Practical Modeling Tips in RAMMS::Rockfall

Improving Model Quality, Efficiency and Interpretation

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Interpreting Results: Global vs Local

A single simulation produces one dataset — but its interpretation depends entirely on where it is evaluated

Global Evaluation (Entire Domain)

- Includes **release, transition, and runout zones**
- Aggregates **all trajectory data**
- Represents **overall system behaviour**

Use for:

- Model verification
- Scenario comparison
- Understanding global variability

Local Evaluation (Specific Locations)

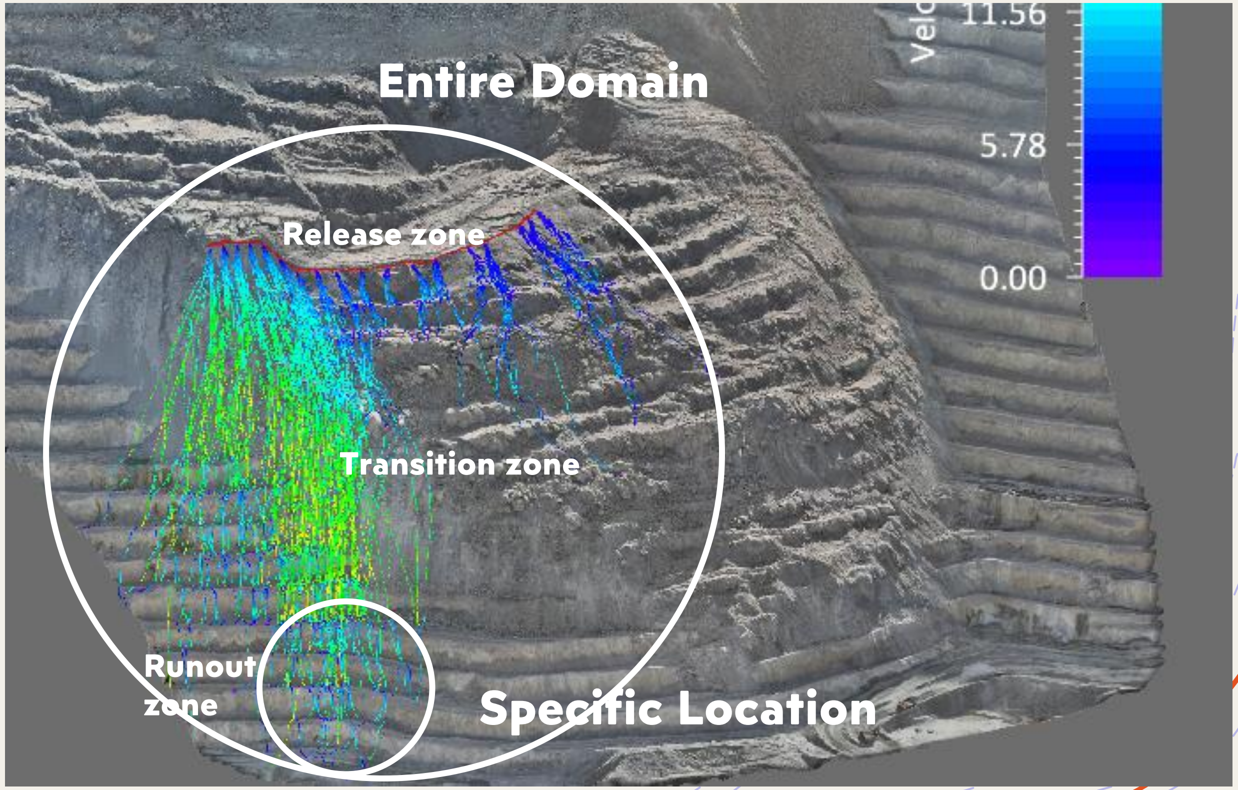
Focus on **defined positions in the domain**

Protection dams, Barrier lines / nets, Roads / infrastructure

Use for:

- **Engineering design values**
- Impact conditions at **protective measures**
- Site-specific risk assessment

What happens in the whole domain? vs.
What happens at my structure?



Plots: Scenario (All Data) – Global Statistics

Content:

- Evaluates **all trajectory values across entire domain**
- Produces **comprehensive statistical report (HTML)**

Includes:

- Min, Mean, Median, Q95, Q99, Max
- Histograms, PDF, CDF, Boxplots

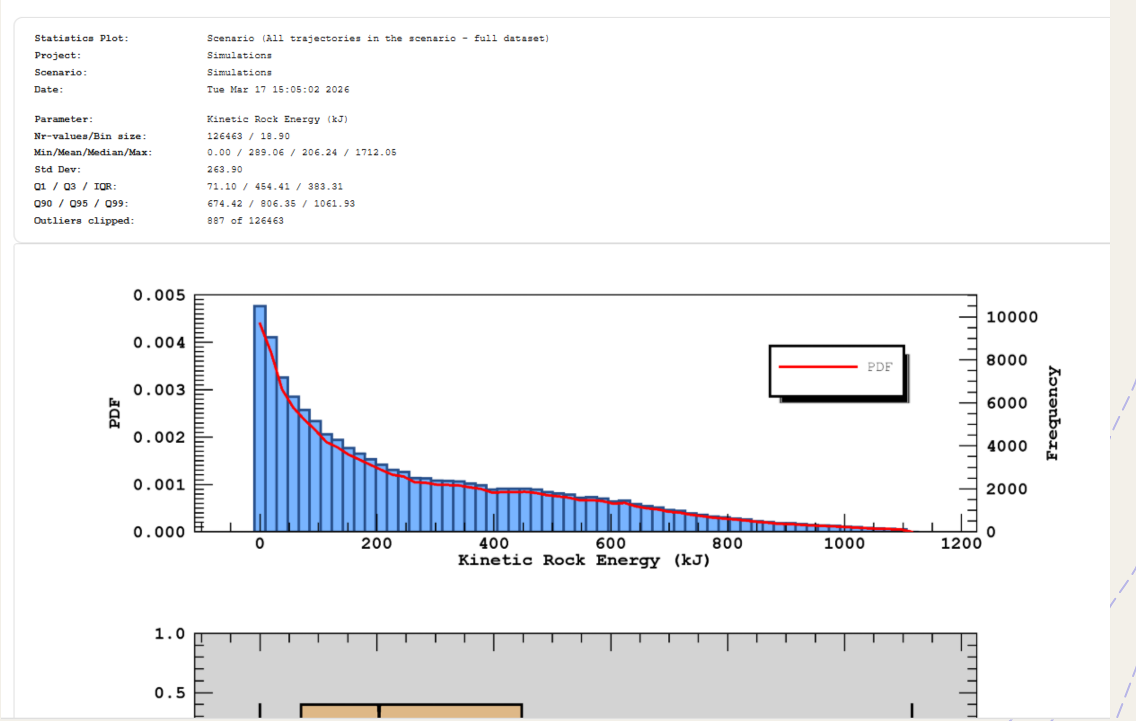
Engineering Use:

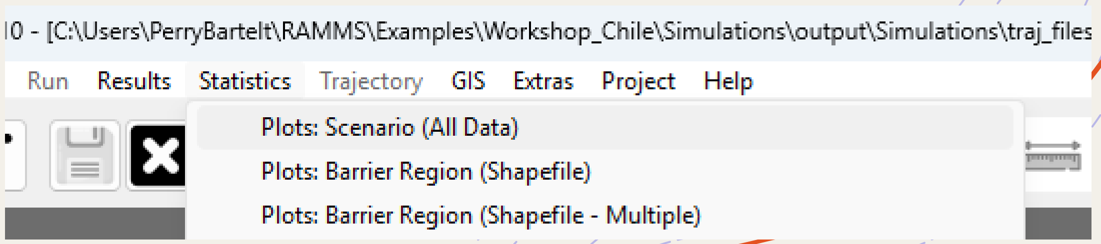
- Global hazard characterization
- Scenario comparison
- Understanding distribution shape (skewness, extremes)

