# **STEP TRAMM**



USER

GUIDE

**STEP TRAMM** 

Landslide and debris runout simulation



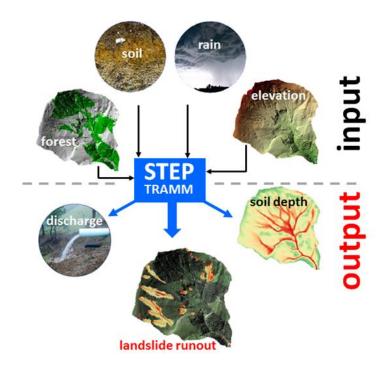
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<u>Copyright and disclaimer</u>: The software is provided without warranty of any kind with respect to simulations of landslide and debris flows. Copyright belongs to STEP group.

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## **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

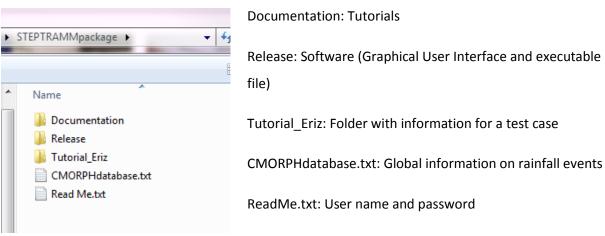
- Windows operating system
- 64-bit operating system
- ≥ 8 GByte RAM (limiting size of simulated system)

#### August 2017, P. Lehmann and J. von Rütte

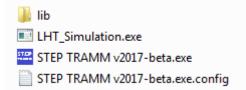


# **Applying STEP TRAMM – step by step**

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



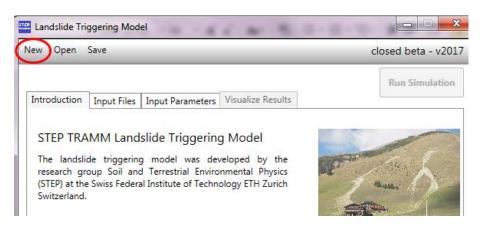
and open the folder "Release" containing the following items



 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.

-		
Ĺ	Login	
I		
	Username	
	Osemanie	
L.	Password	
ł.		
	Login	
	*By login in you accept disclaimer conditions	
i	found in the user guide.	

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)

🚟 New Project			×
Project Name	TestApplication		
Project Directory	C:\Users\peterle\Desktop		Browse
		ОК	Cancel

**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").

Model - Pro	oject: TestApp	olication	H-H-1	
				closed beta - v2017
			7	Run Simulation
Files Input	Parameters	Visualize Results		
ile	▼ Go	? Grid re	solution [m]	?
	▼ Go	?		Hexagonalise ?
	▼ Go	?		
		Files Input Parameters ile • Go • Go	ile ▼ Go ? Grid re ▼ Go ? ▼ Go ?	Files Input Parameters Visualize Results ile

**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"

Drganize 🔻 New folder					833 🗸	(?
Name	Date modified	Туре	Size			
DEM.txt	17.02.2017 08:31	Text Document	4'373 KB			
Landslide_inventory.txt	20.01.2017 16:07	Text Document	1 KB			
mask.txt	17.02.2017 08:31	Text Document	1'121 KB			
vegetation.txt	17.02.2017 08:31	Text Document	1'121 KB			
	Tester	duction Input Files	Input Parameters	Visualize Re		
	[ Inde	ouccon	inport diameters			
1						
		1				
		elect Elevation File	Go	?		
		ad DEM file				
				? ?		
		ad DEM file				
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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)

In the second	New folder							•	
Fa	Name	Date mo	dified	Туре	Size				
	DEM.txt	17.02.201	17 08:31	Text Document	4'373 KB				
<b>.</b> =	Landslide_inventory.txt	20.01.201	17 16:07	Text Document	1 KB				
<b>1</b>	📄 mask.txt 🛛 🗧 👘	17.02.201	17 08:31	Text Document	1'121 KB				
	vegetation.txt	17.02.201	17 08:31	Text Document	1'121 KB				
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			Introdu	uction Input Files	Input Parameters	Visua	alize Results		
1									
2									
8			DEA	A +44		] _	<b>C</b> · 1		
8			DEN	И.txt	▼ Go	?	Grid re		
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			Sele	ect Mask	▼ Go ▼ Go	] ? ] ?	Grid re		
		_	Sele Bro	ect Mask wse mask file	Go	] ?	Grid re		
		_	Sele Broy Defi	ect Mask wse mask file ine with mapping e	✓ Go ditor Go	2	Grid re		
		_	Sele Bro Defi Set	ect Mask wse mask file	✓ Go ditor Go	] ?	Grid re		

