CAPRA

Probabilistic Risk Assessment Platform

User Manual

Software

Landslide Tool V1.0.0

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Chapter 1

Introduction

1.1. Problem description

The CAPRA Landslide Tool is a tool developed to be used in the open free source QGIS software. This tool allows the user to obtain the safety factor against landslide considering external hazards for a terrain. The Landslide tool uses the infinite slope theory to obtain the factor of safety against landslide given the soil parameters in terms of effective stresses, the rain hazard in terms of multi-year average monthly rainfall and seismic hazard in terms of peak ground acceleration.

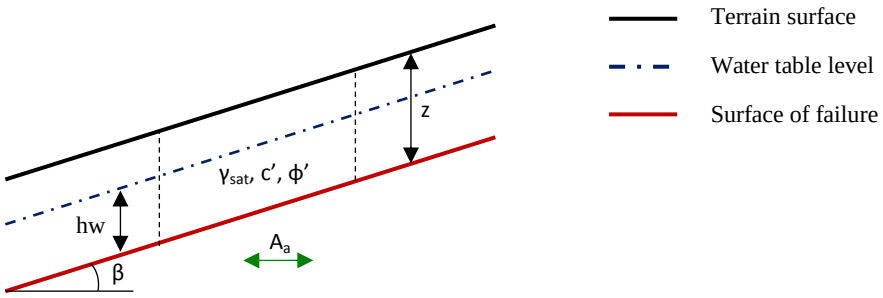


Figure 1 Infinite slope typical cross section

1.2. Theoretical framework

This tool uses the infinity slope theory to obtain the factor of safety against landslide based on a few parameters. The Eq. [1] presents the basic formula used to obtain the factor of safety against landslide based on minimum parameters.

$$SF = \frac{\frac{c'}{\gamma_{sat} * z * \cos^2\beta} + \tan\phi'\left(1 - \frac{\gamma_w * h_w}{\gamma_{sat}}\right) - A_a * \tan\phi' * tan\beta}{A_a + tan\beta} \qquad \text{Eq. [1]}$$

where:

SF := Factor of safety against landslide.

c' := effective cohesion of soil layer.

ϕ' : = effective soil angle of internal friction layer.

γ_{sat} := satured unit weight of soil layer.

z := depth of the soil layer to the potential failure surface.

h_w := Intensity for the known MDR.

γ_w := unit weight of water, *9.81 kN/m^3*.

A_a : = Peak ground acceleration.

β := terrain slope.

$$h_w = \frac{RFI - LLR}{ULR - LLR}$$

RFI := multi-year average monthly rainfall intensity.

LLR := lower limit of multi-year average monthly rainfall intensity to neglect water in the soil layer.

ULR := upper limit of multi-year average monthly rainfall intensity to consider completed saturated the soil layer.

1.3. Objectives

The principal objective of this tool is to obtain the factor of safety against landslide for a specific condition of rainfall and seismic hazard using the infinite slope methodology approach.

Chapter 2

Tool installation

2.1. Minimum installation requirements

The hardware and software requirements for the installation of this tools are specified in the following sections.

2.1.1. Minimum hardware requirements

The following are the minimum hardware requirements:

2.1.1.1 Processor and OS

- PC or compatible computer with Pentium III processor (or higher) and processor speed over 1.5 GHz.
- Operating systems: Microsoft XP or Higher.

2.1.1.2 RAM Memory

- Free hard drive capacity of 250 Mb or Higher.
- 512 Mb Extended Memory (RAM).

2.1.2. Software requirements

The following are the minimum software requirements:

- If the computer where this software is going to be installed does not have installed QGIS, please install the QGIS software. It can download from: https://qgis.org/en/site/forusers/download.html.

2.2. Installation process

The following steps must be followed for the installation of the tool:

1. Verify that all software requirements are meet before installation. Please see section 2.1.2.
2. Open QGIS software, then, go to the Add model from file in the Processing Toolbox/Models.
3. Choose the file “CAPRA_LANDSLIDE_TOOL.qgs” from the popup menu.
4. Once the installation has been completed successfully, you can visualize the tool in the Models.

If you cannot install this tool or get any error message during the installation process or when the program starts, please send an email with the description to ecapra@uniandes.edu.co.

Chapter 3

Graphical user interface

3.1. General description

This software allows the user to obtain the factor of safety against landslide for a terrain. The methodology used is presented in section 1.2.

