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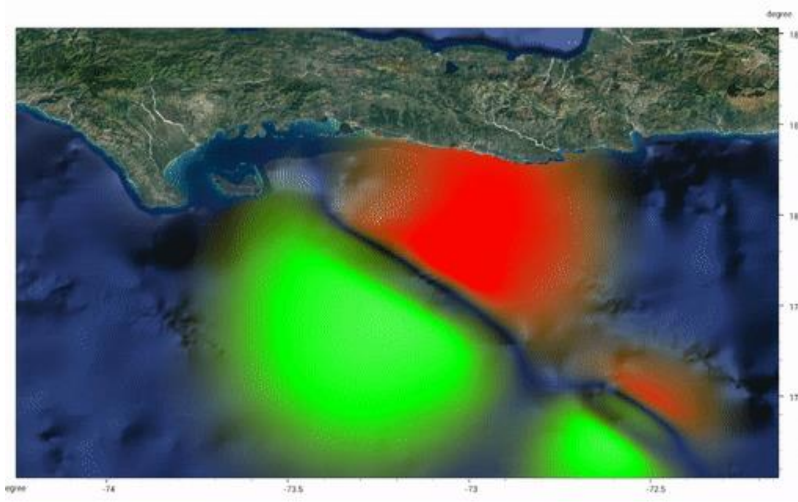
LISEM

