



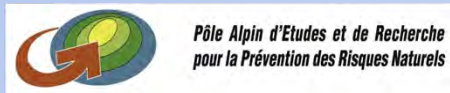
**½ JOURNÉE RISQUE ROCHEUX  
APPORTS DE LA SCIENCE À LA  
COMPREHENSION ET À LA GESTION  
DU RISQUE ROCHEUX SUR  
L'AGGLOMERATION GRENOBLOISE  
Mardi 8 Mars 2016**



Fred BERGER  
(F. Bourrier et S. Lambert)  
Irstea

*Estimation de la propagation des blocs éboulés pour le zonage  
Et  
l'aide au dimensionnement d'ouvrages de protection*

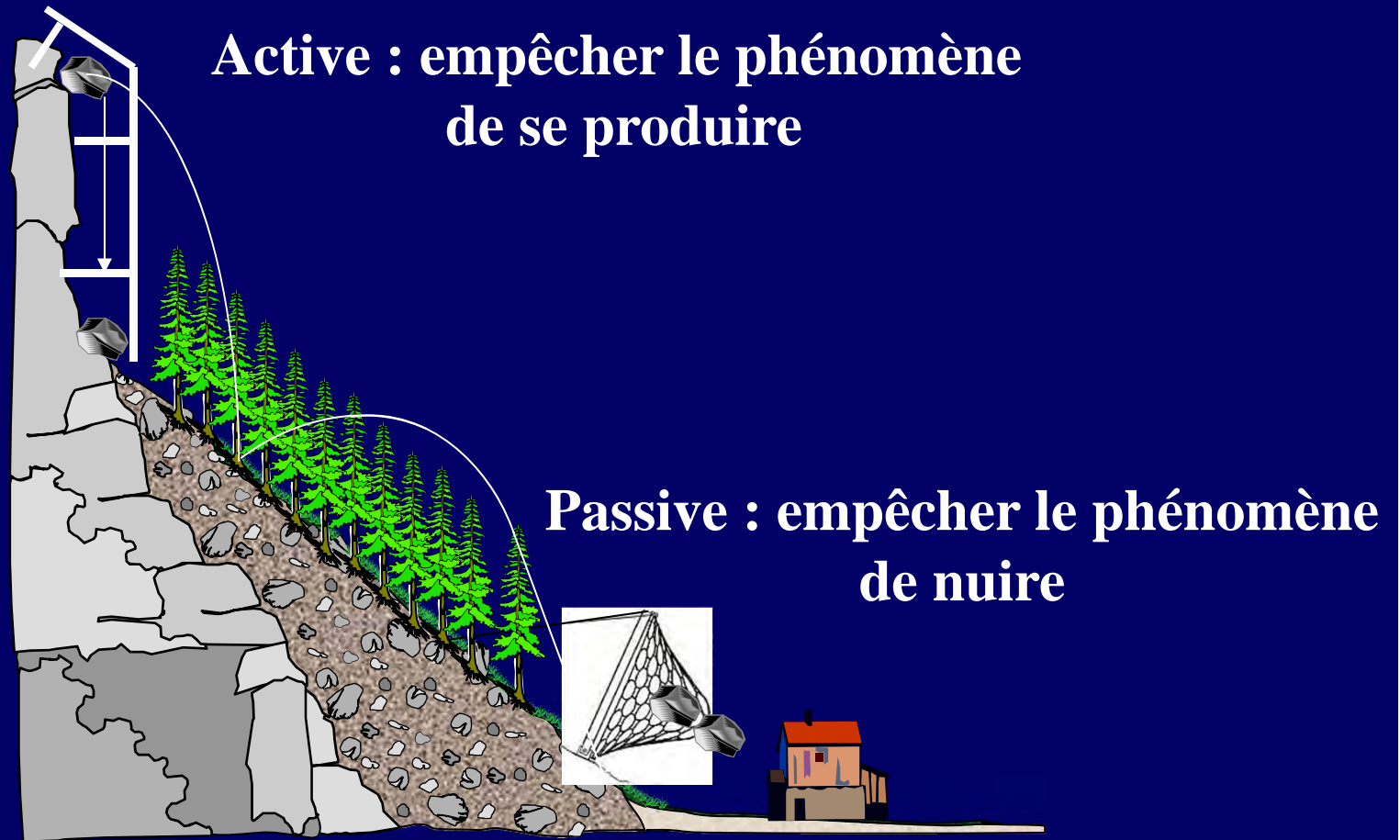
Organisation



Collaborations scientifiques

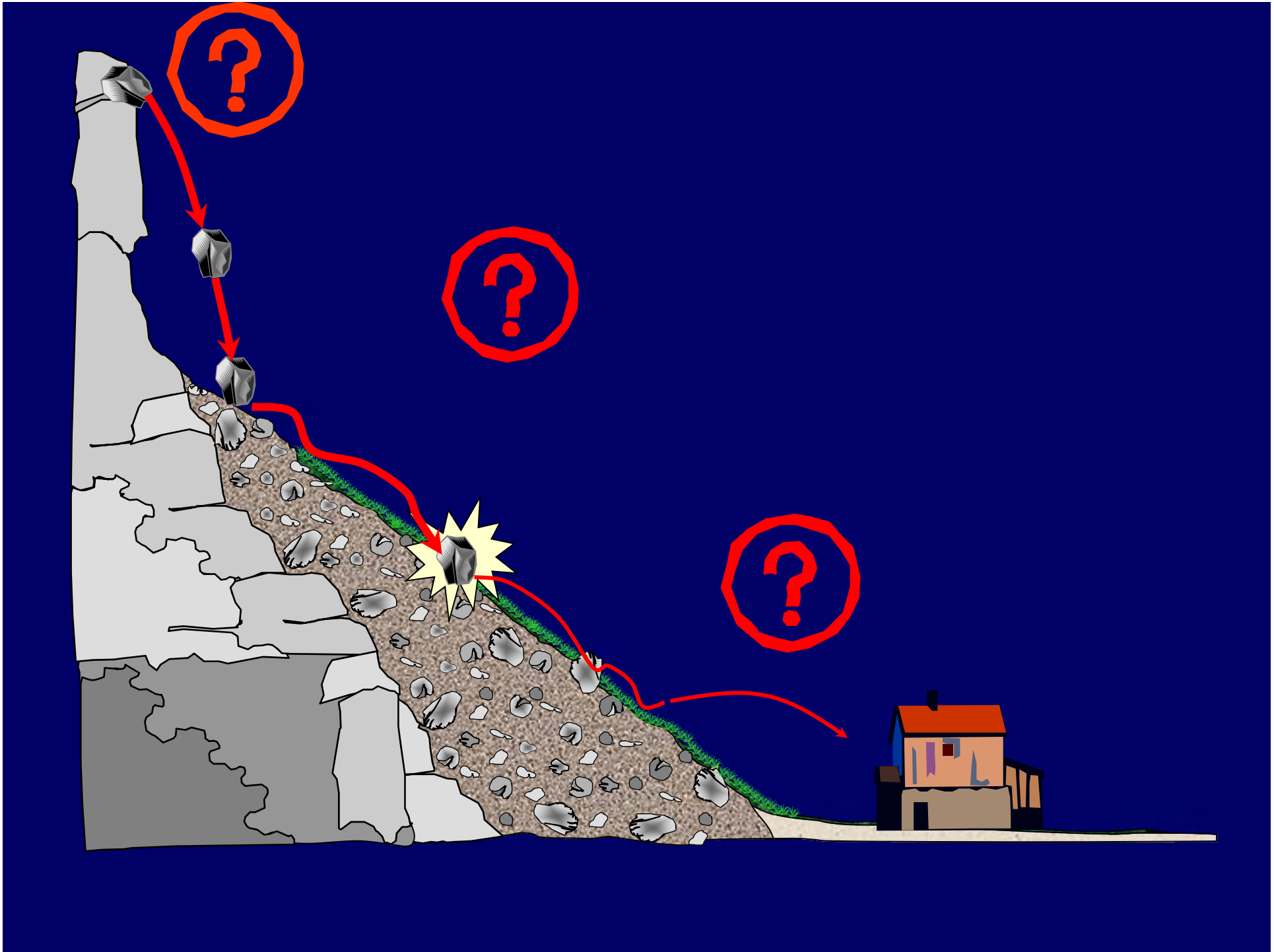


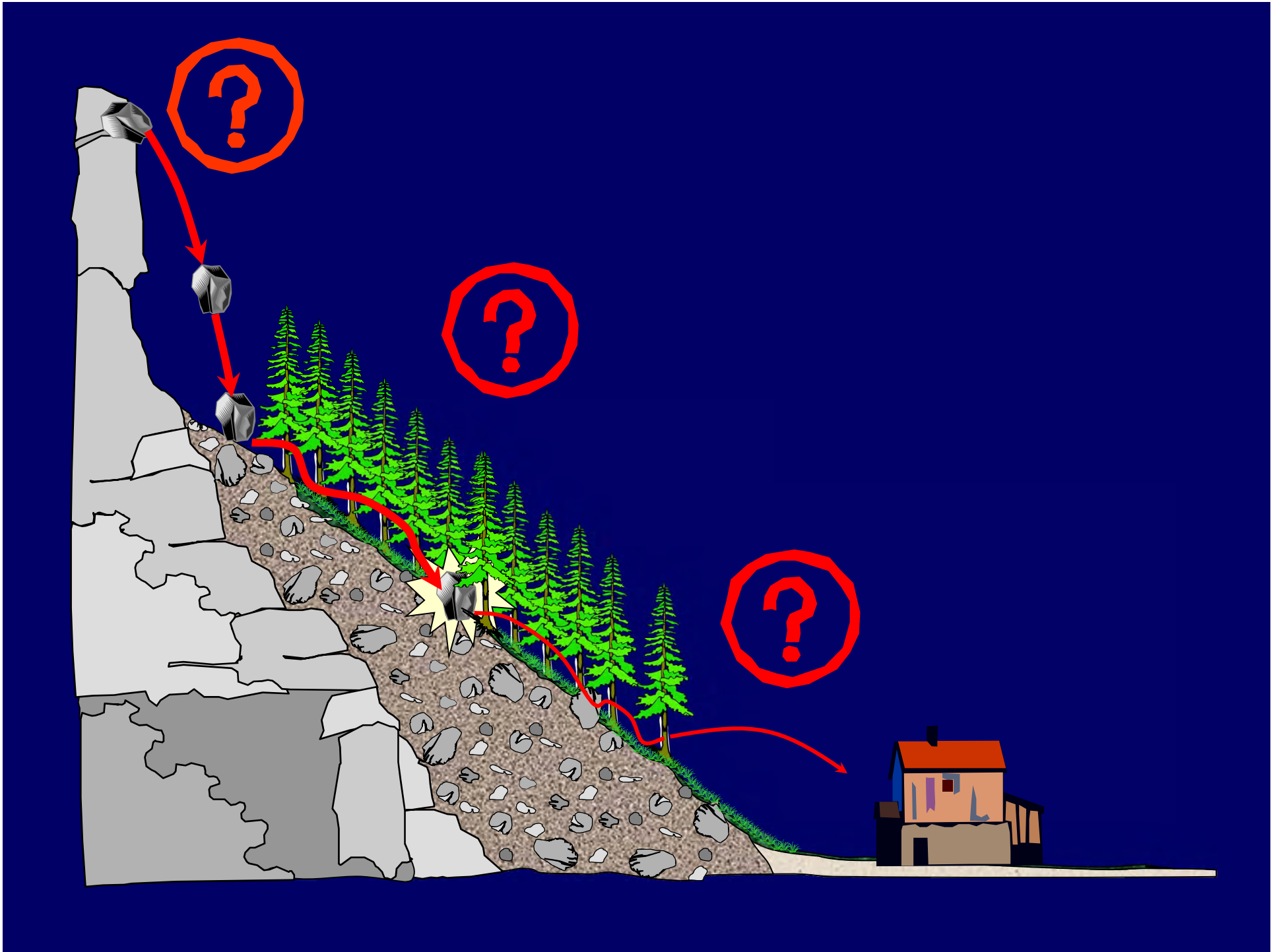
## Du risque naturel.....à la protection