Important Limitation:

No spatial specificity — not suitable for structure design

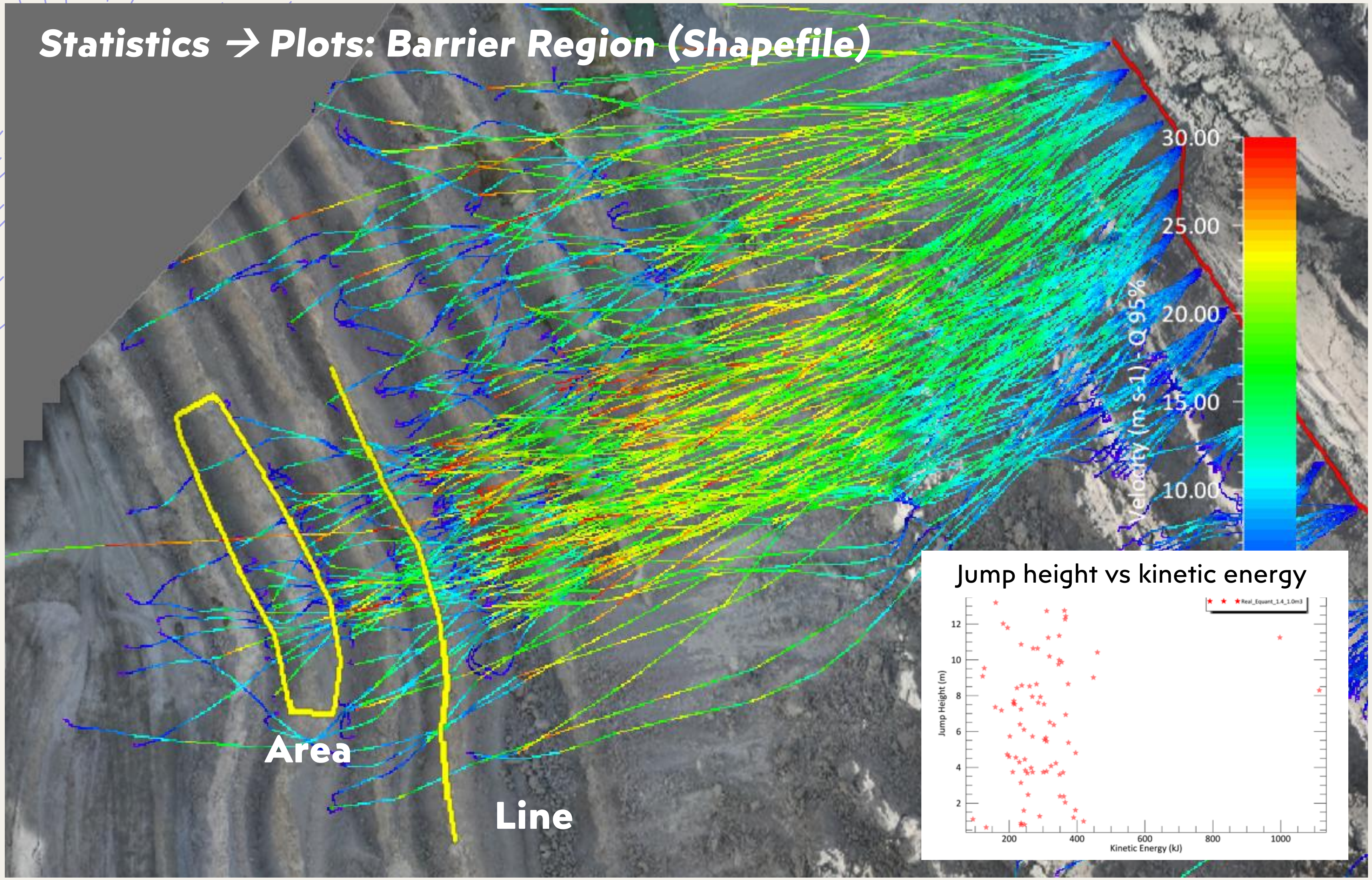
Statistical report appears in browser





Statistics → Plots: Scenario (All Data)

Barrier Region (Shapefile): Targeted Analysis using Lines or Polygons



Evaluates **trajectory values intersecting a user-defined region**

- **Polygon** → e.g. net field, building footprint
- **Line** → e.g. road, dam crest

Generates a **statistical report as an HTML file.** Opens directly in a **web browser**

- Descriptive statistics (Mean, Q95, etc.)
- Distribution plots
- Jump height vs kinetic energy
- Number of passing trajectories and deposited trajectories

Engineering Use:

- Determination of **design-relevant impact values**
- Direct evaluation at **protective structures and infrastructure**

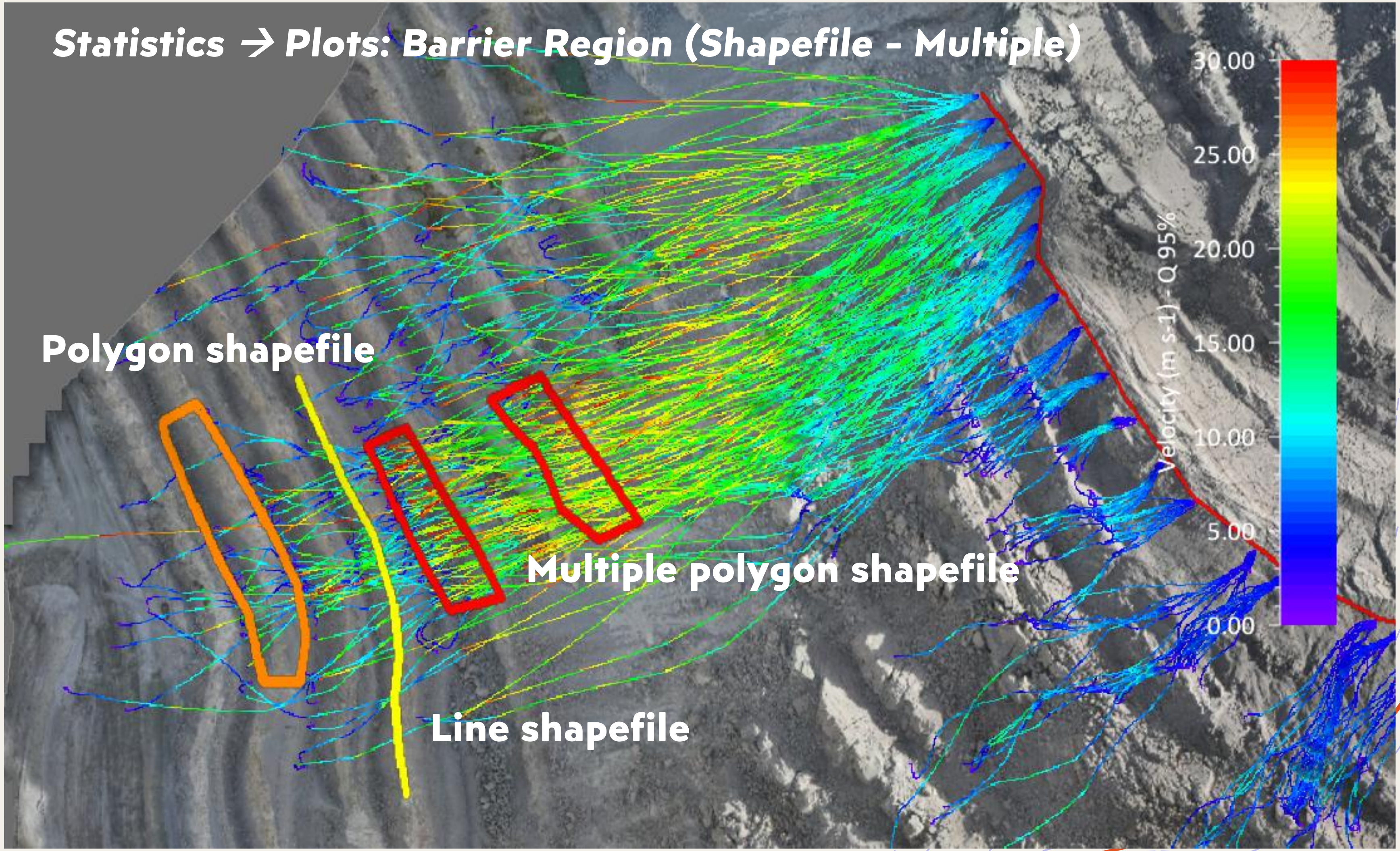
Barrier Region (Multiple): Comparing Structures

