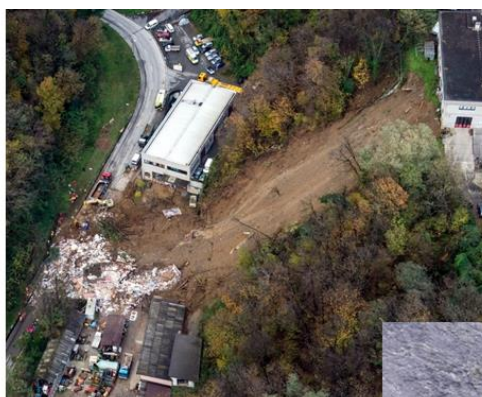


# STEP TRAMM



## STEP TRAMM

Landslide and debris  
runout simulation

# USER GUIDE



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Test example – step by step page 3

Three applications of STEP TRAMM page 14

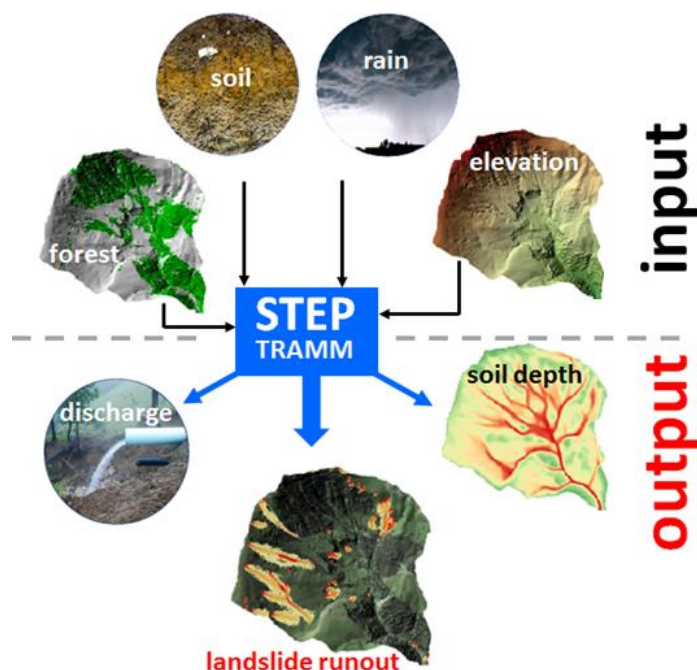
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**Copyright and disclaimer: The software is provided without warranty of any kind with respect to simulations of landslide and debris flows. Copyright belongs to STEP group.**

How to cite: Lehmann, P., J. von Rütte, and D. Or: STEP TRAMM: Landslide Triggering Model (version 2017.8). Software available at <http://www.step.ethz.ch/step-tramm.html>



# STEP TRAMM Landslide triggering software



## 1. Output of STEP TRAMM

For a specific catchment and rainfall signature, STEP TRAMM computes

- Time and location of landslides
- Debris flow run out pathway
- Soil depth map
- Surface runoff
- Damage map (fraction of broken mechanical elements denoted as “fibers”)

## 2. Contents of STEP TRAMM package

- Folder “Release” with software and executable file
- Folder “Tutorial\_Eriz” with files for test cases and rainfall events
- Folder “Documentation” with some tutorials
- “Read Me” file with user name and password
- Global rainfall data (extreme events) “CMORPHdatabase”

## 3. System requirements to run STEP TRAMM

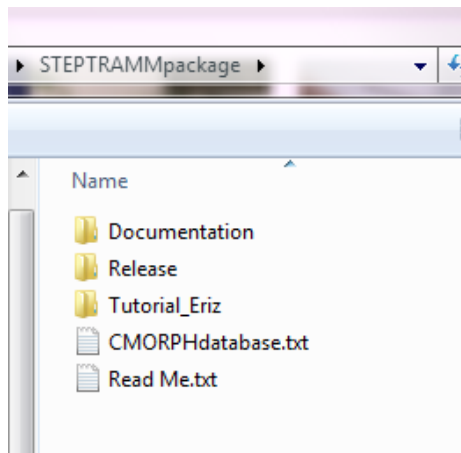
- Windows operating system
- 64-bit operating system
- $\geq 8$  GByte RAM (limiting size of simulated system)

August 2017, P. Lehmann and J. von Rütte



# Applying STEP TRAMM – **step by step**

1. Download and open (unzip) the folder “STEPTRAMMpackage”:



Documentation: Tutorials

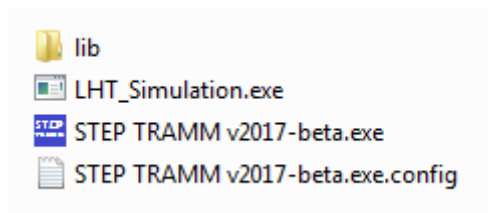
Release: Software (Graphical User Interface and executable file)

Tutorial\_Eriz: Folder with information for a test case

CMORPHdatabase.txt: Global information on rainfall events

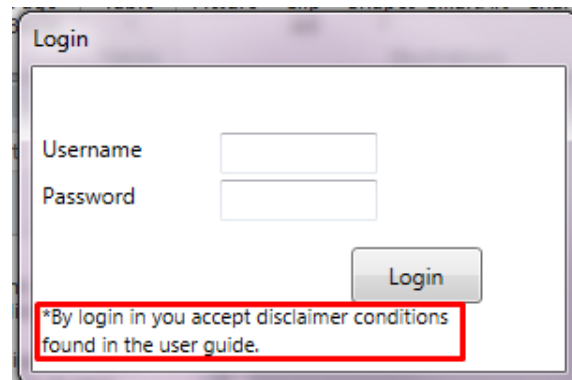
ReadMe.txt: User name and password

and open the folder “Release” containing the following items

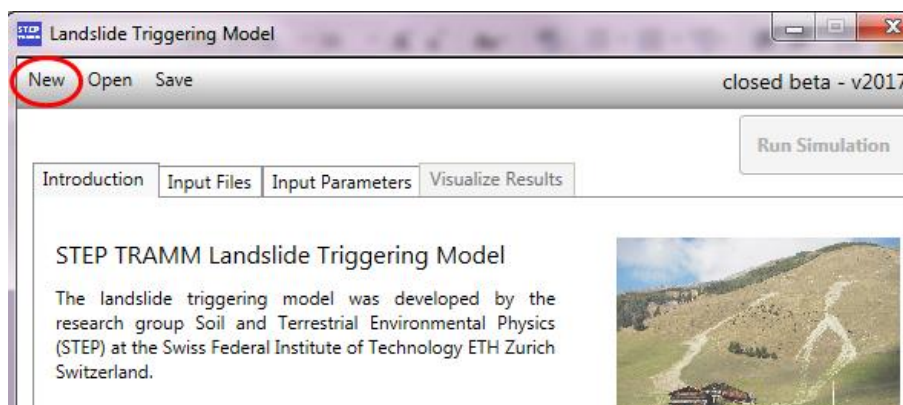


2. Double click on the executable file “STEP TRAMM v2017-beta.exe”, write your username and password in the opening window and click on “Login” button

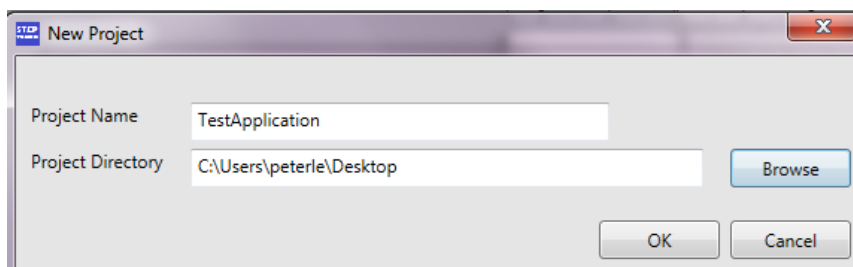
**Disclaimer:** The software is provided without warranty of any kind with respect to simulations of landslide and debris flows. It is a scientific tool under development to be tested for various applications.



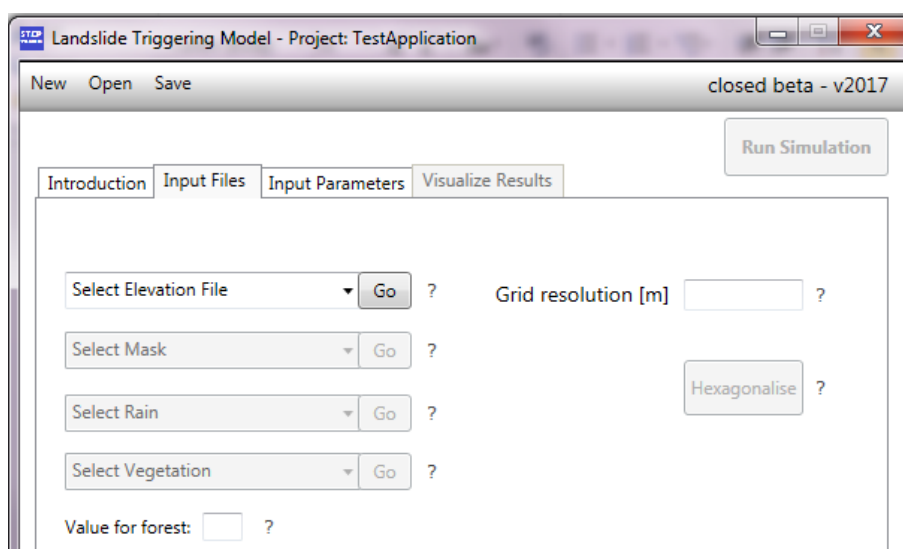
3. In the opening window choose “New” to make a new simulation project.