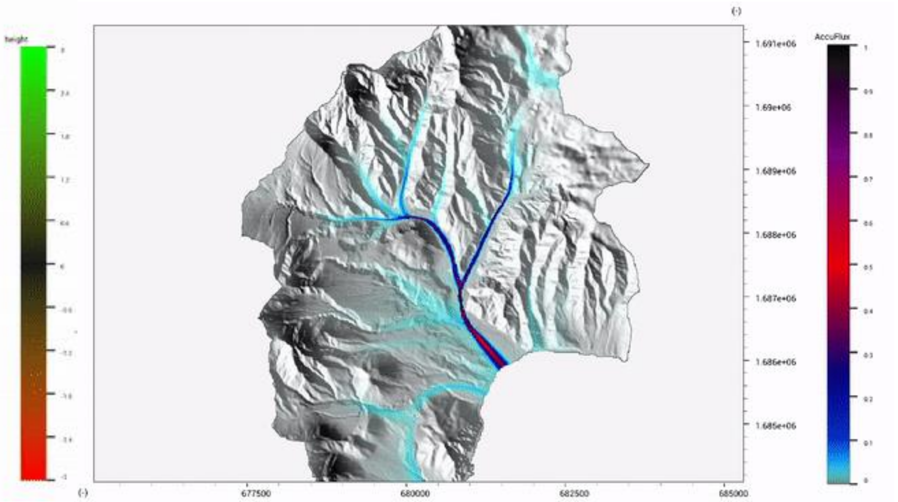
DR. B. VAN DEN BOUT

PROF. DR. V. G. JETTEN

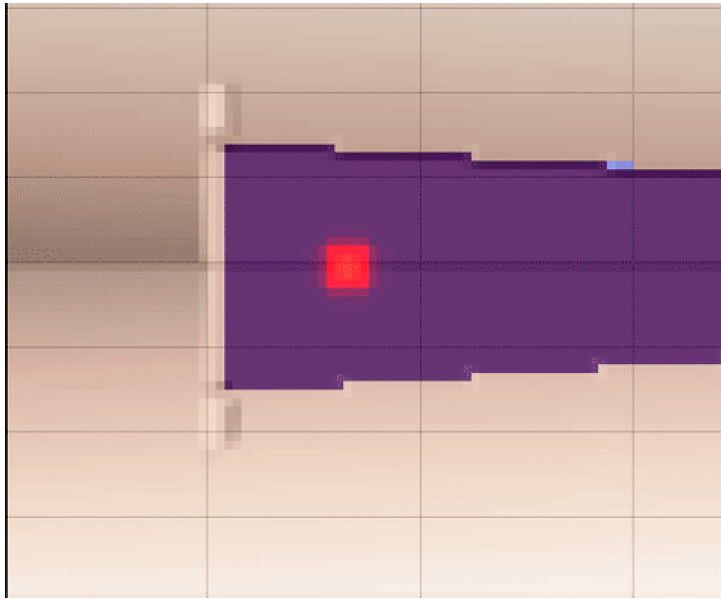
Tsunami



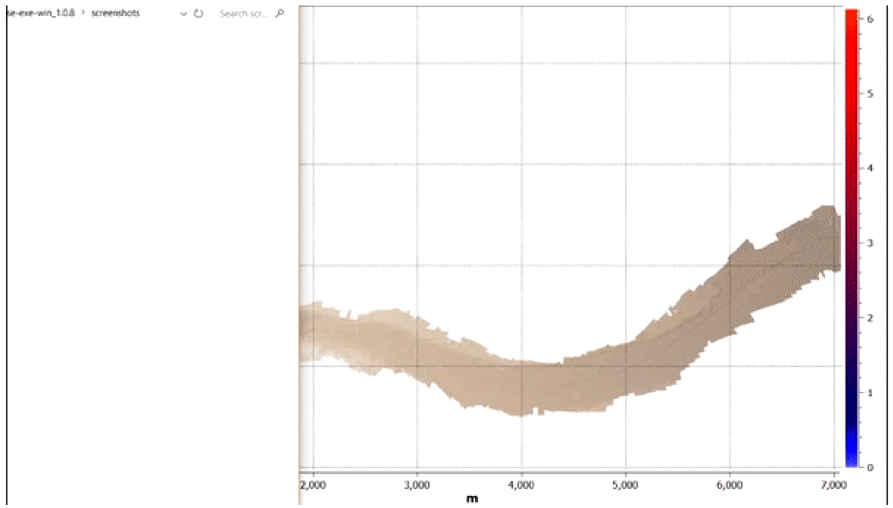
Analysis



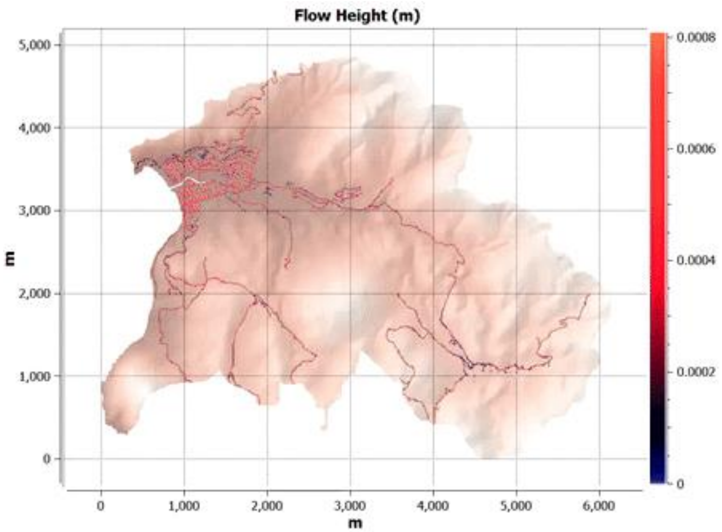
Waves



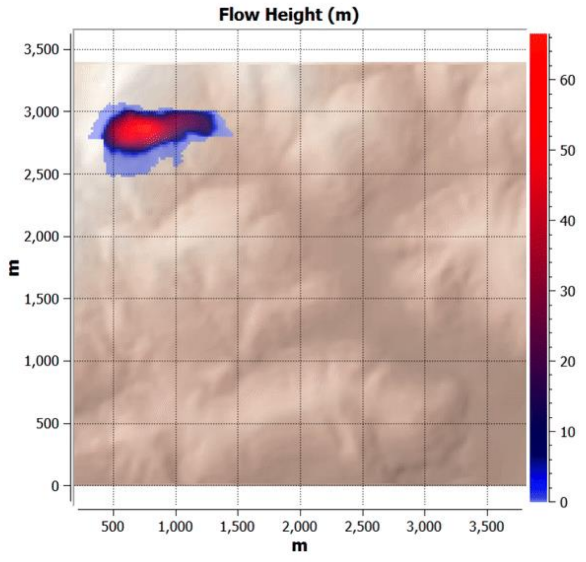
Floods



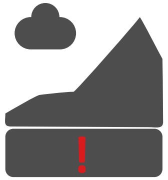
Multi-Hazard



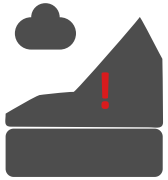
Landslide



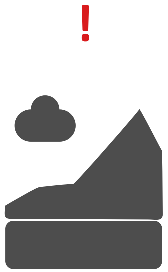
Multi-Hazard Interactions



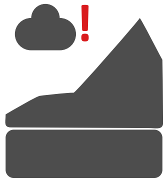
Deep Sub-Surface



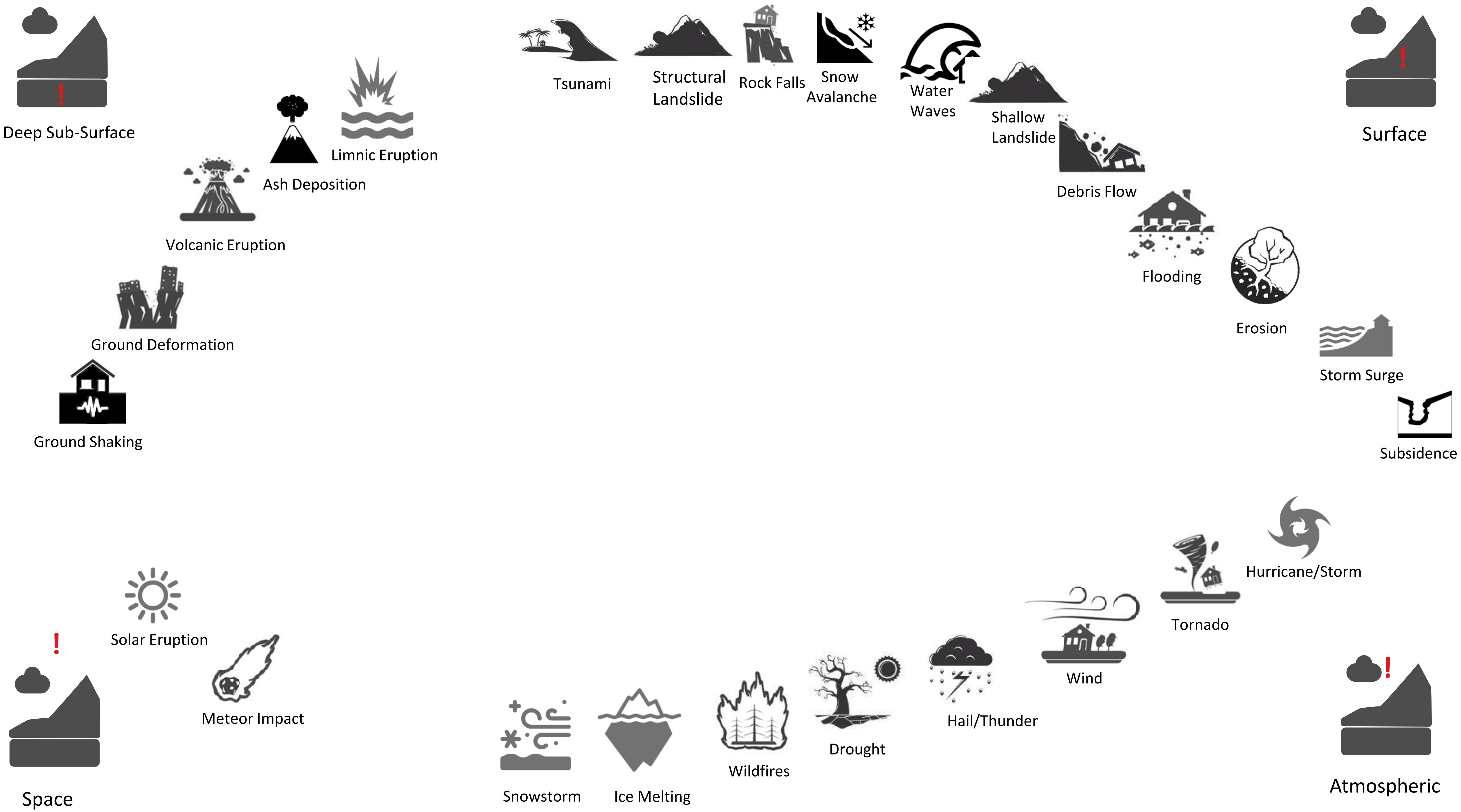
Surface

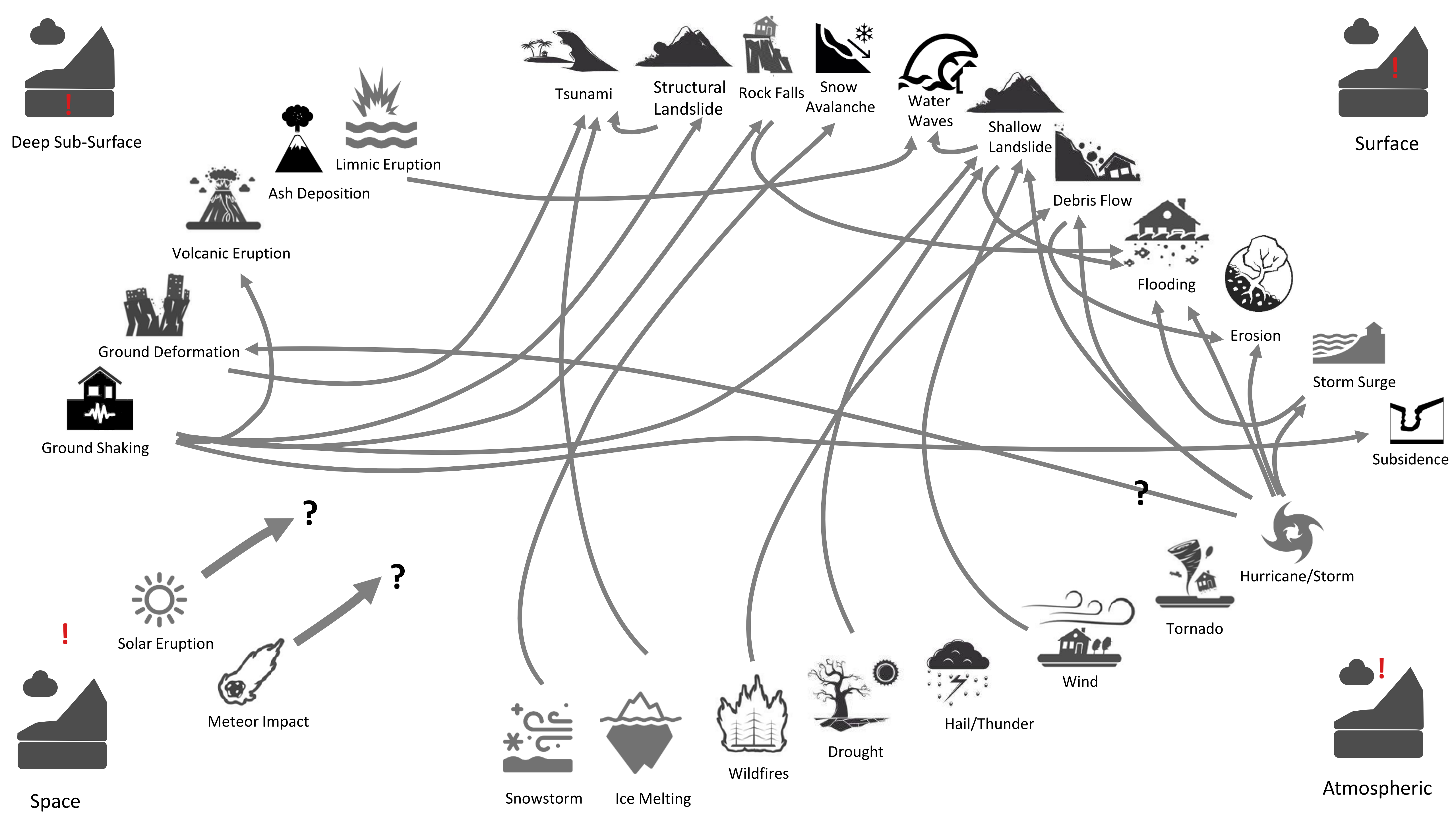


Space



Atmospheric


Deep Sub-Surface
Limnic Eruption
Ash Deposition
Volcanic Eruption
Ground Deformation
Ground Shaking
Tsunami
Structural Landslide
Rock Falls
Snow Avalanche
Water Waves
Shallow Landslide
Debris Flow
Flooding
Erosion
Storm Surge
Subsidence
Surface
Hurricane/Storm
Tornado
Wind
Hail/Thunder
Drought
Wildfires
Ice Melting
Snowstorm
Atmospheric
Solar Eruption
Meteor Impact
Space