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"

Introduction Input Files Input Paramete	ers Visualiz	Rain Interval	B. Bayers Surveyort
DEM.txt G	o ?		
mask.txt 🗸 G	o ?	Rainfall Interval in minutes	10
Select Rain 🗸 G	• ?		
Add manually rainfall intensity Load table with rainfall intensities Access global rainfall data base	o ?		ОК

**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".

Rainfall	🚟 Rainfall	
Rainfall Intensity [mm/hr] 10 Reset Insert	Rainfall Intensity [mm/hr] Reset Number 1	20       Insert       Rainfall Intensity       10
STEP		

RAM

STEP TRAMM landslide triggering model

**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".

rganize 🔻 New folder						:==		
🕛 🗠 Name	*	Date modified	Туре	Size				
DEM.txt		17.02.2017 08:31	Text Document	4'373 KB				
Landslide_invent	ory.txt	20.01.2017 16:07	Text Document	1 KB				
Landslide_invent		17.02.2017 08:31	Text Document	1'121 KB				
vegetation.txt		17.02.2017 08:31	Text Document	🔛 Landslide Trig	gering Mode	I - Project: TestAppl	ication	
				New Open	Save			
				DEM.txt mask.txt			? ?	

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

570	Lar	ndslide Ti	riggering Mod	lel - Project: TestAp	plication	1.	·		• X
1	Vew	Open	Save					closed beta	a - v2017
Γ				1	Ve r	D 11	1	Run Sim	nulation
h	Intr	oduction	Input Files	Input Parameters	Visualiz	ze Results			
	l	DEM.txt		▼ Go	?	Grid res	solution [m]		?
		mask.txt		▼ Go	?				
		2 Rainfall	files	▼ Go	?			Hexagonalise	?
		vegetatio	n.txt	▼ Go	?				
	۷	alue for f	forest:	?					



**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:

Soil depth from external source?	External soil type map?			
Homogeneous soil depth [m]:	Select Soiltype Map Browse			
or	or			
Browse	Import SoilGrid Files			

**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 "Hexaganolisation 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 SQUAREROOT of 20AREA/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"

Landslide Triggering Model - Pro	oject: TestApplicatio	n	
New Open Save	_	_	closed beta - v2017
Introduction Input Files Input	Parameters Visual	ize Results	Run Simulation
Soil properties Soil Textural Class	Choose Soiltype	•	
Soil Cohesion (in Pa) ?	Sand Loamy sand Sandy Ioam		value range: 0 - 5000 Pa value range: 2000 - 3000 Pa
Friction Angle (in degrees) ? Initial Water Saturation ?	Loam Silt Ioam Silt Sandy clay Ioam	0.0 (dry co	mmon value anditions) up to to 1.0
	Clay Ioam Silty clay Ioam Sandy clay Silty Clay Clay	for a satur	ated soil

**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.

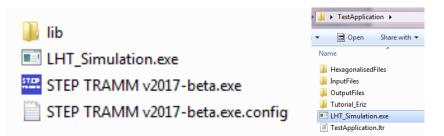
🚟 Landslide Triggering Model - F	Project: TestApplic	ation	
New Open Save	_	_	closed beta - v2017
Introduction Input Files Inp	ut Parameters V	isualize Results	Run Simulation
Soil properties			
Soil Textural Class	Loam	•	
Soil Cohesion (in Pa) ?	1500		common value range: 0 - 5000 Pa
Root Strength (in Pa) ?	3000		common value range: 2000 - 3000 Pa
Friction Angle (in degrees)	30		30° is a common value
Initial Water Saturation ?	0.75		0.0 (dry conditions) up to to 1.0 for a saturated soil
		Save	
	and including the state		<b>x</b>
All required parameters are o button on the top right.	lefined. Now you	can run the simu	ulation using the
			ОК



#### 15. Click "Ok" and then the "Run Simulation" button is colored

Landslide Triggering Model - Project: TestApplication							
New Open Save closed beta - v2017							
Introduction Input Files Ir	put Parameters Visualize Results	Run Simulation					

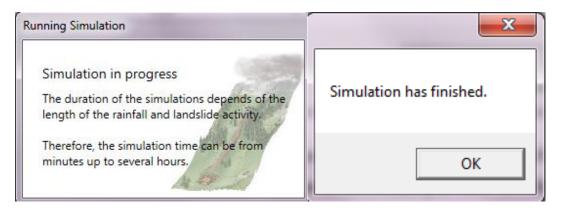
**16**. Attention: Copy the file "LHT\_Simulation.exe" that is contained in the "STEPTRAMMpackage" in the "Release" folder and place it into the project folder (in this example denoted as "TestApplication");