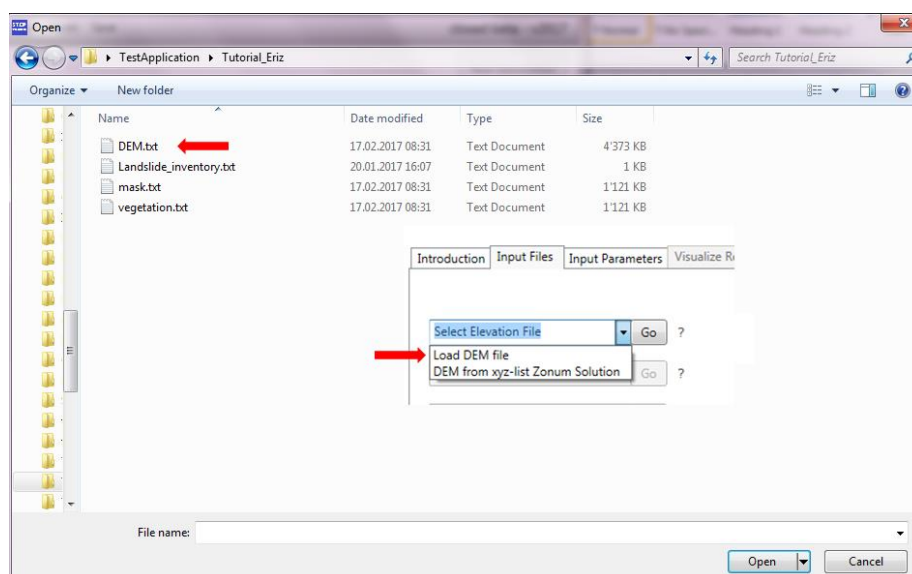
4. In the new window choose name and directory of the project (attention: file path not longer than 100 characters)



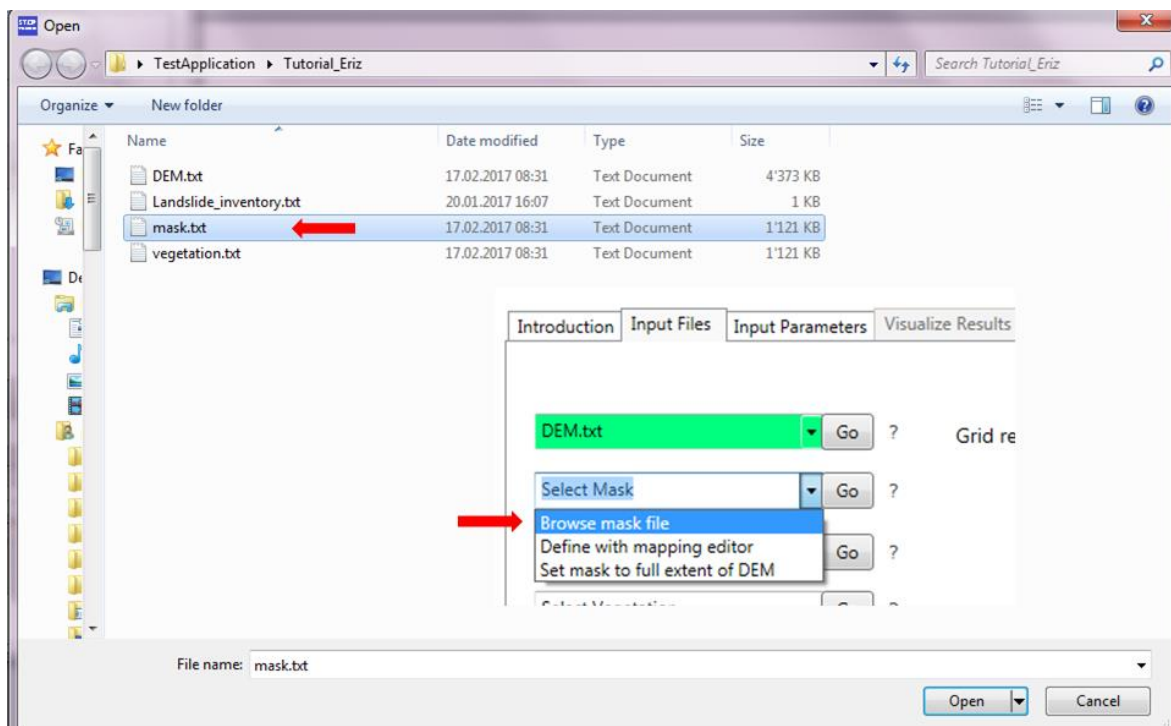
5. Now you must provide information on elevation, land cover, area of interest and vegetation. We do it here with an example we provide in the folder “Tutorial\_Eriz” that belongs to the package (you may place the folder in the actual project - here called “TestApplication”).



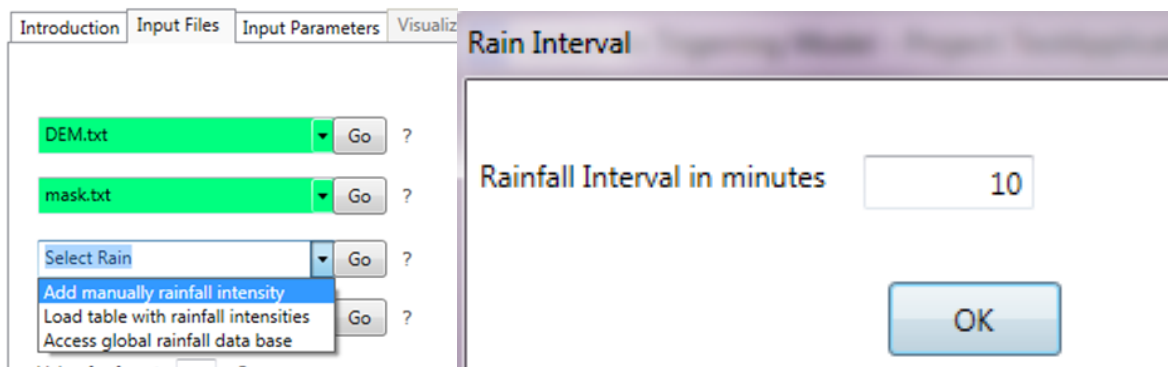
6. Next to the box “Select Elevation File” click on black arrow and choose “Load DEM file”, click “Go”, browse the file “DEM.txt” from the folder “Tutorial\_Eriz” and click on “Open”



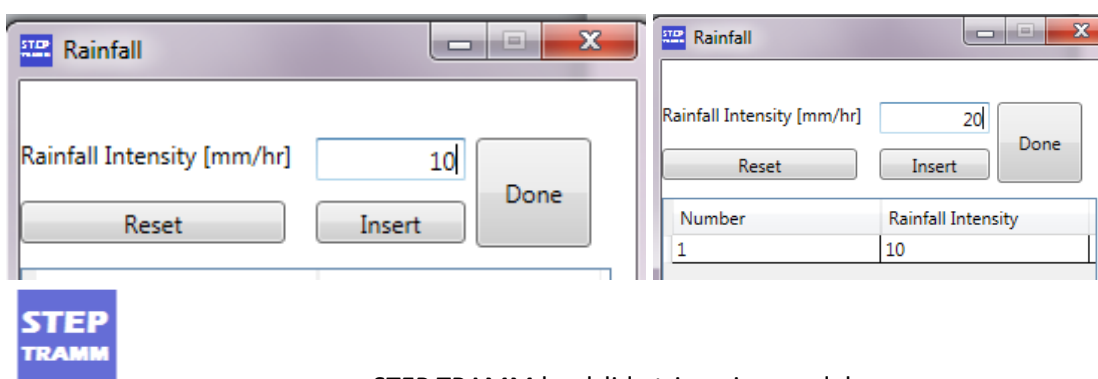
7. Next click on arrow head next to “Select Mask” to define region of interest and choose “Browse mask file” and browse the file “mask.txt” and click “Open”. Note: Only for windows 7 the chosen files are colored green (see “DEM.txt” below)



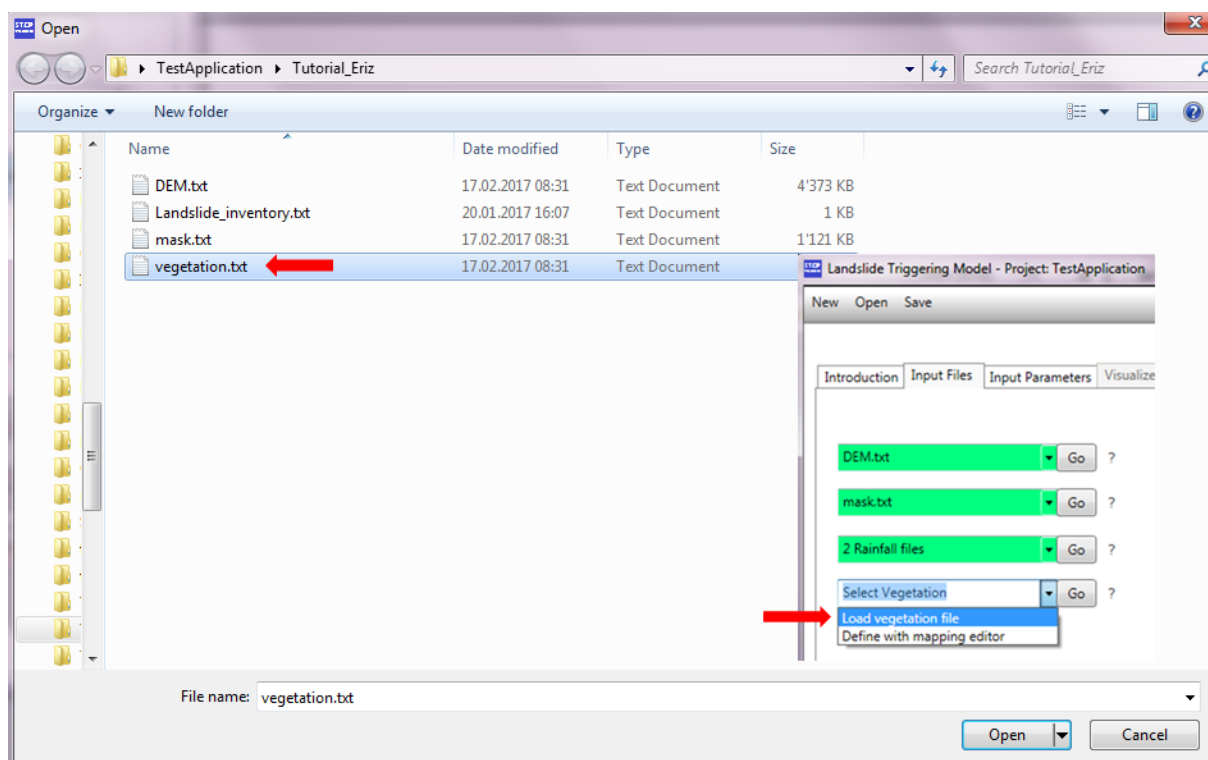
8. Define rainfall event by clicking on black arrow head next to “Select Rain”, click on “Add manually rainfall intensity” and click on “Go”; in the new window write “10” to define that the rainfall is specified in steps of 10 minutes; click “Ok”