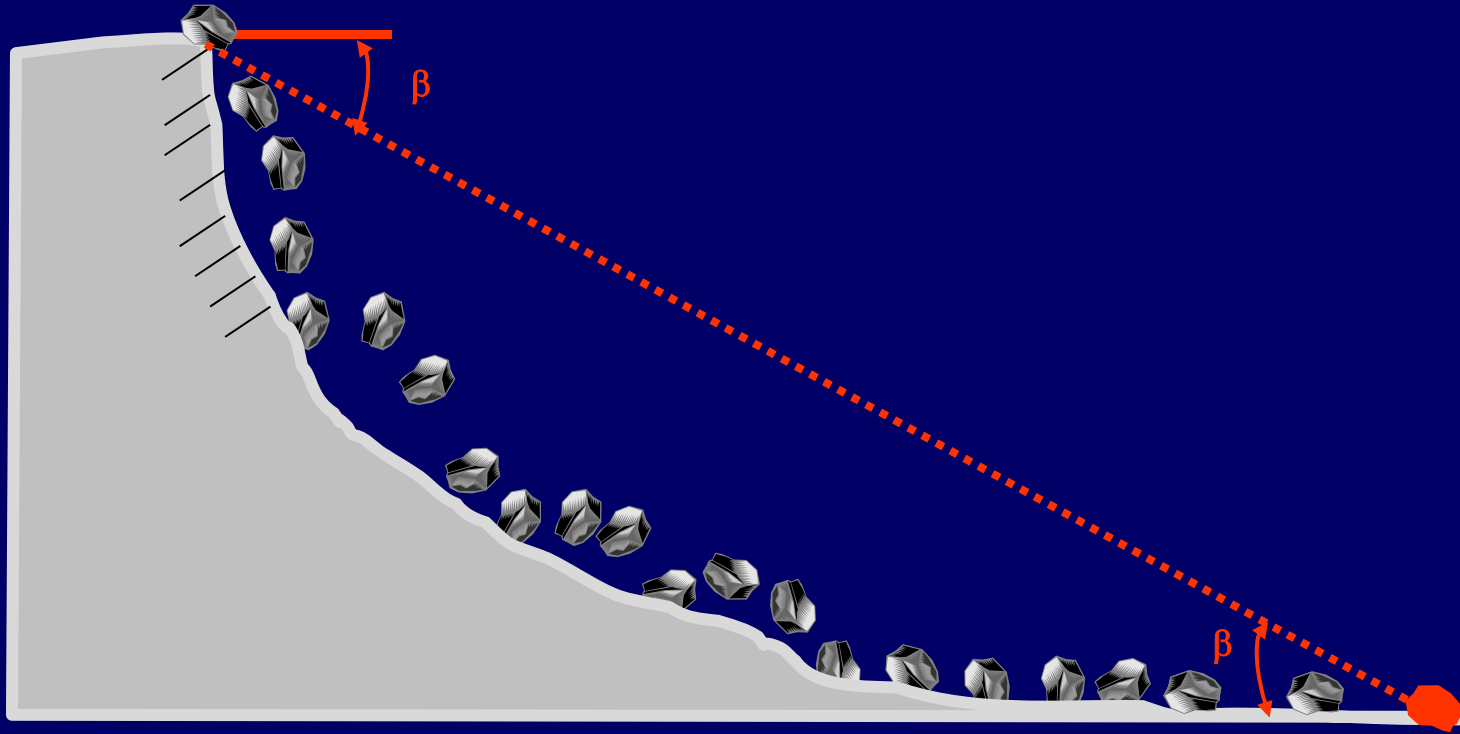


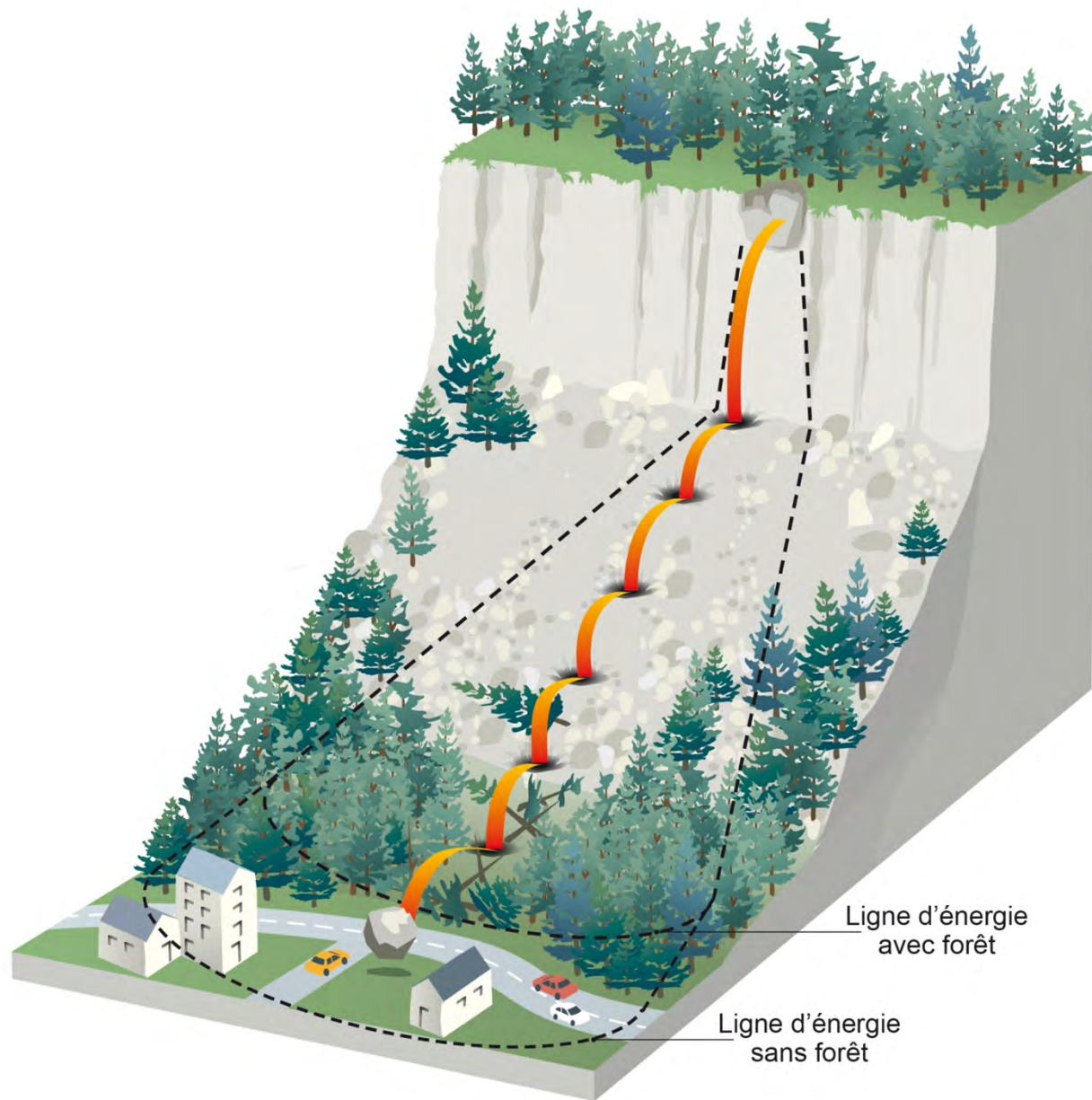
**Génie civil : emmailloter, filet, etc.**

**Génie biologique : gérer au mieux l'existant, reboiser, revégétaliser**



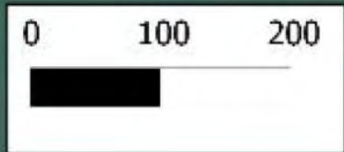
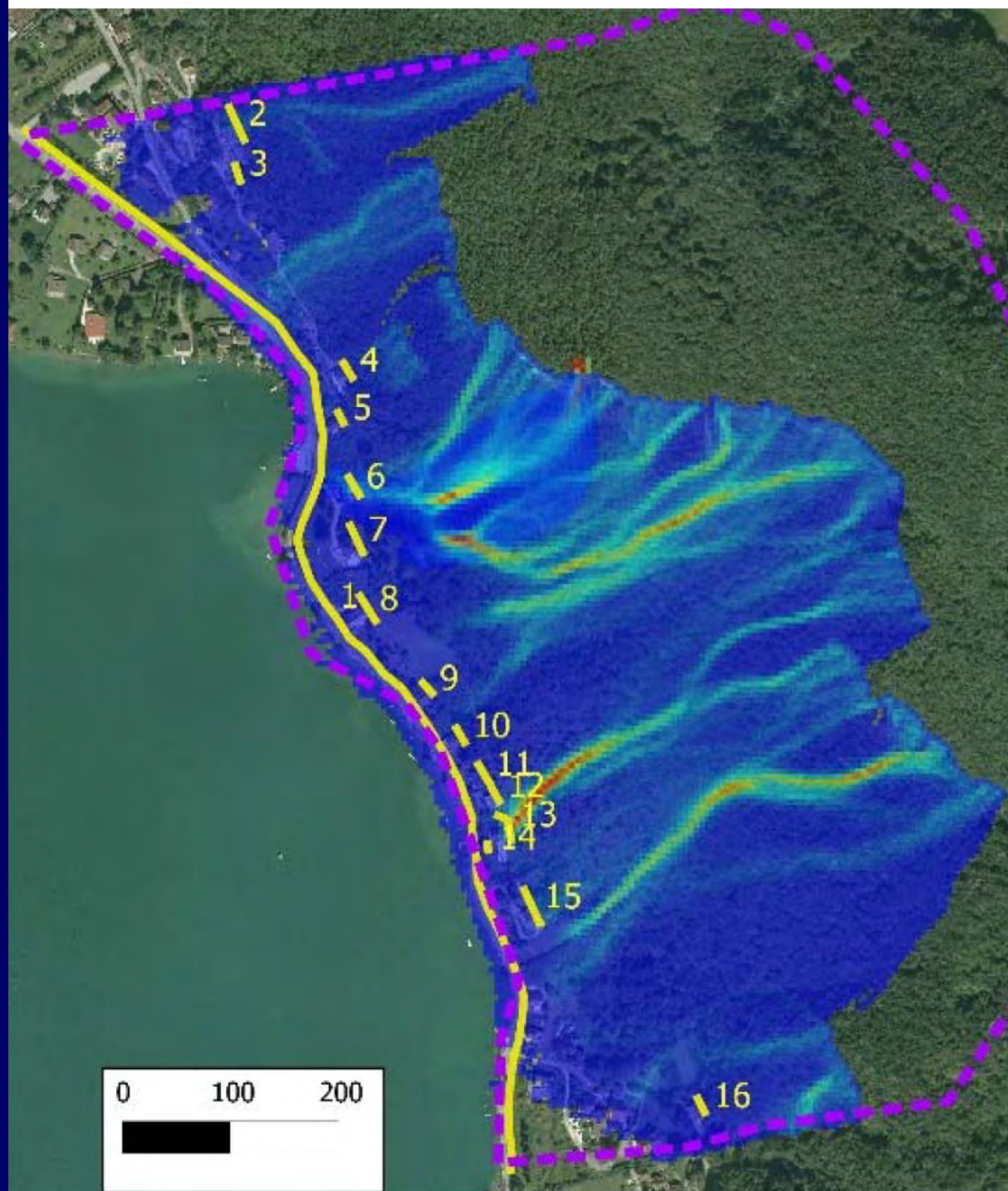


