Manual of classification schemes of debris flow events in alpine catchments

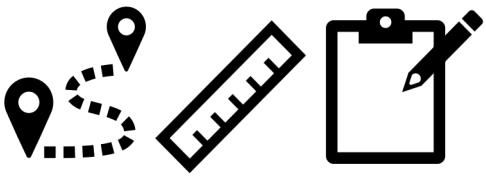
Methodological approach

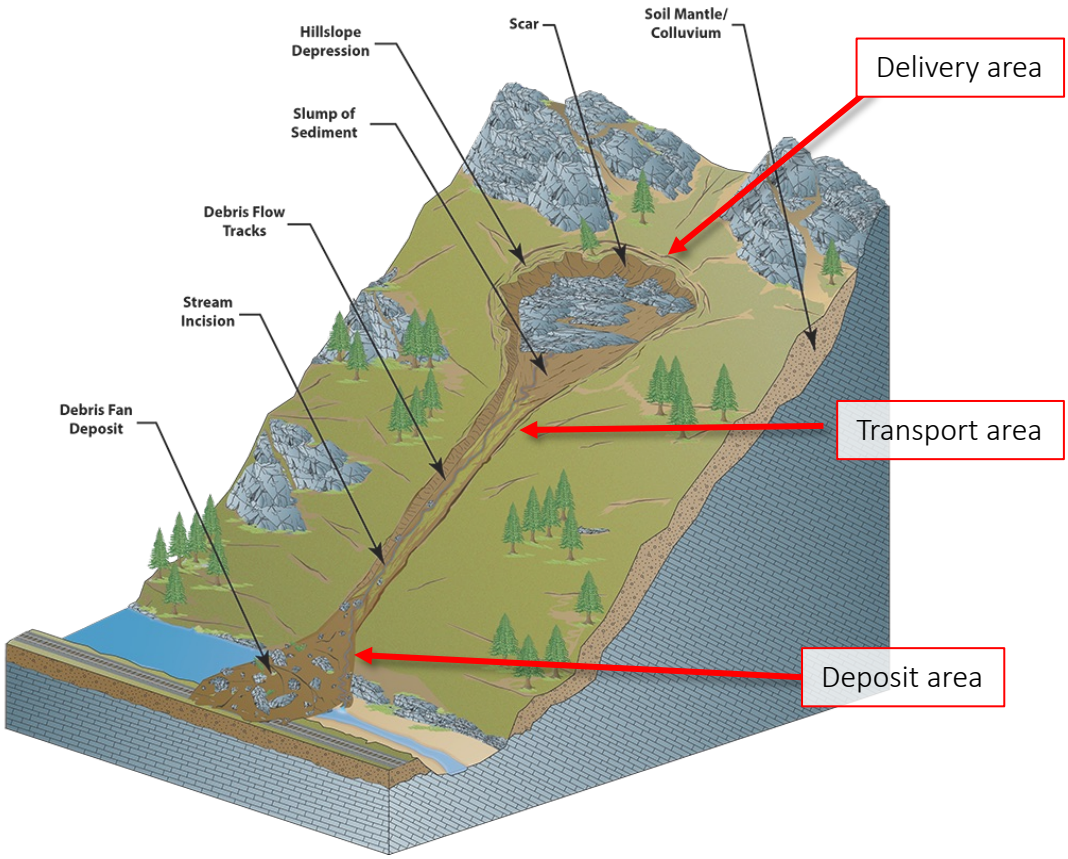
Objectives:

- Identification of the characteristic **processes** of the catchment area
- Quantitative and qualitative classification of the sediments, that are transported and deposited
- - Estimation of the **contribution of additional material** that may influence the dynamics of the catchment

Classification lists suitable for terrain use:

- List of UNIMIB for water courses
- List of UNIMIB for steep walls subject to gravitative processes
- UNIMIB list for the qualitative and quantitative characterisation of deposits





List of UNIMIB for watercourses (1/6)

Need to quantify potentially mobilisable debris

Survey of the channels and preparation of a **quick data sheet** dividing the canal into **homogeneous** sections according to morphological, geological and vegetative characteristics of the canal and the basin.