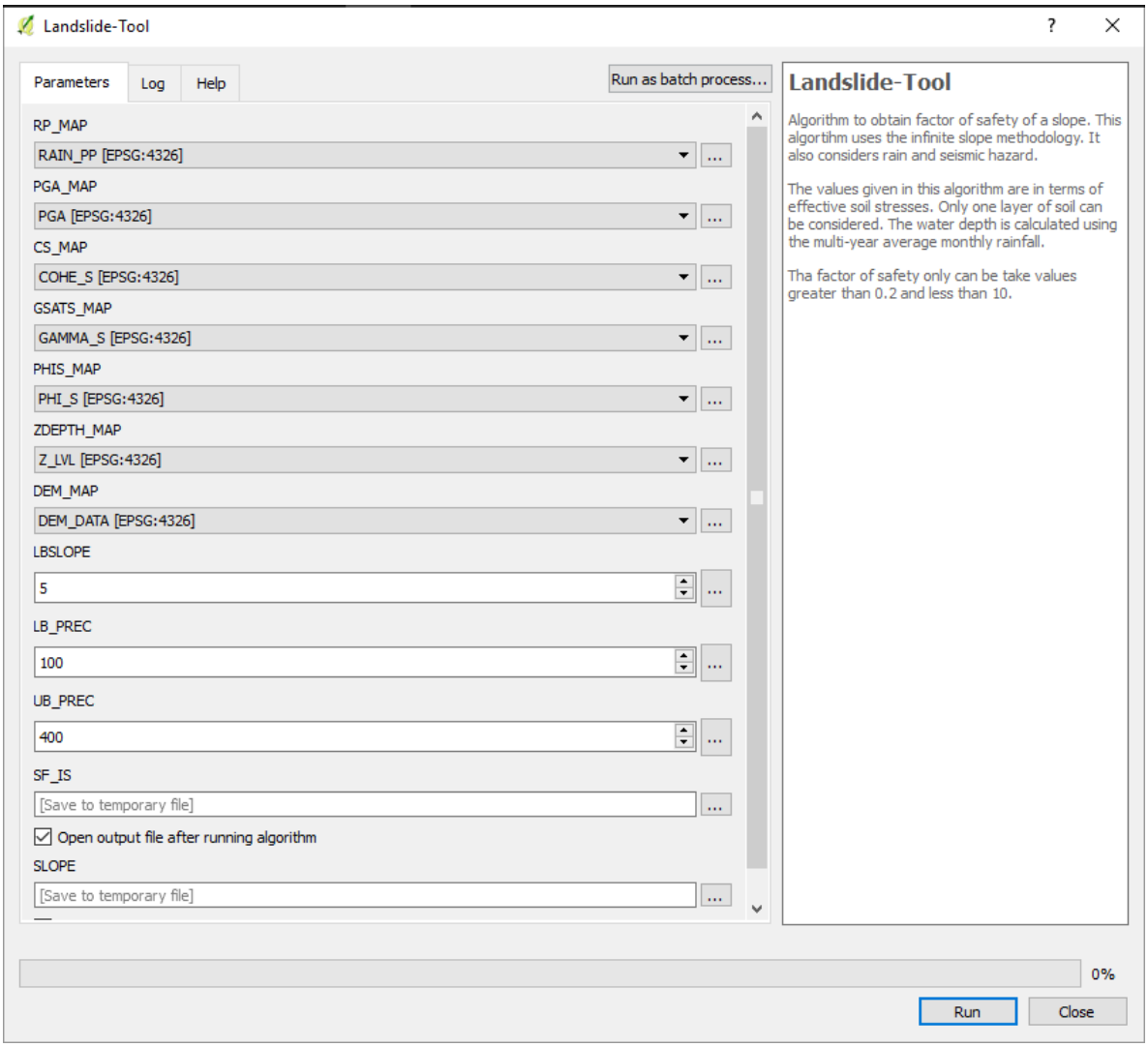


Figure 2 Graphical user interface

3.2. Input parameters setting and data type

The following table specify the input setting and data type for all parameters used by the tool. Also, some recommended values are included. All raster file shall be in projected coordinates and must have the same coordinate system.

Table 1 Input parameters

Item	Parameter	Format type	Value	Units
1	**SOIL LAYER DATA**			
1.1	CS_MAP	Raster file	-	kN/m^2
1.2	GSATS_MAP	Raster file	-	kN/m^3

Item	Parameter	Format type	Value	Units
1.3	PHIS_MAP	Raster file	-	degrees
1.4	ZDEPTH_MAP	Raster file	-	m
2	**TERRAIN MODEL**			
2.1	DEM_MAP	Raster file	-	m
2.2	LBSLOPE	Double	Values between 0 -10 Default value 5	degrees
3	**RAINFALL HAZARD**			
3.1	RP_MAP	Raster file	-	mm
3.2	LB_PREC	Double	Default value 100	
3.3	UB_PREC	Double	Default value 400	
4	**SEIMIC HAZARD**			
4.1	PGA_MAP	Raster file	-	g/g

3.3. Output parameter

The following table specify the output file and data type for all parameters used by the tool.