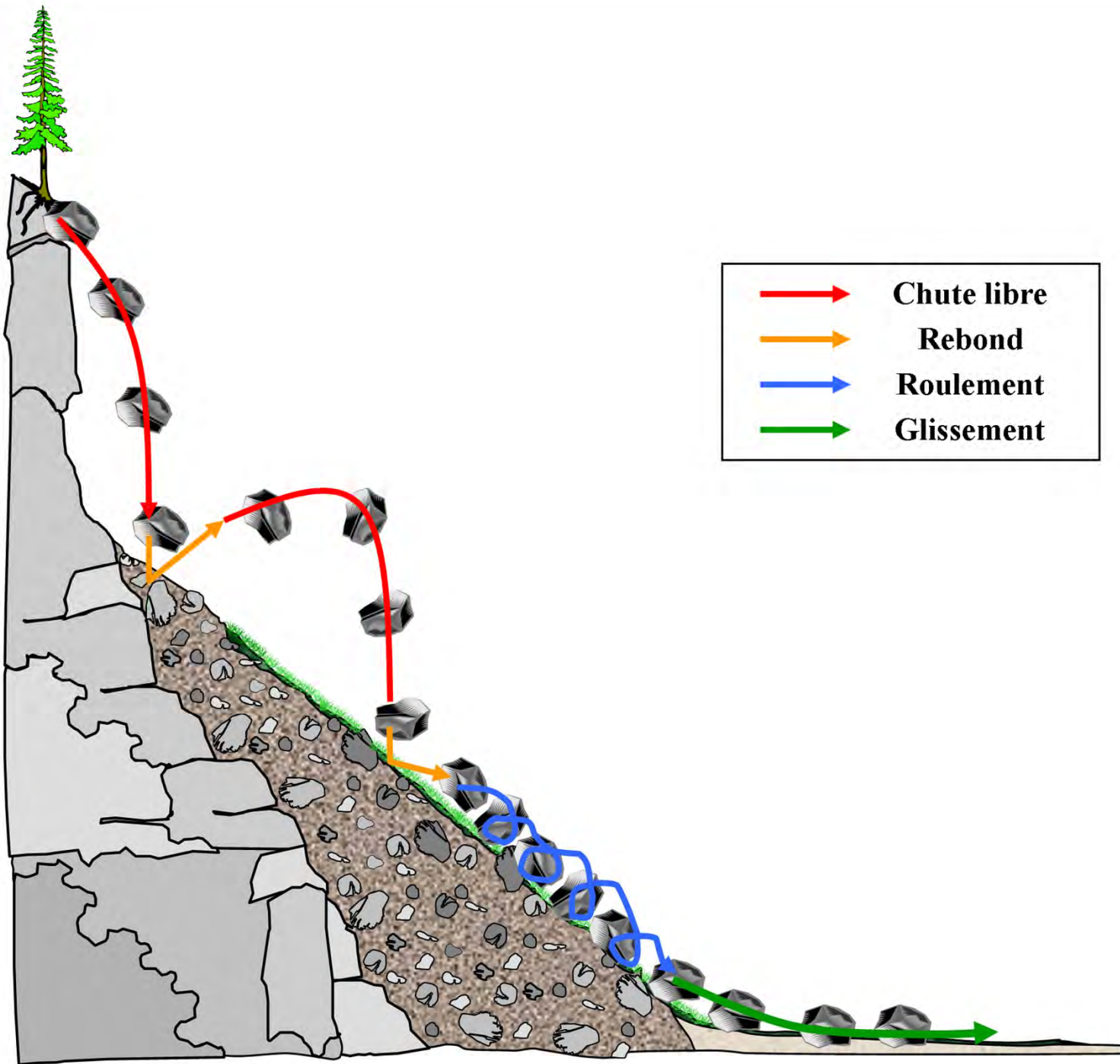




Ligne d'énergie  
avec forêt

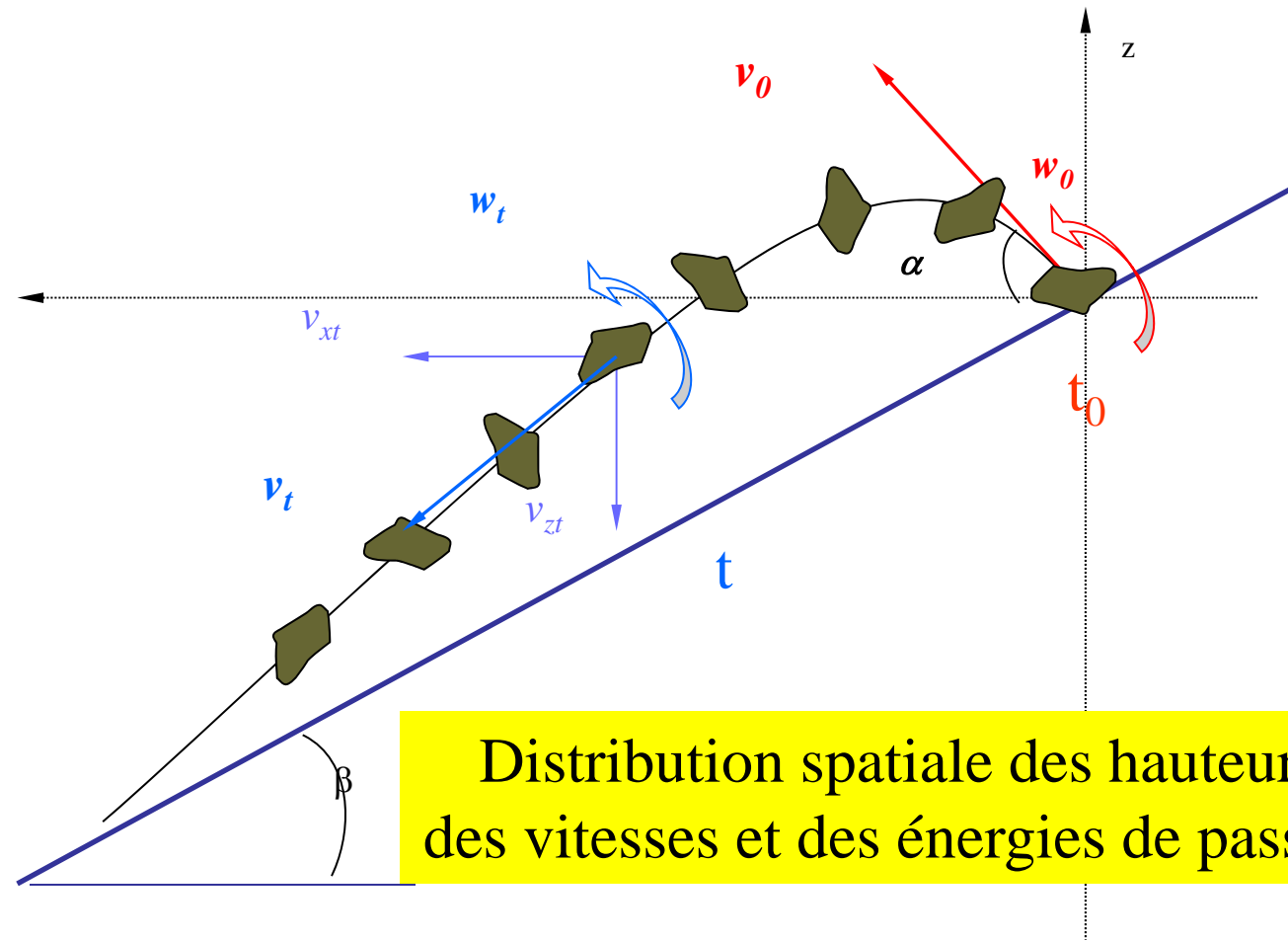
Ligne d'énergie  
sans forêt



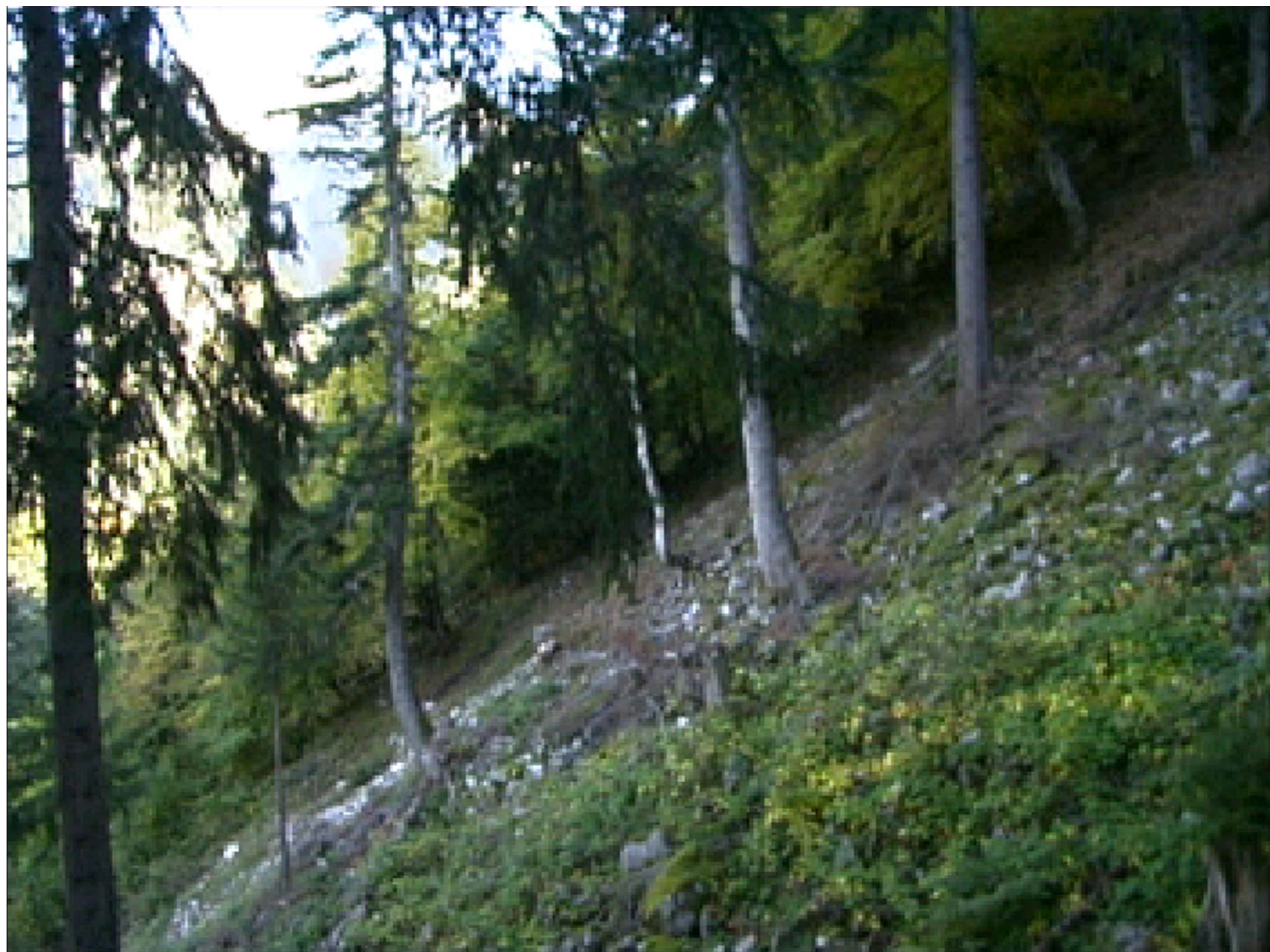




$W_t$ : vitesse de rotation  
 $V_t$ : vitesse de translation



Distribution spatiale des hauteurs,  
des vitesses et des énergies de passage











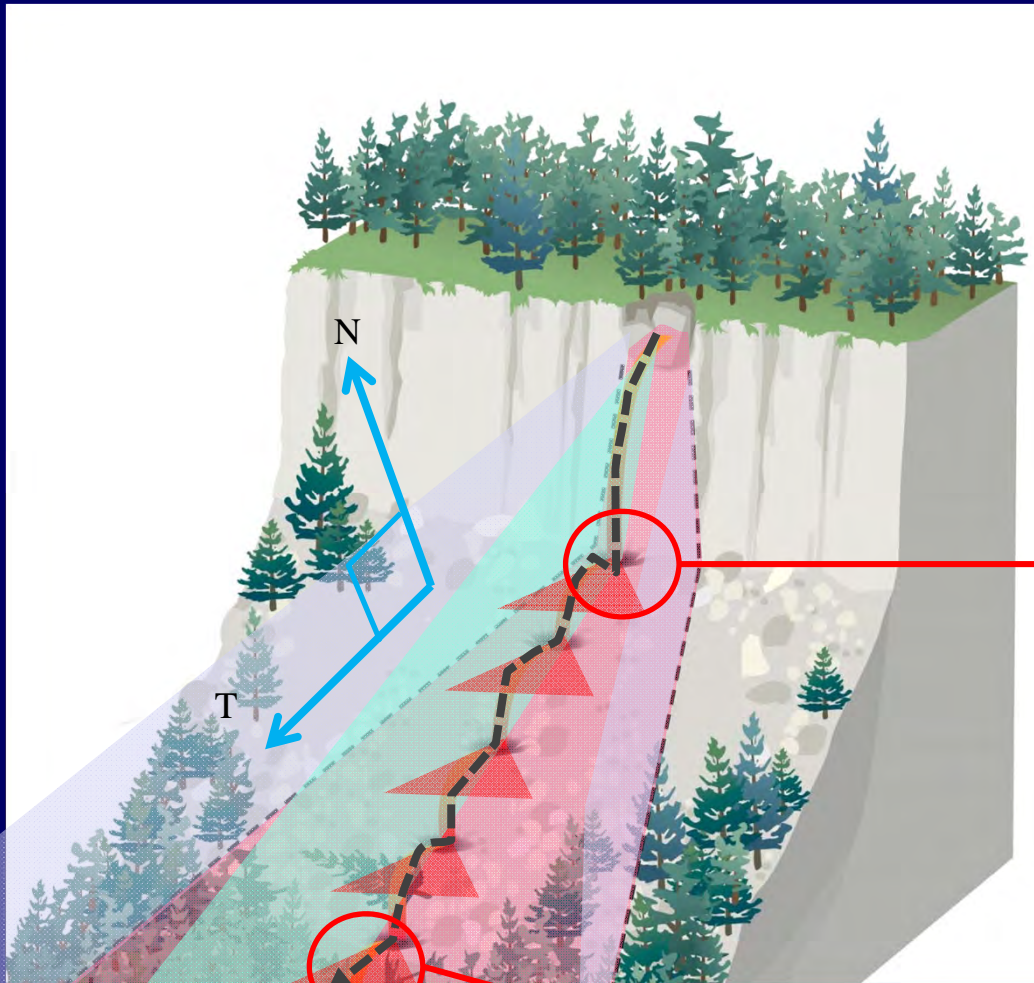