BACINO IDROGRAFICO:	ID BACINO:	NOME CANALE:	ID ASTA:		DATA:

			ALVEO				LITOLOGIA				SPONDE		VEGETAZIONE (5)			APPORTO SEDIMENTO LATERALE		
sub-ID	Quota inf /GPS	Quota sup /GPS	Tipo (1)	Forma (2)	larghezza riempimento [m]	spessore riempimento [m]	Litologia prevalente	Litologia subordinata	Vol modale [m^3]	Vol 95th perc [m3]	Sponda dx (4)	Sponda sx(4)	detrito veg (5)	percent detrito veg (%)	vegetaz viva (6)	Tipo (7)	Connettività (8)	Volume [m^3]
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		

1	
	1: In roccia
	2: In detrito
	3: Tombinato
	4: Canalizzato

2	
	1: trapezio
	V
	R: rettangolare

4	
	1: deposito di versante
	2: in erosione
	3: Roccia
	4: Artificiali

5	
detrito veg. Prevalente	0: No
	1: < 0.3m
	2: < 1m
	3: > 1m

6	
veg. viva	4: Alberi in alveo
	5: Alberi su sponde
	6: Arbusti in alveo
	7: Arbusti su sponde

7	
	1: Frana superficiale (quota)
	2: Frana profonda (quota)
	3: Erosione accelerata
	4: Sovralluvionamento
	5: Debris flow
	6: Talus di crollo
	7: Torrente con detrito
	8: Torrente senza detrito
	9: crolli lungo il tratto
	10: accumulo di detriti

8	
	1: Connesso
	2: Disconnesso
	3: Parzialmente discon.

	OSTACOLI	OPERA 1		OPERA 2		OPERA 3		OPERA 4		OPERA 5		OPERA 5			
sub-ID	presenza ostacoli (9)	Tipo (10)	Stato (11) (s)	Tipo (10)	Stato (11) (s)	Tipo (10)	Stato (11) (s)	Tipo (10)	Stato (11) (s)	Tipo (10)	Stato (11) (s)	Tipo (10)	Stato (11) (s)	ID scheda detrito	NOTE
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															

9	
	1: Morene
	2: Fan
	3: Conoide
	4: Terrazzi fluviali
	5: Briglie contenim.
	6: Vasche di sedim.
	7: Attraversamenti
	8:. Vegetazione

10	
	O1: Briglia
	O2: Soglia
	O3: Traversa
	O4: Repellente/pennello
	O5: Argine
	O6: Difesa spondale in cls
	O7 Scogliera in massi clc
	O8: Gabbionata
	O9: Selciatone di fondo
	O10: Vasca di espansione
	O11 Tombinatura
	O12: Ponte

11	
	O1: Funzionante
	O2:Danno funzionale
	O3: Danno strutturale
	O4: Non funzionante

List of UNIMIB for watercourses (2/6)

		ALVEO			
Quota inf /GPS	Quota sup /GPS	Tipo (1)	Forma (2)	larghezza riempimento [m]	spessore riempimento [m]

Form

2	T: Trapeze
	V
	R: Rectangular

Type

1	1: In rock
	2 In debris
	3: Gully
	4: channalized

Typ: in debris (2)
V-Form(V)

Typ: in debris (2)
Form: Trapeze (T)

Type: channelized (4)
Form: Trapeze (T)

Type: Gully (3)

List of UNIMIB for watercourses (3/6)

LITOLOGIA			
Litologia prevalente	Litologia subordinata	Vol modale [m^3]	Vol 95th perc [m3]

Modal volume= volume category of the highest frequency

Volume 95° percentile = Corresponds to a volume whose probability that there are larger volumes is less than 5%.

Dominant lithology:
Limestone

Volume 95th percentile

Modal volume

Subordinate lithology:
Conglomerate

List of UNIMIB for watercourses (4/6)

SPONDE		VEGETAZIONE		
Sponda dx (3)	Sponda sx(3)	detrito veg (4)	percent detrito veg (%)	vegetaz viva (5)

Living vegetation

5	4: Trees in the riverbed
	5: Trees in the bank area
	6: Shrubs in the riverbed
	7: Shrubs in the shore area

Right and left bank area

3	1: Talus
	2: In erosion
	3: Bedrock
	4: Channelized

Dominant plant remains

4	0: None
	1: < 0.3 m
	2: <1 m
	3: > 1 m

Predominant plant remains = length along the axis with the most frequent plant remains in the river bed

Predominant debris = Percentage of debris, related to the total deposition.

