AVALANCHE HAZARD & RISK CONCEPTUAL MODEL – PREWORK

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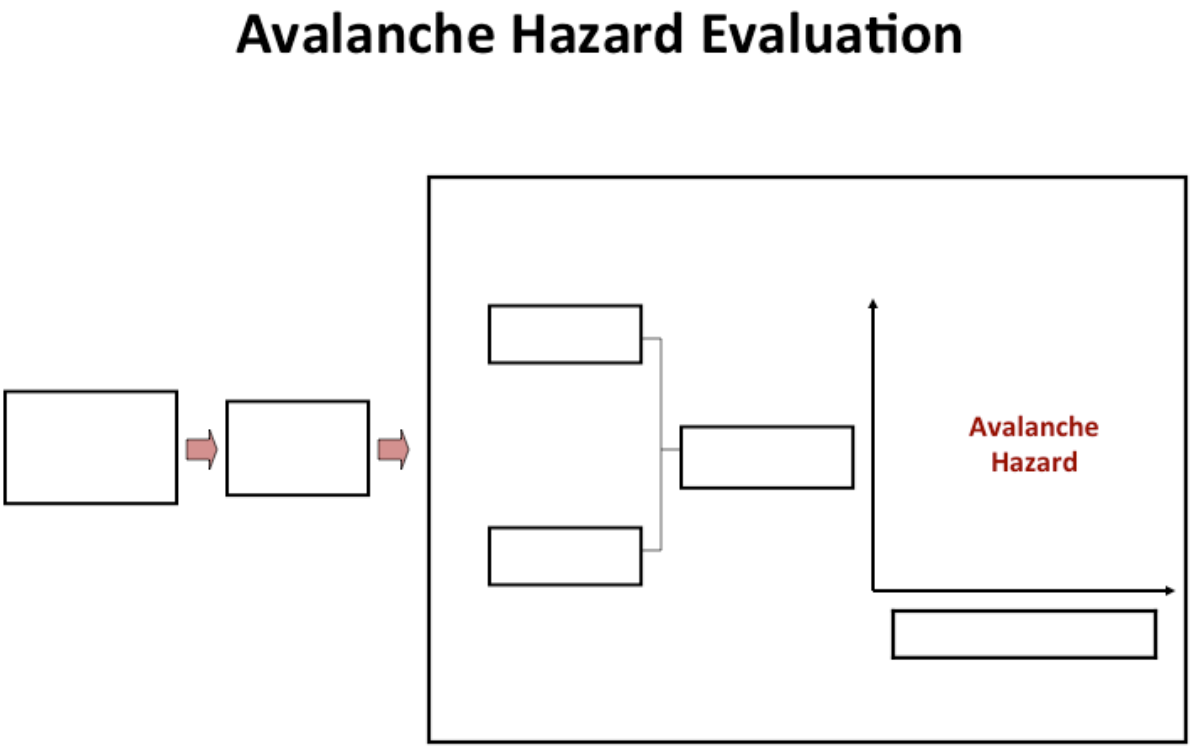
1) Review the Conceptual Model of Avalanche Hazard materials on the following page and fill in the blank diagram below. Note: Don't worry, we will spend time on this model in the lecture but want the student to be exposed to the model before the lecture.

2) Read one or both of the recommended readings, these are web articles about avalanche problems:

http://avalanche.state.co.us/forecasts/help/avalanche-problems/

https://utahavalanchecenter.org/avalanche-problem-toolbox

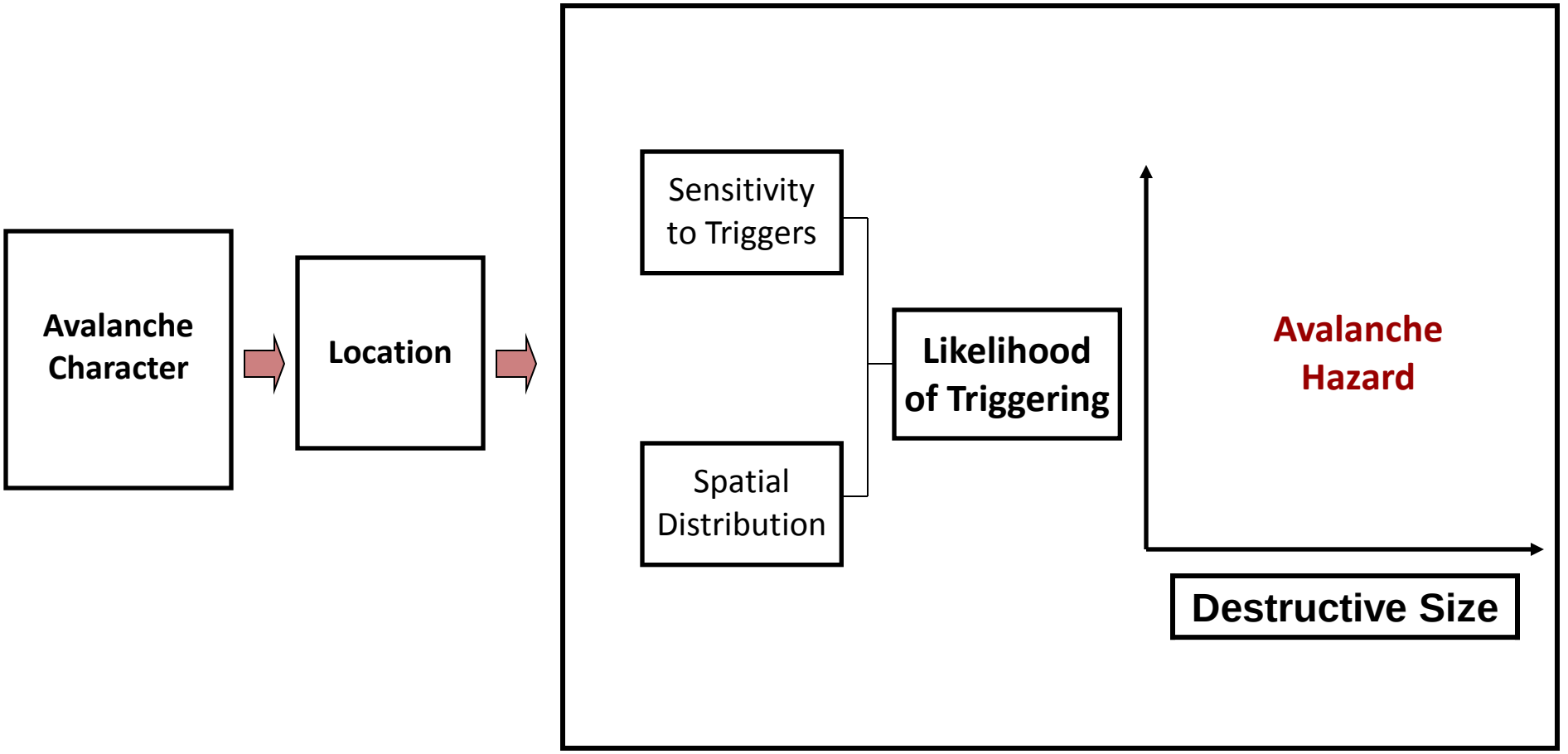


Conceptual Model of Avalanche Hazard

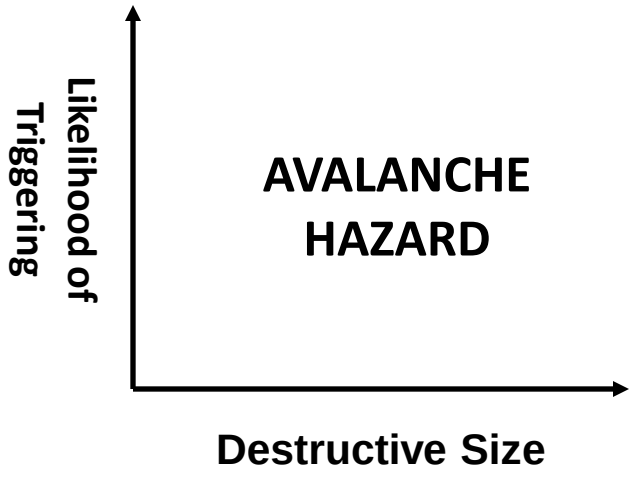
This workbook describes a conceptual model of avalanche hazard, and provides detailed reference material for use when evaluating avalanche hazard. The model was developed by systematically deconstructing avalanche hazard into its critical component pieces. Each piece was then further deconstructed to accommodate a detailed analysis. The model was then reassembled, and represents the analysis process for an avalanche hazard evaluation.

This model was developed by committee through the ADFAR2 project by Parks Canada and the Canadian Avalanche Centre. Committee members are: Grant Statham, Karl Birkeland, Pascal Haegeli, Ethan Greene, Chris Stethem, Bruce Tremper, Clair Israelson, John Kelly, Bruce McMahon and Brad White.

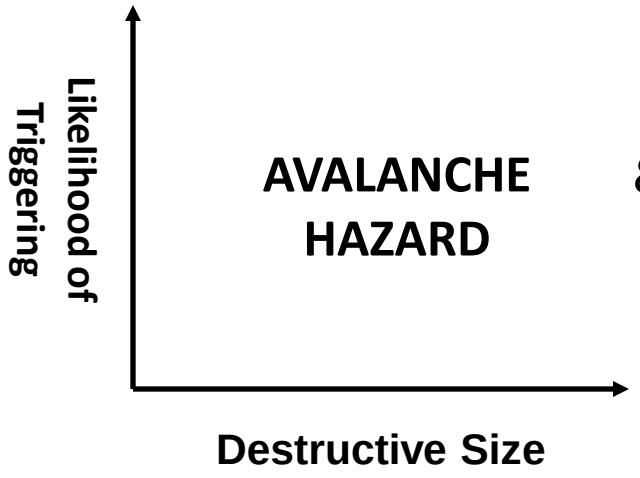
Avalanche Hazard Evaluation



avalanche hazard; avalanche danger is the potential for an avalanche(s) to cause damage to something of value. It is a function of the likelihood of triggering and the destructive size of the avalanche(s). It implies the potential to affect people, facilities or things of value, but does not incorporate vulnerability or exposure to avalanches. Avalanche hazard is commonly expressed using relative terms such as high, moderate and low.



avalanche risk is the probability or chance of harm resulting from interactions between avalanche hazard and a specific element(s) at risk. Avalanche risk is determined by the exposure of that element, and its vulnerability to the avalanche hazard.



AVALANCHE HAZARD & **VULNERABILITY & EXPOSURE** = **AVALANCHE RISK**

Establish the Context

The first step in any avalanche hazard analysis is to **formulate the problem** for the analysis.

1. Operational application
2. Spatial scale
3. Temporal scale

Scale

SPATIAL SCALE

- Terrain feature
- Path/Run
- Mountain
- Drainage
- Range
- Region
- Other: _____