Table 2 Output parameters

Item	Parameter	Format type	Value	Units
1	**TERRAIN MODEL**			
1.1	SLOPE	Raster file	-	degrees
2	**FACTOR OF SAFETY**			
2.1	SF_IS	Raster file	0 to 12	-

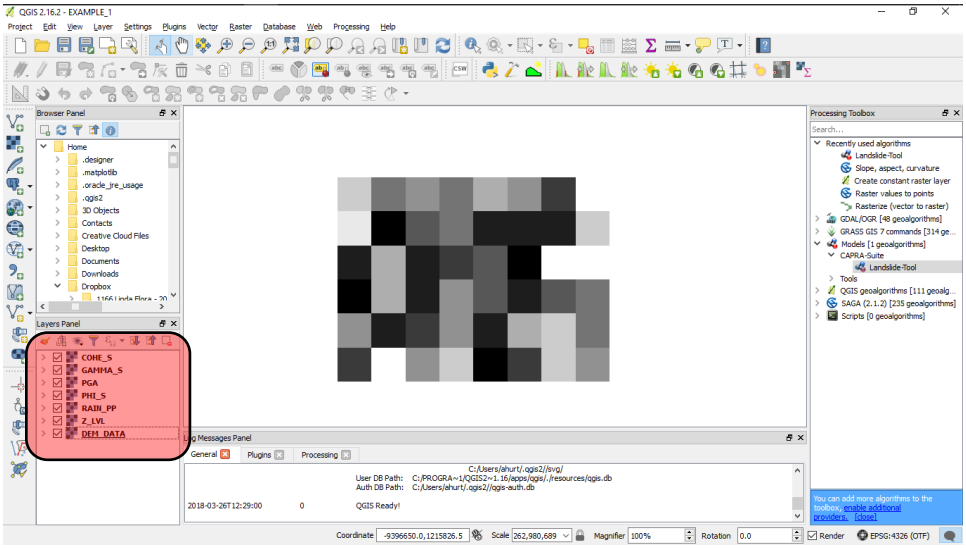
Chapter 4

Step-by-step tutorial

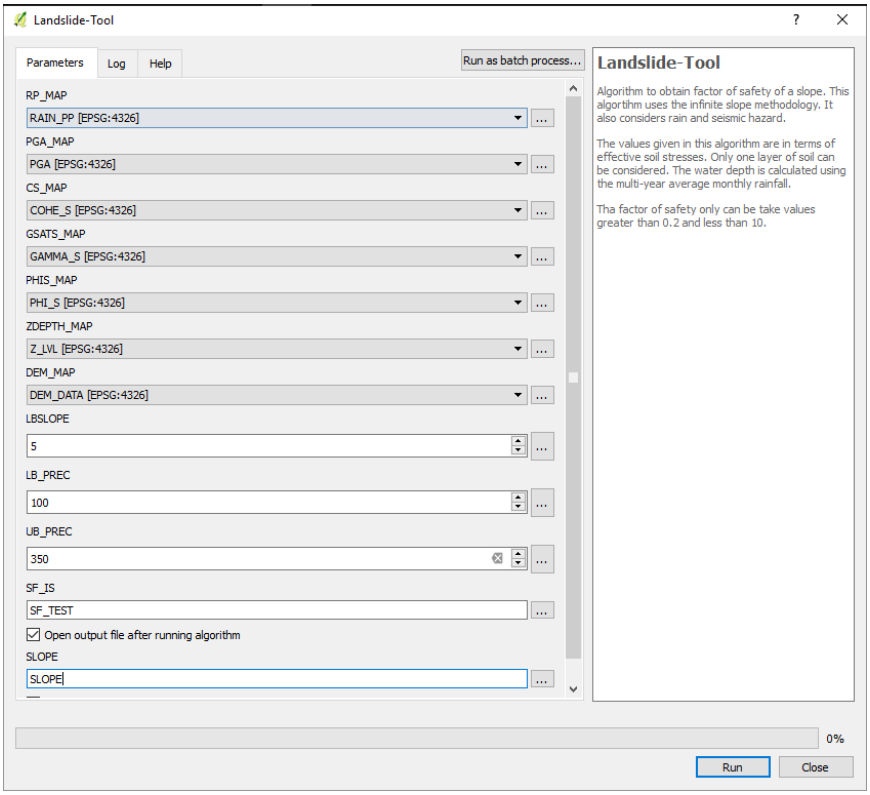
4.1. Tutorial

This tutorial shows you how to use the tool. The step you must follows are the followings:

1. Open the **QGIS** software. Wait until the program is loaded completely.
2. Load the input raster files from the **Example Folder** to QGIS. Please verify that all the files are loaded (see the figure below).



3. Go to **Processing Toolbox/Models/CAPRA-Suite/Landslide-Tool** and click on it. It will appear a new window (see figure below).



4. First you must be read the **Help Tab** to get information about the format for the input raster files. Then assign the raster files as follows:

Input field	Raster File
RP_MAP	RAIN_PP
PGA_MAP	PGA
CS_MAP	COHE_S
GSATS_MAP	GAMMA_S
PHIS_MAP	PHI_S
ZDEPTH_MAP	Z_LVL
DEM_MAP	DEM_DATA

5. After you finish to assign the raster files. Fill the next field as follows:

Input field	Value
LBSLOPE	5
LB_PREC	100
UB_PREC	350

6. Then finally assign a name to the output raster as follows:

Input field	Raster File Name
SF_IS	SF_TEST
SLOPE	SLOPE

7. After you have finished to set up all the required information, then click on **Run button**. Once the tool has finished the calculation you will get the following figure. You can also edit to add the data

8. Close the program.