Oppsummering av State-of-the-art artikler fra International Conference on Landslide Risk management, Vancouver

Presentert av Unni K. Eidsvig

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Bakgrunn for konferansen

- Skred er en av hovedtypene av naturlige farer. Det kan ramme plutselig å være vanskelig å forutsi. Skred er sterkt konsentrert i område. Å utrede de farlige områdene på forhånd og estimere fare og risiko gir mulighet for å sette i verk forebyggende tiltak
- Fordeler med forebyggende tiltak er todelt
  - *Det redder liv og eiendom når det går et skred*
  - *Det hindrer store utgifter*

Innhold

- 8 state-of-the-art artikler
- 4 inviterte
- 100 artikler

State-of-the-art artikler

- SOA 1: A **framework** for landslide risk assessment and management
- SOA 2: **Hazard** characterization and **quantification**
- SOA 3: **Probabilistic** stability **analysis** for individual slopes in soil and rock
- SOA 4: Estimating landslide **motion mechanism**, travel distance and velocity
- SOA 5: Estimating temporal and spatial variabililty and **vulnerability**
- SOA 6: **Risk assessment and management**
- SOA 7: Landslide hazard and risk zoning for **urban planning** and development
- SOA 8: Landslide risk assessment for **individual facilities**

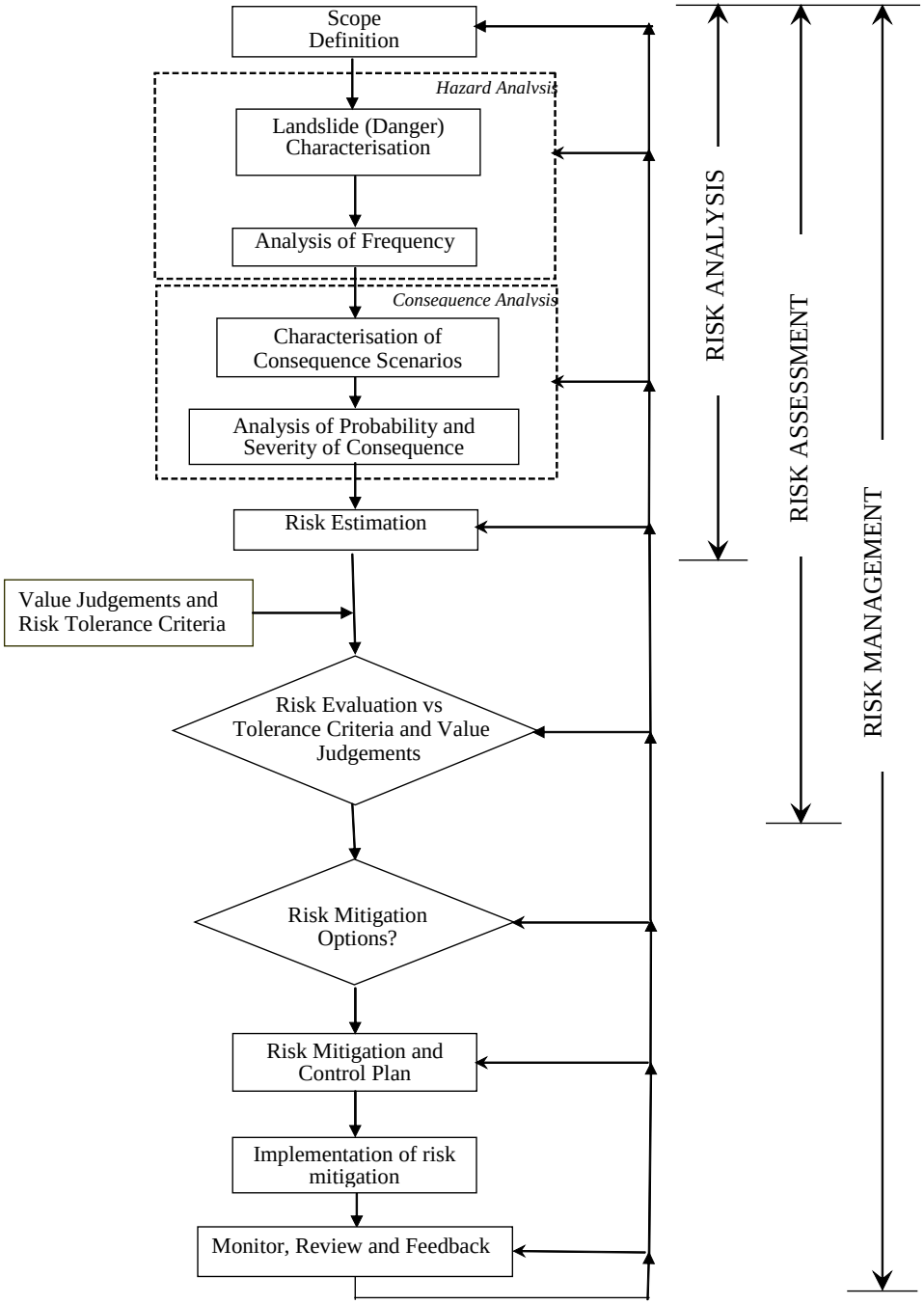


Figure 1 – Flow chart for landslide risk management.

SOA 1: A framework for landslide risk assessment and management

(Fell, Ho, Lacasse and Leroi)

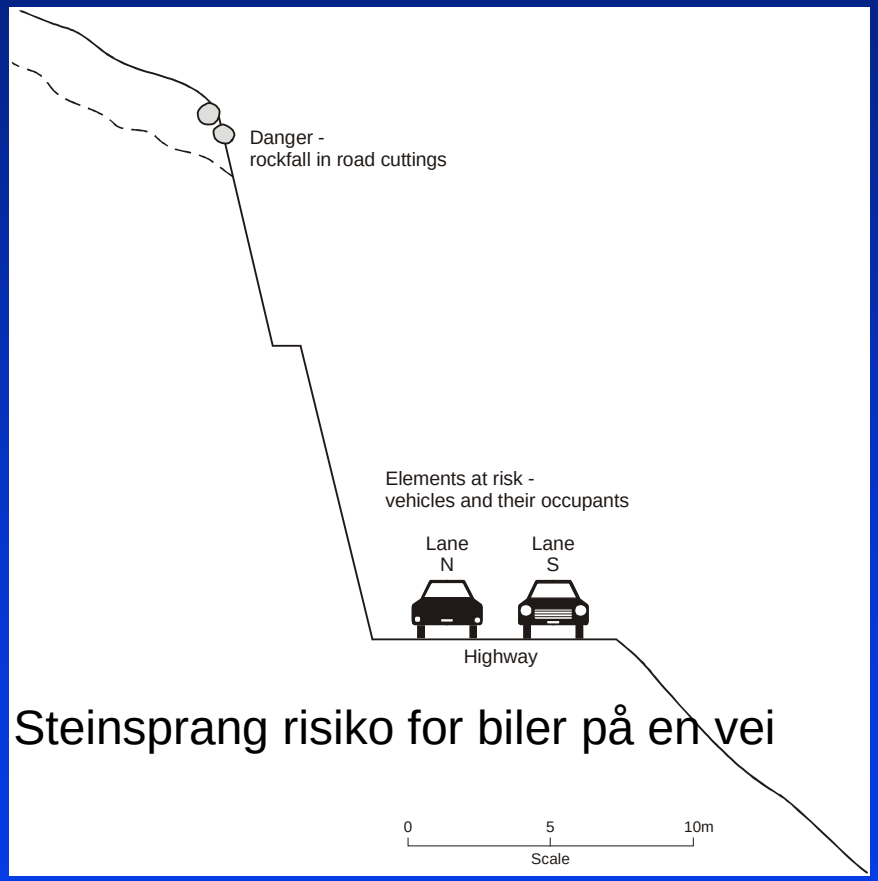
sk Management

nical Society Symposium

SOA 1: A framework for landslide risk assessment and management

Artikkelen inneholder mange konkrete eksempler:

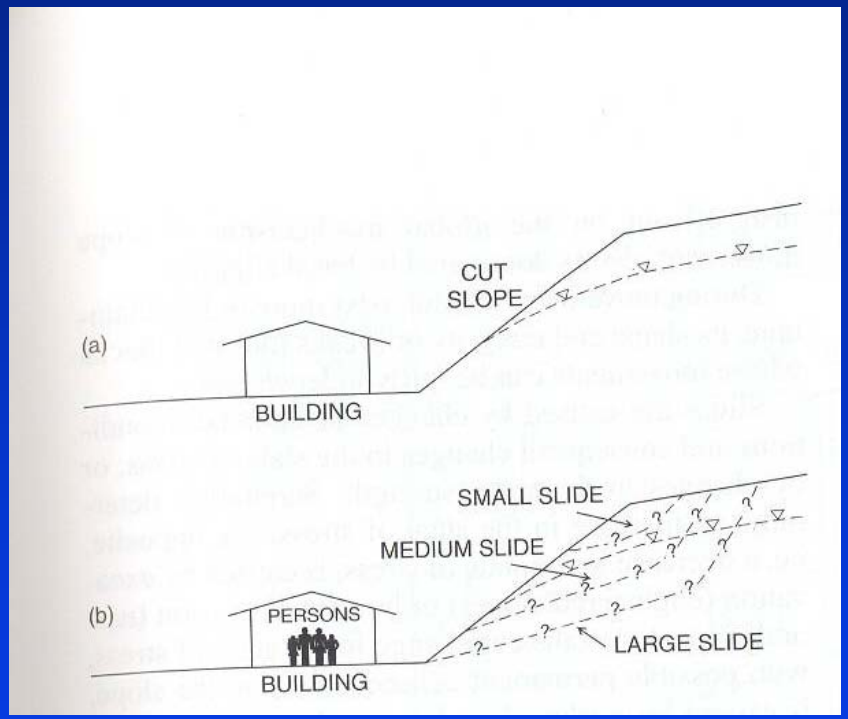
- Beregning av skred risiko mot hus.
- Steinsprang risiko for biler på en vei
- Skredrisiko fra deponi med gruve avfall



Steinsprang risiko for biler på en vei

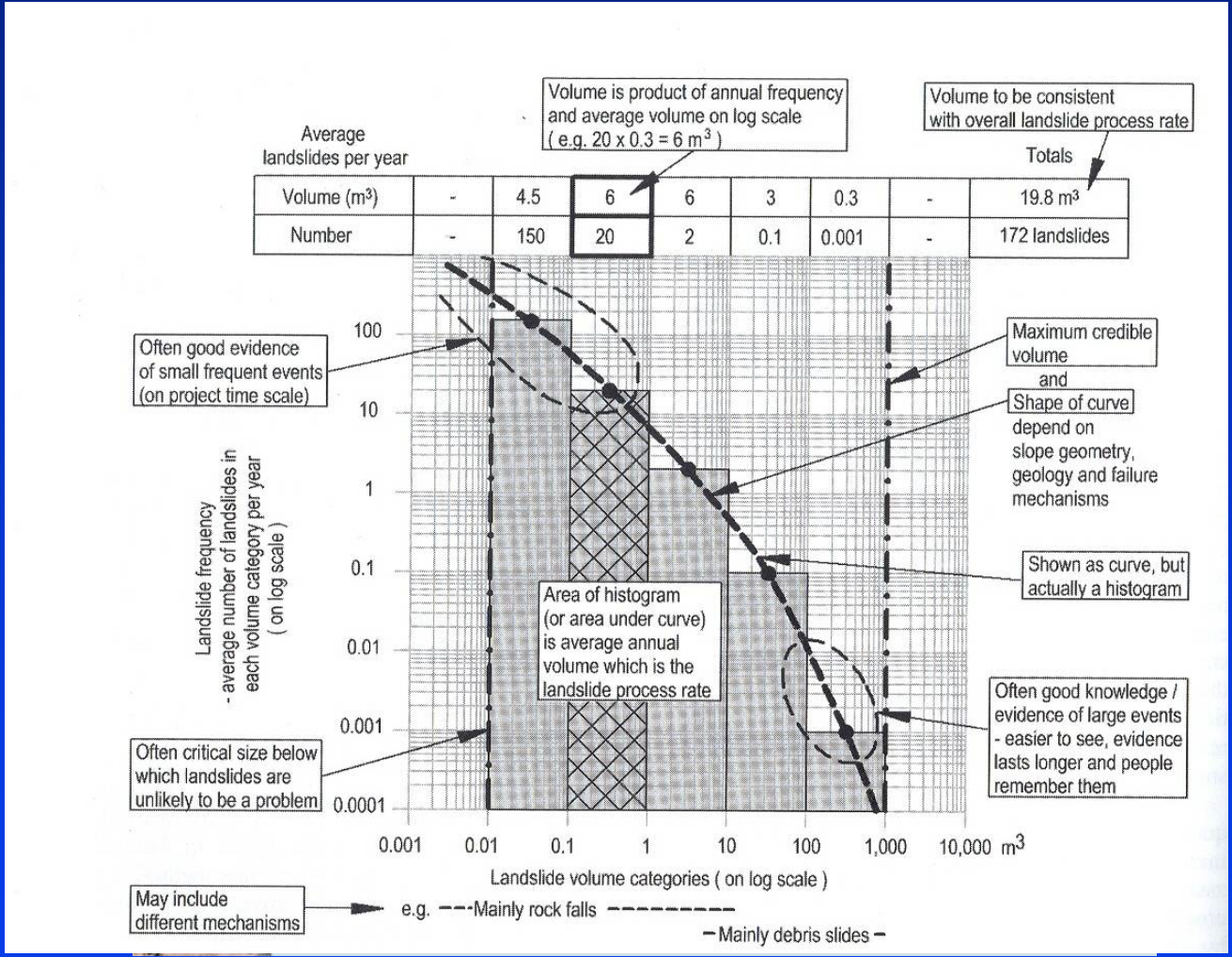
SOA 2: Hazard characterization and quantification (Picarelli, Oboni, Evans, Mostyn and Fell)

Sammenlikning mellom en deterministisk angrepsvinkel (a) og en risiko basert angreps vinkel (b)