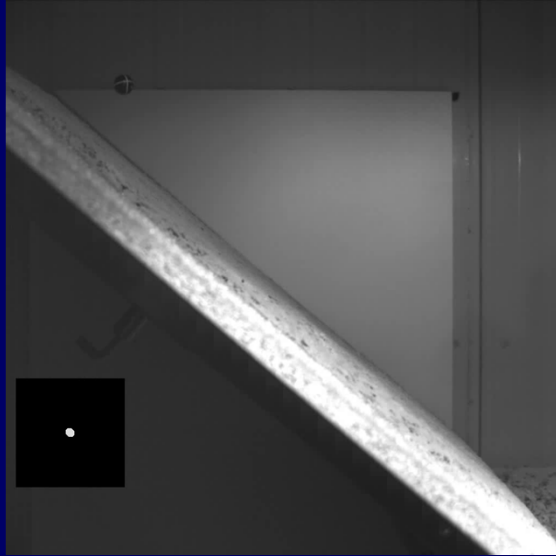


$$V_{\text{réfléchi}} = \alpha * V_{\text{incidente}}$$

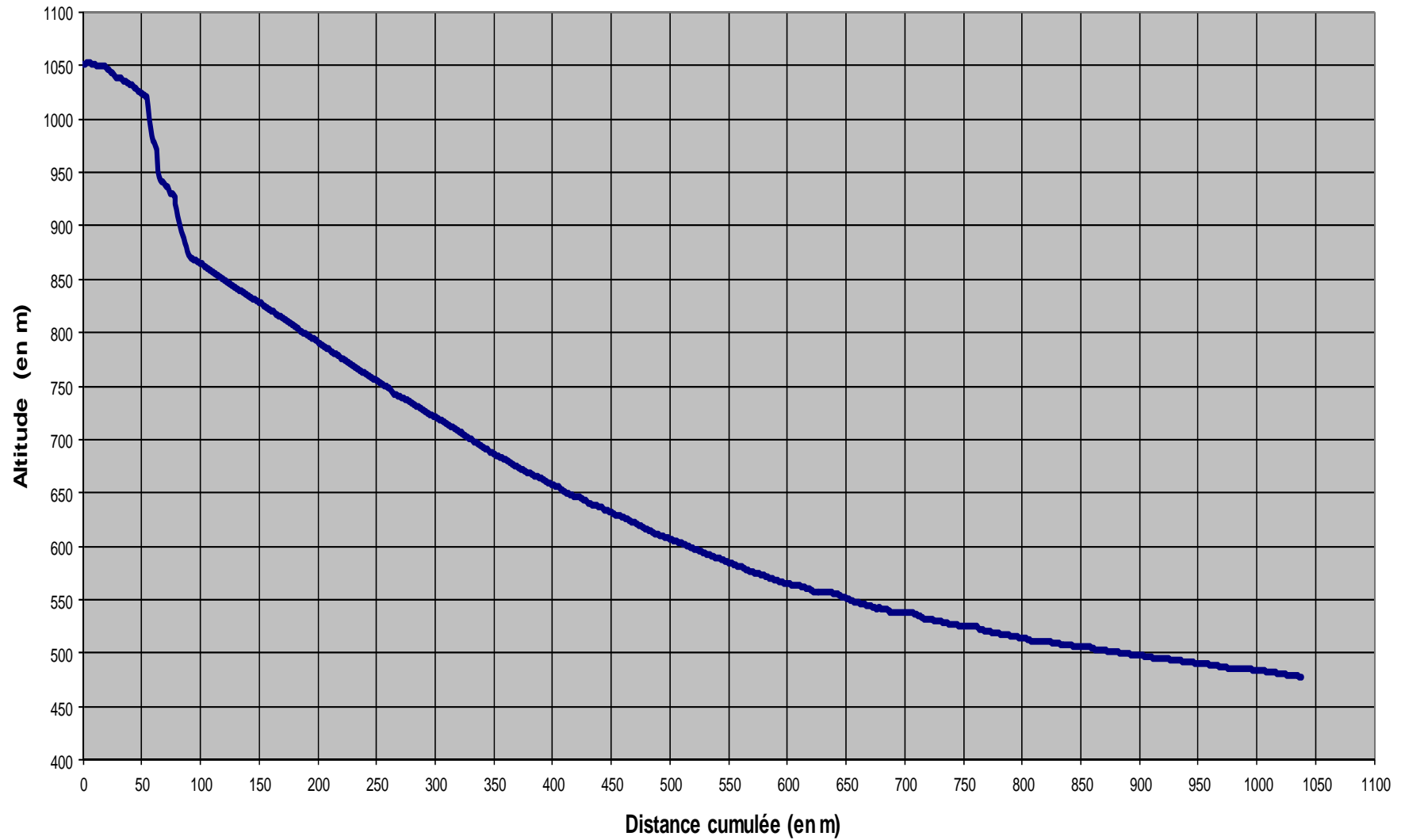
Fonction de la nature du sol , des obstacles,  
du projectile  
(2D, 2.5D, 3D)

Déviations latérales (2.5D, 3D)

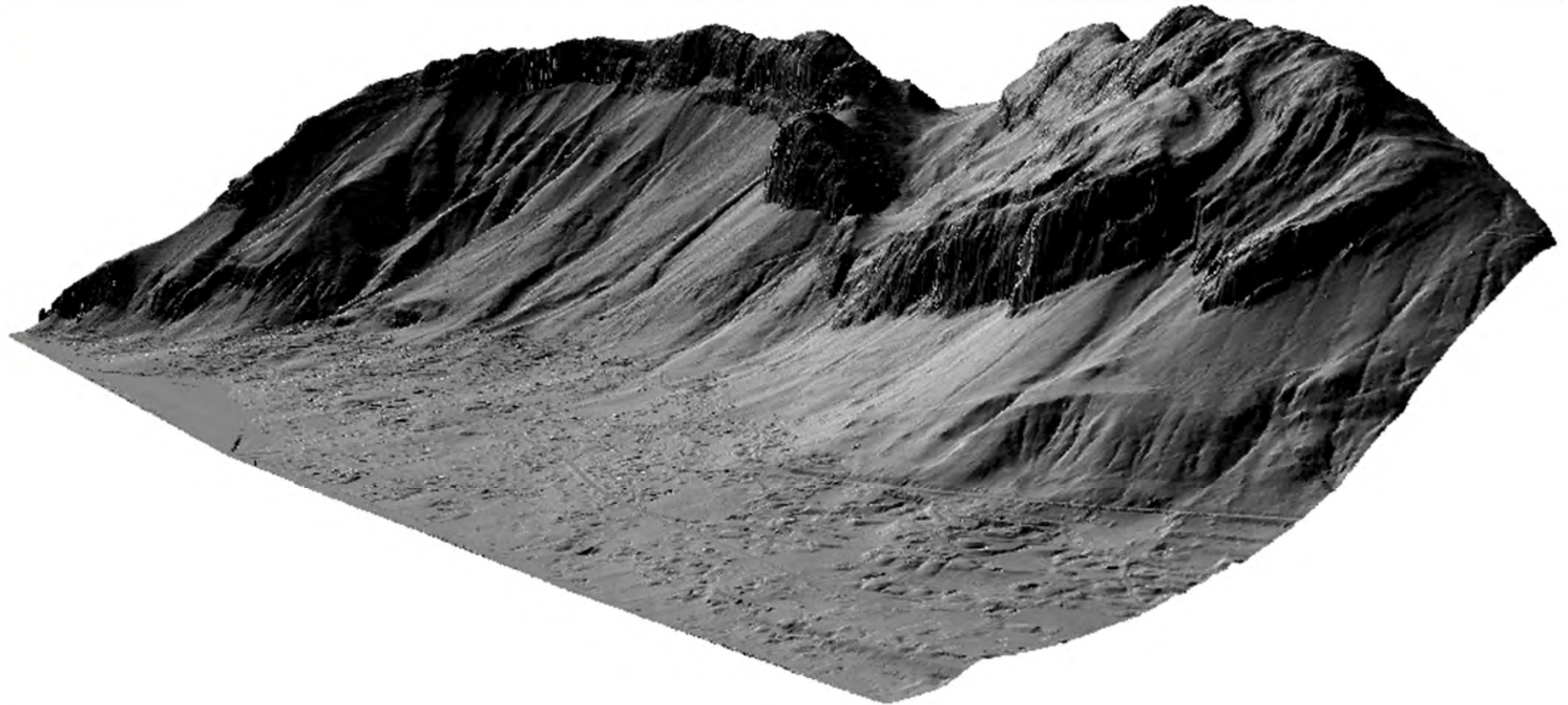
Fonction de la nature du sol , des obstacles,  
du projectile



