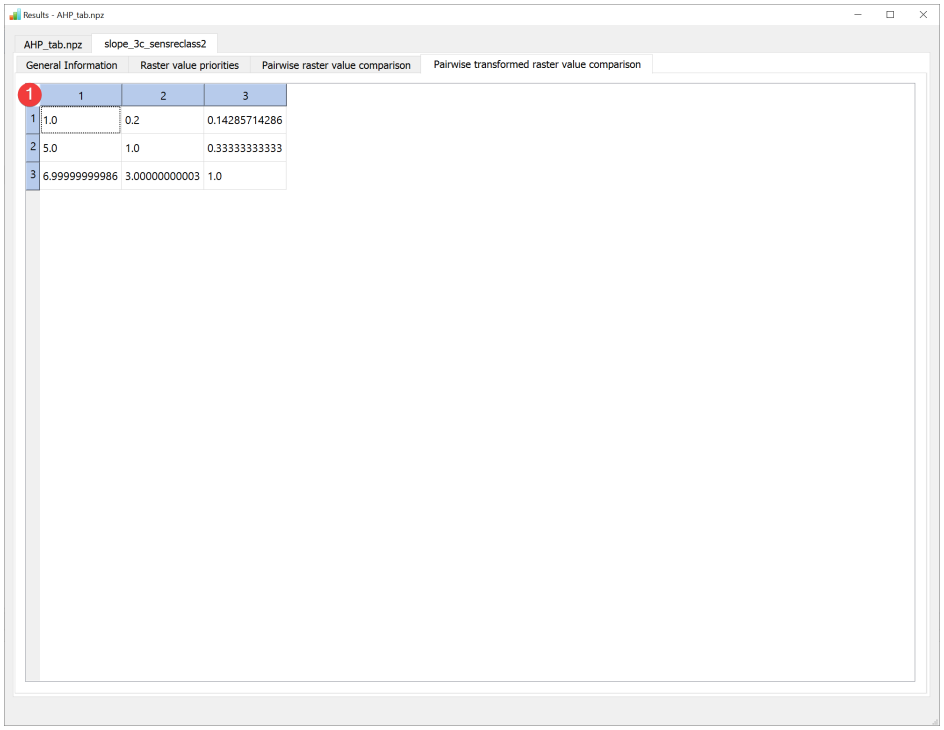


Fig. 2.22: AHP Results Widget - pairwise transformed raster value comparison

2.2.10 Results - ANN

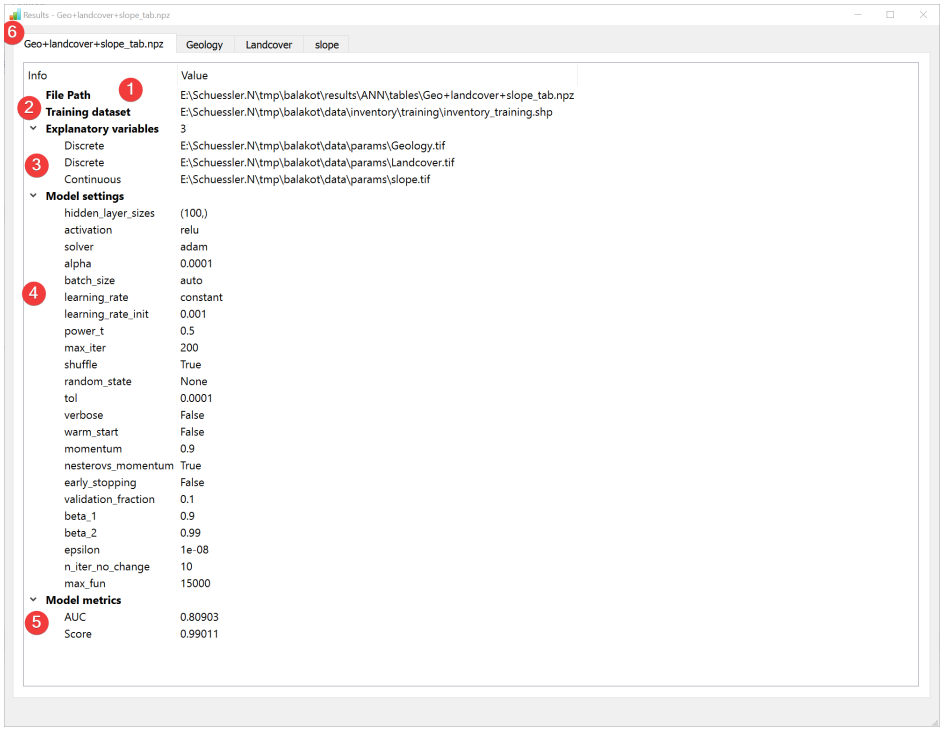


Fig. 2.23: ANN Results Widget - overview tab

Display the results of the *Artificial Neural Network (ANN) analysis*.

Overview

- (1) Shows the path to the results file.
- (2) Shows the path to the used feature dataset.
- (3) Shows the type and path to the used raster datasets.
- (4) Shows the settings used when creating the model.
- (5) Shows basic model metrics (hover your mouse over the results to show all available digits).

In addition to the overview tab (6) each raster dataset has its own tab:

LSAT PM assigns a Class ID (1) for each unique value in the raster if it is a discrete type. Note that these may differ from the original raster values.

Class (2) shows the amount of pixels in the raster dataset with that unique value / Class ID Landslides (3) shows the amount of pixels in the raster dataset with that unique value / Class ID that also contain landslides.

Continuous type raster datasets will only have one Class ID:

The information (1, 2, 3) is identical to the discrete raster datasets except there being only one Class ID.

You can open this widget after finishing an *ANN analysis* or by right clicking the output .npz in the *catalog*.

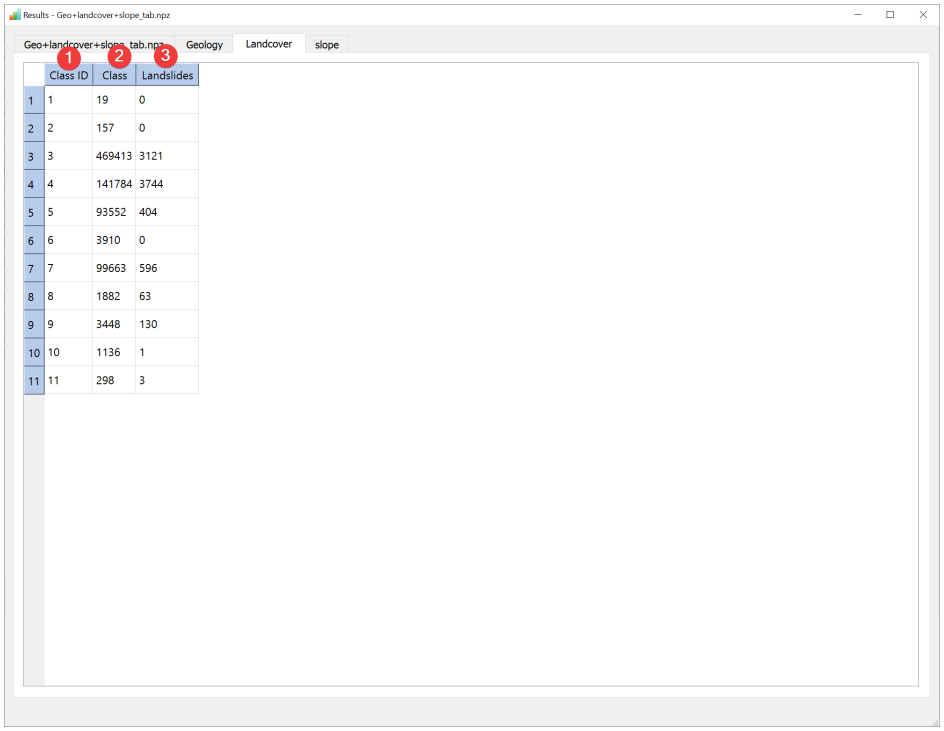


Fig. 2.24: ANN Results Widget - raster dataset tab (discrete)

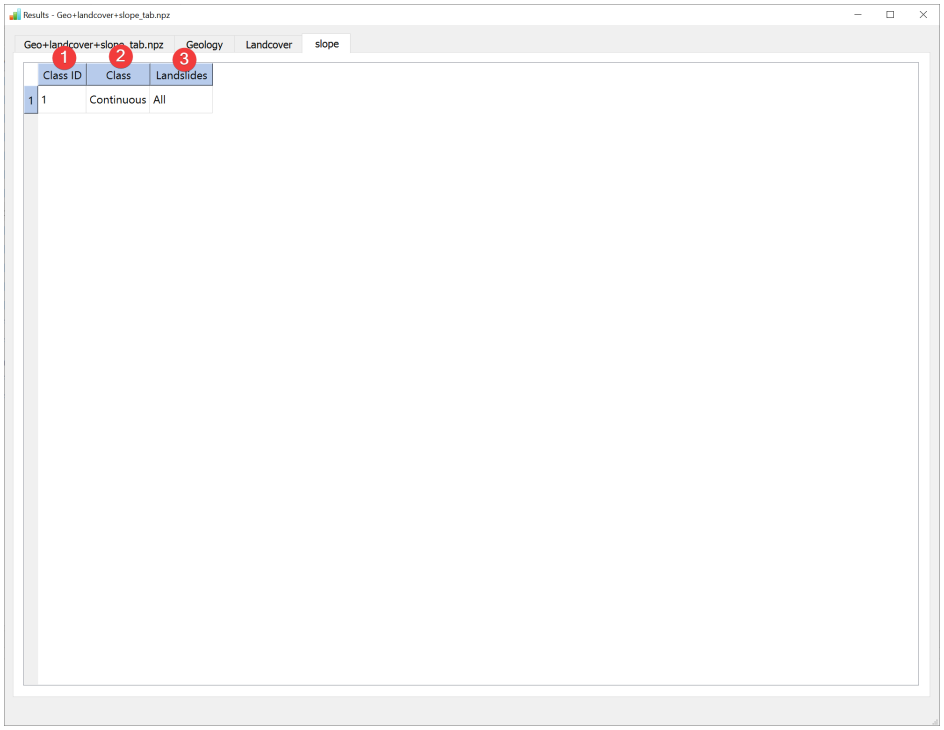


Fig. 2.25: ANN Results Widget - raster dataset tab (continuous)

2.2.11 Results - LR

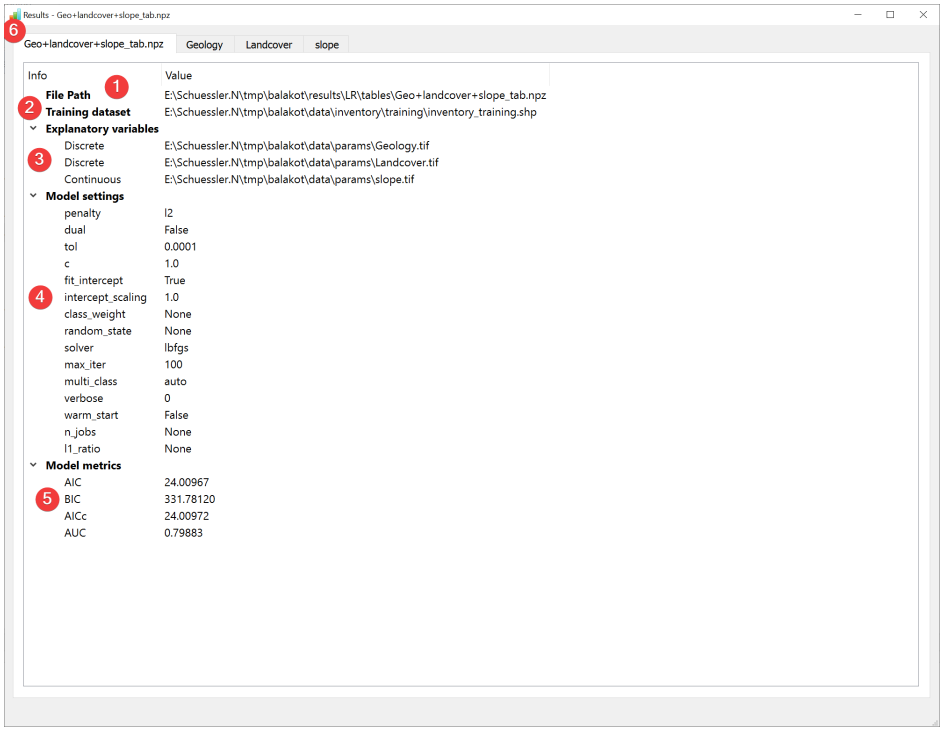


Fig. 2.26: LR Results Widget - overview tab

Display the results of the *Logistic Regression (LR) analysis*.