Evaluates **multiple shapefiles simultaneously**

Each region:
- Processed independently
- Own statistical report

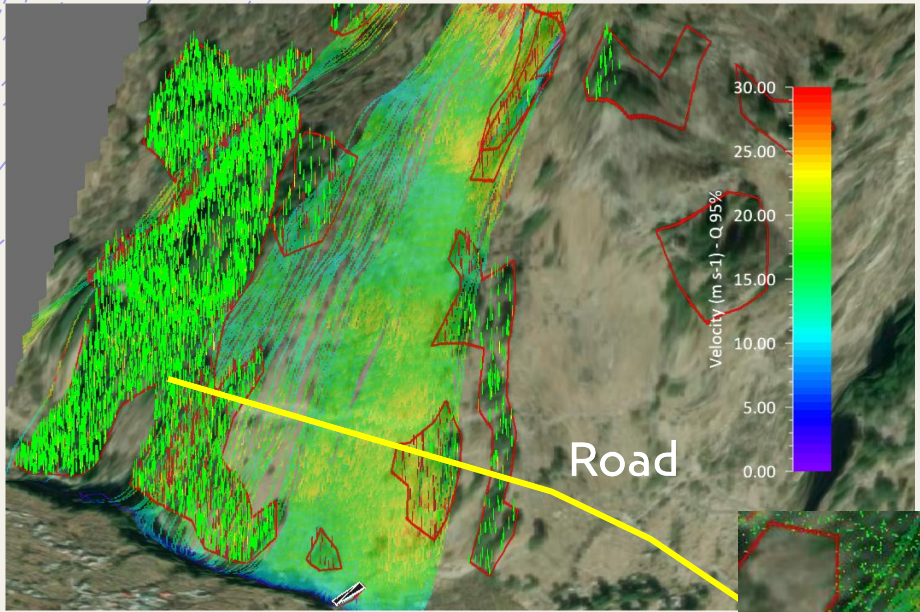
Typical Use Cases:
- Several barriers or net fields
- Different road sections
- Alternative mitigation designs

Engineering Benefit:
Direct comparison of:
- Impact energy
- Frequency
- Critical locations

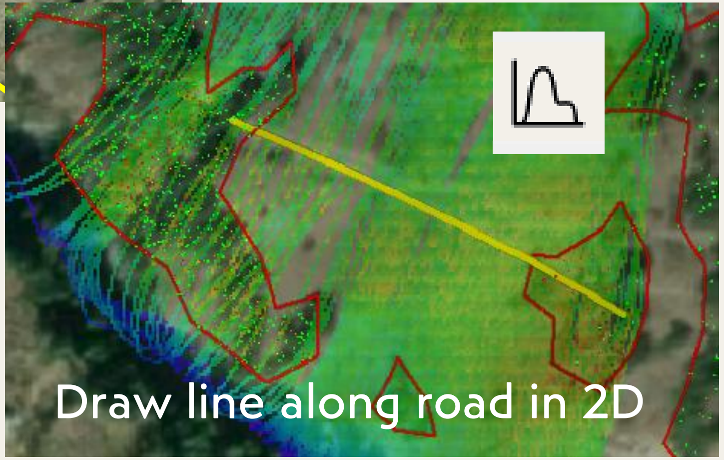


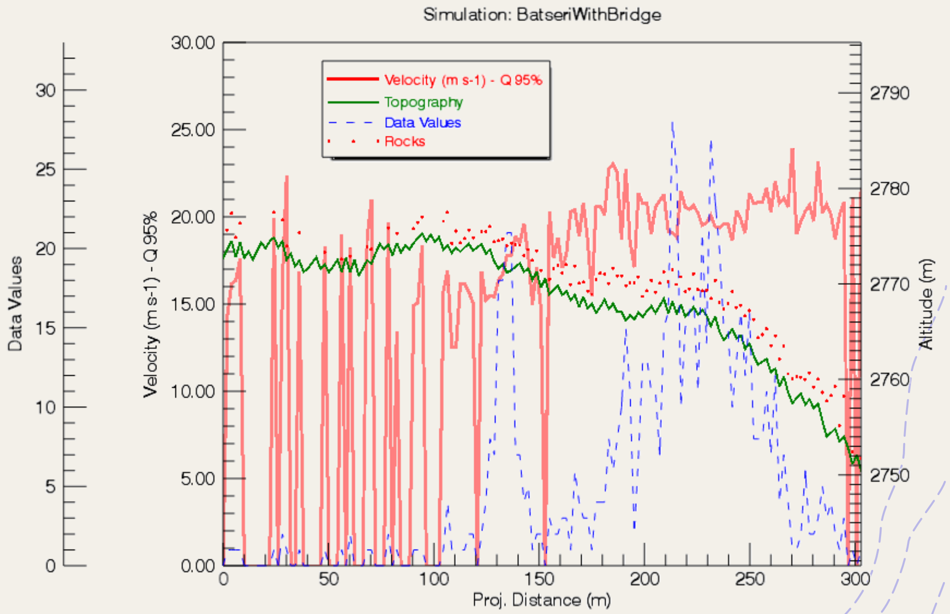
Line Profile:
Exploring Results Along a Line

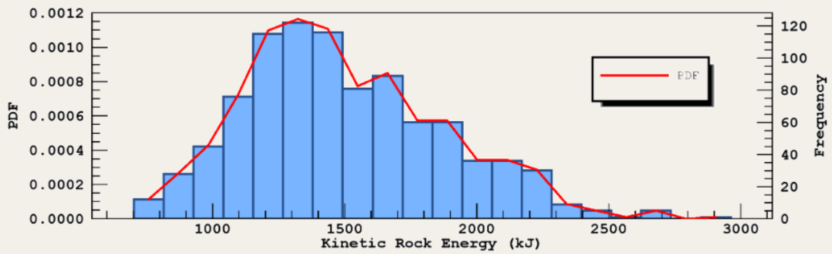
Visualize how key parameters vary along a user-defined line (e.g. road or dam)



- Extracts values of the **active parameter** along a drawn line
- Displays results as a **profile plot along distance**
- **Makes HTML statistics report**
- Useful for identifying:
    - Maximum values
    - Spatial trends
    - Critical locations







Reach Probability in RAMMS::Rockfall

Core Idea: Probability that a rock reaches a location (cell or object)