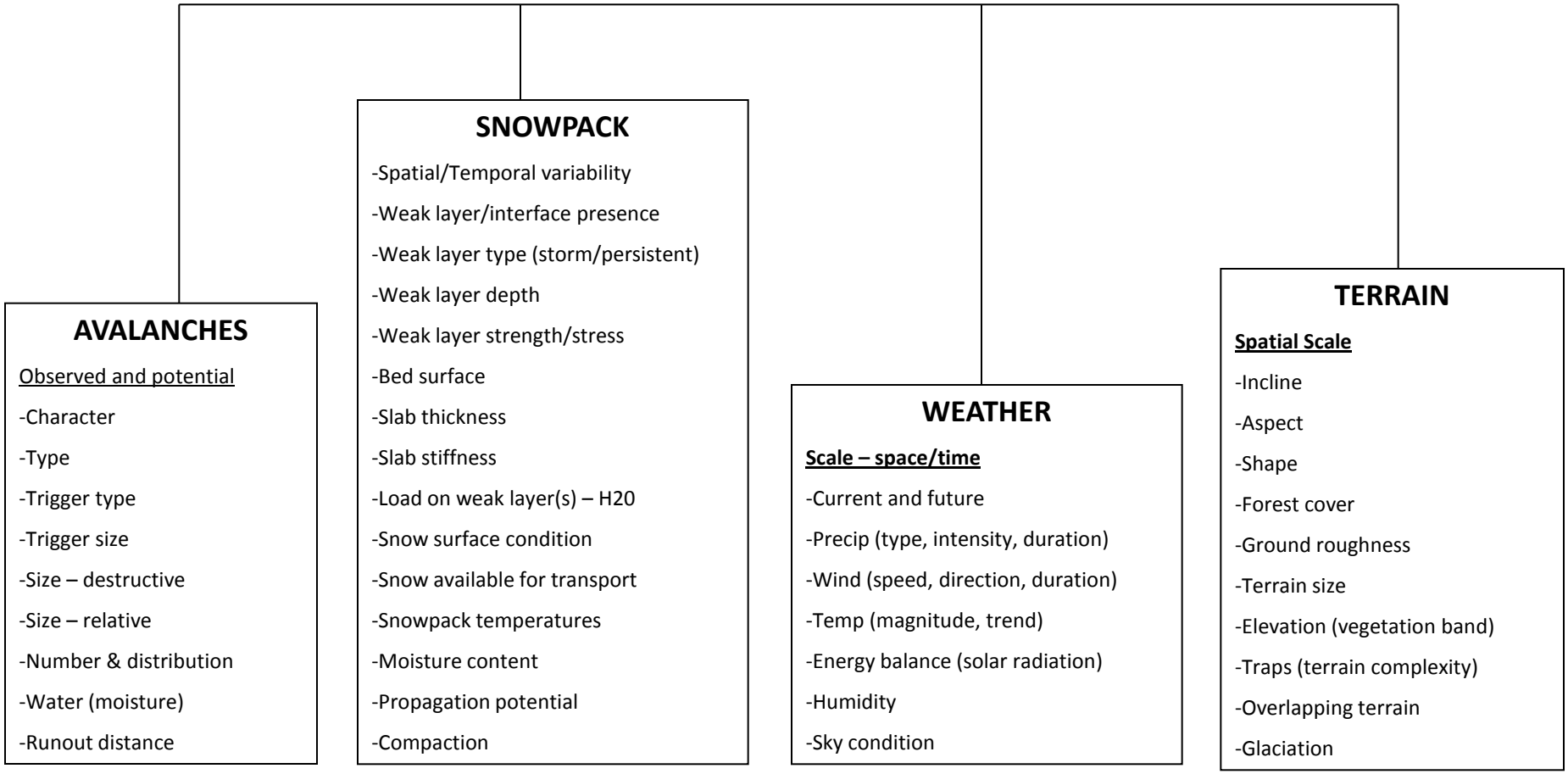
TEMPORAL SCALE

- Now
- Hours
- Days
- Weeks
- Years
- Other: _____

Evidence and Data

Avalanche hazard factors (examples of commonly used factors)

The strength and weight given to these factors is a judgemental assessment with no hierarchy of data type



Avalanche Character

Identify the Avalanche Character(s) that best represents the avalanche problem(s) within the defined Location. When multiple characters exist, they should be prioritized in order of importance.