Overview

- (1) Shows the path to the results file.
- (2) Shows the path to the used feature dataset.
- (3) Shows the type and path to the used raster datasets.
- (4) Shows the settings used when creating the model.
- (5) Shows basic model metrics (hover your mouse over the results to show all available digits).

In addition to the overview tab (6) each raster dataset has its own tab:

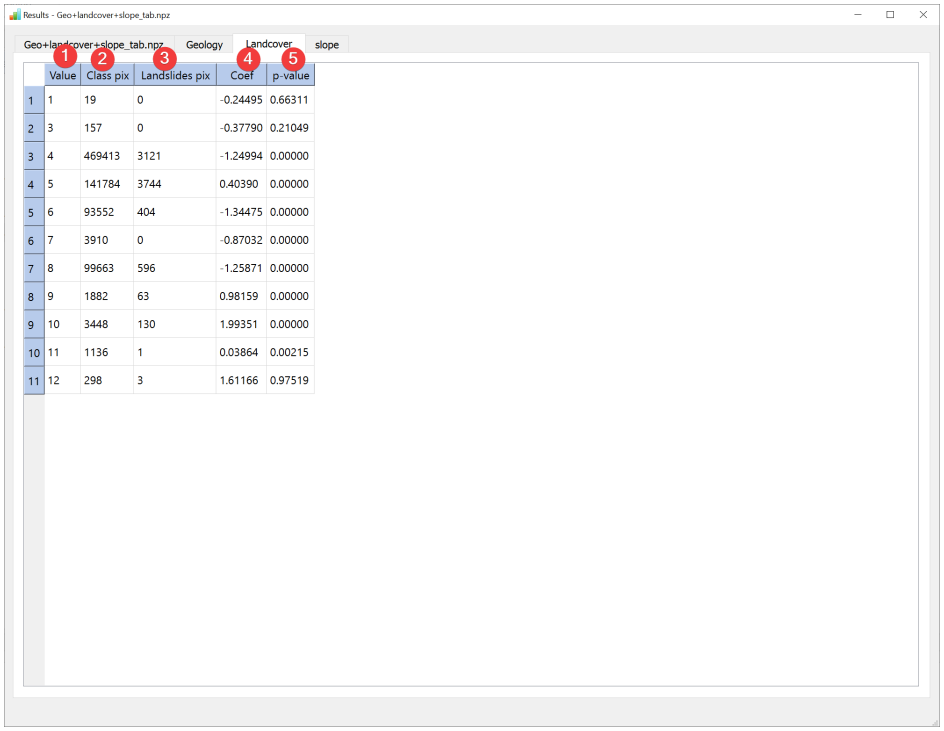
The value (1) is the unique value in the raster if it is a discrete type.

Class pix (2) shows the amount of pixels in the raster dataset with that value. Landslides pix (3) shows the amount of pixels in the raster dataset with that value that also contain landslides. Coef (4) is the calculated coefficient for that value. The p-value (5) column contains the calculated p-value for that value.

Continuous type raster datasets will only have one value:

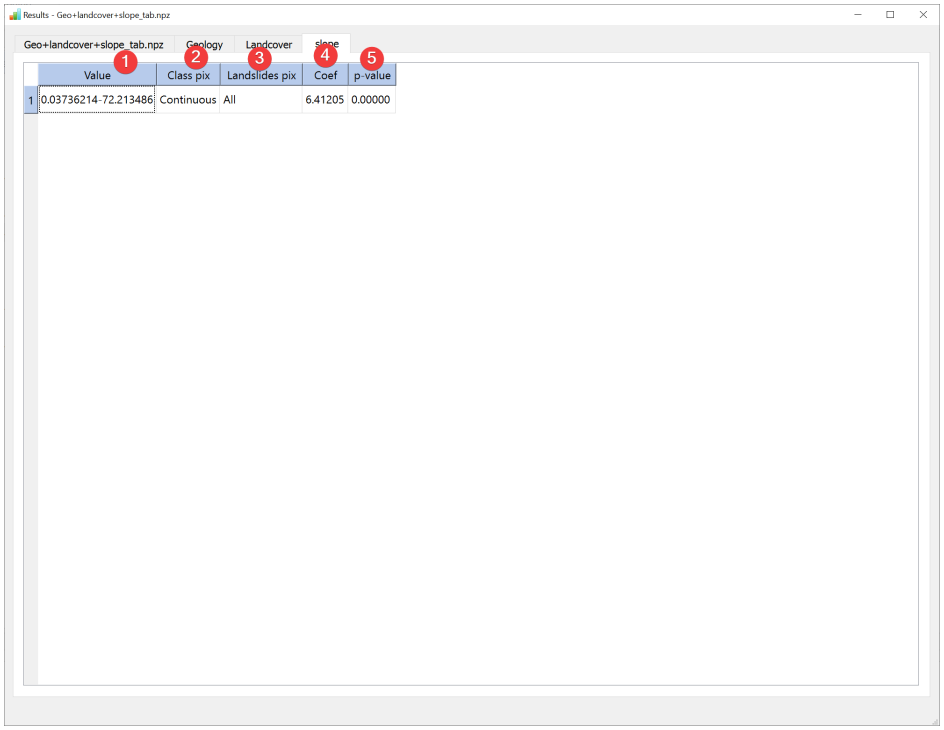
The information (1, 2, 3, 4, 5) is identical to the discrete raster datasets except there being only one value displaying the range of values in the raster dataset.

You can open this widget after finishing an *LR analysis* or by right clicking the output .npz in the *catalog*.



	Value	Class pix	Landslides pix	Coef	p-value
1	1	19	0	-0.24495	0.66311
2	3	157	0	-0.37790	0.21049
3	4	469413	3121	-1.24994	0.00000
4	5	141784	3744	0.40390	0.00000
5	6	93552	404	-1.34475	0.00000
6	7	3910	0	-0.87032	0.00000
7	8	99663	596	-1.25871	0.00000
8	9	1882	63	0.98159	0.00000
9	10	3448	130	1.99351	0.00000
10	11	1136	1	0.03864	0.00215
11	12	298	3	1.61166	0.97519

Fig. 2.27: LR Results Widget - raster dataset tab (discrete)



	Value	Class pix	Landslides pix	Coef	p-value
1	0.03736214-72.213486	Continuous	All	6.41205	0.00000

Fig. 2.28: LR Results Widget - raster dataset tab (continuous)

2.2.12 Results - WofE

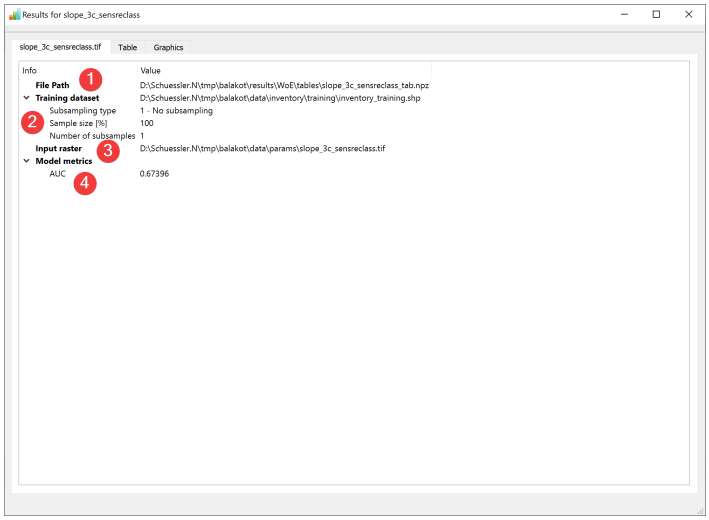


Fig. 2.29: WofE Results Widget - overview tab

Display the results of the *Weight of Evidence (WofE) analysis*.

Overview

- (1) Shows the path to the results file.
- (2) Shows the path to the used feature dataset and how it was subsampled.
- (3) Shows the path to the used raster datasets.
- (4) Shows basic model metrics (hover your mouse over the results to show all available digits).

The table contains all results of the calculation:

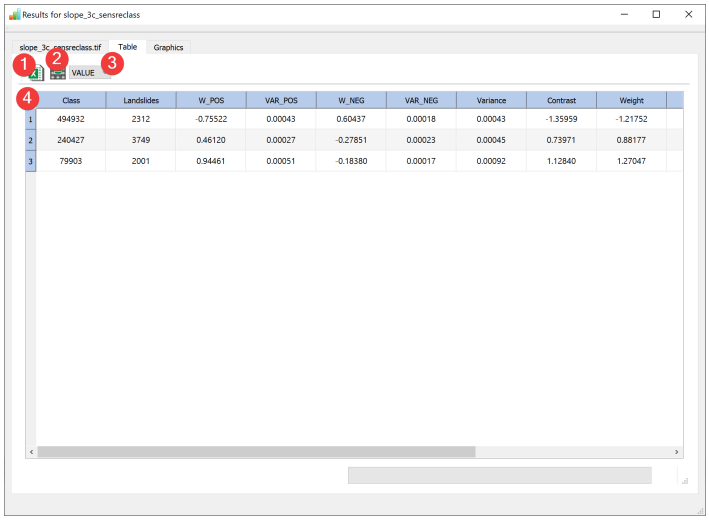


Fig. 2.30: WofE Results Widget - table tab

- (1) Exports the table (4) as an excel file.

- **(2) Saves a raster with the column selected in the table (4) replacing the original raster** values using a dialog.
- (3) Selects an attribute from the raster attribute table to display on the far left column.

The Graphics tab shows selected results:

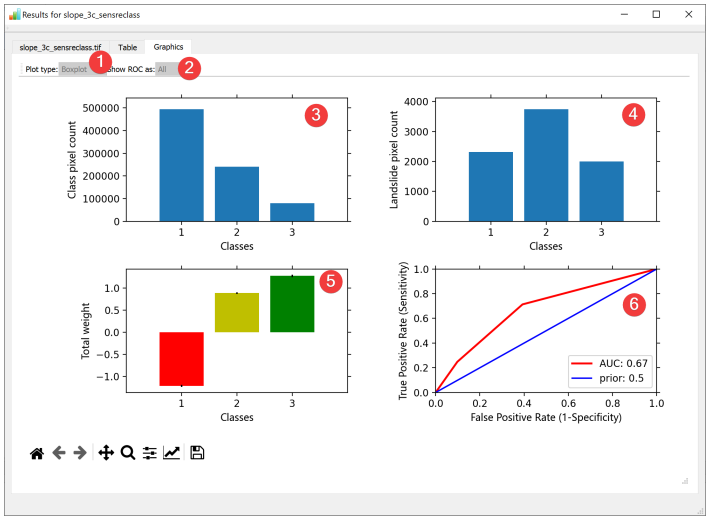


Fig. 2.31: WofE Results Widget - graphics tab

- (1) Switches between Box-, and Violinplots for (4) and (5) (Only if multiple samples were used).
- (2) Switches between all ROC curves or a range for (6) (Only if multiple samples were used).
- (3) Shows the pixel count for each raster dataset value.
- (4) Shows the landslide pixel count for each raster dataset value.
- (5) Shows the total weight for each raster dataset value.
- (6) Shows the ROC curve.

You can open this widget after finishing a *WofE analysis* or by right clicking the output .npz in the *catalog*.

2.3 Settings

Change language and network settings.

2.3.1 Language

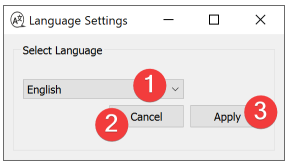


Fig. 2.32: Language Widget

The language widgets changes the language of the LSAT User Interface.