Definitions

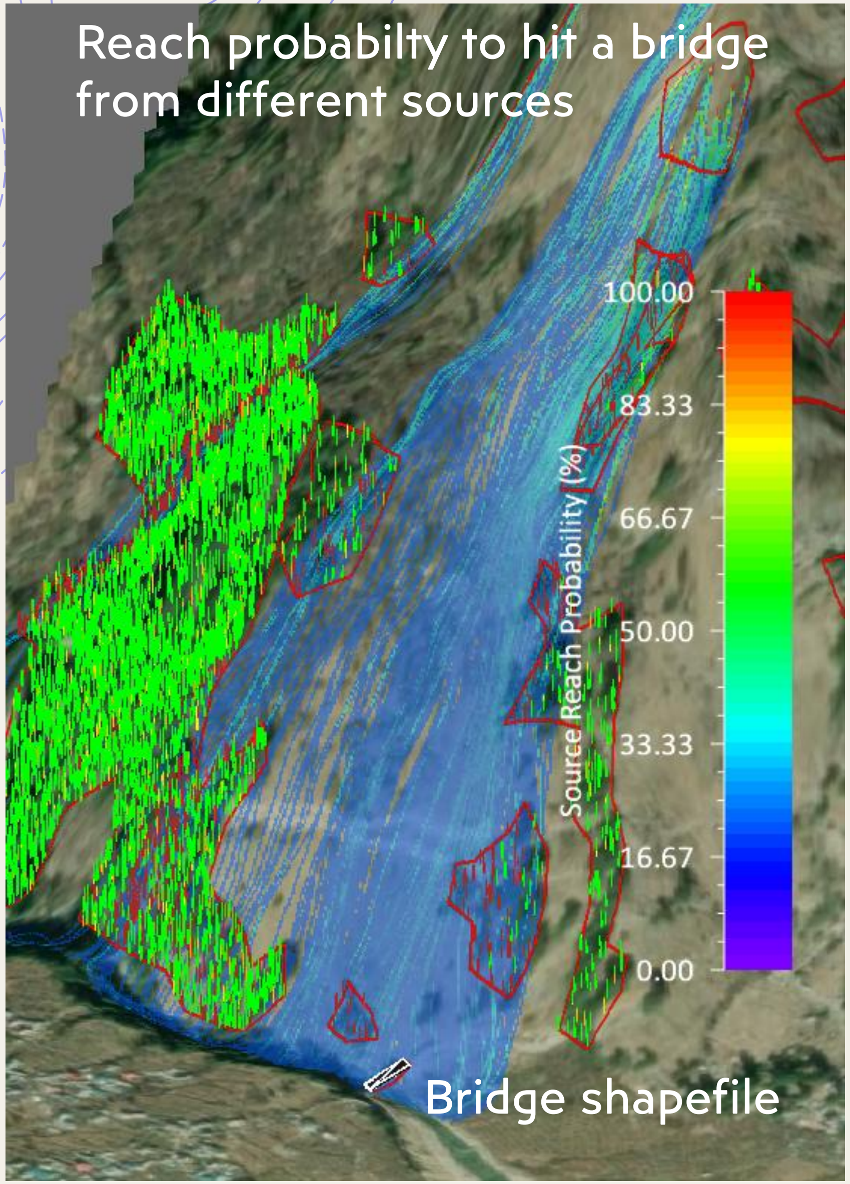
- n_S : number of source cells
- n_R : number of rocks
- n_O : number of orientations per source
- n_C : number of **contributing source cells** *(at least one trajectory reaches target)*
- n : number of trajectories reaching the target (cell or polygon)

Key Distinction:

- *Source vs Total* → **which release areas are considered** (n_S or n_C)
- *Raster vs Polygon* → **cell or polygon**

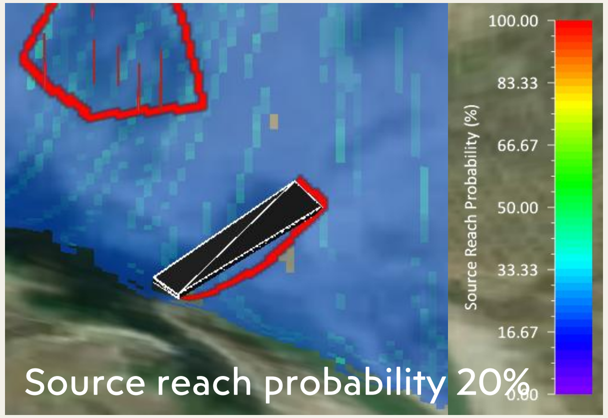
Source Reach Probability	$P_{\text{source}} = \dfrac{n}{n_R \cdot n_C \cdot n_O}$	Includes **all contributing source locations** • Unstable zone analysis • Scenario comparison • Source attribution
Total Reach Probability	$P_{\text{total}} = \dfrac{n}{n_R \cdot n_S \cdot n_O}$	Includes **all release sources** Used for: • Hazard mapping • Zonation • Risk modelling
Reach Probability (Polygon / Obect)	$P_{\text{polygon}} = \dfrac{n}{n_R \cdot n_C \cdot n_O}$	Computed for **entire objects (polygons)** Examples: • Buildings • Roads • Protection structures

Practical Use of Reach Probability



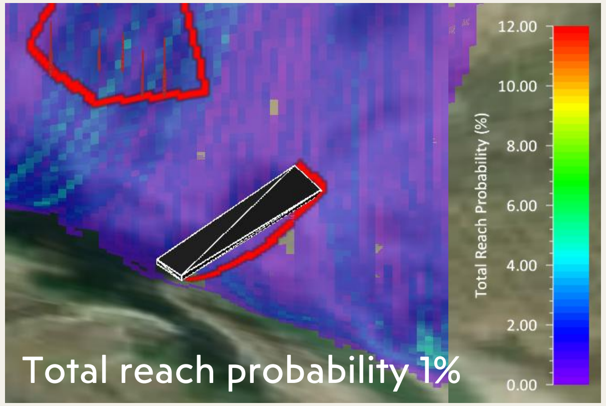
Source Reach Probability

$$P_{\text{source}} = \frac{n}{n_R \cdot n_C \cdot n_O}$$



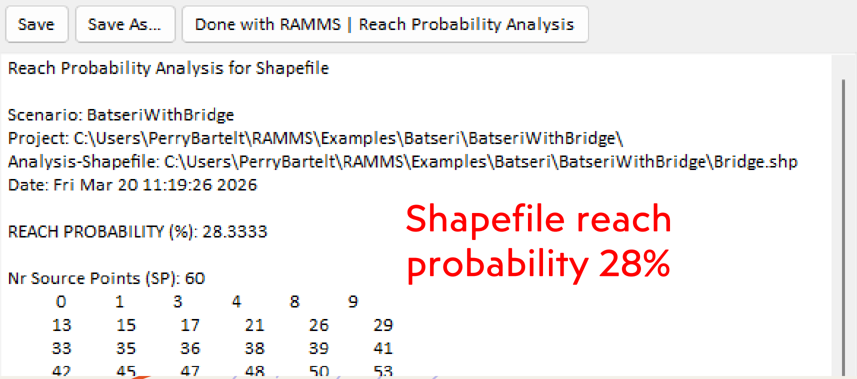
Total Reach Probability

$$P_{\text{total}} = \frac{n}{n_R \cdot n_S \cdot n_O}$$



Reach Probability from Shapefile

$$P_{\text{polygon}} = \frac{n}{n_R \cdot n_C \cdot n_O}$$


Save | Save As... | Done with RAMMS | Reach Probability Analysis

Reach Probability Analysis for Shapefile

Scenario: BatseriWithBridge
Project: C:\Users\PerryBartelt\RAMMS\Examples\Batseri\BatseriWithBridge\
Analysis-Shapefile: C:\Users\PerryBartelt\RAMMS\Examples\Batseri\BatseriWithBridge\Bridge.shp
Date: Fri Mar 20 11:19:26 2026