List of UNIMIB for watercourses (5/6)

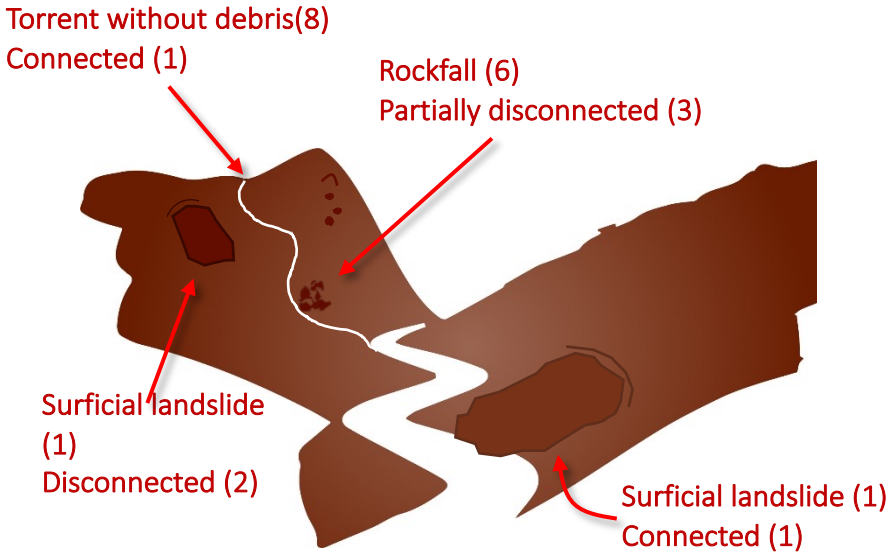
Tipo (6)	Connettività (7)	Volume [m^3]

Connectivity

7	1: Connected
	2: Disconnected
	3: Partially disconnected

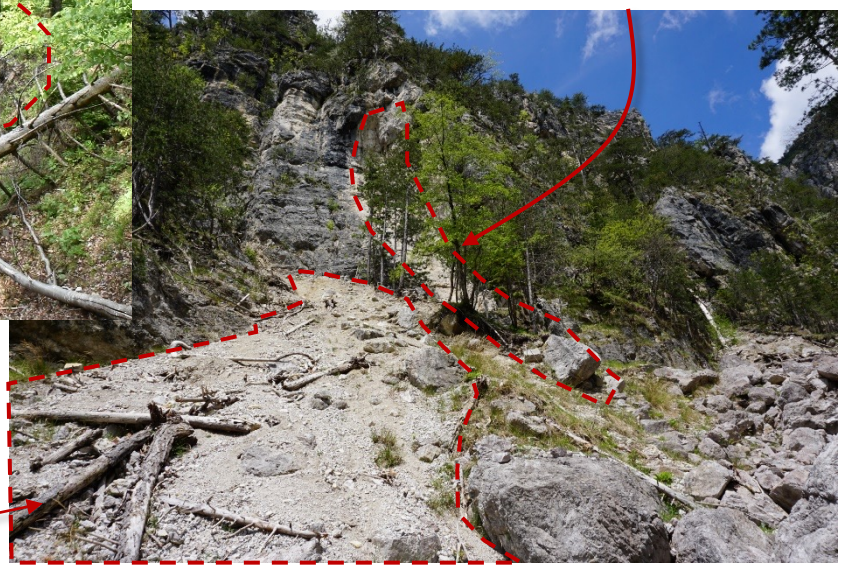
Art

6	1: Surficial landslide
	2: Deep-seated landslide
	3: Accelerated erosion
	4: Flooding
	5: Debris flow
	6: Talus
	7: Torrent with debris
	8: Torrent without debris
	9: Rockfall along the section
	10: Accumulation of debris



Accelerated erosion (3)
Connected to the riverbed

Rockfall along the section (9)
Connected to the riverbed



Accumulation of debris (10)
Connected to the riverbed

List of UNIMIB for watercourses (6/6)