Usage

1. Select your preferred language in the combo box (1).
2. Click Apply (3).
3. Restart LSAT.

When you close the dialog with Cancel (2) the language won't change after a restart.

Information

The translations are stored in core/resources/qt_*language*.qm

They are created from .ts files in the same directory.

The initial language for LSAT is English. If LSAT can not translate a string it will fall back to the English version.

2.4 Help

The manual you are reading right now.

2.4.1 Manual

If you have you used the installer to install LSAT the most recent *documentation* for your version was a part of the installed files.

The newest version of the manual can be found online in its own repository.

CHAPTER

THREE

DATA

Import, view and modify raster and vector files

3.1 Import

Import raster and vector files

3.1.1 Import Inventory

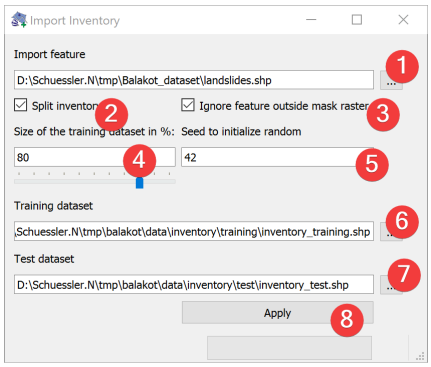


Fig. 3.1: Inventory Import Widget

Import Inventory (vector) files into LSAT Projects.

Usage

1. Pick a vector dataset to import. You can either type the absolute path to the file or select it from your PC (1).
2. (Optional) Disable splitting the inventory into training and validation datasets.
3. (Optional) Disable ignoring feature parts outside the mask raster.
4. Adjust the size of the training dataset as percent of the import feature either by typing a number (4) or adjusting the slider.
5. (Optional) Define a seed to initialize the random function (5).
6. (Optional) Adjust the training dataset output location either by typing the output path or

with a dialog (6)

7. (Optional) Adjust the test dataset output location either by typing the output path or with a dialog (7)
8. Start the Import (8)

LSAT *clips* the feature with region.shp of the current project on the fly if you choose to ignore features outside the mask.

By defining a seed to initialize random (5) you can recreate the inventory split on a later date.

To achieve the best results in later *analyses* consider splitting the inventory.

Most LSAT widgets expect the inventory to be in their default locations. While you can always point to another folder or file it is easier to leave the default output locations.

Why subsample?

When we subset the inventory at the beginning of the modeling in training and test dataset, we do a sampling, which is always associated with a sampling error. The sampling error increases with the decreasing sample size. Thus, if we use 80% of the observations to train the model and 20% to test the model, we generally have two samples that exhibit different sample errors. Just imagine that a generated model has a performance with the training dataset indicated by AUC index of 0.84. Evaluating the model with the test dataset showed an AUC index of 0.79. Is this an indication of a poor generalization or is this value still in the possible range of the model's uncertainty? This question can be answered generating a set of samples, which have the size of the test dataset. For example, if our test dataset has 20 observations, we would randomly draw several samples of this size from our training dataset and compute the ROC curve. Based on this subsampling, we would get a range of AUC values that would suggest to us the possible variance of the model given the specific sample size and specific pattern distribution. If the ROC curve of the test dataset falls within this range, we could assume that the sampling error very likely governs the observed drop in the AUC index, and the model generalizes for new events sufficiently well (in the range of its uncertainty). However, if the AUC index of the test dataset is clearly outside the estimated sample error range, we have to assume that the model has a drop in the prediction quality due to other generalization issues such as overfitting or maybe a consideration of correlated but non-causal factors (pseudo-correlations).

Splitting process

LSAT only considers the total number of features when splitting the inventory into a training and test dataset.

Input and Output

Input	Vector dataset
Output	Training vector dataset Default path: /data/inventory/training/inventory_training.*ext* (Optional) Test vector dataset Default path: /data/inventory/test/inventory_test.*ext*

3.1.2 Import Raster

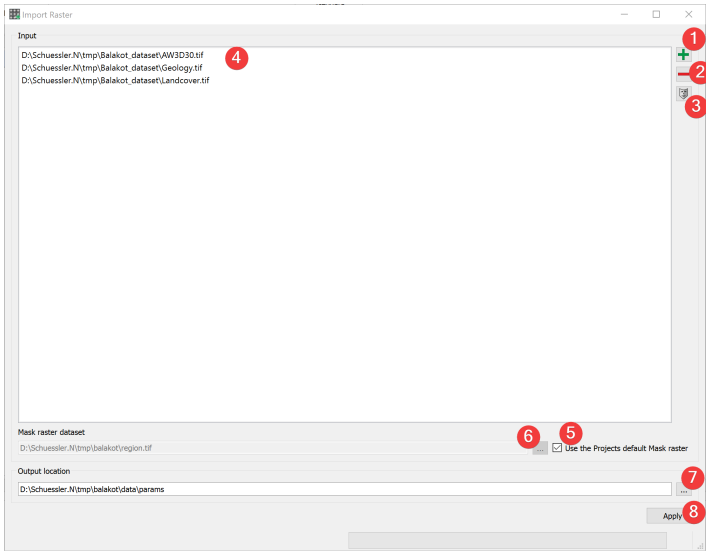


Fig. 3.2: Raster Import Widget

Import raster files into LSAT Projects.

Usage

1. Add at least one raster dataset. You can either drag and drop the rasters from your file manager into the input list (4) or select them from your PC (1).
2. (Optional) Change the mask raster dataset from the projects default by unchecking (5) and either picking an input raster by selecting it in the list (4) and clicking (3) or pick a mask from your PC (6).
3. (Optional) Change the output location of the output files by either typing in an existing folder or picking one from your PC (7)
4. Start the import process (8) (the *import dialog* opens).

To remove a raster from inputs, select it and press the minus button (2).

To achieve the best results in later *analyses* do not change the mask raster dataset.

Import Dialog

The raster import dialog opens from the *import raster widget* and by importing the projects mask when *creating a new project*

Usage

1. Pick a resampling technique (3) best suited for the type of raster you want to import (1).
2. Proceed with the import (4).

The input raster info (1) shows an embedded version of the *Raster Info Widget* for the import raster dataset.

You can compare basic information of the mask and import raster (2).

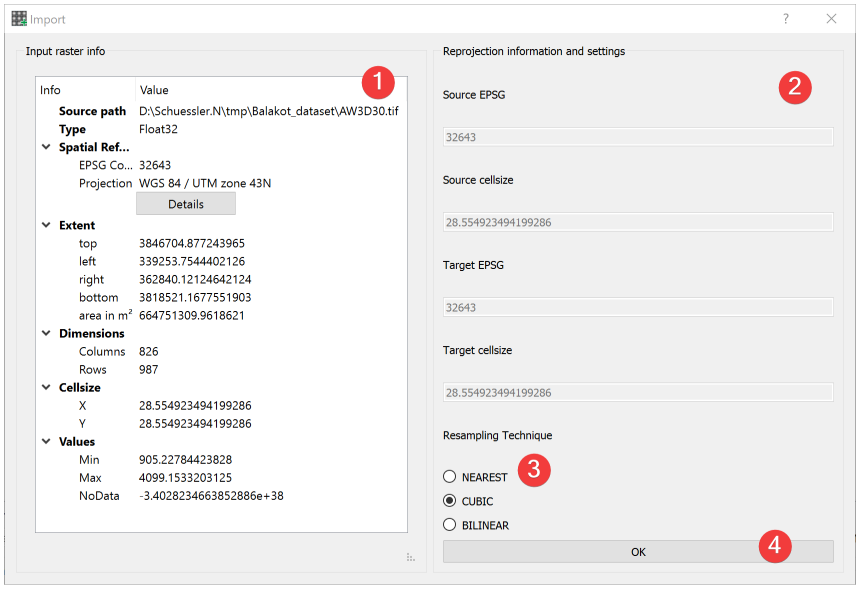


Fig. 3.3: Raster Import Dialog

Resampling techniques:

NEAREST	Nearest-neighbor interpolation. Should be applied when transforming discrete data (e.g., classified raster datasets) such as lithology
CUBIC	Cubic spline interpolation. Should be used when projecting continuous datasets such as DEM.
BILINEAR	Alternative to Cubic spline interpolation when projecting continuous datasets.

Import Process

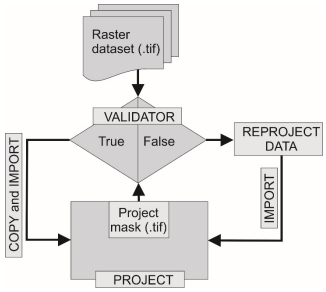


Fig. 3.4: Schematic workflow for raster dataset import

LSAT PM compares five properties of the input raster dataset to the mask raster dataset:

1. EPSG Code
2. Raster dimension (Number of rows/columns)
3. Raster origin
4. NoData count

5. NoData value

If all are the same the input raster dataset gets copied, else it gets reprojected.

If LSAT detects that the input raster is a discrete dataset it either copies an existing raster attribute table or creates a new one.

Input and Output

Input	Raster datasets (.tif) Mask raster (.tif) providing the spatial reference and the cell size. (Default: project mask)
Output	Imported raster datasets (.tif) Path: /data/params/*name*.tif

3.2 Vector Tools

Modify and extract information from vector datasets.

3.2.1 Geoprocessing Tools

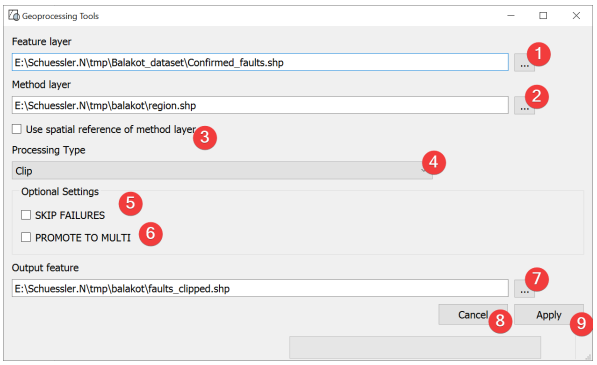


Fig. 3.5: Geoprocessing Tools Widget

Process vector files.

Usage

1. Select a feature layer. You can either type in the absolute file path yourself or pick one with a dialog (1).
2. Select a method layer. You can either type in the absolute file path yourself or pick one with a dialog (2).
3. (Optional) Choose to create the output in the spatial reference of the method layer (3)
4. Pick the *processing type* (4)
5. (Optional) Choose to proceed with the process if failures are encountered (5)
6. (Optional) Choose to promote to multi (6) (e.g. polygon -> multipolygon)
7. Select the output file. You can either type in the absolute file path yourself or pick one

with a dialog (7).

8. Start the process (9)

(2) Closes and resets the widget.

Processing Types

Clip

Returns parts of the feature layer that are inside the method layer.

Erase

Returns parts of the feature layer that are outside the method layer.

Intersect

Returns parts of the feature layer that are inside the method layer and adds attributes from the method layer.

Symmetrical Difference

Returns parts of the feature layer and the method layer that do not overlap.

Union

Returns all parts of the feature layer and the method layer with differing values if they overlap. If the features overlap they get both attributes.

Information

Geoprocessing Tools only supports Shapefiles (.shp) as of now.

Input and Output

Input	Feature layer (.shp) Method layer (.shp)
Output	Processed Shapefile (.shp)

3.2.2 Random Sampling

Create predefined subsamples.

Usage

1. Pick a vector dataset to subsample. You can either type the absolute path to the file or select it from your PC (1).
2. Define the number of subsamples to create (2).
3. (Optional) Define a seed to initialize the random function (3).
4. (Optional) Decide to keep the corresponding test part (6).
5. (Optional) Adjust the size of the training part either by typing the number (4) or adjusting the slider (5)

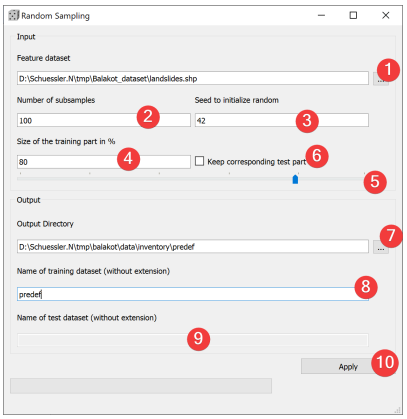


Fig. 3.6: Random Sampling Widget

6. (Optional) Adjust the output location either by typing the output path or with a dialog (7).
7. (Optional) Name the training dataset(s) (8).
8. (Optional) Name the test dataset(s) (8) (Only if you save them).
9. Create the subsample(s) (10).