REACH PROBABILITY (%): 28.3333

Nr Source Points (SP): 60

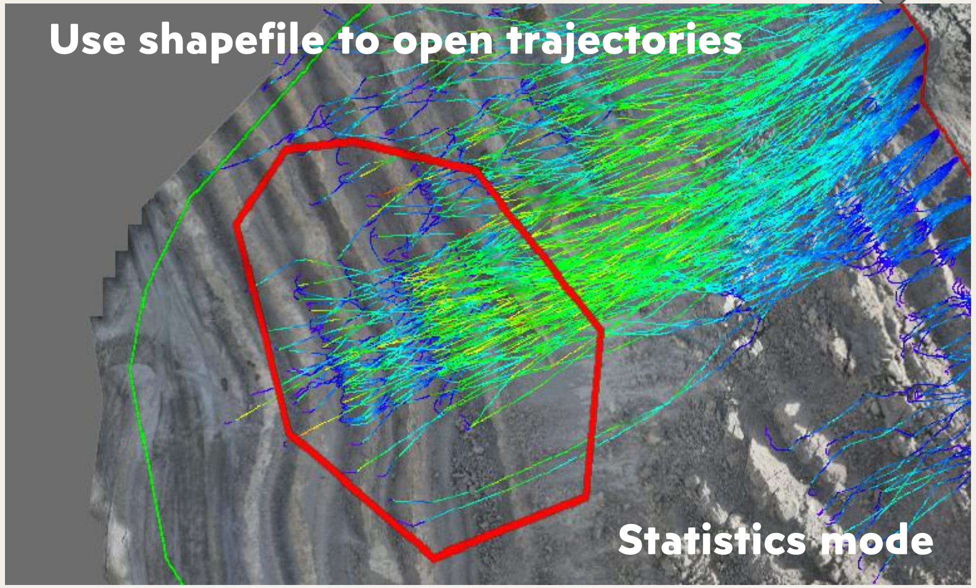
0	1	3	4	8	9
13	15	17	21	26	29
33	35	36	38	39	41
42	45	47	48	50	53

Shapefile reach probability 28%

Opening Trajectories for Analysis

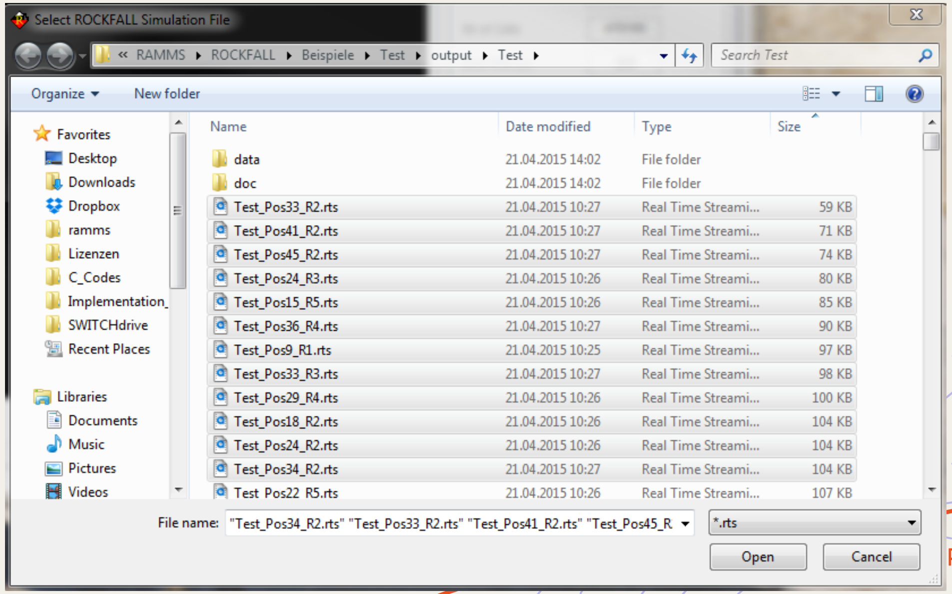
Recommended Workflow (Best Practice)

- Use **Statistics Mode → Open Trajectories from Shapefile**
- Select a **polygon or line shapefile**
- Opens only trajectories:
  - **Passing through**
  - Or **stopping within the selected area**
- ✅ Efficient way to isolate *relevant trajectories* (much smaller subset)



Alternative: Open via File Browser

- Menu: **Track → Open → Rockfall Trajectories (Ctrl + T)**
- Select files from: .../output/<Scenario>/traj_files
- Limitations:
  - Only **file** names available (no spatial context)
  - Can be **time-consuming and error-prone**



Detailed Analysis of Trajectories

Access Individual Trajectory Information

- Select a trajectory in *Trajectory Mode*
- Open: ***Trajectory* → *View Trajectory Data Log File***

Trajectory Data Log File (Key Tool)

- Records values at every time (dump) step
- Includes:
  - Velocity, energy, bounce height
  - Position and interaction with terrain

Batch Processing of Trajectories

- Create logs for all opened trajectories:
  → ***Trajectory* → *Create All Data Log Files (Ctrl + L)***
- Output location: …/output/<Scenario>/data
- Can be time- and disk-space intensive

Trajectory Input File (XML)

- Access via: **Trajectory → View Input File (xml)**
- Contains: Initial conditions, rock properties and model settings
- Useful for: Reproducibility, debugging and verification

Rock type: 2 (0: Sphere, 1: Cuboid, 2: Rock)
pts-file: C:\Users\...\Real_Equant_1.4.pts

Selected trajectory: C:\Users\...\output\Test_RTS_Files_Normal\traj_files\Test_RTS_Files_Normal_Pos1_PTS

t (s)	x (m)	y (m)	z (m)	p0 ()	p1 ()	p2 ()
0.000	2793296.700	1180256.300	2359.697	0.137	0.465	
0.002	2793296.700	1180256.300	2359.697	0.137	0.465	
0.020	2793296.700	1180256.300	2359.695	0.137	0.465	
0.040	2793296.700	1180256.300	2359.689	0.137	0.465	
0.060	2793296.700	1180256.300	2359.679	0.137	0.465	
0.080	2793296.700	1180256.300	2359.665	0.137	0.465	
0.100	2793296.700	1180256.300	2359.647	0.137	0.465	
0.120	2793296.700	1180256.300	2359.625	0.137	0.465	
0.140	2793296.700	1180256.300	2359.599	0.137	0.465	
0.160	2793296.700	1180256.300	2359.570	0.137	0.465	
0.180	2793296.700	1180256.300	2359.536	0.137	0.465	
0.200	2793296.700	1180256.300	2359.499	0.137	0.465	
0.220	2793296.700	1180256.300	2359.457	0.137	0.465	
0.240	2793296.700					
0.260	2793296.700					
0.280	2793296.700					
0.300	2793296.700	1180256.300	2359.253	0.137	0.465	
0.320	2793296.700	1180256.300	2359.192	0.137	0.465	
0.340	2793296.700	1180256.300	2359.127	0.137	0.465	
0.360	2793296.700	1180256.300	2359.058	0.137	0.465	
0.380	2793296.700	1180256.300	2358.985	0.137	0.465	
0.400	2793296.700	1180256.300	2358.908	0.137	0.465	
0.420	2793296.700	1180256.300	2358.828	0.137	0.465	
0.440	2793296.700	1180256.300	2358.743	0.137	0.465	
0.460	2793296.700	1180256.300	2358.655	0.137	0.465	
0.480	2793296.700	1180256.300	2358.562	0.137	0.465	
0.500	2793296.700	1180256.300	2358.466	0.137	0.465	
0.520	2793296.700	1180256.300	2358.366	0.137	0.465	
0.540						
0.560						
0.580						
0.600						
0.620						
0.640						