Modell for sammenheng mellom skredstørrelse og -frekvens

SOA 2: Hazard characterization and quantification



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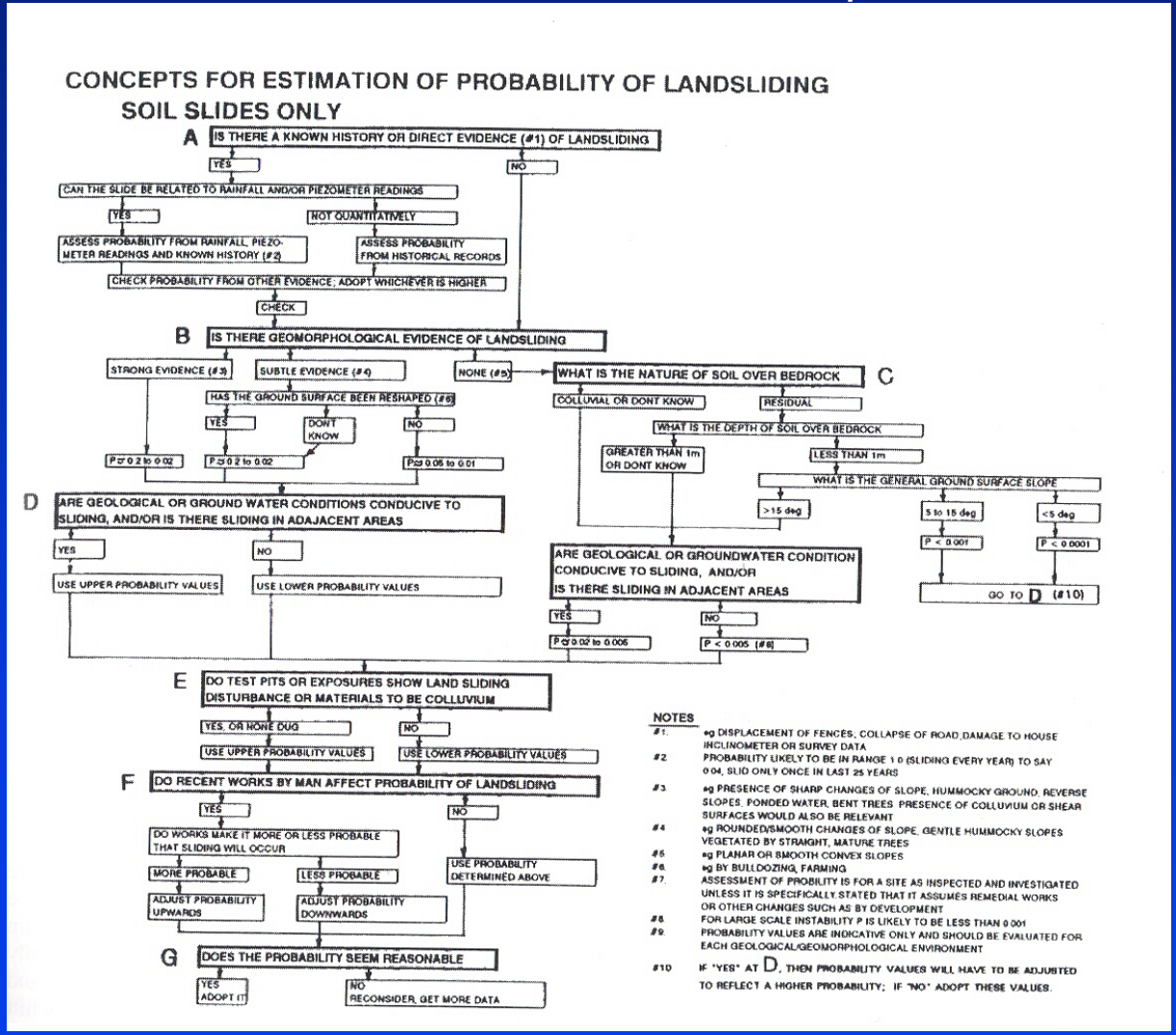
Prosess diagram for å estimere skred sannsynligheten

SOA 2: Hazard characterization and quantification



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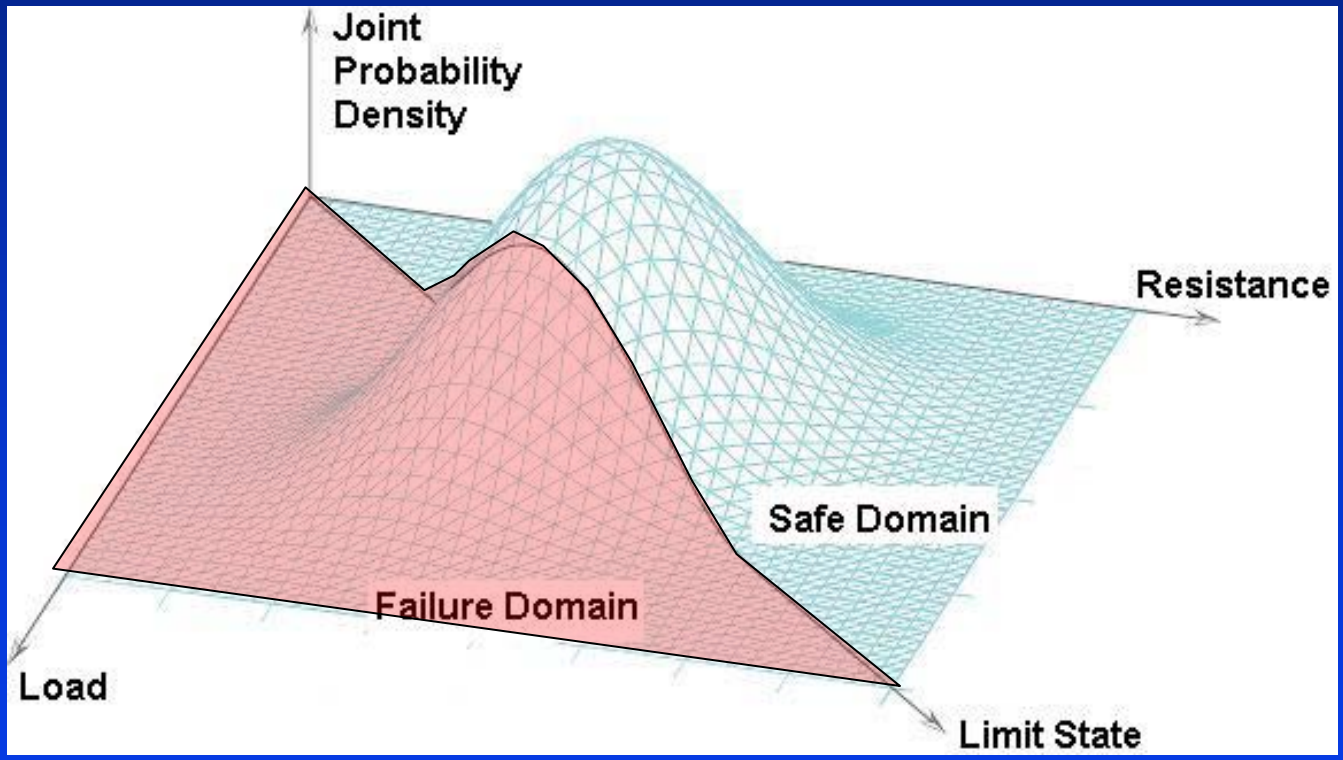
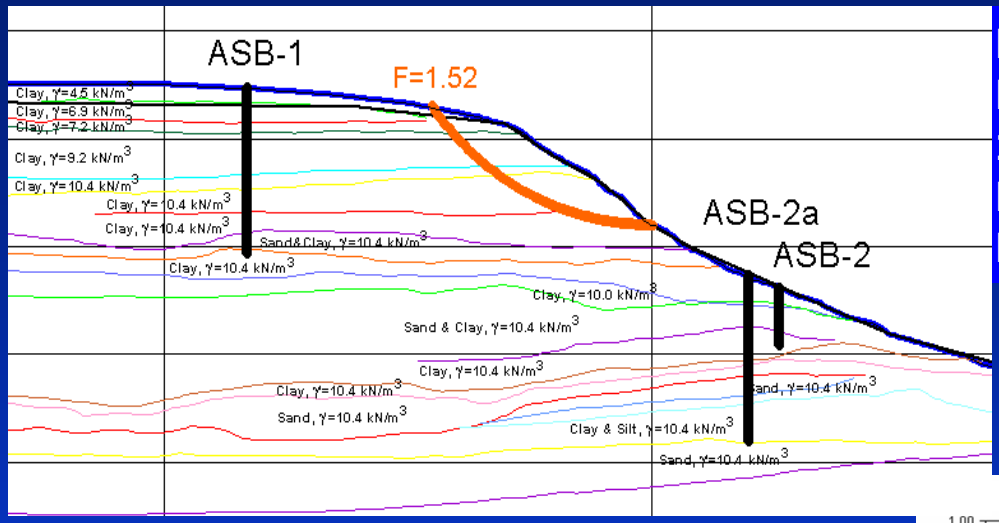
SOA 3:Probabilistic stability analysis for individual slopes in soil and rock (Nadim, Einstein, Roberds)