## 2D = profil en long (données discrètes)



**2-2.5 -3D = Modèle Numérique de terrain  
(donnée continue)**



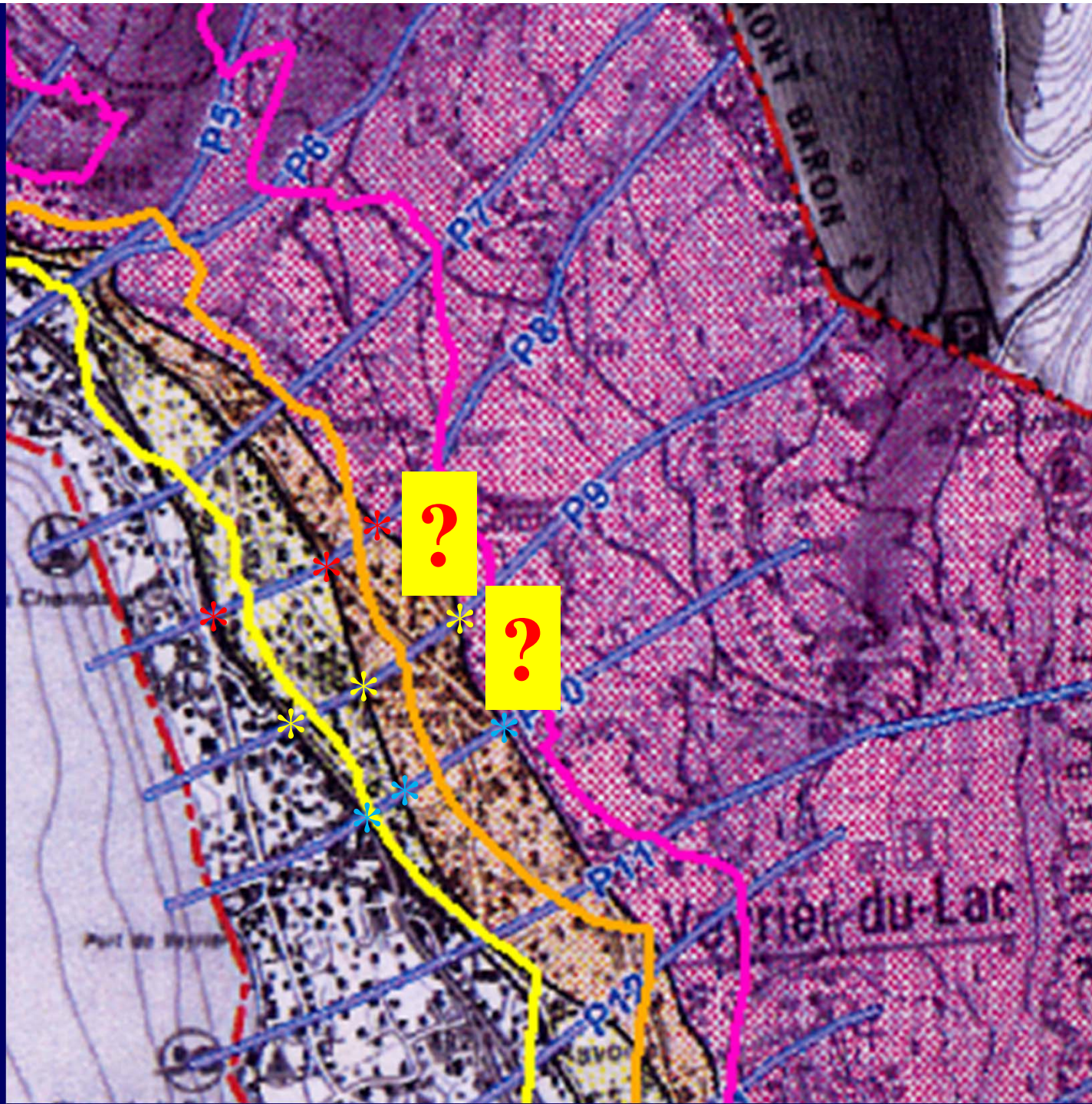
General / Général / Allgemeines			
Date	.. / .. / ....	Sample #	...
Location		Mean Slope angle	...°
		Type of zone	<input type="checkbox"/> Source <input type="checkbox"/> Transport <input type="checkbox"/> Deposition
Rock / pierre / Stein			
Shape of rock	<input type="checkbox"/> disc	<input type="checkbox"/> sphere	<input type="checkbox"/> square <input type="checkbox"/> rectangle
Size of rock [m]	Height:	Width:	Depth:
Density [t/m <sup>3</sup> ]	(Gneiss = 2850, Dolomite = 2700, Mica schist = 2650, Limestone = 2500)		
Soil elasticity / Elasticité du sol / Untergrund - Dämpfung			
Soil depth [cm]	.. - .. cm		
Moisture	<input type="checkbox"/> Soft, wet, loose material	<input type="checkbox"/> Soft, moist, loose material	<input type="checkbox"/> Medium hard dry, loose material <input type="checkbox"/> Medium hard, scree (talus/ Hangschutt) <input type="checkbox"/> Hard, some loose material <input type="checkbox"/> Bedrock
Vegetation cover	<input type="checkbox"/> Meadow/grass <input type="checkbox"/> Herbs and shrubs <input type="checkbox"/> Forest		
Slope surface - roughness / rugosité du versant / Rauigkeit der Oberfläche			
1. Topography	Slope length m	type a	type b
		type c	
	1 m	<input type="checkbox"/>	<input type="checkbox"/>
	5 m	<input type="checkbox"/>	<input type="checkbox"/>
	25 m	<input type="checkbox"/>	<input type="checkbox"/>
2. Obstacles	Number of objects over 10 m representative slope length		
		(0)	(1)
		(2)	(3-4)
		(5-7)	(>7)
Maximum obstacle height normal to the slope direction	0.1 - 0.25 m	<input type="checkbox"/>	<input type="checkbox"/>
	0.25 - 0.5 m	<input type="checkbox"/>	<input type="checkbox"/>
	> 0.5 m	<input type="checkbox"/>	<input type="checkbox"/>
Lying tree stems	Diam. = cm	<input type="checkbox"/>	<input type="checkbox"/>
	Length = m	<input type="checkbox"/>	<input type="checkbox"/>
Forest & bushes / Forêt et taillis / Wald und Bewuchs			
1. Representative forest plot 10m x 10m		2. Representative bush cover plot 10m x 10m	
Nr. of trees [-]		Nr. of stems [-]	Species:
Diam. Mean [cm]		Diam. Mean [cm]	
Diam. Min. [cm]		Diam. Min. [cm]	
Diam. Max. [cm]		Diam. Max. [cm]	
	Coniferous %		
	Broadleaved %		
	Species:		
3. Rockfall indicators			
Nr. of rockfall damages on trees			
Nr. rocks stopped behind trees			
Remarks / remarques / Bemerkungen			

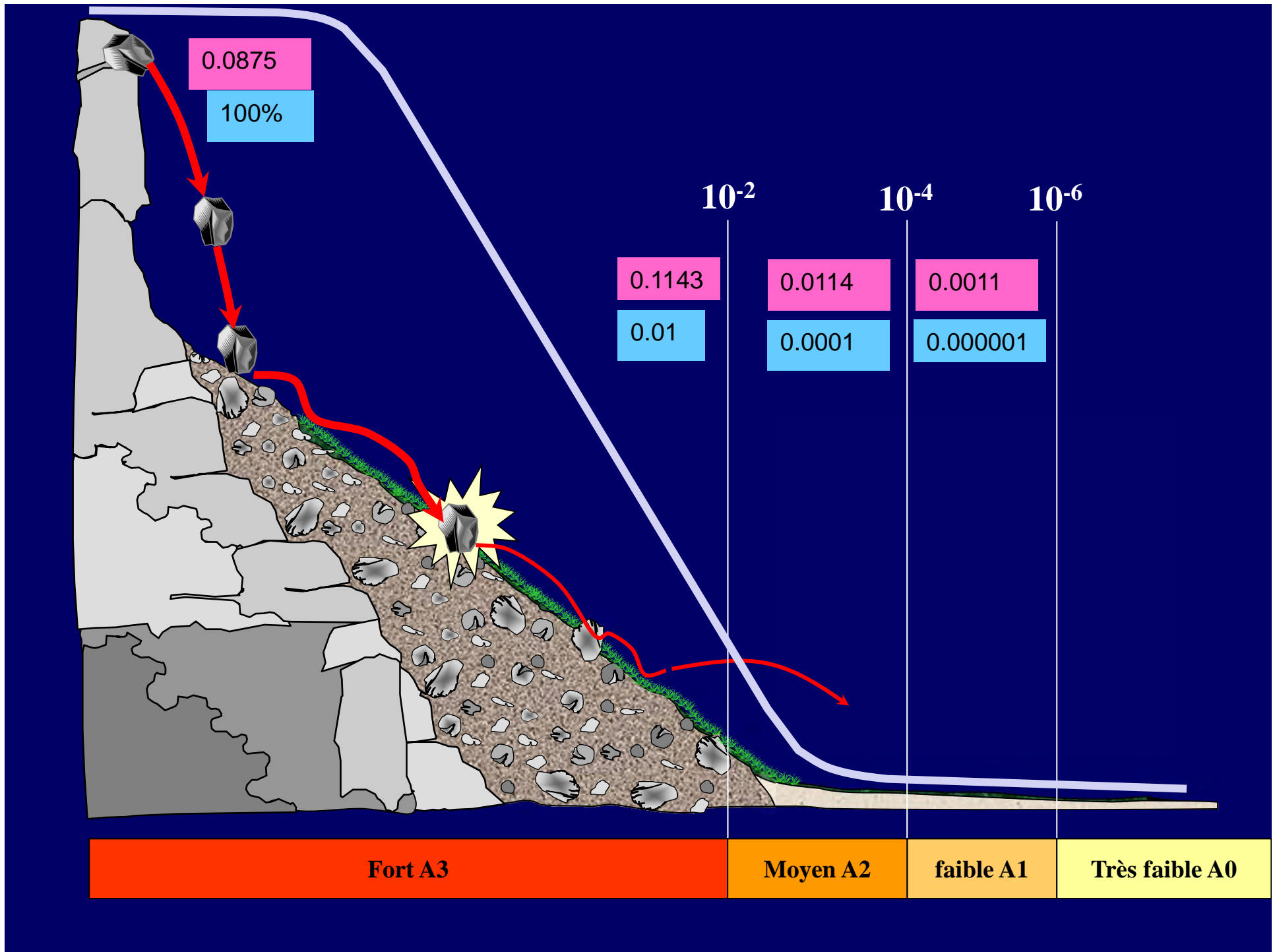
	ratio diff Vmax Ecran	Ratio diff Vmax Ecran 2	ratio diff Hmax Ecran1	Ratio diff Hmax Ecran 2	ratio diff Ecmx Ecran1	ratio diff Ecmx Ecran2	ratio diff distance	Probabilité d'atteinte 385-400m	Dépassement 385-400m
Part.17	-10%	-19%	17%	13%	-13%	-4%	10%	Yes	Yes
Part. 1	3%	-8%	35%	43%	-9%	1%	4%	Yes	Yes
Part. 2	2%	-3%	-37%	9%			-1%	Yes	No
Part.15	83%	72%	1%	9%	372%	413%	3%	Yes	No
Part.14	-22%	-23%	-21%	-31%	-13%	-21%	0%	Yes	No
Part. 8	-43%	-44%	-44%	-35%	-63%	-66%	1%	Yes	No
Part.12	-63%	-76%	-96%	-94%	-92%	-84%	1%	Yes	No
Part. 4	-51%	-64%	-9%	-30%	-88%	-86%	-8%	No	
Part.11	-27%	-28%	-58%	-46%	-26%	-22%	-6%	No	
Part. 7	38%	24%	435%	632%			-9%	No	
Part. 9	-61%	-68%	-100%	-100%	-82%	-85%	-9%	No	
Part.13	-31%	-37%	-62%	-63%	-27%	-28%	-29%	No	