By defining a seed to initialize random (4) you can recreate the subsamples on a later date.

You can only name the test dataset if keep the corresponding part (6) and if the size of the training part (4) is < 100 %.

Sampling process

LSAT only considers the total number of features when sampling the inventory into a training and test dataset.

Input and Output

Input	Vector dataset
Output	Vector training dataset(s) Naming scheme: /*Name (8)*_*Nr. of subsample*.*ext* (Optional) Test vector dataset(s) Naming scheme: /*Name (9)*_*Nr. of subsample*.*ext*

3.2.3 Subset By Attributes

The Subset by Attributes Widgets subsamples vector files based on values in the feature attribute table.

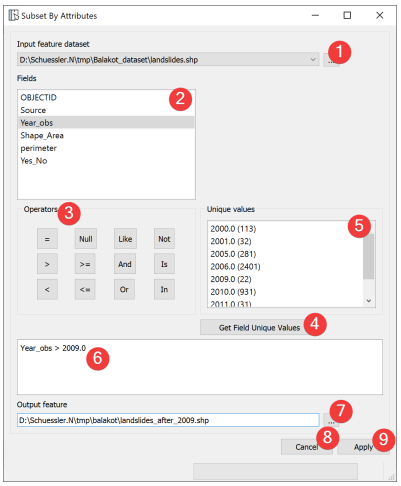


Fig. 3.7: Subset By Attributes Widget

Usage

1. Select an in input vector file with a dialog (1)
2. Formulate an equation in the field (6) that defines the subset you want.
3. Select the output vector location. You can either type in the absolute file path yourself or pick one with a dialog (7).
4. Start subsampling (9).

To get a Unique values list (5) of the selected Field (2) press get Field unique values (4).

You can double click Fields (2) and Unique values to copy them into (6). Operates can be copied over by clicking on them.

Clicking on Cancel (8) closes the widget.

Input and Output

Input	Vector dataset
Output	Vector dataset

3.3 DEM Tools

Derive rasters from DEM raster files

3.3.1 Aspect

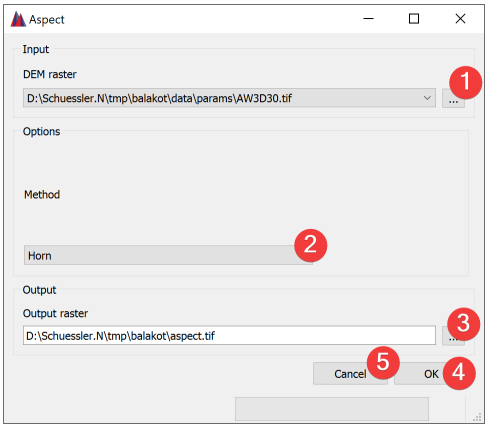


Fig. 3.8: Aspect Widget

The aspect widget creates a new raster based on the calculated aspect from an input DEM raster.

Usage

1. Select the input DEM raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the Method to calculate the aspect (2).
3. Select the output aspect raster location. You can either type in the absolute file path yourself or pick one with a dialog (3).
4. Start the calculation (4)

If you want to use the created aspect raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Clicking on Cancel (5) closes the widget.

Input and Output

Input	Digital Elevation Model raster dataset (.tif)
Output	Aspect raster dataset (.tif)

3.3.2 Hillshade

The hillshade widget creates a new raster based on the calculated hillshade from an input DEM raster.

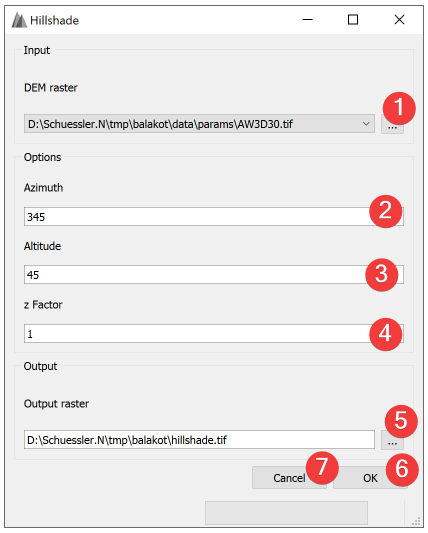


Fig. 3.9: Hillshade Widget

Usage

1. Select the input DEM raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the Azimuth (2) (Default: 345).
3. Select the Altitude (3) (Default: 45).
4. Select the z Factor (4) (Default: 1).
5. Select the output hillshade raster location. You can either type in the absolute file path yourself or pick one with a dialog (5).
6. Start the calculation (6)

If you want to use the created hillshade raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Azimuth defines the location the light is shining from in degrees (0-360).

Altitude defines the altitude the light is shining from in degrees (0-90).

z factor exaggerates the DEMs height.

Clicking on Cancel (7) closes the widget.

Input and Output

Input	Digital Elevation Model raster dataset (.tif)
Output	Hillshade raster dataset (.tif)

3.3.3 Roughness

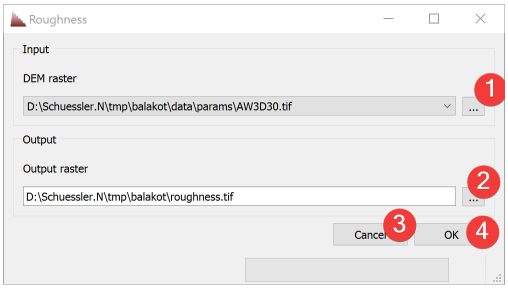


Fig. 3.10: Roughness Widget

The roughness widget creates a new raster based on the calculated roughness from an input DEM raster.

Usage

1. Select the input DEM raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the output roughness raster location. You can either type in the absolute file path yourself or pick one with a dialog (2).
3. Start the calculation (4)

If you want to use the created roughness raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Clicking on Cancel (5) closes the widget.

Input and Output

Input	Digital Elevation Model raster dataset (.tif)
Output	Roughness raster dataset (.tif)

3.3.4 Slope

The slope widget creates a new raster based on the calculated slope from an input DEM raster.

Usage

1. Select the input DEM raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the Output Unit (2).
3. Select the Method to calculate the slope (3)
4. Select the output slope raster location. You can either type in the absolute file path yourself or pick one with a dialog (4)
5. Start the calculation (6)

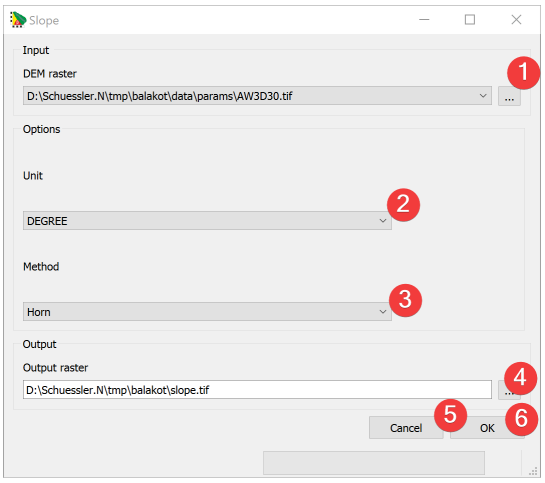


Fig. 3.11: Slope Widget

If you want to use the created slope raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Clicking on Cancel (5) closes the widget.

Input and Output

Input	Digital Elevation Model raster dataset (.tif)
Output	Slope raster dataset (.tif)

3.3.5 Topographic Position Index (TPI)

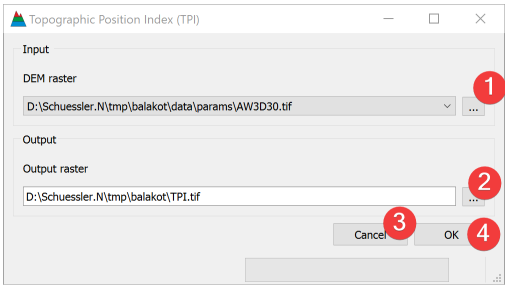


Fig. 3.12: Topographic Position Index (TPI) Widget

The TPI widget creates a new raster based on the calculated Topographic Position Index (TPI) from an input DEM raster.

Usage

1. Select the input DEM raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the output TPI raster location. You can either type in the absolute file path yourself or pick one with a dialog (2).
3. Start the calculation (4)

If you want to use the created TPI raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Clicking on Cancel (3) closes the widget.

Input and Output

Input	Digital Elevation Model raster dataset (.tif)
Output	Topographic Position Index (TPI) raster dataset (.tif)

3.3.6 Terrain Ruggedness Index (TRI)

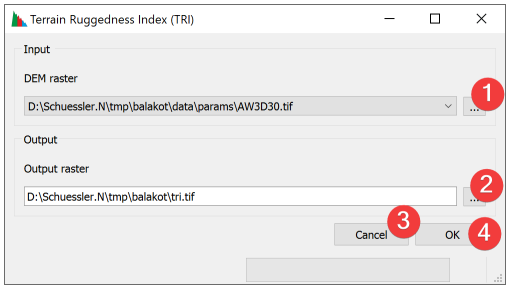


Fig. 3.13: Terrain Ruggedness Index (TRI) Widget

The TRI widget creates a new raster based on the calculated Terrain Ruggedness Index (TRI) from an input DEM raster.

Usage

1. Select the input DEM raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the output TRI raster location. You can either type in the absolute file path yourself or pick one with a dialog (2).
3. Start the calculation (4)

If you want to use the created TRI raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Clicking on Cancel (3) closes the widget.

Input and Output

Input	Digital Elevation Model raster dataset (.tif)
Output	Terrain Ruggedness Index (TRI) raster dataset (.tif)

3.4 Raster Tools

Derive rasters from DEM raster files

– _combine:

3.4.1 Combine

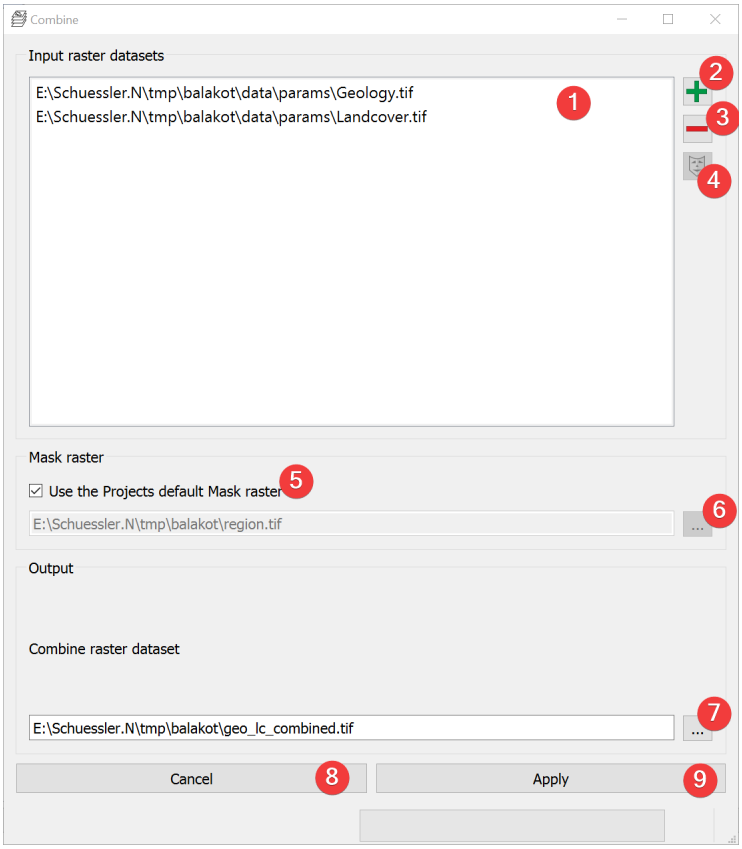


Fig. 3.14: Combine Widget

Creates a raster dataset based on unique combinations of input raster datasets.