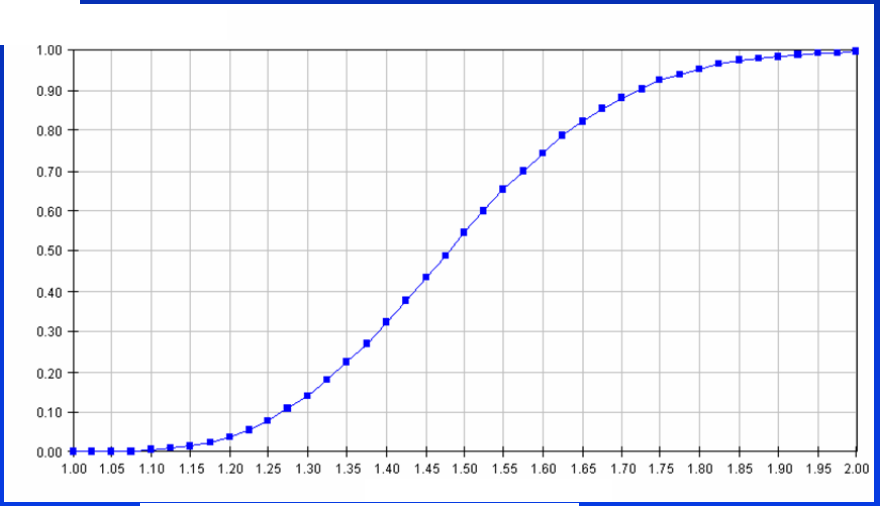
Eksempel på FORM analyse



Deterministic safety factor: $SF = 1.52$
Median of safety factor: $SF_{median} = 1.48$
FORM probability of failure: $P_f = 4.2 \cdot 10^{-4}$
Reliability Index: $\beta = 3.34$

Atlantis Field in Gulf of Mexico, Slump E

Cumulative distribution of SF

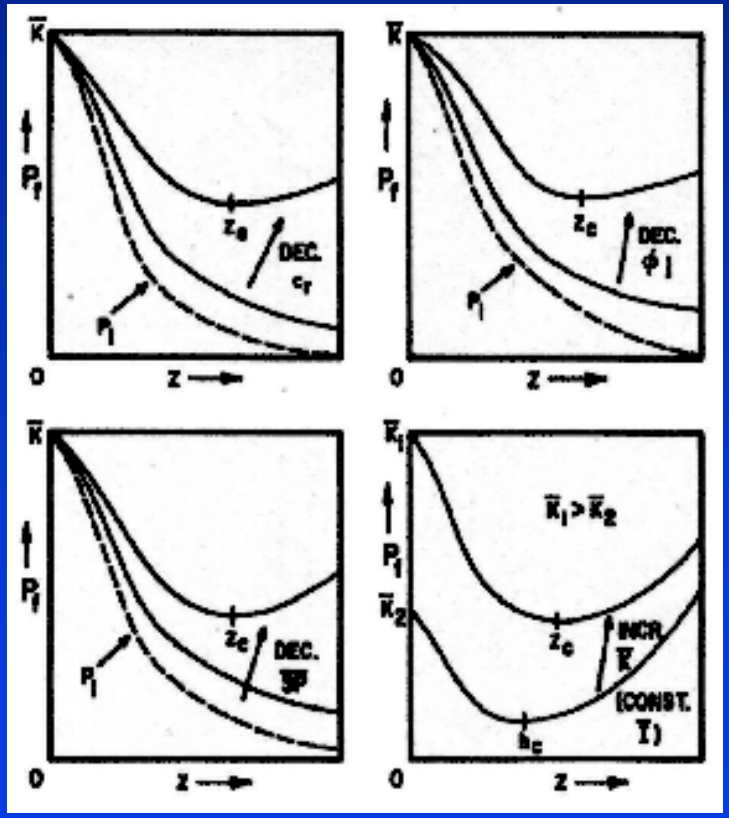


SOA 3: Probabilistic stability analysis for individual slopes

in soil and rock

Brudd sannsynlighet som funksjon av skråningshøyde

SOA 3: Probabilistic stability analysis for individual slopes in soil and rock



SOA 4: Estimating landslide motion mechanism, travel distance and velocity (Hungr, Corominas and Eberhardt)

En enkel klassifisering av skred for typiske hastigheter

TYPE	VELOCITY CLASS*							COMMENT
	ES	VS	S	M	R	VR	ER	
SLIDES IN ROCK								
Translational (or Wedge) Rock Slide							■	May be slow in very weak rocks
Rotational Rock Slide(Slump)	■	■	■	■	■			Very weak rock mass
Compound Rock Slide	■	■	■	■	■	■	■	Various types of mechanisms
Rock Collapse							■	Strong rock, joints, rock bridges
FALLS AND TOPPLES								
Rock (Debris) Fall							■	Fragmental fall, small scale
Rock Block Topple							■	Single or multiple blocks
Rock Flexural Topple	■	■	■	■	■			Very weak rock mass
SLIDES IN SOIL								
Clay Slump (Rotational)	■	■	■	■	■			Non- sensitive
Clay Slide (Compound)	■	■	■	■	■			Non- sensitive
Sand (Gravel, Talus, Debris) Slide					■	■	■	Usually shallow
FLOW-LIKE LANDSIDES								
Dry Sand (Silt, Gravel, Talus Debris) Flow	■	■	■	■	■			No cohesion
Sand (Silt, Debris, Peat) Flow Slide							■	Liquefaction involved
Sensitive Clay Flow Slide							■	Quick clay
Debris Avalanche							■	Non-channelized
Debris (Mud) Flow						■	■	Channelized
Debris Flood						■	■	High water content
Earth Flow	■	■	■	■	■			Plastic clay
Rock Avalanche							■	Begins in bedrock
Rock Slide-Debris Avalanche							■	Entrains debris

* Extremely Slow, Very Slow, Slow, Moderate, Rapid, Very Rapid, Extremely Rapid (>5 m/sec; Cruden & Varnes 1996).