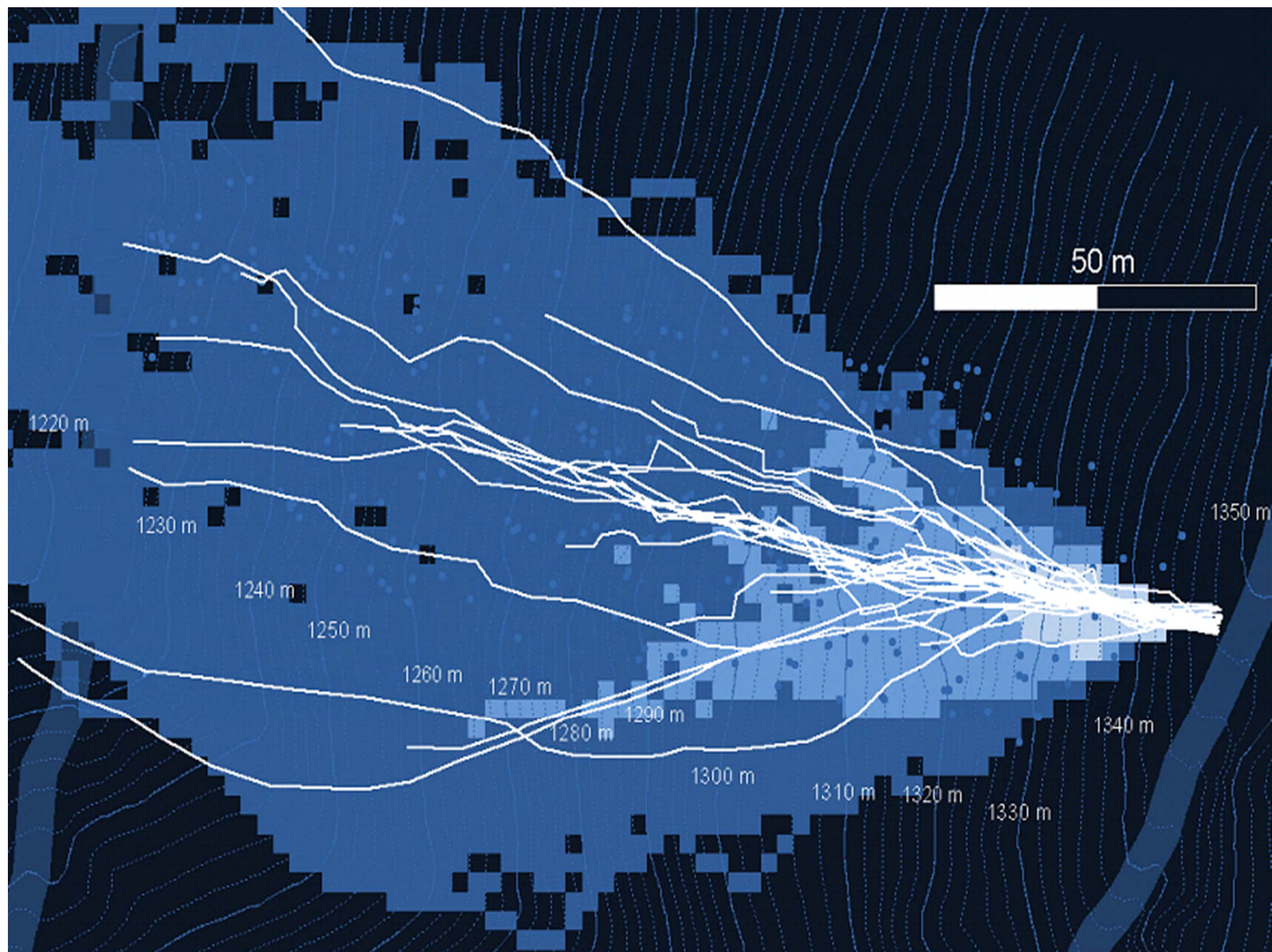
$$\text{Ratio} = \frac{(\text{Simulé-Observé})}{\text{Observé}}$$

	Ratio difference entre -20% et 20%
	Ratio difference non dans l'inter -20% - 20%
	Données non communiquées