Character	Weak Layer / Interface	Slab Properties	Persistence	Weak Layer Location	Propagation Potential	Relative Size Potential
Loose Dry	Various (no cohesion)	None	Hours/days	Near the surface	Down slope entrainment	R1-2
Loose Wet	Various (no cohesion)	None	Hours/days	Any level	Significant down slope entrainment	R1-3
Wind Slabs	DF, PP	4F-K Wind transported	Hours/days	Upper pack	Terrain feature	R1-3
Storm Slabs	PP, DF	F-P Soft -stiff	Hours/days	In or just below storm snow	Path	R1-4
Wet Slabs	Various	4F-P Wet grains	Hours/days	Mid pack to deep	Path	R1-5 (climax)
Persistent Slabs	PWLs such as SH, FC, CR, FC/CR combo	4F-P Stiff-Hard	Weeks/months	Upper to mid pack	Path to adjacent paths	R2-4
Deep Persistent Slabs	PWLs such as DH, FC, CR, FC/CR combo	1F-K Hard	Weeks/months	Deep or basal	Path to adjacent paths	R3-5 (climax)
Cornices	~	~	Months w/ short peaks	~	~	~
Comment	Typical failure plane	Typical kind of slab	Typical duration of instability	Relative to HS	Typical expectation	Typical range of size relative to path

Location

Specifically describe where in the terrain a particular Avalanche Character is expected to be found.

Location
Describe the terrain using aspect, elevation, vegetation bands, operating zones or terrain features.

Sensitivity to Triggers

Determine the Sensitivity to Triggers based on what kind of triggering will initiate avalanches of any size within the defined Location.

Sensitivity	Natural Triggers	Human Triggers	Explosive Triggers		Cornice Triggers
			Size	Result	
Unreactive	No avalanches	No avalanches	Very large explosives	No slab	No slab from very large cornice fall
Stubborn	Few	Difficult to trigger	Large explosives & air blasts	Some	Large
Touchy	Several	Easy to trigger	Single hand charge	Many	Medium
Very Touchy	Numerous	Triggering certain	Any size	Numerous	Any size
Description of observation	Natural avalanche occurrences	Ease of triggering by a single human	Size of explosive and effect		Size of cornice fall that will trigger a slab

Spatial Distribution

Determine the density and distribution of the instability within the defined Location.

Distribution	Density	Evidence
Isolated	The instability is spotty and found in few locations.	Evidence is rare and hard to find.
Specific	The instability exists in portions of terrain.	Evidence exists but is not always obvious.
Widespread	The instability is found in many locations.	Evidence is everywhere and easy to find.
Comment	How is the evidence distributed within the location identified?	How hard is it to find?

Likelihood of Triggering

Determine the Likelihood of Triggering within the defined Location. This is a judgemental combining of both Sensitivity to Triggers and Spatial Distribution.

Likelihood of Triggering
Almost Certain
Likely
Possible
Unlikely
Very Unlikely

Destructive Size

Determine the destructive potential of the avalanche(s) resulting from a specific Avalanche Character within a defined Location.

Destructive Size	**Avalanche destructive potential** (definition)	**Typical mass**	**Typical impact pressure**	**Typical path length**
1	Relatively harmless to people.	<10 t	1 kPa	10 m
2	Could bury, injure, or kill a person.	10^2 t	10 kPa	100 m
3	Could bury and destroy a car, damage a truck, destroy a wood frame house, or break a few trees.	10_3 t	100 kPa	1000 m
4	Could destroy a railway car, large truck, several buildings, or a forest area of approximately 4 hectares.	10_4 t	500 kPa	2000 m
5	Largest snow avalanche known. Could destroy a village or a forest area of approximately 40 hectares.	10_5 t	1000 kPa	3000 m