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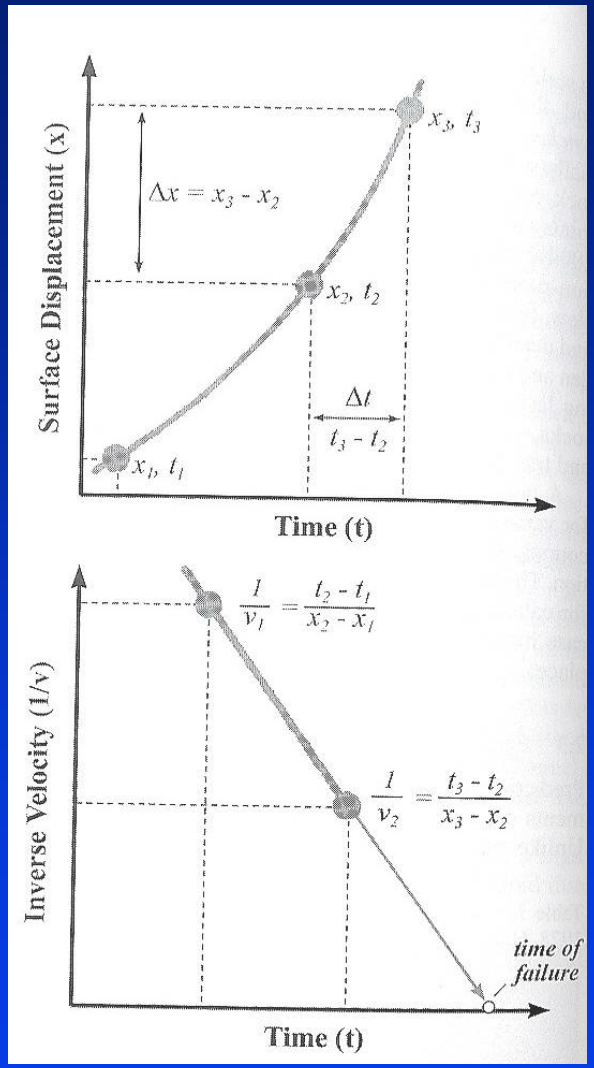
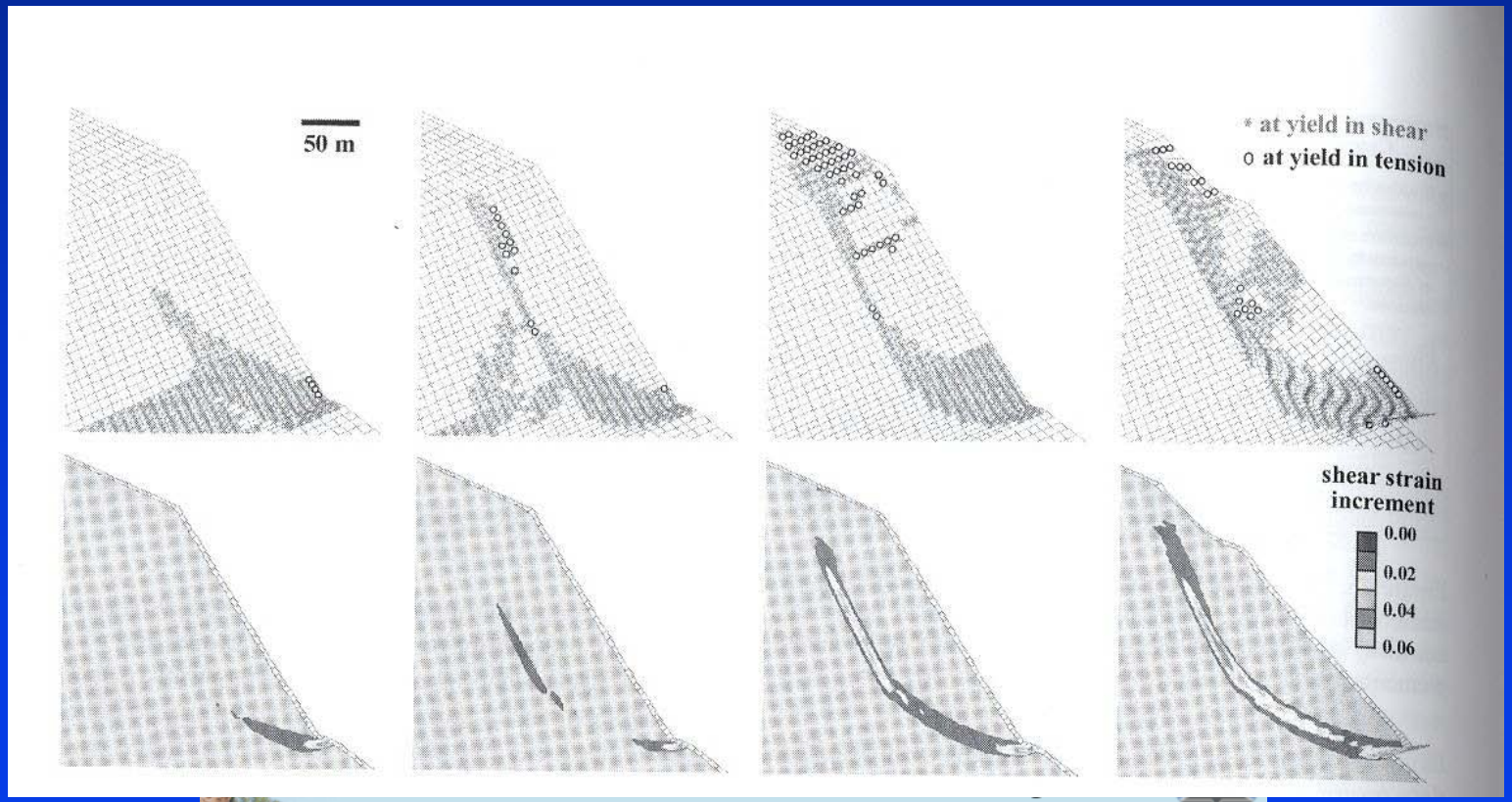
Prediksjon av brudd tidspunkt