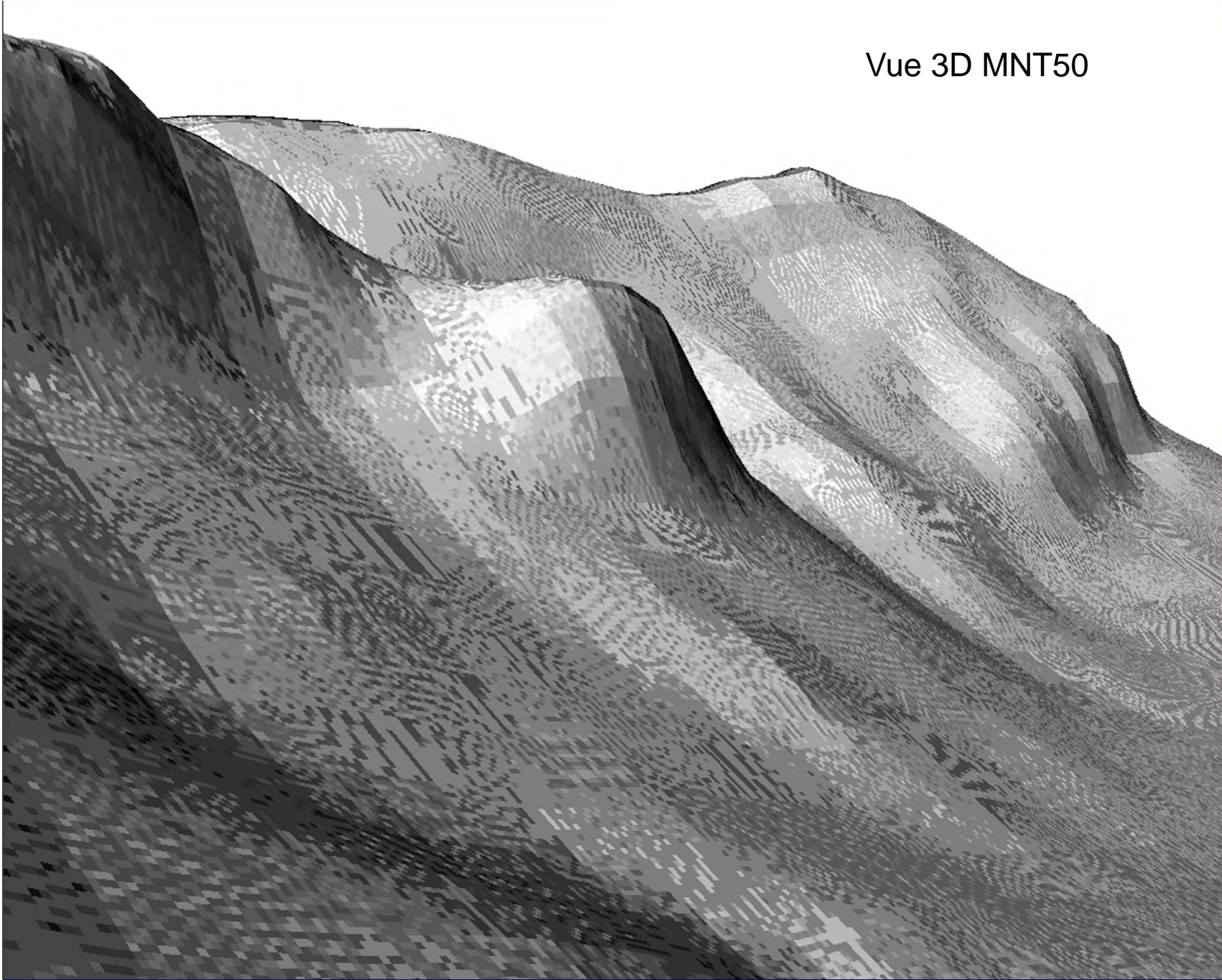


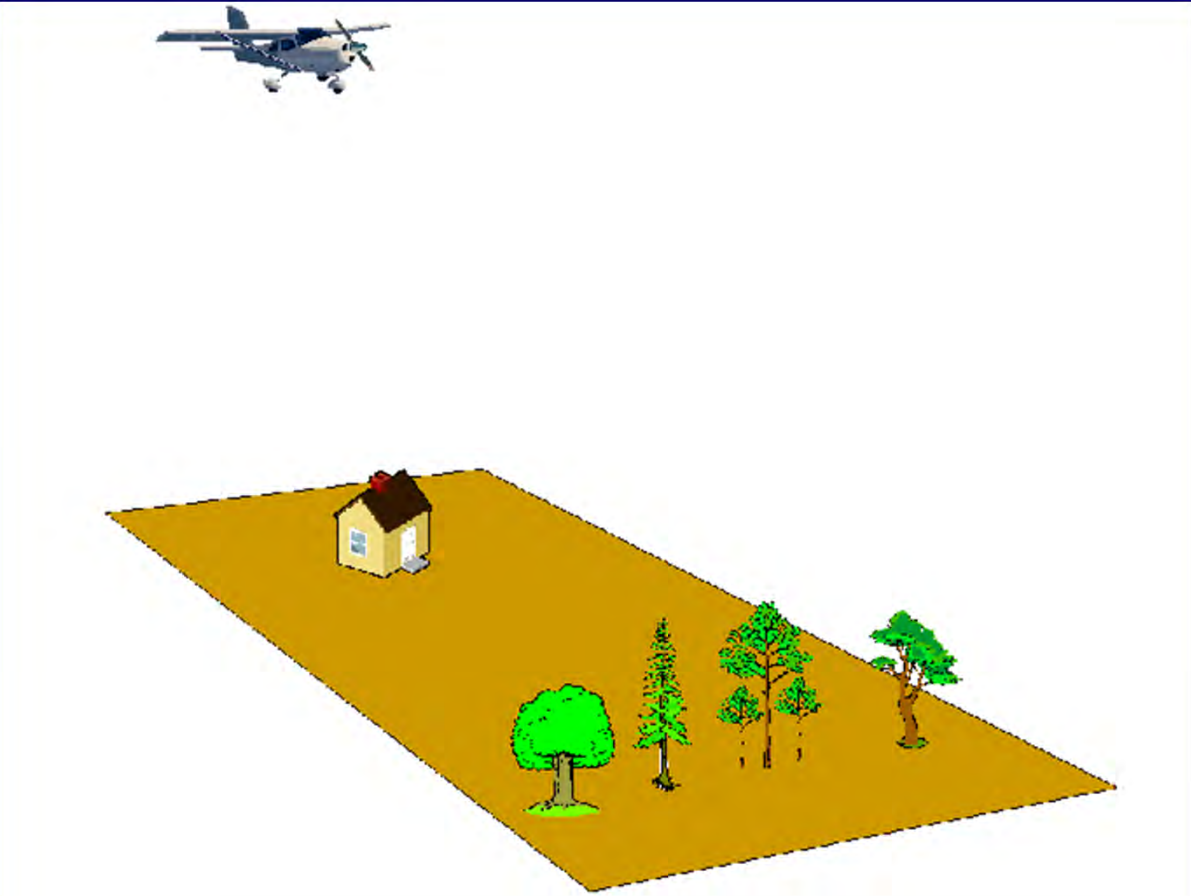






Vue 3D MNT50

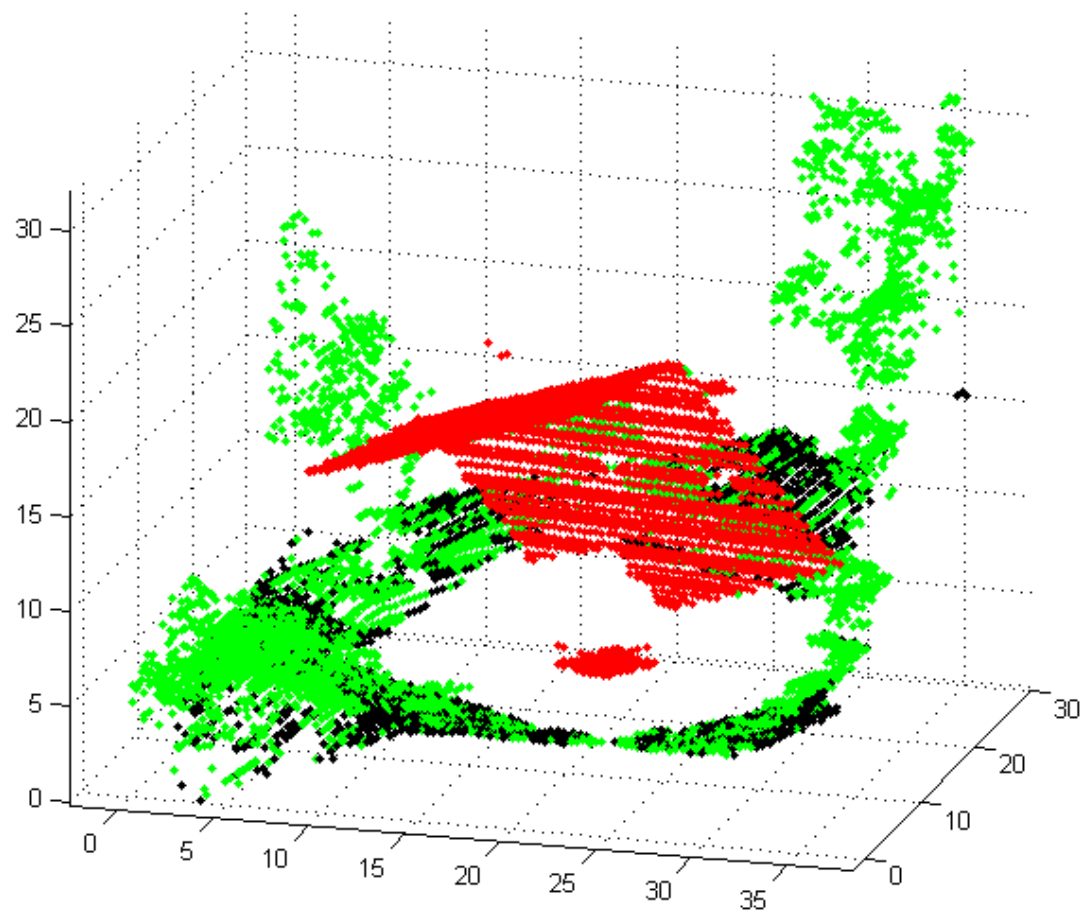




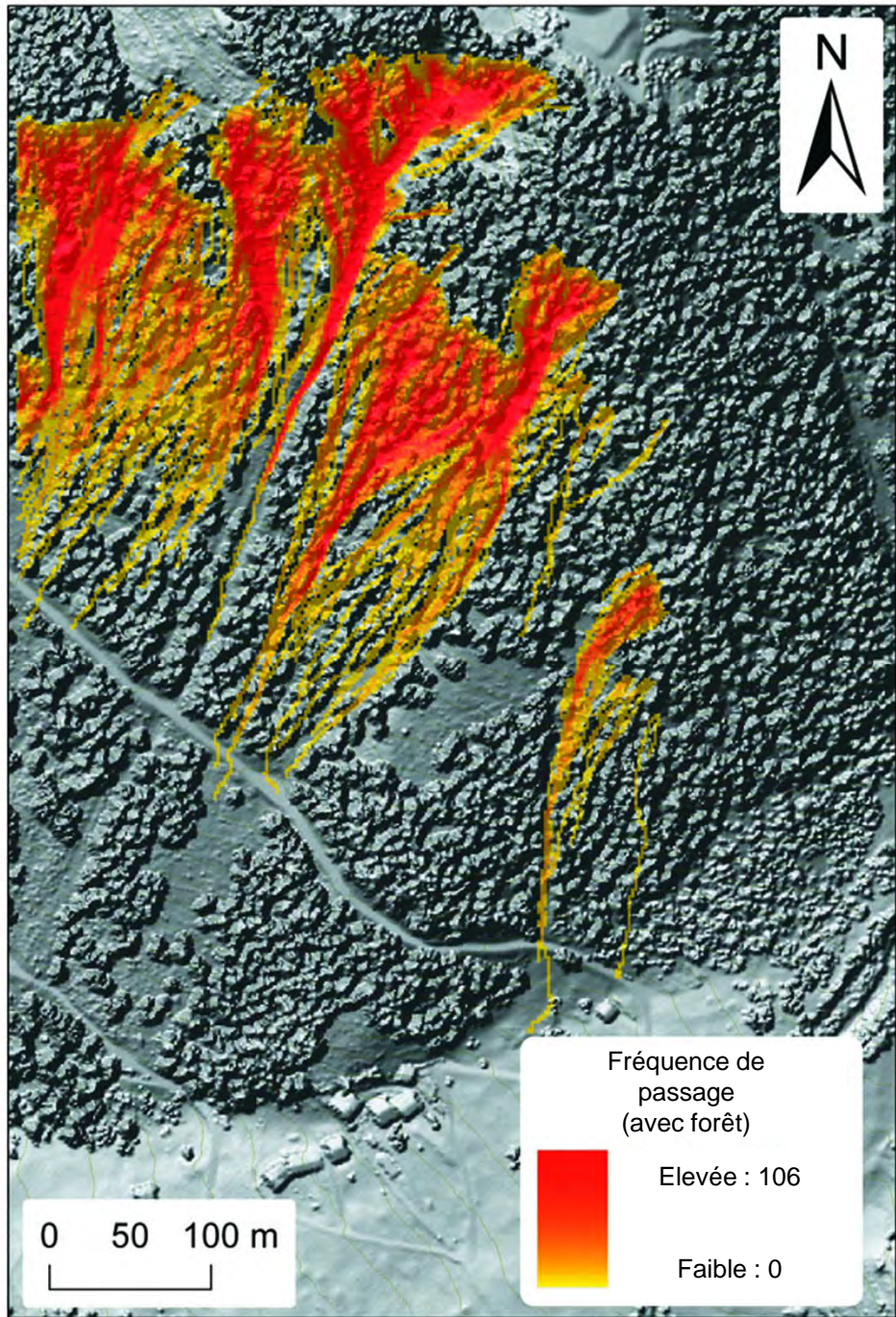
Vue 3D Lidar

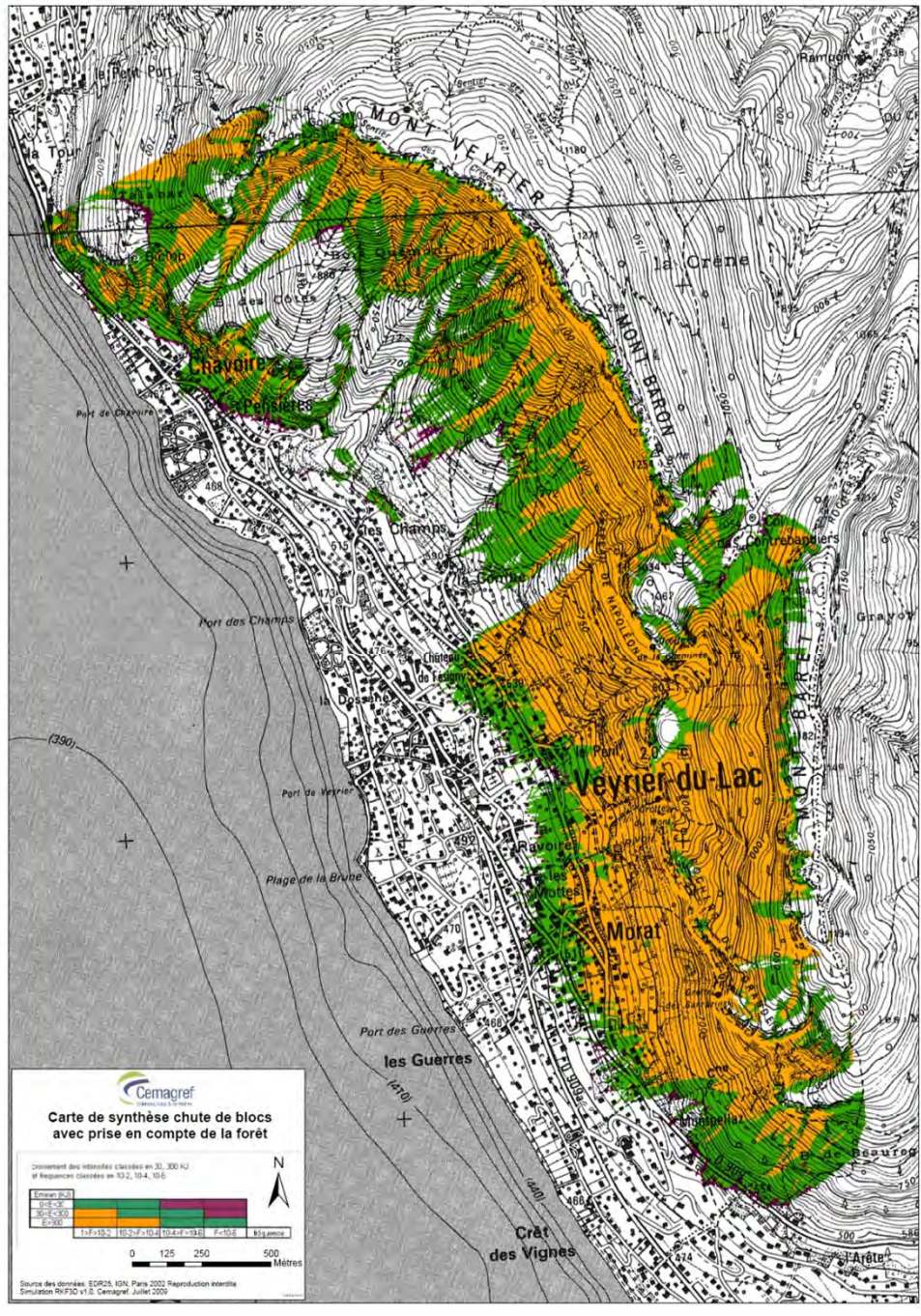












# Zones de départ



## Intensité



## Activité

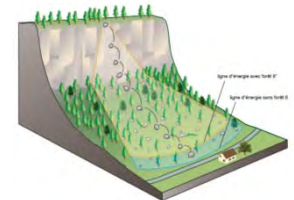
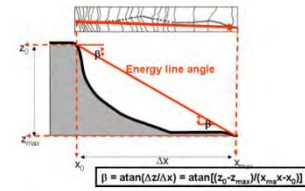