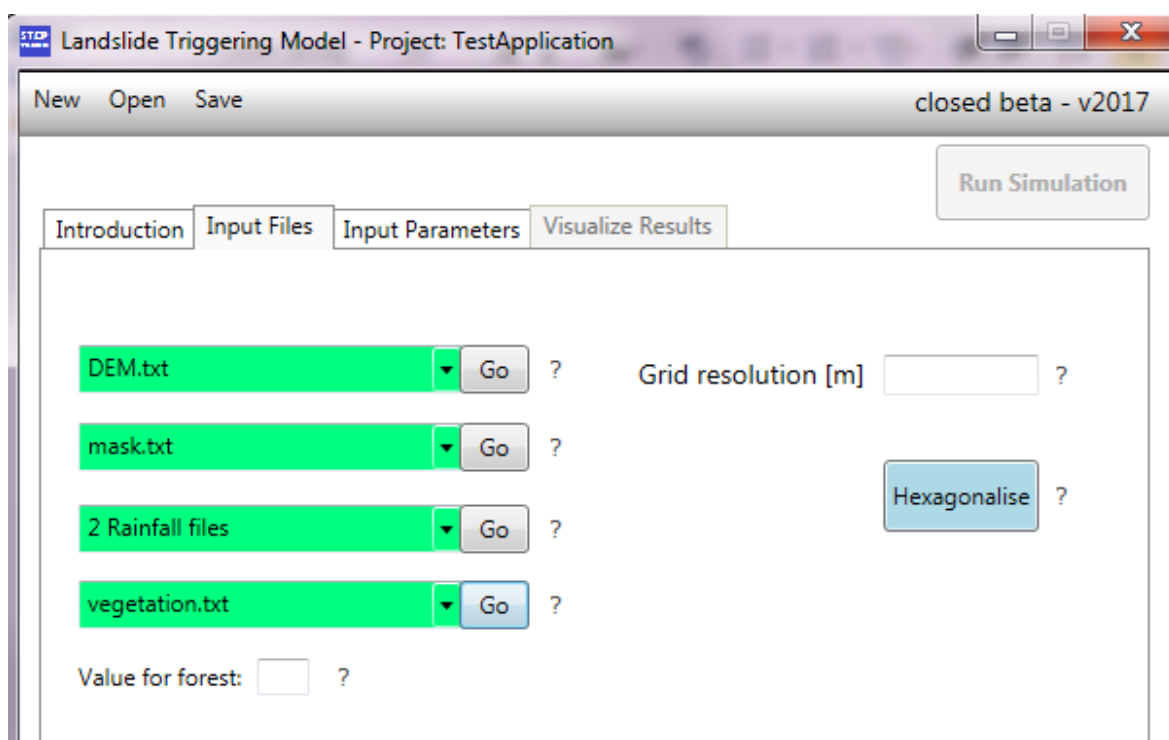
9. In the new window write “10” for intensity of 10 mm per hour, click “insert”; then write “20” for intensity of 20 mm/hour for the period between 10 and 20 minutes, then click “Insert” and “Done”.



10. Then in “Input Files” window click on black arrow head next to “Select Vegetation”, choose “Load vegetation file” and click on “Go” and browse file “vegetation.txt” and click “Open”.



11. Now the file names listed in the “Input files” window should look as follows (note: green color for Windows 7 only).





**Note:** Usually STEP TRAMM (i) computes the soil depth and (ii) uses one soil type (soil textural class) for the study area. **For advanced users it is possible to prepare an own soil depth map and maps of silt, sand and clay fraction** (all these maps must have the same header and spatial resolution as the other input files). If you want to test these options you must click on corresponding boxes. As a special case, you may also create a “Soil Type Map” (option: “Select Soiltype Map”) assigning to each grid cell a number based on the following rule:

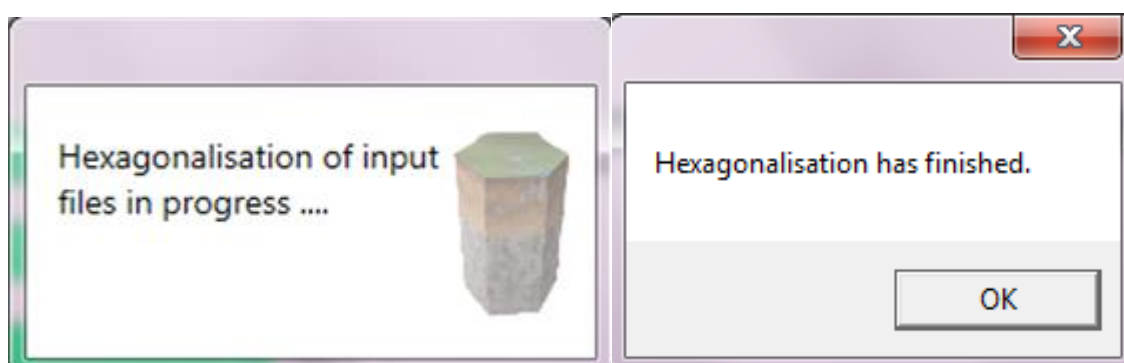
Sand (0.0), Loamy sand (1.0), Sandy loam (2.0), Loam (3.0), Silt loam (4.0), Silt (5.0), Sandy clay loam (6.0), Clay loam (7.0), Silty clay loam (8.0), Sandy clay (9.0), Silty clay (10.0), Clay (11.0)

Optional input data:

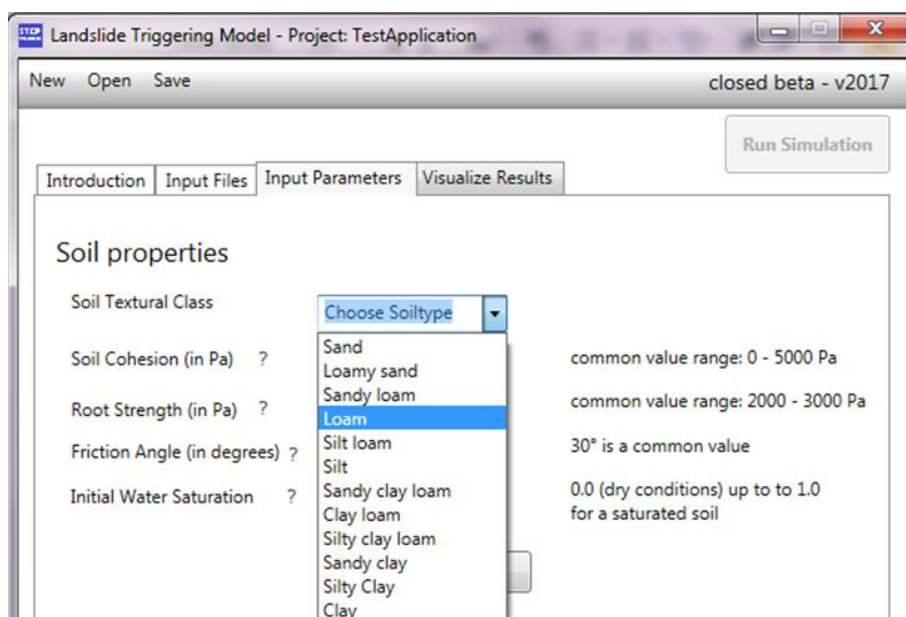
**12.** Type in value “1” as “Value for forest” and “5.0” as value for grid resolution, then click on “Hexagonalise” button (now the model computes soil depth and generates soil columns of hexagonal cross-section); a “progress window” will appear, stating that hexagonalisation is in progress; wait until another window appears stating “Hexagonalisation has finished”.

**Very important: You cannot change “Grid resolution” any more after hexagonalisation !**

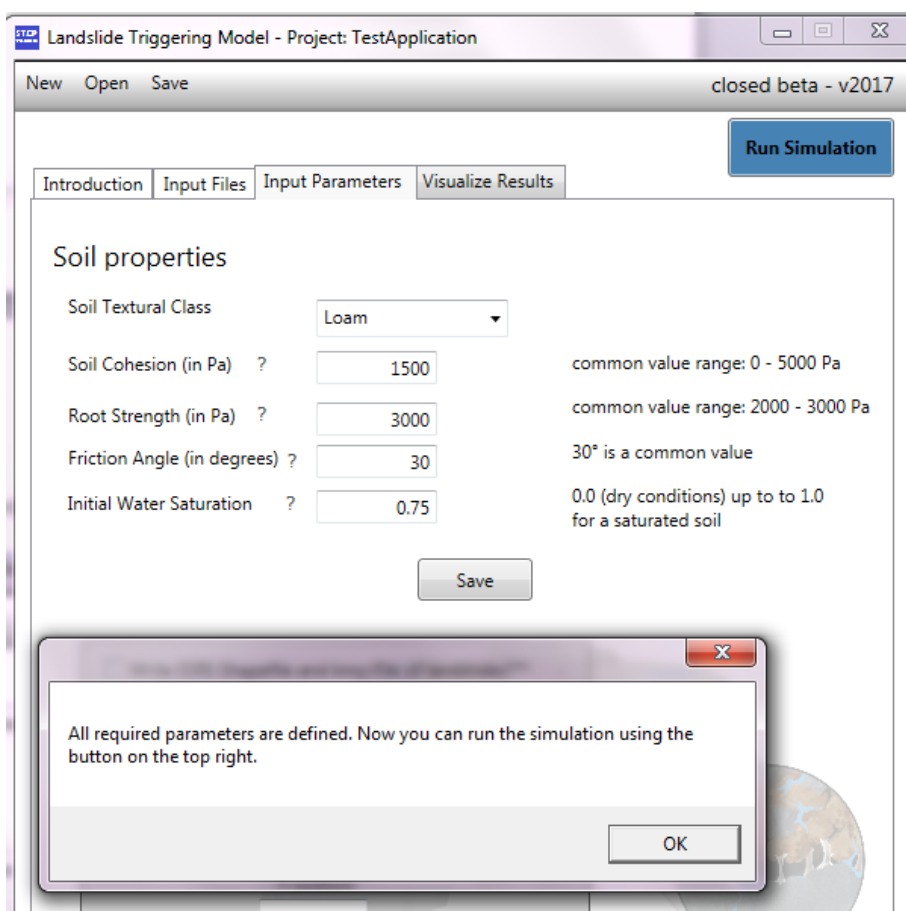
Note: As a rule of thumb with respect to memory allocation, for a catchment of area “AREA” in square kilometers, the “Grid Resolution [m]” should not be smaller than the  $\sqrt{20 \text{ AREA} / \text{RAM}}$  with RAM as Random Access Memory of the computer in GByte.