SOA 4: Estimating landslide motion mechanism, travel distance and velocity

Prediksjon av form og plassering av en bruddflate i fjell skråning

SOA 4: Estimating landslide motion mechanism, travel distance and velocity



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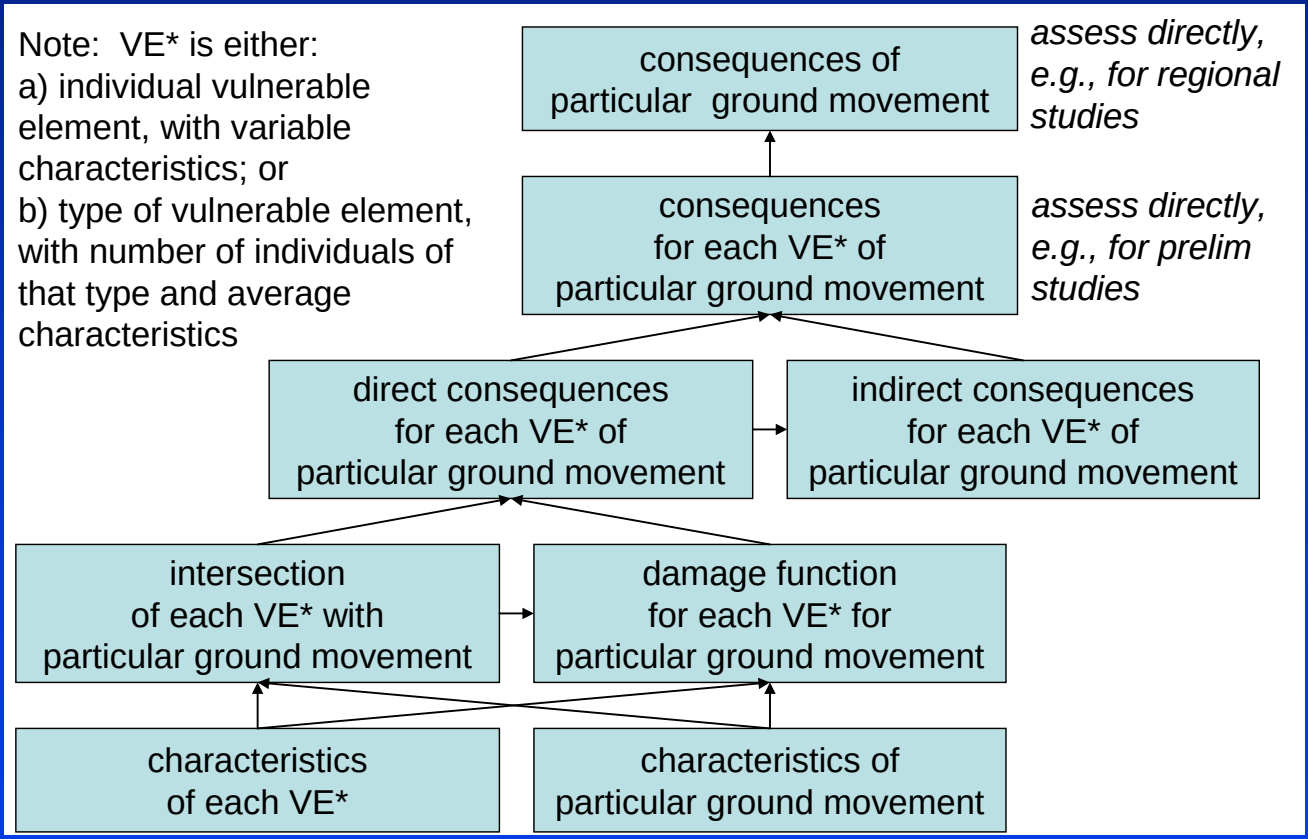
SOA 5: Estimating temporal and spatial variabililty and vulnerability (Roberds)

Oppsummering av prosessen for sårbarhetshåndtering

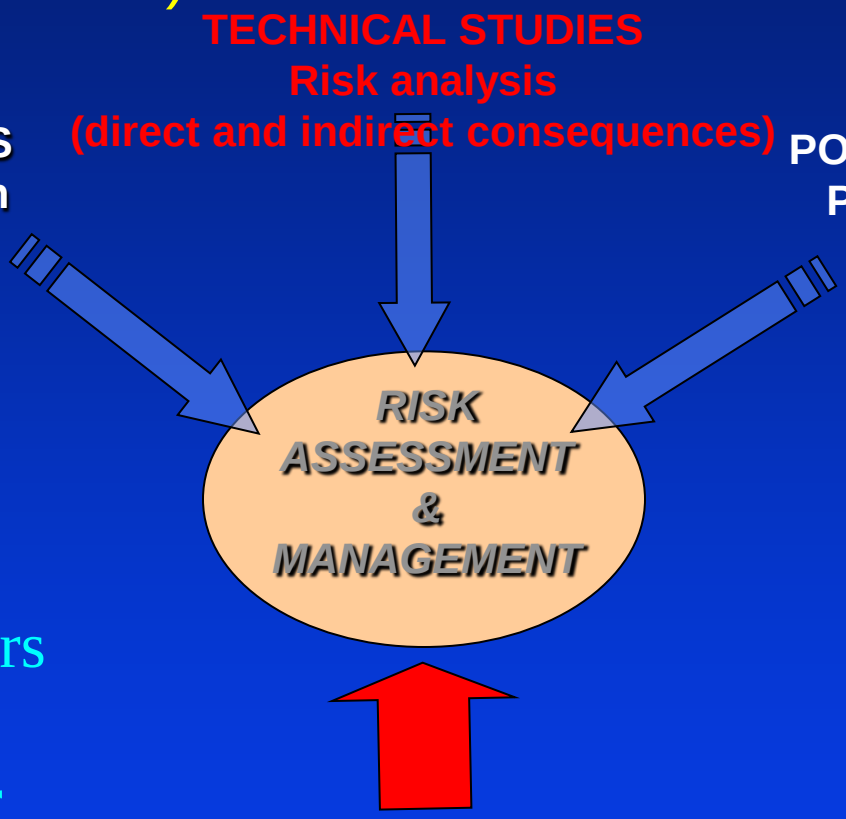


Eksempler

SOA 5: Estimating temporal and spatial variabililty and vulnerability

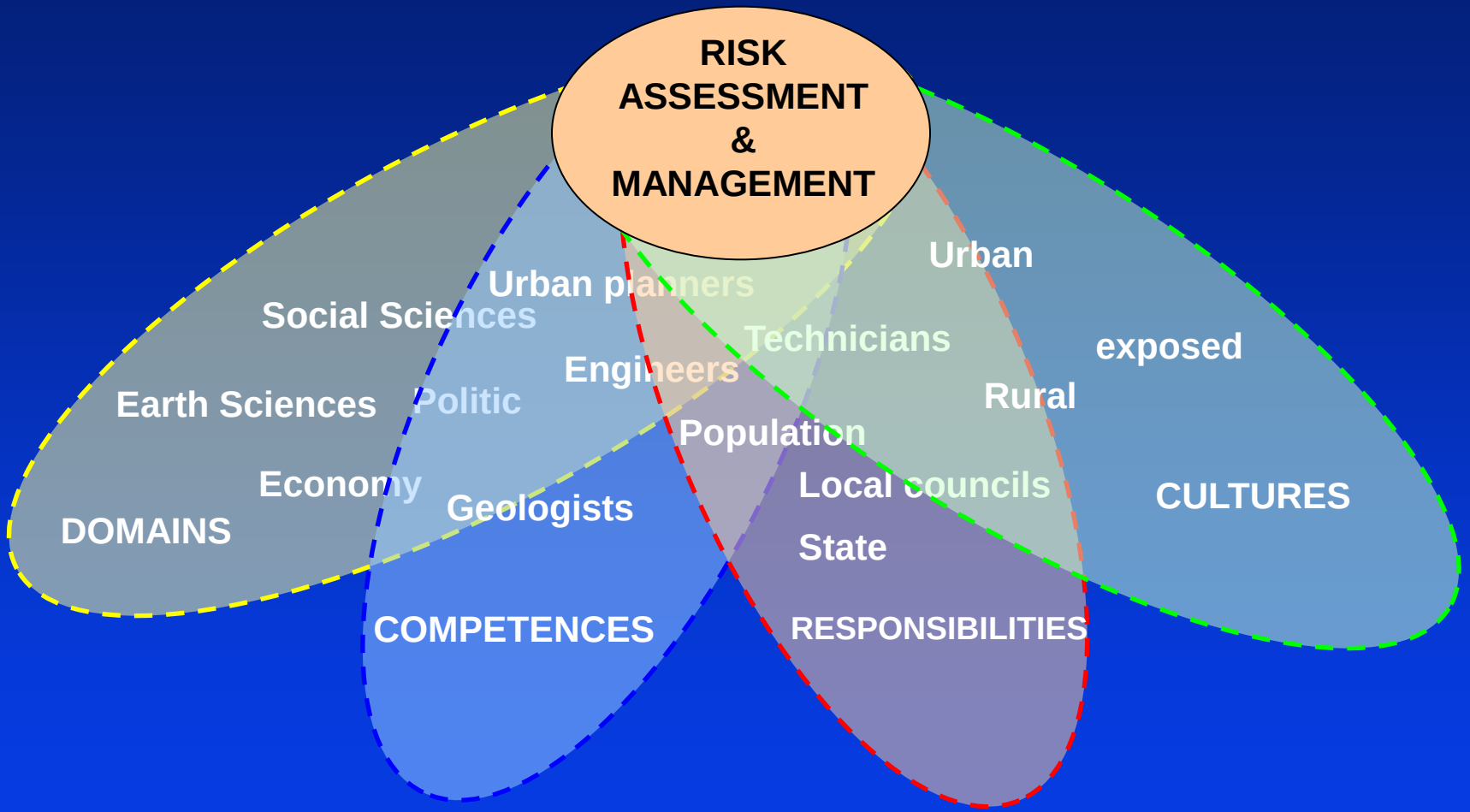
- Sårbarhet for et skredutsatt område
- Sårbarhet for strømledning/-stolpe
- Sårbarhet for biler på vei nedenfor en fjellskråning