OSTACOLI	OPERA 1		OPERA 5			
presenza ostacoli (8)	Tipo (9)	Stato (10) (s)	Tipo (9)	Stato (10) (s)	ID scheda deposito	NOTE

ID List of the deposit (see: List of UNIMIB deposits)

Obstacles

8
1: Moraine
2: Fan
3: Conoid
4: Fluvial terraces
5: Weirs
6: Sedimentation basin
7: Transitions
8: Vegetation

Type of protective structures

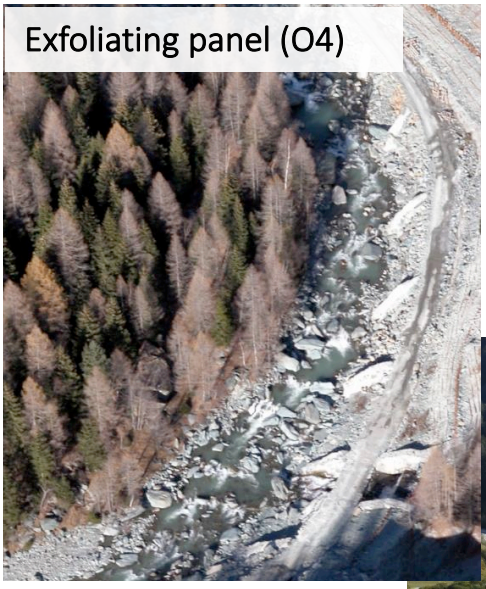
9
O1: Weir
O2: Threshold
O3: Cross beams
O4: Welding off/panel
O5: Dam
O6: Bank stabilisation
O7:Rock outcrop
O8: Basket
O9: Ground paving
O10: Expansion tank
O11: Gully
O12: Bridge

Status of the protection structures

10
O1: Functioning
O2: Functional damage
O3: Structural damage
O4: Non functioning

Ground paving (O9)

Exfoliating panel (O4)



Weirs (O1)
Rock outcrop (O7)
Sedimentation basin(6)

Compensation container (O10)

List of UNIMIB deposits (1/4)

Qualitative and quantitative characterisation of the deposit

1. Abschätzung des Volumens
2. Granulometric characterisation:

- mittels Drohnenbefliegung (rechteckige Gitter);
- from laboratory samples of fine material;
- from the photographic analysis of cross-sectional images
- by point counting along sections in the deposit

Need to integrate the individual sieve curves

3. (Simplified) evaluation of the lithology

ID:	Data:	Bacino:	Opera:	ID tratto:	GPS:

deposito complessivo	
larghezza deposito [m]:	
lunghezza deposito [m]:	
spessore deposito [m]:	

sorvolo drone:	Y	N
campione spaccato:	Y	N
campioni blocchi	Y	N

volume dei blocchi	
volume modale (m3)	
volume 95th perc [m3]	
volume massimo (m3)	

stima qualitative del rapporto deposito grossolano/fine:	
% fine	
% gross.	

stima del materiale vegetale presente			
	< 0.3 m	< 1 m	> 1 m
< 1%			
< 5%			
< 20%			
> 20%			

litologia dei materiali presenti							
litologia	freq%	alterazione					
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5

stima delle percentuali lungo spaccati								
ID spaccato	% fine < 6 cm	% fine sottocarapace	% fine carapace	altezza spaccato	spessore carapace	tipologia deposito	campione (Y/N)	ID foto
1								
2								
3								
4								
5								

caratterizzazione del detrito grossolano (grid by number)

larghezza deposito [m]:		spessore deposito [m]:	
lunghezza deposito [m]:		step di misura dei blocchi [cm]	

descrizione blocchi grid by number

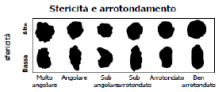
ID	A1 [cm]	A2 [cm]	A3 [cm]	sfericità		arrotondamento						litologia	alterazione (ISRM)						
1				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
2				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
3				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
4				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
5				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
6				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
7				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
8				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
9				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
10				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
11				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
12				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
13				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
14				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
15				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica

larghezza deposito [m]:		spessore deposito [m]:	
lunghezza deposito [m]:		step di misura dei blocchi [cm]	

descrizione blocchi grid by number

ID	A1 [cm]	A2 [cm]	A3 [cm]	sfericità		arrotondamento						litologia	alterazione (ISRM)						
1				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
2				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
3				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
4				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
5				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
6				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
7				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
8				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
9				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
10				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
11				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
12				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
13				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
14				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
15				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica

Stericità e arrotondamento



F (W1)	inalterata
SW (W2)	debolmente alterata /decolorata
MW (W3)	moderatamente alterata <50% decomp.
HW (W4)	fortemente alterata >50% decomp.
CW (W5)	completamente alterata

List of UNIMIB deposits (2/4)

Qualitative estimation of the deposit

deposito complessivo	
larghezza deposito [m]:	
lunghezza deposito [m]:	
spessore deposito [m]:	

Overall dimension of the deposit

volume dei blocchi	
volume modale (m3)	
volume 95th perc [m3]	
volume massimo [m3]	

Volume estimation of the most frequent volumes and the maximum volume of the deposit

stima qualitativa del rapporto deposito grossolano/fine:	
%fine	
%gross.	

Fine material = 2R < 6 cm

Coarse material = 2R > 6 cm

sorvolo drone:	Y	N
campione spaccato:	Y	N
campioni blocchi	Y	N

Collection of information for the qualitative analysis of the deposit

Evaluation of plant detritus in relation to lithological detritus

F (W1)	inalterata
SW (W2)	debolmente aletrata /decolorata
MW (W3)	moderatamente alterata <50% decomp.
HW (W4)	fortemente alterata >50% decomp.
CW (W5)	completamente alterata

Estimation of the lithologies present in the deposit and their relative quantity

(Re)use of sediments with regard to the circular economy

stima del materiale vegetale presente	<0.3 m	<1 m	>1 m
<1%			
<5%			
<20%			
>20%			

litologia dei materiali presenti							
litologia	freq%	alterazione					
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5
		chimica	W1	W2	W3	W4	W5
		fisica	W1	W2	W3	W4	W5

List of UNIMIB deposits (3/4)

stima delle percentuali lungo spaccati								
ID spaccato	%fine <6 cm	%fine sottocarap	%fine carapace	altezza spaccato	spessore carapace	tipologia deposito	campione (Y/N)	ID foto
1								
2								
3								
4								
5								

% fines in the total outcrop

% Fine content soil

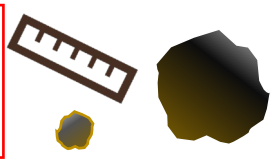
% Fine fraction surface

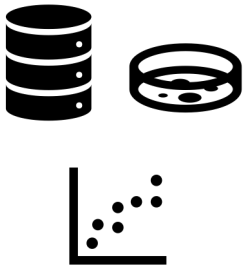
Origin of the deposit (debris flow, rockfall, etc.)

Collection of a split depot sample for laboratory analysis

FEINANTEIL = 2R < 6 cm

GROBANTEIL = 2R > 6 cm





Height outcrop

Surface = surface layer of coarse debris not associated with the deposit.

List of UNIMIB deposits (4/4)

caratterizzazione del detrito grossolano (grid by number)

larghezza deposito [m]:	
lunghezza deposito [m]:	

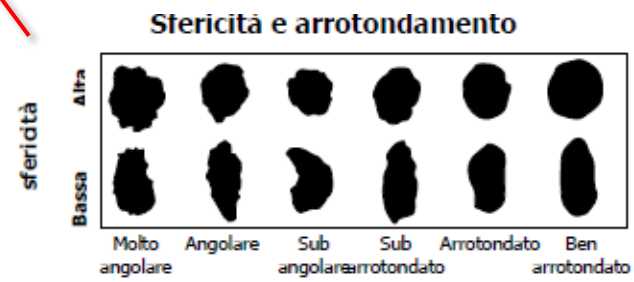
spessore deposito [m]:	
step di misura dei blocchi [cm]	