**13.** Now the “Input Parameters” window opens; click on the black arrow next to “Choose Soiltype” and choose “Loam”

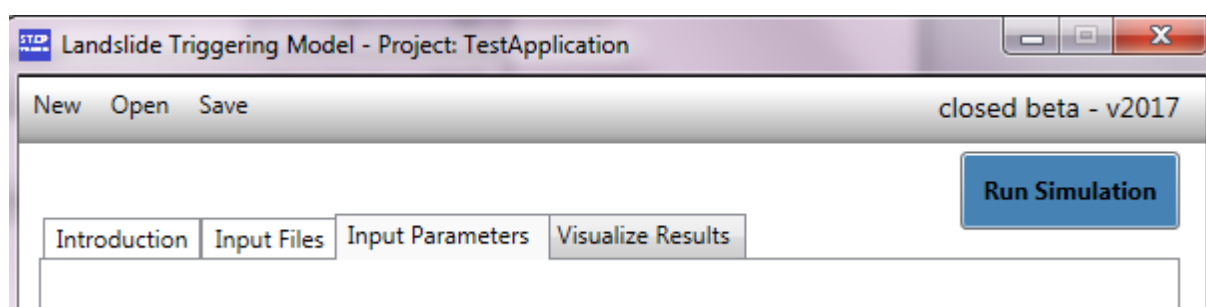


**14.** Type in the information shown below in the other boxes, click “Save” to see a message in a new window stating that all input information is provided.

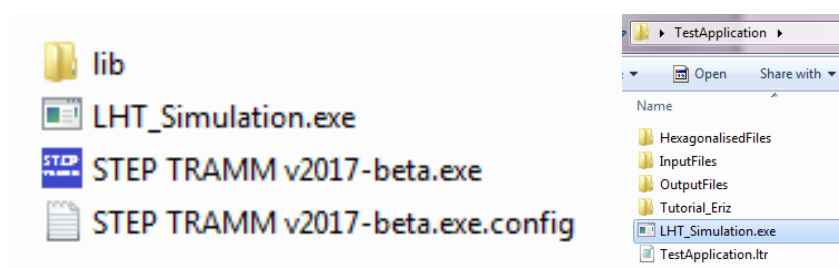




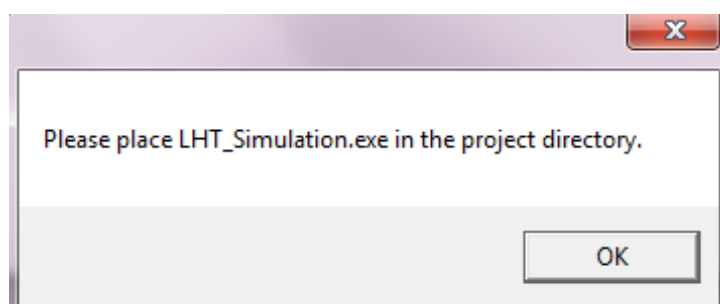
15. Click “OK” and then the “Run Simulation” button is colored



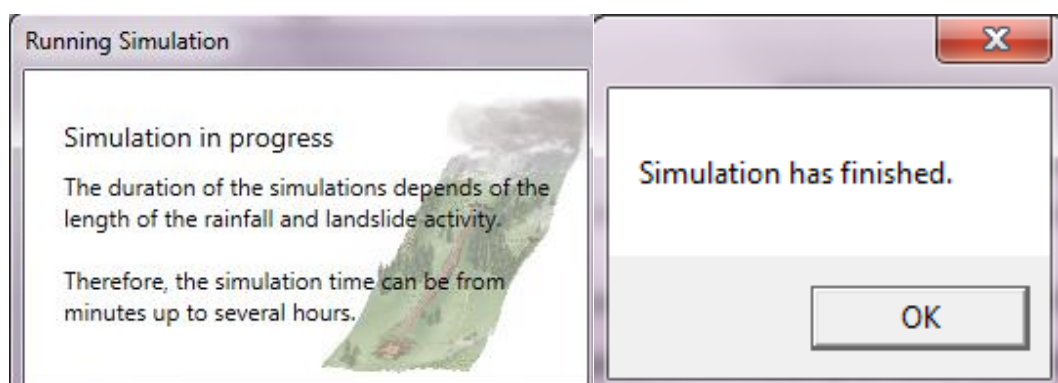
16. Attention: Copy the file “LHT\_Simulation.exe” that is contained in the “STEPTRAMMpackage” in the “Release” folder and place it into the project folder (in this example denoted as “TestApplication”);



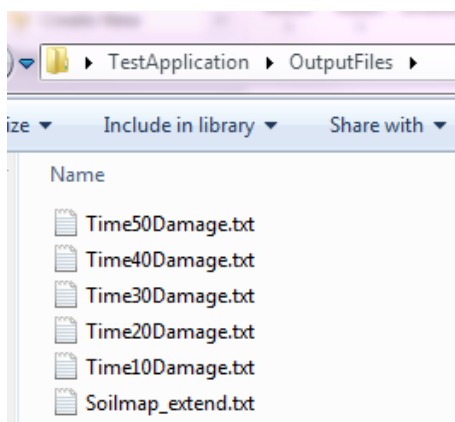
otherwise you will obtain the following message after clicking on “Run Simulation” button:



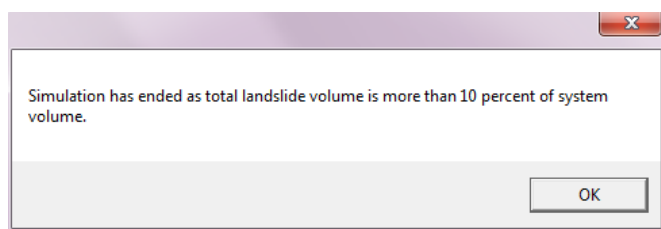
17. Click on “Run Simulation” button; a window will appear to inform you that simulation is running “Simulation in Progress” (the project cannot be changed now) and eventually a new window opens to state that simulation is done.



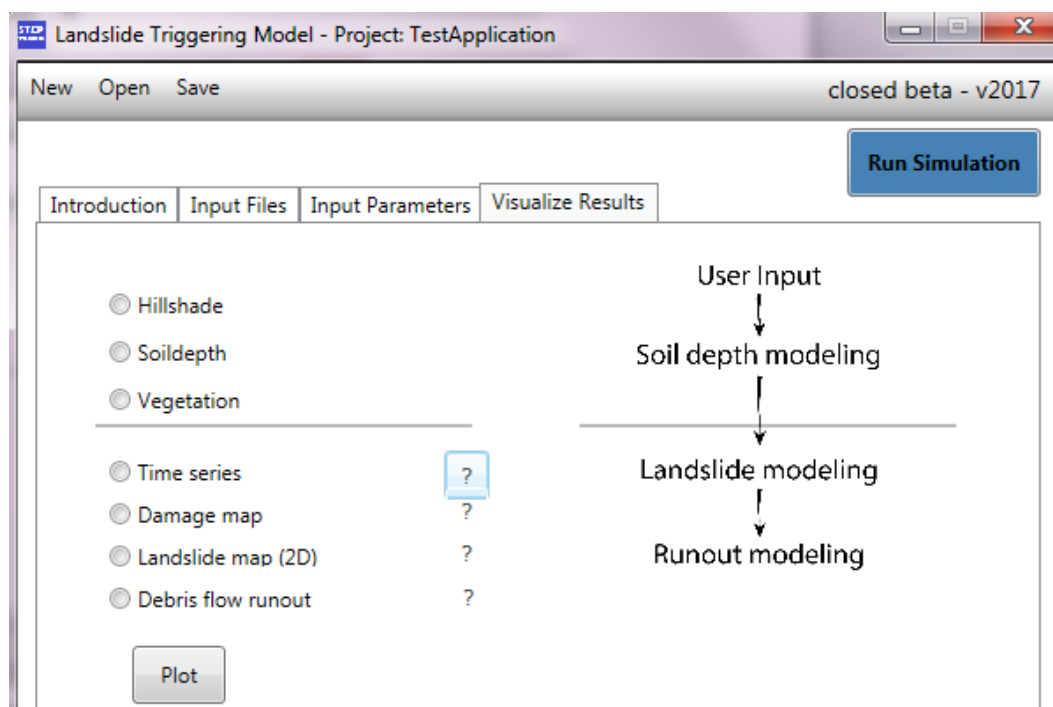
**18. Note A:** The simulation may take several minutes or hours depending on the size of the catchment and the duration of the simulated event. To check intermediate progress, you can find in the “OutputFiles” folder text files that are written if a manifold of 10% of simulation time is over (the written file “Time50Damage.txt” means that 50% of time are simulated).