Trajectory Output File

RAMMS Input File | .Test_RTS_Files_Normal_i1.xml

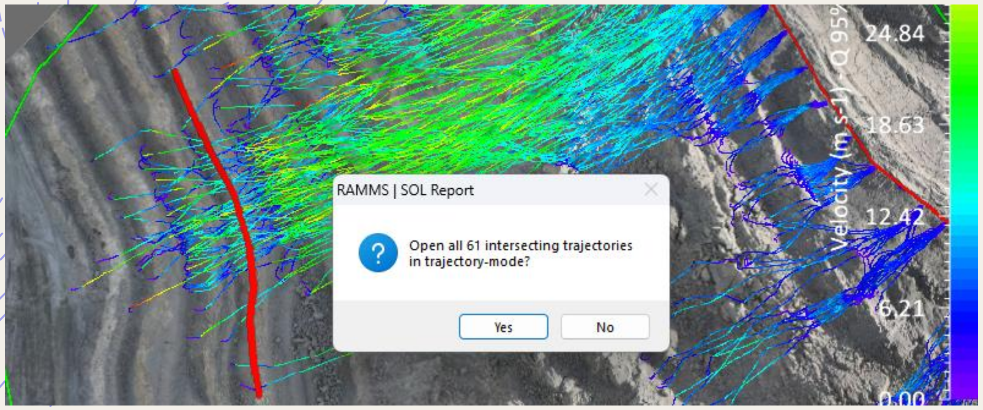
OK

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<rockfall version="2.0.3 DEV" xmlns="https://ramms.ch">

  <domain>
    <project>TestChantSura</project>
    <chamber>0</chamber>
    <gravity>0.0 0.0 -9.81</gravity>
```

Input File

Probability of Reaching Target Line (SOL)



What is the SOL Analysis?

- Evaluates how many trajectories **reach and cross a defined target line**
- Target line (SOL) = e.g. **road, railway, fence, or infrastructure** = «Schadenobjektlinie»
- Defined using a **line shapefile**

Save | Save As... | Done with RAMMS | SOL Report

```
--- RAMMS::Rockfall 2.0.10 ---

--- SOL / prA Report ---

Generated:      Mon Mar 23 09:54:01 2026
Project:        Simulations
Scenario:       Simulations

SOL-file:       TargetLine.shp
SOL segments:   1
Rock types:     1 ( REAL_EQUANT_1.4_1.0M3.PTS )

Total simulations: 400

--- SOL-Segment 1 Analysis ---
  Length [m]: 148.78   (16596.54/107851.73 <-> 16605.92/107830.95)
  Total prA (sum over types): 6.14666E-002
  Per rock type:
    -   nSim=400  nEr= 61  pEr=15.25 %  prA=6.14666E-002  vol=0.95 m3  type=REAL_EQUANT_1.4_1.0M3.PTS

Explanations:
SOL:  Schadenobjektline (Damage object line)
```

Probability that a released rock reaches the line

$$pEr = \frac{nEr}{nSim}$$

$nSim$:number of simulated trajectories
nEr: number reaching the target line

Practical Applications

- Check **alignment of protective structures**
- Compare **different scenarios or rock types**
- Provide input for **risk and hazard assessments**

Additional Feature

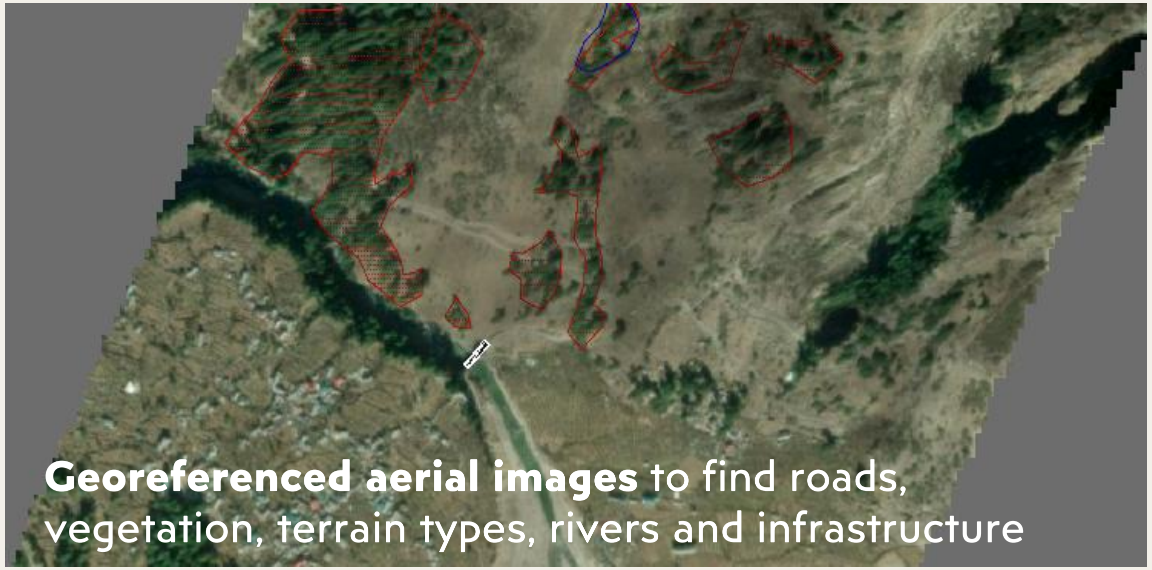
•Open all trajectories **reaching the SOL directly in Trajectory Mode**
→ Enables detailed back-analysis of critical impacts

Probability of Occurrence (prA) Includes **release frequency / event likelihood**

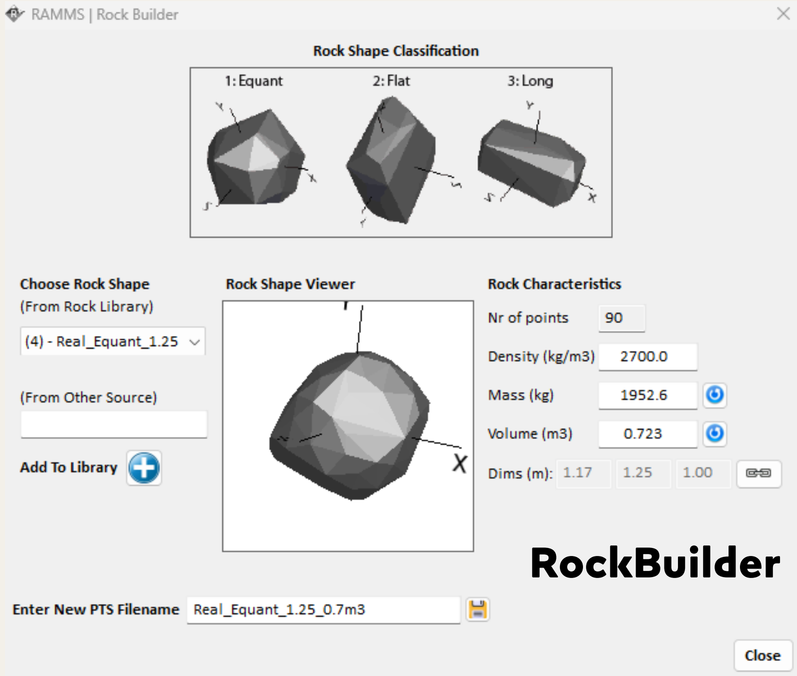
$$pA = \frac{nEr \cdot \sqrt[3]{V} \cdot pEr}{L}$$

Model Preparation: Key Practical Steps