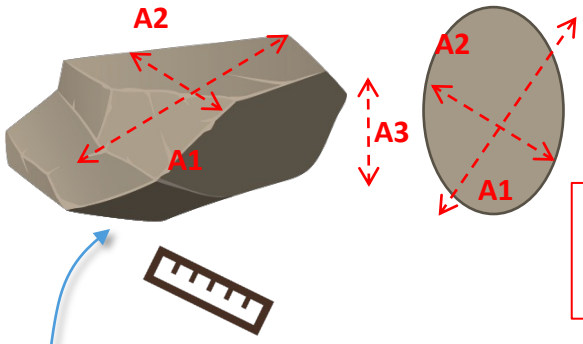
descrizione blocchi grid by number

ID	A1 [cm]	A2 [cm]	A3 [cm]	sfericità		arrotondamento						litologia	alterazione (ISRM)						
1				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
2				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
3				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
4				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica
5				A	B	MA	A	SA	ST	AT	BAT		W1	W2	W3	W4	W5	chimica	fisica

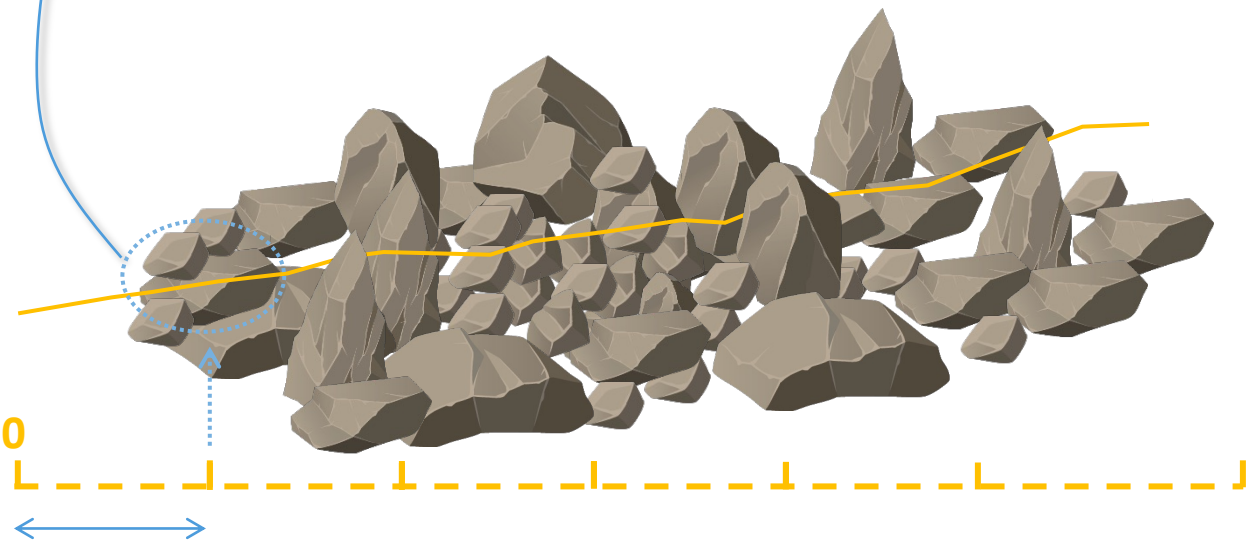
Sphericity of the block: high (A) or low (B), depending on the three axes

F (W1)	unchanged
SW (W2)	Slightly weathered/colour difference
MW (W3)	Moderately weathered <50% decomposed.
HW (W4)	Heavily weathered >50% decomposed.
CW (W5)	Totally weathered





Measuring axes along the diagonals and their perpendiculars



Characterisation of coarse detritus: Laying out a metre and sampling blocks along the transect at constant intervals (e.g. measuring steps every 1 m).

List of UNIMIB escarpments

Measurement of steep walls

If the pool is characterised by the presence of walls that are potential collapse points

Simplified approach to estimate the potential for debris production from the wall and the expected block size.

PARETE										
ID-parete	Orientazione dip/dipdir	punto GPS	altezza [m]	larghezza [m]	litologia	volume unitario (1)			qualità ammasso [GSI]	connettività (2)	copertura vegetale
						L	M	H			
						L	M	H			
						L	M	H			
						L	M	H			
						L	M	H			

Wall height

Alignment of weak points (fractures, joints, stratification, etc.)