## Propagation



## Probabilité d'occurrence

## Modélisation trajectographique



## Guides de sylviculture



## Législation, réglementation, fonds

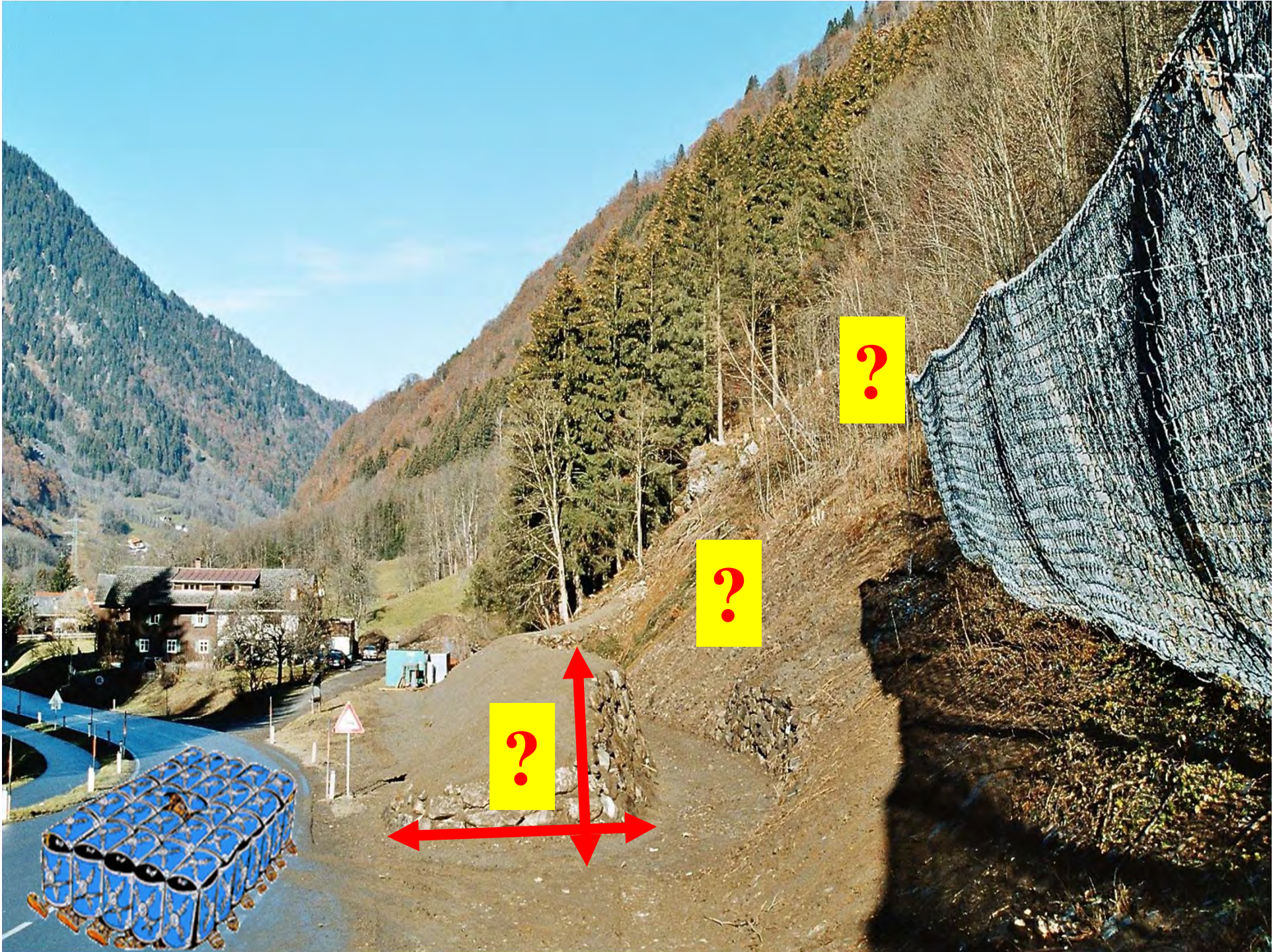


### Aléa

		Intensity				Rocks avalanche
		V < 0.25 m³	0.25 < V < 1 m³	1 < V < 10 m³	V ≥ 10 m³	
Probability of occurrence	Low	Low	Moderate	Moderate	High	Only one level: Very High using an EIA < 25
	Moderate	Low	Moderate	High	Very High	
	High	Moderate	Moderate	High	Very High	
	Very High	Moderate	Moderate	High	Very High	



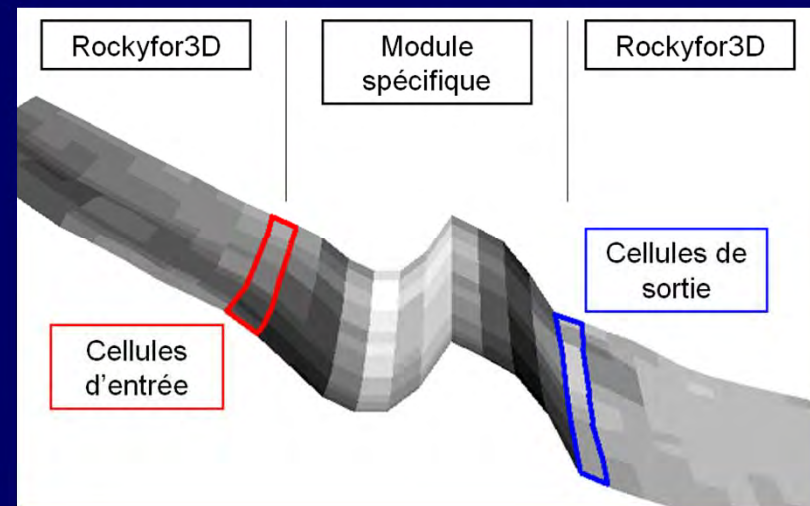
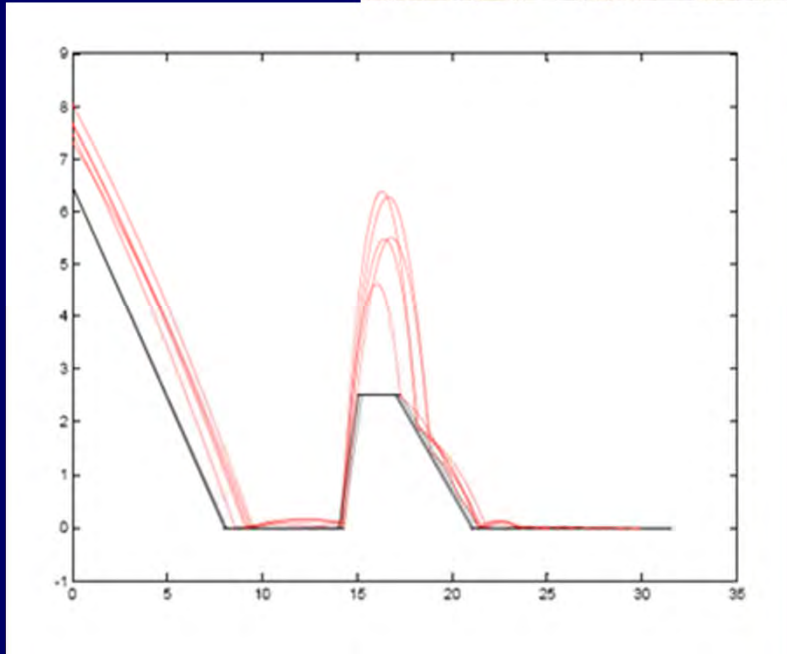
## Zonage et gestion









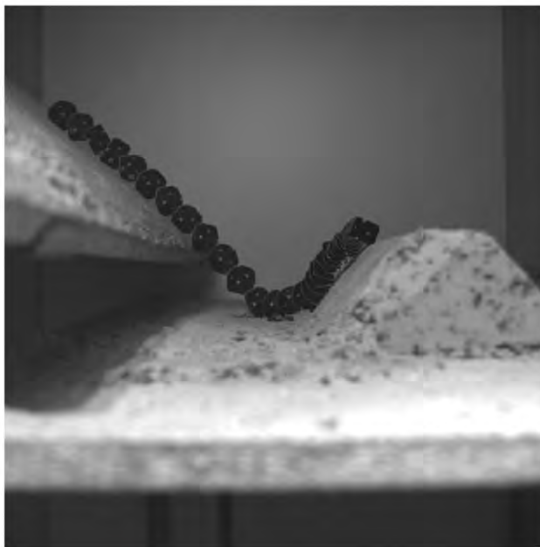




Sphère



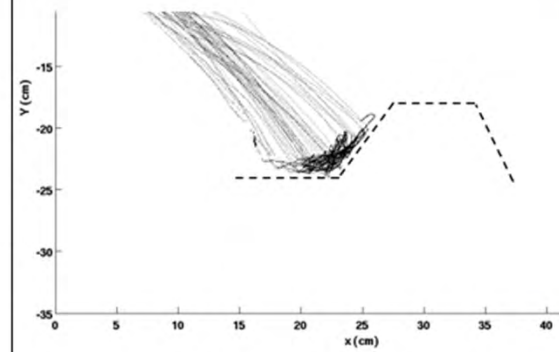
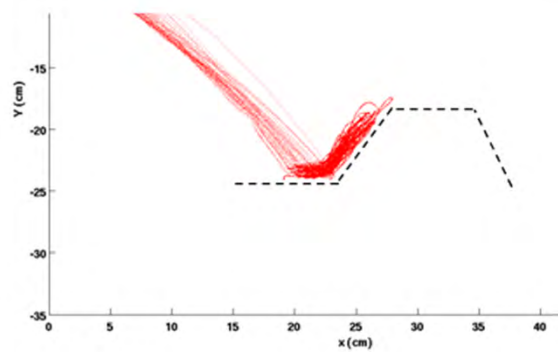
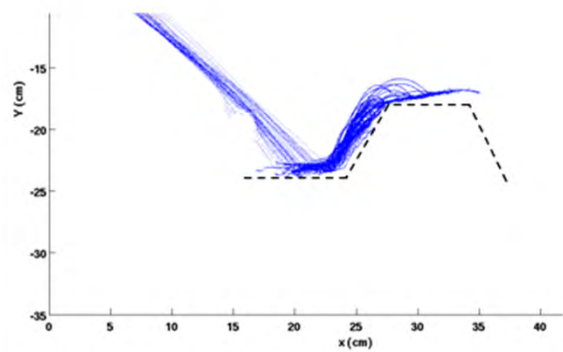
Cube



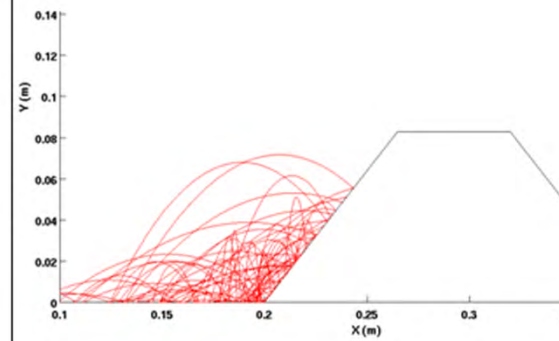
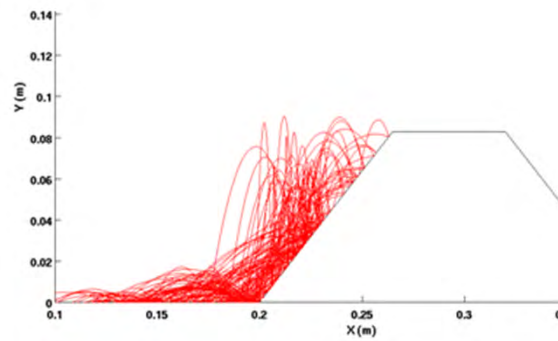
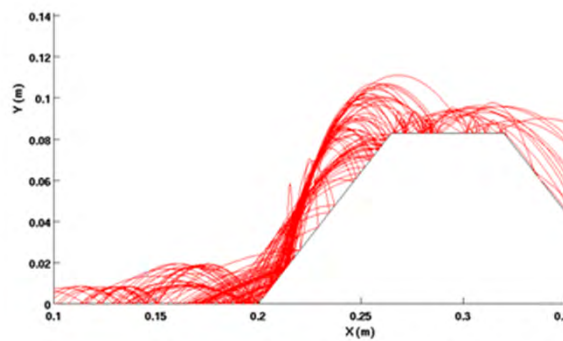
Pavé droit



Essais



Simulations







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Mardi 8 Mars 2016**



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Organisation



*Pôle Alpin d'Etudes et de Recherche  
pour la Prévention des Risques Naturels*

Collaborations scientifiques