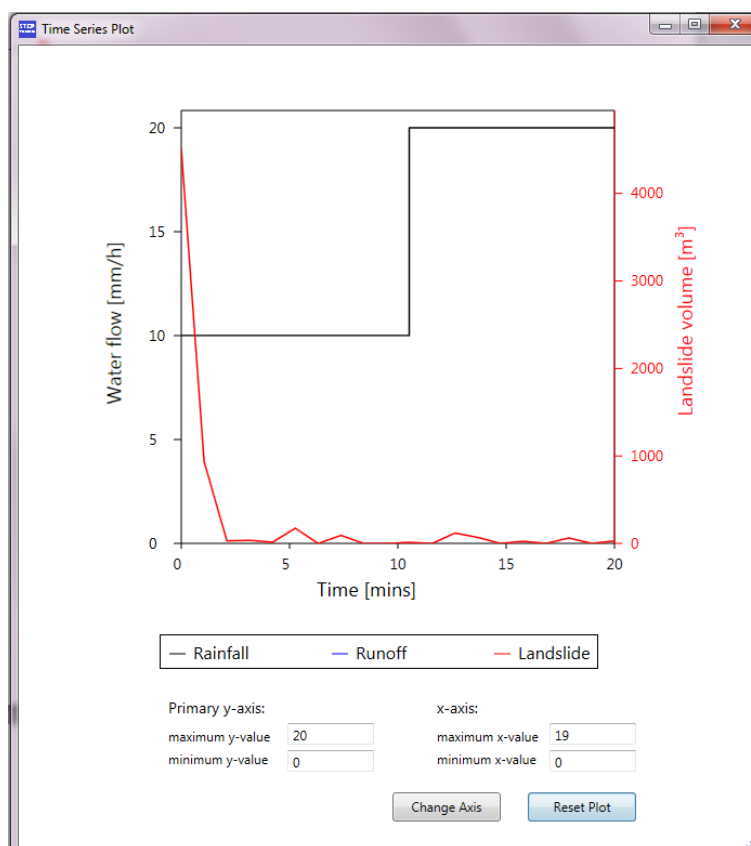
**19. Note B:** You may simulate a case where more than 10% of the landscape fails and the simulation then stops without generating output.



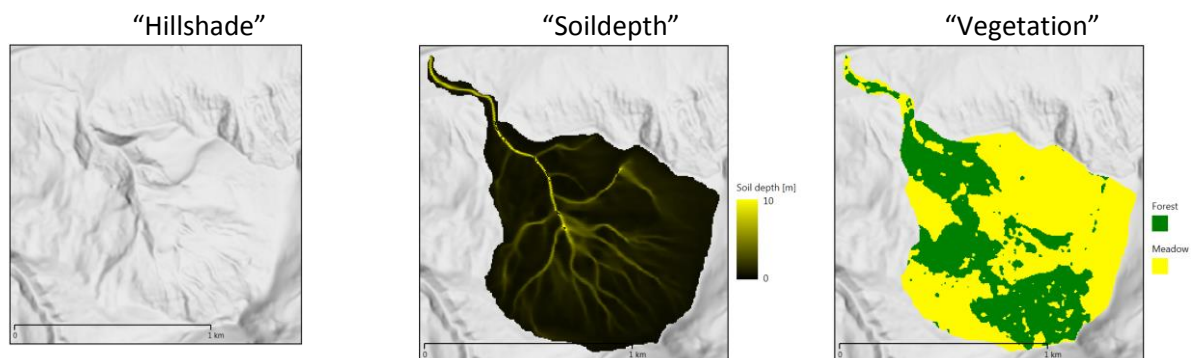
**20.** Now the output can be visualized on page “Visualize Results”. Click on the radio button to choose the result you want to see and then click on “Show map”.



**21.** To see rainfall, runoff and released mass click on “Time series” You can choose the range of values for each axis (values below 0.1 mm/h cannot be plotted).

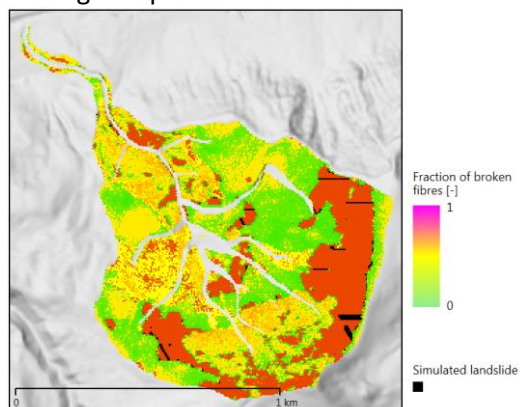


**22.** Some basic characterization of the catchment are shown next

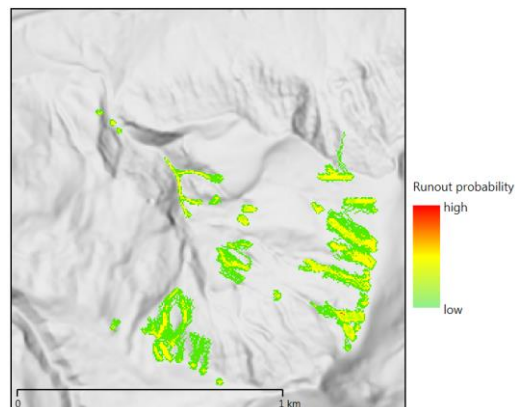


**23.** Map of damage (local failures expressed by broken internal mechanical elements denoted as fibers; released mass in black) and “Debris flow runout”

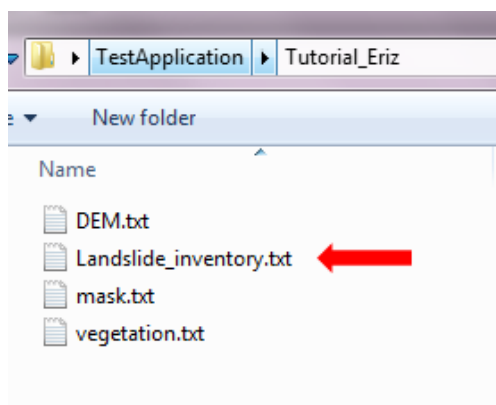
Damage map



Debris flow simulation

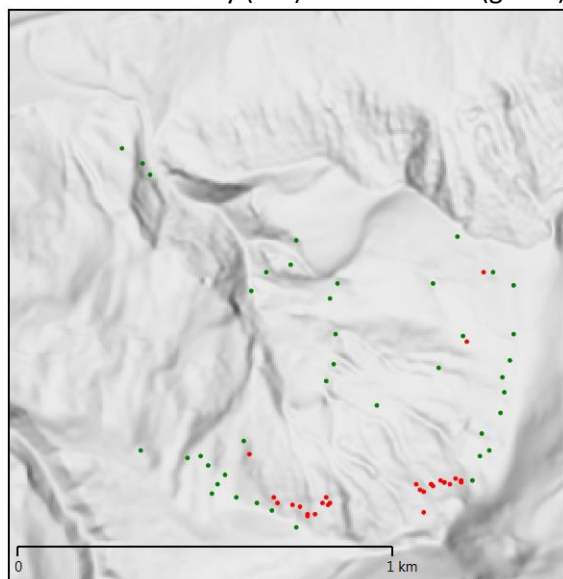


**24.** If you have inventory information on position of landslides, click on “Landslide inventory vs. Simulation”, select file “Landslide\_inventory.txt” in folder “UserFiles” and click “open”:

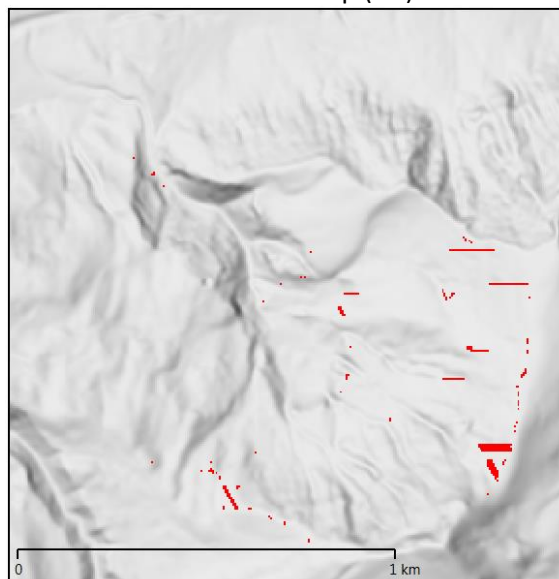


**25.** The results are shown below; next to the comparison to the inventory you see the picture that is obtained when you click on “Landslide map (2D)”

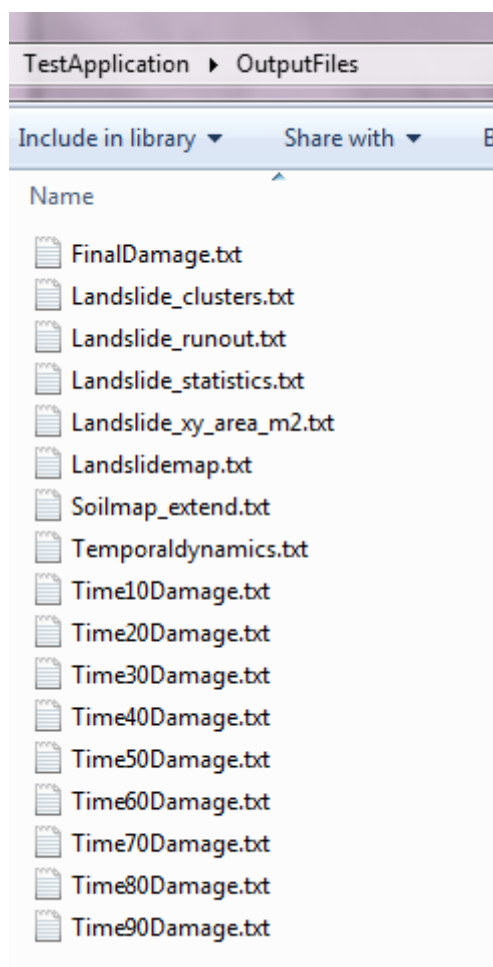
Landslide inventory (red) vs. simulation (green)