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

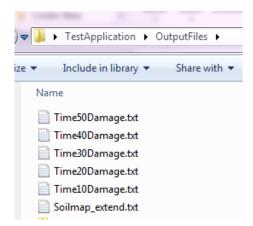
	×
Please place LHT_Simulation.exe in the project	directory.
	ОК

**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).



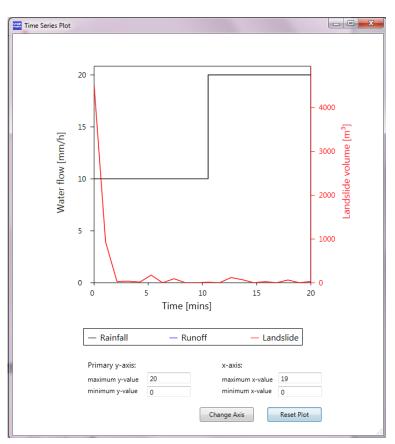
**19**. **Note B:** You may simulate a case where more than 10% of the landscape fails and the simulation then stops without generating output.

	×
Simulation has ended as total landslide volume is more than 2 volume.	10 percent of system
	ОК

**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".

🕮 Lan	dslide Tri	ggering Mod	el - Project: TestApp	olication		
New	Open	Save	_	_	_	closed beta - v2017
						Run Simulation
Intr	oduction	Input Files	Input Parameters	Visualize Results		
	Soil Veg Tim Dan Lan	shade depth letation e series nage map dslide map (2 pris flow runou			User Inpur j pil depth mod andslide mod g Runout mode	deling leling

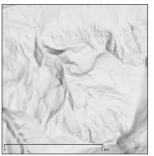


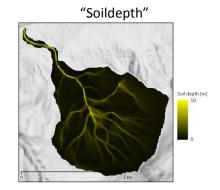


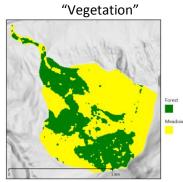
**21**. To see rainfall, runoff and released mass click on "Time series" You can choose the range of values for each axis (values below 0.1 mm/h cannot be plotted).

22. Some basic characterization of the catchment are shown next



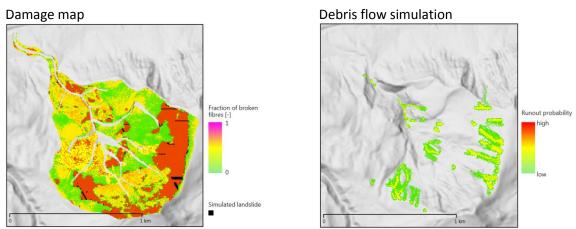








**23**. Map of damage (local failures expressed by broken internal mechanical elements denoted as fibers; released mass in black) and "Debris flow runout"

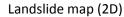


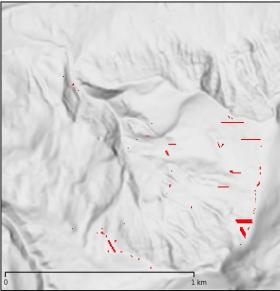
**24**. If you have inventory information on position of landslides, click on "Landslide inventory vs. Simulation", select file "Landslide\_inventory.txt" in folder "UserFiles" and click "open":

-	TestApplication  Tutorial_Eriz
•	New folder
Nam	e
L n	EM.txt andslide_inventory.txt nask.txt egetation.txt

**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)







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

the second se
TestApplication   OutputFiles
Include in library
Name FinalDamage.txt
Landslide_clusters.txt
Landslide_statistics.txt
Landslidemap.txt
Soilmap_extend.txt
Time10Damage.txt
Time30Damage.txt
Time50Damage.txt
Time60Damage.txt
Time70Damage.txt
Time80Damage.txt

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

Eandslide Triggering Model - Project: TestApplication	X
New Open Save	closed beta - v2017
×	
Save data to the project?	
Yes No Cancel	



# **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"

Landslide Triggering Model - Project: NewZealand	Landslide Triggering Model - Project: NewZealand
New Open Save	New Open Save
Introduction Input Files Input Parameters Visualize Re	Introduction Input Files Input Parameters Visualize Results
Select Elevation Go ? G	guiDEM.txt Go ? Grid res
Load DEM file DEM from xyz-list Zonum Solution Go ?	Browse mask file Define with mapping editor 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



w Open Save	_			Tent
Introduction Input Files	Input Parameters	Visualize		1-2
			Reset	156
guiDEM.txt	▼ Go	?	Draw forest areas	E. C.
reg_mask.txt	▼ Go	?	Delete area	1 Cast
1 Rainfall files	Go	?	Delete open lines	11
Define with mapping ed	itor 🔽 Go	?	Save Vegetation	E CONTR
Load vegetation file Define with mapping ed	itor			