Deep Sub-Surface
Surface
Space
Atmospheric
Tsunami
Structural Landslide
Rock Falls
Snow Avalanche
Water Waves
Shallow Landslide
Debris Flow
Flooding
Erosion
Storm Surge
Subsidence
Limnic Eruption
Ash Deposition
Volcanic Eruption
Ground Deformation
Ground Shaking
Solar Eruption
Meteor Impact
?
?
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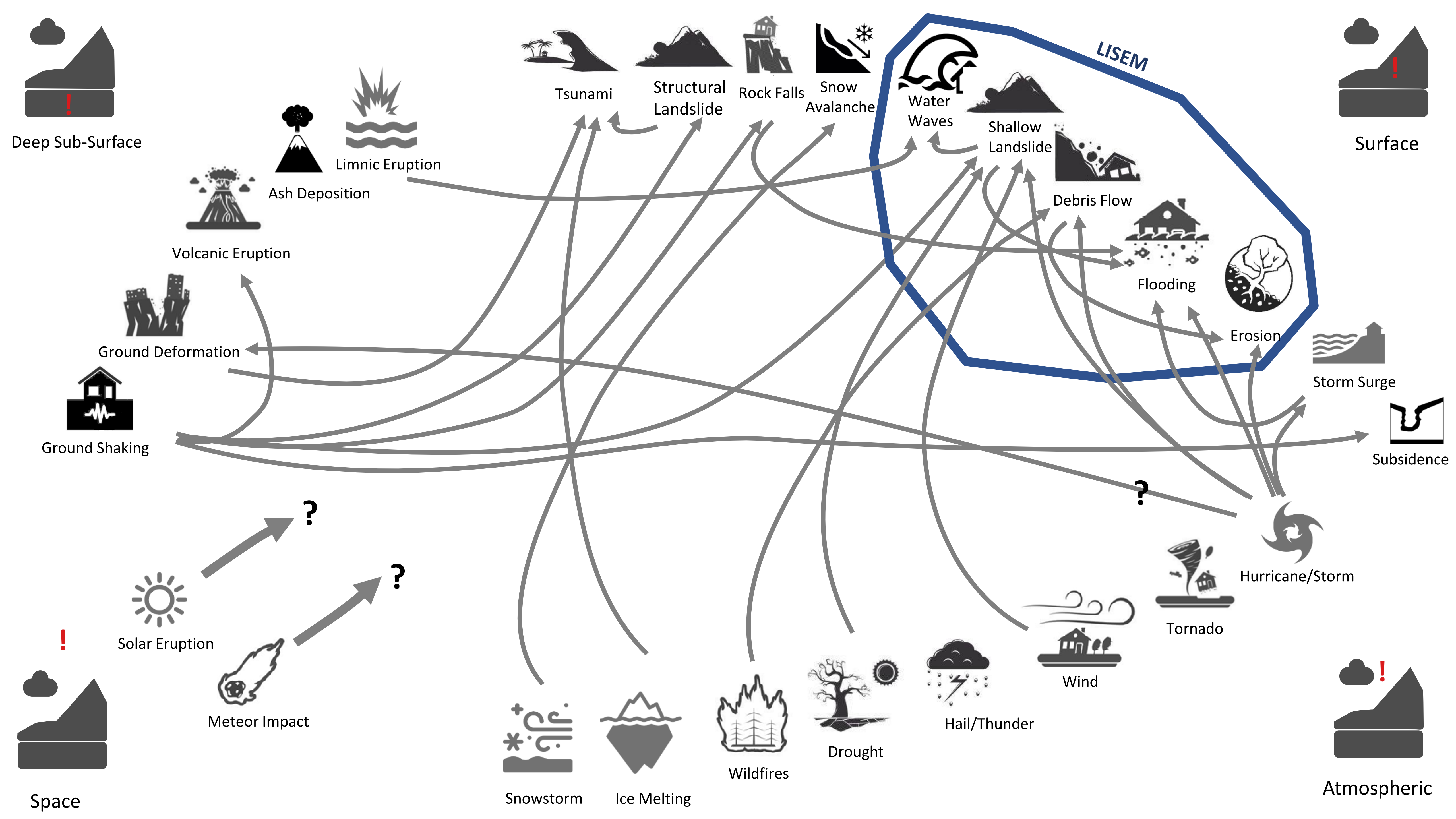
Hurricane/Storm
Tornado
Wind
Hail/Thunder
Drought
Wildfires
Ice Melting
Snowstorm



Deep Sub-Surface
Surface
Space
Atmospheric
LISEM
Tsunami
Structural Landslide
Rock Falls
Snow Avalanche
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Hail/Thunder
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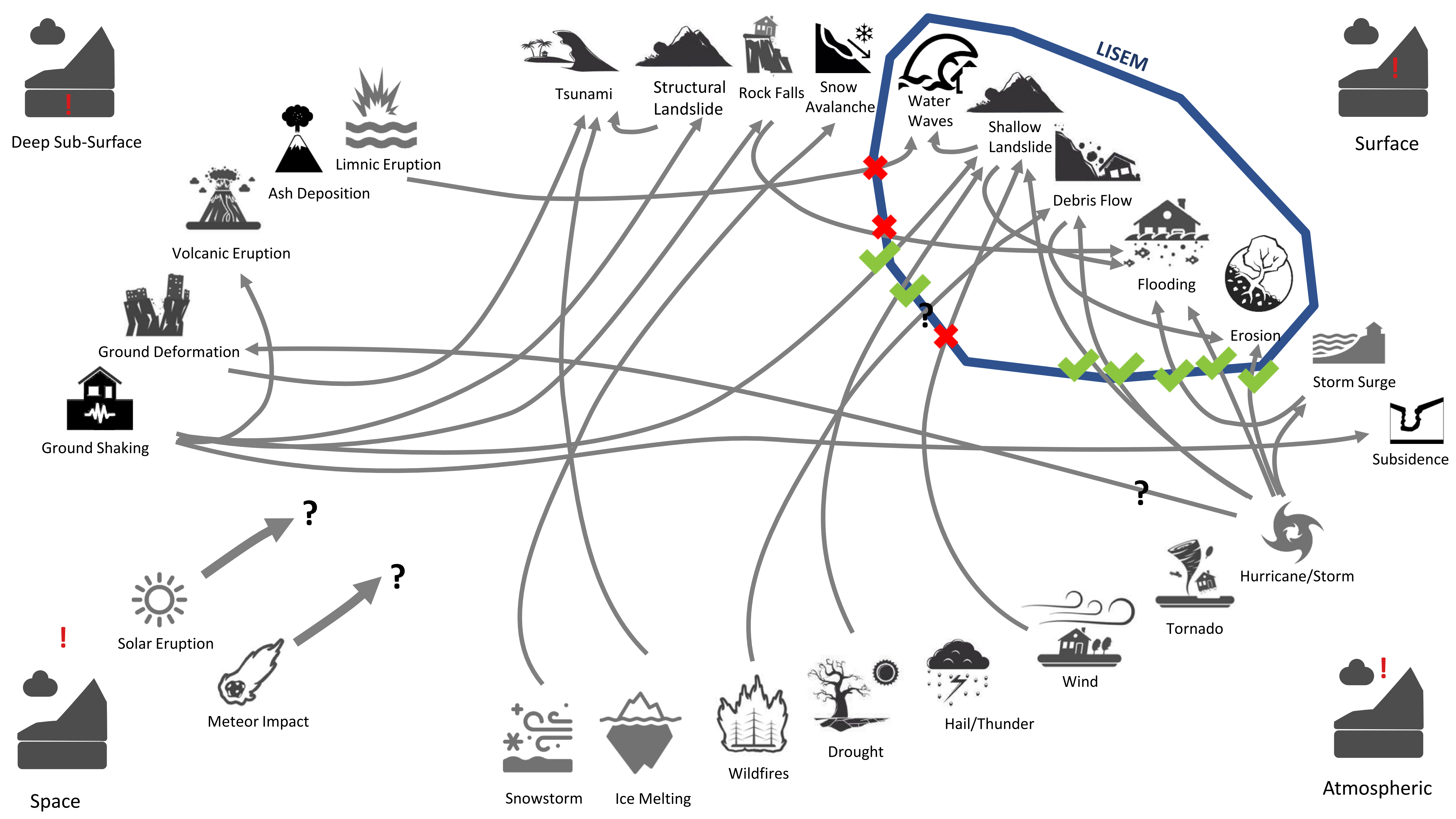
Hurricane/Storm



Deep Sub-Surface
Surface
Space
Atmospheric
LISEM
Tsunami
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Rock Falls
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Water Waves
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Debris Flow
Flooding
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Ground Deformation
Ground Shaking
Solar Eruption
Meteor Impact
Snowstorm
Ice Melting
Wildfires
Drought
Hail/Thunder
Wind
Tornado
Hurricane/Storm

AIMS OF LISEM

- Systematic Integration of state-of-the-art numerical solutions for natural hazards

- Flexibility and customization
  - User makes most assumptions, not the model!
  - Model at fundamental level, larger behavior emerges

- Helping with dealing with uncertainties in complex simulations

- Making gathering and processing data easier

LISEM MODEL

- Over 30 years of expert knowledge
  - Limburg Soil Erosion Model
- Integrated approach to modelling
  - Both spatially (multi-hazard)
    and temporally (feedbacks between events)
- Multi-Hazard simulations
  - Including interactions
- Implement fundamental rules
  - Larger behavior is emergent

LISEM Classic

Interface-based
Command line option

Processes:

- Hydrology
- Flow/Floods
- Erosion

Event/Continuous

LISEM (Hazard)

Scripting and Interface-based
Command line option

Processes:

- Hydrology
- Flow/Floods
- Erosion
- Slope failures
- Landslide/Debris flow
- Storm surging
- Tsunami
- Interactions with Seismic and Wind

Event/Continuous with scripting

WWW.LISEMMODEL.COM

LISEM Docs Download Publications Showcases About Blog Search...

What is LISEM?

Lisem (Lisem Integrated Spatial Earth Modeller) is a free and open-source software tool that allows users to manipulate geo-spatial data. Featuring both simple operations and advanced algorithms, complex models can be developed. The tool features an internal scripting environment designed for easy data manipulation, a geospatial data viewer, and the LISEM model, which aims at simulation of Hydro-meteorological surface hazards. Additionally, the software comes with Python bindings that allow for interactions with other libraries and automization of code. Have a look at the documetion for more information on how to use and install LISEM.