SOA 6: Landslide Risk Assessment and Management (Leroi, Bonnard, Fell and McInnes)

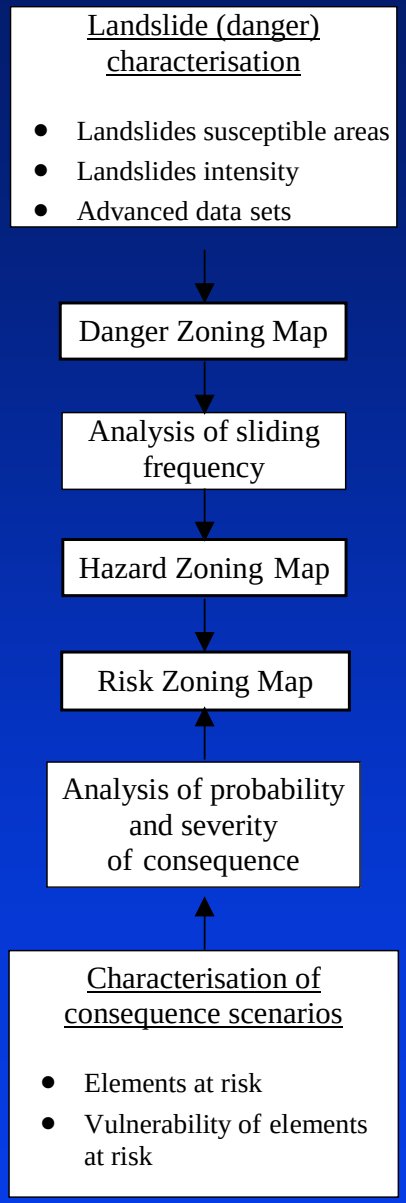


Technicians
Administration
Decision-makers
Population
Law-maker
Judge
Media

SOA 6: Landslide Risk Assessment and Management



Rammeverk for fare- og risikokartlegging



SOA 7: Landslide hazard and risk zoning for urban planning and development

(Cascini, Bonnard, Corominas, Jibson and Montero-Olarte)

Eksempler

SOA 7: Landslide hazard and risk zoning for urban planning and development

- Kartlegging av skredfare i Colombia
- Kartlegging av skredfare i Sør-California
- Kartlegging av historiske skred-data og skredfare i de Sør-Italienske Appenninene
- Kartlegging av fjellskredfare i Andorra
- Kartlegging av skredrisiko på Island

Sårbarhet for mennesker, bygninger og veier I forhold til debris strømning I Cairns, Australia

Unit	People	Buildings	Roads
Hill slopes	0.05	0.25	0.3
Proximal debris fan	0.5	1.0	1.0
Distal debris fan	0.05	0.1	0.3

SOA 7: Landslide hazard and risk zoning for urban planning and development

Eksempel på sårbarhetsmatrise for bygninger

Landslide characteristics	Buildings at risk S	L	M	H
T				
M				
S				
V				
R				

S - Squatter
L - Low-rise building
M - Multi-storey building
H - High-rise building

T - Type of failure
M - Mechanism of failure
S - Scale
V - Velocity
R - Runout distance

Location, nature and other properties of low-rise building

Vulnerability	Scale (m^3)	Distance to slide (m) <10	10-50	>50	Nature			...
	$<10^2$	0.3	0.2	0.1				
	10^2 -10^3	0.4	0.3	0.2				
	10^3 -10^4	0.6	0.5	0.4				
	$>10^4$	1.0	0.9	0.8				

SOA 8: Landslide risk assessment for individual facilities

Table 2. Comparison of different qualitative slope rating systems.

Case No. / Place (Section in SOA8)	Primary application	Type of slope for rating		Rating method
		Slope	Facility	
1 / Hong Kong (Section 3.1)	– Risk ranking – Prioritization for action	Un-engineered cut slopes and retaining walls	All types	– Scoring system, with hazard and consequence ratings – Expert formulation scheme
2 / Hong Kong (Section 3.2)	– Risk ranking – Prioritization for action	Un-engineered fill slopes	All types	– Scoring system, with consequence rating before hazard rating – Expert formulation scheme
3 to 6 / Hong Kong (Section 3.3)	– Risk ranking – Prioritization for action – QRA tool	Un-engineered cut slopes, fill slopes and retaining walls	All types	– Scoring system, with hazard and consequence ratings – Expert formulation scheme
7 & 8 / USA (Section 3.4)	– Preliminary screening – Risk ranking – Prioritization for action – Preliminary estimate	Rock cut slopes	Roads	– Scoring system, with emphasis in hazard rating – Mixed scheme
9 / Canada (Section 3.5)	– Risk ranking – Prioritization for action	Rock cut slopes	Railway	– Hazard rating system – Mixed scheme
10 / Australia (Section 3.6)	– Risk ranking – Prioritization for action	Man-made slopes but primarily rock cut slopes	Primarily Roads	– Risk matrix system, with hazard and consequence ratings – Expert judgment scheme
11 / Malaysia (Section 3.7)	– Risk ranking – Prioritization for action	All types including natural slopes	Primarily Roads	– Scoring system, with hazard and consequence ratings – Expert formulation scheme
12 / Australia (Section 3.8)	– Risk ranking – Land-use planning	Clay slopes	Different types of land-use	– Scoring system, with simple hazard and consequence ratings – Expert formulation scheme
13 / Japan (Section 3.8)	– Risk ranking – Prioritization for action	Rock slopes, deep-seated landslides and debris flows	Roads	– Scoring system, with emphasis in hazard rating – Expert formulation scheme
14 / New Zealand (Section 3.8)	– Risk ranking – Prioritization for action	Cut and fill slopes	Roads	– Scoring system; primarily hazard rating – Mixed scheme
15 / UK (Section 3.8)	– Risk ranking – Prioritization for action	Rock slopes	Roads	– Scoring system; primarily hazard rating – Mixed scheme