Landslide map (2D)

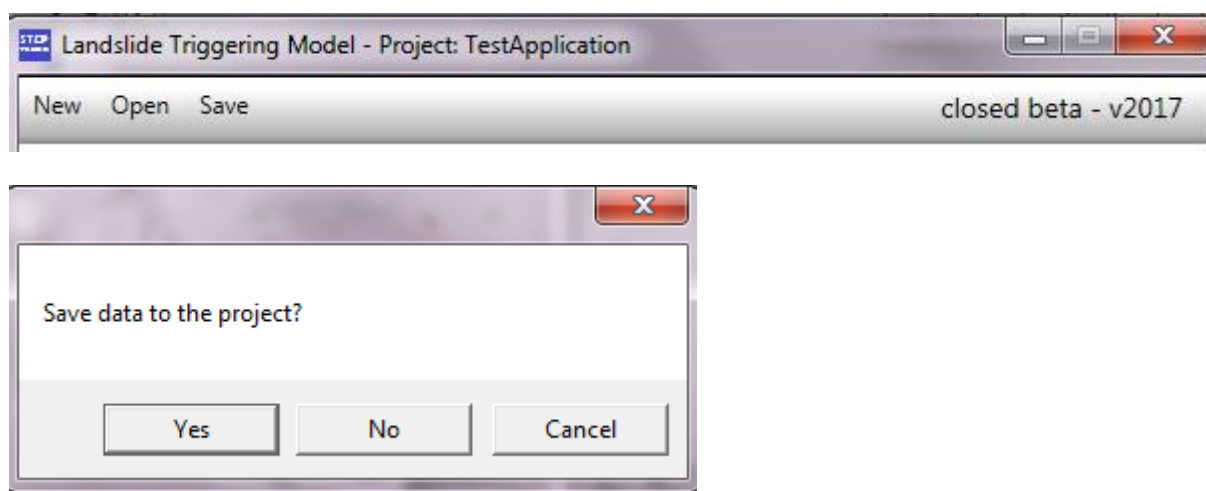


**26.** In addition to the graphical presentation the results are saved as text file in folder “OutputFiles”



- Files “Time%Damage.txt” contain a sentence stating the landslide volume after a certain fraction of simulation time
- “FinalDamage.txt” is a list for each soil column with coordinates and defining the fraction of broken fibers and the water content
- “Landslide\_clusters.txt” is a map with a positive integer for each landslide cluster
- “Landslide\_runout.txt” is a map with the probability of debris flow passage
- “Landslide\_statistics.txt” lists coordinates and characteristics of each landslide
- “Landslide\_xy\_area\_m2.txt” lists coordinates and areas of each landslide
- “Landslidemap.txt” lists the coordinates, depth and triggering time (in minutes) of each soil column
- “Soilmap\_extend.txt” lists some properties of each soil column (including simulated soil depth)
- “Temporaldynamics.txt” is a list of rainfall, river discharge and landslide volume as a function of time

**27** To save the project at the end of a simulation, click on “Save” and confirm “Yes” in the new window that appears.



# Three main applications of STEP TRAMM

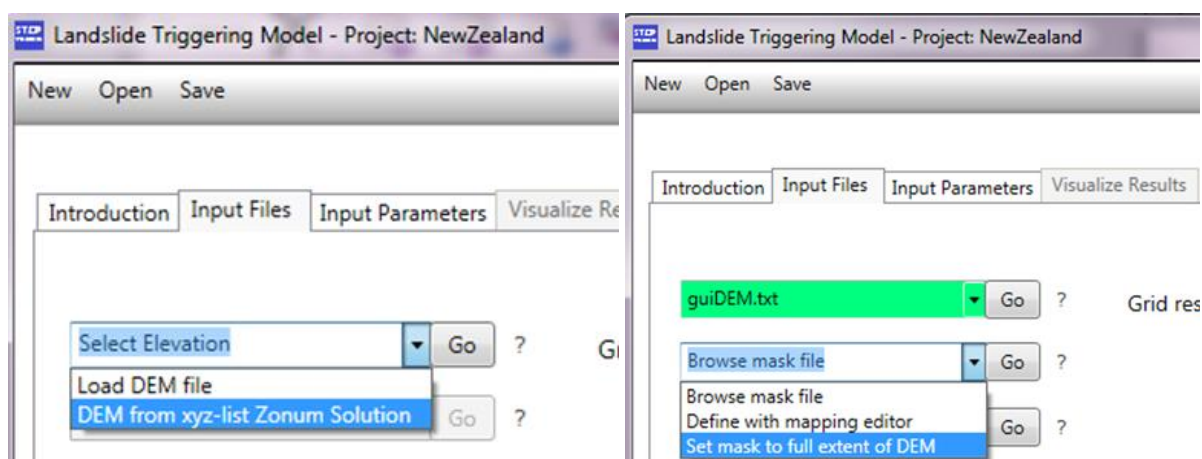
We differentiate between three types of applications of the model depending on the required (or available) information and the intention of the user.

## A) Quick test (minimum information required)

To make first estimates of landslide risks and to delineate vulnerable regions, the user may be interested to “load” the catchment with water and to see where it fails.

- The fastest way to do so is by downloading elevation information directly from the web (see file “Zonum\_tutorial.pdf”); the user has then a list of coordinates that can be read by STEP TRAMM

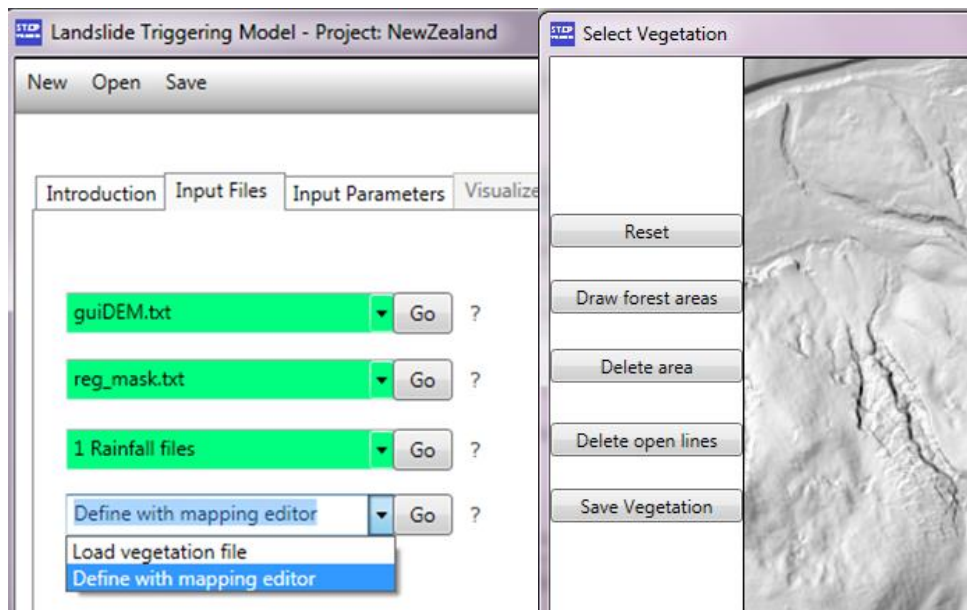
1) In box “Select Elevation file” choose “DEM from xyz-list Zonum solution”. You do not bother to define a region of interest and choose in “Select Mask” the option “Set mask to full extent of DEM”



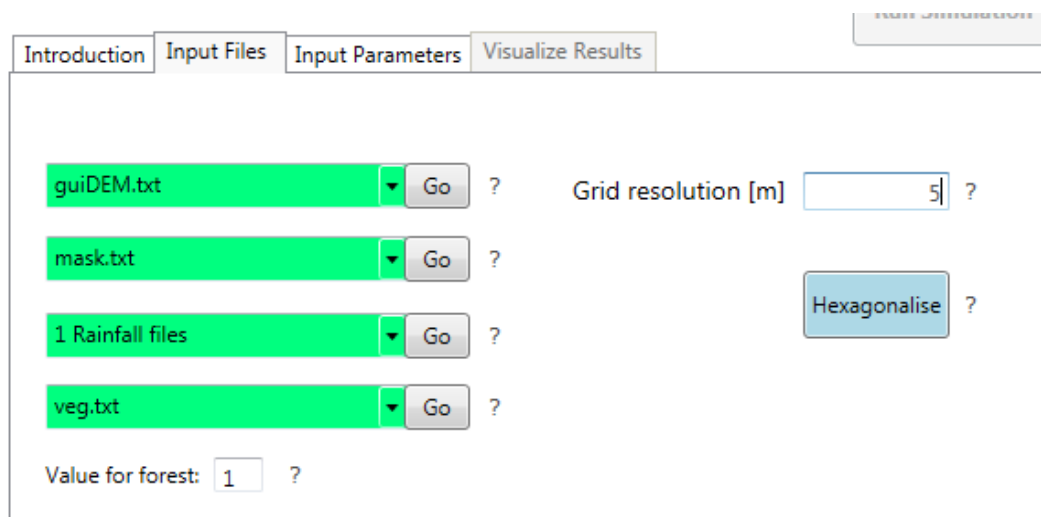
2) To see where landslide may occur you may add rain by choosing “Add manually rainfall intensity” and specify a rainfall duration and amount of interest.