ITC

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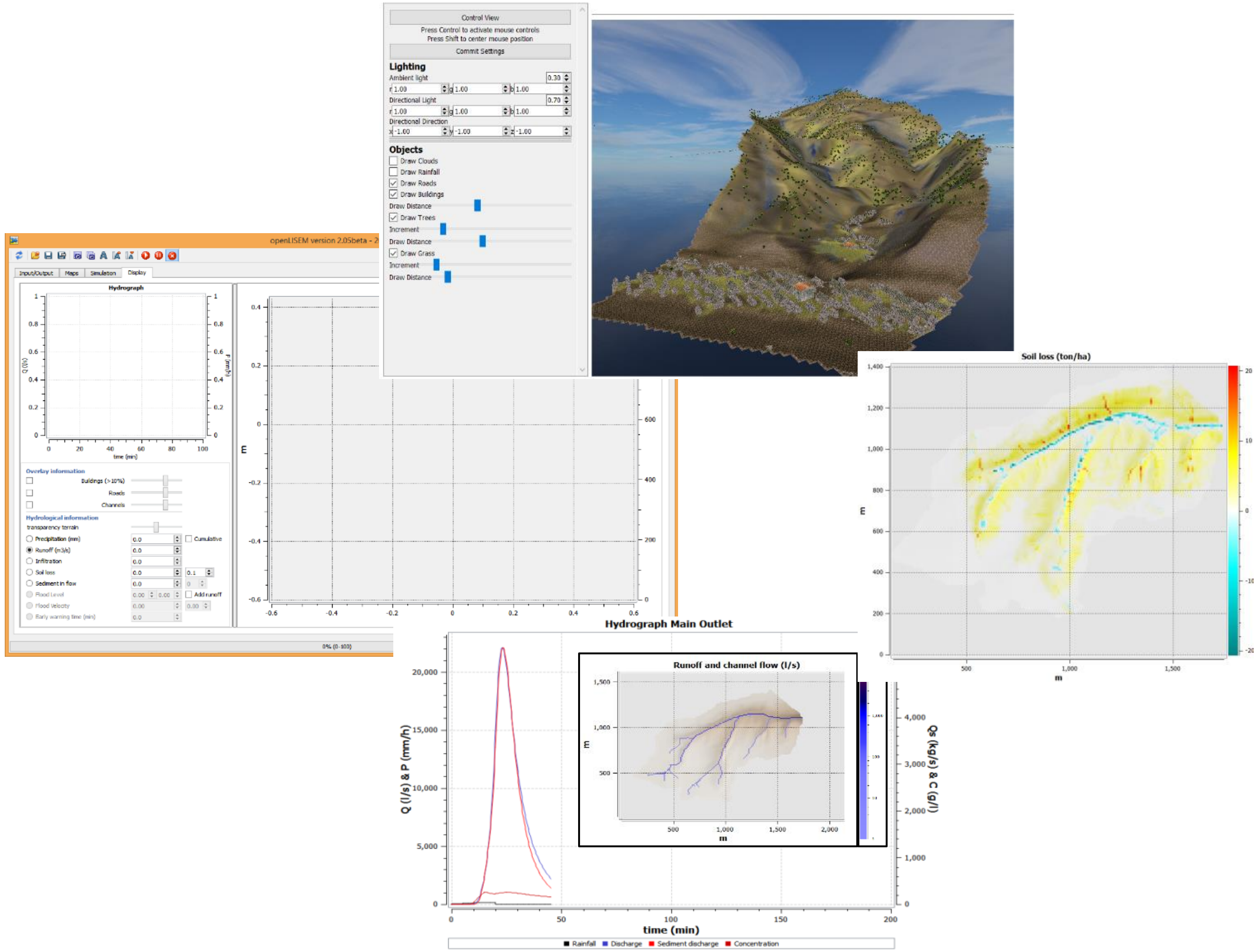
OpenLisem ITC

YouTube

bastianvandenbout / LISEM Public

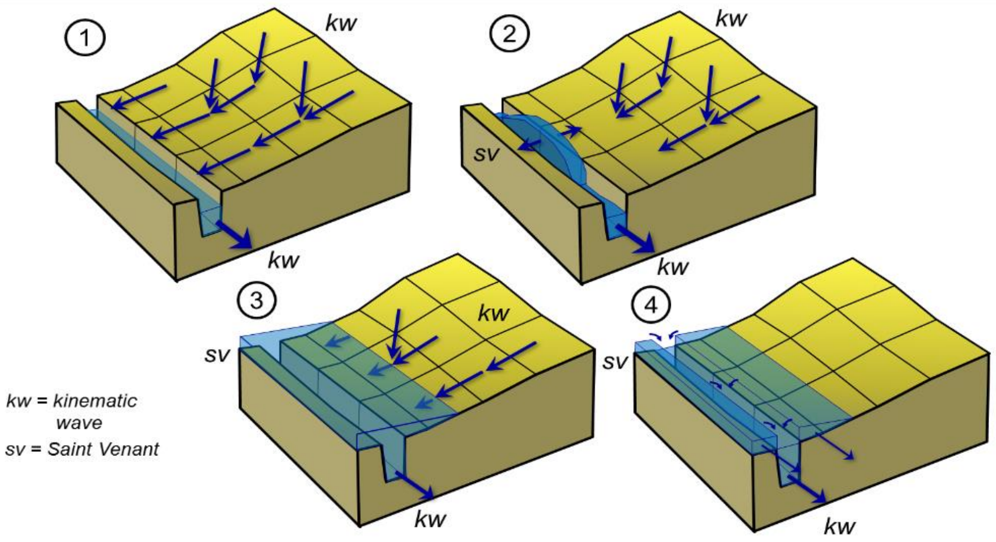
vjetten / openlisem Public

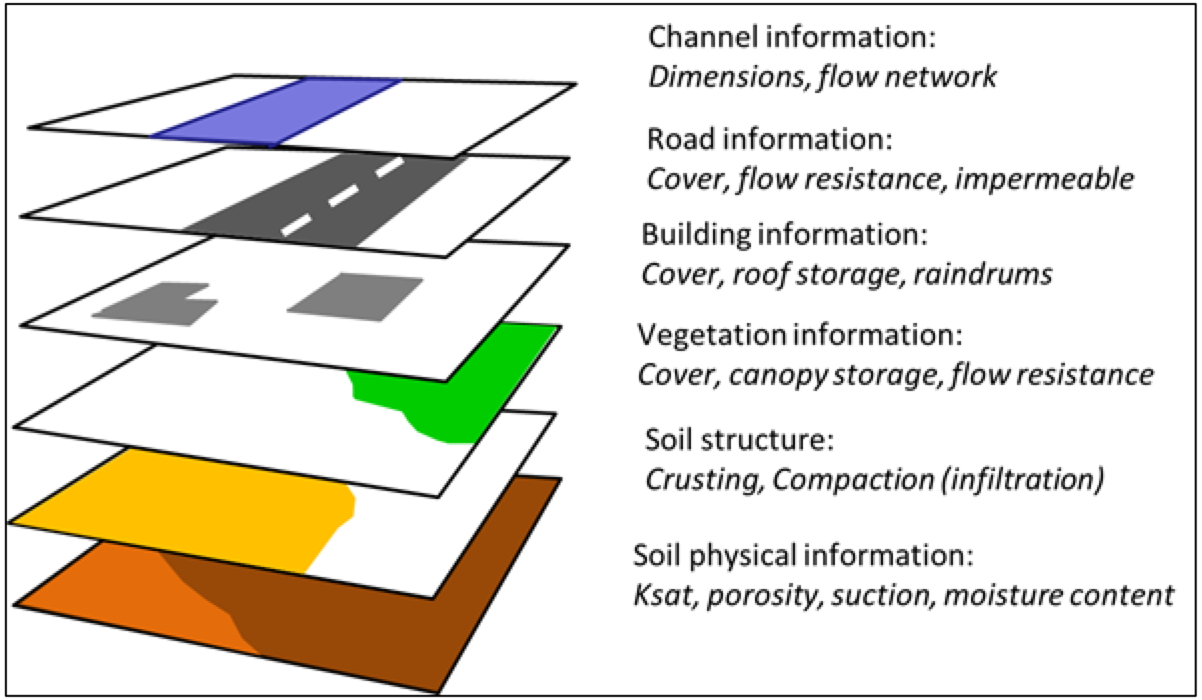
LISEM Classic



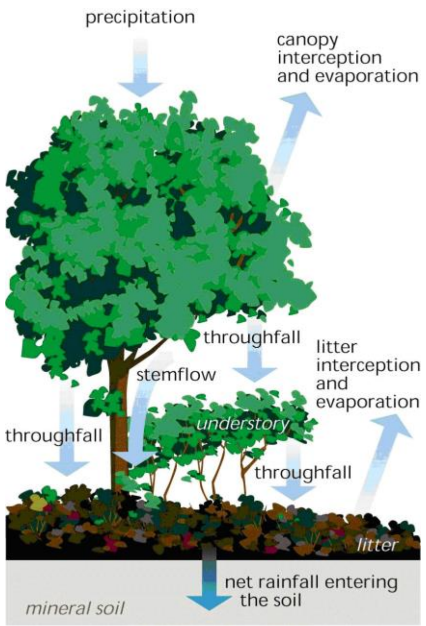
Model Principles

- Data as sub-pixel fractions
- Multiple flow types (1D and 2D linked)
- Fully integrated erosion/hydrology





HYDROLOGY



- Hydrology from rainfall through groundwater towards catchment outflow
- Simulation of water flow base on Saint Venant equations

Mass conservation

Storage Advection source

$$\frac{\partial h}{\partial t}+\frac{\partial (uh)}{\partial x}+\frac{\partial (vh)}{\partial y}=R-I$$

Momentum Balance

Storage Advection source

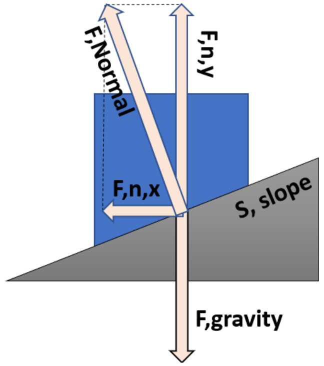
$$\frac{\partial u}{\partial t}+\quad u\frac{\partial (hu^2)}{\partial x}+\frac{\partial huv}{\partial y}\quad =S_x$$

Storage Advection source

$$\frac{\partial v}{\partial t}+\frac{\partial huv}{\partial x}+\frac{\partial (hv^2)}{\partial y}\quad =S_y$$

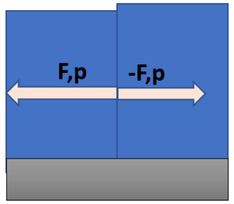
Gravity
9.81!