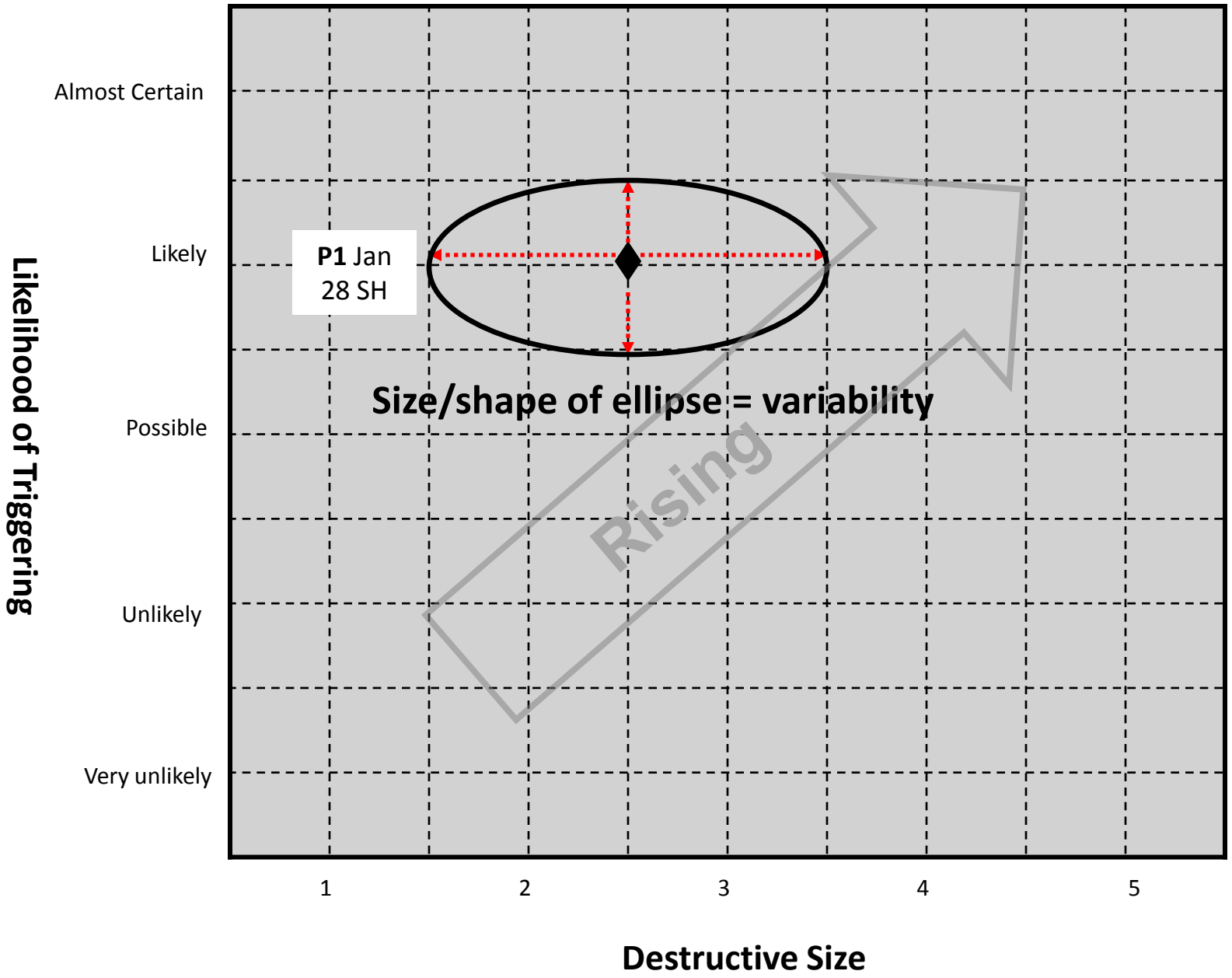
Confidence

Express the Forecaster's degree of confidence

Degree: GOOD, FAIR, POOR

- Anomalies
- Unusual events
- Unprecedented events or conditions
- Amount of data
- Quality of data
- Spatial scale
- Temporal scale
- Spatial variability
- Temporal variability
- Lingering instability
- State of knowledge
- Forecaster's experience

Avalanche Hazard Chart (example)



Avalanche Hazard Chart (example)