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

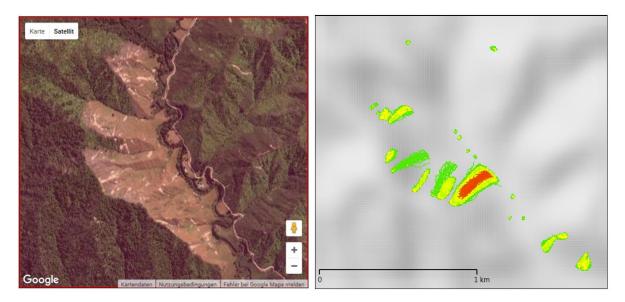
Introduction	Input Files	Input Parameters	Visualize	Results			
guiDEM.tx	t	▼ Go	?	Grid res	solution [m]	5	?
mask.txt		▼ Go	?			[	)
1 Rainfall	files	▼ Go	?			Hexagonalise	?
veg.txt		▼ Go	?				
Value for fo	orest: 1	?					

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

Introduction	Input Files	Input	Parameters	Visualize R	lesults
Soil prop					_
Soil Textur Soil Cohes	al Class ion (in Pa)	?		•	
Root Stren	gth (in Pa)	?			
Friction An	igle (in degre	ees) ?			
Initial Wate	er Saturation	?			



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\_peparation\_QGIS.pdf"
- The user takes an extreme event for the regions using the file "CMORPHdatabase.txt" that is contained in the STEP TRAMM package

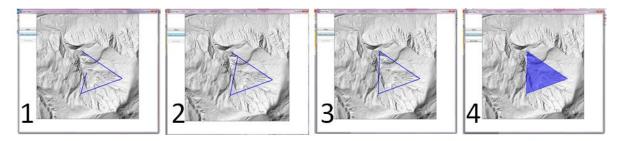
1) You upload the DEM (below the file is called "DEM.txt") and to mark the region of interest in the window "Browse mask file" you choose "Define with mapping editor"

Introduction	Input Files	Input Parame		neters	Visua	alize Results
DEM.txt				Go	?	Citerrat
DEMILAL				00	f	Grid resolu
Select Mas	ik		•	Go	?	
Browse ma						
	n mapping ed o full extent o			Go	?	
Select Veg	etation		Ŧ	Go	?	

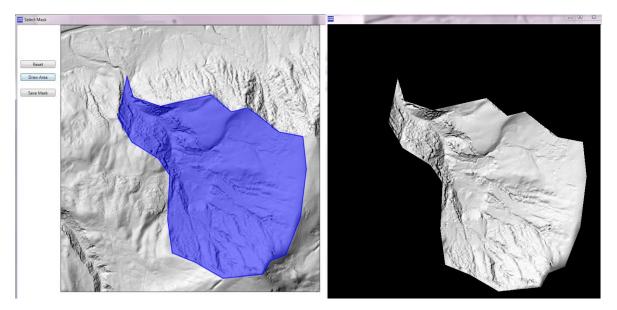


2) In the "mapping editor" you choose "Draw Area" and then you draw a polygon on the map. Important: In order to close the polygon, you must proceed as shown with the simple example (triangular shape) shown below.

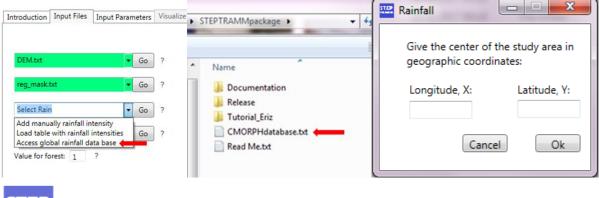
Note: When you draw the last line of the polygon (1), move the cursor close to the first line (2), until the line "snaps" (jumps) to the starting point (3). Now just click on the map and the polygon becomes filled (4), indicating that you can save it now by choosing "Save Mask".



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

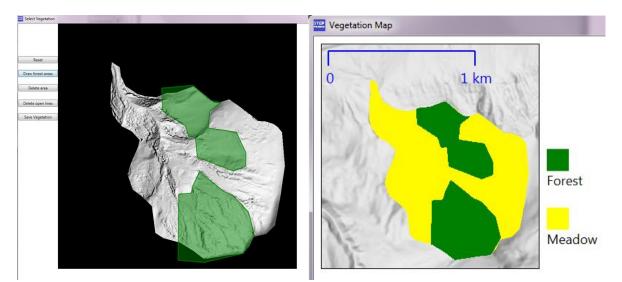


4) To anticipate if landslides may occur for a heavy rainfall event, under "Select Rain" you may choose "Access global rainfall database" to select an intense rainfall event of this region from a Global database . For that purpose you must define the center point (in geographical coordinates)





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).