$$S_{f,x} = -ghS_x$$
$$S_{f,y} = -ghS_y$$



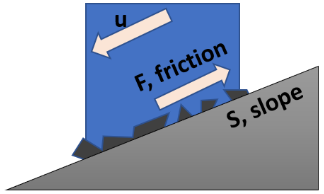
Pressure
Reaction = Action!

$$F_p = \int_0^h gh\,dh = \frac{gh^2}{2}$$



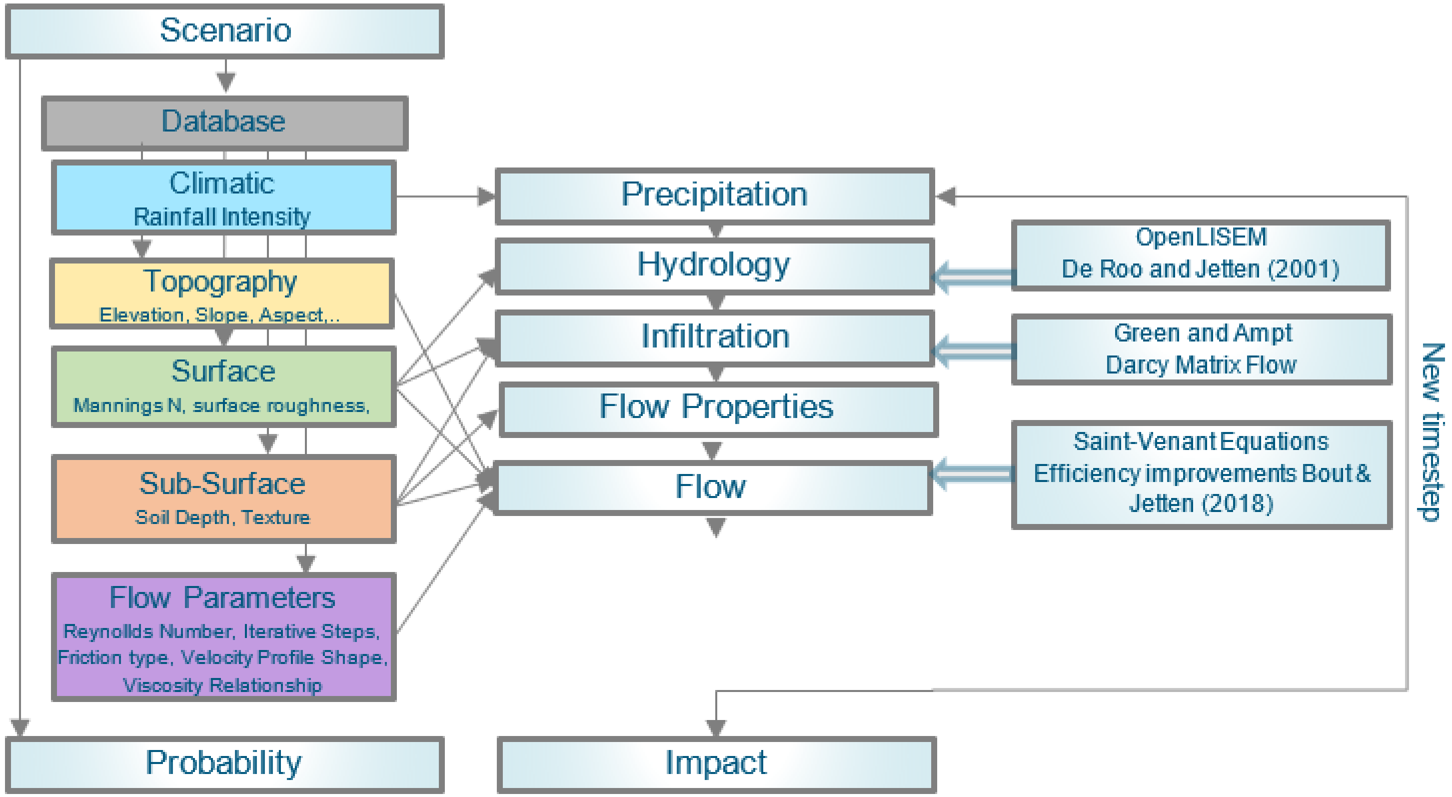
Friction
Manning was right

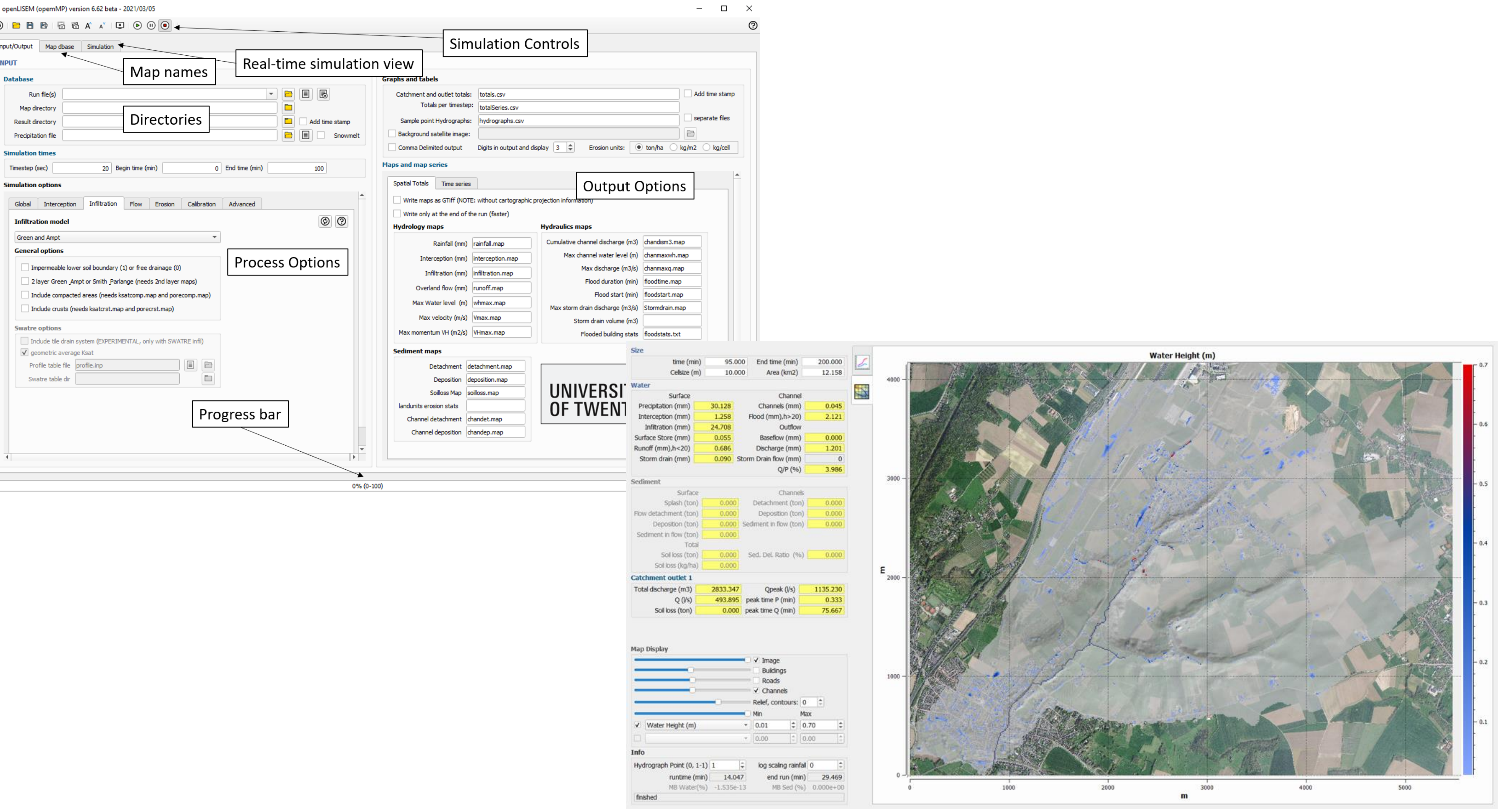
$$S_f = \frac{g}{n^2}\frac{\vec{u}|\vec{u}|}{h^{\frac{4}{3}}}$$



Model setup

- Physically-based model customized for the relevant scale/areas of study; Efficient upscaling to maximize potential