- **DEM quality:** Check for holes and artefacts. Use grid resolutions between **0.5–2.0 m**
- **DEM from DXF:** Convert topographic DXF data to GeoTIFF using available tools
- Use **georeferenced aerial images** to support interpretation (slope, contours)
- Validate with **field evidence:** scar depths and lengths
- Use **clear and consistent naming** for shapefiles, rocks and scenarios
- Use the **RockBuilder** to define realistic rock geometries



Georeferenced aerial images to find roads, vegetation, terrain types, rivers and infrastructure



RockBuilder

Simulation Setup: Practical Guidelines

Calculation domain:

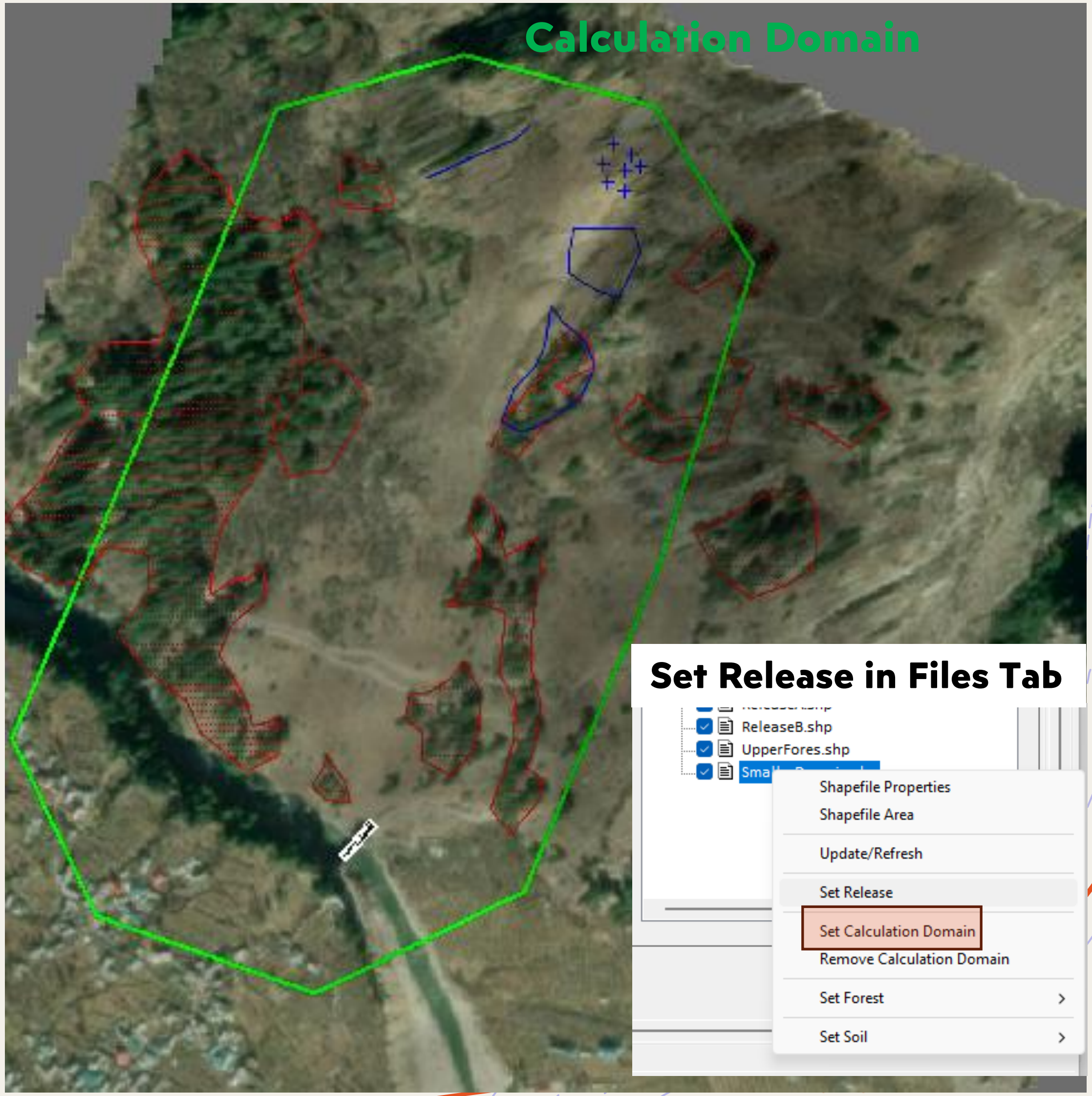
- Use a shapefile to **limit the model area and reduce computation time**
- Right-click the polygon in the file tree and select '***Set Calculation Domain***'.
- The boundary turns **green**, indicating the active domain.
- Use this feature only for large project regions.

Statistical Stability

- Use **≥ 10 random orientations** (typically 10–20)
- Increase until results are **statistically stable**
- Check using **Barrier Region Plots**

Numerical Performance

- To ensure optimal performance, the number of threads should evenly divide either **nr of release locations** or **nr of random orientations** (the larger of both).



Video Export

Enable Video Export with FFmpeg

One-time setup for exporting videos from rockfall simulations in Trajectory mode

FFmpeg is not bundled with RAMMS due to licensing constraints.

1. **Download FFmpeg** — Visit the official builds page: https://www.gyan.dev/ffmpeg/builds/
2. **Choose the package** — Download ffmpeg-release-essentials.7z or ffmpeg-release-essentials.zip
3. **Extract the archive** — Locate ffmpeg.exe inside the extracted bin folder
4. **Copy into RAMMS** — Place ffmpeg.exe in the RAMMS installation bin folder (admin rights may be required)

No admin rights?

Store ffmpeg.exe anywhere on your computer and define the full path in GUI Preferences:

```
FFMPEG
"C:\path\to\ffmpeg.exe"
```

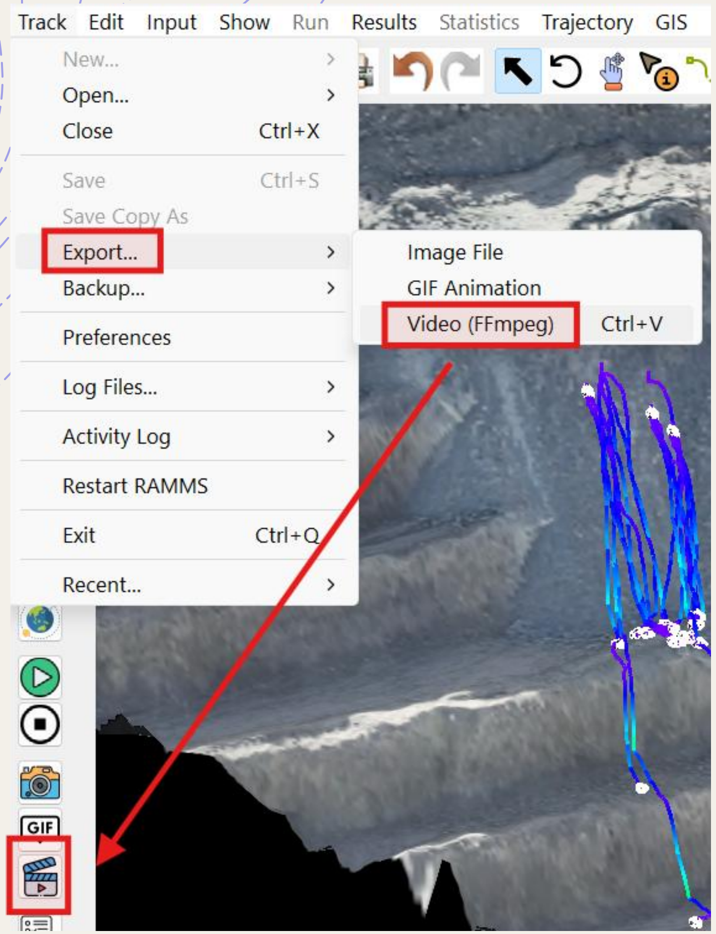
If the path contains spaces, keep the quotation marks.

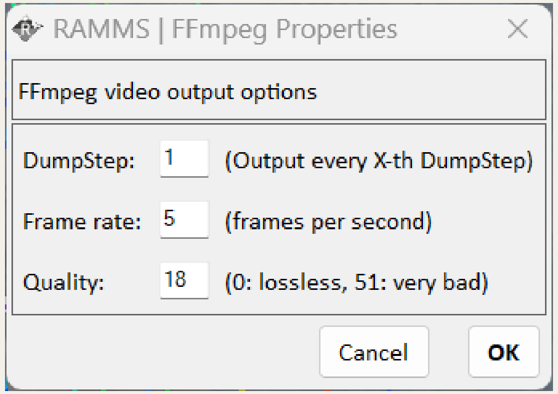
Result

RAMMS automatically detects FFmpeg after setup and enables video export.

Summary: Download FFmpeg once, place ffmpeg.exe in the RAMMS bin folder or define its path in Preferences, and RAMMS will enable video export automatically.

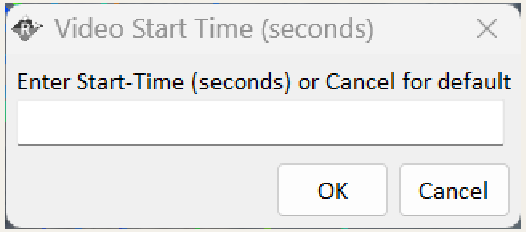
Video Export

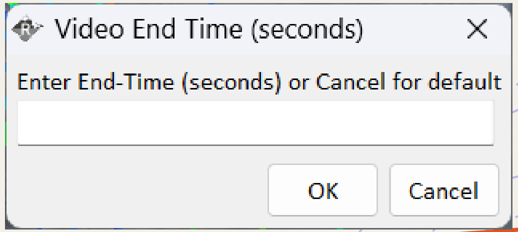




Export simulation results as videos to visualize rockfall trajectories; define file name, start time, and end time during export.

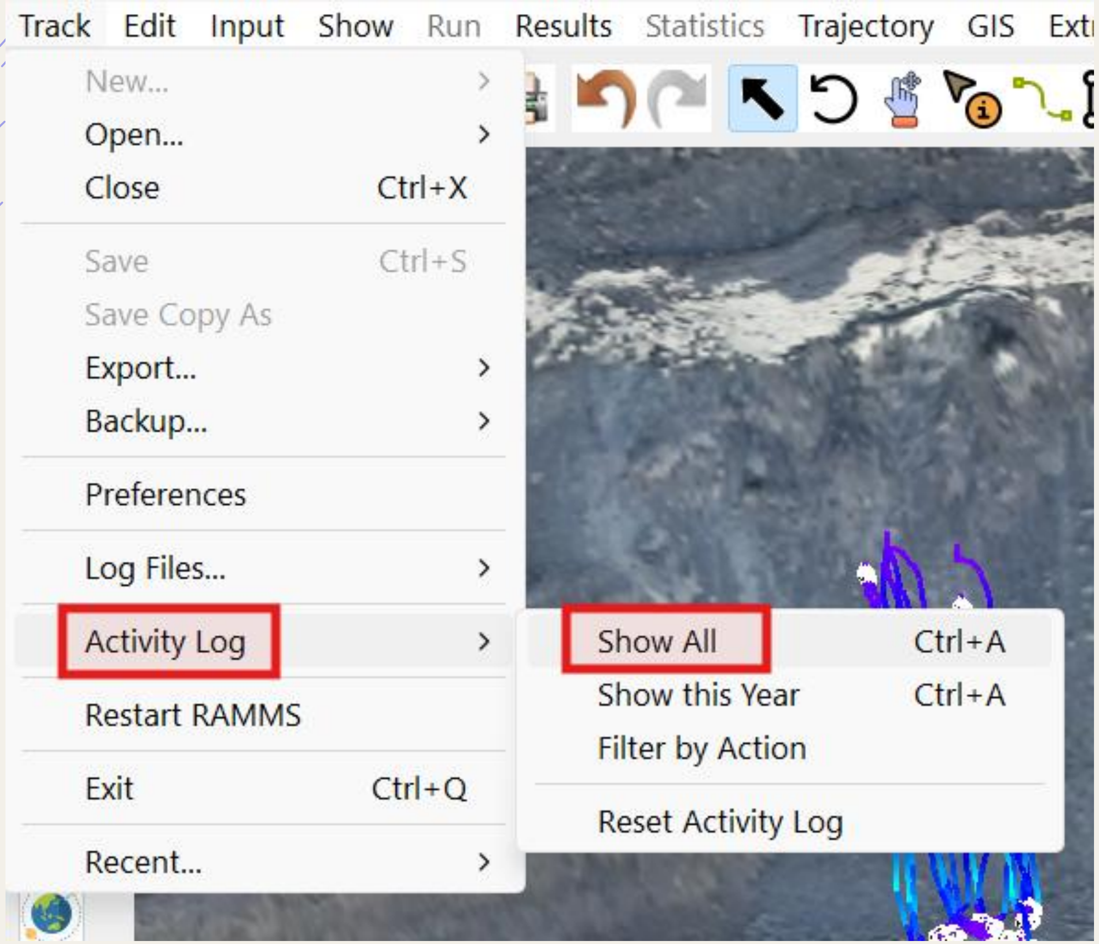
Enter filename

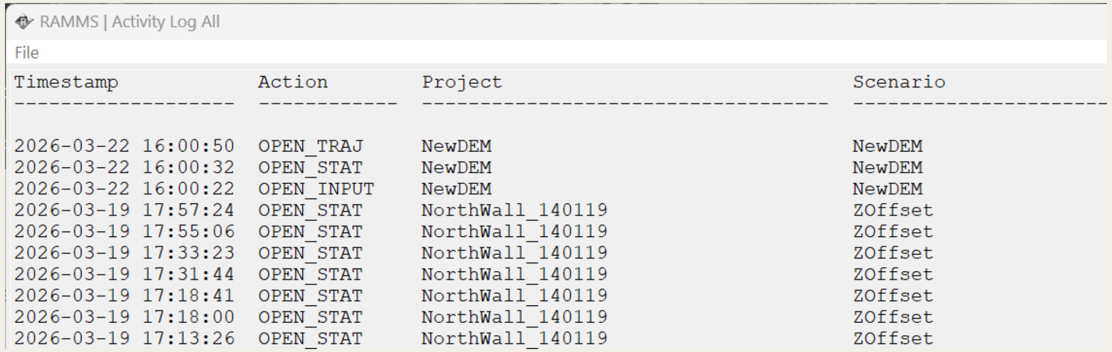




Reports and Logging

Activity-Log: Records the most important actions you take in RAMMS::Rockfall so you can audit your work, retrace steps, and find files quickly (File → Activity-Log).





RAMMS | Activity Log All

File

Timestamp	Action	Project	Scenario
2026-03-22 16:00:50	OPEN_TRAJ	NewDEM	NewDEM
2026-03-22 16:00:32	OPEN_STAT	NewDEM	NewDEM
2026-03-22 16:00:22	OPEN_INPUT	NewDEM	NewDEM
2026-03-19 17:57:24	OPEN_STAT	NorthWall_140119	ZOffset
2026-03-19 17:55:06	OPEN_STAT	NorthWall_140119	ZOffset
2026-03-19 17:33:23	OPEN_STAT	NorthWall_140119	ZOffset
2026-03-19 17:31:44	OPEN_STAT	NorthWall_140119	ZOffset
2026-03-19 17:18:41	OPEN_STAT	NorthWall_140119	ZOffset
2026-03-19 17:18:00	OPEN_STAT	NorthWall_140119	ZOffset
2026-03-19 17:13:26	OPEN_STAT	NorthWall_140119	ZOffset

Summary

1. Interpret results at the right scale: global vs local
- Global statistics → overall system behaviour
- Local (shapefile-based) analysis → **design values at structures**

2. Use shapefiles to focus analysis and support engineering decisions
- Target specific elements (roads, dams, barriers)
- Compare multiple protection options directly

→ **Analysis must match the engineering question**

3. Combine statistics and probabilities to quantify hazard
- Distributions (Q95, max) capture variability and extremes
- Reach probability and SOL analysis quantify **impact likelihood**

→ Basis for **hazard and risk assessment**

4. Use trajectories and outputs to understand, verify, and communicate results
- Trajectory analysis explains **physical behaviour and critical events**
- Logs and profiles support **detailed investigation**
- Video export and reports enable **clear communication of results**