1: volume unitari	L: <1 dm^3
	M: <1 m^3
	H: >1 m^3

2: connettività	Connesso
	Disconnesso
	Parzialmente discon

GRANDI VOLUMI INSTABILI					
ID-gvi	Volume (m3)	altezza [m]	larghezza [m]	profondità [m]	connettività (2)
1					
2					
3					
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Estimation of large unstable volumes that could lead to a significant mass contribution of debris in a single event --> Also relevant from the aspect of hazard

Glossary

1.1 In rock = channel bottom in rock
1.2 In debris = channel bottom consisting of deposits of different grain size and shape.
1.3 Tombined = artificial channel in which the water flows in a certain area
1.4 Canal = artificial canal bed and bank
2.T Trapezoidal = duct with trapezoidal cross-section
2.V V = channel that has the shape of a "V" in section
2.R Rectangular = channel that has a rectangular shape in section
3.1 Slope deposit = bank consisting of material resulting from the chemical and physical decomposition of the slope substrate
3.2 Erosion = Banks with signs of erosion
3.3 Rock = Bench in the overhanging or underground rock
3.4 channelled = artificial banks
4.0 No = No plant remains present in the river bed
4.1 <0.3 m = the predominant plant remains in the riverbed have a length of less than 0.3 m
4.2 <1 m = the predominant plant remains in the river bed have a length of less than 1 m
4.3 >1 m = the predominant plant remains in the soil white a length of more than 1 m
5.4 Trees in the riverbed = Trees are present in the riverbed
5.5 Trees on the shore = Trees are present on the shore
5.6 Shrubs in the riverbed = Shrubs are present in the riverbed
5.7 Shrubs on the shore = shrubs are present on the shore
6.1 Shallow landslide = Landslide with a width to length ratio of 0.5/1 and a thickness of 0/2 m
6.2 Deep landslide = landslide more than 2 m thick
6.3 Accelerated erosion
6.4 Flooding = general raising of the river bed through sediment deposition
6.5 Debris flow = mass movement of a mixture of solid material and water and behaviour between river and landslide
6.6 Rockfall deposit = deposit formed by repeated rock collapses
6.7 Torrent with bedload = Torrent characterised by the presence of bedload in the riverbed.
6.8 Bedload-free stream = stream characterised by the absence of bedload in the riverbed.
6.9 Collapses along the track = downward movement of blocks by free fall, impact, bounce, roll or slide with little interaction between blocks
6.10 Debris accumulation = deposit whose origin is difficult to determine
7.1 Connected = lateral sediment supply directly connected to the main channel
7.2 Disconnected = lateral sediment supply not connected to the main sewer
7.3 Partially disconnected = lateral sediment supply partially connected to the main bar
8.1 Moraine = glacial deposit
8.2 Fan = generated trough flooding
8.3 Cone = Debris cone
8.4 Fluvial terraces = alluvial deposits due to alternating deposition and fluvial erosion
8.5 Retaining fence = a strong wall, usually located on the riverbed, raised on the sides to direct the flow towards the centre
8.6 Sedimentation basin = basin built on the riverbed to control floods
8.7 Crossing = River crossing
8.8 Vegetation = Obstacle due to the presence of living and/or dead vegetation
9.O1 Bridle = a strong wall, usually standing on the riverbed and raised on the sides to direct the flow towards the middle
9.O2 Sill = structures at the bottom of the riverbed designed to reduce erosion

9.O3 Weir = a special damming measure on a watercourse. They are built to impound the course of a river; they have a similar function to dams, but unlike dams they cause a moderate rise (backwater) of the free surface, so that the water upstream of the dam itself does not leave the natural river bed

9.O4 Repellent/panel = structure arranged transversely to the bank with the function of diverting the flow away from the eroding bank

9.O5 Slope = longitudinal encroachment whose crest height is greater than the height of the terrain to be protected.

9.O6 Concrete bank reinforcement = concrete bank

9.O7 Boulder cliff = shore consisting of a structure of large boulders

9.O8 Cages = bank stabilisation consisting of a structure of cages made of wire mesh and filled with stones

9.O9 Floor pavement = floor paved with stones

9.O10 Expansion tank = storage basin parallel to the watercourse for flooding in times of floods

9.O11 Gully = Term used in hydraulic engineering, especially in the past, for the drainage of water from water-saturated soil layers through drainage with shafts and other canal systems.

9.O12 Bridge = An artefact of wood, iron, masonry or reinforced concrete used to ensure the continuity of a road or railway when crossing a watercourse.