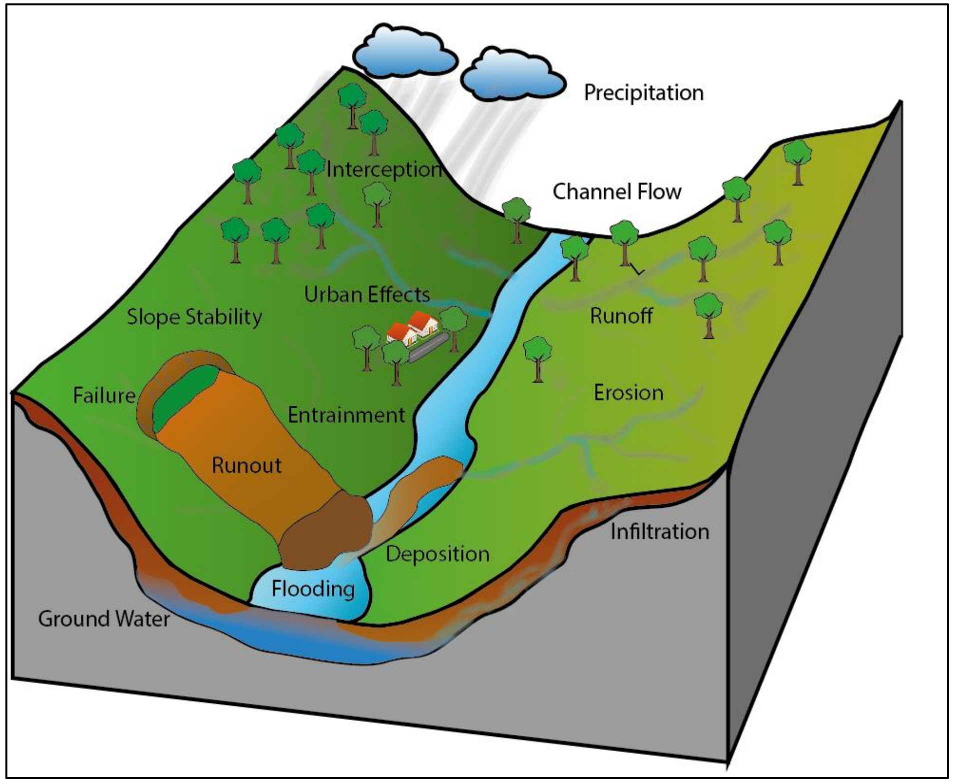

openLISEM (opemMP) version 6.62 beta - 2021/03/05
Simulation Controls
Real-time simulation view
Map names
Directories
Process Options
Output Options
Progress bar
Water Height (m)

LISEM Hazard

- Multi-hazard integrated simulation
  - Hydrology
  - Flow
  - Slope Stability
  - Landslides/Debris flows
  - Tsunami
  - Coastal

- Scripting
  - Custom models
  - Automatic Calibration
  - Data processing/visualization

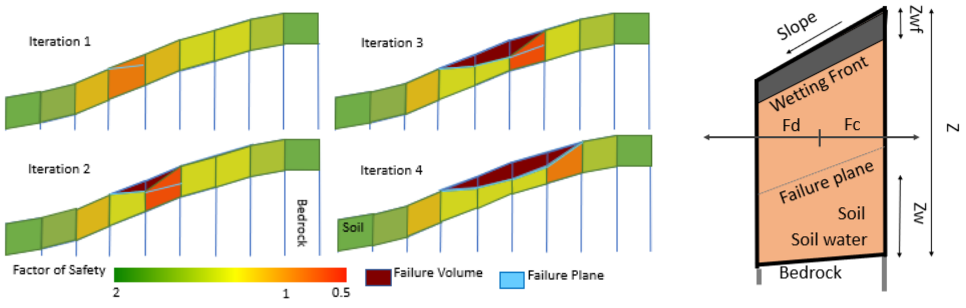
- Raster editor (Paint for geo-data!)



Underlying princples

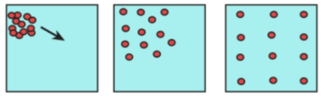
- Slope stability
- Two-phase flow equations
- Bussinesq equations for coastal

- Automatic calibration
  - Brute-force
  - Gradient descent
- Linking with real-time forecast data

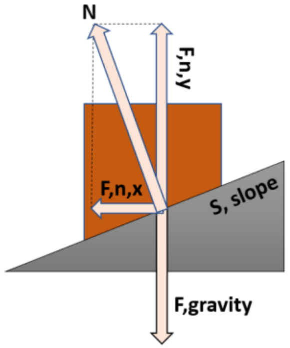


Flow – Solids Related

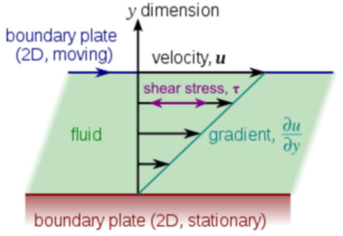
Diffusion, concentrations spread out



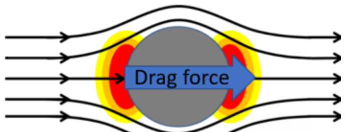
Solids create their own stability
Internal friction angle!