Usage

1. Add at least two raster datasets. You can either drag and drop the rasters from your file manager into the input list (1) or select them from your PC (2).
2. (Optional) Change the mask raster dataset from the projects default by unchecking (5) and either picking an input raster by selecting it in the list (1) and clicking (4) or pick a mask from your PC (6).
3. Select the combined raster output location. You can either type in the absolute file path yourself or pick one with a dialog (7).
4. Start the calculation (9)

If you want to use the output raster in your LSAT Project you need to import it using the *Import Raster Widget*.

If any raster has noData the output raster will also have noData at that location.

Information

The input raster dataset values that lead to the output values are stored in the outputs Raster Attribute Table (RAT).

Input and Output

Input	Input raster datasets (.tif) Mask raster dataset (.tif)
Output	Combined raster dataset (.tif)

3.4.2 Contingency analysis

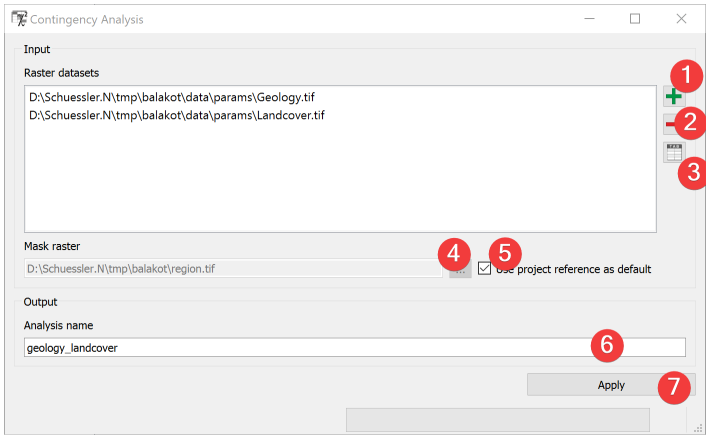


Fig. 3.15: Contingency Analysis Widget

The contingency analysis estimates association between categorized (discrete) raster datasets. The contingency analysis computes Pearson's contingency coefficient C and Cramer's V.

Usage

1. Add at least two discrete raster datasets. You can either drag and drop the rasters from your file manager or select them from your PC (1).
2. If necessary change the mask raster by unchecking (5) and selecting a new one (4).
3. Name the output file (6).
4. Start the Analysis (7).
5. View the *results* by double-clicking on the output file in the *catalog*.

If you want to remove a raster from inputs, select it and press the minus button (2).

You can view the *Raster Attribute Table (RAT)* of an Input raster by selecting it and pressing the RAT button (3).

Input and Output

Input	Raster datasets (.tif) with limited discrete classes. Mask raster (.tif) providing the spatial reference and the cell size. (Default: project mask)
Output	Analysis file (.npz) Path: /results/statistics/*output name*_ctg.npz

Results

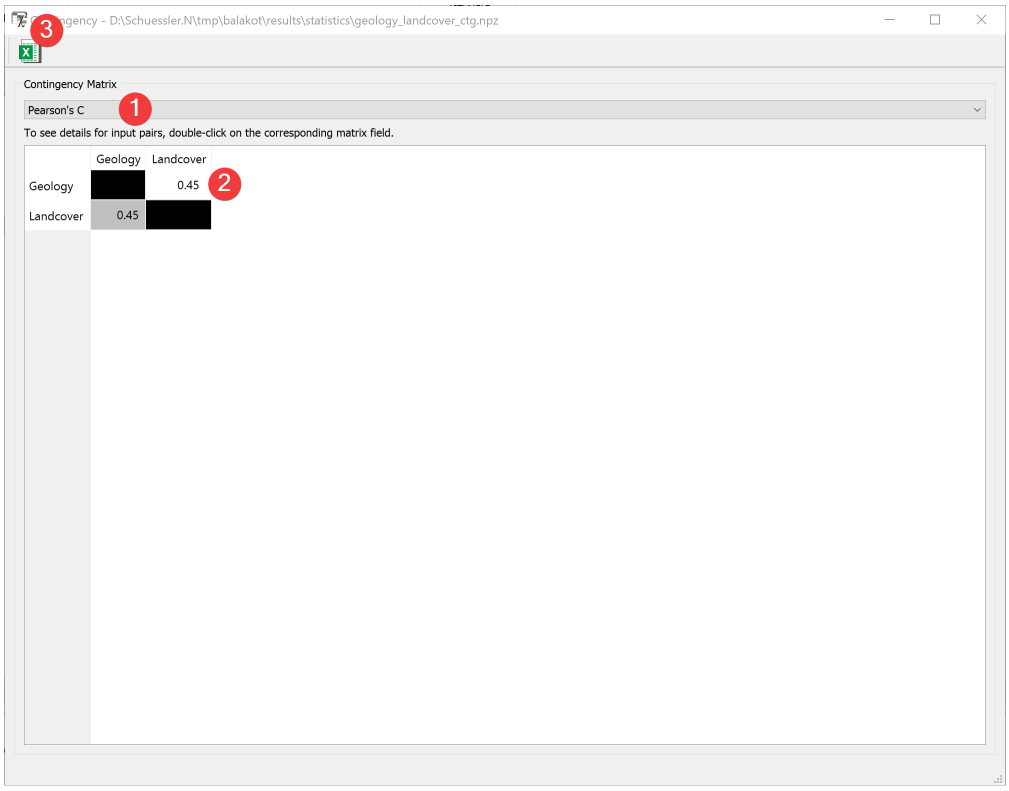


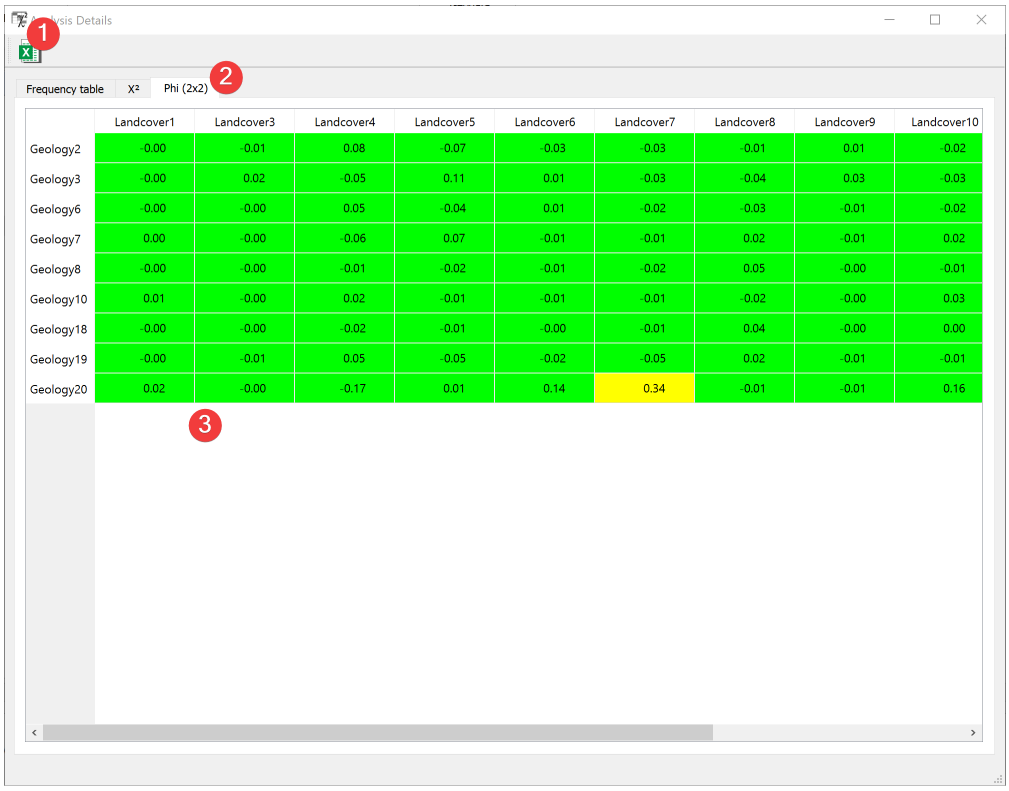
Fig. 3.16: Contingency Analysis Results Widget

This window shows the pairwise raster comparison.

Choose between displaying Pearson's C or Cramer's V in the Table (2) with the combo box (1).

Clicking the button (3) opens a dialog to export the current Matrix in the Table (2) as an excel file.

Double-clicking a cell in the Table (2) opens the details for that comparison.



	Landcover1	Landcover3	Landcover4	Landcover5	Landcover6	Landcover7	Landcover8	Landcover9	Landcover10
Geology2	-0.00	-0.01	0.08	-0.07	-0.03	-0.03	-0.01	0.01	-0.02
Geology3	-0.00	0.02	-0.05	0.11	0.01	-0.03	-0.04	0.03	-0.03
Geology6	-0.00	-0.00	0.05	-0.04	0.01	-0.02	-0.03	-0.01	-0.02
Geology7	0.00	-0.00	-0.06	0.07	-0.01	-0.01	0.02	-0.01	0.02
Geology8	-0.00	-0.00	-0.01	-0.02	-0.01	-0.02	0.05	-0.00	-0.01
Geology10	0.01	-0.00	0.02	-0.01	-0.01	-0.01	-0.02	-0.00	0.03
Geology18	-0.00	-0.00	-0.02	-0.01	-0.00	-0.01	0.04	-0.00	0.00
Geology19	-0.00	-0.01	0.05	-0.05	-0.02	-0.05	0.02	-0.01	-0.01
Geology20	0.02	-0.00	-0.17	0.01	0.14	0.34	-0.01	-0.01	0.16

Fig. 3.17: Contingency Analysis Results Widget (details)

This window shows the pairwise raster value comparison.

Choose between displaying the frequency table, Chi-squared or Phi (2x2) in the Table (3) by selecting the corresponding tab (2).

Clicking the button (1) opens a dialog to export the current Matrix in the Table (3) as an excel file.

3.4.3 Euclidean distance

This widget estimates the closest Euclidean distance of a raster cell to the feature dataset.

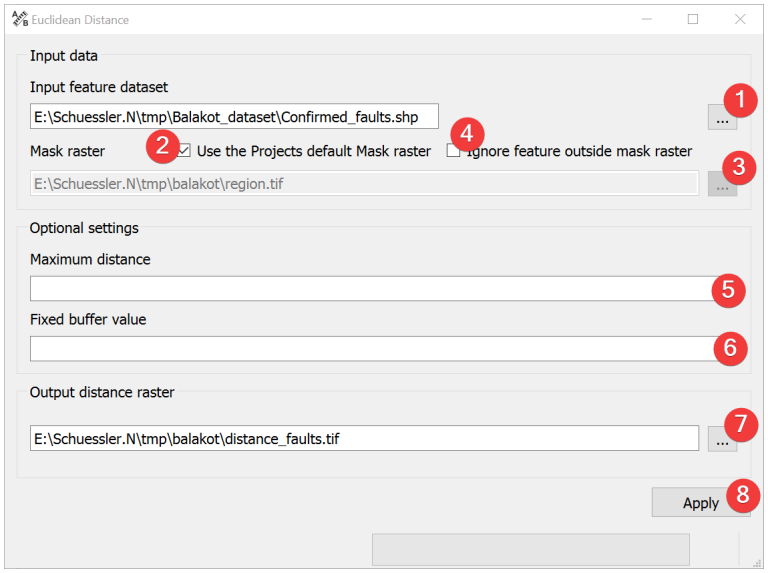


Fig. 3.18: Euclidean Distance Widget

Usage

1. Select the input feature file. You can either type in the absolute file path or select it from your PC (1).
2. If necessary change the mask raster by unchecking (2) and selecting a new one (3).
3. (Optional) Choose to ignore (4) parts of the input feature that are not inside the mask.
4. (Optional) Set the maximum distance to calculate the distance (5).
5. (Optional) Set the value to write into cells within the distance (6).
6. Select the output distance raster location. You can either type in the absolute file path yourself or pick one with a dialog (7).
7. Start the calculation (8)

If the input feature dataset lies at least partially outside the mask and these parts are not ignored LSAT extents the output raster while keeping the mask raster cell size.