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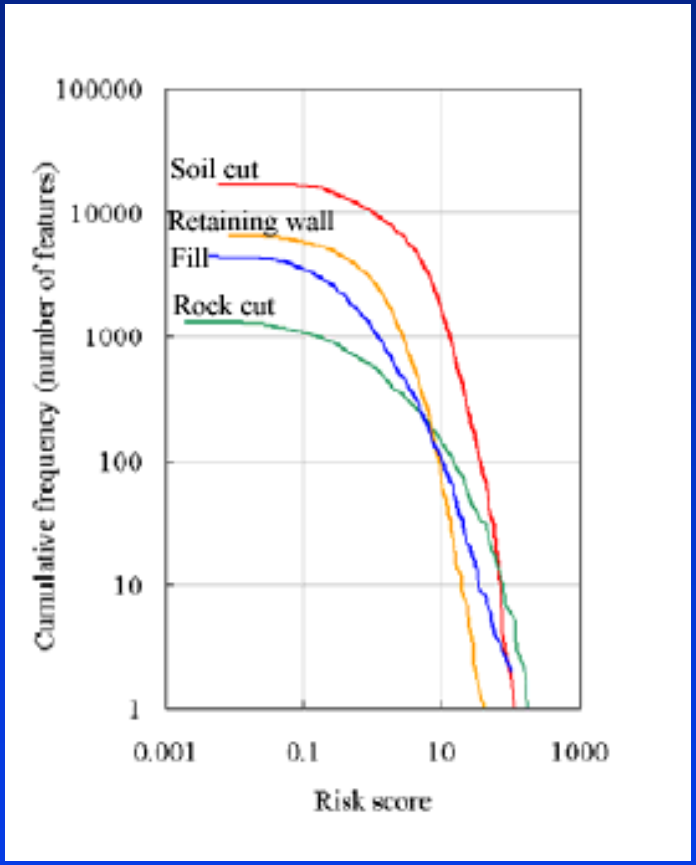
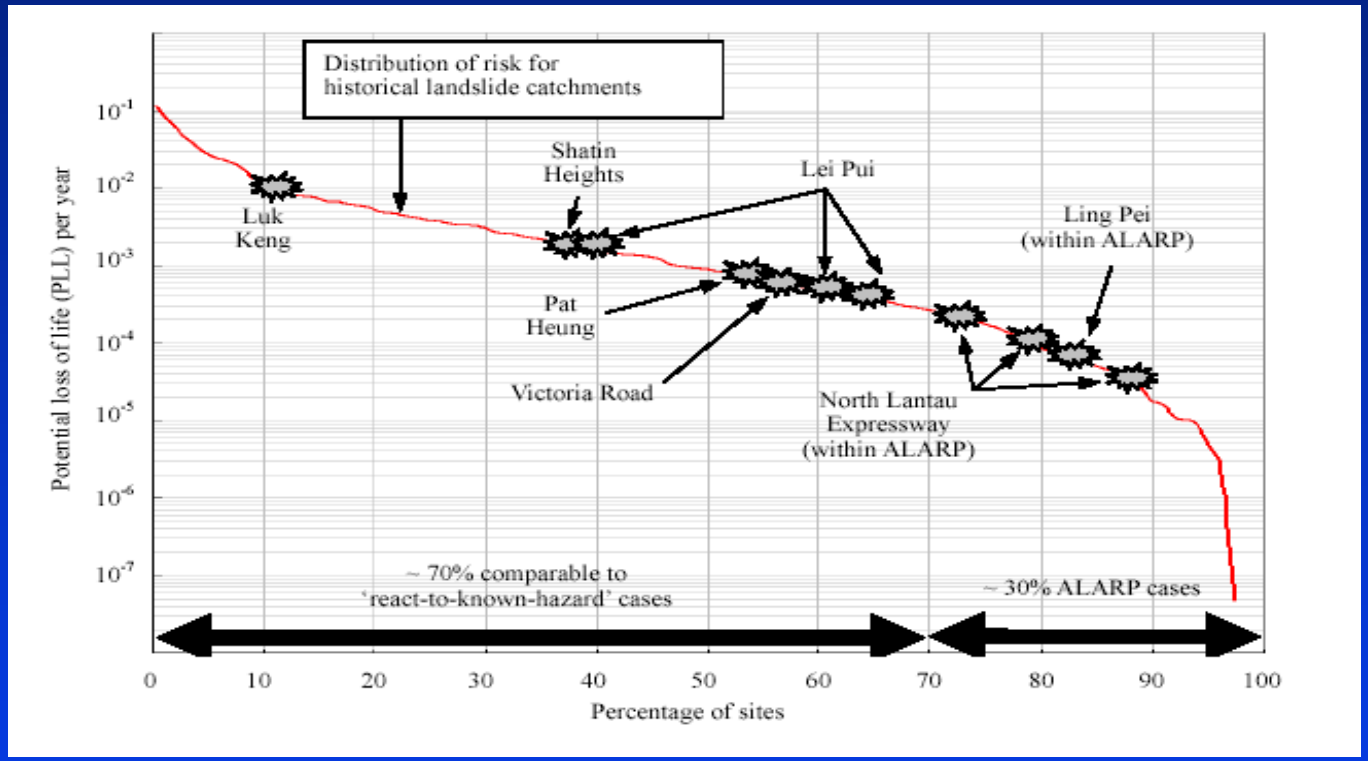
Fordeling av risikoscore for ulike skråningstyper i Hong Kong (Wong)

SOA 8: Landslide risk assessment for individual facilities



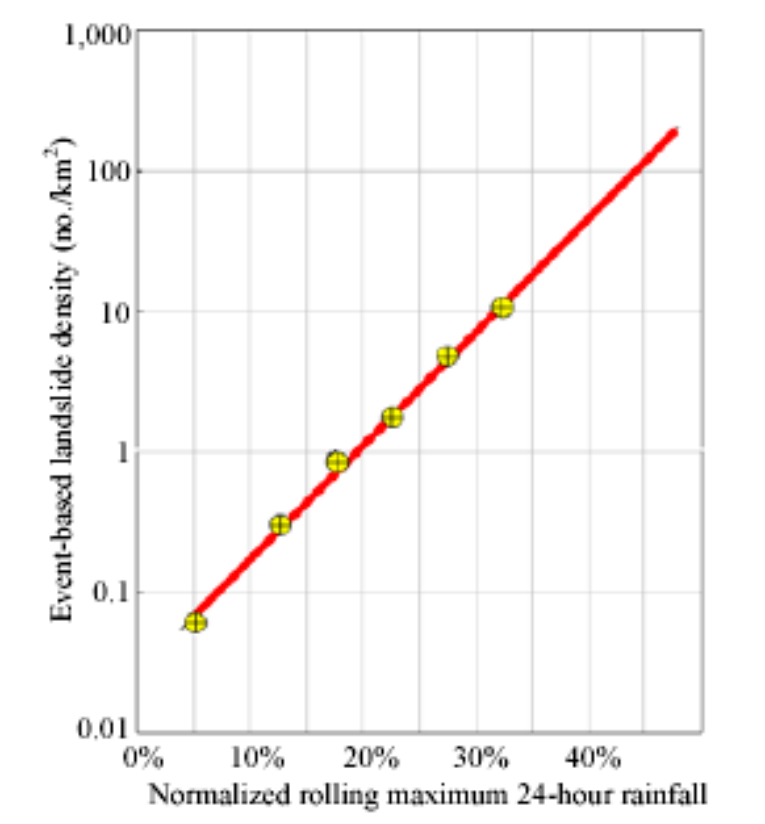
Risikoprofil over skredutsatte lokaliteter

SOA 8: Landslide risk assessment for individual facilities



Sammenheng mellom regnmengde og skredintensitet

SOA 8: Landslide risk assessment for individual facilities



Konklusjon

- Et funn med masse opplysninger og basiskonsepter.
- Anbefales til alle interesserte!