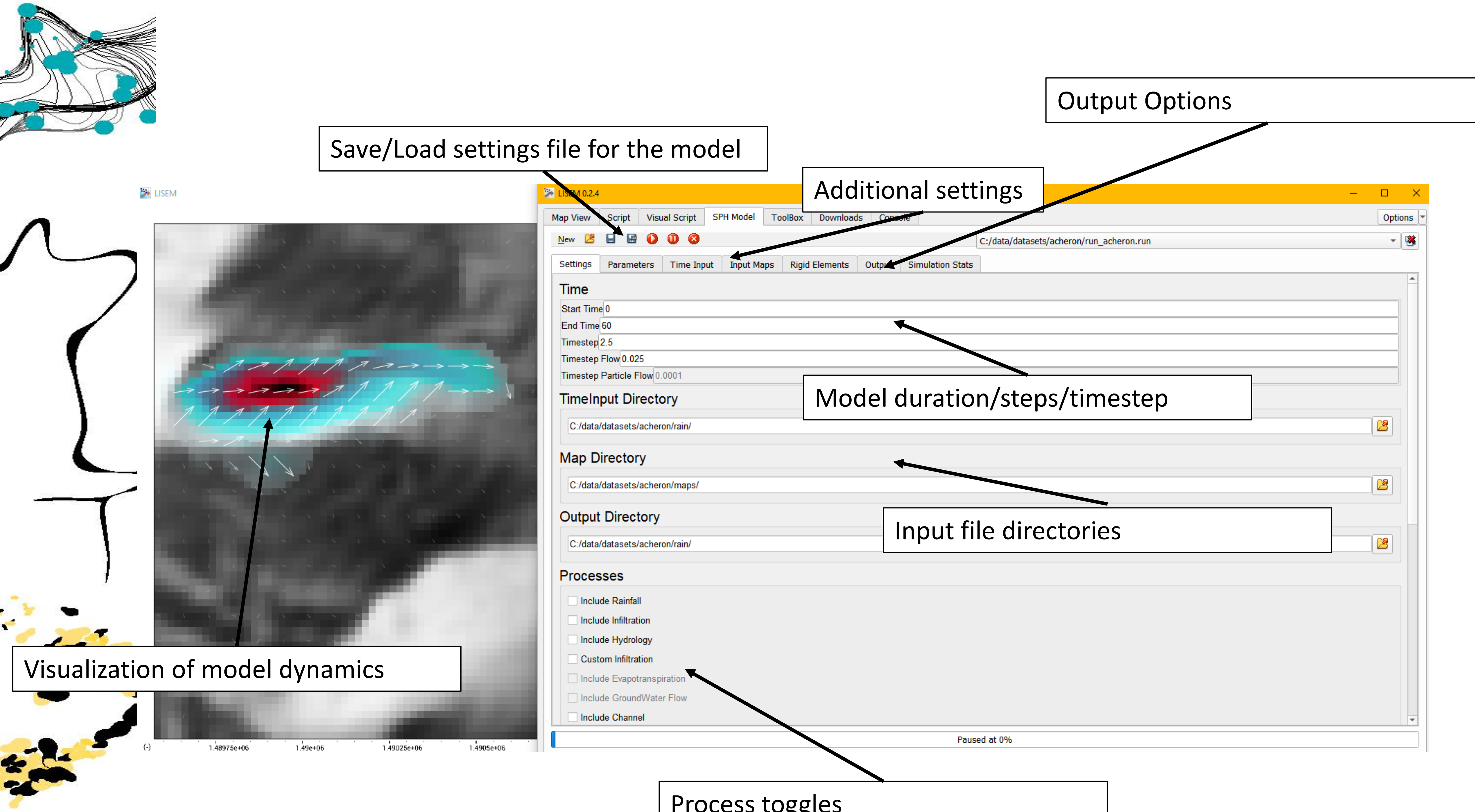
Viscosity
Sediment increase thickness

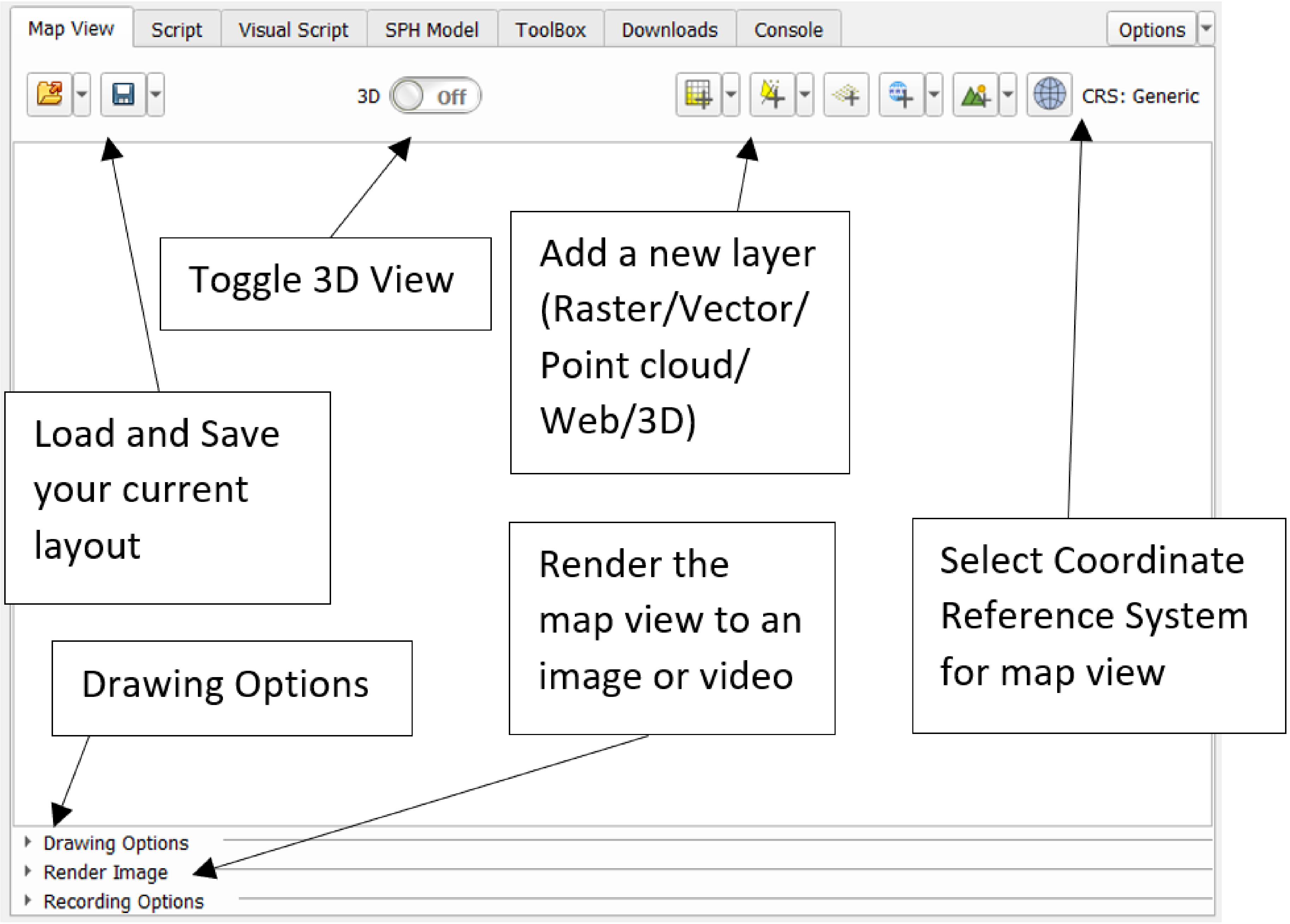


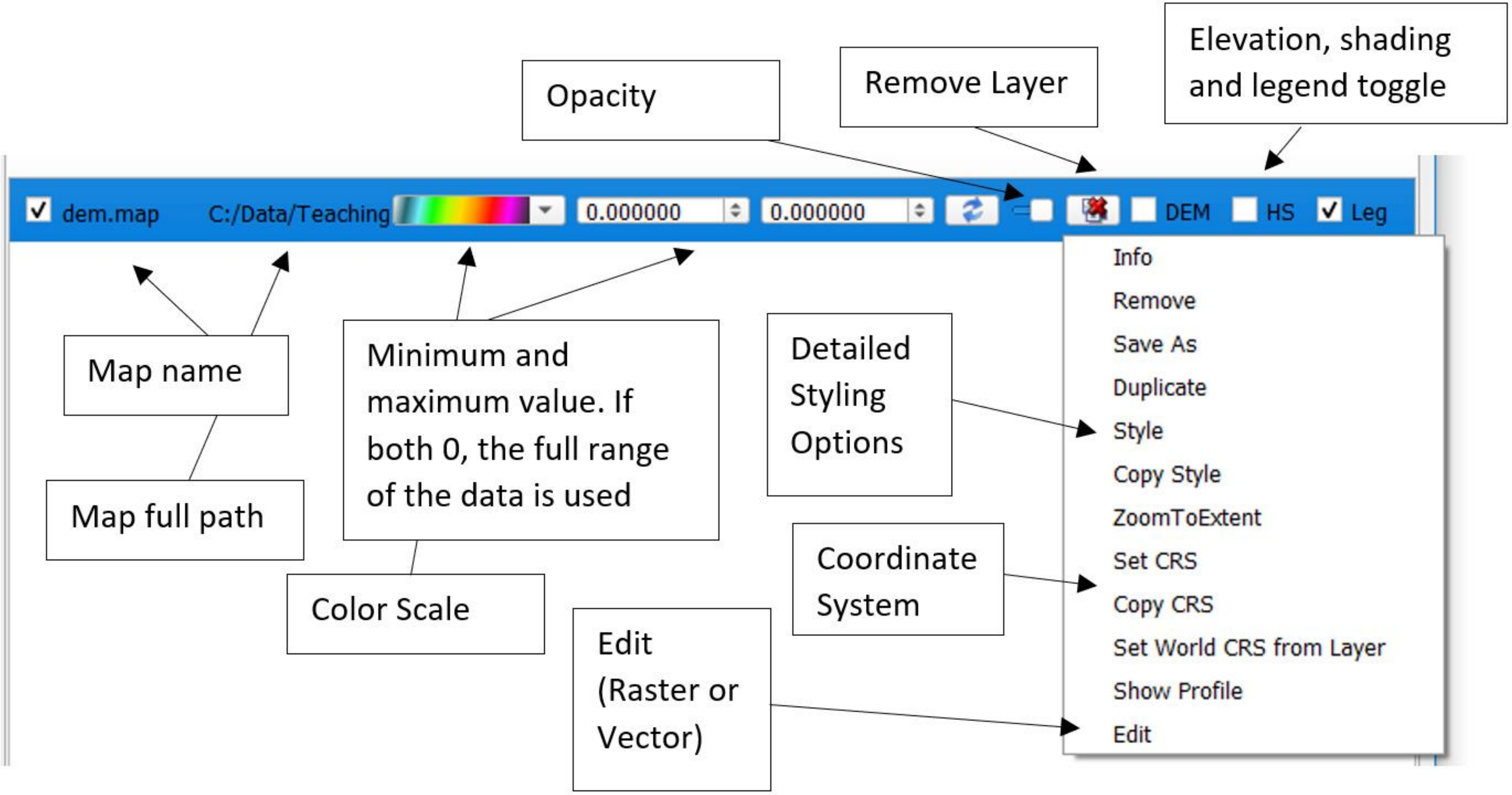
Drag-Force
Grains and water flow want to move together



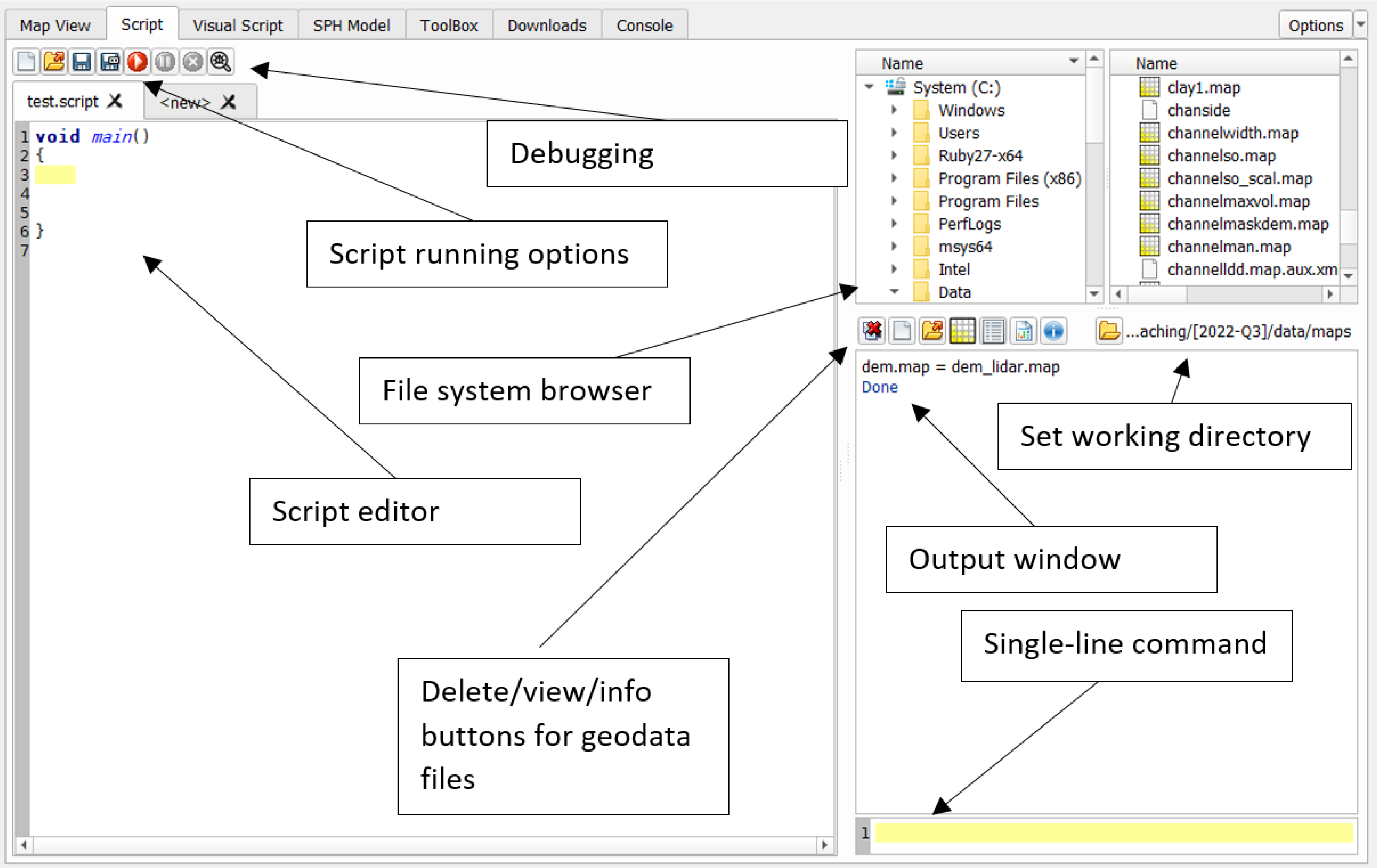
Result: LONG EQUATIONS
linked with catchment processes