If you want to use the output raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Input and Output

Input	Feature dataset to calculate the distance from Mask raster dataset (.tif)
Output	Euclidean distance raster dataset (.tif)

3.4.4 Lookup

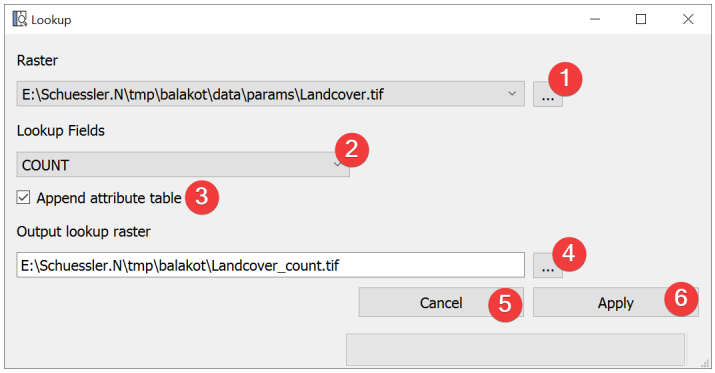


Fig. 3.19: Lookup Widget

Create a raster dataset based on values in the raster attribute table (RAT) of the input raster dataset.

Usage

1. Select an input raster dataset with a dialog (1)
2. Select the RAT field (2) from which to create the new raster dataset
3. (Optional) Choose not to append the raster attribute table of the input raster (3)
4. Select the lookup raster output location. You can either type in the absolute file path yourself or pick one with a dialog (4).
5. Start the lookup (6)

If you want to use the output raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Information

RAT values that are neither int nor float will not be displayed in the combobox (2) but will be appended if you choose to do so (3).

You can only lookup discrete rasters with a RAT.

Input and Output

Input	Input raster dataset (.tif)
Output	Lookup raster dataset (.tif)

3.4.5 Reclassify

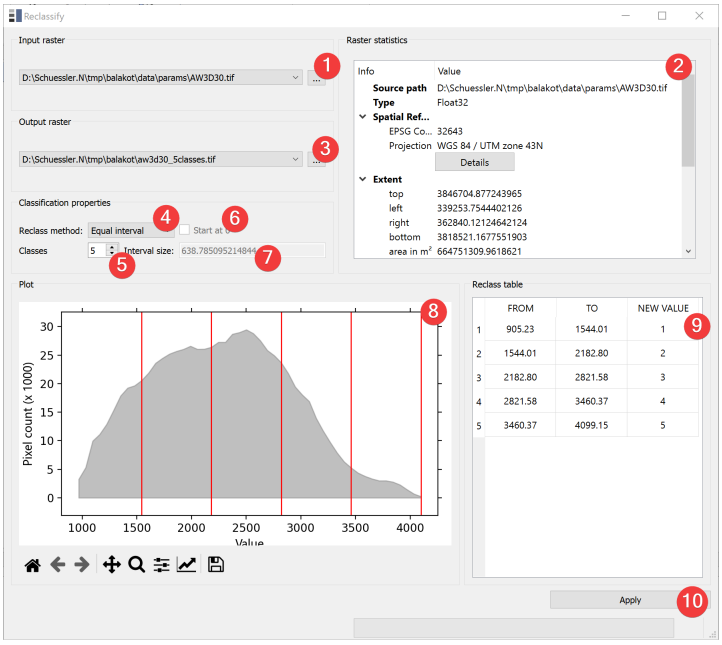


Fig. 3.20: Reclassify Widget

The reclassify widget reclassifies raster datasets.

Usage

1. Select the input raster. You can either select from imported rasters using the Input combo box or select one from your PC (1).
2. Select the output location of the reclassified raster. You can either type in the absolute file path yourself or pick one with a dialog (3).
3. Select a *reclass method* (4).
4. Set the related classification properties (5, 6, 7, 8).
5. Start the reclassification (10).

If you want to use the created reclassified raster in your LSAT Project you need to import it using the *Import Raster Widget*.

The Plot (8) and the reclass table (9) preview the output raster. The gray area in the Plot show the distribution of the input rasters values. The red lines indicate the boundaries of the new values.

If the input raster is of type float it will be displayed as a gray area. If it is an integer raster there will be bars in the plot (8) instead.

The raster statistic (2) shows an embedded version of the *Raster Info Widget*

Reclassification methods

Equal interval:

The user defines the number of classes. The classes have the same interval.

Quantile:

The user defines the number of classes/quantiles. Each class has the same amount of raster pixels (minor deviations are possible).

Defined interval:

The user defines the interval size. Optionally the classification can start at 0.

Unique:

Each input value gets assigned a new value.

Manual:

The user defines the class boundaries. Right click into the plot to create a new border. Double click a border to remove it. Left click, drag and release to move an existing border. Automatically gets activated when the user clicks into the Plot.

Input and Output

Input	Continuous raster dataset (.tif)
Output	Discrete (Int32) raster dataset (.tif)

3.4.6 Sensitivity Reclassification

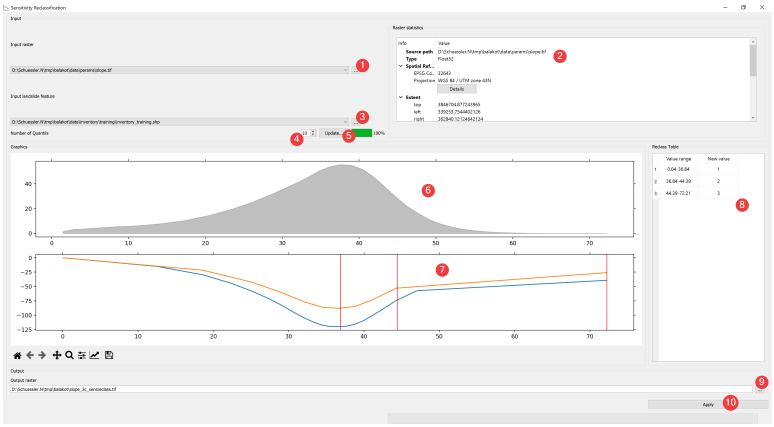


Fig. 3.21: Sensitivity Reclassification Widget

Use the cumulative variation of the contrast to reclassify a raster.

Usage

1. Select the input raster. You can either select from imported rasters using the Input raster combo box or select one from your PC (1).
2. Select the input inventory. You can either select from imported features using the Input feature combo box or select one from your PC (3).
3. Set the number of quantiles (4)
4. Update (5) the lower plot (7)
5. Set the boundaries of the new values by right clicking in (7). If needed remove boundaries by double clicking them. Move boundaries by clicking on them and move the mouse while holding the mouse button.
6. Select the output location of the reclassified raster. You can either type in the absolute file path yourself or pick one with a dialog (9).
7. Apply (10) your sensitivity reclassification to create the output raster.

You can run multiple analyses with varying number of quantiles with each analysis updating the lower plot (7).

The lower plot (7) and the reclass table (8) preview the output raster. The red lines in (7) indicate the boundaries of the new values. The upper plot (6) shows the distribution of the input rasters values.

If you want to use the created raster in your LSAT Project you need to import it using the *Import Raster Widget*.

Information

The raster statistics (2) shows an embedded version of the *Raster Info Widget*

If the input raster is of type float it will be displayed as a gray area. If it is an integer raster there will be bars in the upper plot (6) instead.

Sensitivity Reclassification uses *Weights of Evidence* to calculate the cumulative contrast for the lower plot.

3.5 Viewer

Derive rasters from DEM raster files

3.5.1 Geodata Viewer

View your projects raster datasets.

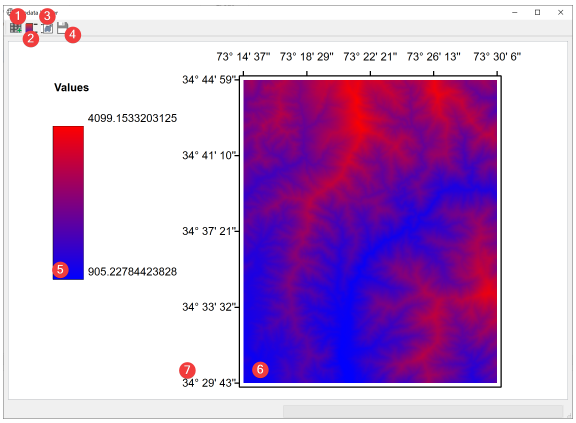


Fig. 3.22: Geodata Viewer Widget

Overview

- Click (1) to add raster datasets (6) to the view with a dialog
- Select a raster (6) in the scene and click (2) to show its legend (5)
- Add a bounding box (7) by selecting a raster (6) and clicking (3)
- Export the current view as a pic (.png) with a dialog (4)

Information

If you start the Widget from the *catalog* the selected raster will be available from the start. This widget displays coordinates in degrees (°), minutes (') and seconds ('') WGS84 (EPSG 4326).

CHAPTER

FOUR

ANALYSIS

Run analysis and manage their results.

4.1 ANALYSIS

Analyze your data

4.1.1 Analytic Hierarchy Process (AHP)

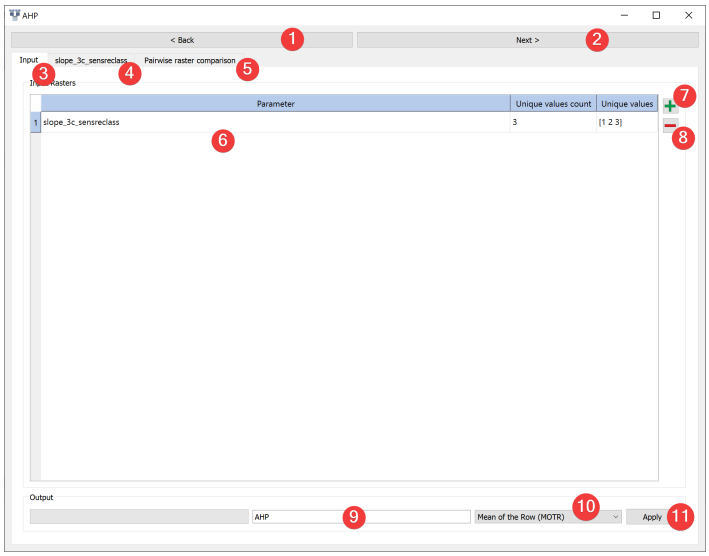


Fig. 4.1: AHP Widget - input tab

Run Analytic Hierarchy Process (AHP) analysis.

Usage

1. Add rasters to the calculation with a dialog (7)
2. Provide an name for the output files (9)
3. Select a method to derive the priority vector (10)
4. Move to the raster value comparison tab (4) or click next (2).

Remove raster datasets from the calculation by clicking (8)

Raster tabs (4):

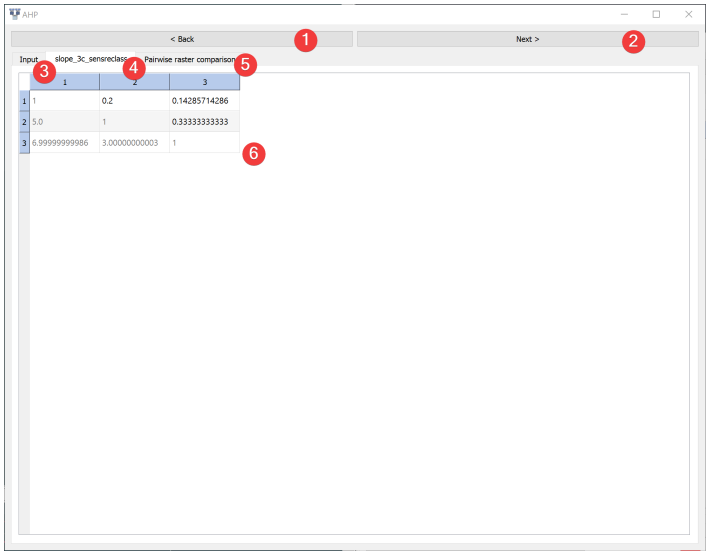


Fig. 4.2: AHP Widget - raster tab

1. Assign a *rating* to each pairwise raster value comparison (6)
2. Continue to the pairwise raster comparison tab (5)

Pairwise raster comparison tab (5):

1. Assign a *rating* to each pairwise raster comparison (6)
2. Return to the input tab and click Apply (11)

After the calculation finished you can view the *results* (2) by right clicking the output .npz in the *catalog*.