3) The vegetation cover may not be critical for such first tests and in “Select Vegetation” you may choose “Define by mapping editor” and you just press “Save vegetation” in the opening new window

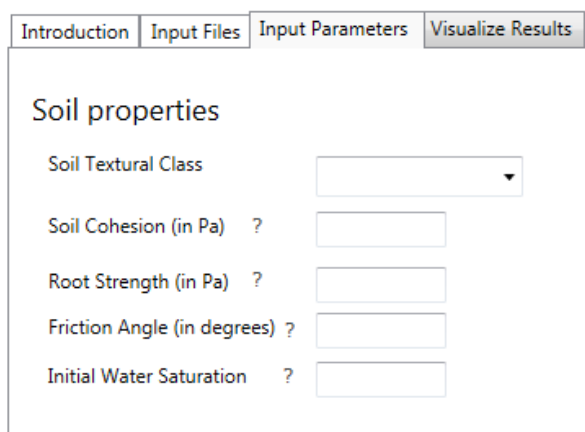




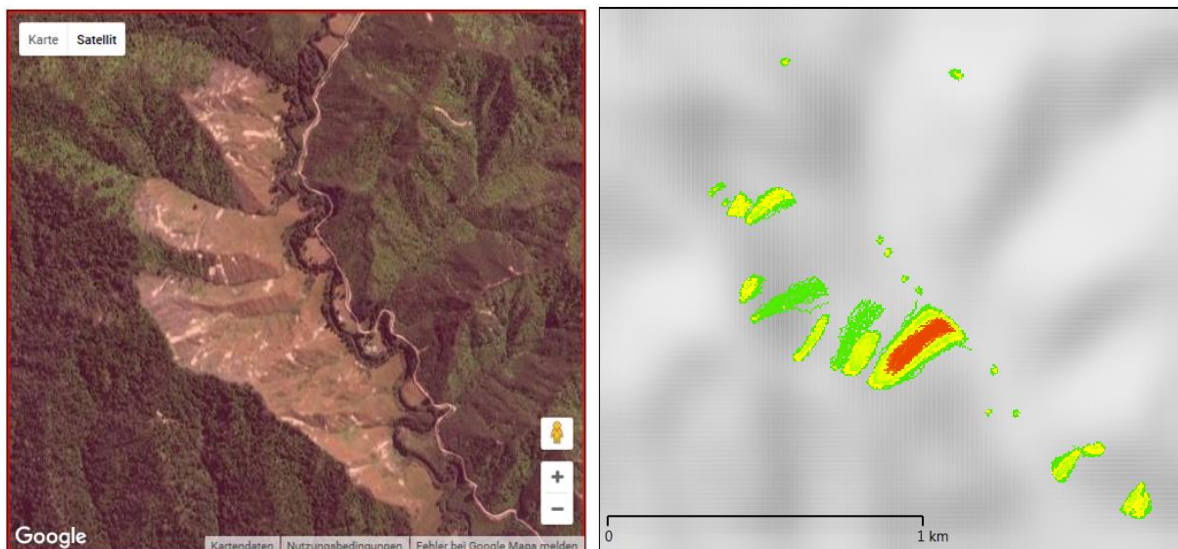
4) For simulations we propose to choose a grid resolution of 5 m (for simulations of soil depth, water flow and landslides)



5) Then you can “play” with parameter values to see when landslides occur



8) Here are results for simulations for a region in new Zealand



## B) Simulation of extreme event in area of interest

The user is interested in landslide and debris flow pattern in a certain catchment for an intense rainfall event

- The user downloads the digital elevation map from USGS data base following the tutorial “Tutorial\_Data\_preparation\_QGIS.pdf”
- The user takes an extreme event for the regions using the file “CMORPHdatabase.txt” that is contained in the STEP TRAMM package

1) You upload the DEM (below the file is called “DEM.txt”) and to mark the region of interest in the window “Browse mask file” you choose “Define with mapping editor”

Introduction
Input Files
Input Parameters
Visualize Results

DEM.txt
Go
?
Grid resolu

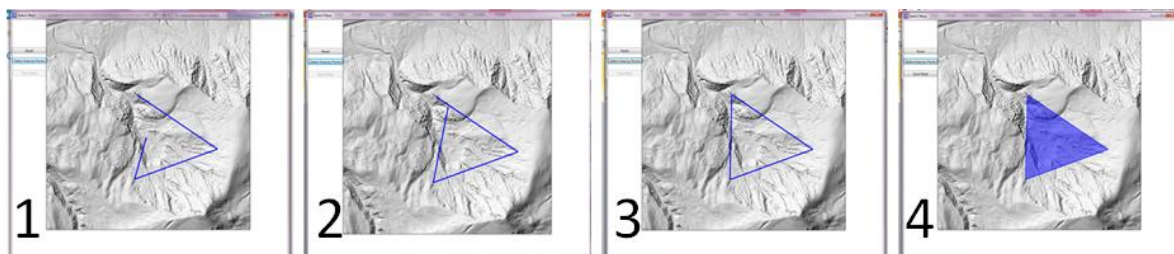
Select Mask
Go
?

Browse mask file
Define with mapping editor
Set mask to full extent of DEM
Go
?

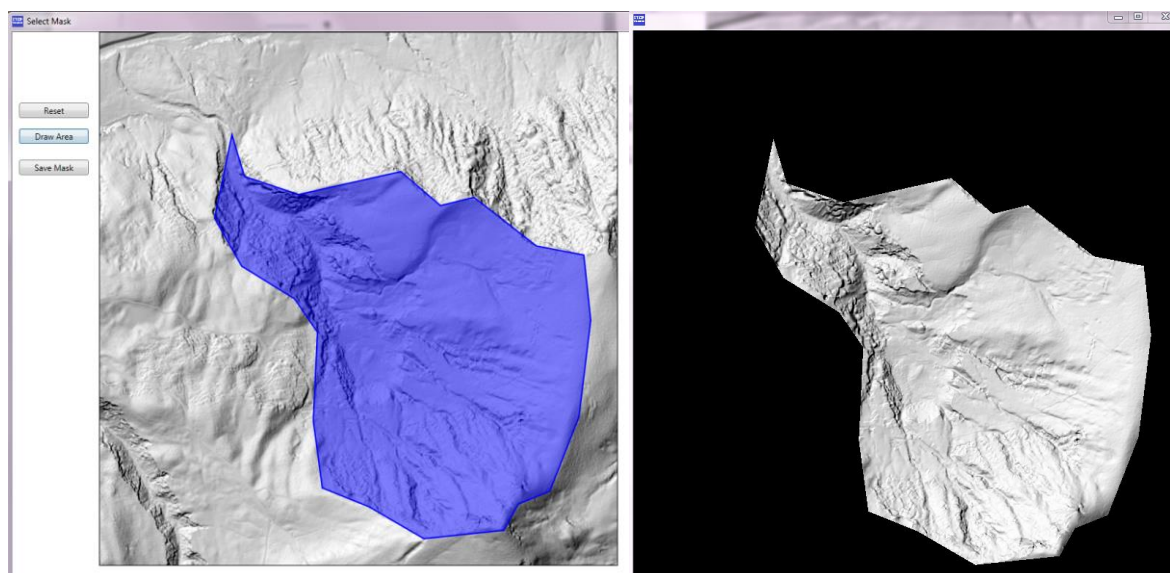
Select Vegetation
Go
?

2) In the “mapping editor” you choose “Draw Area” and then you draw a polygon on the map. Important: In order to close the polygon, you must proceed as shown with the simple example (triangular shape) shown below.

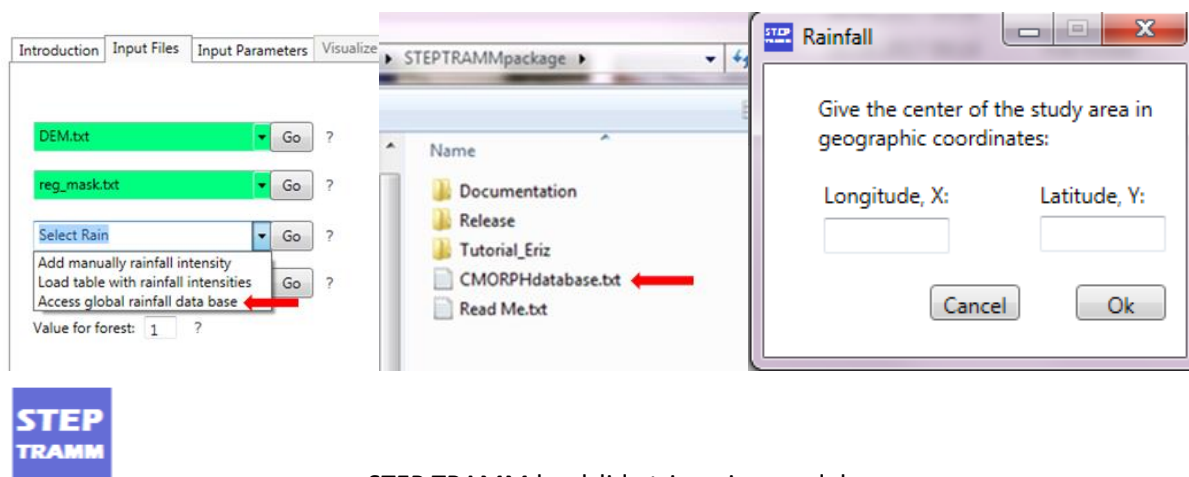
Note: When you draw the last line of the polygon (1), move the cursor close to the first line (2), until the line “snaps” (jumps) to the starting point (3). Now just click on the map and the polygon becomes filled (4), indicating that you can save it now by choosing “Save Mask”.