Output Options
Save/Load settings file for the model
Additional settings
Model duration/steps/timestep
Input file directories
Visualization of model dynamics
Process toggles
LISEM
LISEM 0.2.4
Map View
Script
Visual Script
SPH Model
ToolBox
Downloads
Console
Options
New
C:/data/datasets/acheron/run_acheron.run
Settings
Parameters
Time Input
Input Maps
Rigid Elements
Outp
Simulation Stats
Time
Start Time 0
End Time 60
Timestep 2.5
Timestep Flow 0.025
Timestep Particle Flow 0.0001
TimeInput Directory
C:/data/datasets/acheron/rain/
Map Directory
C:/data/datasets/acheron/maps/
Output Directory
C:/data/datasets/acheron/rain/
Processes
Include Rainfall
Include Infiltration
Include Hydrology
Custom Infiltration
Include Evapotranspiration
Include GroundWater Flow
Include Channel
Paused at 0%
1.48975e+06
1.49e+06
1.49025e+06
1.4905e+06


Map View
Script
Visual Script
SPH Model
ToolBox
Downloads
Console
Options
3D
Off
CRS: Generic
Toggle 3D View
Add a new layer (Raster/Vector/ Point cloud/ Web/3D)
Load and Save your current layout
Drawing Options
Render the map view to an image or video
Select Coordinate Reference System for map view
Drawing Options
Render Image
Recording Options



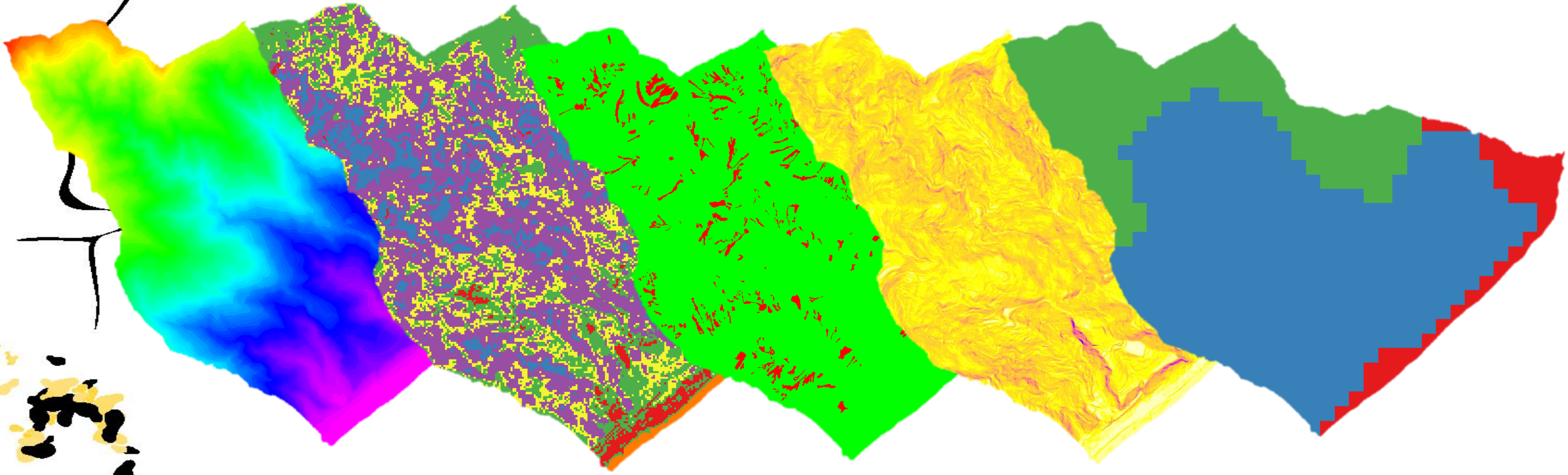
Opacity
Remove Layer
Elevation, shading and legend toggle
dem.map
C:/Data/Teaching
0.000000
0.000000
DEM
HS
Leg
Info
Remove
Save As
Duplicate
Style
Copy Style
ZoomToExtent
Set CRS
Copy CRS
Set World CRS from Layer
Show Profile
Edit
Map name
Map full path
Minimum and maximum value. If both 0, the full range of the data is used
Color Scale
Detailed Styling Options
Coordinate System
Edit (Raster or Vector)



Map View
Script
Visual Script
SPH Model
ToolBox
Downloads
Console
Options
test.script
<new>
void main()
{
}
Debugging
Script running options
File system browser
Script editor
Delete/view/info buttons for geodata files
Name
System (C:)
Windows
Users
Ruby27-x64
Program Files (x86)
Program Files
PerfLogs
msys64
Intel
Data
clay1.map
chanside
channelwidth.map
channelso.map
channelso_scal.map
channelmaxvol.map
channelmaskdem.map
channelman.map
channelldd.map.aux.xm
...aching/[2022-Q3]/data/maps
dem.map = dem_lidar.map
Done
Set working directory
Output window
Single-line command

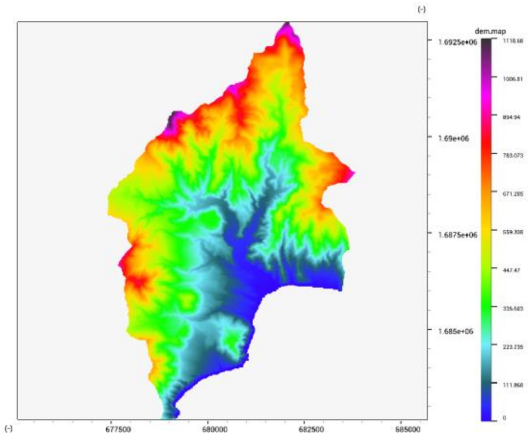
INPUT DATA

- Often many layers required for simulating complex events

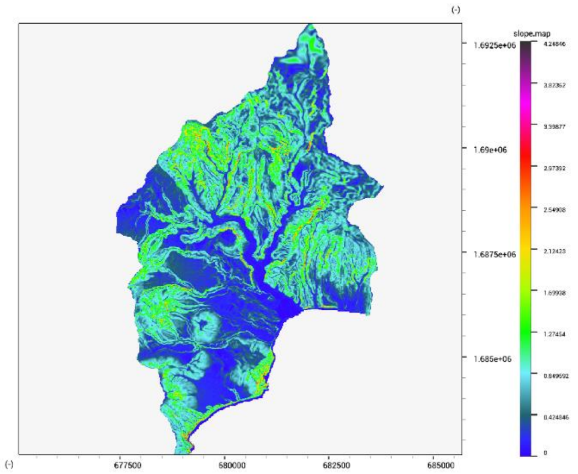


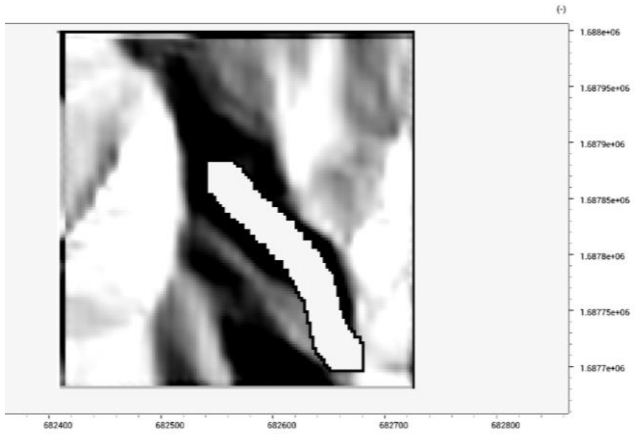
LISEM Hazard

- Scripting allows for easy preparation of data
  - Warping, interpolating, classification, simulation, filtering, projecting, analysis, derivatives, rasterizing and more

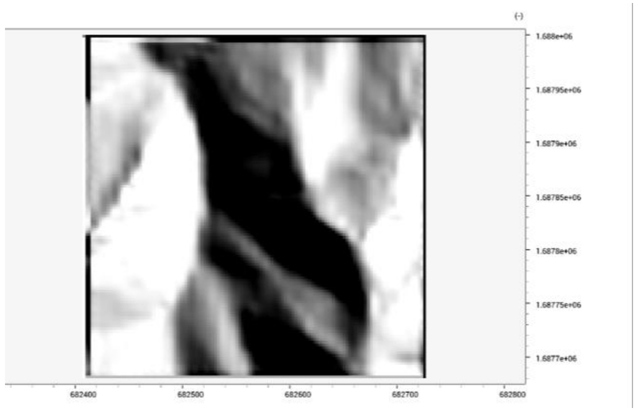


Slope.tif = Slope(dem.tif)





fixed.tif = InpaintNS(dem.tif)



SOFTWARE AVAILABILITY

- Written in c++
  - Qt for interface
  - GDAL for data in/output
  - OpenGL/OpenCL for visualization/compute
  - OpenMP for multi-core processing
  - Many more….
- Available on Github (GPL-3)
- Compiled windows binaries on Sourceforge
  - Compilation on linux possible but takes some extra work
- www.lisemmodel.com

SUPPORTING TECHNOLOGIES

- The resulting equations need to be solved Fast
- Program build in c++, data preparation and output using GDAL

Parallel computing (using your quadcore)