Information

Scale of preference (Saaty, 1977)

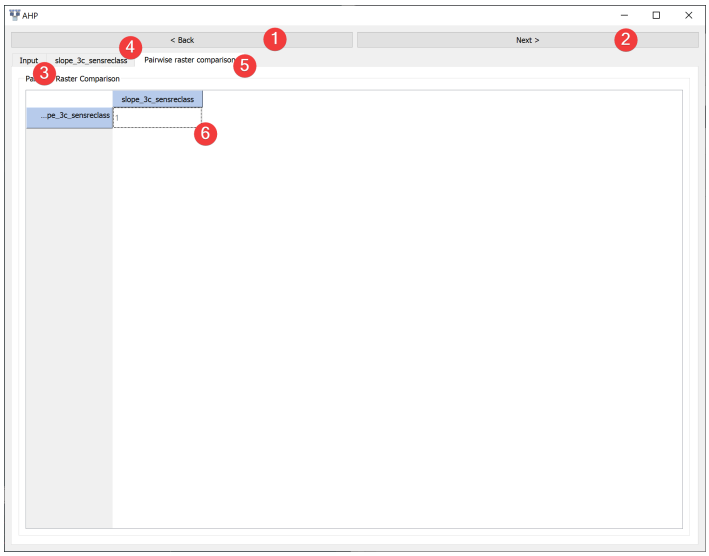


Fig. 4.3: AHP - pairwise raster comparison tab

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of over another	Experience and judgment slightly favor one over another
5	Essential or strong importance	Experience and judgment strongly favor one over another
7	Demonstrated importance	One is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	The evidence favoring one over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values	Compromises
Reciprocals	Inverse comparison	Inverse comparison

You can write number < 1 as fractions in the pairwise comparison table, e.g. "1/7" get converted to 0.14285714286.

LSAT supports AHP for raster datasets with up to 10 values. If you have a continuous raster or a raster dataset with more unique values reclassify them first with the *Sensitivity Reclassification Widget* or *Reclassify Widget*.

Input and Output

Input	Raster dataset(s) (.tif)
Output	AHP model raster dataset (.tif) Output path: /results/AHP/rasters/*output name*.tif AHP model information (.npz) Output path: /results/AHP/tables/*output name*_tab.npz

4.1.2 Artificial Neural Network (ANN)

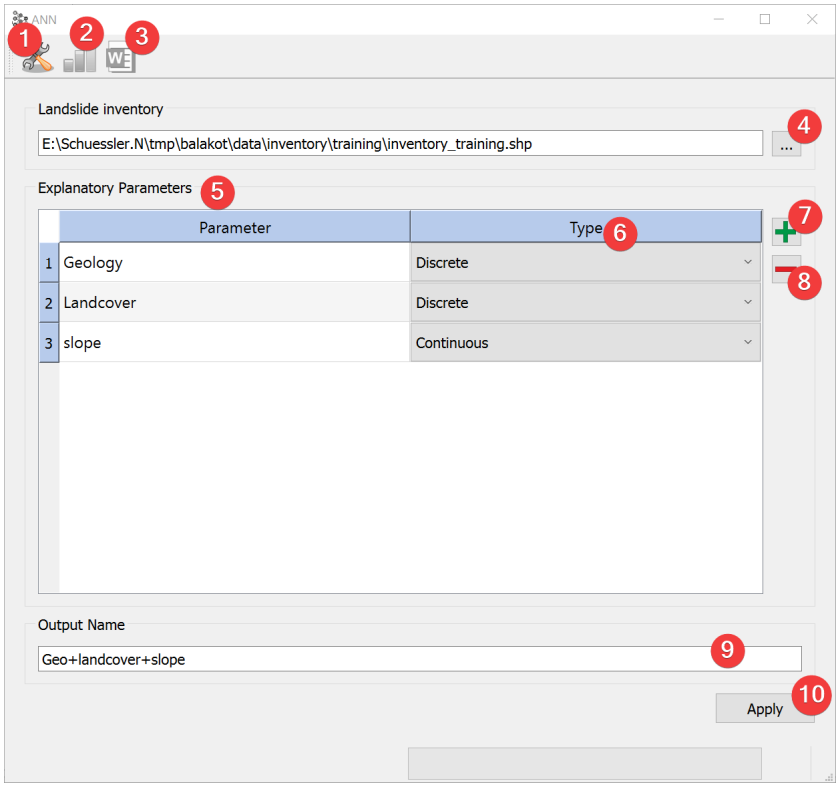


Fig. 4.4: ANN Widget

Run Artificial Neural Network (ANN) analysis.

Usage

1. Add a vector file with the landslide inventory. You can either type the absolute path to the file or select it from your PC with a dialog (4).
2. Add (7) raster datasets to the explanatory parameters (5)
3. Set the type (6) of each parameter using the combobox
4. (Optional) Adjust the calculation settings in the *advanced settings* (1)
5. Provide an output name (9)
6. Start the calculation (10)

Remove raster datasets from the calculation by clicking (8).

After the calculation finished you can view the *results* (2).

Support for automatically writing a report (3) is coming soon.

Advanced Settings

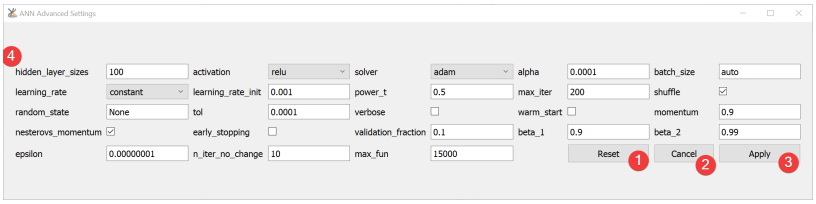


Fig. 4.5: ANN Advanced Settings Widget

To learn more about the individual parameters (4) see scikit-learns MLPClassifier documentation

After changing the values you can reset (1) them to default values or apply (3) them.

Close and cancel (2) at any time without making changes to the Settings.

Edit the defaults by changing [DEFAULT] in *LSAT Folder*/core/widgets/ANN/ann_config.ini.

Information

LSAT PM uses scikit-learns MLPClassifier to apply ANN to spatial data.

Changes made to the settings are persistent.

Input and Output

Input	Raster dataset(s) (.tif) Feature dataset (Vector file)
Output	ANN model raster dataset (.tif) Output path: /results/ANN/rasters/*output name*_ann.tif ANN model information (.npz) Output path: /results/ANN/tables/*output name*_tab.npz ANN model (.pkl) Output path: /results/ANN/tables/*output name*_model.pkl

4.1.3 Logistic Regression (LR)

Run Logistic Regression (LR) analysis.

Usage

1. Add a vector file with the landslide inventory. You can pick one from the project with the combobox or select it from your PC with a dialog (4).
2. Add (7) raster datasets to the explanatory parameters (5)
3. Set the type (6) of each parameter using the combobox
4. (Optional) Adjust the calculation settings in the *advanced settings* (1)
5. Provide an output name (9)
6. Start the calculation (11)

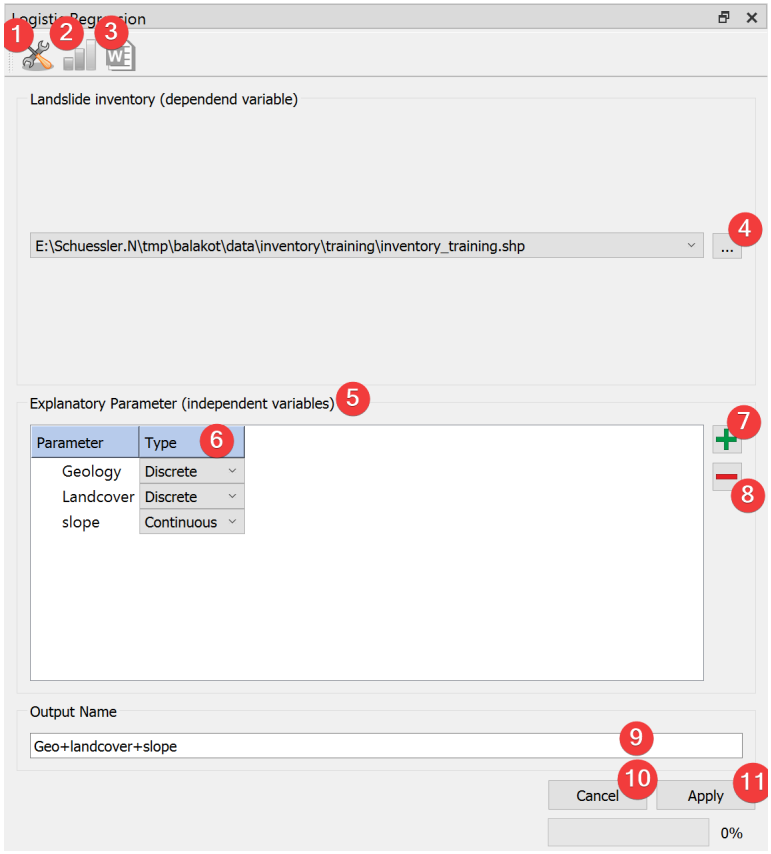


Fig. 4.6: LR Widget

Remove raster datasets from the calculation by clicking (8).

After the calculation finished you can view the *results* (2).

Support for automatically writing a report (3) is coming soon.

Advanced Settings

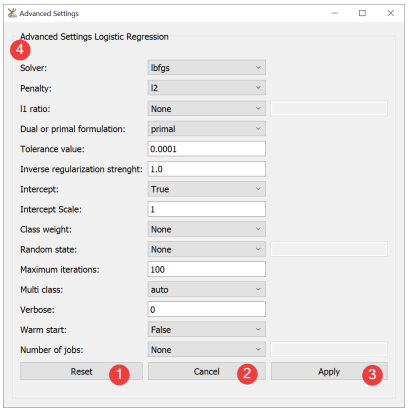


Fig. 4.7: LR Advanced Settings Widget

To learn more about the individual parameters (4) see scikit-learns LogisticRegression documentation. For a brief overview hover your mouse cursor over the parameters name.

After changing the values you can reset (1) them to defaults or apply (3) them.

Close and cancel (2) at any time without making changes to the settings.

Edit the defaults by changing [DEFAULT] in *LSAT Folder*/core/widgets/LogisticRegression/configLogReg.ini.

Information

LSAT PM uses scikit-learns LogisticRegression to apply LR to spatial data.

Changes made to the settings are persistent.

Input and Output

Input	Raster dataset(s) (.tif) Feature dataset (Vector file)
Output	LR model raster dataset (.tif) Output path: /results/LR/rasters/*output name*_lr.tif LR model information (.npz) Output path: /results/LR/tables/*output name*_tab.npz LR model (.pkl) Output path: /results/LR/tables/*output name*_model.pkl

4.1.4 Weight of Evidence (WofE)

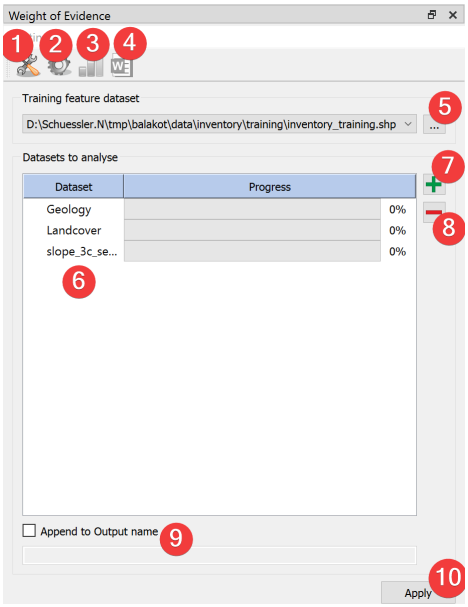


Fig. 4.8: WofE Widget

Run Weights of Evidence (WofE) analysis.