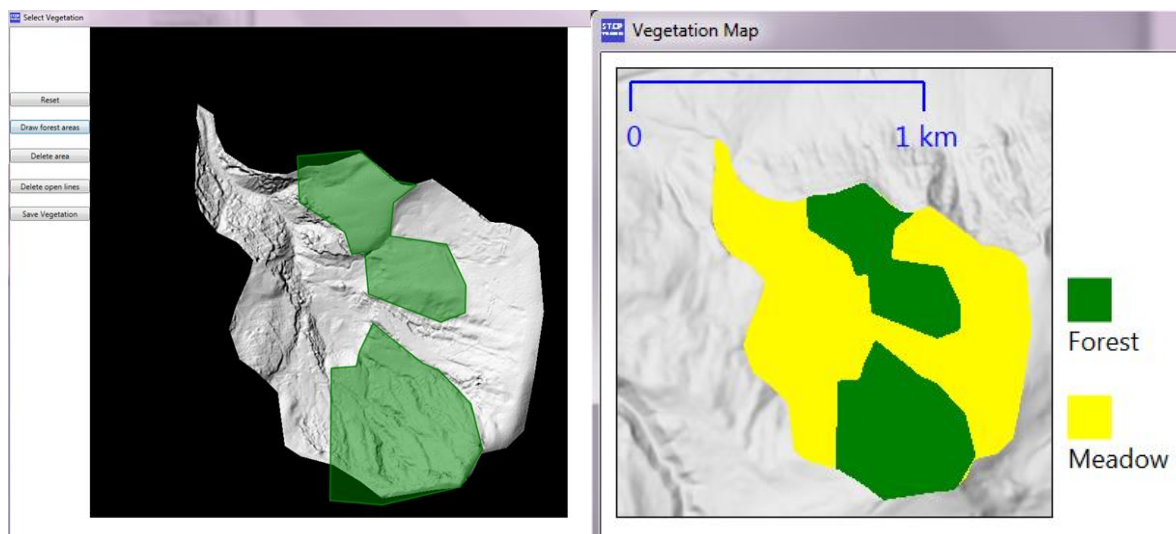
3) A resulting mask file could look as follows (after clicking “Save Mask”, the picture at the right is shown)



4) To anticipate if landslides may occur for a heavy rainfall event, under “Select Rain” you may choose “Access global rainfall database” to select an intense rainfall event of this region from a Global database . For that purpose you must define the center point (in geographical coordinates)



5) Similarly you can define land cover in “Select Vegetation” by choosing “Define with mapping editor” as shown below (selected forest areas at the left, resulting cover at the right).

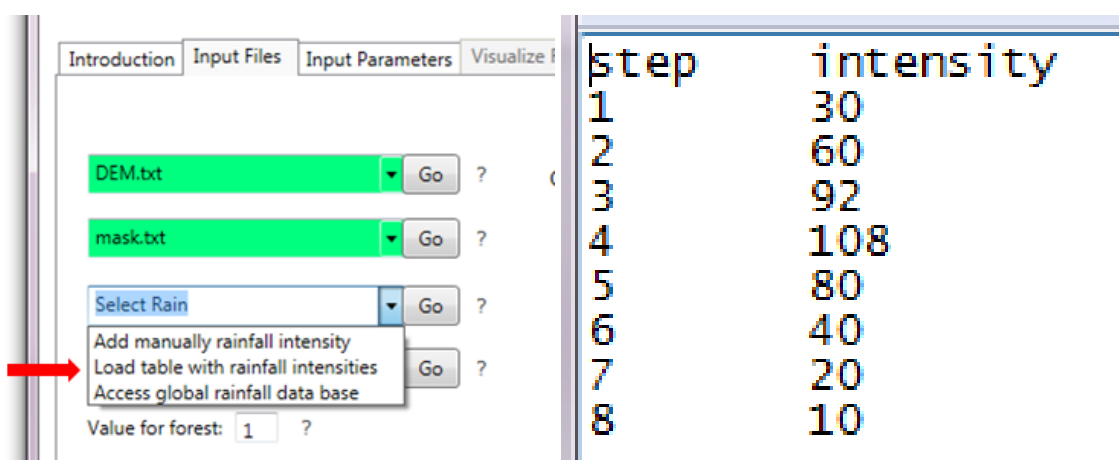


### C) Scientific analysis of case study

The user is interested in landslide and debris flow pattern in a certain catchment for an intense rainfall event

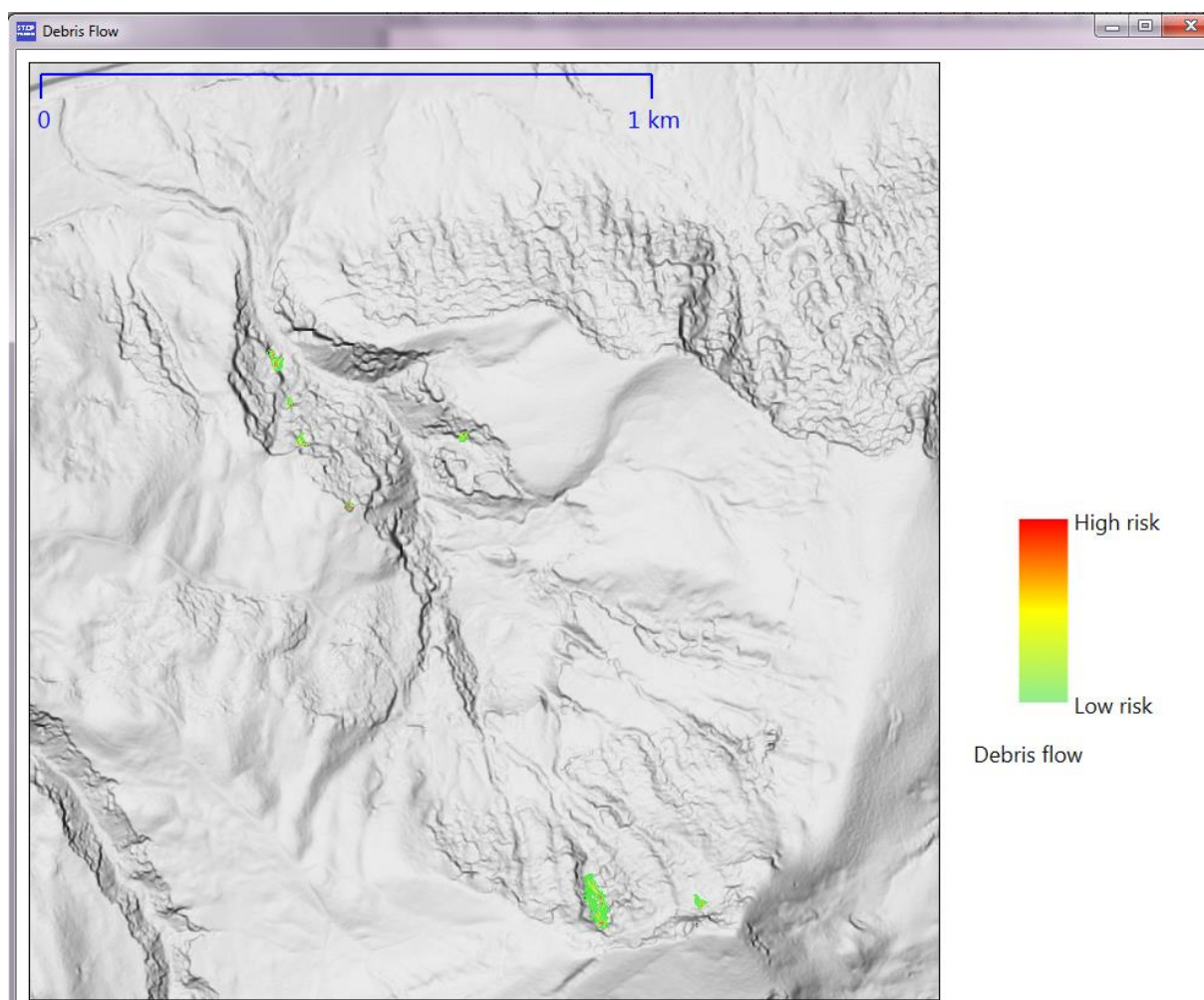
- The user has DEM information of area of interest of high resolution (~2m)
- The user has information on rainfall intensity dynamics

1)The user may study a certain rainfall event that triggered landslides. For that purpose simulations may be carried out with higher spatial resolution (in this example 2 m). For “Select rainfall” you must choose “Load table with rainfall intensities”, then define the rainfall interval in minutes and then browse a table consisting of two columns (rainfall steps in the first, intensities in mm/hour in the second column).



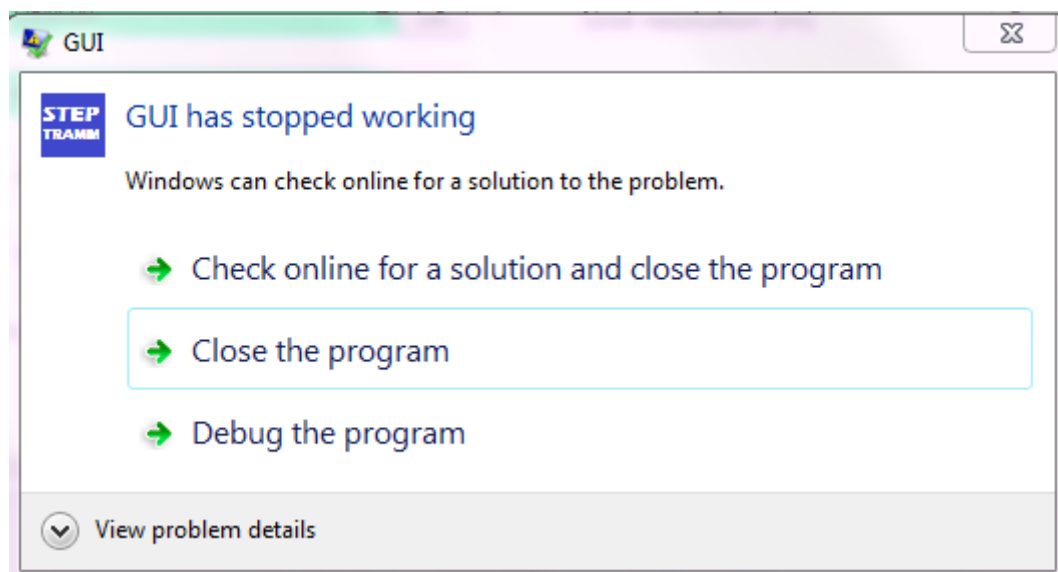


2) results (debris flow ) are shown on the map below



## Problems / remarks

When a simulation fails, the following window appears.



To ensure that the failed application stopped, check in the “Task Manager” if there are still STEP TRAMM processes running; if this is the case, mark the process and click “end process”