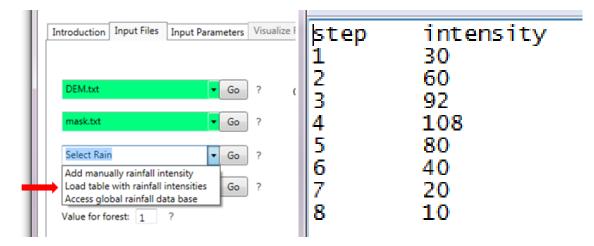


#### C) Scientific analysis of case study

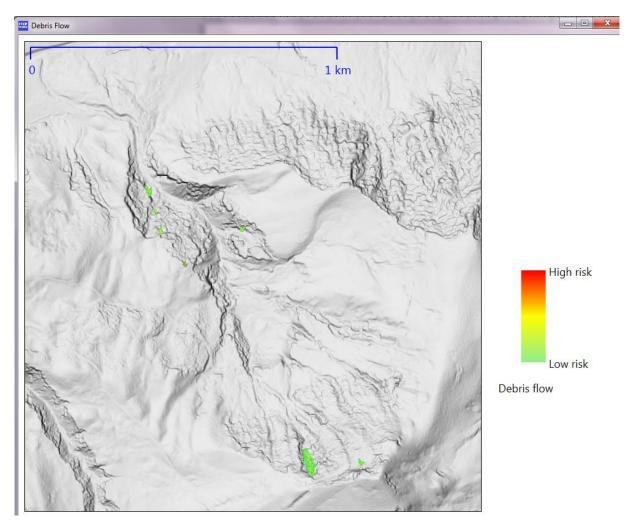
The user is interested in landslide and debris flow pattern in a certain catchment for an intense rainfall event

- 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).





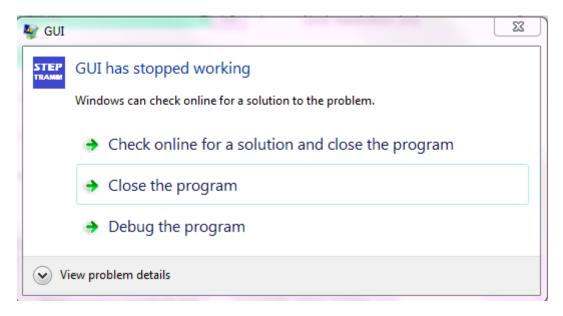


2) results (debris flow ) are shown on the map below



## **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"

Image Name	User Name	CPU	Memory (Private	Descriptio
nvwmi64.exe		00	22'760 K	
wxdsync.exe		00	12'956 K	
OUTLOOK.EXE *32		00	218'384 K	Microsoft
POWERPNT.EXE *32		00	74'384 K	Microsoft
prevhost.exe		00	6'564 K	Preview h
prevhost.exe *32		00	3'080 K	Preview F
RainMap.exe *32		13	5'484 K	RainMap.
RAVBg64.exe		00	6'868 K	
RAVBg64.exe		00	9'648 K	HD Audio
RAVBg64.exe		00	5'620 K	HD Audio
Retrospect Client System Tray.exe *32		00	3'536 K	Retrospe
R:BMGUI64.exe		00	5'904 K	Realtek H
SnippingTool.exe		01	5672 K	Snipping
sphvow64.exe		00	12'880 K	Print driv
splwow64.exe		00	4832 K	Print driv
STEP TRAMM v2017-beta.exe *32		00	78'348 K	GUI
STEP TRAMM v2017-beta.exe *32		00	128'932 K	GUI
taskeng, exe		00	3'916 K	Task Sch
taskhost.exe		00	10'808 K	Host Proc
taskmgruexe		00	7588 K	Windows
vcpkgsrv.exe *32		00	6'092 K	Microsoft
vapkgsrv.exe *32		00	6'072 K	Microsoft
vpnui.exe *32		00	6'988 K	Cisco Any
WavesSvc64.exe		00	3'332 K	Waves M
winlogon.exe		00	4 148 K	
WINWORD.EXE *32		00	88'448 K	Microsoft
WINWORD.EXE *32		00	120'940 K	
wispös.exe		00	-€160 K	
WolframKernel.exe		00	60'516 K	
WolframKernel.exe		00	48'252 K	Wolfram
<				