Usage

1. Add a vector file with the landslide inventory. You can pick one from the project with the combobox or select it from your PC with a dialog (5).
2. Add (7) raster datasets to the datasets to analyze (6)
3. (Optional) Adjust the calculation settings in the *advanced settings* (1)
4. (Optional) Add an appendix to the output name by checking (9) and typing it in
5. Start the calculation (10)

After the calculation finished select a dataset (6) to view the *results* (3).

Advanced Settings

Weight of Evidence uses the same Advanced Settings as *Model Builder*.

1. Choose between On-the-fly subsampling (2), predefined subsamples (3) or select neither to use single sample mode
    - On-the-fly subsampling (2)
        1. Set the size of the subsamples as percent of the import feature either by typing a number (1) or adjusting the slider.
        2. Set the number of samples to generate on-the-fly
    - Predefined subsamples (3)

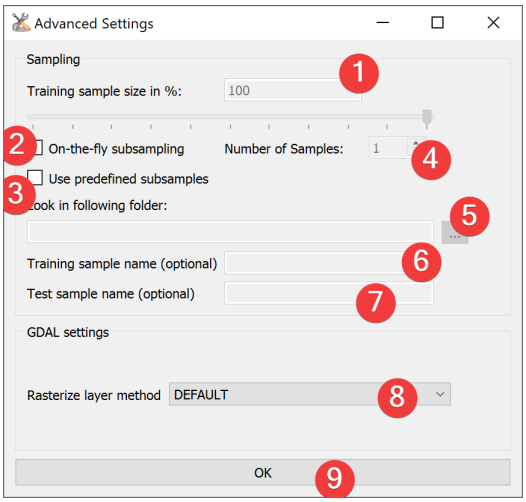


Fig. 4.9: WofE Advanced Settings Widget

1. Provide a path to the folder with the predefined subsamples. You can either type in the absolute path yourself or pick one with a dialog (5).

- Single sample mode (neither (2) nor (3) selected)

  1. By selecting neither (2) or (3) LSAT will use 100% of the feature.

2. (Optional) Change the rasterization method (8)
3. Select OK (9)

Information

The output raster dataset (.tif) contains the calculated Weights.

Only discrete raster datasets are suitable to analyze with WofE. If you have a continuous raster reclassify them first with the *Sensitivity Reclassification Widget* or *Reclassify Widget*.

Input and Output

Input	Raster dataset(s) (.tif) Feature dataset (Vector file)
Output	WofE model raster dataset (.tif) Output path: /results/WoE/rasters/*output name**appendix (if any)*_woe.tif WofE model information (.npz) Output path: /results/WoE/tables/*output name**appendix (if any)*_tab.npz

4.2 Model Managment

Manage your models

4.2.1 Model Builder

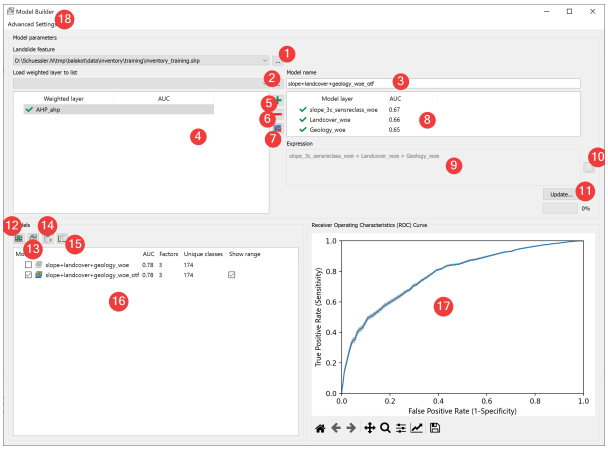


Fig. 4.10: Model Builder Widget

Create models with the results of the analyses.

Usage

1. Pick a feature dataset to use for model creation. You can either choose from the projects features or select one from your PC (1).
2. (Optional) Adjust the *advanced settings* (18)
3. (Optional) Add datasets from outside your project (2) to the available ones (4)
4. Select the datasets (4) you want to for the model and add them to the model layers (8). You can either right click on them or select them and click (5).
5. Name the model (3)
6. (Optional) Adjust the *Expression* (10)
7. Create the model (11)

To move a dataset from the model datasets (8) to the list of available datasets you can either right click it or select it and click (6).

To remove a dataset from the list of available datasets (4) select it and press (7).

After LSAT finished creating the model it appear in the list of models (16). Select it to:

- Export the model as an raster (12)
- View detailed *model information* (13)
- Delete the model (14)
- Open the model in the *Zoning Widget* (15)

The receiver operating characteristics (ROC) Curve is displayed in (17). If you generated a model using multiple samples a range will indicate the minimum and maximum ROC curves.

Advanced Settings

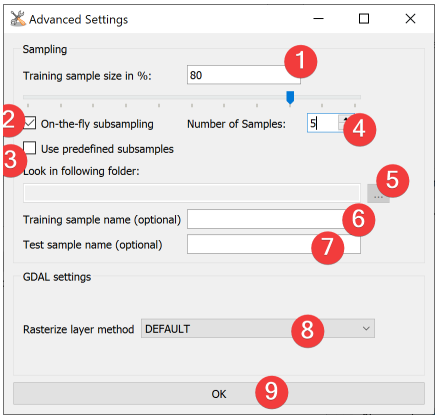


Fig. 4.11: Model Builder Advanced Settings

Model Builder uses the same Advanced Settings as *Weights of Evidence*.

1. Choose between On-the-fly subsampling (2), predefined subsamples (3) or select neither to use single sample mode
   - On-the-fly subsampling (2)
     1. Set the size of the subsamples as percent of the import feature either by typing a number (1) or adjusting the slider.
     2. Set the number of samples to generate on-the-fly
   - Predefined subsamples (3)
     1. Provide a path to the folder with the predefined subsamples. You can either type in the absolute path yourself or pick one with a dialog (5).
   - Single sample mode (neither (2) nor (3) selected)
     1. By selecting neither (2) or (3) LSAT will use 100% of the feature.
2. (Optional) Change the rasterization method (8)
3. Select OK (9)

Expression Builder

With the expression builder you can modify and weigh input parameters. And so convert the normally entirely data-driven models into hybrid models.

The default expression (4) does not modify the output in any way.

You can write any expression (4). Double click on input datasets (1) and example operators (3) to add them at the cursor location in (4). You switch between example numpy operators using (2).

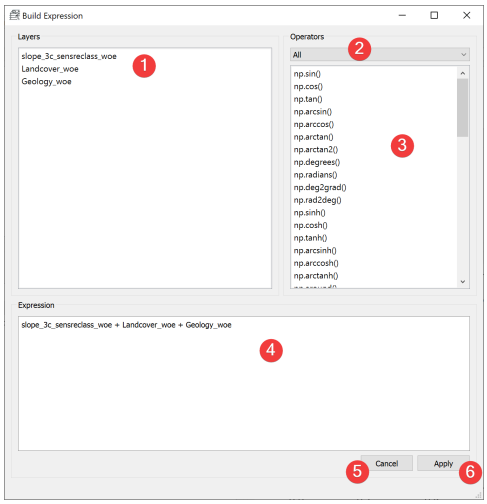


Fig. 4.12: Model Builder Expression Builder

Warning: The expressions will be executed using eval(). While this is a powerful tool it can also break LSAT.

Input and Output

Input	Vector dataset (features) Analysis results
Output	Model (.npz) Default path: /results/susceptibility_maps/*name*.npz (Optional) Model Raster (.tif) Default path: /results/susceptibility_maps/*name*.tif

4.2.2 Zoning

Convert your models into landslide susceptibility maps.

Usage

1. Pick the input model with a dialog (1)
2. Pick the output map location. You can either type in the absolute file path yourself or pick one with a dialog (2).
3. **Define the landslide susceptibility zones (2 Alternatives):**
    1. Set default table (3)
    2. **Define the zone boundaries yourself:**
        1. Add (5) and delete (6) zones as needed
        2. Name the zones in the reclass table (11)
        3. Set the "Targeted landslide area in zone %" for each zone except the last

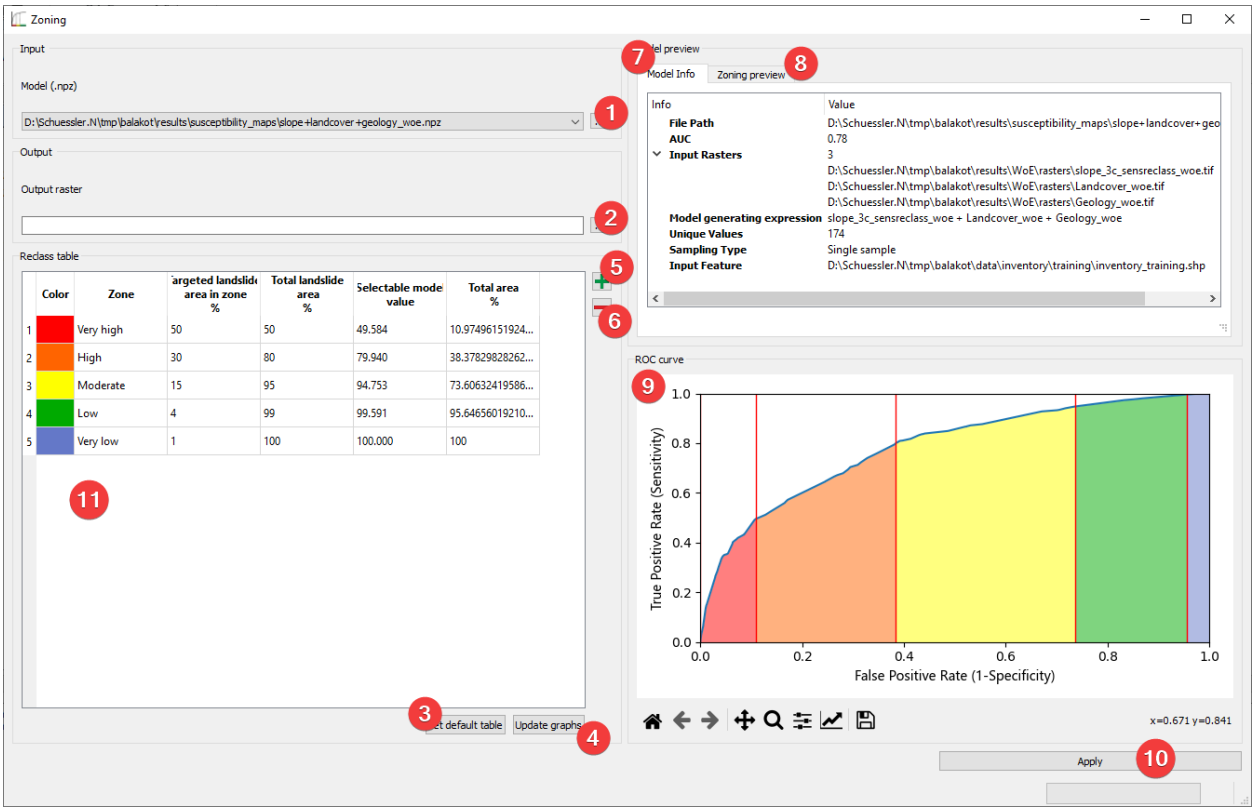


Fig. 4.13: Zoning widget

4. Update the graphs (4)
5. Apply (10)

The model info (7) shows an embedded version of the *Model Info Widget*

Zoning preview (8) and the ROC curve (9) offer a sneak peek at the resulting map.

If you started Zoning from the *Model Builder Widget* the selected Model will be available to you right away.

Information

The True Positive Rate (TPR) (y axis in (9)) corresponds roughly to the cumulative landslide area. The False Positive Rate (FPR) (x axis in (9)) corresponds approximately to the total area without landslides.

Input and Output

Input	Model (.npz)
Output	Landslide susceptibility map (.tif) Default path: /results/susceptibility_maps/*name*.tif

CHAPTER

FIVE

INDICES AND TABLES

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